MOTION PICTURE PROJECTION

Second Edition

By JAMES R. CAMERON

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MOTION PICTURE PROJECTION

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An Elementary Text-Book

BY JAMES R. CAMERON

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GLOSSARY OF ELECTRICAL AND MECHANICAL TERMS

ACETATE. A salt formed by the action of acetic acid upon a base.

ACTUAL HORSE POWER. The exact useful power given out by an engine: found by subtracting the power used by the machine itself from the indicated horse power.

ACHROMATIC LENSES. The color effect caused by the chromatic aberration of a simple lens greatly impairs its usefulness. This may be overcome by combining into one lens a concave lens of flint glass and a convex lens of crown glass.

ALIGN. To place or form in line.

ALLOY. A mixture of two or more metals.

ALTERNATING CURRENT. A current that changes its flow of direction so many times a second according to the construction of the alternator. Written A. C.

AMMETER. An instrument used to measure the flow of amperes.

AMPERE. The unit of current strength.

AMPERE HOUR. The quantity of electricity passed by a current of one ampere in one hour.
One ampere flowing for one hour.
Two amperes flowing for one-half hour.
One-half ampere flowing for two hours: all equal one ampere hour.

ANCHOR BOLTS. Bolts used for fastening machines to their foundation.

ANTI-FRICTION METAL. A tin-lead alloy like Babbitt metal.

APERTURE. An opening of any description in a partition.

ARC. The arc between two carbon electrodes slightly separated.

ARC RECTIFIER. An apparatus used to change A. C. to D. C.

ARMATURE. A collection of pieces of iron designed to be acted on by a magnet.

ASBESTOS. A fibrous variety of ferro-magnesium silicate; is a non-conductor of heat and fireproof.

ASBESTOS COVERED WIRE. A cable containing very fine strands of copper wire all twisted together and covered with an asbestos covering. Used wherever heat is generated.

On motion picture circuits used between the table switch and arc lamp.

AUTOMATIC. Self acting.

AUTOMATIC SHUTTER. The shutter covering the film aperture in gate of machine and controlled by the centrifugal or governor movement, is so arranged that the shutter will remain up so long as the machine is in motion, but should the machine stop for any reason then the shutter falls and cuts off the rays of light from the film in gate. (A fire prevention device.)

AUTO TRANSFORMER. A transformer provided with only one coil instead of two. Part of the coil being traversed by the primary circuit and part being traversed by the secondary circuit.

B. & S. W. G. Abbreviation for Brown & Sharpe. Wire Gauge.

B. W. G. Abbreviation for Birmingham Wire Gauge.

B. X. Metal tubing containing two conductors, each conductor insulated from the other by a rubber covering, and both wires wrapped with a composition covering so as to completely fill the tubing.

BABBITT METAL. An anti-friction metal.

BACK FOCUS. Properly called working distance.

BACK FOCAL LENGTH OF LENS. The distance from the back of the lens to the film in the gate, while the film image is in focus on the screen.

BALANCE WHEEL. A fly wheel. A wheel added to machinery for the purpose of preventing too sudden variations in speed.

BALL & SOCKET JOINT. A joint in which a spherical object is placed within a socket made to fit it.

BALL BEARING. A bearing whose journal works upon a number of metal balls. Used to reduce friction to a minimum.

BED PIECE. The frame carrying the dynamo or motor.

BORE. The interior diameter of a cylinder.

BRUSH. A rod of carbon held in a holder and pressed against the commutator.

BUSINESS. Action by the player; e. g., business of shutting door.

BUST. A small, magnified part of a large scene.

CABLE. An insulated electric conductor.

CAM FRICTION. The friction existing between the cam and the member connected to it.

CAMERA. An expression used to command the photographer to begin taking the scene.

CANADA BALSAM. A gum obtained from the Balsam Fir of Canada. Used for cementing lenses.

CARBON. One of the elements, exists in three forms, charcoal, graphite and diamond. It is used as electric conductor for arc lamps and incandescent lamp filaments. The carbons used for arc lamps generally have a central core of soft carbon.

CARRYING CAPACITY. The capacity of an electrical conductor to carry current without overheating.

CENTIMETER. Unit of length, 0.3937 inch.

CENTRIFUGAL FORCE. The force which draws a body constrained to move in a circular path, away from the center of rotation.

CHANGE OVER. The stopping of one projecting machine and the simultaneous starting of a second machine in order to maintain an uninterrupted picture on the screen when showing a multiple-reel story.

CHECK NUT, generally called lock-nut. A nut placed over another nut on same bolt to lock the main nut in place.

CHROMATIC. Relating to color.

CHROMATIC ABERRATION. When white light is passed through a spherical lens, both refraction and dispersion (the decomposition of white light into several kinds of light) occur. This causes a separation of the white light into the various colors and causes images to have colored edges. This effect which is most observable in condenser lenses is due to the unequal refrangibility of the simple colors.

CINE. A prefix used in description of the motion-picture art or apparatus.

CIRCUIT. The path through which the electric current flows.

CIRCUIT BREAKER. Any apparatus for opening or closing a circuit.

CIRCUIT-CLOSED. A circuit closed so as to give the current a continuous path.

CIRCUIT, OPEN. A circuit with its continuity broken, as by the opening of a switch.

CLOSE-UP. Scene or action taken with the character close to the camera.

COLLODION. A solution of pyroxylin (soluble gun cotton) in ether. Used in film cement.

COMMUTATOR. That part of a dynamo that changes the direction of the currents.

COOLING PLATE. The plate around the film aperture on gate which protects the gate itself from getting overheated from the rays of light from arc lamp.

CONDUCTOR. Anything that will permit the passage of electricity. A wire.

CONDENSERS. A lens or set of lenses used to gather the rays of light from the arc lamp and bring them to a fixed point of focus on aperture in gate.

The lens combination which deflects the diverging rays of the luminant into the objective.

Collector Lens. The lens next to the source of light.

Converging Lens. The lens nearest the objective.

Middle Lens. Of a three-lens combination, the lens lying between the collector lens and the converging lens.

CONDUIT. A metal pipe through which electrical conductors are run.

CONTACT, ELECTRIC. A contact between two conductors giving a continuous path for the current.

CONSTANT LOAD. A load whose pressure is steady and invariable.

CONTINUOUS. Uninterrupted without break, or interruption.

CONVERTER. An electric machine or apparatus for changing the potential difference of an electrical circuit.

CORROSION. Chemical action which causes destruction of a metal, usually by oxidation or rusting.

CORRUGATED. Formed with a surface consisting of alternate valleys and ridges.

COULOMB. The practical unit of quantity of electricity. It is the quantity passed by a current of one ampere intensity in one second.

CRATER. The depression that forms in the positive carbon of a voltaic arc.

CURRENT FREQUENCY. The number of times alternating current changes its flow of direction a second. The changes are called cycles.

CUT-BACK. Scenes which are returns to previous action.

CUT-IN. Anything inserted in a scene which breaks its continuity.

CUTTING. Editing a picture by elimination of useless or unacceptable film.

DEVELOPING. Making visible the latent image in an exposed film.

DIRECT CURRENT. A current that flows in the one direction. Written D. C.

DIMMER. An adjustable choking coil used to regulate the intensity of electric incandescent lamps.

DIRECTOR. The person who directs the actual production of the photoplay.

DISSOLVE. The gradual transition of one scene into another.

DOUBLE EXPOSURE. The exposure of a negative film in a camera twice before development.

DOUBLE PRINTING. The exposure of a sensitive film under two negatives prior to development.

DOUSER. The manually operated door in the projecting machine which intercepts the light before it reaches the film.

DUPE. A negative made from a positive.

DUPLEX. Double; working in two ways at once.

DYNAMOS. A machine driven by power used to convert mechanical energy into electrical energy.

E. M. F. Abbreviation for electric-motive force.

ECONOMIZER. A step-down transformer.

EFFECTIVE APERTURE. The largest diameter of a lens available under the conditions considered.

ELECTRICITY. An unknown power; a powerful physical agent which manifests itself mainly by attraction and repulsions, also by luminous and heating effects, by violent commotions, by chemical decompositions and many other phenomena.

ELECTRODE. The terminal of an open electric circuit.

EQUIVALENT FOCUS. The distance from a point half way between the back and front combination of lenses to the film in the gate while picture is in focus on screen.

Can be obtained by measuring the distance between the front and back combination then dividing by two and adding the result to the back focal length. (Written E. F.)

The equivalent focus of a plurality of lenses in combination is the focal length of a simple thin lens which will under all conditions form an image having the same magnification as will the given lens combination.

EXHAUST FAN. An air propeller used to create a vacuum.

EXTERIOR. A scene supposed to be taken out of doors.

FADE-IN. The gradual appearance of the picture from darkness to full screen brilliancy.

FADE-OUT. The gradual disappearance of the screen-picture into blackness. (The reverse of fade-in.)

FEATURE. A pictured story, a plurality of reels in length.

FIRE TRAP. An arrangement of rollers on the upper and lower magazines through which the film is fed, used to prevent the flame, in case of fire, from entering the magazines.

FIXING. Making permanent the developed image in a film.

FLAT. A bit of painted canvas, or the like.

FLASH. A short scene, usually not more than three to five feet of film.

FLASH-BACK. A very short cut-back.

FOCAL. Pertaining or belonging to a focus.

FOCUS. The point of concentration. When rays reflected from all points meet or concur.

FOOTAGE. Film length measured in feet.

FLICKER SHUTTER. A revolving shutter on head of machine just in front of the projection lens, its use being to cut off the rays of light from screen while the film is in motion in gate.

FRAME (verb). To bring a frame into register with the aperture during the period of rest.

FRAME (noun). A single picture of the series on a motion-picture film.

FRAME LINE. The dividing line between two frames.

FRAMING DEVICE. An attachment on the machine which allows the operator to frame the picture on screen.

FUSE. A short length of wire of a given fusable point introduced into the electrical circuit.

FUSING POINT. The temperature at which metals melt and become liquid.

GENERATOR. An apparatus for maintaining an electrical current.

GOVERNOR MOVEMENT. The movement that works the automatic shutter, works by centrifugal force.

GRAPHITE. A soft form of carbon, used as a lubricant.

GROUND. The contact of an electrical conductor with the earth, or with some other conductor not in the circuit.

HORSE POWER. A unit of rate of work. Equal to the raising of 33,000 pounds, one foot in one minute; equal to 746 watts.

INDUCTION. The property of a charged body on A. C. to charge a neighboring body running parallel to it without any tangible form of connection.

INDUCTOR. A step-down transformer.

IMPEDANCE. Is to an A. C. circuit what resistance is to a D. C. circuit.

INSULATING TAPE. A prepared tape to cover the ends of bared wire.

INTERMITTENT MOVEMENT. The movement that drives the intermittent sprocket, generally a four-to-one movement.

INTERMITTENT SPROCKET. The sprocket which engages the film to give it intermittent movement at the picture aperture.

INSERT. Any photographic matter, without action, in the film.

INTERIOR. Any scene supposed to be taken inside a building.

IRIS. An adjustable lens diaphragm.

IRISING. Gradually narrowing the field of vision by a mechanical device on the camera.

JOINING. Splicing into a continuous strip (usually 1,000 feet) the separate scenes, titles, etc., of a picture.

KILOWATT. Equal to 1,000 watts.

LAMINATED. Made up of a number of thin sheets.

LANTERN PICTURE. A still picture projected on a screen by means of an optical lantern or stereopticon.

LANTERN SLIDE (see slide). The transparent picture from which a lantern picture is projected.

LEADERS. That piece of blank film attached to the beginning of the picture series.

LENS. A lens may be defined as a piece of glass or other transparent substance with one or both sides curved. Both sides may be curved, or one curved and other flat.

The object of the lens is to change the direction of rays of light and thus magnify objects or otherwise modify vision.

Lenses may be classed as:

Double convex	Double concave
Plano convex	Plano concave
Concavo convex	Convexo concave

The focus of a lens is the point where the refracted rays meet.

LIGHT BEAM. A bundle of light rays.

LIGHT RAY. A thin line of light.

LOCATION. Any place selected for the action of an outdoor scene.

LOST MOTION. Motion in a part of machine that produces no useful results.

LUBRICANT. An oil used to diminish friction in the working parts of machinery.

LUG. A wire terminal.

MAGAZINE VALVE. The film opening in the magazine of a motion-picture projector.

MAN POWER. Equal to one-tenth of a horse power.

MASKS. Opaque plates of various sizes and shapes used in the camera to protect parts of the negative from exposure.

MICA. A mineral more or less transparent and used for insulating.

MIL. Unit of length.

MIL, CIRCULAR. Unit of area.

MOTION-PICTURE. The synthesis of a series of related picture elements, usually of an object in motion.

MOTION-PICTURE FILM. The ribbon upon which the series of related picture elements is recorded.

MOTION-PICTURE PROJECTOR. An optical lantern equipped with mechanisms for suitably moving motion-picture film across the projected light.

MOTOR GENERATOR. A motor connected to a generator.

MOTOR REGULATOR. An adjustable rheostat used to regulate the speed of the motor.

MOVIES. Motion pictures.

MULTIPLE. Multiple connection is when each lamp draws its supply direct from the main and is not depending on any other lamp or set of lamps for supply.

MULTIPLE-REEL. A photoplay of more than a thousand feet of film in length.

NEGATIVE. The opposite to positive; the pole to which the current is supposed to flow.

NEGATIVE. The developed film, after being exposed in a camera.

NEGATIVE STOCK. Light sensitive film intended for motion-picture camera use.

NON CONDUCTOR. Any material that does not conduct electricity.

OBJECTIVE. The picture-forming member (lens) of the optical system. The objective lens of a moving picture machine generally consists of four lenses, two in the front combination and two in the rear. The two lenses in the front are cemented together with Canada Balsam and called the compound lens. The back combination consists of two lenses separated by a metal ring, called the duplex lens.

The convex or greatest convex side of a lens always faces the screen.

OHM. The unit of electrical resistance.

OSCILLATION. A moving backward and forward; swinging like a pendulum.

OPTIENCE. A collection of persons assembled to see motion pictures.

PAM. Contraction for panorama.

PANORAM. The act of, or device for, turning a motion-picture camera horizontally, to photograph a moving object, or to embrace a wide angle of view.

PHOTOPLAY. A story in motion pictures.

POLARITY. Pertaining to the two opposite poles of a circuit; the positive and negative.

POLYPHASE. More than one phase, multiphase.

POSITIVE. The developed film, after being printed through a negative.
POSITIVE STOCK. The light-sensitive film intended to be printed upon through a negative.
PRE-RELEASE. A picture not yet released for public showing.
PRESSURE, ELECTRIC. Electric motive force, voltage.
PRIMARY COIL. The coil of a transformer, connected to the source of electrical supply.
PRIMARY COLORS. Red, yellow, blue.
PRIMARY POWERS. Water power, wind power, tide power, power of combustion, power of vital action.
PRINT. Same as "positive."
PRODUCER. The maker of photoplays.
PROGRAM. The complete show for a single optience.
PROJECTION DISTANCE. The distance between the screen and the objective of a stereopticon lantern or motion-picture projecting machine.
PROJECTING LENS. Properly called projection objective.
PROJECTION OBJECTIVE. The objective which forms an image of the lantern slide or film, upon the screen.
PROPS. Contraction of properties. Objects used as accessories in a play.
RACING OF MOTORS. The rapid acceleration of speed of a motor when the load upon it is removed.
REEL. An arbitrary unit of linear measure for film—approximately a thousand feet.
REEL. The metal spool upon which the film is wound.
REFLECTION. The change of direction experienced by a ray of light when it strikes a surface and is thrown back or reflected. Light is reflected according to two laws.

(a) The angle of reflection is equal to the angle of incidence.

(b) The incident and the reflected rays are both in the same plane which is perpendicular to the reflecting surface.

REFRACTION. The change of direction which a ray of light undergoes upon entering obliquely a medium of different density from that through which it has been passing. In this case the following laws obtain:

(a) Light is refracted whenever it passes obliquely from one medium to another of different optical density.

(b) The index of refraction for a given substance is a constant quantity whatever be the angle of incidence.

(c) The refracted ray lies in the plane of the incident ray and the normal.

(d) Light rays are bent toward the normal when they enter a more refracted medium and from the normal when they enter a less refracted medium.

REGISTER. A term denoting facial expression of emotions.

RELEASE. The publication of a photoplay.

RETAKE. Rephotographing a scene.

REWIND. The process of reversing the winding of a film, usually so that the end to be first projected shall lie on the outside of the roll.

REWINDER. The mechanism by which rewinding is accomplished.

RESISTANCE BOX. A box filled with resistance coils connected in series.

RHEOSTAT. An instrument used to offer resistance to the flow of current. Made of a number of metal coils connected in series and mounted on a frame.

RUBBER COVERED WIRE. A cable either solid or stranded with a rubber covering and an outer protective covering of cotton braid. Used for mains for motion picture work.

SCENE. The action taken at a single camera setting.

SCENARIO. A general description of the action of a proposed photoplay.

SCREEN. The surface upon which a picture is optically projected.

SECONDARY COIL. The coil of a transformer in which the current is induced, connected to the lamp.

SERIES. An electrical connection where lamps are connected so that they depend on each other for supply, the current passing through each lamp successively.

SHOOTING A SCENE. Photographing the scene.

SHORT CIRCUIT. Two wires of opposite polarity coming in contact with each other without any controlling device.

SHUTTER. The obscuring device, usually a revolving segmental disc, employed to intercept the light during the movement of the film in motion-picture apparatus.

Shutter—Working Blade (also variously known as the cutting blade, obscuring blade, main blade, master blade or travel blade). That segment which intercepts the light during the movement of the film at the picture aperture.

Shutter—Intercepting Blade (also known as the flicker blade). That segment which intercepts the light one or more times during the rest or projection period of the film to eliminate flicker.

SIXTY CYCLE A. C. This is when every part of the circuit is 60 times positive and 60 times negative every second. The current changes its flow of direction 60 times a second.

SINGLE PHASE. Using only two wires and one E. M. F. sometimes called monophase or uniphase.

SINGLE PICTURE CRANK (sometimes referred to as trick spindle). That spindle and crank on a motion-picture camera which makes one exposure at each complete revolution.

SLIDE (Stereo Slide). The transparent picture from which a screen still is projected.

SLIDING FRICTION. The friction existing between two bodies in sliding contact with each other.

SPEED REGULATOR. An attachment on machine (generally a friction disc arrangement) used to regulate the speed of machine (not the speed of motor).

SPHERICAL ABERRATION. The reflected rays of concave spherical mirrors do not meet exactly at the same point. This is called spherical aberration.

SPLICING. Joining the ends of film by cementing.

SPLIT REEL. A reel having two or more picture subjects thereon.

SPOT. The illuminated area on the aperture plate of a motion-picture projector.

SPROCKET. The revolvable toothed member which engages the perforations in the film.

STAGE CABLE. A cable containing twin conductors each insulated from the other and the whole thing covered with a composition covering. Used for temporary purposes.

STEP-DOWN TRANSFORMER. A transformer that steps down the voltage and raises the amperage.

STEP-UP TRANSFORMER. A transformer that steps up the voltage and lowers the amperage.

STEREOPTICON. A lantern for projecting transparent pictures, i. e., lantern slides, often a double lantern for dissolving.

STILL. A picture from a single negative.

STRIKING THE ARC. The act of bringing the carbons of an arc lamp together, and immediately separating them, thus establishing the arc.

SWITCH BOARD. A board to which wires are led connecting with cross bars or switches.

SWITCH, DOUBLE POLE. A heavy switch which connects and disconnects two leads simultaneously.

SWITCH, KNIFE. A switch with knife-like blades used on circuits carrying high amperage.

SWITCH, SNAP. A small switch made to give a sharp break used on home lighting circuits.

SWITCH, THREE WAY. A switch so constructed that by turning its handle, connection can be made from one lead to either of two other leads, and also so that connection can be completely cut off.

TAKE-UP (noun). The mechanism which receives and winds the film after it passes the picture aperature. Generally consists of a split pulley and tension spring, its use is to drive and control the speed and tension of the reel taking up the film in lower magazine.

TAKE-UP (verb). Winding up the film after it passes the picture aperture.

TENSION SPRINGS. On gate of machine, used to give the proper tension to film while passing aperture.

THREE WIRE SYSTEM. A system of distribution of electric current where three wires instead of two sets of two wires are used. The middle or neutral wire acts as positive wire for the negative, and as negative wire for the positive. The advantage of the system is the saving of copper.

THREE PHASE. A system of electrical distribution making use of three separate currents. These currents may be superimposed and generally only three wires are used in this transmission.

THROW. Projection distance. Distance from front combination of lens to screen.

TILT. The act of, or device for, moving a camera vertically while in use.

TINTING. Coloring a film by dyeing the gelatine side of it.

TONING. Coloring a film by chemical action on the silver image.

TRAILER. That piece of blank film attached to the end of a picture series.

TRANSFORMER. An apparatus used on alternating current systems to raise or lower the voltage.

TRANSVERTER. A motor generator set, an A. C. motor connected to a D. C. generator.

TRICK CRANK. A camera crank giving a single exposure for each turn.

TRICK-PICTURE. A picture in which unnatural action appears.

TWO PHASE. An A. C. system of electrical distribution making use of two currents of different phase. Can be arranged with either 3 or 4 wires.

VISION. A new subject introduced into the main picture, by the gradual fading-in and fading-out of the new subject, as, for example, to visualize a thought.

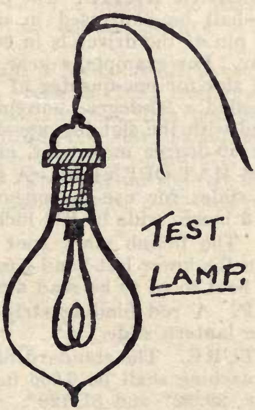
VOLTAGE. Electric motive force or pressure.

VOLTMETER. An instrument used to measure the electric pressure.

WATT. The practical unit of electrical power. Equal to amperes times volts.

WATT HOUR. Amount of watts times length of hours.

WORKING DISTANCE. The distance from the principal focus of a lens to its nearest face; e. g., the distance from the slide or film to the nearest lens of the objective.



MOTION PICTURE STANDARDS

The following have been adopted as standards by the Society of Motion-Picture Engineers, and are promulgated to encourage uniformity and standard practice throughout the Industry as a whole. Their early universal adoption will save the industry a great deal of present annoyance and monetary loss.

FILM SPEED. A film movement of sixty feet per minute through motion-picture mechanisms shall be considered as standard speed.

FRAME LINE. The dividing line between pictures on motion-picture film shall lie exactly midway between the marginal perforations.

INTERMITTENT GEAR RATIO. The movement of the intermittent gear shall be expressed in degrees of rotation during which the pin of the driver is in contact with the slot of the driven gear. For example, a gear in which the pin is engaged with the slot for one-quarter of a revolution of the driver shall be called a 90-degree movement; that in which the pin is engaged with the slot for one-sixth of a revolution shall be called a 60-degree movement, etc.

LANTERN SLIDE MAT OPENING. A standard opening in mats of lantern slides for use in conjunction with motion pictures shall be 3 inches wide by 2¼ inches high.

THUMB MARK. The thumb mark spot on a lantern slide shall be located in the lower left-hand corner next the reader when the slide is held so as to be read against a light.

LANTERN STRIP. A red binding strip to be used on the lower edge of the lantern slide.

PICTURE APERTURE. The standard film picture aperture in a projecting machine shall be 0.906 inch wide and 0.6795 inch high, namely, 29/32″ and 87/128″.

PROJECTION ANGLE. The maximum permissible angle in picture projection shall not exceed twelve degrees (12°) from a perpendicular to the screen surface.

PROJECTION LENS FOCI. The focus of motion-picture projection lenses shall increase in ¼″ steps to 8 inches and from 8 to 9 in ½-inch steps.

PROJECTION LENS MOUNTING. Picture projecting lenses shall be so mounted that the light from the film picture aperture shall have an uninterrupted full path to the rear component of the lens.

PROJECTING LENS HEIGHT. The standard height from the floor to the center of the projecting lens of a motion-picture machine shall be 48 inches.

PROJECTION LENS OPENING. The diameter of unit opening for projecting lens holder shall be 1 15/16 inch.

PROJECTION OBJECTIVES. Shall have the equivalent focal length marked thereon in inches and quarters and halves of an inch, in decimals, with a plus (+) or minus (—) tolerance not to exceed 1 per cent. of the designated equivalent focal length also marked by the proper sign following the figure.

REEL. The approved standard reel shall be 10 inches in diameter; 1½ inches inside width; with 5/16-inch center hole, with a key-way ⅛″ by ⅛″ extending all the way through; a 2-inch hub; and a permissible flange wabble of not more than 1/16-inch.

STANDARD PICTURE FILM. Shall be one and one-third inches wide, and carry a picture for each four perforations. the vertical position of the picture being longitudinal of the film.

STANDARD REEL FILM. Shall have black film leaders, with tinted (red, green or blue) trailers; should have marking thereon embossed rather than punched in the film; and each reel of a multiple-reel story should end with a title, and the next reel begin with the same title.

TAKE-UP PULL. The take-up pull on film shall not exceed 15 ounces at the periphery of a 10-inch reel or 16 ounces on a (11-inch) reel.

ELECTRICITY

No one knows exactly what electricity is, we do not even know what it consists of, we do know that electricity and magnetism are one and the same. Electricity is not matter nor yet is it energy, although it is a means of transmitting energy, and we know how to handle this force for this purpose.

It is an undeniable fact that energy cannot be created nor can it be destroyed, but we can convert one kind of energy into energy of another kind. For example, should we light a fire under a vessel containing water we will convert the heat energy from the coals to steam energy in the vessel containing the water, and we could again change this steam energy into mechanical energy, as is done with the locomotive.

It is also possible to convert mechanical energy into electrical energy, so by connecting the mechanical energy created by the steam to a dynamo we would produce electrical energy.

It is also possible to convert electrical energy into mechanical energy. A motor is used for this purpose.

The word dynamo is used to designate a machine which produces direct current as distinguished from the alternator or generator which produces alternating current. A dynamo does not create electricity but produces an induced electric-motive force which causes a current of electricity to flow through a circuit of conductors in much the same manner as a pump causes water to flow through a pipe. The point to be settled in the minds of those taking up electricity is that the dynamo merely sets into motion something already existing, by generating sufficient pressure to overcome the resistance to its movement.

Although we speak of alternating and direct current, it should be clearly understood that it is impossible to get a continuous current with a dynamo. The current is really a pulsating one, but the pulsations are so small and follow each other so quickly that the current is practically continuous.

Electromotive Force. When a difference of electrical potential exists between two points, there is said to exist an *electromotive force,* or tendency to cause a current to flow from one point to the other. This electromotive force is analogous to the *pressure,* caused by a difference in level of two bodies of water connected by a pipe. The pressure tends to force the water through the pipe, and the electromotive force tends to cause an electric current to flow.

Electromotive force is commonly designated by the letters *E. M. F.* or simply *E.* It is also referred to as *pressure* or *voltage.*

Current. A current of electricity flows when two points, at a difference of potential, are connected by a wire, or when the circuit is otherwise completed. Similarly, water flows from a high level to a lower one, when a path is provided. In either case the flow can take place only when the path exists. Hence to produce a current it is necessary to have an electromotive force and a closed circuit. The current continues to flow only as long as the electromotive force and closed circuit exists.

The strength of a current in a conductor is defined as the quantity of electricity which passes any point in the circuit in a unit of time. Current is designated by the letter *C* or *I*.

Resistance. Resistance is that property of matter, in virtue of which bodies oppose or resist the free flow of electricity. Water passes with difficulty through a small pipe of great length or through a pipe filled with stones or sand, but very readily through a large, clear pipe of short length. Likewise, a small wire of considerable length and made of poor conducting material offers great resistance to the passage of electricity, but a good conductor of short length and large cross-section offers very little resistance.

Resistance is designated by the letter ***R***.

Volt, Ampere and Ohm. The *volt* is the practical unit of electromotive force.

The *ampere* is the practical unit of current.

The *ohm* is the practical unit of electrical resistance. The *microhm* is one millionth of an ohm, and the *megohm* is one million ohms.

The International ohm, as nearly as known, is the resistance of a uniform column of mercury 106.3 centimeters in length by one square milimeter in cross-section at a temperature of zero centigrade.

The ampere is the strength of current which, when pased through a solution of silver nitrate, under suitable conditions, deposits silver at the rate of .001118 gram per second.

The volt is equal to the E. M. F. which, when applied to a conductor having a resistance of one ohm, will produce in it a current of one ampere.

All substances resist the passage of electricity, but the resistance offered by some is very much greater than that offered by others. Metals have by far the least resistance, and of these, silver possesses the least of any. In other words, silver is the best conductor. If the temperature remains the same, the resistance of a conductor is not affected by the current passing through it. A current of ten, twenty or any number of amperes may pass through a circuit, but its resistance will be unchanged with constant temperature. Resistance is affected by the temperature and also by the degree of hardness. Annealing decreases the resistance of a metal.

Conductance is the inverse of resistance; that is, if a conductor has a resistance of R ohms, its conductance is equal to $\frac{1}{R}$.

Resistance Proportional to Length. The resistance of a conductor is directly proportional to its length. Hence, if the length of a conductor is doubled, the resistance is doubled, or if the length is divided, say into three equal parts, then the resistance of each part is one-third the total resistance.

Resistance Inversely Proportional to Cross-Section. The resistance of a conductor is inversely proportional to its cross-sectional area. Hence the greater the cross-section of a wire the less is its resistance. Therefore, if two wires have the same length, but one has a cross-section three times that of the other, the resistance of the former is one-third that of the latter.

As the area of a circle is proportional to the square of its diameter, it follows that the resistances of round conductors are inversely proportional to the squares of their diameters.

Specific Resistance. The specific resistance of a substance is the resistance of a portion of that substance of unit length and unit cross-section at a standard temperature. The units commonly used are the centimeter or the inch, and the temperature that of melting ice. The specific resistance may therefore be said to be the resistance (usually stated in microhms) of a centimeter cube or of an inch cube at the temperature of melting ice. If the specific resistances of two substances are known, then their related resistance is given by the ratio of the specific resistance.

Calculation of Resistance. It is evident that resistance varies directly as the length, inversely as the cross-sectional area, and depends upon the specific resistance of the material.

If a circuit is made up of several different materials joined in series with each other, the resistance of the circuit is equal to the sum of the resistances of its several parts. In calculating the resistance of such a circuit, the resistance of each part should first be calculated, and the sum of these resistances will be the total resistance of the circuit.

Resistance Affected by Heating. The resistance of metals depends upon the temperature, and the resistance is increased by heating. The heating of some substances, among which is carbon, causes a decrease in their resistance. The resistance of the filament of an incandescent lamp when lighted is only about half as great as when cold. All *metals*, however, have their resistance increased by a rise in temperature. The percentage increase in resistance with rise of temperature varies with the different metals, and varies slightly for the same metal at different temperatures. The increase is practically uniform for most metals throughout a considerable range of temperature. The resistance of copper increases about .4 per cent. per degree Centigrade. The percentage increase in resistance for alloys is much less than for the simple metals. Standard resistance coils are therefore made of alloys, as it is desirable that their resistance should be as nearly constant as possible.

QUANTITY, ENERGY AND POWER.

Quantity. The strength of a current is determined by the amount of electricity which passes any cross-section of the conductor in a second; that is, current strength expresses the *rate* at which electricity is conducted. The *quantity* of electricity conveyed evidently depends upon the current strength and the time the current continues.

The Coulomb. The coulomb is the unit of quantity and is equal to the amount of electricity which passes any cross-section of the conductor in one second when the current strength is one ampere. If a current of one ampere flows for two seconds, the quantity of electricity delivered is two coulombs, and if two amperes flow for one second the quantity is also two coulombs. With a current of four amperes flowing for three seconds, the quantity delivered is 12 coulombs. The quantity of electricity in coulombs is therefore equal to the current strength in amperes multiplied by the time in seconds.

Energy. Whenever a current flows, a certain amount of energy is expended, and this may be transformed into heat, or mechanical work, or may produce chemical changes. The unit of mechanical energy is the amount of work performed in raising a mass of one pound through a distance of one foot, and is called the foot-pound. The work done in raising any mass through any height is found by multiplying the number of pounds in that mass by the number of feet through which it is lifted. Electrical work may be determined in a corresponding manner by the amount of electricity transferred through a difference of potential.

The Joule. The joule is the unit of electrical energy, and is the work performed in transferring one coulomb through a difference of potential of one volt. That is, the unit of electrical energy is equal to the work performed in transferring a unit quantity of electricity through a unit difference of potential. It is evident that if 2 coulombs pass in a circuit and the difference of potential is one volt, the energy expended is 2 joules. Likewise, if 1 coulomb passes and the potential difference is 2 volts, then the energy expended is also 2 joules. Therefore, to find the number of joules expended in a circuit, multiply the quantity of electricity by the potential difference through which it is transferred.

Power. Power is the *rate* of doing work, and expresses the amount of work done in a certain time. The horse-power is the unit of mechanical energy, and is equal to 33,000 foot-pounds per minute, or 550 foot-pounds per second. A certain amount of work may be done in one hour or two hours, and in stating the work done to be so many foot-pounds or so many joules, the rate at which the work is done is not expressed. Power, on the other hand, includes the rate of working.

It is evident that if it is known that a certain amount of work is done in a certain time, the rate at which the work is done, or the power, may be obtained by dividing the work by the time, giving the work done per unit of time.

The Watt. The electrical unit of power is the watt, and is equal to one joule per second; that is, when one joule of work is expended in one second, the power is one watt. If the number of joules expended in a certain time is known, then the power in watts is obtained by dividing the number of joules by the time in seconds.

The power is obtained by multiplying the current by the voltage, or by multiplying the square of the current by the resistance.

The watt is sometimes called the *volt-ampere.*

For large units the *kilowatt* is used, and this is equal to 1,000 watts. The common abbreviation for kilowatt is K. W. The *kilowatt-hour* is a unit of energy, and is the energy expended in one hour when the power is one kilowatt.

Equivalent of Electrical Energy in Mechanical Units. The common unit of mechanical energy is the foot-pound, and from experiment it has been found that one joule is equivalent to .7373 foot-pound; that is, the same amount of heat will be developed by one joule as by .7373 foot-pound of work.

As one horse-power is equal to 550 foot-pounds per second, it follows that this rate of working is equivalent to

$$\frac{550}{.7373} = 746 \text{ joules per second (approx.)}.$$

Hence one horse-power is equivalent to 746 watts. Therefore, to find the equivalent of mechanical power in electrical power, multiply the horse-power by 746; and to find the equivalent of electrical power in mechanical power, divide the number of watts by 746.

Ohms Law. Ohms law is merely the fundamental principle on which most of electrical mathematics are worked.

A series of formulas used by electricians in figuring voltage, amperage and resistance:

Formula 1

To find the amount of current flowing in a circuit divide the voltage by the resistance, or

$$\text{Current} = \frac{\text{Electric Motive Force}}{\text{Resistance}}$$

For instance, if we have a line voltage of 100 and our circuit has a resistance of 5 ohms, then by dividing 100 by 5, we would get our amperage.

```
5 ) 100 ( 20
    100
    ———
```

so we would have 20 amperes.

Formula 2

To find the amount of resistance in a circuit, divide the voltage by the amount of amperage drawn, or

$$\text{Resistance} = \frac{\text{Electric Motive Force}}{\text{Current}}$$

For instance, suppose we have a line voltage of 100 and are using 20 amperes at arc lamp, then by dividing the 100 by 20 we would get the amount of resistance we have in our circuit.

20) 100 (5
100

so we would have 5 ohms resistance in our circuit.

FORMULA 3

To find the voltage of a circuit, multiply the amount of amperes drawn by the amount of resistance, or

Electric Motive Force = Amperes Times Resistance

For example: If we had 20 amperes at arc and our circuit was offering 5 ohms resistance, then by multiplying 20 by 5 we would get our voltage.

20 amperes
5 ohms

100 volts

To find Volts. Multiply number of Amperes by amount of Resistance.
To find Resistance. Divide Voltage by Amperage.
To find Amperage. Divide Voltage by Resistance.

To find Watts. Multiply Voltage by Amperage.
To find Amps. Divide Watts by Volts.
To find Volts. Divide Watts by Amperage.

GENERATION OF ELECTRICITY

Everyone is acquainted with the horseshoe magnet and the small pocket compass, and these two articles will serve as an illustration.

Now if one of the legs of the horseshoe magnet be brought near the compass, it will be found that one end of the needle will be attracted to it, whilst if the other leg be presented the other end of the needle is attracted. One leg, at its end, has north polarity, because it attracts the south pole of the compass needle, whilst the other end, having south polarity, attracts the north end of the needle, so that between the ends of the two legs there exists what is known as a "magnetic field," or space wherein magnetic lines of force are present. These lines of force are invisible, but if the magnet be laid on a table, and a piece of paper put over it, and if on the paper be sprinkled some iron filings it will be found, when the paper is tapped by the finger, that these filings group themselves around the ends of the magnet in circles, being closer together at the ends than further away, or higher up towards the bend of the horseshoe. The magnetic field is the most dense between the legs of the magnet at their ends. If a copper wire be passed up and down between the ends of the legs an electric current will be induced in the wire, its direction of flow varying with the upward and downward motion of the wire. In this case the electricity is obtained from the magnet by "induction," this being the elementary principle upon which all dynamos, whether for lighting or power, is based. In the dynamo the horseshoe is replaced by electro-magnets, the large stationary pieces of soft iron surrounded with covered copper wire, whilst the armature, the part which revolves, replaces the thin pieces of copper wire in the above simple experiment. The armature does not touch the magnets, and there is no friction except that in the bearings of the armature shaft, in which it is necessary to revolve, and which is made as easy as possible by a liberal supply of oil. It will also be seen that the electricity is not pumped from the atmosphere, but is simply the revolution of a bundle of copper wires between the poles of a powerful electro-magnet. The ends of the electro-magnets are thickened out, and each one made semi-circular so that the armature may revolve between the north and south poles and the electro-magnets, consisting of soft iron, are wound round with insulated copper wire, so that a portion of the electricity generated in the armature may be shunted around them and so keep always, whilst the dynamo is in action, as powerful electro-magnets. When the dynamo is stopped, these magnets retain a small amount of magnetism, which is gradually strengthened to its maximum as the armature is started revolving, the dynamo "building up" as it is termed. Anyone who has watched the starting up of a dynamo will have noticed that when running slowly the lamp connected to it as "pilot" gradually shows a red filament, which becomes brighter as the revolutions increase, until, when the correct speed is reached for which the dynamo was designed, the right voltage will show on the voltmeter and the pilot lamp attain its full brilliancy.

The armature of the dynamo is the only part which revolves, and this consists of a steel shaft supported in bearings at each end, to which the pulley is attached to receive the belt for transmitting the power from the engine to the dynamo. On the shaft are built up thin sheets of soft iron provided with grooves in which the different sections of insulated copper wire are laid lengthwise, their ends being connected to what is called the "commutator" fastened to the shaft. This consists of bars of copper made into a drum, each bar being insulated from its neighbour by means of strips of mica, and on the commutator rest lightly the carbon or copper brushes to convey the electricity to the lamps or motors.

The number of coils of wire on the armature depends upon the voltage the dynamo is designed to give, and the speed at which it has to run, also upon the strength of the magnetic field of the electro-magnets; and the thickness of these conductors will depend upon whether it has to give a large or small current strength. If the voltage is to be high, and small current strength, many conductors of fine wire are employed; if the voltage required is to be low, and large current strength, a few sections of thick wire are required.

A machine as above described is known as a continuous-current dynamo, to distinguish it from an "alternator," and the current obtained from it flows in a continuous circuit from the positive brush or collector on the commutator, through the lamps or motors, and completes the circuit to the other brush.

The mistaken notion of electricity being obtained by friction has probably arisen from the fact that, resting on the top and bottom of the commutator are carbon or copper brushes, but these are for the purpose of turning the currents, which are generated in the armature as alternating currents, into one direction. They also act as collectors to convey the electricity to the external circuit for lamps, motors, or other electricity-consuming devices, and do not offer practically any friction, only resting lightly against the surface of the revolving commutator.

For supplying extensive areas such as towns where the demand for electricity is scattered, alternating-current machines or "alternators" are employed which do not require commutators, the high voltage generated, 2,000 volts and upwards, being led to transformer stations, where it is reduced, by means of stationary transformers, to 110 and 220 volts for feeding lamps direct, or for motors and other uses. The field magnets of these alternators are energised by a continuous or direct current supplied from a small dynamo generally fixed on the alternator shaft, and running at the same speed.

ALTERNATING CURRENTS

A continuous or direct current is one of uniform strength always flowing in one direction, while an *alternating current* is continually changing both its strength and direction. The various principles and facts concerning direct current distribution apply also to alternating current systems. But in addition to the simple phenomena due to the resistance, which occur with direct currents, there are certain additional factors that must be considered in connection with alternating current transmission.

The flow of a direct current is entirely determined by the ohmic resistance of the various parts of the circuit. The flow of an alternating current depends upon not only the resistance, but also upon any *inductance* (self or mutual) or *capacity* that may be contained in or connected with the circuit. These two factors, inductance and capacity, have no effect upon a direct current after a steady flow has been established, which usually requires only a fraction of a second. In an alternating current circuit either or both of them may be far more important than the resistance and in some cases may entirely control the action of the current. Alternating current problems involving the consideration of three factors are usually more complicated and difficult to solve than those relating to direct currents. By an extension of the principles and methods employed for direct currents, however, alternating current systems can be designed correctly and without great difficulty.

The only reason practically for employing alternating currents for electric lighting and power purposes is the economy effected in the cost of transmission, which is accomplished by the use of high voltages and transformers. The cross section of a wire to convey a given amount of electrical energy in watts with a certain "drop" or loss of potential in volts, is inversely proportional to the square of the voltage supplied; that is, it requires a wire of only one-quarter the cross-section and weight if the initial voltage is doubled. The great advantage thus obtained by the use of high voltages can be realized either by a saving in the weight of wire required or by transmitting the energy to a greater distance with the same weight of copper.

When the alternating current, or E. M. F., has passed from zero, to its maximum value, to zero, in one direction, then from zero, to its maximum value, to zero, in the other direction, the complete set of values passed through repeatedly during that time is called a *cycle*. This cycle of changes constitutes a complete *period*, and since it is repeated indefinitely at each revolution of the armature the currents produced by such an E. M. F. are called *periodic currents*. The number of complete periods in one second is called the *frequency* of the pressure or current.

The term *frequency* is applied to the number of cycles completed in a unit of time—one second. The word *alternations* is sometimes used to express the frequency of an alternator, meaning the number of *alternations per minute*. In practice the frequency is usually expressed in *cycles*. An alternation is half a period or cycle; since the current changes its direction at each half cycle, it follows that the number of alternations or reversals is twice the number of cycles.

If the current from an alternator performed the cycle sixty times a second, it would be said to have a *frequency* of 60 *cycles,* which would mean 120 alternations per second, or 120 × 60 seconds = 7200 alternations per minute.

The frequency of an alternating current is always that of the E. M. F. producing it.

Unless otherwise specified, *frequencies* are in the term of cycles, thus: a frequency of 60 means 60 cycles. The frequency of commercial alternating current depends upon the work it is expected to do. For power a low frequency is desirable, frequencies for this purpose varying from 60 down to 25.

For lighting work frequencies from 60 to 125 are in general use. Very low frequencies cannot be used for lighting owing to the flickering of the lamps. A number of central stations have adopted a frequency of 60 as a standard for lighting and power transmission.

Most of the peculiarities that alternating current exhibits, as compared with direct current, are due more or less to the fact that an alternating current is constantly changing, whereas a continuous current flows uniformly in one direction. When a current flows through a wire it sets up a magnetic field around the wire, and since the current changes continually this magnetic field will also change. Whenever the magnetic field surrounding a wire is made to change, an E. M. F. is set up in the wire, and this induced

E. M. F. opposes the current. For example, when the current rises in the positive direction, the magnetism increases, in let us say, the clockwise direction about the conductor; after the current passes the maximum value and begins to decrease, the lines of force commence to collapse, reaching zero value when the current reaches zero; then when the current rises in the negative direction the magnetic lines expand in the counter-clockwise direction, and so on. The result is that the counter E. M. F. of self-induction, instead of being momentary, as when the current is made and broken through a conductor, is continuous, but varies in value like the applied E. M. F. and the current. The value of an induced E. M. F. is proportional to the rapidity with which lines of force are cut by the conductor, and as the lines of force vary most rapidly when passing the zero point (changing from + to —) or *vice versa*, the induced E. M. F. is maximum at that moment.

When the current, and therefore the magnetism, is at the maximum value in either direction, its strength varies very little within a given momentary period of time, and consequently the *induced* E. M. F. is zero at the moment the current and magnetism is at maximum, the E. M. F. of self-induction not rising and falling in unison with the applied E. M. F. and the current, but lagging behind the current exactly a quarter of a cycle.

This property of a wire or coil to act upon itself *inductively* (self-induction) or of one circuit to act inductively on another independent circuit (mutual induction) is termed *Inductance*.

The *Unit* or *Coefficient* of inductance is called the *henry*, the symbol for which is L.

Many devices met with in alternating current work have this property of inductance. A long transmission line has a certain amount of it, as have induction motors and transformers.

The effect of *inductance* in an alternating current circuit is to oppose the flow of current on account of the counter E. M. F. which is set up. This opposition may be considered as an apparent additional resistance and is called *reactance* to distinguish it from ohmic resistance.

Reactance is expressed in ohms, like resistance, because it constitutes an opposition to the flow of the current. Unlike resistance, however, this opposition does not entail any loss of energy because it is due to a counter pressure and is not a property analogous to friction. Its effect in practice is to make it necessary to apply a higher E. M. F. to a circuit in order to pass a given current through it than would be required if only the resistance of the circuit opposed the current.

ELECTRICAL RESISTANCE

THE RHEOSTAT

The question of electrical resistance as applied to the projection circuit has long been a stumbling block to a great number of operators, while we admit that the subject is complicated, and some of its phrases hard to follow, it is essential that the theory of electrical resistance be mastered if we are desirous of progressing in the art of projection.

Electrical resistance is that property of anything in an electric circuit which will resist the flow of current. The effect of resistance is to produce heat.

The unit of electrical resistance is the ohm, and is so named after Dr. G. S. Ohm who gave us the series of formulas now known as Ohm's Law; it will be necessary to thoroughly understand the working of this law to be able to work out any of the numerous problems in electrical resistance. Ohm's Law states that: The current is directly proportional to the voltage and inversely proportional to the resistance. This means that if the voltage of a circuit be increased the current will proportionally increase, and should the resistance of a circuit be increased then the current will be proportionately decreased. Should the voltage be decreased there will be a proportional decrease in the current, if the resistance in the cir-

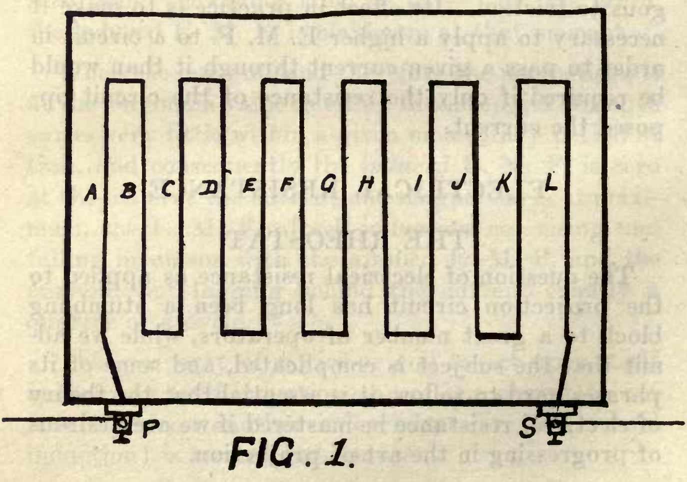


FIG. 1.

cuit is decreased there will be a proportional increase in current. Expressed mathematically

$$\text{Current} = \frac{\text{Electric Motive Force}}{\text{Resistance}}$$

Current is equal to the Electric Motive Force (Voltage) divided by the Resistance (in ohms) or

$$C = \frac{E}{R}$$

If by dividing the voltage by the resistance we get the amount of current, then by dividing the voltage

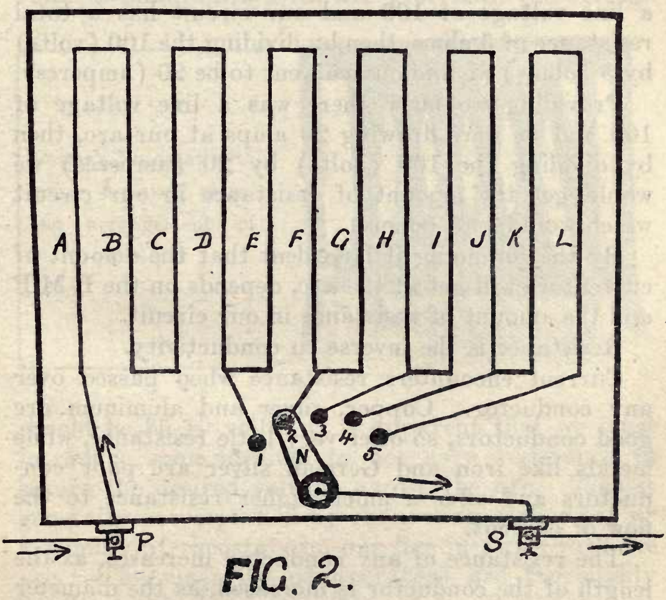


FIG. 2.

by the current we will naturally get the amount of resistance in our circuit, or—

$$R = \frac{EMF}{C}$$

and so to find the voltage all we have to do is to multiply the current by the amount of resistance in our circuit, or—

$$EMF = C \times R$$

It will thus be seen that providing we have two known quantities the third unknown quantity can easily be obtained by the use of one of the above formulas; for instance, let us suppose that we have a line voltage of 100 and our circuit has a total resistance of 5 ohms, then by dividing the 100 (volts) by 5 (ohms) we find our current to be 20 (amperes).

Providing we knew there was a line voltage of 100 and we were drawing 20 amps at our arc, then by dividing the 100 (volts) by 20 (amperes) we would get the amount of resistance in our circuit which would be 5 (ohms).

By the foregoing it is evident that the amount of current we will get at the arc, depends on the E M F and the amount of resistance in our circuit.

Resistance is the inverse to conductivity.

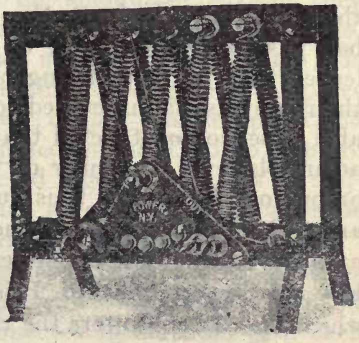
Current encounters resistance when passed over any conductor. Copper, silver and aluminum are good conductors, so offer very little resistance, while metals like iron and German silver are poor conductors and offer a much higher resistance to the flow of current.

The resistance of any conductor increases, as the length of the conductor is increased, as the diameter of the conductor is decreased; or as the temperature of conductor is increased (the resistance of insulating material and carbon decreases with an increase of temperature). To find the resistance of a copper wire, multiply its length in feet by 10.5 and divide the product by its area in circular mills.

Resistance is introduced into our projection circuit for two reasons, first to bring the supply voltage down to a suitable voltage for maintaining an arc and secondly to act as ballast on our line.

The voltage supply generally runs around 220 or 110 volts and as we only need approximately 50 volts to maintain a D.C. arc (for A.C. the voltage

Power's Rheostat with cover removed showing arrangement of coils.



should be 35-40 volts) it is apparent that we must introduce some medium to act as a resistance to secure the desired voltage across the arc. This is generally accomplished by connecting a rheostat or a number of rheostats on our line in series with the arc. The majority of operators are thoroughly familiar with the construction of the various makes of rheostats now on the market, but for the benefit of those who are not, let us here explain their general construction and operation.

A rheostat is constructed of a number of metal coils or grids (these coils or grids are made of some metal offering high resistance to the flow of current over them, generally iron or German silver) connected in series, these coils or grids are mounted on a metal frame from which they are insulated, the whole thing being covered with a perforated metal cover. The first and last coil are each connected to a terminal which allows for the connection of the conductors (see Fig. 1). The current enters the rheostat through terminal P, then passes through the coil or grid A to B, then to C and so on till it has passed through each of the coils in turn and leaves the rheostat through terminal *S*. Most of the rheostats manufactured today are of the adjustable type, so constructed that by the turning of an adjusable lever a number of the coils can be cut in or out of the circuit, thus cutting in or out resistance, thereby lowering or increasing the amperage at the arc. Fig. 2 is an elementary drawing showing how this is accomplished. P is the terminal through which the current enters the rheostat, S the terminal

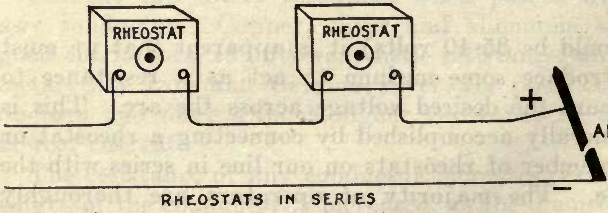


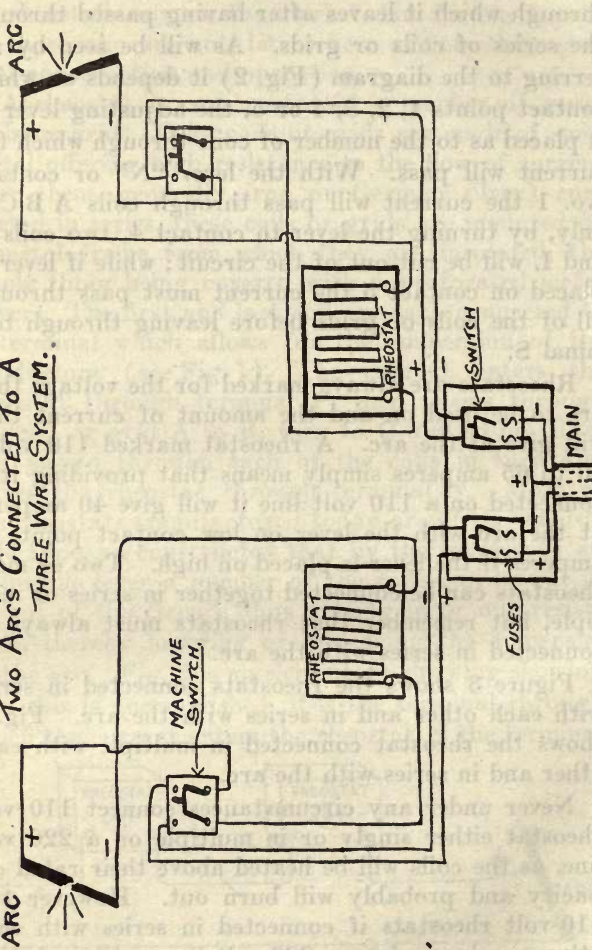
Fig. 3

through which it leaves after having passed through the series of coils or grids. As will be seen by referring to the diagram (Fig. 2) it depends on which contact points 1, 2, 3, 4 or 5, the adjusting lever N is placed as to the number of coils through which the current will pass. With the lever "N" or contact No. 1 the current will pass through coils A B C D only, by turning the lever to contact 4, two coils K and L will be cut out of the circuit; while if lever is placed on contact 5 the current must pass through all of the coils or grids before leaving through terminal S.

Rheostats are always marked for the voltage they are to be used on and the amount of current they will give at the arc. A rheostat marked 110 volts, 40 to 65 amperes simply means that providing it is connected on a 110 volt line it will give 40 amperes at the arc with the lever on low contact point, 65 amperes if the lever is placed on high. Two or more rheostats can be connected together in series or multiple, but remember that rheostats must always be connected in series with the arc.

Figure 3 shows the rheostats connected in series with each other and in series with the arc. Fig. 4 shows the rheostat connected in multiple with each other and in series with the arc.

Never under any circumstances connect 110 volt rheostat either singly or in multiple on a 220 volt line, as the coils will be heated above their rated capacity and probably will burn out. However two 110-volt rheostats if connected in series with each other can be used on a 220-volt line until such time as a 220-volt rheostat can be obtained.



Two Arc's Connected To A Three Wire System.

Where a number of rheostats are connected together in series the resistance in our circuit is equal to the sum of the separate rheostats. So by taking three rheostats that have a resistance of 4, 6 and 10 ohms, respectively, and connecting same in series with each other and in series with the arc, we would have a total of $4+6+10=20$ ohms resistance from the three. Where a number of rheostats are connected together in multiple, the resistance in our circuit is equal to their product divided by their sum, or—

$$\frac{4\times6\times10}{4+6+10}=\frac{240}{20}=12 \text{ ohms.}$$

Rheostats are extremely wasteful, being about 50 per cent efficient when new; the electrical energy is converted into heat which goes to waste. For instance, let us suppose that the supply voltage is 110 and that we are drawing 50 amperes at the arc, $110\times50=5{,}500$ watts registered on the meter and to be paid for. Our arc voltage is approximately 50 volts, so $50\times50=2{,}500$ watts, the amount actually used at the arc, $5{,}500-2{,}500=3{,}000$ watts wasted in the rheostat. As the line voltage is in-

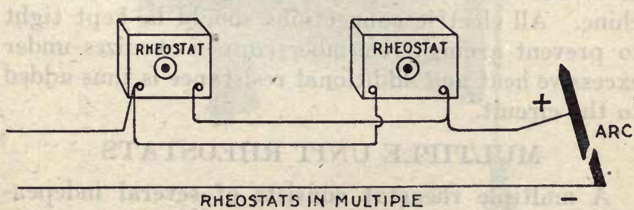
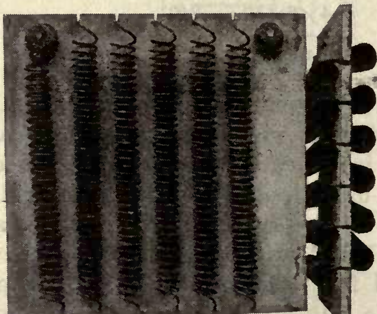


Fig. 4

creased the percentage wasted is proportionately much greater.

Rheostats should be installed outside the projection room wherever possible, preferably on a shelf near the ceiling and located near enough to the vent to allow the heat from the rheostat to be carried to the open air. They should be kept away from anything inflammable. Where the rheostat is located away from the projector it is advisable to have a control switch so placed that the operator can cut

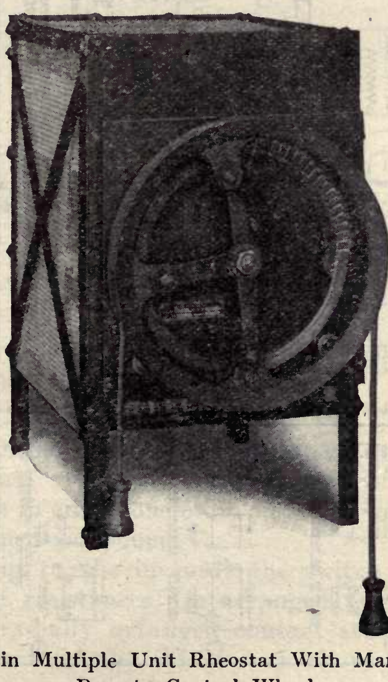


Separate Unit of Robin Multiple Unit Rheostat

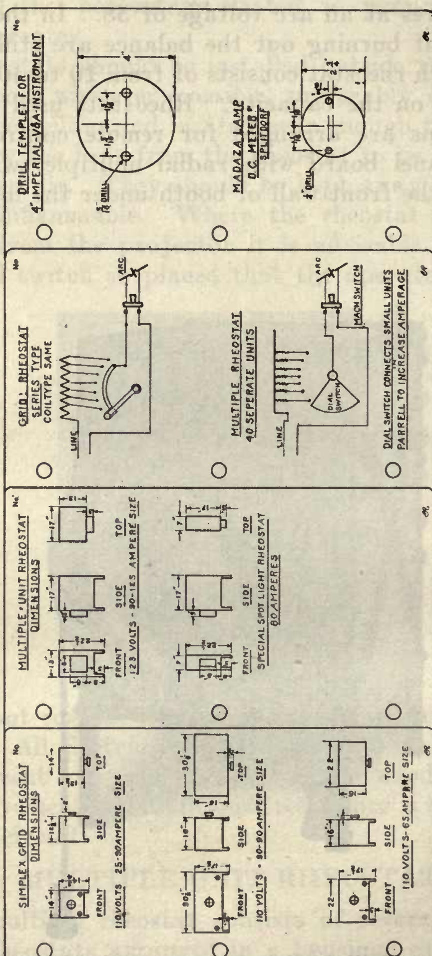
in or out resistance without having to leave his machine. All electric connections should be kept tight to prevent arcing; remember copper oxodizes under excessive heat and additional resistance is thus added to the circuit.

MULTIPLE UNIT RHEOSTATS

A multiple rheostat consists of several independent rheostats arranged in a housing; each unit is a separate arc rheostat, delivering two and one-half amperes at an arc voltage of 58. In the event of any unit burning out the balance are still operable. Each rheostat consists of from 10 to 40 units, depending on the capacity. Rheostats used on big installations are arranged for remote control, the control panel board with radial multiple switch is placed in the front wall of booth under the look-out port holes.



Robin Multiple Unit Rheostat With Manual Remote Control Wheel

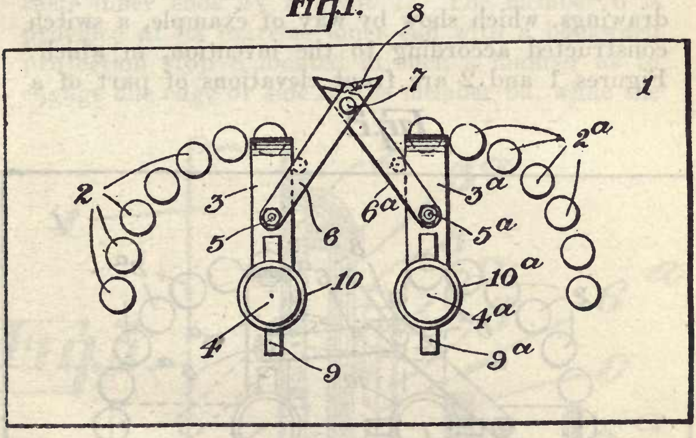


Standard Rheostat Dimensions

NEW DEVICE FOR CONTROLLING RESISTANCE

A patent has just been granted for an electrical regulating switch for limiting the current in two separate circuits to a predetermined maximum. The invention relates to a new or improved regulating switch and is particularly adapted for use in connection with motion-picture projectors, especially in cases where two or more machines are used. The

Fig. 1.



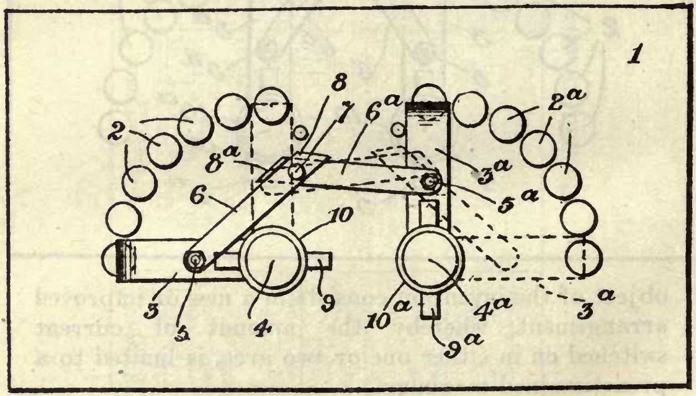
object of the invention consists in a new or improved arrangement whereby the amount of current switched on in either one or two arcs, is limited to a predetermined maximum.

According to the inventor the switch arms for each set of resistances are arranged to move over the usual radially arranged contact studs, preferably disposed side by side or one above the other.

These switch arms are connected by two hinged or pivoted connecting members, the inner ends of each of which are pivoted to one another, while their opposite ends are connected to the respective switch arms. The inner ends of each of the connecting members are provided with projecting stops, each arranged to engage the opposite member and thus limit the stroke or extent of rotation of either switch arm relatively to the other.

In order that the invention may be readily understood, reference is directed to the accompanying drawings, which show by way of example, a switch constructed according to the invention, in which: Figures 1 and 2 are front elevations of part of a

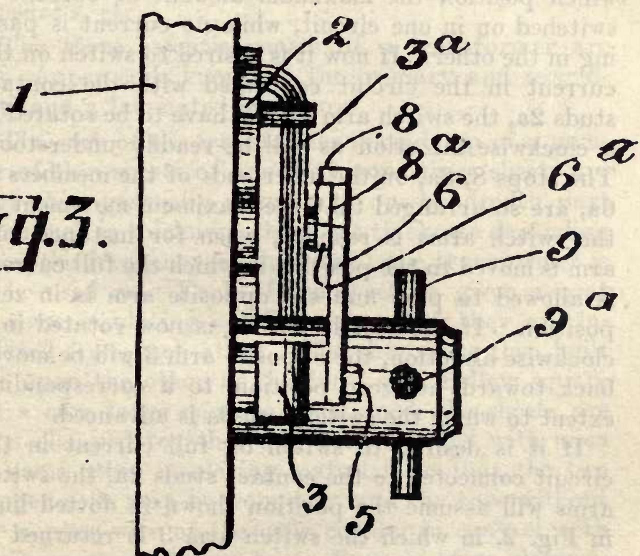
Fig. 2.



switchboard showing the switch arms for the two sets of resistances in varying positions. Figure 3 is a part and elevation of Figure 2 seen from the left. The switchboard 1 is provided with two sets of radially disposed contact studs 2, 2a, connected in the usual manner to two sets of resistances (not shown in the drawings). Each set of contact studs is provided with a switch arm 3, 3a, pivotally mounted on the switchboard at 4, 4a, respectively. The switch arm 3 has pivoted thereto at 5 one end of a connecting member 6, while the switch arm 3a has pivotally connected at 5a one end of a connecting member 6a.

The members 6 and 6a are connected at or near their inner ends by a pivot 7. The member 6 is provided at its extreme inner end with a backward projection stop 8 located in such a manner as to engage one edge or side of the member 6a, while the

Fig. 3.



member 6a is provided at its inner end with a forward projecting stop 8a arranged to engage one edge of the opposite member 6. Each of the switch arms is provided with an operating handle 9, 9a, secured at or near the front end of the rotatably mounted holders 10, 10a, respectively.

The operation of the apparatus is as follows: When the switch arms 3, 3a, are in the position shown in Fig. 1, both are in the zero position in which no current is passing through either of the resistances. If it is desired to switch on the arc, connected with the contact studs 2, the switch arm 3 is rotated in an anti-clockwise direction, that is, into the position shown in full lines in Fig. 2 in which position the maximum amount of current is switched on in one circuit, while no current is passing in the other. If now it is desired to switch on the current in the circuit connected with the contact studs 2a, the switch arm 3a will have to be rotated in a clockwise direction as will be readily understood. The stops 8, 8a, on the inner ends of the members 6, 6a, are so arranged that the maximum movement of the switch arms is reached, when for instance, one arm is moved to the position in which the full current is allowed to pass and the opposite arm is in zero position. If the switch arm 3a is now rotated in a clockwise direction, the opposite arm 3 will be moved back towards its zero position, to a corresponding extent to which the switch arm 3a is advanced.

If it is desired to switch on full current in the circuit connected to the contact studs 2a, the switch arms will assume the position shown in dotted lines in Fig. 2, in which the switch arm 3 is returned to its zero position.

THE STEP-DOWN TRANSFORMER

To a great many projectionists the working principle of a transformer is a mystery, whereas it is one of the simplest electrical devices built.

A transformer is a device for changing the voltage and current of an alternating current circuit.

Transformers are spoken of as Step-up and Step-down transformers. It is the step-down transformer that is used for motion picture work, so that is the one we shall deal with in this article.

Step-down transformers are known under many trade names such as Economizers, Inductors, Compensarc's, etc.

The three essential parts of a transformer are two copper coils known as the primary and secondary, and a laminated iron core.

The core of the transformer is made up of a number of thin sheets of annealed iron; these sheets are very thin, generally running to one-hundredth part of an inch in thickness, the exact thickness depending upon the frequency of the circuit the transformer is to be used on. Each of the sheets is given a coat of some insulating compound, so that they are insulated from each other. The sheets are then built one upon the other in the form of a hollow square till a core large enough is obtained, the sheets are then clamped together and are insulated with mica or some other insulating material, so that the two copper coils may be wound around the core without the copper wire of the coils coming in contact with the iron core. Figure 1 is a diagram of an elementary transformer, showing the primary coil wound around one leg of the core and the secondary coil wound around the opposite leg.

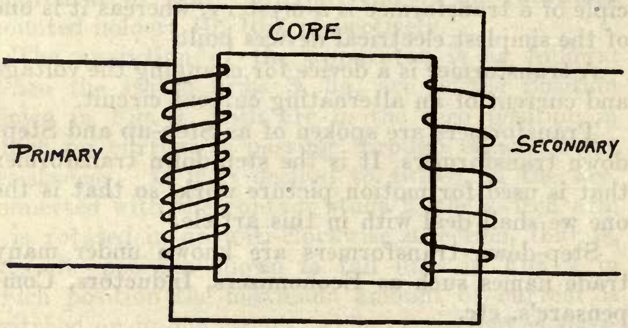


Fig. 1

When we close the circuit on the primary side of transformer the current passing through the primary coil magnetizes the iron core, this magnetism in turn induces an A. C. current in the secondary coil. So that while the primary and secondary coil are insulated from the core and from each other, there is a magnetic connection between both coils and core.

If we turn back to the basic principle of induction the working principle of the transformer is made clear.

If an A. C. current is passed through a conductor encircling a bar of soft iron, the iron will become a magnet and remain so just as long as current is passed through the conductor.

If a bar of iron carrying a conductor around it, be magnetized in a direction at right angles to the plane of the conductor a momentary E. M. F. will be induced in the conductor; if the current be reversed another momentary E. M. F. will be induced in the opposite direction in the conductor.

The pressure induced in the secondary coil depends on the ratio between the number of turns in the primary and secondary coils. Suppose the primary coil has (50) turns of wire and the secondary (5) turns, there would be a transformation ratio of 10 to 1, so if the primary coil was supplied with current at a pressure of 500 volts, the pressure in the secondary coil would be one-tenth of this or $500 \div 10 = 50$ volts.

Now let us suppose that we have a flow of 20 amperes in the primary coil and that the ratio is the same (10 to 1), then $20 \times 10 = 200$ which equals the flow of current in the secondary coil.

On the primary coil we have 20 amperes at a pres-

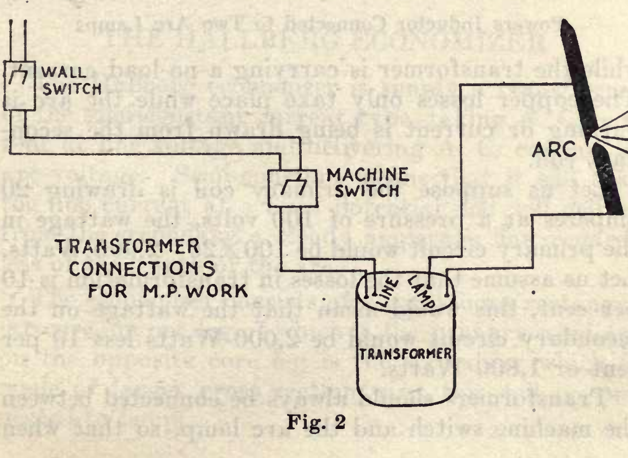
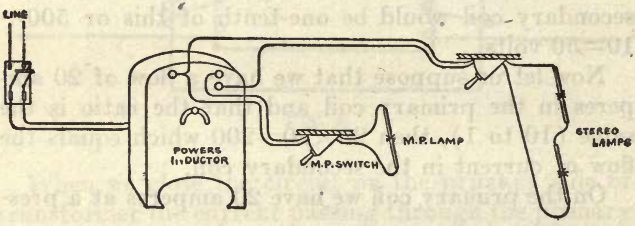


Fig. 2

sure of 500 volts or $500 \times 20 = 10{,}000$ Watts or 10 K. W. On the secondary we have 200 amperes at a pressure of 50 volts or $200 \times 50 = 10{,}000$ Watts or 10 K. W. So we see that the wattage on the primary is equal to the wattage on the secondary, assuming that there is no loss in transformation.

We know that there are two forms of losses in all transformers, the iron or core loss and the copper or coil loss. These losses total about 10 per cent. The core losses are going on as long as the switch on line side of the transformer is closed; in other words



Powers Inductor Connected to Two Arc Lamps

while the transformer is carrying a no-load current. The copper losses only take place while the arc is burning or current is being drawn from the secondary coil.

Let us suppose the primary coil is drawing 20 amperes at a pressure of 100 volts, the wattage in the primary circuit would be $100 \times 20 = 2{,}000$ Watts. Let us assume that the losses in transformation is 10 per cent, this would mean that the wattage on the secondary circuit would be 2,000 Watts less 10 per cent or 1,800 Watts.

Transformers should always be connected between the machine switch and the arc lamp, so that when the machine switch is pulled, it stops a no-load current from passing through the primary coil of the transformer.

POINTS TO REMEMBER ABOUT TRANSFORMERS

Make sure that the primary coil (marked line) is connected to the source of supply.

See that transformer is connected between machine switch and arc lamp.

Do not use any resistance device in series with a transformer.

Make sure that all the connections are tight.

Cover all line terminals on transformer with tape.

Place transformer away from metal walls of booth.

Keep arc short.

See that voltage and cycles marked on transformer corresponds with supply voltage and cycles.

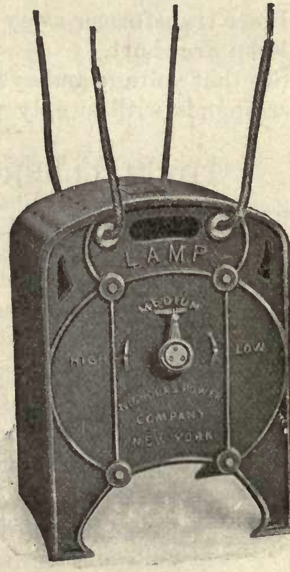
THE HALLBERG ECONOMIZER

The Hallberg economizer is simply a transformer of the semi-constant current type, taking A. C. current at line voltage and delivering A. C. current at arc voltage. Semi-constant means that it will take the line current at a fixed potential and will deliver from the secondary a steady amperage flow regardless of the length of the arc.

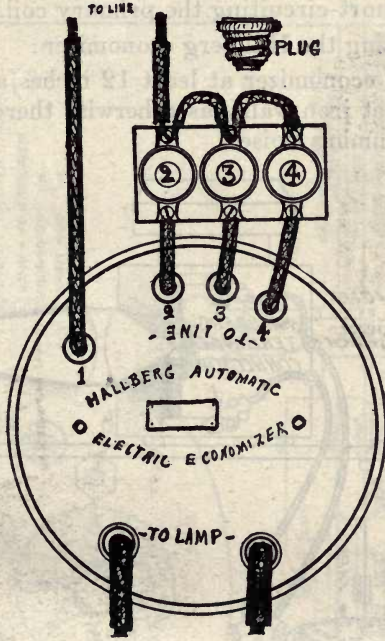
The economizer consists of a continuous rectangular core, on one leg of which is the primary winding, on the opposite core leg is the secondary which is made of larger cross section wire, this coil is connected to lamp.

Hallberg Economizer

Power's Inductor



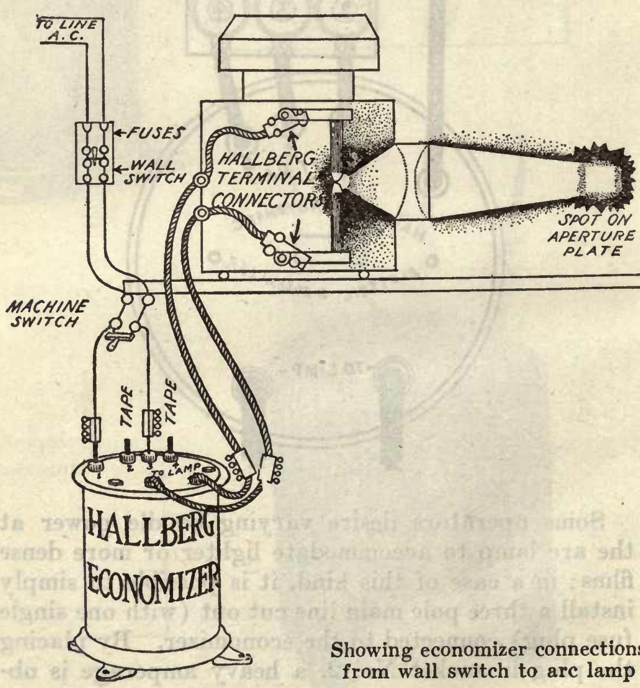
On 110 volts the economizer line wires are usually attached to terminals 1 and 2 for any voltage from 100 to 105, to 1 and 3 for 110 volts or to 1 and 4 for voltage between 115 and 210.



Some operators desire varying candle power at the arc lamp to accommodate lighter or more dense films; in a case of this kind, it is possible to simply install a three pole main line cut out (with one single fuse plug) connected to the economizer. By placing the plug in socket No. 2, a heavy amperage is obtained. Unscrew plug and place in 3 and we get a medium current, and if we place plug in 4 we get the lowest amperage possible. This gives us three degrees of amperage at arc. By installing more than one fuse at a time we would blow the fuse, as this would be short-circuiting the primary coil.

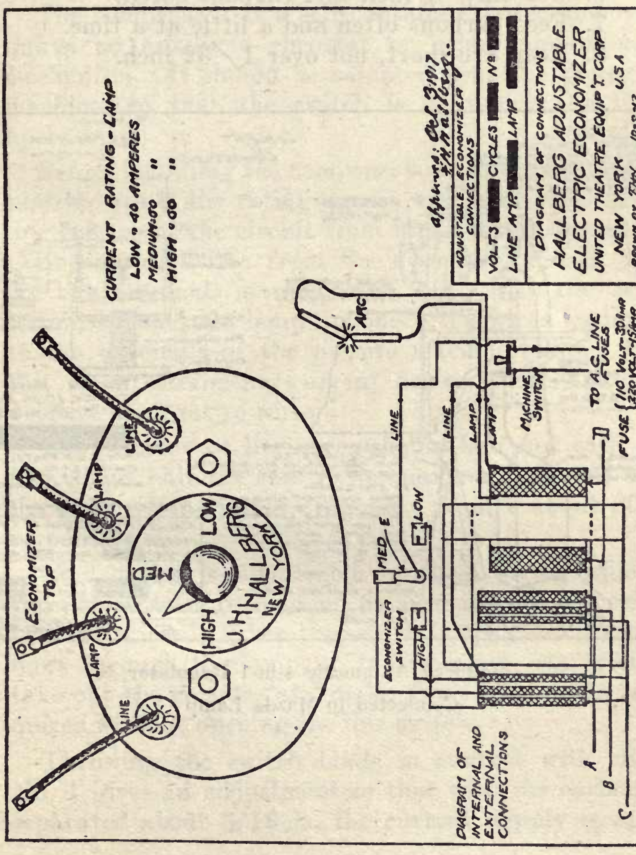
When using the Hallberg economizer:

1. Place economizer at least 12 inches away from sheet iron walls, as otherwise there will be a humming noise.

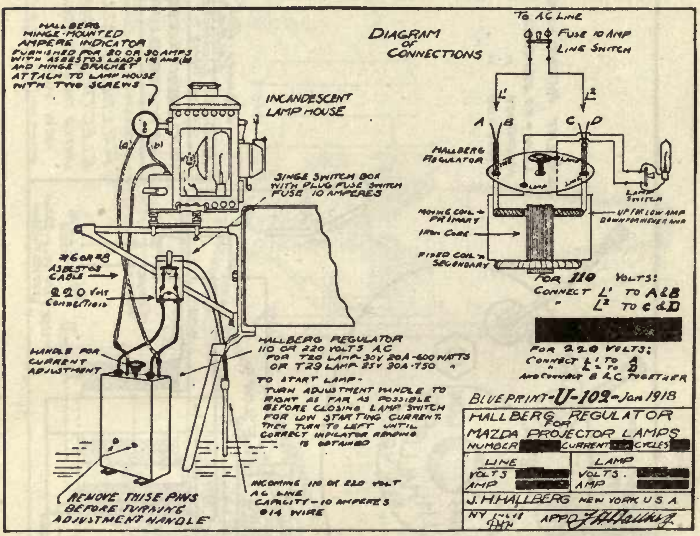


Showing economizer connections from wall switch to arc lamp

2. 30 amperes line fuses are large enough for 110 volts and 15 amperes for 220 volts.
3. Connect fuses, switches and wires exactly as illustrated.



4. Make sure that all connections are tight, especially at the carbon clamps in the lamp house.
5. Cover all line terminals on economizer with tape.
6. Use only ⅝ inch soft carbons cored.
7. Feed carbons often and a little at a time.
8. Keep arc short, not over 1/32 inch.



Hallberg Automatic 4-in-1 Regulator
Connected to Mazda Lamp

INSTRUCTIONS FOR INSTALLING AND OPERATING A-C. TYPE "A" COMPENSARC

The compensarc is a self-contained device and requires no auxiliary rheostat or other controlling mechanism. It should be mounted near the picture machine, so that the switch is convenient to the operator.

Before installing the compensarc examine the name plate to see if the rating agrees with the cycles and line voltage of the circuit from which it will operate. Connect both wires from the operating circuit to the two terminals marked "line," and from the two terminals marked "lamp" connect the wires leading to the terminals of the picture machine lamp. As this is an alternating-current device, there are no positive or negative wires.

The primary or line wires should be fused with a fuse about half the size of the maximum current at the lamp. This would ordinarily require about 30-ampere fuse.

This device is adjustable in three steps, which three steps have been found to meet the general service conditions. When the switch is open no current flows through the lamp, so the operator can freely take out the carbons and make any adjustments required without opening the line switch.

Throwing the switch blade in contact with clip No. 1 gives an adjustment so that with the carbons separated about 3/16 in. the current supply is approximately 30 amperes, which gives a light suitable for light films or a short throw. In contact with clip No. 2 the adjustment changes so that approximately 40 amperes flow through the lamp. This is the usual operating position of the compensarc switch and gives a powerful white light which is found to be best adapted for all films.

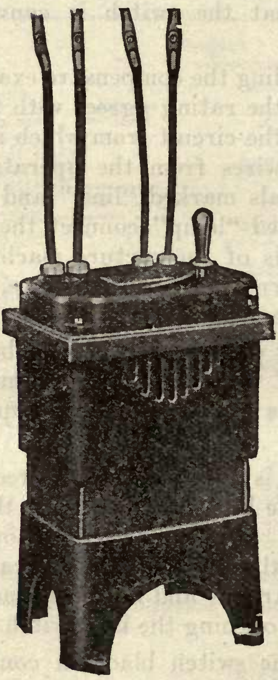


Fig. 1. A-C. Compensarc

Throwing the switch blade over to clip No. 3 allows approximately 60 amperes to flow through the lamp. This gives an intense light and is required only where the films are very dense or the throw is very long.

The alternating-current compensarc is a transformer device for use on alternating-current circuits which cuts down the current supply on 110-220 volts, with the voltage required at the arc approximately 35, in an efficient manner, the efficiency being exceedingly high as compared with the rheostat, which wastes all of the energy between 110 and 35 volts, converting this energy into heat.

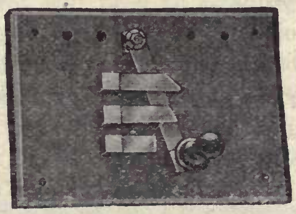


Fig. 2. Slate Top of A-C. Compensarc Showing Switch Blades

In order to determine if your compensarc is in good condition on all three steps, first, start an arc on any one of the steps, then jump the switch quickly to the other two steps in succession, watching the light. There should be an appreciable difference in the light, which you can very readily detect in trying this one or two times.

On account of the efficiency of the compensarc there is so little energy converted into heat that the outfit can be installed in the operating room, whereas it would be impossible to do the same with the rheostat. If you think the compensarc is heating up, do not attempt to determine the temperature with your hand, but put a thermometer on it on the hottest part for about five or ten minutes, and then take a reading of the thermometer. Temperature rise should never exceed 40 deg. C. or 72 deg. F.

If you will observe some of the following points, you will be pretty sure to get good results:

1st—Make sure that the two leads marked "lamp" are connected directly to the lamp of the picture machine. It is not necessary to select for positive or negative leads.

2nd—The other two cables coming from the compensarc should be connected to the line direct.

3rd—Never connect any resistances up with the compensarc on either the lamp or the line side. The compensarc is intended to cut out all resistances. Be sure the line voltage and frequency agree approxi-

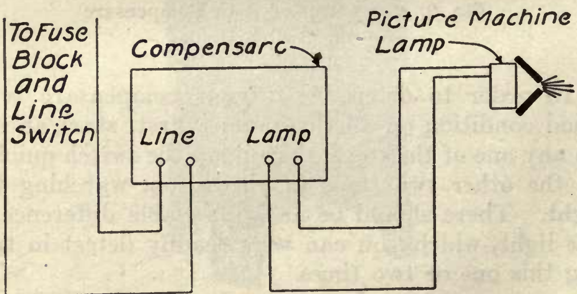


Fig. 8. Diagram of Connections for A-C. Compensarc

mately with the line voltage and frequency marked on the name plate on the compensarc.

4th—Be sure that all connections from the line to the lamp terminals are tightened up and see that the switch has not been damaged in shipment. In every case try to get the best results on the given current that you possibly can by focusing the arc in relation to the lens. This can only be determined by trial. If you operate the arc too closely to the condenser lens you are apt to crack it.

Do not try to run any more current in the lamp than necessary for the light required. A 5/8-in. carbon will operate very satisfactorily on 40 amperes, with about a 3/16 in. separation. Very much more current than this will tend to produce noise at the arc. This noise is not caused by the compensarc, but is caused by the alternating current in the arc and will be present no matter what kind of an outfit is used.

Flexible Armored Cable. Twin Conductors

A-C. COMPENSARCS IN MULTIPLE

In cases where more than 60 amperes of current is desired in connection with the motion-picture projection, two alternating-current compensarcs connected as shown in Fig. 4 can be used to give entirely satisfactory service. Two standard alternating-current compensarcs connected in this manner can be used to give a maximum of 120 amperes to the motion picture lamp. Eight values of current ranging between 30 and 120 amperes inclusive can be secured by this connection.

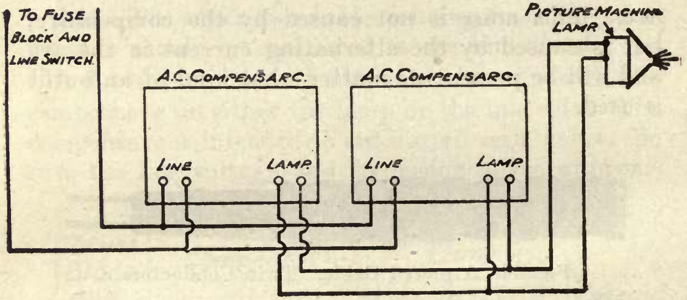


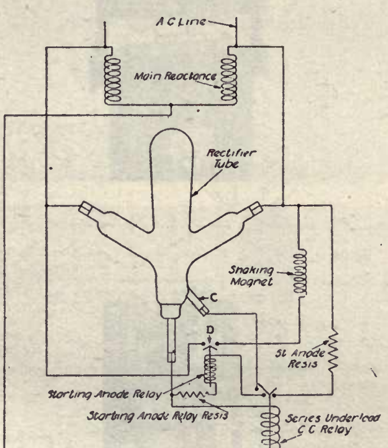
Fig. 4. Diagram of Connections for Use of Two A-C. Compensarcs in Multiple

MERCURY ARC RECTIFIERS

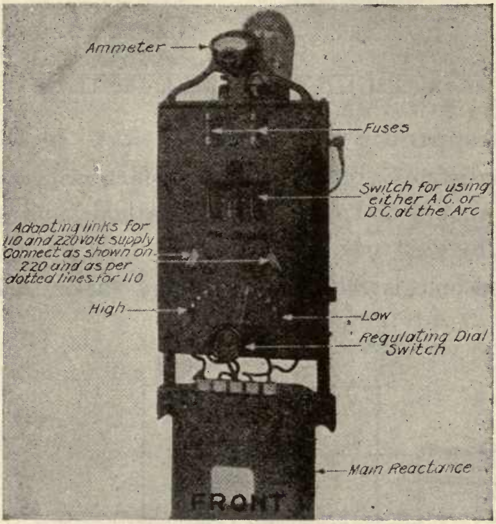
An apparatus used to change A. C. to D. C.

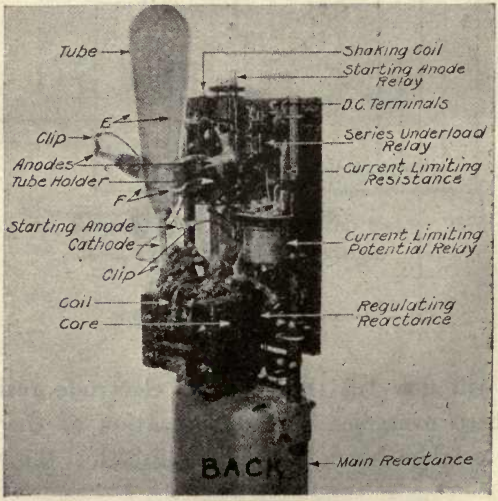
Consists of a glass bulb into which are sealed two iron anodes and one mercury cathode and a small starting electrode.

The bulb is filled with mercury vapor. No current will flow till the starting electrode resistance has been overcome by the conization of the vapor in its neighborhood. To accomplish this, the voltage



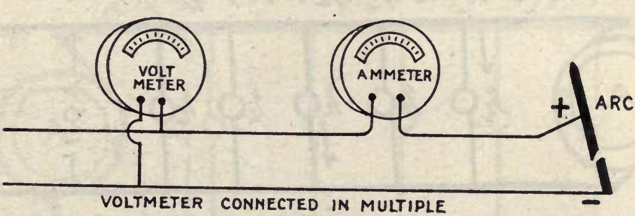
Mercury Arc Rectifier Connections





Front and back view of mercury rectifiers

is raised sufficiently to cause the current to jump the gap between the mercury cathode and the starting cathode, or by bringing the cathode and starting electrode together in the vapor by tilting and then separating them, thus drawing out the arc. When this has been done current will flow from the anode to the mercury cathode and not in the reverse direction. In order to maintain the action a lag is produced in each half wave by the use of a reactive or sustaining coil, hence the current never reaches its zero value otherwise the arc would have to be restarted.



VOLTMETER CONNECTED IN MULTIPLE
AMMETER CONNECTED IN SERIES

THREE-WIRE SYSTEM

A system of wiring for current distribution where three wires are used in place of two sets of two wires. The advantage of the system is the saving of copper and consequently the cost of wiring. By means of the three-wire system we are able to increase the pressure at which the current is transmitted, and take advantage of the greater efficiency of the lower voltage lamps.

A conductor rated to carry a current of 20 am-

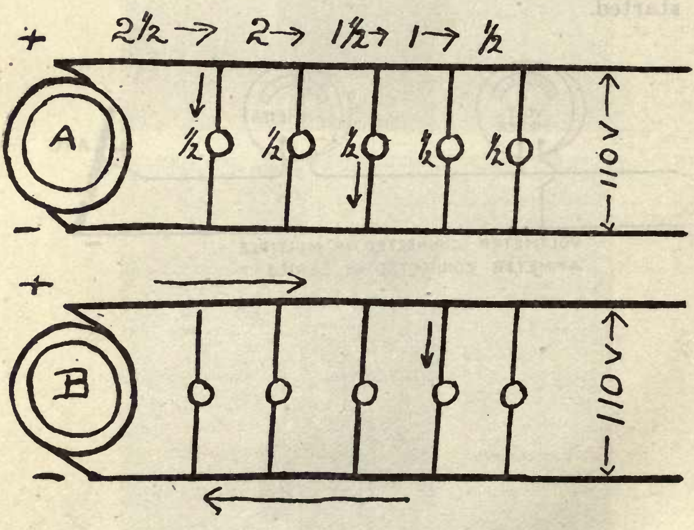


FIG 1.

peres, can carry that 20 amperes at a pressure of 10 volts or 10,000 volts, and as electrical energy is equal to the amount of current multiplied by the voltage, it will readily be seen that the transmitting capacity of a current can be greatly increased by increasing the voltage without increasing the size of the conductor. However, incandescent lamps are usually made for use on a pressure of 110 volts, so it would be necessary to either cut down the voltage to this pressure or connect a number of the lamps in series to take care of the extra pressure.

Fig. 1 shows two 110 volt dynamos A and B supplying two independent circuits. In each case five

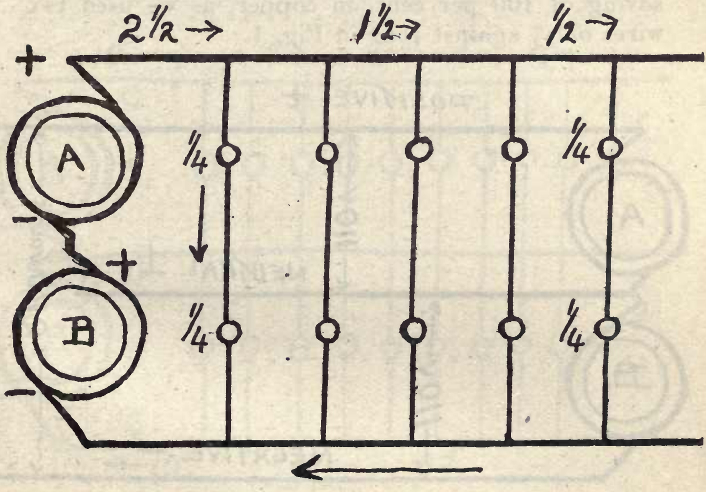


FIG 2.

110 volt ½ ampere lamps are connected across a 110 volt circuit, each dynamo supplying 2½ amperes at a pressure of 110 volts; which means a total wattage of 550 W. for the ten lamps. Fig. 2 shows us the same two dynamos, now connected together in series, and the same ten lamps, this time connected in series of pairs across a potential of 220 volts (on account of the dynamos being connected in series). As the voltage in this case is just double each lamp now draws ¼ ampere instead of ½ ampere as in Fig. 1 which makes the wattage in this case $220 \times 2\frac{1}{2} = 550$ watts, thus the wattage in each case is the same, but in Fig. 2 we have made a saving of 100 per cent. in copper, as we used two wires only, against four in Fig. 1.

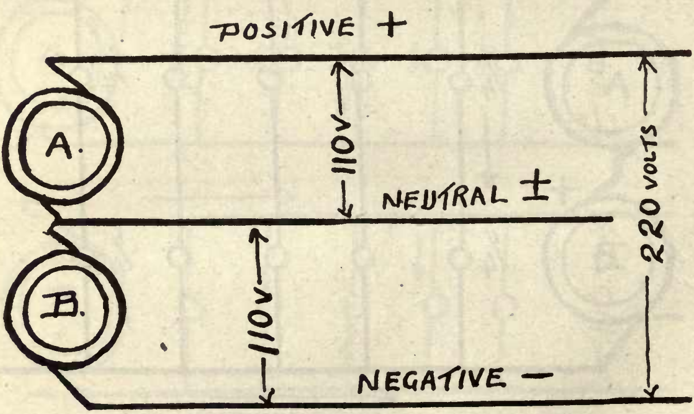


FIG. 3.

The arrangement in Fig. 2 is open to objection, however, as should one of the lamps burn out or be turned off, its companion will also go out. This is overcome in the three wire system by introducing a third wire into the circuit (Fig. 3) thus providing a supply or return wire to any of the lamps and permitting any of the lamps to be cut out of the circuit without affecting any of the others.

The three wire system is generally obtained by connecting two dynamos of a like capacity in series and connecting a third or neutral wire to a point common to both dynamos. The dynamos being connected in series, we get the added voltage of the dynamos when connected between the two outside

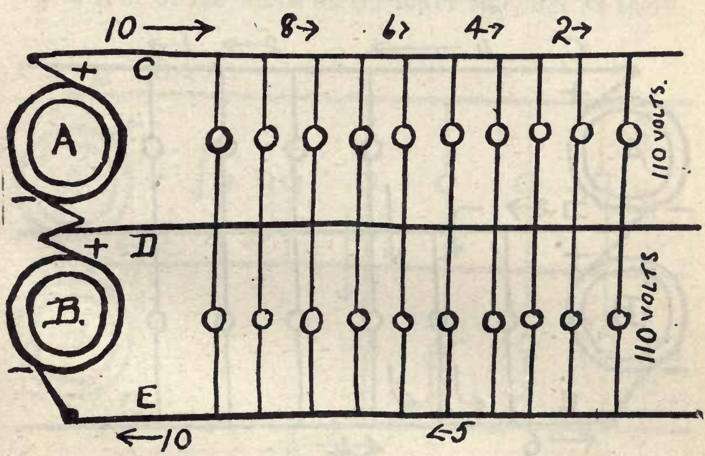


FIG 4.

wires, and the voltage of one dynamo only when connected between either of the outside wires and the neutral (Fig. 3).

No current will flow over the neutral wire, if the system is kept balanced (the same amount of amperage is drawn off either side of the system) and the flow of current in the neutral wire at any time is the difference between the amperage drawn from either side.

Fig. 4 shows a three wire system, A and B, being two 110 volt dynamos connected in series, C is the positive wire, D the neutral wire and E the negative wire. The ten circles on either side of the neutral wire represent lamps, each taking one ampere, as we have the same amount of current (10 amperes)

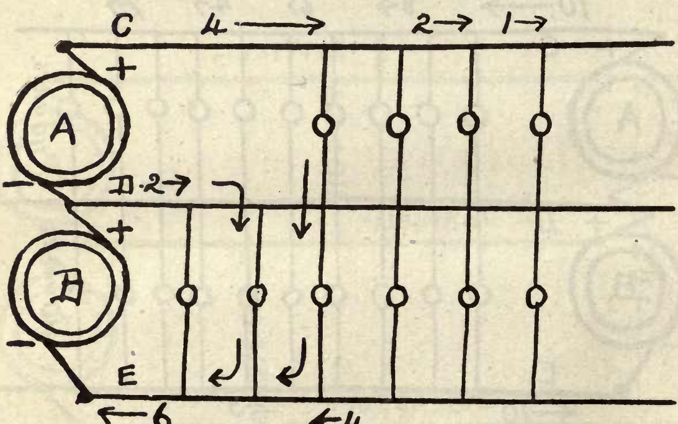


FIG 5

drawn off either side, the system is balanced and there is no flow of current in the neutral wire. The ten amperes being drawn from dynamo A over positive wire C and after passing through the lamps returning to dynamo B by way of negative wire E.

An unbalanced three wire system is shown in Fig. 5, taking it for granted that each of the lamps is taking one ampere, we have four amperes on one side and six on the other, 6 — 4 = 2, so our system is unbalanced to the extent of two amperes, and this represents the flow of current in the neutral wire. Four amperes being drawn from dynamo A over positive line C then after passing through the four lamps on the upper side, the four amperes goes to feed four of the lamps on the lower side, but as there

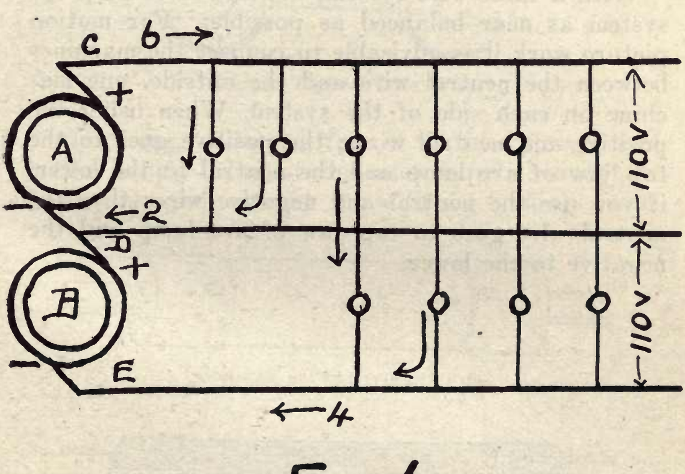


FIG. 6.

are six lamps to feed on the lower side, the two extra amperes are drawn from dynamo B over neutral wire D (which under the circumstances acts as a positive). So in Fig. 5, we have four amperes flowing from dynamo A over positive line C, two amperes flowing from dynamo B over neutral wire D, and six amperes flowing to dynamo B over negative line E.

In Fig. 6 we have another unbalanced system, in this case six amperes are drawn from dynamo A over positive line C and after feeding the six lamps on the upper side, four amperes are used to feed the four lamps on the lower side, the two extra amperes going back to dynamo A over the neutral wire D (which now acts as a negative) and four amperes going to dynamo B over negative line E.

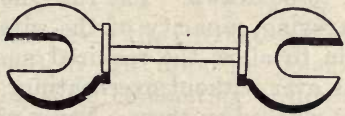
With a three wire system, the idea is to keep the system as near balanced as possible. For motion picture work it is advisable to connect the machines between the neutral wire and the outside, one machine on each side of the system. When using the positive and neutral wires, the positive goes to the top jaw of arc lamp and the neutral to the lower, if you use the neutral and negative wires then the neutral wire goes to top jaw of arc lamp and the negative to the lower.

FUSES

A safety device used on your line to protect the circuit.

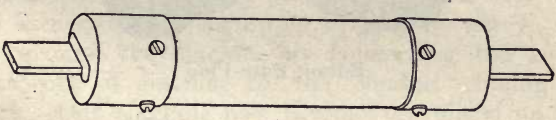
A short length of fusable wire introduced in a circuit so that if the temperature of circuit should rise above the rated capacity of fuse the wire will melt and thereby open the circuit.

Fuses are made in different shapes and sizes, the moving picture operator, however, will only be called upon to handle the under-mentioned.



Copper-Tipped Fuse Link

Link Fuse. The link fuse is the fuse always used in the booth, being of the open type it cannot be readily boosted without same being plainly seen.



Enclosed or "Cartridge" Fuse

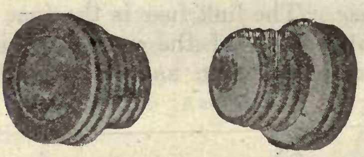
Section of Enclosed Fuse

Link fuses have no protective covering, so should always be installed in a metal cabinet.

Cartridge Fuse. Made by connecting two metal cap terminals with a short paper tubing. The two metal caps are connected by a thin wire which runs through the paper tubing, the tubing is filled with some non-conducting powder.

Plug Fuses. Plug fuses are used for protecting the house wiring and circuits carrying small amperage.

In fusing upon any circuit you must take into consideration the size of the wire used and the amount of amperage to be drawn. The fuse should be rated under the carrying capacity of the wire with a sufficient margin to allow the required number of amperes to pass over without overheating. The rating of all fuses is marked on them. Never use a fuse not marked.



Edison Fuse-Plug

TESTING FOR GROUNDS

Always remember that like poles repel each other while unlike poles attract each other, in other words the negative polarity is attracted by the positive polarity, and vice versa, while the negative has no attraction for negative nor the positive for positive.

The positive wire of one system will have no attraction for the negative wire of any other system, except its own, nor will the negative of one system find any attraction in the positive of any other system.

A ground is merely the current from one polarity being attracted by the opposite polarity, through the ground or some conducting medium other than that in the circuit.

Supposing that we are working on a three wire system and our neutral wire is grounded, and that we take and connect one of the outside wires to the upper jaw of arc lamp, and we connect the neutral wire to the lower jaw (the neutral wire now acts as negative to the upper or positive wire). We now ground the machine by connecting the metal framework of machine to the conduit coming in booth. Our machine now becomes grounded on the neutral because we have made contact between the frame of machine and the already grounded conduit. Should we now connect our test lamp between the upper jaw of arc lamp and frame of machine or lamp house we will naturally get a light as we are connected between the two polarities of the system.

Now should the arc lamp become grounded (caused we will say by the mica insulation coming out of jaw connection) on the lower jaw it would mean that the system is grounded on the negative polarity and the arc itself is grounded on the negative polarity, and this may or may not blow the fuse. But should it be the upper jaw of lamp that becomes grounded then our arc would be grounded on the opposite polarity to that of the machine, and thus cause a short circuit.

To test for a ground in the lamp house, first disconnect the ground wire and connect the terminals of test lamp between the upper and lower carbons. We should now get a light, as we are connected between both polarities, this test merely shows that we have current in our lamp.

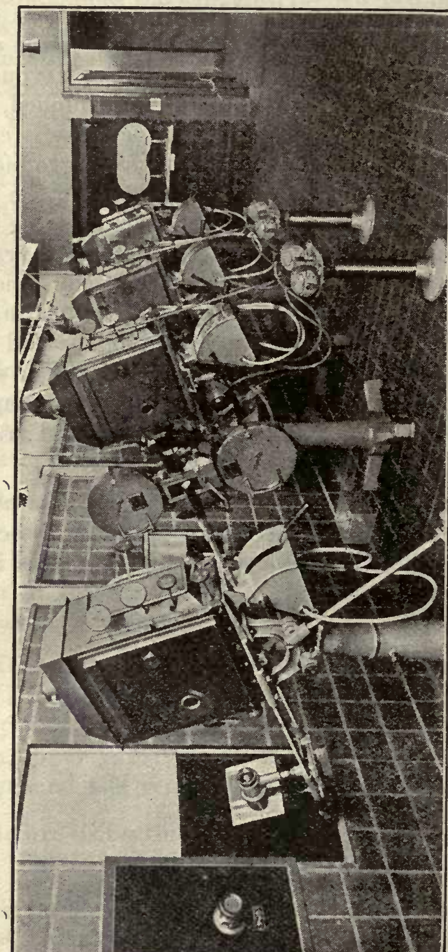
Connect the test lamp between the upper carbon and the frame of lamp house, if we get a light then our lower jaw is grounded, if we do not get light then take it for granted that lower is free from grounds.

Next test to see if the upper is grounded by connecting the test lamp between the lower jaw of arc lamp and the frame of lamp house, if we get a light then upper jaw is grounded. Always find the cause of ground and remove same at earliest opportunity.

Before using the test lamp see that lamp is alright and that it makes good contact in socket.

To test for a ground in the rheostat, use a bell set. First connect the terminals of bell set between the two binding posts of rheostat, and if rheostat is free from open circuits you should get a ring, next connect the terminals of bell set between one of the coils or plates in rheostat and the iron frame, if you get a ring it signifies that the rheostat is grounded, but this test will not tell you which coil or plate is causing the ground. To find exactly where ground is, proceed as follows: connect bell set between the first coil and frame, if you get a ring, disconnect the first coil, now connect between the second coil and frame, if you get a ring disconnect the second coil, and do the same to third and fourth coil, keep testing in this manner till bell stops ringing, then the coil you removed last was the coil that was grounded, so if you have removed six coils and the bell stops ringing when connected between the seventh coil and frame, it was coil number six that was grounded.

If the rheostat is made of more than one section, test each section separately and find which section the ground is in, then proceed as above. This is to save time.



An Up-to-Date Projection Room

THE PROJECTION ROOM

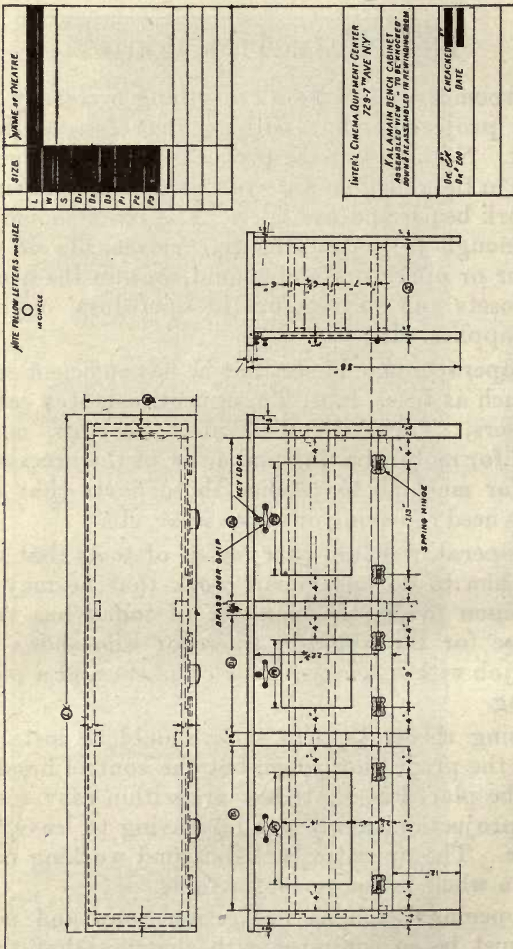
The room should contain everything necessary for perfect projection, but nothing that can be done without. Nothing but the projection of films should be done in the room, an ante-room should be provided with work bench and rewinder. The room should be large enough to permit the free movements of the operator or operators and should contain the necessary closets and shelves for the operators' clothes, tools, supplies, etc.

The operator should see that he has sufficient supplies, such as fuses, lugs, film cement, asbestos cable, condensers, various lubricants, carbons, mica, brushes for motor, belting and a few of the necessary parts for machine to replace those parts that are liable to need replacing owing to wear, etc.

The operator should carry a kit of tools that will permit him to do any repair work that he may be called upon to do, the manager of today has very little use for the would-be operator who shows up on the job with a ten cent pair of pliers and a piece of string.

If using rheostats then same should be installed outside the projection room, but the control handles should be placed so that they are within easy reach of the projectionist, without his having to leave the machine. The operator will thus find working conditions a whole lot more comfortable.

All openings such as projection holes and port holes must be so equipped with shutters that they will all close automatically in case of fire.

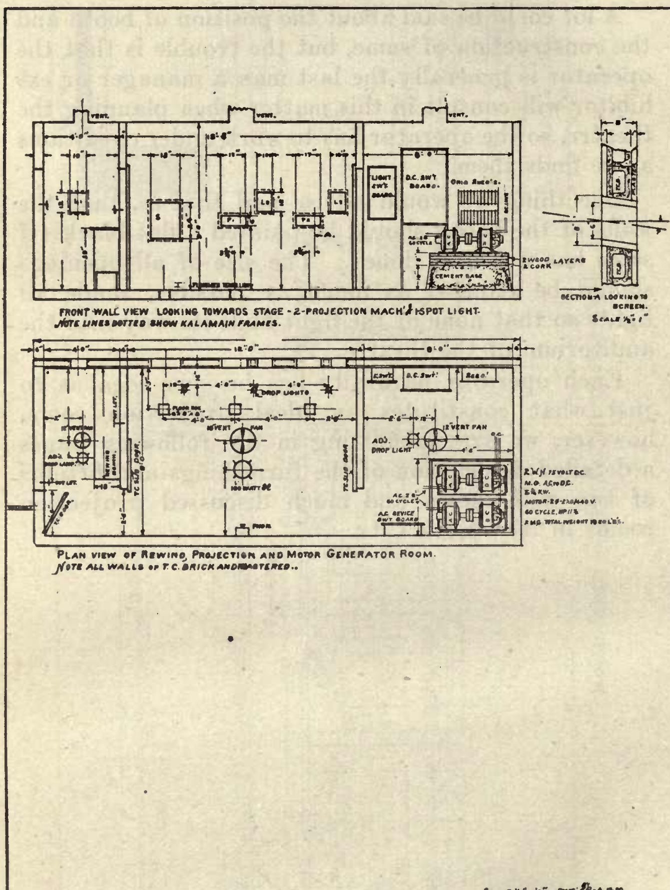


Robin Booth Supply and Rewinding Table

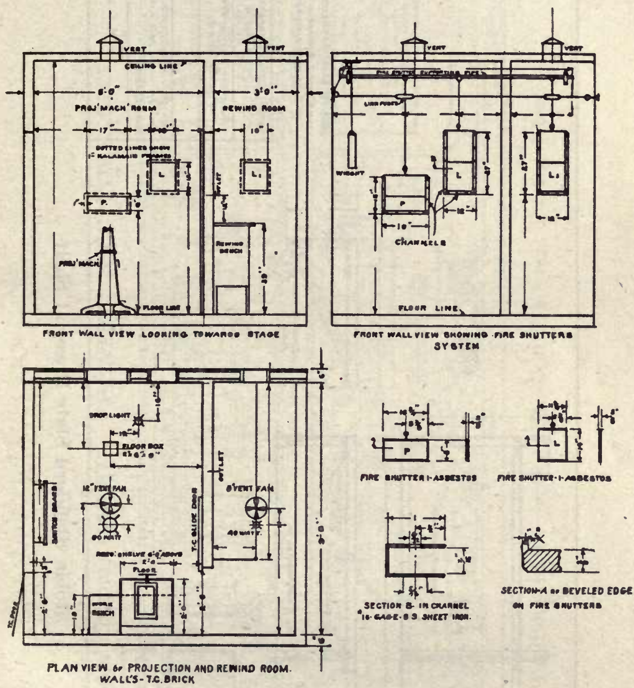
A lot could be said about the position of booth and the construction of same, but the trouble is that the operator is generally the last man a manager or exhibitor will consult in this matter when planning the theatre, so the operator has to work under conditions as he finds them.

One thing we would advise and that is, that the walls of the booth should be painted a flat black (if same has not been done). The size of all openings should be reduced as much as possible, shade all lights so that none of the light finds its way into the auditorium of the theatre.

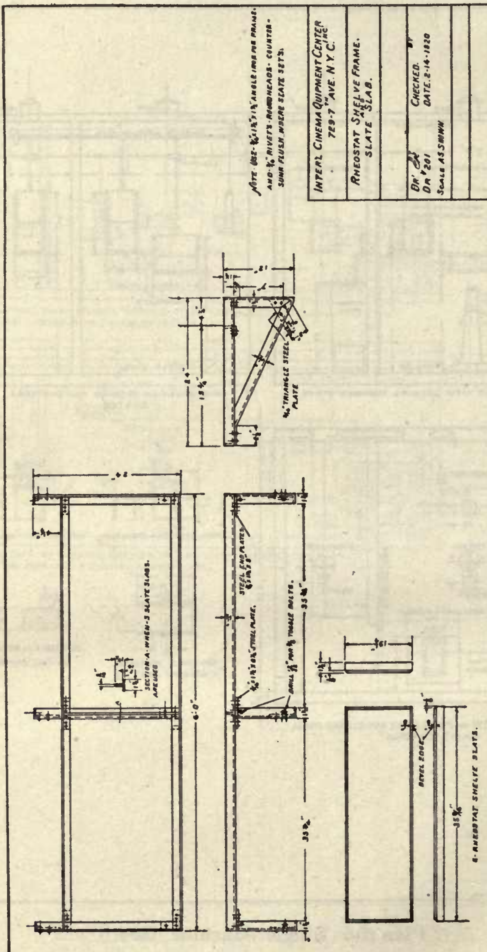
Each operator naturally has his own idea as to just what constitutes an ideal projection room, however, we are submitting in the following pages a detailed description of the furnishings and fittings of two well known and much discussed projection rooms in New York City.



Booth Plan, Reo Theatre, New York City

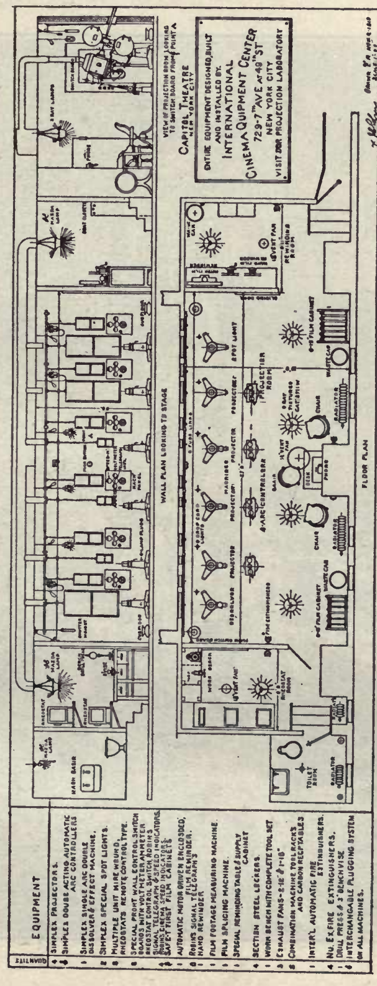


Plan for Single Machine Booth

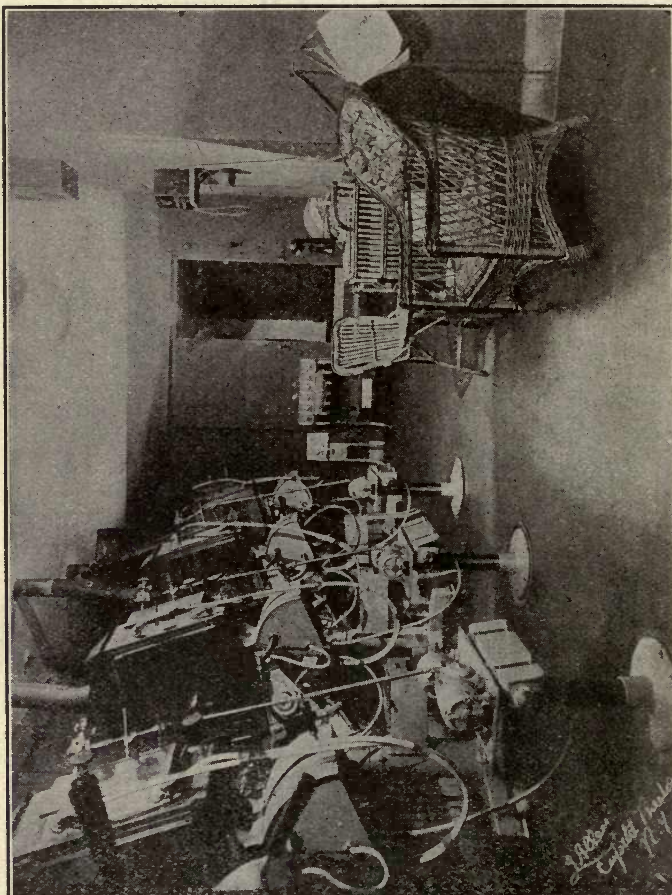


Robin Standard Slate Rheostat Shelf

PROJECTION ROOM, CAPITOL THEATRE, NEW YORK CITY



Showing Positions of Projection, Rheostat Controls, Panels, Etc.



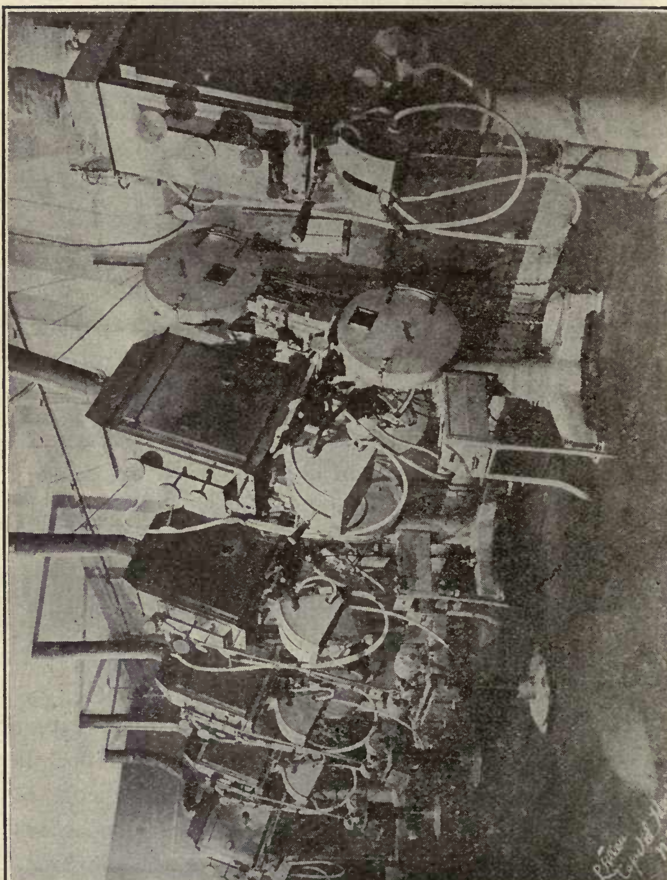
Capitol Theatre, New York City

AN IDEAL PROJECTION ROOM

"The largest theatre in the world," the New York Capitol, has a projection room in keeping with the rest of its luxurious appointments. The projection room proper is 41 feet long and 19 feet deep and as will be seen by the accompanying photographs, it is furnished with everything necessary for perfect projection. Four of the latest Type S Simplex machines are responsible for the projection, each machine is equipped with an automatic arc control and a metal cabinet for receiving hot carbon stubs.

There is also a special spotlight and a Simplex Stereopticon, the spotlight is fitted with an 8-inch iris diaphragm so constructed and arranged that any sized spot can be immediately obtained, it is also fitted with a curtain dissolve which allows the operator to gradually flood or dim the stage for special lighting effects, and dispenses with the troublesome masks.

Current supply is D. C. through 50-125 multiple unit rheostats. The rheostats are placed in a special room adjoining the projection room, the rheostat controls being on the front wall near each projector within easy reach of the operator. Each machine draws 125 amperes at an approximate pressure of 68 volts.



Capitol Theatre, New York City

The wiring for the projectors is brought under the floor up through the machine pedestals and then to machine switch. Cool and comfortable working conditions are assured at all times, the room having 4 windows opening directly into the street besides two 24-foot exhaust fans; a vent pipe runs from the lamp house of each projector to the open air.

At the far end of the projection room is the rewind room, here are found a specially built film vault for the storage of film, an enclosed motor rewind equipped with an automatic stopping device in case the film should break in the course of rewinding. The comfort of the projectionists has not been overlooked. An up-to-date washroom and lavatory together with a rest room for their special use adjoins the projection room.

The throw is 197 feet and the picture is projected on one of Robins' special white screens. The projection of the pictures and the musical score are synchronized through the medium of the Robins speed indicators.

PROJECTION ROOM INTERNATIONAL CINEMA QUIPMENT CENTER

The projection room is 20 feet long by 10 feet deep by 11 feet in height. It is built of 6-inch hollow tile, plastered on both sides. Floor is arched reinforced cement with 2-inch covering of red on the top, which renders the booth neat in appearance and easily kept clean.

Placed in the bottom of the booth are four 11 by 16-inch openings covered with fine mesh screen providing fresh air intake. An 18 by 24-inch vent flue leading to the outside carries away the warm air. This flue has a double opening in the booth, one which is covered by a grill, and in the other opening is placed an electric ventilating fan, which is controlled through the switchboard. By arranging the exhibits in this manner it does not impede the free passage of air.

There are eight openings in the booth. Each is protected by the International Fire Shutter System, which consists of kalomein frames built into the wall with channel iron slideways attached into which are fitted 1½-inch asbestos fire shutters. The shutters are suspended by chains with fuseable links from a pipe which runs along the front wall of the booth, and is controlled by gravity when a fuse melts and releases a string, the weight turns the pipe and drops all shutters.

The fire shutter is very neat in appearance and extremely effective.

There are two indirect fixtures in the booth which are controlled by push button placed adjacent to the entrance of the booth. About 12 inches from the front wall of the booth, and directly in front of each machine, is a drop light with a Crescent lamp guard and porcelain socket. The lighting of the booth is all on direct current.

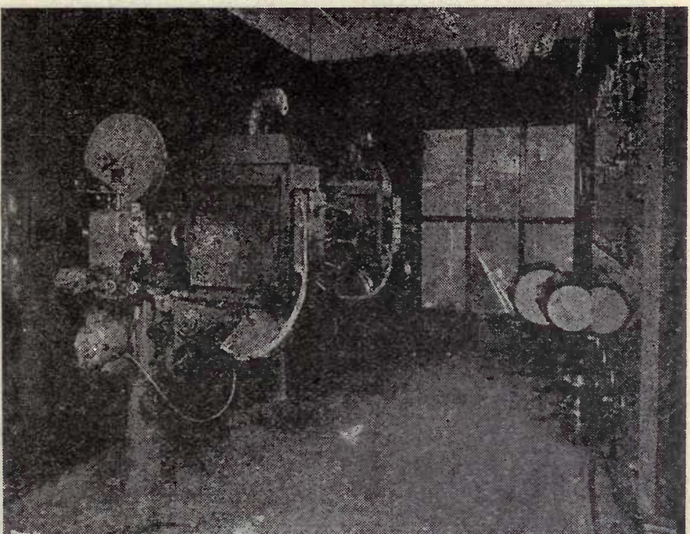


Fig. 1

There is a signal telegraph controlled from the review desk in the interior of the theatre and a return call system; also an extension Bell telephone connecting with the main switchboard of the International Cinema Quipment Centre. For the storage of film during the course of projection the two 15-inch 5-section Safe-T-First cabinets are used.

Directly in the rear of the booth is a large kalomein bench 6 feet long by 18 feet wide, which is used as a rewinding table, and the lower portion, which is divided into drawers, is used for accessories and supplies.

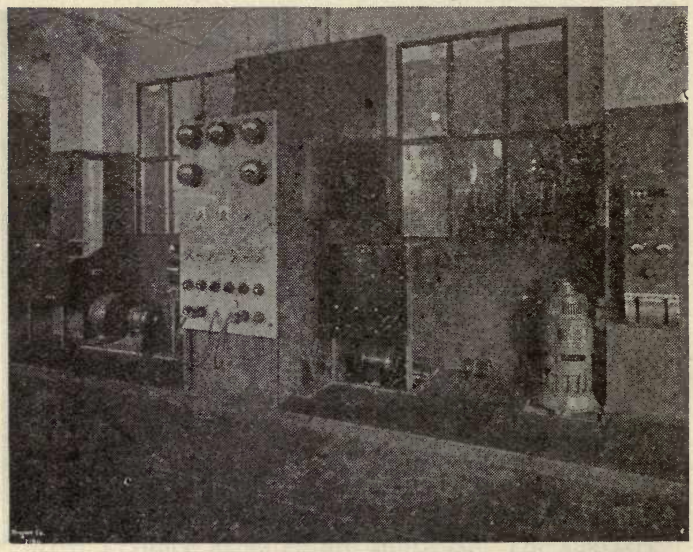


Fig. 2

There is also provided an automatic sprinkler system in the booth, fire extinguishers and pails.

The electric service consists of 110/220 volt Edison D. C., 110/220 volt single phase 60 cycle A. C. and 220 volt two phase A. C. This power is supplied direct from the lighting company on a special service run from the basement. Directly behind the machines in the rear wall of the operating room is a special control board designed by J. E. Robin. This board is 6 feet square of a dead face type. All meters and switches operate from the front and are back connected. The board is built of blue Vermont marble 2 inches in thickness.

Fig. 3 shows the appearance of the front and Fig. 4 the rear. On the face of the board are mounted two Weston D. C. ammeters, two Weston A. C. ammeters and one Weston D. C. and one Weston A. C. volt meters. The six hand wheels directly underneath the meters control volt and ammeter switches, rendering it possible to read the amperage or voltage on either side of the line, or the arc, and on any control device being tested. Each D. C. ammeter is provided with five interchangeable shunts, and each A. C. ammeter with three current transformers, which are shown to the left of the photograph Fig. 4. The A. C. ammeter has a push button underneath in the circuit which is connected with a multiplier to permit reading on the low voltage of transformer. The two other hand wheels shown on the left are on the right side of the booth control field rheostat, and the upper row of switches machine motor circuits and lighting, vent fans and Mazda lamp A. C. transformers. The lower row are the four main line switches—two provided for the generator switchboard and two for the engines.

As shown on photograph Fig. 4—12-200 ampere Kleigl plugging pockets. These are underneath the front of the board and underneath the booth directly from each projecting machine is run in conduit, concealed in the floor two No. 0 wires, which come out through a furrel in the bottom of the board, of which there are four, and terminate in five-foot long generator cable with a Kleigl plug attached.

Directly underneath the projecting machine in the booth is a ventilator, where are located A. C. arc transformers, A. C. Mazda transformer, D. C. and A. C. rheostat and D. C. Mazda lamp rheostat. All

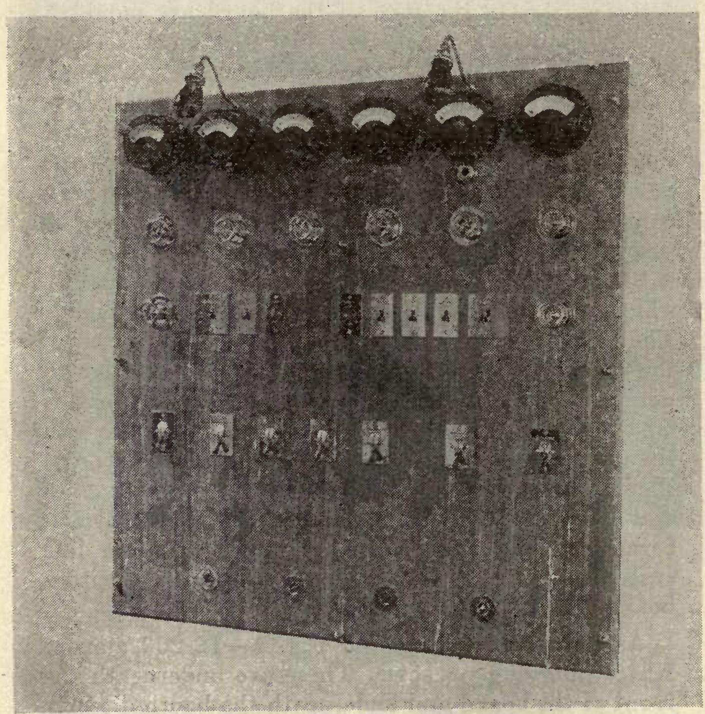


Fig. 3

connections from these devices run direct from the main switchboard and terminate in the box of main switchboard. It is possible, therefore, by plugging in one of the four machines into the pockets to operate on the different kinds of apparatus either A. C. or D. C., running one or four machines simultaneously.

All wiring of conduits are concealed in the floor and walls of the booth, and the wires leading to the machines, meters and arc switch come up directly in the centre of pedestal. Set flush in the wall directly underneath the lookout hole in front of each projector is a special control panel board of blue Vermont marble with a volt meter and ammeter mounted on the face of the same, and Robin Cinema electric speed indicator. There is also provided a radial rheostat switch connected to the multiple unit rheostat. This switch is used to control the amperage at the arc which may be run from 5 to 100 amperes. This marble cover on panel board is arranged with hinges to open down into the booth, thus rendering it accessible.

In addition to the general booth equipment there is shown to the rear of the booth in photograph the motor generator testing department. In this space are five different types of motor generators, both single and two phase, with special panel board in front of each one with control switches and instruments.

Each generator is mounted on an iron pan, which is attached to frame and rests on cork and rubber to prevent noise when in operation. The top of the platform is covered with a battleship linoleum bound with brass. The switchboard shown in the centre controls the motor generator sets, and is interconnected with the main switchboard in the booth. This board is also dead type with the front of the blue Vermont marble of 2-inch thickness, with all switches back connected and enclosed with a steel cabinet with two doors making it accessible from the rear. On the upper row are instruments consisting of two two-

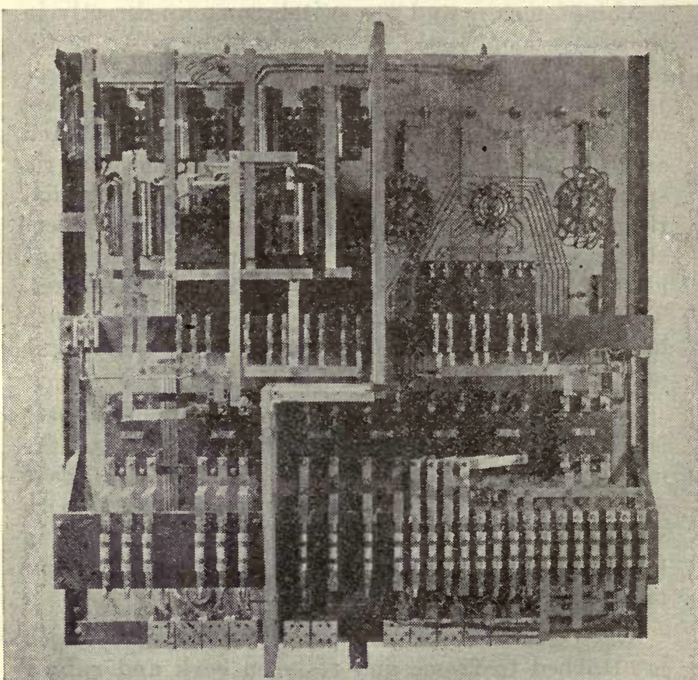


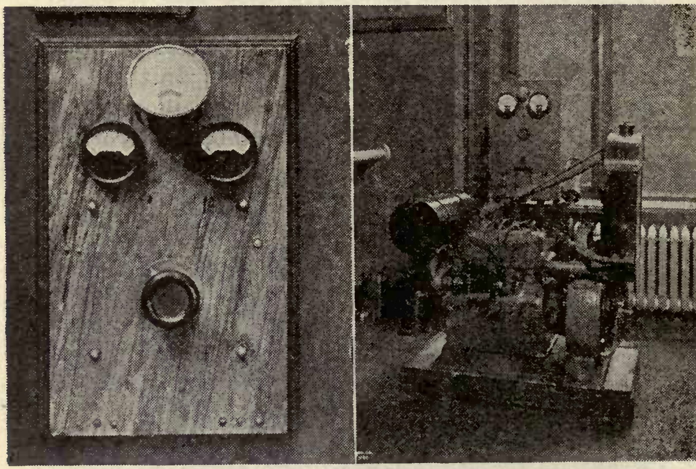
Fig. 4

phase Weston indicating watt meters, one Weston single indicating watt meter. This serves to show the wattage used in running the various machines. The two lower machines are without meters, which are connected across the two, coming out of the bottom of the board, which indicate in watts the power being taken in any of the generators. In this manner the current being used can easily be determined. The voltage and amperage may be obtaind from the meters on the individual panel or from the interior of the instruments in the booth.

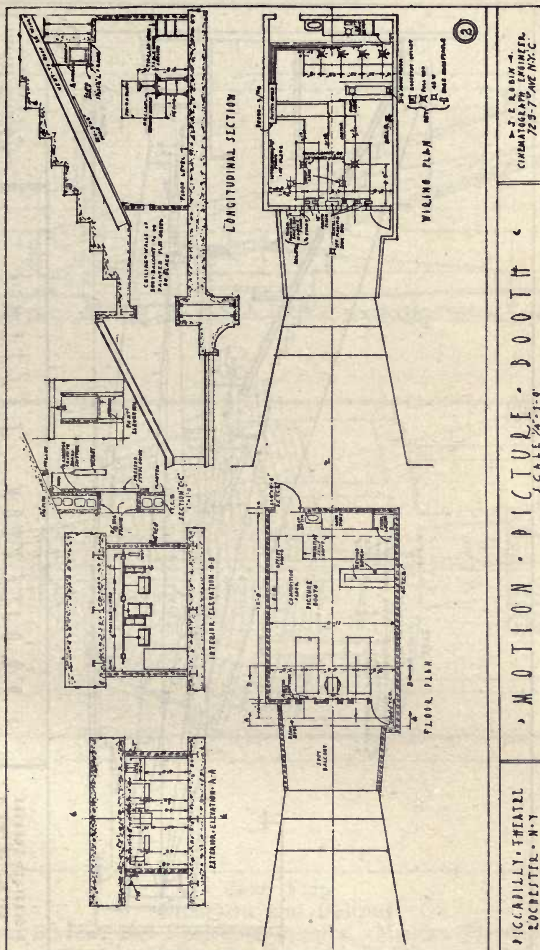
There are 10 plugging pockets on the board, two being connected with each machine. The two cables shown coming out of the board connect with the main switchboard in the booth. It is possible, therefore, to plug one or two arcs on any of the generators or for comparative test to run two generators simultaneously with one arc on each.

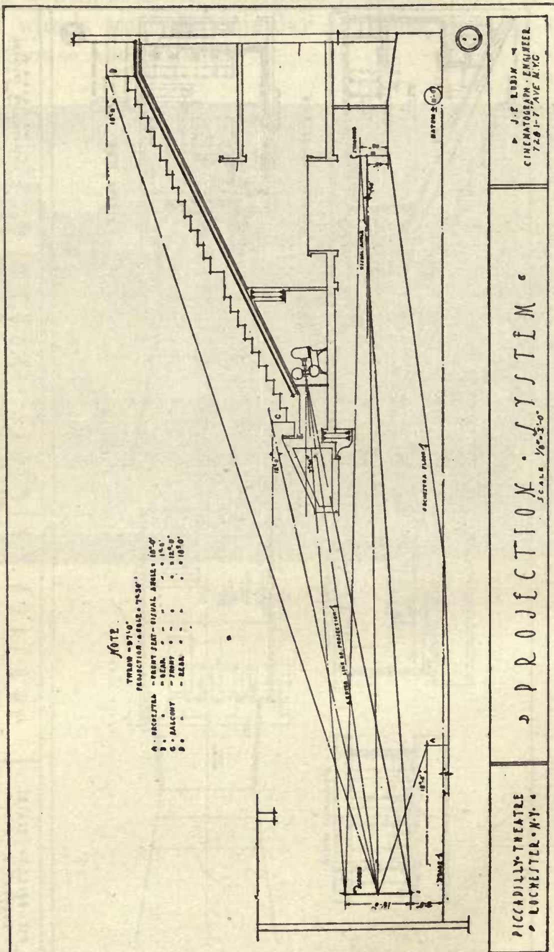
This switchboard contains both current transformers, voltmeter multipliers and resistances and other necessary switches, cutouts and accessories.

The machines consist of two Type "S" Simplex—one Simplex Mazda equipment with A. C. and D. C. regulator and one Simplex with 1½ to 1 shutter—5 to 1 movement and Argus sheck adapter. This machine is also equipped with Feaster non-rewind. All projectors are enameled battleship gray with fittings in nickel. Each machine is equipped with volt and ampere meters on front panel, also Robin Cinema electric speed indicators, lamp house with Simplex arc periscope, which throws the image of the arc on the walls or ceiling. The Mazda lamp, A. C. transformers and D. C. rheostats are located in the floor of the booth, and are controlled from the interior by hand wheels somewhat similar to those used in the pilot house aboard ship.

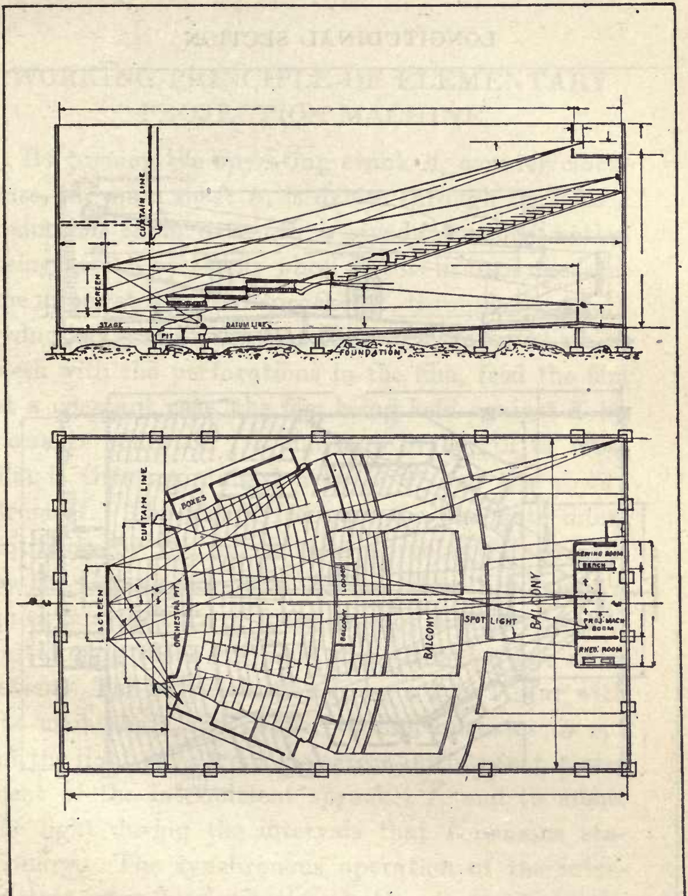


Figs. 5 and 6


LONGITUDINAL SECTION
WIRING PLAN
INTERIOR ELEVATION B-B
FLOOR PLAN
EXTERIOR ELEVATION A-A
MOTION · PICTURE · BOOTH
PICCADILLY · THEATRE
ROCHESTER · N·Y
CINEMATOGRAPH ENGINEER

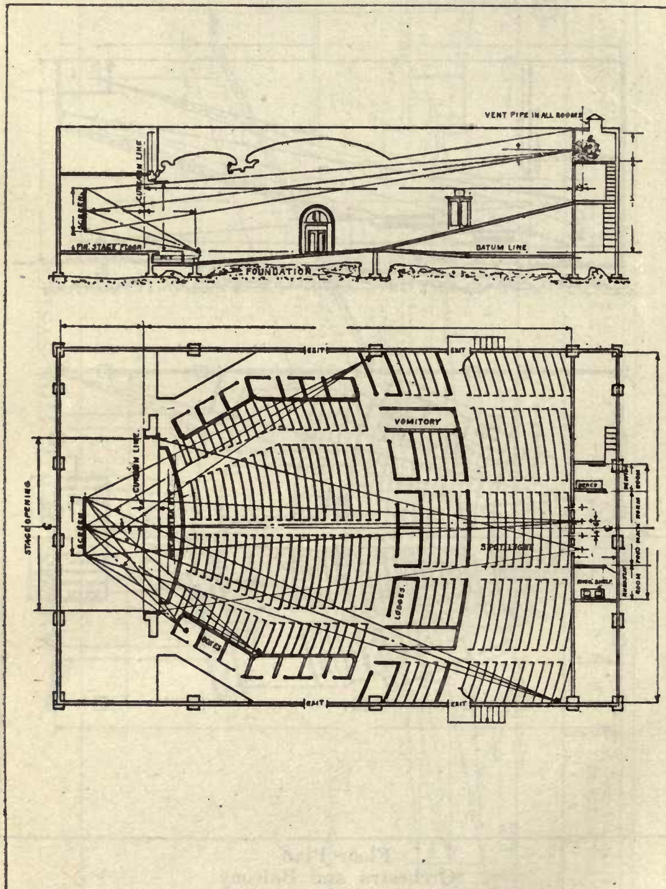


BALCONY PROJECTION SYSTEM



Floor Plan
Orchestra and Balcony
Visual Screens and Projection Angles. Modern Theatre Projection Layout to Determine Size and Position of Screen and Height Above Stage.

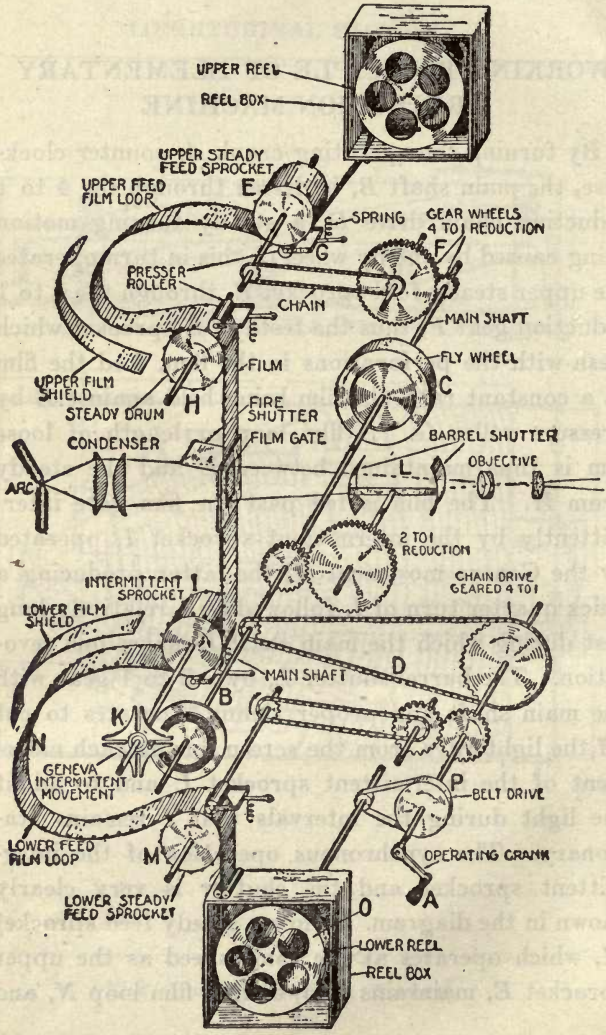
LONGITUDINAL SECTION



Floor Plan, Single Floor Theatre

WORKING PRINCIPLE OF ELEMENTARY PROJECTION MACHINE

By turning the operating crank *A*, counter clockwise, the main shaft *B*, is driven through the 4 to 1 reduction chain drive *D*, a steady turning motion being caused by the fly wheel *C*, this in turn operates the upper steady feed sprocket *E*, through the 4 to 1 reduction gear *F*, thus the teeth of *E* sprocket which mesh with the perforations in the film, feed the film at a constant rate, the film being held against *E* by pressure roller *G*. A film loop or length of loose film is thus maintained between *E* and the steady drum *H*. The film is fed past the film gate intermittently by the intermittent sprocket *I*, operated by the Geneva movement *K*, the latter producing a quick quarter turn of *I*, followed by a relatively long rest during which the main shaft *B* makes one revolution. The barrel shutter *L*, by a 2 to 1 gear with the main shaft and proper timing, operates to cut off the light rays from the screen during each movement of the intermittent sprocket *I*, and to admit the light during the intervals that *I* remains stationary. The synchronous operation of the intermittent sprocket and the shutter is very clearly shown in the diagram. A lower steady feed sprocket *M*, which operates at the same speed as the upper sprocket *E*, maintains a lower feed film loop *N*, and



UPPER REEL
REEL BOX
UPPER STEADY FEED SPROCKET
UPPER FEED FILM LOOP
E
SPRING
GEAR WHEELS 4 TO 1 REDUCTION
F
G
PRESSER ROLLER
CHAIN
MAIN SHAFT
FILM
FLY WHEEL
C
UPPER FILM SHIELD
H
STEADY DRUM
FIRE SHUTTER
FILM GATE
BARREL SHUTTER
CONDENSER
OBJECTIVE
ARC
L
2 TO 1 REDUCTION
INTERMITTENT SPROCKET
I
CHAIN DRIVE GEARED 4 TO 1
LOWER FILM SHIELD
D
MAIN SHAFT
B
K
N
GENEVA INTERMITTENT MOVEMENT
P
BELT DRIVE
LOWER FEED FILM LOOP
M
OPERATING CRANK
A
LOWER STEADY FEED SPROCKET
O
LOWER REEL
REEL BOX

feeds the film to the lower reel *O*. Because of the increasing diameter of the roll of film due to winding the film on reel *O*, the velocity of rotation of *O* must be allowed to vary; this is accomplished by means of the belt drive *P*, the belt permitting slippage below the maximum speed. *It should be carefully noted* that the total revolutions made by each of the three sprockets *E*, *I*, and *M*, is the same, the only difference being that *the motion of E and M is constant while that of I is intermittent.*

LIGHT

That light travels with a speed, which is much greater than the speed of sound is shown by the fact that the flash of a distant gun is always seen long before the sound of the report is heard and that lightning always precedes thunder.

For most purposes it is sufficiently accurate to take the velocity of light as 186,000 miles per second.

Light always travels out from a source in straight lines.

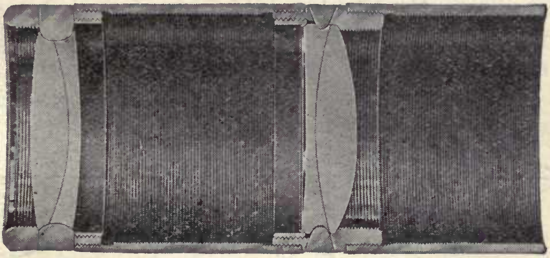
Up till the year 1800, the Corpuscular theory of light was the one most generally accepted, that light consists of streams of very minute particles, or corpuscles projected with the enormous velocity of 186,000 miles per second from all luminous bodies. The facts of straight line propagation and reflection are exactly as we should expect them to be if this were the nature of light.

A usual hypothesis which was first completely formulated by the great Dutch physicist—Huygens (1629-1695), regarded light like sound, as a form of wave motion. This hypothesis met at the first with two very serious difficulties; in the first place light, unlike sound, not only travels with perfect readiness through the best vacuum which can be obtained with an air pump, but it travels without any apparent difficulty through the great interstellar spaces which are probably infinitely better vacua than can be obtained by artificial means. If, therefore, light is a wave motion, it must be a wave motion of some medium which fills all space and yet which does not hinder the motion of the stars and planets. Huygens assumed such a medium to exist, and called it ether.

The second difficulty in the way of the wave theory of light, was that it seemed to fail to account for the fact of straight line propagation. Sound waves, water waves and all other forms of waves with which we are familiar bend readily around corners, while light apparently does not. It was this difficulty chiefly which led many of the famous philosophers, including the great Sir Isaac Newton, to reject the wave theory and to support the projected particle theory.

Within the last hundred years, however, this difficulty has been completely removed and in addition other properties of light have been discovered, for which the wave theory offers the only satisfactory explanation. If the wave theory is to be accepted, we must conceive with Huygens, that all space is filled with a medium, called the ether, in which the waves can travel. This medium cannot be like any of the ordinary forms of matter; for if any of these forms existed in interplanetary space, the planets and the other heavenly bodies would certainly be retarded in their motion. As a matter of fact, in all the hundreds of years during which astronomers have been making accurate observation of the motion of heavenly bodies no such retardation has ever been observed. The medium which transmits light waves, must therefore have a density which is infinitely smaller even in comparison with that of our lightest gases. The existence of such a medium is now universally assumed by physicists.

Just as sound waves are disturbances set up in the air by the vibrations of bodies of ordinary dimensions, so light waves are disturbances set up in the ether probably by the vibrations of the minute corpuscles or electrons, of which the atoms of ordinary matter are supposed to be built up. Since these corpuscles are extremely small in comparison with ordinary bodies it is not surprising that their rates of vibration are enormously larger than the vibration rates of tuning forks, or other bodies which send out sound waves. Just how these corpuscles are set into vibration and in just what manner they vibrate, we cannot say as yet with certainty, but since we do know that an increase in the temperature of all bodies means an increase in the agitation of the molecules and atoms of which these bodies are composed. It is not surprising that the vibrations which communicate light waves to the ether take place in general in bodies which have a high temperature and that the hotter the body becomes the more intense becomes the light waves which it emits.

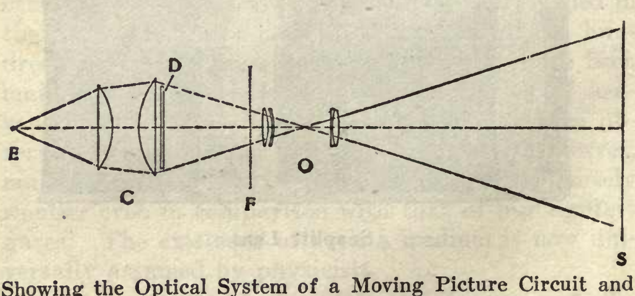


Snaplite Lens

PRINCIPLES OF OPTICAL PROJECTION

The process is almost the reverse of ordinary photography. For instance, in photography a scene by means of the photographic objective or lens is photographed and a reduced image is obtained on ground glass. This glass is replaced by a sensitized plate and by the use of chemicals the image is fixed thereon.

In projection the process is reversed, that is, a transparent slide is made from the picture, or the roll of film taken with the motion picture camera is developed and used in the motion picture machine (the projector). By means of a condensed light they are strongly illuminated and with an objective lens an enlarged image is projected upon the screen, this screen image corresponding to the real objects photographed. The principles of optical projection for motion picture machine will readily be understood from the diagram below.



Showing the Optical System of a Moving Picture Circuit and How Rays of Light Travel from Arc E to Screen S

At *E* is an electric arc or other suitable illuminant, the light from which is caught up by the condenser *C*. This condenser is an arrangement of lenses so constructed as to gather up the greatest volume of light possible and to concentrate the light which it gathers at the center or diaphragm plane of the objective when the objective is located at the proper distance from the film, which distance is determined by the focal length of objective lens.

The film should be placed at such a point that the entire area of the aperture in gate is fully illuminated, and it should also be placed so that the greatest number of light rays possible should pass through it.

Proceeding from the slide *D* or film *F* the light passes through the objective *O*, where the rays cross, and the object is therefore reversed, by means of the objective, the object is also imaged or delineated upon the screen *S*, the degree of sharpness or flatness of the image depends upon the optical connection of the lens.

Great care should be taken to line up properly the arc, condensers and the objective lens, as under the best of conditions less than 5% of the light from arc reaches the screen.

LENSES

The optical system of a moving picture circuit comprises:

(*a*) The arc lamp or mazda lamp.
(*b*) The condensers.
(*c*) The lens, or objective.

The optical system is a very important one and one that has long been neglected by the majority of operators. A number of men who have been operating machines for years have never taken the lenses apart and have no idea of the different combinations making up the objective lens.

There is no motion picture book published that we know of which goes far enough into this matter, and we would advise anyone desirous of getting all the information possible on lenses to study the books dealing with this subject that may be found in the various libraries.

The following is an outline of what an operator should know, and has been gathered from several books dealing with optical systems and lenses.

Reflection. The change of direction experienced by a ray of light when it strikes a surface and is thrown back or reflected. Light is reflected according to two laws:

(*a*) The angle of reflection is equal to the angle of incidence.
(*b*) The incident and the reflected rays are both in the same plane which is perpendicular to the reflecting surface.

Refraction. The change of direction which a ray of light undergoes upon entering obliquely a medium of different density from that through which it has been passing. In this case the following laws obtain:

(*a*) Light is refracted whenever it passes obliquely from one medium to another of different optical density.

(*b*) The index of refraction for a given substance is a constant quantity whatever be the angle of incidence.

(*c*) The refracted ray lies in the plane of the incident ray and the normal.

(*d*) Light rays are bent toward the normal when they enter a more refracted medium and from the normal when they enter a less refracted medium.

A lense may be defined as a piece of glass or other transparent substance with one or both sides curved. Both sides may be curved, or one curved and the other flat.

The object of the lens is to change the direction of rays of light and thus magnify objects or otherwise modify vision.

Lenses may be classed as:

Double convex	Double concave
Plano convex	Plano concave
Concavo convex	Convexo concave

The focus of a lens is the point where the refracted rays meet.

Spherical Aberration. The reflected rays of concave spherical mirrors do not meet exactly the same point. This is called spherical aberration.

Effect of Spherical Aberration. It produces a lack of sharpness and definition of an image. If a ground glass screen be placed exactly in the focus of a lens the image of an object will be sharply defined in the center but indistinct at the edges, and if sharp at the edges it will be indistinct at the center. To avoid this a disc with a hole in the center is placed concentric with the principal axis of the lens, thus only the center part of the lens is used.

Chromatic Aberration. When white light is passed through a spherical lens, both refraction and dispersion (the decomposition of white light into several kinds of light) occur. This causes a separation of the white light into the various colors and causes images to have colored edges. This effect which is most observable in condenser lenses is due to the unequal refrangibility of the simple colors.

Achromatic Lenses. The color effect caused by the chromatic aberration of a simple lens greatly impairs its usefulness. This may be overcome by combining into one lens, a convex lens of crown glass and a concave lens of flint glass.

Back Focal Length. The distance from the back of the lens to the film in the gate of machine while the film is in focus on the screen. (Written B. F.)

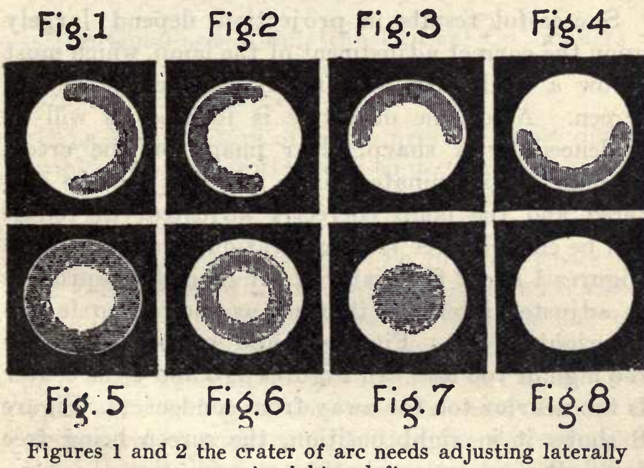
Equivalent Focus. The distance from a point half way between the back and front combination of lenses to the film in the gate while picture is in focus on screen.

Can be obtained by measuring the distance between the front and back combination then dividing by two and adding the result to the back focal length. (Written E. F.)

Objective Lens. The objective lens of a moving picture machine generally consists of four lenses, two in the front combination and two in the rear. The two lenses in the front are cemented together with Canada Balsam and called the compound lens. The back combination consists of two lenses separated by a metal ring, called the duplex lens.

The convex or greatest convex side of a lens always faces the screen.

It is absolutely necessary to keep the lenses clean, it will be impossible to get good definition or sharp focus on the screen if the objective lens is not scrupulously clean. Never place the fingers on the glass



Figures 1 and 2 the crater of arc needs adjusting laterally to right or left
Figures 3 and 4 the crater too high or too low
Figures 5, 6 and 7 the crater is too near or too far away from condenser
Figure 8 shows arc in correct position

surface of lens, as though it may not show when looking through the lens it will undoubtedly affect the definition of picture on screen.

Condenser lenses should be cleaned every day, and the objective lens once or twice a week. It will not be found necessary to take the lens apart to do this, as it will only be the exposed glass surfaces that will need attention. Use a clean soft handkerchief for this purpose. The lens can be taken apart every three or four months and all surfaces thoroughly cleaned, great care should be taken when taking the lens apart so that you get the lenses back in the same position and order.

Successful results in projection depend largely upon the correct adjustment of the lamp, which must throw a brilliantly illuminated clear circle on the screen. After the objective is focused as will be evidenced by a sharp, clear image on the creen, examine the illuminated circle. If the light be centered and the lamp correctly adjusted, the circle will be entirely free from coloration or shadows. In Figures 1 and 2 the crater of arc needs to be properly adjusted laterally, it being as shown too far to the right or left. Figures 3 and 4 show the crater too high or too low. In Figures 5, 6 and 7 the crater is too near or too far away from condensers. Figure 8 shows it in right position, the screen being free from all shadows or ghosts.

Fig. 9 shows the various lenses: (*a*) double convex; (*b*) plano convex; (*c*) concavo convex; (*d*) double concave; (*e*) plano concave; (*f*) convexo concave.

The first three are thicker at the center than at the border, and are called converging; the second three which are thinner at the center are called diverging.

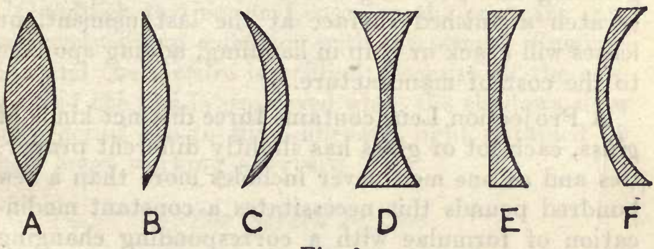


Fig. 9

The Gundlach-Manhattan Optical Co., makers of the Gundlach Projection Lens, issue the following data regarding Lenses.

The Manufacture of lenses presents many difficult problems for the optician to contend with because of the peculiar characteristics of optical glass as well as the fact that it is not a material easily worked owing to its hard, brittle nature. To produce lenses that are well corrected in the optical sense and maintain a uniform standard of quality requires not only scientific knowledge of optics and mathematics of a high order to compute the formula but also the utmost skill and precision must be used during the mechanical operations to obtain the desired result. Even then it depends upon a master optician for the final adjusting and testing before the lens is ready for market because a good lens may be spoiled by improper mounting. In this respect lenses are different from articles made of other materials which can readily be made to conform to dies, patterns or blue-print specifications with certainty that when these are followed, the finished article will be perfect.

Each lens goes through several operations of grinding and polishing and a stray bit of grit may scratch a finished surface at the last moment, or lenses will crack or chip in handling, adding spoilage to the cost of manufacture.

A Projection Lens contains three distinct kinds of glass, each lot of glass has slightly different properties and as one melt never includes more than a few hundred pounds this necessitates a constant modification of formulae with a corresponding changing of tools which involves a big expense.

All this, of course, applies to a maintainance of a standard of quality and explains why ordinary projection lenses made with no special care and taken as they come naturally cost a great deal less than Gundlach Projection Lenses which must all pass the same tests and reach a fixed standard of quality before leaving the factory. Further, lenses of large aperture require more care in grinding and polishing than lenses of less curvature and their adjustment is more sensitive. Besides, the larger lenses must be made separately while those of smaller diameter with flatter surfaces can be made two or more at a time reducing the cost of manufacture proportionately.

It is an axiom of optics that the best lens is never too good for the purpose and this is particularly true as regards projection, it being obvious that a poor lens makes a picture which is unsatisfactory to a large number of people and the theatre owner or producer suffers in consequence by criticism of the show and loss of business. Now, a poor lens not only will not focus sharply but the image is flattened and lacks contrast because what should be black becomes gray and light and shade gradations of the film image are not reproduced in their proper values.

Gundlach Projection Lenses on the contrary give uniformly sharp definition with the utmost illumination and the picture is brilliant because all the contrast of the film is preserved while the shadows show more detail due to the additional light obtained by their large working aperture.

The Screen Picture

The size of the film image is ¾x1″ and the opening in the aperture plate has been standardized by the principal machine manufactures at our suggestion and is now 29/32″ wide with the height ¾ of the width. The picture is magnified in the same proportions, therefore, the screen must be 9 inches high for each foot in width. For example, 9′x12′, 10′6″x14″ or 12′x16′. A picture 16 ft. wide requires a magnification of the film image of about 212 diameters or nearly 44,944 times the size of the original.

The importance of standardization of the opening in the aperture plate may be realized from the fact that the two sizes formerly used 15/16″ wide and 29/32″ wide with a difference of only 1/32″ would result in a difference of about 6 inches between the width of pictures made with matched lenses for a picture 16 ft. wide so that pictures of the same size could be obtained only by using lenses of different focal lengths, an inconvenient and difficult method of securing this result.

It is our opinion that the quality of the picture is more important than its size, or, in other words, we must have perfect projection as the first consideration. Owing to the unavoidable loss in definition and illumination incidental to an increase in magnification it is advisable to keep the size of the picture within a reasonable limit which we think is about 12x16. Above this size the surface area increases very rapidly with each additional foot in width. The distance the picture is projected is not so important unless it necessiates the use of lenses of abnormally short or long focus.

Theoretically, there is a loss of light in inverse ratio to the square of the distance, but in practice a picture of a given size can be projected within a reasonable distance without any noticable change in luminosity. Obviously this imposes a limitation to the size of theatres, therefore it is not advisable to make a theatre so large that good projection cannot be secured. The best results are obtained with lenses ranging between 4″ and 7½″ focal length and any deviation from these is not advisable.

The picture is projected from the same film whether it is thrown 25 ft. or 150 ft. while an enlargement of the picture is secured only by magnification of the film image with a consequent depreciation of the light by spreading it over a greater surface. The definition is impaired as the natural result of magnifying a film image which is not absolutely sharp to begin with. On the contrary, a difference in the distance does not bring these factors into consideration although other difficulties arise if an effort is made to produce too large a picture with a very short focus lens or a comparatively small picture with a relatively long focus lens. The thing to avoid is extreme or abnormal conditions because the best result can be obtained only by being careful that each factor having an influence upon the quality of the picture is normal and efficient. Most important of these is Gundlach Projection Lenses which insure uniform definition with a brilliant image and the utmost luminosity. We differentiate between brilliancy of the image and the working aperture of the lens or the amount of light it collects and transmits because the former is determined by its color correction which if good, will preserve the contrast of the film and if poor, will flatten the image while luminosity is merely the inevitable result of making the diameter large in proportion to the focal length.

Three principal factors govern the illumination of the picture, first the light source including its adjustment, current consumption and condenser system by which the film is illuminated.

Next is the working aperture of the projection lens or the ratio between its diameter and focal length.

The third is the size of the picture or its surface area.

The working aperture of the lens is the only one in which we are directly interested.

This ratio in Gundlach Projection Lenses is carried out to the highest degree with resulting apertures of F.2. to F.3.5. according to the focal length is not being practical for many reasons to maintain a uniform aperture of F.2.

That the size of the picture is an important consideration is evident as it must be clear that the same amount of light spread over a larger surface will be weaker.

For comparison we give the following examples:

Size of Picture	Surface Area	Magnification
9x12	108 sq. ft.	158.88 diameters
12x16	192 sq. ft.	211.84 diameters
15x20	300 sq. ft.	264.80 diameters

The Projection Lens

This we have already mentioned as being the ratio between the diameter and focal length and this determines the amount of light transmitted by lenses of all kinds. Obviously there must be a physical limitation to this and in practical optics this is 1—2, so the diameter cannot be more than half the focal length. Even to attain this result is an achievement, it involves making lenses with strong curves, each made separately with the utmost care and great precision in mounting and the adjustment of the components of the complete lens in relation to each other.

This means the distance from the optical center of the lens to the point where it defines a sharp image when focused for infinity and this measurement can be made accurately only by optical means. Commercially we grade the focal lengths in quarter inches in engraving the cells but we mark the exact focal length in hundredths of an inch on the wrapper and use this measurement in filling orders.

To cite an instance a 16 ft. picture at 99 ft. requires a lens of 5.60 focus. A lens of exactly 5½ inch (5.50) focus would make the picture oversize and 5¾ focus would be too long. To meet this condition, we would make a selection from 5½″ lenses in stock of those the nearest to 5.60″ focus but longer rather than shorter. Of course there is a possibility in every case that an error in measuring the distance will be a disturbing factor and some allowance should be made by the customer for some difference between the size of the picture and screen which is unavoidable and easily painted out.

Lenses are matched by selection as the focal length cannot be modified after they are finished. In manufacturing they deviate to some extent from the focal length prescribed by the optical formula running both under and over for which reason they are not necessarily the exact focal length engraved upon the mounts. For example, a 4″ lens may vary within the quarter inch from 3.95″ to 4.20″, it being our practice to mark the mounts within 5/100″ under to 20/100″ over of the actual focal length and it will be perceived that two lenses marked with the same focal length may at the most have a difference of ¼″ and matching for pictures of the same size necessitates that both lenses shall be exactly the same focal length. This being the case the lenses must be matched when they leave our factory unless a lens to be duplicated is sent to us so we can measure it or if it was purchased from us we will have a record of its focal length which we can locate if given the order number or date of invoice. The exact focus in hundredths of an inch is shown by our invoices in parenthesis, for example, (4.36), and purchasers should make a note of this to faciliate placing repeat orders for duplicates when they wish to match a lens or replace one which has been damaged.

This system has proven a great convenience to many of our customers and constitutes a real service which adds greatly to our detail in making and supplying lenses. Sometimes we are called upon to match or duplicate a lens we sold several months or years ago, and it is quite an advantage to the customer to get a new lens that will make the picture the same size it was before without any loss of time.

It should be noted by every user of a projection lens that the components are not interchangeable and no liberty whatever should be taken with the arrangement or adjustment of a lens. A broken element cannot be replaced unless the complete lens is returned for repairs and the broken parts should be preserved as they may be useful in determining the exact original focal length, otherwise this may be changed by replacing the broken lens. Odd combinations or lenses are absolutely of no value and we cannot undertake to utilize them to make up complete lenses or for repairs.

The condition of many lenses sent in to us indicates great carelessness in handling them and Projectionists should be cautioned to handle them more gently. There is positively no excuse for so many scratched surfaces, broken lenses and ruined mounts after allowing for reasonable accidents.

The terms quarter and half size have no real place in optical nomenclature although commonly used. No doubt they originated in the early days of photography when applied to portrait lenses used for quarter size (3¼x4¼) and half size (4¾x6½) cameras. These were the first lenses used for projection and eventually each size was made in a number of different focal lengths. The Projection Lenses of to-day are made by a modification of the formula of the original Petzvel Portrait Lens which we have brought to perfection with the improved optical glass at our command. The sizes of Gundlach Projection Lenses are numbered to prevent them from being unfairly compared or confused with so-called quarter and half size lenses of smaller diameter and less light efficiency.

We wish to make it clear that there is no optical difference between our No. 1 and No. 2 size Projection Lenses. The No. 2 size is merely a continuation of the No. 1 size, providing longer focal lengths with the same relative working aperture to maintain the illuminating power but it is evident that in corresponding focal lengths the No. 2 size will transmit more light than the smaller size, therefore, it is a decided advantage to use the No. 2 lenses in any focal length in which they are made from 5¾″ up. If the increased illumination is not needed on the screen it can be saved in current so the lens of large aperture is an economy to this extent.

To answer a question frequently put to us, we state that the keystone effect incidental to projecting the picture from an angle can not be corrected by the Projection Lens, this being the natural result of a difference in the length of the light rays from the lens to the top and bottom or sides of the screen as the case may be, causing a greater magnification of the image at one point than at the other. Theatre architects should be informed that the location of the operating room should be planned to bring the machines in a horizontal line with the center of the screen.

In event that lenses we supply do not make the picture close enough to the desired size, on account of an error in measuring the distance, report at once the exact width of the picture they produce and we can then allow for the error and determine what the distance actually is and the focal length required.

If you want Gundlach lenses to make a picture the same size as it is made by some other lens send the lens to us to be measured because you cannot depend upon the focal length engraved on the mount.

Computing the Focal Length

The focal length required is ascertained by a computation based upon the size of the opening in the aperture plate, the size of the picture wanted and the distance it is to be projected.

The distance is somewhat uncertain owing to errors made in measuring it which we have known to amount to as much as fifteen feet but in case a mistake has been made by which lenses of the wrong focus have been secured it is easily rectified. We should then be informed the exact width of the picture made by the lenses the customer has received and as we have a record of their exact focus, we can calculate from these two factors what the correct distance is and determine the proper focal length of the lenses to send in exchange. The distance of projection can be obtained by referring to the architect's plans of the theatre if these are available.

Measure the distance accurately, and you can depend upon us to supply lenses of the correct focal length.

Cleaning and Assembling

First note whether the extension tube is attached to the front or rear end so you will replace it correctly. Clean both sides of the front combination but do not remove it from the cell. To remove the retaining ring from the rear cell, press lightly on opposite sides of the ring with two fingers and unscrew it. Too much pressure will make it bind so it will not turn. Clean inside surfaces of the two lenses of the rear combination and replace in the cell. Be careful they are seated evenly, then screw up the retaining ring just tight enough to prevent them from moving, then clean the outside surface.

The rear lens is convex on both sides and the flatter side is the outside rear surface. The retaining rings should face towards the centre; reversing the cells will disturb the correction.

To remove grease or oil from the surface of the lens use a soft rag free from grit, moistened with a little gasoline.

Be careful when screwing the parts together to avoid skipping a thread and do not screw up any joints very tight.

Do not use a hard sharp tool to remove the retaining rings or it may slip and scratch the lenses.

LENS TABLE OF FILM PROJECTION

DISTANCE FROM FILM TO SCREEN

Stero.	M. P.	15	20	25	30	35	40	45
8	2	5.04	6.74	8.44	10.14	11.84	13.54	15.24
		6.72	8.99	11.25	13.52	15.78	18.05	20.31
9	2¼	4.48	5.99	7.50	9.01	10.52	12.03	13.54
		5.97	7.98	10.00	12.01	14.03	16.04	18.05
10	2½	4.02	5.38	6.74	8.10	9.46	10.82	12.18
		5.36	7.17	8.99	10.80	12.61	14.42	16.24
11	2¾	3.65	4.89	6.12	7.36	8.59	9.83	11.06
		4.87	6.52	8.17	9.18	11.46	13.11	14.76
12	3	3.34	4.47	5.61	6.74	7.87	9.00	10.14
		4.46	5.97	7.48	8.99	10.50	12.01	13.52
13	3¼	3.08	4.13	5.17	6.22	7.26	8.31	9.35
		4.11	5.50	6.90	8.19	9.69	11.08	12.48
14	3½	2.86	3.83	4.80	5.77	6.74	7.72	8.69
		3.81	5.10	6.40	7.69	8.99	10.28	11.58
15	3¾	2.66	3.57	4.47	5.38	6.28	7.19	8.10
		3.55	4.76	5.97	7.17	8.38	9.59	10.80
16	4	2.49	3.34	4.19	5.04	5.98	6.74	7.59
		3.32	4.45	5.59	6.72	7.85	8.98	10.12
17	4¼	2.34	3.14	3.94	4.74	5.54	6.34	7.14
		3.12	4.19	5.25	6.32	7.38	8.45	9.52
18	4½	2.21	2.97	3.72	4.48	5.23	5.99	6.74
		2.95	3.96	4.96	5.97	6.98	7.98	8.99
19	4¾	2.09	2.81	3.52	4.24	4.95	5.67	6.38
		2.79	3.74	4.70	5.65	6.61	7.56	8.51
20	5	1.98	2.66	3.34	4.02	4.70	5.38	6.06
		2.64	3.55	4.45	5.36	6.27	7.17	8.08
21	5¼	1.89	2.54	3.18	3.83	4.48	5.13	5.77
		2.51	3.37	4.24	5.10	5.96	6.83	7.69
22	5½	1.80	2.42	3.04	3.65	4.27	4.89	5.51
		2.40	3.22	4.05	4.87	5.70	6.52	7.34
23	5¾	1.72	2.31	2.90	3.49	4.08	4.67	5.27
		2.29	3.08	3.87	4.65	5.44	6.23	7.02
24	6	1.64	2.21	2.77	3.34	3.91	4.47	5.04
		2.19	2.95	3.70	4.46	5.21	5.97	6.72
25	6¼	1.57	2.11	2.66	3.20	3.75	4.29	4.83
		2.10	2.82	3.55	4.27	5.00	5.72	6.45
26	6½	1.51	2.03	2.56	3.08	3.60	4.12	4.65
		2.02	2.72	3.41	4.11	4.81	5.51	6.20
27	6¾	1.45	1.95	2.46	2.96	3.46	3.97	4.47
		1.94	2.61	3.28	3.95	4.63	5.30	5.97
28	7	1.40	1.89	2.37	2.86	3.34	3.83	4.31
		1.87	2.52	3.16	3.81	4.46	5.11	5.75
29	7¼	1.35	1.82	2.29	2.76	3.23	3.69	4.16
		1.80	2.42	3.05	3.67	4.30	4.92	5.69
30	7½	1.30	1.75	2.21	2.66	3.11	3.57	4.02
		1.74	2.34	2.95	3.55	4.16	4.76	5.37
31	7¾	1.26	1.70	2.14	2.58	3.01	3.45	3.89
		1.68	2.26	2.85	3.43	4.02	4.60	5.19
32	8	1.22	1.64	2.07	2.49	2.92	3.34	3.77
		1.62	2.19	2.75	3.32	3.89	4.45	5.02
33	8¼	1.18	1.59	2.00	2.42	2.83	3.24	3.65
		1.57	2.12	2.67	3.22	3.77	4.32	4.87
34	8½	1.14	1.54	1.94	2.34	2.74	3.14	3.54
		1.52	2.05	2.59	3.12	3.65	4.19	4.72
35	8¾	1.11	1.50	1.88	2.27	2.66	3.05	3.43
		1.48	2.00	2.51	3.03	3.55	4.06	4.58

LENS TABLE OF FILM PROJECTION—*Continued*

DISTANCE FROM FILM TO SCREEN

Stero.	M. P.	50	56	60	64	70	76	80
8	2	16.93	18.97	20.33	21.69	23.73	25.77	27.13
		22.58	25.30	27.11	28.92	31.64	34.46	36.17
9	2¼	15.05	16.87	18.07	19.28	21.09	22.91	24.12
		20.07	22.48	24.10	25.71	28.12	30.54	32.15
10	2½	13.54	15.17	16.26	17.34	18.98	20.61	21.70
		18.05	20.22	21.67	23.12	25.30	27.47	28.92
11	2¾	12.30	13.78	14.77	15.76	17.24	18.73	19.72
		16.40	18.38	19.70	21.01	22.99	24.97	26.29
12	3	11.27	12.63	13.54	14.44	15.80	17.16	18.07
		15.03	16.85	18.05	19.26	21.07	22.89	24.10
13	3¼	10.40	11.65	12.49	13.33	14.58	15.84	16.67
		13.87	15.54	16.66	17.77	19.45	21.12	22.23
14	3½	9.66	10.82	11.60	12.38	13.54	14.71	15.48
		12.87	14.43	15.46	16.50	18.05	19.60	20.64
15	3¾	9.00	10.09	10.82	11.54	12.63	13.72	14.44
		12.00	13.46	14.42	15.39	16.84	18.29	19.26
16	4	8.44	9.46	10.14	10.82	11.84	12.86	13.54
		11.25	12.61	13.52	14.42	15.78	17.14	18.05
17	4¼	7.94	8.90	9.54	10.18	11.14	12.10	12.74
		10.58	11.86	12.72	13.57	14.85	16.13	16.98
18	4½	7.50	8.40	9.01	9.61	10.52	11.42	12.03
		9.10	11.21	12.01	12.82	14.03	15.23	16.04
19	4¾	7.10	7.96	8.53	9.10	9.96	10.82	11.39
		9.47	10.61	11.38	12.14	13.28	14.43	15.19
20	5	6.74	7.55	8.10	8.64	9.46	10.27	10.82
		8.98	10.07	10.80	11.52	12.62	13.70	14.42
21	5¼	6.42	7.20	7.72	8.23	9.01	9.79	10.30
		8.55	9.59	10.28	10.97	12.00	13.04	13.73
22	5½	6.13	6.87	7.36	7.86	8.60	9.34	9.83
		8.17	9.16	9.82	10.47	11.46	12.45	13.11
23	5¾	5.86	6.57	7.04	7.51	8.22	8.93	9.40
		7.81	8.75	9.38	10.01	10.96	11.90	12.53
24	6	5.60	6.28	6.74	7.19	7.87	8.55	9.00
		7.48	8.38	8.99	9.59	10.50	11.40	12.01
25	6¼	5.38	6.03	6.46	6.90	7.55	8.20	8.64
		7.17	8.04	8.62	9.20	10.07	10.94	11.52
26	6½	5.17	5.80	6.22	6.63	7.26	7.89	8.31
		6.90	7.74	8.39	8.85	9.69	10.53	11.08
27	6¾	4.98	5.58	5.98	6.38	6.99	7.59	8.00
		6.64	7.44	7.98	8.52	9.32	10.13	10.67
28	7	4.80	5.38	5.77	6.16	6.74	7.32	7.71
		6.40	7.18	7.70	8.21	8.99	9.77	10.28
29	7¼	4.63	5.19	5.57	5.94	6.51	7.07	7.44
		6.17	6.92	7.42	7.92	8.67	9.43	9.93
30	7½	4.47	5.02	5.38	5.74	6.28	6.83	7.19
		5.97	6.69	7.18	7.66	8.39	9.11	9.59
31	7¾	4.33	4.86	5.21	5.56	6.08	6.61	6.96
		5.77	6.48	6.95	7.42	8.12	8.82	9.29
32	8	4.19	4.70	5.04	5.38	5.89	6.40	6.74
		5.58	6.26	6.72	7.17	7.85	8.53	8.98
33	8¼	4.06	4.56	4.89	5.22	5.71	6.21	6.54
		5.41	6.07	6.51	6.95	7.61	8.27	8.71
34	8½	3.94	4.42	4.74	5.06	5.54	6.02	6.34
		5.25	5.89	6.32	6.74	7.38	8.02	8.44
35	8¾	3.82	4.29	4.60	4.91	5.38	5.84	6.15
		5.10	5.72	6.13	5.65	7.17	7.79	8.20

LENS TABLE OF FILM PROJECTION—*Continued*

DISTANCE FROM FILM TO SCREEN

Stero.	M. P.	84	90	96	100	104	110	116
8	2	28.49	30.53	32.57	33.93	35.29	37.33	39.36
		37.99	40.71	43.42	45.24	47.05	49.77	52.49
9	2¼	25.32	27.14	28.95	30.16	31.37	23.18	34.99
		33.76	36.18	38.60	40.21	41.82	44.24	46.55
10	2½	22.78	24.42	26.05	27.14	28.22	29.86	31.49
		30.37	32.55	34.72	36.17	37.62	39.80	41.97
11	2¾	20.70	22.19	23.67	24.66	25.65	27.13	28.61
		27.61	29.59	31.56	32.88	34.20	36.18	38.15
12	3	18.97	20.33	21.69	22.60	23.50	24.86	26.22
		25.30	27.12	28.93	30.14	31.35	33.16	34.97
13	3¼	17.51	18.77	20.02	20.86	21.69	22.95	24.20
		23.35	25.02	26.70	27.81	28.93	30.60	32.27
14	3½	16.26	17.43	18.59	19.37	20.14	21.31	22.47
		21.68	23.23	24.78	25.82	26.86	28.41	29.96
15	3¾	15.17	16.25	17.34	18.07	18.79	19.88	20.97
		20.22	21.67	23.12	24.09	25.06	26.51	27.96
16	4	14.22	15.24	16.25	16.93	17.61	18.63	19.65
		18.95	20.31	21.67	22.58	23.48	24.84	26.20
17	4¼	13.38	14.34	15.30	15.94	16.57	16.52	18.48
		17.83	19.11	20.39	21.25	22.10	23.38	24.66
18	4½	12.63	13.54	14.44	15.05	15.65	16.56	17.47
		16.85	18.05	19.26	20.07	20.87	22.08	23.29
19	4¾	11.96	12.82	13.68	14.25	14.83	15.86	16.54
		15.96	17.10	18.24	19.10	19.77	20.92	22.06
20	5	11.36	12.28	12.99	13.54	14.08	14.89	15.71
		15.15	16.23	17.32	18.05	18.77	19.86	20.95
21	5¼	10.82	11.60	12.38	12.89	13.41	14.19	14.96
		14.42	15.46	16.49	17.18	17.87	18.91	19.94
22	5½	10.33	11.07	11.81	12.31	12.80	13.54	14.28
		13.77	14.76	15.73	16.40	17.07	18.06	19.04
23	5¾	9.88	10.59	11.29	11.77	12.24	12.95	13.66
		13.16	14.11	15.06	15.69	16.32	17.26	18.21
24	6	9.46	10.14	10.82	11.27	11.72	12.40	13.08
		12.61	13.52	14.42	15.03	15.63	16.54	17.45
25	6¼	9.07	9.73	10.38	10.81	11.25	11.90	12.55
		2.10	12.97	13.84	14.42	15.00	15.87	16.74
26	6½	8.72	9.35	9.98	10.40	10.82	11.44	12.07
		11.64	12.48	13.31	13.87	14.43	15.27	16.10
27	6¾	8.40	9.00	9.60	10.01	10.41	11.02	11.62
		11.20	12.01	12.81	13.35	13.89	14.69	15.50
28	7	8.10	8.68	9.27	9.65	10.04	10.62	11.21
		10.80	11.58	12.36	12.87	13.39	14.17	14.94
29	7¼	7.82	8.38	8.94	9.32	9.69	10.26	10.82
		10.42	11.17	11.93	12.43	12.93	13.68	14.43
30	7½	7.55	8.10	8.64	9.00	9.37	9.91	10.45
		10.08	10.80	11.53	12.01	12.50	13.22	13.95
31	7¾	7.31	7.84	8.36	8.71	9.07	9.59	10.12
		9.75	10.46	11.16	11.63	12.10	12.80	13.50
32	8	7.08	7.59	8.10	8.44	8.78	9.29	9.80
		9.44	10.12	10.80	11.25	11.70	12.38	13.06
33	8¼	6.86	7.36	7.85	8.18	8.51	9.01	9.50
		9.15	9.81	10.47	10.91	11.35	12.01	12.66
34	8½	6.66	7.14	7.62	7.94	8.26	8.74	9.22
		8.88	9.52	10.16	10.58	11.01	11.65	12.29
35	8¾	6.46	6.93	7.40	7.71	8.02	8.48	8.95
		8.62	9.24	9.86	10.27	10.6	11.31	11.93

THREE COMBINATION LENS

There is now on the market a three combination lens, known as the Keen-o-lite three combination lens; it is so constructed that the rear objective lens is never more than two inches from the aperture plate, thus giving an increased light illumination on the screen, after allowing for the additional reflection and absortion loss due to the extra third combination. Below is the report of Professor Weinrich of Columbia University who lately made some comparative tests with the lens.

Report of Professor Weinrich of Columbia University.

I herewith submit report on my comparative test of a KEEN-O-LITE and a lens of another make, both of six and three quarters inch focal length.

The primary object of the test was to compare the illumination produced upon the screen by the Keen-o-lite Lens and another projection lens of high standing and the same focal length, the same light flux passing through the frame-plate in both cases.

As the design of the "Keen-o-lite" lens is based upon the actual conditions as they exist in the modern projection machine it may be well to first consider these conditions from a somewhat theoretical point of view.

The most practical way of adjusting the arc, condensers and frame-plate of a projection machine is such as to produce an enlarged image of the positive crater, a little larger than the aperture, upon the frame-plate. In order that the picture be as uniformly illuminated and spotless as possible, it is best to have the most concentrated part of the beam and the sharpest image of the crater a short distance from the frame-plate, on the condenser side; i. e., have a slightly extra focal image thrown upon the aperture. This adjustment naturally produces a diverging beam through the aperture of the frame-plate. In order to utilize as much as possible of this diverging beam we either have to allow the light to fall upon a comparatively small lens placed near the aperture or a comparatively large one a greater distance away. In the design of the Keen-o-lite lens the former of these two methods was adopted and skilfully executed. The "back focus" of the ordinary type of 6¾-inch lens is about 6 inches while in the case of the Keen-o-lite it is only a little more than one-third as much, and the clear aperture of the back lens is only slightly smaller than that of the other. The entering beam in the case of the "Keen-o-lite" is therefore very considerably larger, and with it the total brightness of the picture as was verified by test.

There are, however, two further advantages of the Keen-o-lite lens which are even more important than the foregoing. They are: a more uniformly illuminated picture, from center to edge or corner, and better definition.

The rays which the ordinary lens does not utilize are to a much greater extent from the edges and corners of the film than from the central part and therefore would increase the illumination of these parts of the picture relatively to the center, thereby producing a more uniform illumination over the entire surface of the screen.

The definition given by a lens can in general be made more perfect by the addition of more elements and curved surfaces. The addition of the extra element of the Keen-o-lite has produced a lens of very decidedly better definition than any other.

The figures hereinafter given were obtained with a set-up like that of the average machines using 6½-in., 7½-in. condensers. The source was brightly illuminated opal glass bounded by a ½-in. circular aperture in imitation of the positive crater. The position of source condensers and frame-plate were absolutely the same during all tests and the brightness of the source invariable. The conditions were hence the same as in the projection machine itself but their invariability made the test much more dependable than if an arc had been used. The results of the test were as follows:

Keen-o-lite gave 12.5% more light at center of screen.
Keen-o-lite gave 32.5% more light half way out to corner.
Keen-o-lite gave 63.0% more light at corners.

Integrating these results we find that the *total* illumination of the screen is about 32.8% greater in the case of the Keen-o-lite lens over the lens of another make.

The definition given by the Keen-o-lite is also decidedly superior.

ROBIN CINEMA ELECTRIC TIME SYSTEM

This system, invented by J. E. Robin in 1914, is what the name implies, a system to provide an accurate and predetermined running schedule for motion picture and synchronizing the music with same.

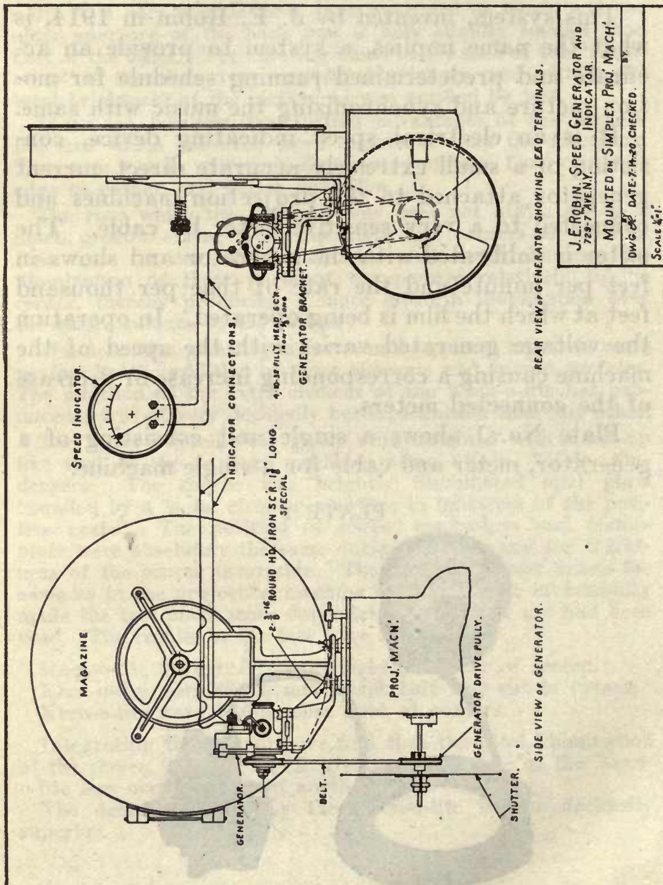
It is an electrical speed indicating device, consisting of a small extremely accurate direct current generator attached to the projection machines and connected to a very sensitive meter by cable. The meter is calibrated with the generator and shows in feet per minute and the rate of time per thousand feet at which the film is being operated. In operation the voltage generated varies with the speed of the machine causing a corresponding increase or decrease of the connected meters.

Plate No. 1 shows a single unit consisting of a generator, meter and cable for a single machine.

PLATE 1

Generator and Meter, Single Unit

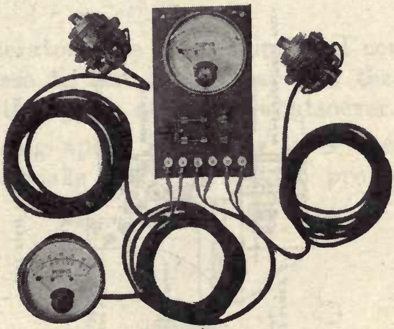
PLATE 4



Robin Speed Indicator Attached to Simplex Projector

Plate No. 2 shows an equipment for two projection machines with switchboard and two meters.

PLATE 2

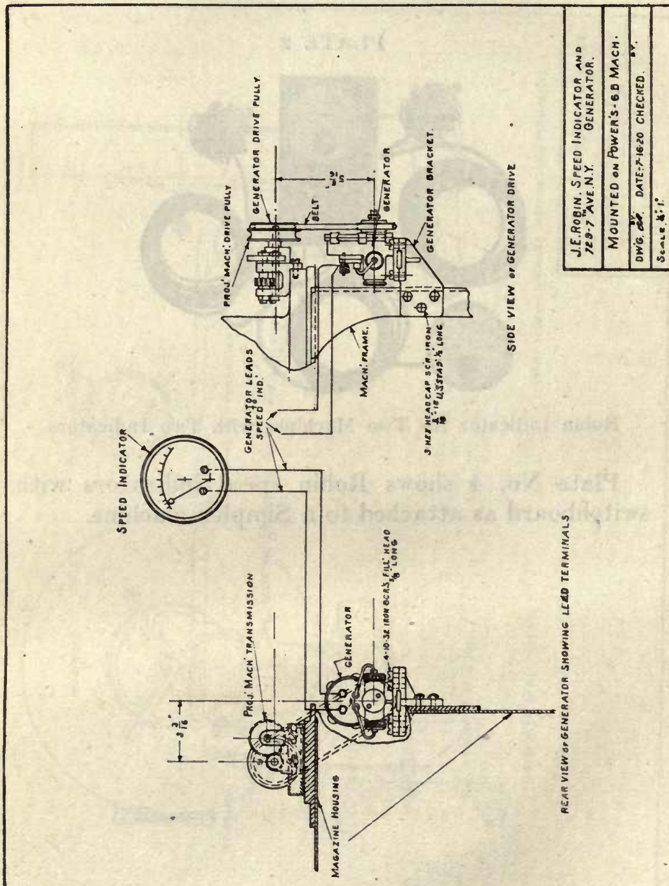


Robin Indicator for Two Machines with Two Indicators

Plate No. 4 shows Robin speed indicators with switchboard as attached to a Simplex machine.

Plate No. 3 as attached to Powers projector.

PLATE 3

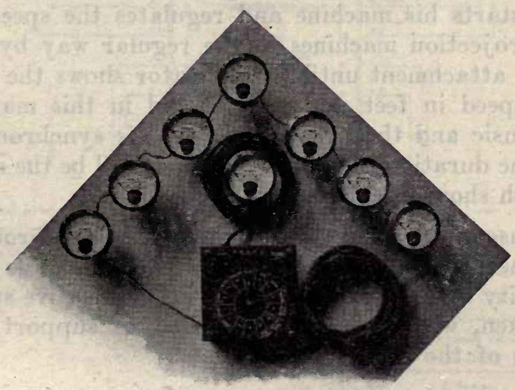


Robin Speed Indicator Attached on Powers Machine

The meters and generators are made of the best materials throughout and are carefully tested prior to leaving the factory and the operator should experience no trouble whatsoever in maintaining the same.

The generators are ballbearing and contain sufficient grease to last for a year and therefore require practically no attention whatsoever.

In ordering speed indicators it is necessary to specify the make and type of the projection ma-



Robin Signal Telegraph With Eight Synchronized Meters as Installed in New York Capitol

chines, the diameter of the shutter shaft and the distance for the cable required. Where it is desired to use a meter in the orchestra pit, the distance between the two projection machines and the orchestra pit, measured on one side of the circuit, should be given.

In the majority of the larger theatres it is customary for the director to be present in the reviewing room at the time the rehearsal is made. Then the proper length of the performance is predetermined and the running speed noted, and the musical director arranges his music accordingly.

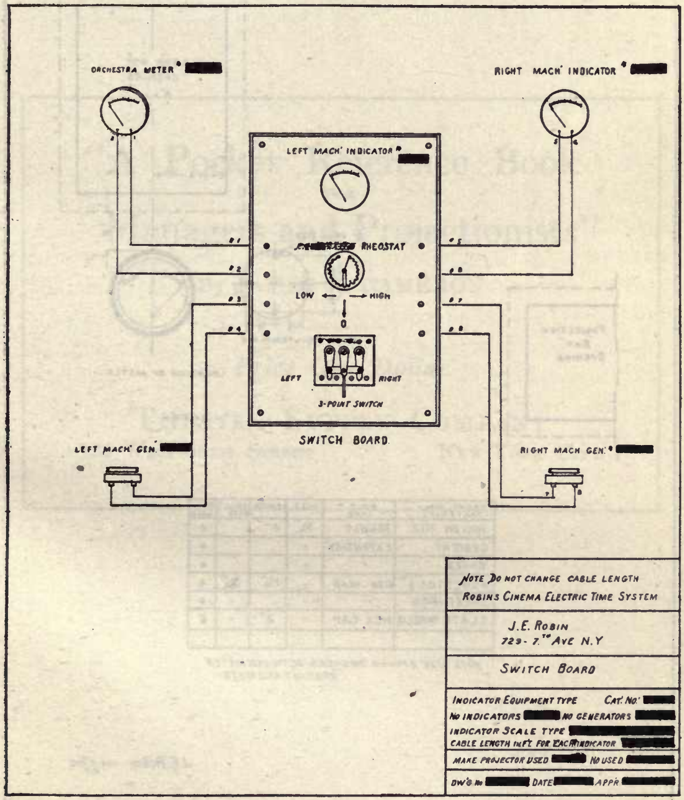
With the operating speed predetermined the operator starts his machine and regulates the speed of the projection machines in the regular way by the motor attachment until the indicator shows the correct speed in feet per minute, and in this manner the music and the projection speed is synchronized and the duration of the performance will be the same at each showing.

In use in the majority of leading theatres throughout the country where it has proved the value and necessity of projecting pictures at the relative speed as taken, with music synchronized to support the action of the photoplay.

Plate No. 5, illustrates switchboard and connection for equipment of two projection machines, two meters in the booth and one for the orchestra pit.

ROBIN ELECTRIC TIME SYSTEM

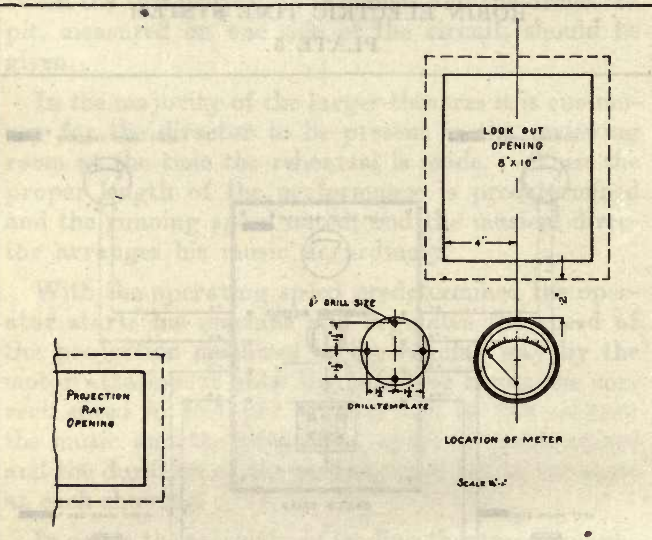
PLATE 5



Two Machines, Three Meters and Switchboard

Plate No. 6 illustrates correct position for instruments with meter underneath the lookout holes and which gives the measurements of both and drilling template.

PLATE 6



FRONT WALL MATERIAL	BOLT TYPE	SIZE	LENGTH	DRILL SIZE	NO USED
HOLLOW TILE	TOGGLE	1/4"	3"		4
CEMENT	EXPANSION	"			4
BRICK	"	"			4
ASBESTOS 1/2"	HEX HEAD	"	1 1/4"	9/32"	4
SHEET IRON	"	"		"	4
SLATE PANEL 1 1/2	HEX CAP	"	2"	"	4

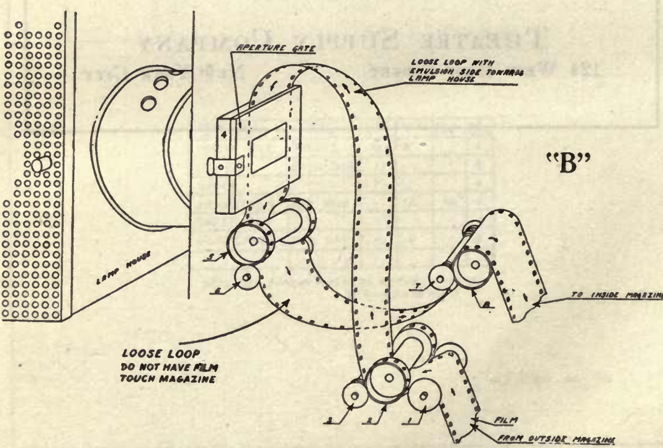
NOTE USE SPRING WASHERS BETWEEN METER BRACKET AND NUTS

J E. ROBIN. 729-7th AVE N.Y.

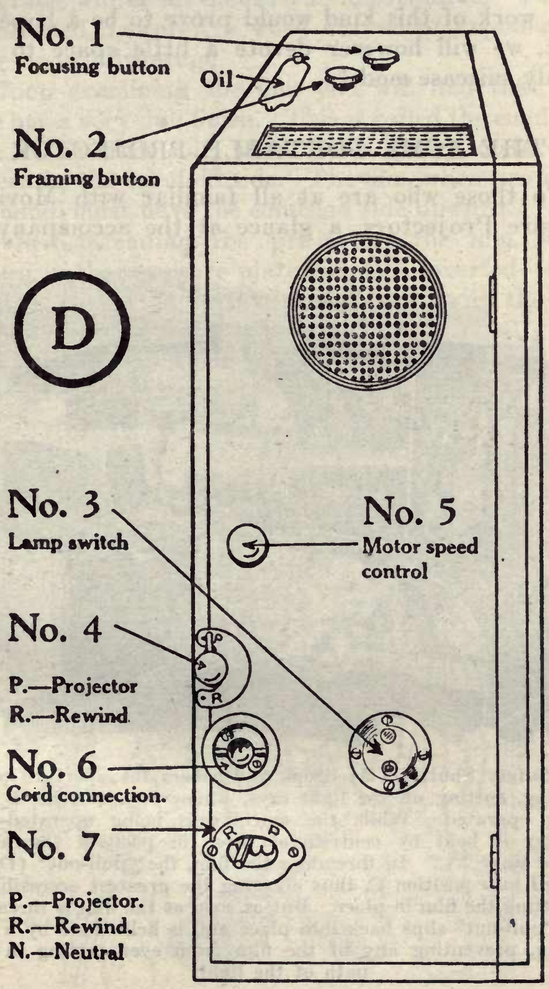
Robin Speed Indicator

PORTABLE PROJECTORS

The portable projector has made a permanent place for itself in the motion-picture industry, several hundreds of this class of machine are in daily use in studios, cutting-rooms and viewing rooms, salesmen are using them to help sell their wares. Motion pictures are becoming a part of the curriculum in churches and schools through the medium of the portable projector. This type of machine has been brought to a high stage of perfection, it is now possible to get a complete motor-driven motion-picture machine enclosed in a carrying case measuring approximately 18″x17″x8″ and weighing about 25 lbs, and this compactness has not been obtained by sacrificing accuracy. Portable projectors are built along various lines, each manufacturer having his own ideas



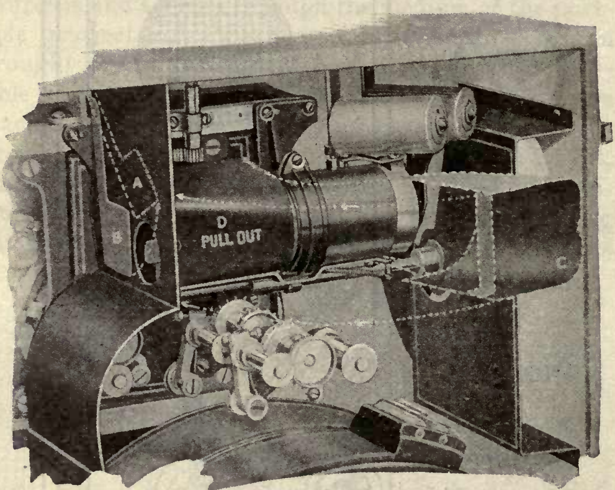
"B"


No. 1
Focusing button
Oil
No. 2
Framing button
D
No. 3
Lamp switch
No. 5
Motor speed control
No. 4
P.—Projector
R.—Rewind.
No. 6
Cord connection.
No. 7
P.—Projector.
R.—Rewind.
N.—Neutral

on this subject, and to attempt to describe each type in a work of this kind would prove to be a hopeless task, we will however devote a little space to the handy suitcase model.

THE ACME PORTABLE PROJECTOR

To those who are at all familiar with Moving-Picture Projectors, a glance at the accompanying



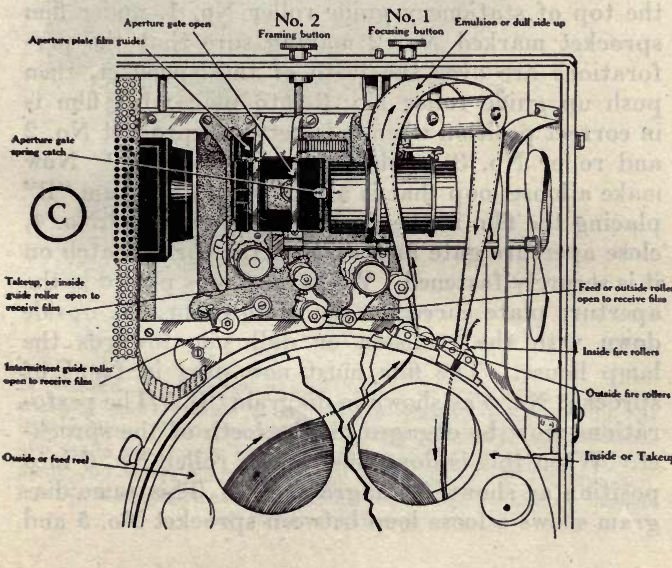
The Safety Shutter (B) drops and covers the aperture plate opening, cutting off the light rays, whenever the Acme is not being operated. While the machine is being operated the Shutter is held by centrifugal force in position shown by dotted lines "A." In threading the film, the "pull-out" (D) is opened into position C, thus allowing the greatest accessibility in getting the film in place. But as soon as the film is threaded this "pull-out" slips back into place and is held there by a coil spring, preventing any of the film from ever getting in the path of the light.

diagrams will be all the instruction required. To the uninitiated, however, a word or two of explanation may be of advantage.

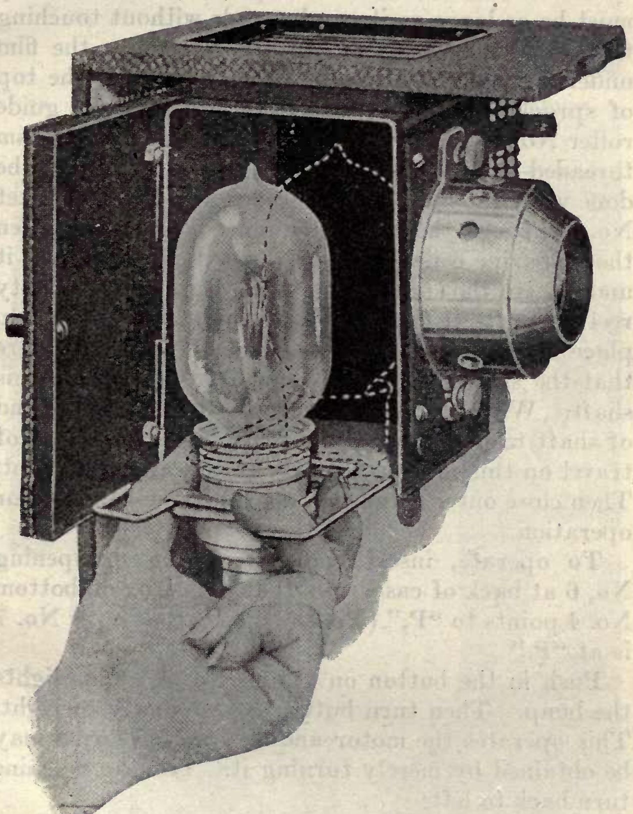
Upon examining the film you will find that one side has a very dull finish. This is called the emulsion side. The other side, which has a glossy surface, is known as the celluloid side. The film, when properly rewound, must have the emulsion side upward.

When threading the projector, the film, when placed in the aperture plate, must be inverted—that is, show the image "upside down"—and with the dull or emulsion side toward the lamp house.

To thread the Acme pull out the round film guard between the gate marked No. 4 and the lens, push down the three guide rollers numbered 3, 6 and 7 in diagram



"B" these are shown in diagram "C" in open position. Next open aperture gate by lifting spring catch on gate number 4 towards you, this is done through the small round hole in the division plate between the lamp house and projector. Next open the magazine by pushing down on the catch, swinging the outer half outwards so that the magazine when open hangs at right angles from the projector, then place the full reel of film on the shaft of the outer magazine, turn clip on this shaft down to keep reel in place. Next draw the film through the rollers and pull towards you. The emulsion or dull side must be face upward, and three feet of film should be drawn from the outer magazine in order to thread the Acme, then partly close the outside magazine, place the film over the top of stationery guide roller No. 1, under film sprocket marked No. 2 making sure that the perforations are over the teeth of this sprocket, then push up guide roller No. 3 into place; the film is in correct position when it is between sprocket No. 2 and roller No. 3 as shown in diagram "B." Now make a loose loop that is also shown in diagram "B" placing the film in the aperture plate marked No. 4, close aperture gate and see that the spring catch on it is securely fastened. When the film is placed in the aperture plate correctly the picture must be upside down with the emulsion or dull side towards the lamp house. The film must now pass in front of sprocket No. 5 as shown in diagram "B." The perforations must be engaged on the teeth of the sprocket. When this is done push guide roller No. 6 into position as shown in diagram "B." This same diagram shows a loose loop between sprocket No. 5 and



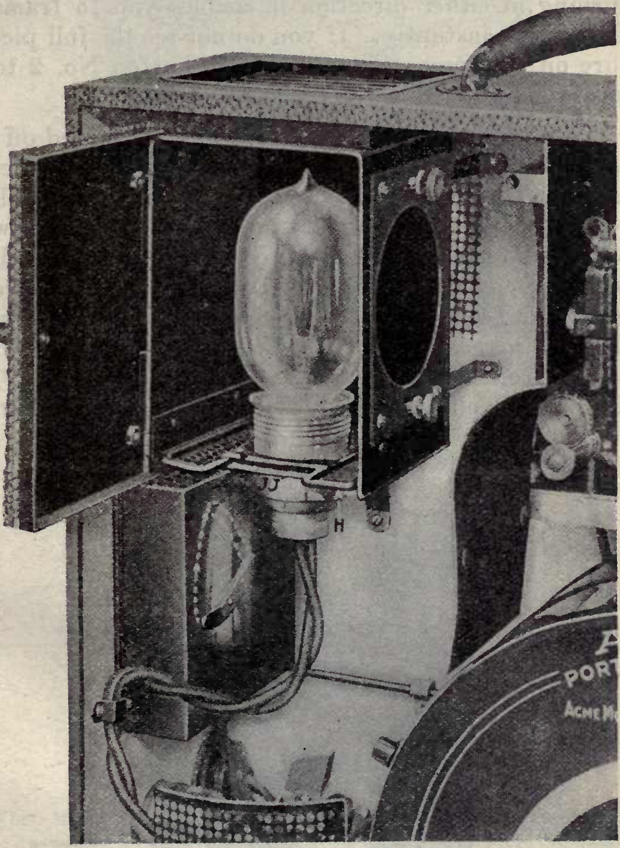
If desired you can change the lamp in the Acme in a few seconds—merely slide it out of its housing, as shown in the illustration. Both up-and-down and horizontal adjustments are made by simply loosening the screws, getting the adjustment you want, then tightening them again. The Condenser, in case it needs cleaning, is easily removable by merely loosening the two thumb-screws.

sprocket No. 8; this is imperative. This loop must be as large as it can be made without touching the round magazine underneath it. Place the film underneath the guide roller No. 7 and over the top of sprocket No. 8. When this is done close guide roller No. 7; now you have the projector mechanism threaded—open the outer magazine, which can be done while the film is in it. Place film from sprocket No. 8 through the slot of the inner magazine between the magazine rollers. Take the end of film; place it underneath the spring clip on the center of the empty reel hub, give it one turn to securely fasten the film, place this reel on the inner magazine shaft, be sure that the slot in this reel slides over the key on this shaft. When in position turn down clip on the end of shaft to hold this reel in place. The direction of travel on this inner reel is always towards the right. Then close outer magazine, machine is now ready for operation.

To operate, insert connection plug in opening No. 6 at back of case. See that indicator on bottom No. 4 points to "P," (Picture); also that lever No. 7 is at "P."

Push in the button on switch No. 3. This lights the lamp. Then turn button No. 5 slowly to right. This operates the motor and any speed desired may be obtained by merely turning it. To stop machine turn back to left.

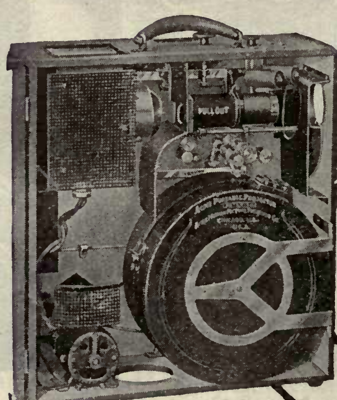
Button No. 1, on top of the projector, operates the focusing device, and if you cannot get the image sharp by turning this button, open the case door and adjust the lens tube in the lens jacket by moving it forward or backward with your hand until the right effect is obtained.

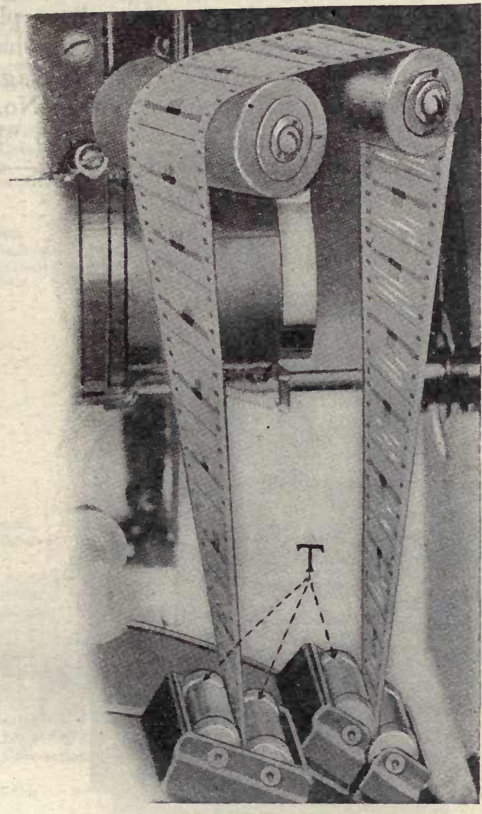


The simple button (on outside of case) moves the rheostat up and down, as shown by the dotted line in the illustration, thus giving practically any speed required.

Button No. 2 operates the framing device, and by turning in either direction it enables you to frame the picture instantly. If you do not see the full picture on the screen, simply operate button No. 2 to locate correctly.

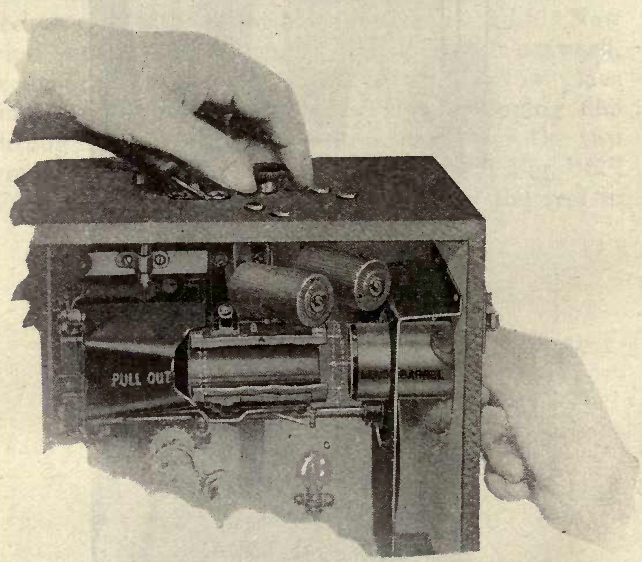
To rewind after using, be sure light is turned off; take off the full reel from inner magazine shaft. Remove empty reel from outer magazine. Stand full reel on rim, with end of film toward the right. Now wind end on hub of empty reel, dull side outward, securing end firmly with a few turns. Now place empty reel on inner magazine shaft, slipping film through magazine rollers. Loop film over the two wooden rollers in top of case as shown in Fig. "C." Turn down clip on inner shaft holding the reel in



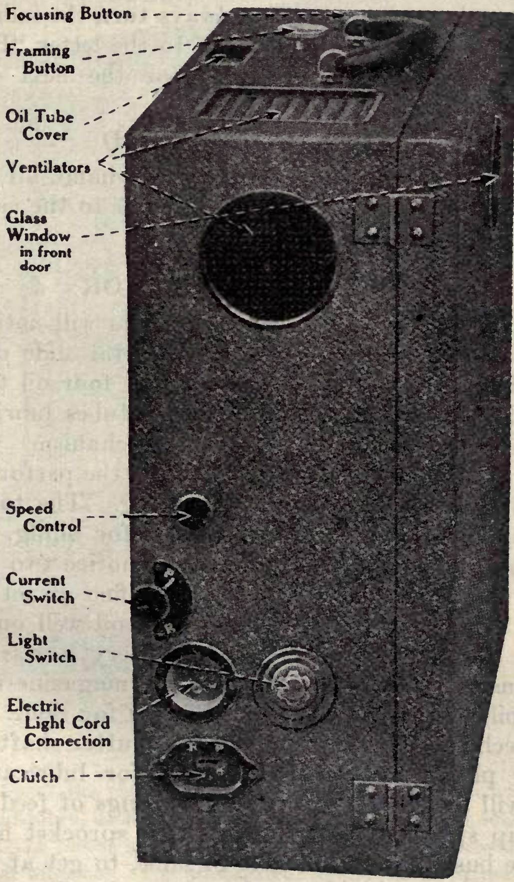


When the reel has been run through the Projector (and must be re-wound to be run again), you merely transfer the reels on the feed and take off shafts, run the film over the two wooden rollers, and turn the button releasing the motor. None of the projecting mechanism is used for this purpose, but remains at a standstill during the rewinding operation.

place. Bring outer magazine around to closing position, threading film through magazine rollers, placing reel on shaft, again turning down clip on shaft to hold reel in place. Close and lock outer magazine. At back of case, turn indicator on button No. 4 to "R."—Rewind. Turn also lever No. 7 to "R."—Rewind. Then turn button No. 5 to right—slowly —to operate motor for rewinding.



The lens barrel is easily taken out through the front opening without having to remove shutter or any other part. This lens barrel merely slides into the lens jacket (A), and this jacket is moved forward or backward (in B) by the button on top of case. Correct focus for any distance may be obtained by sliding the lens either way within this jacket.



Rear View of Acme Showing Adjustments and Controls

Caution

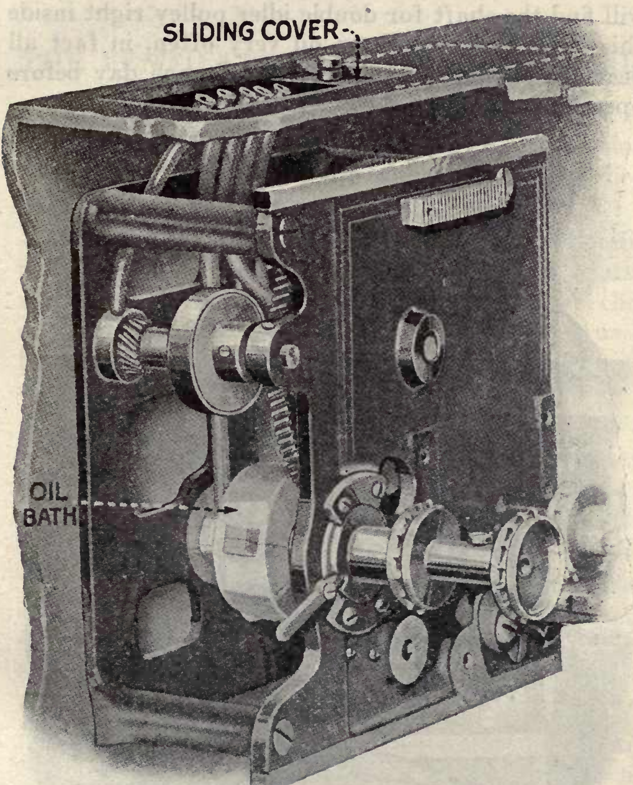
When through rewinding, always turn the indicators on buttons No. 4 and No. 7 to the letter "P"—Picture—before making ready for the next projection.

OPERATING BY HAND

To operate the Acme Projector by hand, all that is necessary is to move the lever No. 7 to the center groove which releases the motor.

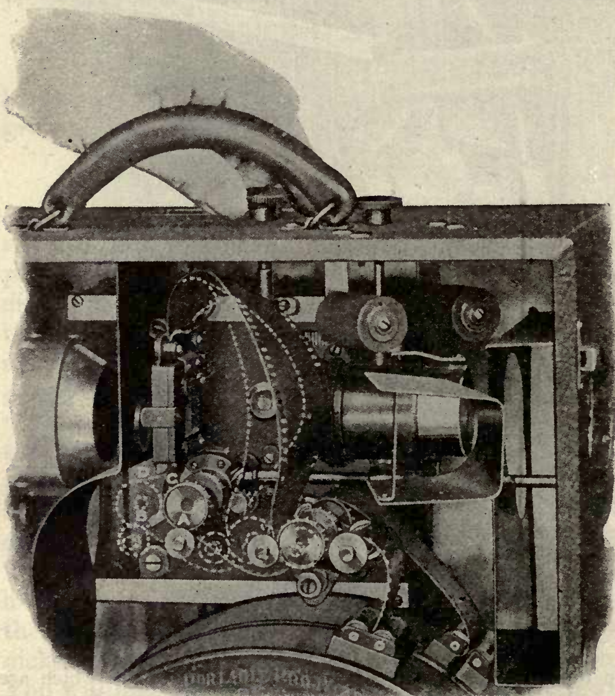
OILING THE PROJECTOR

On the top of the machine case you will notice a small oblong opening that has a metal slide door, push back this slide and you will find four oil tubes directly underneath it. These four tubes lubricate the bearings in the back of the mechanism. The motor has an oil tube coming through the perforated guard that leads to its inner bearing. The top of the fan has a drilled screw—this is for oiling. On the end of the fan bracket you will notice two fibre pulleys. Between these two you will find an oil hole which lubricates them. There is an oil well on the outer end of the motor which is very accessable. The inside of the two shafts in the magazine must have oil—you will find oil holes there for same. On the mechanism you will find on the shutter shaft two nickel plated brackets with holes for lubricating. You will find oil holes on shaft bearings of feed and take-up sprockets—the intermittent sprocket has a bronze bushing with oil hole in same, to get at this, slide the mechanism forward as far as it will go. On side of case opposite door in about the center close to the bottom is a round hard rubber bushing, you



On top of the case is a sliding cover, just beneath which are five oil-tubes, each leading directly to an oil-hole at some bearing. The motor shaft and belt pulleys are also provided with similar oil-tubes. The intermittent mechanism is of the Geneva type and *runs in an oil bath.* The Acme intermittent movement can be adjusted without having to remove the mechanism from the case.

will find the shaft for double idler pulley right inside this hole; this must have oil very often, in fact all bearings should have a drop of oil each day before operating machine.



Merely turning the button on top of the case in either direction frames the picture instantly. The illustration shows that, in framing, the aperture plate and lens remain absolutely stationary—the movement, forward or backward, of the mechanism adjusts the relative position of the picture until it "frames" correctly.

THE VENTILATING, HEATING AND COOLING OF THEATRES

Rapid as has been the development of the motion-picture theatre, in one department there has been but little visible progress—ventilation.

We therefor approached the Monsoon Cooling System of New York City who are experts on this subject, and they were pleased to have their chief engineer Mr. E. L. Garfield co-operate with us in the preparation of a technical article on the subject of theatre ventilation.

Some blame attaches to the exhibitor because of the scant attention he has given to this important subject. But the underlying cause, to my mind, is the general lack of specialized knowledge on theatre ventilation.

Winter ventilation, for instance, is almost universally treated with absolute disregard for its effect on the heating. The natural result is a house warm enough, but ill-smelling and stuffy; or a house with a pure atmosphere, but a bit too chilly for comfort.

The usual treatment of summer ventilation and cooling leaves out of consideration the high percentage of moisture, humidity, to be found in the atmosphere in hot weather. And yet this humidity causes more discomfort in a warm theatre than the high temperature itself.

Let us first consider the proper method of ventilating a theatre in cold weather. It must be recognized from the outset that this is impossible without the loss of some heat. How great this heat loss is depends on:

1.—The frequency of air change.

2.—The degree of scientific skill applied to the problem.

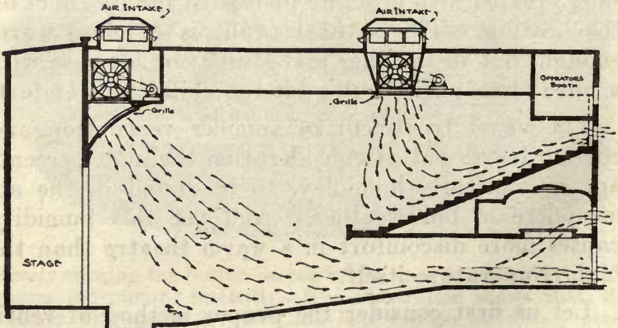
The two generally accepted methods of heating and ventilating a theatre may be classified as follows:

1.—All direct radiation for heat, with exhaust fans for ventilation.

2.—Indirect radiation or warmed air supply for both heating and ventilation, combined with a small amount of direct radiation.

Direct radiation comprises the use of the ordinary steam or water radiators, the heat being applied directly to the air in the immediate vicinity of each radiator.

Indirect radiation (or tempered air supply) consists of warming fresh air and forcing it into the auditorium at one or more points.



Monsoon Cooling Apparatus. The Arrows Show How the Air Currents Reach Every Point of the Auditorium

Mainly for reasons of economy, I would use the first method outlined above for the smaller theatre—say, one up to 800 seats. It is simple and practical. With sufficient radiation, properly distributed, there can be no great difficulty in maintaining a fairly even temperature.

Successfully to combine this method of heating with good ventilation demands careful study so as to effect the proper air change with minimum heat loss, and without objectionable drafts. I have little regard for exhausting at the ceiling line because it assumes that the warm air at the ceiling is necessarily foul air.

This is wrong: foul air is heavy. It has been breathed and become laden with moisture, carbon dioxide and organic impurities thrown off by the lungs. Naturally, being heavy, it lies close to the floor line; and because it lies near the floor line, it is at this point that we must exhaust if we would remove the foul, ill-smelling air.

Furthermore, this heavy air does not readily absorb heat. It is therefore the coldest air in the house; and if we exhaust it we pass out with it the smallest possible amount of heat. Consequently, from the standpoint of heat economy, it costs least to remove this air, while it costs most to remove air at the ceiling line.

With these facts established, it is obvious that the air should be exhausted at the floor line near the stage, or at the end opposite from the entrance doors. The fan apparatus should effect a complete air change within a certain limited period, to be decided on by a competent ventilating engineer. Such an air change, calculated on ordinary winter temperatures, might prove too frequent during a few unusually cold periods. The thing to do then is to cut down the air change slightly, in the interests of heat economy by reducing the speed of the fan.

The only possible objection to this method of heating and ventilating is the possible slight tendency to drafts through the doors, but this can be compensated for by placing extra radiation at the entrances.

Heating and ventilating in this manner will produce fairly satisfactory results, and its cost is not out of proportion to the cost of the average house of 800 seats. It could not be improved upon except by the use of indirect heating, usually too expensive for the small theatre.

In the larger house the cost of indirect heating does not loom up so large in proportion to the cost of the complete building. In fact, the cost may prove in most cases to be less that that of direct heating. And, certainly, in view of the splendid results, the indirect method is far more desirable.

In laying out an indirect heating and ventilating system for the larger house, warm air supply units are located at the stage end (opposite from the entrance doors). These supply the required amount of fresh air at a temperature of 70° or over. It is imperative that large fans be used, so that the apparatus can be run at low speed, handling the air at low velocity, thus insuring absence of drafts, of noise and of vibration.

The fresh air supply is taken at least 20 feet above ground level, so that it is pure and free from dust. In this way, we eliminate the necessity for an air-washer, which is expensive, requires constant attention and is objectionable for other reasons. The roof or the attic is usually the best location for the heating and ventilating equipments.

The air blown into the theatre finds its way out through openings at the floor line but, to insure positive circulation, exhaust fans are sometimes advisable. A large part of the air supplied naturally passes out through the entrance doors and also through openings in the rear of the balcony, if there is one. The fundamental principle is to keep removing the air from the floor line or breathing zone, and to allow the warm, fresh air blown in to settle like a blanket of warmth evenly over the entire auditorium.

Two desirable advantages that appeal instantly to the theatre manager are these:

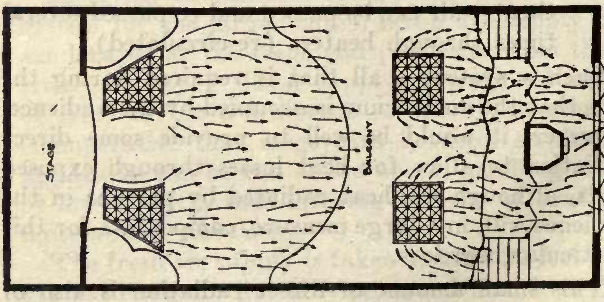
1.—No inrush of cold air from outdoors when the entrance doors are open. On the contrary, an outward motion of warmed air, due to slight pressure maintained by heating fans.

2.—House heated very rapidly before opening, as theatre air can be passed and re-passed several times through heaters (re-circulated).

Such a system is all that is required during the time that the auditorium is occupied by the audience. However, it would be well to provide some direct radiation to allow for heat losses through exposed walls, although the heat radiated by persons in the audience will, in a large measure, compensate for this particular heat loss.

This small amount of direct radiation is also of good use at times—overnight, particularly—when the temperature falls below freezing point, with danger to water pipes, etc. For this we need just enough direct radiation to keep the temperature at 35° F, as it is not economical to run the fans for heating when the theatre is not occupied and ventilation is not required. The dressing-rooms, toilets, rest-rooms, etc., have the usual direct radiation.

Extremely cold weather that falls below normal is unusual and generally of short duration. For this reason, it is not a great hardship to sacrifice a small part of our fresh air supply for fuel economy, particularly as the system is designed for maximum fresh air supply and therefore permits of some reduction. During these periods some of the warm air already blown into the theatre is brought back to the heating units and mixed with fresh, outdoor air. By the use of an arrangement of dampers, it is possible to obtain a mixture of fresh air and re-circulated air in proportion to meet any unusual drop in temperature. This feature is utilized only during the few short periods of extreme cold.



Monsoon Cooling Apparatus Installed in Large Theatre

When absolutely perfect results are desired—and finances permit—a profitable investment is a system of thermostatic control of mixing dampers, a thermostatic control of steam valves, or a combination of both. With this system the lower the temperature, the greater the quantity of theatre air re-circulated and mixed with fresh air. On the other hand, a rise in temperature is accompanied by an automatic shutting off of steam in part of the indirect heaters, so reducing the temperature of the fresh air supply.

And now summer ventilation and cooling. At this season of the year an enormous quantity of moisture is thrown off by the human body, and the problem then becomes one of removing the air in such volume as to remove with it this moisture as rapidly as it is formed.

Actually, there is no binding necessity to lower the temperature. The point at issue is to make the human body comfortable, and this can easily be done by creating a breeze, passing it over and around every person in the audience and carrying away the bodily heat and, especially, *evaporating the moisture constantly forming on the skin.* It is simply taking advantage of an old principle, the practical working efficiency of which is convincingly demonstrated every time a perspiring person takes a trolley or automobile ride on a hot day. It's the breeze that cools. It can be nothing else, since the temperature is no lower.

The cost of cooling by the breeze method is very small in comparison with the lower temperature method. All that is necessary is sufficient fan capacity to effect a very rapid air change—from ten to fifteen times that required for winter ventilation. It will be found that this is sufficient to create a perceptible movement of air that will prove entirely satisfactory. It may be honestly advertised as a "cooling system" and can be depended upon to keep the house comfortable in the hottest summer weather.

As with the winter ventilation, best results can be expected only if the "cooling system" is laid out by a competent engineer who has had practical experience in this line of work. Unless this precaution is taken, there can be no safe assurance that the air currents are evenly distributed over the house—that the breezes can be felt throughout, that they are not too strong in some quarters as to be objectionable.

It is equally important that a fan apparatus be specified designed specially for moving tremendous volumes of air at low velocity and operating slowly enough to be silent.

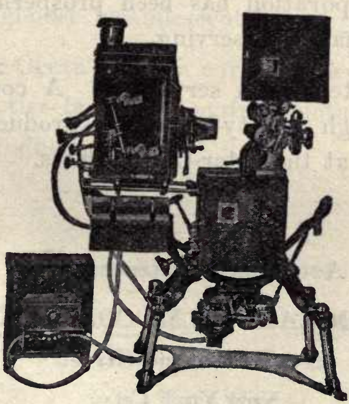
An economical arrangement, for a theatre under construction is to arrange the fan apparatus so that part of the cooling and ventilating fans are used with the indirect heaters to form the heating and ventilating units for winter operation. Or, stated the other way, the fans used in the heating and ventilating units may also be used for cooling in summer, in combination with auxiliary cooling equipment to give the additional air volume required in hot weather.

The cooling and ventilating system alone, without heating, can be installed in any theatre, no matter how old, at any time.

Ventilation of theatres is now receiving more attention than ever. And the time is coming—soon, too—when the problem of ventilating will receive fully as much attention as any other connected with the designing and building of theatres.

Hot weather cooling, too, will receive more consideration. And why not? If it is profitable to heat a theatre in winter to attract or keep business, why not cool the house in summer for the same reason?

As the importance of these subjects is better appreciated, it will be realized more and more that they should be handled, not by hit-or-miss guesswork, but by competent engineers who know by scientific training and experience what is needed and how to provide it.

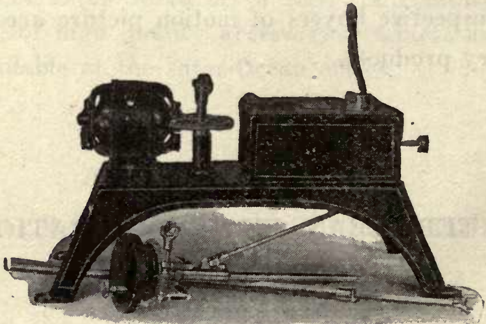


AUTOMATIC ARC CONTROLS

The hand-fed arc is fast losing favor, most theatres are now equipping their projectors with arc controls. There are various makes of arc controls on the market, but as it has been the lot of the writer to have seen the Peerless automatic controller under various stages of manufacture and to have been in close touch with them under actual working conditions in various Broadway theatres we shall take the liberty of discussing this special type in these pages.

This Control is made for use on all makes of projectors having Direct Current at the arc, and will operate equally well with current supplied by a Motor Generator, Converter, Mercury Arc Rectifier or 110 volt D.C. from the power companies.

The instrument is designed to stand on the floor at the rear of the projector, the power being trans-



Peerless Automatic Arc Control Before Assembling mitted from the motor mounted on the Control to the feed handle of the arc lamp by means of a telescoping tube and shaft that automatically adjusts itself for the various height projectors.

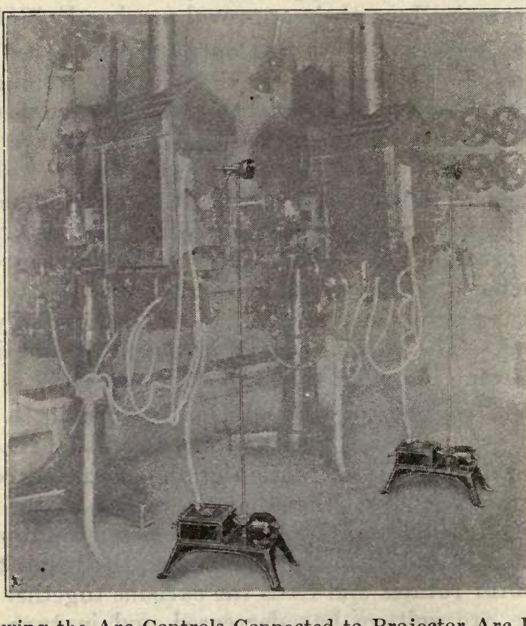
A complete feed handle assembly shown in the accompanying line drawing, consisting of the parts M, J, N, F, P with a worm gear and worm mounted thereon is supplied as a part of the *Peerless* Control, and replacing the regular feed rod and handle on the projector.

The actuating element is completely enclosed and the entire device is approved by the Underwriters Laboratories Inc., their approval number E-4988.

The operation of the Control is governed by changes in the arc voltage there being two highly sensitive magnets in series with each other connected directly across the line in multiple with the arc and their strength varies directly proportionate to the variation in the arc voltage. These magnets influence an armature carrying contact points having a gap of approximately ".006", and to the armature is connected a spring which in turn is attached to the adjusting screw marked "A" on the accompanying line cut. The various length arcs may be obtained by screwing in or out this adjusting screw.

These contacts open and close a circuit to the special wound series type motor. It will be readily seen that when the attraction of the magnet exceeds the opposite pull on the spring attached at the end of the screw "A" that the armature will move toward the magnet and the circuit close with the result that the motor rotates and feeds the carbons together until the arc voltage has decreased and in turn the magnetic strength of the magnets decreased to a point where the spring is the stronger, with the result that the circuit is opened.

Due to the type of construction employed in the manufacture of this element, a degree of sensitiveness of less than 1/5 of one volt is obtained, that is to say, that an increase in the arc voltage of less than 1/5 of one volt above the point for which the adjustment is set will close the circuit. Thus securing a delicacy and fineness of operation that is truly remarkable.



Showing the Arc Controls Connected to Projector Arc Lamp

A gear reduction through two sets of worm gears one on the Control itself and the other on the feed handle provides a gear ratio of 6400 to one, with the result that the movement of the carbons can scarcely be detected with the naked eye, and insures against any disturbances on the arc crater, as would be the case where they moved rapidly such as is so often the practice with the hand-fed arc.

A high resistance unit is connected in series with the motor, permitting some current to enter the motor at all times when the knife switch of the projector is closed. This resistance serves the purpose of reducing to a minimum the load which the circuit breaker has to break and acts as a discharge coil as well, thus eliminating any destructive spark.

The automatic arc controls have been on the market long enough to have their general merit well proven and taken altogether are highly recommended for use in theatres desiring high grade screen results.

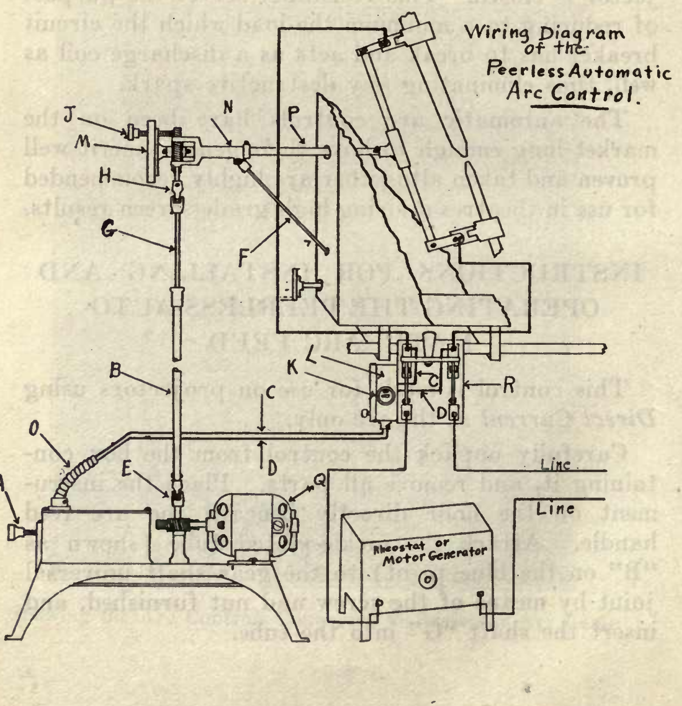
INSTRUCTIONS FOR INSTALLING AND OPERATING THE PEERLESS AUTOMATIC ARC FEED

This control is made for use on projectors using *Direct Current* at the arc only.

Carefully unpack the control from the box containing it, and remove all parts. Place the instrument on the floor directly beneath the arc feed handle. Attach the nickle-plated tube (shown as "B" on the blue print) to the gear shaft universal joint by means of the screw and nut furnished, and insert the shaft "G" into the tube.

If the arc control is to be used on a Powers, Motiograph or Type "S" Simplex arc lamp, remove the arc feed handle and rod and replace with the complete assembly furnished with the control same as it is received.

If the control is to be used with the "regular" type Simplex arc lamp, having the feed rod rigidly attached to the arc lamp, it is only necessary to remove the Simplex fibre handle and in its place assemble the parts shown as "N", "J", "M" and the gears, collars, etc. onto the Simplex rod.



Drill a small hole in the rear of the lamp house, about five inches below the opening for the arc feed rod and insert the anchor "F", or attach anchor to one of the adjusting rods by means of clips furnished.

Attach the universal joint at the end of the rod "G" to the shaft "H" on the feed handle.

The control is then ready for the electrical connections. Bear in mind that the *Peerless* control is a voltage-governed device and is actuated by changes in voltage at the arc, caused by the increase in the arc gap due to the consuming of the carbons. It is necessary, therefore, that the device be connected in multiple with the arc, and at a place in the lamp circuit where it will receive current *after* it has passed through the rheostat or motor-generator, as shown on the blue print.

Attach a snap switch and a fuse block, shown as "K" and "L" on the print, at a convenient place at the rear of the projector, a good place being at the side of the arc lamp knife switch box, as illustrated. Encase the wires "C" and "D" in flexible Greenfield conduit "O" and run to the switch and make connections. From the switch "K" run wires to inside of knife switch "R" cabinet and connect to each of the arc feed wires as shown, being sure that the current which will enter the control at this point, has already passed through the rheostat or motor-generator.

See that the snap switch "K" is "off" and strike the arc and allow it to burn until the crater has properly formed on the carbons. Bring the carbons together to the arc gap which you wish maintained, turn on the switch and loosen knurled clamping screw

"J" on the feed handle. If the motor runs when the carbons are at the gap desired, slowly screw out the arc gap adjusting screw "A" until the motor stops. Any arc gap desired may then be obtained by screwing in or out the screw "A",—in, to shorten the gap and out, to lengthen it. The control will automatically maintain the arc gap for which screw "A" is set, and further adjustment of it is not needed and its position should not be changed.

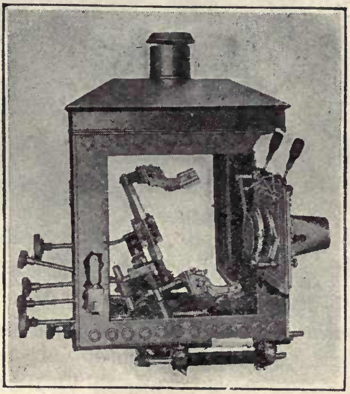
When putting a new trim of carbons in the lamp, allow them to burn in before turning on the snap switch "K", as the voltage at the arc is much lower than normally until craters have formed, which would result in the control failing to feed until the craters had formed and the voltage raised to normal at the desired gap.

POWER'S TYP"E" LAMPHOUSE AND LAMP

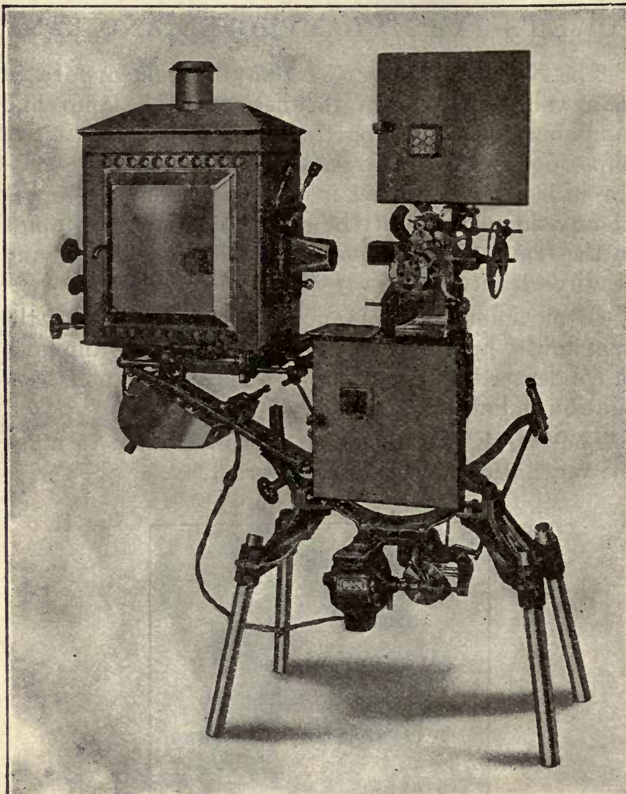
The Nicholas Power Company have incorporated many new features in the new typ"E" lamp and lamphouse. The proportions of the lamphouse are imposing, the extra large area facilitates an operator in being able to get inside the lamphouse to get at any adjustment of the arc lamp. Two openings in the front of lamphouse allows it to be easily and readily cleaned.

Of paramount importance is the ventilation of the lamphouse, hundreds of dollars are wasted annually in condenser breakage solely on account of poor ventilation in lamphouses.

The typ"E" lamphouse is so constructed to make the ventilation scientifically correct.

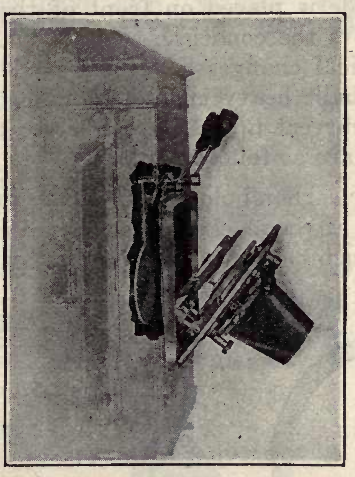


Type "E" Lamphouse and Lamp showing Inside Dowser



6B. Equipment with Typ"E" Lamphouse complete with Lamp Assembled

The condenser mount is mounted on a heavy grey iron frame hinged to the lamphouse to open forward, this allows the operator to bring the whole condensing set easily into full view for cleaning, etc. The condenser holders are made of an extra heavy type of grey iron so constructed that the expansion and contraction of the holders are fairly even and



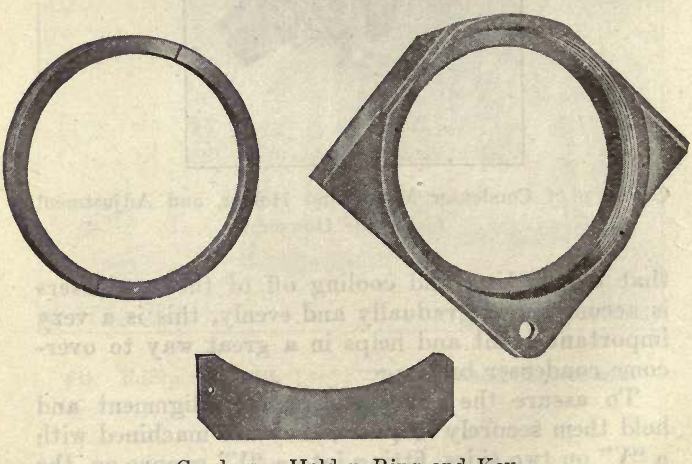
Close-Up of Condenser Mount and Holder, and Adjustment for Inside Dowser

that the heating and cooling off of the condensers is accomplished gradually and evenly, this is a very important point and helps in a great way to overcome condenser breakage.

To assure the condenser proper alignment and hold them securely in place, they are machined with a "V" on two sides, fitting into a "V" groove on the mount. Placed directly under the condenser mount is an adjustment which controls the back condenser (one nearest the arc) allowing the operator to space his condensers to the exact local distance.

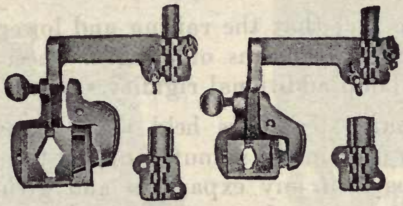
The lamphouse is equipped with an inside dowser to protect the condensers from the heat of the arc while the operator is "forming a crater," etc., the dowser handle is placed on front of the lamphouse directly above the condenser mount locking adjustment. Radical changes have been made in the arc lamp, it is built heavy enough to take care of any amount of current up to 150 amperes; the features of the lamp are as follows:

1—Upper carbon holder designed to take from 5/8 to 1 1/8-inch carbon. Lower carbon holder 5/16-inch to 5/8-inch carbons, manufactured with the "V"



Condenser Holder, Ring and Key

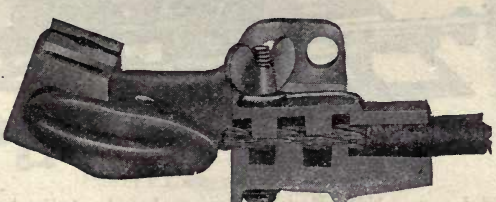
type, assuring a rigid hold on the carbons without breaking them.



Upper and Lower Carbon Holder showing "V"-shaped inserts and inter-locking corrugations for clamping wires

2—Both upper and lower carbon holders are equipped with a clamp which is to take the place of lugs for the wires. These clamps have been so manufactured of a series of interlocking corrugations on both top and bottom of clamp so that when wires have been clamped between them, they will have a positive hold. To take care of any possible arcing, the clamp and the carbon holder have been manufactured of one piece.

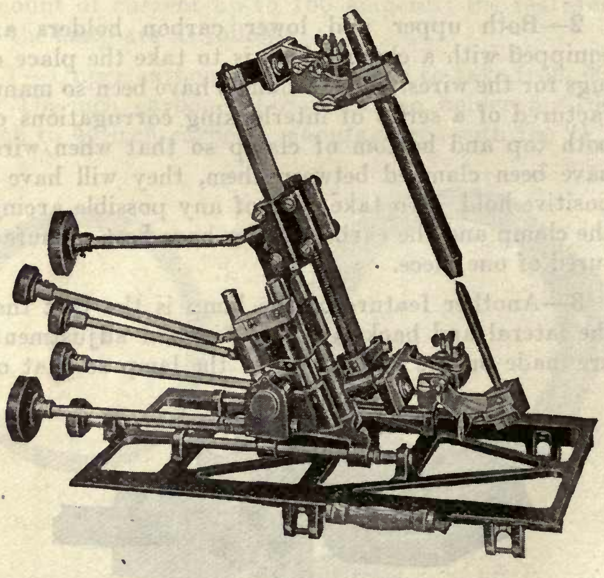
3—Another feature of the lamp is the fact that the lateral and backward and forward adjustments are made on the lower part of the lamp so that on



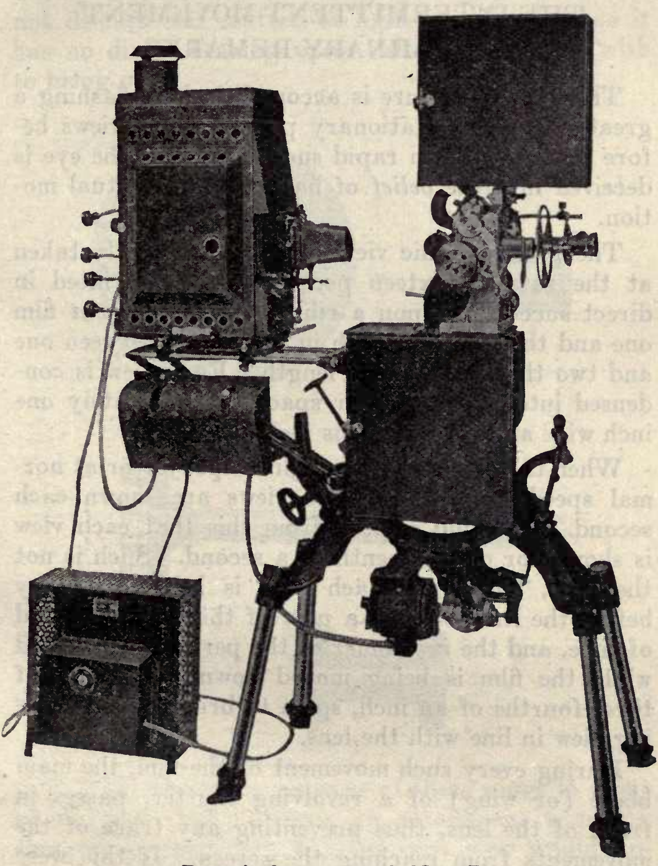
Cross Section of Carbon Holder showing Position of Wire in Inter-Locking Corrugations adjusting the carbons, it will not change the position of the crater of the upper carbon.

4—The fact that the raising and lowering of the lamp is done by means of a worm wheel and gear, gives the lamp additional rigidity.

5—Square steel bars held with a spring cover have been used in the manufacture of the rack rods, to take care of any expansion and giving same a greater wearing surface.



Typ"E" Lamp. Note that the top carbon is stationary. The lateral and back and forward adjustments are made on lower carbon



Power's Cameragraph No. 6B

THE INTERMITTENT MOVEMENT
PRELIMINARY REMARKS

The moving picture is accomplished by flashing a great number of stationary photographic views before the eye in such rapid succession that the eye is deceived into the *belief* of having beheld actual motion.

The photographic views, which are usually taken at the rate of sixteen per second, are printed in direct succession upon a ribbon of *transparent* film one and three-eighths inch in width and between one and two thousand feet in length. Each view is condensed into a rectangular space approximately one inch wide and three-fourths inch high.

When the film is run through the projector at normal speed, sixteen of these views are shown each second. It would appear from this that each view is shown for one-sixteenth of a second. Such is not the case, however. Each view is held stationary before the lens for only a *part* of this minute period of time, and the *remainder* of the period is consumed while the film is being moved down a distance of three-fourths of an inch, so as to bring the succeeding view in line with the lens.

During every such movement of the film, the main blade (or wing) of a revolving shutter, passes in front of the lens, thus preventing any trace of the movements from reaching the screen. If this were not done, the picture would be greatly marred by streaks of light known as "travel ghost." An additional wing (and sometimes two) is inserted in the shutter wheel for the purpose of doing what is technically known as "equalizing the light." We will not discuss this matter of light equalization, as it has no direct bearing upon the point that we wish to bring out.

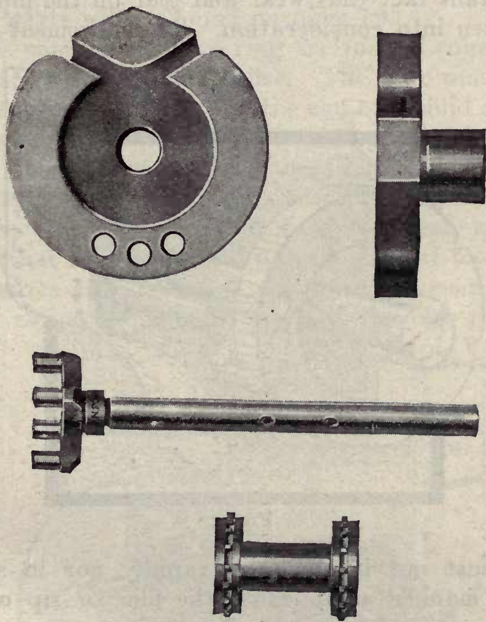


Fig. 1

It is the necessary passage of these wings in front of the lens that prevents an attainment equalling theoretical perfection wherein each view would appear on the screen for its entire allotment of one-sixteenth of a second without interruption of any kind.

It would probably be possible to devise a way to move the film so rapidly that the eye could not perceive any trace of the movement, and thus the necessity of using the revolving shutter would be eliminated, but we are prevented from doing this by the very important fact that wear and tear on the film must be taken into consideration. The movement of the

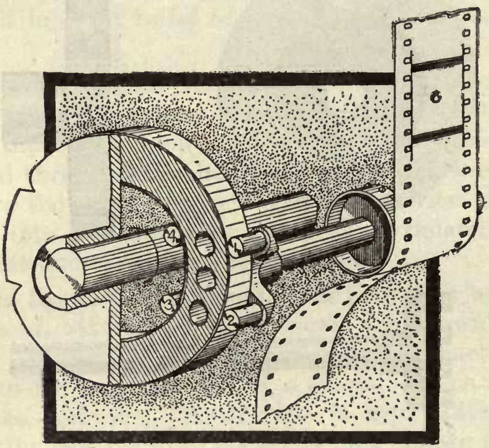


Fig. *a*

film must not be made so rapidly nor in such a jerky manner as to cause the film to rip or pull apart.

TECHNICAL DESCRIPTION OF THE INTERMITTENT MOVEMENT

The term "intermittent movement" is used to designate that part of the mechanism of a moving picture projector, which performs the important function of stopping the film at regular intervals, so that the photographic views may be successively held in line with the lens.

This movement consists primarily of four elements, namely: a diamond shaped cam, a locking ring, a pin cross and a sprocket. Photographic views of these parts will be found on page 193.

The cam and locking ring are formed together on the face of a solid steel disc. The four pins of the pin cross are formed from the end of a solid cylinder of steel. The remainder of this cylinder is turned down to the proper diameter to act as a spindle upon which the sprocket is securely fastened. The sprocket has two rows of teeth to mesh with the holes that are perforated on each side of the film.

Figures *a*, *b*, *c*, and *d*, show these elements in action. A portion of the back of the cam-ring disc

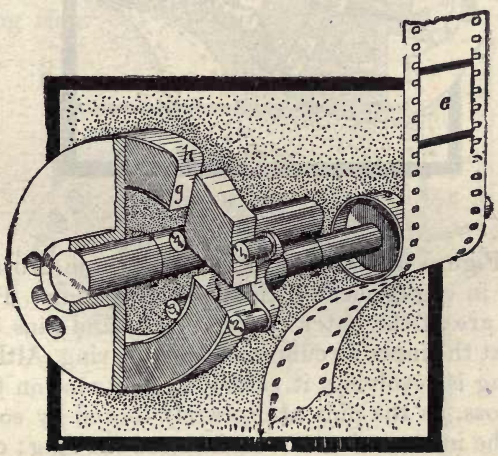


Fig. *b*

has been cut away so as to expose the workings of the movement during one revolution of the disc. The curved arrows indicate the direction in which the parts are revolving. The sprocket is in mesh with a short strip of film. Portion *e* of this film, which lies between the heavy black cross lines, represents one of the photographic views to be projected upon the screen.

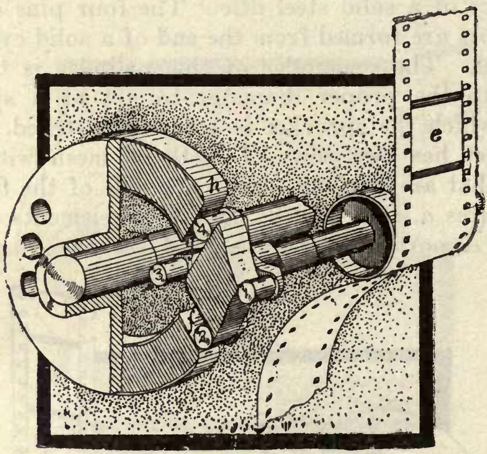


Fig. *c*

In Figure *a*, the four pins of the pin cross are shown in engagement with the locking ring. Pins 1 and 2 are at the outer circumference and pins 3 and 4 are at the inner circumference of the ring. Although the ring is revolving, it cannot impart motion to the pin cross, as the pins are securely locked by contact with the inner and outer surfaces of the ring; consequently the pin cross, the sprocket and the film are at rest. It is during this period of rest that the photographic view is being projected on the screen.

In Figure *b*, the pins are disengaging from the locking ring. The cam is just starting to engage with pin 1. As the engagement takes place the pin is pushed forward and upward, thus imparting a rotary motion to the pin cross spindle. The sprocket, being fastened to this spindle rotates with it, thus pulling the film downward.

In Figure *c*, pin 1 has almost reached the apex of the cam. Pin 2 is traveling into slot *f*, pin 3 is describing an arc in the space between the ends of the locking ring, and pin 4 is traveling out of slot *g*. As pin 1 slides over the apex of the cam, pin 4 engages with the curved surface *h* at the end of the locking ring, and the pin is thrown forward and upward until it slides on to the outer surface of the locking ring.

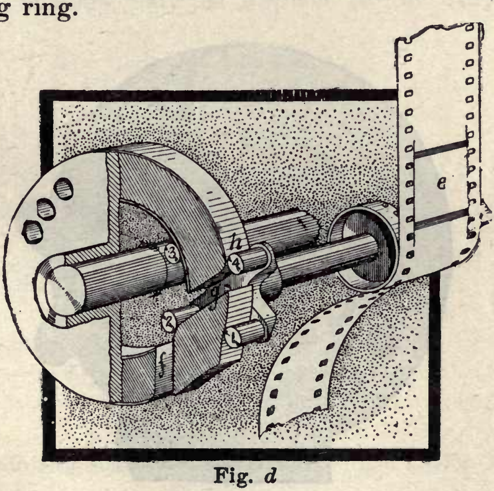
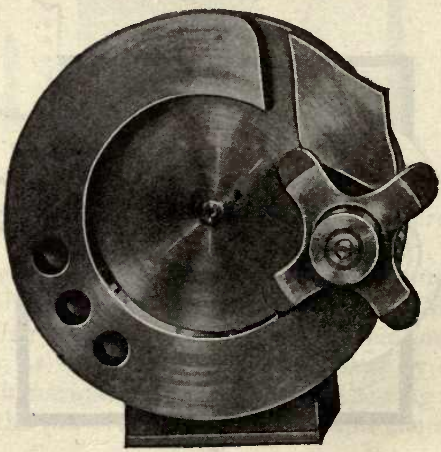


Fig. *d*

In Figure *d*, pin 4 has just reached the outer surface of the ring. The four pins are immediately locked as the locking ring travels into the space between them. In contrast to the pin position in Figure *a*, pins 1 and 4 are now at the outer circumference and pins 2 and 3 are at the inner circumference of the locking ring. It can readily be seen that the pin cross spindle has made a quarter revolution, and that view *e* has been drawn downward a corresponding distance.

Bear in mind that these pins can only move in the path of a circle. As pins 2 and 4 travel through their respective slots it would appear to the uninitiated mind as though the pins must travel in a straight line. This is not the case, however. The fact that the cam-ring disc is revolving, constantly changes the position of these slots so that their

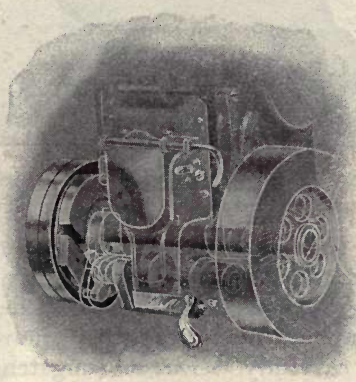


straight lines intersect the circular path of the pins at successively different points.

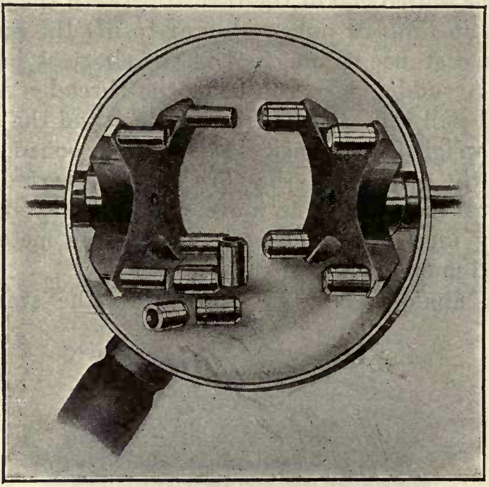
One great advantage that this particular movement has to offer, may be demonstrated by making the following simple experiment:

Tie a one foot length of ordinary cotton thread to a piece of metal weighing slightly over one pound. Take the untied end of the thread between the fingers and by an upward pull, endeavor to lift the piece of metal a distance of one foot in the shortest possible time. A sudden jerk will snap the thread. A slow upward pull will allow the thread to stand the strain of the weight, but considerable time is consumed in lifting the metal. If the slow pull is exerted until the metal has started to move, the pull may then be steadily increased, and consequently the metal can be lifted much more quickly.

This analogy may be applied to the star and



Intermittent Movement with Oil-Tight Casing cam intermittent movement, which has been carefully designed, to move the film downward, by starting the motion with a scarcely perceptible pull that steadily increases to a maximum as pin 1 (Figure *c*) slides over the apex of the cam, after which it decreases in the same steady manner until the pins are locked by the ring, and the film is again at rest. Not

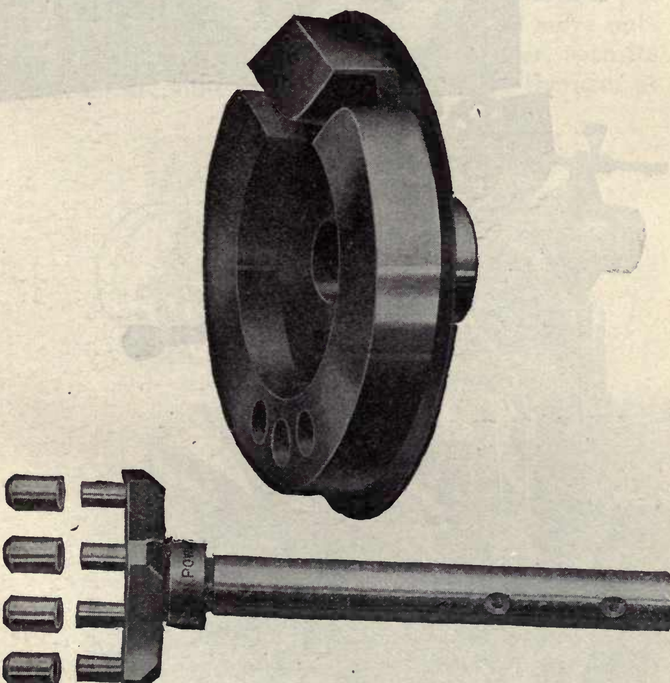


A magnified view of the pin cross of the Power's Machine, with and without roller bearings in place

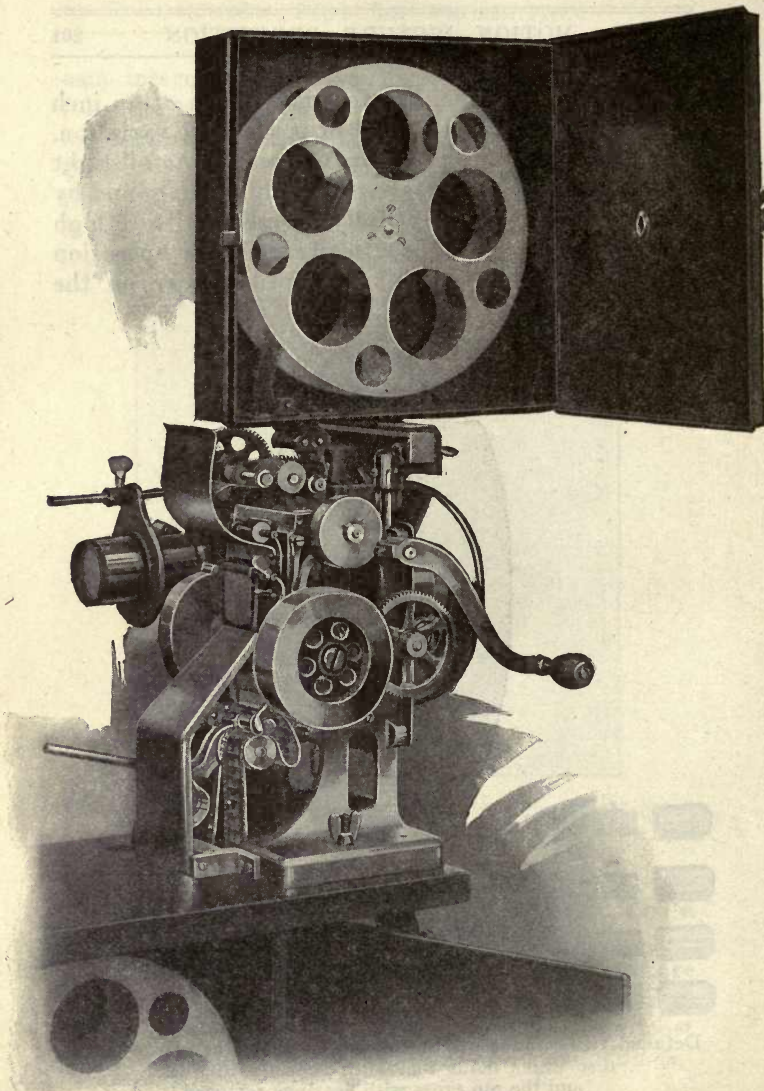
a moment of time is lost, and yet the film is moved so easily that the wear and tear is reduced to a minimum.

The elements of the intermittent movement are made from carefully selected tungsten-chromium steel, which is very tough and durable. The most delicate instruments are used in measuring the dimensions of the elements, one ten-thousandth of an inch plus or minus being the limit of permissible variation.

The cam and pin cross are enclosed in an oil-tight casing. An oil cup is fastened to this casing, and by keeping the parts plentifully supplied with a high grade machine oil, a practically noiseless operation of the movement without perceptible wear on the parts, is insured.



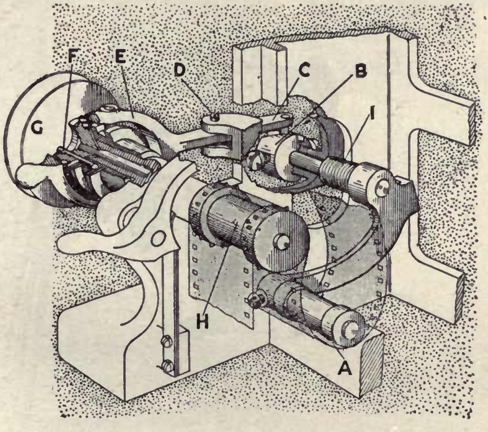
Detailed views of the new movement, showing the cam with the disc which holds the roller bearings in place, and the pin cross with bearings removed



Power's Cameragraph No. 6A
Showing film threaded through machine

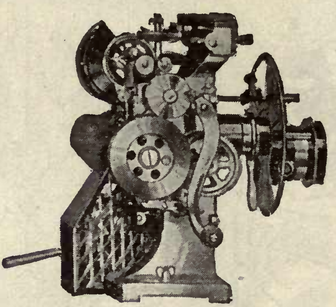
WORKING OPERATION OF POWER'S LOOP-SETTER

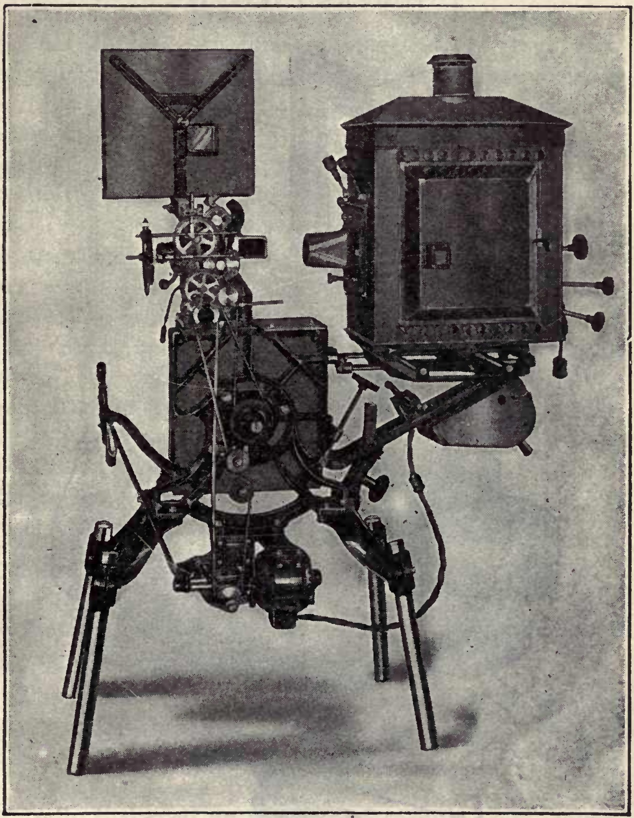
The illustration shows a strip of film forming the lower loop around roller (A). When the loop is lost (drawn taut), the roller is necessarily elevated, thus causing a slight rotary motion in cylinder (B). A diagonal slot in this cylinder, in contact with a pin fastened to arm (E), causes the arm to move outward; but as arm (C) operates as a lever, with its fulcrum at point (D), the other end of the arm at



Automatic Loop-Setter

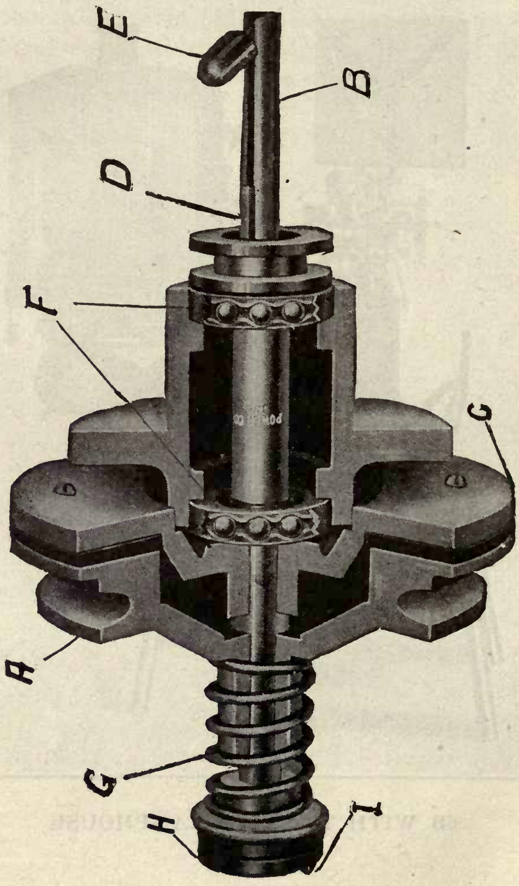
(E) moves inward, thus disengaging pin (F) from the driving pulley (G). This breaks the connection whereby motion is transmitted to take-up sprocket (H), and the sprocket stops revolving. The loop reforms instantly, and roller (A) is forced back into its original position by coil spring (I). Pin (F) immediately re-engages with driving pulley (G), and the take-up sprocket (H) starts to revolve again as a natural consequence. The whole train of operation is automatic—its results instantaneous.





6B WITH TYPE "E" LAMPHOUSE

POWERS TAKE-UP



POWER'S 6B TAKE-UP

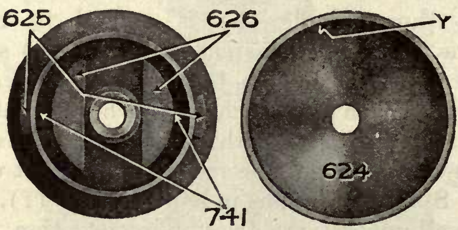
The 6B Take-up is simplicity itself. It consists primarily of two friction discs, which are held in contact by means of a spring. One of these discs is faced with fibre, which assures an excellent frictional contact. The driving disc (a) is left free to revolve around Take-up spindle (b), as an axis. The driven disc (c) is fastened to spindle (b). By frictional contact, motion is transmitted from disc (a) to disc (c) and thus spindle (b) is caused to revolve also. The take-up reel fastens to spindle (b) at (d). The reel is held firmly on the spindle by means of catch (e). When the catch is in a horizontal position, it is in exact line with spindle (b), thus making it very easy to put the reel on, or take it off the spindle. Spindle (b) runs in ball bearings (f), which eliminate all unnecessary friction in operation.

As the film winds on the reel, the steadily increasing load gradually retards the speed at which disc (c) revolves, and this automatically regulates the revolutions of the Take-up reel, so that at every moment the proper tension on the film is assured.

The friction between discs (a) and (c) may be adjusted by increasing or decreasing the tension on spring (g). This may be accomplished by simply giving a few turns in either direction, to collar (h), which is threaded on the end of spindle (b). When the desired tension has been secured, the collar may be locked in place by means of set screw (i).

AUTOMATIC SHUTTER

The shutter covering the aperture in gate of machine and controlled by the centrifugal movement. It is so arranged that the shutter will be held up by centrifugal force as long as the machine is in motion, but should the machine stop for any reason then the shutter falls and cuts off the light from film. It is



The Centrifugal Movement with Cover Removed

a fire prevention device. Should the automatic shutter refuse to work and same cannot be remedied by oiling, it will then be necessary to take the cover off the centrifugal movement Figure 624, then examine springs and shoes Figure 741, and see if the shoe track *Y* is not scratched.

MOTOR TROUBLES & REMEDIES

Sparking may be due to overload, wrong position of brushes, broken coil, weak field, and to any of the causes named for dynamos.

Sparking

Symptom. Intermittent Sparking. On a varying load, in which the work comes on, at the beginning or end of each cycle, and then falls off during the remainder of the cycle, a motor often sparks just as the peak load comes on.

The cause is the heavy current taken at the instant of maximum load, which distorts and weakens the effective field and shifts the neutral point. This weakening of the field results in a still larger current in the armature, aggravating the evil.

Remedy. Add a compounding coil on the motor to assist the shunt, or exchange the motor for a compound-wound one, or one with interpoles.

Failure to Start

(1) *Symptoms.* Motor does not start. Little or no current passes on closing the D.P. switch and pushing starting handle over.

Probable Causes. Brushes not down. Switch not making contact in the jaws. Starting switch not touching the contacts. Fuse broken. Controller fingers not touching contact plates. Break in series coil (if a series motor). Terminal loose. No current on mains.

If the no-volt release coil excites, or if a long arc is observed on breaking circuit, it indicates that the shunt field gets its current and the probable cause of the failure to start is that the shunt is connected in series with the armature owing to two of the leads from the starter being reserved.

Remedy. Trace out the connections or use testing set.

Failure to start

(2) *Symptom.* Motor does not start, but takes excessive current. Fuse or overload cut-out acts.

Cause. It is assumed the motor is not overloaded; this can be tested by taking load off and trying to start motor light. If a shunt motor there may be a short circuit in connecting cables or in field coil; or in armature; or a break in field coil.

Remedy for broken field. If field excites when brushes are up, but not when they are down, the symptoms point to a short circuit in or across armature, or brushes.

Examine brushes for short circuit to frame, for copper dust, oil, or broken down insulation.

Then disconnect armature and excite field. Move armature round quickly by hand. A drag will be felt as the short circuited coils pass the poles. If the armature can be driven at a fair speed by belt, with the field excited, the short-circuited coils will warm up and can probably be located in this way.

If the above symptoms occur with a series-wound motor, the cause may be a short in the field or armature, but not a break.

A fairly common cause is incorrect connecting up.

Another cause, particularly with machines that have been dismantled, is incorrect polarity of the field coils. Thus if the coils are connected up so that they are all of the same polarity, the effect is the same as with a broken field wire as the field is completely neutralized. If only one of the field coils is reversed in a four-pole motor, the motor would probably not start and would in any case take an excessive current.

Remedy. Test the coils for polarity.

Incorrect Speed

A certain amount of speed adjustment may be obtained by altering the position of the brushes. Moving the brushes backwards from the neutral point has the effect of increasing the speed, whilst moving them forward reduces the speed.

Excessive Speed

Symptom. Motor starts, then speed gradually increases till motor runs at very excessive speed. This only occurs when a motor starts light or on a very light load such as a loose pulley.

Cause. If shunt or compound motor. Shunt coil connected in *series* with armature instead of in parallel.

On first switching on, the magnets excite, as the armature is stationary and allows the full shunt current to pass the coils. As the armature speeds up it puts a back E.M.F. in the circuit, gradually reducing the current passing and thus weakening the field. The faster the armature goes the weaker the field becomes. A short circuit in the shunt might produce same result if motor starts absolutely light.

Remedy. Connect up the shunt.

Fuse Blows

Symptom. Motor starts and runs up to its proper speed, but fuse or overload acts on putting load on.

Cause. This is a sign of overload. Probably belts too tight, bearings tight or dry.

If the fuse blows whilst starting up there may be a ground on the motor. This should be tested. If the starter is provided with shunt sector the fuse may blow whilst starting up, owing to a bad contact to this sector, due either to dirt or to a hollow place in the metal.

In the case of a compound-wound motor a cross connection or leakage between the series and shunt windings will cause the fuse to blow if the cross is in a position that the shunt is practically short circuited by the series.

Starter Overheats

Symptom. Motor starting against load takes excessive current. Last few coils of resistance overheat (probably smoke or get red hot). Fuse or overload acts, or motor sparks.

Cause. Overload; or starter too small.

When a motor starts against a load having considerable inertia, such as heavy line shaft with several large pulleys and tight belts, or against a heavily fly-wheeled machine, time must be given for it to get up speed. If the starter is moved over the contacts more quickly than the motor can accelerate, an excessive current will pass, causing the motor to spark. The starter must be put on more slowly and this will cause it to heat up unless it has been liberally rated.

Remedy. Exchange starter for one having more margin, that is one which permits of starting up slower. This does not mean a starter for a larger H.P.

Starts Suddenly

Symptom. Motor does not start nor take current till most of resistance is cut out, then takes rush of current and starts suddenly.

Cause. A break in the starting resistance.

Temporary Remedy. Connect the contacts where break occurs, until resistance can be repaired.

Wrong Direction

Symptom. Motor runs in wrong direction.

Remedy. Reverse armature or field connections, whichever is the easier, but not both.

In a compound-wound machine both the shunt and series coil must be reversed if the field be reversed; but if the machine be provided with interpoles these must be treated as part of the armature and must therefore not be reversed when the field is reversed.

Motor Reverses

Symptom. Motor starts up and runs correctly on light load. On an overload, or reduced voltage, motor reverses and runs backwards.

Cause. This applies to a compound-wound motor, with the series or compound coil connected up in opposition to the shunt coil.

Remedy. Reverse the series coil.

Flashing

Symptom. Severe sparking or flashing apparently all round the commutator; over-heating of the armature and burning of the insulation between a couple of the segments.

Cause. The cause of the above is a broken wire in the armature winding.

Remedy. If the broken end cannot be located and repaired easily, the armature must be stripped until the break is found and the section re-wound. A temporary repair can sometimes be made sufficiently to enable the motor to continue working, by joining across the two segments on each side of the burnt mica with a short piece of copper wire, the wire being laid on the ears of the commutator and sweated in with a soldering iron. This practically converts two segments into one, and the motor will run in this way quite satisfactorily. If the commutator lugs are not readily accessible, a copper pin may be driven hard down between the two segments in a part not under the brushes.

Flashing Over

Symptom. On an overload and sometimes on a normal load a motor will flash from the brushes to a part of the commutator or to the rocker, and blow the fuses. This is more liable to happen with a weak field.

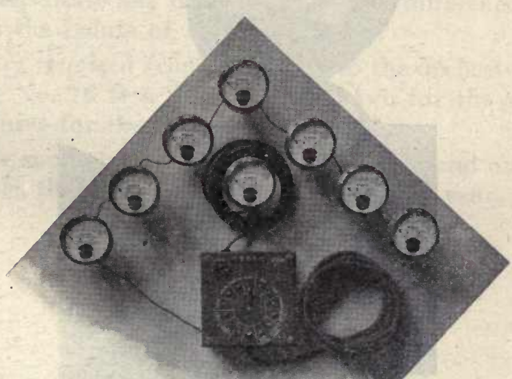
Cause and Remedy. The cause is that the motor has too much forward lead, and the brushes should be moved back a little.

ROBIN SIGNAL TELEGRAPH SYSTEM

The Robin Signal Telegraph system is an audible and visual signal system which provides a positive means of transmitting co-ordinated signals between the operating room, stage, and orchestra pit with certainty and dispatch.

The system consists of a master station which is placed on the stage director's stand or on the orchestra leader's desk, and is connected with the orchestra pit and meters in the booth.

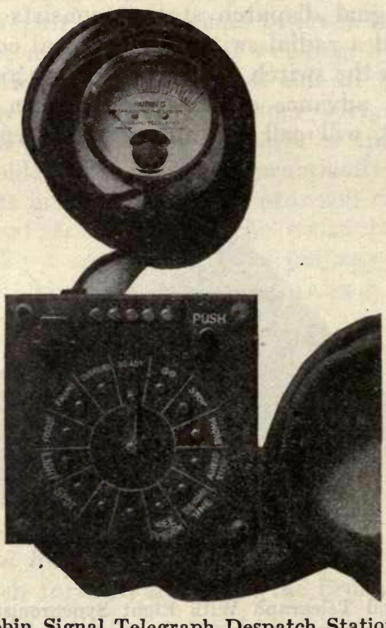
The signal dispatch station consists of a panel board and a radial switch with several contacts. In operation the switch can be set at any point desired as far in advance as desired and when the button is pushed, will call the operator's attention to the signal.



Robin Signal Telegraph With Eight Synchronized Meters as Installed in New York Capitol

At the master station is provided an instrument similar to those installed in the booth, and which serves the purpose of a master meter and conveys to the director or leader sending the signal, means of ascertaining the correct working of the system and also as a telltale of whether the instruments in the booth are registering the correct signals. If the master meter does not function, none of the others will operate.

The meters in the booth are generally placed one under each look-out hole, that the operator, no mat-



Robin Signal Telegraph Despatch Station

ter where located, receives the same signal. Each meter has a plate provided with a scale on which is engraved, "ready, go, stop, slower, faster, see programe, light, focus, and frame."

This instrument supersedes the use of the telephone and the ordinary and troublesome return call buzzer system.

In actual operation instead of the leader or stage director telephoning to the operator and calling him away from his projection machines he throws the switch over on the signal and presses the button and the operator, without leaving his position receives both an audible and visual signal.

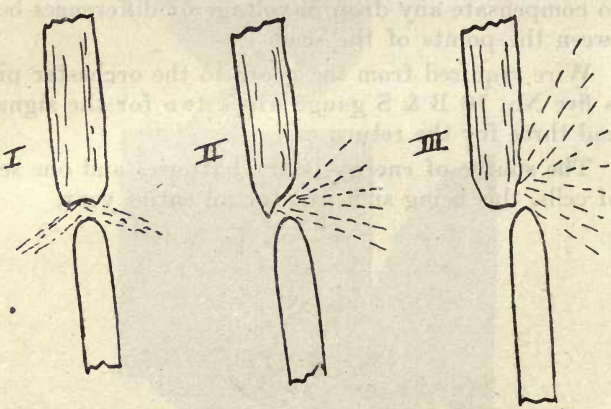
At the rear of the control board on the master station is mounted a capirating rheostat with resistance to correspond with the various points on the scale. There is also provided an adjusting rheostat to compensate any drop in voltage or differences between the points of the scale

Wire required from the booth to the orchester pit is five No. 16 B & S gauge wires, two for the signal and three for the return call.

The source of energy is dry batteries and one set of cells, this being sufficient for an entire year.

CARBONS

There are two classes of carbons generally used in arc lamps, solid and cored; they are composed of coke, tar, or the graphite deposited in the inside of retorts used for manufacturing illuminating gas. With solid carbons the crater travels around the ends of the carbons, the current always tending to take the path of least resistance; with *cored* carbons, which are solid except for an inner core of softer carbon, the travel of the crater is reduced and the distribution of light more steady. The effect of the core is to confine the current to the center of the rod, and consequently the arc, due to the core having a higher conductivity than the surrounding material. With cored carbons the voltage across the arc is reduced.



Right and wrong way to set D. C. arc. I. Lower carbon not far enough forward. II. Correct setting. III. Lower carbon too far advanced

In an alternating current arc the crater alternates from one carbon to the other with each reversal of current, so that both carbons are consumed equally when the rods are horizontal. When vertical, the upper carbon will be consumed about 8 per cent. faster, owing to the action of the ascending currents of heated air.

The Projection Arc

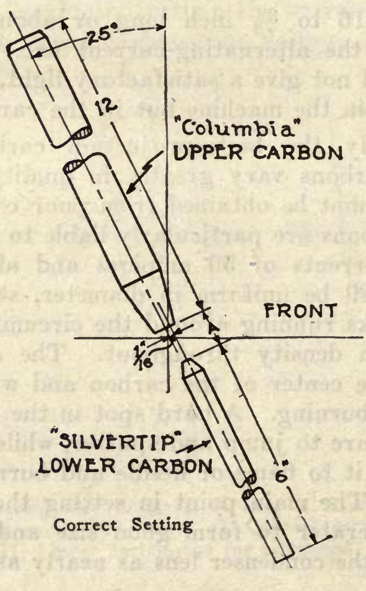
Since the experience of some operators has been limited to projection with the alternating-current arc, the following suggestions are offered on projection with the direct-current arc:

The direct-current arc should be approximately 5/16 to 3/8 inch long or about twice the length of the alternating-current arc. Too short an arc will not give a satisfactory light, the trouble being not in the machine but in the carbon setting.

Use only the best projection carbons. Projection carbons vary greatly in quality and good results cannot be obtained from poor carbons. Inferior carbons are particularly liable to give trouble on arc currents of 50 ampères and above. Good carbons will be uniform in diameter, straight, free from cracks running around the circumference, and uniform in density throughout. The core will be true to the center of the carbon and will not drop out while burning. A hard spot in the carbons will cause the arc to jump and sputter, while a soft spot will cause it to flame or needle and burn away very rapidly. The main point in setting the carbons is to get a crater to form good size and facing the center of the condenser lens as nearly as possible.

Take care to have the carbons in perfect alignment sidewise and a long enough arc that the lower carbon does not "mushroom." Pull the upper carbon back slightly which will face the crater forward toward the condenser. If the upper carbon is not back far enough the crater will point downward and not toward the condenser. If too far back, a long "skirt" will form on the back edge of the upper carbon which will give an unsteady light and may break off in feeding, giving a very poor light until a new crater can be formed.

Do not try to decide upon the merits of carbons by burning just one carbon of a kind in just one



Correct Setting

way; try out a carbon setting at least one whole day to see if results cannot be improved.

There has come into use recently a small diameter metal coated hard core negative carbon which has been found in many cases to improve the operation of the arc by holding it quiet and steady.

CARBON COMBINATIONS FOR NATIONAL CARBONS

DIRECT CURRENT

Current	*Size Carbons*
For 25 to 50 Amps. D. C. use	5/8 x 12 inch Cored Upper 5/16 x 6 inch Metal Coated Solid Lower
For 50 to 65 Amps. D. C. use	3/4 x 12 inch Cored Upper 11/32 x 6 inch Metal Coated Solid Lower
For 65 to 70 Amps. D. C. use	7/8 x 12 inch Cored Upper 11/32 x 6 inch Metal Coated Solid Lower
For 70 to 85 Amps. D. C. use	7/8 x 12 inch Cored Upper 3/8 x 6 inch Metal Coated Solid Lower
For 85 to 100 Amps. D. C. use	1 x 12 inch Cored Upper 7/16 x 6 inch Metal Coated Cored Lower

ALTERNATING CURRENT

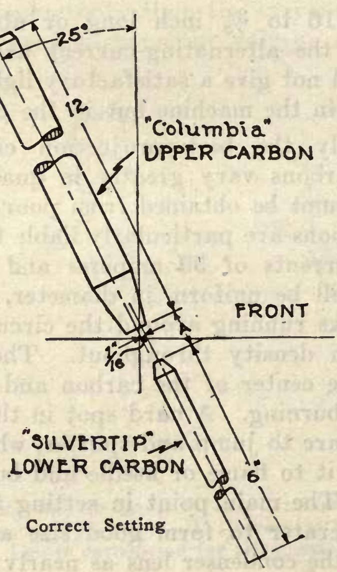
Amperes	*Carbon Diameter*
40 or less than 60	5/8 inch Combination
60 or less than 75	3/4 inch Combination
75 or less than 100	7/8 inch Combination

Projector Carbon Manufacturing Process

In the manufacture of high-grade projector carbons it is necessary to use an especially prepared carbon flour. The flour is carefully mixed with the necessary binding material and forced by hydraulic presses under high pressure into the desired shape.

Take care to have the carbons in perfect alignment sidewise and a long enough arc that the lower carbon does not "mushroom." Pull the upper carbon back slightly which will face the crater forward toward the condenser. If the upper carbon is not back far enough the crater will point downward and not toward the condenser. If too far back, a long "skirt" will form on the back edge of the upper carbon which will give an unsteady light and may break off in feeding, giving a very poor light until a new crater can be formed.

Do not try to decide upon the merits of carbons by burning just one carbon of a kind in just one



Correct Setting

way; try out a carbon setting at least one whole day to see if results cannot be improved.

There has come into use recently a small diameter metal coated hard core negative carbon which has been found in many cases to improve the operation of the arc by holding it quiet and steady.

CARBON COMBINATIONS FOR NATIONAL CARBONS

DIRECT CURRENT

Current	*Size Carbons*
For 25 to 50 Amps. D. C. use	5/8 x 12 inch Cored Upper 5/16 x 6 inch Metal Coated Solid Lower
For 50 to 65 Amps. D. C. use	3/4 x 12 inch Cored Upper 11/32 x 6 inch Metal Coated Solid Lower
For 65 to 70 Amps. D. C. use	7/8 x 12 inch Cored Upper 11/32 x 6 inch Metal Coated Solid Lower
For 70 to 85 Amps. D. C. use	7/8 x 12 inch Cored Upper 3/8 x 6 inch Metal Coated Solid Lower
For 85 to 100 Amps. D. C. use	1 x 12 inch Cored Upper 7/16 x 6 inch Metal Coated Cored Lower

ALTERNATING CURRENT

Amperes	*Carbon Diameter*
40 or less than 60	5/8 inch Combination
60 or less than 75	3/4 inch Combination
75 or less than 100	7/8 inch Combination

Projector Carbon Manufacturing Process

In the manufacture of high-grade projector carbons it is necessary to use an especially prepared carbon flour. The flour is carefully mixed with the necessary binding material and forced by hydraulic presses under high pressure into the desired shape.

If a cored carbon is wanted, a steel needle is suspended in the center of the die. The forced carbons are then placed on racks to cool and when sufficiently cool they are cut in the proper length for baking. To insure absolute straightness, correct size and perfect stock before baking, the cooled carbons are thoroughly inspected before being turned over to the baking department.

In the furnaces, the carbons are subjected to the temperature necessary to produce a uniform carbon of certain definite prescribed qualities. After the bake is completed, the furnace is sampled and the carbons examined by the testing department before being sent along for finishing. These tests are even more severe than those to which a projector carbon is subjected by the user.

Upon receiving the testing department's O.K., the carbons are sorted for straightness and examined for imperfections, and if they are hollow shells, made ready for coring. Every precaution is taken in the coring department, where the hollow shells are filled to see that the core material fills the entire length of the carbon. The composition of the coring material is of considerable importance as it determines largely the burning quality and color of the arc. After coring, the carbons are dried, finished, pointed, inspected and placed in the shipping stock.

The Carbon Arc

In the direct current arc, the crater of the positive carbon forms the principal light source. The positive crater is of relatively large area, while the negative spot is small and is not usually considered as a light source. While 95% of the light emitted by the arc comes from the positive crater, the characteristics of the negative carbon are of vital importance in securing steadiness of operation. In operation,

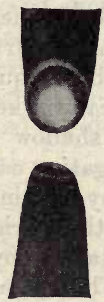


Fig. 1

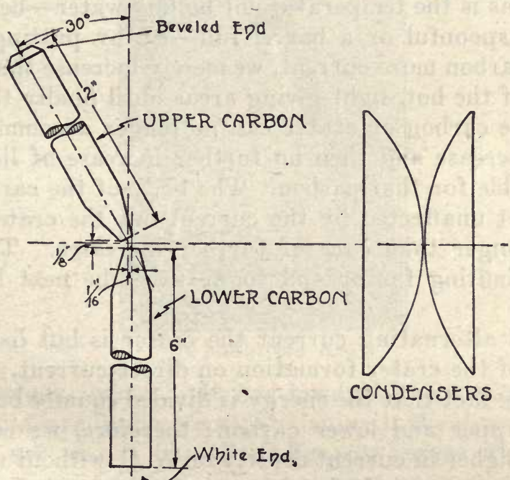
Fig. 2

the positive crater is set so as to face the axis of the optical system. In setting the carbons in this position, care must be taken to reduce to a minimum the shading of the crater by the negative carbon. In this respect, the direct current arc is superior to the alternating current arc. A direct current arc is longer and therefore gives less shading of the crater. The greatest advantage of the direct current arc is the fact that the current travels only in one direction and therefore the positive crater receives electrical energy continously and consequently maintains a higher temperature.

As was stated above the characteristics of the lower carbon on direct current are of greatest importance in securing steadiness of operation. The size of the upper carbon is determined by the power imputed to the arc. If the positive is too small the current will overlap the end of the carbon and the arc will be noisy and unsteady. If too large, the crater covers the end of the carbon and the arc again will be unsteady, because the average temperature at the tip is lower. With the negative carbon, the carrying capacity is the important factor since the size of the negative carbon required by the negative spot is small. A small carbon keeps the arc steady and also eliminates the shadow due to the shading of the crater by the negative carbon itself. This problem has been solved by plating the solid negative over its entire length with a series of metallic coats forming a shell of metal of low electrical resistance around the carbon. This metallic coating volatizes in the heat of the arc and thus prevents the spattering of the rear condenser lens with the heavy metal beads formed with the old style metal coat. The coating carries the major part of the current and makes possible the use of a small negative with the high currents required by long throws and dense films.

The direct current arc is inherently stable and the range of arc voltage can be made whatever the projectionists desire, but there is one fact to be borne in mind that, for each given current value there is a definite arc voltage at which the arc operates at maximum efficiency. With a constant current value, gradually shortening the arc length, will finally produce an unstable arc; just previous to that point is the limiting voltage for the current chosen. Or, otherwise, a given current requires a certain arc length of voltage. To increase the current and not change the arc length, is equivalent to shortening the arc in the first case and the arc becomes noisy. For this reason increasing voltages are required for increasing currents.

When using small diameter solid metal coated negatives on direct current we start at 52 volts for 30 amperes and increasing by 2 volts for each increase of 10 amperes, reaching 62 for the arc voltage at 100 amperes, a saving of 0.7 kw. or 10 percent. in arc wattage, than in case where the old style large diameter cored negatives are used, starting at 55 arc



volts for 30 amperes direct current, and increasing voltage and current in same proportion as recommended in former case.

In the past when using cored negative carbons the basis for choice of the negative was a ratio of 1 for the negative diameter, to 1.65 for the positive diameter, or a cross-sectional ratio of 1.2.

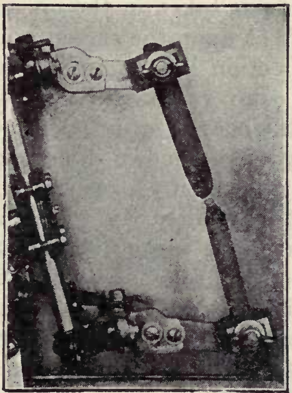
Under the table of Carbon Combinations for direct current projection, the new developed solid small diameter metal coated negative calls for a cross-sectional ratio of 1.4, the negative having ¼ area of the positive.

What determines the size of a carbon for given service is the ability to stand up under it but the limiting factor differs in A. C. and in D. C.

On direct current the limiting factor is the crater. Since the temperature of a carbon arc is constant just as is the temperature of boiling water—be there a teaspoonful or a barrel full—so, by putting into the carbon more current, we merely increase the number of the hot, light-giving areas until finally the tip of the carbon or crater can no longer accommodate an increase and then no further increase of light is possible for that carbon. The body of the carbon is as yet unaffected by the current but the crater can no longer take care of further increases. This is the limiting factor and so we take the next larger sizes.

On alternating current the crater is but half the size of the crater formation on direct current, owing to the fact that the energy is divided equally between the upper and lower carbon; therefore, we can go still higher in current density on A. C. without reaching a crater limit but we now find that the carbon body cannot carry an unlimited amount of current without glowing and oxidizing away sharply, so we are limited on A. C. to the physical characteristics of the carbon. Using the old style alternating current carbon, a short air gap gives a hissing and sputtering arc which is very unstable. By using cored carbons, the cores of which are impregnated with carefully prepared chemicals, an absolutely silent and steady alternating current arc can be obtained. By using the proper chemicals a light source of high intensity is obtained which is far above that of the old cored carbons.

This change in the construction of carbons for use with alternating current projection is one that has come to the front in the last year and has met with



A Mushroom Arc

marvelous success. It has brought the alternating current arc in close competition with the direct current arc and it has allowed many houses who had seriously considered adopting other sources of illumination to continue with the alternating current arc without necessitating a single change in or about the lamp house or in the wiring. The mere substitution of these new carbons for the old style alternating current carbons makes the alternating current arc a very desirable and economical light source for projection.

In addition to fulfilling the general requirements, the carbon arc has other characteristics which make it adaptable for motion-picture work. These characteristics are: Color of light; Reliability; Flexibility; Steadiness.

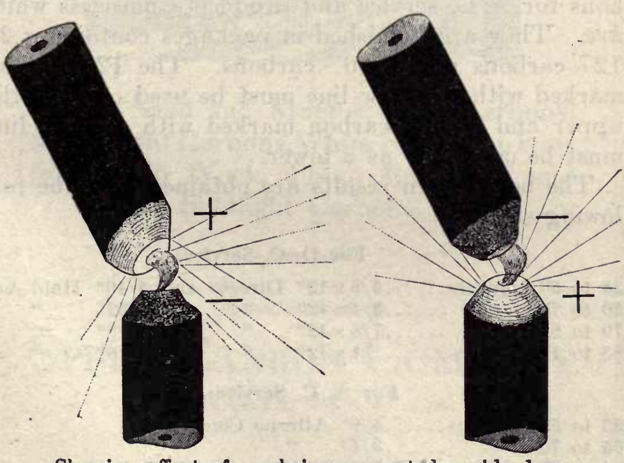
Color of Light: Until recently, the color of the light used for the projection of the high-class film was a source of much annoyance. It is obvious that where the picture is taken in the open and in bright daylight, the effect upon the screen would be inferior unless the projection light source approached that of daylight in color value. The light of the direct current arc is the nearest approach in color value to daylight of any of the known illuminants that could be used for motion-picture projection. The light is a pure white of high intensity. The light of the alternating current arc using the modern high-grade projector carbon approaches that of the direct current arc both in color value and intensity. A pure white light is beyond doubt the proper kind of light to use for projection since it brings out the high lights and shadows and will project upon the screen a picture that will please the most critical audience.

Reliability: The arc in the hands of an efficient projectionist, is a very reliable light source. It is not easily affected by fluctuations in line voltage and therefore will give an even screen illumination where other illuminants will fail. Carbons have a definite length of life and therefore the projectionist can guard against the failure of light in the middle of a reel of film.

Flexibility: The carbon arc gives a steady, flexible light, variable at the will of the operator according to the density of the film. No two films are alike and no two parts of the same film are of the same density and consequently to give a true artistic presentation of any picture you must have a flexible light source.

Steadiness: Both the direct and alternating current arcs are giving absolutely steady illumination. The traveling of the arc and negative shadows have been eliminated in arc projection.

In conclusion, emphasis should be placed upon the use of proper carbon combinations. The carbon manufacturer specifies a definite diameter of carbon for a definite current requirement and any deviation from this will result in poor projection. If the projectionist is without positive knowledge of the amount of power he is using he can obtain this by means of a voltmeter and ammeter. Standard instruments for this purpose can generally be obtained from the local power plants.



Showing effect of arc being connected upside down

THE SPEER CARBON

Speer Projector Carbons have a texture designed to withstand high current densities and insure long life, but soft enough to give a pleasing, steady, white light of great intensity. In order to meet the demand for service of the highest class, three types are offered the trade. The Directo Carbon is made especially for D. C. positives, but may be used as D. C. negatives. It is of the soft cored type and is distinguished by the perfect flush crater developed. The Hold-Ark Carbon, of the hard cored type, is made for D. C. negative work only, is double electroplated and is extensively used by projectionists who desire a noiseless, steady, white light. The Alterno combination sets are the highest development of carbons for A. C. service and produce a noiseless white arc. They are furnished in packages containing 25 12″ carbons and 50 6″ carbons. The 12″ carbon marked with a yellow line must be used only as the upper and the 6″ carbon marked with a white line must be used only as a lower.

The best screen results are obtained with the following sizes:

For D. C. Service:

25 to 50 amperes	......5/8 x 12″	Directo	and	5/16″	Hold-Ark
50 to 70 "	......3/4 x 12″	"	"	11/32″	"
70 to 85 "	......7/8 x 12″	"	"	3/8″	"
85 to 100 "	...... 1 x 12″	"	"	7/16″	"

For A. C. Service:

35 to 55 amperes	......5/8″	Alterno	Combination
55 to 70 "	......3/4″	"	"
70 to 85 "	......7/8″	"	"

THE ELECTRIC ARC

When a current, under a pressure, is passed through two carbon rods, with their ends first in contact and afterward gradually separated a short distance, a brilliant arc of flame called the *electric arc,* is established between them. This arc is composed of carbon vapor, that is, the high temperature caused by the passage of the current through the resistance of the contact surfaces causes the carbon to practically boil and the vapor thus arising, being a much better conductor than the air, conducts the current across the gap from one carbon tip to the other. This volatilization occurs chiefly at the end of the positive carbon terminal where the current enters the arc, and this point is also the seat of the highest temperature and maximum light-emitting power. As the arc is maintained across the gap, disintegration of the carbon takes place, the carbons waste away, and a cup-shaped depression, termed the *crater,* is formed in the *positive carbon,* while the tip of the negative carbon has a conical form. The negative carbon being at a lower temperature than the positive, the vapor of the boiling carbon condenses upon its surface as pure graphite. Both carbons waste away, but the consumption of the positive carbon is about twice as rapid as that of the negative, since it is this carbon from which most of the vapor comes and part of which is re-deposited as graphite on the negative cone-tipped carbon.

The light emitted by any heated body increases with its temperature. The temperature of the carbon in the crater, when in a state of ebullition, is about 3500° C., this being the hottest portion of the arc, and consequently the point from which the most light is emitted. About 12 per cent of the energy supplied to an electric arc appears as light, the balance being represented by the heat evolved. About 85 per cent of the light emitted from an arc lamp is reflected from the crater, the maximum illumination being in a zone surrounding the lamp at an angle of about 40° to the horizontal.

When the arc is "struck" by bringing the carbon electrodes together, and then, separating them for a short distance, the arc possesses peculiar characteristics depending upon the length of the gap between the ends of the carbons. When this distance is too small the arc emits a peculiar hissing noise, and is called a *hissing arc.* It is caused by a too rapid volatilization of the carbon, due to the excessive current that would flow through the lamp with a short gap between the carbons. *Spluttering sounds* produced by the arc are due to impurities in the carbon, or loose-grained carbons. By adjusting the distance between the carbons, a point will be found where the arc burns quietly and steady, and is then termed a normal or silent arc; if this distance be exceeded the arc flames. Impure carbons, or carbons not properly baked, will produce a flaming arc, which is accompanied by a loss of light and rapid increase in carbon consumption.

FILM

Motion picture film is a strip of flexible, supple, transparent celluloid 1⅜" wide. One side of the film is given an emulsion coating much the same as on an ordinary photographic film pack. The margin of the film is perforated, there being 64 perforations to the foot of film or four on either side of each picture (16 pictures to one foot of film) these perforations are for the purpose of feeding the film through the camera or projector. The film comes to the projectionist on metal reels, each reel containing approximatly 1,000 feet of film, generally five or six reels making one feature picture. The projectionist should always examine his film before running it through the projector; this he does by running the film from one reel on to another, by using a rewinding machine and letting the film pass between the first finger and thumb of the left hand; care should be taken to see that all patches are secure, that the film is free from "frame-ups" and that the perforations are in such a condition that the film will pass readily through the projector without jumping off the sprockets. The reels should then be placed in a fireproof film cabinet in chronological order, care being taken to see that the film is wound on reels emulsion side out and that the beginning of the film subject comes off first, in other words that the film does not go through the projector tail-end first. Remember that the film passes through the projector upside down and emulsion side to source of light. As soon as the film has passed through the projector it should be rewound and placed back into the safety cabinet ready for the next show. The majority of film exchanges request that the film be returned to them unrewound just as it is taken off the projector after it has been run, it being the rule in exchanges that the film be examined starting at the end and working back to the beginning of the subject; this is to eliminate the risk of their sending the picture on to the next theatre, tail-end first. Care should be taken to see that all pieces of film are kept off the floor of the operating and rewinding room; a special can fitted with a self-closing door or lid should be a part of the necessary equipment of the operating room. Film should at all times be handled with great care, as owing to the ingredients from which it is made, nitro-cellulose and camphor, it is highly inflammable. Never under any circumstances expose film near a naked light; do not smoke while handling film or in a room where film is stored; film should not be stored in a warm dry atmosphere unless it is kept in a humidor. Do not attempt to run a show if using inflammable film without having the projector enclosed in an approved fireproof booth; perhaps an editorial we prepared for the Educational Film Magazine on this subject will be appropiate here.

In New York State and, in fact, every state of the Union certain very stringent rules and regulations have been drawn up and must be complied with before it is possible to obtain a permit for the purpose of showing motion pictures. We advise all those in any way interested in the showing of motion pictures to get a copy of the law and read it carefully over.

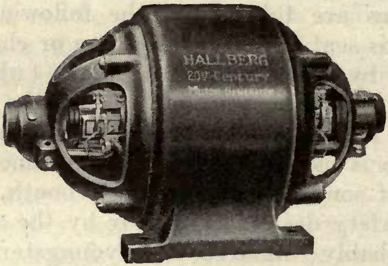
The code distinctly states that no motion-picture machine shall be used unless same has been approved by the Board of Fire Underwriters. This board demands that all motion-picture machine manufacturers shall make the machines as fireproof as possible; the machine must be so constructed that only a short length of film can be exposed while the machine is in operation. The machine must be equipped with an automatic fire shutter, so arranged that the shutter will immediately drop in case of trouble and thus cut off the heat of the arc lamp from the film.

The law then goes on to state that even this machine equipped as it is with all these fire prevention devices shall not be used unless the said machine is installed in a fireproof booth. They are as particular regarding the booth as they are with the machine; the booth must be constructed of asbestos, concrete, brick, or some other approved fireproof material. Certain minimum dimensions are given as the size of the booth and it must have a door that is automatically self-closing. The projector and observation ports in the booth must be equipped with metal or asbestos shutters, so arranged that they will automatically close in case of fire in the booth. There must be a flue or vent running from the booth to the open air to carry off the smoke in case of fire. The booth must also contain fire bucket, pails of sand, and fire extinguishers.

Now that we have a fireproof projecting machine installed in a fireproof booth, the authorities go one better and state that with all these precautions there is still a great danger of fire unless a duly qualified licensed man is placed in charge of the handling of film and the operating of the projection machine. They demand that theater managers shall take all these necessary precautions against fire on account of the highly inflammable nature of the film. Both the theater manager and the professional operator lay themselves open to severe penalties should they not live up to the letter of the law. These rules are not laid down to throw obstacles in the way of those desirous of showing motion pictures; they were drawn up after due and careful consideration for the public safety.

When we stop to consider that a film is run to-day in a theatre where all these very necessary precautions are taken, and the following day the same film is sent to some class-room or church, there to be run by some amateur operator (whose knowledge of projection is limited to the threading up of the machine and the switching on of the current) who is using a projecting machine set up on the top of some table—minus the booth, minus the various safety devices called for by the authorities, with probably hundreds of youngsters crowded around the machine—we come to the conclusion that either too much precaution is taken in the case of the theatres or not enough in the church and class-room. We come out here and state that it is the latter. There are hundreds of churches, schools, and educational bodies throughout the country which are using inflammable film without taking the necessary precaution against the ever-present fire risk.

When inflammable film is used, it matters not what make of projector you are using, you must install the machine in a fireproof booth that has been approved by the proper authorities, and an experienced man should be placed in charge. The law is very clear and definite on this point.



SCREENS

The screen has in the past been one of the most neglected features of the average picture theatre. He who states that this or that particular screen is the best in all cases is in the same class with the country fair medicine vendor who calmly proclaims that his pill has the virtue of curing all ills from mange to matrimony.

The sole duty of a screen is to reflect light. We see the picture on the screen not by the light that strikes the screen, but by the light which the screen reflects to the eye. We would not be able to see a picture projected onto a black screen, for the simple reason that there would be no light reflected. Then again, the screen that reflects the most light need not necessarily be the ideal screen, the manner in which the light is reflected must be taken into consideration.

There are so many things to consider when choosing a screen for any particular installation that it is almost impossible to give general information that can be applied without qualification. The following are a few of the points that should be considered:

Size and shape of theatre.

Is there a balcony?

Location of the projection room in relation to the screen.

Layout of seats as regards the viewing angle.

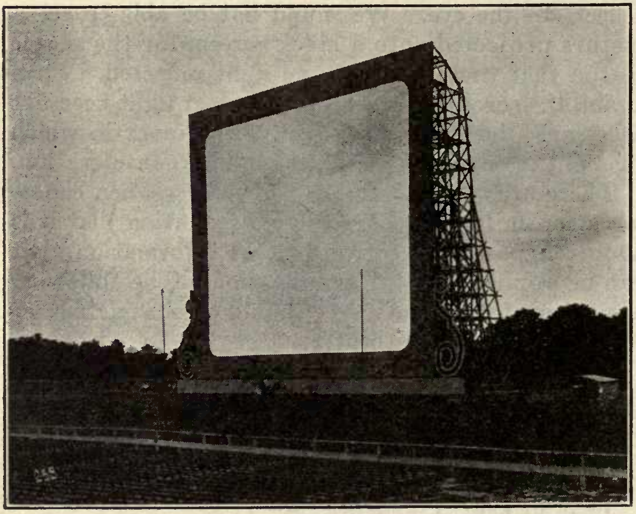
Is the screen to be fixed or movable, and is there to be light behind it at times?

Distance from screen to nearest row of seats.

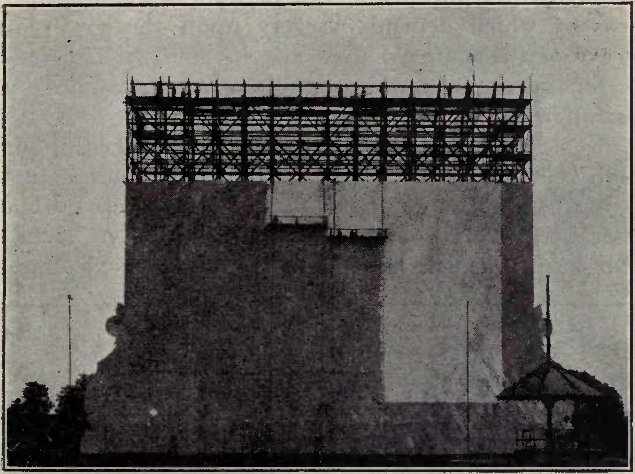
Kind and quantity of light to be used in projector and its source.

Some further points to be borne in mind are these: No screen reflects all of the light that reaches it because all materials are more or less absorbent. No screen can be an efficient direct reflector and at the same time a satisfactory diffuser of light, as these two qualities are in direct opposition. In referring to the two classes of screens, it would probably be better to speak of one as a direct reflector and the other as an indirect reflector.

With a given source of light projected at normal, i. e., from directly in front and viewed from the same position, the direct reflecting screen will be much



The Largest Motion-Picture Screen Ever Constructed. It Measured 165 by 135 Feet. A Simplex Type "S" Projector Using 170 Amperes, With a Throw of 350 Feet Projected a Picture 100 by 75 Feet brighter than the indirect reflecting one, but when viewed from angles the indirect reflector is the brighter, the difference increasing as the angle increases. To the observers seated rather close to the screen of average size the picture will be more satisfactory if an indirect reflector is used, because the



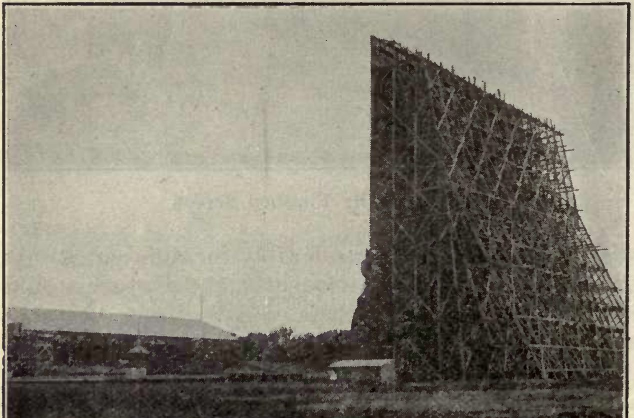
Partially Finished Screen

viewing angle varies considerably for different points on the screen, and consequently the picture would not be of uniform brightness if a direct reflector were used.

Generally, the direct reflecting screens are metallic surfaced (there are a few exceptions), while the indirect reflectors have a non-metallic (mineral or fabric) surface. Metallic surface screens generally show very contrasty pictures, the high lights being very bright and glary, and the shadows very deep. There is a lack of graduation in the toning, however, so that the picture is deficient in fine detail. The indirect reflectors on the other hand are generally not contrasting because their high lights are subdued, i. e., not glary, and the shadows are not so deep or black but the picture is full of half tones, the fineness of which depends largely upon the grain or weave of the material used and its uniformity.

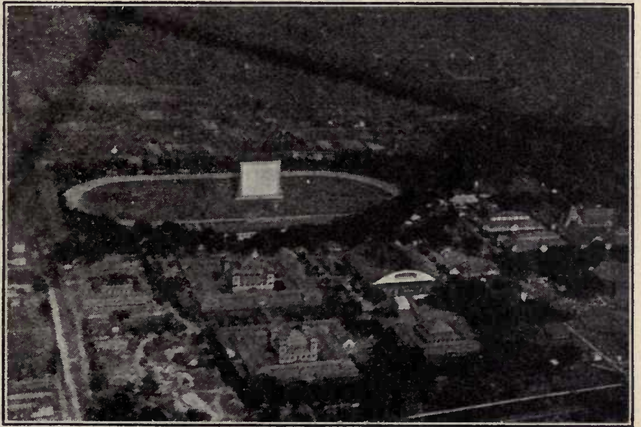
The maximum in screen value may be summed up as follows:

Most light from given current consumption or high reflection and slight absorption of the incident light. Uniform distribution of the reflected light over a wide angle without loss of brightness. Detail and half tones without diminishing contrast clear,



Rear View of World's Largest Screen Showing Tremendous Amount of Lumber Used bright "high lights" without glare, absolute opaqueness, great durability and ease of transportation and installation, adaptability to different light sources, such as arc or incandescent lamps, direct or alternating current.

Since all of these features cannot be incorporated in any one screen, it becomes necessary to decide



The Projected Picture Could be Easily Seen Six Blocks Away. The Screen Was Used at the Methodist Centenary, Columbus, Ohio

which one has the best combination of the above mentioned points in accordance with the requirements of the auditorium being equipped. While the writer has never made a thorough test of the matter, he is of the opinion that it is unwise to attempt to decide the amount of current necessary for a given installation by considering only the seating capacity of the house and the size of the screen. The shape of the auditorium and the arrangement of the seats in relation to the screen are matters of the utmost importance when considering not only the amount of illumination necessary but also the kind of screen upon which the light is to be projected, because if the room be wide in proportion to the depth or there is a deep balcony with the projection room at a considerable elevation, so that there are some seats from which the viewing angle is greater than 20 or 25 degrees of either the axis of projection or of the perpendicular face of the screen, or both, it will be necessary to install a screen of the indirect reflecting type so that the illumination will be distributed over these wide angles, and since distributing a given amount of light over a greater area proportionately reduces the amount of light available *per degree*, it will be necessary, if a given screen brightness is to be maintained, to use more current in a house having rather large angles than would be used if the angles were not so great. This does not necessarily mean that as generally used one class of screen is more costly in the matter of current than the other. It all depends upon whether or not the screen is suited to the house. If, for instance, an indirect reflecting screen is installed in a long, narrow house, a large proportion of the light will be reflected toward the side walls and ceiling and wasted. On the other hand, if a direct reflector screen be installed in a house that is rather wide or where the picture is projected at an angle, there will be a pronounced "fade-out" or loss of light from all seats that are not in the direct reflective angle of the screen. Now, in order to overcome the fade-out and increase the light to seats outside of this direct reflective angle, the projectionist usually increases the incident illumination to a degree far beyond the amount needed for proper screen brightness, a practice that is not only wasteful as regards electric current, but produces the glare in the "high lights" that is extremely unpleasant to the observer as well as injurious to the eyes.

The screen should be outlined with a dull black border, and should be placed so that no light save the light from the projector reaches it. The location of the screen must be governed by local conditions, but it is well to see that it is placed high enough so that the lower part of the picture can be comfortably seen in all parts of the house, and yet not so high that those sitting down front have to strain their neck looking up to the picture. Wherever possible the screen should be placed so that the center beam of light strikes the center of the screen at right angles. By doing this distortion and "keystone effect" will be overcome.

METHOD AND APPARATUS FOR PROJECTING MOTION PICTURES WITH COLOR EFFECTS

David Wark Griffith has received from the Commissioner of Patents at Washington the exclusive right to "make, use and vend certain methods and apparatus for the projection of motion and other pictures with color effects."

The Griffith patent, granting protection for a term of seventeen years, was secured by Albert L. Grey, Mr. Griffith's general manager, through Attorney O. Ellery Edwards, and will give the producer ample protection against the copying or appropriating of his lighting effects in color, first introduced by Mr. Griffith in connection with the showing of "Broken Blossoms" at the George M. Cohan Theatre, New York City.

The Griffith patent covers a wide range of lighting, including the process and apparatus by means of which either moving or other pictures may be projected onto an illuminated screen which has colored lights blending with the pictures shown. These and other inventions are covered by the patent, the embodiment of which are as follows:

"The process of producing colored pictures on an opaque screen, which consists of throwing pictures by a projector onto one surface of said screen and simultaneously illuminating the screen with diffused colored lights thrown onto the same surface of the screen in a direction oblique to the stream of light from the projector.

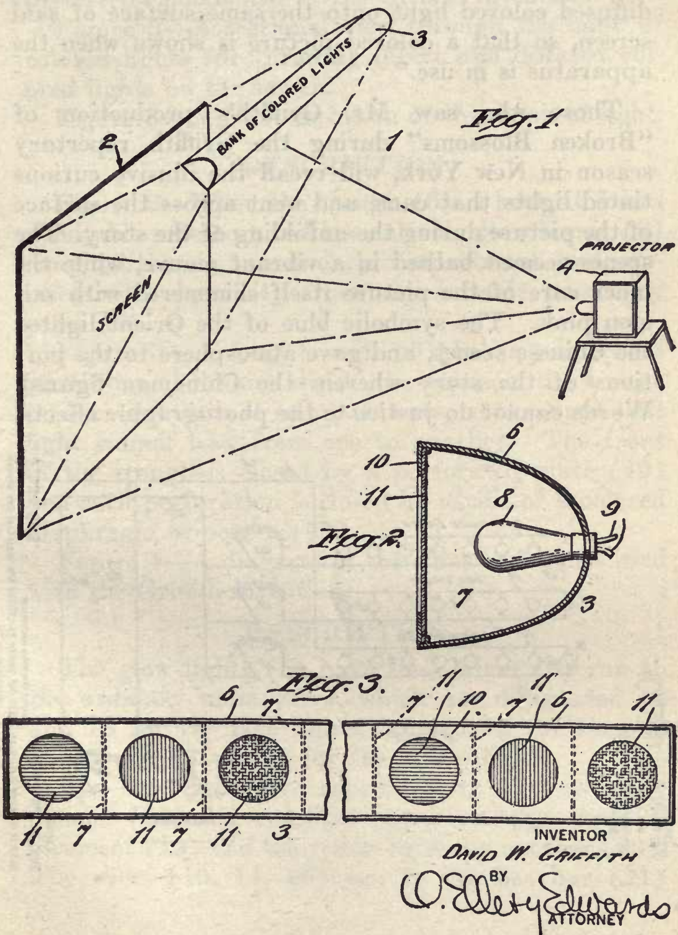
D. W. GRIFFITH.

METHOD AND APPARATUS FOR PROJECTING MOVING AND OTHER PICTURES WITH COLOR EFFECTS.

APPLICATION FILED MAY 14, 1919.

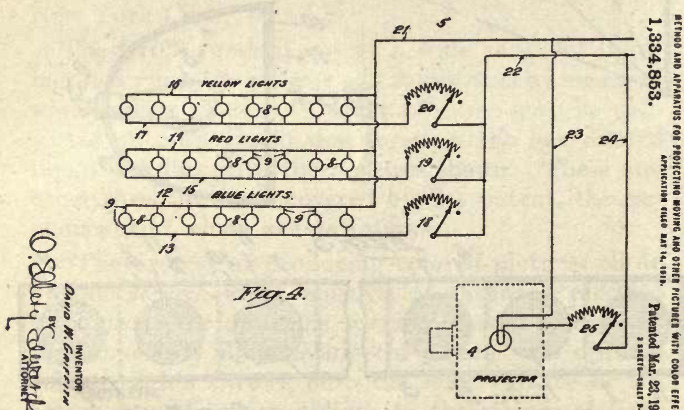
1,334,853. Patented Mar. 23, 1920.

2 SHEETS—SHEET 1.



"In an apparatus of the class described, the following equipment: An opaque screen, a projector, a bank of colored lights out of the path of light from said projector and for the purpose of throwing diffused colored light onto the same surface of said screen, so that a colored picture is shown when the apparatus is in use."

Those who saw Mr. Griffith's production of "Broken Blossoms" during the Griffith repertory season in New York, will recall the illusive curious tinted lights that came and went across the surface of the picture during the unfolding of the story. The scenes seemed bathed in a vibrant mauve, while the inner core of the picture itself shimmered with salmon pink. The symbolic blue of the Orient lighted the Chinese scenes, and gave atmosphere to the portions of the story wherein the Chinaman figured. Words cannot do justice to the photographic effects,



many of which were like beautiful moving canvasses colored by an impressionistic touch.

Figure 1—A perspective diagrammatic view of the preferred embodiment of the Griffith invention.

Figure 2—A sectional view through the bank of colored lights for throwing direct and diffused colored lights on the screen.

Figure 3—A front elevation of this bank of light.

DESCRIPTION

Figure 2—When the trough (6) is bent, it forms a suitable reflector, and has suitable glow lamps (8) mounted therein, one in each compartment, and supplied with electricity from any suitable source by wires (9).

Figure 3—A long trough (6) has a number of partitions (7) which divide the space in the trough into several distinct compartments, so arranged that light cannot leak from one to another. The front of the trough is closed by a perforated plate (10) and each perforation is closed by means of a colored diaphragm or screen (11).

Figure 4—A diagram of the wires and lights used with the Griffith invention.

DESCRIPTION

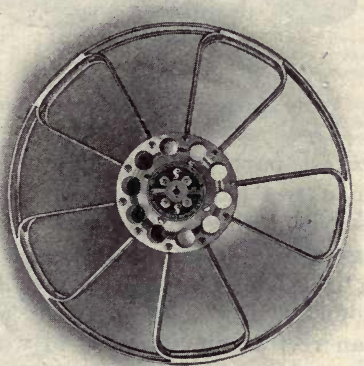
The glow lights (8) have their wires (9) run to the ordinary main wires, which are designated 12 and 13 for the blue lights, 14 and 15 for the red lights, and 16 and 17 for the yellow lights.

The blue lights are controlled by a rheostat or dimmer (18), the red lights by a corresponding instrument (19) and the yellow lights by another (20). The wires (12, 14, 16) run to the bus bar (21) and the rheostat (18, 19, 20) are connected to the other bus bar (22). Wires 23 and 24 connect these bus bars through the projector (4) and its regulator or rheostat (25).

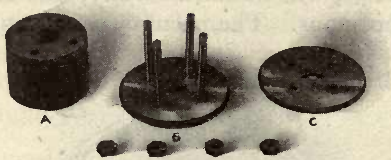
If electricity be shut off the red and yellow lights, and turned on the blue lights, the entire screen will appear blue, and the images from the projector will be correspondingly colored. Also, by the regulators or dimmers (18 and 25) the intensity of illumination of the screen may be varied so that an infinite number of color effects may be produced with one set of colored lights.

SIMPLEX-BOYLAN EVEN TENSION REEL

That long neglected yet very important device, the film reel has at last claimed the attention of the machine manufacturers. Just how many thousands of dollars are wasted yearly in film damage due to defective reels, will be hard to say, but the amount must be enormous. The pecular part being that the



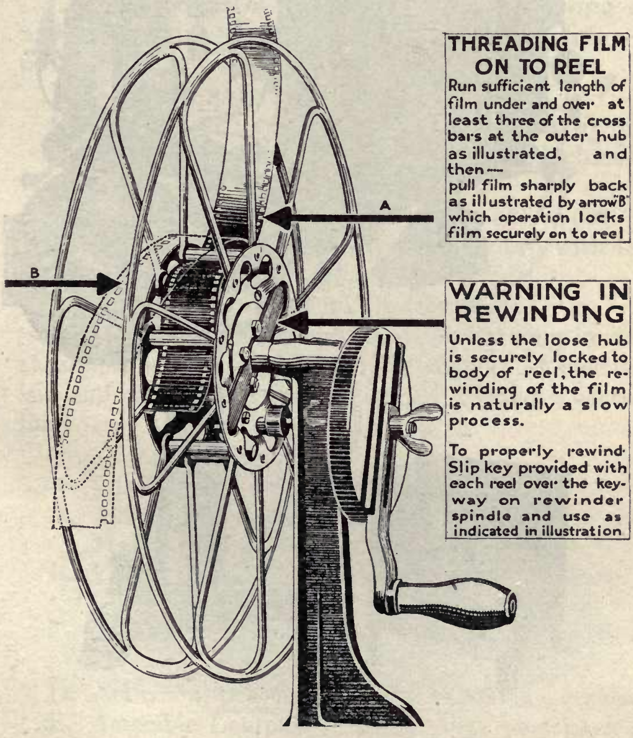
film exchanges are the worst offenders, sending out features worth hundreds of dollars on reels that are in such a condition that the film has to materially suffer in passing through the projector, or in transportation. The Simplex Machine Co. were quick to recognize the merits of the reel designed by Grove S. Boylan, and after incorporating several improvements are now placing the reel on the market as the Simplex-Boylan Even Tension Reel. The reel is light in construction yet very strongly made, the sides are made of cold rolled steel wire, which eliminates all rough sharp edges, saving both the film and the operators fingers. The hub is of die cast composition specially designed to prevent the slightest chance of inefficiency.



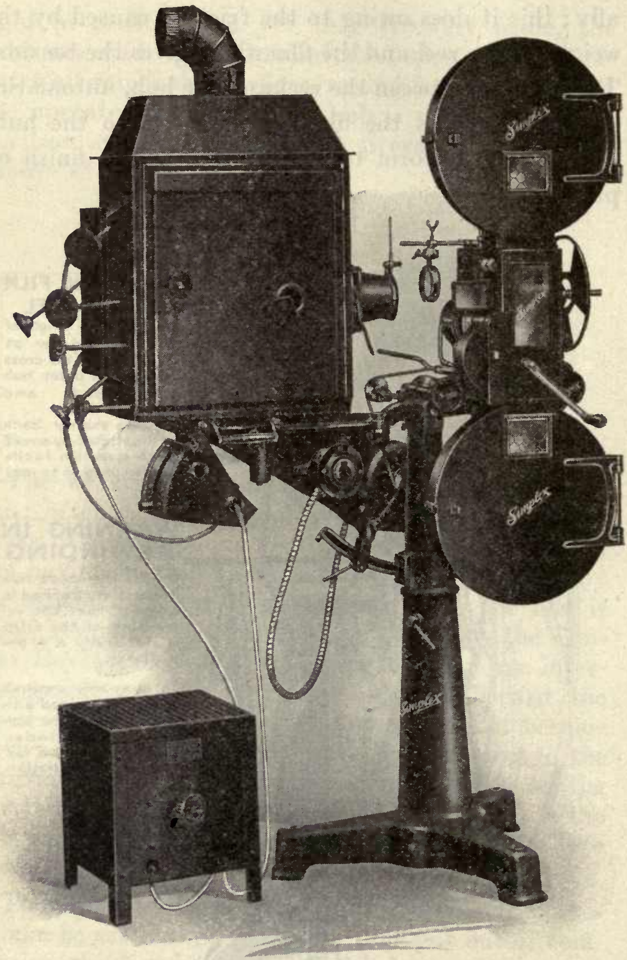
Parts Making Up the Hub of Reel

The weakest part of every reel is naturally the hub; often a reel has to be discarded after a few weeks of service owing to the keyway in the hub of reel having become badly worn, caused generally by the strain it is called on to bear while the film is being rewound. It will be seen that with the Simplex-Boylan reel all parts liable to wear are interchangeable making it unnecessary to discard the whole reel should the hub or any part of it become worn; then again it will be seen by referring to the diagram that the tension while rewinding is on the key that engages across the hub, rather than on the hub itself, thus greatly increasing the life of the reel.

The premier advantage is that the projector take-up can be screwed up tight and thus put out of commission, the Simplex-Boylan reel being so constructed that it will take care of the film tension automatically; this it does owing to the friction caused by the weight of the reel and the film which gives the tension. The friction between the reel and the hub, automatically increases as the film is wound on to the hub, thus giving uniform tension from start to finish of picture.



Simplex-Boylan Even Tension Reel



Simplex Type "S"

INSTRUCTIONS FOR INSTALLING THE SIMPLEX PROJECTOR

Unpacking

Upon arrival of the machine use utmost care in unpacking.

Use nail puller in opening case and removing all nails used in securing cleats supporting different part.

Never use a hammer to knock out cleats.

Cleats removed; parts can be lifted out one by one.

Pay special attention when removing Mechanism from case.

Don't take hold of shutter shaft to lift it out.

Take hold of bottom with right and top with left hand thus lifting it out of case.

Unusual strain will bend shutter shaft.

Simplex Machines while simple and strong in construction, are a carefully adjusted piece of mechanism and cannot be handled roughly beyond a certain limit.

Setting Up Simplex Projector

A. Assemble pedestal column to base.
Have two feet of base face screen.

B. Fasten lower magazine and take-up to base.
Use two screws furnished for the purpose.

C. Fasten mechanism to pedestal top by means of two wing screws.

D. Attach upper magazine to top of mechanism.

E. Assemble Lamphouse to carriage just back of Mechanism.

Connecting Up Asbestos Leads

D. C.

Attach three (3) ft. wire to Lamphouse and lower switch box terminal.

Attach four (4) ft. wire to opposite lower switch box terminal and to one side of rheostat.

Attach six (6) ft. length to other side of rheostat and connect other end to upper carbon holder.

A. C.

In connecting transformers or current savers, connect wires from main line switch or wall switch to upper terminals on pedestal switch. Now connect two wires from lower terminals on above switch to primary winding of whatever transforming device is used, which will be found marked "line." Then connect two wires from terminals marked "lamp" on the transforming device, after which connect other two ends of these two wires to the upper and lower carbon holders inside of lamphouse.

Condenser

Place 6½ in. condenser toward arc and 7½ in. toward screen.

Lens Assembly

The flat surface of the moving picture lens should face the arc; the bevel side the screen. This also applies to achromatic lenses.

Shutter, Stereo Lens Holder and Framing Device

Shutter should be placed on shutter shaft in front of mechanism in accordance with instructions in following pages.

The framing handle should be inserted in framing device on lower part of mechanism facing lamphouse.

Take lens holder, insert lens between adapters, tighten with holder ring and fasten to upper part of mechanism away from operator with stereo rod inserted in stereo arm.

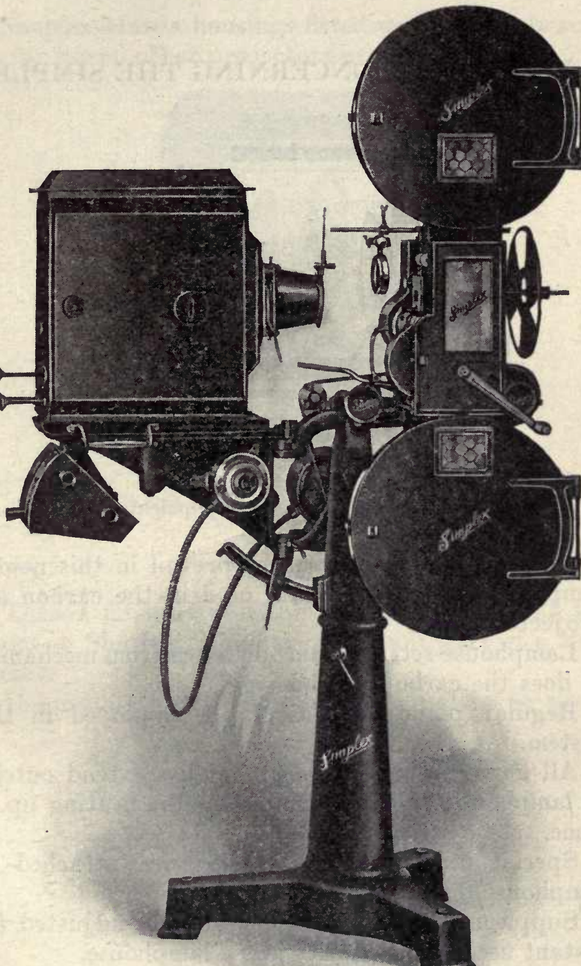
Attaching Motor

For the attaching of the Motor Table a slot will be found on the left of the pedestal column, nuts and washers for fastening same are furnished.

Two sets of holes will be found on Motor Table, either set of which may be used according to drive. When using old style drive in conjunction with pedestal pulley, use inner set of holes. If motor is to be used in connection with new speed control, use the outer set. Two 5/16 in. wing screws are furnished for fastening motor to table. After attaching motor to table, fasten snap switch to slide over arm for which three holes are provided. The canvasite cord attached to the snap switch should then be connected to the line intended to furnish power for the motor by means of an attachment plug or other device. On AC when using constant speed induction motor furnished with the new friction speed controller, a 10 ampere fuse is recommended, as this motor requires about three times the normal running current for starting under full load.

On DC Motors a three ampere fuse is of sufficient capacity and is recommended for the protection of the motor.

Lower magazine has a reversible take-up pulley with two grooves. The large grooves should be used with the long take-up belt for large reels, 5 in. hub, taking 1,000 ft. of film or over. The small groove should be used with the small take-up belt with reels having small hub. If take-up does not work properly, reverse pulley, you may have it on wrong.



Simplex Mazda Equipment

against going back on him it must be designed right in the first place.

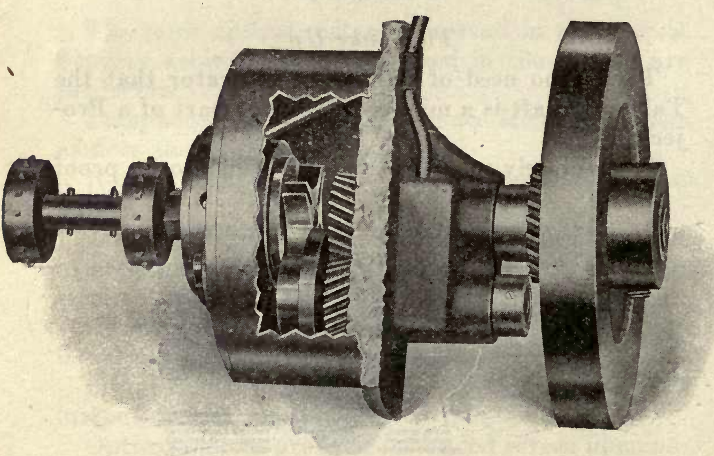
Now, there are two ways of designing a Take-up Shaft.

One way is to design it wrong, to have the belt pull sideways on the shaft, cramping it in its bearings, and then to try to overcome the difficulty by introducing ball bearings.

The other way is to design it correct in principle, like the Simplex Take-up Shaft here illustrated.

When you read the explanations you will quickly see that the belt-pull doesn't come on the shaft at all; so there's no cramping or friction to try to reduce by "anti-friction" bearings.

And, as you know, the probability of any piece of mechanism going wrong increases directly as the



The Heart of the Simplex

number of parts it contains. So being extremely simple as well as free from blunders in design, the Simplex Take-up Shaft is dependable in the highest degree.

The Intermittent Movement

The Simplex embodies the "star and geneva" movement, this principle being as highly refined as is possible to do with the best procurable material and precision workmanship.

No other intermittent movement has yet been evolved which compares with the geneva movement for accuracy, length of wear and yet allows for perfect adjustment to compensate for any amount of wear.

Movement lies in oil chamber, the lubrication for which is conveyed through oil tubes easily accessible.

Shafts and sleeve bearings are ground fit, insuring long service and perfect fit and alignment.

Adjustment of star and cam is made by means of eccentric bushing and by use of fork wrench without removing any portion of the mechanism.

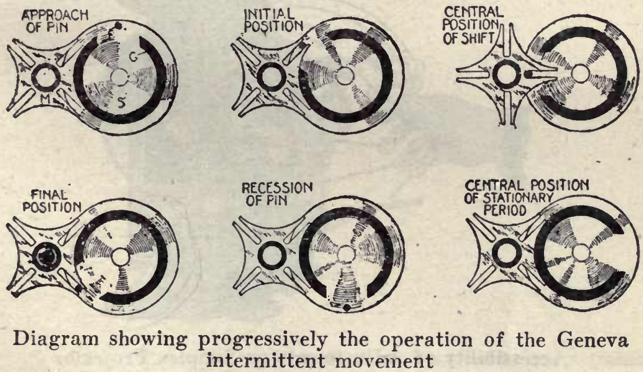


Diagram showing progressively the operation of the Geneva intermittent movement

Complete intermittent unit may be removed entirely and replaced in two minutes, only tools required for so doing being screw driver and pliers.

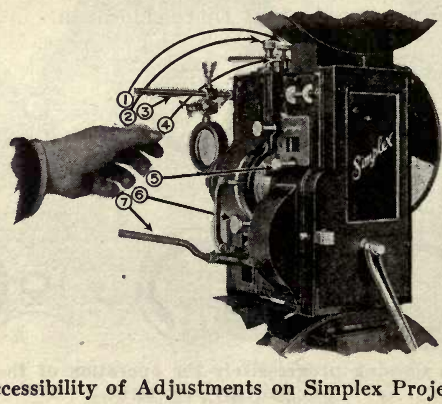
Casing is absolutely dust-proof, insuring against abnormal wear.

All mechansm adjustments that are most generally used are located within easy reach of the user's left hand.

1, 2, 3—Are used for making all stereopticon adjustments.

4—Focuses the projector lens which is contained within the mechanism, this method of focusing doing away with the common practice of reaching in front of the mechanism to focus lens and the attending danger while so doing of knocking against revolving shutter.

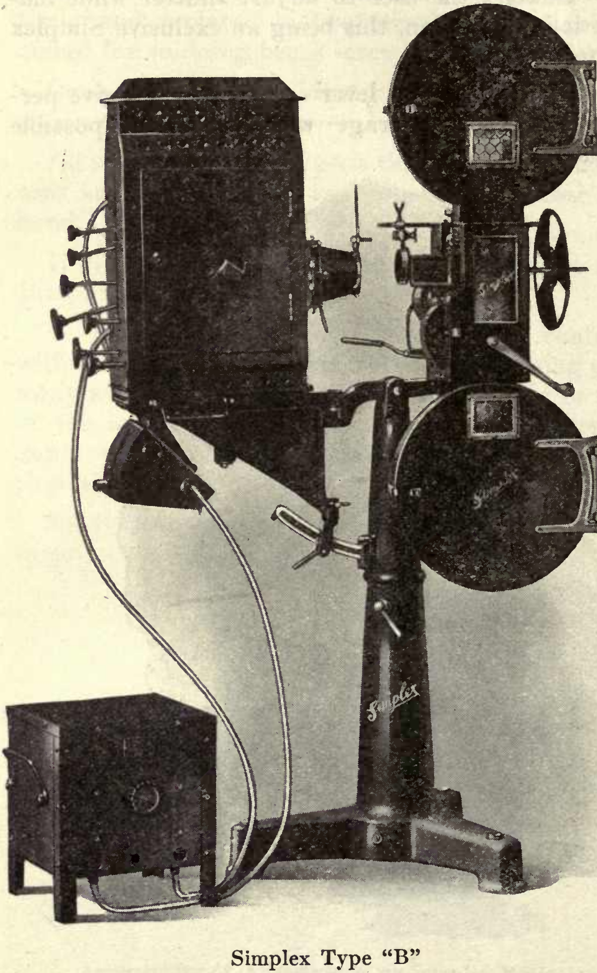
5—Indicates knob which locks door cover lower loop.



Accessibility of Adjustments on Simplex Projector

6—Enables the user to adjust shutter while machine is in operation, this being an exclusive Simplex feature.

7—Indicates frame lever so arranged to give perfectly balanced leverage with the least possible exertion.



Simplex Type "B"

VARIABLE SPEED CONTROL

Installation and Operation

When it is desired to change from hand driven machines to motor driven, simply loosen up the set screw (three turns) which holds the motor drive pulley shaft in the lug on the base of the mechanism frame. The driving shaft on the speed control, S-575-X (page 314), which has a small gear on it, is then inserted into the hole in the lug on the base of the mechanism frame.

In attaching the device, it is very important that care should be taken to mesh the gear on the shaft of the speed control S-575-X with the main driving gear on the mechanism. The set screw should then be tightened. At the same time, the idler pulley shaft on the pedestal fits into the opening on the right of the speed control, and is tightened with the knurled head or wing screw from underneath, but the set screw to hold the driving shaft should be fastened first. Fasten the right end of the speed control at whatever position it takes on the idler pulley shaft on the pedestal. Do not force it into position, as it may cause the gear on the speed control and the main driving gear, to bind, and eventually ruin them by wearing unevenly. The important thing is to see that the two gears mesh properly and the remainder of the speed control will take the position which will give best results.

To install the device on motor driven machines you have to remove the motor drive pulley on the main driving shaft also the idler pulley on the pedestal shaft. Place the speed control on the machine in the same manner as described above for changing from hand driven machines to motor driven.

The present D. C. Motors can be used by making a slight alteration in them, but in the case of alternating current, a new constant speed induction type of motor is provided. This abolishes the commutator type of motor and means lower maintenance costs and longer life of motors.

The arrangement of the belt for the speed control is shown in the accompanying illustration Fig. C better than could be described in a few words. The illustration amplifies the description for placing the speed control on the machine.

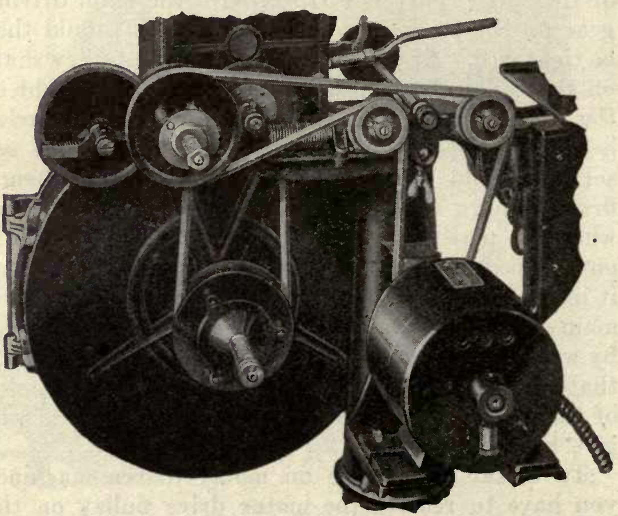


Fig. C

It may be advisable, however, to give a few details in connection with the operation of the device.

The variable speed control is operated or controlled by Handle S-438-M (page 314). By turning this handle either to the left or right, the movement of it either tightens or releases the Tension Spring F-119-X and moves the friction disc S-218-L. This friction disc S-218-L operates between the two other discs X-7 and D-118-X. At any time, it is only the rim of the friction disc S-218-L that comes in contact with the other discs X-7 and D-118-X. When the handle is turned so that the contact of the friction disc is near the center of the other discs, the speed is low because the contact is almost at the center of the circle of the two discs and revolves on a small circumference. As the friction disc S-218-L is moved out near the edge of X-7 and D-118-X the circumference of the circle increases, and the speed is correspondingly increased.

It is absolutely necessary, if the friction disc S-218-L is to drive the control and the mechanism, that it have a friction contact.

No oil of any description can be used on the friction discs or the other discs. And further, as oil may accumulate on these discs from time to time from the shaft, the discs must be wiped off occasionally. As soon as the oil accumulates, friction is eliminated, the speed reduced and the device may stop entirely. A small amount of vaseline may be applied to the fibre disc occasionally; it should, however, be wiped clean after applying.

It also must be borne in mind that the nuts N-136-X holding the spring on the shaft S-470-X must not be tightened too much; just enough to catch the thread sufficiently to hold the spring, as a very little pressure on the discs is required to run the control.

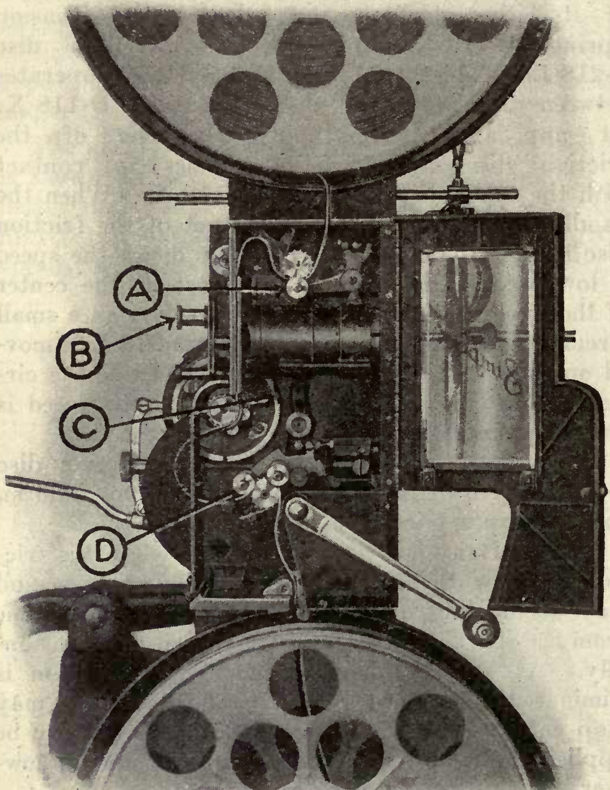


PLATE 1

In changing the speed, the idler pulley moves with the tension spring F-119-X, and adjusts the belt so that no matter what speed is required, the belt adjusts itself to requirements.

THREADING SIMPLEX

To thread the film through the Simplex head, open up film rollers A and D, Plate 1, open gate by pressing plunger B; now draw out of upper magazine through magazine valve about three feet of film, pass film under top feed sprocket and close film roller A, thread through gate, making sure that the film is riding on runners; engage film on teeth of intermittent sprocket, then close gate by tripping catch C; next pass film over lower feed sprocket and close film rollers D, thread through the lower magazine valve and engage on clip on lower reel. Care must be taken to see that a loop of film is formed between the upper sprocket and gate, and between the intermittent and lower sprocket.

BEFORE STARTING YOUR SHOW

See that—

Carbons are long enough to last through the picture.

Lamphouse is free from grounds.

All electrical connections are tight.

Arc is not burning upside down.

The light spot is focused on aperture in gate.

Projector is oiled, intermittent bath is full, grease cups are filled and are feeding.

Magazines are lined up with mechanism, so that film travels in a straight path from top to lower magazine.

Take-up tension is all right, if using Simplex-Boylan reels, see that take-up on machine is out of commission.

Sprockets are free from dirt; remember that dirt on the intermittant sprocket may cause jumping of the picture on the screen.

Tension springs on gate of projector are adjusted properly.

There is no deposit of emulsion on the tension springs and shoes.

Light or revolving shutter is synchronised with intermittent sprocket.

Reels on which films are wound are in such a condition that the film runs off same unhampered.

Lenses and condensers are clean.

Picture is in focus, and in frame.

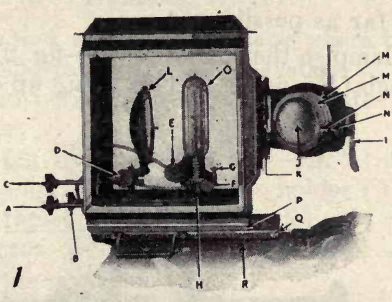
INSTRUCTIONS FOR SETTING UP SIMPLEX MAZDA EQUIPMENT

The Condensers

Condensers (J—fig. 1) will be found wrapped with paper covering. Note that sizes of condensers ($6\frac{1}{2}$ and $7\frac{1}{2}$) are plainly marked on wrappings.

Unscrew condenser rings (M—fig. 1) and drop condensers into same carefully.

Screw condenser holder ring back in to place securely enough to hold condenser. Great care must be taken against tightening this ring too firmly, as



1

by so doing will bind condenser and prevent expansion when same becomes heated, resulting in possible breakage.

When this has been done condenser holders containing condensers are then dropped into containers (N—fig. 1) with rounded or convex surfaces facing one another.

Note that the $6\frac{1}{2}$ condenser sets in container nearest the lamp and the $7\frac{1}{2}$ condenser sets in container nearest the film.

Now swing condenser mount back into position, locking the same by engaging handle (I—fig. 1) with lock (K—fig. 1).

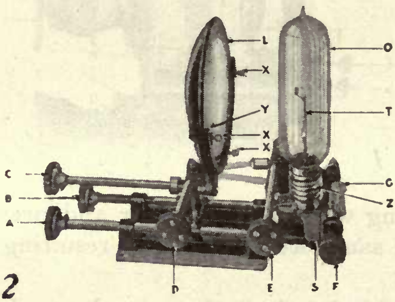
Placing Lamphouse on Machine.

Lamphouse is now placed on swinging table, making sure that sliding base (P—fig. 1) sets accurately into base groove (Q—fig. 1), then fasten lamphouse to base with wing screw (R—fig. 1).

Setting Lamp in Holder.

Loosen knob (H—fig. 1), turning same out to its fullest extent, then screw lamp (O—fig. 1) into its socket, as far as possible.

Adjust lamp so that filament (T—fig. 2) is parallel with knob (F—fig. 2). This lining up of filament



2

is imperative and absolutely necessary in procuring correct focus, as will be later described.

When proper alignment has been made, tighten knob (H—fig. 1) firmly; this operating rigidly secures lamp into required position (see illustration, fig. 4).

Inserting Lamp and Holder into Mechanism.

Lamp and holder are now ready for inserting into lamphouse.

Hold knob (F—fig. 4) and thumb piece (S—fig. 4) securely between thumb and forefinger of the right hand.

Insert lamp slowly into position, making sure that collar (U—fig. 4) engages with rod (U-1—fig. 6), and also note that contact strip (V—fig. 5) engages between slot and contact holder (W—fig. 5), pushing in as far as it will go.

Inserting Mirror.

We have now reached that stage where the mirror plays an important part in our system.

Clean and polish mirror carefully with clean soft tissue paper.

Now loosen thumb screws (X—fig. 2) and insert mirror (L—fig. 1) carefully into holder (Y—fig. 2), tightening thumb screws (X—fig. 2) only sufficiently to hold mirror in place without undue pressure.

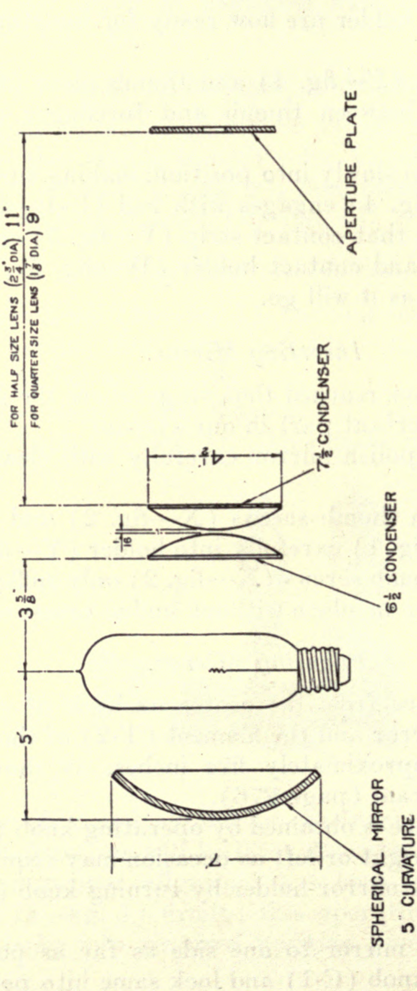
Focusing Mirror.

The distance from the center or back of convex surface of mirror and the filament (T-2) of the lamp should be approximately five inches, as shown in Optical Diagram (page 276).

This distance is obtained by operating knob (A-1) either to the right or left as occasion may require.

Now unlock mirror holder by turning knob (D-1) to the left.

Now swing mirror to one side as far as possible by means of knob (C-1) and lock same into position



OPTICAL SYSTEM

THE PRECISION MACHINE CO. INC.

by turning knob (D-1) to right. This throwing
mirror to one side is done in order to prevent mir
image from being confused with lamp filament, as
be described later.

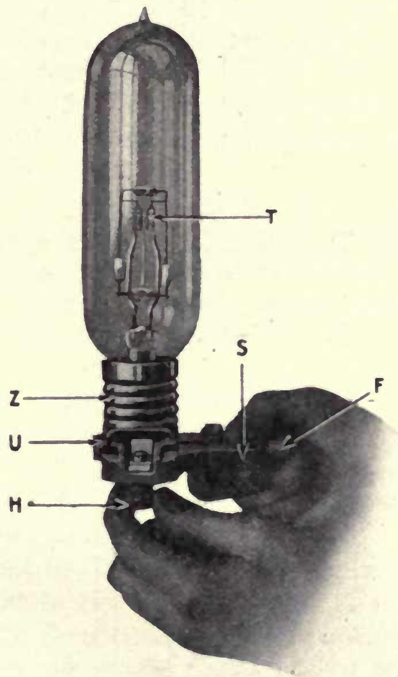
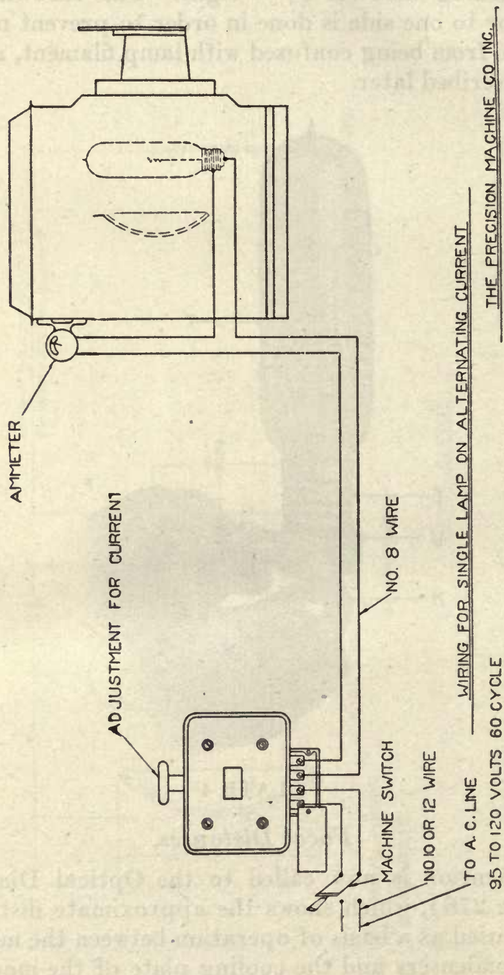


PLATE 4

Focal Distances.

Attention is now called to the Optical Diagr
(page 276), which shows the approximate distan
to be used as a basis of operation between the mirr
the condensers and the cooling plate of the machi

SIMPLEX MAZDA WIRING DIAGRAM



Should a quarter size ($1\frac{3}{4}''$ diameter) projector lens be used it is now necessary to place ruler against the surface of the $7\frac{1}{2}$ inch (front) condenser and move lamphouse slowly forward or backward until a distance of nine inches separates the front condenser surface from the film position or aperture plate on mechanism.

Should the half size ($2\frac{5}{8}''$ diameter) projector lens be used, this distance should be increased to eleven inches.

Adjusting Lamp.

Turn knob (B—fig. 1), which is used to carry lamp carriage forward and backward, until lamp filament (T—fig. 2) is $3\frac{5}{8}$ inches away from flat surface of $6\frac{1}{2}$ (rear) condenser.

Connecting Up Apparatus.

(For alternating current)

We are now ready to connect the apparatus with regulator, as designated in diagram marked "A. C. Wiring Diagram" (page 278).

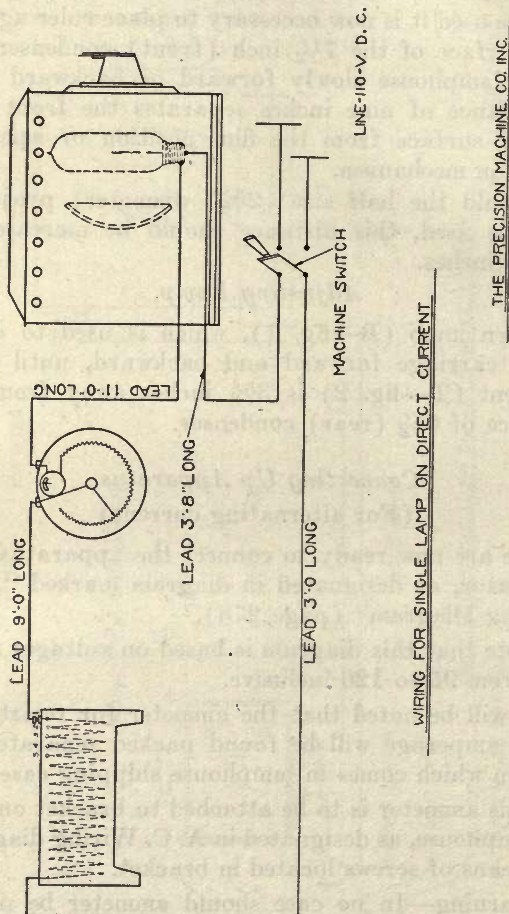
Note that this diagram is based on voltages ranging from 95 to 120 inclusive.

It will be noted that the ammeter for registering lamp amperage will be found packed separately in carton which comes in lamphouse shipping case.

This ammeter is to be attached to bracket on rear of lamphouse, as designated in A. C. Wiring diagram, by means of screws located in bracket.

Warning—In no case should ammeter be placed onto regulator, as it will not register properly in this location, owing to electrical disturbances.

SIMPLEX MAZDA WIRING DIAGRAM



Turn knob (B—fig. 1) which is used to carry lamp carriage forward and backward until lamp filament (T—fig. 2) is 3⅝ inches away from flat surface of 6½ (rear) condenser.

Connecting Up Apparatus.
(For direct current)

We are now ready to connect the apparatus with regulator as designated in diagram marked "Wiring for Single Lamp on Direct Current" (page 280).

Note that this diagram is based on voltages ranging from 95 to 120, inclusive.

It will be noted that there are two resistance units. One a fixed resistance or "cage type," the other a plate or dial type.

Attention is called herewith to the ammeter, which is mounted upon the latter dial resistance plate.

Turn regulator handle on dial to the right until it reaches the stop.

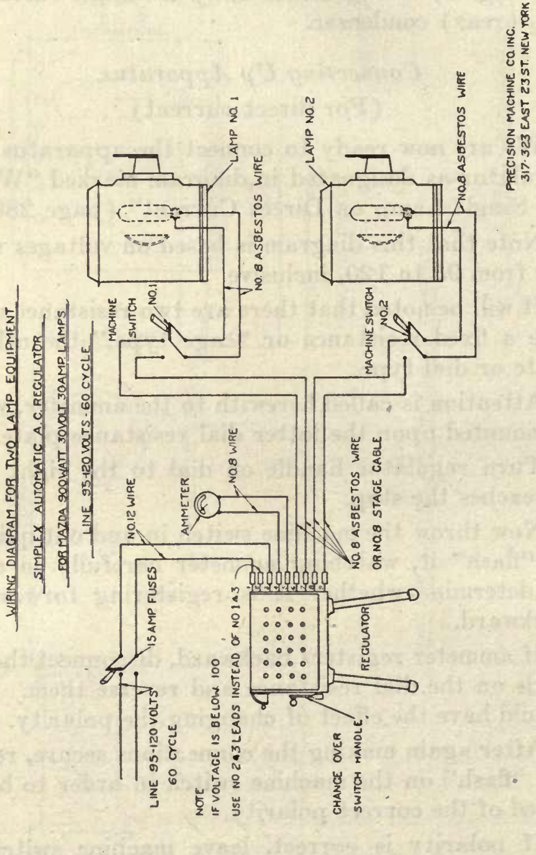
Now throw the machine switch in and out quickly, or "flash" it, watching ammeter carefully in order to determine whether it is registering forward or backward.

If ammeter registers backward, disconnect the two leads on the dial resistance and reverse them. This should have the effect of changing the polarity.

After again making the connections secure, repeat the "flash" on the machine switch in order to be assured of the correct polarity.

If polarity is correct, leave machine switch in. This will result in ammeter registering a reading of something over 35 amperes. This should cause no

SIMPLEX MAZDA WIRING DIAGRAM



concern, as the amperage will drop to approximately 25 amperes within a moment or two.

Note:—The ammeter must be closely watched during the burning period of the lamp and must in no case exceed the lamp rating, which is indicated on metal base of lamp.

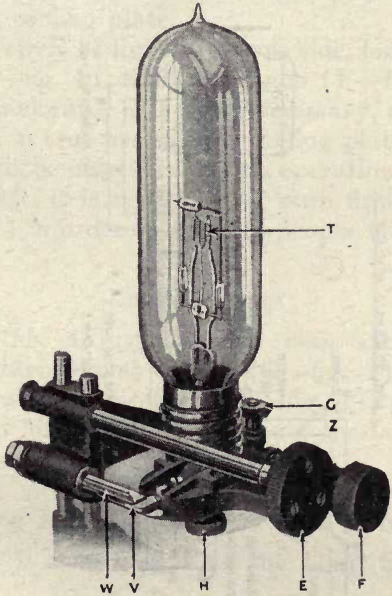
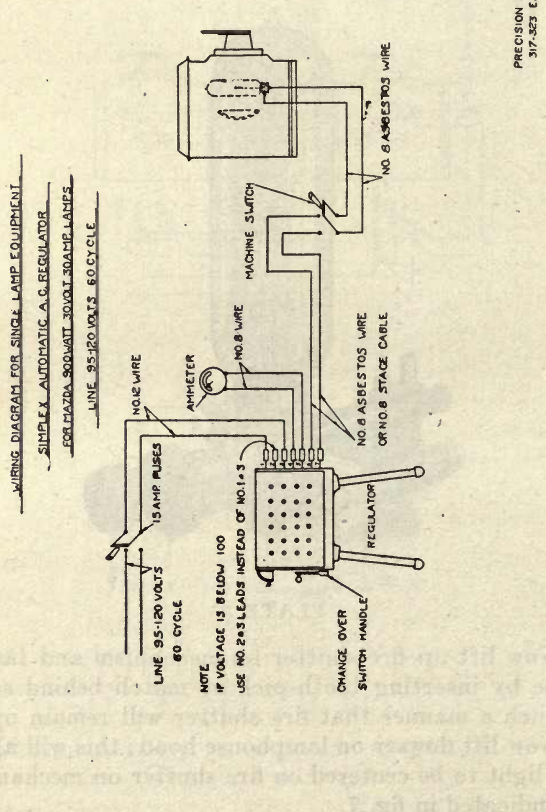


PLATE 5

Now lift up fire shutter on mechanism and fasten same by inserting tooth-pick or match behind same in such a manner that fire shutter will remain open.

Now lift dowser on lamphouse hood; this will allow the light to be centered on fire shutter on mechanism as indicated in fig. 7.

SIMPLEX MAZDA WIRING DIAGRAM



Focusing Lamp.

It is necessary that this circle of light shall cut all corners of cooling plate, as shown in fig. 7.

Should the light circle be either too high or too low, adjustment for bringing it into true position is made by operating knob (E—fig. 1) and watching results on cooling plate.

Should circle of light be to one side, loosen thumb screw (G—fig. 1), then turn knob (F—fig. 1) forward or backward, as may be necessary, until circle of light is in true position on cooling plate.

Should it be necessary in this operation to adjust lamp to left, it is necessary to push firmly against knob (F.1) in order to produce proper movement of lamp.

Locking Lamp.

When this adjustment has been satisfactorily made, tighten thumb screw (G—fig. 1) securely. This operation locks knob (F—fig. 1), preventing lamp from loosely swinging should the lamp holder be taken out.

Focusing Lamp Filament on Card or Shutter.

Now it is necessary that the lamp filament be focused.

We now remove the projector lens from mechanism and move revolving shutter out on shutter shaft until a distance of 10¼ inches separates the cut-off blade on shutter from the aperture plate or film position on mechanism.

Should it not be convenient to use revolving shutter for this purpose, a card may be placed in the same position, making sure, however, that the distance of 10¼ inches is maintained.

We now have an image of the lamp filament outlined on the shutter blade or card, as indicated in fig. 8. If image is not in exact focus, check up carefully all measurements. If measurements are all correct, it is now necessary to sharpen up or focus filament by turning knob (B—fig. 1) either to right or left until the filament is clearly outlined upon card or shutter blade.

Results on Focusing Card or Shutter.

Now unlock mirror by turning knob (D-1.) to left and swing mirror over by means of knob (C-1.).

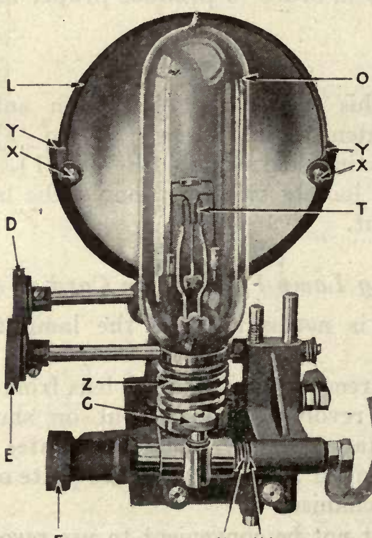


PLATE 6

We now see besides the lamp filament on the card or shutter another image; this is much fainter in definition than the lamp filament. This faint image is called the mirror image.

It is now necessary to sharpen this up as much as possible; this is done by adjusting mirror (L.1), turning knob (A-1) forward or back until clear definition is obtained.

It is now necessary to center mirror image in same position as the filament image.

By swinging knob (C-1) to right will register mirror to left, and vice-versa.

Should mirror filament register too high or too low, immediate true position may be obtained by turning knob (C-1) to right or left.

Merging Both Filaments.

Now that both filaments show up sharp and are both in relative position, swing mirror over by means of knob (C-1); this will move mirror image over on card or shutter, the purpose being to register the mirror image filament in between the open spaces of the lamp filament, as shown in fig. 9.

Locking Mirror.

Now make sure that the results on card or shutter are all that should be desired, and lock mirror into position by turning knob (D—fig. 1) to right.

Increased Amperage.
(Direct current)

After the lamp and resistance have become sufficiently warmed up, turn the dial handle slowly to the left, carefully watching the ammeter until the indicator of same registers 30 amperes.

Increasing Amperage.

(Alternating current)

Now bring lamp up to full capacity of 30 amperes by turning regulator handle to right, while carefully watching ammeter until same registers at 30 amperes.

Warning—Do not under any circumstances exceed 30 amperes, as by so doing will result in the overloading and subsequent damage to lamps.

Clear Field of Light.

We now have the lamp at full amperage.

Replace projector lens into mechanism.

Focus same up sharply.

Screen should now show a clean, evenly distributed field of light.

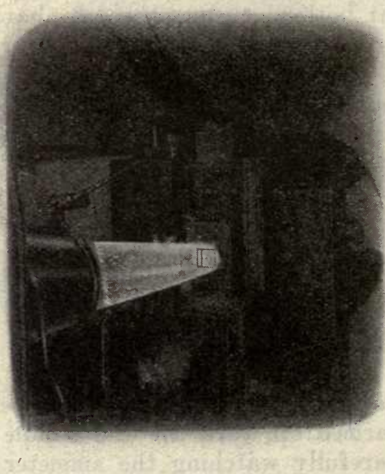


PLATE 7

Should any discoloration or shadows be apparent on screen, slide lamphouse carefully and slowly backward or forward until discoloration disappears.

When screen is all cleared up through the foregoing operation, fasten lamphouse by tightening up wing screw (R—fig. 1).

Now take away focusing card and readjust shutter (if necessary), and the equipment is ready for operation.

Adjusting Extra Lamp.

In order to be prepared for any emergency, it is wise to have an extra lamp and holder all ready for instant use.

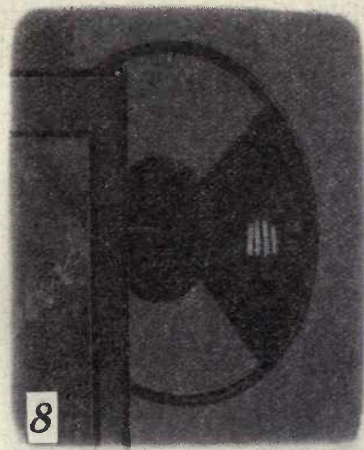


PLATE 8

Follow instructions for setting lamp into holder, as described in Section 3, and set to one side, where it will be quickly available.

Should same be required while machine is in operation, pull machine switch, throw back regulator handle to "low" and withdraw burned out or defective lamp and insert new lamp and holder as described in Section 4.

CAUTION—MAKE SURE THAT MACHINE SWITCH IS OFF BEFORE WITHDRAWING OLD LAMP.

Now throw in machine switch and bring regulator up to 30 amperes.

Now center spot light on cooling plate, as before described, and get as clear a field as possible until an opportunity of procuring permanent readjustment is available.

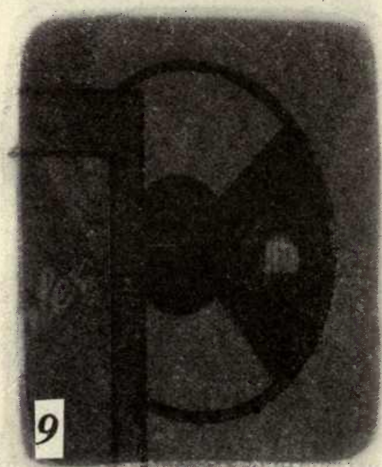
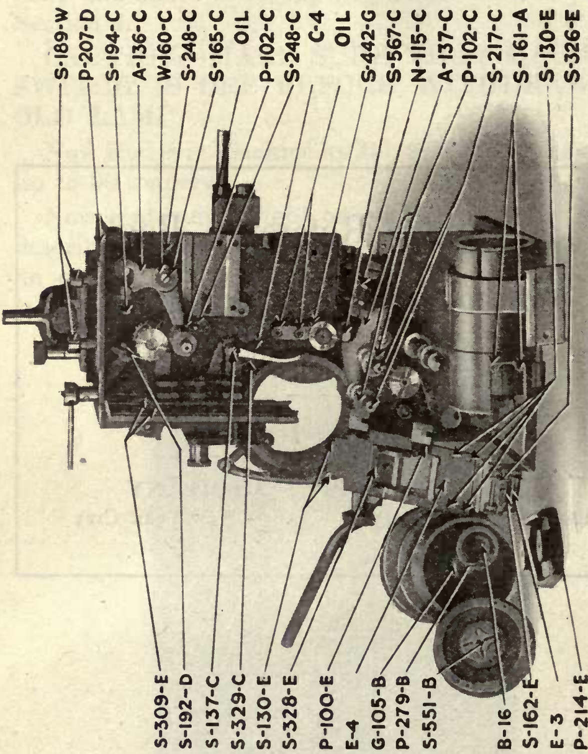


PLATE 9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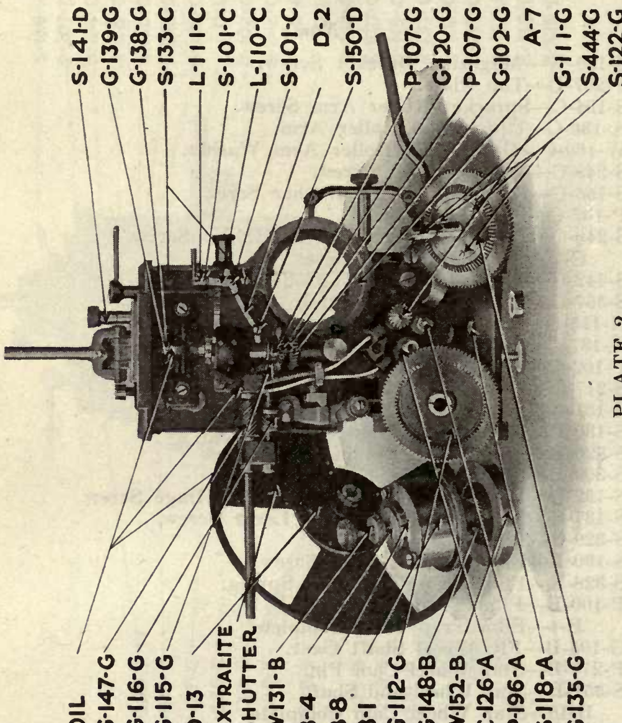
P-207-D
S-194-C
A-136-C
W-160-C
S-248-C
S-165-C
OIL
P-102-C
S-248-C
C-4
OIL
S-442-G
S-567-C
N-115-C
A-137-C
P-102-C
S-217-C
S-161-A
S-130-E
S-326-E
S-309-E
S-192-D
S-137-C
S-329-C
S-130-E
S-328-E
P-100-E
E-4
G-105-B
P-279-B
S-551-B
B-16
S-162-E
E-3
P-214-E

PLATE 1

SIMPLEX PARTS
(HEAD)

Name

S-189-W—Magazine Bracket Screw.
P-207-D—Top Plate.
S-194-C—Sprocket Roller Arm Screw.
A-136-C—Upper Pad Roller Arm.
W-160-C—Upper Pad Roller Arm Washer.
S-248-C—Roller Holder Screw.
S-165-C—Pad Roller Arm Washer Screw
P-102-C—Pad Roller.
S-248-C—Upper Magazine Roller Holder Screw.
C-4—Film Trap Trip Lever
S-442-G—Intermediate Shaft Collar Set Screw.
S-567-C—Pad Roller Arm Stud.
N-115-C—Sprocket Roller Arm Nut.
A-137-C—Lower Pad Roller Arm.
P-102-C—Pad Roller.
S-217-C—Pad Roller Screw.
S-161-A—Projecting Lens Holder Screw.
S-130-E—Film Guide Holder Screws.
S-326-E—Film Guide Retain Spring.
S-309-E—Film Trap Shoe.
S-192-D—Upper and Lower Left Door Hinge Screw.
S-137-C—Film Trap Door Trip Lever Screw.
S-329-C—Trip Lever Spring.
S-130-E—Film Guide Holder Screw.
S-328-E—Film Trap Door Pad Spring.
P-100-E—Film Trap Door Pad.
E-4—Film Trap Door Complete.
G-105-B—Fly Wheel Shaft Gear.
P-279-B—Star Wheel Cam Pin.
S-551-B—Star Wheel and Shaft.
B-16—Star Wheel Cam Complete.
S-162-E—Film Guide Retain Spring Screw.
E-3—Intermittent Film Guide.
P-214-E—Film Projector.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G-139-G
G-138-G
S-133-C
L-111-C
S-101-C
L-110-C
S-101-C
D-2
S-150-D
P-107-G
G-120-G
P-107-G
G-102-G
A-7
G-111-G
S-444-G
S-122-G
OIL
G-147-G
G-116-G
G-115-G
D-13
EXTRALITE
SHUTTER
W-131-B
B-4
B-8
B-1
G-112-G
G-148-B
W-152-B
C-126-A
P-196-A
S-118-A
G-135-G

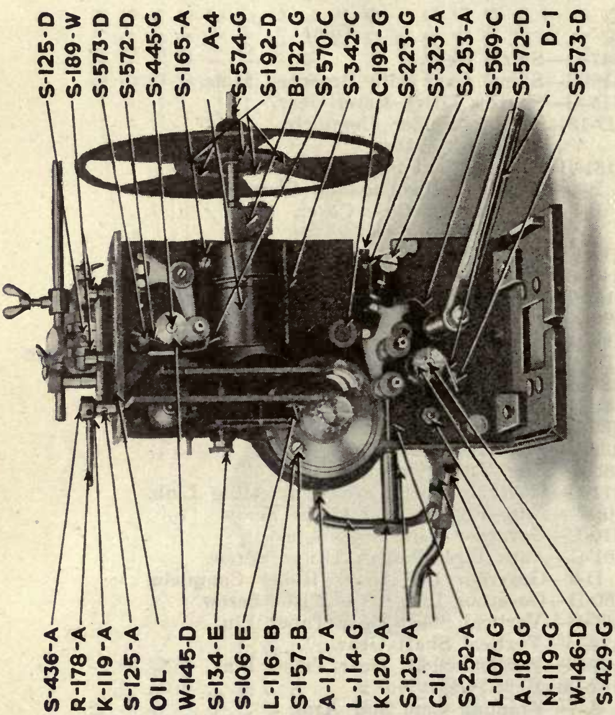
PLATE 2

SIMPLEX PARTS

(HEAD)

Name

G-147-G—Spiral Gear.
G-116-G—Spiral Gear with Broached Hole.
G-115-G—Shutter Drive Bevel Gear.
D-13—Shutter Spider Complete.
Extralite Shutter.
W-131-B—Intermittent Sprocket.
B-4—Eccentric Bushing and Sleeve.
B-8—Intermittent Case Cover.
B-1—Intermittent Case.
G-112-G—Main Driving Gear.
G-148-B—Fly Wheel Gear.
W-152-B—Fly Wheel.
C-126-A—Main Driving Gear Clutch.
P-196-A—Picture Framing Handle Pivot.
S-118-A—Motor Drive Pinion Set Screw.
G-135-G—Intermediate Bevel Gear.
S-141-D—Stereo Focusing Knob Set Screw.
G-139-G—Upper Sprocket Shaft Gear.
G-138-G—Bevel Gear No. 3.
S-133-C—Film Trap Screw.
L-111-C—Governor Lift Lever Connecting Link.
S-101-C—Auto Fire Shutter Hinge Screw.
L-110-C—Governor Lift Lever Link.
S-101-C—Auto Fire Shutter Hinge Screw.
D-2—Governor Lift Lever Roller Complete.
S-150-D—Governor Lift Lever Pivot Screw.
P-107-G—Vertical Shaft Gear Taper Pin.
G-120-G—Vertical Shaft Gear.
P-107-G—Vertical Shaft Gear Taper Pin.
G-102-G—Bevel Gear No. 2.
A-7—Framing Cam and Arm.
G-111-G—Lower Sprocket Gear.
S-444-G—Intermediate Shaft.
S-122-G—Intermediate Bevel Gear Fastening Screw.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S-573-D
S-572-D
S-445-G
S-165-A
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S-574-G
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B-122-G
S-570-C
S-342-C
C-192-G
S-223-G
S-323-A
S-253-A
S-569-C
S-572-D
D-1
S-573-D
S-436-A
R-178-A
K-119-A
S-125-A
OIL
W-145-D
S-134-E
S-106-E
L-116-B
S-157-B
A-117-A
L-114-G
K-120-A
S-125-A
C-11
S-252-A
L-107-G
A-118-G
N-119-G
W-146-D
S-429-G

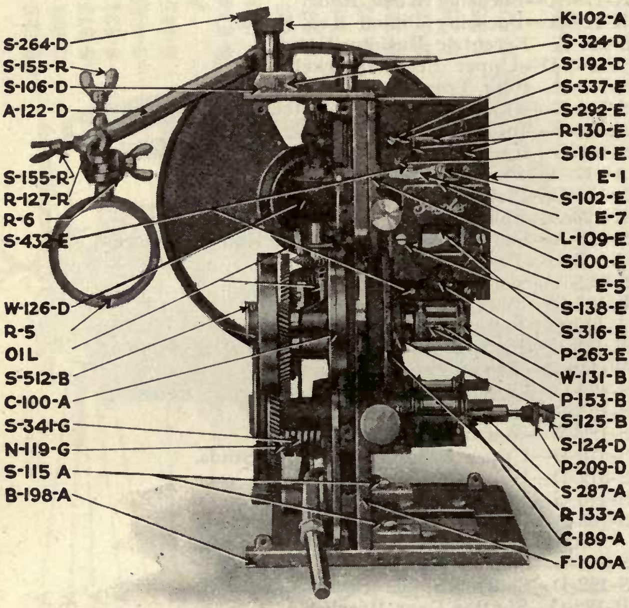
PLATE 3

SIMPLEX PARTS

(HEAD)

Name

S-436-A—Focusing Knob Set Screw.
R-178-A—Focusing Knob Rod.
K-119-A—Focusing Pinion Rod Knob.
S-125-A—Eccentric Bushing Screw.
W-145-D—Upper Feed Sprocket.
S-134-E—Film Trap Door Stud Screw.
S-106-E—Right Back Cover Latch Plate Screws.
L-116-B—Intermittent Case Cover Lock.
S-157-B—Intermittent Case Cover Lock Screw.
A-117-A—Picture Framing Arm.
L-114-G—Picture Framing Connecting Link.
K-120-A—Shutter Adjusting Screw Knob.
S-125-A—Shutter Adjusting Screw Knob Set Screw.
C-11—Framing Handle Complete.
S-252-A—Shutter Adjusting Screw.
L-107-G—Picture Framing Lever.
A-118-G—Picture Framing Handle Arm.
N-119-G—Picture Framing Lever Pivot Screw Nut.
W-146-D—Lower Feed Sprocket.
S-429-G—Lower Sprocket Shaft.
S-125-D—Eccentric Bushing Screw.
S-189-W—Magazine Bracket Screw.
S-573-D—Upper & Lower Stripper Studs.
S-572-D—Upper & Lower Stripper.
S-445-G—Upper Sprocket Shaft.
S-165-A—Pad Roller Arm Washer Screw.
A-4—Projecting Lens Holder & Slide.
S-574-G—Shutter Shaft.
S-192-D—Shutter Spider Screws.
B-122-G—Shutter Gear Bracket.
S-570-C—Upper Pad Roller Arm Spring.
S-342-C—Projecting Lens Holder Slide Rod Spring.
C-192-G—Intermediate Shaft Retaining Collar.
S-223-G—Framing Slide Lever Stud Set Screw.
S-323-A—Shutter Adjusting Slide.
S-253-A—Shutter Adjusting Slide Set Screw.
S-569-C—Lower Pad Roller Arm Spring.
S-572-D—Upper and Lower Stripper.
D-1—Driving Handle Complete.
S-573-D—Upper & Lower Stripper Stud.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S-106-D
A-122-D
S-155-R
R-127-R
R-6
S-432-E
W-126-D
R-5
OIL
S-512-B
C-100-A
S-341-G
N-119-G
S-115 A
B-198-A
K-102-A
S-324-D
S-192-D
S-337-E
S-292-E
R-130-E
S-161-E
E-1
S-102-E
E-7
L-109-E
S-100-E
E-5
S-138-E
S-316-E
P-263-E
W-131-B
P-153-B
S-125-B
S-124-D
P-209-D
S-287-A
R-133-A
C-189-A
F-100-A

PLATE 4

SIMPLEX PARTS
(HEAD)

Name

S-264-D—Stereo Lens Adjusting Screw.
S-155-R—Stereo Universal Clamp Wing Screw.
S-106-D—Stereo Slide Stop Screw.
A-122-D—Stereo Arm.
S-155-R—Stereo Universal Clamp Wing Screw.
R-127-R—Stereo Lens Adjusting Rod.
R-6—Stereo Lens Holder Universal Clamp.
S-432-E—Film Trap Shoe Screw.
W-126-D—Governor Weight.
R-5—Stereo Lens Holder.
S-512-B—Fly Wheel Set Screw.
C-100-A—Framing Cam.
S-341-G—Picture Framing Handle Friction Spring.
N-119-G—Picture Framing Lever Pivot Screw Nut.
S-115-A—Centre Frame Screw.
B-198-A—Mechanism Base.
K-102-A—Focusing Pinion Knob.
S-324-D—Stereo Slide.
S-192-D—Film Shutter Screw.
S-337-E—Lateral Guide Roller Spring.
S-292-E—Lateral Guide Roller Shaft.
R-130-E—Lateral Guide Roller.
S-161-E—Auto. Fire Shutter Stop Screw.
E-1—Film Trap Complete.
S-102-E—Auto. Fire Shutter Link Retain Screw.
E-7—Auto. Fire Shutter Lift Lever.
L-109-E—Auto. Fire Shutter Lift Link.
S-100-E—Auto. Fire Shutter Lever Screw.
E-5—Film Heat Shield Complete.
S-138-E—Film Trap Heat Shield Retain Screw.
S-316-E—Auto. Fire Shutter.
P-263-E—Right Back Over Latch Plate.
W-131-B—Intermittent Sprocket.
P-153-B—Intermittent Sprocket Taper Pin.
S-125-B—Eccentric Bushing Screw.
S-124-D—Driving Arm Retain Screw.
P-209-D—Driving Arm Retaining Plug.
S-287-A—Handle Shaft.
R-133-A—Framing Cam Adjusting Ring.
C-189-A—Handle Shaft Driving Collar.
F-100-A—Centre Frame.

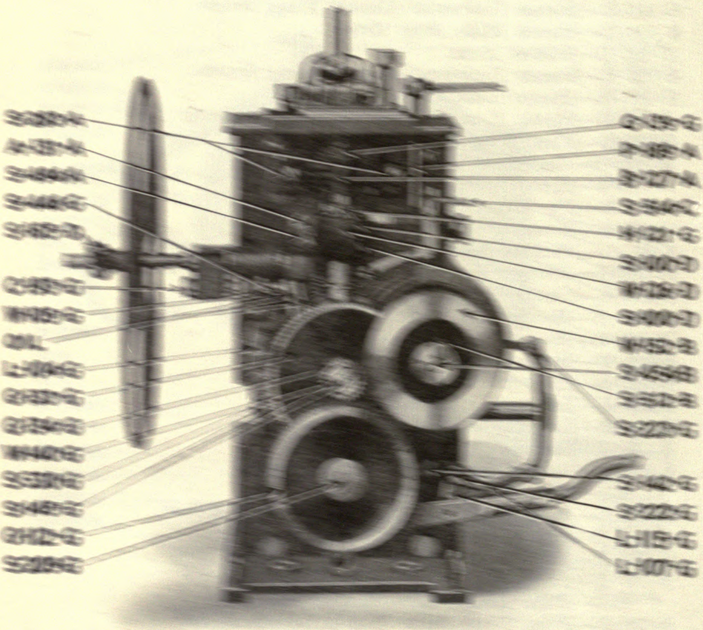


PLATE 5

SIMPLEX PARTS

(HEAD)

Name

S-283-A—Vertical Shaft Bracket Screw.
A-131-A—Focusing Back Arm.
S-494-A—Focusing Back Retain Screw.
S-446-G—Spiral Driving Gear Shaft.
S-165-D—Shutter Spider Collar Screw.
C-198-G—Spiral Driving Gear Shaft Collar.
W-105-G—Spiral Drive Gear Shaft Washer.
L-104-G—Framing Slide Lever.
G-138-G—Intermediate Gear No. 2.
G-134-G—Intermediate Gear No. 1.
W-140-G—Intermediate Gear Retain Washer.
S-330-G—Framing Slide Lever Spring.
S-145-G—Intermediate Gear Washer Retain Screw.
G-112-G—Main Driving Gear.
S-209-G—Main Driving Gear Retain Screw.
G-139-G—Upper Sprocket Shaft Gear.
P-189-A—Focusing Pinion.
B-127-A—Vertical Shaft Bracket.
S-514-C—Fire Shutter Lifting Stud.
H-121-G—Governor Upper Link Holder.
S-100-D—Auto. Fire Shutter Lever Screw.
W-126-D—Governor Weight.
S-100-D—Governor Weight Screw.
W-132-B—Fly Wheel.
S-454-B—Fly Wheel Shaft.
S-512-B—Fly Wheel Set Screw.
S-223-G—Picture Framing Connecting Link Screw.
S-142-G—Picture Framing Lever Pivot Screw.
S-222-G—Picture Framing Link Screw.
L-115-G—Picture Framing Link.
L-107-G—Picture Framing Lever.

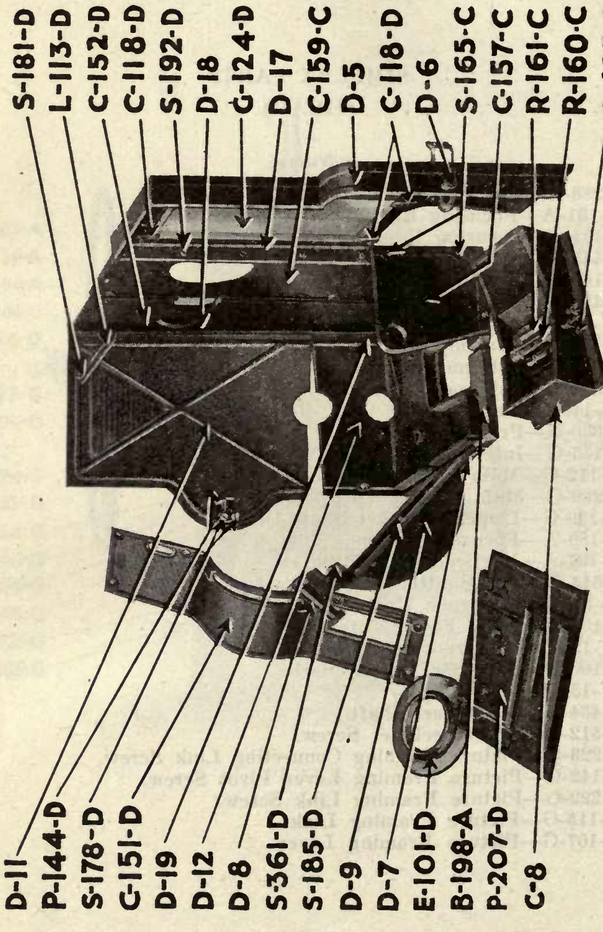

S-181-D
L-113-D
C-152-D
C-118-D
S-192-D
D-18
G-124-D
D-17
C-159-C
D-5
C-118-D
D-6
S-165-C
C-157-C
R-161-C
R-160-C
S-485-C
D-11
P-144-D
S-178-D
C-151-D
D-19
D-12
D-8
S-361-D
S-185-D
D-9
D-7
E-101-D
B-198-A
P-207-D
C-8

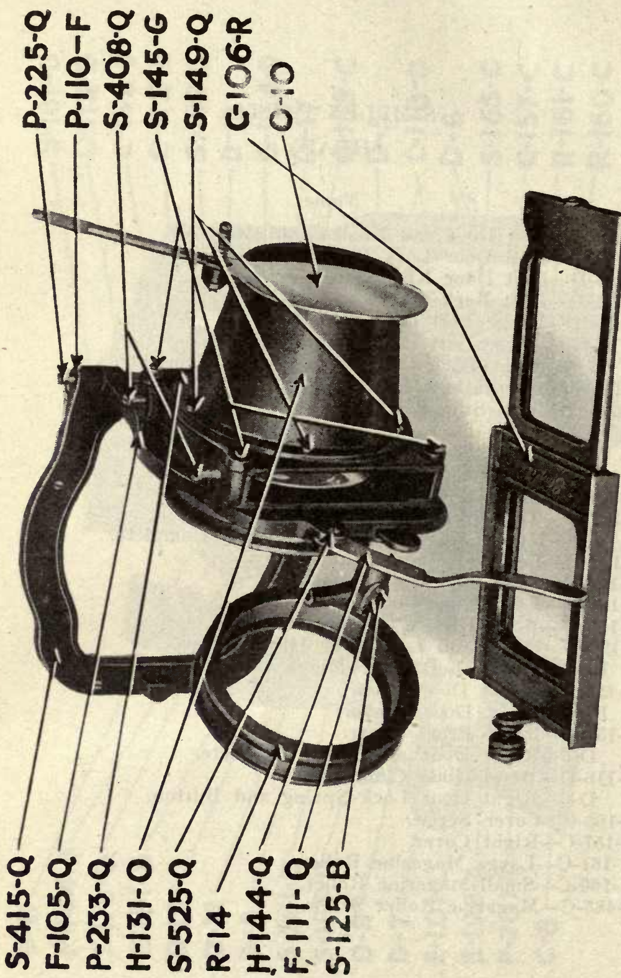
PLATE 6

SIMPLEX PARTS

(HEAD)

Name

D-11—Left Door and Knob Complete.
P-144-D—Left Door Lock Pin.
S-178-D—Left Door Knob Screw.
C-151-D—Left Back Cover.
D-19—Lower Left Door Hinge.
D-12—Lower Left Door Complete.
D-8—Right Back Cover Latch Knob Complete.
S-361-D—Intermittent Sprocket Stripper.
S-185-D—Lock Stop Screw.
D-9—Right Back Cover Complete.
D-7—Right Back Cover Hinge Complete.
E-101-D—Medium Size Escutcheon.
B-198-A—Mechanism Base.
P-207-D—Top Plate.
C-8—Upper Magazine Roller Holder Complete.
S-181-D—Left Door Stop Link Screw.
L-113-D—Left Door Stop Link.
C-152-D—Left Front Cover.
C-118-D—Bevel Glass Clamp.
S-192-D—Right and Left Door Hinge Screw.
D-18—Upper Left Door Hinge.
G-124-D—Right Door Glass.
D-17—Right Door Hinge.
C-159-C—Right Front Cover.
D-5—Right Door and Knob Complete.
C-118-D—Bevel Glass Clamp.
D-6—Right Door Lock Spring and Button.
S-165-C—Cover Screw.
C-157-C—Right Cover.
R-161-C—Large Magazine Roller.
R-160-C—Small Magazine Roller.
S-485-C—Magazine Roller Screw.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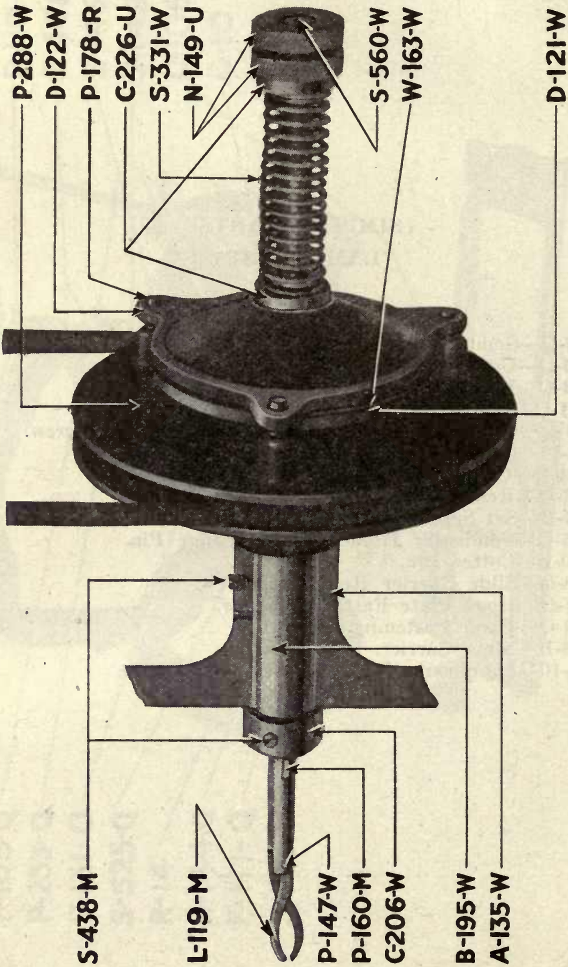
S-145-G
S-149-Q
G-106-R
C-10
S-415-Q
F-105-Q
P-233-Q
H-131-O
S-525-Q
R-14
H-144-Q
F-111-Q
S-125-B

PLATE 7

SIMPLEX PARTS
(LAMPHOUSE)

Name

S-415-Q—Condenser Holder Frame Support.
F-105-Q—Condenser Holder Frame.
P-233-Q—Hood Plate.
H-131-O—Lamphouse Hood.
S-525-Q—Condenser Holder Frame Locking Pivot Screw.
R-14—Condenser Holder Sets.
H-144-Q—Condenser Holder Frame Handle.
F-111-Q—Rear Condenser Holder Frame.
S-125-B—Set Screw.
P-225-Q—Condenser Holder Frame Hinge Pin.
P-110-F—Cotter Pin.
S-408-Q—Slide Carrier Retaining Screw.
S-145-G—Hood Plate Fastening Screw.
S-149-Q—Hood Fastening Screw.
O-106-R—Slide Carrier.
O-10—Lamphouse Hood Dowser and Handle.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P-178-R
C-226-U
S-331-W
N-149-U
S-560-W
W-163-W
D-121-W
S-438-M
L-119-M
P-147-W
P-160-M
C206-W
B-195-W
A-135-W

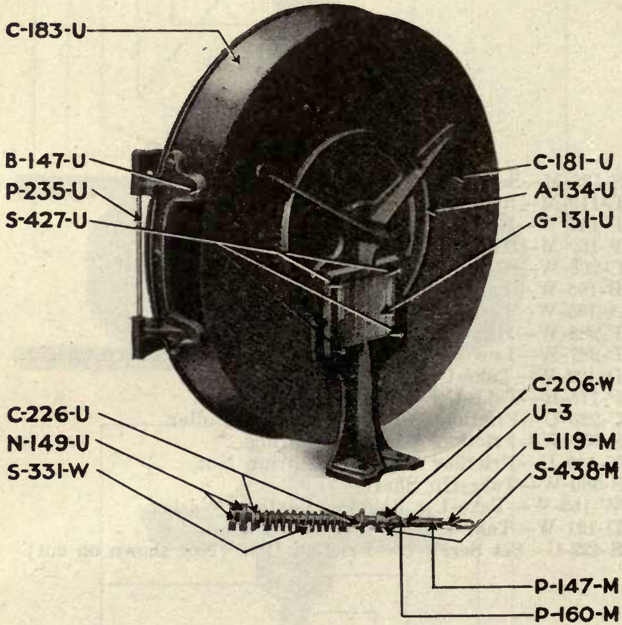
PLATE 8

SIMPLEX PARTS

(TAKE-UP)

Name

S-438-M—Set Screw.
L-119-M—Reel Lock.
P-147-W—Reel Lock Pin.
P-160-M—Reel Shaft Collar Pin.
C-206-W—Magazine Collar.
B-195-W—Take-Up Shaft Bearing Bushing.
A-135-W—Lower Magazine Arm, 16".
P-288-W—High Speed Take-Up Pulley.
P-287-W—Low Speed Take-Up Pulley (Not shown on cut.)
D-122-W—Take-Up Floating Friction Disc.
P-178-R—Take-Up Pulley Pin.
C-226-U—Friction Adjusting Spring Collar.
S-331-W—Friction Adjusting Spring.
N-149-U—Friction Adjusting Spring Nut.
S-560-W—Take-Up Shaft.
W-163-W—Take-Up Friction Leather Washer.
D-121-W—Take-Up Shaft Friction Disc.
S-422-G—Set Screw for Friction Disc (Not shown on cut).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P-235-U
S-427-U
C-181-U
A-134-U
G-131-U
C-206-W
U-3
L-119-M
S-438-M
C-226-U
N-149-U
S-331-W
P-147-M
P-160-M

PLATE 9

SIMPLEX PARTS
(MAGAZINE)

Name

C-183-U—Upper Magazine Cover.
B-147-U—Magazine Hinge Bracket.
P-235-U—Magazine Hinge Pin.
S-427-U—Magazine Wire Glass Retaining Plate Screw.
C-226-U—Friction Adjusting Spring Collar.
N-149-U—Friction Adjusting Spring Nut.
S-331-W—Friction Adjusting Spring.
C-181-U—Upper Magazine Case 16″.
A-134-U—Upper Magazine Arm 16″.
G-131-U—Upper Magazine Door Wire Glass.
C-206-W—Upper Magazine Collar.
U-3—Upper Take-Up Shaft.
L-119-M—Reel Lock.
S-438-M—Magazine Collar Set Screw.
P-147-M—Reel Lock Pin.
P-160-M—Reel Shaft Collar Pin.

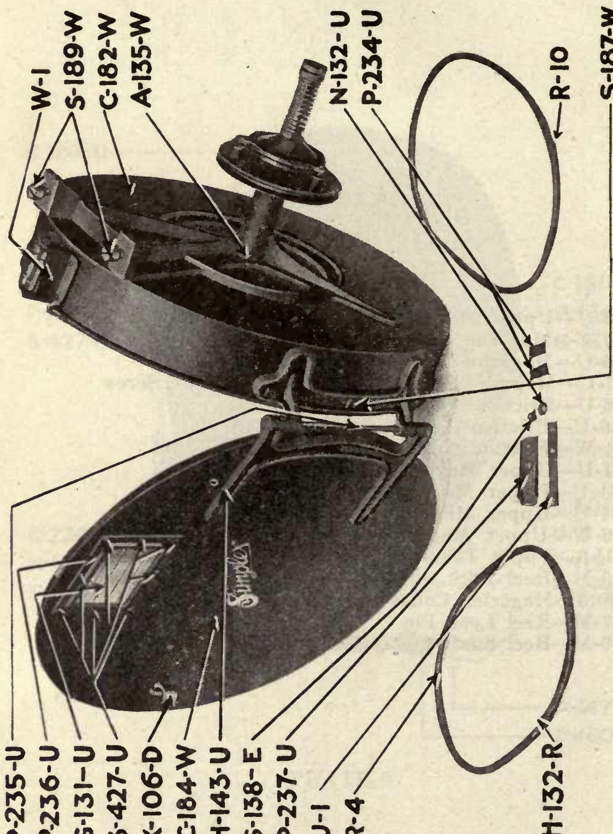

W-1
S-189-W
C-182-W
A-135-W
N-132-U
P-234-U
R-10
S-187-W
P-235-U
P-236-U
G-131-U
S-427-U
K-106-D
C-184-W
H-143-U
S-138-E
P-237-U
U-1
R-4
H-132-R
Simplex

PLATE 10

SIMPLEX PARTS
(MAGAZINE)

Name

P-235-U—Magazine Hinge Pin.
P-236-U—Magazine Wire Glass Retaining Plate.
G-131-U—Lower Magazine Door Wire Glass.
S-427-U—Magazine Wire Glass Retaining Plate Screw.
N-135-U—Magazine Wire Glass Retainer Plate Nut.
K-106-D—Lower Magazine Door Knob.
C-184-W—Lower Magazine Cover 16″.
H-143-U—Magazine Hinge.
S-138-E—Magazine Latch Spring Retain Screw.
P-237-U—Magazine Latch Spring Protector.
U-1—Magazine Latch.
R-4—Take-Up Belt for Reels with Small Hubs.
H-132-R—Belt Hook.
W-1—Lower Magazine Roller Holder.
S-189-W—Magazine Arm Screw.
C-182-W—Lower Magazine 16″.
A-135-W—Lower Magazine Arm 16″.
N-132-U—Magazine Latch Spring Retaining Nut.
P-234-U—Magazine Latch Spring Distance Piece.
R-10—Take-Up Friction Belt for Reels with Large Hubs.
S-187-W—Lower Magazine Hinge Screw.

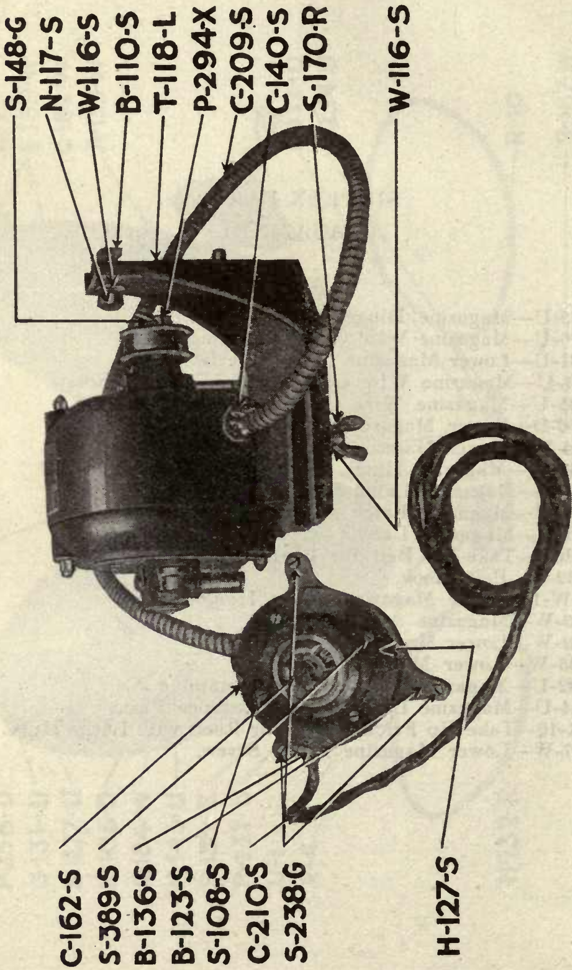

S-148-G
N-117-S
W-116-S
B-110-S
T-118-L
P-294-X
C-209-S
C-140-S
S-170-R
W-116-S
C-162-S
S-389-S
B-136-S
B-123-S
S-108-S
C-210-S
S-238-G
H-127-S

PLATE 11

SIMPLEX PARTS

(MOTOR)

Name

C-162-S—Outlet Box Cover with Switch Bridge.
S-389-S—Snap Switch.
B-136-S—½″ T. & B. Bushing.
B-123-S—Snap Switch Bracket.
S-108-S—Binding Post Cover Fastening Screw.
C-210-S—Canvasite Cord.
S-238-G—Switch Box Bracket Fastening Screw.
H-127-S—Snap Switch Holder.
S-148-G—Motor Pulley Screw.
N-117-S—Motor Table Attachment Bolt Nut.
W-116-S—Motor Table Attachment Bolt Washer.
B-110-S—Motor Table Attachment Bolt.
T-118-L—Motor Table.
P-294-X—Motor Pulley.
C-209-S—Armored Cable.
C-140-S—⅜″ Squeeze Connectors.
S-170-R—Motor Fastening Screw.

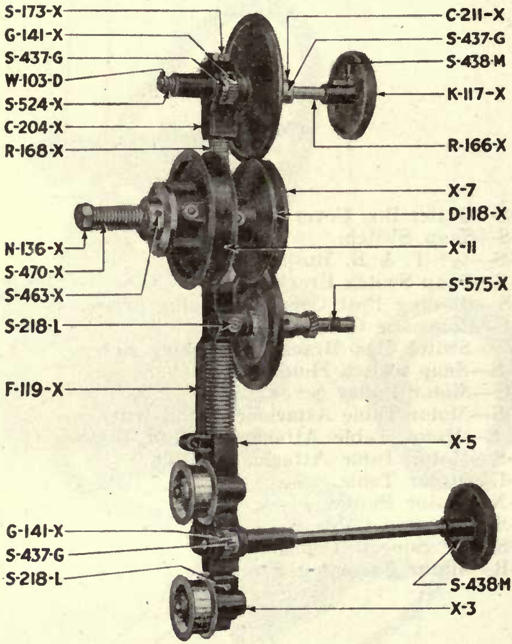

S-173-X
G-141-X
S-437-G
W-103-D
S-524-X
C-204-X
R-168-X
N-136-X
S-470-X
S-463-X
S-218-L
F-119-X
G-141-X
S-437-G
S-218-L
C-211-X
S-437-G
S-438-M
K-117-X
R-166-X
X-7
D-118-X
X-11
S-575-X
X-5
S-438-M
X-3

PLATE 12

SIMPLEX PARTS
(SPEED REGULATOR)

Name

S-173-X—Friction Disc Carrier Stop Screw.
G-141-X—Speed Adjusting Gear.
S-437-G—Collar Set Screw.
W-103-D—Starting Rod Friction Spring Retaining Washer.
S-524-X—Starting Rod Friction Spring.
C-204-X—Starting Mechanism Friction Disc Carrier.
R-168-X—Square Rod for Horizontal Handle.
N-136-X—Friction Spring Nut.
S-470-X—Friction Spring.
S-463-X—Internal Friction Disc Driving Flange Set Screw.
S-218-L—Set Screw.
F-119-X—Speed Control Main Frame.
G-141-X—Speed Adjusting Gear.
S-437-G—Gear Set Screw.
S-218-L—Carrier Set Screw.
C-211-X—Starting Knob Rod Collar.
S-437-G—Gear Set Screw.
S-438-M—Starting Knob Set Screw.
K-117-X—Speed Control Knob.
R-166-X—Starting Knob Rod.
X-7—External Friction Disc Complete.
D-118-X—Internal Friction Disc.
X-11—Speed Control Main Pulley and Oil Cup.
S-575-X—Speed Control Motor Pinion Stud.
X-5—Tension Pulley Carrier Complete.
S-438-M—Speed Control Knob Set Screw.
X-3—Idler Pulley Carrier Complete.

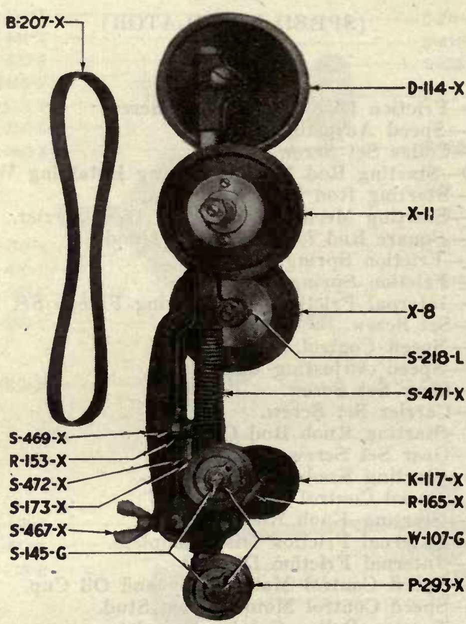

B-207-X
D-114-X
X-11
X-8
S-218-L
S-471-X
S-469-X
R-153-X
S-472-X
S-173-X
S-467-X
S-145-G
K-117-X
R-165-X
W-107-G
P-293-X

PLATE 13

SIMPLEX PARTS
(SPEED REGULATOR)

Name

B-207-X—Speed Control Belt.
S-469-X—Tension Pulley Carrier Roller Screw.
R-153-X—Tension Pulley Carrier Roller.
S-472-X—Square Rod Friction Spring.
S-173-X—Friction Spring Screw.
S-467-X—Main Frame Clamp Screw.
S-145-G—Pulley Carrier Screw.
D-114-X—Starting Mechanism Friction Disc.
X-11—Speed Control Main Pulley and Oil Cup.
X-8—Speed Control Friction Disc.
S-218-L—Set Screw.
S-471-X—Belt Tension Spring.
K-117-X—Speed Control Knob.
R-165-X—Speed Adjusting Knob Rod.
W-107-G—Pulley Washer.
P-293-X—Deflecting Pulley.

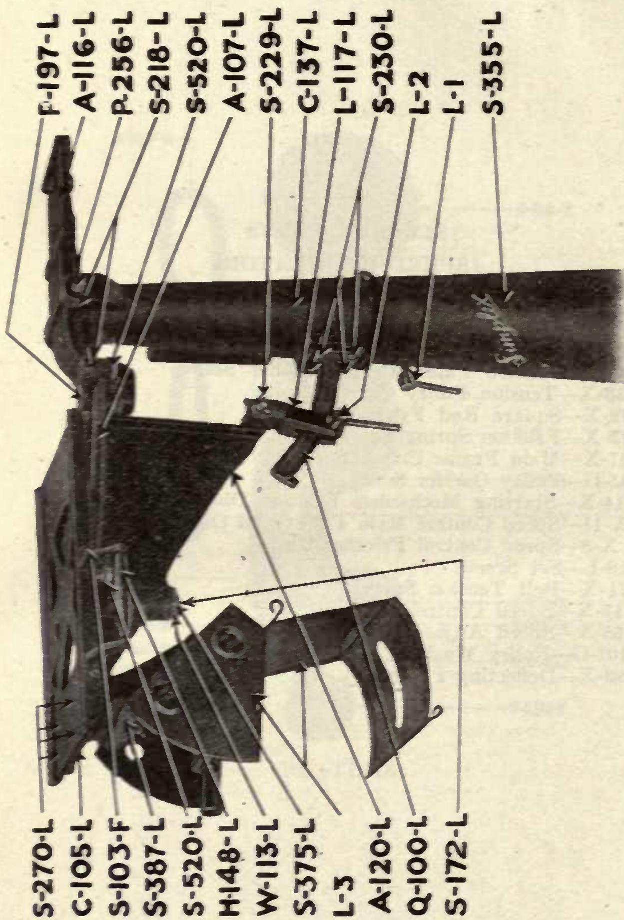

F-197-L
A-116-L
P-256-L
S-218-L
S-520-L
A-107-L
S-229-L
C-137-L
L-117-L
S-230-L
L-2
L-1
S-355-L
S-270-L
C-105-L
S-103-F
S-387-L
S-520-L
H-148-L
W-113-L
S-375-L
L-3
A-120-L
Q-100-L
S-172-L

PLATE 14

SIMPLEX PARTS
(PEDESTAL)

Name

S-270-L—Switch Box Screw.
C-105-L—Lamphouse Carriage.
S-103-F—Lamphouse Carriage Handle Fastening Screw.
S-387-L—Knife Switch 60 Amperes.
S-520-L—Auxiliary Arm Pivot Screw.
H-148-L—Lamphouse Carriage Handle.
W-113-L—Lamphouse Carriage Washer.
S-375-L—Lamphouse Carriage Pivot Stud.
  L-3—Switch, Box and Cover Complete for 60 Amperes.
  L-5—Switch, Box and Cover Complete for 100 Amperes.
A-120-L—Slide Over Arm.
Q-100-L—Quadrant.
S-172-L—Lamphouse Carriage Retain Screw.
P-197-L—Slide Over Arm Pivot.
A-116-L—Pedestal Arm.
P-256-L—Pedestal Arm Pivot.
S-218-L—Pedestal Arm Pivot Set Screw.
S-520-L—Auxiliary Arm Pivot Screw.
A-107-L—Auxiliary Arm.
S-229-L—Quadrant Lock Retaining Screw.
C-137-L—Pedestal Column.
L-117-L—Quadrant Lock.
S-230-L—Quadrant Stand Screw.
  L-2—Quadrant Lock Clamp Handle and Set Screw.
  L-1—Pedestal Stand Handle and Set Screw Complete.
S-355-L—Pedestal Stand.

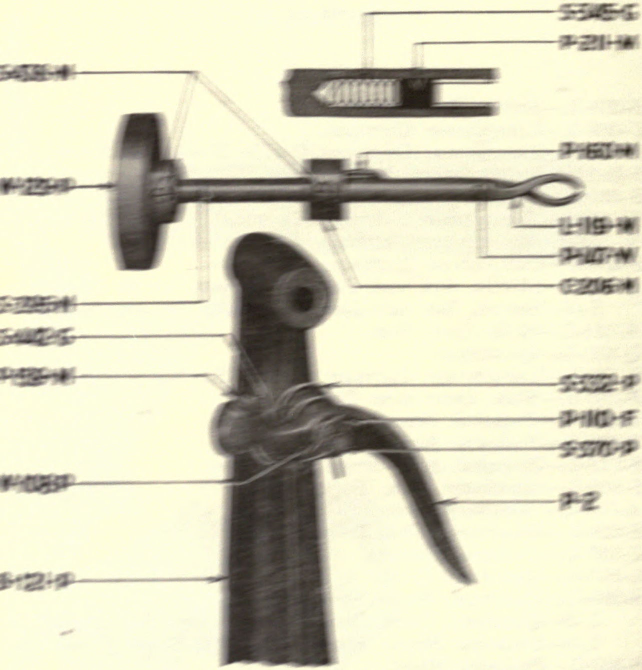


PLATE 16

SIMPLEX PARTS
(REWINDER)

Name

S-408-M—Rewinder Set Screw.
W-129-P—Friction Brake Wheel.
S-295-L—Rewinder Reel Shaft.
S-442-G—Set Screw.
P-159-M—Bracket Lever Leather Plug.
W-108-P—Friction Brake Lever Washer.
B-121-P—Rewinder Idler Bracket.
"P"—Rewinder Idler Bracket Complete.
S-346-G—Reel Shaft Plunger Spring.
P-211-M—Reel Shaft Plunger.
P-160-M—Reel Shaft Collar Pin.
L-119-M—Reel Lock.
P-147-W—Reel Lock Pin.
C-206-M—Rewinder Collar.
S-382-P—Friction Brake Lever Spring.
P-110-E—Cotter Pin.
S-370-P—Friction Brake Lever Stud.
P-2—Rewinder Brake Lever.
P-1—Friction Brake Wheel Assembly Complete.

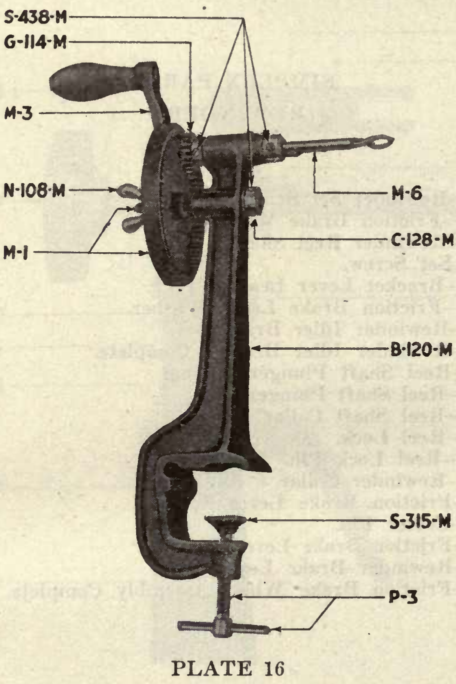


PLATE 16

SIMPLEX PARTS
(REWINDER)

Name

"M"—Rewinder Bracket Complete.
S-438-M—Rewinder Set Screw.
G-114-M—Rewinder Spur Gear.
M-3—Rewinder Handle.
N-108-M—Internal Gear Shaft Nut.
M-1—Internal Gear & Shaft (Includes C-128-M, S-438-M.)
M-6—Rewinder Reel Shaft and Locks.
C-128-M—Internal Gear Shaft Collar.
B-120-M—Rewinder Bracket.
S-315-M—Rewinder Fastening Screw Shoe.
P-3—Rewinder Fastening Screw Complete.

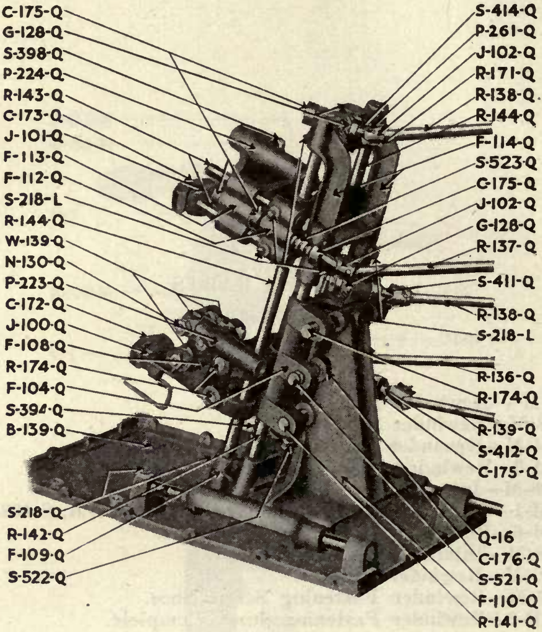


PLATE 17

Name

C-175-Q—Collar for ⅜″ Shaft.
G-128-Q—Spiral Gear for ⅜″ Shaft.
S-398-Q—Contact Piece Connection Screw.
P-224-Q—Contact Piece for Top Carbon.
R-143-Q—Upper Carbon Secondary Guide Rod.
C-173-Q—Upper Carbon Clamp.
J-101-Q—Upper Carbon Jaw.
F-113-Q—Upper Carbon Secondary Sliding Frame.

F-112-Q—Upper Carbon Main Sliding Frame.
S-218-L—Set Screw.
R-144-Q—Upper and Lower Carbon Frame Guide Rod.
W-139-Q—Insulating Washer.
N-130-Q—Upper Carbon Contact Piece Retain Nut.
P-223-Q—Contact Piece for Lower Carbon.
C-172-Q—Lower Carbon Clamp.
J-100-Q—Lower Carbon Jaw.
F-108-Q—Lower Carbon Secondary Sliding Frame.
R-174-Q—Lower Carbon Cross Feed Sliding Rod.
F-104-Q—Burner Cross Feed Sliding Frame.
S-394-Q—Carbon Feed Screw.
B-139-Q—Burner Base.
S-218-Q—Headless Set Screw.
R-142-Q—Main Sliding Frame Guide Rod.
F-109-Q—Lower Frame Casting of 3rd Sliding Frame.
S-522-Q—Screw for Vertical Adjustment of Arc.
S-414-Q—Driving Shaft in Top Frame.
P-261-Q—Universal Joint Cotter Pin.
J-102-Q—Universal Joint.
R-171-Q—Universal Joint Rivot.
R-138-Q—Handle Rod 10″.
R-144-Q—Upper and Lower Carbon Frame Guide Rod.
F-114-Q—Top Frame Casting of 3rd Sliding Frame.
S-523-Q—Screw for Top Carbon Longitudinal Adjustment.
C-175-Q—Screw for Top Carbon Longitudinal Adjustment.
C-175-Q—Collar for ⅜″ Shaft.
J-102-Q—Universal Joint.
G-128-Q—Spiral Gear for ⅜″ Shaft.
R-137-Q—Handle Rod 9″.
S-411-Q—Driving Shaft in Lower Carbon Frame.
R-138-Q—Handle Rod 10″.
S-218-L—Set Screw.
R-136-Q—Handle Rod 8″.
R-174-Q—Lower Carbon Cross Feed Sliding Rod.
R-139-Q—Handle Rod 10½″.
S-412-Q—Driving Shaft in Lower Carbon Frame.
C-175-Q—Collar for ⅜″ Shaft.
Q-16—Horizontal Longitudinal Adjustment of Arc Screw.
C-176-Q—Collar for ½″ Shaft.
S-521-Q—Screw for Crosswise Adjustment of Arc.
F-110-Q—Main Sliding Frame.
R-141-Q—Main Cross Feed Sliding Rod.

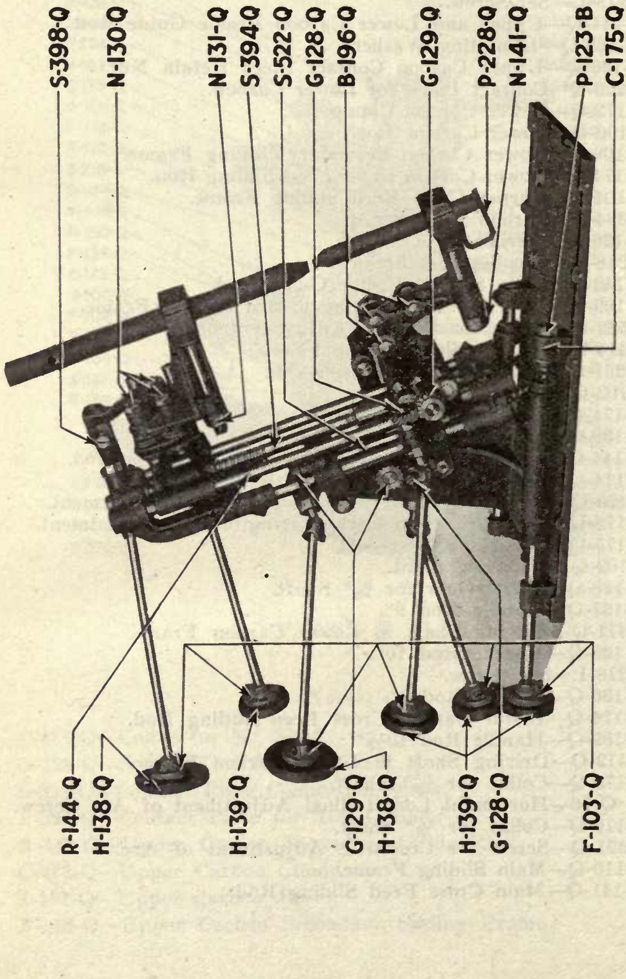

S-398-Q
N-130-Q
N-131-Q
S-394-Q
S-522-Q
G-128-Q
B-196-Q
G-129-Q
P-228-Q
N-141-Q
P-123-B
C-175-Q
R-144-Q
H-138-Q
H-139-Q
G-129-Q
H-138-Q
H-139-Q
G-128-Q
F-103-Q

PLATE 18

SIMPLEX PARTS
(ARC LAMP)

Name

R-144-Q—Upper and Lower Carbon Frame Guide Rod.
H-138-Q—Large Fibre Handle.
H-139-Q—Small Fibre Handle.
G-129-Q—Spiral Gear for ½″ Shaft.
G-128-Q—Spiral Gear for ⅜″ Shaft.
F-103-Q—Handle Flange.
S-398-Q—Contact Piece Connection Screw.
N-130-Q—Upper Carbon Contact Piece Retain Nut.
N-131-Q—Upper Carbon Clamp Nut.
S-394-Q—Carbon Feed Screw.
S-522-Q—Vertical Adjustment of Arc Screw.
G-128-Q—Spiral Gear for ⅜″ Shaft.
B-196-Q—Carbon Jaw Bolt.
G-129-Q—Spiral Gear for ½″ Shaft.
P-228-Q—Lower Carbon Stop Pin.
N-141-Q—Lower Carbon Clamp Nut.
P-123-B—Taper Pin.
C-175-Q—Collar for ⅜″ Shaft.

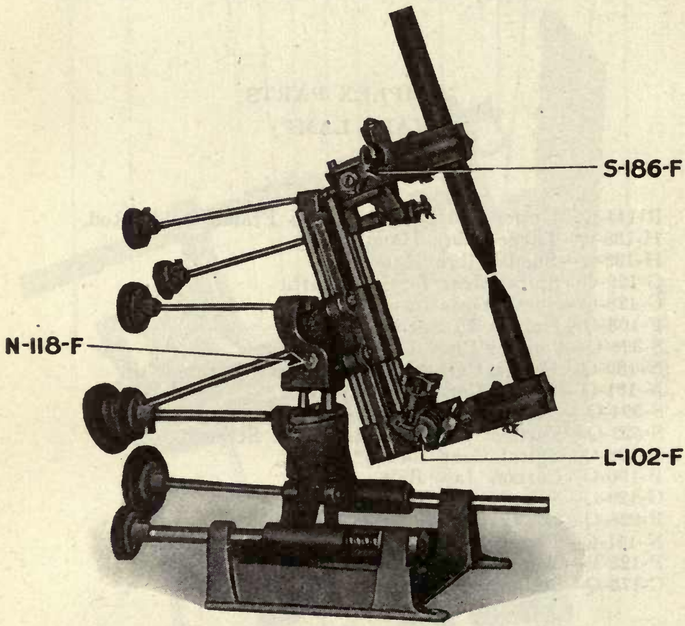


PLATE 19

SIMPLEX PARTS

(ARC LAMP)

Name

N-118-F—Carbon Feed Bracket Support Screw Nut.
L-102-F—Carbon Jaw Tilt Screw Lever.
S-186-F—Lower Carbon Holder Wing Screw.

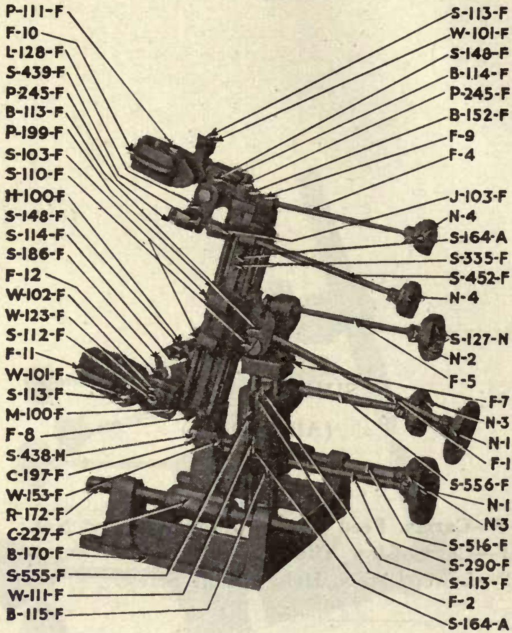


PLATE 20

S-113-F—Carbon Holder Clamp Screw.
W-101-F—Carbon Holder Washer.
S-148-F—Set Screw.
B-114-F—Carbon Holder Bracket.
P-245-F—Upper Carbon Tilt Screw Cotter Pin.
B-152-F—Upper Carbon Feed Rack (Sub-Bracket).
F-9—Upper Carbon Feed Rack Support.
F-4—Upper Carbon Feed Rack Bracket Adjusting Screw.
J-103-F—Upper Carbon Tilt Screw Universal Joint.
N-4—Feed Knob.
S-164-A—Tension Spring Screw.
S-335-F—Lamp Adjusting Gear Friction Spring.
S-452-F—Upper Carbon Tilt Screw Adjusting Shaft.
N-4—Feed Knob.
S-127-N—Feed Knob Hub Screw.

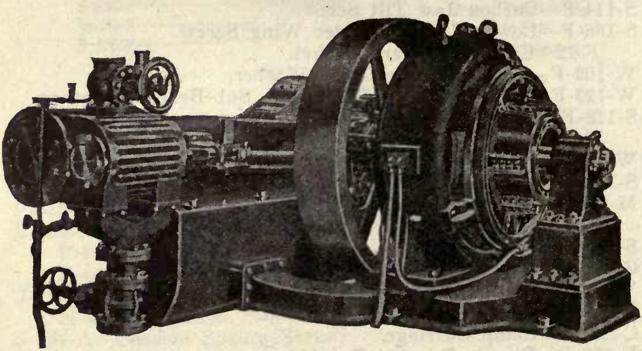
N-2—Carbon Feed Bracket Tilt Screw Knob.
F-5—Carbon Feed Bracket Tilt Screw.
F-7—Carbon Feed Bracket Support.
N-3—Feed Knob.
N-1—Feed Knob.
F-1—Carbon Feed Gear and Shaft.
S-556-F—Lamp Lateral Screw Shaft.
N-1—Feed Knob.
N-3—Feed Knob.
S-516-F—Lamp Carriage Screw.
S-290-F—Lamp Adjusting Gear Shaft.
S-113-F—Carbon Holder Clamp Screw.
F-2—Lamp Adjusting Bracket Plate and Pins.
S-164-A—Lamp Adjusting Friction Spring Screw.
P-111-F—Carbon Holder Pin.
F-10—Upper Carbon Holder.
L-128-F—Carbon Jaw Tilt Screw Lever.
S-439-F—Upper Carbon Jaw Tilt Screw.
P-245-F—Upper Carbon Tilt Screw Cotter Pin.
B-113-F—Carbon Feed Bracket.
P-199-F—Carbon Feed Bracket Plate.
S-103-F—Carbon Feed Bracket Plate Screw.
S-110-F—Carbon Feed Bracket Support Screw.
H-100-F—Carbon Jaw Tilt Screw Handle.
S-148-F—Set Screw.
S-114-F—Carbon Jaw Tilt Screw.
S-186-F—Lower Carbon Holder Wing Screw.
F-12—Carbon Holder Bracket.
W-102-F—Carbon Holder Mica Washer.
W-123-F—Upper Carbon Feed Rack Sub-Bracket Washer.
S-112-F—Carbon Holder Bracket Screw.
F-11—Lower Carbon Holder.
W-101-F—Carbon Holder Washer.
S-113-F—Carbon Holder Clamp Screw.
M-100-F—Carbon Holder Sheet Mica.
F-8—Lower Carbon Feed Rack Bracket.
S-438-M—Set Screw.
C-197-F—Lamp Carriage Screw Collar.
W-153-F—Lamp Carriage Screw Washer.
R-172-F—Lamp Carriage Guide Rod.
C-227-F—Lamp Carriage.
B-170-F—Burner Support Bracket.
S-555-F—Lamp Adjusting Plate Tension Spring.
W-111-F—Lamp Adjusting Plate Washer.
B-115-F—Lamp Adjusting Bracket.

DYNAMOS

A dynamo electric machine is a device for converting mechanical energy into electric energy. The word dynamo is generally understood to mean a machine for converting mechanical energy into electrical energy, and the word motor means a machine for converting electric energy into mechanical energy, the essential parts of a dynamo and motor are the same, namely—the armature and field magnet.

Dynamos are divided into two general classes, according to the character of the current they deliver. A direct current dynamo delivering a current that always flows in one direction, that is, the current never reverses, though it may change in value or pulsate.

Alternating current dynamos or alternators, de-



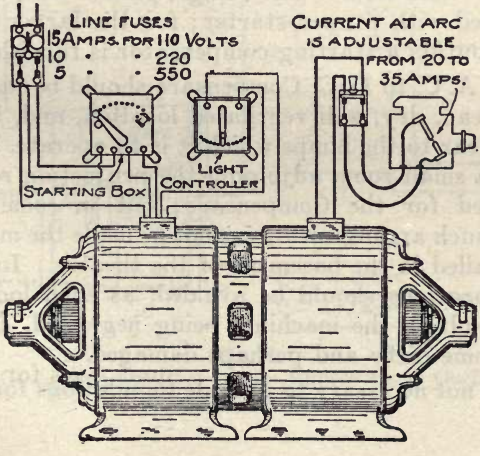
100 K.W. Engine-Type Generator and Automatic High-Speed Engine

liver a current that periodically reverses its direction of flow, the number of reversals per second depending on the number of poles in the dynamo and on the speed of rotation.

A direct current dynamo usually consists of a series of conductors arranged on the surface of a cylindrical iron core or in slots near the surface, the conductors in most cases being parallel with the axis of the core.

The core is mounted on a shaft that is supported on bearings so that the armature can be rotated near the pole faces of a field magnet. This magnet is excited by one or more field coils. Any even number of poles may be used according to the size and type of machine.

The principal parts of a dynamo are: armature core, bands on armature core, commutator, shaft, field coils, pole faces, brushes, rear end bearing, front end bearing, rear end journal, front end journal, terminal block and bedplate.



FORT WAYNE A. C. TO D. C. COMPENSARCS

The A. C. to the D. C. Compensarcs is what is commonly known as a motor generator set, that is, two machines, a generator and a motor coupled together and mounted on a common base.

The sets are shipped completely assembled and require only proper installation, filling of the bearings with oil and proper connections to the supply and lamp circuits before putting into service. It should be understood that these compensarcs are special machines for use only on picture projection arcs and cannot be used for ordinary constant voltage purposes.

The complete equipment consists of the A. C. to D. C. compensarc proper, two short-circuiting switches, one for each picture machine, and the panel on which is mounted the instrument and field control rheostat. All single-phase outfits are equipped with proper starter; for the larger multiphase outfits a starting compensator is furnished.

The A. C. to D. C. Compensarc should be installed in a clean, dry, well ventilated location, and, if possible, near to the lamps which it is to operate. Oftentimes a small room adjoining the projection room is provided for the Compensarc; but in some cases where such arrangements cannot be made the machine is installed in the basement of the theatre. Inaccessible locations should be avoided, as such locations will result in the machines being neglected, allowed to become dirty and perhaps damaged.

It is not necessary to provide foundations for these compensarcs, but the floor on which they are placed should be firm and free from vibration.

The machines are clamped to a pair of wooden skids, which form a foundation for the boxing.

A. C. TO D. C. COMPENSARC

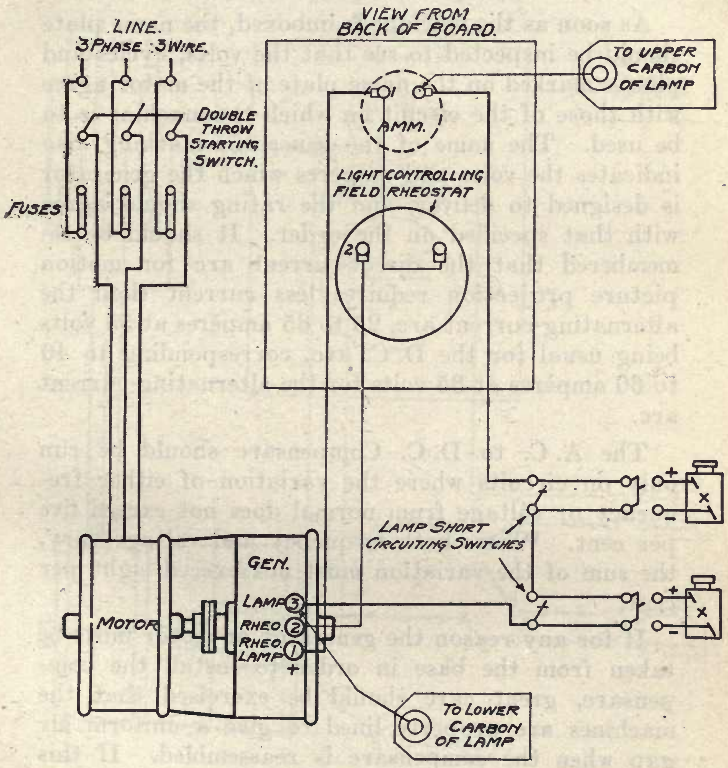


Fig. 1
Connection Diagram for 35-Ampère Lamp Outfit

The machine should if possible be left attached to these skids until it has been conveyed to the location which it is finally to occupy. It is preferable that all wiring should be done before the boxing is removed from the machine, as the boxing will be effective in keeping the machine clean.

As soon as the machine is unboxed, the name plate should be inspected to see that the volts, cycles and phases marked on the name plate of the motor agree with those of the circuit on which the machine is to be used. The name of the generator marking also indicates the volts and ampères which the generator is designed to deliver, and the rating should agree with that specified on the order. It should be remembered that the direct-current arc for motion picture projection requires less current than the alternating-current arc, 25 to 35 ampères at 55 volts being usual for the D. C. arc, corresponding to 40 to 60 ampères at 35 volts for the alternating-current arc.

The A. C. to D. C. Compensarc should be run only on circuits where the variation of either frequency or voltage from normal does not exceed five per cent. Where both frequency and voltage vary, the sum of the variation must not exceed eight per cent.

If for any reason the generator or motor must be taken from the base in order to install the compensarc, great care should be exercised that the machines are properly lined to give a uniform air gap when the compensarc is reassembled. If this is not done, trouble will occur due to the set being out of line. Dowell pins are provided on the generator end. To remove these hold the squared head of the pin with a wrench and tighten up the nut which will pull out the pin. Be careful that any liners found under the feet are carefully replaced

A. C. TO D. C. COMPENSARCS

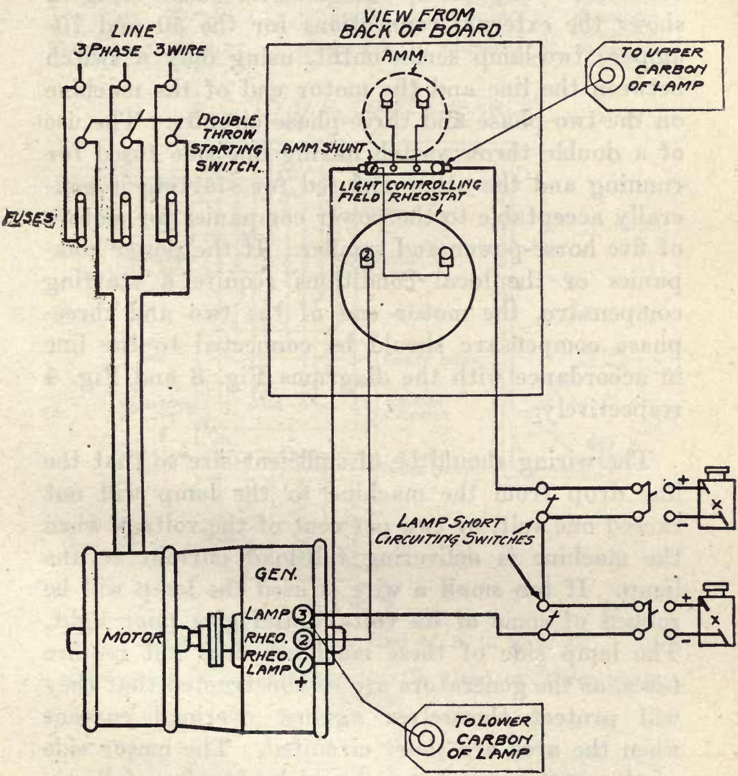


Fig. 2

Connection Diagram for the 50 and the 70-Ampère Lamp Outfit in their proper place. Should the coupling be taken apart, it must be assembled carefully, making sure that the halves fit properly.

Diagram Fig. 1 shows the external connections for the 35 ampères two-lamp series outfit. Fig. 2 shows the external connections for the 50 and 70-ampère two-lamp series outfit, using only a switch between the line and the motor end of the machine on the two-phase and three-phase circuits. The use of a double throw switch having one side fused for running and the other unfused for starting is generally acceptable to the power companies for motors of five horse-power and smaller. If the power companies or the local conditions require a starting compensarc, the motor end of the two and three-phase compensarc should be connected to the line in accordance with the diagrams Fig. 3 and Fig. 4 respectively.

The wiring should be of sufficient size so that the line drop from the machine to the lamp will not exceed one volt, or two per cent of the voltage when the machine is delivering full-load current to the lamp. If too small a wire is used the lamp will be robbed of some of its voltage and give poor light. The lamp side of these machines does not require fuses, as the generators are so constructed that they will protect themselves against overload current when the arcs are short circuited. The motor side of the various machines should be fused as follows:

	Two 35-ampère Lamps Alternately	Two 50-ampère Lamps Alternately	Two 70-ampère Lamps Alternately
	Fuses	Fuses	Fuses
Single-phase 110-volt....	80-ampère	100-ampère	120-ampère
Single-phase 220-volt....	40-ampère	50-ampère	60-ampère
Two-phase 110-volt....	40-ampère	60-ampère	70-ampère
Two-phase 220-volt....	20-ampère	30-ampère	35-ampère
Three-phase 110-volt....	50-ampère	75-ampère	80-ampère
Three-phase 220-volt....	25-ampère	35-ampère	40-ampère

A. C. TO D. C. COMPENSARCS

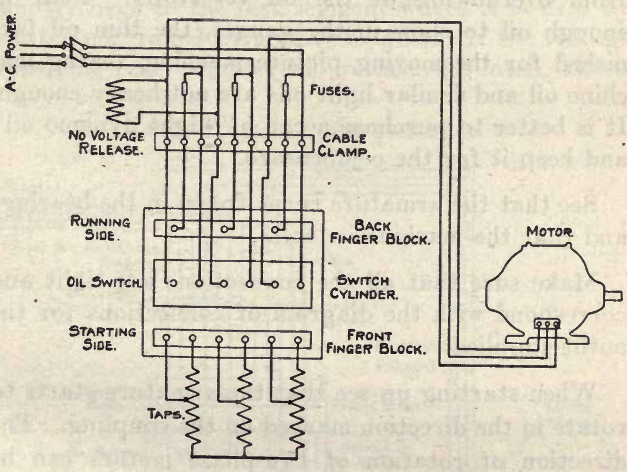


Fig. 8

Connections of Motor End of A. C. to D. C. Compensarc When Compensator Is Used on Three-phase Circuits

Before starting the set see that it is perfectly clean and that the brushes move freely in their holders and make good contact with the commutator. Be sure that the oil wells are clean and filled. These machines have overflow gauges with hinged caps. The oil wells should be filled through the overflow gauges rather than through the hinged covers in the bearings. This method will prevent waste and annoyance from overflowing of the oil reservoirs. Pour in enough oil to show in the gauges, the thin oil furnished for the moving picture machine, sewing machine oil and similar light oils are not heavy enough. It is better to purchase a can of "light dynamo oil" and keep it for the compensarc.

See that the armature turns freely in the bearings and that the machine is level.

Make sure that all the connections are tight and correspond with the diagram of connections for the outfit supplied.

When starting up see that the armature starts to rotate in the direction marked on the coupling. The direction of rotation of two-phase motors can be reversed by interchanging two line leads of the same phase. In the case of single and three-phase motors it is only necessary to interchange any two line leads of the motor. Immediately after starting, see that the oil rings revolve and carry the oil up to the shaft. Always keep the oil at the proper level in the well, that is, nearly to the lip of the overflow gauge.

STARTING THE COMPENSARC

In starting up the A. C. to D. C. Compensarc, have the switches at the lamps open. If a single-phase outfit, close the main switch and move the starting arm on the starting box from the "off" position to the split segment which will introduce the necessary starting coils to cause the armature to start to rotate. When the armature has attained nearly full speed, the starting arm should be moved quickly over to the last segment where it is held by a latch controlled by a relay magnet. If the voltage fails, the relay magnet will release the latch, allow-

A. C. TO D. C. COMPENSARCS

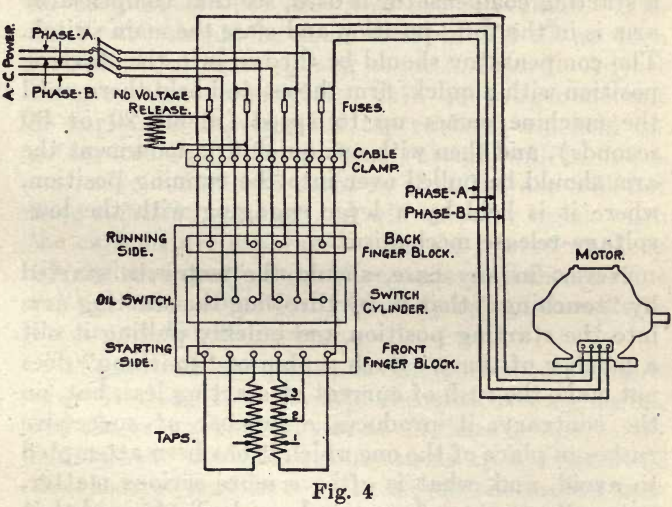


Fig. 4

Connections of Motor End of A. C. to D. C. Compensarc When Compensator Is used on Two-phase Circuits ing the starting arm to automatically return to the "off" position stopping the motor.

The arm of the starting box should never be left in starting position longer than one minute, usually much less time will suffice. When the power companies do not require the use of starting compensators in connection with the two and three-phase outfits they should be equipped with double-throw starting switches which have only one side fused.

When starting up, the switch should be closed to the unfused side. When the speed of the armature is up to normal the switch should be quickly changed to the running side (fused side).

To start up an A. C. to D. C. Compensarc where a starting compensator is used, see that compensator arm is in the "off" position and close the main switch. The compensator should be thrown into the starting position with a quick, firm thrust and held there until the machine comes up to speed (about 20 or 30 seconds), and then with one quick firm movement the arm should be pulled over into the running position, where it is held by a lever engaging with the low-voltage release mechanism.

Never, in any case, should the motor be started by "touching," that is, by throwing the starting arm into the starting position and quickly pulling it out a number of times. Such a plan of "touching" does not make the rush of current at starting less, but, on the contrary, it produces a number of successive rushes in place of the one which it has been attempted to avoid, and, what is often a more serious matter, causes the contact fingers to be so badly burned that it is necessary to replace them. To stop the machine open the main switch. The compensator arm should automatically return to the "off" position on the opening of the main switch; if it does not, throw it over to the "off" position by hand.

STARTING FIRST LAMP

When the speed of the machine is up to normal and the starting box or switch is in running position and the rheostat handle set as marked by the white arrow, short-circuit the one lamp by means of its short-circuiting switch. Then close the lamp switch and bring the carbons together so that they barely touch; then separate them about 1-16 of an inch, gradually increasing the separation as carbons heat up until the proper length of arc is reached. The D. C. arc should be from 5-16 to 3-8 of an inch long or about twice as long as an A. C. arc. Adjust the generator field rheostat until the proper amount of current is flowing. If the carbons are held together too long the machine voltage will be automatically reduced to zero, so that the arc will not have sufficient voltage, and will therefor break when the carbons are separated. Should this occur, keep the carbons apart about 10 seconds until the machine voltage can automatically build up again, then strike the arc as directed above.

The switchboard panel, having instruments mounted on it along with the field rheostat, is very useful, and the proper current can at all times be accurately maintained. As the machine warms up, the handle of the rheostat may have to be moved one or two buttons from the mark to maintain the desired voltage and current. If the circuits are all connected as shown in the diagram, the polarity should be as indicated, the upper carbon being positive. Should the upper carbon be negative and the instrument on the panel board read backward, the trouble must be corrected. See that all connections are made as indicated on the diagram. The polarity must come correct if the connections are made in accordance with the diagram of connections, and the armature of the set rotates in the direction marked on the coupling.

STARTING THE SECOND LAMP

To start the second lamp, bring the carbons together to close the circuits; close the lamp switch and open the short-circuiting switch. This puts the two lamps in series, the current from the first lamp flowing through the second lamp. The arc at the second lamp is adjusted in the regular manner while both lamps are burning. When ready to change over from one lamp to the other, bring the carbons of the first lamp together and close its short-circuiting switch, continuing the projection on the second lamp.

It has been found in practice that the following scheme gives the most satisfactory results. A minute or two before the end of a reel of film is reached bring the carbons of the second lamp together, close its line switch and open its short-circuiting switch. The current for the first lamp flowing through the carbons of the second lamp causes the tips of the carbons of the second lamp to heat up to a white heat without actually drawing an arc. Since the tips of the carbons are heated up by this method a normal arc is easily and quickly secured when it is time to change over to the second lamp.

Care must be taken that the two lamps are not both burning any longer than is necessary, as the Compensarc is not intended to carry both lamps continuously. The ammeter on the panel will show the current flowing through the arc when either one

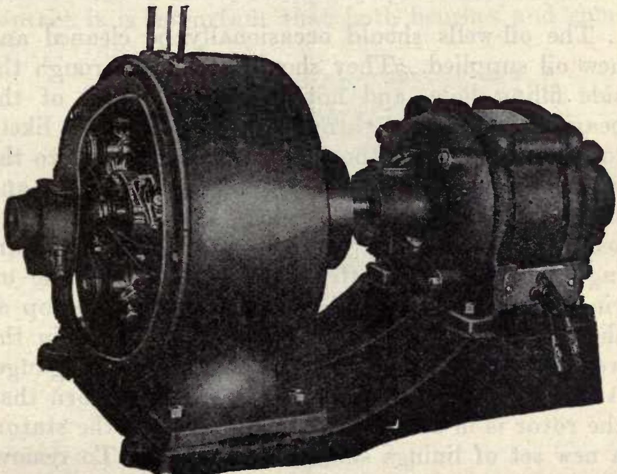


Fig. 5

A. C. to D. C. Compensarc

or both lamps are burning. The voltage is automatically increased by the machine to compensate for the increased drop due to the second lamp and the current is held practically constant.

It is important that all parts of the machine be kept clean. Oil should not be allowed to collect either on the machine or on the floor about it, and the machine should as far as possible be kept free from dust. When the coils of a machine are allowed to become dirty and oil-soaked, it reduces their insulation strength and eventually causes them to burn out. A small hand bellows will be found convenient for removing the dust from the armature windings.

BEARINGS

The oil-wells should occasionally be cleaned and new oil supplied. They should be filled through the side filling hole, and not through the top of the bearing, for if filled through the top the oil is likely to flow out through the ends of the bearings into the windings. Only good grades of oil free from dust and sediment should be used for poor oil or oil containing sediment will greatly shorten the life of the bearings. Immediately after starting see that the oil rings revolve freely and carry the oil to the top of the shaft. Keep the oil at the proper level in the well, that is, nearly to the lip of the overflow gauge. As soon as the bearing linings become so worn that the rotor is in danger of rubbing against the stator, a new set of linings should be inserted. To remove the bearings, take out the set screws in the bearing housings, lift the oil rings and drive out the bearings with a wooden block of the same diameter as the bearings. The bearings are a light driving fit in the housing and must be handled carefully. When repair bearings are supplied for the alternating current motors the set screw depression is already in the bearing, but the direct current bearings, which regulate the end play, are supplied without being previously spotted. They must be spotted before being put in place, using a 3-16 inch drill and spot-drilling for the tip of the set screw the same distance from the end of the bearing as is the bearing being replaced.

COMMUTATOR AND BRUSHES

It is very important that the brushes make perfect contact with the commutator, and to secure good contact it is important that both brushes and com-

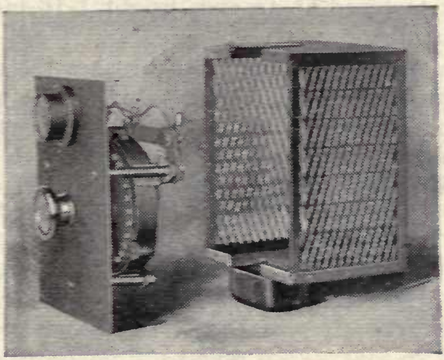


Fig. 6

Special Cabinet Panel with Ammeter and Field Rheostat

mutator be kept clean and free from carbon dust and dirt.

To secure proper commutation and proper operation, the brushes must occupy the correct position on the commutator. This proper position of the brush yoke has been determined at the factory while the machine was on test, and is indicated by corresponding chisel marks on brush yoke and frame. It is very important that these marks indicated by white lead should be in line to secure satisfactory operation of the machine.

If the brush holders should become loosened or moved in any way, they must be carefully reset so that they make the proper angle with the commutator as shown in Fig. 7. They must also be so spaced around the commutator that the distance from tip to tip of the brushes are exactly the same. Care should be taken that the brush-holders are securely fastened at an even height 1-16 inch above the commutator.

When replacing worn down brushes the new ones should be fitted to the commutator by means of fine sandpaper, carefully pulled under the brush in the direction of rotation, being held tightly to the contour of the commutator. If the brushes are inspected once a week and all gum cleaned away from the brushes so that they move freely in the brush-holders,

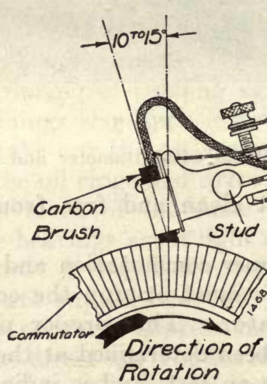


Fig. 7

Showing Correct Method of Setting the Brushes much longer life of brushes and commutator will result. If the pressure is too heavy the wear of both brushes and commutator will be excessive, while if the pressure is too light the contact will not be properly made between brushes and commutator and sparking may result; the proper pressure of the springs on the brushes is just sufficient to insure good contact between brushes and commutator. A dirty commutator can be best cleaned by rubbing with a clean cloth saturated with kerosene or machine oil. To keep the commutator in good condition, wipe it from time to time with a piece of canvas lightly coated with sperm or machine oil. Lubricant of any kind should be used sparingly.

If the commutator begins to cause trouble at any time, due to roughness, it should be given immediate attention. Any delay will aggravate the case and may result in undue sparking, heating and consequent troubles. The roughness may be removed by polishing the commutator with a piece of very fine sandpaper by pressing it against the surface of the commutator with a block of wood shaped to the curvature of the commutator face. In using the sandpaper (emery cloth should never be used) it should be moved back and forth along the surface parallel to the shaft to prevent grooving the face of the commutator. When sanding is finished, the commutator surface and brush faces must be wiped carefully to remove any copper dust and grit which may have adhered to them. If the commutator has been allowed to become very rough it may be necessary to grind it down to a true surface, using a small piece of fine sandstone. In using this it should be steadied against the brush holders (properly protected) or other steady-rest. Brushes should be lifted from the commutator while grinding it. After grinding polish with fine sandpaper.

If the above treatment does not remedy the trouble it will be necessary to tighten the commutator segments and turn down the commutator. The commutator should be trued by taking off the lightest cut possible, using a sharp tool and high cutting speed. Following the operation of turning down the commutator, the mica between the bars should be carefully cut down below the surface of the bars. Next remove the tool marks from the surface of the commutator with very fine sandpaper, and blow all the copper dust and chips from in and around the commutator bars, making a final inspection to see that at no place does the copper dust or chips bridge over the mica from one bar to another. The truing of the commutator should be required only after a long period of service, if the machine has been properly cared for, and should be done only by someone familiar with such work.

D. C. TO D. C. MOTOR-GENERATOR SET

For Projection Arc Control
For 2 Arcs in Series Used Alternately

GENERAL

The D. C. to D. C. motor-generator set consists of two machines, a generator and a motor, coupled together and mounted on a common base.

The sets are shipped completely assembled and require only proper installation, filling of the bearings with oil and proper connection to the supply and lamp circuits before putting in service. Understand that these sets are special machines for use only on picture projection arcs and cannot be used for ordinary constant voltage purposes.

The complete equipment consists of the D. C. to D. C. motor-generator set, proper starting box, two short-circuiting switches (one for each picture machine) and the panel on which is mounted the ammeter and field control rheostat.

INSTALLATION

Install the D. C. to D. C. motor-generator in a clean, dry, well ventilated location and, if possible, near to the lamps which it is to operate. Oftentimes a small room adjoining the projection room is provided for the set, but in some cases where such arrangement cannot be made the machine is installed in the basement of the theatre. Avoid inaccessible locations, as such locations will result in the machines being neglected, allowed to become dirty and perhaps damaged.

It is not necessary to provide foundations for these machines, but the floor on which they are placed must be firm and free from vibration.

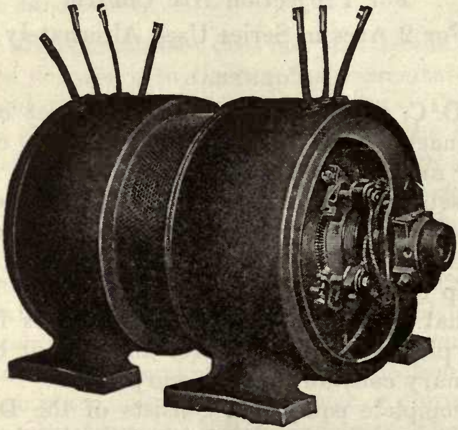


Fig. 2
D. C. to D. C. Motor-Generator Set

The machines are shipped clamped to a pair of wooden skids which form a foundation for the boxing. If possible, leave the machine attached to these skids until it has been conveyed to the location which it is to finally occupy. It is preferable that all wiring should be done before the boxing is removed from the machine, as the boxing will be effective in keeping the machine clean.

As soon as the machine is unboxed, inspect the name plate to see that the volts marked on the name plate of the motor agree with those of the circuit on which the machine is to be used. The marking of the generator name plate indicates the volts and amperes which the generator is designed to deliver and this rating should agree with that specified in the order.

CONNECTIONS

Wiring Diagrams

Diagram Fig. 8 shows the external connections for the 35-ampère two-lamp series outfit and Fig. 9 shows the external connections for the 50, 70 and 100-ampère two-lamp series outfit.

D. C. TO D. C. MOTOR-GENERATOR SETS

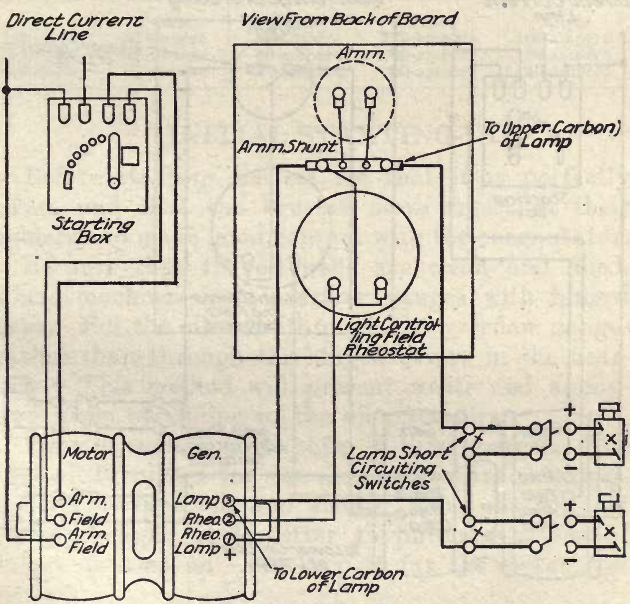


Fig. 8

Connection Diagram for 35-Ampère Lamp Outfit

Wiring

Be sure that the wiring is of sufficient size so that the line drop from the machine to the lamp will not exceed one volt, or two per cent of the voltage when the machine is delivering full load current to the lamp. If too small a wire is used the lamp will be robbed of some of its voltage and give poor light.

D. C. TO D. C. MOTOR-GENERATOR SETS

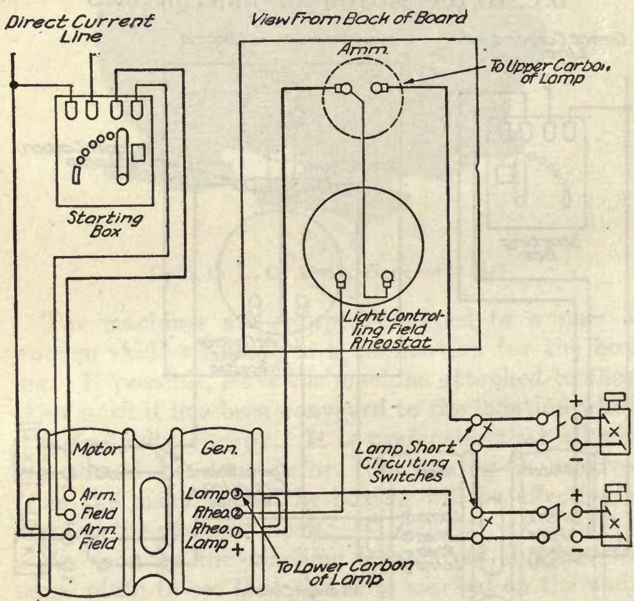


Fig. 9

Connection Diagram for the 50, 70 and 100-Ampère Lamp Outfit

Fuses

The lamp side of these machines does not require fuses, as the generators are so constructed that they will protect themselves against overload current when the arcs are short circuited.

The motor side of the various machines should be fused as follows:

	Two 35-ampère Lamps Alternately	Two 50-ampère Lamps Alternately	Two 70-ampère Lamps Alternately	Two 100-ampère Lamps Alternately
	Fuses	Fuses	Fuses	Fuses
115 volts	60-ampère	80-ampère	120-ampère	160-ampère
230 volts	30-ampère	40-ampère	60-ampère	80-ampère
550 volts	15-ampère	20-ampère	30-ampère	40-ampère

INITIAL STARTING

Before starting the set see that it is perfectly clean, and that the brushes move freely in their holders and make good contact with the commutator.

Be sure that the oil wells are clean and filled. These machines have overflow gauges with hinged caps. Fill the oil wells through the overflow gauges rather than through the hinged covers in the bearings. This method will prevent waste and annoyance from overfilling of the oil reservoirs.

Pour in enough oil to show in these gauges. The thin oil furnished for the moving picture machines, sewing machine oil, and similar light oils are not heavy enough; it is better to purchase a can of "light dynamo oil" and keep it for the motor-generator.

See that the armature turns freely in the bearings, and that the machine is level.

Make sure that all connections are tight and agree with the diagram of connections for the outfit supplied, so that when starting up the armature will start to rotate in the direction marked on the coupling.

Immediately after starting, see that the oil rings revolve freely and carry the oil up to the shaft. Always keep the oil at the proper level in the well, that is, nearly to the lip of the overflow gauge.

OPERATION

Starting the Motor-Generator

In starting up the D. C. to D. C. set have the switches at the lamps open. Close the main line switch and move the lever of the starting box to the first contact point holding it there for two or three seconds to allow the armature to start to rotate. Then move the lever slowly over the remaining contact points until it reaches the running position where it will be held in place by the retaining magnet. If the voltage fails the retaining magnet will release the latch allowing the starting arm to automatically return to the "off" position stopping the motor.

To stop the machine open the main switch. The arm of the starting box should then automatically return to the "off" position. If it does not, throw it over to the "off" position by hand.

Starting First Lamp

When the speed of the machines is up to normal and the arm of the starting box is in running position and the rheostat handle set as marked by the white arrow, short circuit the one lamp by means of its short-circuiting switch. Then close the lamp switch of the other lamp and bring the carbons together so that they barely touch; then separate them about 1/16 of an inch, gradually increasing the separation as carbons heat up until proper length of arc is reached. The D. C. arc should be from 5/16 to 3/8 of an inch long, or about twice as long as an A. C. arc. Adjust the generator field rheostat until the proper amount of current is flowing.

If carbons are held together too long, the machine voltage will be automatically reduced to zero, so that the arc will not have sufficient voltage and will, therefore, break when carbons are separated. Should this occur, keep carbons apart about 10 seconds until machine voltage can automatically build up again; then strike the arc as directed above.

The switchboard panel has an ammeter mounted on it along with the field rheostat and is very useful as the proper current can at all times be accurately maintained. As the machine warms up, the handle of the rheostat may have to be moved one or two buttons from the mark to maintain the desired voltage and current.

If the circuits are all connected as shown in the diagram the polarity should be as indicated. The upper carbon must be positive. Should the upper carbon be negative and the instrument on the panel read backward, the trouble must be corrected. See that all connections are made as indicated on the diagram.

The polarity must come correct if the connections are made in accordance with the diagram of connections and the armature of the set rotates in the direction marked on the coupling.

Starting the Second Lamp

To start the second lamp bring the carbons together to close the circuit, close the lamp switch and open the short-circuiting switch. This puts the two lamps in series, the current from the first lamp flowing through the second lamp. The arc at the second lamp is adjusted in the regular manner while both lamps are burning.

When ready to change over from one lamp to the other bring the carbons of the first lamp together and close its short-circuiting switch, continuing the projection on the second lamp.

It has been found in practice that the following scheme gives the most satisfactory results. A minute or two before the end of a reel of film is reached bring the carbons of the second lamp together, close its line switch and open its short-circuiting switch. The current for the first lamp flowing through the carbons of the second lamp causes the tips of the carbons of the second lamp to heat up to a white heat at the tips without actually drawing an arc. Since the tips of the carbons are heated up by this scheme a normal arc is easily and quickly secured when it is time to change over to this second lamp.

Take care that the two lamps are not both burning any longer than is necessary, as the motor-generator is not intended to carry both lamps continuously. The ammeter on the panel will show the current flowing through the arc when either one or both lamps are burning; the voltage is automatically increased by the machine to compensate for the increased drop due to the second lamp and the current is held practically constant.

THE TRANSVERTER

The Transverter is a vertical machine, self-contained and occupies a floor space of less than two feet square. The panel carrying the switches and meters can be located at any point convenient to the operator, while the machine is best placed near a wall anywhere on a floor not subject to vibration, and in a location which is not damp and which affords ready inspection.

A pair of steel lugs will be found on the sides of the generator frame. After the machine is taken out

of the crate, it can be very conveniently handled by these lugs, should it be necessary to lift it any distance to its permanent location. When located, it should be placed upon the four pieces of cork composition which are sent with the machine, and which serve to minimize vibration and at the same time insulate the frame from ground. It is not necessarv to bolt it down.

Installation Instructions

Wiring—Make connection from the A. C. line service to the starting switch and from the starting switch to motor terminals, 1, 2 and 3; then close the switch and make sure that the armature rotates in the direction indicated by the arrow on the top bearing housing. If the armature rotates in the wrong direction, it must be reversed by interchanging any two of the A. C. motor terminals.

Caution—Do not change connections inside of Transverter unit to correct direction of rotation or polarity. The machines are all checked up complete with their equipment when tested. The motor must be connected to proper side of the line and connections to panels must be made correctly to bring polarity of the instruments and lamp carbons correct.

Fuses—Fuse the A. C. motor side of these machines only. The D. C. Generator circuit does not require fuses or switches other than shown on the wiring print. The A. C. fuses at the A. C. motor starting switch must be of large enough capacity to carry the maximum load of the machine.

Wiring to Lamps—Use wire of sufficient size to carry rated current of Transverter to connect from

L and A on the Transverter to panelboard and lamps. No. 14 or No. 12 size wire may also be used to connect F on Transverter to the F on the Field Regulator in panel board.

The Transverter is a motor generator with the motor below and the generator above, the two being built into one unit.

The shaft of the generator is supported at its upper end in a radical ball bearing, its lower end taking half of a coupling, the other half of which is located at the top of the motor shaft. The shaft of the motor is supported by two radical ball bearings, top and bottom, and a ball thrust, which takes the combined weight of both rotor and armature.

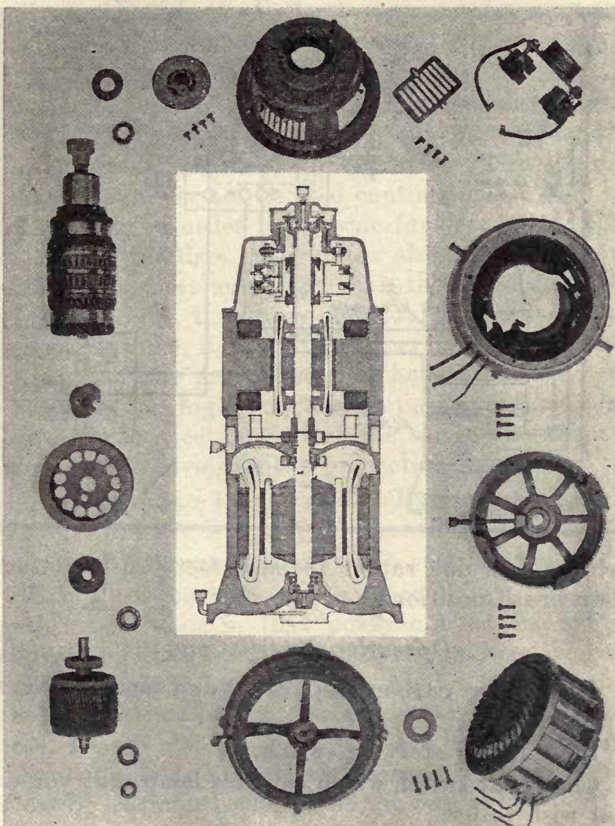
The coupling is so constructed as to carry a centrifugal fan which provides ventilation from above and below, discharging the air out of openings in the side of the unit.

Grease cups are provided for each of the bearings, the latter being enclosed in dust-proof housings.

The driving unit is a simple, two or three phase induction motor of ample capacity, running very close to constant speed regardless of load.

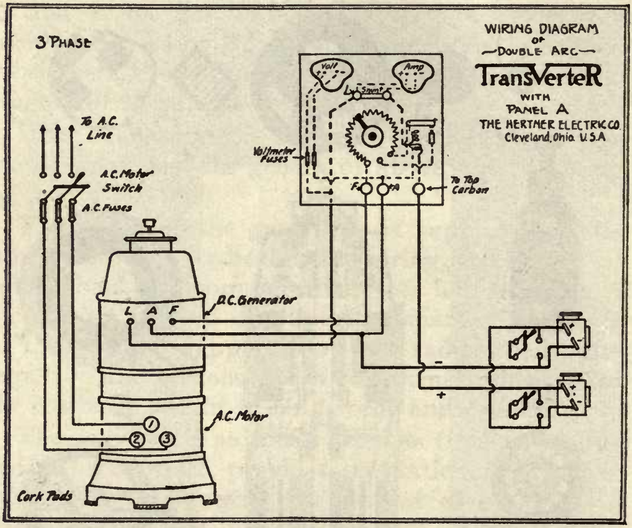
The generator is of the constant current type. The design is bipolar, which lends itself most readily to constant current characteristics as shown in the curve.

The field winding is shunt with interpole windings for commutation. The brushes and interpoles are so positioned relative to the main poles as to get a practically constant current over a wide range of voltage, which, in the double arc machine, reaches from 50 to approximately 115 volts. The position of the



Parts Making Up the Transverter

brushes on the commutator should never be shifted by rocking them, as this will change the entire characterization of the machine. If any sparking de-



velops, it is due rather to imperfect brush contact than brush position.

Operating Instructions

Have lamp carbons separated and lamp switches open.

Close motor starting switch.

Close that switch which controls lamp that you do not wish to use.

Permit the generator voltage to build up before attempting to strike the arc, then strike the carbons together quickly and lightly, separating them immediately to about 1-16 of an inch, gradually increasing the separation as the carbons heat up until a proper length of arc is reached. (Note: 55 volts will then show on the Voltmeter, provided proper size carbons are used and they are set at correct angle.)

Adjust for amperes desired by means of the Field Regulator in panel. (Note: The Regulator provides means of obtaining more amperage from the Transverter than its rated capacity. This greater amperage should not be used continuously. It is intended only in order to provide for very dense films or colored pictures. Regulator also provides means of obtaining less amperage than the rated capacity of the machine, thus providing for films that do not require so much light. If the operator will take advantage of the provisions that have been made for obtaining the high and low amperage, he will improve the projection and at the same time effect a considerable saving in the projection light bills.)

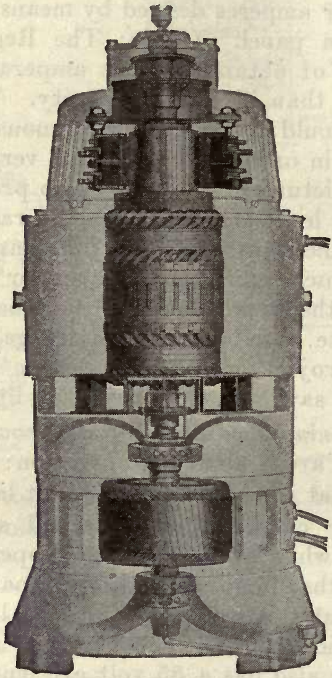
For Obtaining Two Arcs Simultaneously—Assuming that one arc is alreay in operation:

Adjust that arc to about a 55 volt length;

Bring the carbons of the second arc lamp together and while in that position open the switch controlling that lamp, then slowly separate the carbons to about 1-16 of an inch, gradually increasing the separation as the carbons heat up until this second lamp also has a 55 volt arc length. (Note: The Voltmeter on the panel board will then be indicating combined voltage of the two arcs.)

To discontinue the use of either arc, merely close switch controlling that lamp.

Note: If operator will follow the above instructions carefully, he can heat up the carbons in the second lamp or burn in a new trim of carbons without disturbing the arc of the other lamp. The two arcs can be used simultaneously for dissolving the pictures.



Phanton View of Transverter

General Care

Keep the machine clean.

Keep the commutator clean (but do not use sand or emery paper on it). If it becomes dirty, hold a pad of coarse canvas or cheese cloth against its surface while running, and when free of dirt wipe the surface with a clean cloth pad that is slightly moistened with pure vaseline.

Do not permit the carbon brushes to become too short, as disastrous sparking will result. A new set of carbon brushes should be put in before the old ones are completely worn out. When putting in new brushes it is well to first put in two, one in each holder at opposite ends of the commutator, then as soon as they are worn into a perfect fit to the surface of the commutator, replace the remaining old brushes with new ones.

The machine has ball bearings and they require a very small amount of lubrication.

The three grease cups on the machine should each be given one turn twice each week. If this is done these grease cups will require refilling once each thirty to forty days.

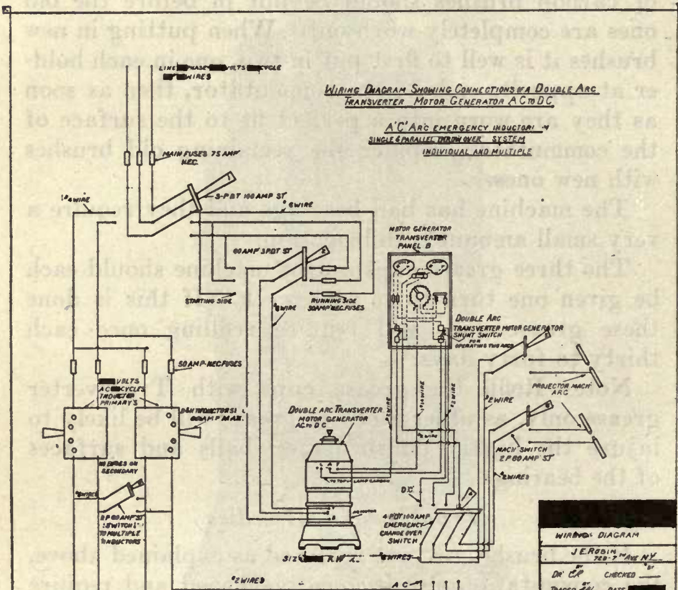
Note: Refill the grease cups with Transverter grease only, as other kinds of grease will be likely to injure the highly polished steel balls and surfaces of the bearings.

Troubles and Remedies

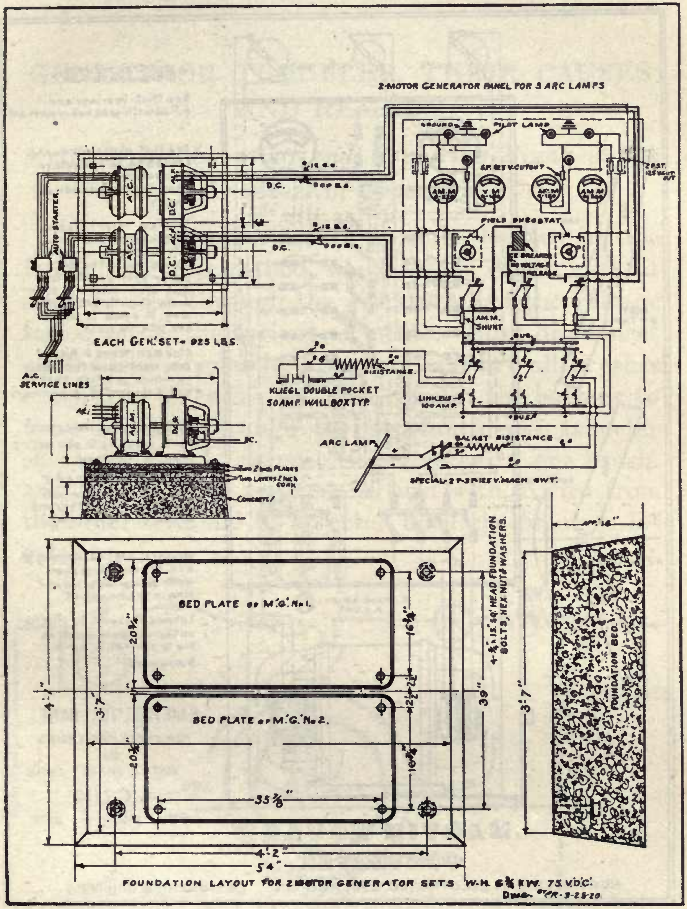
If the brushes are not replaced as explained above, the commutator may become blackened and require attention either by the application of a stone, or, in severe cases, it may require the removal of the armature so as to turn the commutator in a lathe.

Should the bearings become dry or an improper lubricant be used, it may cause the destruction of a bearing and require its replacement.

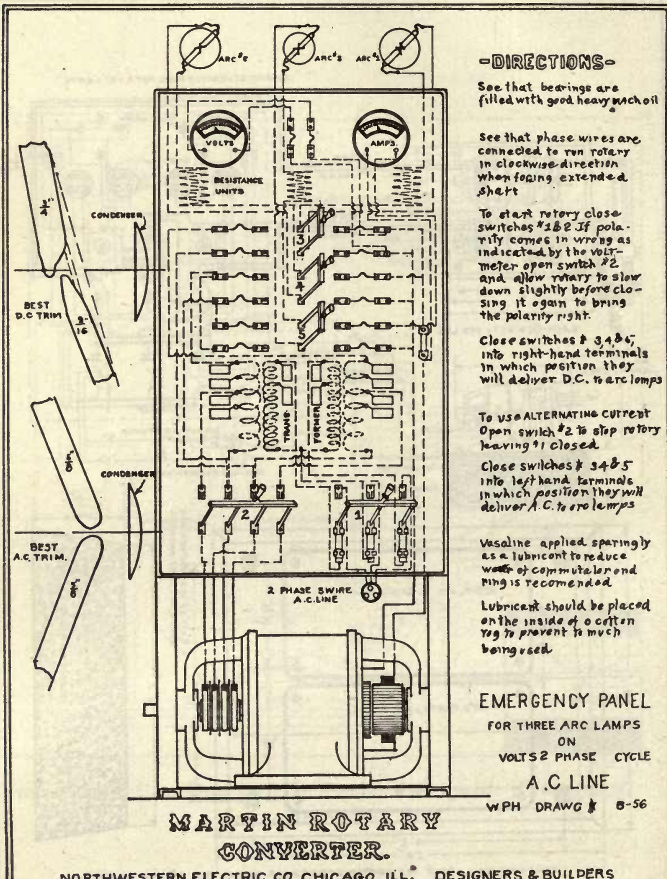
In case it is necessary to have any repair parts or supplies, order these direct from the factory, giving the serial number on the name plate of the machine.



Connections of a Double-Arc Transverter, with Emergency Inductor System



Wiring Diagram For Two Motor Generators and Control Switchboard, Two Projectors and One Spotlight, Permitting Single or Dual Operation of Motor Generators. J. E. Robin.


ARC #3
ARC #2
ARC #1
VOLTS
AMPS.
RESISTANCE UNITS
CONDENSER
CONDENSER
3/4"
BEST D.C TRIM
9/16
5/8
BEST A.C. TRIM.
5/8
3
4
5
TRANS-
FORMER
2
1
2 PHASE 5 WIRE A.C. LINE
-DIRECTIONS-
See that bearings are filled with good heavy mach oil
See that phase wires are connected to run rotary in clockwise direction when facing extended shaft
To start rotory close switches #1 & 2 If polarity comes in wrong as indicated by the voltmeter open switch #2 and allow rotary to slow down slightly before closing it again to bring the polarity right.
Close switches # 3, 4 & 5 into right-hand terminals in which position they will deliver D.C. to arc lamps
To use ALTERNATING current Open switch #2 to stop rotory leaving #1 closed
Close switches # 3 4 & 5 into left hand terminals in which position they will deliver A.C. to arc lamps
Vasaline applied sparingly as a lubricant to reduce wear of commutator and ring is recomended
Lubricant should be placed on the inside of a cotton rag to prevent to much being used
EMERGENCY PANEL
FOR THREE ARC LAMPS
ON
VOLTS 2 PHASE CYCLE
A.C LINE
WPH DRAWG # B-56
MARTIN ROTARY CONVERTER.
NORTHWESTERN ELECTRIC. CO. CHICAGO. ILL. DESIGNERS & BUILDERS

GENERTAOR TROUBLES, THEIR CAUSES AND REMEDY

Methods for Locating and Repairing Break in the Armature of Generator

A break in an armature must be located by the fall of potential method, which means that a current must be sent through the armature and the voltage tested across the various segments. First disconnect all the leads from the armature and lift all brushes except one on each pole, then connect the battery to these brushes through the resistance and ammeter shown in Fig. 1, connect the detector to one brush, and then to each segment in turn with a wire from the other terminal of detector until the break is located.

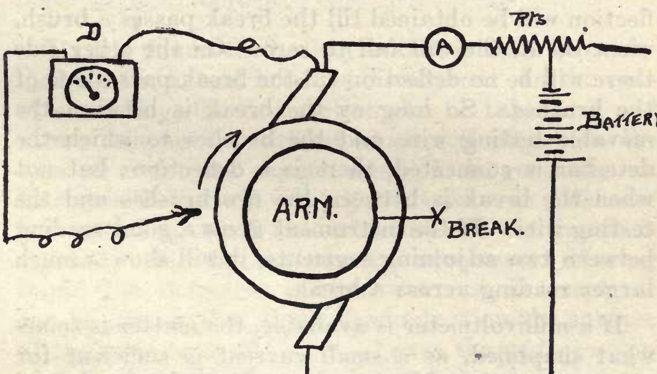


FIG 1.

If the two wires from the detector are connected to the segments that the brushes are standing on, a deflection will be seen caused by a fall of voltage through the coils. If we gradually draw the moveable wire over the segments towards the other brush, the deflection will gradually fall to zero, providing it is on the side on which the break does not occur (Fig. 1). If, however, the wire is drawn over the segments on the other side, the deflection on the instrument will remain constant until the failing segment is reached, when the deflection will drop to zero as the wire passes over the break.

Instead of moving the testing wire around the commutator, a course that might not always be convenient, it could be held stationary against the commutator, say a few segments from one of the brushes, and the armature gradually pulled around till the break appeared.

In this case on the unbroken side a constant deflection will be obtained till the break passes a brush, when the needle will fall to zero. On the other side there will be no deflection till the break passes one of the brushes. So long as the break is between the movable testing wire and the brushes to which the detector is connected, there is a deflection; but not when the break is between the fire brushes and the testing wire. If the instrument gives a good reading between two adjoining segments, it will show a much larger reading across a break.

If a millivoltmeter is available, the matter is somewhat simplified, as a small current is sufficient for testing, such for instance as the current taken by an incandescent lamp. If, therefore, the armature be connected to a source of supply through a lamp, a millivoltmeter will give a good deflection across a break. Millivoltmeter is the instrument used as a shunted ammeter in conjunction with various law resistances called shunts; when used as a millivoltmeter in the manner above described, it is used alone, the armature itself taking the place of the shunt (Fig. 2).

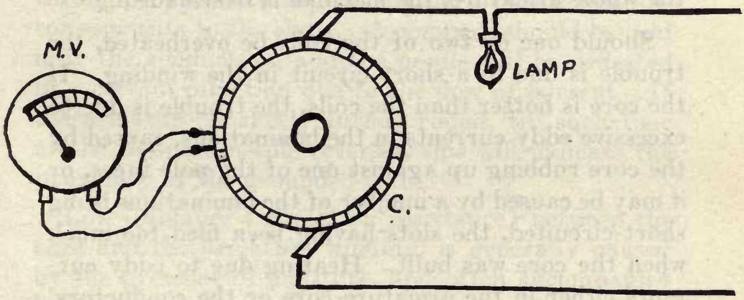


FIG. 2.

Having found the broken section it must be examined till the actual break is discovered. In the case of a winding, the bad section can be taken out and a new one put in without much difficulty. In the case of a formed wound drum, it is generally an inaccessable bottom wire that breaks. In this case it is usual to strip the armature till the break is reached; this is not always necessary. Having found the defective section, cut out as much as can be got at, that is the conductors on the surface of the core or in the slots. Leave the end crossing wires in, but with the ends separated and rewind the section with the end crossings on top of the others.

Overheating the Armature

Several causes will cause overheating of the armature, the most common being—overload, grounds, eddy currents in the core, eddy currents in the conductors, short-circuit in the coils, sparking at the commutator, heat conducted from the bearings, low insulation. If the excessive heating is uniform over the whole armature, the machine is overloaded.

Should one or two of the coils be overheated, the trouble is due to a short circuit in the winding. If the core is hotter than the coils, the trouble is due to excessive eddy currents in the laminations, caused by the core rubbing up against one of the pole faces, or it may be caused by a number of the laminations being short-circuited, the slots having been filed too much when the core was built. Heating due to eddy currents either in the armature core or the conductors, cannot be remedied by the projectionist, the maker of the machine should be immediately notified. The test is to run the generator on open circuit and take note of the rise in temperature. To test for a ground in the windings, first disconnect the generator from the circuit, and then run it up to normal speed. Using an ordinary test lamp, touch the opposite brushes to make sure you have the voltage.

Then connect the lamp terminals between the generator frame and the poles. Should there be a ground the test lamp will either glow or light. The cause of the ground should then be located and removed.

Locating Ground Coil

To locate a grounded coil is a difficult job, and should not be undertaken by anyone who is not familiar with electrical apparatus.

The armature should be removed from the field and set on trestle, a current (not to exceed the normal current of the dynamo) should be passed through the armature from any one of the commutator segments to the shaft. A compass should be held near the conductors, and the needle will be deflected in a certain direction due to the flow of current. If the armature is slowly turned round, till such time as the compass needle reverses, this will indicate the proximity of the grounded coil.

Low insulance (insulation resistance) between the core and the armature winding, is generally caused by the presence of moisture, and often accompanied by vapor arising from the armature. This can be remedied by baking the armature in an oven at a temperature of about 200° F, or by running the machine unloaded for a few hours and sending a small current round the windings.

The short circuiting of the coils is generally accompanied by heavy sparking and a smell of burning may be caused by copper dust, oil on bits of solder lodged between the commutator arms.

Locating Short-Circuited Coil

To locate a short-circuited coil, use the same method to locate break in armature. It is best to test between each pair of segments, remembering that the readings will all be alike when connected across the good coils, and that a variation in the reading points to a fault.

The remedy for a short circuited coil is to strip the damaged parts and rewind.

A temporary repair job can be accomplished by disconnecting the short circuited coil from the commutator arms, and then bridging the arms, thus cutting out the defective coil.

Should the short circuiting of the coils be due to copper dust, oil, etc., between the commutator arms, all that will be necessary will be to dislodge the foreign substance.

When a generator is overloaded, the temperature of the armature will rise, and heavy sparking of the brushes will also result. If the machine is run without removing the overload, the insulation of the armature may be destroyed.

Overheated Bearings

A hot bearing may result from one or more of the following causes: Insufficient lubrication, faulty lubrication, grit or other foreign matter in the bearings; armature not centered with respect to pole pieces; side pull due to magnetic pull on armature; end pressure of collar against the bearing—due to machine being out of line, with its driving shaft, or to want of alignment in engine; to a bent armature shaft; shaft rough or cut, etc., etc.

Only the best of oil, free from sediment and grit should be used for lubrication, the ordinary machine oil supplied and used on the projector, is too thin for this class of work, all the oil cups should be kept clean and filled, the oil rings should be watched to see that they carry the oil up to the shaft.

When the heating of a bearing is due to the presence of dirt or grit, it should be cleaned with some thin oil or kerosene. If kerosene is used do not forget to use a good lubricant directly after the cleansing.

The bearing caps should just be tight enough to run freely, without any side play. If a bearing is too tight the oil cannot get through as the oil passage remains full. The same thing occurs if the oil passages become choked with dirt or grit.

Do not tighten up the bearing caps with pliers, as sufficient pressure can be brought to bear with the finger and thumb. After tightening up the caps the armature should revolve freely, and when in motion the armature should come gradually to rest. Should the armature stop quickly the bearings are too tight.

A bent shaft will cause the armature to rub pole pieces, and thus produce sparking, vibration and overheating. To overcome this it will be necessary to remove the armature from the machine and have the shaft straightened in what manner is most handy. It may be found necessary to withdraw the shaft from armature before this can be accomplished.

A rough shaft may be caused by dirt, grit or overheating. The roughness, if not excessive, can be taken out by the use of a little emery cloth, but care should be taken to remove all grit and filings when the job is finished. If the roughness is so great that it cannot be taken out with the use of emery cloth, it will be necessary to remove the armature, and smooth up the shaft in a lathe, using a very fine file and emery cloth.

Noise in a generator can be laid to one of the following causes: Bent or broken shaft; armature out of balance; brushes grinding commutator; armature hitting pole pieces; loose bearings. All screws and bolts should be periodically gone over and any loose one tightened. If the noise is due to the armature not being properly balanced, the makers of the machine should be notified, as this is due to faulty construction of the generator.

A grinding or squeaking noise from the brushes can sometimes be stopped by the application of a very little vaseline to the commutator. If, however, the noise continues, the brushes should be removed and examined to see that a "hard place" has not developed. Should this be the case, the brushes should be filed down past the "hard place" and then replaced in the holders.

In the event of a short-circuit a fuse would naturally blow, and all generators should be fused up as near the terminals as possible.

A series-wound generator would spark and pull the engine up. It would not give any current to the arc.

A compound-wound generator would spark and show a drop in voltage.

A shunt-wound generator would lose its field and would not excite till such time as the short was removed.

INSTRUCTIONS FOR THE INSTALLATION OF THE "IMSCO" 1 K. W. MOTION PICTURE PROJECTING AND 32 VOLT INCANDESCENT LIGHTING PLANT

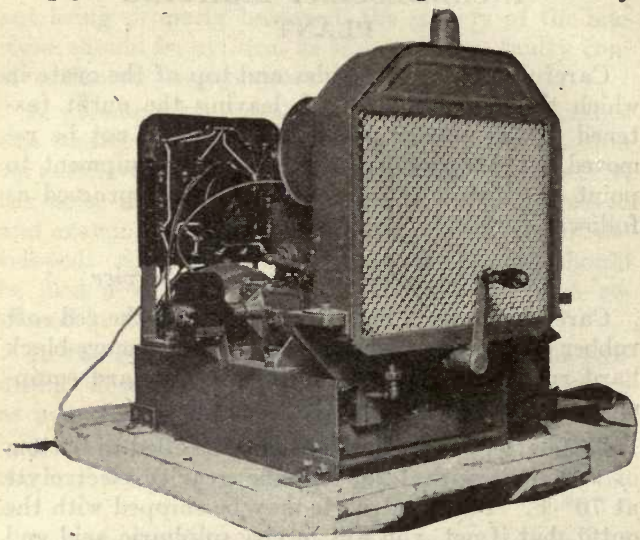
Carefully remove the sides and top of the crate in which the engine is packed, leaving the outfit fastened to the wooden skids, which should not be removed. Transport Engine and entire equipment to point at which it is to be used and then proceed as follows:

Prepare Storage Battery for Service

Carefully unpack battery, and remove the red soft rubber nipples and discard them. Next remove black hard rubber vent plugs, which are standard equipment, and remain on battery in service.

The battery cells should at once be filled to bottom of vent hole with 1.285 specific gravity electrolyte at 70° F. This electrolyte may be shipped with the outfit, but if not, you will receive sulphuric acid and distilled water separately and you may proceed to mix the electrolyte as follows:

Pour a quantity of distilled or pure rain water into a clean wooden container. Do not use a metal container for either water, acid, or electrolyte, or the electrolyte will be of no use. Next pour very carefully into the water enough sulphuric acid to bring the specific gravity of the mixture to 1.285 by the hydrometer. You will find the hydrometer with the outfit and to adjust it for service, unscrew the tube carefully, and remove the package in the glass tube. Remove the cardboard from the hydrometer scale, replace it in the glass tube, and screw the rubber tube back in place again. To test the electrolyte simply draw some of it into the glass tube and hy-



Imsco Engine and Generator

drometer will show the specific gravity reading. Always remember that after testing battery cells in this manner the electrolyte taken out should be returned to the cell after reading is taken. Before testing the new electrolyte, thoroughly stir it to make sure it is well mixed and should you find that you have added too much sulphuric acid and the reading is too high, add distilled water until the reading is 1.285. Never pour water into sulphuric acid (pure) or you will likely be a fit subject for the hospital. Always pour the acid into the water. Also never stir the electrolyte with anything but a clean wooden stick or mixture will be ruined.

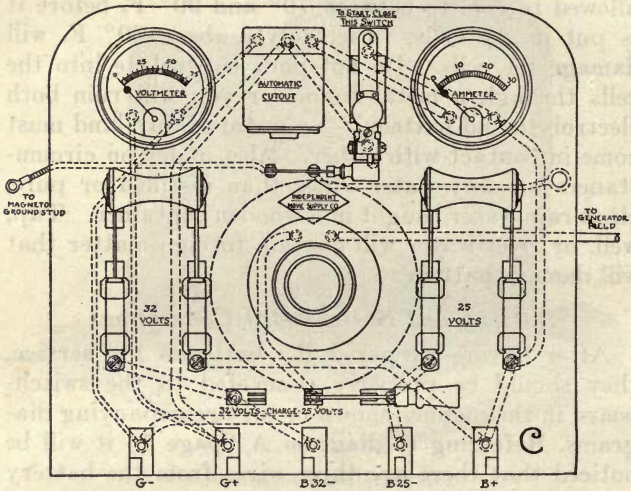
When sulphuric acid is poured into water the temperature of the mixture will be raised by the chemical action to a very high degree and it should be allowed to cool to between 70° and 90° F. before it is put in the cells. Electrolyte above 90° F. will damage the cells. Do not pour electrolyte into the cells through a metal funnel or you will ruin both electrolyte and battery. No metal of any kind must come in contact with either. Also under no circumstances use any water other than distilled or pure, clean rain water caught in a wooden container. Tap, well, or river water will contain foreign matter that will damage battery.

Battery and Switchboard Connections

After having prepared the batteries for service, they should be properly connected to the switchboard in the manner shown in the accompanying diagrams. Referring to diagram A (page 5) it will be noticed that there are three wires from the battery to the three right hand terminals on the bottom of the switchboard. It is important that the connections be made as shown and to prevent confusion the three lugs on the end of the three wires supplied, have different irregular surfaces, making it impossible to attach any of them to the wrong terminal.

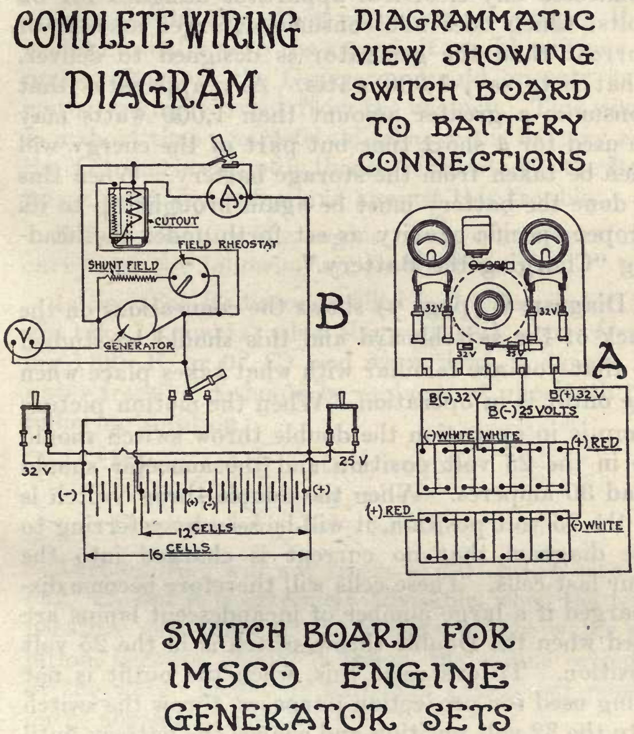
The batteries are shipped in two units of eight cells each and these units must be connected in series, as shown in the diagram, with the short wire supplied for this purpose, and in the exact manner shown. That is to say, one end of the short wire must be connected to the white, or — terminal of one set of cells

FRONT VIEW OF SWITCH BOARD
SWITCH BOARD FOR
IMSCO ENGINE
GENERATOR SETS



and the other end of the wire to the red, or + terminal of the battery, the second wire to the white, or — terminal of the twelfth cell of the battery, and the third wire to the other white — terminal at the last cell of the battery. See that all connections of all the cells are tight. After the batteries have been filled with electrolyte and connected as shown they are ready for charging.

Diagram B (page 5) shows the complete wiring diagram and it will be seen that the right hand switch, because it is connected across only 12 cells of the battery, delivers current at 25 volts and this



switch only should be used for the Motion Picture T29, 30 ampere lamp. Do not connect this lamp to the other switch or it will immediately burn out. The left hand switch, because it is connected across the entire battery, or 16 cells, will deliver current at 32 volts and this switch therefore should be used for incandescent lighting of the huts or buildings, or wherever light is needed. To this switch also may be connected any electrical apparatus designed for 32 volts, which does not consume a larger amount of current than the generator is designed to deliver. That is to say, 1,000 watts. Any apparatus that consumes a greater amount than 1,000 watts may be used for a short time but part of the energy will then be taken from the storage battery. When this is done the battery must be again brought up to its proper specific gravity as set forth under the heading "Charging the Battery."

Diagram C (page 4) shows the connections on the back of the switchboard and this should be studied so that you are familiar with what takes place when the outfit is in operation. When the motion picture lamp is in operation the double throw switch should be in the 25 volt position and the ammeter should read 30 amperes. When the double throw switch is in the 25 volt position, it will be seen by referring to the diagram that no current is charged into the four last cells. These cells will therefore become discharged if a large number of incandescent lamps are used when the Double throw switch is in the 25 volt position. To overcome this, when the outfit is not being used for projection purposes, throw the switch into the 32 volt position and charge the battery until all the cells come up to the required specific gravity. (See "Charging the battery.") Always have switch in 32 volt position when using incandescent lamps only, or any 32 volt apparatus.

At the top of the switchboard, in the center, will be seen the automatic cutout which automatically disconnects the battery from the Generator should the Engine for any reason stop. The reason for this piece of apparatus is that, should the gasoline give out or should any other circumstance happen that would normally stop the engine, it would continue to operate because the Generator would operate as a motor, taking current from the battery. This would in a short time completely discharge the battery and the Automatic cutout is therefore inserted in the Battery circuit as a safeguard against this trouble.

Before starting the engine observe and carefully carry out the following six instructions:

1. See that Radiator is filled with clean water (it will take 11 quarts) when the weather is above freezing (32° F. or 0° C) and when there is danger of water freezing it should be replaced at once with the following solution:

> Glycerine—2 parts by volume.
> Water—8 parts by volume.
> Denatured Alcohol—1 part by volume.

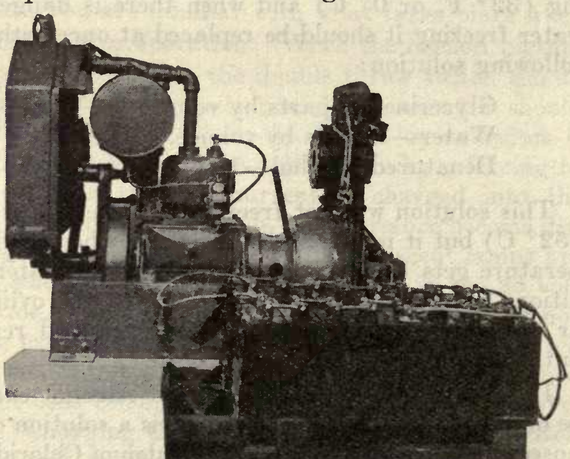
This solution will not freeze at 20° below zero F. (52° C) but it is extremely advisable, when the temperature gets below 0°.C., to draw off the water solution, because, should it freeze, the engine cylinder or the water jacket or both will crack and render outfit absolutely useless.

If for any reason Glycerine and Alcohol cannot be obtained, an excellent substitute is a solution composed of 4.2 lbs. of 75 per cent. Calcium Chloride to each gallon of water.

This solution would be about 31° beaume, or 1.27 specific gravity, which solution has a freezing point of about 55° C. or 23° below zero F.

Calcium Chloride is much easier to obtain than Glycerine and Alcohol, and it has the decided advantage in that it is much easier shipped.

2. Remove the handhole plate from one side of crank case of engine and pour in about one gallon of the engine oil that comes with outfit. When the proper amount of oil is in the crank case, the oil gauge on the left-hand side of engine bed will show about two-thirds full. When the weather is cold, however, the oil will be too heavy to immediately flow up into the gauge and will not do so until it becomes warm. If you place one gallon in the crank case as above set forth, you need have no apprehension. Replace plate and then fill bearing on Commutator end



Showing Battery Connections

of Generator with oil also. This bearing is a ring oiled bearing and once filled will require only intermittent filling unless oil is spilled out when engine is shipped around. The entire engine and bearings, other than the one mentioned, is lubricated by the splash system from the crank case.

3. See that Gasoline tank is filled with gasoline that has been strained. Any foreign matter in gasoline will clog up Carburetor or connections between it and the tank.

4. See that small needle valve on the bottom of Carburetor is open one and one-half turns. The best way to be assured of this is to first close it tight and then open it the required amount.

5. See that small lever on Breaker Box of high tension magneto is about one-half way down for starting and when the engine starts it should be pushed down (advanced) as far as it will go. This lever is the spark control lever and operates exactly the same as that on the steering post of an automobile. It is retarded (up) when starting, and advanced (down) when the engine is running. It is important that this lever be adjusted as set forth above, otherwise the engine will not operate at its proper speed.

6. See that electrical connections between magneto and spark plug and magneto and switchboard are tight. Loose connections will cause a poor spark and engine will not start.

After the above adjustments have all been made the engine is ready to start and you should proceed as follows:

1. Open small single blade switch on switchboard. This switch, when closed, short circuits the ignition system and stops engine. Therefore, the engine will not start until this switch is opened.

2. Press finger on button switch on circuit breaker on switchboard for a few seconds and the Generator will operate as a motor until the engine starts. After the engine comes up to speed, the Generator will generate current.

Should the engine not start after a few seconds, it may be due to any of the following causes:

1. In very cold weather gasoline, unless warmed, will not vaporize and it is extremely difficult to start an engine under these conditions. When the temperature is low and you experience this difficulty it is advisable to draw off part of the water and heat it. Hot water around the jacket will vaporize the gasoline, and engine will start without further trouble.

2. Spark plug points may be too far apart or too close together. Remove spark plug with wrench supplied with outfit and after cleaning points set them not more than 1-32″ apart, replace plug tightly in cylinder head and connect wire.

3. Cylinder may not be receiving gasoline from carburetor. This may be due to some foreign substance clogging the pipe between the gas tank and carburetor or clogging the small intake valve controlled by lever at bottom of carburetor. To remedy the former, shut off gasoline at valve on gas tank, remove pipe and see that it is clear; also suck on, not blow through pipe connection on carburetor. The chances are very remote that the second fault is present and it can be removed by holding hand over air

intake on carburetor. The suction from the cylinder will clear the passage.

4. *Too Much Gasoline.* If the cylinder receives too much gasoline, the mixture will be too "rich" and will not ignite. The gasoline flow is controlled by small valve lever at bottom of carburetor, and this should be open about one or one and a half full turns. The proper amount of opening, however, will vary with temperature and it is right when engine is running with load at its normal speed (about 1,250 revolutions per minute).

5. *Too Little Gasoline.* If too little gas is being fed to cylinder the mixture will be too "thin" and will not ignite. To determine this, place hand over air intake of carburetor. Do not interfere with gasoline intake valve, if engine continues to run normally after starting. In this case, all that was necessary was to get a fairly heavy charge of gas in cylinder for starting. Do not keep air intake closed for more than a dozen or so revolutions of engine or you will flood the cylinder with pure gasoline and it will not ignite.

Seven times out of ten, after engine has once been run and will not start again, there is no gasoline in tank. A gasoline engine will not operate without gasoline. Do not look in gasoline tank with match.

6. *Platinum Points in Magneto Breaker Box May Be Dirty.* To remove cover of breaker box, slide the spring that holds it over to one side. You can then lift off the cover. Clean breaker points with clean rag. Do not scrape them.

When the engine runs smoothly, take a piece of fine sandpaper No. 00 that is shipped with the outfit, and hold it on commutator, while it is revolving, until commutator is thoroughly polished. Do not use emery or emery cloth. It will ruin commutator and break down insulation. Do not be afraid of a shock with this outfit. It cannot generate more than 32 volts and it cannot be felt. You can touch any part, any time, with both hands, without danger.

It is necesasry to keep commutator very clean because of the low voltage, and any grease thereon acts as insulation and machine will not generate current. See that brushes make good contact with commutator but do not have tension too tight; just enough tension on springs to hold brushes in place is all that is necesasry. Any greater amount will cause the brushes to wear a rut in comutator and impair its efficiency.

With this outfit you have a standard 16 cell, 32 volt, 80 ampere hour Willard Storage Battery and the following instructions and information apply particularly to this type of battery. You should, however, be thoroughly familiar with the practical operation of storage batteries in general and by reading carefully the storage battery data under the heading "General Storage Battery Data" contained in this article, you will then be in a far better position to handle this apparatus.

Charging the Battery

As soon as the proper connections have been made and the engine is running normally and the batteries properly filled with the electrolyte they must be put on charge at half the finish rate stamped on the name plate. If this rate is not stamped on plate it is safe to assume that the finish charge rate is about five or six amperes and with the amount of current showing on the ammeter (no lights burning) the battery should be charged continually until the specific gravity of the electrolyte stops rising. At this point all the cells should be "gassing" freely and the voltage should read at least 2.4 volts per cell. Test voltage with voltmeter supplied with outfit. This voltmeter is a low voltage instrument and no more than one cell at a time should be tested with it. Remember there are 16 cells to the battery and you will get a voltage reading from any one of them by placing one terminal of the voltmeter on the positive terminal of the other cell and the other meter terminal on the negative cell battery.

The amount of current supplied by the generator may be varied at will up to 31.25 amperes by increasing or decreasing the resistance in series with the field of the generator. This is done by turning the black rheostat control wheel on the switchboard. Arrows on this wheel show which way to turn it to increase or decrease current.

If during the charge the temperature of the electrolyte in any one cell exceeds 100° F. the current from the generator must be reduced until the temperature falls below 90° F. This will necessitate a longer time to complete the charge, but must be strictly adhered to.

When the cells are completely charged the specific gravity of the electrolyte in each cell should be between 1.280 and 1.300. If above this (1.300) remove a little electrolyte with the hydrometer syringe and add a little distilled water while the battery is still charging (in order to thoroughly mix solution) and after three hours, if the electrolyte is within the limits specified, the battery is ready for use. If the specific gravity of the electrolyte is below 1.280 while the voltage of the cells is about 2.4 (after first charge only) remove a little electrolyte and add the same quantity of 1.400 specific gravity electrolyte. Leave on charge as before. You cannot test 1.400 electrolyte with your hydrometer, because the scale does not read that high, but you can mix 1.400 specific gravity electrolyte by taking seven parts, by volume, of pure sulphuric acid and pouring it into nine parts of volume of distilled water. The acid should be poured into the water and allowed to cool below 90° F. before being placed in battery cells.

The standard vent plugs are now inserted and the battery is ready for service.

After this preliminary charging you should experience no difficulty at any time with the battery, inasmuch as it is, when properly connected to the switchboard, "floated" across the generator terminals and when the generator set is being used for incandescent lighting purposes, that is to say, for lighting up the huts, etc., the ammeter should show about one ampere for every 25 watt lamp in use and about one and one-quarter amperes for each 40 watt lamp in use. In this way a slight amount of additional current will be charged into the battery and it will therefore remain continually charged.

Discharging and Recharging

The lights may be operated from the storage battery without running the engine, and in this case the rate of discharge will be according to the following table:

Delivering						hours
1 ampere	battery	will	supply	same	for	80
2 amperes	"	"	"	"	"	40
4 amperes	"	"	"	"	"	20
8 amperes	"	"	"	"	"	10
10 amperes	"	"	"	"	"	8
12 amperes	"	"	"	"	"	$6\frac{3}{4}$
20 amperes	"	"	"	"	"	4
30 amperes	"	"	"	"	"	2 2-3

and so forth. The number of amperes being taken from the battery may be found by multiplying the number of lamps in use by the wattage of the lamp and dividing the result by 32, which is the battery voltage.

For example: You are using 8 twenty-five watt lamps and four forty watt lamps.

$8 \times 25 = 200$ watts
$4 \times 40 = 160$ watts

Total 360 watts = lamp consumption in watts

$$\frac{360}{32} = 11\frac{1}{4} \text{ amperes.}$$

By referring to the preceding table it will be found that the battery would discharge 12 amperes for $6\frac{3}{4}$ hours and by using the above formula you can work out the solution for any condition.

It is not advisable to completely discharge battery under any circumstances because heavy discharge rates maintained for any great length of time will injure the battery.

When the lights are operated from the storage battery without the engine running, the battery should be charged later and specific gravity readings taken of the electrolyte until the hydrometer shows a reading of from 1.280 to 1.300.

The large incandescent lamp supplied for the motion picture machine consumes 30 amperes at 25 volts and is known as the Edison T 29 Monoplane Filament Projection Lamp. When using this lamp the leads from the lamp house must be connnected to the 25 volt switch on the switchboard. Under no circumstances connect it to the 32 volt switch or lamp will immediately burn out. This lamp may be operated for a short time, about 2 hours, from the battery, without the engine running. This, however, should only be done in case of emergency and the batteries should be charged as soon as possible afterwards. With the engine running and the moving picture 30 ampere lamp in operation, the ammeter on the switchboard should read 30 amperes. The lamp then is consuming the current supplied by the generator and the storage battery in this case is simply floated across the line, keeping the lamp voltage normal. Do not try to operate lamp from generator without storage battery connected to switchboard.

In cases of great emergency, where it is impossible to take the engine, the batteries may be used alone to run the picture machine and lamps for a short period. Care should be taken to connect the moving picture lamp wires to the twelfth cell terminal of battery and the lamps used for lighting purposes to the 32 volt terminal at the sixteenth or last cell.

As before stated, the battery alone, under no circumstances, should be used in connection with the motion picture lamp for a longer period than 2 hours because the battery will become overdischarged. The amount of current still in battery can be determined by testing the electrolyte with the hydrometer and it should not be allowed to drop below 1175, after which it should be charged from the generator at from 10 to 15 amperes until the specific gravity of the electrolyte reaches about 1265 and then the amperes should be reduced to about 5 and the charge continued until the electrolyte reading is between 1275 and 1300.

Regulating Engine to Procure Proper Amperage. The amount of current delivered by the generator is in direct proportion to the amount flowing through the shunt field of the machine. It may be varied up to 31¼ amperes by adjusting the rheostat control wheel on the front of the switchboard. The generator will not deliver its full capacity unless the engine is running at its normal speed of 1250 revolutions per minute. Should the engine be running too slow with generator delivering current the carburetor on the engine may be delivering too much or too little gasoline and this, as previously stated, may be adjusted by means of the small needle valve lever on the bottom of the carburetor.

Care of the Battery

In the proper care of a storage battery if the following things are remembered you will escape 75 per cent of your battery troubles:

First—Test the specific gravity of all cells with a hydrometer two or three times a month. If any of the cells are below 1200, the battery is more than half discharged, and it should be charged with the ammeter on the switchboard reading 10 amperes, until the normal specific gravity is reached (1275 to 1300).

Second—Pure water must be added to all cells regularly and at sufficiently frequent intervals to keep the solution at the proper height. Add water until solution is one-half inch above top of plates.

Never let solution get below top of plates.

Plugs must be removed to add water, then replaced and screwed on after filling.

The battery should be inspected and filled with water once every week in warm weather and once every two weeks in cold weather.

Do not use Acid or Electrolyte, only pure water.

Do not use any water known to contain even small quantities of salts or iron of any kind.

Distilled water or fresh, clean rain water only should be used.

Use only a clean vessel for handling or storing water.

Add water regularly, although the battery may seem to work all right without it.

In order to avoid freezing of the battery, it should always be kept in a fully charged condition. A fully charged battery will not freeze in temperatures ordinarily met.

Electrolyte will freeze as follows:

Sp. gr. 1,150, battery empty, 20 above zero F.
Sp. gr. 1,180, battery 3/4 discharged, zero F.
Sp. gr. 1,215, battery 1/2 discharged, 20 below zero F.
Sp. gr. 1,250, battery 1/4 discharged, 60 below zero F.

Therefore, it will be seen that there is no danger of the battery freezing up if it kept at a specific gravity of from 1250 to 1300 and it should be kept as near 1275 as possible. Under no circumstances should acid or electrolyte be added to the cells to bring them up to the required specific gravity. Nothing but pure water must be put in the cells after the battery has been once placed in commission and the specific gravity must be kept up by charging only.

General Storage Battery Data

A storage battery, secondary battery, or accumulator, as it is variously called, is an electrical device in which chemical action is first caused by the passage of electric current, after which the device is capable of giving off electric current by means of secondary reversed chemical action. Any voltaic couple that is reversible in its action is a storage battery. The process of storing electric energy by the passage of current from an external source, is called charging the battery; when the battery is giving off current, it is said to be discharging. A storage battery cell has two elements or plates, and an electrolyte. The two plates are usually made of the same material, though they may be of two different materials. The material used in the construction of both plates of battery furnished is lead.

Polarity.—The terms positive and negative are employed to designate the direction of the flow of current to or from the battery; that is, the positive plate is the one from which the current flows on discharge, and the negative plate is the one into which current flows on discharge. In a lead battery the positive plate, on which the lead peroxide is formed, has a comparatively hard surface of a reddish-brown or chocolate color, while the negative plate, which carries the sponge lead, has a much softer surface of a grayish color.

Electrolyte.—The electrolyte used with the lead type of battery is always a diluted solution of sulphuric acid. The specific gravity of the electrolyte when the battery is fully charged, varies from about 1.210 for stationary batteries to 1.300 for automobile ignition batteries and other portable batteries.

The proper specific gravity to use varies with the conditions, and the specific gravity may be found by the use of a hydrometer. When the cells of the battery shipped with this outfit are fully charged, the specific gravity of the electrolyte, as indicated by the hydrometer, should be 1275 to 1300 at 70 degrees F. The final density is the usual practice. None but sulphur or brimstone acid should be used. When diluting, the acid must be poured into the water slowly and with great caution.

Never Pour the Water into the Acid.—The specific gravity of commercial sulphuric acid is 1.835, and 1 part of such acid should be mixed with 5 parts (by volume) of pure water. Care should be taken that no impurities enter the mixture. The vessel used for the mixing must be a lead-lined tank or one of wood that has never contained any other acid; a wooden washtub or spirits barrel answers very well. The electrolyte when placed in the cell should come ½ inch above the top of the plates. Before putting the electrolyte in the cells, the positive pole of each cell should be connected to the negative pole of the next cell in the series and the whole battery of cells should be connected, through a main switch, to the charging source—the positive pole of the baattery to the positive side of the charging source, and the negative pole to the negative side. After adding the electrolyte the battery should be charged at once or at least inside of 2 hours. A little pure water should be added occasionally to the electrolyte to make up for evaporation, and a small quantity of acid should be added about once a year to make up for that thrown off in the form of spray or that absorbed by the sediment in the cells. Do not use anything but pure distilled water in storage batteries because any impurities such as those commonly found in tap or well water will in a very short time absolutely ruin the battery.

Test of Specific Gravity—The specific gravity of the electrolyte is the most accurate guide as to the state of charge of a lead-type storage battery. The test of the specific gravity is made by means of a hydrometer having a suitable scale for the type of cell to be tested. In all portable types of batteries, and ordinarily in vehicle batteries, it is usually necessary to draw some of the electrolyte from the cell in order to test its specific gravity with the hydrometer, which should have a scale reading from 1150 to 1300.

Charging—The normal charging rate is the same as the 8 hour discharge rate specified by manufacturers. The charge should be continued uninterruptedly until complete; but if repeatedly carried beyond the full-charge point, unneccessary waste of energy, a waste of acid through spraying, a rapid accumulation of sediment, and a shortened life of the plates will result. At the end of the first charge, it is advisable to discharge the battery about one-half, and then imemdiately recharge it. It is advisable to overcharge the batteries slightly about once a week, in order that the prolonged gassing may thoroughly stir up the electrolyte and also to correct inequalities in the voltages of the cells. If the discharge rate is very low, or if the battery is seldom used, it should be given a freshening charge weekly.

Indications of a Complete Charge—A complete charge should be from 12 to 15% greater in ampere-hours than the preceding discharge. The principle indications of a complete charge are: (1) The voltage reaches a maximum value of 2.4 to 2.7 per cell, and the specific gravity of the electrolyte a maximum of 1275 to 1300 per cell. If all the cells are in good condition and the charging current is constant, maximum voltage and specific gravity are reached when there is no further increase for¼ to ½ hour. (2) The amount of gas given off at the plates increases and the electrolyte assumes a milky appearance, or is said to boil.

Voltage Required—The voltage at the end of a charge depends on the age of the plates, the temperature of the electrolyte, and the rate of charging; at normal rate of charge and at normal temperature, the voltage at the end of the charge of a newly installed battery will be 2.5 volts per cell or higher; as the age of the battery increases, the point at which it will be fully charged is gradually lowered and may drop as low as 2.4 volts. All voltage readings are taken with the current flowing; readings taken with the battery on open circuit are of little value and are frequently misleading. After the completion of a charge and when the current is off, the voltage per cell will drop rapidly to 2.05 volts and remain there for some time while the battery is on open circuit. When the discharge is started, there will be a further drop to 2 volts, or silghtly less, after which the decrease will be slow. Cells should never be charged at the maximum rate except in cases of emergency.

Direction of Current—The charging current must always flow through the battery from the positive pole to the negative pole. If it is necessary to test the polarity of the line wires when no instruments are available, attach two wires to the mains, connect some resistance in series to limit the current, and dip the free ends of the wires into a glass of acidulated water, keeping the ends about 1 inch apart. Bubbles are given off most freely from the negative end.

Discharging—Heavy overdischarge rates maintained for a considerable time, are almost sure to injure the cells. The normal discharge rate should not be exceeded except in case of emergency. The amount of charge remaining available at any time can be determined from voltage and specific-gravity readings. During the greater part of a complete discharge, the drop in voltage is slight and very gradual; but near the end the falling off becomes much more marked. Under no circumstances should a battery ever be discharged below 1.7 volts per cell, and in ordinary service it is advisable to stop the discharge at 1.75 or 1.8 volts. If a reserve is to be kept in the battery for use in case of emergency, the discharge must be stopped at a correspondingly higher voltage. The fall in density of the electrolyte is in direct proportion to the ampere-hours taken out, and is therefore a reliable guide as to the amount of discharge.

Miscellaneous Points

Restoring Weakened Cells — There are several methods of restoring cells that have become low: (1) Overcharge the whole battery until the low cells are brought up to the proper point, being careful not to damage other cells in the battery. (2) Cut the low cells out of circuit during one or two discharges and in again during charge. (3) Give the defective cells an individual charge. Before putting a cell that has been defective into service again, care should be taken to see that all the signs of a full charge are present.

Sediment in Cells—During service, small particles drop from the plates and accumulate on the bottom of the cells. This sediment should be carefully watched, especially under the middle plates where it accumulates most rapidly, and should never be allowed to touch the bottom of the plates and thus short-circuit them. If there is any free space at the end of the cells, the sediment can be raked from under the plates and then scooped up with a wooden ladle or other non-metallic device. If this method is impracticable, the electrolyte, after the battery has been fully charged, should be drawn off into clean containing vessels; the cells should then thoroughly washed with water until all the sediment is removed, and the electrolyte should be replaced at once before the plates have had a chance to become dry. In addition to the electrolyte withdrawn, new electrolyte must be added to fill the space left by the removal of the sediment; the new electrolyte should be of 1.3 or 1.4 sp. gr. in order to counteract the effect of the water absorbed by the plates while being washed. If at any time any impurities, especially any metal other than lead or any acid other than sulphuric acid, gets into a cell, the electrolyte should be emptied at once and the cells thoroughly washed and filled with pure electrolyte.

Idle Batteries.—If a battery is to be idle for, say. 6 months or more, it is usually best to withdraw the electrolyte, as follows: After giving a complete charge, siphon or pump the electrolyte into convenient receptacles, preferably carboys that have previously been cleaned and have never been used for any other kind of acid. As each cell is emptied, immediately refill it with water; when all the cells are filled, begin discharging and continue until the voltage falls to or below 1 volt per cell at normal load, and then draw off the water.

*Putting Battery into Commission**—To put an idle battery into commission, first make sure that the connections are right for charging; then remove the water, put in the electrolyte, and begin charging at once at the normal rate. From 25 to 30 hour continuous charging will be required to give a complete charge.

Sulphating—Lead sulphate is practically an insulator. Some of this material is formed in all lead-sulphuric-acid storage cells on discharge and is reconverted to lead oxide or lead peroxide on recharging the cell. If present in excessive quantities, the sulphate adheres to the plates, especially the positive, in white soluble patches, preventing chemical action, increasing the resistance of the cell, and causing unequal mechanical stresses that may buckle the plates. The most frequent causes of sulphating are overdischarging, too high specific gravity of electrolyte, and allowing the battery to stand for a considerable length of time in a discharged condition.

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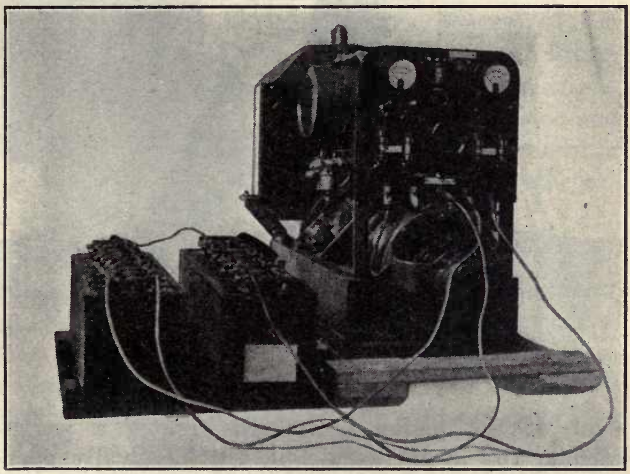
*This does not apply to battery received with this outfit because it has been fully charged before leaving the factory and still holds this charge because the electrolyte was drawn off after a complete charge and the cells hermetically sealed with the red rubber caps. After you commence charging as set forth in a previous paragraph it will take only a fraction of the time set forth in the above paragraph to bring the battery up to its full capacity.

Theory of the Engine

In order to be able to understand the machine, it will be necessary for you to have a rudimentary knowledge of what goes on inside the engine.

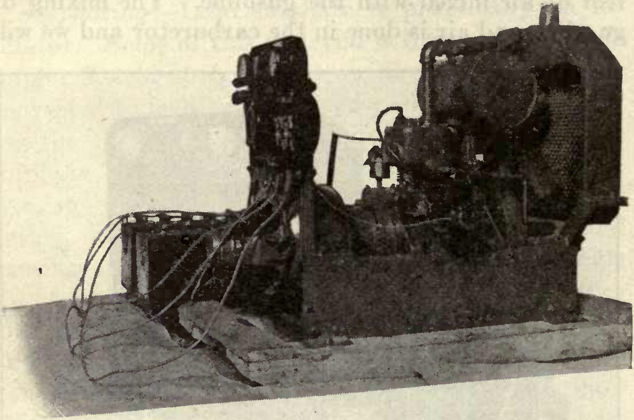
To begin: In order to have power we must use some heat agent—in this instance gasoline. Our 1 K. W. plant as usually operated consumes one pint of gasoline per hour and burns about 460 cubic feet of air mixed with the gasoline. The mixing of gasoline and air is done in the carburetor and we will



Switchboard Showing Automatic Cut-Out, Starting Switch, Voltmeter, Ammeter, Field Regulator, 25 and 32-Volt Switches

hereafter call the mixture of air and gasoline, Gas. This gas is explosive and can be ignited by an electric spark and with compression and proper ignition, will give power and turn the shaft as follows:

Referring to (Fig. 1, Plate H), we see the gas coming from the carburetor (G) through the valve (I), called the inlet valve, into the cylinder. The piston (P) is moving downward as shown by the arrow, it being at this time pulled downward by the connecting rod (R) which is pulled downward by the crank (A) on the shaft (S) which is (we will say) being revolved by the generator at first. The move-



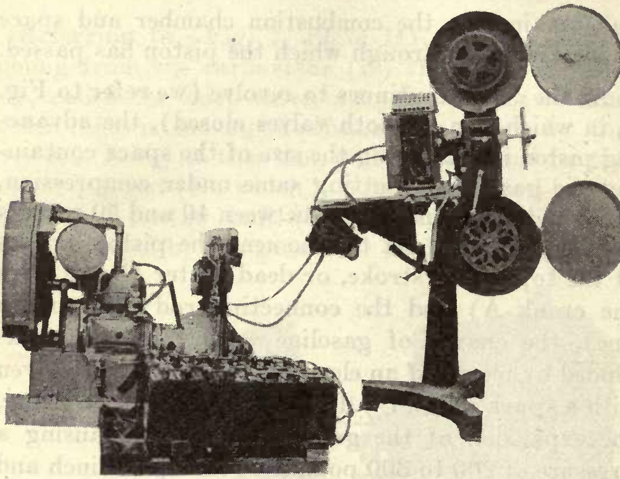
Side View Showing Bosch Magneto

ment of the piston downward creates a partial vacuum and at the same time the inlet valve opens and gas rushes through the carburetor and through the intake pipe (H) and from there past the valve (I) into the cylinder to fill this partial vacuum. The intake valve opens at the beginning of the stroke, or nearly that, according to the ideas of the designing engineer. At the bottom of the stroke the intake valve will close, and we then have a volume of gas, retained in the combustion chamber and space in the cylinder, through which the piston has passed.

As the crank continues to revolve (we refer to Fig. 2, in which you see both valves closed), the advancing piston is decreasing the size of the space containing the gas, hence putting same under compression, which in this engine ranges between 40 and 50 pounds per square inch. At the moment the piston arrives at the top of the stroke, or dead center (being when the crank A) and the connecting rod (R) are in line), the charge of gasoline vapor and air is exploded by means of an electric spark, generally given with a spark plug (U) described later. Upon firing, the expansion of the gas is very great, causing a pressure of 200 to 300 pounds to the square inch and thus forcing the piston downward again, as shown in Fig. 3, which is called the power stroke, or the explosion stroke.

We now have had the intake stroke, the compression stroke, and the power stroke. After the power stroke has arrived at the limit of downward movement, we may get rid of the burned gases in order to be ready for a fresh charge, and that is accomplished by the mechanical opening of the exhaust valve (E) the moment the piston is about to start upward, and the piston then pushes the gas out through this valve and through the pipe (M) into the muffler, or into the air if there is no muffler.

We have described the four cycles, each cycle being represented as we have seen, by intake, compression, power and exhaust strokes respectively.



The Spark Plug

A spark plug is a device so constructed as to make an electrical gap across which the electric spark jumps and is to be exposed to the gases in the cylinder, firing them as a consequence.

There are many kinds of spark plugs, the most universal probably being the same as used on this engine, there being an electrode, or wire, running down through the center of a porcelain core, this being surrounded by metal threaded parts which screw into the cylinder, and from which the central electrode is insulated by the porcelain. The end of the central electrode is brought to within a short distance of the extension of the outer metal shell on the exposed part of the spark plug inside the cylinder. One wire from the magneto is connected to this.

central electrode on top of the spark plug by means of the thumb nut thereon. The ground is through the base of the magneto to the engine, thereby completing the circuit, when the spark plug jumps across the gap between the point of the electrode and the extension of the metal case of the spark plug.

For magneto service these extremities should be adjusted to about 1-50 inch gap. If they are too wide apart there will be trouble in missing.

Be sure all wire connections are tight.

Magneto and Spark Plug Test

If at any time you wish to determine whether the magneto is firing properly, simply disconnect the wire at the spark plug, and holding the wire 1-8 inch from engine at any point, and see if the spark jumps across the engine in motoring or running.

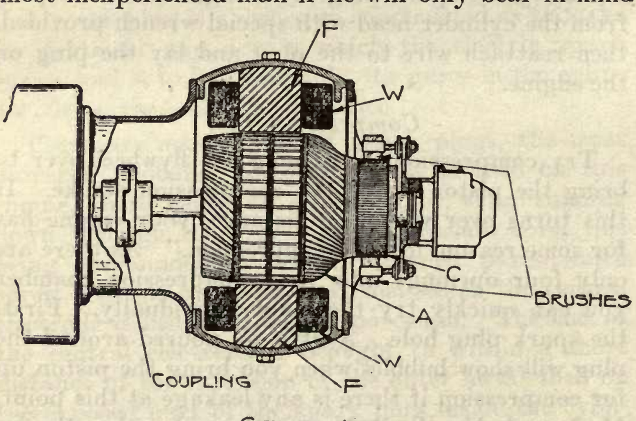
To try the spark plug for firing, remove the plug from the cylinder head with special wrench provided, then reattach wire to the plug and lay the plug on the engine.

Compression Test

Try compression by turning the flywheel over to bring the piston up on the compression stroke. If this turns over without resistance, your engine has for some reason 'lost its compression." As there are only four openings into your compression chamber you can quickly try these out individually. First, the spark plug hole. A little oil poured around the plug will show bubbles when you bring the piston up for compression if there is any leakage at this point. Most probably the leaking is through either the intake or exhaust valves. Unscrew the nuts on top of cylinder head and take off complete cylinder head and valves for examination. On both of these valves you will find slots on top in which you can use a screwdriver for turning the valves back and forth to work any deposit or carbon or foreign matter that may be preventing them from making a tight seat. If dirty, clean thoroughly with gasoline. With these tight, and still no compression, it must be a leakage past the piston. This is practically impossible in this engine, unless you have run it "dry" and stuck or broken the piston rings.

In General

In general, the best advice is to leave all parts of the engine alone until you have carefully thought out where the trouble probably lies and what is causing it, and this can be clearly and accurately done by the most inexperienced man if he will only bear in mind



GENERATOR

FIG. 1

and trace out the three lines, compression, ignition and mixture.

The generator is shunt wound which is the simplest form of generator used. Fig. 1 gives cross section of same. "A" is armature which revolves in fields "F" and shaft of armature being fastened to engine shaft as shown by coupling is turned at engine speed. The field windings "W" energizes the fields and consist of many turns of fine wire. The armature windings as they pass through the lines of force produced by fields generate electrical power which is collected from the commutator "C" and delivered to the battery and service lines as required.

There is only one bearing on generator which is as shown, the split coupling connecting armature shaft to engine shaft constituting the other bearings.

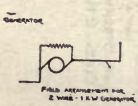


FIG. 2

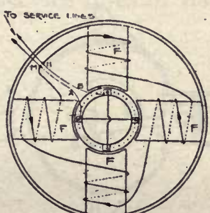


FIG. 3

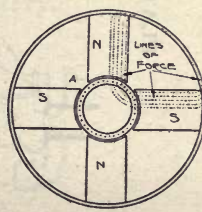


FIG. 4

By referring to Fig. No. 2 the wiring diagram will be seen for a shunt wound generator. Fig. No. 3 shows the same as it is actually arranged on the generator. The fields "H" are wound around the pole pieces and the two wires leading to them join the armature leads (A) and (B) at (M) and (N) or as the name implies the shunt wound generator means

PLATE H

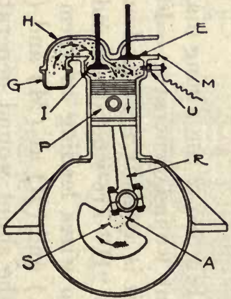


FIG. 1
SUCTION

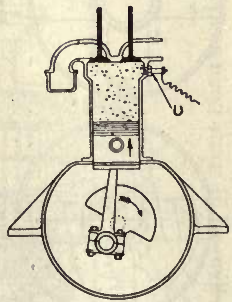


FIG. 2
COMPRESSION

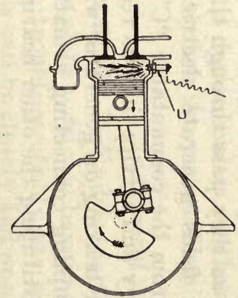


FIG. 3
EXPLOSION

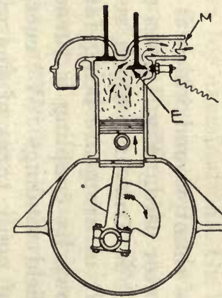


FIG. 4
EXHAUST

CYCLE OF OPERATIONS
IN A
FOUR STROKE CYCLE
GAS ENGINE

that the field windings are shunted or paralleled with the armature leads.

Fig. 4 shows the armature and fields and as noted the field poles alternate North pole and South pole magnetism. This could be compared to + and (—), the North pole comparing to + and South pole to (—), because the lines of force flow from (N) to (S) as current always flows from + to (—).

Referring again to Fig. 4 the lines of force produced by the fields flow from the (N) poles through the iron body of the armature to the South poles and return to the (N) poles through the outside frame of the generator.

As the windings of armature as represented pass through the lines of force, electric current is generated which is collected and delivered by the commutator to the service lines or battery.

ELECTRICAL APPARATUS FOR THE STUDIO AND THEATRE

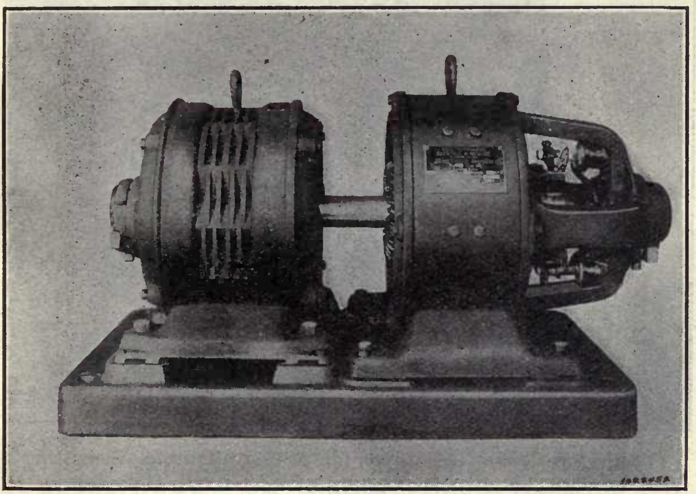
The question of whether alternating or direct current should be used in the production or projection of motion pictures is no longer open for argument. Studio engineers and projectionists are quite familiar with the decided advantages of direct current from the standpoint of both economy and good illumination. In fact, a comparison of the cost of operation per candle power and the relative photographic value is so much in favor of direct current that it is almost universally employed. To-day, alternating current for motion-picture work can be considered a deviation from standard practice.

A motor generator is conceded to be the most satisfactory piece of apparatus to convert A. C. to D. C. for use either in the studio or theatre. Before proceeding, however, into the discussion of generating and converting equipment, let us consider briefly the respective requirements for satisfactory illumination in the studio and theatre, then we shall discuss in a general way the design of apparatus suitable to meet these requirements.

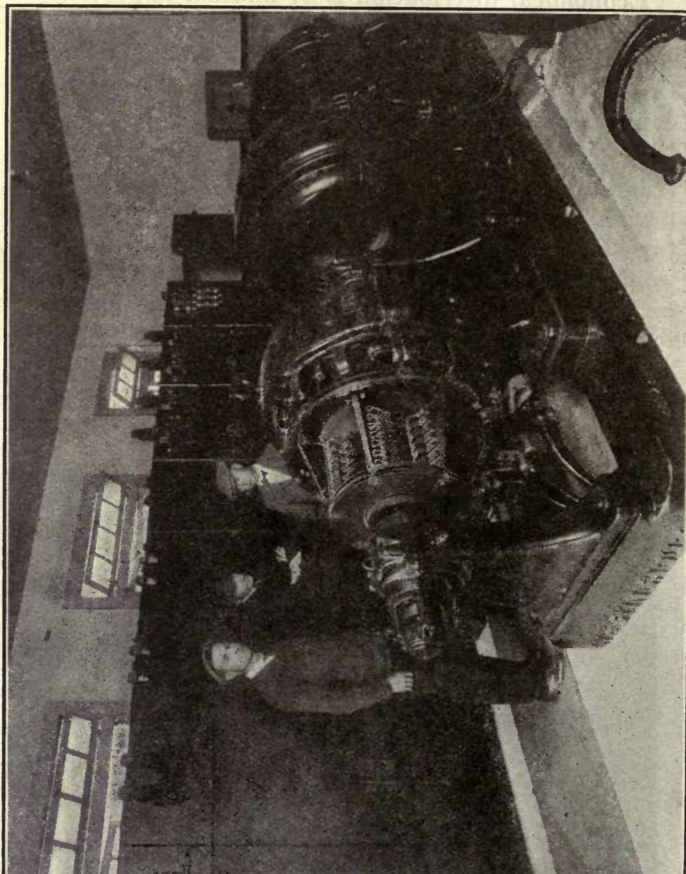
For best results in studio lighting, the Mercury Vapor tubes for producing the soft lights as well as the arcs used for contrast and "close-ups," must be supplied with a very steady direct current. The motion-picture camera is very susceptible to fluctuations in light resulting from unsteady voltage; therefore, generating or converting apparatus, suitable for stage lighting, must have electrical characteristics to conform with this essential requirement.

Economical distribution is of unusual importance in the studio on account of the large number of circuits and heavy current handled. The three-wire system is used considerably because of the saving in copper in making the installation.

In connection with the three-wire system of distribution, a very important item is the matter of flexibility. The studio director is very liable to call for "lights" or a change in the illumination, which would result in an unbalanced circuit greatly in excess of that for which commercial three-wire generators or converters are designed. Even if it were possible for the electrician to connect the circuits so as to obtain a balanced condition, the time required to make the proper connections would prove a detriment



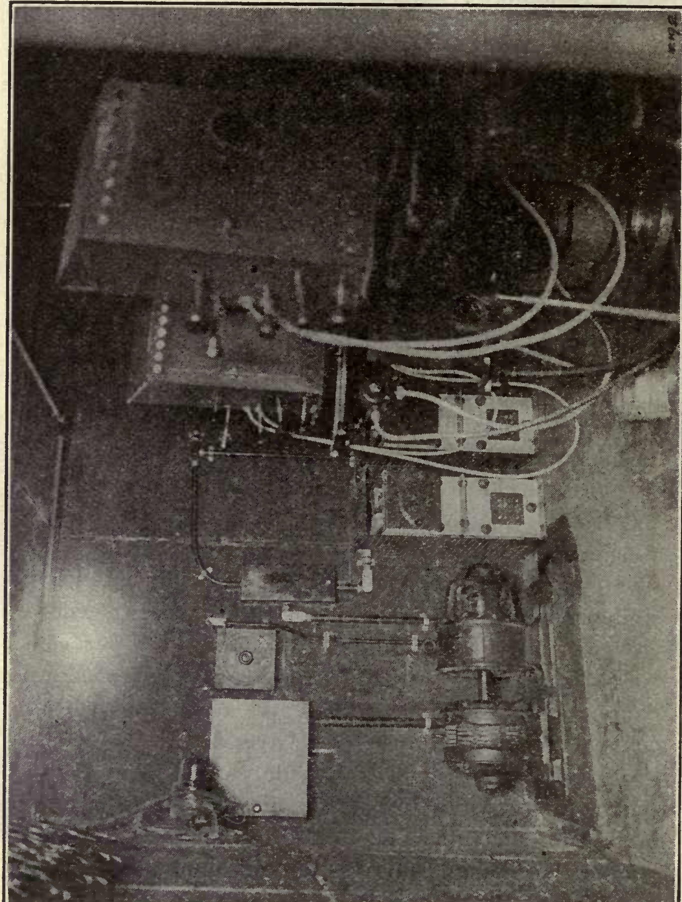
Westinghouse Motor Generator for Motion Picture Projection



Three Unit Motor Generator for Studio Lighting, Consisting of Two 150 Kil. Generators and 50 Cycle Induction Motor. Part Installation in Robert Brunton Studios, Los Angeles, Cal.

to rapid production. Every minute counts—time is very valuable in the present-day production of motion pictures. Also the matter of convenience should be given consideration. Assuming that the load could be kept balanced, or nearly so, by making the proper connections, this work of plugging in the different circuits so as to obtain a nearly balanced load would prove very inconvenient. For these reasons this frequent condition of large unbalanced loads introduces a great objection to the application of commercial three-wire apparatus designed to carry not over 25 per cent. unbalanced current.

Westinghouse three-unit motor generators meet all the requirements indicated above. They consist of two 115 volts, flat compound, direct-current generators, mounted on a common base with and directly connected to a synchronous or induction motor of the proper characteristics. The generators are connected in series and a lead brought out from the intermediate point forms the neutral for the three-wire system. Each machine will carry its full rated load independent of the other; therefore the motor generator will operate satisfactorily under a 50 per cent. unbalanced kilowatt or 100 per cent. unbalanced ampere load. These generators give a constant voltage characteristic, because they are designed for flat voltage regulation over a wide range of load, and their use provides for a most flexible three-wire distribution system. The Westinghouse Company is a pioneer in recommending and furnishing this type of apparatus for stage lighting. Studio engineers were quick to recognize its relative merits, consequently

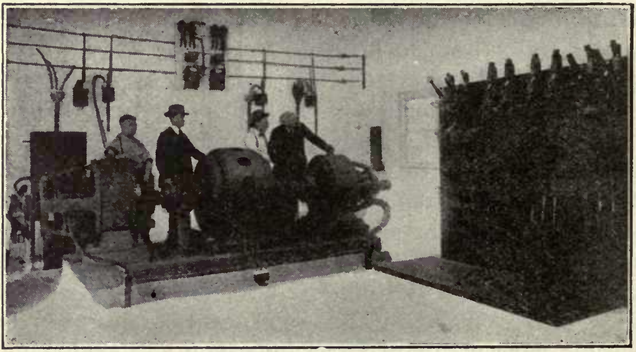


Westinghouse Generator Showing Rheostats and Control the position of the three-unit motor generator is fully established.

The one most essential requirement for best results in motion-picture projection is direct current of constant value at all times. The importance of this requirement is fully appreciated when one considers that any fluctuations of current in the arc circuit causes a corresponding irregularity in the candle power developed, which is noticeable on the screen. It should be borne in mind that the public is paying mainly for results produced on the screen, and any unsteady light, which detracts from the picture, is always accompanied by a tremendous hazard of losing patronage.

Westinghouse motion-picture equipment fulfills this essential requirement for successful projection of the picture in the theatre. This equipment consists of chiefly a two-unit motor generator with ballast rheostats. The generators are wound for 75 volts and designed specially to give close voltage regulation over a wide range of load, including 100 per cent. overload during the time the second arc is warming up. The ampere capacity of these generators is sufficient to accommodate the 100 per cent. overload during this period. These motor generators are built in different sizes to meet the needs of the smallest to the largest theatre, and are furnished with induction motors, single or polyphase, in all commercial frequencies and voltage. The ballast rheostats insure constant current despite variations of the resistance in the arc circuit. This equipment is designed to supply current for two arcs operating in parallel circuits. This arrangement has a decided advantage, due to the fact that one arc operates entirely independent of the other; therefore, if one arc would be "lost" while it is being adjusted for the next reel, the arc which is still operating will in no way be affected. This means that the transition from one projector machine to the other and from one reel to the other is accomplished without the slightest danger of any interruption in light while the picture is on the screen.

As a guide to those who contemplate the purchase of electrical equipment for motion-picture work, either in the studio or theatre, or to those who will be responsible in any way for the successful operation of such equipment, we cannot emphasize too forcibly the great importance of using equipment designed especially for this purpose. The expense involved in the production of the picture and the value of public opinion to any theatre owner justify utmost precaution, and any expense incurred in the purchase of equipment which will insure best results.



WESTINGHOUSE MOTOR-GENERATOR

GENERAL INFORMATION

Unpacking. When uncrating the equipment protect the various units against severe shocks and blows, especially if the temperature of the air is very low. Do not remove the blocking between the generator and motor frames until the set is finally installed at its permanent location. Furthermore, these sets should never be moved from their permanent location unless suitable blocking is placed between the motor and generator frames. This is important so as to prevent bending the bearings out of alignment. Be sure to protect all the equipment from moisture and make certain that all windings of the motor and generator are dry before subjecting them to operating voltage.

Location. All of the electrical equipment should be finally installed in a clean, dry, well ventilated place and in such a manner as to be easily accessible for inspection and cleaning. The room or enclosure for the equipment should be sufficiently well ventilated so that the air temperature will never be in excess of 104° Fahrenheit.

Foundation. A foundation should be provided for the motor-generator so that the bottom of the bedplate will be approximately two feet above the level of the surrounding floor. To prevent the magnetic hum and vibration of the set being transmitted to the surrounding supports such as floor and walls of the building, it is desirable to build a vibration and sound-absorbing base.

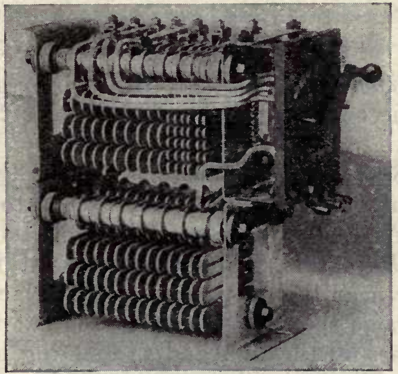
Such a base may be constructed readily with solid planking two inches thick and layers of solid cork each layer two inches thick. Anchor bolts should be placed in the foundation so that they will extend a sufficient distance above the sound-absorbing base to permit the placing of nuts. The supporting foundation should preferably be made of hollow concrete. The cork should be placed in two layers on the concrete foundation. On top of the cork should be placed the plank frame constructed of the two layers of two-inch plank. The planks of one layer should be laid at right angles with the plank in the other, both layers to be bolted or nailed together securely. The anchor bolts must be located so that they will not touch any portion of the motor-generator bedplate. After the plank frame is in place the anchor-bolt nuts should be drawn up tight. The motor-generator may then be mounted on the plank frame and, if desirable, the bedplate may be bolted down to the plank frame as holes are provided for this purpose. If so desired, heavy felt may be substituted for the cork but cork is much more resilient and will remain elastic indefinitely, whereas felt will not.

When constructing the foundation and sound-absorbing base it is essential that the top of the plank platform be made level so that the oiling system of the motor-generator will not fail after the set is installed.

Throughout this article, equipments for two typical types of installations will be considered under the captions of single light, and two-light equipments or installations.

The single-light equipment is required for each installation wherein only one motion picture machine is to be used.

The two-light equipment is required for each installation wherein two motion picture machines are to be operated alternately, for "change over" or "continuous picture service." For this latter service one lamp is "warmed up" for a period of approximately one minute when another motion picture machine is in operation.



Ballast Rheostat

EQUIPMENT REQUIRED

For each single-light installation a motor-generator and one ballast rheostat are required, the control switch being optional; whereas, for each two-light installation, a motor-generator, two ballast rheostats and two control switches are required.

INSTALLATIONS

Foreword. For all cases wherein the instructions are equally applicable to both types of installations, namely, two-light and single-light, no distinction will be necessary. However, when the instructions apply to only one of these types, then the type which is involved will be clearly indicated.

A *control switch* is a single-pole, single-throw knife switch, which must be protected by a suitable cover if mounted on the frame of a motion picture machine. If the control switch is mounted on a switchboard panel, then the individual cover is not required for this switch.

INSTALLATION

Motor-Generator. Install the motor-generator either in the operating booth, or as near the booth as possible.

Motor Starting Equipment. Install the motor control equipment, for the motor-generator, in the booth, if permissible, or as near the booth as possible.

Ballast Rheostats. Install the ballast rheostats either in or near the operating booth. Each ballast rheostat frame should be mounted so that the three tie rods, passing through and supporting the grids, are horizontal. This places the grids in an upright position which permits a free circulation of air vertically between the grids.

Control Switches. The control switch for each ballast rheostat should, preferably, be mounted on the frame of the motion picture machine, with which the ballast rheostat is to be used, beside the cut-out switch connected to the arc lamp terminals.

Indicating Meters. A suitable direct-current ammeter and voltmeter should be used and connected in the generator circuit. These meters should be installed in the operating booth, in a position where they can be easily seen by an operator when he is projecting pictures.

Switchboard or Panel. A panel should be used on which are mounted the meters, and the generator field rheostat.

WIRING AND CONNECTING MOTOR-GENERATORS

TYPE CS POLYPHASE MOTOR

Connect the motor and auto-starter by referring to the diagram furnished with the auto-starter. If the circuit is 2-phase, 4-wire, connect leads from one phase to motor terminals A1 and A2 and leads from other phase to terminals B1 and B2. If circuit is 2-phase, 3-wire, connect outside leads to terminals A1 and B1 and middle lead to A2 and B2. If circuit is 3-phase connect any lead to any terminal. To obtain proper direction of rotation see instruc-

Type "A" Auto-Starter

tions below. If fuses are used in the running circuit they should carry current in excess of current indicated in nameplate as follows:

2-phase, 4-wire circuit, all leads, 25 per cent.

2-phase, 3-wire circuit

outside leads, 25 per cent.

middle lead, 75 per cent.

3-phase, 3-wire circuit, all leads, 25 per cent.

If circuit-breakers are used in the running circuit they should be adjusted to open the circuit with the above overload capacities.

Fuses in the starting circuit should carry four to five times the rated current.

TYPE AR SINGLE-PHASE MOTOR

Voltages. This motor can be connected for operation on either 110 or 220-volt circuits.

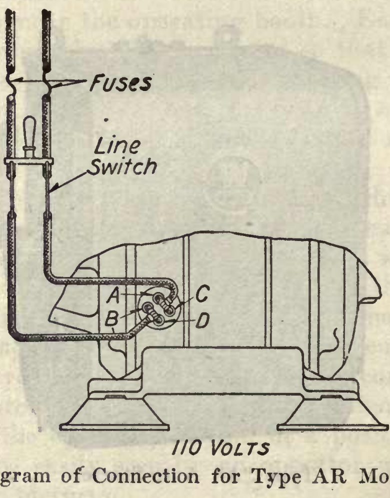


Diagram of Connection for Type AR Motors

Connections. The diagram shows the connections. The motor is connected directly to the line through a circuit-breaker or a line switch and fuses.

TYPE SK DIRECT-CURRENT MOTOR

Connections. Refer to the diagram and make the following connections for counter-clockwise rotation looking at the commutator end:

Connect A2 to starting resistors, thence to + line.
Connect A1 to S1.
Connect S2 and F2 to — line.
Connect F1 to + line.

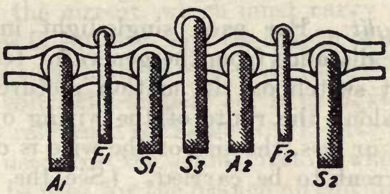


Fig. 6—Diagram of Type SK Motor Terminals

WIRING AND CONNECTING EQUIPMENTS

Single Light and Two-Light Equipment. Should be wired and connected as indicated by Fig. 12, or Fig. 13, if a control switch is used. If a control switch is not used, then the wiring for Fig. 12 should be modified by omitting the leads to the control switch and by connecting a lead from the lower left-hand stud of the cut-out switch to terminal 7 on the ballast rheostat, instead of to terminal 8. Likewise, the wiring of Fig. 13 should be modified by omitting the leads to the control switch and by connecting the lead from the lower right-hand stud of the change-over switch, to terminal 7 on the ballast rheostat.

TYPE SK GENERATOR

Connections. The diagram and directions below show the connections for clockwise rotation looking at the commutator end:

Connect A1 to + line.
Connect A2 and F2 to S2.
Connect S1 to — line.
Connect F1 to field rheostat, thence to + line.

MINIMUM SIZE OF WIRE FOR INSTALLATION

Single-light. For each single-light installation, wherein the distance from the generator terminals to the cut-out switch on the motion picture machine, measured along the route of the wiring or conduit, is 300 feet or less, the size of the wire is determined by the current to be carried. (See the "National Electric Code.") If the distance is over 300 feet, the exact distance should be referred to the Company for recommendations as to the proper size of wire to be used.

Two-light. The minimum size of wire to be used for the circuit, which must carry current for both lamps for a two-light installation, is indicated in Table No. I, hereinafter given. The column headed "Length in Feet of Circuit Which Must Carry Current for Both Arc Lamps," represents the distance from the generator terminals to the generator switch, or to the point where the circuit, which must carry current for both lamps, branches or divides into separate circuits, one for each lamp. The distance must be measured along the route of the wiring or conduit. If this distance is greater than 300 feet, the exact distance should be referred to the Company for recommendations as to the proper size of wire to be used. The size of all wires which carry current for one lamp only, will be governed by paragraph 25, but the distance is measured along the route of the wiring or conduit from the cut-out switch on each motion picture machine, to the generator switch or to the point where the branch circuit for each lamp joins the main generator circuit. For example, assume an installation, wherein the length of the circuit, which must carry current for both lamps is 130 feet, and the length of each branch circuit to each lamp is -30 feet, then if a 2¾-kilowatt, 75-volt, 36.7-ampere set is used, it will be observed by reference to Table No. I, that No. 00 wire must be used for the main circuit, whereas No. 6 wire may be used for the branch circuit to each lamp.

For *each two-light* installation, wherein the length of the main circuit, which must carry current for both lamps or wherein the length of the branch circuit to either lamp is greater than 300 feet, a diagram should be prepared which represents the wiring, and the length of each wire should be accurately indicated thereon. This diagram should be referred to the Company for recommendations as to the proper size of wire to be used for each circuit.

Emergency Service. For each installation, wherein alternating current is to be used for emergency service, we strongly recommend that all wiring and switches, which will be used for carrying this current to each lamp, be made of sufficient capacity to carry the alternating current, bearing in mind the fact that, in order to produce the same volume, or candle-power, of light, the alternating current (measured in amperes) must be approximately three times as great as the direct current ordinarily used.

Motor Circuits. The wiring for the circuit of each direct-current or alternating-current motor should be of a capacity such that the speed of the motor will not be appreciably affected by the line voltage drop at any load up to and including 30 per cent overload for a few minutes or 100 percent overload momentarily.

LUBRICATION

Before starting, fill the oil reservoirs with the best quality of clean dynamo oil; overflow plugs must always be kept open. The old oil should be withdrawn occasionally and fresh oil substituted. The old oil can be filtered and used again.

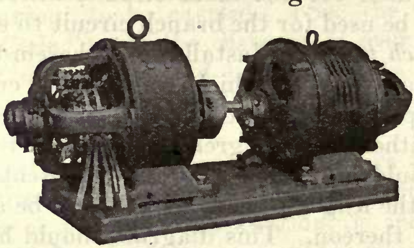


Fig. 8—Motor-Generator with Single-Phase Alternating-Current Motor

STARTING THE MOTOR-GENERATOR

General. After the apparatus is properly installed and all wiring is correctly connected, open all of the switches in the generator and lamp circuits; turn the contact arm, on the generator field rheostat to the contact marked "in," and then start the motor as explained below.

TYPE CS POLYPHASE MOTOR

To Start Motor. See that the auto-starter handle is in the off position. Close the circuit-breaker, if one is used, then close the main switch. Move the auto-starter handle from the off to starting position. When the motor attains practically full speed, move handle of auto-starter to running position. Do not leave the auto-starter handle in starting position.

If an auto-starter is not required, the starting switch must be thrown to the starting position until the set operates at almost full speed and then the switch may be thrown to the running position.

TYPE AR SINGLE-PHASE MOTOR

To Start Motor. Close the line switch. The motor starts as a repulsion motor with current flowing through the brushes and commutator. At nearly full speed, a centrifugal governor inside the armature automatically short-circuits the armature windings, thus causing the motor to run as a squirrel-cage induction motor. The brushes are thrown off by the end thrust of the armature. If the motor does not come to full speed, which is shown by continued sparking at the brushes, the motor is overloaded and will overheat. Apparently there is a load on the generator. Look over the generator circuit and make sure that all load is removed by opening all cut-out switches.

TYPE SK DIRECT-CURRENT MOTOR

To Start Motor. See that all instructions for connecting and installing the motor have been complied with and that the handle of the starter or controller is in the "off" position. Close the line switch or circuit-breaker and move the starter or controller handle step by step to the running position. Motors of less than 10 horsepower can usually be brought to full speed in 15 seconds, and the large motors in about 30 seconds; the time, however, varies with the torque required. If the motor does not start when the third step is reached, first open the line switch or circuit-breaker, then move the handle of the controller to the "off" position, and look for overload or faulty connections.

INSPECTION OF OILING SYSTEM

After the motor-generator is started, raise the covers of all bearings and see that all oil rings are rotating properly and carrying oil up on the journals.

STOPPING THE MOTOR-GENERATOR

TYPE CS POLYPHASE MOTOR

To Stop Motor. Open circuit-breaker or main switch. Move the handle of auto-starter to the off position. If neither circuit-breaker nor main switch is used, the auto-starter may be used to close and open the main circuit.

TYPE AR SINGLE-PHASE MOTOR

To Stop Motor. Open the line switch or circuit-breaker.

TYPE SK DIRECT-CURRENT MOTOR

To Stop Motor. When a starting rheostat is used, open the line switch or circuit-breaker. Never force the starter handle to the "off" position, but allow it to return automatically.

If the motor is to be shut down for a considerable period, open the line switch or breaker.

REVERSING MOTOR-GENERATOR

The rotating element of the motor-generator should revolve in a clockwise direction as observed by viewing the generator end of the set. If this is not the case when the motor is started, then the wiring connections for the motor must be changed.

TYPE CS POLYPHASE MOTOR

To Reverse Motor. To reverse a two-phase, four-wire motor, the two leads of one phase should be interchanged. To reverse a two-phase, three-wire motor, the two outside leads should be interchanged. To reverse a three-phase motor, any two leads should be interchanged.

TYPE AR SINGLE-PHASE MOTOR

To Reverse Motor. The direction of rotation is determined by the position of the brushes and is indicated by a scale on the rocker ring and a pointer on the front bearing bracket. The scale consists of three lines marked RR,N, and RL, respectively. When the rocker ring is turned so that the pointer is opposite RR, the motor will run in a right-hand or clock-wise direction (facing the commutator); and when the pointer is opposite RL, the rotation will be left-hand or counter-clockwise. N is the neutral point; the armature will not turn if the pointer is opposite this line. To reverse the motor, therefore, loosen the rocker ring set-screw and turn the rocker ring until the pointer is opposite the line for the reverse direction of rotation.

ADJUSTING THE EQUIPMENT

After the set is running properly, gradually adjust the generator field rheostat until the potential between the generator terminals, as indicated by a reliable voltmeter, is approximately 75 volts.

Single Light. For single-light equipments (see Fig 12) the control switch, if one is used, should always be opened and ballast rheostat contact arm moved to extreme right before striking the arc. After the arc is struck and the carbons have been sep-

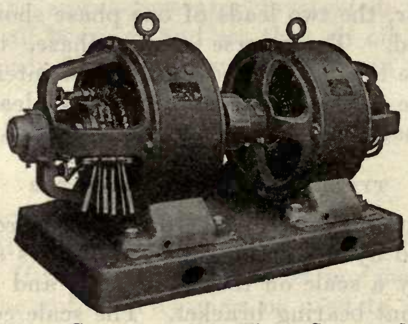


Fig. 9—Motor-Generator with Direct-Current Motor

arated, close the control switch and then readjust the carbons until the potential across the arc is between 50 and 55 volts, as indicated by a reliable voltmeter, the terminals of which are connected directly to the carbons in the lamp. If, under these conditions, the current through the lamp, as indicated by a reliable ammeter, is less than required, and no greater than the full load rating of the generator, then the ballast rheostat contact arm should be moved towards the left until the proper current is obtained. The button on which the proper current is obtained should be marked, so that the operator can always place the arm in proper position.

Two Light. For two-light equipments the control switch connected to the ballast rheostat in the circuit of either lamp, must always be opened before striking the arc.

With lamp No. 2 cut off the circuit, open control switch No. 1 and strike the arc in lamp No. 1. After the carbons have been separated slightly, close control switch No. 1, move contact arm of ballast rheostat No. 1 to extreme right, and then readjust the carbons until the potential across the arc is between 50 and 55 volts, as indicated by a reliable voltmeter, the terminals of which are connected directly to the carbons in lamp No. 1. If, under these conditions, the current through lamp No. 1, as indicated by a reliable ammeter, is less than required or less than the full-load rating of the generator, then the contact arm of the ballast rheostat No. 1 should be moved towards the left one button at a time until the proper current is obtained.

With lamp No. 1 cut off the circuit, open control switch No. 2, move contact arm to extreme right, and strike the arc in lamp No. 2. After the carbons have been separated, close control switch No. 2, and then readjust the carbons until the potential across the arc is between 50 and 55 volts, as indicated by a reliable voltmeter, the terminals of which are connected directly to the carbons in lamp No. 2. If, under these conditions, the current through lamp No. 2, as indicated by a reliable ammeter, is less than required or less than the full load rating of the generator, then the contact arm of the ballast rheostat No. 2 should be moved towards the left one button at a time until the proper current is obtained.

OPERATING THE EQUIPMENT

Single Light. After the adjustments, specified in paragraph 44, have been made, the equipment is operated in the usual manner, which needs no further explanation.

Two Light. After both ballast rheostats have been properly adjusted, as specified in paragraphs 46 and 47, and the crater in the positive or upper carbon in each lamp is properly formed, the entire equipment is ready for operation as hereinafter given.

Insert reel No. 1 in machine No. 1; open control switch No. 1; strike the arc in lamp No. 1, and then separate the carbons slightly, close control switch No. 1; adjust the carbons properly and then project pictures in the usual manner.

Reel No. 2 should be inserted in Machine No. 2. About one minute before the end of reel No. 1 is reached, open control switch No. 2; strike the arc in lamp No. 2, and separate carbons slightly. A few seconds before the end of reel No. 1 is reached, close control switch No. 2, and if necessary make a final adjustment of the carbons. At the proper time, as the end of reel No. 1 is reached, begin projecting pictures with machine No. 2, and cut lamp No. 1 off the circuit.

Reel No. 3 should be inserted in machine No. 1. About one minute before the end of reel No. 2 is reached, open control switch No. 1; strike the arc in lamp No. 1, and adjust the carbons properly. A few seconds before the end of reel No. 2 is reached, close control switch No. 1, and if necessary, make a final readjustment of the carbons. At the proper time, as the end of reel No. 2 is reached, begin projecting pictures with machine No. 1, and cut lamp No. 2 off the circuit.

The cycle of operation, as specified in paragraphs 50, 51 and 52, may be carried out indefinitely at the rate of three, four, or five 1000-feet reels per hour, without injury to the electrical equipment, provided each lamp does not require more than the full-load rated current from the generator operating at the potential of 75 volts.

CARE OF MOTOR GENERATOR

TYPE SK GENERATOR AND MOTOR

Commutator. The commutator must be kept clean and the brushes properly adjusted and fitted to the commutator. Wipe the commutator at frequent intervals, depending on the character of the service, with a piece of clean canvas cloth free from lint. Apply lubricant sparingly; a piece of paraffin rubbed lightly across the commutator surface will furnish sufficient lubrication. No other attention is required by a commutator which is taking on a polish and shows no sign of wear. A rough, raw, copper-colored surface should be smoothed with a piece of sandpaper or fine standstone ground to fit. In any case the final smoothing should be with fine (No. 00) sandpaper. When using the paper or stone lift the brushes and do not replace them until all grit is removed. Never use emery cloth or emery paper on the commutator.

Brushes. The brushes are set in the neutral position at the factory and the brackets to which they are attached is doweled in position. This adjustment should not be altered, as it is correct for either direction or rotation.

New brushes should be of the same make and grade as those shipped with the machine. Brushes should have only sufficient clearance in the box to slide easily.

TYPE AR SINGLE-PHASE MOTOR

Renewing Brushes. To remove brushes from the holder, turn the rocker ring so that the brushes are brought between the arms of the bearing bracket. Remove the screws of the clips that hold the brushes in place. After inserting new brushes, turn the rocker ring so that the pointer is opposite the line for the proper direction of rotation.

The front bracket of the motor should not be removed unless unavoidable. If the bracket is removed, when replacing make sure that the steel pin in the brush-raising ring enters the corresponding slot in the brushholder casting. Failure to observe this may result in poor operation.

GENERAL POINTERS

Generator Excitation. When a generator is started, it may fail to build up its voltage properly. This may occur even though the generator operated perfectly during the preceding run. This may be due to one or more of the following causes:

(a) Slow speed.

(b) Open shunt-field circuit, caused by faulty connections or defective field coil or field rheostat.

(c) Open armature or commutating-field circuit.

(d) Incorrect setting of brushes.

(e) Reversed series or shunt coils.

(f) Poor brush contact due to dirty commutator or brushes sticking in holders.

(g) Loss of residual magnetism.

Examine all connections; try a temporarily increased pressure on the brushes; look for a broken or burned out resistor coil in the rheostat. An open circuit in the field winding may sometimes be traced with the aid of a magneto and bell; but this is not an infallible test, as some magnetos will not ring through a circuit of such high resistance as some field windings have, even though the winding be intact. If no open circuit is found in the rheostat or in the field winding, the trouble is probably in the armature. But if it be found that nothing is wrong with the connections or the winding it may be necessary to excite the field from another generator or some other outside source. Calling the generator that we desire to excite No. 1, and the other machine from which current is to be drawn No. 2, the following procedure should be followed:

Open all switches and remove all brushes from generator No. 1; connect the positive brushholder of generator No. 1 with the positive brushholder of generator No. 2; also connect the negative holders of the machines together (it is desirable to complete the circuit through a switch protected by a fuse of about 5 amperes). Close the switch. If the shunt winding of generator No. 1 is all right, its field will show considerable magnetism. If possible, reduce the voltage of generator No. 2 before opening the exciting circuit; then break the connections. If this cannot be done, set the field rheostat contact arm of generator No. 1 on button marked "IN," then open the switch very closely and gradually lengthen the arc, which will be formed, until it breaks.

A very simple means for getting a compound-wound machine to pick up is to short-circuit it through a fuse having approximately the current capacity of the generator. If sufficient current to melt this fuse is not generated, it is evident that there is something wrong with the armature, either a short circuit or an open circuit. If, however, the fuse has blown, make one more attempt to get the machine to excite itself. If it does not pick up, it is evident that something is wrong with the shunt winding or connections.

If a new machine refuses to build up voltage and the connections apparently are correct, reverse the field connections; i. e., interchange the field wires which are connected to the positive and negative terminals of the generator. If this interchange of connections does no good, re-establish the original connections and locate the fault as previously advised.

Brushes. All brush faces resting on the commutator should be fitted to the commutator so that they make good contact over the entire area. This can be most easily accomplished after the brushholders have been adjusted and the brushes inserted. Lift one set of brushes so that they will not be forced against the commutator. Place a piece of sandpaper against the commutator with the sanded side towards the brushes. Replace one brush in its holder and allow the spring to force it against the sandpaper. Draw the sandpaper in the direction of rotation under the brush, releasing the pressure as the paper is drawn back, being careful to keep the ends of the paper as close to the commutator surface as possible and thus avoid rounding the ends of the brush. After the first brush is properly ground, it should be lifted sufficiently to prevent it being forced against the commutator, after which the remaining brushes of the set may be similarly ground one at a time.

By this means a satisfactory contact is quickly secured, each set of brushes being similarly treated in turn. If the brushes are copper plated, their edges should be slightly beveled, so that the copper does not come in contact with the commutator.

Make frequent inspection to see that:

(a) Brushes are not sticking in holders.

(b) Pig-tail shunts are properly attached to brushes and holders.

(c) Tension is readjusted as the brush wears.

(d) Copper plating is cut back so it does not make contact with commutator.

(e) Worn-out brushes are replaced before they reach their wearing limit and break contact with the commutator.

(f) Any free copper picked up by the face of the brushes is removed.

Commutator. The commutator is perhaps the most important part of the machine in that it is most sensitive to abuse. Under normal conditions, it should require little attention beyond frequent inspection. The surface should always be kept smooth, and if, through extreme carelessness, neglect or accident, it becomes badly roughened, the armature should be removed and the commutator turned down in an engine lathe.

Sparking at the brushes may be due to any one of the following causes:

(a) The machine may be overloaded.

(b) The brushes may not be set exactly on the neutral position. If so, the neutral should be determined by running the machine in both directions of rotation and obtaining the same voltage at full load current in both directions.

(c) The brushes may be welded in the holders or have reached their limit of wear.

(d) The brushes may not be fitted to the surface of the commutator.

(e) The brushes may not bear on the commutator with sufficient pressure.

(f) The brushes may be burned on the ends.

(g) The commutator may be rough. If so, it should be smoothed.

(h) A commutator bar may be loose or may project above the others.

(i) The commutator may be dirty, oily or worn out.

(j) The carbon brushes may be of an unsuitable grade.

(k) The brushes may not be equally spaced around the periphery of the commutator.

(l) Some brushes may have extra pressure and may be taking more than their share of the current.

(m) The contact between some brush pigtails and brushholders may be poor, forcing the other brushes to carry too much current.

(n) High mica.

(o) Vibration or chattering of the brushes.

These are the more common causes, but sparking may be due to an open circuit or loose connection in the armature. This trouble is indicated by a bright spark which appears to pass completely around the commutator, and may be recognized by the scarring of the commutator at the point of open circuit. If a lead from the armature winding to the commutator becomes loose or broken it will draw a bright spark as the break passes the brush position. This trouble can be readily located, because the insulation on each side of the disconnected bar will be more or less pitted.

The commutator should run smoothly and true, and have a dark glossy surface.

Heating of Field Coils. Heating of field coils may result from any of the following causes:

(a) Too low speed.

(b) Too high voltage.

(c) Too great forward or backward lead of brushes.

(d) Partial short-circuit of one coil.

(e) Overload.

Heating of Armature. Heating of armature may result from any of the following causes:

(a) Too great load.

(b) A partial short-circuit of two coils heating the two particular coils affected.

(c) Short-circuits or grounds in armature winding or commutator.

(d) Bad commutation with consequent large circulating currents in armature coils undergoing commutation.

Heating of Commutator may result from any of the following causes:

(a) Overload.
(b) Sparking.
(c) Too high brush pressure.

Bucking is the very expressive term descriptive of the arcing between adjacent brush arms. In general, bucking is caused by excessive voltage between commutator bars, or by abnormally low surface resistance on the commutator between brushholders of opposite polarity. Any condition tending to produce poor commutation increases the danger of bucking. Among other causes are the following:

(a) Rough or dirty commutator.

(b) A drop of water on the commutator from the roof, leaky steam pipes or other source.

(c) Short-circuits on the line producing excessive overloads.

MOTION PICTURE EQUIPMENT—SINGLE LIGHT

Schematic Connections

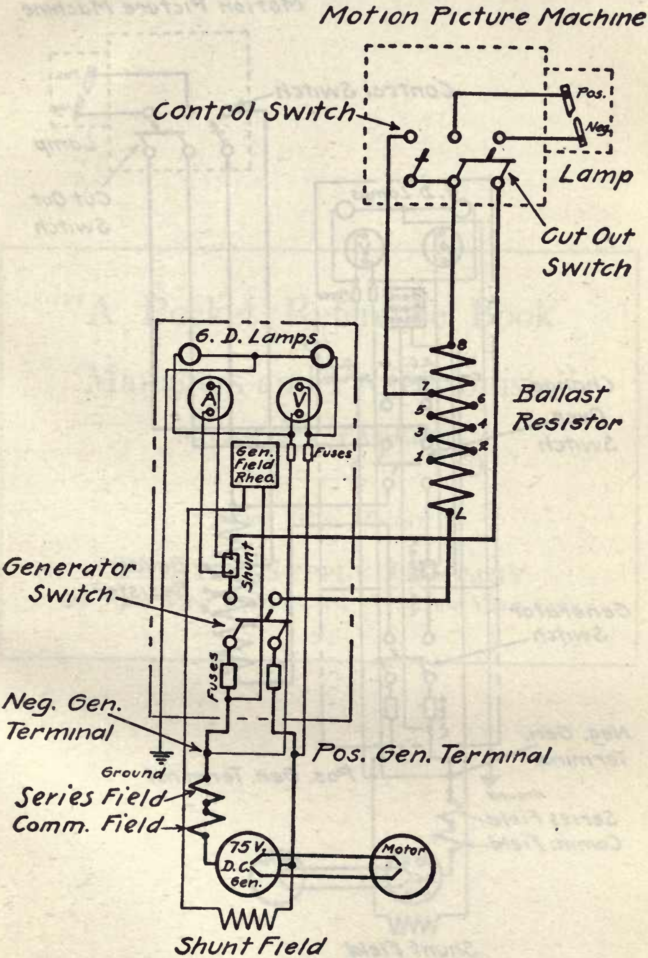


Fig. 12

MOTION PICTURE EQUIPMENT—SINGLE LIGHT

Schematic Connections; Panel Provided for Emergency Service

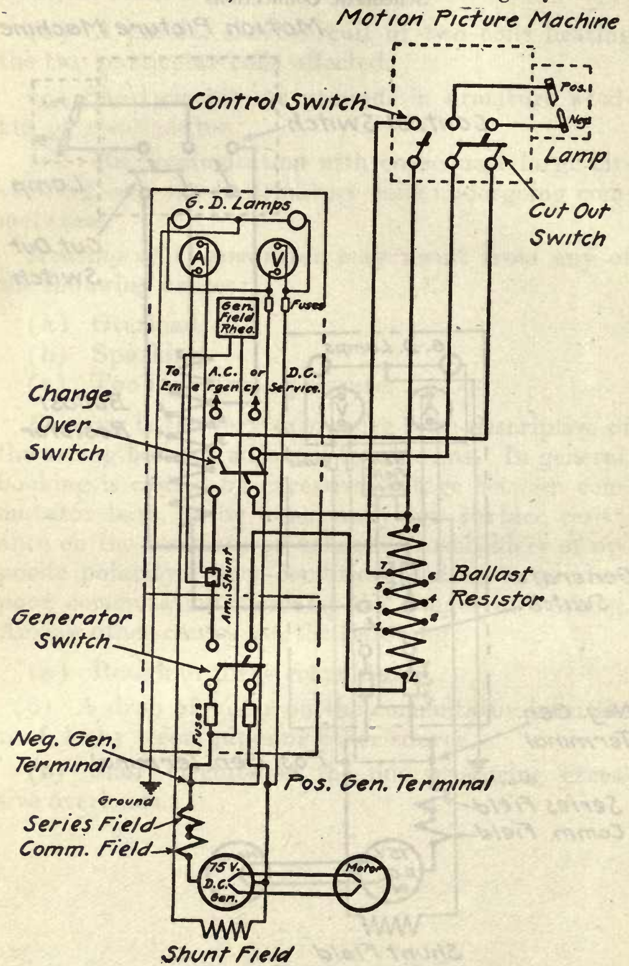


Fig. 13

MEASURING WIRE

First scrape off the insulation, then take one strand of wire and insert it in the smallest slot possible on a Brown and Sharp wire gauge. Find out (by using wire table) the number of circular mils contained in the one strand, then multiply the number of circular mils by the number of strands in the wire, then refer to wire table on page 449, and find the nearest corresponding number of circular mils, look opposite to find what size wire you have.

For instance, suppose we are going to measure a length of stranded wire, we first take one strand and measure with B. & S. gauge. Let us take it for granted that it measures No. 14, now find out by using table on page 76 how many circular mils there are in a No. 14 wire—4,107; next count the strands in the wire and say we count 7; then, by multiplying the 4,107 by 7 we will find the circular mils in the whole wire or $4{,}107 \times 7 = 28{,}749$ circular mils in the whole wire. Now find the nearest corresponding number to 28,749 in circular mil table and we find it is 26,250, and looking over to the first column we find this to be a No. 6 wire.

CARRYING CAPACITY OF COPPER WIRE

B. & S. Gauge	Circular Mils	Table A Rubber Insulat. Ampere	Table B Other Insulats. Ampere
18	1,624	3	5
16	2,583	6	8
14	4,107	15	16
12	6,530	17	23
10	10,380	24	32
8	16,510	35	46
6	26,250	50	65
5	33,100	54	77
4	41,740	65	92
3	52,630	76	110
2	66,370	90	131
1	83,690	107	156
0	105,500	127	185
00	133,100	150	200
000	167,800	177	262
0000	211,600	210	312
	200,000	200	300
	300,000	270	400
	400,000	330	500
	500,000	390	590
	600,000	450	680
	700,000	500	760
	800,000	550	840
	900,000	600	920
	1,000,000	650	1,000
	1,100,000	690	1,070
	1,200,000	730	1,150
	1,300,000	770	1,220
	1,400,000	810	1,290
	1,500,000	850	1,360
	1,600,000	890	1,430
	1,700,000	930	1,490
	1,800,000	970	1,550
	1,900,000	1,010	1,610
	2,000,000	1,050	1,670

The lower limit is specified for rubber-covered wires to prevent gradual deterioration of the high insulations by the heat of the wires, but not from fear of igniting the insulation. The question of drop is not taken into consideration in the above tables.

POINTS TO REMEMBER

To find the positive or negative polarity when connected up, strike the arc and let same burn for a second or two, then throw off the switch and look to see which of the carbons cool off first. Whichever remains red the longest is the positive and this should always be the carbon in the top jaw of lamp.

If you find that the lower carbon remains red longer than the top, then your lamp is burning upside down, or in other words, the positive line is connected to the lower jaw instead of the top. This can be remedied by changing the wires at arc, wall-switch, or table-switch.

Should both carbons remain red the same length or time you have alternating current.

The Department of Water Supply, Gas and Electricity call for the use of link fuses in the operating booth on the machine line. Cartridge fuses are not allowed.

Always see that all electrical connections are tight and that lamphouse, etc., is free from grounds.

Examine the lamp leads every so often. Remember that copper oxidizes when overheated.

See that you have enough carbon in holders to run the reel through.

When buying or fitting condensers and mounts for same, remember to leave room in mounts for the expansion and contraction of condensers. Remember that cold draughts will break your condensers.

The joint resistance of two conductors connected in parallel is equal to the product of the resistances, divided by their sum.

The joint resistance of any number of resistances connected in parallel is the reciprocal of the sum of the reciprocals. (The reciprocal of a number is 1 divided by that number.)

The total resistance of a number of resistances in series is equal to the sum of all of them.

The heating of the rheostat is proportional to the square of the current it carries.

Drop in voltage is proportional to the product of the current and resistance for a direct current circuit, and the product of current and impedance for an alternating current circuit.

To find the size of a picture obtainable under given conditions and lens. Multiply distance from center of lens to screen by one dimension of slide or film and divide by equivalent foçal length of lens, taking all measurement in inches.

To find focal length of lens for a given slide or film to produce a given size of picture. Multiply slide or film dimension by length of throw and divide by dimension of picture. All measurements in inches.

To find length of throw needed to obtain a certain size of picture. Multiply required picture dimensions by focal length of lens and divide by slide or film dimension.

One foot of film contains 16 pictures.

One turn of the crank runs off 1 foot of film.

Resistance of any conductor is equal to its length in feet divided by the area in circular mils, multiplied by the resistance per mil foot which is 10.8 ohms.

Resistance of all metals increase with an increase of temperature.

Resistance of insulating material and carbon decrease with an increase of temperature.

To set the flicker shutter, loosen up the set screw so that shutter revolves freely on the shaft, now turn shutter till single set screw is in groove of shaft and then tighten, now loosen the two screws on the collar and open the gate of machine. Turn the balance wheel till you see that the intermittent movement is just about to revolve, then the large blade of shutter should just be coming up to cover lens, and should be so fixed that the blade of shutter is covering the front of lens as long as the intermittent sprocket is in motion.

Another way to set it is as follows: Turn the balance wheel till two teeth of the intermittent sprocket have passed a given point; this represents one-half of a picture or, in other words, that the picture has completed one-half of its movement, now set the large blade of the flicker shutter dead over the front of lens.

Always keep carbon holders clean so that carbons make good contact.

Always have a spare belt (driving and take-up) near at hand.

Keep your fingers off the glass surfaces of lenses.

Oil machine often a little at a time, keep oil off the floor of the booth.

Keep oil off the friction discs.

Never use oil on the arc lamp. Use graphite.

Renew motor brushes, whenever necessary, and keep grease cups filled.

TABLE OF RESISTIVITIES AND CONDUCTIVITIES OF METALS

Substances	Specific Resistance in Microhms Per Cubic Centimeter	Relative Conductivity at Zero, Centigrade
Pure Silver	1.49	100.00
Refined Copper	1.59	99.90
Pure Gold (unalloyed)	2.04	86.65
Aluminum (annealed)	2.89	63.09
Swedish Iron	10.08	16.00
Platinum (pure)	11.00	10.60
Lead	19.63	8.88
German Silver	30.00	7.70
Mercury	94.30	1.60

TABLE OF BRIGHTNESS VALUES IN CANDLE-POWER PER SQUARE INCH

White paper in bright sunlight	15
Coal gas flame	3
Kerosene flame	0.9
Acetylene flame	30–60
Welsbach mantle (mean)	30
Carbon filament	750
Tungsten filament (ordinary vacuum practice)	1,000
Tungsten filament (ordinary gas-filled practice)	2,000–7,000
Nearnst lamp glower (max.)	3,000
Lime light	2,000
Tungsten filament (special practice)	24,000
The sun at mid-day	660,000

CURRENT REQUIRED BY MOTORS

H. P.	Direct-Current Motors			Alternating-Current Motors								
				Single Phase			Two Phase (4 wire)			Three Phase (3 wire)		
	110 V.	220 V.	500 V.	110 V.	220 V.	500 V.	110 V.	220 V.	500 V.	110 V.	220 V.	500 V.
1	9	4.5	2.0	14	7	3.1	6.4	3.2	1.4	7.4	3.7	1.6
2	17	8.5	3.7	24	12	5.3	11	5.7	2.5	13	6.6	2.9
3	26	13	5.6	34	17	7.5	16	8.1	3.5	19	9.3	4.1
5	40	20	8.8	52	26	11	26	13	5.5	30	15	6.4
7½	60	30	13	74	37	16	38	19	8.1	44	22	9.3
10	76	38	17	94	47	21	44	22	10	50	25	12
15	112	56	25				66	33	15	76	38	17
20	150	75	33				88	44	19	102	51	22
30	226	113	50				134	67	29	154	77	33
40	302	151	66				178	89	39	204	107	45
50	368	184	81				204	102	45	236	118	52
75	552	276	122				308	154	68	356	178	77
100	736	368	162				408	204	90	472	236	104
150	1,110	555	244				616	308	135	710	355	156
200	1,474	737	324				818	409	180	940	470	208

This table gives the current taken, at full load, by various sizes of electric motors for direct and alternating current at the ordinary pressures of 110, 220 and 500 volts. The current taken by direct current motors depends upon the efficiency, and with alternating-current motors it also depends upon the power factor. These qualities vary somewhat in motors of different make, so the above values must be considered as fair averages. They are useful in making wiring calculations, fixing size or fuses, etc. The current given for two-phase motors is the full-load current taken in each phase; the current for the three-phase motors is the current in each of the three-line wires.

VOLTS LOST ON COPPER WIRE

Table of volts lost or drop per ampère per 1,000 feet of conductor. (Calculated by $E = I \times R$. Formula (29).) Copper wire, B. & S. gauge (70° F.).

Size, B. & S.	Volts Drop per Ampère per 1,000 Ft.	Size, B. & S.	Volts Drop per Ampère per 1,000 Ft.
0000	.0493	17	5.088
000	.0621	18	6.415
00	.0783	19	8.089
0	.0987	20	10.20
1	.1242	21	12.86
2	.1570	22	16.22
3	.1980	23	20.45
4	.2496	24	25.79
5	.3148	25	32.52
6	.3970	26	41.01
7	.5006	27	51.72
8	.6312	28	65.21
9	.7958	29	82.23
10	1.040	30	103.7
11	1.266	31	130.7
12	1.696	32	164.9
13	2.012	33	207.9
14	2.537	34	262.2
15	3.200	35	330.6
16	4.035	36	416.8

SIZE OF WIRES FOR MOTORS OF DIFFERENT HORSE POWER

DIRECT CURRENT

	110 Volts			220 Volts		
H. P.	Full-load Current	Size of Wire Mains	Size of Wire Branches	Full-load Current	Size of Wire Mains	Size of Wire Branches
1	8	14	14	4	14	14
2	15	14	12	8	14	14
3	23	10	8	12	14	14
4	30	8	6	15	14	12
5	38	6	6	19	12	10
7.5	56	5	4	28	8	8
10	75	3	1	38	6	6

SINGLE-PHASE

1	12	....	12	6	....	14
2	23	....	8	11	....	12
3	33	....	6	16	....	10
4	44	....	4	22	....	8
5	53	....	3	26	....	6

THREE-PHASE

1	....	....	....	3	14	14
2	....	....	....	5	14	14
3	....	....	....	8	14	14
4	....	....	....	10	14	14
5	....	....	....	13	14	12
7.5	....	....	....	19	12	8
10	....	....	....	26	8	6

CONVERSION TABLES

(1) Watts to Horse Power

Watts	Horse Power	Kilowatts	Horse Power
1	.0014	.5	.670
5	.0067	.75	1.005
10	.0134	1.0	1.34
20	.0268	2.0	2.68
25	.0335	3.0	4.02
30	.0402	4.0	5.36
40	.0536	5.0	6.70
50	.067	6.0	8.04
75	.100	7.0	9.38
100	.134	8.0	10.0
200	.268	9.0	12.1
250	.335	10.0	13.4

(2) Horse Power to Watts

Horse Power	Watts	Horse Power	Kilowatts
1/16	46.62	4	2.984
⅛	93.25	5	3.730
¼	186.5	6	4.476
½	373.0	7	5.222
¾	559.5	8	5.968
1	746.0	9	6.714
2	1492.0	10	7.460
3	2338.0	20	14.920

POWER REQUIRED FOR DRIVING FANS

Diameter of Blades	Power required in Watts	Approx. cub. feet of Air moved per hour	Average Speed in Revolutions per minute
12 inches	50	60,000	1,000
15 "	70	72,000	900
18 "	100	120,000	750
24 "	200	300,000	600
30 "	350	420,000	500
36 "	450	720,000	450
42 "	550	840,000	360
48 "	650	1,000,000	300

SPARKING DISTANCES IN AIR

Volts	Distance (Inches)	Volts	Distance (Inches)
5,000	.225	60,000	4.65
10,000	.47	70,000	5.85
20,000	1.00	80,000	7.1
30,000	1.625	100,000	9.6
35,000	2.00	130,000	12.95
45,000	2.95	150,000	15.00

Inches to millimetres

Inches		mm.		cm.
1/16	=	1,58	=	0.16
1/8	=	3,17	=	0,32
1/4	=	6,35	=	0,63
3/8	=	9,5	=	0,95
1/2	=	12,7	=	1,27
5/8	=	15,9	=	1,59
3/4	=	19	=	1,9
7/8	=	22,2	=	2,2
1	=	25,4	=	2,54
2	=	50,8	=	5,08
3	=	76,2	=	7,6
4	=	101,6	=	10,1
5	=	127	=	12,7
6	=	152	=	15,2
7	=	177	=	17,7
8	=	203	=	20,3
9	=	229	=	22,9
10	=	254	=	25,4
11	=	280	=	28
12	=	304	=	30,4

The above values are correct to 1/2 mm.

Centimetres to inches

cm.		inches
1	=	3/8
2	=	13/16
3	=	1 3/16
4	=	1 9/16
5	=	1 31/32
6	=	2 3/8
7	=	2 3/4
8	=	3 5/32
9	=	3 9/16
10	=	3 15/16
11	=	4 5/16
12	=	4 11/16
13	=	5 1/8
14	=	5 1/2
15	=	5 15/16
16	=	6 5/16
17	=	6 11/16
18	=	7 1/16
19	=	7 1/2
20	=	7 7/8

The above values are correct to 1/32 in.

TABLE OF ELECTRICAL UNITS

Name of Unit	Usually Expressed	Repre-senting	Equivalent to
Volt	E.M.F.E.	Pressure	Ampères × Ohms
Ampère	C.; A.	Current	Volts ÷ Ohms
Ohm	R.	Resistance	Volts ÷ Ampères
Watt	W.	Power	Amp. × Volt; $^1/_{746}$ H.P.
Kilowatt	K.W.	Power	1,000 Watts; 1⅓ H.P.
Kilowatt-Hour	K.W.H.	Work	1,000 Watt-hours
Horse Power	H.P.	Power	746 Watts
Horse Power Hour	H.P. Hour	Work	746 Watt-hours

CAPACITY OF FUSE WIRES

Dia. in 1/1,000 in.	Copper Ampères	Wires Tin Ampères	Lead Ampères
92	286.0	46.0	38.0
63	166.0	26.0	22.2
48	105.0	17.0	14.0
36	70.0	11.2	9.4
28	48.0	7.7	6.5
22	33.5	5.4	4.5
18	24.8	4.0	3.35
15	18.4	3.0	2.5
12	14.1	2.8	2.0
10	11.5	1.8	1.5
9	9.0	1.5	1.2
7	6.8	1.0	.9
6	4.7	.76	.64
4	3.5	.55	.45

REFLECTING POWER OF WALLS, PAPER, ETC.

Black Cloth .... 1 per cent.
Chocolate Paper .... 5 per cent.
Dark Red .... 12 per cent.
Dark Brown .... 13 per cent.
Blue .... 25 per cent.
Yellow .... 40 per cent.
White Glazed .... 75 per cent.

APPROXIMATE LOSS OF LIGHT DUE TO ARC LAMP GLOBES

Clear Glass .... 12 per cent.
Light Ground Glass .... 30 per cent.
Heavy ditto .... 45 per cent.
Thin Opal .... 45 per cent.
Heavy Opal .... 60 per cent.
Holoplane (cut glass) .... 15 per cent.

A comparison of the following tables will show the superiority of using direct current from the basis of energy consumed and greater candle-power from the tained. It is regrettable that the quality of the light from direct current cannot be shown in this table of comparative results.

Comparison of candle-powers obtained from alternating and direct current circuits with a given current consumption:

Arc amperes	Candle-power using A. C.	Candle-power using D. C.
20	624	4,900
25	894	6,220
30	1,700	8,750
40	1,830	12,000
50	4,566	16,500
60	4,650	.....

WATTS CONSUMED PER HOUR FOR A GIVEN CANDLE-POWER

Candle-power	I. C. with resistance	A. C. with resistance	A. C. with economizer	A. C. with rectifier
4,000	1,900	5,800	1,700	1,300
5,000	2,250	6,900	2,200	1,500
6,000	2,600	....	....	1,800
7,500	3,100	....	....	2,250
10,000	3,800	....	....	2,700
12,000	4,400	....	....	3,200
16,500	5,500	....	....	3,900

EQUIVALENTS OF UNITS OF LENGTH

	Millimeter	Centimeter	Meter	Kilometer	Mil	Inch	Foot	Yard	Mile (Stat.)	Mile (Geog.)
Millimeter	1	01	.001	.000001	39,37079	.039371	.003281	.001094	.0000006	.0000097
Centimeter	.10	1	1	.00001	393.7079	.3937079	.032809	.010936	.0000062	.000007
Meter	1000	100	1	.001	39,370.79	39.37079	3.28090	1.09363	.000621	.000716
Kilometer	1,000,000	100,000	1000	1		39,370.79	3280.899	1093.633	.621382	.716330
Mil	.025399	.0025399	.0000254		1	001	.000083	.000028		
Inch	25.3994	2.53994	.025399	.0000254	1000	1	.083333	.027777	.0000158	.000015
Foot	304.7945	30.47945	.304795	.0003084	12000	12	1	.333333	.000189	.000104
Yard	914.3835	91.43835	.914384	.0009144	36000	36	3	1	.000568	.000493
Mile (Statute) ...		160,931.4	1.609.314	1.609314		63,360	5280	1760	1	.868381
Mile (Geog'ph.) .		185,329	1853.29	1.85329		72,963,2	6080.27	2026.76	1.1516	1

TABLE SHOWING CARRYING CAPACITY OF WIRES: DISTANCE TO WHICH FULL LOAD MAY BE CARRIED AT 2 VOLTS DROP AND NUMBER OF LIGHTS EQUIVALENT TO FULL CURRENT GIVEN

B. & S. Gage	Rubber Insulation	Distance in Feet Causing a Loss of 2 Volts	Total Capacity in Watts		Total Number of Lamps of Different Voltages and Wattages that may be supplied											
					25-Watt		40-Watt		60-Watt		100-Watt		150-Watt		250-Watt	
	Ampères		110 V.	220 V.	110 V.	220 V.	110 V.	220 V.	110 V.	220 V.	110V.	220 V.	110V.	220V.	110V.	220V
14	15	26	1650	3300	66	132	41	82	27	54	16	33	11	22	6	13
12	20	30	2200	4400	88	176	55	110	36	73	22	29	14	29	8	17
10	25	38	2750	5500	110	220	68	137	46	91	27	55	18	36	11	22
8	35	43	3850	7700	154	308	96	192	64	128	38	77	25	51	15	30
6	50	50	5500	11000	220	440	137	275	91	183	55	110	36	73	22	44
5	55	56	6050	12100	242	484	151	302	100	201	60	121	40	80	24	48
4	70	56	7700	15400	308	616	192	385	128	256	77	154	49	99	30	61
3	80	61	8800	17600	352	704	220	440	146	292	88	176	58	117	35	70
2	90	68	9900	19800	396	792	247	494	165	330	99	198	66	132	39	78
1	100	67	11000	22000	440	880	275	550	183	366	110	220	73	146	44	88
0	125	78	13750	27500	550	1100	343	686	229	458	137	274	91	182	55	110
00	150	82	16500	33000	660	1320	412	824	275	550	165	330	110	220	66	132
000	175	89	19250	38500	770	1540	481	962	320	640	192	384	128	256	77	154
0000	225	87	24750	49500	990	1980	618	1236	412	824	247	494	165	330	99	198
200000	200	92	22000	44000	880	1760	550	1100	367	734	220	440	146	292	88	176
300000	275	104	30250	60500	1210	2420	756	1512	504	1008	302	604	201	402	121	242
400000	325	114	35750	71500	1430	2860	893	1786	596	1192	357	714	238	476	143	286
500000	400	117	44000	88000	1760	3520	1100	2200	733	1466	440	880	293	586	176	352
600000	450	123	49500	99000	1980	3960	1237	2474	825	1650	495	990	330	660	198	396
700000	500	130	55000	110000	2200	4400	1375	2750	916	1832	550	1100	366	732	220	440
800000	530	135	60500	121000	2420	4840	1512	3024	1008	2016	605	1210	403	806	242	484

USEFUL EQUIVALENTS FOR ELECTRIC HEATING PROBLEMS

Unit.	Equivalent Value In Other Units.
1 K. W. Hour =	1,000 Watt hours 1.34 horse power hours 2,654,200 ft. lbs. 3,600,000 joules 3,412 heat units 367,000 kilogram metres .229 lbs. coal oxidized with perfect efficiency 3.53 lbs. water evaporated at 212° F. 22.75 lbs. of water raised from 62° to 212° F.
1 H. P. Hour =	.746 K. W. hour 1,930,000 ft. lbs. 2,545 heat units 273,740 k. g. m. .175 lbs. coal oxidized with perfect efficiency 2.64 lbs. water evaporated at 212° F. 17.0 lbs. water raised from 62° F. to 212° F.
1 K. W. =	1,000 Watts 1.34 H. P. 2,654,200 ft. lbs. per hour 44.24 ft. lbs. per minute 737.3 ft. lbs. per second 3,412 heat units per hour 36.9 heat units per minute 9.48 heat units per second .2275 lbs. coal oxidized per hour 2.58 lbs. water evaporated per hour at 212° F.
1 H. P. =	746 Watts .746 K. W. 33,000 ft. lbs. per minute 550 ft. lbs. per second 2,545 heat units per hour 42.4 heat units per minute .707 heat units per second .175 lbs. coal oxidized per hour 2.64 lbs. water evaporated per hour at 212° F.
1 Joule =	1 Watt second .00000278 K. W. hour .102 k. g. m. .0009477 heat units .7373 ft. lbs.

Unit.	Equivalent Value In Other Units.
1 ft. lb. =	1.356 joules .1383 k. g. m. .000000377 K. W. hour .0001285 heat units .0000005 H. P. hour
1 Watt =	1 joule per second .00134 H. P. .001 K. W. 3.412 heat units per hour .7373 ft. lbs. per second .003 lbs. of water evaporated, per hour 44.24 ft. lbs. per minute
1 Watt per Sq. In. =	8.19 thermal units per sq. ft. per minute 120° F. above surrounding air (Japanned cast iron surface) 66° C. above surrounding air (Japanned cast iron surface)
1 Heat Unit =	1055 Watt seconds 778 ft. lbs. .252 calorie (Kg. d.) 107.6 kilogram metres .000293 K. W. hour .000393 H. P. Hour .0000688 lbs. coal oxidized .001036 lbs. water evaporated at 212° F.
1 Heat Unit per Sq. Ft. per Minute =	1221 Watts per sq. inch .0176 K. W. .0296 H. P.
1 Kilogram Metre =	7.23¼ ft. lbs. .00000366 H. P. hour .00000272 K. W. hour .0093 heat units
1 lb. Bituminous Coal Oxidized with perfect efficiency =	14,544 heat units 1.11 lbs. Anthracite coal oxidized 2.5 lbs. dry wood oxidized 21 cu. ft. illuminating gas 4.26 K. W. hours (theoretical value) 5.71 H. P. hours (theoretical value) 11,315,000 ft. lbs. (theoretical value) 15 lbs. of watei evaporated at 212° F.
1 lb. Water Evaporated 212° F. =	.283 K. W. hour .379 H. P. hour 965.7 heat units 103,900 k. g. m. 1,019,000 joules 751,300 ft. lbs. .0664 lbs. of coal oxidized

RECAPITULATIONS

DEFINITIONS OF PRACTICAL ELECTRICAL UNITS

Quantities to be Measured.	Synonyms.	Symbol.	Name of Practical Unit.	Comparative Values.	REMARKS Fundamental or absolute 51 C. G. S. Units are: Centimeter (C) for Length. Gramme (G) for Mass. Second S (3) for Time.
Current.	Strength. Intensity. Rate of Flow. Coulomb per Sec. Volume (obsolete).	I	Ampere.	Coulombs ÷ Seconds. Volts ÷ Ohms.	One Ampere deposits .0003-286 gramme, or .004991 grain of copper per second on the plate of a copper voltmeter.
Quantity.	Ampere-Second.	Q	Coulomb.	Amperes × Seconds.	One hour = 3,600 seconds; hence one ampere-hour = 3,600 ampere-seconds, or = 3,600 coulombs.
Electromotive Force. Difference of Potential.	Pressure Tension.	E M F or E	Volt.	Amperes × Ohms. Joules ÷ Coulombs.	One volt = .933 standard Daniell cell (zinc sulphate of a density of 1.4 and copper sulphate of a density of 1.1).
Resistance.		E	Ohm.	Volts ÷ Amperes.	One legal ohm is the resistance of a column of pure mercury, 1 square millimeter in section and 106 centimeters long, at °Centigrade. 1 true ohm = 1.00283 legal ohms.
Capacity.		M	Farad.	Coulombs ÷ Volts.	The microfarad, one-millionth of a farad, has been generally adopted as a practical unit; the farad is too large a unit for practical use.
Power Activity.	Electrical H. P. Rate of doing Work. Effect. Work ÷ Time.	P or Pw. or H P	Watt. (Volt-ampere).	Volts × Amperes. (Amperes) × Ohms. (Volts) ÷ Ohms. Joules ÷ Seconds.	One watt = 1/746 electrical horse power. One electrical horse power = volts × amperes / 746 One electrical horse power = (amperes) x ohms / 746 One electrical horse power = (volts) / 746 ohms
Work, Heat, Energy.	Power × Time.	W or Wj.	Joule (Volt-coulomb.)	Watts × Seconds. Volts × Coulombs. (Amperes) × Ohms × Seconds. (Volts) × Seconds ÷ Ohms.	One joule is the work done or heat generated by a watt in a second. One joule is the heat necessary to raise .238 gramme of water 1° C.; or one joule = .238 calorie or therm. One joule = .7375 foot-pound in a second.

COPY OF THE RULES

ISSUED BY THE DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY, NEW YORK CITY

The Operator's License and copy of these rules shall be displayed in a conspicuous place in the booth while the public is in or has access to the premises.

No operator shall conduct an exhibition except where to his knowledge a permit or license of the department of licenses is exhibited on the premises.

The apparatus and its construction shall be tested by the operator prior to each performance. No defective apparatus, or apparatus of a type not approved by this department shall be operated. No apparatus with a lamp served with oxy-hydrogen or acetylene gas shall be approved.

It is forbidden to overfuse (see electrical code, section 418 of the Code of Ordinances) or to make any electrical connections not sanctioned by the aforesaid chapter (see section 438).

The operator shall report promptly every defect in the apparatus or its connection, the correction of which he is unable to secure.

Badly torn films shall not be used and their presence in the booth shall be reported as soon as practical.

The booth at all times shall be kept clean. No pieces of film or loose combustible material shall be allowed to remain in the booth, unless kept in a metal box provided with a close fitting cover constructed without the use of solder.

The door of the booth shall be kept closed while the public has access to the premises.

No person shall be allowed in the booth except the manager or owner of the premises, a licensed operator, a person specially authorized by the commissioner in writing, or any duly accredited officer of the city.

The interior of the booth shall remain readily accessible to the persons mentioned in the foregoing section. The door of the booth shall not be latched on the inside nor the handle removed from the outside, nor shall any signalling device be permitted which is operated from the front of the house.

No film other than that on the machine or on the rewinder shall be exposed in the booth at any time.

No smoking is permitted in the booth at any time.

No matches, fire or open light is permitted in the booth while the public is on or has access to the house or premises.

Every fire, together with the apparent cause thereof, shall be promptly reported.

Advance report shall be made of the installation of a moving picture machine for a one night exhibition.

The apparatus shall at all times be in charge of a licensed operator.

It is forbidden to operate while under the influence of liquor or drug or to read while operating.

Certificates shall not be loaned or transferred.

COMMONWEALTH OF PENNSYLVANIA

Moving Picture Act of May 1, 1909

Section 1. That it shall be unlawful for any person, firm, association, or corporation to erect, set up, construct, maintain, or use any permanent booth or enclosure for the purpose of operating therein moving picture machines, unless they are built, erected and constructed as follows:

Size: All permanent booths or enclosures to be at least seven feet high, the floor space to vary according to the number of machines in booths or enclosures, as follows:

One picture machine, six feet by eight feet.

One picture machine and one stereopticon, nine feet by eight feet.

Two picture machines and one stereopticon, twelve feet by eight feet.

The same to be made of structural steel as follows:

Four outside horizontal members at top and bottom.

Four corner uprights and members supporting roof, to be made of one and one-half inch by one and one-half by one-fourth inch angle-irons.

Intermediate uprights to be spaced every two feet, and to be made of either one and one-half inch by one and one-half inch by one-fourth inch angle-irons or two inch by two inch by one-fourth inch tee-irons.

Tee-irons, to which roof is attached, to be made of one and one-half inch by one and one-half inch by three-sixteenth inch tee-irons.

All joints to be made with a three-sixteenth inch steel plate, to which each angle-iron or tee-iron shall be riveted or bolted by the use of at least (2) one-fourth inch bolts or rivets.

All bolts or rivets in frame to have flat heads, said heads always to be placed on exterior side of booth; all angle or tee-irons being so countersunk as to accomplish this result.

Frame to be built with a six-foot by two-foot doorway; frame of said doorway to be built of one inch by one inch by three-sixteenth inch angle-irons, which are to be joined together by the use of a three-sixteenth inch steel plate.

Covering of Booth: Sides and top of booth to be covered with asbestos boards of at least one-fourth inch in thickness; said boards to be cut and arranged that vertical joints between boards shall always come over an angle or tee-iron, so that both boards may be securely fastened to the same.

After booth is complete, all openings where combustible material is exposed must be plugged with asbestos cement, or other equally satisfactory material. When joints of asbestos boards, on outside of booth, do not come over angles of tee-irons, the cracks between the boards shall be covered by a strip of asbestos board at least one-eighth inch thick and two inches wide; said strips to be securely fastened to both boards in such manner as to cover the exposed points. The above-mentioned strips and all asbestos boards shall be secured in the proper place by the means of proper bolts and nuts; said bolts and nuts to be spaced not more than six inches apart.

Flooring: Floor shall be made of two parts, an upper and a lower floor. Lower floor shall be made of boards seven-eighth inch minimum thickness, supported on lower leg of horizontal angle-irons. Resting on this floor shall be a floor made of asbestos boards of three-eighth inch minimum thickness, or an equally good material.

Windows: There shall not be more than two windows per machine in the booth—one for the operator and one for the machine. Window for machine shall not be more than six inches high and twelve inches long, and shall be located and cut after machine is set up. Operator's window shall not be more than four inches wide or more than twelve inches high.

All windows shall be provided with gravity-doors, which, when closed, shall overlap the window opening at least one inch on all sides; said doors to be held open normally by use of a fine combustible cord in series with a fusible link, so arranged that the doors may easily be released by hand.

Main Door: Outside of door to be provided with a substantial spring, sufficient to keep door closed. Door to be provided with stop to prevent it from swinging into booth or injuring the hinges.

Shelves: To be made up of slate slabs or board not less than seven-eighth inch thick, not exceeding four feet in length or twelve inches in width. Said shelves, if of board, to be painted with at least three coats of asbestos paint, and supported by means of angle-iron. Upper shelf to be used for the rewinding and the repairing of films; the lower shelf to be used for the storage of films. A separate metal case, made without solder, shall be provided for each film when the same is not in the magazine or in the process of winding; said films to be kept in these cases.

Ventilation: Booths to be provided with an inlet in each of four sides; said inlets to be fifteen inches long, three inches high, the lower side of the same not to be more than three inches above floor level. Said inlets to be covered on the inside by a wire net of not greater than one-eighth inch mesh netting, to be firmly secured to the asbestos boards by means of iron strips and screws.

Near the center at the top of the booth shall be a circular opening of not less than ten inches in diameter; the upper side of said opening to be provided with an iron flange; which flange is to be securely fastened to the tee-irons supporting the roof. Securely fastened to this flange shall be a vent-pipe of not less than ten inches in diameter; said pipe leading to the outside of the building or to a special incombustible vent-flue. In this vent-pipe shall be placed a box containing a twelve-inch electric fan; said box to be provided with a door of sufficient size to permit of the examination or removal of this fan; this door to be made tight, and provided with proper fastenings. Box and vent-pipes to be made of galvanized iron or other non-combustible material; fan to be so connected that it can be controlled from within the booth.

Wiring: If house lights are controlled from within the booth, an additional emergency control must be provided near the main exit and kept at all times in good condition.

All electric wires to be brought in to the booth and carried to all machines, lights, et cetera, in conduits; one light will be allowed for each machine, and one for the rewinding-bench, but all such lights shall be provided with wire guards.

Rheostats: All rheostats to be mounted on slate insulator, properly supported; said supports to be made of iron and securely fastened to the floor; rheostats to be securely fastened to slate insulator.

Machine: Must be securely fastened to the floor to prevent accidental overturning of the same: Provided, that this section shall not apply to cities of the first and second clases.

Sect. 2. That it shall be unlawful for any person, firm, association, or corporation to erect, set up, construct, maintain, or use any portable booth or enclosure, for the purpose of operating therein moving-picture machines, unless they are built, erected and constructed as follows:

Size: Portable booths or enclosures are to be at least six and one-half feet high and five feet square, and are permitted for the use of one picture machine only.

Frame: The frame is to be made of standard pipe angle-iron, ventilator trap, and suitable fittings. The pipe frame and angle-iron trap are to conform strictly to specifications hereinafter set forth, and the fittings and details of construction must be approved by the Department of Factory Inspection of the Commonwealth of Pennsylvania.

Skeleton Frame: Four corner uprights, to be made of three-quarter inch standard pipe.

Eight horizontal members, to be made of three-quarter inch standard pipe.

Eight corner fittings, to be made of iron or bronze castings.

Ventilator Trap: Ventilator trap, to be made of one-inch by one-eighth inch angle-iron, shall extend full width of the top and two inches beyond the front of the top pipe; shall be suitably hinged, not less than two feet from the edge of the front angle corners, and joints to be made with one-eighth inch steel plates, riveted or bolted to each angle-iron by the use of at least two three-sixteenths inch rivets or bolts.

Covering of Booth: The side and top covering of the booth shall be made of an approved pure asbestos cloth, same as used for asbestos curtains, weighing not less than two pounds to the square yard. Seams and hems in the asbestos cloth shall lap at least one inch, and be stitched on each edge with asbestos sewing twine. The top covering shall be made separate from the side covering. It shall completely cover the top and have the outside flap hang down all around the sides, not less than six inches deep. It shall be fastened tightly and secured to the top pipes and ventilator trap by means of asbestos cords. The side covering shall be made in one piece, extending around all four sides, and overlapping at the rear of the booth not less than eighteen inches, so as to form a flap doorway. The side covering shall extend from top pipes— to which it shall be suspended by approved metal hooks or rings, spaced not more than twelve inches apart—to the floor, with a flap of not less than three inches all around resting on the floor. The metal hooks or rings for suspending the side covering shall be attached to the hem of the cloth by means of a metal strap and two rivets. The side covering shall be drawn down tight and secured to the bottom pipe frame by means of asbestos tie cord. The cloth covering for top and sides must at all times be kept free from rents or holes and be maintained in good condition.

The side covering shall overlap eighteen inches in the rear of the booth. This overlap shall extend from top to bottom and shall be so arranged as to form a means of entrance and egress.

Flooring: The frame shall be placed on a mat or carpet made of approved asbestos cloth, not less than seven feet square. This mat must be spread out smoothly on a substantial floor or platform, so that it shall extend one foot from the frame on all sides.

Ventilation: The top of the frame shall be fitted at the rear with a hinged ventilator trap, as described in foregoing section of frame. The asbestos cloth top covering shall be so arranged and so attached to the frame that, when the hinged trap is raised, the asbestos covering shall be raised also in the rear.

Windows: The look-out window for the operator shall be not more than four inches wide and twelve inches high. The windows for the machine shall not be more than six inches high and twelve inches long. All windows shall be located and cut after machine is set up.

The openings shall be cut in the cloth with care and the edges reinforced by stitched hems of asbestos cloth; they shall be provided with asbestos flaps, securely stitched at the top of the openings. These flaps, when closed, shall overlap the window opening at least two inches on the bottom and sides, and shall be weighted across the bottom edge by a piece of three-eighth inch pipe, or equal weight of metal, securely sewed in the pocket in the cloth.

Window Shutters and Ventilator Trap: The window flaps or shutters are to be held open normally by the use of a fine combustible cord. The hinged ventilator trap is to be raised, for ventilation, not more than six inches at the rear, and shall be held open by a collapsible prop sustained by fine combustible cord. The cord from the window shutters and the ventilator prop shall be in series with a fusible link, and also approved tension clip, so arranged that the automatic opening of the link, or release of the tension clip by the operator, will insure the immediate closing of all openings by the dropping of the flaps and the ventilator trap. This fusible link and tension clip shall be arranged in a position directly over the machine, within reach of the operator.

Provided, hovever, that portable booths or enclosures shall not be permitted to be used in any theatre or public hall in which permanent booths or enclosures have been installed; it being the intention of this section that portable booths or enclosures shall be used only for temporary exhibitions of moving pictures in places of assemblage—such as schools, churches, association halls, lodge rooms, theatres—without permanent booths. Provided, That this section shall not apply to cities of the first and second classes.

Sect. 3. It shall be the duty of the Department of Factory Inspection, by and through its Chief Factory Inspector, his deputy or deputies, to take such means as it may deem necessary to enforce the provisions of this statute. It shall be the duty of said Chief Factory Inspector, his deputy or deputies, within a reasonable time after the approval of this act, to inspect all booths or enclosures in which moving pictures are now being operated. Any such person or persons, who shall fail to comply with the said order of abatement or discontinuance, so issued as aforesaid, shall be deemed guilty of a misdemeanor, and, on conviction, shall be punished by a fine of not less than twenty-five dollars and not more than five hundred dollars, or an imprisonment in the county jail for a term of not less than ten days nor more than ninety days, within the discretion of the court, for each and every such violation.

Sect. 4. Any person or persons who violate or ignore any of the provisions of sections one and two of this act shall be deemed guilty of misdemeanor, and on conviction thereof shall be punished by a fine of not less than fifty dollars and not more than five hundred dollars, or an imprisonment in the county jail for a term of not less than ten days nor more than ninety days, for each and every violation.

Laws 1909; No. 206; page 346.

Laws 1911; page 64.

§ 1. That it shall be unlawful for any person or persons to give or participate in, or for the owner or owners of any building, tent, tents, or any premises, lot, park, or common or anyone having control thereof to permit within said building, tent or tents, or any premises, lot, park or common, the exhibition of any fixed or moving pictures of a lascivious, sacrilegious, obscene, indecent, or of an immoral nature and character or such as might tend to corrupt morals.

§ 2. Any person who shall violate any of the provisions of the 1st section of this act shall be deemed guilty of misdemeanor and upon conviction thereof shall be sentenced to pay a fine not exceeding $1,000 or suffer an imprisonment in the jail of the proper county for a period not exceeding one year, or either or both, within the discretion of the court.

Laws 1911; page 746.

To regulate the construction, maintenance and inspection of buildings used for the exhibition of moving pictures in all cities of the first class.

Laws 1913; No. 229.

§ 4 (on page 230). The annual license fee for any places of amusement, buildings, tents or inclosures, or any part thereof situated in any city, borough or township of this commonwealth, which is used for the exhibition of fixed or moving pictures or stereoptican views exclusively (whether scenery or apparatus are employed or not) shall be $25, irrespective of the number of chairs or seating capacity of such places of amusement, buildings, tents or inclosures. (State Board of Censors.)

Laws 1915; No. 239.

§ 2. It shall be unlawful to sell, lease, lend, exhibit or use any motion picture film, reel or view, in Pennsylvania, unless the said film, reel or view has been submitted by the exchange, owner, or lessee of the film, reel or view, and duly approved by the Pennsylvania State Board of Censors.

§ 7. Upon each film, reel or view which has been approved by the board, there shall be furnished and stamped by the board the following certificate or statement: Approved by Pennsylvania State Board of Censors; and shall also furnish a certificate in writing to the same effect, which certificate shall be exhibited to any member of the board of employee thereof upon demand of the holder thereof.

In the case of motion pictures, shall be shown on the screen to the extent of approximately 4 feet of film.

In case of slides or views, each set shall have at least two slides or views shown with a similar statement.

§ 17. For the examination of each film, reel or set of views of 1200 linear feet or less the board shall receive in advance a fee of $1 and $1 for each duplicate or print thereof which must be applied for at the same time and by the same person.

§ 20. Any member or employee of the board may enter any place where films, reels or views are exhibited; and such member or employee is hereby empowered and authorized to prevent the display or exhibition of any film, reel or view which has not been duly approved by the board.

§ 24. Every person intending to sell, lease, exhibit, or use any film, reel or view in Pennsylvania shall furnish the board when the application for approval is made, a description of the film, reel or view, to be exhibited, sold or leased, and the purposes thereof, and shall submit the film, reel or view to the board for examination; and shall also furnish a statement or affidavit that the duplicate film, reel or view is an exact copy of the original film, reel or view, as submitted for examination to the board and that all eliminations, changes or rejections, made or required by the board in the original film, reel or view has been or will be made in the duplicate.

§ 25. It shall be unlawful for any person to hinder or interfere in any manner with any member or employee of the board while performing any duties in carrying out the intent or provisions of this act.

§ 26. If any elimination or disapproval of a film, reel or view is ordered by the board, the person submitting such film, reel or view for examination will receive immediate notice of such elimination or disapproval, and, if appealed from, such film, reel or view will be promptly re-examined, in the presence of such person, by two or more members of the board and the same finally approved or disapproved promptly after such re-examination, with the right of appeal from the decision of the board to the Court of Common Pleas of the proper county.

§ 27. Any person who violates any of the provisions of this act and is convicted thereof summarily before any alderman, magistrate or justice of the peace, shall be sentenced to pay a fine of not less than $20 nor more than $50 for the first offense. For any subsequent offense the fine shall not be less than $50 nor more than $100. In default of payment of a fine and costs, the defendant shall be sentenced to imprisonment, in the prison of the county where such offense was committed, for not less than 10 days and not more than 30 days.

§ 28. If any person shall fail to display or exhibit on the screen the approval seal as issued by the board of a film, reel or view which has been approved and is convicted summarily before any alderman, magistrate or justice of the peace, he shall be sentenced to pay a fine of not less than $5 and not more than $10; in defaut of payment of a fine and costs, the defendant shall be sentenced to imprisonment in the prison of the county where such offense was committed for not less than two days and not more than five days.

NEW YORK

Penal Law.
Con. Law; Ch. 40.

§ 484; Sub. 1.—Any person who admits to or allows to remain in any kinetoscope or moving picture performance owned, leased, managed or controlled by him or by his employer, or where such person is employed or performs such service as door keeper or ticket seller or ticket collector, any child actually or apparently under the age of sixteen years, unless accompanied by its parent or guardian, or unless such kinetoscope or moving picture exhibition is given under the auspices or for the benefit of any school or church or educational or religious institution not operated for profit, is guilty of a misdemeanor.

Penal Law.
Con. Law; Ch. 40.

§ 485. Certain employment of children under the age of sixteen years prohibited.

Sub. 5 (as amended by Law 1916; Ch. 278).

But this section does not apply to the employment of any child in posing or acting, or as a subject for use, in or for, or in connection with, the making of a motion picture film with the written consent of the mayor of the city, or the president of the board of trustees of the village where such concert or exhibition takes place. Such consent shall not be given unless 48 hours previous notice of the application shall have been served in writing upon the society mentioned in section 491 of this chapter (Society for the Prevention of Cruelty to Children), if there be one within the county, and a hearing had thereon if requested and shall be revocable at the will of the authority giving it. It shall specify the name of the child, its age, the names and residence of its parents or guardians, the nature, time, duration and number of performances permitted, together with the place and character of the exhibition; and where any child is to be employed in the making of a motion picture film it shall provide that the child is to be employed only in the manner described and set forth in the statement in writing submitted with the application as hereinafter provided. Any person applying for such consent for the use or employment of any such child or children in any place in the state, in posing or acting for or as a subject for use in or in connection with the making of a motion picture film shall submit with such application a true and accurate statement in writing setting forth and describing in detail the entire part to be taken and each and every act and thing to be done and performed by such child in the making of such film, to the local official having authority to issue such permits or of any such society having jurisdiction in such place. But no such consent shall be deemed to authorize any violation of the first, second, fourth or fifth subdivision of this section.

Laws 1913; Ch. 308.

(Being Con. Laws, Ch. 20, Article 12a.) Gen. Bus. Law.

§ 209. No cinematograph or any other apparatus for projecting moving pictures save as excepted in §§ 211 and 213 of this article which apparatus uses combustible films of more than 10 inches in length, shall be set up for use or used in any building, place of public assemblage, for entertainment, unless such apparatus for the projecting of moving picture shall be inclosed therein in a booth or enclosure constructed of concrete, brick, hollow tile or other approved fireproof framework covered or lined with asbestos board or with some other approved fire resisting material, and unless such booth shall have been constructed as provided in § 210 of this article and the certificate provided in § 212 of this article shall have been issued to the owner or lessee of the premises wherein such booth is situated.

§ 210. The booth provided for in § 209 of this article shall be constructed according to plans and specifications which shall have been first approved, in a city, by the mayor or chief executive officer of the city department having supervision of the erection of buildings in such city; in a village, by the president of such village; in a town outside the boundaries of a city or village, by the supervisor of such town. Provided, however, that no plans and specifications for the construction of such booths shall be approved by any public official, unless the following requirements are substantially provided for in such plans and specifications.

1. Dimensions.—Such booths shall be at least 6 feet in height. If one machine is to be operated in such booth the floor space shall be not less than 48 square feet. If more than one machine it to be operated therein, an additional 24 square feet shall be provided for each additional machilne.

2. General Specifications.—In case such booth is not constructed of concrete, brick, hollow tile or other approved fire proof material than asbestos, such booth shall be constructed with an angle framework of approved fireproof material, the angles to be not less than 1¼ inches by 3/16 of an inch thick,

the adjacent members being joined firmly with angle plates of metal. The angle members of the framework shall be spaced not more than 4 feet apart on the sides and not more than 3 feet apart on the front and back and top of such booth. The sheets of asbestos board or other approved fire resisting material shall be at least ¼ of an inch in thickness and shall be securely attached to the framework by means of metal bolts and rivets. The fire resisting material shall completely cover the sides, top and all joints of such booth. The floor space occupied by the booth shall be covered with fire resisting material not less than ⅜ of an inch in thickness. The booth shall be insulated so that it will not conduct electricity to any other portion of the building. There shall be provided for the booth a door not less than 2 feet wide and 5 feet 10 inches high, consisting of an angle frame of approved fireproof material covered with sheets of approved fireproof material ¼ of an inch thick and attached to the framework of the booth by hinges, in such manner that the door shall be kept closed at all times, when not used for ingress or egress.

The operating windows, one for each machine to be operated therein and one for the operator thereof, shall be no larger than reasonably necessary to secure the desired service, and shutters of approved fireproof material shall be provided for each window. When the windows are open, the shutters shall be so suspended and arranged that they will automatically close the window openings, upon the operating of some suitable fusible or mechanical releasing device.

Where a booth is so built that it may be constructed to open directly on the outside of the building through a window, such window shall be permitted for the comfort of the operator, but such booth shall not be exempted from the requirement of the installation of a vent flue as hereinafter prescribed. Said booth shall contain an approved fireproof box for the storage of films not on the projecting machine. Films shall not be stored in any other place on the premises; they shall be rewound and repaired either in the booth or in some other fireproof enclosure. The booth in which the picture machine is operated shall be provided with an opening or vent flue in its roof or upper part of its side wall leading to the outdoor air. The vent flue shall have a minimum cross-sectional area of 50 square inches and shall be fireproof. When the booth is in use there shall be a constant current of air passing outward through said opening or vent flue at the rate of not less than 30 cubic feet per minute.

§ 211. Sections 209 and 210 of this article shall not be retroactive for any booth approved by the appropriate public authority or official prior to this article taking effect, provided such booth have or be so reconstructed of the same material as to have dimensions as specified in section 210 of this article; provided such booth conform to the specifications of section 210 as regards vent flue, box for storage of films, specifications for rewinding and repairing films and specifications for windows and doors, and provided such booth be of rigid fireproof material, and be insulated so as not to conduct electricity to any other part of the building and be so separated from any adjacent combustible material as not to communicate fire through intense heat in case of combustion within the booth.

§ 212. After the construction of such booth shall have been completed, the public officer charged herein with the duty of passing upon the plans and specifications therefor shall within 3 days after receipt of notice in writing that such booth has been completed cause such booth to be inspected. If the provisions of sections 209 and 210 of this article have been complied with, such public officer shall issue to the owner or lessee of the premises wherein such booth is situated a certificate stating that the provisions of sections 209 and 210 of this article have been complied with.

§ 213. Where motion pictures are exhibited daily for not more than one month, or not oftener than 3 times a week, in educational or religious institutions, or bona fide social, scientific, political or athletic clubs, a portable booth may be substituted for the booth required in sections 209 and 210 of this article. Such booth shall have a height of not less than 6 feet and an area of not less than 20 square feet and shall be constructed of asbestos board, sheet steel of no less gauge than 24, or some other approved fireproof material. Such portable booth shall conform to the specifications of section 210 of this article with reference to windows and door, but not with reference to vent flues. The floor of such booth shall be elevated above the permanent support on which it is placed by a space of at least ½ inch, sufficient to allow the passage of air between the floor of the booth and the platform on which the booth rests, and the booth shall be insulated so that it will not conduct electricity to any other portion of the building.

§ 214. (As amended by Laws 1916; Ch. 185).

The above sections 209, 210, 211, 212 and 213, referring to permanent and portable booths, shall not apply (a) to any miniature motion picture machine in which the maximum electric current used for the light shall be 350 watts. Such miniature machine shall be operated in an approved box of fireproof material constructed with a fusible link or other approved releasing device to close instantaneously and completely in case of combustion within the box. The light in said miniature machine shall be completely enclosed in a metal lantern box covered with an unremovable roof. (b) To the use or operation of any so-called miniature motion picture apparatus which uses only an enclosed incandescent electric lamp and approved acetate of cellulose or slow burning films, and is of such construction that films ordinarily used on full-sized commercial picture apparatus cannot be used therewith.

§ 215. Before moving pictures shall be exhibited with a portable booth under section 213 of this article, and before a miniature machine without a booth shall be used as prescribed in section 214 of this article, there shall be obtained from the appropriate authority, as defined in section 210 of this article, a certificate of approval.

§ 216. The violation of any of the provisions of this article shall constitute a misdemeanor. This act shall not apply to cities which have local laws or ordinances now in force which provide for fireproof booths of any kind for moving picture machines or apparatus.

Laws 1916; Ch. 184.

(Being Con. Laws, Ch. 21, § 18 and § 18a. Gen. City Law.)

§ 18. It shall not be lawful for any person or persons, save as excepted in section 18a of this article, to operate any moving picture apparatus and its connections in a city of the first class unless such person or persons so operating such apparatus is duly licensed as hereinafter provided. Any person desiring to act as such operator shall make application for a license to so act to the mayor or licensing authority, designated by the mayor, unless the charter of said city so designates, which officer shall furnish to each applicant blank forms of application which the applicant shall fill out. Such officer shall make rules and regulations governing the examination of applicants and the issuance of licenses and certificates. The applicant shall be given a practical examination under the direction of the officer required to issue such license and if found competent as to his ability to operate moving picture apparatus and its connections shall receive within 6 days after such examination a license as herein provided. Such license may be revoked or suspended at any time by the officer issuing the same. Every license shall continue in force for one year from the date of issue unless sooner revoked or suspended. Every licence unless revoked or suspended, as herein provided, may at the end of one year from the date of issue thereof be renewed by the officer issuing it in his discretion upon application and with or without further examination as he may direct. Every application for renewal of license must be made within the 30 days previous to the expiration of such license. With every license granted there shall be issued to every person obtaining such license a certificate, certifying that the person named therein is duly authorized to operate moving picture apparatus and its connections. Such certificate shall be displayed in a conspicuous place in the room where the person to whom it is issued operates moving picture apparatus and its connections. No person shall be eligible to procure a license unless he shall be of full age. Any person offending against the provisions of this section, as well as any person who employs or permits a person not licensed as herein provided to operate moving picture apparatus and its connections, shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine not exceeding the sum of $100, or imprisonment for a period not exceeding 3 months, or both.

§ 18a. Nothing contained in § 18 shall be considered to apply to any so-called miniature motion picture apparatus which uses only an enclosed incandescent electric lamp and approved acetate of cellulose or slow burning films, and is of such construction that films ordinarily used on full sized commercial picture apparatus cannot be used therewith.

Laws 1916; Ch. 622.

(Being an amendment to Workmen's Compensation Law. Con. Law, Ch. 67, § 2, group 40.)

§ 2. Compensation provided for in this chapter shall be payable for injuries sustained or death incurred by employees engaged in the following hazardous employments:

Group 40.—Manufacture of moving picture machines and films.

NEW JERSEY

All lights used in theatres shall be properly protected by globes or glass coverings, or in such other manner as the board or body having control of the extinguishment of fires in any such city shall prescribe; the owners or managers or the persons having charge thereof, shall provide, such means of communicating alarms of fire, accident or danger to the police and fire departments respectively, and shall also provide such fire hose, fire extinguishers, buckets, fire hooks, axes, fire doors and other means of preventing and extinguishing fires as the body or board having control of the extinguishment of fire shall direct; no obstruction or any article or thing whatever shall be placed in any aisle or passageway in any such theatre.

The board or body having control of the extinguishment of fires may detail not to exceed two members of its force at each and every place of public amusement where machinery and scenery are used while such place is open to the public, whose duty it shall be to guard against fire, and who shall have charge and control of the means provided for its extinguishment and shall have the direction and control of the employees of the place to which they may be detailed, for the purpose of extinguishment of any fire which may occur therein.

Any person or corporation who shall wilfully violate, or neglect or refuse to comply with any provision or requirements of this act, or any regulation, order or special direction duly made thereunder, shall for every such offense, pay to the city in which such offense shall be committed, a penalty of not less than fifty, nor more than two hundred dollars in the direction of the judge or court, which penalty may be recovered in any court now or hereafter provided for the enforcement of the ordinance of such city, and for the collection of penalties for the violation thereof, and it shall be the duty of the board or body having the control of the extinguishment of fires in such city to enforce the provisions of this act, and to arrest any person or persons who shall violate the provisions of this act, or any regulation, order or special direction duly made thereunder.

Laws 1912; Ch. 197.

§ 1. It shall be unlawful to use or to set for use any cinematograph or other apparatus or machine for projecting or exhibiting moving pictures, when such apparatus or machine uses films of a combustible material more than ten inches in length, in any building, place of public assemblage or entertainment, unless such apparatus or machine be enclosed in a booth or other enclosure covered or lined with asbestos or other strong and fire-resisting material that will withstand, on a twelve inch square sample at least a centre load of at least 250 pounds, and which shall be sufficient to resist a temperature of at least 1500 degrees Fahrenheit for at least thirty mniutes, and after which being immersed in water, will not lose more than fifty per centum of its initial strength.

§ 2. The booths provided for in the last section of this act shall be at least seven feet in height, inside dimensions; if for the use of one such machine or apparatus as is mentioned in the last section, the area occupied by such booth shall not be less than 48 square feet; if more than one such machine or apparatus is to be operated therein, an additional 24 square feet of area shall be provided. Such booth shall be constructed with a framework of iron angles not less than 1¼ inches by 1¼ inches by 3/16 of an inch thick. The adjacent iron members being firmly joined with angle plates or iron; the iron members of the framework shall be spaced not more than 4 feet apart. The fire material herein mentioned shall completely cover the sides and top; all joints of such booth and framework shall be pointed up with asbestos retort cement; the sheets of such fire resisting material shall be at least ¼ of an inch in thickness, and shall be securely attached to the iron framework by means of iron bolts and rivets. The floor of such booth shall be covered with such fire resisting material not less than ⅜ of an inch in thickness. For each booth there shall be provided a door not less than two feet in width and six feet in height, consisting of an angle iron frame covered with sheets of said fire resisting material ¼ of an inch in thickness, and attached to the framework of such booth by hinges, in such manner that the door shall be kept closed automatically at all times, when not used for ingress or egress. The windows in such booth used in connection with the machines and apparatus, and by the operators thereof, shall not be larger than is reasonably necessary to secure the desired service, and such fire resisting material shall be provided for each window and shall be so suspended and arranged that they will automatically close the window openings upon the operation of either a fusible or mechanical releasing device, with a fusible link attached, also booth to be provided with an opening for ventilation, this opening to be provided with an automatically closing door or a riveted conductor pipe to outside of building or into chimney.

§ 3. No booth of the character above mentioned shall be constructed until plans and specifications therefor have been submitted to and approved by the executive officer of the municipality wherein such booth is to be constructed, having in charge the department relating to the erection of buildings, or in municipalities where no such department exists by the executive officer or body in charge of the fire department thereof; no plans or specifications shall be approved which do not conform to the minimum requirements set forth in the last preceding section hereof.

§ 4. Every such certificate of approval shall expire in 60 days after its date, and no booth shall be erected under such certificate of approval unless the same be erected within 60 days from the date of such approval.

§ 5. After any booth shall have been constructed in accordance with the terms of this act, the owner of the premises wherein the same is to be located, or the lessee thereof, or the person for whom such booth is being constructed, shall notify the proper officer or body provided in this act, of the fact of the completion of such construction, within five days after such completion. Thereupon such officer or body shall cause such booth to be inspected, and if found to have been constructed in accordance with the plans and specifications, and with the requirements of this act, and in such manner as to render safe the operation of the apparatus or machines intended to be used therein for the purpose of projecting moving pictures, such officer or body shall issue to the owner, lessee or other person above mentioned, a certificate to that effect. Such certificate shall be posted in such public part of such booth as to enable the same to be distinctly seen from a point in such building or place of assemblage at least five feet distant from such booth.

§ 6. The board or body having charge of the supervision and control of the erection of buildings in any municipality shall prescribe the details for the submission of plans and specifications and their approval, the inspection of such booth and their approval and the issuance of ccrtificates under this act, and shall fix the fees to be paid for such certificates and inspection.

§ 7. For a violation of any of the provisions of this act the person so offending shall be fined the sum of $50; on complaint and proof of such violation before any police justice, recorder, justice of the peace or other magistrate in municipalities where the office of police justice or recorder does not exist; and such penalty shall be inflicted for each day such violation may be persisted in. Such penalty may be exacted against the owner or lessee of the premises wherein such violation occurs, or both.

§ 8. This act shall take effect immediately and all acts and parts of acts inconsistent with the provisions hereof are hereby repealed.

Laws 1914; Ch. 190.

(Being a Supplement to Laws 1912; Ch. 197.)

§ 1. The act to which this act is a supplement shall not apply to moving picture machines using only cellulose acetate films not more than 100 feet in length nor more than one inch in width and not requiring more than 500 watts of electric current to operate the arc, except when such machines are used or exhibited in theatres or public places of entertainment, regularly used as such, to which admission fees are charged.

Laws 1913; Ch. 122.

(Being a Supplement of the "City Commission Act" Law of 1911; Ch. 221.)

§ 1. In order to lessen the dangers caused by fire, explosion and panic, the board of commissioners shall have power to regulate the use of dance halls, schools, churches, opera houses, and all buildings used for public entertainment or amusement; to compel the owners, lessees, or person operating or controlling the same to provide adequate and sufficient exits and fire escapes therefrom, and to prevent the obstruction thereof; to properly guard all lights and electric wires therein; to regulate the construction, installation and use of moving picture machines, scenery and other apparatus used in such buildings.

Laws 1916; Ch. 276.

§ 1. A portable booth may be used for temporary one night exhibitions of moving pictures in places of public assemblage in such halls and buildings as are used by commercial and fraternal organizations, churches, schools, and civic societies and social clubs where by reason of the temporary nature of the entertainment it is deemed impracticable to install a permanent booth; provided, however, that no portable booth shall be used or permitted where entertainments last over three nights in succession.

§ 2. Such portable booth shall conform strictly to the following specifications: Each portable booth shall be at least 6 feet in height, inside measurements. If for the use of one picture machine, the area occupied by such machine shall be not less than 20 square feet, and 20 additional square feet for each additional picture machine to be operated therein; such portable booth shall be constructed with the framework of angle iron not less than 1¼ inches by 1¼ inches and 3/16 of an inch thick; the iron members of such framework shall be spaced not more than 4 feet apart on the sides, and not more than 3 feet apart on the front, back and top of such portable booth, and shall be enclosed and completely covered on all sides, top and bottom, with either twenty-four gauge steel plate or one-quarter inch asbestos boards, excepting that if the bottom is covered by asbestos boards said boards shall be at least $3/8$ of an inch thick. The floor of such portable booth shall be elevated above the permanent support on which it is placed by a space of at least $1/2$ inch. Each portable booth shall be provided with self-closing doors not less than two feet in width and 5 feet and 10 inches in height, consisting of an angle iron frame covered with either 24 gauge steel plate or one-quarter inch asbestos board, and attached to the framework of such portable booth by hinges, in such manner that the door shall be kept closed automatically at all times, when not used for ingress or egress. The windows in such portable booth used in connection with the machines and apparatus, and by the operators thereof, shall not be larger than is reasonably necessary to secure the desired service. Twenty-four gauge steel plate or $1/4$ inch asbestos board shall be provided for each window, and shall be suspended and arranged that they will automatically close the window openings upon the operation of either a fusible or mechanical releasing device, with a fusible link attached; and so far as possible the construction of said portable booth must meet the requirements and specifications for a permanent booth. Such portable booth may be constructed of a folding type, but in such case it must be constructed in such manner that when it is assembled for use it will be rigid with all its joints tight.

Laws 1911; Ch. 143.

§ 2. Any person having the management or control of any theatre or place wherein theatrical, acrobatic or vaudeville performances are given by paid performers, or wherein any moving picture show is given, his agents or servants, who shall admit thereto, or permit or suffer to remain therein any child under the age of sixteen years, unaccompanied by a parent, guardian or adult friend, shall be guilty of a misdemeanor and punished by a fine not exceeding one hundred dollars.

Supplement to "An Act relating to regulating and providing for the government of cities." Laws 1902; Ch. 107.

Laws 1912; Ch. 331.

§ 1. Every city of this state which has adopted or which may hereafter adopt the act to which this is a supplement shall have power by ordinance to provide regulations for operating cinematographs or moving picture machines and other similar apparatus, involving the use of a combustible film more than 10 inches in length, and any such city shall have power by ordinance to provide for and require examination by such official of said city "as the governing body thereof shall select" of any and all persons over eighteen years of age desiring to act as operators of such machines and to authorize such official to issue a license annually to such person or persons as shall successfully pass an examination conducted under rules and regulations to be approved by the governing body of any such city. Such ordinance may provide for a fee to be paid by every person to whom a license or renewal shall be issued and a penalty for operating any such machine without having such license therefore and for violation of other terms and provisions of such ordinance, in any amount not exceeding $50 for each offense or imprisonment not exceeding 30 days in default of the payment of such fine.

Laws 1917; Ch. 134.

§ 1. No licensed operator or booth shall be required for any motion picture exhibition in which the apparatus for projecting such motion pictures uses only an enclosed incandescent lamp; and only cellulose acetate or other slow burning films of a size or perforation differing from the standard as used in regularly licensed theatres, moving picture theatres or similar establishments, providing such exhibition is approved by the municipal authorities having jurisdiction.

Laws 1914; Ch. 112.

§ 1. No operator's license shall be required to operate any cinematograph or moving picture machine or other similar apparatus involving the use of a film more than 10 inches in length when such apparatus or machine uses only cellulose acetate films, or other non-explosive films not more than 100 feet in length nor more than one inch in width and does not require more than 500 watts of electric current to operate the arc.

MASSACHUSETTS

Acts 1914; Ch. 791.

§ 1. No cinematograph, or similar apparatus, involving the use of a combustible film more than ten inches in length, shall be kept or used for the purpose of exhibiting such films in or upon the premises of a public building, public or private institution, schoolhouse, church, theatre, special hall, public hall, miscellaneous hall, place of assemblage, or place of public resort, until such cinematograph or similar apparatus has been inspected and approved by an inspector of the building inspection department of the district police, who shall have placed thereon a numbered metal tag; nor until a booth, or enclosure, which has been inspected and approved by such an inspector and his certificate issued therefor, has been provided for said apparatus; nor until such precautions against fire as the chief of the district police may specify have been taken by the owner, user or exhibitor therefor; provided, however, that no such cinematograph or similar apparatus shall be operated with oxyhydrogen gas, so-called, or with limelight. In addition, in the city of Boston, the location of any booth or enclosure surrounding said apparatus, shall be approved by the building commissioner, who may order such additional precautions against fire as he may deem necessary.

§ 2. The inspectors of the building inspection department of the district police are hereby empowered and directed to inspect any cinematograph or similar apparatus involving the use of a combustible film more than ten inches in length, which is to be kept or used in or upon any of the premises defined in section one of this act; and also to inspect any booth or enclosure provided for the same; and the chief of the district police shall make such rules and regulations as he may deem necessary for the safe use thereof.

§ 3. For the inspection of a cinematograph or similar apparatus, or for the inspection of a booth or enclosure, as provided by section 1 of this act, a fee of two dollars shall be paid by the owner or user thereof.

§ 4. Except as provided for in section 6 of this act, no person shall exhibit or operate any cinematograph or similar apparatus involving the use of a combustible film more than ten inches in length, in or upon any of the premises defined in section 1 of this act, until he has received a special or first-class license so to do from an inspector of the building inspection department of the district police. No such license shall be granted until the applicant has passed an examination proving him to be thoroughly skilled in the working of the mechanical and electrical apparatus or devices used in, or connected with, the operation of a cinematograph or similar apparatus, as hereinbefore defined, and no person under twenty-one years of age shall be eligible for such examination. The fee for the examination shall be three dollars and shall accompany the application for license. The first-class license shall be for the term of one year from the date thereof, but may be renewed yearly without examination, by an inspector of the building inspection department of the district police, upon the payment of a fee of one dollar.

§ 5. Any person eighteen years of age or over, desiring to act as an assistant to a holder of a special or first-class license, shall register his name, age and address on a form furnished for the purpose by the chief of the district police; and, upon the payment of a fee of one dollar, the said chief may issue a permit allowing such person to assist such a licensed operator in a booth or enclosure; but such person shall not himself operate the cinematograph or similar apparatus. The permit shall be for the term of one year from the date thereof, but may be renewed yearly by the chief of the district police upon the payment of a fee of fifty cents.

§ 6. A second-class license giving the right to operate a hand-driven cinematograph or similar apparatus, but only in the presence of a holder of a special or first-class license, may be granted to any person who is not less than twenty years of age and who has been employed for three months as an assistant under the supervision of a licensee or licensees in or upon any of the premises defined in section 1 of this act. The applicant, as a condition of receiving the said second-class license, shall pass an examination satisfactory to an inspector of the building inspection department of the district police, and shall present to the chief of the district police an affidavit signed and sworn to by him, stating that he has so worked for said period. The chief of the district police may require that the affidavit be corroborated. The fee for the examination shall be two dollars and shall accompany the application for license. The license shall be for the term of one year from the date thereof, but may be renewed yearly by an inspector of the building inspection department of the district police upon the payment of a fee of fifty cents.

§ 7. Any person over twenty-one years of age who has held a second-class license for three months or more and has worked regularly during that period in a booth or enclosure in or upon any of the premises defined in section 1 of this act, may receive a license of the first class upon presenting to the chief of the district police an affidavit signed and sworn to by him stating that he has so worked for the said period and upon passing the examination and payment of the fee as provided for in section 4 of this act.

§ 8. Any person who has operated a cinematograph or similar apparatus under a license issued by the district police under any preceding act and any person over twenty-one years of age who presents to the chief of the district police an affidavit signed and sworn to by him stating that he has operated a cinematograph or similar apparatus in a booth or enclosure, in a theatre or hall devoted to public exhibitions of moving pictures outside the commonwealth for a period of three months or more shall be eligible for the examination for a special or a first-class license as provided in sections 4 and 10 of this act.

§ 9. A first-class license shall apply only to the operation of a hand-driven cinematograph or similar apparatus.

§ 10. The holder of a first-class license as defined in this act, or any person designated in section 8 of this act who passes an examination satisfactory to the district police, may be granted a special license to operate by hand or by motor any cinematograph or similar apparatus which has been inspected and tagged by the district police. The fee for the examination shall be three dollars and shall accompany the application for a license. The license shall be for the term of one year from the date thereof, but may be renewed yearly by an inspector of the building inspection department of the district police upon the payment of a fee of one dollar.

§ 11. An operator's license or an assistant's permit issued under this act may be suspended or revoked for cause at any time by an inspector of the building inspection department of the district police, but the person whose license or permit is so suspended or revoked may appeal to the chief of the district police, whose decision in the matter shall be final.

§ 12. Except in the city of Boston, the chief of the district police may grant permits for the special exhibition of pictures by the use of a cinematograph or similar apparatus in or upon any of the premises defined in section 1 of this act, which, in his opinion, are in safe condition for such exhibitions, and he may prescribe such regulations as he may deem necessary for the presentation of the same. A fee of two dollars shall accompany the application for each permit.

§ 13. The provisions of sections 1 to 5, inclusive, of this act, shall not apply to any cinematograph or similar apparatus operated with only cellulose acetate films not more than one inch and one-fourth in width and requiring not more than five hundred watts of electric current to operate the arc; provided, however, that such machines shall not be kept or used in or upon any of the premises defined in section 1 of this act except under such regulations as the chief of the district police shall prescribe.

§ 14. This act shall not apply to licenses or special licenses to operate cinematographs or similar apparatus issued by the district police and now in force, but upon the expiration of any such licenses the holder of a special license shall be entitled to a special license under this act upon the payment of the renewal fee as provided for in section 10, and the holder of a license shall be entitled to a first-class license under this act upon the payment of the renewal fee as provided in section 4 of this act.

§ 15. Any person, firm, corporation or association of persons, keeping or using a cinematograph or similar apparatus contrary to the provisions hereof, or in violation of any rule or regulation made by the chief of the district police, or, in the city of Boston, in violation of any regulation or requirement made by the building commissioner in accordance with the provisions hereof, shall be punished by a fine of not less than fifty nor more than five hundred dollars.

§ 16. Chapters five hundred and sixty-five and five hundred and sixty-six of the acts of the year nineteen hundred and eight; chapter two hundred and eighty-one of the acts of the year nineteen hundred and nine; chapters forty-eight and four hundred and forty of the acts of the year nineteen hundred and eleven; chapter one hundred and eighty-two of the acts of the year nineteen hundred and twelve, and all acts and parts of acts inconsistent herewith are hereby repealed.

§ 17. Notwithstanding any of the provisions of this act, the chief of the district police may grant special licenses for operators of moving pictures in churches, schoolhouses, or public institutions in the cities and towns of the commonwealth, except Boston, which, in his opinion, are in safe condition for said exhibitions, and he may prescribe regulations for the proper conduct of the same. A fee of two dollars shall accompany each application for such special license. (Approved July 7, 1914.)

REGULATIONS GOVERNING THE TRANSPORTATION OF INFLAMMABLE MOTION PICTURE FILMS

Section 246 of Article 20 of Chapter 10 of the Code of Ordinances:

"No person shall transport inflammable motion picture films in any underground subway train, or carry the same into any underground subway station, provided, however, that the provisions of this paragraph shall not apply to inflammable films transported in the course of interstate commerce in railway baggage or express cars under the jurisdiction and subject to the regulations of the interstate commerce commission. No person shall transport inflammable motion picture films in any street car, elevated train, omnibus, ferryboat or other public conveyance, or carry the same into any railway station or ferryhouse unless each film shall be separately enclosed in a tightly closed metal box. Not more than 8 films so enclosed shall be carried at one time by any person."

Adopted by the Board of Aldermen, June 8, 1915, and
Effective June 22, 1915.

QUESTIONS AND ANSWERS

Ques. What is a gramme?

Ans. Unit of weight, the weight of a cubic centimeter of water at a temperature of 4 degrees centigrade.

Ques. What is a centimeter?

Ans. The unit of length, one thousandth millionth part of a quadrant of the earth's surface.

Ques. What is a coulomb?

Ans. Unit of quantity—quantity of current which, impelled by one volt would pass through one ohm in one second.

Ques. What is a joule?

Ans. The unit of work, the work done by one watt in one second.

Ques. What is a circular mil?

Ans. A unit of area, a mil is one thousandth part of an inch, and a circular mil is the area of a circle whose diameter is one mil.

Ques. What is ohms law?

Ans. The current in amperes is equal to the electric motive force in volts, divided by the resistance in ohms.

EXAMPLE. If we had 100 volts and 4 ohms resistance in our circuit we would get the amperage (current) by dividing 100 (volts) by 4 (ohms) which would equal 25 amperes.

The resistance in ohms is equal to the electric motive force in volts, divided by the current in amperes.

EXAMPLE. If we had 100 volts and 25 amperes then by dividing 100 (volts) by 25 (ampères) we would get 4 (ohms).

The electric motive force is equal to the current in amperes multiplied by the resistance in ohms.

EXAMPLE. If we had 25 amperes and 4 ohms resistance and we multiplied them we would get 100 (volts).

Ques. How would you judge what size fuse you would use on your line?

Ans. Take into consideration the size of the wire and the amperage to be drawn, the fuse must be the weakest part of the circuit.

Ques. What is meant by conductor? What is generally used for this purpose?

Ans. Anything that allows the passage of electricity through it. Copper.

Ques. What is the carrying capacity of a No. 6 rubber covered wire?

Ans. 50 amperes.

Ques. What is the carrying capacity of a No. 6 weatherproof wire?

Ans. 65 amperes.

Ques. Name the three kinds of wire used in moving picture work.

Ans. Rubber covered wire for mains, asbestos covered wire for lamp leads used between the table switch and the arc lamp (wherever heat is generated) and stage cable used for one night stands.

Ques. State if rubber covered wire, weatherproof wire and asbestos wire are all fireproof?

Ans. No, weatherproof wire is moisture proof but not fireproof.

Ques. What size wire would you use for your mains for moving picture work?

Ans. Size 6 or larger.

Ques. What size wire would you use for your motor connections and what size fuse?

Ans. Size 14 wire and a 6 ampere fuse.

Ques. What is the carrying capacity of a 14 wire?

Ans. 15 ampres.

Ques. On direct current which wire would you connect to the top carbon?

Ans. The positive.

Ques. On which line, your positive or negative would you connect your rheostat?

Ans. On either line it makes no difference.

Ques. On which line would you connect a transformer?

Ans. A transformer must be connected to both lines of a circuit.

Ques. What is asbestos covered wire?

Ans. A cable containing very fine strands of copper wires all twisted together and the whole thing covered with asbestos.

Ques. What is rubber covered wire?

Ans. A cable either solid or stranded covered with a rubber covering and an outer protective covering of cotton braid.

Ques. What is stage cable?

Ans. A cable containing twin conductors each insulated from the other and wrapped with a composition covering.

Ques. How would you connect a lug to one of the lamp leads?

Ans. After scraping off the asbestos insulation would insert cable into hole of lug and would tighten up with pliers.

Ques. What is a short circuit?

Ans. Two wires of opposite polarity coming in contact with each other without any controlling device.

Ques. What is a rheostat and how is it constructed?

Ans. An instrument used on your line to produce resistance and bring the current to a fixed working standard.

It is made of a number of metal coils or plates (generally iron or German silver) connected in series and mounted on some insulated material, the whole thing being enclosed in a metal cabinet.

Rheostats are made both adjustable and non-adjustable.

Ques. Can you use rheostats on A. C. or D. C.?

Ans. Rheostats can be used on both A. C. and D. C., but it is cheaper to use an economizer or a transformer instead of a rheostat on A. C.

Ques. How many rheostats would you use on 110 volts?

Ans. One 110 volt rheostat in series on your line.

Ques. If automatic shutter on Powers machine refused to raise when machine started what would you do?

Ans. Put a little oil in oil hole in top of movement; if it still refused to raise, would take off casing and see if shoes or springs were caught or dirty.

Ques. Suppose the automatic shutter raised up when machine started but would not stay up what would you do?

Ans. Put a little heavy oil in movement.

Ques. Suppose the automatic shutter did not drop when machine stopped how would you fix it?

Ans. Put a little thin oil in movement, and if this failed examine shoes and springs.

Ques. What controls the size of the picture on the screen?

Ans. The focal length of the lens and the distance of machine from screen.

Ques. What would cause a travel ghost on screen?

Ans. The flicker shutter not being adjusted right.

Ques. What would happen if the take-up belt refused to drive take-up or fell off while the machine was running?

Ans. Film would bunch up around lower sprocket and then fall on floor.

Ques. Name six revolving parts on the head of machine leaving out the sprockets and idlers?

Ans. Flicker shutter, balance wheel, intermittent movement, centrifugal movement, take-up and gears.

Ques. Name the fire prevention devices on the head of machine.

Ans. Upper and lower magazines, upper and lower fire traps, upper and lower fire shields, automatic shutter, cooling plate.

Ques. In threading machine how would you put in film?

Ans. Upside down and the emulsion side towards lamphouse.

Ques. What comprises the optical system in a moving picture circuit?

Ans. The source of light, condensers and lens.

Ques. Name some of the various kinds of lenses.

Ans. Double convex, double concave, plano convex, plano concave, concavo-convex.

Ques. What is meant by the back focal length of lens?

Ans. The distance from the back of the lens to the film in gate while the picture is in focus on screen.

Ques. Of what use are the condensers?

Ans. To bring the light of arc lamp to a point of focus on aperture in gate.

Ques. Which end of the lens goes towards the screen?

Ans. The greatest convex side.

Ques. What is meant by a keystone effect?

Ans. When the machine is set up above the level of the screen and it is necessary to tilt the machine, the bottom of the picture will be wider than the top, owing to the light rays having to travel further to the bottom of the screen than to the top.

Ques. Give your definition of motion pictures.

Ans. An optical illusion based on the persistence of vision.

Ques. What is a fuse, and how many kinds are there?

Ans. A fuse is a safety device used on your line to protect your circuit. Plug fuses, cartridge fuses and link fuses.

Ques. How many sets of fuses do you use on your line for motion picture work and what would you call them?

Ans. Two, main and booth fuses.

Ques. What size fuse would you use at the main and what size at booth, using No. 6 wire?

Ans. Fifty ampere cartridge fuse at main and 45 ampere link fuse in booth.

Ques. Why not use a 45 ampere cartridge fuse in booth?

Ans. The department calls for the use of link fuses only; the reason cartridge fuses cannot be used in booth is that cartridge fuses are easily tampered with or boosted.

Ques. Why do you use a smaller size fuse in the booth than you do on your mains?

Ans. So that in case of trouble the fuse in the booth will go first (it being the weakest part of the circuit) and you will not have to run down to main fuses in cellar, as you would have to do if main fuses were to blow.

Ques. How would you install a link fuse?

Ans. On a slate base in a metal cabinet fitted with a self-closing door.

Ques. What would happen on your line if you got a short circuit?

Ans. Blow your fuses.

Ques. Can you use a 60 ampere cartridge fuse on your mains on a No. 6 wire?

Ans. No, as this would be overfusing, the carrying capacity of a No. 6 wire is 50 amperes, and the fuses must be the weakest part of your circuit.

Ques. What is an ampere, a volt and an ohm?

Ans. The ampere is the unit of current, the volt is the unit of electric motive force (or pressure), and the ohm is the unit of electrical resistance.

Ques. What is a watt?

Ans. The electrical unit of power. Amperes times volts equals watts.

Ques. What is a kilowatt?

Ans. 1,000 watts equal one kilowatt.

Ques. How many watts in one horse power?

Ans. 746 watts equal one horse power.

Ques. What is an ampere-hour?

Ans. Current in amperes multiplied by time in hours.

Ques. What is a second?

Ans. The unit of time, the time of one swing of a pendulum making 86,400 swings in a solar day.

Ques. What is meant by the safe carrying capacity of wires?

Ans. All wires will heat when a current of electricity passes through them. The greater the current or the smaller the wire, the greater will be the heating effect. Large wires are heated comparatively more than small wires because the latter have a relatively greater radiating surface.

Ques. What parts of a dynamo are liable to be short circuited?

Ans. The terminals, brush holders, commutator, armature coils and field coils.

Ques. Suppose on looking over your motor you found that there were several ridges on the commutator, where would you look for the cause?

Ans. The brushes are not set right or the tension of brushes on commutator is too great.

Ques. How would you go about setting a Simplex flicker shutter?

Ans. When setting the shutter, set the framing lever in center, move the shutter adjusting block to a point equidistant between the two pins by means of the knob on the back of the mechanism facing towards lamphouse. Four teeth on intermittent sprocket represents one full move of one section on star, moving the sprocket two teeth either backward or forward would mean center. Now adjust shutter as follows: On a three wing shutter the center of the blade with the word "Simplex" stamped on it should be on center with the lens; on a two wing shutter the center of either blade will cover the lens. The position can best be determined by the set screw on the spider, which should face the operator in a horizontal position. In setting shutter always keep as close to the lens as possible.

Ques. What is a D. C. to D. C. motor generator?

Ans. It is a D. C. motor connected to a D. C. generator, used to give a D. C. controlled light at arc, thereby doing away with the use of rheostats. When we take into consideration the fact that a rheostat on 110 volt circuit wastes from 35% to 50% of the current, and on 220 volts, rheostats waste from 65% to 75% it will be easily seen why a D. C. generator should be installed in place of rheostats.

Ques. Show by figures what would be the saving if you installed a Hallberg D. C. generator and discarded your rheostats, taking it for granted that you were drawing 80 amperes at the arc on a 110 volt circuit.

Ans. With rheostats we would be consuming 110 volts times 80 amperes or 8,800 watts, while with the generator we would be consuming 110 volts times 57 amperes (this being the amount of current generator draws from line) or 6,270 watts. With rheostats we consume 8,800 watts per hour, while with generator we only consume 6,270 watts per hour, the generator showing a saving of 1,530 watts per hour.

Ques. State what advantage a motor generator has over rheostats aside from the question of current saving.

Ans. You do away with the heat generated by the rheostats.

Ques. What is a Hallberg 4 in 1 automatic regulator?

Ans. Consists of an adjustable transformer with separate line and lamp coils. The primary coil is wound in two sections, each section insulated from the other. Each section is wound for 110 volts. For 110 volts you connect the two sections in multiple while for 220 volts you connect the two sections in series. It is used for moving picture circuits when using the mazda lamp instead of arc. (See page (?.)

Ques. What is meant by stealing the arc?

Ans. When two arcs are connected to one source of supply, as when two arcs are connected to one generator, and where the striking of the second arc automatically puts out or draws from the first arc.

Ques. What is meant by the strength of a current?

Ans. The quantity of electricity which flows past any point of the circuit in one second.

Ques. What is the difference between a dynamo and an alternator?

Ans. A dynamo generates D. C., while an alternator generates A. C.

Ques. Suppose you had one 110 volt 25 ampere rheostat connected on a 110 volt circuit D. C. and you had one 110 volt 25 ampere rheostat connected on a 110 volt circuit A. C. at which arc would you draw the most amperage and why?

Ans. On the A. C. arc because with A. C. you have to feed the carbons closer together than on D. C. and that draws a little more amperage.

Ques. How does a dynamo create current?

Ans. It does not create current but generates an induced E. M. F. which causes a current to flow through a circuit.

Ques. How should a knife switch be installed?

Ans. So that gravity tends to open same.

Ques. Is it possible to reverse the rotation of a motor, if so how?

Ans. Yes, by reversing the current through the fields or the current through the armature.

Ques. What is the difference between a D. C. and an A. C. rheostat?

Ans. Rheostats are made for either A. C. or D. C. There is no difference between them.

Ques. How many rheostats would you use on 220 volts and how would you connect same?

Ans. One 220 volt rheostat in series with your line or two 110 volt rheostats in series with each other and in series on your line.

Ques. With 55 volts coming in, how many rheostats would you use, and how would you connect same?

Ans. Use two 110 volt rheostats in multiple with each other and in series on your line.

Ques. What effect does it have by connecting rheostats in multiple and rheostats in series?

Ans. Rheostats in series give you the sum of their resistance, for instance if they each offered 4 ohms resistance and we connected same in series with each other we would have 8 ohms resistance on our line. If we connected the same two rheostats in multiple we would only then have approximately 2 ohms resistance.

Ques. Why don't they use copper coils instead of iron in a rheostat?

Ans. Because iron offers more resistance than copper, copper being a good conductor.

Ques. Is all the resistance offered in your rheostat?

Ans. No, everything on your line offers resistance, all substance offers resistance to the passage of electricity through them, the amount of resistance depending on the substance and its size, that is, on its length and cross section.

Ques. Do metals offer more or less resistance when hot?

Ans. The resistance of all metals increases with an increase of temperature, while carbons and insulating materials decrease with an increase of temperature.

Ques. Is it possible to get a short circuit in the rheostat?

Ans. Yes, when the arc lamp is burning, as you then have two polarities in rheostat.

Ques. How many kinds of current are there and state what they are.

Ans. Two, direct current and alternating current.

Ques. What is meant by direct current?

Ans. Direct current is a current that always flows in the same direction; always leaves the dynamo through the positive pole and returns through the negative pole.

Ques. What is alternating current?

Ans. Alternating current is a current that changes its flow of direction so many times a second. Each part of the circuit being so many times positive and so many times negative every second.

Ques. What is current frequency?

Ans. The number of times alternating current changes its flow of direction in a second. (These changes are called cycles.)

Ques. Which current is the best for moving picture work and why?

Ans. Direct current, gives a better arc, more easily controlled, and is not so noisy as A. C.

Ques. Is it possible to change A. C. into D. C.?

Ans. Yes, there are various machines on the market for this purpose—transverters, arc rectifiers and motor generator sets.

Ques. Suppose you had 110 volts D. C. coming into the theatre and you had one 110 volt rheostat on your line, and then the current was changed from D. C. to A. C. what changes would you make on your line and state reasons why.

Ans. Would take off the rheostat and install an economizer (step-down transformer) this would give me a saving of about 66% (makers claim).

Ques. Suppose you changed a rheostat for an economizer on a 220 volt line, would there be a saving? If so, about how much?

Ans. About 80% (makers claims).

Ques. State an easy way to test whether you have

A. C. or D. C. at arc lamp, and if you are on D. C. whether you are connected right (positive line connected to top carbon).

Ans. First strike the arc and let it burn a second or two, then throw off the switch and open lamphouse door, if both carbons remain red for the same length of time we have A. C., but should one carbon remain red longer than the other we have D. C. The top carbon should remain red longest, so if the bottom remains red longer than the top we know that we are burning upside down. (Positive line is connected to bottom carbon instead of to top).

Ques. Suppose you find you are burning upside down, where on your line would you make the change?

Ans. At table switch, arc lamp or wall switch.

Ques. Could you change polarity at the rheostat if you were burning upside down?

Ans. No, as you have only one polarity at the rheostat.

Ques. What is meant by constant current type of a current rectifying device?

Ans. Where two arc lamps are connected to one apparatus like a transverter or a motor generator, and where the voltage and not the amperage is doubled when both arcs are struck. For instance, if we had one arc operating at 55 volts and 50 amperes and we struck the second arc we should then have two arcs operating at 50 amperes 110 volts (approximately).

Ques. What is a three wire system?

Ans. A distribution system invented by Edison, where two dynamos are connected in series and the third or neutral wire is taken from a point common to both dynamos.

Ques. How many rheostats would you use if you were using the two outside wires of a three wire system?

Ans. Two 110 volt rheostats in series with each other, as between the outside wires we would have 220 volts.

Ques. Suppose you were drawing 50 amperes off one side of a three wire system and 40 amperes off the other, how many amperes would be flowing in the neutral wire?

Ans. As the amount of current in the neutral wire is the difference between the amperage drawn off either side, we would have a flow of 10 amperes in the neutral wire.

Ques. Suppose that we were drawing 45 amperes off either side of a three wire system what would be the amount of amperage flowing in the neutral wire?

Ans. If we were drawing 45 amperes off each side of the system, the system would be balanced and there would be no flow of current in the neutral wire.

Ques. What are the advantages of a three wire system?

Ans. The saving of copper is the advantage of the system, as by its use the size of the conductors may be reduced, by increasing the pressure at which the current is transmitted, without increasing the voltage of the lamps. If for example the neutral wire is made the same size as the two outside wires, the total weight of the copper for the three wire system will be three-eighths ($3/8$) of that required for two two-wire systems for the same load, distance and percentage of loss.

Ques. What are the disadvantages of a three-wire system?

Ans. The system is more complicated, the cost of the switches, panel boards, etc., is increased, that the system is more subject to disturbances, if for example the fuse on the neutral wire should melt, the lamps on the system might be considerably damaged in case the two sides of the system were not balanced.

Ques. Can you connect between the positive and neutral wire for moving picture work?

Ans. Yes, you will then need one 110 volt rheostat.

Ques. Which wire on a three-wire system is grounded?

Ans. The neutral wire.

Ques. If we were connected on the positive and neutral wires of a three-wire system, and we got a ground on the lower jaw of arc lamp, would that blow the fuse.

Ans. No, all metal machines must be grounded, and by so doing the lamphouse becomes the same polarity as the neutral wire. Therefore the ground being on lower jaw which is neutral and the same polarity as lamphouse, it may not blow the fuse.

Ques. What is a transformer, how is it made and how does it work?

Ans. A transformer consists of two copper coils, the primary and the secondary, and a laminated iron core. The two coils are insulated from one another and from the core. The primary coil is connected to the source of supply and the secondary is connected to the lamp. As a matter of fact these coils are each usually made of several sections. The voltage induced in the secondary coil is equal to the voltage impressed on the primary coil multiplied by the ratio of the number of turns in the secondary to the number in the primary coil, less a certain drop due to impedance of the coils and to magnetic leakage. This drop is negligible on no load. Step-up transformers are used to raise the voltage. Step-down transformers are used to step down the voltage. The efficiencies of transformers are high, varying from 94% to 95% at one-fourth load to 98% at full load for sizes above 25 K. W.

The current enters the transformer through the primary coil and the alternations of the current in this coil sets up a magnetic field in the transformer. The secondary cuts the lines of magnetic force and carries off a new current to the arc lamp.

Ques. Does a transformer change the current from A. C. to D. C.?

Ans. No, it gives off a magnetized A. C. current to arc lamp.

Ques. Can you use a transformer on direct current?

Ans. No.

Ques. Why do they make the core of a transformer of a soft metal like iron, instead of steel?

Ans. Because the softer the metal the more easily it is to magnetize and it will lose its magnetism quicker after the current has been shut off.

Ques. State in one word how an economizer or transformer works.

Ans. Induction.

Ques. What is meant by induction?

Ans. A charged body running parallel to another body (it being a conductor) tends to charge the neighboring body without any tangible form of connection.

Ques. How are the coils in a transformer or economizer connected, in multiple or series?

Ans. They are *not* connected, they are insulated from each other.

Ques. What is the difference between an economizer, an inductor and a step-down transformer?

Ans. None, they are all the same and answer the same purpose.

Ques. Where on your line would you connect your economizer and why?

Ans. Between the table switch and the arc lamp, so that by pulling the table switch you put the arc and the economizer out of commission at the same time, whereas if economizer was connected between the table switch and the wall switch it would be necessary to pull both switches or at least pull wall switch to put both out of commission.

Ques. How many working parts are there in a transformer?

Ans. None.

Ques. Where is the difference between a step-up and a step-down transformer?

Ans. In the ratio of the coil windings.

Ques. What is a transverter?

Ans. A motor generator set, an A. C. motor connected to a D. C. generator gives a D. C. current at arc lamp. Or a D. C. motor connected to a D. C.

generator that gives a controlled D. C. current at arc lamp.

Ques. What is a mercury arc rectifier used for?

Ans. To change A. C. to D. C.

Ques. What is the difference between a motor, a motor generator and a generator?

Ans. A motor transforms electrical into mechanical power. A generator transforms mechanical power into electrical power. A motor generator is a device consisting of a motor mechanically connected to one or more generators.

Ques. What is the difference between a starting box and a speed regulator?

Ans. Motor starting rheostats or starting boxes are designed to start a motor and bring it gradually from rest to full speed. They are not intended to regulate speed and must not be used for that purpose. Failure to observe this caution will result in burning out the resistance which in a motor starter is sufficient to carry the current for a limited time only, whereas in a speed regulator, sufficient resistance is provided to carry the full load current continuously.

Ques. What is meant by self-induction?

Ans. A characteristic of alternating current circuits, where the current tends to create a counter E. M. F. Self-induction varies greatly with conditions depending upon the arrangement of the circuit, the medium surrounding the circuit, the devices or apparatus supplied or connected in the circuit, etc. For example, if a coil having a resistance of 100 ohms is included in the circuit, a current of one ampere can be passed through the coil with an electric pressure of 100 volts, if direct current is used; while it might require a potential of several hundred volts to pass a current of one ampere if alternating current is used, depending upon the number of turns in the coil, whether it is wound on iron or some other non-magnetic material.

Ques. State six reasons for the film jumping on the screen.

Ans. Dirt on sprockets, especially the intermittent sprocket, losing the bottom loop, not enough tension in gate of machine, sprocket shaft not true, shaft bushings badly worn, holes in the films worn.

Ques. Suppose you blow the fuse when you strike the arc, where would you look for the trouble?

Ans. In the rheostat.

Ques. Suppose you blow the fuse when you close the table switch, where would you look for the trouble?

Ans. Between the table switch and the arc lamp.

Ques. If you strike the arc and only get a spark and carbons refuse to hold arc where would you look for the trouble?

Ans. Loose connection or oxidized connection in rheostat or on line.

Ques. Is it possible to get a fire on the machine, if so how?

Ans. Yes, bad patches in film opening up while going through machine, torn sprocket holes on each side of film, take-up refusing to work, automatic shutter failing to work, film breaking in gate between upper and intermittent sprocket, dirt and pieces of film gathering in film aperture in gate.

Ques. State what you would use to test for ground or open circuit in rheostat.

Ans. A bell set.

Ques. How would you test for ground and how for open circuit in rheostat?

Ans. First test bell set by connecting both terminals together, if you get a ring then set is all right and proceed as follows: Place one of the terminals of bell set on the frame of rheostat and the other terminal on the first coil or plate of rheostat, if you get a ring, then rheostat is grounded. If you do not get a ring then rheostat is free from ground. If grounded, to locate which plate or coil is causing the ground, proceed as follows: Place terminal of bell set on frame and other terminal on first coil, if you get a ring, disconnect first coil then test the second and so on till bell stops ringing. As soon as bell stops ringing it signifies that, the coil that you disconnected last is the coil that was grounded.

To test for open circuit, place the terminals of bell set on the terminals on rheostat and if you get a ring then rheostat is O. K.

Ques. If you were drawing 30 amperes on a 110 volt circuit, how many kilowatts would you be using?

Ans. Volts times amperage equals watts, so 110$\times$30 equals 3,300, and as there are 1,000 watts in a kilowatt that means that we have 3 3/10 K. W.

Ques. How would you measure a No. 6 rubber covered stranded wire?

Ans. First, scrape off the insulation, then measure one of the strands with a B. & S. wire gauge, we would find that this strand would be a No. 14, then by referring to the wire table we would find that a

14 wire contains 4,107 circular mils, then we count the strands in the cable and we find there are seven, so we multiply 4,107 by 7 which equals 28,749, then we again refer to wire table to find the nearest number to 28,749 which is 26,250 and looking across wire column we find that this is a No. 6 wire.

Ques. State how you would test lamphouse for grounds.

Ans. Take test lamp and after making sure that there was current in the lamphouse (by placing test lamp terminals on carbons) would proceed as follows: Would place one terminal of test lamp on the upper carbon and the other terminal on lamphouse, if test lamp lights, then the lower jaw must be grounded, if we do not get a light then lower jaw is O. K. Then we place one of the test lamp terminals on the lower jaw or carbon and the other terminal we place on metal of lamphouse, if we get a light then the upper jaw is grounded, if we do not get a light then the upper jaw is O. K. If machine was grounded we would of course remove ground wire before making the test as above.

Ques. Name three essential parts of a dynamo.

Ans. Armature, commutator, field coils.

Ques. What is the object of the field magnets?

Ans. To provide a field of magnetic lines of force to be cut by the armature inductors as they revolve in the field.

Ques. What is an armature?

Ans. A collection of inductors mounted on a shaft and arranged to rotate in a magnetic field with provision for collecting the current induced in the inductors.

A simple loop or turn of wire may be considered as the simplest form of armature.

Ques. What is a commutator?

Ans. A device for causing the alternating currents generated in the armature to flow in the same direction in the external circuit. It consists of a series of copper bars or segments arranged side by side forming a cylinder and insulated from each other by sheets of mica.

Ques. How do armature and field magnets differ in dynamos and alternators?

Ans. In the dynamo the field magnet is the stationary part and the armature revolves. While in an alternator the reverse is the case.

Ques. Name five parts of a dynamo.

Ans. Bed plate, field magnets, armature, commutator, brushes.

Ques. The primary coil of a transformer is supplied with a current of 25 amperes at 2,000 volts, the pressure received from the secondary is 250 volts. What is the current from the secondary coil, taking it for granted that the transformer is 100% efficient?

Ans. Input equals output. Input is 2,000 times 25 equals 50,000 watts. Watts divided by volts equals amperes, so 50,000 divided by 250 equals 200. Therefore the current from the secondary is 200 amperes.

Ques. What is the name of the coil in which the current is induced?

Ans. The scondary.

Ques. What is the proper rate of speed of showing 1,000 feet of film?

Ans. About fifteen to seventeen minutes. Or about sixteen pictures to the second.

Ques. If the machine is running at proper speed (sixteen pictures to the second) about how long is each picture held on the screen?

Ans. For one-sixteenth part of a second *less the time it takes the intermittent sprocket to move the film.*

Ques. Mention some of the different makes of moving picture machines.

Ans. Powers, Simplex, Standard, Motiograph, Baird, Edison, Lubin, Pathe, Kinemacolor, Cameron.

Ques. Which would show the greater saving, a D. C. economizer or rheostats?

Ans. The initial cost of the D. C. economizer would be greater than that of rheostats, but the working cost of the D. C. economizer would show a great saving over that of the rheostats.

Ques. Why are flicker shutters made with two or three blades when only the largest blade is used to cut off the picture from screen while the film is in motion in gate of machine?

Ans. The second and third blades are on to equalize the light.

Ques. What is a wire gauge?

Ans. A gauge used to measure wires.

Ques. What is the difference between Greenfield and B. X.?

Ans. Greenfield is a metal tubing without wires while B. X is the same tubing with wires.

Ques. Does a transformer take any current when the switch on the lamp side of same is open?

Ans. Yes. A no-load passes through the primary.

Ques. What is meant by an oil-cooled transformer?

Ans. A transformer filled with mineral oil to help keep the transformer cool, never used on moving picture work, the fire risk is too great.

Ques. What would cause the breaking of a brand new film while passing through the machine, taking it for granted that the film was handed to you in perfect condition, and that you had just run some six or seven reels of film through the machine without mishap?

Ans. Caused by the emulsion coming off the new film and adhering to the tension bars in gate of machine, which would give undue tension to the film.

Ques. What is meant by fading a picture? When and how is it done?

Ans. Fading is done by the gradual cutting off of the light (either when taking or projecting the picture). The operator fades one reel into the other when changing from one machine to the other. This is accomplished by the dowsers on the machines, by slowly closing one and at the same time slowly opening the other.

Ques. On which coil of an economizer is the greatest wattage?

Ans. As transformers are not 100% efficient there is a loss in transforming the current, this loss amounts to approximately 5% and as the output equals the input less the loss, it will mean that we have more wattage on the primary than on the secondary.

Ques. What is the inverse of resistance?

Ans. Conductivity.

Ques. State one of the disadvantages of using A. C. for motion picture work.

Ans. Both carbons form a crater and the arc keeps traveling around carbons making it difficult to get a good steady light on screen.

Ques. Of what use is the field magnet in a dynamo?

Ans. To provide a field of lines of force to be cut by the armature inductors.

Ques. State one of the advantages of A. C. over D. C. as far as transmission goes.

Ans. Reduces the cost of transmission by using high voltage and transformers.

Ques. What is the armature?

Ans. A collection of inductors mounted on a shaft and arranged to turn in a magnetic field for collecting the current induced in the inductors.

Ques. What is a commutator?

Ans. A device for causing the alternating currents generated in the armature to flow in the same direction in the external circuit.

Ques. Which end of the lens faces arc?

Ans. The flat or lesser convex end.

Ques. What would you use to scrape off the emulsion from tension bars?

Ans. Copper or any soft metal.

Ques. Where is the most luminous part of an arc?

Ans. In the crater of the positive carbon.

Ques. What is the difference between a D. C. converter and a rotary converter?

Ans. A D. C. converter converts D. C. to D. C., while the rotary converter converts A. C. to D. C.

Ques. What is meant by a circuit?

Ans. The path in which the current flows.

Ques. What is a closed circuit?

Ans. When all switches, etc., on a line are closed giving the current a continuous path.

Ques. What is meant by insulation?

Ans. Some non-conducting material on or around a conductor to prevent the escape of current.

Ques. Show by sketch how a lens is set and how it works.

Ans. See page (?)

Ques. What is a circuit breaker?

Ans. A switch which opens automatically when the current or pressure exceeds or falls below a certain fixed standard.

Ques. What effect has it by connecting dynamos in series and dynamos in multiple?

Ans. Dynamos in series increase the volts, dynamos in multiple increase the amperes.

Ques. Name a number of good conductors, fair conductors and non-conductors.

Ans. Silver, copper, mercury and aluminum are good conductors. Water, the body, and dry wood are partial conductors and mica, slate, glass are non-conductors.

Ques. Describe fully what is meant by an electric arc.

Ans. Suppose two carbons are connected in an electric circuit, and the circuit closed by touching the tips of the carbons together (striking your arc); on separating these carbons again the circuit will not be broken, providing the space between be not too great, but will be maintained through the arc formed at this point. The current is assumed as passing from the upper carbon (positive) to the lower carbon (negative). We find in a direct current arc that most of the light issues from the tip of the positive carbon, and this portion is called the crater of the arc. The lower carbon becomes pointed as the upper one hollows out to form the crater. The negative carbon is also incandescent, but not to the same extent as the positive. Between the carbons there is a band of violet light (the arc proper) and this is surrounded by a luminous zone of a golden yellow color. The carbons are worn away or consumed by the passage of the current. The positive carbon being consumed about twice as quick as the lower.

With alternating current the upper carbon becomes positive and negative alternately, and there is no chance for a good crater to be formed, both carbons giving off the same amount of light and being consumed at about the same rate.

Ques. What is a voltmeter used for and how would you connect same?

Ans. Used to measure the pressure or voltage, connected in multiple on your line.

Ques. What is an ammeter and how is it connected?

Ans. Used to measure the current or amperage, connected in series on the line.

Ques. What causes hissing of an electric arc?

Ans. Feeding carbons too close together, feeding it a higher current than that required for the length of arc employed.

Ques. What is the reason of using a cored carbon in the positive jaw of arc?

Ans. To reduce the voltage required to maintain the arc by lowering the boiling point or the vaporizing temperature of the crater.

Ques. State the advantages of rubber as an insulator.

Ans. It is flexible, fairly strong and waterproof.

Ques. Can you use a bell set to find ground in lamphouse?

Ans. Yes. Place one terminal of bell set on upper carbon and other terminal on lamphouse frame, if bell rings then the upper jaw is grounded, if no ring then upper jaw is O. K. Then place one terminal of bell set on lower carbon and other terminal on lamphouse, if bell rings then the lower jaw is grounded, if you do not get a ring then lower jaw is O. K.

Ques. How often would you test lamphouse for grounds?

Ans. Before show each day.

Ques. Suppose you found that either the upper or lower jaw was grounded, where would you first look for the trouble?

Ans. Probably the mica insulation has worked out of jaws of lamp.

Ques. State what care you would take of film while it is in your charge.

Ans. Would examine all film before showing, keep each reel in a metal box or can, and keep all these cans in another metal box constructed without solder and with a self-closing door.

Ques. Name three causes of sparking at your motor.

Ans. Dirt, uneven brushes and broken segment in the commutator.

Ques. Under what conditions can you rewind film in the booth?

Ans. Never rewind films in booth while arc is burning, or while audience is in theatre.

Ques. What would you do in case of fire in the booth?

Ans. Stop motor and switch off arc, drop the booth shutters, turn on the house lights, notify manager and try and extinguish fire.

Ques. What precautions would you take the prevent fires?

Ans. Keep all films in fireproof cans, only have the film on the way to the machine exposed at any time, keep booth free from all pieces of film and all combustible material, see that take-up and automatic shutter work O. K., keep lamphouse free from all grounds, keep all electrical connections tight, keep machine clean and in good running order, have a bucket of water and one of sand near at hand in booth, place all hot carbons into a bucket of water when you take them from arc lamp.

Ques. How would you adjust the take-up without stopping the machine?

Ans. If the belt was slipping would use a little rosin or tighten up the tension screw, or use the idler pulley if machine was equipped with one. If take-up refused to revolve the bottom reel, would stop machine and fix.

Ques. Why do they ground an all metal machine?

Ans. For safety.

Ques. How would you find the amount of resistance offered by any conductor?

Ans. The resistance of any conductor is equal to its length in feet divided by the area in circular mils multiplied by the resistance per mil-foot (which is 10.5 ohms).

Ques. What is the international ohm?

Ans. The resistance offered by a column of pure mercury 106.3 centimeters in length by one square milimeter in cross section at a temperature of zero centigrade.

Ques. What percentage of light is lost between the arc lamp and the screen?

Ans. Take the crater of arc as 100%, only 33% of this is picked up by the condensers on D. C. (On A. C. the percentage is much less.) Then there is a 16% reflection loss (4% at each of the four glass-to-air surfaces of condensers) plus an absorption loss of 9% (absorption loss being reckoned as 6% per inch, and assuming the condenser combination to have an axial thickness of 1½ inch) or, in other words, the light falling upon the condensers is subjected to a reduction of 25% in passing through them. Thus only 25.75% passes on to the film being projected. About 50% of this light will be lost passing through the film, so that only 12.85% is sent on to projection lens. In its passage through the objective lens the light is further reduced some 25% in intensity (4% reflection loss at each of the six glass-to-air surfaces) therefore but 9.65% emerges from lens. This is again cut 50% by the flicker shutter, leaving only 4.80% of the original amount emanating from arc lamp for the illumination of the creen picture. Other factors such as the distance to screen and the effective aperture of the objective also enter, so this is only a rough approximation.

Ques. What is a six to one intermittent movement?

Ans. A movement with which each picture on the film is moved into place before the aperture of the projector in an interval of time equal to one-sixth of the period required for a complete revolution of its driving member (cam).

Ques. Is both voltage and amperage used up in arc lamp, or is the voltage used up and amperage returned; or is the voltage returned to dynamo and amperage used up at arc?

Ans. The voltage is used up forcing the amperage through the resistance. The amperage returns to dynamo. This can be proved by connecting an ammeter in your circuit.

Ques. What would be the result if you lost your bottom loop?

Ans. Film would jump or break.

Ques. What regulates the speed of the reels in the upper and lower magazines?

Ans. The top reel is regulated by film tension and the lower is regulated by the tension spring and split pulley.

Ques. Of what use is the flicker shutter on head of machine?

Ans. To cut off the rays of light from screen while the film is in motion in gate.

Ques. What causes the film to remain stationary in gate of machine?

Ans. The intermittent movement.

Ques. What is it that works the automatic shutter?

Ans. The centrifugal movement.

EXAMINATION QUESTIONS

1. Name some of the different lenses used in moving picture work.

2. Under what conditions can you rewind film in the booth?

3. To which end of the table switch (lamp or line) would you connect the primary coil of a transformer?

4. How is a transformer constructed and how does it work?

5. How would you judge what size fuse to use on a line?

6. How is a rheostat made, and what is it used for?

7. Name three kinds of wires used in moving picture work.

8. What is meant by induction?

9. State the difference between an auto transformer and a step-down transformer.

10. How would you ground an all metal machine, and after you have same grounded would you expect to get a light with test lamp if you connected it between either carbon of arc lamp and the lamphouse frame?

11. Name three causes of sparking at your motor.

12. What would happen if the neutral fuse on a three-wire system was to melt, providing the system was balanced?

13. Explain fully what is meant by a D. C. economizer.

14. Show by sketch the setting of a D. C. arc and a jack-knife setting.

15. Which fuse would you remove first on a three-wire system and give reason why?

16. Where is a transverter used on A. C. or D. C.?

17. What is meant by stealing the arc?

18. Is the primary coil of an economizer connected in series or multiple on your line?

19. Is there any difference in the construction of a step-up and a step-down transformer, which is used for moving picture work?

20. Describe fully what regulates the speed of a Powers, Simplex and a Standard machine.

21. Do you get A. C. or D. C. from the secondary coil of a transformer?

22. Does the resistance of metals and carbons increase or decrease with an increase of temperature?

23. What is a rectifier used for?

24. Name the fire prevention devices on the head of machine.

25. What controls the size of the picture on the screen?

26. What precautions would you take before starting your show?

27. How many sets of fuses would you use on your line and what would you call them?

28. Of what use are the condensers?

29. Suppose when you struck the arc the fuse melted where would you look for the trouble?

30. How are the coils in a transformer connected, in multiple or series?

31. What would you do in case of fire?

32. Show by sketch how a lens works and how it is put together.

33. What is the carrying capacity of a No. 6, a No. 8, a No. 14 rubber covered wire?

34. Name the mechanical and electrical safety devices on the machine and on the line.

35. What precautions must you take when on a three-wire system?

36. Give an easy way to test for A. C. or D. C.

37. What is the back focal length of a lens?

38. Name the advantages and disadvantages of a three-wire system. State how a three-wire system is obtained.

39. What would you use to change D. C. to A. C.? Is this ever done for moving picture work? If so, state when.

40. What is a keystone effect on screen?

41. What is ohms law?

42. What is a converter and where is it used?

43. What is the difference in construction between a step-down transformer, an economizer, and an inductor?

44. What is meant by current frequency? Do we get current frequency on D. C.?

45. What is a kilowatt, and a circular mil?

46. Show by sketch two rheostats connected in multiple with each other and in series on your line. State where you would use them.

47. With two 110 volt 25 ampere rheostats connected in series, how much resistance (in ohms) will they offer in our circuit?

48. What is an electric arc?

49. Explain how you would test lamphouse and rheostat for ground.

50. What size wire would you use for motor connections and what size fuse?

51. Show by sketch two machines connected to one source of supply.

52. On which line, positive or negative, would you connect your rheostat?

53. What is the difference between A. C. and D. C.?

54. State what combination of carbons you would use if you were drawing 50 amperes D. C.

55. Name the principal parts of a dynamo.

56. How do you get the equivalent focus of a lens?

57. Explain what the flicker or light shutter is used for.

58. What is a lug?

59. Name six causes of the film jumping on screen.

60. What is the difference between a short circuit and a ground?

61. State if there would be any saving, if you installed an economizer in place of a rheostat on 110 volt A. C. circuit.

62. State how you would go about measuring a stranded and a solid wire.

63. With two 110 volt 25 ampere rheostats connected in multiple, how much resistance in ohms would they offer on our line?

64. Show by sketch a complete circuit from the main fuses in cellar up to arc lamp, taking it for granted that you have 220 volts D. C. to work on.

65. Show by sketch a complete circuit using a transformer.

66. Suppose the output of a transformer was

2,500 watts, 50 volts, what would be the amount of amperage?

67. If you connected three 110 volt 50 ampere rheostats in series, and connected them on a 220 source of supply what approximate amperage would this give you at arc lamp?

68. What would be the ohmic resistance of three 110 volts 30 ampere rheostats, connected in series?

69. What is the voltage, if we have 4½ ohms resistance on line and are getting 35 amperes at arc lamp?

70. Connected between the neutral and positive wire of a three-wire system and with 4 2/5 ohms resistance on circuit, what amperage have we at arc lamp?

71. When and how is fading done?

72. On which coil of a transformer, the primary or secondary, is the most wattage and give your reason for this.

73. State fully what precautions you would take so that you could project a picture free from frame-ups.

74. By what would you judge the proper rate of speed in projecting pictures, how long should it take you to run off a 2,000-foot reel?

75. What is the wattage on a mazda lamp used for moving picture projection work?

76. How would you measure a stranded wire?

77. Name six parts on a motor generator and state their uses.

78. What size fuse would you install providing you were connected up on a 220 volt circuit and had two 110 volt 25 ampere rheostats on your line?

79. Name three causes of your film breaking.

80. What lubricant would you use on the following parts of the machine? (*a*) Arc lamp? (*b*) Intermittent movement? (*c*) Gears? (*d*) Motor bearings?

81. Which would be the cheaper to install and which the cheapest as far as operating cost, a D. C. economizer or rheostats?

82. What would cause the breaking of a brand new film while passing through machine? Is there any way to help overcome this?

83. What is meant by a travel ghost, how would you remedy same?

84. State the working principle of a Powers intermittent movement.

85. Why are flicker shutters made with more than one blade?

86. Of what use is the loop setter and on which make of machine will you find same?

87. Is it possible to take out a travel ghost while the machine is in motion, if so how would you go about it?

88. What is a pin cross and where on the machine is it situated?

89. How should fuses be installed?

90. State one of the disadvantages of A. C. current for moving picture work.

91. Is it possible to use cored carbons on D. C.?

92. Name three good conductors, three fair conductors and three non-conductors.

93. What is meant by conductivity?

94. State how you would repair a torn film.

95. How would you determine the amount of am-

perage that would flow over a circuit in a given time?

96. What effect would it have on your rheostat, if you changed from D. C. to A. C.?

97. How would you find the saving of a D. C. economizer or a motor-generator set, over that of a rheostat?

98. Are there any precautions that should be taken with new film to prevent the breaking of same while passing through the machine?

99. Suppose you start the machine and you find lower reel is not taking up, where would you look for the trouble?

100. What is meant by the armature? Does the armature revolve in a dynamo and alternator?

101. What are the brushes in a motor made of?

102. How are the coils or plates of a rheostat connected, in series or multiple?

103. What is meant by series connection and multiple connection?

104. Suppose the film broke while passing through the machine, state exactly what you would do.

105. Is an ammeter and voltmeter connected in series or multiple on your line?

106. What is meant by reflection and refraction?

107. Why do we get double the voltage and not double the amperage, when connected between the two outside wires of a three-wire system?

108. What is meant by chromatic aberration?

109. What is a friction disc speed regulator?

110. What is an ampere-hour?

111. State the uses of following parts of the machine:

(*a*) Flicker shutter
(*b*) Balance wheel
(*c*) Speed regulator
(*d*) Intermittent movement
(*e*) Tension bars
(*f*) Centrifugal movement
(*g*) Fire traps
(*h*) Framing device
(*i*) Objective lens
(*j*) Condensers
(*k*) Dowser
(*l*) Take-up

112. State how you would clean the lenses of the machine, and what you would use for this purpose.

113. Why not use a cartridge fuse in the booth cut out?

114. What would be the result supposing you connected two 110 volt 25 ampere rheostats in multiple, on a 220 volt circuit?

115. What is meant by a balanced circuit?

116. How many volts will a No. 6 wire carry?

117. What is stage cable, rubber covered wire, and asbestos wire?

118. State in your own way how we are deceived into the belief of motion while watching pictures on the screen.

119. What is an achromatic lens?

120. What is a ground? What is a short circuit?

121. State how it is possible to get a fire on head of machine.

122. Does a transformer change A. C. to D. C.?

123. How would you go about cleaning the head of machine? What would you use for this purpose?

124. What is meant by the arc lamp burning upside down? How would you remedy this?

125. What is a frame-up?

126. State how an objective lens is put together and say exactly what it does.

127. What is the principle of the revolving shutter and how would you time it?

128. What would happen if a coil in your rheostate melted out?

129. Show by sketch two machines connected to a three-wire system, using rheostats, and mark the polarity of the wires.

(*a*) Flicker shutter
(*b*) Balance wheel
(*c*) Speed regulator
(*d*) Intermittent movement
(*e*) Tension bars
(*f*) Centrifugal movement
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