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EXTENSIONS TO THE MANHATTAN ELEVATED RY. in New York city were formally applied for hy that corporation on Jan. 31. The extensions are as follows: (1). A line from the Battery along West St. to connect with all the North River ferries, and turning hack through West 13th St. to a connection with the Sixth Ave. line. (2). A line connecting the east and west side lines through Canal and Centre Sts. (3). A line from Ninth Ave. and 53d St. along Tenth Ave., the Boulevard and Kingsbridge Road to King's Bridge. (4). A line from Tremont Ave. north via Third Ave., Pelham Ave., Kingsbridge Road and Webster Ave. to 201st St. The company agrees to complete extensions 1, 2 and 4 in two years. Extension 3 would he completed in three years to 169th St., and in two years more to a finish. The structure is to he similar to the present elevated structures. Authority is also asked to make four-track lines of all the present elevated lines, and to huild enlarged platforms at the City Hall Station. No mention is made as to the motive power to he adopted.

Under the Rapid Transit law, the Rapid Transit Commission has power to grant a franchise to the Manhattan Co. on such terms and conditions as it deems for the hest interest of the city; hut before such franchise will become operative the consents of a majority of the property-holders on the streets proposed to be occupied must he secured.

THE TRACK ELEVATION AT CHICAGO, provided for by the modified ordinances as actually passed on Jan. 24, require the elevation of 31½ miles of track, instead of the 22 miles noted in an issue of Jan. 20. The ordinances provide for abolishing 92 grade crossings and estahlishing 84 subways and openings. The total cost of the work will he about $6,000,000, of which $2,000,000 will be for the suhways. The list of the roads involved, with the length of work and number of suhways for each, is as follows:

	Miles.	No. of Suhways.
Chicago, Burlington & Quincy R. R., from Blue Island Ave. to city limits, 5½ miles; from 21st St. to Western Ave., ¾ mile...	6¼	22
Chicago & Northwestern Ry., from Blue Island Ave. to 12th St	1¾	3
Chicago Terminal Transfer R. R., from Blue Island Ave. to Kedzie Ave., 2¾; from 12th St. to 39th St., 2¼ miles; from 31st to 39th St., 1 mile	6	13
Chicago & Alton R. R., from 18th St. to Rockwell St	4½	29
Chicago, Madison & Northern R. R., from 18th St. to canal hridge	2½	2
Chicago, Rock Island & Pacific Ry., from 69th St. to 78th St	1	0
Pittshurg, Cincinnati, Chicago & St. Louis Ry., from 12th St. to 39th St., 2¼ miles; from 31st St. to 39th St., 1 mile	3¼	3
Atchison, Topeka & Santa Fe Ry., from Western Ave. to Rockwell St., ½ mile; from 18th St. to canal hridge, 2½ miles..	3	3
Union Stock Yards & Transit Co., from 12th St. to 39th St., 2¼ miles; from 31st St. to 39th St., 1 mile............	3¼	9
Total	31½	84

A COMBINATION TROLLEY AND STORAGE BATTERY electric railway system is to be tried in Hanover, Germany. The municipal regulations prevent the use of overhead wires in the huilt-up portions of the city, and as either conduit or storage system alone was considered too expensive, a plan has heen adopted whereby the trolley will be used in the suburbs and will furnish current both to the motors and to a storage battery placed under the seats of the car. When the end of the overhead wire is reached, the trolley pole will be tied down and the batteries called into service. As the length of run in the streets where trolley wires are forbidden is short, a comparatively small battery can be employed. An advantage of the system is that longer life to the battery plates is secured by the fact that the battery is not removed for recharging.

A DEVICE FOR COUNTING ELECTRIC CARS crossing the Brooklyn Bridge will shortly be tried in connection with the operation of trolley cars on the Bridge. Mr. C. B. Martin, Electrical Engineer of the Bridge, is responsible for the scheme, which is as follows: At the New York end both trolley wires will have an insulated section about 60 ft. long supplied by a tap from the feeder system. In series with this tap is an electromagnet, which tips a lever attached to a continuous counter resembling in principle a cyclometer. When a car enters this section current flows through the magnet, operates the lever and causes the counter to register. The present schedule calls for the movement of 3,000 to 5,000 cars per day across the Bridge, and the companies are to pay a toll of 5 cts. per car.

ELECTRICITY CAN BE DRAWN FROM THE EARTH is the conclusion reached by the manager of the Bell Telephone Co., St. Louis, Mo., and it is heralded by St. Louis papers as a new and wonderful discovery. The scheme is to use the leakage of the street railways to charge storage batteries or to run lights directly, by tapping the ground in different sections between which a difference of potential can be found. The idea is far from new, and its operation on any considerable scale would he absurd. The accounts of the managers' experiments, if newspaper reports are correct, indicate that proper return circuits are not provided by St. Louis electric railways, and that it is high time the city authorities looked into the matter if they do not want the underground pipes in the streets destroyed by electrolysis.

A DEPARTMENT OF ELECTRICITY FOR CHICAGO is being seriously considered and will probably be formed in the near future. The city has at present some 1,248 fire alarm boxes, 1,294 police telephone boxes, 2,700 miles of overhead wire and 860 miles of underground wire, a municipal lighting system, including 1,460 arc lamps of 2,000 c. p. and three large electric light plants. The city also contains private plants to the number of 400, and a vast quantity of wire, poles, street cars and other apparatus employed in the production and use of electricity. The care of these and the proper inspection of future work demands a special department, so that the Fire Department may be relieved of the responsibility of a branch fully as foreign to its functions as is the Building Department or Water-Works of the city.

A 108-MILE ELECTRIC TRANSMISSION PLANT is under consideratoin in Southern California. The undertaking involves the erection of a dam across the Kern River, in Kern county, Cal., and the construction of a line to convey the high tension current to Los Angeles. The Kern River drains an area of some 2,345 sq. miles, and a total of about 12,000 HP. can be obtained. A pressure of 30,000 volts is proposed for transmission. While this is exceptionally high, the dry atmosphere and infrequent rainfalls warrant its adoption. The dam already mentioned will form a storage reservoir, with a volume of about 13,721,400,000 gallons or the equivalent of 42,000 acre-feet. Should the project be carried out, it would be by far the longest electric power transmission line in the world.

THE MOTOR SUSPENSION PATENT, upon which Judge Wheeler, of the U. S. Circuit Court, based his decision in favor of the "Sprague Electric Ry. & Motor Co." (Eng. News, Jan. 27, 1897), is owned by the General Electric Co. and is No. 324,892. The following claims form the basis for his decision.

2. The combination of a wheeled vehicle and an electro-dynamic motor mounted upon and propelling the same, the field-magnet of said motor being sleeved upon an axle of the vehicle at one end, and supported by flexible connections from the body of the vehicle at the other end, substantially as set forth.

6. The combination with a wheeled vehicle, supported upon its axle by springs, of an electro-dynamic motor flexibly supported from such vehicle, and centered upon the driving axle thereof, substantially as set forth.

9. The combination with a wheeled vehicle, of an electro-dynamic motor centered upon the driving axle thereof at one end, a spring support for that end of the motor from the truck or body of the vehicle, and relieving axle wholly or partly of dead weight, and a spring support for the other end of motor from the truck or body of vehicle, substantially as set forth.

THE MOST SERIOUS RAILWAY ACCIDENT OF THE week occurred in a cut at Orono Basin Mills, Me., on the Maine Central R. R., Jan. 29. The "Provincial Express," including 5 cars and a smoker, was thrown into the ditch, killing two persons and injuring several others. The train was running about 35 miles per hour at the time of the accident, which is attributed to spreading rails.

A 5-IN. DRIGGS-SCHROEDER RAPID-FIRE GUN burst at the 73d round, while being tested at Sandy Hook, on Jan. 30. Five feet of the rear of the gun and a steel jacket were blown away and one man was injured. The gun had shown no evidence of weakness from preceding shots, and the cause of the failure is as yet unknown, though under official investigation.

NAVAL SURGEONS AS CIVIL ENGINEERS are a failure, according to the investigation going on concerning the building of a brick wall around the Naval Hospital, in Brooklyn. The government is now suing the contractor, J. M. Brosnan, to recover damages for bad work performed. Mr. F. C. Prindle, C. E., U. S. N., in charge of the Docks and Yards department, at the Brooklyn Navy Yard, reports that this brick wall, 10 ft. high and 16 ins. thick, is absolutely worthless. In some places even the outside bricks have no mortar between them; old, uncleaned brick were used, and the interior is simply a mass of broken bricks, waste and dirt, without mortar or cement. The explanation for this is that the wall was built without a regular inspector and without engineering supervision other that that performed by the surgeons stationed at the hospital. When the work was completed a board of civil engineers, appointed to pass upon it before final payment, discovered and reported the fraud.

THE NICARAGUA CANAL "CONTRACT," concerning which the New York "Herald" has exclusive information through its Panama correspondent, is an idle rumor that would not be worth contradiction did it not impugn the integrity of the engineers with the Commission. This "Herald" item credits the Commission with officially stating that the canal can be built for "less than three-fourths of the original estimates," and adds that the contract for the canal has actually been let to an Ohio and New York syndicate. It also charges that if each of the thirteen engineers with the Commission represents a separate syndicate, with a corresponding rivalry in its effort. The explanation of all this is that the "Herald" confounds the visit and statements of an independent party of Chicago contractors, now following up the Commission, with the work of the Commission itself. It is hardly necessary to state that the Commission will make its first report to the government; is not yet in a position to make any official estimates of cost, and has no power to award contracts. The item regarding the Commission's engineers is only another case of "mix" with the contractors before referred to, who represent a Chicago syndicate.

THE $11,000,000 PHILADELPHIA LOAN BILL has failed to pass the common council, but may be reconsidered. The loan is for a variety of public improvements, including $3,700,000 for the improvement of the water supply. The mayor's advisory committee has made a report urging that the water loan be made at once, and the proceeds used "for the increase, improvement and filtration of the public water supply." It also urges that the purification works should be owned and operated by the city. As we have previously noted, many propositions for filtering plants to be built and operated by private companies are now before the city. We should not be surprised, could the facts be known, if the friends of some of these propositions are behind the defeat of the loan bill. Meanwhile, the Reading Railroad Co. has renewed its proposition to give the city the perpetual use of the rights in the Schuylkill River, held by the Schuylkill Navigation Co., in return for the remission by the city of the $3,000,000 due the latter on account of the Reading subway. Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief Engineer of the Water Bureau, urges that the rights named are of little value to the city.

INTERMITTENT FILTRATION OF THE SEWAGE OF Baltimore is reported as having been adopted by the city council. Application will be made to the legislature for authority to submit to popular vote the question of issuing bonds for sewerage and sewage disposal systems.

THE FILTRATION OF THE WATER SUPPLY of the District of Columbia is recommended by Capt. D. D. Gaillard, U. S. A., Engineer in Charge of the Washington Aqueduct, and Surgeon-General Geo. M. Sternberg, U. S. A. Capt. Gaillard estimates the cost of constructing a slow sand filtration plant at $1,164,900, and a mechanical filtration plant at $810,000; the relative annual charges for operation and capital account would be, he estimates, $141,912 for slow sand, and $140,379 for mechanical filtration. Both reports advise that an expert commission be employed to report on the most suitable method for purifying the supply. Capt. Gaillard also advises the further introduction of meters to stop waste. Accompanying these reports was one on the pollution of the Potomac River, by Mr. F. H. Newell, Hydrographer U. S. Geological Survey.

VIEWS IN THE COMPLETED PORTION OF THE BOSTON RAPID TRANSIT TUNNEL.

We publish herewith a series of interior views of the new Boston Subway which bring out beautifully the clean, light and cheerful appearance of the finished structure. These views are particularly interesting in the light of the objections which are frequently raised by the opponents of underground city rapid transit lines that such tunnels are bound to be ill-ventilated and gloomy places, which the public will naturally avoid, preferring instead the surface and elevated lines where air and light are plentiful. While it has often been pointed out that the ground for apprehensions of this sort was really very small at the present time, it is nevertheless gratifying to find these claims so completely fulfilled in this first attempt at underground city passenger transit in the United States.

These illustrations have been selected from a series of heliotype views published in the Third Annual Report of the Boston Transit Commission, and we abstract from the same report some of the more interesting information regarding the interior finish, lighting, track construction, electrical equipment, etc. In our issue of May 30, 1895, we published the plans adopted for the underground construction, and in the succeeding issues of Feb. 4 and June 24, 1897, a very full description of the various methods of carrying on the work was given. In the present article this information will not be repeated.

As many of our readers know, electric cars have been in operation through a large portion of the Boston subway since Sept. 1, 1897, under contract with the West End Street Ry. Co., of Boston. This contract was signed in December, 1896, and it granted to the West End Street Ry. Co., subject to certain restrictions and limitations, "the entire use and occupation of the subway constructed and to be constructed under the subway acts." The annual rental paid by the company for this privilege is a sum equal to 4⅞% of $7,000,000, or 4⅞% of the net cost of the subway should it be less than $7,000,000. Since the average rate of interest at which the city has borrowed money to build the subway is less than 3½%, this rental leaves about 1⅜% to provide for sinking fund requirements. The street railway company was required by the contract to light the subway and to equip it with tracks, wires, fixtures, furniture and all apparatus necessary for the maintenance and operation of the railway, and also to provide such apparatus and labor as are necessary to keep the tracks, stations, etc., clean, dry, and in good sanitary condition. The available motor power was limited to electricity, compressed air or some equally clean and inoffensive agent, and the use of steam or animal motive power was wholly forbidden except in cases of temporary emergency. The various other requirements of the contract related to questions of operation, damages, alterations, repairs, etc., and are not of particular interest in this connection.

It will be seen, therefore, that the equipment of the subway for running cars was done entirely by the street railway company, subject to the approval of the Transit Commission. This part of the work is described in a statement made by the railway company to the Transit Commission as follows:

Track.—The rails used are of the standard 85-lb. section recommended by the American Society of Civil Engineers for steam railways. Each rail is protected for its entire length by a rolled steel guard rail of special section securely bolted to the track rail. This guard rails weighs 43 lbs. per yard. The track rails are laid with Continuous rail joints on oak and chestnut ties thoroughly treated with woodiline to exclude moisture, thereby ensuring better insulation and greater durability. Rolled steel tie plates are used on each tie. Each rail is bonded with two No. 0000 copper bonds, and every 500 ft. all the tracks are properly bonded together and cross connected, the return to the station being by 500,000 circular mils cables.

Overhead Work.—An inverted trough made of kiln-dried cypress lumber is securely fastened to the iron-work of the roof structure, from which it is insulated by sheet rubber. Car barn hangers are set flush into this trough and insulated with sheet rubber between the hanger and the trough. The insulating bolt, carrying a special mechanical clip, supports the trolley wire, which is of figure 8 cross-section, and has an area of about 362,000 circular mils. These hangers are placed 12 ft. apart on tangents and 6 ft. apart on curves. The current is taken from cables running in a conduit from the central power station of the railway company.

Electric Lighting System.—Both incandescent and arc lights are used to light the subway. The incandescent lamps are run in lines on each side of

FIG. 1.—BELLMOUTHS UNDER TREMONT ST. NEAR HOLLIS ST., SHOWING PASSAGE OF SOUTH BOUND SHAWMUT AVE. TRACK UNDER NORTH BOUND TREMONT ST. TRACK.

FIG. 2.—TWO-TRACK SUBWAY UNDER BOYLSTON ST. MALL, BOSTON COMMON, LOOKING EAST.

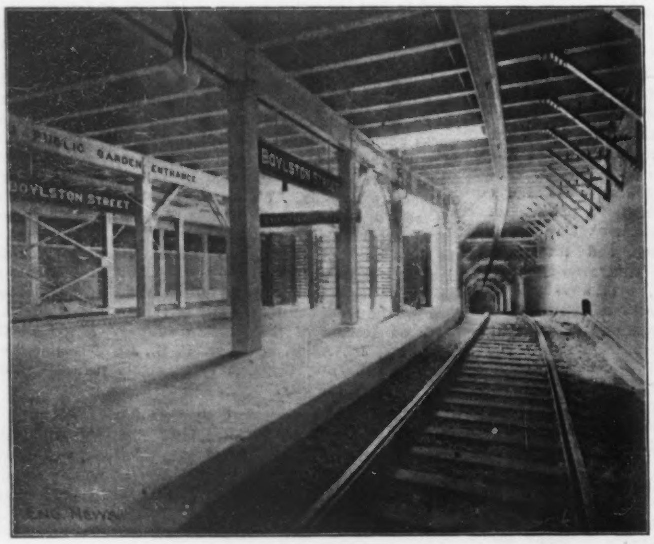


FIG. 3.—BOYLSTON ST. STATION LOOKING SOUTH TOWARD INCLINE TO SUB-SUBWAY.

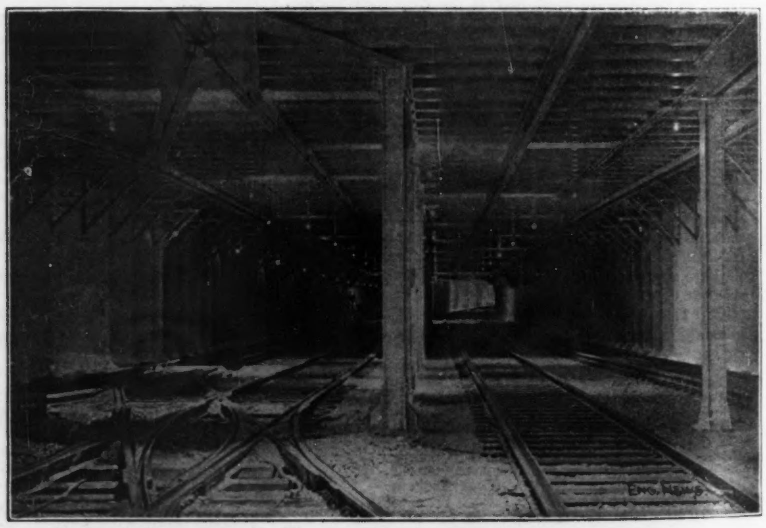
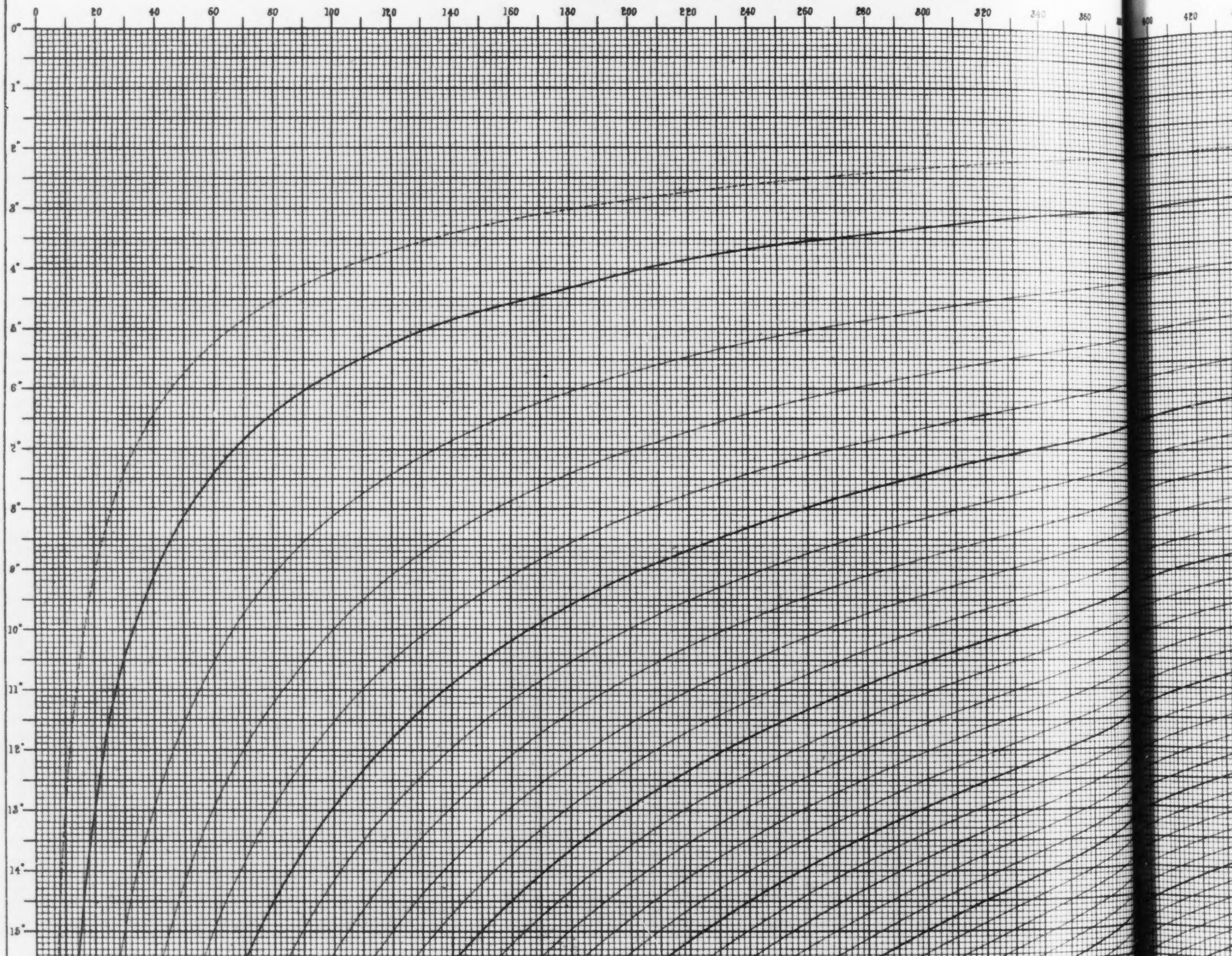


FIG. 4.—FOUR-TRACK SUBWAY UNDER TREMONT ST. MALL, BOSTON COMMON.

DIAGRAM
FOR OBTAINING THE
DIFFERENCE OF ELEVATION AND HORIZONTAL DIST
CORRESPONDING TO ANY
READING OF A VERTICAL TELEMETER.

Designed By Neville B. Craig.



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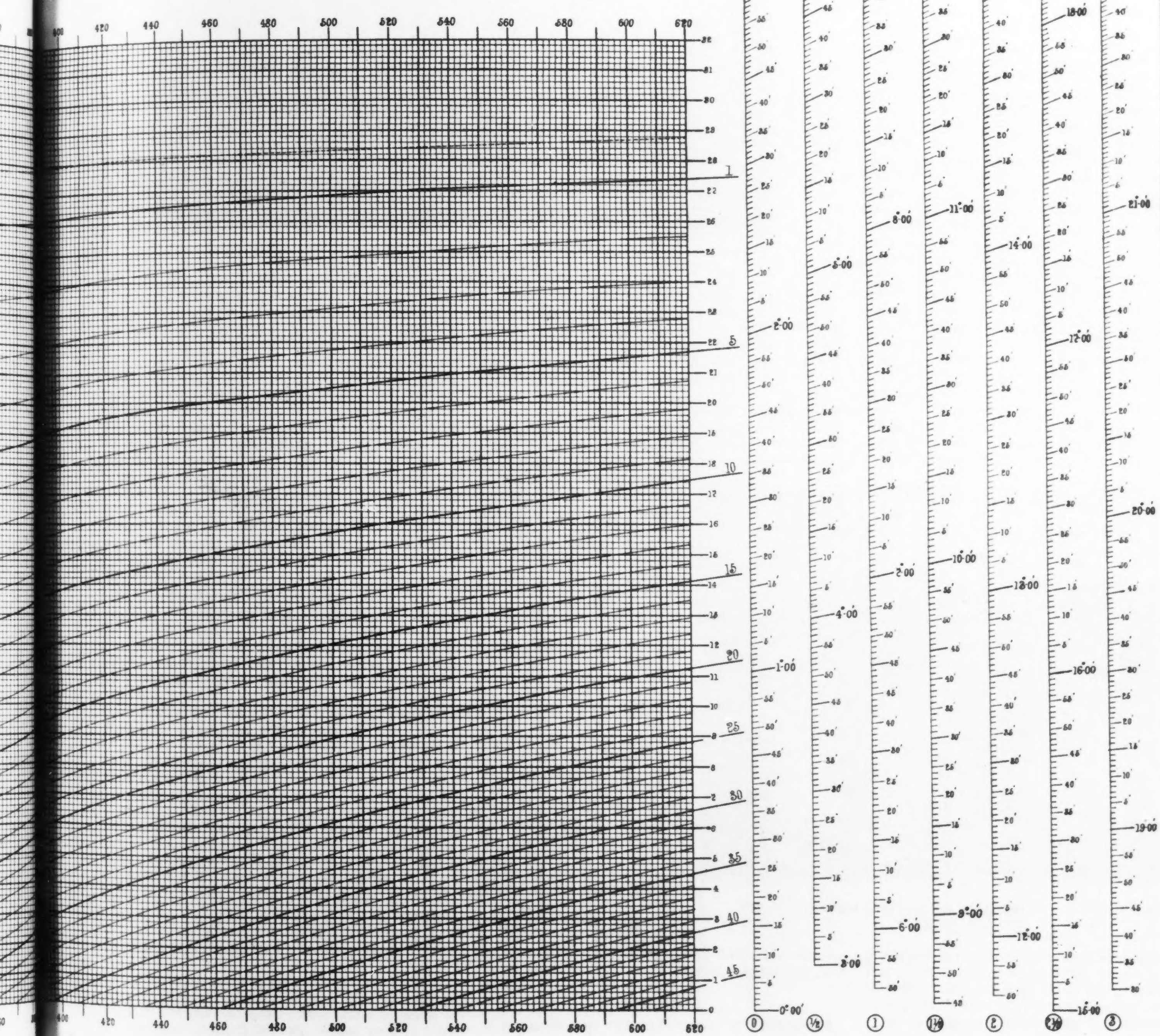
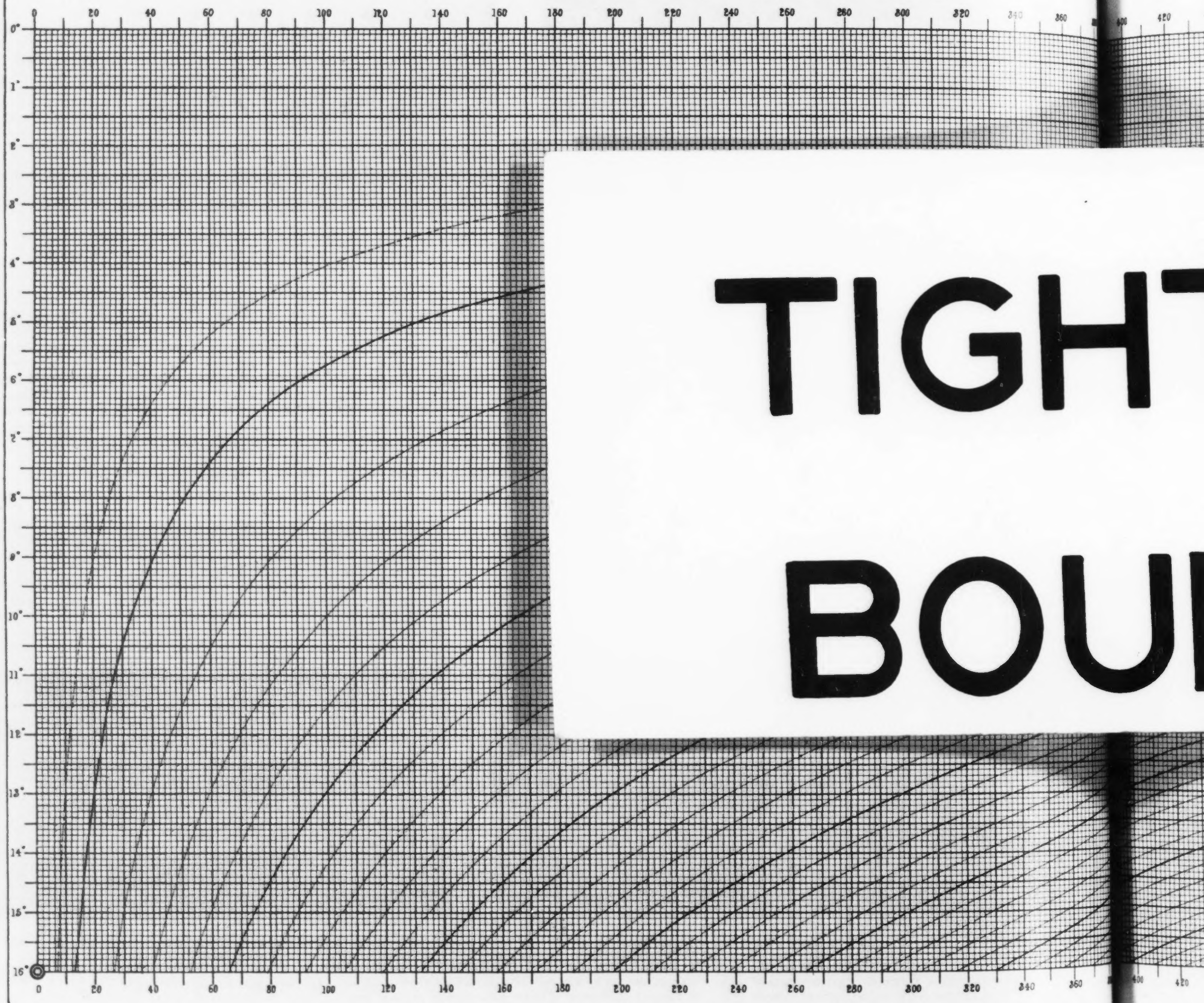


CHAS. HART & SONS, LITH., 36 VESEY ST., N. Y.

Diagram
For Obtaining The
Difference Of Elevation And Horizonta Dist
Corresponding To Any
Reading Of A Vertical Telemete

Designed By Neville B. Craig.



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the subway and also on the roof between tracks. The lamps are placed about 36 ft. apart, and the line circuits are alternated so as to distribute the lamps properly. The regular railway circuit is used. The current for one of the lines is supplied from the Dorchester power station, and that for the other lines from the central power station.

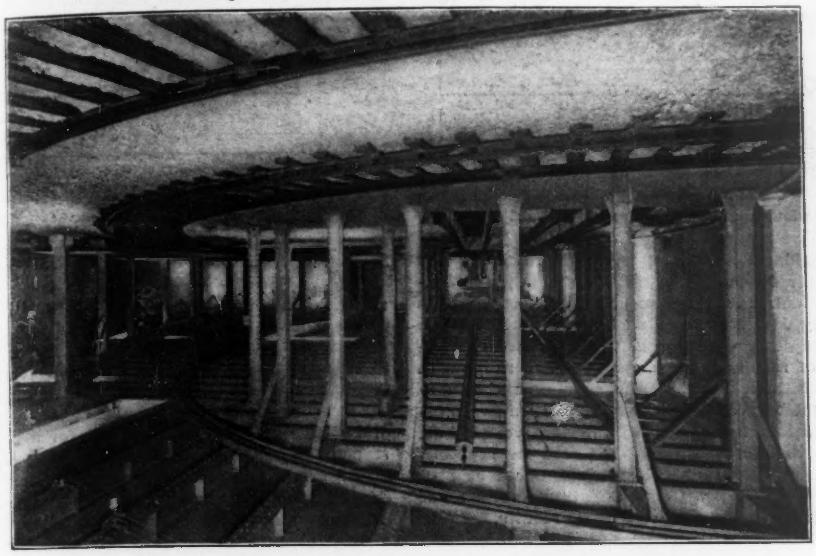


FIG. 5.—RETURN LOOP AND CAR PITS AT PARK ST. STATION.

The lamps are run in five series. In the event of trouble with one lamp the other four lamps in the series are not affected, but continue to burn by reason of the alternating feature in the distribution of the current. It is very improbable, therefore, that any trouble which may arise will cause the subway to be left in darkness. The station lighting by the arc lamps is so arranged that in the event of trouble in one circuit the current will be supplied by the alternating circuit. Under the junction of Tremont and Boylston streets a large room has been arranged in which has been installed the switch-board properly equipped for controlling the lighting of the subway, and so arranged that it is possible in the event of an emergency to throw a portion of the incandescent lamps onto the circuit of the Boston Electric Light Co.

Station Equipment.—Four ticket offices are located at the foot of each stairway, which are heated and lighted by electricity. On the platforms, at the foot of the exit stairways, are turnstiles through which exit may be made, but which bar entrance. Some features of the station construction proper, which was done by the Transit Commission, and not by the railway company, are properly described at this point.

The station walls are lined with white porcelain tiles, while the steel columns are encased with concrete and are painted white like the brick-work and the exposed iron-work of the roof. The staircase coverings are of classic design, with walls of Deer Island granite lined with white porcelain brick, and have glass roofs. The specifications called for enameled tile, measuring 6 × 9 × 1½ ins., laid in Portland cement mortar.

Fire Piping.—The subway is provided with three lines of 3-in. wrought iron pipe properly equipped with valves, fire hose and nozzles for fighting fire. These pipes are connected with the city water service.

The foregoing statement, studied in connection with the illustrations, give a very clear idea of the interior and station construction and equipment of the subway. At the date of the report, Aug. 15, 1897, the total amount of money expended on the subway by the Transit Commission amounted to $3,718,512. In addition, $324,591 had been expended on the Charlestown Bridge, which is also being constructed by the Transit Commission. These sums do not include the money expended directly by the West End Street Ry. Co. On the whole, the report states that the work has progressed satisfactorily.

Among the special work conducted by the Transit Commission is found a series of observations made to determine the speed of the surface street cars in the section traversed by the subway. The speed was found to vary from 12 to 15 miles per hour for the fastest trips to from 2½ to 6 miles per hour for the slowest trips. The slowest trips were made, of course, when the most people were traveling, and the fastest trips when the fewest people were traveling. In other words, the number of people who suffered the disadvantages of the trips which were slower than the average was much greater than the number who enjoyed the advantages of the trips which were faster than the average.

The interior finish of the walls of the subway is a matter to which the engineers gave much attention. The sides of the subway, at the stations, are lined with white enamel brick; but it was desired to use some less expensive coating on the roof and for the walls at places other than stations. Many experiments were tried on the Boylston St. section with coatings of different manufacturers, which were thoroughly tested, subjected to frequent washing, etc., to determine whether the efflorescence on the concrete or other action was likely to injure the color and appearance. One coating gave excellent results and was applied to two sections. Since that time, however, a still more satisfactory coating has been found and has been used on Section 4, and will probably be used on the other seven sections of the tunnel.

The ventilation of the subway has been provided for by building concrete chambers at various points in which a fan and electric motor are placed. Air is drawn from the subway and discharged through a grated opening into the street.

A DIAGRAM FOR THE REDUCTION OF TELEMETER READINGS.

By Neville B. Craig.*

(With two-page plate.)

After long experience on surveys conducted by the Corps of Engineers, U. S. A., by the U. S. Coast and Geodetic Survey, by the Mississippi River Commission, and by the State of New York, the writer has had frequent occasion to apply the tachymetric methods of making topographical surveys, there employed, to surveys of smaller areas, for railroad and municipal corporations, in which the larger scale used and increased fidelity in delineating minute details made greater accuracy essential and largely increased the number of observations required.

The increased accuracy has been attained by decreasing the length of the telemeter readings to about 600 ft., with occasional readings under favorable circumstances as great as 800 ft.; by introducing the principle of a fixed vernier in the graduation of the telemeter (or stadia rod as it is frequently called), and by attaching to the telemeter a simple device which enables the rodman to hold it in a vertical position. These modifications, together with a well-considered system of keeping the notes, have made it possible, with the telemeter, to run lines of two miles in length with an error in distance of about 3 ft., and an error in level of about 0.15 ft.

The worst difficulty still remained to be encountered, viz., the labor of making the office reductions from the field notes. In municipal work, particularly, the number of observations required is so large that the labor of reduction ordinarily involved becomes a serious objection to the entire method. When the telemeter is held vertically upon any point the observations consist (1) in reading the interval on the telemeter intercepted by the extreme of the three horizontal wires usually placed in the telescope at the focus of the eye piece; (2) in measuring the vertical angle made by the line of sight from the telescope to some definite point on the telemeter; (3) in measuring the height of the transverse axis of the transit instrument above the station mark on the ground beneath it. From this data it remains in the office to determine, (1) the horizontal distance from the instrument to the telemeter, and (2) the difference of elevation between the station mark over which the instrument stands and the point upon which the telemeter is held.

The Mathematical Principles.

The mathematical solution of these two problems is extremely simple, but when we consider that a topographical survey for municipal purposes under the most favorable circumstances involves, at the very least, 5,000 telemeter readings to the square mile, and often treble that number, it is possible to appreciate the entire impracticability of making a direct solution in each case by unaided numerical calculation. The mathematical principles may be indicated as follows:

FIG. 6.—VIEW ON SURFACE SHOWING EXITS AND ENTRANCES TO PARK ST. STATION.

Let

D = The horizontal distance of the telemeter from the center of the transit.

H = The difference of elevation between the point sighted on the telemeter and the center of the instrument.

R = The reading of the telemeter as graduated.

V = The angle made by the line of sight with a horizontal plane.

*1603 Venango St., Philadelphia, Pa.

f = The principal focal length of the object glass.

c = The distance from the object glass to the center of the transit.

C = (f + c) = A constant, which varies slightly with the transit used.

Then, having so graduated the telemeter that D = R + C holds true for a horizontal reading, the following formulae will give, with substantial

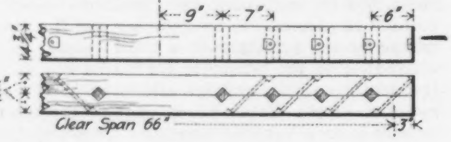


Fig. 1.—Rankine's Beam.
(Keys of white oak 1¼ ins. square, halves tapered and driven up.)

accuracy, the general values of D and H for any reading likely to occur in practice:

$$D = R \cos^2 V + C \cos V.$$
$$H = \tfrac{1}{2} R \sin 2V + C \sin V.$$

It will be sufficiently close and within the probable error of the observations if C be taken only to the nearest foot, and no practical error will be introduced if we write $\cos^2 V$ for $\cos V$, and $\tfrac{1}{2} \sin 2V$ for $\sin V$ in the last terms of the two equations. The formulae will then reduce to

$$D = (R + C) \cos^2 V$$
and
$$H = \tfrac{1}{2} (R + C) \sin 2V$$

On the United States Lake Survey and on the earlier surveys conducted by the Mississippi River Commission, tables published by Assistant Engineers Ockerson and Teeple were used to facilitate the application of these formulae, and greatly reduced the amount of labor involved.

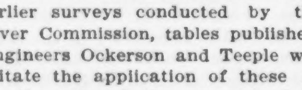


Fig. 4.—Cast-Iron Key.

There was an obstacle, however, to the general use of these tables in the fact that they were constructed for Lake Survey use, so that with a given vertical angle and a telemeter reading in meters the tables would show the difference of elevation in feet. Other tables have since been constructed which use the same unit for both horizontal and vertical measurements, but, even with these, the work of reduction, when the number of observations was large, remained as a serious obstacle.

Many attempts have been made to construct a diagram that would give a graphical solution of

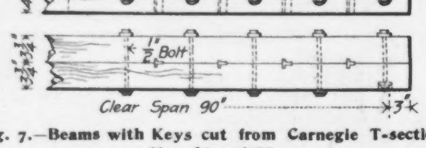


Fig. 7.—Beams with Keys cut from Carnegie T-sections Nos. 21 and 95.

the two equations, but, so far as the writer is aware, with uniformly unsatisfactory results. It would be an easy matter to construct, as several persons have done, a diagram covering only a few degrees of vertical angle that would give very close results,* but when the diagram is extended to 15° or 20°, as usually constructed, either the scale must be reduced at a great sacrifice in accuracy or the diagram made so large as to be absolutely impracticable.

The apparent impossibility of obtaining both accuracy and sufficient range of vertical angles, within the limits of a diagram of reasonable size, has caused a resort to the use of specially constructed logarithmic scales. The use of these scales has been a great advance over the use of tables; they can be handled with great rapidity and give results sufficiently accurate. There are, however, two objections to their general use. They are quite expensive, and persons, who are only for brief periods engaged in topographical work, prefer more tedious methods rather than incur the expense of these scales for merely occasional use. They also require that the persons using them should have a knowledge of logarithms not generally to be found among the class of men usually employed as recorders on topographical work.

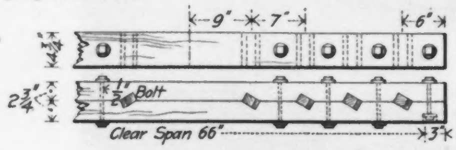


Fig. 2.—Brunel's Beam.
(Keys of white oak, 1x2 ins., halves tapered and driven up.)

A consideration of the foregoing facts has led the writer to construct the accompanying diagram which has given more satisfactory results than any device of the kind he has hitherto tried. In the rapidity with which it can be used and accuracy of results it compares very favorably with the logarithmic scale. It is so simple that any intelligent boy can be taught to use it in five minutes, and it is comparatively inexpensive. It has, too, all the vertical range required in practice, and if necessary its vertical range could be still farther increased without affecting the size of the diagram or the accuracy of its results.

The Use of the Diagram.

In using this diagram it is desirable that one man should confine his attention exclusively to the diagram, while a second calls off the notes and puts down the results. One man with the diagram can easily keep two men each with a note book busy making out elevations.

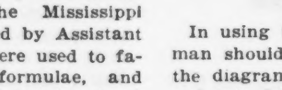


Fig. 5.—Key cut from Carnegie Steel section T-21.

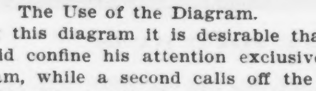


Fig. 6.—Key cut from Carnegie Steel section T-95.

To obtain the difference of elevation corresponding to any given telemeter reading and vertical angle.—To a fine needle driven through the paper at the center of the concentric circles at the lower left-hand corner of the diagram attach one end of a fine thread about 3 ft. in length. To the other end of the thread attach a small weight sufficiently heavy to hold the thread tense in any desired position. Move the weight until the thread is drawn perfectly straight through the point of graduation at the right-hand end of the diagram indicated by the degrees and minutes in the vertical angle. Then look along the lower margin of the diagram, which has divisions for every 2 ft. up to 620 ft., for a point corresponding to the telemeter reading (R) plus the instrumental constant (C) taken to the nearest foot. The interval between the point so obtained and the thread, measured on a perpendicular to the base of the diagram is then noted, the intervals between the heavy horizontal lines being regarded as 1 ft., and divided by the fine lines into fifths, which can be readily bisected by the eye, so that we can estimate tenths of a foot with considerable certainty.

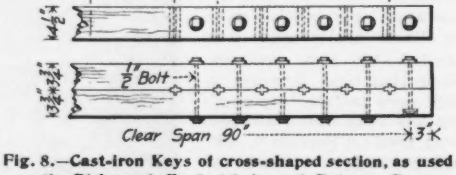


Fig. 8.—Cast-iron Keys of cross-shaped section, as used on the Richmond, Fredericksburg & Potomac Ry.

Then to the telemeter reading (R) add the instrumental constant (C), divide the sum by ten and multiply the quotient by the numerical coefficient enclosed in the small circle on the diagram directly under the degrees and minutes of the protractor corresponding to the vertical angle. Add the result to that previously obtained from the diagram and the sum will be the difference of level (H) required.

Example.—Suppose the telemeter reading (R) = 602 ft., the instrumental constant (C) = 1 ft., and the angle of elevation (V) = 21° 16'. Required, the difference of elevation (H). Following the directions above, we obtain from the diagram 22.95 ft. The numerical coefficient directly under 21° 16' at the right-hand end of the diagram is

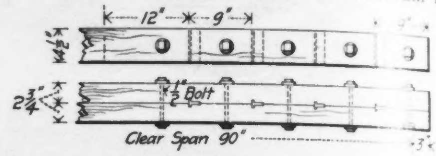


Fig. 3.

3; so we have $22.95 + \dfrac{602 + 1}{10} \times 3 = 203.85$ ft. = H, the difference of level required. Logarithmic calculation gives 203.82 ft.

To find the horizontal distance corresponding to any given telemeter reading and vertical angle.—Discard the thread altogether. Look along the left-hand margin of the diagram (which has divisions for every six minutes) for a point corresponding to the degrees and minutes of the given vertical angle. Follow a horizontal line through the point so found until it intersects a perpendicular to the base of the diagram erected at a point corresponding to the telemeter reading (R) plus the instrumental constant (C). The curved line falling nearest to this point of intersection will indicate, by the number attached, the number of even feet to be subtracted from the given telemeter reading plus instrumental constant (R + C) in order to obtain the horizontal distance (D).

Example.—Given the telemeter reading R = 610 ft., the instrumental constant (C) = 1 ft. and the angle of elevation (V) = 15° 30'. Required, the horizontal distance (D). The point of intersection, found as directed above, falls between two curves numbered on the right 43 and 44. By estimation we read 43.7. Hence 610 + 1 — 43.7 = 567.3 ft. = D. Logarithmic calculation gives 567.36 ft.

In making the horizontal reductions it is not usual to record fractions of a foot in the result, as only graphical accuracy is desired, but with differences of elevation it is desirable to read the diagram to tenths of feet. The curved broken line is the curve of one-half foot correction. Whenever the correction is less than half a foot it is disregarded, that is, assumed to be zero. In any case where the telemeter reading plus the instrumental constant exceeds 620 ft., the limit of the

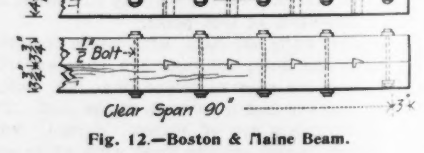


Fig. 12.—Boston & Maine Beam.

diagram, we use one-half or one-third (R + C) and multiply the result by 2 or 3, as the case may be. When (R + C) is very short, as for example, 51 ft., it is better to use 510 ft. and divide the result by 10.

THE EFFICIENCY OF BUILT-UP WOODEN BEAMS.

II.

By Edgar Kidwell.*

In the present paper will be given the results of experiments made since the publication in this journal † of a former article under the above caption. The method of experimentation is precisely as described in that paper and need not be repeated here.

Rankine's Beam.—Fig. 1 represents a beam advocated by no less an authority than Rankine. He says:

*A diagram of this class is given in our department of "Letters to the Editor," this week.—Ed.

*Professor of Mechanical and Electrical Engineering, Michigan College of Mines, Houghton, Mich.
† Engineering News, March 11, 1897.

Considering that the stress at the neutral surface is equivalent to thrust in a direction sloping at 45° the opposite way, it would seem that the best position for the keys would be that shown in (our) figure, their fibers being made to slope in the direction of the thrust, and the bolts made to slope in the direction of the tension. This, however, so far as I know, has never yet been tried.§

The writer does not consider this reasoning perfectly sound. The stresses mentioned refer entirely to the case of a solid beam, nor could any amount of bolting, etc., change them in any way or add any strength to a solid beam. The problem in case of a built beam is how most effectually to prevent motion along the joint between the component sticks, and it seems evident that this can be done best when the pressure on the keys, bolts or other means used is resisted by surfaces at right angles to the direction of motion. Since the tension side must elongate, it is clear that as soon as Rankine's beam is loaded the bolts will tend to become vertical and in consequence permit the component sticks to slide up on the inclined faces of the keys. The beam will therefore fail under a moderate load.

Two beams, Nos. O B and O C, were tested, and the results bear out the above statements. Both beams started out fairly well, but the bolts soon bent toward the vertical, the joint between the sticks opened and the deflection became excessive. Had the bolts been placed 90° from their present position they would have drawn up tighter as the bottom stick elongated. Hence it was decided to test two of the beams, Nos. O D and O E, placed upside down. These two beams were rigid from the very start, and No. O D was the stiffest of the four.

These beams are expensive to build. The bolts are extra long and should be provided with cast-iron seats under washers, or else notches of large size would have to be cut into the timbers, causing serious loss of strength. The writer therefore cannot recommend Rankine's design.

Brunel's Beam.—Fig. 2 shows a beam much used by the distinguished English engineer, I. K. Brunel.* The test beam differs from Brunel's actual construction to the extent that all keys on one side of the center of span are turned the same way, while Brunel made the key nearest the wall face in a direction opposite to the others next to it. Keys so placed seem to do no good, since the component sticks slide over them.

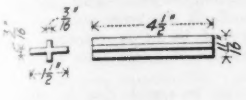


Fig. 9. Cast Iron Key.

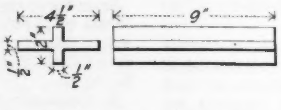


Fig. 10.—Dimensions of full-size Key used on R. F. & P. Ry. for Stringers consisting of two pieces 9x15, superimposed.

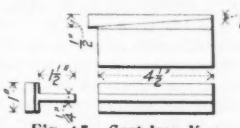


Fig. 15.—Cast-Iron Key with Wedge.

Diagram 1 shows that this construction gives a beam that is quite stiff, but less efficient than can be got with the plain joggle keys. The component sticks ride up on the inclined faces of the keys and force open the joint—not, however, to the same degree as in Rankine's design, owing to the bolts being vertical. The number of bolts and size of washers necessary to prevent this would be prohibitive. The writer also finds that more time is necessary to make a good fit between the keys and their slots than is the case with the regular joggle keys laid parallel to the joint. He therefore cannot recommend any form of beam with inclined keys.

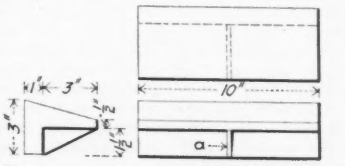


Fig. 11.—Dimensions of full-sized cast-iron Keys used on Boston & Maine Ry. for Stringers consisting of two pieces 10x12, superimposed.
(The fin "a" prevents key from shaking out of its slot.)

Fig. 13.—Key used with Boston & Maine Test Beam.

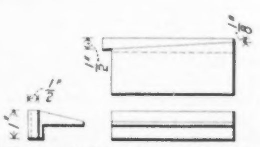


Fig. 14.—Model of Boston & Maine Key fitted with Wedges.

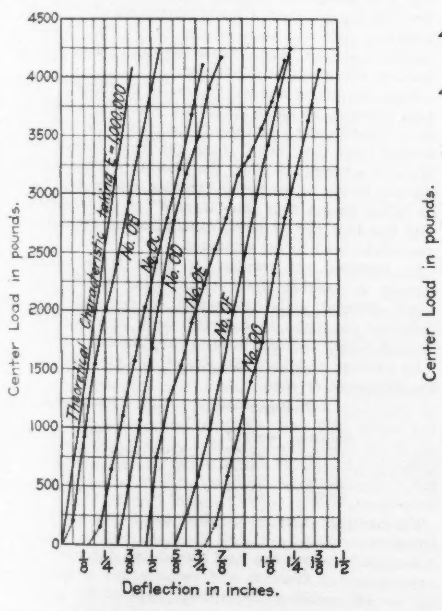


Diagram 1.—Tests of Rankine's and Brunel's Beams.
(Each horizontal space = 1-16-in. deflection.)

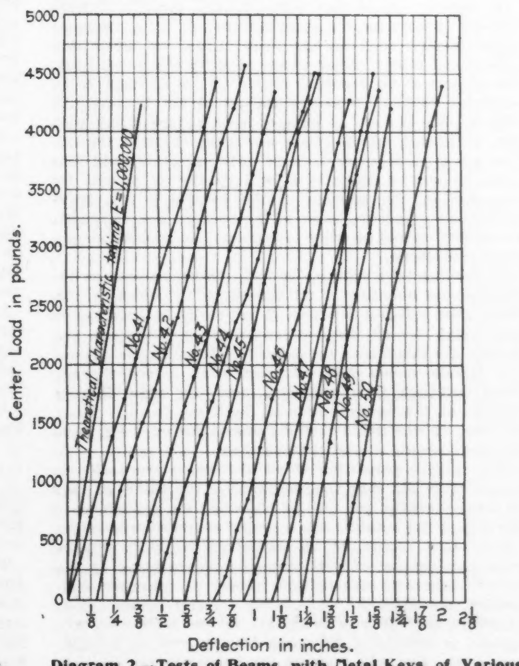


Diagram 2.—Tests of Beams with Metal Keys of Various Shapes.
(Each horizontal space = 1-16-in. deflection.)

Summary of Tests on Beams with Inclined Keys.

Kind of beam.	No. of test.	Beam like figure.	Ratio, span to depth.	Efficiency, per cent.
Rankine's	O B	1	12	67.9
"	O C	1	12	58.8
Rankine's inverted	O D	1	12	42.6
" "	O E	1	12	42.7
Brunel's	O F	2	12	88.0
"	O G	2	12	80.6

The prevous paper brought to notice various forms of metal key not included in the tests. These have all been tried, and Diagram 2 shows deflection curves for all except Nos. 39 and 40.

T-Shaped Cast-Iron Keys. Beams Nos. 39 and 40.—Fig. 3 shows the beam and Fig. 4 the key used. The test showed that unless the depth of the stem of the key is at least double the width of the head, these keys roll easily and produce a beam neither very efficient nor rigid. Further, the stems, as well as the heads, must be fitted to their slots with extreme care.

T-Shaped Steel Keys.—These were sawed from Carnegie sections. Keys like Fig. 5 were used in beams Nos. 41 and 42, while the key in Fig. 6 was used in beams Nos. 43 and 44. In all other respects the beams were the same as Fig. 7. The efficiencies were low and the beams were not rigid. The stem of Fig. 5 is too short, while both keys are difficult to fit properly because the metal is too thin. The same is true of any other stock section the writer has seen, so that either a special heavy section would have to be rolled for such work or cast keys must be used.

Cast-Iron Keys of Cross-Shaped Section. Beam No. 45.—The form of iron key used for packing wooden chords on Howe truss bridges has been used for built stringers on the Richmond, Fredericksburg & Potomac R. R. Figs. 8 and 9 show test beams and key, and Fig. 10 the dimensions of the actual key used for stringer composed of two 9 x 15-in. timbers. The efficiency and stiffness of the beam built with this key exceed that of any others in this set of tests and are due to the ample breadth of key to resist the tendency to roll over.

The Boston & Maine Key. Beams Nos. 46 and 47.—Fig. 11 shows actual size of key used on this road for stringers, made of two 8 x 12-in., or one 8 x 12-in., and one 8 x 13-in. timbers. Figs. 12 and 13 show the test beam and key. The writer believes this key would give better results were the horizontal stem increased in length 50%.

Metal Keys, with Driving Wedges.—It was thought advisable to determine whether any gain in strength and stiffness could be got by providing some of these forms of key with wedges. Beams Nos. 48, 49 and 50 were, therefore, made exactly like Fig. 12, except that No. 48 had a key like Fig. 14, and Nos. 49 and 50, a key like Fig. 15. It will be seen that this expedient produced a moderate gain in strength, but a great increase in stiffness, which is the more important of the two. Fitting keys accurately to their slots will not of itself give the stiffest construction, and therefore wedges should be used. Some engineers object to wedges on the ground that they are liable to split out the daps. The writer has found that the wedges can be driven up till their ends are battered, without splitting out a dap in a single case. Nor, in the whole series of tests, did any beam in which wedges were used fail by shearing out a dap; every break began on the tension side of the built beam.

Summary of Tests on Beams with Metal Keys.

No. of beam.	—Like Fig.— Beam.	Keys.	Ratio of span to depth of beam.	Efficiency, per cent.	Remarks.
39	3	4	16.4	61.1	No wedges.
40	3	4	16.4	79.3	
		Average	....	70.2	
41	7	5	12	53.6	
42	7	5	12	70.4	
43	7	6	12	51.1	
44	7	6	12	73.2	
		Average	....	62.1	
45	8	9	12	88.1	
46	12	13	12	67.2	
47	12	13	12	70.3	
		Average	....	68.8	
48	12	14	12	79.7	With wedges.
49	12	15	12	67.2	
50	12	15	12	78.5	
		Average	....	72.8	

§ "Civil Engineering," page 463.
* "Transverse Strength of Yellow Pine Timber," H. D. Smith. "Proceedings Institution of Civil Engineers," Vol. CXXVIII., Part II.

BOILER TESTING WITH VARIOUS FUELS.*

By David P. Jones,† M. Am. Soc. Naval Engineers.

Coal as Fuel.

In burning coal, the usual practice of the writer is to secure, whenever possible, previous to making the test, a sample of the coal to be used and make a proximate analysis of the same in order to determine the amount of volatile matter and fixed carbon. The advantage of doing this is that it affords a clue to the most advantageous method of burning the coal in the furnace. Different coals require different treatment, and the action of the coal burning in the crucible is an index of what may be expected in the furnace.

In addition to making the proximate analysis, the heating value of the coal is also determined by burning in an oxygen calorimeter. This latter determination enables the conducting engineer to know, during the progress of the trial, whether the boiler is showing the per cent. of efficiency that ought reasonably to be expected.

Of course the heating value of the fuel could be approximately determined from the proximate analysis by empirical formulae. But as most of such formulae are based upon the average amount of hydrogen (in the volatile matter) being from 3 to 4% (which is the average in the bulk of American soft coals) they fail to give proper results when there is a larger per cent. of hydrogen.

A nearer approximation to the heating value could be obtained from an ultimate analysis of the coal by using Dulong's or Mahler's formulae, but ultimate analyses are not always practicable.

Coals containing a high per cent. of volatile matter, and consequently showing comparatively high heating values by experiment and calculation, are misleading in estimating results. For some reason, not yet determined, but a small per cent. of the heat contained in the volatile ingredients is utilized in the furnace. With the deep red flame and smoke, it slips up the chimney without doing the work. Especially is this the case in coals containing a large per cent. of hydrogen.

In making the proximate analysis, close attention should be given to the rapidity of ignition of the coal, to the length of time the volatile flame is burning off, to the peculiarities of the carbon button, and also to the color and peculiarities of the ash. All such data are a clue to the method of burning in the furnace; whether to fire heavy, medium or light, whether to force or burn slowly, whether to check or increase the draft.

Much can also be learned from the appearance of the carbon button that is left in the crucible after burning off the volatile matter. The lignites and the hard anthracites leave no indurated residuum, but the residuum after burning off the volatile matter, looks somewhat similar to the original sample. The coals of West Virginia, especially the Pocahontas and the New River varieties, leave a large porous residuum or coke that is much swollen. Indeed, this is a characteristic of most of the soft friable coals. The bituminous and semi-bituminous coals of Pennsylvania also leave a porous residuum, but not so large or so swollen as the West Virginia coals.

The coals of Ohio leave a button somewhat porous, but not so large as the Pennsylvania coals. The coals of Illinois and Iowa (the latter a most inferior coal) leave a hard, flat, metallic-looking button. There is one variety of Colorado coal that leaves a large porous coke, very similar to that of West Virginia. This indication, in the Colorado coal, is apt to be misleading, for it is a much inferior coal to either the Pocahontas or New River. This is indicated by the fact that the coal referred to contains but about 60% of fixed carbon. As a rule the large porous cokes indicate the quality of the coal as being of the best semi-bituminous variety with from 70 to 80% of fixed carbon.

In general, with coals containing as low as 50% of fixed carbon, a well-designed boiler should develop an efficiency of 70%. Below 50% fixed carbon only the best boilers, with the greatest care and management of the fires, will show an efficiency of 70%. By efficiency is meant the number of heat units in the amount of water evaporated, from and at 212° per pound of fuel, divided by the heat units per pound of fuel.

The allowance for moisture in coal, when calculating results of tests, frequently leads to much controversy. The distinction between "dry coal" and commercially "dry coal" is often very fine, but it should always be made. There should be no question of deducting the moisture from coals mined from wet mines, or coals that have become wet from extraneous causes, but many engineers in their zeal to secure good results frequently make deductions for moisture when the moisture should not be allowed to apply on the commercial results.

Much misunderstanding could be avoided if contracts involving the sale and testing of boilers were made more specific and explicit in reference to the fuel used. It must be understood that the foregoing remarks have reference to the commercial bearing of the results.

The method of starting and stopping the test is of vital importance. The usual or "standard" method adopted by the American Society of Mechanical Engineers many years ago, and confirmed by the recent committee on revision of the code for testing boilers, in a preliminary report, directs that the fires be hauled and started afresh. This, in the opinion of the writer, is not the best method to secure the most reliable results, nor is it good for the boiler. The immense loss of heat due to the rush of cold air into the furnaces and connections, while the fires are being hauled, cannot be measured, while the shock to the boiler itself must be most injurious.

From close observation in a number of cases, the writer has discovered that when starting a test by the method of hauling fires, it has taken the boiler from two to three hours to recover its normal condition, or condition existing previous to hauling. Of course, in a test of considerable length the per cent. of loss would be diminished.

The method of starting usually pursued by the writer is the "alternate" method. In this case the fires are well cleaned before the test and allowed to burn down until they are quite thin. They are then judged by one or more observers. At the end of the test they are allowed to burn down to the same condition as existed when the test was started. The object of having the fires thin is so that any error, even from faulty judgment, will be but slight. Indeed, in any case it must be much less than the unmeasured loss caused by the rush of cold air and the checking of the evaporation due to hauling fires.

In all or nearly all tests conducted by the writer, within the past three years, the uniform practice has been to take frequent samples of the flue gases and analyze them.

It is well to take the draft at the furnace door, as well as at two or three different points in the connections between the furnace and the uptake. Any serious or erratic variation in the diminution of the draft from the furnace to the uptake or base of the stack at once indicates some abnormal condition.

In large cities where municipal ordinances impose penalties upon excessive smoking of boiler chimneys, boiler or furnace manufacturers give guarantees that the operation of their furnaces or boilers will not produce smoke. Legal contests frequently result from such guarantees. A good plan for the testing engineer to follow is to take periodic kodak views showing the top of the stack and the volume of smoke. Where this is impracticable, an excellent method is to use charts with a number of squares, shaded and numbered according to the density of the smoke. The observer can then enter such numbers in his log as may be indicated by the smoke from the stack, compared with the chart.

Oil as Fuel.

In burning oil as fuel under boilers, there is a large variety of burners for spraying the oil. The ordinary double-nozzle, such as the Reed burner or the Brown burner and others, using steam to spray the oil, is good. The system of the National Supply Co., of Chicago, is an excellent method of feeding the oil to the burners. In this system the oil is pumped into a tank filled with tubes, through which steam circulates, heating the oil. The oil in this heater tank is under pressure, and this pressure can be regulated at will by the oil pumps. By this method, the pressure at the burners is also regulated. The connecting pipes at the burners, are, of course, fitted with valves in order to regulate the relative supply of oil and steam.

In running tests with oil as fuel, the surest plan to determine the quantity of oil burned, is by weighing. In the system referred to above, it can easily be arranged to first weigh the oil, then afterward pump it through the meter. By this means the meter is calibrated. In general the meters record less oil than what passes through them, although in a prolonged test on some Stirling boilers, at the power house of the West Chicago Street Ry. Co., it was found that the meters recorded 6% more oil than actually passed through them.

The relative proportion of oil and steam can easily be regulated by the general appearance of the flames as they strike the targets, and also by observing the appearance of the jets at the nozzles. When proper combustion is taking place, there should be no indications of black streaks from the nozzles of the burners. Observations of the smoke stack will also indicate proper or improper combustion, for when the oil is being properly burned there should be very little or no smoke. In this connection it is curious to notice the difference between two oil firemen, both good. One will regulate the burner valves so as to give a clean, sharp, cutting flame, while the other will secure an intense, mellow flame, both apparently giving equally good results.

During such tests careful observations should be taken of the flames in the different flue connection passages in the boilers. Such observations are great aids in securing the best combustion.

Where oil fuel is used, care must be taken to see that the flames from the burner nozzles should not be allowed to impinge directly upon the boiler tubes. Targets for preventing this and distributing the flames can easily be made of fire-brick or tiling.

In determining the efficiency of the boiler the heating value of the oil must, of course, be ascertained. This can only be accomplished by analysis, as up to the present time there seems to be no successful method of determining the heating value by the oxygen calorimeter. The average results of the analyses of many samples of oil used by the writer in testing are as follows:

Carbon	85.20
Hydrogen	11.78
Oxygen	3.05
Heating value, per lb . . . B. T. U.	19,437

In general the heating value of most fuel oil is from 20,000 to 21,000 B. T. U. In tests using oil as fuel the writer has, in tests of 18 hours' duration, secured an evaporation of 14.89 lbs. of water from and at 212° per lb. of oil.

In conclusion it may be stated, that in addition to the data usually recorded in boiler tests, the following should not be neglected:

1. Temperature of the oil in the heating tank. 2. Pressure of oil at the burners. 3. Specific gravity of the oil. 4. Samples of the oil for analysis.

No. 2 is most useful in making comparisons, and may indicate the cause of faulty combustion.

Waste Gases of Blast Furnaces as Fuel.

The measurement of the volume of fuel gas entering the furnaces is obtained by taking the pressure of the gas, in inches of water, at the upper end of the down comer to the boilers, also taking the pressure near the burners, as well as the draft in the furnace. The temperature of the gas as it enters the furnace must also be taken. From this data the volume of the gas can be computed, or the volume can be easily ascertained from a Cook's chart. This chart is based upon Napier's formulae for flow of gases. In ascertaining these pressures, in inches of water, it is best to use a differential gage.

The volume of air entering the furnace to unite with the carbonic oxdie (the fuel constituent of the gas) can be ascertained from knowing the size of the air openings, and calculating the volume from Clark's Rules and Tables, being sure to secure the other necessary data, that is the barometric pressure, and the pressure in the furnace. The use of anemometers to ascertain the volume of air is not to be commended, as they do not record the full amount of the flow.

In determining the character of the fuel gas a sample pipe should be fitted into the lower end of the down comer, just before it reaches the gas ducts leading to the furnace. Another sample pipe for the flue gas should be fitted in the uptake of the boiler. Both these sample pipes should be connected with inspirators, whose action will draw the gas into the sample bottles. Samples of the fuel gas and of the flue gas should be taken simultaneously, and analyzed without delay. As many samples as possible should be taken during such tests.

The sample of fuel gas should show a large per cent. of CO, this being the heating constituent of the gas. The flue gas should show a good percentage of CO_2, and, with perfect combustion there should be no CO. Traces of CO, however, always exist. From the samples of fuel gas its heating value can be calculated.

Upon the grates a small fire called a "lighter" is usually kept burning, so as to ignite the gas as it enters the furnace. Usually this small fire is not necessary, except immediately after the "casts" from the iron furnace are made. When the "cast" is over, the blowing engine started, and the gas valves to the boiler furnaces are opened, care must be taken to see that the "lighter" is in condition to ignite the fuel gas at once, otherwise the accumulation of gas might lead to an explosion.

In working out results for tests it is usually customary to express the heating value of the gas as so many thermal units per pound, or per cubic foot, then reducing the same to its equivalent in a coal of known heating value, the coal used in the "lighter," for instance.

An average of fifteen samples of fuel and flue gases gave the following results:

	Fuel gas, By volume.	Fuel gas, By weight		Flue gas, By volume.	Flue gas, By weight.
CO_2	7.16	10.88	CO_2	17.14	24.33
O	0.50	0.54	O	6.12	6.32
CO	26.63	25.51	CO	0.76	0.68
N	65.65	63.07	N	75.98	68.67

The heating value of the fuel gas being 4,380 Favre & Silberman × 25.5 = 11,187 B. T. U. per lb. of gas. To this must be added the heat due to the difference between temperature of fireroom and temperature of entering gas 520° — 70° = 450 × .24 (specific heat of the gas) = 108 B. T. U. Total heating value of pound of gas = 11,295 B. T. U.

Bagasse as Fuel.

Bagasse in the residuum of milled or diffused sugar cane. Mill bagasse is now being extensively used as fuel by the Louisiana sugar planters, who find it an excellent substitute for the expensive coal fuel formerly generally used. Of the mill bagasse there are two varieties, the bagasse ground from stubble cane and the bagasse from seed cane. Stubble cane is the cane raised from the stubble of the previous year. Seed cane, as its name indicates, is raised from the seed. The fuel value of the stubble cane bagasse is greater than that of the seed cane bagasse, as it contains more woody fiber.

Boilers using bagasse as fuel have exterior furnaces, either with closed ash pits, or hollow grate bars, as this fuel is best burned with forced draft. As the bagasse is

*Abstract of paper read before the American Society of Naval Engineers, January 8, 1897, at Washington, D. C.

†1202 Fisher Building, Chicago, Ill.

ground in the mill, it is moved on carriers to the furnaces, into which it is dropped through hoppers fitted with automatically moving covers. With the present arrangements in use, the fuel is dropped on the grate bars in the form of a cone, and is spread over the entire bars by the fireman as occasion demands.

It is the tradition and practice of many bagasse firemen, and of some engineers, who ought to know better, that the best way to burn this fuel is to leave it undisturbed in the form of the cone or pyramid as it drops from the feed hopper. It is difficult to impress them with the fact that a more even distribution over the grates, and covering unsuspected air holes, is the best method of firing. Undoubtedly, their way has the merit of being much less laborious.

The imperfect combustion of bagasse is easily detected by the presence of smoke from the stack. With good combustion there is little or no smoke. It is a fair grade of fuel and leaves a packed or indurated ash that is very difficult to remove from the furnaces. When first started into the furnaces, the bagasse has to be ignited from a wood fire, but once under way, it needs no aid, except at the intervals of cleaning fires, this cleaning being necessary about every eight hours. To properly clean, everything should be hauled out of the furnace. During this interval of cleaning the supply of bagasse fuel is stopped by being diverted to some of the other furnaces. After such cleaning a little wood is needed in the furnace to ignite the bagasse. If the cleaning is done quickly there is often heat enough in the brick furnace arch to ignite the bagasse without using wood. A record of the weight of wood when so used should be kept to be added to the fuel account.

In running tests using this fuel one of the difficulties is to secure an accurate record of the amount of fuel used, without interfering with the operation of the sugar mill. To attempt to weigh the bagasse as it comes from the mill, especially in tests of long duration, and with large plants, would be a perplexing and laborious task, as the amount used per hour may amount to several tons. The volume of bagasse is comparatively large per unit of weight, and as there must be no diminution or stoppage of the feed from the mill, it would require in a plant of large capacity a considerable force of men and teams for the work. Besides, the conditions of burning the bagasse would be changed from the normal method, as during this process of weighing the bagasse would be drying, thus giving higher results than in every day practice when it is fed from the mill direct to the furnace.

The usual and most convenient method of arriving at the quantity of fuel consumed is to carefully weigh the cane before it is ground in the mill. From this weight must be deducted the amount of juice extracted from the cane. The amount of this juice, or "extraction," as it is called, is always carefully recorded by the chemists and officials of the mill. The general average of extraction is something over 76%.

In starting tests using bagasse fuel the standard, or fire hauling, method can be used without the great losses attending such a method with coal fuel. The bagasse is easily hauled out, and the kindling of the new fuel is almost instantaneous, so that the loss by the inlet of cool air is not so great as that due to cleaning coal fires. But even in burning bagasse, the "alternate" method of starting is to be preferred, and should be employed whenever practicable.

The great source of loss in burning bagasse is its excessive moisture, the evaporation of which mean a loss of heat. There is financial success for the engineer who can devise some economical means of drying bagasse while it is en route from the mill to the furnaces. The same remark can be applied to peat and tan fuels.

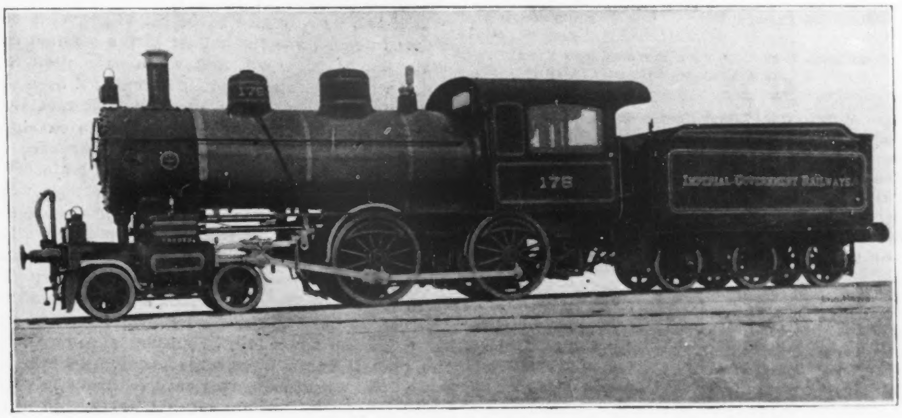
The heat constituents of bagasse consists of fiber, sugar and molasses. The approximate amount of moisture in bagasse of 75% extraction, is 51%. The fuel value per pound of fiber is 8,325 B. T. U. of sugar, 7,223 B. T. U. of molasses and dry matter 6,956 B. T. U. An average pound of bagasse of 75% extraction contains water 51%, fiber 40%, sugar 6%, and molasses 3%. The heating value of one pound of dry bagasse of this extraction is, therefore, 3,972 B. T. U. As it requires about 15.4% of this heat to evaporate the contained water, the effective heating value is 3,361 B. T. U., making 1 lb. of coal, of a heating value of 13,500 B. T. U., equal to 4 lbs., approximately, of bagasse. The heating values given for the fiber, sugar and molasses are from calorimetric tests made by Dr. Atwater.

Some determinations recently made in a Mahler calorimeter by Prof. Magruder, Ohio State University, upon bagasse containing 44.26% moisture gave a heating value per pound as 4,535 B. T. U. This heating value, considering the difference in amount of moisture, is not far different from the values determined by Dr. Atwater.

LOCOMOTIVE FOR THE IMPERIAL GOVERNMENT RAILWAYS OF JAPAN.

The Japanese railways are supplying locomotive builders in the United States with numerous orders, and we illustrate this week one of 20 eight-wheel passenger engines shipped in January to the Imperial Government Railways of Japan by the Brooks Locomotive Works, of Dunkirk, N. Y.

The engines are all for the Japanese gage of 3 ft. 6 ins., and are good representatives of standard American practice. Certain European features, however, which are standards in Japan, are the spring buffers, the screw couplings (shown below the buffers), the "knives" in front of the leading wheels, the copper firebox, the six-wheeled tender, and the Smith automatic vacuum brake. They are two-cylinder simple engines, and will burn bituminous coal for fuel. The tender has not a plate frame, as in European practice, but has rigid pedestals attached to the iron underframe, with a semi-elliptic spring over each axle box. The tank is of 3-16-in. and ¼-in. plates. The cab is of steel, of the pattern adopted as standard by this firm of builders. The leading dimensions are as follows:



PASSENGER LOCOMOTIVE FOR THE IMPERIAL GOVERNMENT RAILWAYS OF JAPAN.
The Brooks Locomotive Works, Dunkirk, N. Y., Builders.

Dimensions of Passenger Locomotives for Japan.

Running Gear:
Driving wheels (4), diameter ....4 ft. 6 ins.
Truck wheels (4), " ....2 " 3½ "
Tender wheels (6), " ....3 " 0 "
Driving wheel centers ....Cast iron
Journals of driving axles ....6½ × 8 ins.

Wheelbase.—Driving ....7 ft. 0 ins.; Truck ....5 ft. 8 "
Total engine ....19 " 4 "
Engine and tender ....38 " 9 "
Tender ....9 " 10 "
Center of engine truck pin to center of leading driving wheel ....9 " 6 "

Weight in Working Order:
On driving wheels. 50,400 lbs.; on truck wheels. 24,100 lbs.
Engine, total ....74,500 "
Tender, loaded ....52,000 "

Cylinders.—Number ....Two
Diameter and stroke ....15 × 22 ins.
Form of crosshead and guides ....Laird
Connecting rod, length c. to c. .... 5 ft. 10 ins.
Side rod ....Solid ends

Valve Gear.—Type ....Link
Ports, steam ....1⅜ × 14 ins.
Ports, exhaust ....2½ × 14 "
Bridges, width ....1⅜ "
Slide valves, style. .Richardson; max. travel ....6¼ "
" " inside lap....None; outside lap ....1 in.
" " lead.....Variable; (in full gear) ....None

Boiler.—Type ....Straight top
Diam. barrel, inside smallest ring .... 4 ft. 6 ins.
Dome, diam ....1 " 10 "
Thickness barrel plates. ½ in.; smokebox tube plate. ½ in.
Horiontal seams ....Quadruple riveted
Circumferential seams ....Double riveted
Height from rail to center line ....7 ft. 1 in.
Length of smokebox (including extension) ...4 ft. 1½ ins.
Spark arresting device ....Wire netting in smokebox
Working steam pressure ....160 lbs.

Firebox (copper) ....Sloping, over frames
Length inside....6 ft. 6 ins.; width inside. .2 ft. 5½ "
Depth at front....4 " 11½ " depth at back. 4 " 3½ "
Thickness, side plates....½ in.; crown plate ....½ in.
" tube plate ....⅞ and ½ "
Crown stays ....Radial; gratebars ....Rocking
Is fire-brick arch used? ....Yes, on studs
Water Spaces:
Width at front, 3½ ins.; at back, 4 ins.; at sides, 5 ins.

Tubes (solid drawn brass); Number 210
Diameter, outside ....1¾ ins.
Length over tube plates ....9 ft. 7 1-16 "

Heating Surface and Grate Area:
Heating surface, tubes (interior area) .... 965.0 sq ft.
" " firebox .... 89.9 " "
" " total ....1,054.9 " "
Grate area .... 15.2 " "

Miscellaneous:
Exhaust nozzle, single and permanent:
Diameter ....4, 4 3-16, 4⅜ ins.
Smokestack ....Taper
" height of top above rail ....12 ft. 1½ ins.
Capacity of tender tank, ...2,400 gallons
Capacity of coal space ....5 tons
Brake fittings ....Smith automatic vacuum

TESTS OF THE EFFICIENCY OF BOLTED JOINTS.

The results of a series of 14 tests of bolted plates, made in the Engineering Laboratories of the Massachusetts Institute of Technology, are reported in the Technology Quarterly for December, 1897. The specimens were all made from the same sheet of boiler plate steel, 0.43-in. to 0.45-in. thick, of 68,000 lbs. per sq. in. tensile strength. The bolts were of machine steel of 96,000 lbs. tensile strength. The holes in the plates were drilled and reamed, and the bolts were turned to an easy driving fit. The appended table gives a condensed summary of the results.

Joints Nos. 2, 11, 12, 13 and 14 failed by shearing of the bolts, the others by tearing of the plates inclusive were made with three bolts, Nos. 11 and 12 with two bolts, and Nos. 13 and 14 with one bolt:

Summary of Tests of Bolted Joints.

No. of joints.	Bolts, ins.	Pitch, ins.	Width of joint, ins.	Area, net section, sq. ins.	Maximum, lbs. per sq. in.			Ave. thickness, ins.*	Reduction, %.†	Efficiency, %.
					Tension on net section.	Shear on bolts.	Compression.			
1	¾	2	6.01	1.62	63,100	38,500	105,400	.49	31	58
2	¾	2	6.00	1.61	62,600	38,100	104,500	.49	15	57
3	⅞	2 9-16	7.69	2.18	62,900	38,000	121,000	.51	28	61
4	⅞	2 9-16	7.70	2.18	62,300	37,700	120,500	.52	30	60
5	1	3¼	9.76	2.97	60,400	38,100	136,000	.57	28	62
6	1	3¼	9.76	2.97	60,800	38,300	136,900	.58	23	62
7	1⅛	4	12.00	3.88	61,500	39,900	158,600	.59	25	65
8	1⅛	4	12.00	3.88	58,100	37,600	148,600	.56	26	62
9	1¼	4⅞	14.64	4.90	59,600	39,700	173,100	.68	25	65
10	1¼	4⅞	14.64	4.90	59,600	39,700	173,100	.66	22	65
11	1⅜	5¾	11.55	3.96	49,000	32,700	156,700	.68	6	55
12	1⅜	5¾	11.55	3.97	49,800	33,300	160,800	.68	7	56
13	1⅜	...	5.54	1.87	51,400	32,400	155,600	.66	10	57
14	1⅜	...	5.51	1.82	53,200	32,600	159,800	.66	8	59

*Of plate in front of bolts at fracture.
†Reduction of area (net section) %.

From the photographs given in the report it appears that the bolts were placed in double shear; that is, the plate which was broken was gripped by two side plates, the bolts passing through all three. In those joints which failed by shearing of the plates it appears that the shearing resistance of the bolts was only from 32,400 to 38,100 lbs. per sq. in. of the sum of the sections subjected to shearing stress. This appears to be very low for steel of 96,000 lbs. per sq. in. tensile strength. In the case of the plate that broke by tension, the resistance of the net section per square inch ranges from 58,000 to 63,100 lbs. per sq. in., the steel plate itself being of 68,000 lbs. tensile strength. These figures would indicate that in bolted plates the stress is apt to be not uniform throughout the whole sectional area of the plate, and that some portions receive a greater stress than others, so that the full calculated strength of the joint is not developed. The efficiency of the joint is, therefore, apt to be less than would be expected from the ratio of the net to the gross section of the plate.

A COMBINATION OPEN AND CLOSED CAR will be used on the electric lines of the Metropolitan Street Ry. Co., of New York city. These cars have one end enclosed for a distance of about 12 ft., the remainder being open like a summer car.

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"The Government can and ought to assist in every lawful manner private enterprise to unite the two oceans with a great canal," said President McKinley in his speech at the banquet of the National Association of Manufacturers. "Let the Nicaragua Canal be constructed by the United States," said Senator Frye, who followed the President; and Mr. Chas. Emory Smith, the third of the speakers, alluded to "the isthmian canal, which we must have." All these sentiments were vociferously applauded, as was to be expected; and their expression is worth noting as an evidence of the position of leading public men toward the Nicaragua enterprise, and to some extent, as an indication of the sentiment of such men as the members of the Manufacturers' Association upon this question.

And yet, we strongly suspect that if any of the enthusiastic advocates of the canal—to be built and paid for with other people's money—were asked to prove their faith by their works, and invest heavily in the canal enterprise, their enthusiasm would immediately be tempered with a desire to know more concerning it. What will it cost? What revenue can it reasonably be expected to earn? What dangers may threaten this investment, from storms meteorological or political? Are the plans proposed for its construction such as can be practically and successfully carried out? Certainly any man who should invest his fortune in any such enterprise without in some way satisfying himself on such vital questions, would be in need of a guardian; and the nation ought to be as careful in investing the money of its taxpayers or loaning its credit which they must make good as a private individual would be in investing his own money.

To say at the present time what the policy of the nation should be respecting the Nicaragua Canal is premature. No man can say what it is best to do concerning it, till the investigations of the engineering commission now in progress there are completed. It is probably true that the United States wants the Nicaragua Canal; but it does not want it badly enough to repeat the blunders of France in the disastrous ditch at Panama; it does not want such a financial white elephant on its hands as the Manchester and Corinth canals have proved; it does not, we believe, desire an enterprise of such doubtful commercial value as the Baltic and North Sea canal. To sum it up briefly: If the Nicaragua Canal will pay, directly or indirectly, we want it and are going to have it. If it will not pay, anyone who wants to build it for glory is welcome to it.

The dusty condition of the roadbed on a majority of American railways, including important trunk lines as well as minor lines, has been frequently commented upon in its relation to the comfort of passengers and the maintenance of the rolling stock, and more attention is likely to be paid to it in the future. The great bulk of the railway track of this country is ballasted with gravel, and this is likely to continue to be the case. Unfortunately almost any kind of stuff met with on the line which can by any stretch be called gravel is considered as suitable for ballast in the original construction of the road, and when once used it is only in rare instances that it is replaced by a better material. On many such roads a fast train passing over the line in dry weather is enveloped in a cloud of dust which sometimes obscures the track from view from the rear of the train. The discomfort and inconvenience to the passengers which this causes have led to a general objection to summer travel by rail. After gravel ballast has been left undisturbed for some time it becomes compact and consolidated, and is then very free from dust. In the spring, however, much of the roadbed is torn up for tie renewals, so that just when the summer tourist traffic is commencing the road is again intolerably dusty. Besides the discomfort to passengers, dusty roadbeds have no small influence in producing hot boxes, and in increasing the wear of car-journals, crank-pin bearings, cross-heads, eccentrics, and other parts of the machinery.

One way to avoid these difficulties when the renewal of ballast is undesirable, is to spray the track with oil by means of special devices. This has been tried on some of the lines of the Pennsylvania R. R. with very satisfactory results, and the cost is said to be less than $50 per mile. One treatment will usually suffice for the entire summer season, and after a few treatments the ballast will produce but little dust, even when disturbed for surfacing or tie renewals. In re-ballasting with gravel it is a good plan to wash and screen the gravel, as is not unfrequently done in Europe, so as to obtain a clean material of uniform size that will be fairly equivalent to broken stone. Gravel is commonly used for ballast on English railways, either alone or as a top dressing to stone ballast, but it is a very different character of material from the ordinary ballast of American railways. The use of furnace slag is also worthy of more general consideration on roads running through an iron-making district. Broken stone ballast is usually considered as the best, but there are other and cheaper materials which are almost equally dustless, such as slag, clean screened gravel, or even burnt clay.

This subject is one which is especially important, but is very frequently neglected in the construction of electric railway lines, running on suburban roads, and especially those running on their own right of way to pleasure resorts. The pleasure of a ride in open cars over such a line by a holiday crowd is much marred if a cloud of dust is continually flying; and a moderate expenditure for dustless ballast in the original construction may prove an excellent investment.

The annual report of the Department of the Interior upon the "Mineral Resources of the United States" is a public document of great value and usefulness, and one that should be easily obtained from the government by the great number of citizens interested in its contents. Without this accessibility little reason exists for the large expenditure of public funds involved in its preparation and publication. Until quite recently this document, bound in cloth and covering from 700 to 800 pages of printed matter, could be obtained by forwarding 50 cents to the Director of the U. S. Geological Survey, and as a consequence the work was largely circulated among people who care enough about it to take the pains to send for it and pay this small sum. On March 2, 1895, Congress provided that this report was to be issued thereafter as part of the report of the Director of the Geological Survey; though in fact it had been long previously published under the direction of this same officer. The result of this action of Congress, however has been to remove the report from sale and seemingly to limit the edition; and those desiring copies are now notified that they must apply for the report for 1896 to Members of the Fifty-fifth Congress, "who have a limited number for distribution." None are now on sale by the Director of the U. S. Geological Survey.

While this action of Congress may add to the gains of local dealers in public documents, to whom the majority of those desiring this report must now resort, it is a decided step backwards in the lately proposed reform in the distribution of these publications. Comparatively few know members of the Fifty-fifth Congress sufficiently well to ask, or to have granted to them a favor of this kind; and there is a certain element of personal pride involved that will lead seekers after this special report to first apply to those who honestly, or dishonestly have it on sale. Other than the right acquired by long usage, there is no valid reason why Senators and Congressmen should have charge of the distribution of valuable and generally useful publications of this nature, prepared and printed at public expense. It would be more just and businesslike to follow the example of England and some other nations, and put such documents on public sale at a minimum cost. The methods now proposed is certainly not in the line of wise economy; for, while the report will practically cost as much as before in labor and money, it is safe to say that the volumes sent by well-meaning Congressmen to those who have no use for them will far exceed the number received by those to whom the contents would be valuable. As a method of distributing useful information, it is a survival of an out-of-date and reasonless practice which ought long since to have been abolished altogether.

THE VALUE OF FORESIGHT IN ENGINEERING.

The announcement of the Third Avenue R. R. Co., of New York city, that electrical traction on the conduit system will be substituted for the cable on its lines is new evidence that the cable system of street railway traction is soon to become a thing of the past. On a few roads with very steep grades the cable may survive, and it will doubtless continue to be used indefinitely for what are known as "incline railways;" but for ordinary city street railway service, it is plain that the cable is no longer able to compete with electric traction. Why this is the case, it is hardly worth while to consider at much length. Probably the less liability of the electric road to blockades and accidents has had more to do with influencing the change to electric traction than any contrast between the economical application of power in the two systems. Be that as it may, the evident thing is that the cable road is soon to be put away among the obsolete things in engineering; and the strange thing now is that this should not have been foreseen a few years, so that the money that has been expended on enormously expensive cable driving machinery might have been saved.

It is only four years ago that the cable superseded horses on the main line of the Third Avenue Ry. The electric trolley was then almost as marked a success in street railway service as it is at the present time. Why was it not foreseen that the conduit electric railway was among the probabilities, at least, of the near future, and that when it came it would prove superior to the cable system? Looking backward now, it seems as if so simple a matter of mechanical development might have been not only guessed at but foretold with well-nigh certainty.

Whether it could have been foreseen or not, however, it is plain that it was not foreseen by the officers and engineering advisers of the Third Ave. R. R. Co. They were not alone in their failure to discern the future. Cable railway companies in Minneapolis, Washington, Chicago, San Francisco, Los Angeles, and many other cities expended large sums in cable railway machinery only a few years ago, which they soon discarded. The story is hardly yet old of how the owners of the street railway lines of Minneapolis and St. Paul, after actually purchasing equipment for operating their lines by cable became convinced that the cable was obsolete, deliberately sold the new cable plant for what it would bring, pocketed the loss and ordered electric equipment for the system throughout. This was done, we believe, even before the time when the Third Ave. Co. adopted the cable for its lines; but it is fair to say that the exclusion of the overhead trolley from New York caused the building of cable railways there at a time when other cities were discarding the cable for electricity.

It seems to us that the loss which many cable railway companies in this country have suffered through the failure of their officers to "see farther ahead than their own noses," is an excellent illustration of the need of better foresight on the part of engineers. The value of foresight in ordinary business and commercial matters is common knowledge. The merchant or the dealer in almost any sort of goods who cannot form some sort of forecast of the immediate future at least, is pretty sure to find his plans and schemes miscarrying. In engineering the demand is no less evident for a correct analysis of the future, and it is not too much to say that many an engineer has the saving or losing of millions dependent upon his ability to foresee advances in science and industry, changes in mechanical development, and the growth of new social and economic and political factors.

We are often accustomed to think of the engineer as bound by past precedents, and advising his clients solely on the basis of what is good, sound, safe practice as laid down by past experience. But the engineer who does not look at the past to discern what it can tell of the future as well as to learn what is good practice to-day, cannot render the highest service to his employers. For example, here is a corporation proposing to build a short line of railway, through a populous district. If the engineer is given a broad commission as an adviser, he will not fail to compare electric and steam traction not only on their present basis but on the basis of their probable relations a few years hence. In saying this, moreover, we do not at all mean that the engineer will invariably advise the newest fad. Far from it. The task of the ideal engineering adviser is no such sinecure. To illustrate again: The "Alley" elevated railway in Chicago was originally equipped with steam locomotives. After only four years of operation it was determined to change to electricity, and the locomotives, still nearly new, had to be sold for a fraction of their cost. One may cite this as an example of the lack of foresight on the part of the engineer; but on the other hand, it is possible that the reduction in prices of electrical apparatus and the improvements that were made in it during the four years that locomotives were used on the Alley road more than compensated for the loss on the locomotives.

The necessity of foresight on the part of engineers has not been ignored in the literature of the profession; but curiously enough, this literature is almost wholly on one side. The engineer is constantly being told that he doesn't make allowances for the future. He builds his bridges for the locomotives of to-day instead of those of ten years hence. He equips a shop with standard lathes and planers, when he ought to use special tools. He builds cheap railway lines for light traffic when he ought to cut down grades, regardless of expense, to enable a heavy traffic to be hauled at a minimum cost. In short, contributors to technical literature have generally assumed that engineers are as a rule too conservative in their estimate of the future, and that they need to be urged to expend more liberally in original construction to save in operating expenses at a later date.

Now, no one will question that this is often the case; but it is not always so. Probably many of our readers can call to mind instances within their own knowledge where engineers of too sanguine a temperament have built for a future that was never realized. The Third Avenue railroad is a case in point. When the road was changed to a cable line, four years ago, an enormous power station, covering an entire city block was built at 65th St. Engines and cable machinery were provided which afforded a great surplus of power, and a boiler plant big enough to give more steam than the engines could ever use. Big as the machinery equipment was, however, the power-house was so much bigger that the actual power developed per square foot of ground space covered by the building was exceedingly small. We know of no valid reason why such a great surplus of space and power was provided at this place unless the engineer was planning for a vast expansion of traffic in the future; but long before the traffic grows up to the provision made for it, the machinery becomes obsolete, and the company suffers a great loss, because those responsible for the design of its plant provided for the future with too lavish a hand.

We need not take space to multiply instances. The annals of engineering are full of them. We believe that at the present time there are as many engineers who need to be cautioned against an over-sanguine estimate of the future as there are who neglect to provide for anything beyond immediate requirements. The thirteen years, from 1879 to 1892, were years of such enormous growth in all fields of industrial enterprise, that a tendency arose to set up this rate as a standard for the future. The last five years have taught some salutary lessons. We have learned that industrial progress and growth is not necessarily a continuous process; that trade may diminish as rapidly as it increases; that the growth of one section in commerce, population and wealth is often at the expense of some other.

As we said above, the engineer, in a position to act as a responsible adviser, must look well to the future as well as the present; but he must estimate the chances of loss as well as profit, of decadence as well as growth. He must remember that inventive progress is often a greater element of depreciation than actual wear and tear, and that the money he spends in excess of present requirements to make his work good for the next generation will be piling up interest in all the years until the next generation comes upon the scene.

LETTERS TO THE EDITOR.

A Diagram for Stadia Reductions.

Sir: I enclose a blue-print of a small diagram for reducing stadia readings to the horizontal, which I have found quite a time saver and which may prove of interest to others making stadia surveys. During a recent survey I found the time lost in reducing my readings to be considerable, even with the best tables I could find, so I constructed this little diagram for the purpose. It is small enough to paste in the back of a note-book; and after a trial or two, reductions can be made almost at a glance.

Very truly,
E. McCulloh.

1320 Newton St., Los Angeles, Cal., Nov. 3, 1897.

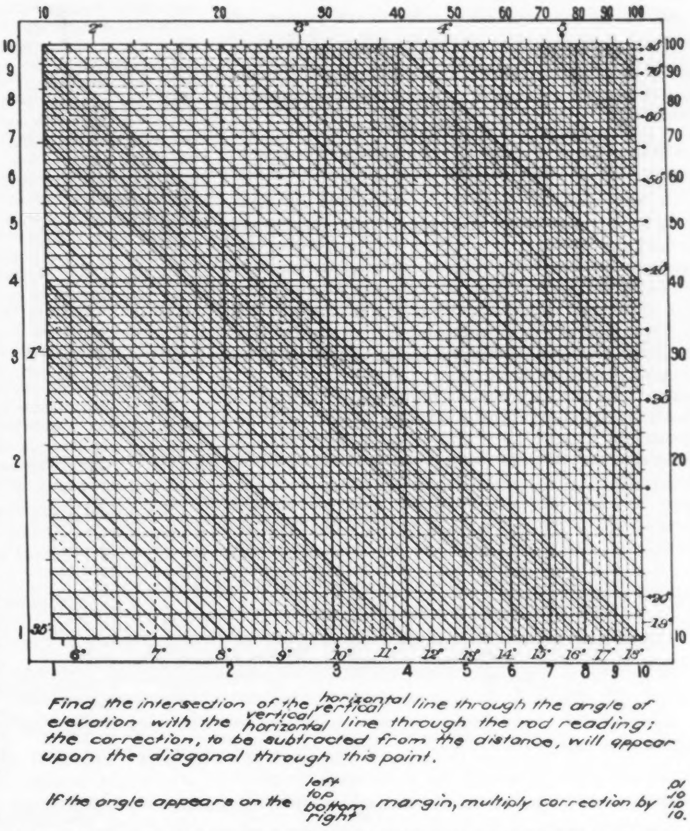


DIAGRAM OF STADIA CORRECTIONS FOR REDUCING INCLINED MEASUREMENTS TO THE HORIZONTAL.
Drawn by E. M. McCulloh, C. E., Los Angeles, Cal.

Tests of Cast-Iron Columns by the New York Building Department.

Sir: Replying to Mr. Henning's inquiry in your issue of Jan. 27, I would say that the 1st, 3rd, 5th and 7th columns in the table of readings of compression, taken from the Phoenix column at Phoenixville, were rising pressures, while the 2nd, 4th, 6th and 8th columns were falling pressures. The initial readings at Phoenixville were, as shown in table, observed at the time the gage registered 60 lbs., they being — 0.0095, — 0.0091, — 0.0097, etc., while the final readings for a gage reading of 220 lbs. were 0.0292, 0.0303, 0.0288, etc. In my letter of the 18th inst. I stated that no attempt was made to record zero readings of the apparatus when the column was without load, owing to the kind of mercury gage used. Therefore, the readings of compression observed at gage reading 200 do not exhibit the total amount of compression from zero to 200 gage reading, but simply a series of readings taken with readings at other loads, from all of which the differences and average difference of compression were derived, and, upon which depend the average factor, 2,730. Consequently no comparison can be drawn from the recorded compression at gage reading 200 and the recorded compression for an equal load in pounds as recorded in Watertown.

The tables of compression as published in your paper of Jan. 13, p. 27, are correct, except in regard to the points mentioned in my letter published in your issue of Jan. 20.

Very truly, William W. Ewing,
Special Engineer Department of Buildings.

New York city, Jan. 31, 1898.

The New York Department of Subsurface Construction.

Sir: It no doubt will be of interest to you to know that the editorial on Subsurface Street Construction in your issue of Oct. 21, 1897, has been of value in bettering the public service in this city.

The writer was promoted to be General Inspector of Street Openings in April last, and since then has been able, through the favorable action of General Collis, late Commissioner of Public Works, to make a start in maintaining a series of maps showing the location of all pipe lines for gas and steam, pneumatic tubes, electrical conduits and street railways, together with all information in regard to the kind of material excavated in constructing them, the grades, lines, distances, etc. By the necessary increase in the number of draftsmen on this work, supplemented by the present corps of inspectors, it is hoped that these records can be made complete for all work done this year, and that much information concerning lines already constructed can be recorded.

Through the recommendation of the Commissioner of Public Works and with the approval of the Mayor the title of the officer in charge of this work was changed to Engineer of Subsurface Construction. The present incumbent being a civil engineer of recognized standing and the first ever appointed to the position.

Those familiar with public work will recognize the difficulty of making these improvements in the service when, as in this case, it is necessary to increase expenses, and that, too, by employing additional engineers rather than politicians. The recent experience on the 5th Ave. work, however, and your valuable criticism have been of great assistance in bringing the subject forward in the proper light and with the necessary weight to be favorably acted upon.

Yours very respectfully,
Wisner B. Martin,
Eng. Sub. Cons.

Department of Highways, New York, Jan 29, 1898.

Notes and Queries.

Correction.—In reviewing the last report of the Engineer and Surveyor of the State of New York, in our issue of Jan. 20, it was said that the mapping of 12,700 sq. miles of territory cost the State $10.32 per sq. mile. It actually cost the State of New York one-half this sum, or $5.16 per sq. mile; as the work was done in co-operation with the Director of the U. S. Geological Survey, and under the existing arrangement the Federal government paid for the other half.

W. H. B. desires information as to the average and probable maximum span of I-beams and channels in actual practice in building construction. The real question is, to what extent are these spans controlled by the size and form of the building, or by practical considerations in designing?

TESTS OF A STORAGE BATTERY ELECTRIC RAILWAY POWER PLANT.

In our issue of Jan. 6 we described at some length the plant and equipment of the Englewood & Chicago Electric Ry., which is operated exclusively on the storage battery system. Since then we have received a copy of the report upon a series of tests of the power plant and batteries made for Mr. Herbert C. Condict (who was at the time General Manager of the road), by Mr. George A. Damon, Engineer of Tests.

The road and its equipment have been so recently described in our columns that it is only necessary to state here that the power plant consists of two Willans central-valve triple-expansion engines, with throttling governors. Each engine is rated at 200 HP., at a speed of 380 revolutions per minute. These are directly connected by the Arnold system to four six-pole Walker dynamos, rated at 190 K-W. each. Steam is supplied by three Heine water-tube boilers rated at 200 HP. each, and fitted with the Roney mechanical stokers. The leading dimensions of the engines are as follows:

Diameter, h. p. cylinder,	10¼ ins.;	h. p. trunk,	3 15-16 ins.
" int. "	14 13/16 ";	int. "	5⅝ "
" l. p. "	23⅝ ";	l. p. "	6⅛ "
" transfer chamber trunk			6½ "
Stroke			7 15-16 "

A running start was made for each of the three tests, and careful records were kept of the coal and water consumption of the boilers, as well as of the water used by the air and feed pumps. Eight Crosby indicators were used on each engine, it being necessary to take cards from the transfer chamber as well as from the three cylinders of each set. Indicator cards were taken every half hour, and as there was not room to take all the cards at the same time, a bell signal was used to warn the attendants not to change the batteries during the short time required to indicate the engines. The output on the switchboard was obtained by Weston instruments, readings of the volts and amperes being taken every five minutes, and the average watts from each of these readings for one hour taken as the watt-hour output for that hour.

Conditions of Tests.—Three separate tests were made under somewhat different conditions, as follows:

Test No. 1, Oct. 30, 1897.—In this test the power house was taken as it was actually found in operation and no changes whatever were made. At that time it was thought to be desirable to charge the batteries by means of three different voltages, and in consequence three generators were operated (Eng. News, Jan. 6). Under these conditions the load was too heavy for one engine, so both engines were used. One engine operated one generator which furnished voltage for the low bus bar, upon which about half the station load was carried. The other engine operated two generators which furnished current to the high and intermediate omnibus bars. To run the two engines it was thought to be necessary to fire two boilers. This test is to be considered as a preliminary run, but the results show the actual condition under which the plant was operating at the time.

Test No. 2, Nov. 5, 1897.—This test was made under somewhat more favorable conditions. The road was operated with one boiler, one engine and two generators. The three voltages were furnished by running one generator upon the high bus-bar and inserting a carbon rheostat between the high and intermediate bars in such a way as to cause a drop in potential of about ten volts between the two bars. The current for the low bus-bar was furnished by the other generator.

Test No. 3, Nov. 26, 1897.—This final test was made under what were thought to be the best possible conditions under which the road could be operated. Only one boiler, one engine and one generator were used. The three-voltage method of charging the batteries was abandoned, and the batteries were charged in successive sets, all at a common potential; the voltage being raised as the batteries became charged in such a way that the load upon the generator was kept nearly constant.

In all three tests an effort was made to use the same kind of coal, from Fairmount, W. Va., which was delivered at the power house at $1.90 per ton.

Figs. 1 and 2 are diagrams of the boiler and engine tests during the third run, on Nov. 26. The analyses of the coal samples, expressed in terms of dry coal, showed that the volatiles and combustibles (with half the sulphur content) were 36.26% and 36.53%; the fixed carbon (plus half the sulphur), 55.41 and 52.84%; the ash, 8.18 and 10.65%. Four determinations of the heating value showed an average of 10,145 B. T. U., indicating a poor quality of coal. From the tabulated statements in the report we have compiled Table No. 1, which shows the most important results of the tests:

TABLE No. 1.—Results of Tests of Power Plant.

	1897 Oct. 30.	Nov. 5.	Nov. 26.
Dry coal per hour, lbs.	1,171	842.8	728.6
Combustible per hour (dry coal less refuse)	1,002	720.8	626.4
Theo. evaporated power, from and at 212°, in lbs., water per lb. coal	10.51	10.51	10.51
Water evap. into dry steam from and at 212°, per hour, lbs.	7,831.5	5,769.6	5,150.6
Water evap. into dry steam from and at 212°, per lb. of dry coal	6.68	6.84	7.06
Water evap. into dry steam from and at 212°, per lb. of combustible	7.81	8.0	8.22
Coal consumption (⅛ refuse):			
Per sq. ft. of grate surface, lbs.	13.36	19.01	16.74
Per sq. ft. of heating surf., lbs.	0.427	0.614	0.534
Commercial HP. of boilers*	227	167	149
Builders rating of boilers,† HP.	400	200	200
Per cent. below rating	43.3	16.5	26.5
Dry steam used, per hr., lbs.	...	4,883	3,903
Dry steam per I. HP. hour, lbs.	...	21.6	18
Average:			
Speed, engine No. 1, revs.	338	...	...
" " " 2, "	356	364	363
Vacuum, " " 1, ins.	21.6	...	...
" " " 2, "	23.1	23.2	24.25
Gage pressure, lbs.	...	163.4	171.3
I. HP. of engines, maximum	...	240	246
" " minimum	...	147	202
" " average	...	226	217
Elec. HP., average	...	176.6	172
Net K-W. hours output	1,875	2,487	1,086.6
Efficiency, av. (el. HP. ÷ I. HP.)	...	78.23	79.3
Water evap. per I. HP. hr., lbs.	...	26	22.25
Per net K-W. hour, lbs.	51.4	46.9	40
Coal burned:			
Per I. HP. hour, lbs.	...	3.78	3.58
Per net K-W. hour, lbs.	7.6	6.9	6.44
I. HP. per lb. of coal	...	0.26	0.28
Watt-hours per lb. of coal	131.5	146	155.2

*(30 lbs. water per hour evap. from 100° F. into steam of 70 lbs. gage pressure.)

†(At 7 sq. ft. of heating surface per HP.)

In the three tests, the results of 7.81 lbs., 8 lbs. and 8.22 lbs. water evaporated per pound of combustible from and at 212° F. may be considered very fair. These figures represent an efficiency of the boiler and furnace of 63.55%, 65.08% and 67.17%, respectively. The first test was made upon two boilers running at 43% underloaded, while each of the other two tests were made upon one boiler under slightly better conditions. The last test, which shows the best efficiency, was made upon a clean boiler in first-class condition. Unfortunately, however, the output of the boiler was 26.5% below its rated capacity, so that the best possible efficiency of the boiler was not obtained. It will be seen that in none of the tests were the boilers given an efficient load.

The highest rate of fuel combustion on any of the tests was 18.5 lbs. of coal per sq. ft. of grate surface, and this with the boiler operating at 16.5% below rating. This means that at full load the rate of combustion would be about 22 lbs. per sq. ft. of grate surface, while a rate of 30 lbs. of coal per sq. ft. of grate surface ought to develop an overload of 40% on the boilers. The stoker makers claim that the stoker ought to easily handle 30 lbs. of coal per hour per sq. ft. of grate surface, but it is certain that with the coal furnished, great difficulty would be experienced in operating the stokers at this rate.

The figures show that the economizer is not giving the most satisfactory results. This is due to the unfavorable conditions under which it was installed, and is now being operated. The saving effected by the economizer is proportional to the drop in temperature of the flue gases, caused by passing around the economizer pipes. It is important then, that the economizer be placed as near the boilers as possible, so as to get the full benefit of the heat in the flue gases. In this plant, however, the design of the station placed the economizer on the outside of the boiler room, and a considerable distance from the uptakes of the boilers. This necessitated a long passage for the hot gases through a brick flue which bears evidence of hasty construction. Furthermore, the settling of the foundations of some of the supports, has caused several cracks. The result is that no small amount of cold air infiltrates through the brick flue and cools the gases before they reach the economizer. One test showed a drop of 100° F. in the temperature of the flue gases between the uptake from the boiler and the entrance to the economizer. The smaller the load carried by the boilers the greater the proportional cooling effect of this air leakage. This was shown by the last test, in which the economizer was operated at a loss. This means that the flue gases were cooled to such an extent that the resultant rise in temperature of the feed-water was hardly sufficient to counteract the loss in radiation in the feed-water pipes leading to and from the economizer, though these were covered. The low temperature of the flue gases is not due entirely to air infiltration through the brick work, as the custom of keeping the ash-pit doors open under the

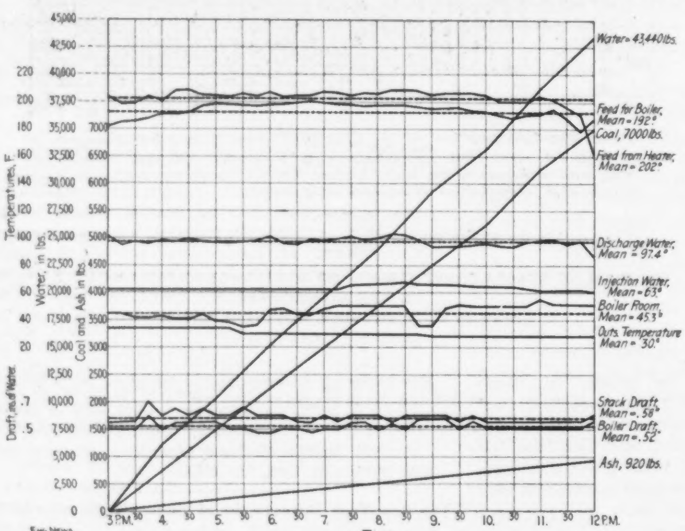


FIG. 1.—DIAGRAM OF BOILER TEST OF NOV 26

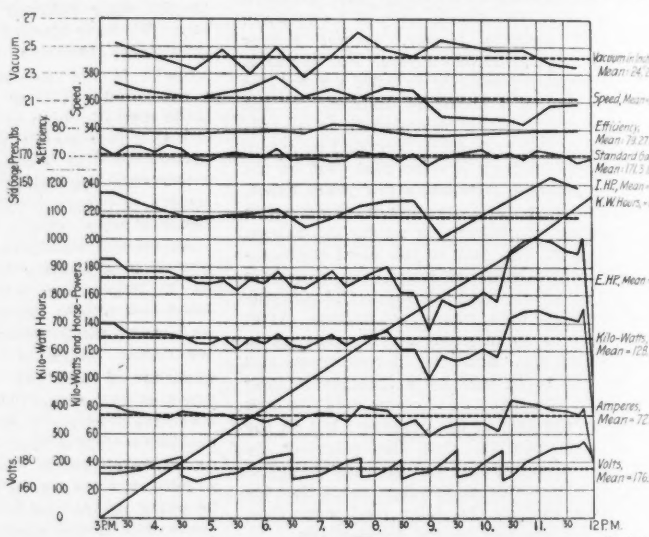


FIG. 2 DIAGRAM OF ENGINE TEST OF NOV. 26.

furnace may result in an excessive amount of air being drawn through the fire. The two boilers not in operation also offered a certain number of openings through which air leaks into the smoke flue. The effect of the cooling of the gases upon the strength of the draft is an interesting point to notice.

After the first tests the engines were completely overhauled by the makers, but the conditions of the final test were not favorable to an accurate engine test or to the most economical operation of the engines. The consumption of 18 lbs. of steam per I. HP., instead of 14½ lbs, as expected, may be attributed in a measure to the following causes: (1) The average vacuum maintained was only 24.25 ins. when it should have been 27 ins.; (2) the steam pressure supplied to the engine averaged only 171.3 lbs. on the gage, when it should have been at least 175 lbs.; (3) the average speed of the engine was 363 when it should have been 380 revolutions.

In the last test, the two lines of cylinders developed different rates of horse-power, owing to an improper adjustment of the cut-off on the north line of cylinders. There seems to be no doubt but that a material improvement can be made in the duty of the engines by a few alterations.

The indicator cards taken with the engine operating one generator, running upon open circuit, show a friction load of only 32.2 I. HP. This is but 14.86% of the average 217 I. HP., and is a very satisfactory figure. The average efficiency between the horse-power developed in the cylinders and the electrical power delivered on the switchboard is shown to be 79.29%, which is also satisfactory. The commercial efficiency of the generator (including the leads to the switchboard) at this load is 93.1%, which is about all that can be expected of a generator running at 32% below its rated capacity.

On Nov. 8 a test was made to determine the efficiency of a battery under actual operating conditions. The battery was charged by the three-voltage method and then discharged while making a round trip. It was then again charged, thus giving two charges and one discharge to determine the efficiency. The battery had already operated over 8,000 miles, and was taken immediately after a trip similar to the one on which it was tested. Table 2 shows a summary of the test. The report states that with coal containing 10,145 B. T. U. per lb., and costing $1.90 per ton, the cost of fuel per car-mile is less than 1 ct. If coal of 13,000 B. T. U. and costing $1.25 per ton had been obtained (and this is practicable in some localities) the cost for fuel would be reduced to ½ ct. per car-mile.

TABLE 2.—Tests of Storage Battery.

	Time	Watt-hours.
First charge:		
On low-volt bus-bar	1 hr. 8 mins.	10,885
On int.-volt bus-bar	54 "	11,315
On high-volt bus-bar	34 "	14,557
Total time charging (2 mins. for 2 changes)	2 hrs. 38 mins.	
Total watt-hour charge		36,757
Second charge:		
On low-volt bus-bar	1 hr. 25 mins.	18,527
On int.-volt bus-bar	44 "	6,354
On high-volt bus-bar	29 "	6,750
Total time charging (2 mins. for 2 changes)	2 hrs. 40 mins.	
Total watt-hour charge		31,631

After the second charge, readings of the voltage upon open circuits were made every five seconds for four minutes, and showed a continual and steady drop from 170 at the beginning to

TABLE 3.—Trial Run with Car.

	Distance, miles.	Time, Mins.	Time, Secs.	No. stops.	Av. speed, miles per hour.	Watt-hrs.	K-W. hrs. per car-mile.
1. Power house to Blue Island	5.90	28	20	12	12.5	5,533.1	.920
2. Blue Island to power house	5.90	29	55	19	11.8	5,098.0	.868
3. Pwr h'se to 63d St.	5.30	27	40	13	11.5	4,394.6	.820
4. 63d St. to pwr h'se	5.30	27	50	13	11.5	4,689.6	.885
Total	22.40	113	45	57		19,715.3	.878

Total number of stops	57
Time from start, not including stops	113 mins. 45 secs.
Total distance, miles	22.40
Length of one back up stop, mile	.04
Total distance, miles	22.44
Average speed, miles per hour	11.84

The road is practically level, but the results of the table would seem to indicate that in general the grade rises from the power house toward the two terminals.

Efficiency.—The efficiency of the battery is shown as follows:

Kilo-watt hours, 1st charge	36.757
" discharge	19.715
" 2d charge	31.631
Efficiency, discharge—1st charge	53.6 %
" " 2d "	62.32%
" average	57.96%

battery. The amount of the first charge was of course influenced by the immediate previous history of the battery and for this reason the efficiency obtained by using the second charge as a basis is the more reliable.

Acceleration Tests.—In the tests made upon a car in actual service no opportunity was afforded for accurate acceleration tests. These were made Nov. 13, 1897, upon a

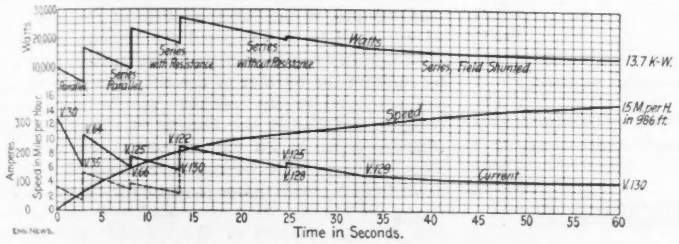


FIG. 3.—DIAGRAM OF BATTERY CHARGES.

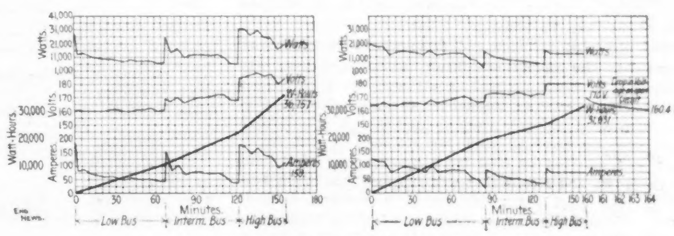


FIG. 4.—DIAGRAM OF ACCELERATION TESTS.

The total station efficiency from coal pile to switchboard is 5.58%. The Chicago Edison Co.'s Harrison St. station produces electrical energy for 0.3 ct. per K-W. 1-hour, burning coal containing 13,000 B. T. U. per lb., and costing delivered $1.05 per ton. The efficiency of that station, therefore, is 4.61%, or 20% less than that of the Edison station. The Edison station has an output of over 3,000 HP., while the Englewood station has a maximum capacity of 500 HP.

The cost of fuel per net K-W.-hour on the switchboard is shown to be 0.611 ct. This high price is to be explained, then, not by the inefficiency of the station, but by the fact that a high price is paid for a poor coal. With a more advantageous arrangement in the purchase of coal there is no reason why this station should not develop a K-W-hour for less than 0.3 ct.

The report contains several recommendations as to improvements in the steam and electrical equipment and in the operation of the plant. In particular it is noted that when two engines are run on account of the size of the load, the steam should be carefully maintained at or near 175 lbs., and the engines should be adjusted for the smallest possible cut-off. With the present practice of carrying a reduced pressure, the benefits of triple-expansion are lost, and the economy must necessarily be impaired.

Tests of the Storage Batteries.

At the same time that the power-house tests were made, a complete log was kept of the operation of the charging plant. On Nov. 26, 31 batteries were in service. These made 123 trips, aggregating 1,688.4 miles, or 13.56 miles per trip. On Nov. 5, however, 34 batteries made 110 trips, aggregating 1,821.8 miles, or 16.56 miles per trip. In addition to the car service of the batteries the motors on the battery transfer carriage and the car transfer table were also operated by the batteries.

The following is a summary of the results of the two runs:

	Nov. 5.	Nov. 26.
Weather	Rainy.	Rainy & cold.
K-W. 1-hours delivered to switchboard	2,638	2,895
" used by cool'g tower motor	151	174
Net K-W.-hours. delivered to charging bus-bars	2,487	2,721
Total number of car-miles	1,821.8	1,668.4
K-W.-hrs. on switchboard per car-mile	1.37	1.63
Coal per net K-W.-hr., lbs.	6.9	6.44
Coal per car-mile, lbs.	9.45	10.50
Cost of coal per ton	$1.90	$1.90
" " " net K-W.-hour	.00655	.00611
" " " car-mile	.00897	.00996

160.4 volts at the end of the readings. This is shown in the diagrams of the charges, Fig. 3.

The observations made upon the car while the battery was discharging consisted in taking voltage and ampere readings every five seconds while the car was in motion, the time between stops and the length and location of each stop, and a continuous record of the speed.

The volt-meter was a standard Weston instrument from the Armour Institute, and was connected across diagonal corners of the battery tray. Each set of batteries consisted of 72 cells arranged in four groups of 18 cells each. Each group is provided with separate contact plates which are connected by means of cables to the controller. The controller has five points and allows the following combination: (1) The four sets of batteries in parallel; (2) Batteries in series parallel in sets of two; (3) Batteries in series with resistance; (4) Batteries in series without resistance; (5) Same as (4), with field of motor shunted.

The volt meter was so connected that it gave the voltage at the battery terminals for each combination.

The motor upon the car was a 50-HP. Walker four-pole series motor. The entire current used at any one time passed through the armature, so that the ammeter was inserted in the positive brush leads. The ammeter used was of the round pattern Weston type, and had been found to be correct by comparison with an Armour Institute standard. Five observers were used to obtain the ammeter and voltmeter readings; one called the time every five seconds, two read the instruments, and the other two kept the records. At times of starting the instruments were read oftener than at five-second intervals. A trial trip was made with another battery to get the observers acquainted with their positions, and as the fluctuations in the current were neither violent nor many, it is believed that the results represent very nearly the actual facts.

The duration of the stops and the time the car was in motion between stops was obtained by means of a stop watch. The record of speed was obtained by means of a Boyer speed recorder, driven from the car axle by a flexible belt. By means of pressing lightly upon the recording pencil a dot was made in the speed curve every five seconds. The test may be divided into four parts,as in Table 3.

The graphical logs of the two charges are shown in Fig. 3, and it will be seen that they differ considerably. This is due to the fact that the charging of the battery was left to the regular operators of the plant, who used their judgment, both as to voltage and as to the time the battery should charge at each voltage. They also determined when the battery was fully charged. In the first charge there is no doubt but that the final voltage was too high, and in the second charge it would seem that the battery was charged too long, both of which conditions reduced the efficiency obtained. The result shows the efficiency in actual service, but does not represent the possibilities of the

straight stretch of track. In these tests the same instruments and observers as on the other car tests were used, and readings were taken in much the same way, with the exception that in this test the observations were made at the time of passing from one point to another of the controller. After the fifth point was reached, the readings were taken at intervals of five seconds. The time between points was obtained by means of a stop watch, and no effort was made to change the motorman's method of procedure in bringing the car up to speed. The average results of five trials are shown graphically in the curve on Fig. 4, which shows clearly the power delivered by the batteries at the different points of the controller and the energy required to accelerate the car.

The current curve shows a maximum of 320 amperes. It will be noticed, however, that at this time all four sets of batteries are in parallel, so that this total of 320 amperes indicates a total discharge rate of each cell of but 80 amperes. The dotted curve below the current curve indicates the actual discharge rate of the individual cells. At the fourth notch it coincides with the total current curve, and at this point indicates the highest discharge rate which is seen to be 220 amperes, and this rapidly decreases until it reaches 100 amperes, which may be taken as a fair value of the current with the car in full motion. It is to be understood, of course, that the practice of coasting in which the current is shut off makes it impossible to obtain the power required per mile from this curve.

In conclusion, it may be said that the foregoing tests do not demonstrate the best results that may be expected of accumulator traction, and were not made for that purpose. No excuse is offered for the fact that the road was not operated under ideal conditions while being tested, as the primary object of the test was to determine where improvement could be made. If this is kept in mind when comparing the results with those obtained upon the trolley systems of about the same size, it will be seen that the cost of fuel for accumulator traction of something less than 1 ct. per car-mile, is favorable to storage-battery traction. The improvements suggested by the test are now being made. The batteries have operated from 8,000 to 14,000 miles and are standing the service remarkably well, so that the maintenance account, up to the present, has been comparatively small.

THE VALUE OF METALLOIDS IN CAST IRON.*

By Maj. Malcolm M'Dowell.

On July 12, 1896, I read before the Western Foundrymen's Association a paper on the practical value of the various metalloids in cast iron, in which I outlined a series of experiments to demonstrate the influence that silicon,

*Abstract of a paper read before the Western Foundrymen's Association, Chicago, Jan. 19.

phosphorus, sulphur, and manganese exert when combined with iron in various proportions, and to ascertain what combination of metalloids with iron will give the best metal for the various uses of a foundryman.

I desire to present for your consideration further ideas on the same subject.

Most furnaces, all but a very few, in fact, grade their product entirely hy fracture, and as a consequence what is No. 1 in fracture from one furnace is not like No. 1 from another furnace. And still the commercial value of pig iron depends entirely on its chemical analysis.

While I do not claim that Table I. is accurate and up to date, it is sufficiently so for me to make plain what I wish to illustrate.

TABLE I.

	Price per ton.	Total carbon.	Silicon.	Phosphorus.	Sulphur.	Manganese.
No. 1, foundry....	$12.00	3.68	2.90	.75	.01	.30
No. 2, " ...	11.50	3.30	2.25	.70	.02	.40
No. 3, " ...	11.00	3.25	1.50	.30	.03	.50
No. 4D, gray forge.	10.50	3.80	1.00	.65	.04	.62
No. 5, mottled " .	10.00	3.75	.70	.50	.05	.05
No. 6, white " .	9.50	3.65	.40	.35	.10	.96

A practical foundryman looking over this table will readily pick out the two columns that give value to pig iron in his work, those of silicon and sulphur. The money column shows a difference hetween $9.50 and $12 of $2.50, while the silicon column shows a difference of 2.50% in silicon, making each 0.1% silicon worth 10 cts.

It is estimated that each atom of sulphur neutralizes ten of silicon. When pig iron carries three or more per cent. silicon, it is called a "softener;" when it goes between 3 and 5% it has various names, such as "silvery;" and after it goes above 5%, and from that to 10%, it is called "ferro-silicon." This carries less sulphur in proportion to its silicon than any other form of pig metal, and as a softener is a question of silicon, 10% "ferro-silicon" is the cheapest softener that can be bought.

While pig iron, softener and ferro-silicon prices are all measured hy the amount of silicon the metal carries, high silicon iron alone will not make a good casting. It requires a proportionate amount of manganese to insure castings that are strong, solid and free from sponginess. A foundryman should keep on hand at least one car load of 10% ferro-silicon and one ton of 80% ferro manganese. Equipped with these two and a coke that will run less than 0.75% sulphur, he can meet any requirements in castings, even if he has nothing hut common cast scrap iron to work with, or an off pig, provided he has an intelligent knowledge of the use of these two metalloids.

I ask your indulgence in giving you my personal experience in the use of a limited knowledge of the value of the metalloids that combine with iron in making castings from a cupola melted metal.

The following is the report of Maj. J. W. Reilly, Commandant, Watertown Arsenal, on some cupola metal made by me to demonstrate to the United States Ordnance Department that it was possihle to make in a cupola a metal costing less, hut superior to gun metal which they specified "should be charcoal pig melted in a hot air furnace," the tensile strength to he not less than 27,000 and not to exceed 38,000 lbs. per sq. in.

Tests hy tension. Cupola steel for Malcolm McDowell, Chicago, Ill.

Nos. 5,170 and 5,171 had stems 2 ins. long, turned down from 1-in. square cast bars.

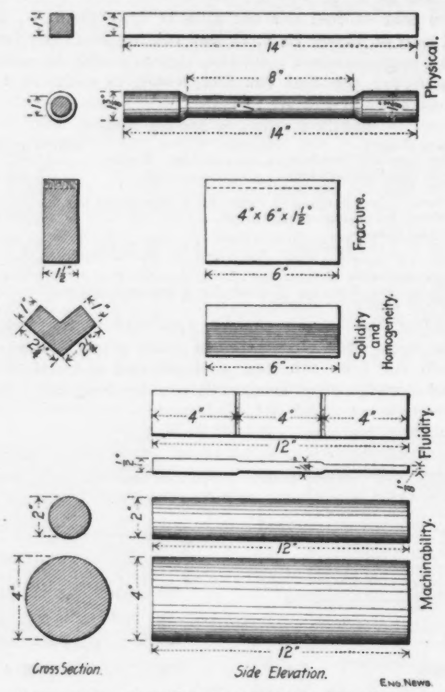
Nos. 5,172 and 5,173 were turned down to grooved form of specimens from 1½-in. round cast bars.

Test No.	Diam. ins.	Area sq. ins.	Total lbs.	Lbs. sq. in.	Fracture.
5,170	.564	.25	12.300	49.200	Fine granular
5,171	.564	.25	11.460	45.840	" "
5,172	1.129	1.00	46.400	46.400	" "
5,173	1.129	1.00	42.820	42.820	" "

Dec. 28, 1894. J. W. Reilly.

Maj. Ordnance Dept., U. S. A., Commanding.

This metal was condemned at first hy the Ordnance Department, because it went over 38,000 lbs. per sq. in., tensile strength. It was claimed that when it did so, the metal was too "cold-short." This idea arose from Capt. Rodman's report, made away back in the '50s. Capt. Rodman, after selecting various brands of the best charcoal pig he could find, took three of them which he considered best, and then, after refining, which was done hy remelting two or three times, he cast his metal into cannons. The preliminary heats made in his first test showed over 38,000 lbs. tensile strength and the metal was hard and hrittle. This was condemned on account of its cold-shortness; hut test bars from suhsequent heats, which were not subjected to so much heat, showed less than 36,000 lbs., and having more elasticity the metal was accepted. It was claimed the cause of the failure of the first heat was that it was too much decarbonized in the furnace, while the second heat



Forms of Cast-Iron Test Pieces Used in Investigation Summarized in Table II.

was drawn earlier, and, therefore, it is claimed, had more carbon. It was not for a lack of carbon hut for a want of silicon.

Table II. represents six different heats. No. 1 of this table is the same as No. 5,170 of the Ordnance Department's report, and it is placed here in this table to show what is possible in making a metal high in transverse and tensile strength with a large amount of elasticity, due to the lowness of phosphorus and sulphur, and which is easily machined. The percentage of nearly all of the metalloids is lower in this heat than in the others, while the heat is highest in transverse and tensile strength. This is due to the special proportions of silicon and manganese, as they are at the points where they exert their best influence on the carbon in combination with the iron, and the carbon being free from the influence of the phosphorus and sulphur in its combination with the iron, leaves the metal with more than usual amount of elasticity. It is these conditions that make the metal tough, not hard, in turning and machining.

The last three columns have to do with questions of great importance:—What comhination of metalloids will make a casting free from sponginess in the corner of a flanged casting? What will make a metal of sufficient fluidity for making special castings? How long can you run silicon in comhination with the other metalloids to secure the greatest strength and solidity, and be easily machined?

Table No. 2 is a tabulated statement of my personal experience in making castings with the limited knowledge I have of the value of metalloids that comhine with iron in castings made from metal melted in a cupola.

AN IMPROVEMENT IN FREIGHT CAR CONSTRUCTION.

A special feature of modern freight car design is the endeavor to increase the carrying capacity to the greatest extent in order to effect an economy in operation by increasing the train loads and reducing the number of trains required to handle a given traffic. A recent modification in design which has been brought out is claimed to increase the capacity of coal and ore cars nearly 17%, so that 60 cars of this style will carry the same load as 70 cars of the ordinary style.

This is effected by utilizing the space ordinarily wasted by the arrangement of the side stakes. In the ordinary construction of gondola cars for coal and ore traffic, the sides are supported by outside stakes set in stake pockets secured to the side sills by U-bolts with the nuts inside, as shown in Fig. 1. With this arrangement the outside of the stake pockets forms the limiting width of the car. In the new design, shown in Fig. 2, the side sills are moved outward to the full limit allowed, their outer faces being in line with the outside of the stake pockets in ordinary cars, and the sides are supported by inside stakes of steel deck beams 3 x 3 ins., or old rails may be utilized for these stakes. These steel stakes are bent to fit against the whole depth of the inner surface of the side sills, to which they are secured by U-bolts engaging with notches in the flanges in the stakes, and held by nuts on the outside of the sill. The side planks are attached to the stakes by bolts passing through notches in the flanges of the stakes and through holes in an outside strap. No ordinary side straps or side tie-rods are required as used in ordinary construction (and both of which are shown in Fig. 1), thus avoiding the boring of the sills for the tie-rod or the rounded end of the strap. Six steel stakes on each side of the car are found to give as much strength as nine wooden straps, and the construction is claimed to be more durable and economical. The U-bolts can readily be inspected and tightened from the outside of the car, thus keeping the stakes upright and preventing bulging of the sides. With this style of construction the body of the car is made of the greatest permissible width, only the thickness of the two sides (say 6 ins.) being deducted from the inside measurement, while with outside stakes the thickness of the stakes (usually about 4½ to 5 ins.), as well as the projections on the stake pockets and the thickness of the sides must be deducted, or about 15 to 18 ins. in all.

The maximum width over all for freight cars is about 9 ft. 6 ins., and gondola cars of the ordinary style on the Lake Shore & Michigan Southern Ry. have a clear inside width of 8 ft. (Eng. News, March 19, 1896). The cross sections in Figs. 1 and 2 are for cars of similar dimensions (34 ft. long and 9 ft. wide over all), differing only in the width on account of the different arrangement of the supports of the sides. The following table gives a comparison of the dimensions and capacities of these cars, and it is estimated that the car with inside stakes will carry one-seventh more

TABLE II.

No. of heat.	Metalloids. Combined carbon.	Uncombined carbon.	Total carbon.	Silicon.	Phosphorus.	Manganese.	Sulphur.	Physical. Transverse 12-in. centers, 1-in. square.	Tensile 1-in. area.	Deflection, 12-in. centers.	Contraction 8-in. bar.	Depth of chill, 1½×4 ×6-in. block.	Fracture.	Solidity and homogeneity.	Fluidity.	Machinability.
1.	0.93	2.19	3.12	1.34	0.08	1.00	0.003	4,300	49,000	0.14	....	¾-in.	¾-in. chill, ⅜-in. mottled, 2⅛ ins. gray, fine homogeneous cast'g.	....	... .	Tough, solid with hard surface, but machined easily.
2.	.70	2.60	3.30	2.00	.64	.80	.025	2,400	28,000	.10	¾-in.	1-16-in.	Open in the center, uneven fracture, dark gray.	Segregation in the center, with open grained fracture.	Edges and corners full and sharp; smooth surface.	Very soft and easily machined.
3.	.75	2.54	3.29	1.92	.60	.79	.027	2,700	30,000	.10	⅞-in.	⅛-in.	Uniform fracture; dark gray.	Spongy, hut a finer grained fracture.	Edges not sharp, hut corners full; smooth surface.	Easily machined and fine finish.
4.	.80	2.44	3.24	1.79	.57	.78	.029	3,100	34,000	.10¼	1 in.	¼-in.	Uniform fracture, hut hright gray.	A fine fracture, hut spots of sponginess.	Edges and corners rounded off; surface was tolerably smooth.	Not so freely machined, but finished finely.
5.	.90	2.39	3.29	1.67	.55	.77	.032	3,400	35,000	.10	1⅛ ins.	⅜-in.	Fine, uniform fracture, but hright gray.	Fine homogeneous, uniform fracture.	Edges rounded off; corners ⅛ wasted —not full; rough surface.	10% more power to machine; fine finish.
6.	1.00	2.25	3.25	1.58	.50	.76	.034	3,500	36,000	.09¾	1¼ ins.	½-in.	Very fine and uniform fracture; bright gray.	Very solid and homogeneous fracture.	½ of the ⅛, and ¼ of ¼ wasted; castings not run full.	20% more power to machine in large castings.

coal than the other when loaded level full, or one-sixth more when the load is heaped up:

	Car with outside stakes.	Car with inside stakes.
Length inside	32 ft. 0 ins.	32 ft. 0 ins.
Width inside	7 ft. 7 ins.	8 ft. 8 ins.
Depth inside	3 ft. 6 ins.	3 ft. 6 ins.
Load with body level full	849.32 cu. ft.	970.67 cu. ft.
Top load (to dotted lines in cuts)	284.80 "	366.08 "
Total load	1134.12 "	1336.75 "
Coal capacity	30 tons.	35 tons.

This improvement is the invention of Mr. E. S. Hart, General Manager of the Rodger Ballast Car Co., Fisher Building, Chicago, Ill., to whom we are indebted for particulars and blue prints. In this connection it is interesting to note that Mr. Wm. L. Tarbet, Consulting Engineer to the Railroad & Warehouse Commission of Illinois, states, in his annual report for 1897, that one of the marked instances of improvements in railway work is the increase in capacity of coal cars by building the sides outside the stakes and widening the floors.

NOTES FROM THE ENGINEERING SCHOOLS.

Massachusetts Institute of Technology.—The students taking fourth year engineering laboratory work recently made a boiler test on one of the boilers in the basement of the Rogers building. The test, lasting 108 hours, was divided into 13 watches of eight hours each, seven men working at one time. Besides the usual measurements observations were made of the temperature of the flue gases at five different levels in the stack, and analyses of the flue gases at the base; measurements of the temperature of the fire, and of the temperature at three points between fire and chimney.

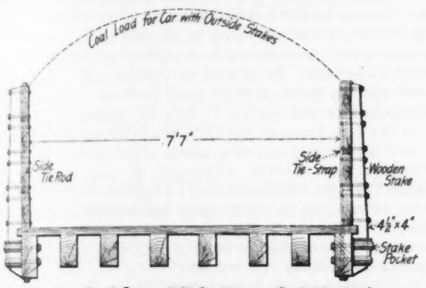


Fig. 1.—Coal Car with Ordinary Outside Stakes.

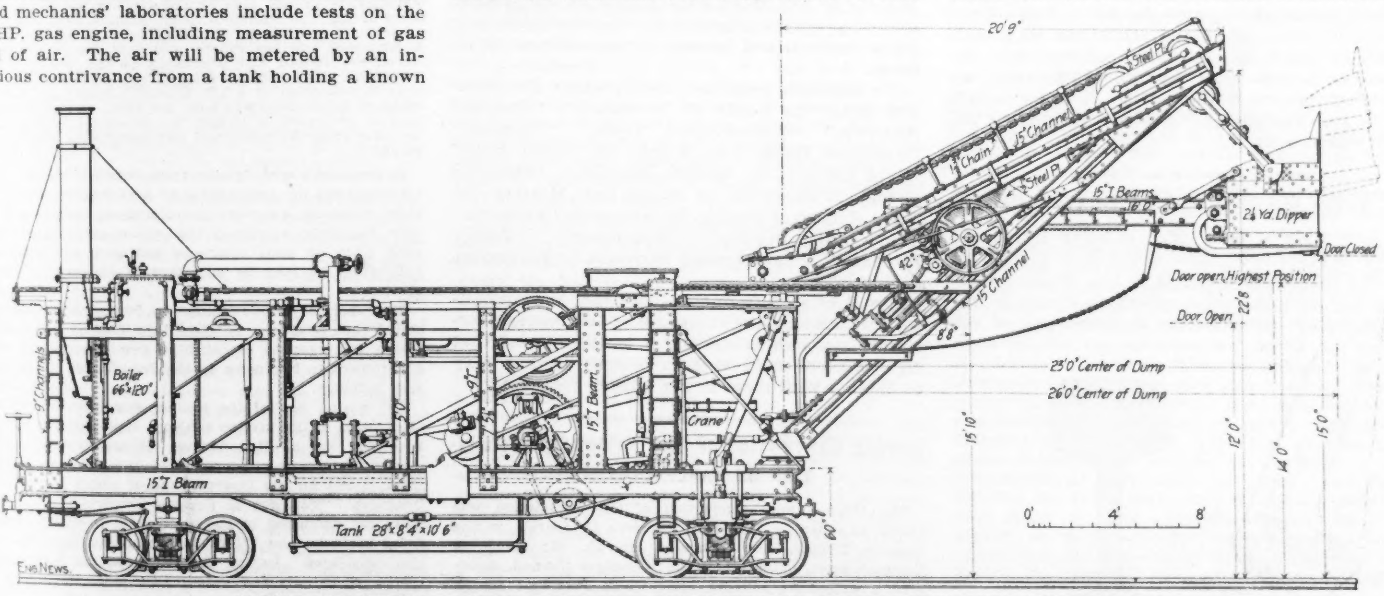
The experiments in the steam, hydraulic and applied mechanics' laboratories include tests on the 40-HP. gas engine, including measurement of gas and of air. The air will be metered by an ingenious contrivance from a tank holding a known amount of compressed air, by means of a second connected tank holding air at atmospheric pressure, the change from high to low pressure being effected by an orifice in the connecting pipe proportional in area to the difference in pressures; tests on the 1,000-gallon per minute rotary pump, determining efficiency and capacity at different pressures; tests on the surface condenser with different numbers of circulations of water through the tube; tests on the 6-in. Swain turbine; valve setting on the 16-HP. Harris Corliss engines; tests to determine the quality of steam, three different styles of calorimeters being used; tests on the Hancock ejector; on the explosive force of different mixtures of gas and air with the use of the tuning fork to determine delicate measurements; determining the ratio of the specific heats of air; and continuation of tests on steels of different carbons.

SPECIAL 93-TON STEAM SHOVEL FOR DIGGING ORE.

Among the interesting details of Mr. Thomas A. Edison's iron ore concentrating works at the Ogden mines, at Edison, N. J., which we described in our issue of Nov. 11, 1897, is the handling of the iron-bearing rock by means of a steam shovel. For this work a special shovel, built by the Vulcan Iron Works Co., of Toledo, O., is used. The general appearance and construction of this shovel is shown in the accompanying cut. With the exception of a few general details the drawings need but little explanation. As will be seen the frame and platform are composed of I-beams and channels braced together with round rods. The crane and dipper handle are also of steel. The platform beams are 15 ins. deep by 36¼ ft. long, and weight 87 lbs. per lin. ft. There are six platform beams.

The operating machinery comprises a 66×120-ins. marine return flue boiler and three engines. This boiler supplies steam to a 13×15-in. hoisting engine, a 7×9-in. swinging engine, and a 6×9-in. crane engine. The location of these engines and of the steam pipes, gearing, etc., is shown by the drawing. The dipper is 2½ cu. yds. capacity, and will hoist 15 ft. in the clear with the door shut and 14 ft. with the door open, allowing it to load into a car 4 ft. high, placed 10 ft. above the shovel track. The swing of the dipper each way from the center is 26 ft.

For the information from which this brief description has been prepared we are indebted to the Vulcan Iron Works Co., of Toledo, O., the builders of the shovel.



SPECIAL 93-TON STEAM SHOVEL USED FOR HANDLING IRON ORE AT THE OGDEN MINES AT EDISON, N. J.
Vulcan Iron Works Co., Toledo, O., Builders.

THE ALTERATION OF METALS BY SEA WATER.

In a paper in the "Annales des Ponts et Chaussees," M. Lidy says that in the operation of dredging at the harbor of Brest, France, a great quantity of metallic objects were brought up from the sea bottom which afforded an opportunity to make observations upon the effect upon bronze, cast and wrought iron of a long submergence in sea water.

The oldest and most interesting bronze object found was the barrel of an arquebus, which in type dated from 1552 to 1600, and was probably lost overboard in a fight with Spaniards in 1594. The chemical analysis of specimens from the exterior and interior of the barrel showed—Copper, on surface, 80.3%; inside, 82.9%; sulphuret of copper, surface, 9.8%; inside, 7.5%; tin, surface, 9.7%; inside, 9.4%; lead, only traces in both cases. M. Lidy concludes that from the excellent state of preservation, after 300 years submersion, bronze of an analogous composition, or containing only traces of lead, iron or zinc, will endure for a great length of time in sea water.

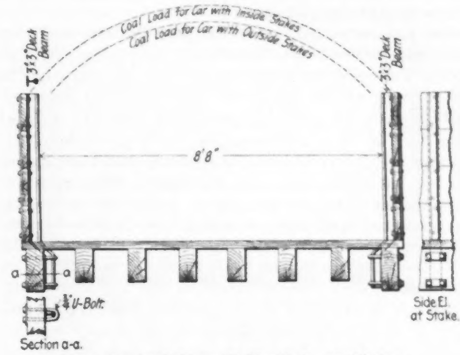


Fig. 2.—Coal Car with Hart's Inside Stakes.

The oldest cast-iron dredged up was in the form of cannon balls and shells, the latter once filled with powder. They dated from 1652 to 1791; and thus had been immersed from 100 to 240 years. These cast-iron objects were all encased in a hard coating, several centimeters thick, made up of sulphurets, sand, rust and calcareous concretions. This coating required a hammer and chisel to break it, and came off like a mold, leaving the objects encased little altered in appearance and simply covered with a viscid, black layer, disagreeable to the smell. It was a mixture of hydrogen sulphide and silica.

This iron had, however, been subjected to very considerable alteration, as revealed by its light weight. All specimens had undergone to a greater or less extent that type of decomposition known as the softening of cast-iron; and M. Lidy believes that the objects examined by him prove, beyond any doubt, that such softening has here taken place. Specimens could be cut with a knife as easily as the graphite in a pencil, and showed a similar brilliant black section, which tarnished quickly upon exposure to the air. It broke easily and was quickly reduced to powder in a mortar; it could be readily sawed, and when struck with a hammer a dull surface was obtained covered with a multitude of small, brilliant points. The chemical composition of a cannon ball, completely decomposed, was about as follows:

Free iron	36.000
Iron combined (oxide, sulphuret, chloride)	12.000
Graphite	13.100
Silica	2.500
Sulphur	0.325
Chlorine	1.178
Phosphorus	trace.
Water, chloride of sodium, about	14,907
Density, about	3.040

Exact analysis is impossible, owing to lack of homogeneity in the material and the fact that it oxidizes very rapidly on exposure to the air. As a result of analysis, M. Lidy concludes that this iron originally contained about 0.933 iron and 0.067 foreign matter; of which latter 0.054 was graphite and 0.010 silica. Comparison, on this basis, shows that the object had lost about 69% of its original total of iron.

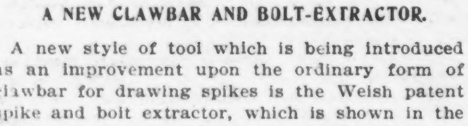
M. Lidy proceeds to investigate the cause of this decomposition. He finds that the saltpeter, sulphur and carbon, forming the powder once in the shell, can all be accounted for, and can have no effect upon the iron. He concludes that the softening is due to a process analogous to electrolytic action, which is known to produce rapid oxidation of iron in humid air. An absolutely analogous action takes place in sea water, complicated by the presence of alkaline chlorides. A double decomposition occurs; the chlorine set at liberty at the positive pole attacks the iron by producing a chloride which carries itself to the negative pole, where it finds itself in an alkaline mixture resulting from the decomposition of the water by the metal set free. The iron is first precipitated in the form of a protoxide, then as a peroxide. As all cast-iron is slightly porous, this action may continue in the same mass, and principally upon the parts which are the best conductors of electricity, until there is little more left than a skeleton of graphite and silica. Mr. Lidy artificially reproduced this same decomposition in new pieces of cast-iron, by electric currents applied in a solution of chloride of sodium. He believes that the harder and less porous cast-iron shows a greater resistance to the dissolving action.

The wrought iron objects found displayed the familiar exfoliation, or alteration by the disappearance of successive layers of fiber. But he also found that a certain amount of iron had disappeared under an action similar to the decomposition of cast-iron; as the density of specimen-bars was 7.2 to 7.4, while the normal density should have been about 7.8.

As a general result of his investigations, M. Lidy concludes that, exposed to the action of sea water, pure bronze will be little affected at the end of 300 years. Cast and wrought iron, however, are rapidly decomposed under this action, not only upon the surface, but in the interior of their mass. In wrought iron the superficial action is much the strongest; while in cast-iron it is the internal action which predominates; and this is peculiarly dangerous because the form of the object is not affected, while the resistance is considerably diminished. M. Lidy believes that the necessity is shown for testing, at intervals, all cast-iron exposed to the sea, so as to be certain of its preservation and strength to sustain the loads placed upon it.

A NEW CLAWBAR AND BOLT-EXTRACTOR.

A new style of tool which is being introduced as an improvement upon the ordinary form of clawbar for drawing spikes is the Welsh patent spike and bolt extractor, which is shown in the accompanying cut. To the flattened end of the



Spike and Bolt Extractor.
Welsh Mfg. Co., Pittsburg, Makers.

bar (A) is pivoted the cylindrical piece (B), the top of which is slotted to receive the bar. Secured to this pivoted piece are the two jaw pieces (C) (C), the front ends or claws of which have cup-shaped recesses (as in the fixed claws of an ordinary clawbar), to receive the back of the head of the spike. The claws are normally held apart by the horizontal spiral spring (D), but when the bar is pulled down the tail (E) wedges the backs of the jaws apart, so that the claw ends are pressed tightly against the spike. In using this device, the tool is set on the tie with the bar in a vertical position, the spring then holding the claws open so that they easily take in the spike. When in position, the bar is pulled forcibly back, causing the claws to grip the spike and pull it vertically, thus keeping it straight instead of bending it backward, as with some forms of ordinary clawbars. It is claimed that the clawbar will pull any spike or bolt without a head that its claws can get hold of. As the claws are movable, they will grip various sizes of spikes or bolts, while the ordinary clawbar, with fixed claws, can only efficiently handle one or two sizes. The weight is about 30 lbs.

This tool has been tried on the Pittsburg & Lake Erie R. R., the Pennsylvania R. R., and the Pittsburg, Fort Wayne & Chicago Ry. Mr. J. A. Atwood, Chief Engineer of the P. & L. E. R. R., writes that it has been given plenty of work and has proved entirely satisfactory. It is made by the Verona Tool Works, for the Welsh Mfg. Co., 937 Liberty Ave., Pittsburg, Pa.

THE PROPER MANIPULATION OF TESTS OF CEMENT.

At the annual meeting of the American Society of Civil Engineers, held Jan. 20 and 21, 1897, as some of our readers will remember, a resolution was passed urging the appointment of a committee to investigate and report upon the proper manipulation of tests of cement. The committee, as finally appointed, consisted of Prof. Geo. F. Swain, Chairman; O. M. Carter, W. B. W. Howe, Alfred Noble, L. C. Sabin, Geo. S. Webster, and Herbert W. York, all members of the society. This committee has recently organized for work and has prepared a circular letter of inquiry for the purpose of securing the opinions of such engineers as have had experience in testing cement, regarding the proper manipulation to be given to the material and apparatus in various kinds of tests. We are requested by Prof. Swain to state that the committee desires to secure the opinion of every person who may be interested in the subject, and has information to impart, whether he be a member of the society or not. Copies of the circular list, of questions prepared by the committee, over 75 in number, will be sent to any address on request.

We may note here that the questions are classified under the heads of "Sampling," "Chemical Analysis," "Microscopical Tests," "Fineness," "Apparent Density or Weight per Cubic Foot," "True Density, or Specific Gravity," "Standard Sand," "Preparation of Pastes and Mortars for Tests of Time of Setting, Soundness and Strength," "Time of Setting," "Soundness," "Tensile Strength," "Compressive Strength," "Transverse Strength."

It will be seen from the above that the committee intends to make the scope of its inquiry thoroughly comprehensive; and it is to be hoped that all engineers interested in cement testing may co-operate with them in the manner requested.

ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF MANUFACTURERS.

The third annual convention of this association was called to order by President Theodore C. Search, in the Masonic Temple, New York city, Jan. 25. Mr. Randolph Guggenheimer, President of the Municipal Council, delivered a welcoming address, after which President Search presented a report. He stated that the total export from the United States for the year ending June 30th, last, amounted to $1,032,998,880, exceeding the largest previous record, that of 1891-92, by over $17,000,000. The export of manufactured articles reached 27% of the total exports, or $276,357,861, during last year, which amount exceeded the value of similar exports in 1896 by 21%. In discussing the reasons for the increasing export trade, Mr. Search said that at present British ships carry nearly $4 worth of our imports to every $1 worth brought in American ships, and at the same time British ships carried about seven times as much of our exports as our own vessels. If we wish to send a salesman to Venezuela and then to Rio or Buenos Ayres, he must make two trips across the ocean, traveling in all some 11,500 miles, if the journey is to be taken with reasonable comfort. The subject of the Nicaragua Canal was touched upon, and its benefits to American manufacturers briefly outlined.

Continuing, Mr. Search strongly advocated the creation of a Federal Department of Commerce and Industry and the furtherance of various reciprocity negotiations with our sister countries. In connection with the scheme of having sample warehouses in commercial centers of foreign countries, he said: "More can be done in a few months with actual samples for examination by intending buyers than in a year of hard work without such advantages." The establishing of trade and technical schools and colleges was strongly advocated, even at the expense of common schools. The value of technical education had been demonstrated by the rapid rise of Germany as an industrial country. In dealing with the consular service and pointing out the evils of a system which permits a consul's removal with every change in the administration, he said:

No business institution could survive such demoralization as this, and it is not reasonable to expect that so essentially commercial an institution as the consular service can be disorganized at will without impairment of its efficiency.

One thing greatly needed by manufacturer engaged in foreign trade is better banking facilities. The trade of the United States with Spanish American countries aggregates $225,000,000 per annum, and practically all the transfers are made through European banks. Mr. Search also favored the adoption of the metric system as an aid to securing foreign trade.

Attention was called to the Paris Exposition of 1900, and Mr. Search said "it was essential that our government appropriate a sufficient sum to provide for the representation of American interests in a manner commensurate with their importance. There is need of hastening of this legislation with an early appropriation and the appointment of the necessary commission to care for American interests."

At the conclusion of the address the announcement of the standing committees was made, after which about 250 delegates and friends adjourned to the steamer "St. Louis," of the International Navigation Co., were they were entertained at luncheon by the President of the company, Mr. Clement A. Griscom. The afternoon session was devoted to the reading of reports of officers and the various special committees, as follows:

The Committee on Languages, Weights and Measures earnestly recommended the adoption of the metric system. The Committee on Transportation recommended the following amendments to the interstate commerce law:

1. Provision for a uniform national classification.
2. Asserting the power of the government through its commission by clothing said commission with such power to regulate the transactions of carriers as will prevent unjust discrimination and extortion in transportation charges.
3. The repeal of the 5th clause of the present act and the adoption of such amendments as will provide that agreements entered into by the carriers for the maintenance of just and equitable rates, whether they provide for division of earnings or not, shall be enforced through the commission and the courts, and shall be subject to the rules, regulations and provisions of the act to regulate commerce and its enforcement as may be provided therein.
4. The adoption of a bill generally known as the anti-scalpers' bill, which will have the effect of prohibiting the sale of or traffic in tickets for passenger transportation by other than the authorized and responsible agents of the carrier.

In connection with foreign transportation, the committee recommended the establishing of American lines of steamships wherever American manufacturers seek to sell, and they earnestly petitioned the government to encourage such lines by mail contracts and such other forms of subvention as may be necessary to support an efficient service.

The report of the Committee on Commerce and Industry stated that already a bill had been drafted and was now before Congress to establish a new department of the government to be known as the Department of Commerce and Industry.

The second day of the session was largely devoted to discussions of the various subjects, treated in the report of President Search. Hon. Warner Miller offered a resolution strongly advocating the proposed International American Bank, a bill for the incorporation of which is now before Congress. "Taxation of Foreign Corporations," meaning those not domiciled in the same State in which they are doing business, and "Untaxed Alcohol for the Arts" were also considered. During the afternoon the Special Committee on Patents and Patent Law made its report, and it was recommended that the Association indorse the bills now pending before Congress to increase the facilities for transacting patent business, and require the registration of persons desiring to practice before the Patent Office.

The question of imitation of American trade marks by foreign manufacturers was brought up in the form of a resolution inviting the attention of the President and Congress to this matter that they might take steps to prevent such frauds. In the evening the discussion was continued along practically the same lines.

Thursday, Jan. 27, the last business session was held in the forenoon. The principal business being the election of officers for 1898, and the selection of the next place of meeting.

The result was as follows: Pres., Theodore C. Search; Vice-Presidents, Alabama, T. W. Pratt; California, J. G. Hamilton; Connecticut, Pliny Jewell; Delaware, C. W. Pusey; Georgia, J. F. Hanson; Illinois, Charles F. Quincy; Indiana, D. M. Parry; Kansas, Thomas Ryan; Kentucky, W. C. Nones; Maine, Charles R. Milliken; Maryland, David L. Bartlett; Massachusetts, William C. Lovering; Michigan, George H. Barbour; Missouri, L. D. Kingsland; Mississippi, W. D. Adams; New Jersey, Benjamin Atha; New York, Charles A. Moore; North Carolina, D. A. Tompkins; Ohio, John H. Patterson; Pennsylvania, John H. Converse; Rhode Island, Samuel M. Nicholson; South Carolina, Ellison A. Smyth; Tennessee, C. D. Mitchell; Vermont, Henry Fairbanks; West Virginia, N. E. Whitaker; Wisconsin, F. W. Sivyer.

After considering several invitations from cities desiring the convention in 1898, Cincinnati was finally chosen.

On Thursday evening the members of the association and their friends were entertained at a banquet at the Waldorf-Astoria. Covers were laid for over 1,000 persons, and the dinner was one of the largest and most notable ever given in New York. The President of the United States was the guest of honor and his remarks upon the currency question and other topics of interest to the country at large excited the greatest enthusiasm. Hon. Warner Miller was Master of Ceremonies, and other toasts and speakers were as follows:

"The American Manufacturer," Theodore C. Search; "The Merchant Marine," Senator Frye; "Reciprocity and Commercial Expansion," Chas. E. Smith; "The Industries of a Nation as Affected by Its Laws," ex-Judge Henry E. Howland.

It is of interest to note that President McKinley, then Governor of Ohio, was the guest of the association at the banquet which concluded its first meeting in Cincinnati, three years ago. The 25 members who gathered around a single table on that occasion were a contrast to the thousand men who filled the Astoria's great ball room to overflowing on the present occasion.

ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The thirteenth annual meeting of this Society was held Jan. 26, 27 and 28, at Peoria, Ill., with an exceptionally good attendance, over 50 members being present. The meetings were held in the Court House, and the Society headquarters were in the Hotel Fey.

At the first session, on Jan. 26, the Secretary, Mr. Jacob A. Harman, presented his report, which showed a total of 92 members in good standing. The President, Mr. C. C. Stowell, Rockford, Fla., delivered the annual address, in which he referred to the broadening field for the engineer and the good prospects for increasing work. From this address we take the following extracts:

The State of Illinois is particularly well situated for the development of its natural waterways. Its streams are not rapid, and are not blocked by precipitous falls, but are susceptible of development by dams and locks, few in number and of inconsiderable height. Freight rates are fixed largely on the possibilities of competition by waterways, and if it is made possible for boats of fair tonnage to reach a city, its freight rates will be put on a new basis. The development of the Chicago drainage canal, and its possibilities as a ship canal, with its development of machinery for handling material in quantities at a profit for prices 70% less than heretofore, has opened a field of possibilities for this State far beyond our wildest dreams.

Mr. Dabney H. Maury, Chief Engineer of the Peoria Water Co., then presented the report of the Committee on Water-Works and Water Supply. The work of this committee during the past year has been devoted to securing information from various cities as to their rules and regulations, water rates and meter rates, which information will be tabulated. This was followed by the reading of a paper on "The Cost of Tie-Plates on the Rio Grande, Sierra Madre & Pacific Ry," by Mr. L. P. Atwood, Engineer of Maintenance of Way. This road uses the Servis steel tie-plates on sawed long-leaf yellow pine ties from Eastern Texas. They cost 6.78 cts. each, delivered at the end of the line; while the expense for unloading, loading, hauling 78 miles by rail and then hauling on push cars to the scene of the work brings the total cost to 8.63 cts. per tie-plate in the track. Another paper by the same author, on "Railway Construction in Mexico," was then read, describing the work on the R. G., S. M. & P. Ry. This line starts from Ciudad Juarez, and is intended eventually to reach the Gulf of California. The track work was done by the company, a Holman tracklaying machine being used, averaging about a mile a day. To expedite the work the ties were delivered on the grade by wagons, and both tramways of the machine were used to deliver rails, so that on May 6, 1896, a record was made of 16,896 ft. of track laid. The tracklaying by machine alone cost $296 per mile; by tie wagons and machine, $423; surfacing cost $180 per mile extra. The track is laid with 56½-lb. rails, with 18 ties per rail length, the joints being broken and suspended. For 30 miles the line is built over sand hills, and the wind frequently blew the sand from under the track so as to make it impassable, but limestone ballast is now used here. Mr. Stewart then described some of the methods employed by the U. S. Geological Survey in surveying and marking the boundaries of the new timber reservations in the Western States.

A discussion on "The Status of the Surveyor in Illinois: Is Surveying a Profession or a Trade," was opened by Mr. S. S. Greeley, of Chicago, who presented a paper on this subject. He compared the practice of surveying and engineering to that of law and medicine, and thought that examinations for licenses should be established for the two former, as they already are for the two latter. He also referred to the new law of Illinois "providing for the licensing of architects, and regulating the practice of architects as a profession." (Eng News., Oct. 21, 1897.) Nearly every year bills for this purpose have been presented to the Legislature, and nearly every year the subject is discussed by the Society, but so far nothing definite has resulted, and Mr. Greeley attributed this to the apathy of the members and to the quiet opposition of the country surveyors.

The paper was followed by a rather desultory discussion, and Mr. Greeley then read the bill proposed by the Society in 1894, but this did not revive the discussion and the meeting then adjourned.

In the evening the members visited the Bradley Polytechnic Institute, and after brief addresses of welcome had been made by Mr. John Warner, Mayor of Peoria, and Mr. O. J. Barbey, President of the Board of Trustees of the Institute, an interesting lecture on "The Park System of Peoria" was delivered by Mr. O. F. Dubuis, Engineer to the Park Board. This lecture was illustrated by plans of the system and a number of beautiful stereopticon views of the park scenery.

The first paper of the morning session on Jan. 27 was one by Prof. Wm. D. Pence, of the University of Illinois, on "A Graphical Representation of the Magnetic Declination." This was illustrated by diagrams of the decimal and secular variations, the former showing the variation at different hours of the day during the four seasons of the year, and the latter showing the variations at several cities during a long term of years. Mr. P. C. Knight, of Pontiac, then presented the report of the Committee on Drainage, in which it was stated that, besides the formation of new drainage districts and the carrying on of ditch and pipe drainage for land and farms, there was a new feature of engineering interest in this work. This is the use of a steam pumping plant for the drainage of a district in Whiteside county, which is overflowed at times of high water in the Mississippi and Rock rivers. Levees have been built to prevent overflow, with culverts to discharge the drainage at low water, but during high water in the rivers the internal drainage is pumped over the embankment by a centrifugal pumping plant, which can deliver 36,000,000 gallons per day at a height of 16 ft. This work was carried out by Mr. Daniel W. Mead.

The Secretary then read a paper by Mr. J. W. Alvord on "The Ferozone-Polarite Treatment of Sewage at Acton, England," describing the system as it was in 1888, since which time it has been adopted in several English towns. A somewhat extended discussion followed this paper. Prof. A. N. Talbot described a somewhat similar system now in use at Champaign and Urbana, Ill., and Prof. Shields stated that a contract had been made to establish a "polarite" treatment plant at Madison, Wis., but that work has so far been prevented by an injunction. The "polarite" is manufactured by a Detroit company, which has applied it to water purification at Nashville, Tenn. A paper on "The Chemistry of Water Supply" was then read by Prof. A. W. Palmer.

About 2 p. m., special cars on the Central Electric Ry. carried the party to the pumping station of the Peoria Water Co., where the plant was explained by Mr. D. H. Maury, the Chief Engineer for the company. They then proceeded to the supplemental pumping plant, where Pelton water wheels are used. This plant was fully described and illustrated in our issue of Jan. 13. When the party had exhausted the limit of time allowed for this inspection, it proceeded to the Atlas Distillery Works for a brief inspection of the plant.

An evening session was held at the Court House. Mr. C. H. Nicolet presented the report of the Committee on Municipal Engineering, which dealt principally with the undesirability of making frequent and unsystematic changes in sidewalk grades and curb lines, as is sometimes done by new city officials. Mr. Jacob A. Harmon then read a paper on "The Proposed State Supervision of Water Supply and Sewage Disposal." In February, 1897, a bill for this purpose, prepared by a committee of this Society, in conjunction with committees of technical and medical societies, was introduced in the State Legislature, and after considerable changes was recomended for passage, but much opposition to the bill was developed from a lack of appreciation of the benefits which the public would derive therefrom. It was based largely on the Ohio law now in force.

The election of officers was then taken up, and resulted as follows: President, A. D. Thompson, City Engineer, of Peoria; Vice-President, W. A. Darling, of Rock Island; Executive Secretary, Jacob A. Harmon, of Peoria; Recording Secretary, Mr. Quade; Trustees, W. D. Pence, of Champaign; S. S. Greeley, of Chicago, and C. C. Brown. It was also voted that the next meeting will be held at Champaign, Ill., in January, 1899.

In the evening a "smoker" was held at the Hotel Fey.

On Jan. 28, the first proceeding of the morning session was the presentation of the report of the Committee on "Specifications and Tests of Paving Brick," by Prof. A. N. Talbot. There was some discussion as to the advisability of using iron bricks or foundry shot in the rattler test, and then the report was accepted as a progress report, the committee being continued to pursue its investigations. A paper on "Deep Well Pumping" was then read by Mr. E. E. Johnson, describing his new type of pump, as illustrated in Engineering News, Jan. 20. He thought it most desirable to have the well bored straight and true, and stated that at De Kalb the specifications required a test of a 15-in. well to be made with a 60-ft. striker, having four flanges 14¾ ins. diameter. Mr. D. W. Mead did not think this important enough to warrant great expense. As to economy in pumping, he said that pumps are now running with 12 to 15 or 25 lbs. of steam per HP. per hour, though in many of the smaller plants this runs up to 75 or 100 lbs. of steam. It was voted that the incoming President should appoint a special committee to consider the subject of water supply for deep wells.

The report of the Committee on Weights and Measures was then read by Mr. S. S. Greeley, of Chicago, urging the use and adoption of the metric system in this country. Mr. Lagron referred to the simplicity of this method in giving scales for drawings and plans and to the ease with which it can be taught. Mr. Johnson, however, disputed the advantages in denoting machinery dimensions, but the report was accepted and the committee continued.

At the afternoon session, Mr. J. E. Miller, of Monmouth, read a paper on "Brick and Macadam for Country Roads," describing the system used at Monmouth, where a single course of brick paving is laid for a width of 8 ft., as has been formerly described in our columns. A paper on "Improving the Wagon Roads of Illinois," by J. T. Schmettzer, of Manteno, was then read. It advocated the use of brick paving and the more general introduction of drainage. In his town there are a number of farm drainage districts, in which the main drains are large tile. The commissioners or highways of the town have contributed to the cost of construction of these drains, and have the privilege of connecting the road drains with them. Mr. E. E. Russell Tratman, Associate Editor of Engineering News, then read a paper on "The Improvement of Transportation in Country Districts," in which he referred to the economical improvement of the roads and the use of steel or brick trackways for the wheels of wagons on dirt, gravel or macadam roads. He also instanced the use of motor cars and traction engines for special passenger and freight traffic on the roads. He then discussed the introduction of local railways of ordinary construction or of electric railways on the roads, considering the latter as specially adapted to meet the requirements of a country district where factories, mills or large farms offer a good amount of traffic.

The report of the Committee on Public Highways was then read by Mr. A. Lagron, of Freeport, who referred to the practical impossibility of securing good permanent roads under the present road laws. He had tried to explain this at a Farmers' Institute meeting, but all the pathmasters present gave him to understand that they and the laws were fully equal to the technical and political requirements of the district, and that they thought he was probably trying to get a "soft job" for himself as road engineer. This led to some discussion as to the legislation required for the establishment of permanently improved roads.

The report of the Committee on Instruments, Blanks and Records was then read by Mr. W. A. Darling. In considering field notes he recommended the card index to give the names of persons and the reference map index for tracts. The envelope system is convenient for filing clippings, rough sketches, etc., and letter files may be used for similar purposes. A paper on "City Map Making," by Mr. M. Huspinger, of Peoria, was then read, and one of the important points suggested in the paper was that the city map should be so made that any citizen could find information on it that would enable him to judge intelligently concerning any proposed improvements.

Resolutions of thanks were then passed to the Central Ry. Co., the Peoria Water Co., the Library Board, the Park Board, etc., for courtesies extended. Mr. C. C. Stowell, the retiring President (who has served for two terms), then called Mr. A. D. Thompson, the new President, to the chair, and after a few remarks by both officers the meeting finally adjourned.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

An account of the first session of the meeting of this society, held on Tuesday morning, Jan. 25, was given in our last issue. Other sessions, devoted to the reading and discussion of professional papers and topics, were held on Tuesday afternoon and evening, and on Wednesday and Thursday morning and afternoon. The meeting had an average attendance of from 30 to 40 members, and the discussions were spirited and interesting. One advantage of the society's having a limited field of operations, as distinguished from the broader fields occupied by the older national societies, is that every paper and topic discussed related to some branch of the one subject of heating and ventilating, and therefore was of immediate interest to every member. The differences of opinion and of details of practice, which were shown in the discussions, evidences the need for the existence of such a society. The fact that the society is not "an organization of business men for business purposes" like the National Association of Manufacturers, but a professional organization for the advancement of knowledge, was strongly emphasized in the remarks of some of the members. They claim, moreover, that the society is a public benefactor, in its educating the public to the necessity of good ventilation, and in its agitation for the enactment of compulsory legislation in regard to the ventilation of schools, to the end that the health of the children may be improved. The claims of the society for public appreciation are warranted by what it has already done for the extension of knowledge, and it is well entitled to recognition by all engineers as holding a worthy place in the ever lengthening list of American engineering societies.

The first paper read was entitled "A New Type of Hot-Blast Radiator," by George I. Rockwood, Worcester, Mass. We will give an abstract of this paper in a later issue. In the discussion no objection was made to the new style of radiator, but the whole question of radiator design, with the difficulties of air-binding, drips, traps, etc., was gone into, showing that much is yet to be learned concerning the best way of building radiator stacks for hot-blast work.

The next paper was entitled "Some Experiments in Steam Circulation," by John Gormly, Philadelphia, Pa. It described some troubles he had with a small steam boiler used for steam heating. On firing up the water remained in the gage glass until ½-lb. pressure was reached, when it suddenly ran down the glass, disappearing within 10 seconds. On opening the fire door the water appeared again. Placing ¾-in. drip pipes at the foot of all the vertical risers, and changing the automatic air valves on the radiators produced no improvement. He then tapped the horizontal steam main on the bottom, so as to intercept any water running along the bottom, and led it by a large pipe into the bottom of the boiler, and this cured the trouble. Mr. Gormly's explanation of the trouble is that it was due to the peculiar construction of the boiler, the steam space being deficient, and water being projected with the steam into the steam main. Tapping the main at the bottom and draining it to the bottom of the boiler let the water flow back into the boiler instead of being driven along the pipes. Considerable discussion followed this paper, several of the members mentioning similar troubles, due to imperfect provision for returning to the boiler the water that might be driven out of it with the steam.

After the discussion of this paper the first "Topic" was taken up: "The rating of heating coils for hot blast heating." It was shown by the limited discussion that none of the members present knew of any standard method of rating these coils, and that an extensive series of experiments will be needed before any satisfactory basis of rating can be reached. The next topic was, "Does the present day competition promote good engineering?" It did not appear what the proposer of the question meant by it, but the variety of answers given showed that it is a question of many sides. Engineering, as far as it relates to the design and to the inspection of plants, has no relation to competition, which is a matter of commerce, and not of engineering. If competion tends to lower quality of material or workmanship, then it tends to bad engineering by the contractor, but this can be met by proper drawing of the specifications and by rigid inspection. In so far, however, as competition tends to lower the cost of good material, it enables the purchaser, for a given outlay, to obtain more for his money and to pay for good engineering.

At the evening session, Jan. 25, the result of the election of officers for the ensuing year was reported as follows: President, Wiltsie F. Wolfe, Boston; Vice-Presidents, J. H. Kinealy, St. Louis; A. E. Kenrick, Brookline, Mass.; John A. Fish, Boston; Secretary, Stewart A. Jellett, Philadelphia; Treasurer, Judson A. Goodrich, New York. Managers: Francis A. Williams, Thomas Barwick and John A. Connolly, all of New York. Council: A. A. Cryer, Wm. McMannis, W. S. Hadaway, New York; R. C. Carpenter, Ithaca, N. Y.; Henry Adams, Washington, D. C.

The paper of the evening was by Prof. R. C. Carpenter, entitled, "A Test of the Heating and Ventilating Plant of the New York State Veterinary College, Cornell University, Ithaca, N. Y." The building is heated by two separate systems, a direct radiation system, which is used during the night, when ventilation is not needed, and a fan ventilation and heating system, used in the day time. The test was made on the latter system only. It included tests of the steam boilers and engines, of the fans, of the quantity of air delivered, of the temperatures of different parts of rooms, of directions of air currents in rooms, of the thermostats, of variations in temperature, etc. The conclusions drawn from the experiments are as follows:

1st, in the ventilation of similar buildings all air should be introduced sufficiently close to the ceiling to prevent the introduction of eddies above the incoming current, and when the rooms are not over 12 or 13 ft. in height this practice is accompanied with an excellent distribution of air.

2d, in case rooms are 20 or more ft. in height the distribution is not improved by admitting air in places above 10 ft. from the floor.

3d, to secure equable distribution the writer believes that, in general, air should be introduced at a distance 2 or 3 ft. from the ceiling and discharged in a direction toward a cold, outer wall, and the vent opening should be on the same side as that for fresh air, situated near the floor line, and, if possible, diagonally opposite the fresh air inlet. When rooms are not over 20 to 30 ft. in plan, dimensions single openings will suffice; when they are larger, additional inlets and outlets should be made, say about one for 20 ft., but so far as possible the general propositions as stated should be applied. I doubt the propriety, in any case, of introducing air so as to form cross currents. In case the room is very large the problem of introducing the air to secure equable distribution is a difficult one and involves so many conditions that it cannot with propriety be discussed here.

4th, the thermostatic control is of great aid in maintaining a uniform temperature, and practically there is no objection, on the score of injurious changes of temperature, to a damper which is rapidly opened or closed.

5th, the thermostat should not be located in a position where the air current cannot freely move, since in heating with air currents, unless there is a perfect distribution of air, the temptrature may vary greatly in different portions of the room.

At the morning session on Jan. 26 the first paper considered was on "Proportioning of Circulating Pipes for Steam and Hot Water Heating," by J. J. Blackmore. It gives a comparison of rules given by Mr. G. H. Babcock, Mr. A. R. Wolff and Prof. R. C. Carpenter, showing great differences between them, and then develops a rule of his own, based on certain assumptions. Mr. Babcock's rule is, "The diameter of the main supply steam pipe should equal 0.1 of the square root of the total amount of radiation in a system." Mr. Wolff's rule is: 0.375 sq. in. area of pipe for 100 sq. ft. of radiating surface, for exhaust steam; for live steam, 0.19 sq. in. is sufficient. Prof. Carpenter gives different ratios of area of pipe to radiating surface, based on the assumed velocity at different pressures. Mr. Blackmore's rule is the amount of surface radiation, R, equals 100 times the area of the pipe a, divided by a ratio, r, for different diameters, which is 3.141 divided by the diameter. This may be expressed in a formula as follows: $R = 100\ ad \div 3.141$. Comparing the several rules for four different cases, viz.: 400, 1,000, 1,600 and 15,000 sq. ft. of radiation, we have the following for the diameters of pipe required, for a length of pipe of 100 ft.:

Sq. ft. Radiation.	Babcock.	Wolff.	Carpenter.	Blackmore.
400	2	1½	2+	2½
1,000	3+	2¼	3½	3½
1,600	4	2¾	4½	4
15,000	12+	8½	13	8½

Mr. Blackmore gives a table of the amount of radiating surface which different sizes of pipe will supply in exhaust steam heating, from which we take the following, for pipe lengths of 100 ft.:

Diameter, ins.	Radiating surface, sq. ft.	Diameter, ins.	Radiating surface, sq. ft.
1½	84	7	8,552
2	200	8	12,560
2½	400	9	18,175
3	700	10	25,336
3½	1,062	11	33,340
4	1,590	12	46,600
4½	2,272	13	55,300
5	3,116	14	70,000
6	5,424	15	84,000

For each 100 ft. (or fraction thereof) the mains are extended beyond 100 ft. the ratio 3.141 ÷ d for pipe one size smaller is to be used in the formula, and for each two pounds increase in pressure the ratio for one size larger is to be taken. For hot water heating the same sizes of pipe may be taken as those given in the table for steam heating.

In the discussion Prof. Carpenter gave a formula, based on Weisbach's, with new coefficients obtained from recent experiments, as follows:

$$p = \frac{W^2 L \left(1 + \frac{3.6}{d}\right)}{7500\ D\ d^5}$$

in which p = drop of pressure in lbs. per sq. in.; W = weight of steam delivered in lbs. per minute; L = length of pipe, or its equivalent, making allowances for bends, valves, etc.; d = diameter of pipe in ins.; D = weight per cu. ft. of the steam of the pressure at exit. He has calculated a set of tables which will be published in full in the society's "Transactions."

The next paper was entitled "Single Pipe Low Pressure Steam Heating," by Mark Dean, Boston, Mass. This paper adds to the existing confusion of formulae for proportioning steam pipes by giving a different formula for mains and for branch pipes. For mains he gives the same formula as Mr. Babcock's, mentioned above, and for branches the following:

To ascertain how much radiation any branch pipe will supply at velocities given above, use the following formula:

$$\frac{V}{L} = C;\ C\ \frac{.0387}{.00007} = R$$

in which V = the velocity of the steam per second; L = the length of pipe containing one cubic foot; C = the number of cubic feet of steam delivered per second to radiator, and R = the number of square feet of radiation supplied.

The paper also gives a number of directions for carrying out the details of the one-pipe system of steam heating.

"The Effect of the Heights of Walls on the Amounts of Heat Transmitted through Them," by J. H. Kinealy, St. Louis, was the next paper presented. It dealt with the fact that in heated rooms the temperature increases from the floor to the ceiling, and that in high rooms the upper part may be very much hotter than the lower. In such cases the average temperature throughout the height should be taken in making calculations of heat transmission through the walls. Prof. Kinealy finds that when the temperature of a room taken 5 ft. above the floor is 70° the temperature at a distance h above the floor is about 65 + h. If h is the height of the ceiling above the floor the average temperature between the floor and the ceiling is about 65 + ½ h.

During one of the earlier sessions a committee of three was appointed to visit two public schools in New York city, one of them being a representative of the old style of building, with furnace heat and imperfect provision for ventilation and the other a new school with all modern improvements, including the blower system of ventilation. The committee made its report the next day, that it had visited the two schools, the old school being found in exceedingly bad condition, with rooms overcrowded, and with the air so bad that it was necessary at every recess to open the windows and flush the rooms with clear cold air to render them habitable, while in the new school the conditions were everything that could be desired and the ventilation admirable. The committee praised the Board of Education and the architects for their work on the new schools. The old school is a relic of the past generation, and is one of a class which will probably soon be unknown in the city.

"Heating and Ventilating Church and Parish Buildings by Forced Draft" was the title of a paper presented by B. H. Carpenter, of Wilkes-Barre, Pa. It contains drawings and descriptions of a successful heating plant, in which the air delivered by a fan is admitted to the auditorium through 87 8-in. ducts leading to the pew ends, and 17 other ducts leading to registers in the side walls and chancel. The air is drawn by an eduction fan from the auditorium through numerous openings in the floor. The air fans are drawn by belts from a 12½-HP. electric motor. To prevent the carrying of vibrations from the fans to the ducts all connections between them are made with canvas and asbestos cloth.

The last paper of the meeting was contribution from a foreign member, Mr. D. M. Nesbitt, of London, Eng., entitled "English Practice in the Warming and Ventilation of Technical and Art Schools." It is an excellent paper, giving an account of the latest and best English practice, which does not differ greatly from the best American practice, in using both pressure and exhaust fans, with screens for filtering the air before admission into the building, but the construction is more expensive than is usual here, including large low-pressure fans and ducts built of glazed brickwork. The paper described also the method of exhausting air from chemical laboratories. It was discussed at some length, and the differences between American and English practice due to different conditions of temperature and weather, were pointed out.

An interesting feature of the morning session of Jan. 27 was the discusion of a question propounded by Mr. Joseph Wright, of Toronto. He had a letter from the chief architect of the department of Public Works of Canada, stating that the hot water practice of the department had been called in question and that the specifications for radiators had been criticised as being 25 years behind the age, the critic stating also that the pipe coils with cluster headers were inferior for circulation and heating purposes to cast iron radiators of the same nominal heating surface. Mr. Wright sketched on the blackboard the kind of radiator used, which was the one used in the United States 25 years ago, but is now almost entirely abandoned, consisting of a cluster of horizontal pipes, from three to six rows wide, surmounted by a marble top and surrounded by an ornamental screen. In the discussion he was plainly told that in using this style of radiator the Public Works of Canada was 25 years behind the age, that the radiator was objectionable in not having provision for a free circulation of air between the pipes, and that it was worse from a sanitary standpoint, as being a collector of dust and of particles of wood and lint from the floor sweepings. It was not considered that a cast iron radiator in itself was any better than one of wrought iron, but it was the close clustering of the pipes and the surrounding of them by ornamental covering that was objectionable.

The committee on uniform contract specifications reported that it had a conference with a committee of the Master Steam Fitters, and that it had been agreed that each committee should prepare its own provisional specifications, that then another conference should be had, and that the American Institute of Architects should then be asked to pass upon the specifications agreed on in the conference. The new officers were then installed, the president, Mr. Wolfe, making a brief address, and the meeting then adjourned.

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