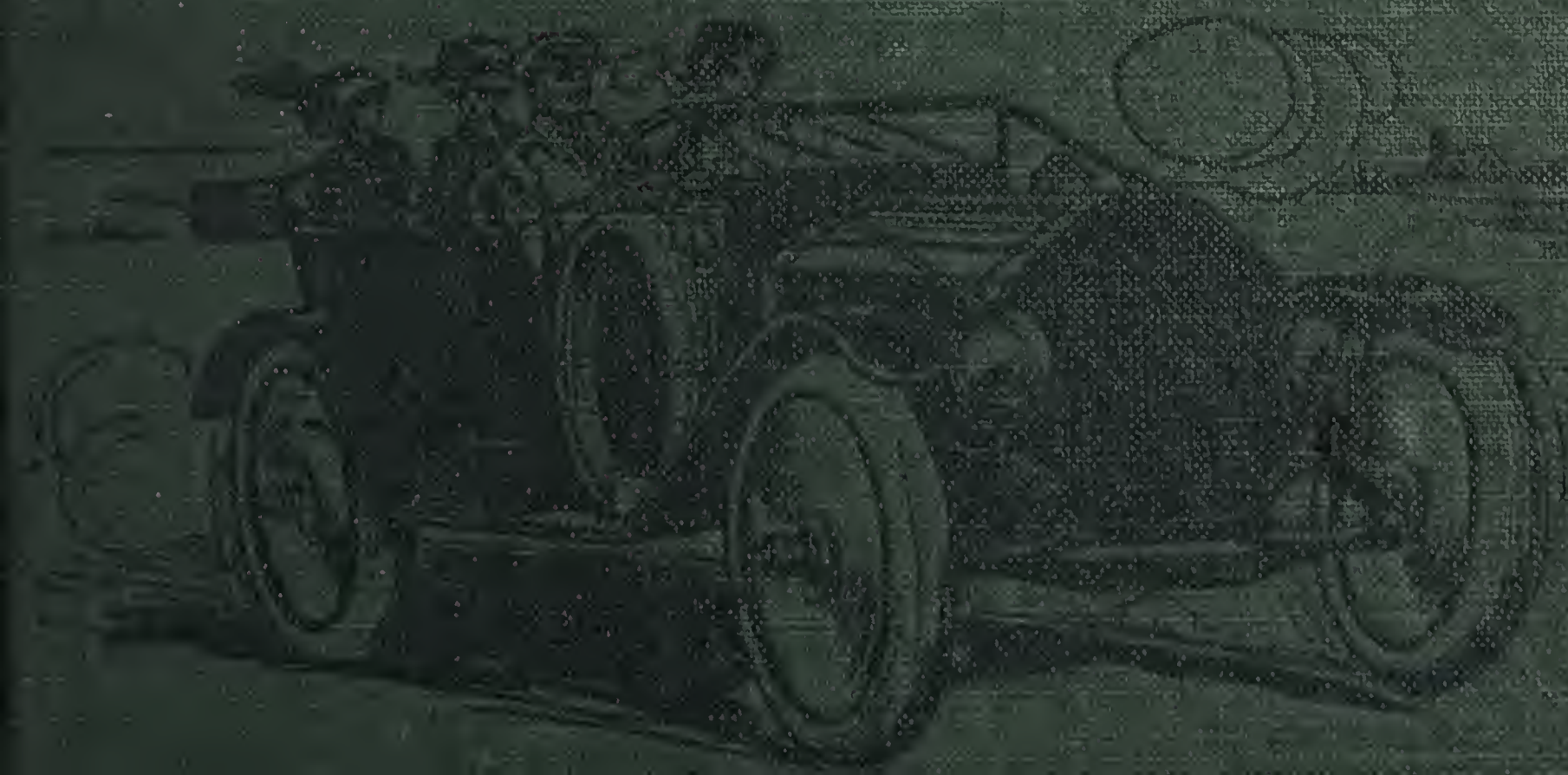
THE USE AND ABUSE OF THE AUTOMOBILE

BY PROF. K. P. NICHOLAS
KANSAS CITY, MO.



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CHIEF INSTRUCTOR OF AUTOMOBILE TRAINING SCHOOL

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MAIN CLASS-ROOM. PROF. K. F. NICHOLAS

Foreword

IN THE following pages you will find the use and abuse of the automobile explained and illustrated as thoroughly as it can be on the printed page. I do not claim that you will be able to learn to be an automobile specialist out of this book alone, for you will discover it is not possible for me to illustrate things as plainly to you in a book as I could if I had you in the class room. However, I do claim that any person who has ever gone through the school room and has heard the instruction given there and the illustrations explained, I do claim that this will bring back to him the things as fresh as the day they were in the class room. You must also realize that you are reading a matter which is not being illustrated by the real article. And yet I do claim that you can get a great deal of good out of this book if you are one who understands anything at all about an automobile. I am certain that after you have read this that you will get more than your money's worth out of it and will be overpleased with what knowledge you have received from the book alone. I believe it is made plainer in this book than in anything yet published. Also the instruction herein is taught the same as you will find in the class room, and the one who is teaching you is one who has had the real experience.

The Use and Abuse of the Automobile

BY PROFESSOR K. F. NICHOLAS

Chief Instructor of the Automobile Training School, Kansas City, Mo.

IN taking up the automobile business, it is really necessary for a man to go to the very bottom so that he may be able to understand every working principle and part of the gasoline engine. Trying to learn this out of a book is impossible. The book principle is to give a man back what he has forgotten, since you can refer back to this and get my instruction just as it was taught in the class room.

To understand its principles, the automobile ought to be taken up just as it was when first invented. Booty Roe was the first man to invent the first four-cycle gasoline engine, although the gasoline engine was not the first propelling vehicle that was ever invented. Steam power was the first, and it made a failure. Later the locomotive took its place. Afterwards steam developed into the automobile, and still later Booty Roe, who discovered that gasoline had power, put it to work. You will notice now that we have the three propelling vehicles—gasoline, steam and electric.

In taking up gasoline, it is really necessary to understand the use and abuse of the gasoline engine. There is no piece of machinery on the face of the earth that is abused any more than the gasoline engine. In contrast look at the locomotive. It runs over smooth rails, and every night when it comes into the round house, it is looked carefully over by mechanics who understand their business, while the gasoline engine on the automobile goes out over the rough roads and is abused from morning to night, and is then run into the shed and has no care whatever. The next morning the man who operates it starts it for its next day's abuse. Did you ever notice that the following usually takes place when a man buys a brand new car?—you certainly have if you are the owner of a car! A man is sent out to you who is supposed to understand his business. He tells you how to operate your car. The first thing he tells you is to be sure to always release your clutch. He has told you wrong when he told you that. The second thing he will tell you is how to turn on the spark, how to change speeds and how to start a car. After he has left you, then your trouble begins, for the first thing you will do is to go to your car, undertake to start it. And when you do,

you will find that it fires backwards, giving you a very severe lick upon the leg or arm, maybe breaking some limb. If this doesn't happen, by the time you get into your seat and undertake to start the car, you will hear a ripping and roaring sound coming from your gears. This is nothing more nor less than the fault of the driver, as you will readily learn when you get further advanced in this book. Another thing you will notice after starting the car, although you may start out all right at first, after changing speeds from first to second, you will find that it gives you a great deal of trouble to change these speeds without making a noise. You may discover that it may not be even this that troubles you, but something else. In short, it will be well worth your time to read this book, as it may be the cause of saving your life.

Suppose you should go to your car in the morning, not having been warned against the dangerous points, and undertake to start it while it was in high speed. You would find your car would make one lunge, leaping over you, and perhaps breaking your neck or back. This has happened to several men among my acquaintance in Kansas City, and is likely to happen to you, provided you are not guarded against these dangerous points.

The above are only a few of the facts concerning the abuse of the gasoline engine. Let us continue. The average man who drives an automobile, if you observe, you will notice him start suddenly, and stop suddenly, and you will notice him turn corners at a high rate of speed. You will also observe that he drives at a high rate of speed over rough places. Again, you will see him drive his car, it may be during the evening, then run into the shed and leave it there untouched. That is the last of it until the next morning. Is not this abuse to the gasoline engine? When anything goes wrong, a cold chisel and a hammer is the way he usually starts to repair it. Such repairing as this makes the first expense of a man's car the least. But the second expense becomes greater, due to the abuse of the gasoline engine. Later on, I will give you the knowledge of using one tool that will make your first expense much greater than the second expense, but it will save you in the long run.

If you will go home after driving your car and take a piece of waste and wipe the grease from all the different parts, you will remove your trouble. Upon doing so, you will discover wires that become oil soaked, cause trouble such as shorts. You will also find that grease gathers in your magneto and shorts it out. And again, the vibration of your car causes the different parts of the car to work loose. By wiping over these parts you will learn the parts which are working loose and know what size wrench to use in order to tighten them up. You have also discovered and prevented trouble that would occur later. For every time a trouble shooter

is called out to fix your car it means a dead expense. And that expense runs very high and it is just as well that you do away with it. The troubles of the gasoline engine are very easy to overcome, providing you understand the principle of every part and why every part performs its work in the way that it does.

If you are to drive an automobile in the city, it is necessary to understand the rules of driving. In coming to a street car crossing, you should always drive across straight ahead and turn to your left. Again, you should always slow down before crossing a street car crossing. Give yourself a chance to look both ways, seeing that you have the clear; then you are at liberty to cross over. Don't take chances on the boulevards, even if you do have the right of way. Sometimes the street cars don't stop—it may because of the brakes not holding, or it may be because the motorman doesn't care. In driving on slippery, wet streets, you should proceed very carefully. Don't lock your brakes suddenly; don't start your car quickly; as this causes skidding and is liable to result in a great deal of trouble. When old people are crossing ahead of you, it is really not necessary to make a noise, since you will find you will have better success in crossing the street without scaring them than you will if you were to blow your horn and frighten them. If you blow the horn quickly, they are sure to jump back in your road, and the chances are you might hit them.

In driving around a bluff or any other place where you notice an icy or slippery place ahead of you, always release your clutch and release your brakes and let your car coast over. To illustrate, when driving a wagon down a hill, if you lock the brakes, the back end of the wagon will try to beat the front end down. By releasing the brakes, the wagon will straighten up at once and pushes the horses ahead of you. Finding you have no horses to an automobile, this will not happen; but if you release your brakes your car will stay straight in the road and will coast over the icy, slippery place without a bit of danger. Otherwise, it is liable to skid sideways and go over a bluff if there is one, which sad experience has happened to a number that I know of, and has caused loss of life to several.

In starting an automobile, the proper thing to do is to always see that your spark is retarded, and that your levers are in neutral. Then, by placing your thumb behind the crank, and by pulling very quickly, you will find that your motor will start off without any danger. After taking your seat in the car, release the clutch clear out, advance the spark about half, and throw your lever into first speed. Then leave the clutch in easily. When the car starts off, just release the clutch far enough to release the motor power from the transmission and shift over from first to second very quickly. To your pleasure you will find that this can be done without making a particle of noise. Then from second to high. Do the same by

releasing the clutch just far enough to release the motor power from the transmission and shift into high speed quickly, lifting your clutch back slowly. You will find that no noise will be made by shifting in this way, as you allow the jack shaft to keep running as well as the drive shaft. These gears both running will slide together without making a particle of noise.

After your car is in good motion, don't lock your brakes suddenly, as it causes a very severe strain upon every part of the gasoline engine. When the brake is locked suddenly it throws a strain upon the jack shaft, upon the drive shaft, upon the propeller shaft and to the differential. This shock or strain has been received all the way through to the rear axles on the rear wheels, and is very apt to cause crystalization. Crystalization will keep working until it has finally lost its strength and gives way. The metal looks like it has been rubbed together, except right in the heart of the piece of metal, which you will find is a fresh break, which has been crystalized in that part, and this part not being strong enough, breaks. Sudden stoppage of a car also throws a strain upon the beads of the tire, and in time causes it to give way.

The Way to Avoid Trouble

By first going to work and straining your gasoline through a chamois skin, you will find that you avoid a great deal of trouble that will occur otherwise. The gasoline, after leaving the oil wells, is hauled in a large tank, from which it is poured into tanks here, and from these tanks to your automobile. During this transit a great deal of dirt has gathered since the time it left the oil well. This dirty gasoline, entering the tanks of the car, will cause trouble, which, of course, means expense to the man who owns the automobile. By straining the gasoline thoroughly through a chamois skin, you avoid this trouble all together. Sometimes water will be found in gasoline. If this be the case, by straining it through a chamois skin, the water also will be kept from passing through. If the gasoline should enter the car dirty and stop it up, such trouble can be located in five minutes from the time you reach the car, provided the owner is an all around expert. But if he is not, he should avoid this trouble.

Broken Parts and the Way to Get Home

If you were to break a rear wheel of your car, at first it would seem almost impossible to get home. However, by taking a pole and placing it

under the car, the same as you would on a wagon, fastening it to the front axle or to the running board, then tying your rear wheel to the pole that is broken so that it cannot turn, you will ascertain with pleasure that you can drive home with the other wheel, since it is bound to turn. This is due to the differential which allows one wheel to stand still while the other one runs twice as fast.

Should you strip out a set of transmission gears, you can also drive home by throwing into high speed. You have what is called a "direct drive." This does away with all the gear power, and you are able to drive in on high speed. You will have to bring your car up to a fairly high speed, allowing the clutch to slip while starting your car. After once getting started, it is no more trouble to drive home this way than it is any time when driving on high speed.

If you should happen to break a connecting rod, by going to work and removing the cylinder and taking out the broken parts and placing the cylinder back on, release the push rod on the intake valve of the dead cylinder, and you will find that you can drive home on the other three cylinders, or the cylinders that you have left.

Should you break a propeller shaft, splice it the same as you would a broken arm by placing four pieces of iron round the sides and wrapping tightly with a piece of wire. Fasten a piece of wire from the front universal joint to the back universal joint, wrapping it in the opposite direction from the way the propeller shaft turns. You will find that both pieces must then go together.

In case that your radiator should happen to be leaking badly when on the road, by getting some corn starch and dissolving it in a bucket of water and pouring this into the radiator, you will discover that it will check the leak at once, and you will be able to drive home without any delay.

In case you were to strip out the differential gears, by going to work and taking the differential out and blocking the gears with a piece of wood, you will be able to go to work and make a stiff drive in which you could drive home without any trouble. However, you must be careful in turning the corners, as one wheel has to slip on the ground while the other one turns.

In case your clutch gets to slipping, and will not hold (if you have the comb clutch), you can raise it by slipping a hacksaw blade under the leather, or a piece of wood, tin, or anything that will raise the leather so that it will seat tight when the clutch is left in. This will keep it from slipping and will allow you to get home safely.

Say that you were to get in a mud hole and one wheel was on good footing, and the other one was in the mud hole, was turning round and wouldn't hold. A good way to stop this is to knock the pin out on the brake

rod on the side of the wheel that is on good footing. This will allow you to lock the brake on the wheel that is slipping and keep it from doing so, as the other wheel will have to turn then and will take you out of the mud hole without a bit of trouble.

If your lamps should go out and you had no matches after night, to light them is a very easy matter. Just take a piece of paper, dip it in the gasoline, take off a high tension wire and allowing the spark to jump across to the paper. This will set it afire, and you can light your coal oil lamps. Then one of those can be taken round and light the rest.

In case a universal joint should give way on one side, about the only way of driving home on your own power is to drive backwards. This can be done without any trouble.

Four Vibrating Coil

The Four Vibrating Coil is a system which is used on a great many cars. It has its good principles and bad principles the same as any other system.

The Four Vibrating Coil consists of four units which have a primary and secondary winding. The figure you see here gives you a plain view of the Four Vibrating Coil, wired up as it should be on the car itself.

It is really necessary for you to go to the very bottom in order to understand the principle of this coil. You will find in taking up the Four Vibrating Coil, or any other coil, one must also understand the effects of lines of force. You will discover that in winding wire in which you flow a current over will create a line of force which cannot be seen, but the effects can. For instance: take a piece of iron; wrap a piece of paper round it; then wrap a wire over; connecting each end of this wire to a set of batteries, and you will find that the iron core becomes magnetized. It is through the lines of force that the iron core becomes magnetized. Hence, you will find wherever there are lines of force there is magnetism, and wherever there is magnetism, there are lines of force. In order to understand this clearly, it is also necessary to be where some one can demonstrate this principle as well as teach it to you. In this teaching you will discover why we are trying to impress upon you that lines of force are magnetism and magnetism is lines of force, for it is really necessary to understand this thoroughly in order to understand how we create a secondary current. A secondary current is made by the breaking of the lines of force. By this method, you will find, the spark was created as hot as it is, and hence the current used on automobiles goes as high as 20,000 volts, starting out with a voltage of five to six. This is done by means of the induction coil.

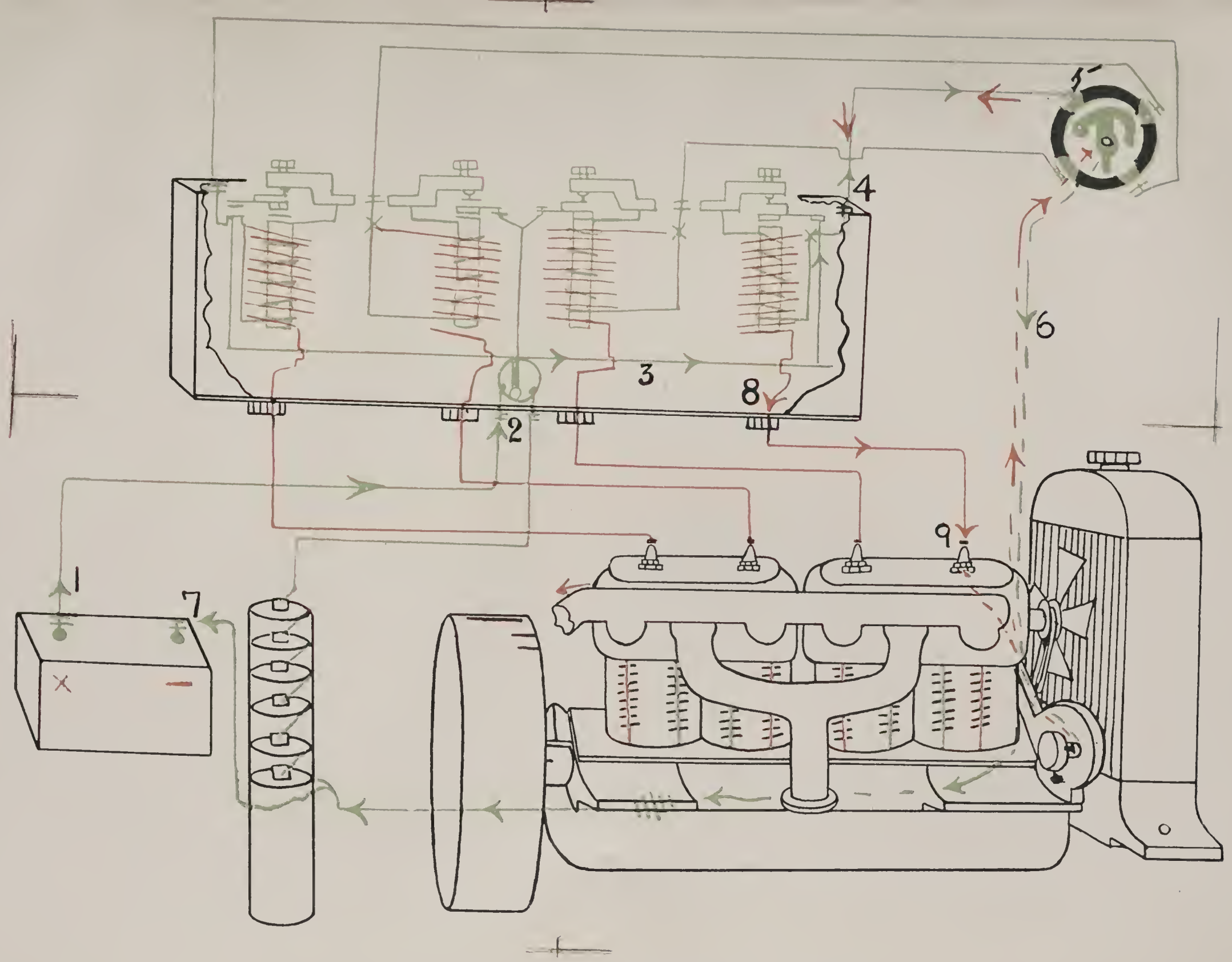


FIG. 20. FOUR VIBRATING COILS.

The first ignition system which was used was the Make and Break system, in which they used the spark coil, and still do today, on a stationary gasoline engine; but on automobiles we use the induction coil.

To increase the current on an induction coil, it is stepped up by flowing a primary current over a primary winding. We creat a line of force by breaking this current. Then we break the line of force and create a high tension current in the secondary winding, in which this current will go ten to one as the winding is made that way. We do not mean one wind of the primary and ten of the secondary, but we mean one of the primary and ten thousand of the secondary. This raises the voltage which is carried to the spark plug, as the high tension current will jump almost three-fourths of an inch. This makes a very hot spark and if you were to take it direct through your body, it would "tie you up" in a knot. You wouldn't be able ever to let go. The shock that you receive from the motor is merely a slight shock, as the entire current doesn't go direct through your body, but only part of it.

In Figure No. 20 I shall explain the Four Vibrating Coils in a way that you may understand the principle from the beginning to the end. It is necessary that a person should understand how to find out the way a motor fires and how to find the compression stroke dead center, and also how to set a timer of magneto.

No. 1 on the figure shows the positive connection; No. 7 shows the negative connection of the storage battery; No. 2 shows the connection of the switch; No. 3 shows the primary wire in the coil box; No. 4 shows the terminal from the coil box to the timer; No. 5 shows the terminal at the timer; No. 6 represents the current returning back to its point of starting; No. 8 shows the high tension current feeding out of the high tension terminal, and No. 9 shows the spark plug where the high tension current feeds to, which is No. 1 cylinder, or should be.

We always have a system by using one end or the other of the motor for No. 1. By using the cylinder next to the radiator for No. 1, you will find you are following the rule as many mechanics do.

As you wish to find out the way this motor fires, you will notice the intake valves and exhaust valves are colored green and red. The green valve stems are the intake valve stems. The red valve stems are the exhaust valves, which will be found nearest the exhaust manifold opening. The intake valves are found nearst the intake manifold opening. To find the way your motor fires, watch the exhaust valve open and close on No. 1 cylinder; then place your thumb and finger on Nos. 2 and 3. If No. 3 opens next, it fires 1, 3, 4, 2; but if No. 2 opens next, it fires 1, 2, 4, 3.

Now, to find compression stroke dead center, by watching the exhaust valves open and close on No. 1 cylinder, you must turn the fly wheel one

complete revolution, getting dead center mark even with the center of the cylinder and it will give compression stroke dead center on No. 1 cylinder. Or, by watching the exhaust valve open and close on No. 4, and getting the dead center mark even with the center of the cylinder, it will give you compression stroke dead center on No. 1. Then set your timer. Fully retard the timer and set it so as to be just ready to make contact with No. 1 point.

After setting your timer so it is just ready to make contact with No. 1 point, you are then ready to start to wire up. Wire you high tension wires in rotation as they are in the drawing. Wire your primary wires from No. 1 point of the batteries to the terminal of the switch, No. 2. The other point of the batteries must be connected to the ground, which is the frame of the motor. Then you will wire your primary wires from your timer to the coil, according to the way the motor fires. As this motor fires 1, 3, 4, 2, you wire No. 1 point to No. 1 point on the coil. You wire No. 2 point on the timer in the direction that the timer hand turns to No. 3 on the coil; you wire No. 3 on the timer to No. 4 terminal on the coil; you wire 4 point on the timer to No. 2 terminal on the coil. This will make your motor 1, 3, 4, 2.

At this point we will trace the current as it travels from this system and what takes places as the current is traveling. When turning the switch on at No. 2, the current starts out on the positive side, No. 1. It passes across switch No. 2, up to the spring over the green wire, across the spring and through the adjustment screw, through the primary winding to terminal No. 4. Then it passes to the timer terminal, No. 5, where it passes in on the contact maker across the shaft, No. 6, from whence it passes down over the green wire back to the batteries where it started from. While this current is passing through the primary winding it creates a line of force, causing the iron core to become magnetized, draws the spring down and breaks the current. Breaking the current, it breaks the line of force and creates a high tension current in the secondary winding. This current passes out over the high tension wire to the high tension terminal, No. 8. From this it passes to the spark plug, No. 9, where it returns over to the timer over the red dotted line. There it passes back through the timer as the red arrows point back through the primary wire, back to terminal No. 4, where it returns back into the secondary winding from which it started.

You will find that No. 1 cylinder fires down; No. 2 cylinder comes up exhausting; No. 3 cylinder comes up compression; and No. 4 cylinder goes down, taking in a charge. As No. 3 cylinder reaches compression stroke dead center, the timer has moved from 1 to 2. As it reaches No. 2 contact point, it closes a circuit again in which it this time passes from the positive side, No. 1, to the switch No. 2, passing over the primary winding, No. 3, to the contact point, No. 2, on the timer. There it returns back over the frame of the motor, back to the batteries where it started from.

While this current passes through No. 3, it creates a line of force, causing the iron core to become magnetized and draws the spring down, breaking the current. Breaking this current, it breaks the line of force and creates a high tension current in the secondary winding, which rushes out over the red wire passing down to spark plug No. 3. There it returns back through the timer, over the primary wire to the secondary winding where it started from. As this takes place, No. 3 cylinder fires down; No. 4 comes up on compression stroke; No. 1 comes up exhausting; No. 2 goes down taking in a charge. As No. 4 reaches compression stroke dead center, the timer has moved from 2 to 3 where the circuit is closed again. This time the current passes from the batteries No. 1 to the terminals of the switch No. 2, passing over the green wire to No. 3 coil where it passes through the primary winding. There it returns over to timer contact No. 3, and returns back over the frame of the motor back to the batteries where it started. Also, a line of force is created in this coil, causing the iron core to become magnetized, draws the spring down and breaks the current and breaks the line of force. Breaking the line of force, it creates a high tension current in the secondary winding which rushes to the spark plug No. 4. There it returns back over the frame of the motor to the timer, returning back over the primary wire to the coil where it started.

As No. 4 fires down, No. 1 goes down taking in a charge; No. 2 comes up compression and No. 3 comes up exhausting. As No. 2 reaches compression stroke dead center, the timer has moved from 3 to 4 where the circuit is closed again and the current passes from the positive side of the battery passing through the switch where it passes through No. 2 coil. There it passes out from the terminal to No. 4 contact point on the timer, returning back over the frame of the motor, back to the batteries where it started from. Also, this current passing through creates a line of force, causes the iron core to become magnetized, draws the spring down and breaks the current, and breaking the current, breaks the line of force and creates a high tension current in the secondary winding, passing out to the spark plug No. 2. There it passes down over the frame of the motor, returns back over the primary wire to the timer, back to the secondary winding where it started from. This causes No. 2 cylinder to fire down, No. 1 comes up on compression stroke, and No. 4 comes up exhausting and No. 3 goes down taking in a charge. The timer has moved back to No. 1 contact point to where it started from. Each one of these cylinders has completed a cycle, as each cylinder has come back to the same point of starting, and a cycle of a four-cycle gasoline engine is one which completes four duties in two revolutions.

You may wonder why the current passes to No. 1 coil first and doesn't pass through all the coils at once. If you will notice, tracing the current

through any of the other points but No. 1, you will come to the timer and you will find that there is no way for the current to go across, as this timer is insulated between the green points. The green points are the only places that they can make contact or close a circuit. The dark points, you will find, are insulated, or otherwise are fibre in which the roller passes over and cannot make contact in any way, shape or form without making contact with the terminals. This way, the wires being connected as they are, the current must flow through first No. 1, then 3, 4, and 2.

You may also wonder why we retard a spark when setting the timer. Of course you realize we advance the spark when the motor is running. The reason we do so is because it takes a space of time for gasoline to burn up. As it takes a space of time, we have got to ignite the gas ahead of time since the motor runs at such a rate of speed that the gas will burn up by the time the piston has reached the dead center, giving us the full benefit of the explosion from the very top down. If we were to ignite the gas on dead center, the gas would be burning and would release, which would cause a great deal of heat and also a loss of power, as you will find that the piston had traveled part way down before the gases would burn up and therefore the explosion would take place too late. You must understand that the piston travels further on the first quarter than it does on the last. For that reason we have got to gain all we can on the first stroke. By gaining our explosion on the dead center, we get the full benefit of the explosion stroke from the top down. So, by setting the timer fully retarded, and setting it to make contact as it comes on dead center, when we advance the spark we ignite the gas while the piston is coming to the top. This way the gases are burning while compressing. The burning of the gases gives greater combustion, which, when fully compressed, gives off a greater explosion than it would if it was to be ignited and even burned on the dead center. This is why we gain so much power out of such small cylinders.

Troubles of the Four Vibrating Coils and How to Locate Them.

If there is a continual buzz of the vibrator and back firing through the carburetor, the trouble is found at the timer. This is caused from dirt, from oil-soaked wires, broken insulation, or wires coming off from the timer touching the frame of the motor somewhere. This trouble is always found at the wires that are connected at the timer or in the timer itself. The reason for this is a continual flowing of current of the primary circuit, which causes a continual line of force. This causes the iron core to be magnetized continually, causing a continual vibration. As it draws the

spring down and breaks the line of force continually, it continually creates a high tension current in the secondary winding. This passes to the spark plug, and hence at the cylinder you will have a continuous spark, which, the moment the gas is drawn in this cylinder, is ignited and fired back through the carburetor. If the wire No. 1 at the storage battery was to get shorter or touch the frame of the motor in any way, it would cause the battery to discharge very fast and chances of ruining your battery .

If the wire of the dry cells leading to the switch No. 2 should happen to get shorter, by chance it might stop your car from running. However, I have known it not to do so for some time, and yet when it did so, would still give off a spark. In this trouble you will find you will have a spark, compression and gasoline, which is a very hard combination for the ordinary man to locate; but it can be located in five minutes by understanding it thoroughly. First take gasoline from the top of your tank and prime your cylinders, about a teaspoonful to each cylinder. You may ask, "Why do you take gasoline from the top of the tank?" Because gas is always lighter and is bound to be at the top. If there is any water in the gasoline it is most surely to be at the bottom. By priming your cylinders with water you would be thrown off on to the wrong trail of trouble. After priming your cylinders with gas from the top of your tank, crank the motor over. If three or four explosions take place, that insures you that your spark is in good shape and will ignite the gas. This trouble is found in the carburetor, showing that the gas is not getting to the cylinders as it should. By trying to flood the carburetor, you will soon locate this trouble. If the carburetor will flood through the air valve, you will know water in your gasoline is causing the trouble and your carburetor is full. If this cannot be flooded, it shows that the spray nozzle is stopped up and will not allow the gasoline to pass through. By removing either the needle valve or the plug at the bottom (should it be a spray nozzle) you can remove this dirt without any trouble. Should it be water, by draining off about a pint, generally removes the water trouble.

Should you find that by priming your cylinders the gas would not ignite, insure yourself that your timer is properly set by putting your No. 1 cylinder on compression stroke dead center, and see if your timer is just where it can make contact. Finding this proper, your trouble lies between the switch, the batteries, the ground wire, loose connections, oil-soaked wires, or missing cylinders. To locate this trouble, first, turn the motor over with the switch turned off, seeing whether your compression is good on all four cylinders. If not, the trouble is very apt to be that the valve is probably being held open by carbon or some other cause. If not, and the compression is even, by taking a screw driver and placing it at each plug while the motor is running, you will find that each cylinder

works out the same, allowing just one cylinder to miss at each point when shorter, and the trouble is that your carburetor is not properly adjusted. If you find that one of these cylinders that you short out, shorts out with your screw driver when allowing two to hit, keep on until you find the one that makes no difference, so that when shorting you still have three hitting. Then you have the cylinder that is missing, as it makes no change by shorting. Take the high tension wire off and see whether the high tension current is feeding to the plug. If it is, remove the plug. If full of grease and dirt, there is your trouble. If not, take the plug to pieces. If the porcelain is cracked, that is your trouble; but if not, your trouble is somewhere else. Then go to work and look at your vibrator on the coil which is feeding that plug. If you find your platinum points are pitted or in bad shape, that is your trouble. If not, go to work and change the coil to a place of one of the others and place the other one in its place. Finding that this coil will not work at the other place, the trouble is that the coil is broken down, which is caused by using too many dry cells on the battery. We should only use six dry cells on a four vibrating coil, or three-cell storage battery.

To adjust these vibrators, go to work and short circuit your timer. Then you can cause the vibrator to operate, and you will be able then to adjust it until you get a rich, "honey bee" hum.

Four Unvibrating Coils with Master Vibrator or Double Ignition System

The view which I show you next, in Figure No. 25, gives you a plain illustration of four unvibrating coils with a master vibrator and a high tension magneto in connection. This view shows your sectional figure of the cylinder that shows you plainly that a motor cannot fire in rotation. As you will notice, No. 1 piston and No. 4 piston are at the top, while No. 2 and No. 3 are at the bottom. Now, should No. 1 fire down, No. 4 would have to go down with it. That would bring 2 and 3 to the top. Should No. 2 fire next, it would undoubtedly take 3 down with it, which plainly shows that it would be impossible to fire No. 3 next, as it would be at the bottom with No. 2, though since this would bring 1 and 4 to the top, you would be able to fire No. 4 next, which would make it fire 1, 2, 4, 3. Otherwise, you could fire No. 1; then 3; then to your 4 and back to 2.

This figure shows you an independent system of the ignition system in the high tension and the primary circuit. They are not connected together in any way. The breaking of the line of force for these coils must be done

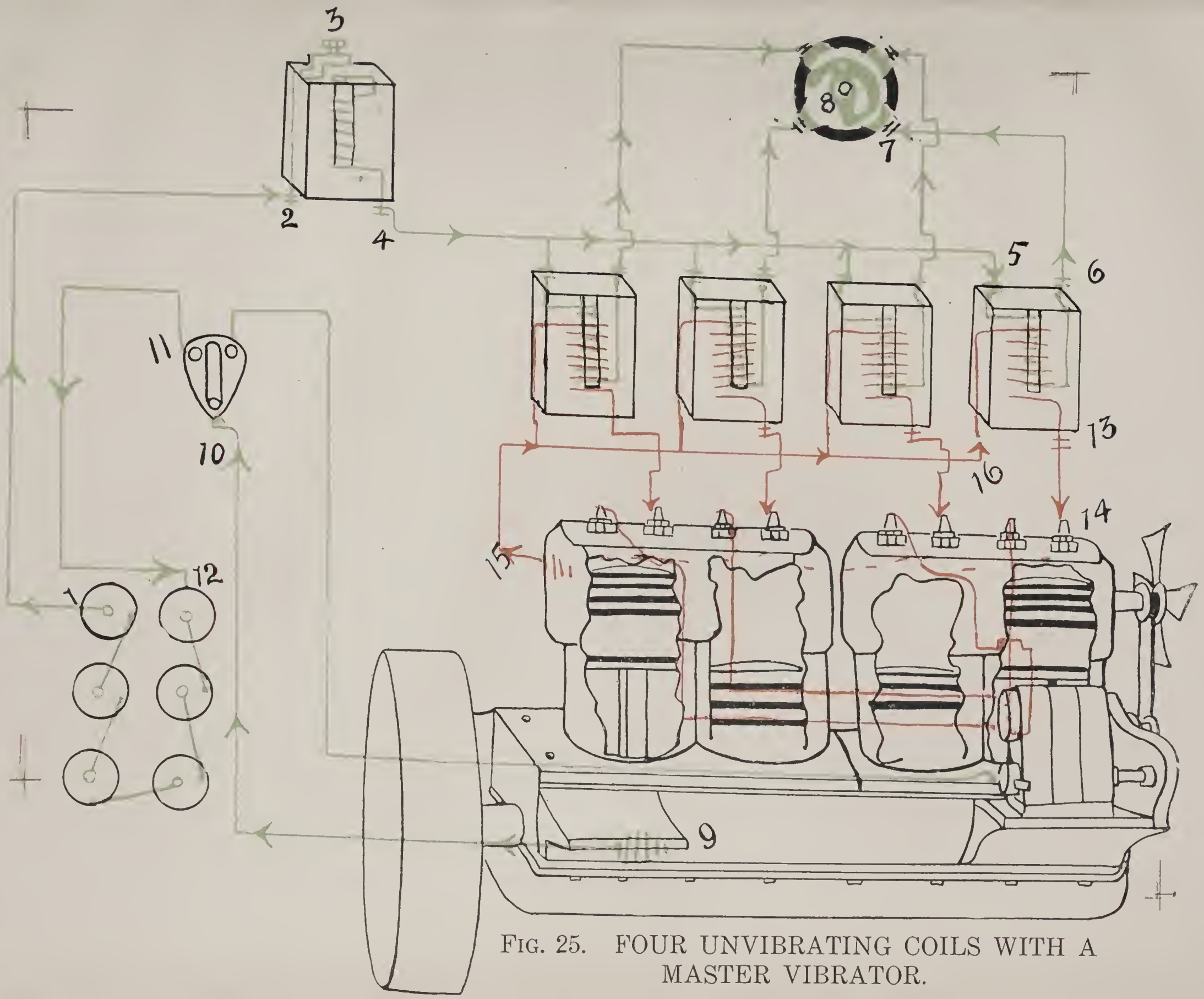


FIG. 25. FOUR UNVIBRATING COILS WITH A MASTER VIBRATOR.

by the master vibrator. The master vibrator receives its name because it is a master over the other four coils.

With this system we get practically the same spark from each and every coil for the simple reason that the break is the same. At each and every time that the current flows through the master vibrator, it passes through one of these coils and the same line of force is created in the master vibrator that causes the break to take place and causes it to be exactly the same. Breaking the line of force, the same will give off more of a uniform, even current than it will with a later or slower or quicker break.

The current after passing from the master vibrator, passes through these coils, and creates a line of force in the unvibrating coil. This coil has two windings, a primary and secondary. In the breaking of the lines of force, there is a high tension current created in the secondary winding.

The high tension magneto, which is in connection with this system, will be explained to you later on, as we would rather take up the magneto all at once and take it up carefully through the same course that we do each system when in the class room.

First, then, we will start in with this system the same that we would with any other to wire it up on the car. The first thing to be done is to find out the way your motor fires, which is done by watching the exhaust valves open and close, and the way they open and close is the way the motor fires.

Always start at one end of the motor for No. 1. After finding the way your motor fires, then go to work and find compression stroke dead center. You will do this by watching the exhaust valves open and close on No. 4 cylinder, and as it closes to the dead center mark even with the center of the cylinder, you will then have compression stroke dead center on No. 1 cylinder. After getting compression stroke dead center, you must set your timer so that it is ready to close the circuit at this time. Do this by retarding the timer as far as possible. Then set the contact maker just ready to make contact with one of your points, which point must be No. 1. After setting the timer and fastening it so it cannot slip, you are ready then to start wiring up.

Start one side for No. 1 of your coils. Wire these high tension wires in rotation, as you see them here. Then connect one wire to the other terminals of the secondary winding, and connect a wire to each one of these terminals fastening it to the frame of the motor, which makes you a high tension return. Now, we will start from the batteries No. 12. Wire these batteries in series, that is, from zinc to carbon and so on through each, which gives you a series wiring. This raises your voltage, leaving amperage stand the same on the six dry cells as it does on one, making the life of these

six batteries the life of one. Then connect No. 1 point to No. 2, which is the primary terminal of the master vibrator. Wire No. 4 terminal from the master vibrator to each one of the terminals of the unvibrating coils on one side. This gives you a feed line to the unvibrating coil. Then connect up your switch which must be connected the same as the motor fires. As this motor fires 1, 3, 4, 2, you will find we have it wired in that way. Wire your No. 1 point to No. 2; wire your No. 2 to No. 3; wire your No. 3 to No. 4; and wire your No. 4 to No. 2.

You will please notice that we have this motor firing at the back of the machine in place of the front. We use the back cylinder for No. 1, showing that you can use either end, it making no difference. The cylinder which you start with must be put on compression stroke dead center before undertaking to set the timer.

Now, that we have this wired up, you will find the green wires are the primary lines and the red wires are the secondary windings. We start and trace the current through this system until the motor has completed a cycle. The current starts out over the batteries at terminal No. 1. It passes over the primary line to the adjustment screw No. 3, and on across the spring and round the primary winding down to terminal No. 4. There it passes over the feed line which connects to terminal No. 5. The current feeds through the primary winding and passes down at terminal No. 6. At this point it passes up over this green wire in the direction the arrow is pointing to terminal No. 7. You will find it passing into the contact maker at this point, then on across to the shaft, and down over the frame of the motor, it returns back to the ground wire and returns back to the batteries where it started from.

This current, while passing through the master vibrator creates a line of force, also creating a line of force in the unvibrating coil, which the current passes through. While this current creates a line of force at both places, the line of force in the master vibrator causes the iron core to become magnetized, draws the spring down, breaking the current which is crossing, through an adjustment screw to the spring. Breaking this current, it breaks the line of force at both places, the master vibrator and the unvibrating coil. Again, breaking the line of force at the unvibrating coil, it creates a high tension current in the secondary winding. This high tension current passes out over the red wire in the direction the arrow points to the spark plug and passes across the frame of the motor over to the ground wire, No. 15, in the same direction the arrow is pointing. It returns back over the high tension return wire to No. 16, where it returns back into the coil where it started from. As this takes place, you will find that the cylinder at No. 14 fires down. As it does so, your No. 4 passes down with it. Your

No. 2 and 3 come up. No. 1 fires down on power stroke and No. 2 came up at the same time exhausting, while No. 3 came up compressing and No. 4 went down taking in a charge. While this is taking place the timer moved from the point it occupied on to the next point, and the circuit was closed again, while the current flowed at once from the battery to the master vibrator and across the feed line again, this time passing through No. 3 coil.

The next point will be connected to No. 3, since the current would pass through that coil and from thence over the frame of the motor it would return back to the batteries from whence it started, the same as the other current has done. The same thing takes effect. The lines of force are created while the current is passing over these primary windings. The spring is drawn down by the magnetized core, breaking the current, and breaking the line of force, creating a high tension current that passes over the coil it is passing through at that time to the cylinder in which the high tension wire is connected.

As No. 3 cylinder fires down, it brings 1 and 4 up. This time No. 4 comes up on compression and No. 2 goes down taking in a charge, while No. 3 goes down on power stroke and No. 1 comes up exhausting. As No. 4 reaches compression, the timer has moved to the next point and it has closed a circuit as you now see it closed on the No. 4 point.

As this circuit is closed the current flows again passing over the feed line the same, only passing through No. 4 coil and from thence it goes to the terminal in which it is making at this time. There it feeds across to the contact-maker which is connected to the shaft and over the frame of the motor your current returns back to the ground wire where it returns back to the batteries from which it started. The same thing takes place. The high tension current is created from the breaking of the line of force, which passes out to No. 4 spark plug and returns back over the high tension return wire, 15, where it started from. This causes No. 4 cylinder to fire down, bringing 2 and 3 up. No. 1 goes down with it taking in a charge as No. 2 comes up on compression and No. 3 comes up exhausting. You will find when No. 2 reaches compression stroke the timer has moved to the next point, in which it closes the circuit again over the primary line. This current passing through the master vibrator again, passes across this time to No. 2 coil. There it passes through the primary winding and passes through the timer where it returns back over the frame of the motor to the ground wire across to No. 10 where it crosses the switch to No. 11 and returns back to the batteries, No. 12, where it started.

You will notice that this current while passing through creates a line of force at both places, the master vibrator and the unvibrating coil, which current is broken at the master vibrator, breaking the line of force at the unvibrating coil, No. 2, creating a high tension current in the secondary

winding that passes out to the spark plug and returns back over the frame of the motor to the ground wire, 15, where it returns back to the secondary winding where it started from.

As this causes No. 2 cylinder to fire down, you will find that No. 2 and No. 3 pass down together, taking in a charge. No. 3 and No. 1 come up compressing, and 4 comes up exhausting. As No. 1 reaches compression stroke dead center again, you will find that the timer is back to the same point that it started from. This has completed a cycle as each one of these cylinders has done four duties and they are back to the same point of starting and are ready to start the same duties over again.

Troubles of No. 25 and How to Locate Them

If you should be driving along and should drive up to a place to stop and should find when you threw off your switch that your motor kept on running, the trouble would be that the wire connected at terminal No. 11 to the battery and terminal No. 12 would be shorted, or the wire connected at the terminal across from No. 11 would be disconnected and it would be impossible to close a circuit. The thing to do is to short circuit the magneto, since a high tension magneto has got to be short circuited in order to stop it.

Should you hear a continual buzz coming from your vibrator, and at the same time find that you had no spark, the trouble would be that the terminal No. 4 wire leading to terminal No. 5 would be shorted in some way, causing continual current to flow over this wire through the ground wire, No. 9.

Should you have a continual buzz of the vibrator and back firing through the carburetor, the trouble would be that there would be a short in your timer, or the wires connecting to the timer, which causes a continual flow of current, and this would ignite the gas at the moment it reached the cylinder.

Or again, should you be driving along and your car should stop suddenly, by trying to start it, you would learn at once that the car would not go; or should you notice that your vibrator wouldn't even hum, then you must look at your batteries. Finding them all wired up and in good shape, you would begin to wonder if you couldn't start it on the mag. Finding that you couldn't do so, you would make up your mind that your trouble is in the ground wire from No. 10 to No. 9. This wire is disconnected and you will find that neither system will give you a spark.

Should you find that you had one of your cylinders missing, the proper way of locating this trouble is to first see that you have got a compression.

Finding that the compression is good, your trouble then is either in the coil or in the spark plug. By examining the spark plug, if you do not find it dirty or the porcelain cracked, you may then go to work and see if your trouble is not in your coil. This can be done easily by changing this coil to the place of another and placing the other one in the place of this one. Finding this coil will not work in the other place and the one put in its place will work, you make up your mind your coil is broken down. The way to fix this coil is to replace it with a new one.

Should you find you have a spark, compression and gasoline, and the motor will not run, you will ascertain that this trouble can be located by priming the cylinders as I have already explained to you. If the gas which you place in the cylinders will ignite, your trouble is in the gasoline system; but should it not, you will know that the trouble in this system lies between the batteries and the terminal No. 2 and the ground wire. This trouble may be weak batteries, loose connections or slight short, in which part of your current passes through the coil and part of it passes back. The amount of current that is passing through the coil does not produce a line of force heavy enough so that when it is broken creates a current high enough to ignite the gas under the compression the gasoline engine goes.

The Uno Sparker

The next system which I shall describe to you will be found in Figure 26. The Uno Sparker will easily be remembered. If a person asks you what it is, you may tell him "Uno."

The Uno Sparker is a system which you will find is not used on many cars, but is a very good system, as it gives you absolutely the same spark on each and every cylinder.

You will notice that this system has but one coil, which is a single coil and also an induction coil, that does its own work all the way through. The system is very simple as there is not a great deal of wiring to it. It is very easy to keep up under those conditions. You will not have a lot of wires to become oil-soaked or to cause broken insulation.

The Uno Sparker can be seen in the above view as it is taken apart. The green view is the timer. The black one, which is in the center with the three holes, is to represent a fibre plat that is placed in between the timer and the distributer. The distributer is the case in which you see the red and black marks, the red marks being the contact points and the dark marks are supposed to be solid rubber, which distributer itself is a solid rubber case. There is no chance for the high tension current to pass any other

way but in the direction that it should go through this distributer case. The red hand which you see in the center with the black dot in the center of it is the distributer brush that wipes upon the four points round the outer edge of this case.

This distributer and timer are combined together as both are given off of the same shaft, which as it appears in the view is green. This, though, is arranged so that the high tension current cannot interfere with the shaft. When it first enters the distributer and passes to distributer brush there is a solid rubber cap which slips over the shaft. The high tension current feeding in from the top cannot pass through this solid rubber cap whatever, but has got to pass across to the contact points where it leaves the distributer over the high tension wires, going to the spark plugs where it returns back over the frame of the motor to the shaft and then on back through the timer over the green wire, from whence it returns back to the secondary winding.

This system shows you two sets of batteries hooked on the coil. We do not use both sets at once; but either one of these sets of batteries can be used at any time you desire. Should one set of batteries become weak and they would not operate this system, you could switch across to your other set and use them, allowing the set that is not in use to rest. After resting for 12 or 14 hours, or during the night, you will find by turning them on again in the morning when you start you can get an hour or two hours work out them before they become so weak they begin to give you trouble. This way you can entirely exhaust a set of batteries.

It isn't necessary that you must have dry cells on this system. You can either use storage batteries or use a generator. Any ignition system which will supply you current can be used on this system as well as any other.

We shall go to work and explain how to wire up this system and set the timer and distributer the same as the other systems. Concerning the distributer it must be known and understood that this system is the system which distributes high tension current from one spark plug to another as the motor should fire.

The first thing to do in coming to this motor is to find out the way your motor fires. You do this by watching your No. 1 exhaust valve open and close, and then watch 2 and 3. Should No. 3 operate next, you will find that the motor fires 1, 3, 4, 2. But if No. 2 operates next, you will find that the motor fires 1, 2, 4, 3. This you can easily remember. The next thing to do is to find compression stroke dead center. You do that by watching the exhaust valve open and close on No. 4 cylinder, and then getting dead center mark even with the center of the cylinder and this gives you compression stroke on No. 1. Or, you can watch the exhaust valve

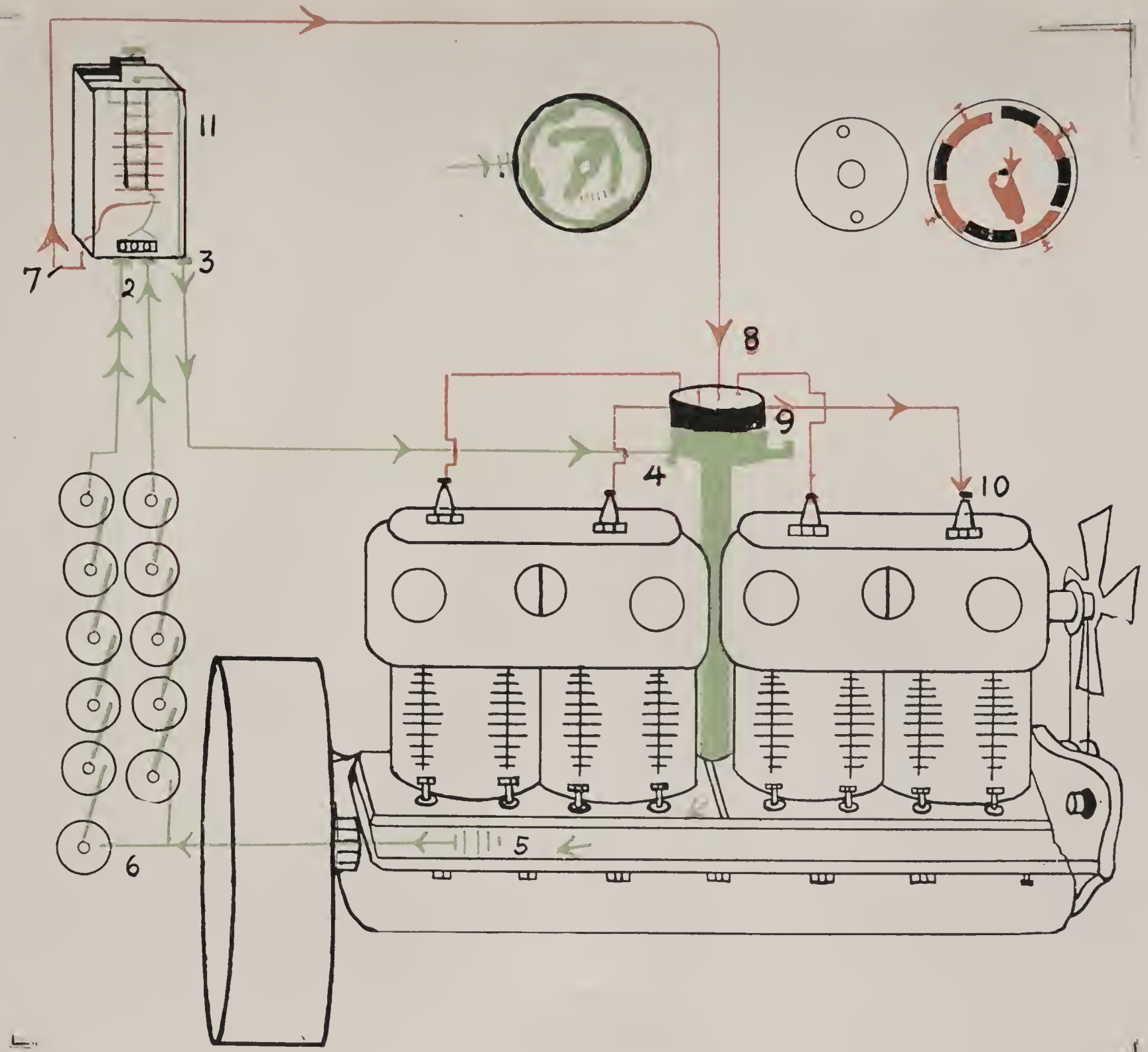


FIG. 26. UNO SPARKER.

open and close on No. 1, and then turn your fly wheel one complete revolution and it will give you compression stroke dead center on No. 1 cylinder. After doing this you are ready to set your Uno Sparker.

Set the timer the same as any other timer so that it is just ready to make contact with one of the points while the timer is fully retarded. Then place the fiber lid over the top. Next place your distributer brush through the center hole which fastens to the shaft. This cannot be put on wrong, as it will only go in one way; but after placing it on, notice exactly the direction in which the brush is pointing and then place the distributer over the top of it. As you have observed the way the brush is pointing, you will find it is pointing in the direction of one of the terminals on the distributer. This terminal is No. 1. The next one is No. 2, in the direction that the distributer hand turns. The next is 3 and 4, so on in rotation. Wire No. 1 points to No. 1 cylinder. Wire the next point to the next cylinder that fires. As this cylinder fires 1, 3, 4, 2, you will notice the next point No. 2 is wired to No. 3; No. 3 is wired to No. 4; and No. 4 is wired to No. 2, making the motor fire 1, 3, 4, 2.

You are now ready to connect the rest of the wires. The high tension wires which lead from the terminal No. 7 of your coil must be connected to the central terminal of the distributer No. 8. Then you will connect your batteries and feed line. Connect the end of the batteries at No. 6 to the ground No. 5. The other end of the batteries to which the primary wires are connected must be connected to the switch terminals at No. 2. Your No. 3 terminal is the lone terminal off by itself which must be connected to No. 4 terminal at the timer. This you will now find is wired up ready for the current to pass over. The current will leave the batteries when the switch is placed in. Passing from the batteries through the switch, it passes over the primary wire which is the green wire through the adjustment screw, across the spring down over the primary feed line, No. 3, to No. 4, where it passes down through the shaft and the frame of the motor, running over to the ground wire, No. 5, and running back to the batteries, No. 6, from which it started.

While this current is passing through the coil, it creates a line of force, drawing the spring down and breaking the current. It breaks the line of force and creates a high tension current in the secondary winding that passes out over the red wire at the terminal No. 7 and passes over the wiring in the direction the arrow is pointing to terminal No. 8. There it crosses over your distributer brush to terminal No. 9 where it passes from this terminal to No. 10, the spark plug, whence it returns from this over the frame of the mtoor to the green shaft. There it passes up over the green shaft into the contact-maker in the timer, whence it passes out over the green wire and returns up to the terminal, No. 3, passing up to No. 11,

where you will notice the primary wire and secondary wire are connected together. There it returns back into the secondary winding, where it started from.

The same thing takes place on this system that takes places on the others as far as the operation of the motor—first No. 1 operating, then No. 3, then No. 4 and then No. 2.

At each time the current flows through this coil, you will find that there is a line of force created. A high tension current is produced from the breaking of the lines of force and passes to the center of the distributer at No. 8. There it is carried off first to the No. 1 point, which you will find is marked 9 to 10, and from this the next time it will pass to No. 2, for the high tension current will be carried to the center of the distributer and distributed off to the next point, and so on around. As these points come in rotation, you must make a change from your distributer to your spark plugs carrying your current to your cylinders according to the way the cylinder fires.

Troubles of the Uno Sparker

Should you have any trouble on a Uno Sparker, you will discover that it is very easy to locate the trouble, provided you remember the sounds which you receive from your motor during the time it is stopping. You will find there exists a continual buzz from this system, and the motor will stop running at once, causing back firing in the carburetor while it is stopping. This trouble will be located between terminal No. 3 and terminal No. 4, at the timer or in the timer, which is a short. This causes a continual flow of current to be carried to each and every cylinder. Every time that the gas is being drawn into the cylinder, the gas is ignited too early and will cause the motor to choke down, backfire and stop. Hearing that your coil is continually buzzing, you will know where the trouble is at once.

Should you get a current off of two plugs at the same time, you will find that it will cause misfiring. This trouble is caused from dirt gathering in the distributer and shorting from one point to another, making the high tension current to pass out over two terminals at once. This can be removed very easily by taking the distributer off and washing it out. This trouble, though, seldomly happens.

Should you be driving along and your motor stops suddenly, not even a sound being heard from it, you will find that the high tension wire has come off of the center of the distributer at No. 8, from which the high tension current has no place to return back over the frame of the motor,

and yet it does so. But the high tension current not now being carried to the plugs will cause no mor explosions after the instant it leaves its terminal.

You will find that if your ground wire was to come off and land in the clear where it could not touch the frame of the motor whatever, the motor would stop at once. But if it didn't, if your batteries would disconnect, or it may be, cause the motor to miss while it is shaking round over the frame of the motor until it has come to some point of grease or far enough away from the motor until the motor once stops, it is then impossible to start the motor again until it is connected. This trouble can be located by going to your batteries and seeing if you have got a good spark. Close your circuit at the batteries. Finding your batteries are strong and in good shape, then go to work and turn your timer so it stands on contact and see if you get a buzz. If not, you will find that the trouble must be your ground wire is disconnected, or the wire leading from the batteries to the switch.

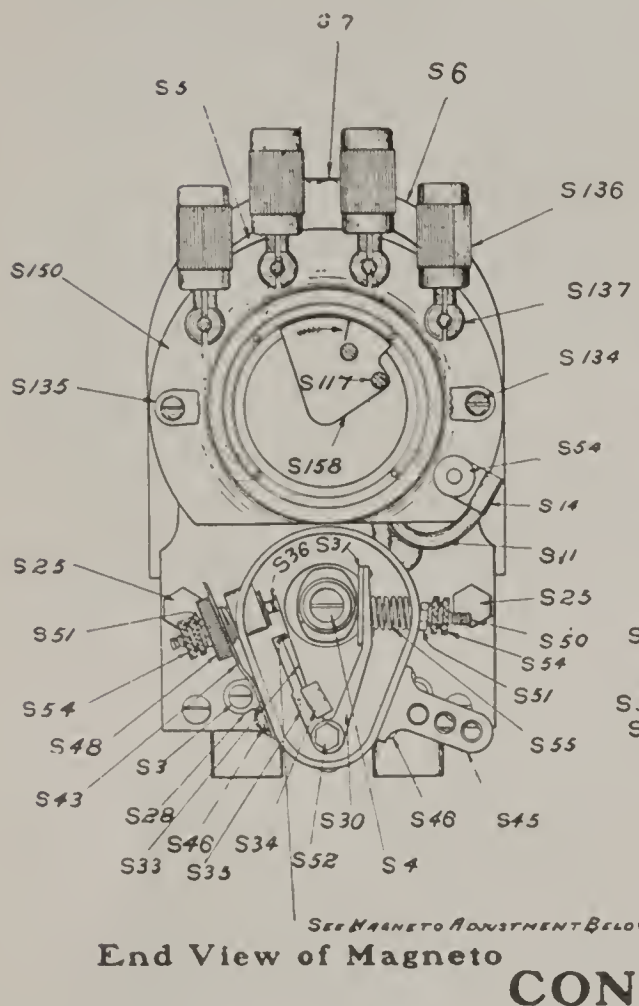
If these batteries become weak, or even loose connections, or oil-soaked wire, or broken insulation at their connections will cause the same trouble as that on the other systems we have gone over, in which you will have compression, spark and gas, but the motor will not run. The trouble can be located by priming the cylinders to see whether the spark is hot enough to ignite the gas, knowing first, of course, that you have got gas in the cylinders.

Magneto

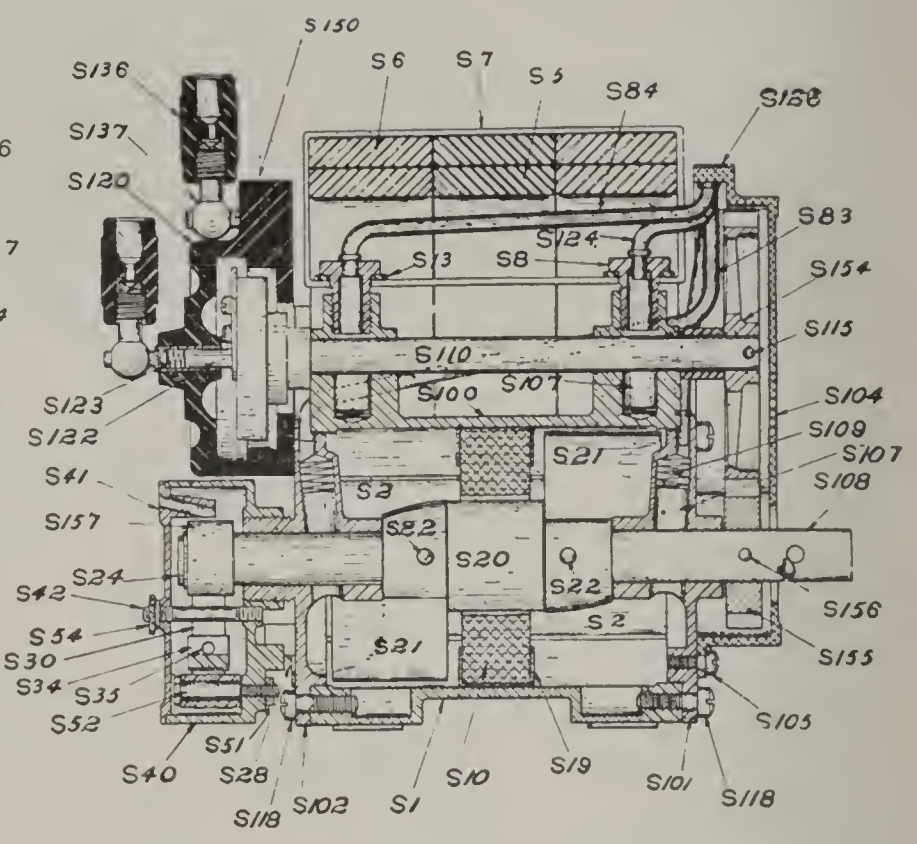
Having finished the vibrating coils, we next take up the magneto. The magneto system runs a little bit different from the systems which we have been working over, although you will find that the Uno Sparker, as far as distributing the high tension current is concerned, distributes it just exactly the same as it does on the magneto. The new principles that we have to take up is adding to what you have gone over.

If you study carefully at the beginning, getting the principle of your motor and the principle of the wiring systems as far as you have gone, you will find that you have got the principle of these systems as far as finding out the way the motor fires and finding the compression stroke dead center. This has got to be done the same on any ignition system that may be used on a gasoline engine.

In taking up the magneto it is really necessary to understand how the current is generated in a magneto. You will discover that the magneto



End View of Magneto



Longitudinal Section of Magneto

CONSTRUCTION

S40—Timer Housing for left hand Magneto
S40½—Timer Housing for right hand Magneto
S41—Timer Housing Lid
S25—Hex. Cap Screw
S43—Insulated Screw Clip
S42—Timer Lid Stud
S30—Cam Lever, with hardened steel plate No. S31
S52—Timer Lever Shaft
S55—Lever Coil Spring
S33—Contact Spring, with platinum point No. S36
S34—Cam Lever Spring Block
S35—Cam Lever Spring Block Screw
S48—Contact Screw Insulation, with contact screw No. S47 and platinum point No. S36
S50—Ground Screw
S51—Ground Screw Nut
S54—Binding Nut
S57—Cam for 4 or 6 cylinders (No. S184 for 1, 2 or 3 cylinders)
S 23—Cam Pin
S 24—Cam Plate
S 4—Inductor Shaft Screw
S 45—Timer Shifting Lever
S 46—Shifting Lever Screw
S 49—Shifting Lever Lock Washers
S154—Large Gear for 4 cylinders (No. S174 for 3 or 6 cylinders)
S155—Small Gear for 4 cylinders (No. S175 for 3 or 6 cylinders)
S115—Large Gear Pin
S156—Small Gear Pin
S150—Distributer Case for 4 cylinders (No. S170 for 6 cylinders)
S116—Spacing Collar
S137—Secondary Terminal
S136—Secondary Terminal Insulation
S134—Distributer Lid Spring Screws
S135—Distributer Lid Springs
S133—Distributer Bolts
S120—Distributer Lid with brush-holder No. S121
S122—Carbon Brush
S123—Carbon Brush Spring
S158—Segment
S110—Distributer Shaft with Disc
S101—Drive End Bearing for 3, 4 or 6 cylinders. (No. S185 for 1 or 2 cylinders)
S102—Timer End Bearing for 3, 4 or 6 cylinders. (No. S186 for 1 or 2 cylinders)
S126—Oiler Name Plate
S 83—Long Oiler Tube
S 81—Oil Wick
S109—Wick Spring
S118—End Bearing Screws
S104—Gear Case
S105—Gear Case Screws
S 28—Timer Stop
S 3—Timer Stop Screws
S 5—Inside Magnet
S 6—Outside Magnet
S 7—Magnet Clamp Strap
S 8—Magnet Clamp Strap Screws
S 13—Lock Washer for S8

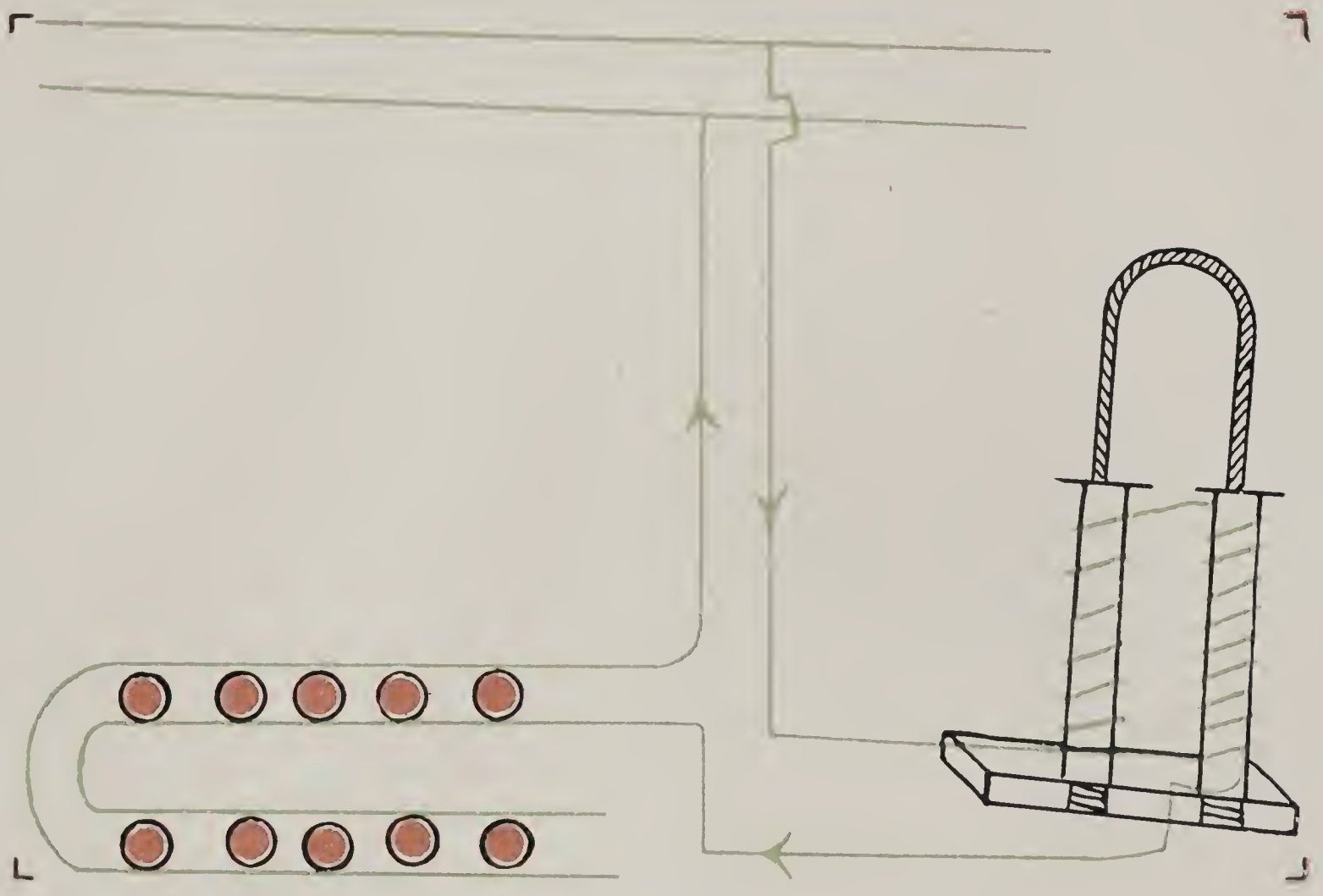


FIG. 38. MAGNET CHARGER.

has magnets which have been magnetized by a line of force passing through the iron bar. These iron bars which are bent in a U-shape and made of steel, contain their magnetism. Any soft metal which is nealed (meaning that it is soft material) will not contain magnetism. Such cores as these, you will find used on vibrating or on unvibrating coils, or any coil that is used for induction coils. The steel magnets which are used upon a magneto must be magnetized whenever they become weak; hence it is necessary that you should know the principle of re-magnetizing the magnets themselves.

As you will study this view over carefully, which is set forth in Figure 38, you will see the principle of magnet bars and how they are made for recharging magnets. This view shows you two bars which should be one and one-half inches thick, and twelve inches long, with an iron washer at each end. You will then wind them with No. 12, double insulated magnet wire. Place twelve windings on each core in the direction you notice the lines are wound from this. One must be wound one way and the other wound the other. This gives you a north and south pole, which winding is then connected to the set of lights wired in parallel as you see them here. These lights, which are 32-candle power, can be wired as you see them, and the switch or connections can be made so that the connections of the line above can be connected at any time, as this line above represents the overhead line of your electric current, since we use a direct current for re-magnetizing a 110. You will find by connecting this up as you see it with the number of winds that I have just mentioned, you will have a pair of magnets that would raise about 600 pounds.

When placing the magnet on the top, as you see it here, turn on the lights one at a time. This will bring your amperage up slowly. Each 32-candle power will give you one amperage. Using 10 lights (you should not use any more than this) gives you 10 amperage. This gives you a heavy enough line of force to fill a magnet of this size winding in a very few minutes.

While this magnet is placed as you see it, then with a brass hammer tap it on the inside and the outside. You will find that at the bottom of these two bars you have a block of iron into which the two are screwed and should be about one inch thick and about four inches wide. This completes your yoke. When this magnet is placed on top and is struck with a brass hammer, it jars the metal of the magnet and allows the pores of the metal to turn in on direction, in which the magnet field will fill up to the top.

The magnet bars after being filled will lift about 25 pounds. When you have a magnet so that it will raise this weight when the current is turned off, you will find that it is as full as you possibly can fill it.

These lights must be turned out one at a time the same as they were turned on before taking your magnet off. By turning them all out at once you are liable to blow fuses, and also liable to burn out your meter. You should use only ten lights at 32-candle power each, as the electric light company is liable to kick if they find you using more than this.

These lines of force that have passed up through the magnet leave it magnetized. Then you have what is called a magnet, and you must understand that you have a line of force which passes from the north pole to the south. This line of force which is passing through must next pass through an armature. You will find the magnets of a magneto must be set on in parallel; that is, the north pole must all be placed on one side, and the south pole must be all placed on one side. This puts the line of force then from north to south. You may ask, "Why?" If you were to put a south pole to a north pole, you will find that you would have a line of force passing round the loop and not passing across. It would pass from the north to the south and back up over the top of the magnet through to the north and back to the south and back over again, and *vice versa*. The line of force working in that way would do you no good. It would be impossible for you to generate a current.

As I have told you in the other systems, we must break the lines of force before we can create a high tension current or create any current at all. Therefore, by placing the north poles all on one side and the south poles all on the other, you will have the line of force passing through the armatures. Then you will find you have a winding made on the armature which this line of force is passing through. While the armature is running at a high rate of speed, it will cut the lines of force and cause a low current to start in this winding, that is, through the breaking or cutting of the lines of force by the armature. Otherwise, if your lines of force were not passing across this armature, you would not have any way of cutting your lines of force, and for that reason you would have no way of starting another current.

A very simple way of telling whether you have your magnets placed on your magneto right or not, is, before placing them on, to place the points of them together. If they lapel against each other they are right, as you will find the north pole will lapel against the north pole and the south pole will lapel against the south pole. When you have them placed together wrong, they will attract, drawing together and sticking tight, and it will be hard to pull them apart. In this instance you have them together wrong and they would not work if placed on your magneto in this way. Another way that you could tell is by taking a small compass. The needle that always points to the north will point to your north pole, and the other end of the needle points to the south pole. In this way you can find which

is north and which is south. By placing all the "norths" on one side and setting them in the magneto you have them so that they will do their work properly.

Another caution: do not set a magneto on iron. It must be set on some non-conductor such as aluminum, fibre, brass, copper, or something of that sort which cannot be magnetized. You may ask, "Why?" For the simple reason, as I hinted to you a few minutes ago, you will find that your lines of force from your magnet bars, instead of passing through your armature, will pass down through this iron below. Passing through the iron below, it is not passing through the armature and for that reason cannot be cut or broken. If you don't break your lines of force you cannot create a current, so by placing it on some non-conductor you will find your lines of force will pass through your armature, and therefore, it will be broken and produce you another current.

All systems that generate a current such as used on a gasoline engine work on the same principle. The generator, the low tension magneto and the high tension magneto, all generate their currents the same. The only difference is that a low tension magneto feeds through a coil box of its own. A high tension magneto has a double winding on its armatures and generates a high tension current from the mag itself.

The Remy Magneto

As I now believe you understand the way the current is started in a generator magneto, I can take you to the view of the Remy magneto, Figure 27, in which I will be able to explain the principle of this without any trouble.

The Remy system shows you a system that is made a great deal different than the most of the systems; but its working principle is absolutely the same, since it comes under Seldom's patents. All ignition systems, you will find, that were made under Seldom's patents, work on the same principles. The Ford magneto is the only magneto made that doesn't come under the Seldom's patents, and it is a magneto in the fly wheel.

The system shown here has a stationary winding at Figure No. 9. This winding does not revolve, but stands still and has two drop forged cups that revolve by the winding, throwing the lines of force in one direction and then the other. This cutting the lines of force first one way and then the other, causes a low current to start in this winding that passes out through the coil and returns back again from whence it started.

You will next notice that the terminal No. 6 shows you a fiber screw in which the current has got to pass over both system through this screw. The wire which is connected here, you will see is green; but it should be yellow wire, as below it is marked "yellow." That point is called the interrupter. The No. 4 terminal is a side in which the breaker-arm is wiping against the cam, that is called the brush. At this terminal you will find that a red wire connects to this, and is also the longest wire coming from the stationary winding of the armature.

You will find that terminal No. 12 is the ground terminal. The short wire from your coil of the magneto is connected to this terminal, and your green wire from the coil box. The large wire which you see, No. 14, is the high tension wire, which is connected to the center of the distributer, No. 15.

You will find that No. 13 shows you the secondary winding off to one side. This winding belongs over the top of the other winding, No. 7.

At No. 3 you will see the switch where the circuit is closed from the battery, or the magneto system. The batteries are connected to two small black wires leading from this coil box, from which you will find all the wires coming from this coil box where all the primary wires come out together.

You will find that to take a magneto and put it together, if it has been taken apart and the gears have been taken off, it is necessary that a person should know how to time a magneto in itself. Set the distributer of the Remy so that the heel of the distributer is even with the segment, No. 16, as you see here in the view. Then set the holes in the armature shaft straight across and slip your gears on. This will time this magneto in itself.

I have figured out a way of timing all magnetos in themselves. You will learn all factories that make them have their own way in timing magnetos in themselves; but the way I use will work on any magneto. This is done by setting the interrupter so that it will break the sixteenth of an inch when fully broken—that is, so that the cam has got the breaker thrown over as far as it possibly will go. Then screw your adjustment screw in or out until the distance between the points of breaking is a sixteenth of an inch. Next turn it back until the two points come together with the interrupter fully retarded so that it is just ready to break in the direction that it should run. Then set your distributer plate so it sets one-third on the contact point where the high tension current feeds off to feed to the spark plug. Then, by slipping the gears on, you will find you have the magneto, for all magnetos in this way will time in themselves.

Now, to set this magneto on the car. The first thing to do, as I have told you, is to find out the way your motor fires, then find compression stroke dead center on No. 1 cylinder. To set this magneto on the car, set

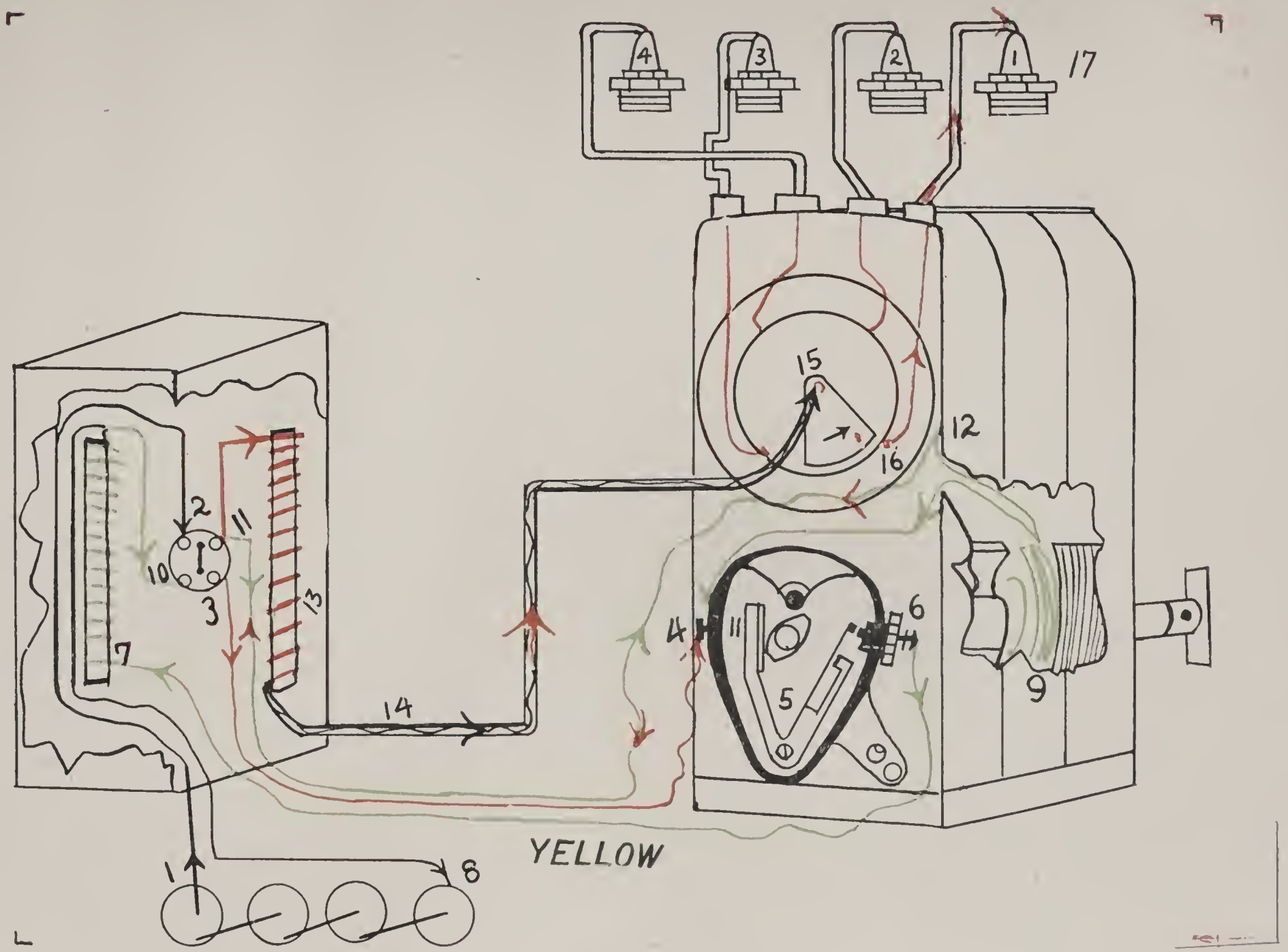


FIG. 27. REMY MAGNETO.

the distributer so it sets one-third upon one of the bottom points in the direction that it turns. If the armature runs clockwise, the distributer will run anti-clockwise, as shown here. Set the little red dot on the distributer plate even with the contact point, No. 16, with the interrupter fully retarded and just ready to break. Place the magneto on the car. Fasten it so it cannot turn from this position and then you are ready to start to wire up. Fasten your green wire to the ground, No. 12; also, the short wire from the primary coil of the magneto. Fasten the long wire from the coil of the magneto to terminal No. 4, which is the brush. Fasten the red wire to the brush. Fasten the yellow wire to the interrupter, No. 6. Fasten the two little black wires to your batteries. Then wire these batteries in series, since it makes no difference which end is fastened to which.

Be sure and not use over four batteries on this system, as you will find that four does the work, and four is all you need, and you do not lengthen the life of the battery by putting on more. In fact, there is a risk in using more than you need, since you take a chance of burning out your coil.

Fasten the large wire, which is the high tension wire, No. 14, to the center of the distributer, No. 15. Then connect your No. 1 point, which you will find at the top as it starts at one side, No. 1, and returns in rotation across.

As this motor fires 1, 2, 4, 3, you will notice No. 1 wired to No. 1 spark plug; that No. 2 is wired to No. 2; No. 3 is wired to No. 4, and No. 4 is wired to No. 3.

We are now ready to trace the current through this system. The current will start when the switch is turned from 2 to 3, closing the circuit across these two terminals. The current passes from No. 1 over the black wire to No. 2, across the switch to No. 3, where it passes down over the red wire to the brush, No. 4. There it passes through the breakerarm, No. 5, passing through the interrupter, No. 6. It then passes back over the yellow wire (which here is colored green) where it returns back to No. 7, and returns back through the primary winding to the top of the coil. There it returns back over the black wire to No. 8, and on to the batteries, where it started from.

While this current is passing through, it creates a line of force. At the time this line of force is taking place, you will find that the current is interrupted by passing through the interrupter as the breakerarm is thrown over by the cam. Breaking the current here, it breaks the line of force which is taking place at No. 7. Breaking this line of force, it also creates a high tension current in the secondary winding, No. 13, the red winding. This current passes out over the high tension wire, No. 14, in the direction

you notice the red arrow pointing, where it travels through No. 15 to the center of the distributer, where it passes down to segment, No. 16. Then it passes to the spark plug, No. 1, jumping from the point of the porcelain to the plug, and returns back over the frame of the motor to the magneto to the ground bar, No. 12. From No. 12 it returns back over the green wire to terminal No. 11, where it returns back into the secondary winding from whence it started, No. 13.

As this motor is in motion, you will then throw the switch from the batteries to the magneto, which is done by throwing it from 2 to 3 to 10 and 11, closing the circuit across those two terminals. The current then starts from a line of force being cut in the magneto at the winding at that point, which can be seen at No. 9.

This current passes out over the long green wire at No. 4 to the brush. Passing through the breakerarm, No. 5, it goes on through the interrupter, No. 6. There it passes over the yellow wire (which is green here) to the terminal winding No. 7. Passing to the top, it returns down over the green wire to 10 and across the switch to No. 11. From No. 11 it returns over the green wire to the ground, No. 12, whence it returns back into the coil from which it started.

As the current is passing through it creates a line of force and is also broken while passing through the interrupter. This current being broken, breaks the line of force which is taking place through the primary winding at No. 7, and creates a high tension current in the secondary winding at No. 13, which passes out over the high tension wire, No. 14, to the center of the distributer, No. 15. There it passes to the segment in which the distributer is on at that time. Passing to the spark plug, it returns back over the frame of the motor to the magneto, then to the second wire, No. 12, from which it returns to the secondary winding, No. 13, from which it started.

Troubles of the Remy System

Should you be driving along, stop your car, come out and undertaking to start it again and find that it would not go, you would naturally look first to see if your batteries were disconnected, since you always start on the batteries. Finding your batteries not disconnected and that they test up all right, you will discover that the trouble is with your brush wire, which is the red wire connected to No. 4 terminal. This wire will be either disconnected or broken, since this wire often breaks in two at the time of the advancing and retarding of the spark.

Should your car stop and you should be unable to receive a spark from the system, and you find your batteries are connected, and testing all right, the trouble will be that the yellow wire, which is the interrupter wire, connected to terminal No. 6, is broken or disconnected, or that the ground wire (green wire connected to No. 12) may be disconnected.

If the red wire and yellow wire were to become oil soaked so that they would short across, your current from the batteries would flow all right, but you would not receive a high tension current, as the current could not be broken, and, therefore, not beaking the line of force it is impossible to produce a high tension current.

If you should be driving along and your car should stop, and you should get out and turn the switch on the batteries, crank it and it would start all right, but when you turned the switch on the magneto the car would stop again, the trouble would be that the long wire from the magneto coil would be broken.

Should you be driving along and your car stop suddenly, and you did not hear any explosion coming from it, the trouble would be that the high tension wire has dropped off. You can locate this at the moment you go to find it whether you have a spark or not. The proper way of finding the spark is to take off the high tension wire from the center of the distributer. Hold it about one-thirty-second of an inch from the frame of the motor, and then press your tickler, and you will see a spark leap from the end of the high tension wire, providing everything is in working order. In case that this wire has come off and you were to look to see if you had a spark you would find your wire was off.

Should the magnets become weak on this magneto it can be told by placing a small screw near to No. 8, and if it will not attract to the magnet tight enough to hold it your magnets are weak and need remagnetizing.

Sometimes you will find that your spark is missing. By looking the car carefully over, it will seem that everything is in perfect shape, such as the spark plugs, the timing and the valve timing, and yet you cannot adjust the carburetor so it will hit whatever, although your pipe line is clear. Upon close examination you will find that the trouble is very apt to be that you have a dirty magneto. The only thing to do is to wash out the magneto, and this can be done in a bucket of gasoline. By plunging this magneto into gasoline, you will remove the grease and dirt which is causing a short in the magneto somewhere.

Should the wires on the Remy magneto become so greasy and dirty that the colors could not be told apart, there is a way in which you can test out these wires to tell one from the other. For instance, take off your batteries. Twist the two battery wires, which are black wires, marked No. 1 and No. 8, together. Then turn the switch upon the batteries. Strike

your wires on the batteries, one wire on the zinc terminal, the other one the carbon terminal, until you receive a spark. The two wires that spark together are the interrupter and brush wire. Finding these two wires, you know that the other one is the ground wire, but as yet you are not able to tell which is the interrupter and which is the brush wire. Now turn the switch on the magneto. Place the ground wire on the zinc and strike one of the other wires on the carbon until you find the one that will spark with the ground wire. This wire is the interrupter wire. The other one must be the brush wire.

Sometimes you will find that the little steel plate the cam rubs against, which is fastened to the breakerarm, No. 5, becomes worn out so that when the cam comes over against it it doesn't break the interrupter far enough apart. This must be replaced with a new one, as the interrupter should break as far as possible, at least one-sixteenth of an inch.

Again, you will find that your platinum points become pitted. If so, it will be necessary that you take a very fine file and dress them off until they are perfectly smooth, and then reset these points so that they are just ready to break when the distributer sets one-third on, the spark being fully retarded.

The Splitdorf Magneto

The next view we take up is the Splitdorf magneto, which you will find at figure 28. This system you will find is somewhat different from the majority of ignition systems, especially in the way the current travels over, and will be found a very hard system to get anywhere. This system, you will find, gives a great deal of trouble. The majority of people do not understand where the trouble is often, caused almost always by not understanding the principle of the Splitdorf.

The system has terminals in place of colored wires, but we have here the wire colored so that it makes it easier for you to trace the current through it. You will find the trouble with this system is that it shorts out through the batteries. You will also have more or less trouble inside of the coil, due to its connections inside. After understanding this thoroughly, there is no reason that a person should have any trouble in locating the troubles of the Splitdorf.

First, in place of having a stationary winding on the armature of this system, we have a winding which is made on the armature and revolves with it. You will find the lines of force passing through the armature are passing through the winding. While passing through the winding, the

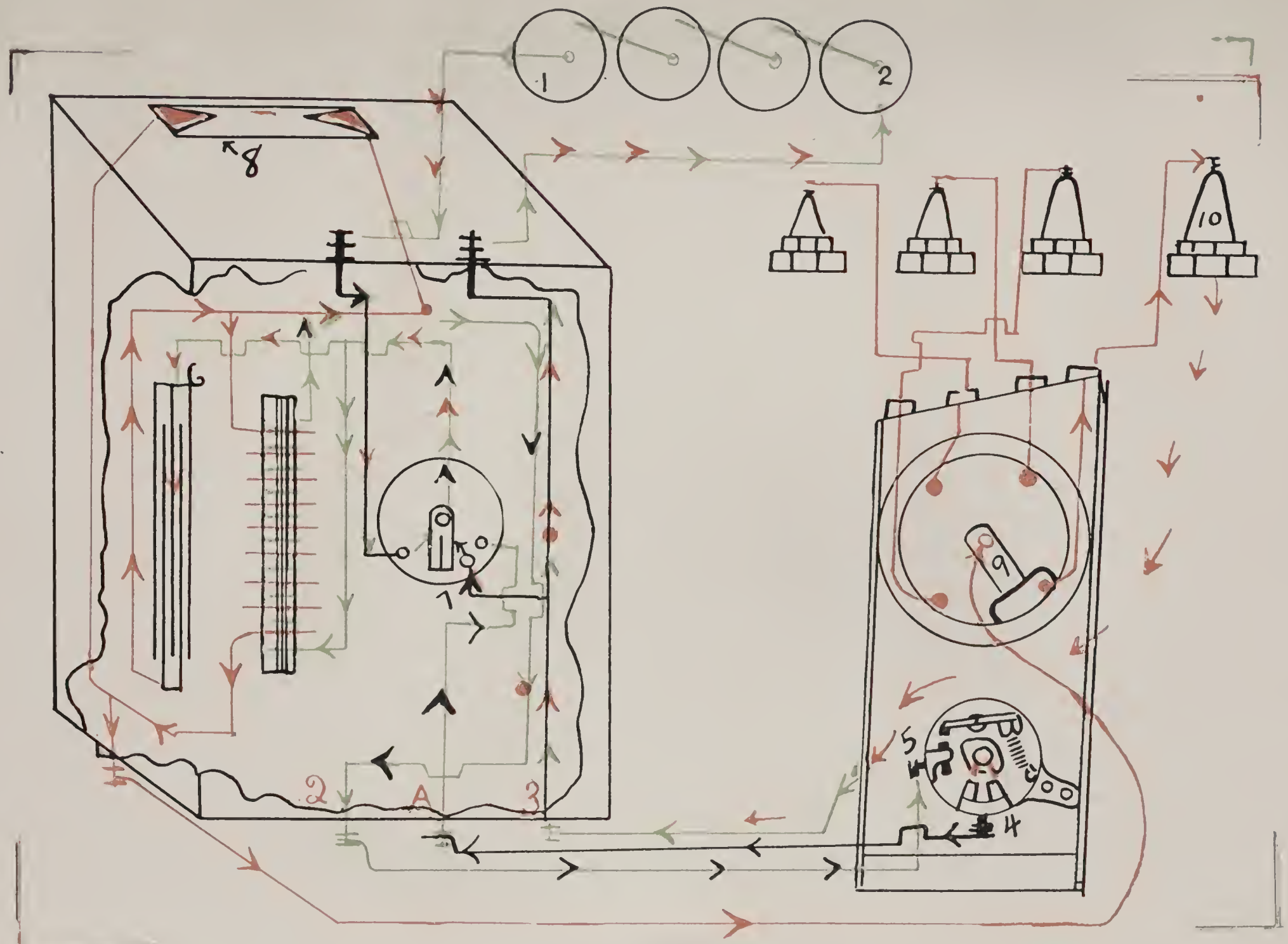


FIG. 28. SPLITDORF MAGNETO.

armature, revolving at a high rate of speed, cuts the lines of force and causes a low current to start over the winding. You will also notice that this current feeds up through the center of the shaft. At the piece of steel on the end you will find two brushes wiping against it, where the current is carried from thence over brushes through terminal No. 4. This point is insulated so that the current must pass through this terminal and cannot go in any other direction. You will find, also, in turning back, the current must pass through the terminal No. 5, in which this is the interrupter, as the current is broken at this place. This is also insulated, and the currents from both systems, the battery and magneto, must pass through this point.

You will find the batteries are connected at the top of the coil, where you will locate two terminals. Also, you will notice that you have at the top at No. 8 a jump gap which the high tension current jumps across, provided the high tension wire comes off. In case the high tension wire comes off, the high tension current must go some place. You will find that the high tension current, in place of going into the winding, and causing harm by burning clear out or breaking it down, passes over the jump gap where it has taken the same course it would have taken had it gone through a spark plug, and then returns to its point of starting.

This system is a little bit different from the Remy as far as timing the magneto in itself, such as the factory times them. This magneto, to time it in itself as it is done at the factory, you must set the distributer so it sets between the two brushes. Then set the cam so it sets straight crossways, slip the gears on, and you will find this magneto will be timed in itself. This is so constructed that the distributer will work with the interrupter, or they both will work together, doing their work at the time they should.

To set this magneto on the car is different from timing it in itself. You must always remember the first thing to do is to find the way the motor fires, which you now understand from the other facts you have gone over. Then find compression stroke dead center, which is done the same way as on the others. Then set your distributer just ready to break when the interrupter is fully retarded. Next set the magneto in its place, fastening it while the No. 1 cylinder is on compression stroke dead center, and then you are ready to start to wiring up. You wire your high tension wires to the spark plug, according to the way the motor fires, as shown by the red wires. No. 1, you will notice, where the distributer is set, leads to No. 1 spark plugs. You will find that No. 2 leads to No. 3, and No. 3 leads to No. 4, and No. 4 leads to No. 2, making it fire, 1, 3, 4, 2. The high tension wire fastens to the center of the distributer, No. 9.

The primary wires leading to your interrupter are numbered. No. 3 goes to ground, as you will notice; A goes to brush, No. 4; No. 2 goes to interrupter, No. 5. The batteries are wired in series, with one end connected to one terminal at the top of the coil and the other is connected to the other terminal. It makes no difference whether 1 is connected where 2 is, and 2 connected where 1 is, it will work just the same.

Now that we have this system wired up, we shall first trace the current as it passes. First turn the switch to the left, where you have but one terminal. The current then starts out from No. 1 at the batteries, feeding to the terminal at the top, where it passes down over the black wire across the switch, up over the green wire, where it returns down to the bottom of the coil. Thence it returns up over the green winding, where it connects on to the red and passes on over to the green. Then it passes down over the green wire to the terminal, No. 2. From No. 2 it passes to terminal No. 5 and passes through the interrupter, across over the frame of the magneto to the green wire, which is the ground wire, back to terminal No. 3. From No. 3 it passes up over this black wire to the terminal at the top of the coil and returns over the green wire to the batteries, No. 2, from which it started.

While this current is passing through, it creates a line of force through the primary winding. At the time the current is passing through the primary winding at No. 5, it is broken. Being broken, the current breaks the line of force at the coil and creates a high tension current in the secondary winding, which is the red winding. Thence it passes down in the direction the arrow points to the bottom terminal. Passing out over the red wire to the center of the distributer, No. 9, it passes down at the point where the brush is on the distributer up to the spark plug, No. 10, where it returns over the frame of the motor to the green ground wire to No. 3 terminal. Thence it passes up over the black wire to the terminal at the top of the box, where it passes over the green wire, in the direction the red arrows are pointing, to the terminal No. 2 of the batteries, where it passes through the batteries back to the terminal No. 1, in the direction the red arrows are pointing, to the terminal at the top of the box. Then it returns down over the black wire across the switch back over the green wire in the direction the red arrows are pointing, where it passes through the condenser, No. 6. Then it passes out at the bottom of the condenser and returns to the top, where it returns into the secondary winding, from which it started.

Now we will turn the switch on the magneto, having traced the battery current through. You will find that the high tension current takes a different course in returning over the magneto system than it does over the battery system. When the switch is turned upon the magneto, it is

turned to the right at the two terminals, closing the circuit on both. The current then starts from the breaking of the lines of force, passing across the magnets. This causes a low current to start in the primary winding of the magneto, passing out at the end of the shaft to the brushes. There it feeds out to terminal No. 4, where it feeds down to the terminal A. From terminal A it feeds up to the switch, feeding across the switch in the direction the black arrows point. It feeds up to the top and then returns to the bottom of the coil, feeding through the primary winding, and back to the top again, where it is connected to the red wire, feeds back over to the green wire, returning in the direction the black arrows point to the bottom terminal, No. 2. Here it feeds over to terminal No. 5 through the interrupter, from which it feeds back inside the magneto, where you will find the other end of the winding on the armature is grounded, returning back into the winding, from which it started.

While this current is passing through the primary winding, it creates a line of force and the line is broken while the current is passing through the interrupter, No. 5. Breaking the lines of force, it creates a high tension current in the secondary winding, which is the red winding, and passing out at the bottom it goes on to the center of the distributer, No. 9. There it passes to the brush on which the distributer is at that time, and thence to the spark plug. Returning over the frame of the motor, it returns to the winding over the ground wire to No. 3, where it passes up over the black wire to the switch, crossing over the switch. It passes over the green wire in the direction the red arrows point, and passes over to the condenser at the top. It then passes down through the condenser in the direction the red arrow is pointing at the center of the condenser, where it returns to the top and back into the secondary winding, from which it started.

You will notice that this current passes over the lines the same way every time the interrupter comes together and is broken. The high tension current starts and passes over the lines in the same way, only passing to different points at the distributer, where it goes to different spark plugs. It returns in the same way, providing it is running on the same system.

In case the high tension wire should come off, you will find that the high tension current takes place, passing out at the bottom of the coil over the red wire, where it passes up to the top to the jump gap, No. 8, from which it jumps across and returns into the secondary winding, where it started from.

In tracing this current over you will find that the green arrows represent the primary current flowing in the direction that it should flow; the red arrows represent the high tension current flowing in the direction

it should flow; the black arrows represent the magneto primary current flowing in the direction it should flow.

Troubles of the Splitdorf System

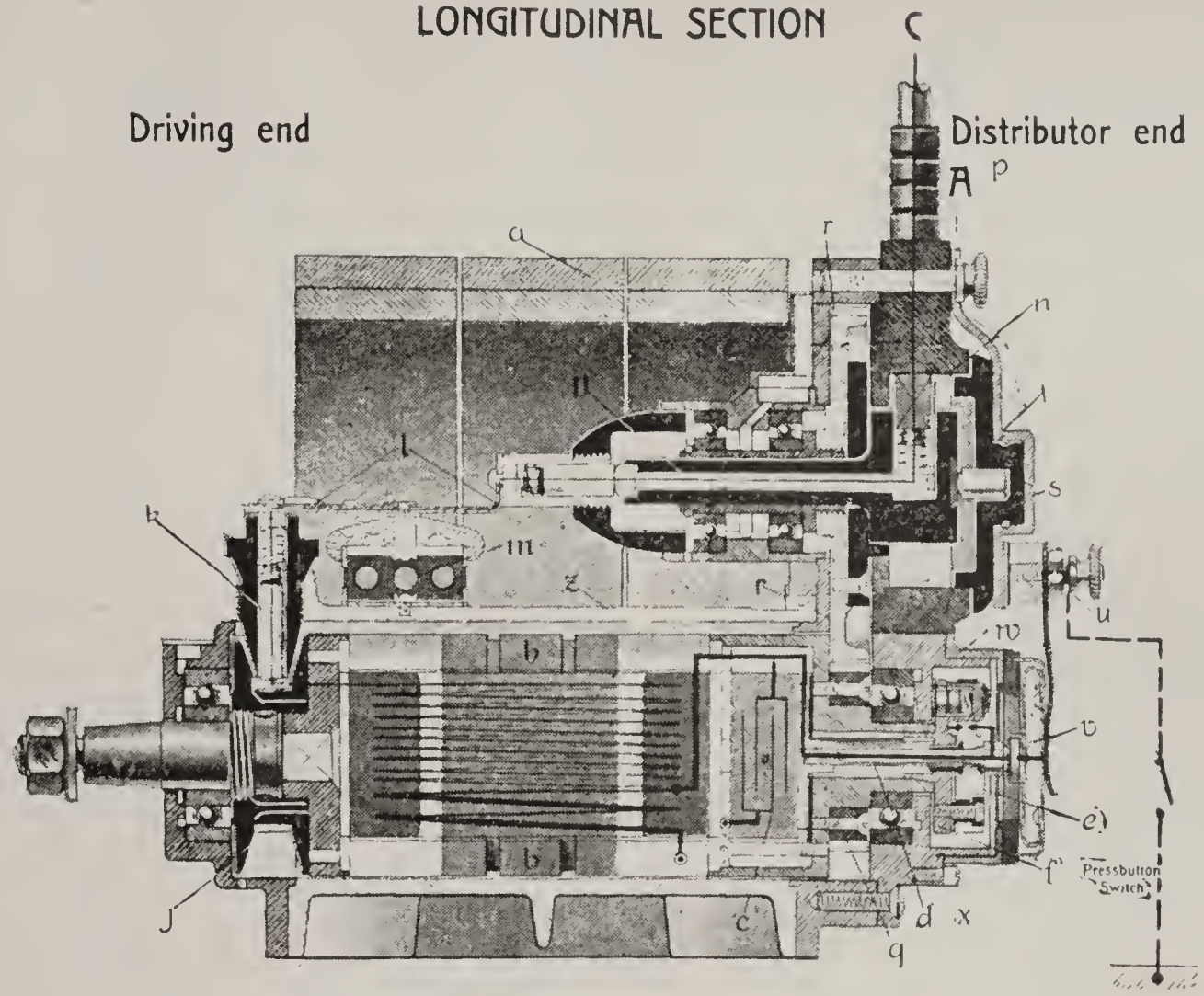
If you find that your batteries run down very quickly, it is caused from running a whole lot on the batteries. You are certain to discover that the batteries will not stand up long if you use them a great deal. Another cause of these batteries becoming run down is because they are placed in an iron box on the side of the running board, which makes connections with the frame of the motor in some way. If the zinc of the battery should happen to come in contact with the metal, the current is at liberty to flow over the frame of the motor to the ground wire, No. 5, where it can pass straight through the coil box to the terminal at the top and run back to No. 2. That causes a continual flow of current that causes the batteries to become run down. Sometimes it is caused from the two wires fastening to the terminals at the top being twisted together and becoming oil soaked, allowing the current to flow and thus running down the batteries.

Should you be driving along the road and find your car stops, and the car should run on the batteries but would not run on the magneto, the chances are that your brushes are worn out. The Splitdorf will run on the batteries without brushes, but will not run on the magneto. If your ground wire was to come off it would not run; or if the high tension wire should come off it would not run. If the interrupter was not breaking far enough it would not work properly, and if the platinum were pitted bad it would give trouble such as missing. You will find that if your interrupter should become disconnected from the throttle, your motor would lope.

You can locate and remedy the other troubles of this system the same as on the Remy, which I have explained, except the testing of the wires. You will discover that these wires cannot be tested out in that way, but you will always find the numbers 2, A, and 3, which are wired, as has been mentioned, 2 to the interrupter, A to brush, and 3 to ground.

The Bosch High Tension System

The Bosch magneto, you will find, is made somewhat different from the others. The interrupter is made quite a bit different, as the whole works revolve inside of the case. As the breaker passes by the fiber rollers,



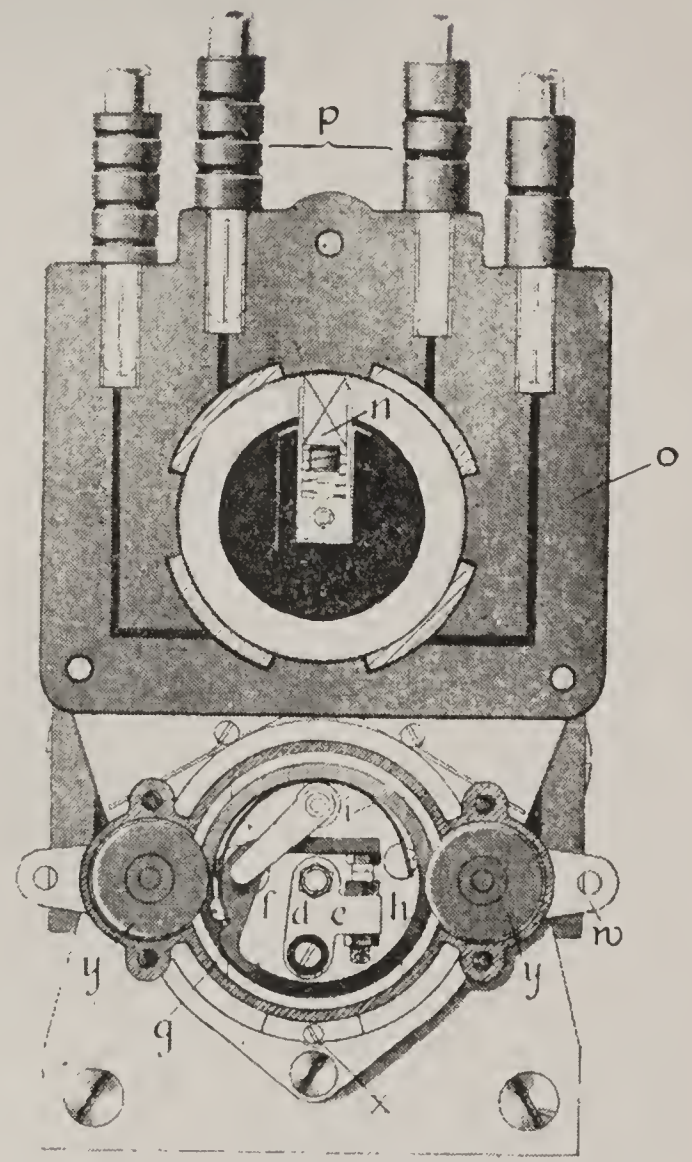


FIG. 39.—TRANSVERSE AND LONGITUDINAL CROSS SECTION OF A TYPICAL HIGH TENSION MAGNETO (BOSCH).

a, double magnets with pole shoes; *b*, armature; *c*, condenser; *d*, current carrying screw; *e*, insulated contact piece on contact breaker; *f*, contact breaker disc; *g*, contact breaker lever; *h*, platinum contact; *i*, contact breaker spring; *j*, slip ring; *k*, central carbon holder for high tension; *l*, connection bridge with carbon brush for distributor; *m*, safety spark gap; *n*, rotary distributor piece with square carbon brush; *o*, distributor disc with metal segments; *p*, connection plug for cable; *q*, gear wheel on the armature; *r*, distributor gear wheel with catch plate; *s*, vulcanite cap for distributor disc; *t*, triangular bracket, *u*, binding contact for short circuiting cable with current carrying spring to the end cap; *v*, end cap with carbon and contact spring; *w*, timing lever; *x*, stop screw for timing lever; *y*, fibre rollers for depressing the contact lever; *z*, dust cover.

Y, it forces this breaker foot in F, which breaks the two points apart. In this way you will find the current is broken in this interrupter.

The high tension system, in place of having one winding on the magneto, you will find has two. Here you will notice a heavy and a light line. You will find that one of these lines that is connected to the armature is a primary winding, and the other is a secondary winding.

The low current in this magneto is started the same as it is in any other, through the breaking of the line of force that crosses from one magnet to the other. As this line of force is broken it causes a low current to start in the primary winding, and this passes out to the interrupter, where it returns across the interrupter to an insulated point E and returns into the winding, from which it started. While this current is passing through it creates a line of force through the armature in the opposite direction. This line of force is broken while passing through the breaker H. The current being broken, breaks the line of force which is taking place through the armature from B to B, and creates a high tension current in the secondary winding that passes to the commutator to the back of the machine. Here it passes up over a brush where the line points from K. Then it passes over the jump gap at the top, M. Passing through a carbon brush to the front of the distributer, it then passes through the terminals that the brush is wiping, on out to the high tension wires to the spark plugs, in which it should go. Then it returns back over the frame of the motor and to a brush at the bottom of the magneto, from which it returns into the secondary winding, from which it started.

You will find this system is like any other system as far as timing it and setting it on the car. We have first got to find the way our motor fires and then find the compression stroke dead center on No. 1 cylinder, setting the interrupter just ready to break when the interrupter is fully retarded and the distributer is one-third on in the direction that it is running. This magneto then is ready to set on the car.

To time this magneto in itself, get the distributer as shown in the front view straight between the two contact points on the distributer; then set the insulated block so that it sets straight up and down as shown. Slip the gears on and this magneto will time in itself.

To stop this system from operating, you must use a wire connected to the terminal U. By closing your switch you will find the current from the primary wire which has been produced from the breaking of the lines of force from your magneto passes out through the interrupter to the insulated point D, where it passes up over a connection made at D to the terminal U. Then it passes back over the wire connected to the switch, and crossing the switch returns to the ground, where it returns to the bottom of the magneto, where the brush is wiping against the arma-

ture, and returns into the armature into the primary winding, from which it started.

As this current does not pass through the point of breaking, you will find that there has been no high tension current produced because there has been no breaking of the primary current. As the primary current is not broken, and the high tension current not being produced, the motor will stop for the want of a spark at the cylinders. Hence to start a high tension magneto you do not turn the switch on; but to stop it, you turn the switch on and short circuit it.

The jump gap which you see at M is where the high tension current jumps across. The brush that you see where the high tension current feeds through in time becomes greasy and sometimes carries a short off across some other point.

You will find that the brush also at the bottom of this magneto becomes worn out and it is necessary to be replaced with a new one, since the primary circuit must have a tight compact.

Should the wire leading from the terminal U to the switch get shorted, you will find that your magneto would stop generating a current and the car would stop. Being unable to receive a spark from the magneto shows that there is a short somewhere between the interrupter and the point of the current feeding through the interrupter.

If you wish to take this interrupter out, pull off the outer case Y. Then take out the screw D, and you will find the front of the interrupter will come out. This cannot be put back in wrong, as there is a key seat which will not allow it to go in any other way. This makes it very handy in dressing your platinum points.

The condenser which you see at No. 1 is to take care of the current that is created from the breaking of the primary line avoiding a hot spark taking place across the platinum points.

This magneto sometimes becomes shorted badly with grease inside, as it is a high tension magneto, and it takes but a very little grease until the high tension current will travel across, which, with a low tension system, you will find is not nearly as apt to short out. In case this happens, by going to work and washing your magneto out with a bucket of gasoline, you can remove this trouble without any further delay.

You will notice that if your motor is not working good at low speed and is hard to start on the magneto, the trouble may be that your platinum points are not breaking far enough apart or your magneto may be weak or the brush at the commutator K may be worn out or gone.

The Storage Battery

Old Type. The old type of storage battery was made up of lead plates and dilute solution of sulphuric acid testing about 1.25 sp. qr. This solution is made up by mixing pure sulphuric acid testing 1.84 with about 4 parts of distilled water, and pouring enough of this into the cell to cover the plates.

Care should be taken to not get any of the acid solution on clothing or any machine parts, as it rapidly eats the fabric or rusts the parts. Do not put this acid in any vessel other than glass, rubber or earthenware.

New Type. The new Edison is much easier to handle, as it has an iron container and cobalt and nickel plates with an alkali solution which does not destroy parts as does sulphuric acid.

Charging. Connect the battery to the charging wires so that the positive wire leads to the positive connection on the battery, and place a 3-way socket in one side of the circuit with three 32 cp-110 volt electric lights as a resistance. This will give you 1, 2 or 3 amperes of current as you insert one, two or three of these lamps.

Do not charge too rapidly. If the battery be a 60-lamp horn cell, it will require 20 horns; either using the three lamps (3 Amp.) or 30 horns if two lamps are used. Test for voltage only and when fully charged this battery should test 6.6 volts.

After using, the pressure begins to drop and the battery must be recharged when the pressure has dropped to about 5 volts.

It will not require as much time to recharge this time, as a large part of the charge is still retained.

To charge more than one battery at a time, connect the batteries together in series as you connect dry cells, positive to negative, etc., and use the same current. About 2 volts in pressure is lost in each batting and if, say, 20 batteries were connected so as to be charged at the same time, this would cause a pressure drop of about 40 volts, and hence, a proportional drop in the current from 3 Amp. to about 2 Amp. To overcome this a less resistance must be placed in the circuit.

It is not advisable to depend on the above scheme for resistance if many batteries are to be charged. A regular rheostat should be provided.

If too large a charging or discharging rate is used, the plates will heat up and buckle, causing a short circuit and ruining the batteries.

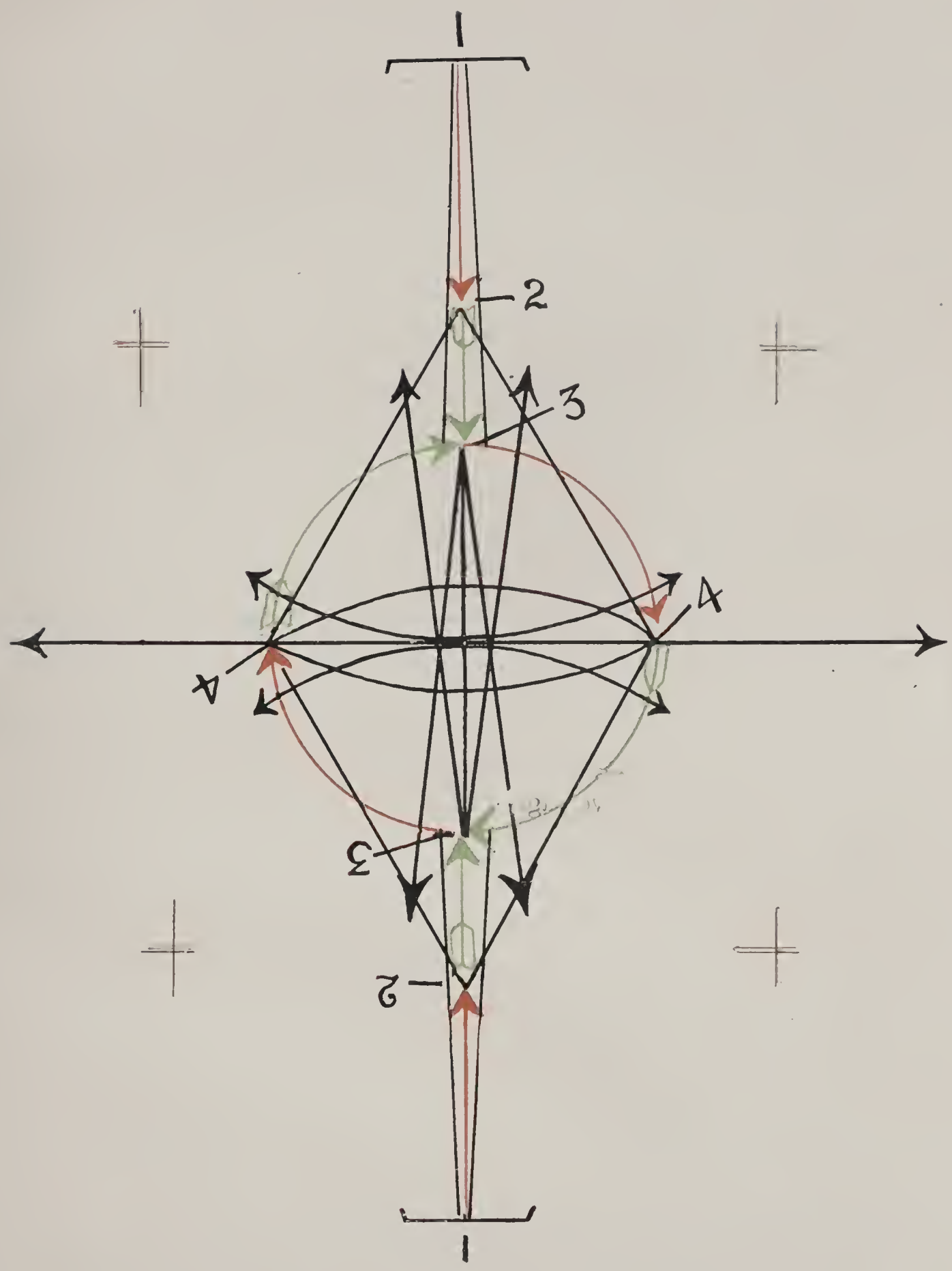


FIG. 31. THE TRAVEL OF A PISTON.

Do Nots

1. Do not test a storage battery with pliers or other pieces of metal. It will probably ruin it.
2. Do not test a storage battery for amperes. It will ruin your tester and the battery.
3. Do not over-load a battery with head lamps. Get a large battery.
4. Do not permit the liquid filler to freeze.
5. Do not charge your own battery if you have a charging station in town and a rate of 25 cents per charge. It costs almost as much for one battery as it does for a half dozen.
6. Do not allow connections to become covered with dirt and oil.

The next thing that we will take up must be the mechanical end of the machinery, as it is necessary to understand the working principle of all the parts of the automobile and their relations.

You will find that valve-timing is a very important thing to understand in any line of machinery, it doesn't make any difference whether it be steam or gasoline, and you will find very few who are operating such machinery who understand it thoroughly.

You will discover that the piston travels farther on one quarter than it does on the last, and for that reason the ordinary mechanic doesn't understand valve-timing as he should.

Speaking of the piston traveling farther on the first quarter than on the last, at first seems impossible; but it does so, and the illustration No. 31 will prove it to you. To look at this illustration alone, not understanding what it is, it would seem to you a Chinese puzzle, but it proves every point of travel of the piston and also the connecting rod. It is necessary to understand this illustration since you will find that your valves open and close at such points that seem impossible that it should do so, for instance, when the intake valve opens past dead center and closes past the bottom center, and when the exhaust valve closes past the top dead center and opens before reaching bottom dead center. When understanding the principle of the over-travel, you will plainly see why these valves open and close at these points.

Figure No. 31 shows a double-hosed engine and its outward travel and its inward travel. No. 1 shows the piston at each end; No. 2 shows where the piston has traveled on the first quarter—the red mark coming from No. 1 to 2. No. 3 shows where the crank has moved from the dead center to the first quarter, No. 4, showing you the travel of the first quarter. Then the green arrow shows you the crank traveling from No. 4 to No. 3 at the bottom. This shows the second travel of the crank, and the green arrow

from No. 2 to 3 gives the travel of the piston, showing that this travel is much shorter than the first. The black mark swung from 4 to No. 4 shows the over-travel as if the crank box was taken apart. You would find that your connecting rod will not swing on this line as it curves from 4 to 4. The lines running in the diamond shape from the center shows the actual rockby past dead center. At this point you will find that the piston does not move a particle while the connecting rod is moving across this space.

You will also observe that there is a drop from No. 4 to No. 3. For instance, to prove this out, go to work and make a circle with your pencil on a piece of paper, measuring the distance across the circle. Then make a mark the same distance above the circle as No. 1 shows you here. Then place a line straight through the center of your circle as the line is drawn here with the red and green arrows; then place two pencils with a piece of string just the length of the mark at the top to the circle, and move the pencil at the circle to the first quarter, drawing your pencil at the top downward and only reaching the first quarter. Then move the pencil at the top backward and forward to make a mark. Then move from the first quarter to the second quarter and still pulling your pencil straight downward, you will see for yourself how the piston travels farther on the first quarter than it does on the last.

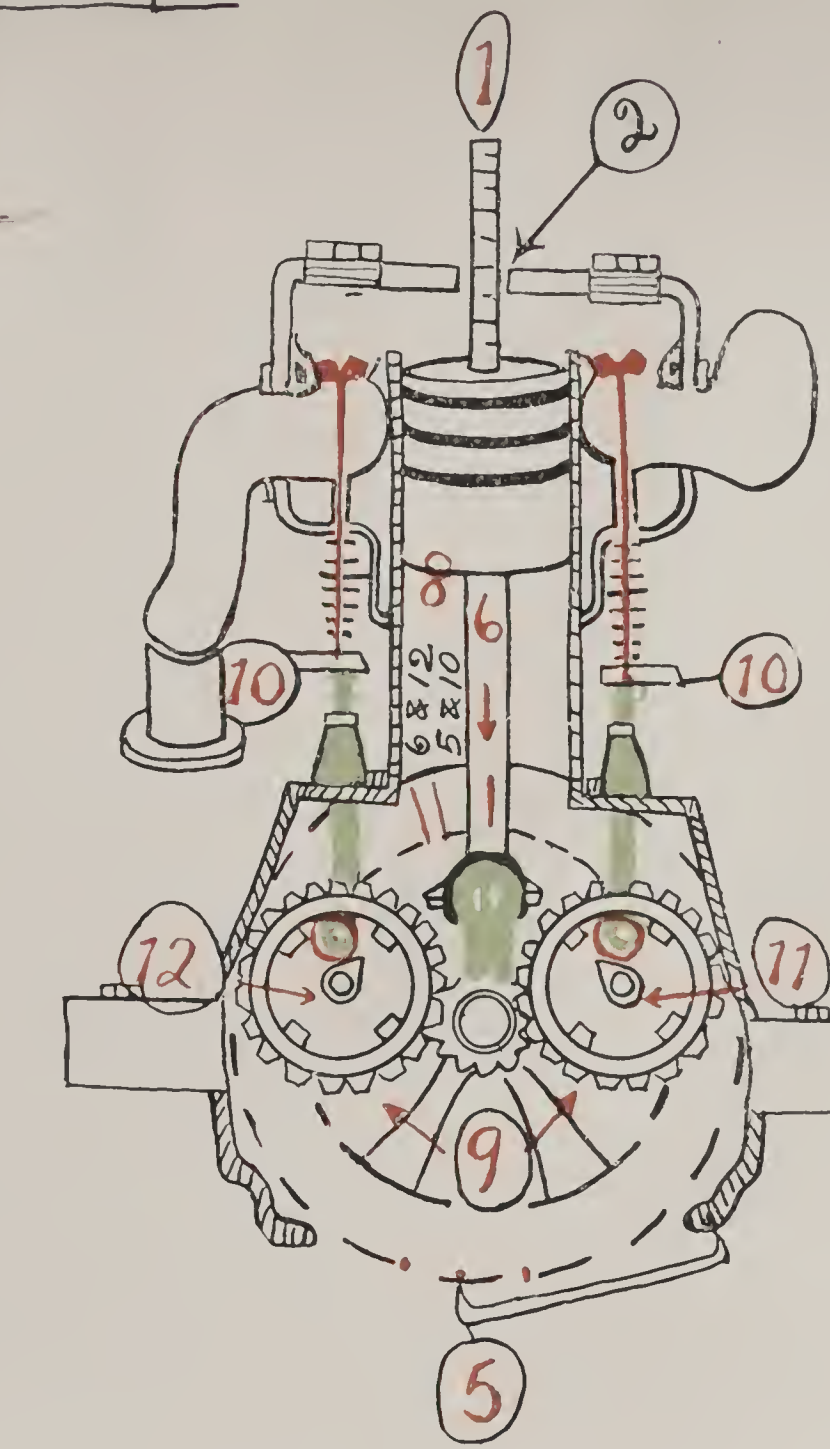
You may ask, "What does this amount to?" It means that it is impossible to find the exact dead center of a flywheel without the means of a triam. You will find that the rockby throws you off one way or the other, and this illustration proves that to you. You may have your piston at the highest point and still the connecting rod be a little off one way or the other. This would throw you off on degrees. The degree marks which you set your valves by must be absolutely right, and those marks are measured from the exact dead center. If you do not have the exact dead center it would be impossible to have the proper degree marks for the exhaust valve to close and the intake valve to open.

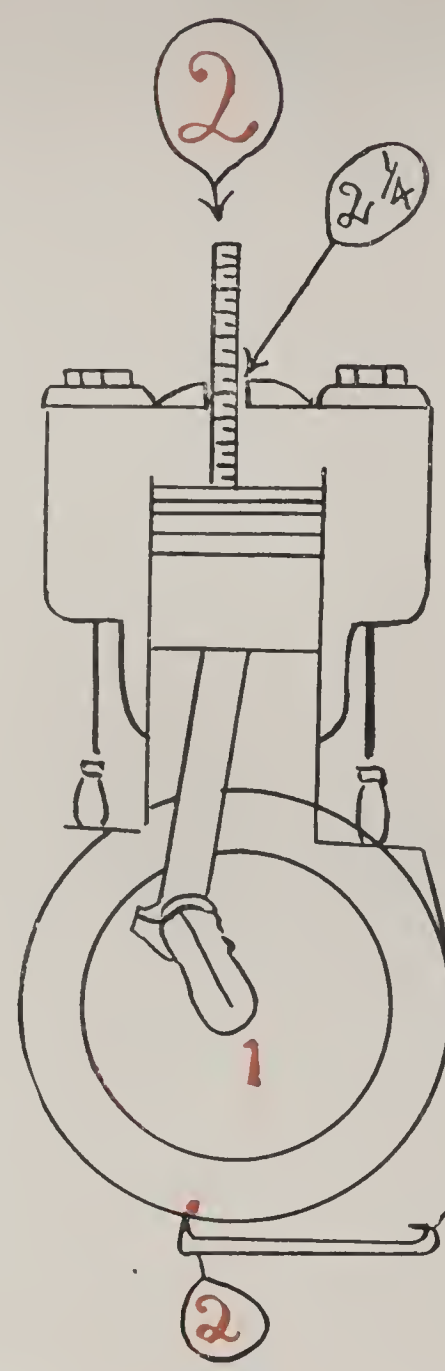
The next figure which I shall explain to you will be showing you the valve timing as it is done, showing you the view of three that represent only a T head motor. The first cylinder is showing you the cams and cam gears, the push rods and valve stems. You will find in Figure No. 30 that it shows you the three cylinders, representing the one with red numbers and also black numbers. The red numbers represent the first to the last thing that you are to do, following these numbers in rotation as they run, and you will find that you will follow valve-timing as it should be done.

You will find that No. 2 is pointing to a mechanical rule, and that No. 7 is pointing to the degrees of a circle. You will also notice that No. 5 is pointing to a triam and No. 8 is placed upon the piston. No. 10 shows a business card between the push rod and the valve stem. No. 6 shows the

60	360	6

7





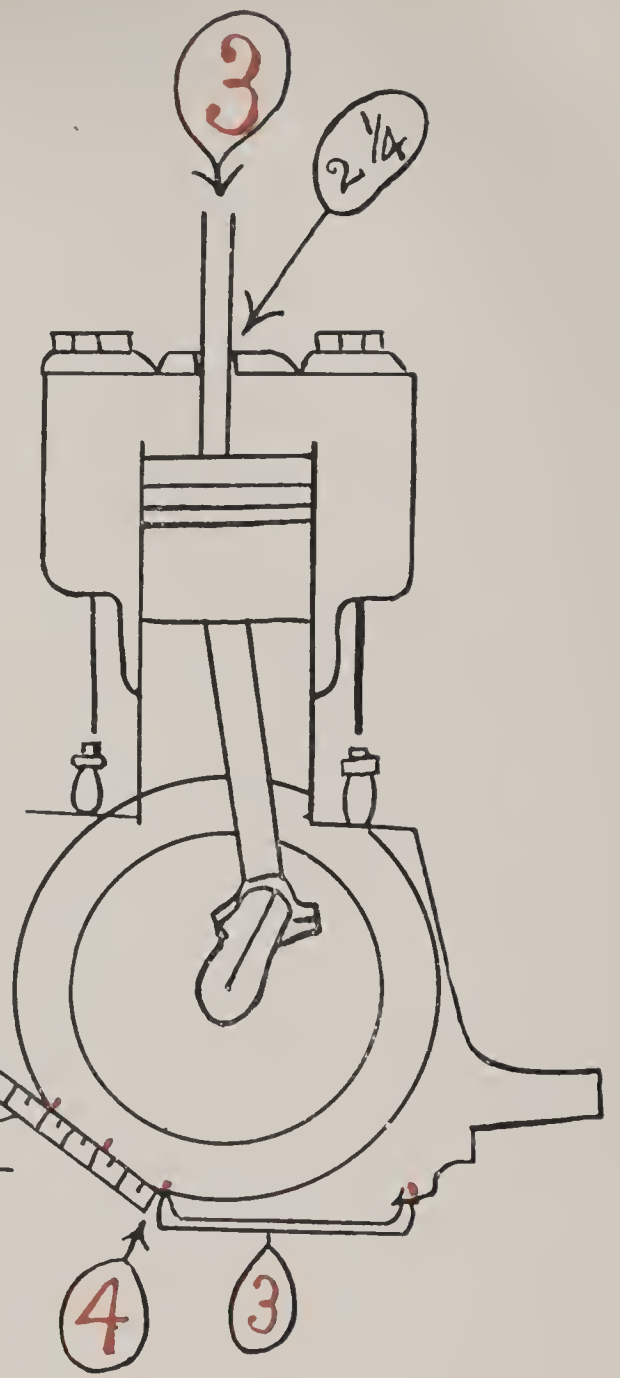


FIG. 30. VALVE TIMING.

connecting rod with an arrow just below it pointing at the exact dead center. No. 11 shows the exhaust cam and No. 12 shows the intake cam. No. 9 shows the exhaust on cam gear and the intake cam gear.

In order to do valve timing it is necessary to find the exact dead center of your flywheel. In order to do this, this illustration will show you plainly how it is done. We will first proceed starting in to find the exact dead center. First remove some plug or other at the head of the cylinder, by which there is always a way to get in the head of a cylinder. After removing the object which may be placed at the head, place a mechanical rule in the head of the cylinder, as we have at No. 1, which is the first thing to do. Raise the piston then, until the rule raises up as high as it will possibly come. Then notice the distance that the rule sets in. Drop this rule one-quarter of an inch lower than the distance at which it stands. That throws your connecting rod over to one side as No. 1 in the center of the flywheel shows you. Now go to work and place a triam at the lowest point of the flywheel, as No. 2 shows you, placing this at the lower point of the flywheel. Make a counter punch mark on the frame of the motor and place the other end of the triam in the counter punch mark. Make a temporary mark on the flywheel where the triam touches. Next raise the piston back up to its highest point, and drop it on the other side the same distance as No. 3 shows you at the head of the cylinder, one-quarter of an inch. Place your triam back to the same counter punch mark on the frame of the motor and put the triam at the lowest point of the flywheel, as No. 3, at the bottom, shows. Make another temporary mark. Take your mechanical rule and measure the difference between these two marks. Make a counter punch mark square in the center between the two. This gives you the exact dead center of the two marks. Now turn the flywheel back until the triam will touch in the counter punch mark on the frame of the motor and in the counter punch marks between the two temporary marks, as No. 5 shows you. This will give you what is called "triam dead center." After you have done this and while the motor is standing in just this position place a mark across the face of the flywheel and a mark on the cylinder to correspond with it, as No. 6 shows you. This gives you exact dead center.

Now, if you wish to place another dead center on the other side for 2 and 3, you may do so by measuring the distance around your wheel. Finding this wheel is 60 inches around, or whatever it may be, take one-half of the distance. Say it is a 60-inch wheel—you will measure 30 inches from the dead center mark, which will give you exact dead center on the other side. This will be the dead center for 2 and 3. The first dead center is 1 and 4.

After you have this dead center mark, you then have a mark to locate the degree marks from, which is exact. To get the degrees of this flywheel, measure the distance around the wheel. Whatever it may be, it must go into 360. We will say that it is a 60-inch flywheel. Sixty goes into 360 six times, giving you six degrees to one inch, or the sixth of an inch to one degree. Then measure the degree marks from the dead center mark back at which you will find the exhaust valve closes between 5 and 10 and the intake opens between 6 and 12, as figure No. 8 shows. You will ask, "How is this?" It is enough to answer that this has been figured out by experts who have figured valve timing of all motors. There are no two motors of which the valve timing is the same, but there is no motor made but the exhaust valve closes some place between 5 and 10 degrees and the intake opens somewhere between 6 and 12. Hence, to get the average, we must do the same as a jewelyrman does regulating a watch. We can find the center. We know that we have got to go to 5, and half of 5 is 2½; added to 5 gives you 7½. That would be 7½ degrees then at the average. The intake opening is between 6 and 12, so that we know we have got to go 6 and somewheres between 6 and 12. Half of 6 is 3, added to 6 gives 9, and hence 9 is the average. Now, we say we take the average and measure 7½ degrees from dead center mark, as the two marks back of the dead center mark shows you the degree marks. We will first place the exhaust closing, which is between 5 and 10, on 7½, which is 1¼ inches. Now, the intake opens between 6 and 12. Finding the average to be 9, which 9 degrees at 6 degrees to an inch is 1½ inches. Measuring 1¼ back, or the 1½ for the two marks, we locate the exhaust closing and the intake opening.

Now you are ready to do valve timing just the same as you will find a great many motors already marked as they leave the factory, although you will discover a number of motors placed on the market that were never marked. In case you were to go up against one of those unmarked motors, and someone had had the gears off, and had the valve timing off, and suppose you were asked to fix it; it would be a "big white feather in your cap" if you were able to go ahead and do the valve timing, correcting and make the motor give the same power that it did the day it left the factory, which thing you can do if you follow the illustration shown.

From this point we must pass on to do the valve timing as it is done on all motors, following after the red figures as they are on the illustration. First, after this, we will pass to No. 9, showing you the two gears, which means that they must be taken off in order to allow the cams to drop down as far as possible—that is, to allow the push rods to come down as far as they can. No. 10 shows you that the adjustment made between the push rod and the valve stem must be made just the distance of a business card, which is about the 64th of an inch thick. You will find by two adjustment

nuts on the push rod you can make this adjustment to that distance. You may ask, "Why not have them so they just touch?" The reason is this: anything running at a high speed has vibration, and if you were to bring them up so they touch the motor running at a high rate of speed would not allow the valve to close, since the vibration of the push rods would hold the valves just a fraction open, causing backfiring through the carburetor and backfiring in the muffler. The valves must then have clearness enough to allow for this vibration so that the valves may seat each time. Notice there are springs above the business card which pull the valve down tight each time.

After you have made this adjustment, you are now ready to start in to set your cams. Turn the first mark, which is the exhaust closing between 5 and 10, even with the dead center mark on the cylinder. Then turn the exhaust cam up No. 11 until it raises the push rod against the valve stem and is just ready to leave it, and place your gear on the exhaust cam shaft. Then turn the exhaust degree mark even with the center of the cylinder, which is between 6 and 12, and turn the intake cam up until it raises the push rod against the stem ready to open it, and slip the intake cam gear on. This is No. 12.

Now you have the valve timing done, and you are ready to place your case on and try your motor out. If you follow this through as I have indicated, there is no chance for you to ever make a mistake.

You may ask, "What is a triam?" The figure just below No. 5 shows you a triam. It is a rod cut fifteen inches long and has each end sharpened to a point where each end can then be bent one inch, leaving you a 13-inch triam. It is used on steam and gasoline engines to find the exact dead center of the flywheel.

In case that you were to grind a set of valves, you will find that it is necessary to adjust your valve rods so that you can slip a business card between each one. To do this, first put No. 1 cylinder on compression stroke dead center, which can be done by watching the exhaust valve open and close on No. 4 cylinder, and that gives you compression stroke dead center on No. 1. Then set the exhaust and intake cam on No. 1 cylinder so you can slip a business card between each one. Turn the flywheel then a half a revolution and adjust the two valve rods on the next cylinder that fires the same. Then turn it another half revolution and adjust the valve rods on the next cylinder that fires, and so on until you have adjusted all the valve rods that you may have.

Say that you were to break your cam shaft and had to put on a new set of cams. To do this, place on a T head motor the exhaust cams all on one side, and the intake cams all on the other. In an L head motor

you will place the exhaust cam on; then two intake cams; then two exhaust cams; then two intake cams and one exhaust cam, and you are ready to start in. Place the gears on and allow all the cams to turn straight down, allowing the push rods to come down as far as possible. In addition, you must have the degree marks for Nos. 2 and 3, as well as 1 and 4 dead center. Turn the first degree mark, which is the exhaust closing, even with the center of the cylinder on 1 and 4. Then turn the exhaust cam up until it raises the push rod against the stem and tighten the set screw that is found in the bottom of the cam, or must be put there. Next turn your intake opening mark even with the center of the cylinder which is between 6 and 12, and turn the intake cam up until it raises the push rod against the stem and locate the set screw in it. Then turn the flywheel half over, bringing your 2 and 3 dead center mark up. It is up to you now which way you want your motor to fire—whether 1, 2, 4, 3, or 1, 3, 4, 2. You must then turn the 2 and 3 dead center exhaust degree mark even with the center of the cylinder and turn the exhaust cam up until it raises the push rod against the stem with No. 3 cylinder just ready to leave, and tighten the set screw in this. Next turn the intake opening mark even with the center of the cylinder and turn the intake cam up until it raises the push rod against the stem so that it is just ready to open on the No. 3 cylinder. Then turn the flywheel half over again, bringing up 1 and 4 dead center. Next the exhaust mark even with the center of the cylinder and turn the exhaust cam up against the push rod on No. 4 cylinder so that it is against the valve stem in a position just ready to leave and tighten the set screw in this. Then turn the intake mark even with the center of the cylinder and turn the intake cam up until it raises the push rod against the stem on No. 4 cylinder, and tighten the set screw in it. No. 4 must always fire after the second cylinder. Now turn the flywheel half a revolution again. Next turn the degree mark even with the center of the cylinder for the exhaust to close and raise the exhaust cam until it raises the push rod against the valve stem on No. 2 cylinder in a position just ready to leave. Then tighten the set screw and turn the intake degree mark up even with the center of the cylinder and then turn the intake cam up until it raises the push rod against the stem ready to open, and tighten the set screw.

Now you are ready to take off the gears and pull out the cam shafts. With a counter punch, make a counter punch mark in the center of each one of these cams. With a drill, drill a hole through the cam and shaft. Then drive a pin that will make a tight fit in the hole and get it in even with the cam. With your counter punch sink this at each end so it cannot work out. Do this to each and every one of your cams and take a file and dress it off smoothly.

Your cams and shaft are now ready to be placed back in the motor. Place the cam shaft back where it belongs and turn up 1 and 4 dead center, bringing the exhaust degree mark even with the center of the cylinder. Turn up the exhaust cam until it raises the push rod against the stem and slip the gear on. Turn the intake degree mark even with the center of the cylinder and then turn the intake cam up until it raises the push rod against the stem just ready to open and put the gear on and you have your cam shaft and cams timed.

Carburetors

The next system we take up will be the carburetors, a very important part of the automobile to understand. In fact, there are very few who understand the principle of a carburetor thoroughly so they can locate their trouble at once.

If you will study this illustration carefully, you will find that you will be able to easily locate the trouble in a carburetor. Very few understand how to adjust a carburetor as it should be. Indeed, very few understand the adjustment principles of the carburetor at all. Very few also understand the color of blaze, the sound, etc. As far as teaching you how to adjust a carburetor is concerned, that I cannot do, nor can any other man living, no more than can you be taught to play a violin. An instructor can teach you the notes, but not to play the music. You will find out what I can teach, and then you will have to learn the music yourself. Often you will hear adjusting a carburetor spoken of as tuning a motor.

The carburetor, you will discover, is not hard to adjust if you once learn the sound of the motor and the color of blaze which you receive, due to different mixtures.

The trouble of carburetors, you will ascertain, is due greatly to the not taking care of the gasoline. A great deal of gasoline is poured into the tanks without being strained. It should be strained through a chamois skin. This will avoid any dirt from passing through, and also will avoid the water from passing through. You will find if water, or dirt either one, pass into the tank, it is going to cause trouble that the ordinary man cannot locate, and yet it is a very easy matter to locate if you understand the principle of the carburetor. For instance, I shall explain to you the Schebler carburetor. The Schebler carburetor is a foreign type that has a water jacket. The type that I am showing you here is type F in which the adjustment is very easily made.

The first thing is to understand the color of blazes that you will receive from rich, weak and proper mixtures. If your mixture is too rich, you will receive a red smoky blaze; if the mixture is too weak, you will receive a yellowish green blaze. When the mixture is just right, you receive a deep blue blaze. This blaze can be seen from the muffler, when it is cut down and will show up at high speed. Also, it can be seen by opening the valve at the head of the cylinder, or priming cups.

The sound which you receive from too rich a mixture is a buzzing sound, which means that the motor runs sluggishly. The weak mixture gives a low, hollow-tone sound. The right kind of a mixture gives a deep, sharp report like two pieces of boards slapped together.

The trouble of the carburetor may be found in several different places. If dirt passes in the pipe line and chokes up, the trouble that you will have is that your motor will choke down, backfiring through the carburetor, causing the car to stop. And when you get out and crank up your car, even though it starts off again at a very high speed like nothing was wrong, it will run only a few minutes until the same thing takes place—backfiring through the carburetor and the stopping of the motor. This shows that the dirt has clogged in the pipe line and the gasoline does not feed through as fast as it ought to, or stops up in the elbow G. This condition allows the gasoline to seep through when the car is stopped and to fill the float chamber full again. Then when you crank your car it starts off because it has a supply of gasoline in the float chamber. After you have removed the pipe line with your pump, you can remove the dirt or blow it out. If you have no pump, get a piece of wire that you can run through and by tying a small swab to it you can pull this through and thus clean the pipe line out.

If this dirt should happen to pass on through under the needle valve H it would allow the inside valve to be held open, and this would cause the carburetor to flood. The gasoline then keeps running in since the inside valve cannot shut it off when it gets to the heighth that it should be at the point D. This running above causes it to run through the spray nozzle and out on the ground, and this is what is called flooding. You may ask, "Is there any other cause of flooding?" There is. You will find that if your cork float becomes soaked with gasoline it becomes heavy and lays down in the gas, allowing the gas to raise higher than it really should, causing the gasoline to run out in the same way. Again you will ask, "Is there any way of fixing this?" There is. If the dirt gets under the inside valve, you can fix it by removing the dirt, and, if the cork float gets soaked by gasoline, by drying it out thoroughly and then taking it and dipping it in some shellac. This should be done three times, letting it dry about fifteen min-

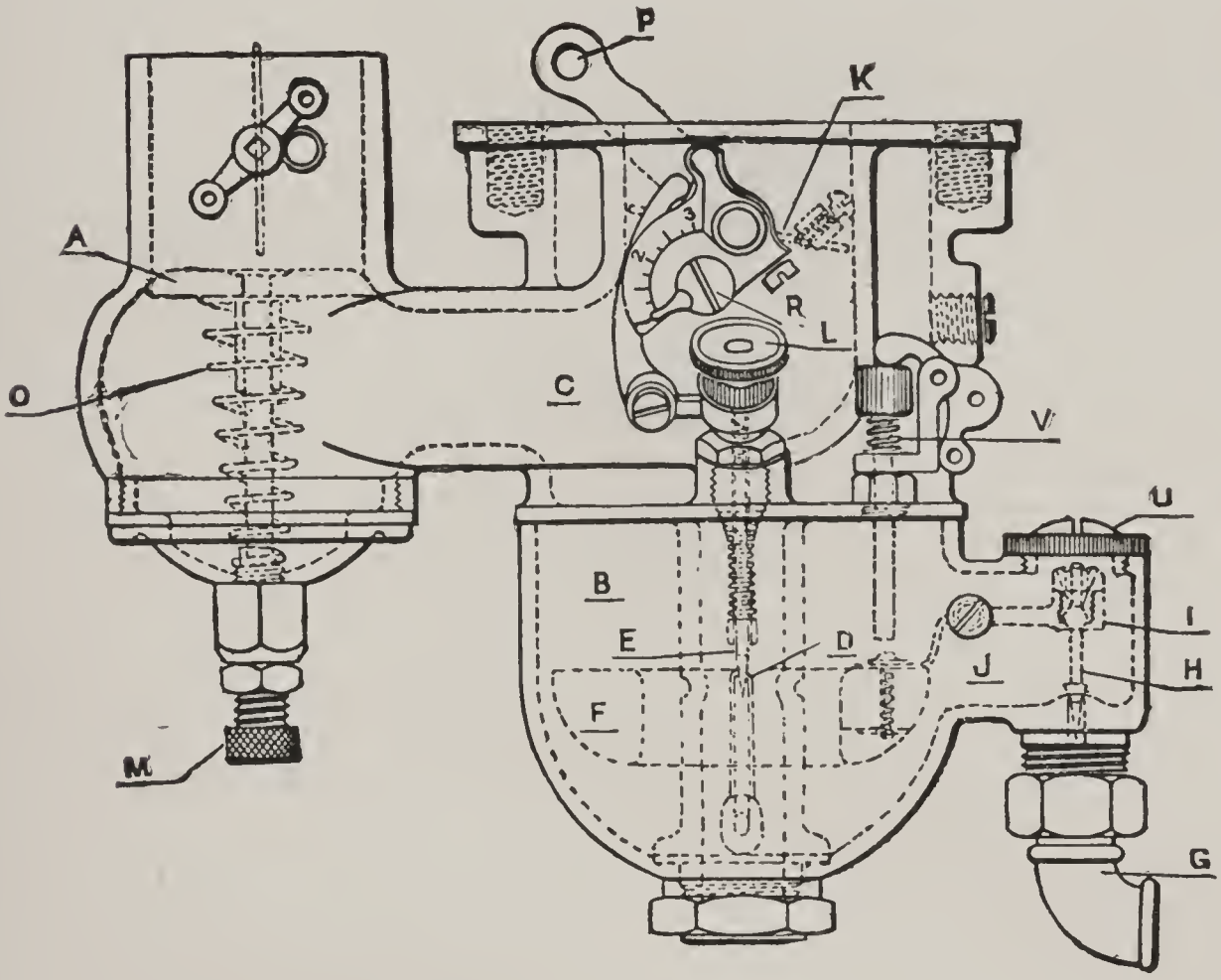


FIG. 162.—The Schebler Carburetter. A compensating air valve A, adjustable by the screw M and spring O, controls the air supply to the mixing chamber C. Above this valve is a shutter which may be partially closed when cranking to increase the suction in order to obtain a rich mixture. The spray nozzle is located at D and the supply regulated by the needle valve E by means of thumb wheel L. The needle valve has two adjustments, one for high speed and one for low. At R is the eccentric high speed adjustment. Throttle valve K is of the butterfly type and is operated by the lever P. Heating is secured by a jacket surrounding the throttle. Gasoline enters the float chamber B through the elbow connection G. The fuel level is maintained by the concentric float F which regulates the supply by the inlet valve H and lever connection J. The float point is adjustable by the needle valve adjusting screw I, accessible by removing cap U. The carburetter is primed by the tickler or flushing pin V.

utes each time. This will prevent the gasoline from soaking into the cork float.

Should the dirt pass on into the float chamber and up into the spray nozzle D, it would cause the gasoline to be shut off entirely from passing on up through the manifold. This trouble can be located only in this way: Take gasoline from the top of your tank, prime the cylinders, and you will find that when cranking your motor the gasoline will ignite, making three or four explosions and then stopping. This proves to you that your spark is all right and that the trouble is in the carburetor system. Now, by going to work and flooding the carburetor by pushing down on the stem V, you will force the cork float down, allowing gasoline to pass in through by J and allowing it to run up above the spray nozzle. If there is no dirt in this spray nozzle it should allow the gasoline to run out through your air hole on to the ground. If it does, you will know then that there must be water in the gasoline. If it does not, it goes to show you that the spray nozzle is stopped up and will not allow the gasoline to pass through.

By taking the nut off the bottom you may be able to take the float chamber apart. This will allow you to run a piece of wire up through the spray nozzle, removing the dirt which has gathered there.

If you have any doubt about water being in your float chamber, go to work and prime the cylinders with gasoline from the bottom of your carburetor. If the car will not start with this, it proves to you that it is water in the gasoline.

The foregoing, you will find, is the most of the trouble that you have with the carburetor. However, in addition, you will find that you will have such trouble as the adjustment not being proper; or the manifold may leak from the vibration of your car, breaking the packing between the manifold and the cylinders, allowing air to pass in through the place where the packing is broken.

You will find that this carburetor has a low and high speed adjustment, which high speed adjustment is found on the throttle V. The low speed adjustment is the needle valve L and the air valve A, which adjustment is made at M.

A very good way to adjust this carburetor that has proved satisfactory to me is to get a very light tension on your air valve spring M, by the adjustment screw, and then open the needle valve L about one turn. Then start your motor, having the throttle closed. Next close the needle valve L until your motor starts to miss. Just as it starts to miss, open the needle valve again until you get a regular explosion on all four cylinders. After receiving a regular explosion, adjust the air valve A with the adjustment screw M until your motor runs in perfect tune. Then open the throttle P wide

open and make the adjustment by the adjustment screw V with a screw driver, until your motor runs in perfect tune at high speed. You will find this can be done by turning the screw one way or the other when it raises the needle valve or lowers it. As the throttle is being pulled open, the needle valve opens, allowing more gasoline to pass in through the spray nozzle. This will allow you to take more gas as you will be taking more air, as the high speed of the motor will draw the air valve open to a greater extent, allowing more air to pass through. It is then necessary to have more gas to make the mixture proper.

The ignition system must be in first class shape when undertaking to adjust the carburetor. The above way of adjusting this carburetor has proved very satisfactory. When you have once become acquainted with the adjustment, you will find it is much easier to make the same as you can then locate your sound and tell whether the sound of the motor is coming right. At first you may not be able to make the adjustment just as you would like to, but practice will make perfect.

Type L

You will find that the type L is practically the same carburetor except it doesn't have a water jacket and the adjustment is made by the air valve and the needle valve. This carburetor is used on a great many small motors, since it gives special satisfaction on such motors.

The troubles in it are found the same way as in the one I have just mentioned, since they are both made by the same factory. The adjustment of the type L is a little bit different from this one. The way I generally adjust the type L carburetor is by opening the needle valve, for a 20-horse motor about three-quarters of a turn; for a 30-horse about one turn and a 40-horse about one and a quarter turn. Then, having a light tension on my air spring, I will start the motor. While the motor is running, I will adjust the needle valve until it begins to hit regular at low speed. Next I open the motor wide and adjust the air valve until the motor begins to draw hard through the air valve. Then I give it gas until you get the proper sound, which resembles two pieces of boards clapped together.

Another way in which you can adjust this carburetor is by opening the needle valve about the same distance and adjusting the air valve for low speed, and then opening the throttle wide and adjust the needle valve until you get it as near as you can.

Still another way: you can open the needle valves the same distance and then start your motor, throwing the throttle open suddenly. If spit-

ting takes place, through the air valve, close the air off until the spitting quits. Then open again until the spitting just takes place, and then open the needle valve little by little until you get the slightest pop and your motor will rush off at high speed. But be sure and open and close the throttle suddenly at each adjustment. This adjustment will only work on the type L Schebler, or such makes.

Stromberg Carburetor

Figure No. 50 shows you a Stromberg carburetor, which is a spring type having a water jacket and air valve adjustment. This carburetor has a spray nozzle, but does not have a needle valve in which the adjustment is made at the spray nozzle. It has a needle valve at the float chamber in which the adjustment of the gasoline is made in the heighth of the glass float chamber C, this adjustment generally being made so that the gasoline stands about one-half in the float chamber while the motor is running. This adjustment is made by the adjustment screw D1.

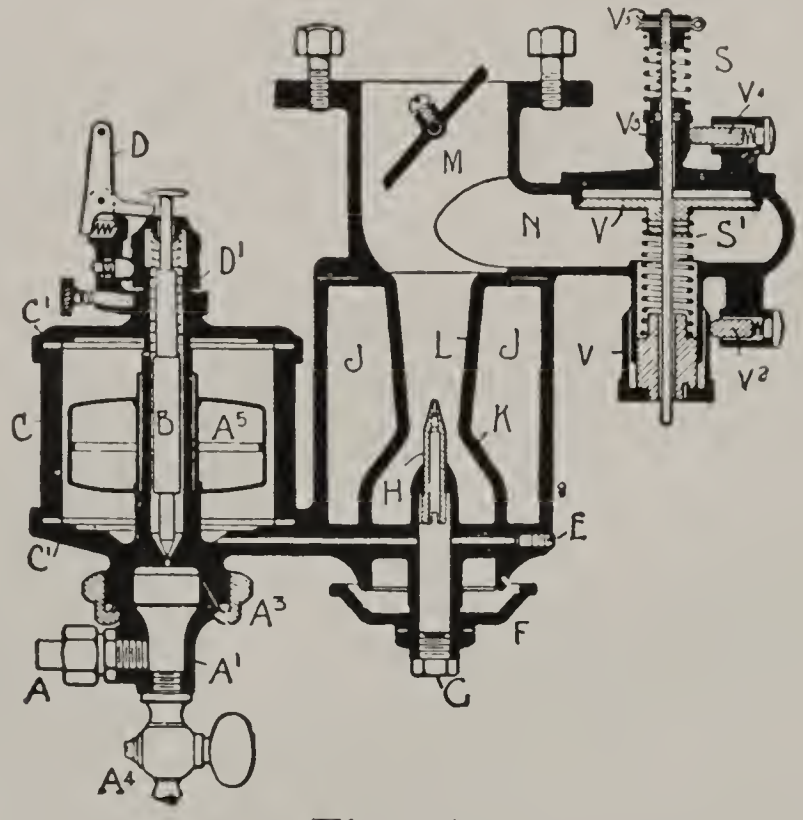


Fig. 50

STROMBERG CARBURETOR.

You will notice that the gas feeds in at the pipe connection A and passes up through the needle valve B at the bottom. Here it passes into the float chamber, raising the float A5. The gas then passes across through the spray nozzle H, where it then passes up through the throttle M

and through the manifold to the cylinders. The air passes in at the bottom of the priming cup F, which is the factory set point, and the straight air passes in through the air valve V going in past N, mixing with the gas at M, and passing up through the manifold in a vapor of gas. The adjustment is made at the adjustment screw above V and the adjustment screw below V, the bottom one being the light spring adjustment; the top one being the heavy spring adjustment, or high speed.

The troubles of this system you will find about the same as the others. The dirt passing in the pipe line will cause it to choke down, which, if noticed at the glass, it will be found that the gasoline is low and seeping in. If this dirt passes in and gets under the needle valve B it will hold it open, allowing the gas to pass in. This gas will run across in the spray nozzle H and over the top into the cup F, and then it will run out on the ground. Sometimes this float chamber A5 becomes punctured, which can be easily fixed by soldering it lightly.

If the dirt which I have spoken of passes across into the spray nozzle H, it will choke the gasoline off entirely, not allowing it to pass up through the throttle M. In this case your motor would stop, and the only way that you could locate our trouble would be first to prime your cylinders to see if your motor will run or not; or, next by priming to see whether the trouble is in the gasoline system or the ignition system. Finding it will ignite the gas shows you that your spark is all right and the trouble is in the carburetor. By pulling back on the lever D, you will raise the needle valve B allowing the gas to run in and fill up to the top of your float chamber. Should it run out of the spray nozzle into the priming cup F this shows you that the gas is passing through and it must be water. After the gas reaches this point, there is nothing to keep it from passing to your cylinders. Should it not, you will find it is dirt in the spray nozzle and this will not allow the gas to pass through.

The dirt can be removed by taking off the screw at the bottom G and with a piece of wire you can remove the dirt, since you can easily see through the spray nozzle.

If this dirt should stop in the cross section from the float chamber to the spray nozzle, by removing the screw E you can push a piece of wire through the cross section, removing the dirt from this point.

If you wish to take this float chamber apart, remove screw C at the top, allow the floating lever to be removed at D and then the adjustment screw D will screw off, allowing you to pull out the needle valve B. Then throw off the top of the case, lift up your glass C and you have everything removed.

By removing screw G you can screw off the priming cup F, allowing you to look through your carburetor.

The letter J is the water jacket into which the hot water from your cylinders passes in and out again, keeping the gasoline hot while it passes up through the air space L.

In case you want to drain off the water that may be in the carburetor, you can do so by opening valve A No. 4 and pulling back on the lever D. Then raise the needle valve B, allowing the gas or water, whichever it may be in the float chamber, to pass down through the valve below.

If you want to adjust this carburetor, you can do so by adjusting the gasoline so it stands about one-half in the float chamber. This can be done by the adjustment screw D. Then have a light tension on both springs. Start the motor and while the motor is running adjust the gasoline by the adjustment screw above D, so that the gas will still stand half in the float chamber while the motor is running. This allows the gas to rise at the proper height in the spray nozzle. Then while the motor is running slowly, adjust the lower valve spring V or spring S, low speed adjustment, until the motor runs perfectly at low speed. Next open the throttle wide open. Leave your spark retarded and adjust the spring above, or heavy spring, until your motor runs perfectly at high speed. This is high speed adjustment.

You will find that this adjustment will work out satisfactorily, providing your ignition system is in good shape.

Transmission

The next mechanical part that we take up is the transmission. You will find that there are a very few that understand how to change speeds on a car, and the reason that they do not is because they do not understand the principle of the transmission. A great many people changing speeds cause the machine to make a ripping, roaring noise. This can be overcome in shifting, if you understand how it is done. The majority of instructors who teach you how to drive a car teach you wrong in this matter. You will admit that you have been in the habit of releasing your clutch clear out when changing speeds, and this should not be done by any means. If you understand the principle of a transmission, you will plainly see why this noise is caused.

When you buy your car, the first thing you are taught is to be sure and push down on the pedal, which is called the release. You are told to do this, but you don't understand why. You will find that you do so because you were told to do so, and told that if you didn't do it you

would rip out your gears, which is true. And yet, if you do push down on the pedal you will chew off all the teeth, and that will be just as bad as to rip them out.

Now, these instructions conflict. You think that you ought to release them out, and I say not to. I do not mean not to release the clutch; but I do mean that you should release the clutch far enough to release the motor power from the transmission, since this is what the clutch is made for.

You will find that a transmission has a jack shaft and a drive shaft. The figure No. 34 will show you a selective type transmission, which you will notice on one shaft has four gears. This is the jack shaft. On the other shaft you will notice that there are three gears, which is the drive shaft. But really, there are only two gears on the drive shaft, as the gear which is running in mash with the other gears is a stub gear inside of which the drive shaft rides. This gear is driven by the clutch which you release and leave in.

You can look at this yourself and see that if you release this clutch clear out you will stop the clutch from running. That is all right in starting up; do that when first starting your car from the standing position. If you stop the clutch and stop this stub gear that is running in mash with the gear on the jack shaft, you will stop the jack shaft from running. As your car is standing still, the other two gears which are slide gears will slide backward and forward on that square shaft. As the gear then is standing still and the gears on the jack shaft are standing still, you can see at once that the gear can be thrown either way in mash with one of the gears and not make a particle of noise. Say that you get first speed. You throw the large gear on the drive shaft forward in mash with the gear that is in the center. This gives you first speed. Now, in order to go from first to second speed you must shift out and throw the near gear on the drive shaft back into mash with the center gear and this will give you second speed. To illustrate the point we will say your car is running when getting first speed. Your drive shaft then would be turning, and also the gears on the drive shaft are bound to be turning also. If your car is coasting while changing speeds, the momentum will keep the two gears on the drive shaft running. Now, if you release the clutch clear out, you can see that you will stop the jack shaft from running. As you do so, you are going to slide this second, or intermediate speed gear, back into mash with a gear that is standing still, while your sliding gear is running from the momentum of the vehicle. This shows you conculsively that the gear that is running is going to rip and roar as it passes by the teeth on the gear in the center of your jack shaft.

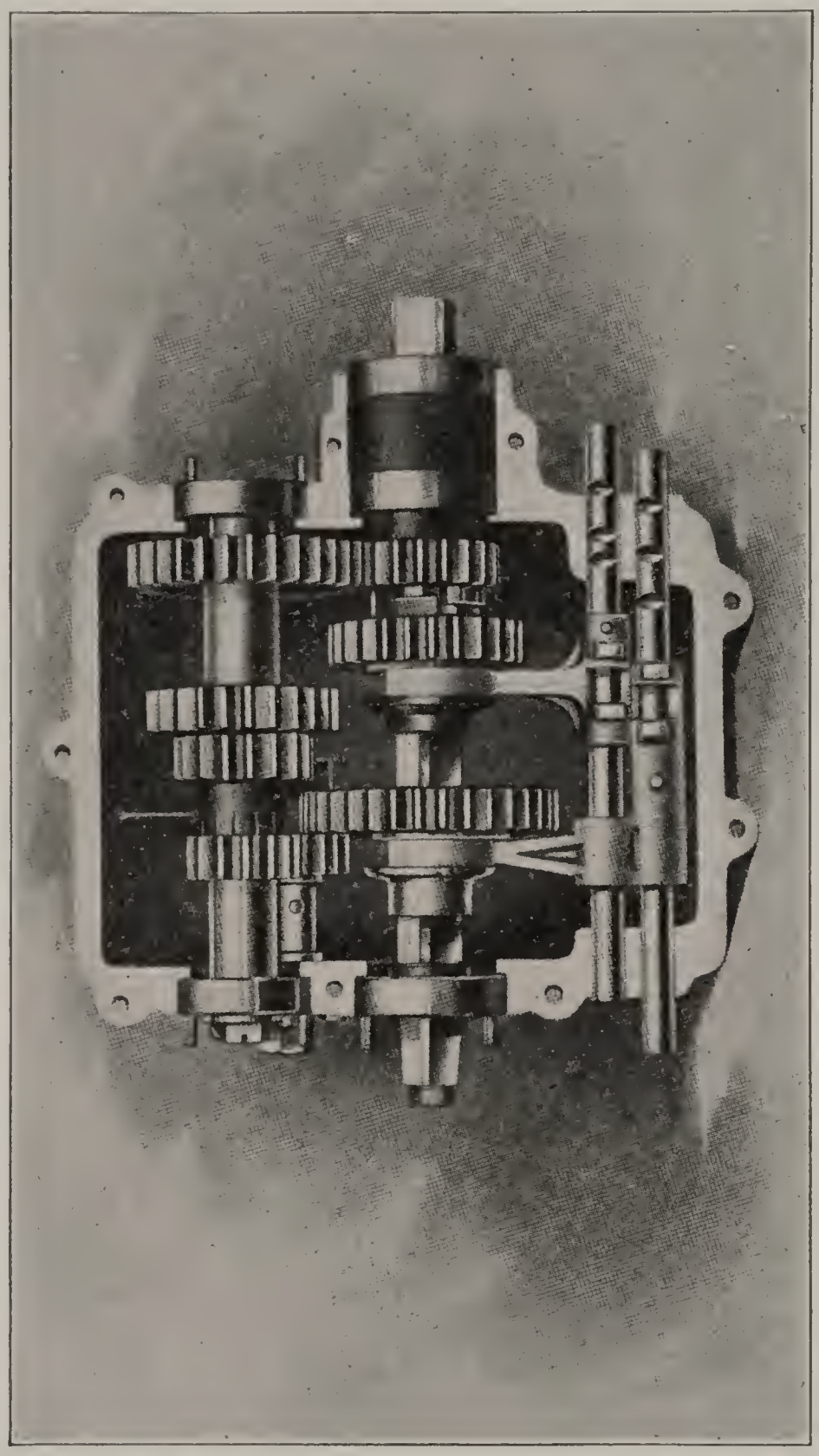


FIG. 34.
SELECTIVE TYPE TRANSMISSION

Since this is true, why should you release the clutch clear out? You should only release the clutch just far enough to release the motor power from the transmission, still allowing the clutch to run from its momentum. If you will allow the jack shaft to run, and the drive shaft also, both gears as they are running towards each other will slide together without making a particle of noise.

When changing from intermediate or second speed to high, the same gear is slid ahead where the two lugs are working together, giving you a direct drive. Then the small gear which is running in mash with the large gear at this time is connected to your sliding gear, making this one shaft straight through, and this gives you a direct drive from the fly wheel straight back to your differential.

I shall now explain to you how to start the car. First see that the spark is retarded. Then notice that your levers are in neutral, for if they are in a speed and you undertake to start the car, it is liable to run over you. Next start your car and take your seat. Shift your clutch out as far as possible until the clutch has stopped running. While all gears are standing still slide them, shifting the gear into first speed. Leave the clutch in easily. When the car starts to moving, after you have a fair speed on low, release the clutch just enough to release the motor power from the transmission and change speeds quickly from first to second. You will find that this can be done without making a particle of noise.

To change from second to high, release the clutch again just far enough to release the motor power from the transmission, shifting as quickly as possible into high speed, leaving the clutch back in easy again. Now you are on direct drive and high speed.

To get reverse, you will notice at the back of the transmission that the largest gear on the drive shaft can be slid into an idle gear which is in mash now with the jack shaft. This gives you the third motion, which will run this gear on the drive shaft to the reverse. This will cause the car to back up.

You may ask, "If all these gears were to drop out, could I get home?" You most certainly could. The sliding gear next to the gear which is in mash from the drive shaft to the jack shaft can be slid ahead and this connects the two lugs together. This connection makes the direct drive. When this is made you will not use any of the gears then whatever. All the teeth could be gone and the direct drive will operate your car. It is rather hard to start on high speed, but by driving your engine up to high speed and leaving the clutch in easily and allowing it to slip until the vehicle starts to moving, you can gradually raise your speed until you are driving on direct drive high speed. You should keep oil about

even with the top of the shaft in this transmission. You will find that these gears must run in oil as they are very hard and will not stand to run dry.

A great many people who are driving selective type transmissions wonder whether or not they would be able to drive any make of a car and know how to change the speeds. That is so easily done that a blind man could do it. Did you ever notice on the slot of the shifting lever that there was one slot shorter than the others? This is always high speed, no matter where you find it and no matter on what corner, it is always high speed. Straight across from it is always first speed. Likewise, straight back from first speed is always reverse, and straight back from high the other slot is always intermediate or second speed.

You will say, "Well, I know some automobles that have not got the slots in that way." This is true, but they can be found just the same. If you have an open slot, throw your lever across it and shove it down to each corner when the motor is standing still. You will find there is one corner which you cannot get the lever into, for two reasons: first, because high speed is one of the shortest shifting spaces there is, and another reason is that nine times out of ten the lugs will come against one another in place of slipping together and will not allow you to go down into the corner. This proves to you that that is high speed. Then across from it is first speed. Straight back from first speed is reverse. Straight back from the point that you cannot get into is second speed. These speeds can always be found in this way on any car with the selective type transmission. It will be but a short time until we will use nothing but the selective type, since it is coming to the front and being used on all of our late type cars. You will find that it has better gears, and you will find that these gears are made in such a way that they stand lots of abuse.

You may have wondered why a gear is so expensive. I shall try to explain to you why the gear is as expensive as it is. The process that a gear goes through makes the expense of it come high. The gear at first is made of soft metal that has been nealed by heating until red hot and buried in sand and allowed to cool very slowly. After it has cooled, it is placed in the lathe, is turned out and then milled until it is made in the shape of a gear. Then it is placed into a grinding machine where it is ground down to a thousandth part of an inch. If this gear now could be placed on the automobile and used, it would be much quicker made and much cheaper, but it has yet to go through a case-hardening and a pickling process. This is done by placing a large kettle of cyanide potassium on a fire and heating until it becomes a liquid. This is white in color when it is placed in the kettle and the workman must be careful not to inhale a particle of it, as it is deadly poison. While this is red hot, the

gears are placed in it and cooked the length of time they desire to case-harden it. About ten minutes cooking will case-harden to the extent of about the 64th of an inch. This liquid substance must go in only far enough to give it the wearing material and still leave the metal inside soft and tough, which gives it strength. If you were to case-harden a tooth clear through, it would be brittle and would break off. After this has been cooked to the length of time desired, it is then taken and put into a pickling process, which is nothing more than brine, water and salt, until it becomes a brine. The gear must be taken out with a pair of tongs which are case-hardened, and must be placed into the brine at once. It must be dropped as straight as possible, for if this gear strikes the least bit crossways, it will cause it to warp. Should the gear warp it is no account and will have to be thrown away. If it is warped even a little, it is placed back into the grinding machine and ground off until it will run quiet. A gear going through all these processes brings the expense of it high. In this way you understand why the gear stands the wear and is so hard. You will find that this would not do for hardening tools, as a tool must be tempered, which process you will find in another place in this book.

Progressive Transmission

The next transmission which I shall explain to you is the progressive. Progressive transmission is so called because you have got to pass through other gears in order to get to the gear you want. This will be shown to you in Figure No. 35.

The progressive sliding gears are fastened together. When one turns they both turn.

This transmission is not being used as much as it used to be, although you will find it on a few of the old type cars even today. You will find this transmission works exactly to the same principle as far as shifting the gears by releasing the clutch is concerned. It is necessary that you release the clutch clear out in order to shift speeds properly. Shifting your speeds, the gear is shifted one way or the other so that it can pass through the other gears in order to get to the gear you want.

In the selective type you will find that this disadvantage is done away with by having the sliding gears separate so that you can slide into a gear and out again and do this without passing through gears. The way of shifting this is that you have but one lever, and this shifts from one end to the other.

On the Progressive you find high speed always at one end and reverse at the other. You will notice, generally to find these speeds you cannot shift your lever clear down into the corner on the end that you find high, as the gear will come up against the lugs and not allow it to go down. You will also find the notches on that end are close together, while on the reverse and first speed the notches are far apart, and you will always find first pseed next to reverse. You will find that second speed may be found next to high and neutral may be found next to high. There is no way of telling this except by going to work and shorting your lever in the center notch and cranking the motor over before turning on the switch. If your car does not start, you know then that you are in neutral. By throwing it back towards reverse one notch you are in first speed. By passing ahead through neutral into the next notch next to high, you are in second speed. By going clear up to the end in which the short notch is found, you are in high speed. By going to the other end, you are in reverse.

First and reverse being found together, it only makes it necessary to throw back into reverse, back up, and throw ahead into first speed and go ahead. And then you have got to pass through first speed and through neutral to pass into second as shown here. Passing into second speed, you pass ahead, throwing the lugs together, and this gives you high speed. In order to do this, you have got to pass through all the gears on the jack shaft, and this is wearing and is more apt to cause trouble than when you pass in and out.

You will notice that the same toruble is caused here by ripping and roaring, and even more so than it is on the selective type.

If you will notice on transmission where the gears are ripped out, you will find that the intermediate gear is ripped out more than any other gear, this being done shifting from first to second. In shifting to first speed we always release the clutch clear out, and it can be done as it stops the jack shaft when the car is standing still, the gears not moving. But in shifting to second speed, the clutch is released clear out and this causes the jack shaft to stop while the drive shaft is running and the gears on the drive shaft rip the teeth off the intermediate gear. You will find by just releasing the motor power the same as on the other, this can be done without making this noise and without ruining your gears.

Sometimes it is impossible for a person to change speeds without making a ripping, roaring noise. I have also known it to be so that they couldn't get into speed. Every time they tried to shift into first speed, it would cause a ripping, roaring noise. This is caused from the clutch being too full. That is, the leather would not leave go or the clutch does not let go on the fly wheel and the jack shaft keeps running. If the jack shaft should keep

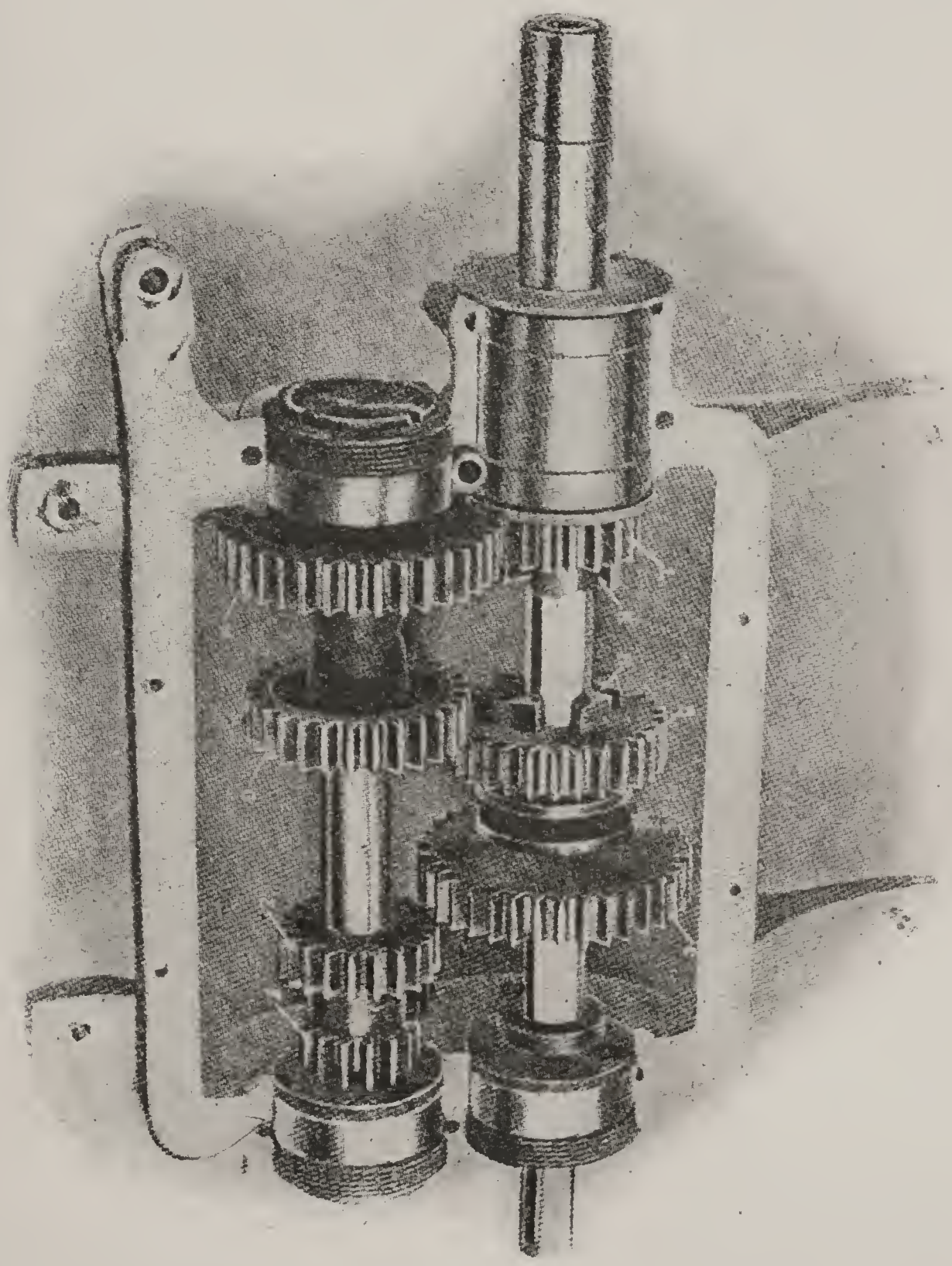


FIG. 35.
PROGRESSIVE TYPE TRANSMISSION

running when your drive shaft is standing still, and you were trying to shift your gear in mash, it would cause a ripping, roaring noise. They do get into mash sometimes by jerking back right quick, and when this is done you will hear a ripping noise and then a snap when the two gears go together. This shouldn't be done. The proper way is to be sure that that is the trouble. If you release the clutch and hold it for about a minute and then try to shift into first speed and find that this ripping noise is still heard, you can make up your mind that your leather is too full. Or, if you have a multiple disc clutch, the trouble is that it is gummed and sticking. To remove this trouble take coal oil and pour it in the case, allowing the motor to run, washing the plates, and you will remove the gum from the plates and they will not stick on you. If the multiple disc clutch runs in oil, fill it up again with fresh, clean oil and you will do away with this trouble. If this should be a leather cone clutch, by getting your car out against an embankment or some other place where it cannot climb, and leaving your clutch in easy while the motor is running and leave it slip, not leaving it in so that it will take hold, you can wear the leather down in a short time so that it will release. Don't leave this in enough to burn the leather. When it gets too hot, stop your motor and let it cool. After it has been worn down, a good idea is to soak the leather with neatsfoot oil. This causes the leather to become soft and pliable again, which will keep it from grabbing. If your leather gets hard and gummy, when you go to lift the clutch in you will find that it grabs and the car will start suddenly, and the clutch should be washed with gasoline or coal oil and the leather should be soaked with neatsfoot oil.

The same thing may be said about the multiple disc clutch when it becomes gummy. It needs cleaning out and fresh oil replaced instead of the dirty oil—that is, if the clutch runs in oil.

Sometimes a cone clutch gets in such shape that when you release it it keeps running and will not stop for about a minute. This is caused from the break or friction in which the clutch comes back again that stops it when releasing it clear out. It is worn out. If you raise your footboard you can see the clutch still running when you have got the clutch released clear out, and you can watch it die down from its momentum. If this be the case you have got to replace it, the trouble being most generally a small piece of leather in which the clutch comes back again. If it is not, it is a very good idea to have a strap or iron fastened onto the frame of the motor where it will run across to the front of the clutch, and rivet a piece of leather on it so that when the clutch is released clear out it will come back against this piece of leather, causing it to stop, for the clutch must stop in order to stop the jack shaft.

Planetary Transmission

The next system that I take up is the Planetary Transmission, about which you will have very little dealings, although it is used still today. Since this transmission is a very hard transmission to understand, you will find you will understand it better by dealing with it practically than you will from this illustration. In fact, it is hard enough to understand when it is taken to pieces and explained in such a way that a person has opportunity to demonstrate as well as to instruct concerning it.

It has a planet of gears, in which you will find there are 12 in this case.

The principle of this transmission, is that it has two cases, since you will notice that K is one of the cases in Figure 36, and H is the other case,

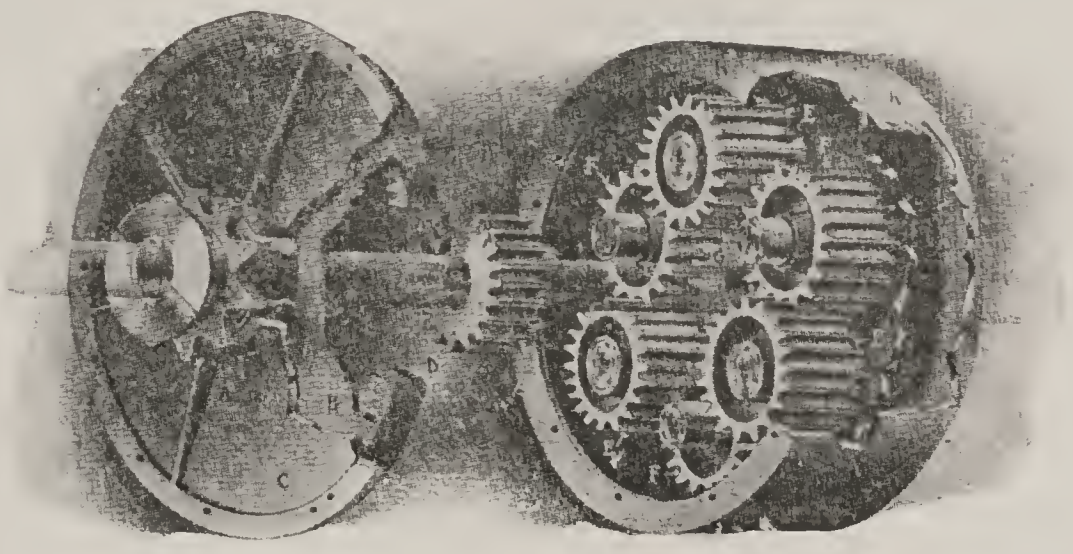


FIG. 36.

having two sets of gears, E being one set of gears and F the other set. These gears lap half with each other. The shaft going through the center has a gear fastened to it, in which this gear runs in mash with gears E. The case K has a gear fastened to the case in which the gears E run in mash with it.

Now gear B runs in mash over the top of the gears E. The plate C goes over in front of the gears that hold them all in place. Gear B that runs over the top of the gear E has a sprocket fastened to it.

The shaft that passes through the center is fastened to the motor which is the crank shaft. You will find it operates in this way. There is a brake band that goes over the case K that holds this case from turning when desired, that is locked by a foot brake. The case H also has a brake over the top of it that is locked by a foot brake. The case H has pins fastened to it that go through the gears E and F.

The gear which is on the shaft D is fastened to the shaft. Now, when this gear on the shaft is turning your motor is running and it must turn when the motor runs, which it drives on the outer half of the gears E. As

this is turning the gears in one direction, the gears F are turning in the other direction. That causes case K to revolve one way and the case H to revolve the other.

If you were to lock the brake band on case K you would hold the gear that is fastened to that case, but it will not allow either the case or the gear to turn. Then the gears E will revolve round over the top of the gear that is fastened to case K. As they revolve round the gear which is running over the top of the gears E will carry gear B round in the same direction with it, giving you first speed.

To get reverse, you will lock the brake band on case H that holds the pins to which the gears E and F are on, not allowing them to revolve round, but to stand still and turn as the gear D is turning in the same direction. You will find that the engine runs, the gears E are running in the opposite direction and the gears F are running in the same direction that the engine is running which runs the gear on the case that is fastened to it in the opposite direction, and this causes the case to revolve the same. This means nothing, except that the gears E turning in the opposite direction from the way the engine is running, cause the gear over the top to run in the opposite direction, and this means the reverse to your sprocket.

By locking a clutch, or throwing it in, which is done by a lever on the side of your car, it will allow the clutch to drop in that fastened to this shaft into a cone that is connected to the case K. Case K has got to turn then with the shaft with which the gear D is turning and as the gears try to turn in the opposite direction and also try to turn the case K the opposite direction from the way the shaft is turning it, it points the gears inside of this case in no direction only in the direction of the shaft, which shaft they all revolve together, giving you a direct drive straight through, and this is high speed.

I have explained this transmission exactly as the gears operate, which explanation I don't expect you will understand even after you have read it. However, if you come to the Automobile school, I am certain that I can show you, so that, by reading this over carefully and working with the transmission, you may be able to understand it thoroughly. It is almost a Chinese puzzle as we have it here, although you will find that it cannot be made any plainer on paper.

To take the Planetary Transmission apart on the Model 10 Buick, you must remove the universal joint shaft and inside of this you will find a set screw which must be removed. When doing this by removing the screw on the case you will find that the transmission will fall to pieces.

Bevel Gear Differential

The next system that we take up is the bevel gear differential, which you will find is used on most of the cars nowadays, since it is a strong differential and stands a great deal of abuse.

There are very few people who understand the principle of the differential. Some owners of cars do not even know that they have got one.

The differential idea is for turning corners, allowing one wheel to stand still while the other one runs faster. If one wheel stands still, not turning at all, the other wheel turns twice as fast. This is done by the bevel gears which you will find inside.

The differential that you will find in Figure 37, shows you the gears as they are inside. The dark gears are the gears which you will find between the two master side gears. There is a master side gear on each side of these gears, although we only show one master side gear. This gear is fastened to the rear shaft. The gear that belong on the other side is fastened to the rear shaft. The dark gear you will find drives in the center between the two. Now the large master gear which you see on the outside part not finished, shows you the driving power of the whole differential. The bevel driving gear which is driving on the large master gear is driven through a universal

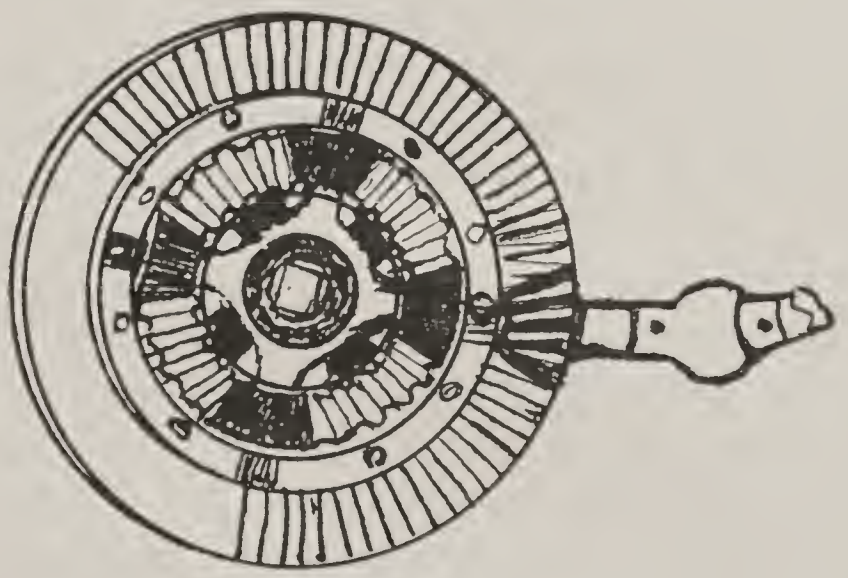


Fig. 37.

joint through the propeller shaft from the transmission. This gear when revolving turns the master gear. The master gear turns the shaft round with it, which the four bevel gears that are placed on across, carries the side master gears along with it, both of them being carried in the same direction, as the bevel gears in the center do not revolve on a straight pull, but, say that you were to turn a corner, you will find that the master gear on the side would stand still and the bevel gears would revolve in the same direction that the large master gear is turning. From this you can plainly see

that the master gear on this side would have to revolve ahead of the bevel gears in the center, which would cause it to run at the speed of the master gear and at the speed of the bevel gears, which would be twice the speed that it would be running. If both side master gears were running with the large master gear and the center bevel gears standing still, then it would only run the speed of the master gear, which is half the speed that it would be running otherwise.

You will find that this differential stands a great deal of abuse, as the bevel gear has a great deal of strength. This particular differential is found in many different types of cars, although it is not the only make there is. We have two more makes, but only one of them is used. That is the spur gear. There is a universal differential which is not used whatever, as it did not prove satisfactory because they worked loose and caused too much noise. This differential works the same as a bevel differential does on a traction engine. That is its principle, to allow one wheel to stand still while the other one turns faster, in making the corners.

If you want to experiment to see the principle of this, jack a car up, turn one wheel one way and you will notice the other wheel turns backwards. But if you start your engine and throw your vehicle in speed, you will find that both wheels run ahead. If you hold one of the wheels, you will find that the other wheel will run twice as fast. This proves to you that the differential is doing as I have just explained.

When the object of one wheel turns backwards when you turn the other ahead, you are not transmitting your power through the large master gear, but are transmitting it through the side master gear, which gear causes the bevel gear to turn in the same direction, while it causes the other master side gear to turn in the opposite direction, and causes the rear wheel on the other side to turn backwards. When the power is transmitted through the large gear, the bevel gears are not turning and are pulling just as hard on one side as they are on the other. The two side master gears are turning with the center bevel gears, and both turning in the same direction. This you will find is the action of the differential.

If you were to get one wheel in a mud hole, the other being on good footing, the one in the mud hole would keep turning and the one on good ground would stand still. The only way to make the other one turn is to hold the one that is in the mud. This can be done by knocking out the pin of your brake rod on the brake band from the wheel that is on a good footing. Then lock your brakes so that the brake band will lock on the wheel that is in the mud without allowing it to turn, and the other wheel has got to turn, and you can drive out.

If you get in a mud hole, you can throw your lap robe or anything else, as hay, brush or any other stuff that will make a good footing, under your

wheels and it will help you to get out. Sometimes by tying a rope or taking the straps off of your top and have a couple of men pull on the front of the car and starting your vehicle, it will help you to pull out of a mud hole.

When this bevel gear differential is put together, it should be packed with hard oil. The housing into which it goes must be filled with non-fluid oil up to the top. This whole differential must run in oil. The oil feeds from the differential over to the rear wheels through the axles. This sometimes feeds out and flies all over your wheel and brake band. To stop this you get a felt washer that goes in the hub over the axle. The wheel, setting up against the felt washer, will keep the oil from passing through the housing into the wheel and flying all over the wheel, getting it all oily and allowing your brakes to slip from oil on the brake band.

If you have trouble getting a wheel off, sometimes you can remove it by taking a block and placing it against the shaft and hitting it with a heavy sledge while a couple of men are pulling downward on the wheel. Should you not be able to get it off in this way, you can take a wheel puller and remove the wheel.

We do not put oil in the hub caps on the rear wheels. For when a car leaves the factory the front hub caps are generally packed with hard oil. I would advise you to remove the hard oil and fill with a non-fluid oil, for this oil will pass through the hub and oil your axle, while the hard oil will lay in the hub cap and your axle will become cut out by gum and grit.

We have five different kinds of axles with which you will become acquainted. There is the live and the dead axle, the similar floating and the three-quarter floating and the full floating. The similar floating axle is different from the full floating or the three-quarter floating, and the live axle is different from the dead axle. The dead axle is one which does not revolve and it is a double chain drive. The rear wheels turn on the axles. The live axle is one which carries the weight of the car on the rear axle, the wheels being fastened to the axles and the bevel side gears are also keyed to the axles. If you were to take these axles apart you must take your rear axle out from under the car, take it all to pieces in order to do any work with your differential. If an axle were to break, you will find that the car would have to be supported by a skid of some kind, such as a pole placed under the rear axle.

The similar floating axle is an axle which carries the weight of the car on bearings as well as the axle, but the wheels are fastened to the axles and also the axles are fastened to the differential. This axle is almost the same as the live axle.

In the three-fourths floating axle, you will find that the weight of the car is carried upon the housing, but the wheels are fastened to the axles and

the shaft is fastened to the differential. The differential can be opened at the top, so that you can get in at the top to work on it.

In the full floating axle, the weight of the car is carried on the housing and the axle has nothing to do except to drive the rear wheels. The rear wheels are fastened to the housing so that the axles can be pulled out from both sides by removing the hub cap, so that you could pull your car in with another car without any axles in it whatever. This makes it a very easy matter to remove a broken axle by going to work and taking off the hub cap on the side of the one that is broken and pulling out the broken piece, removing the hub cap on the other side and push the other broken piece through. This way you can remove the other broken piece and place back the axle on that side and get a new one, shoving it in place so that you will be ready to go inside of 15 minutes from the time you meet with the accident, provided you have another one to replace it with. With the other axles it means from 3 to 5 hour's work.

This differential can be taken out of the housing without taking the housing apart by removing a case at the top, by simply removing the shaft and lifting the differential straight out.

Spur Gear Differential

The next illustration which I shall explain to you is the Spur Gear Differential, shown in Figure 6. This figure shows you the differential as you would be looking at it if you stood behind the illustration. Also, it shows you a side view of the six-spur gears.

The two large gears A and B are the gears that are fastened to the rear axles. The gear F halfs runs in mesh with the Gear B, and the other half runs in mesh with the gear E. The other half of the gear E runs in mesh with the gear A. The same way with the other gears on this differential.

Now, when the power is being thrown upon the differential, it shows a large sprocket called the master sprocket, driven with a chain drive. When pulled ahead this will pull the pins that the gears E and F are on. This causes these gears to pass round with the sprocket gear. You will notice now that the gear E would try to turn ahead; but if it did, Gear F would turn back, and if this took place, gear A would turn backwards while gear B turned ahead, which would be impossible. You will observe that it is just as easy to turn gear F ahead as it is to turn gear E ahead, so for this reason neither gear turns at all, but revolves round with the two gears A and B. This causes these two gears to turn in the same direction that both

large wheels turn as they are connected to the shaft and the shaft fastened to these two gears would turn straight ahead.

Again, if we were to hold the wheel that is on the axle that is connected to the gear A and turn the sprocket gear which would pull the case round with the pins fastened to it, you can see that the gear E would have to turn with gear A, as we would be holding it. Then the gear F would have to turn to the reverse, causing it to force gear B ahead of it. Now you have the speed of the gear F with gear B, and have the speed of the sprocket also. This would give you twice the speed on the gear B and your wheel would turn twice as fast, which it does in turning a corner. The

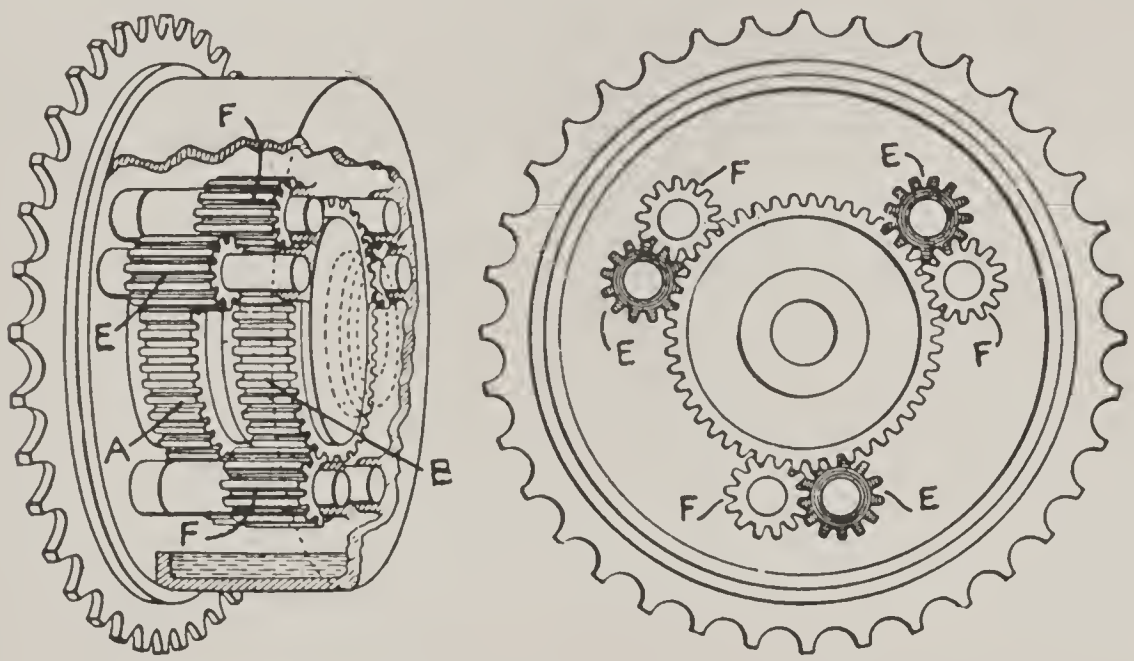


Fig. 6

SPUR GEAR DIFFERENTIAL.

same thing would take place if you were to hold the gear B. Then the gear F would have to turn ahead, causing the gear E to turn backwards, forcing gear A ahead of it, making gear A run twice as fast, which would cause the wheel that is on that side to run twice as fast, also. This would occur in making the swing the other way.

This differential does not stand as much abuse as the bevel, for the simple reason you will find the gears E and F are in mash and the whole strain lies between these teeth. Under hard strain you will find these teeth give way. At such times you will find that this differential strips out. This differential is the same as the other. It must be packed with hard oil, and when put into the housing it must be filled with non-fluid oil.

First Aid in Engine Troubles

Engine firing irregularly may be caused by:

(1) Broken down insulation on wires.
(2) Carburetor not properly adjusted, causing poor mix.
(3) Cracked spark plug.
(4) A defective connection at some part of the circuit.
(5) Gasoline feed partly choked.
(6) Moisture on spark plugs or water in oil case.
(7) Poor contact in timer.
(8) Spark coil not properly adjusted.
(9) Terminals in coil may be loose or damaged.

NOTE—Much irregular firing can be prevented by periodically cleaning the drain on the carburetor. (If gasoline tank has drain, clean it also.)

The next perventive, however, for avoiding an accumulation of dirt in the gasoline system is through the use of No-Shammy Funnels.

Engine emits hissing sound may be caused by:

(1) Broken spark plug.
(2) Cracked exhaust pipe.
(3) Loose union where exhaust pipe connects with muffler.
(4) Open compression tap.

Engine fires regularly, but is weak, may be caused by:

(1) Compensating valve on carburetor not working.
(2) Improper gas mixture.
(3) Insufficient lubrication.
(4) Poor compression caused by loose plugs or valves.
(5) Platinum contacts on coil may need cleaning.
(6) Reduced lift on exhaust valve.
(7) Silencer outlets may be stopped with mud or charred oil.
(8) Vibrator on coil may need adjusting.
(9) Weak spring on inlet valve.

Explosions in silencer may be caused by:

(1) Cylinder missing fire and pumping explosive charges into silencer, which ignite from heat of next exhausted charge.
(2) Exhaust valve stuck or does not seat properly.
(3) Gas mixture too weak to fire in cylinder.
(4) Inefficient spark.
(5) Over-retarded spark.

Knocking in the engine may be caused by:

(1) Defective lubrication.
(2) Fly wheel loose on shaft.
(3) Loose cylinder on crank case, due to nuts slacking off.
(4) Loose or worn bearings.
(5) Pre-ignition, due to carbon deposit.
(6) Spark too far advanced.
(7) Too rich mixture.

Exhaust Pipe becomes red-hot, may be caused by:

(1) Clogged silencer.
(2) Driving with exhaust throttled.
(3) Driving with retarded spark.
(4) Driving in low gear too much.

Engine refuses to start, may be caused by:

(1) Broken or jammed gears.
(2) Dry cylinders.
(3) Battery plug not in position.
(4) Fouled or cracked spark plug.
(5) Gasoline shut off.
(6) Improper gas mixture.
(7) Improper ignition.
(8) Inlet valve stuck.
(9) Open battery switch.
(10) Poor compression.
(11) Water in cylinder caused by leak from water jacket.
(12) Water in gasoline.

Engine runs properly but car drags, may be caused by:

(1) Clutch slipping.
(2) Dry or worn clutch leathers—may need renewing.
(3) Weak clutch springs.
(4) Brakes not completely released.

Engine stops suddenly, may be caused by:

(1) Broken spark plug.
(2) Disconnected electric circuit.
(3) Loose terminal.
(4) No gasoline.
(5) Trembler on spark coil stuck.
(6) Trouble at timer.
(7) Broken wire.

Gradual slowing up with misfiring may be caused by:

(1) Carburetor may be choked up with dirt at jet.
(2) Gasoline tank empty or air-bound.
(3) Gasoline valve partly closed.
(4) Fouled spark plugs, due to over or poor lubrication.

Explosions in Carburetor or inlet pipe may be caused by:

(1) Defective inlet valve spring.
(2) Inlet valve not properly closing.
(3) Leaking valves.
(4) Lean gas mixture.
(5) Spark too far retarded.
(6) Valves incorrectly timed.

Squeaks and their probable causes may be caused by:

(1) Brakes may be partly set.
(2) Lack of proper lubrication at friction surface.

Water in radiator boiling, causing over-heating may be caused by:

(1) Clogged radiator tubes.
(2) Clogged silencer.
(3) Defective pump.
(4) Defective water circulation.
(5) Fan not working.

Tempering Springs

Take two quarts of boiled linseed oil, have your piece of steel red hot, not white heat, and dip piece of steel into the oil, take steel from the oil and hold it over the fire until oil catches fire on the spring, put back in the fire and warm enough so that it will burn again. Do this three times and you will be able to temper any ordinary spring. Cool in cold water.

Rule for Brazing

First get one pint of brazing compound, one pound of granulated spelter, have your piece of iron red-hot and with a small ladle apply your brazing compound until it all melts and runs all around the work, then apply spelter until it thoroughly melts and runs into, keep turning the work while it is in the fire, do not get it too hot or you will burn the brass and kill its strength.

Conditions that Affect Ignition Independent of Batteries

When a gasoline motor misses explosions, nine times out of ten the operator assigns it to a weak battery. This is wrong, for there are a number of things that cause missing not the fault of the battery. Here are a few of them:

If mix is lean, or does not contain enough gasoline vapor, the engine will miss and show a lack of power and in most cases will cause popping or back firing in the carburetor.

If mix is over-rich with gasoline vapor, the engine will run poorly and show a lack of power. This is usually accompanied by an exhaust of black smoke and foul smell.

Loose connections in wiring will cause missing.

Be sure that connections on motor, cell ,and battery are carefully and securely made. This is very important.

Timers on some motors are so designated that poor contacts are caused as soon as the timer wears. Others are of such design that an accumulation of oil or dust prevents clean metallic contact. Either of these conditions will prevent regular running and cause missing.

Cracked or leaky spark plugs cause missing.

Leaky valves in engine cause irregular running and missing.

Improper adjustment of spark coil may cause so severe a strain on the battery as to prevent its giving satisfactory service. It cause missing and prevents the engine from responding quickly to its throttle. Proper adjustment of coil will overcome this.

Suggestions

(1) Stop engine when you leave your car. This will save batteries, and prevent busybodies from starting trouble.

(2) Use plenty of speed when ascending hills. This prevents pounding as well as the trouble of changing clutch to low gear. If pounding should occur, change to low gear immediately.

(3) When starting motor, see that clutch is out. You will save runaways by observing this.

(4) Retard spark before cranking. The engine may fire back and injure you. If you practice the left hand starting method, back firing is less dangerous.

(5) Cylinders should have a good supply of high quality oil. This will help prevent the motor from over-heating and burning the regular supply which will cause the piston rings to cut the cylinders.

(6) Inferior grades of lubricating oil cause carbon deposits on piston head, on points of spark plugs, and on combustion chamber walls. This carbon on the spark plug may form a short circuit, which will interfere with ignition. If this deposit becomes too thick, it will hold sufficient heat from one explosion to another to cause pre-ignition.

(7) When the motor is primed, if it does not start after being turned over the compression three or four times, there is no use to continue cranking, something is wrong.

(8) Throw off the battery switch when engine is not running. It will lengthen the life of the batteries.

(9) Turn on battery switch before cranking engine. Remember this will save labor and bad temper.

(10) Regular inspection of your engine will prevent much trouble and expense.

(11) Throw out clutch at sharp curves and corners. It will prevent accidents and skidding, which wears tires.

(12) It is not good practice to turn down the lights of an acetylene lamp. Better turn off gas and blow out flame instead of allowing it to die down. This keeps the small holes free from soot.

(13) Well inflated tires have longest lives. Full tires present less wearing surface to the road, and there is less risk of cuts and punctures.

(14) Back-firing in a two-cycle engine is generally caused by lean gas mixture.

(15) Carry a flashlight for working around an auto at night. It gives a brilliant light and is perfectly safe around inflammable or explosive materials.

(16) Never allow your motor to run at its maximum speed when car is idle. This puts an unusual strain on many parts of the engine and causes unnecessary wear.

Anti-Freezing Solutions for Motor Cooling Systems

Mixing 20 per cent wood alcohol gives gravity of 97 and will freeze at 5 above, while same quantity of denatured alcohol will freeze at 16 above.

Useful Information

TO TEMPER STEEL VERY HARD.—Water, 4 quarts; flour, 1 part; salt, 2 parts; mixed to a paste. Heat the steel until a coating adheres when dipped in the mixture, then heat to a cherry red and cool in cold soft water. The steel will come out white and very hard.

TO TEMPER STEEL ON ONE EDGE ONLY.—Dip the edge to be tempered into hot lead until proper color, then temper in ordinary fashion.

TO DRILL HARDENED STEEL.—Cover your steel with melted beeswax. When coated and cold, make a hole in the wax with a fine pointed needle or other article the size of the hole required, put a drop of strong nitric acid upon it; after an hour rinse off and apply again; it will gradually eat through.

A mixture of 1 ounce of sulphate of copper, ¼ ounce of alum, ½ teaspoonful of powdered salt, 1 gill of vinegar, and 20 drops of nitric acid will make a hole in the steel that is too hard to cut or file easily.

A small hole drilled at the end of a crack in sheet steel will stop it from growing longer.

ACID TESTS FOR IRON AND STEEL.—A simple acid test for iron and steel is made as follows: The sample to be tested should be filed smooth or polished. Then place it in dilute nitric or sulphuric acid for from 15 to 20 hours; then wash and dry sample. The best steel then has a frosty appearance, ordinary steel has a honeycombed appearance, and iron presents a fibrous structure in the direction in which it has been worked.

ANNEALING STEEL.—For small pieces of steel, take a piece of gas pipe, 2 or 3 inches in diameter, and put the pieces in it, first heating one end of the pipe and drawing it together leaving the other end open to look into. When the pieces are of cherry red, cover the fire with saw dust, use a charcoal fire, and leave the steel in over night.

IN TURNING STEEL OR OTHER HARD METAL.—Use a drip composed of petroleum, 2 parts, and turpentine, 1 part. This will insure easy cutting and perfect tools when otherwise the work would stop, owing to the breakage of tools from the severe strain.

TEMPERING RECIPES.—Resin, 2 lbs.; pitch, 11 lbs.; melted together and dip the hot steel into it.

Salt, ½ cupful; saltpeter, ½ ounce; alum, pulverized, 1 teaspoonful; soft water, 9 gallons. Never heat above a cherry red nor draw any temper.

By melting together 1 gallon spermaceti oil, 21 lbs. tallow, and ½ lb. wax, a mixture is obtained very convenient for tempering any kind of steel article of small size. Adding 1 lb. resin makes it suitable for larger articles.

TO HARDEN GRAVERS.—Heat in charcoal dust (not too hot) and plunge into a box of wet yellow soap. This renders the end of the graver very hard and very tough.

Strong sal soda water or soapy water is much better than clean water to use where water cuts are being taken, either on lathe or planer. When cutting brass, sweet milk is recommended as being better than either of the foregoing.

PERMANENT WHITEWASH.—Slake ½ bushel unslaked lame with boiling water, keeping it covered during process; strain it, and add a peck of salt dissolved in warm water, 3 lbs. ground rice boiled in hot water to a thin paste, ½ lb. powdered Spanish whiting, and a pound of clear glue, dissolved in warm water, mix well together and let stand for a few days. When used put it on as hot as possible.

CURE FOR BURNS.—Slake a lump of quicklime in water, and as soon as the water is clear, mix with linseed oil and shake well; this will form a thick, creamy substance. Bottled it will keep for months.

USE OF TURPENTINE FOR WOUNDS.—The machinist often cuts or bruises his hand and by having a small bottle of turpentine handy he can at once bathe the injured part which will relieve the soreness and perhaps protect from blood poisoning.

CASE HARDENING MIXTURE.—3 prussiate of potash, 1 sal-ammoniac; or 1 prussiate of potash, 2 sal-ammoniac, 2 bone dust.

AUTOMOBILE HORSEPOWER.—The horse power of gasoline automobiles adopted by the Association of Licensed Automobile Manufactures (A.L.A.M.) is as follows:

$$\text{Horsepower} = \frac{\text{bore} \times \text{bore} \times \text{number of cylinder.}}{2\frac{1}{2}}$$

For example, an automobile has 6 cylinders, the bore of each of which is 5 inches. The horsepower of such a car would be:

$$\frac{5 \times 5 \times 6}{2\frac{1}{2}} = 60 \text{ H. P.}$$

TO SOLDER WITHOUT HEAT.—Brass filings, 2 ounces; steel filings, 2 ounces; fluoric acid, ¼ ounce. Put the filings in the acid and apply the solution to the parts to be soldered, after thoroughly cleaning the parts in contact, then press together. Do not keep the fluoric acid in glass bottle, but in lead or earthen vessel.

TO SOFTEN STEEL.—Cover it with clay, heat to a cherry-red in a charcoal fire and let cool over night in the fire.

TO SOFTEN HARD CAST IRON FOR DRILLING.—Heat to a cherry-red, having it to lie level in the fire. Then with a pair of cold tongs put on a piece of sulphur a little less than the size of the hole to be drilled. This will soften the iron entirely through, providing it is not too thick.

TO SHARPEN REAMERS.—Use a stone on face and top of cutting edge, taking care to keep stone perfectly flat.

TO SHARPEN DULL FILES.—Immerse them in diluted sulphate acid until cuts are sufficiently deepened.

List of Tools

1 blow torch.
2 soldering irons, two sizes.
1 set of eight wrenches, to 1 inch.
1 set of carbon scrapers.
3 screw drivers, three sizes.
3 cold chisels, three sizes.
3 punches, three sizes.
1 set bearing scrapers.
2 monkey wrenches, 8 and 10 inches.
1 Billings wrench, 8-inch.
2 lbs. solder.
2 pints muriatic acid.
1 8-lb. vise.
1 volt meter.
1 tire gauge.
1 valve tap and die.
2 hammers, light and heavy.
1 sledge hammer, 5 lbs.
1 roll of tape.
1 spool of copper wire.
1 set auto cleve wrenches.
1 breast drill.
1 set drills, ⅛ to ¾.
5 gals. transmission oil.
5 gals. non-fluid oil.
5 gals. International cylinder oil.
5 gals. Fidelity oil.
25 lbs. hard grease.
1 ball asbestos wicking.
1 ball lamp wicking.
2 Trymo wrenches, 6 and 10-inch.

International oil and Fidelity oil mixed makes pan hard oil.

Hard Questions about the Automobile Plainly Answered

Question. What is the most important part of an automobile?

Answer. The steering apparatus, because you depend your whole life upon it, the same as a pair of lines.

Question. What is a clutch.

Answer. A clutch is a device to release the motor power from the transmission.

Question. When do you release a clutch, and how?

Answer. You release the clutch when starting, changing speeds, coasting, and putting on brakes. When starting your car you release the clutch clear out so as to stop the jack shaft, but after once running, and changing speeds, you only release far enough to release the motor power from the transmission, so as to not stop the jack shaft.

Question. How can you tell the way a motor fires?

Answer. By watching the exhaust valve on No. 1 cylinder open and close. Then watch for No. 2 and 3, the one that operates after No. 1, shows the way the motor fires. If it is No. 3, it fires 1, 3, 4, 2, but if it is No. 2, it fires 1, 2, 4, 3, always going to 4 the third shot.

Question. How can you find compression stroke dead center?

Answer. By watching the exhaust valve open and close on No. 4 cylinder, and then getting the dead center mark even with the center of the cylinder, you have compression stroke dead center on No. 1.

Question. How do you set a timer?

Answer. Put your No. 1 cylinder on compression stroke dead center, then set the timer just ready to make contact with one of the contact points.

Question. How many different ways can a four-cylinder motor fire?

Answer. It can fire two—1, 3, 4, 2; 1, 2, 4, 3.

Question. How do you adjust valve rods?

Answer. By putting No. 1 cylinder on compression stroke dead center, then adjust the intake valve and exhaust valve, so that you can slip a business card between the push rod and the valve stem, then turn the motor half over, and adjust the next cylinder that fires in the same manner, then turning it half over again you adjust the next cylinder that fires, and so on till you have them all adjusted.

Question. When should you adjust valve rods?

Answer. After doing valve grinding or before doing valve timing, or any time you hear a clicking coming from the push rods.

Question. How do you find the exact dead center of a fly wheel?

Answer. By putting No. 1 cylinder piston at the highest point, place a mechanical rule into the head of the cylinder there by dropping the piston one-quarter of an inch, then place a triam at the lower point of the fly wheel and to a counter punch mark made on the frame; make a temporary mark at the point of triam on fly wheel, then turn fly wheel the other way, dropping the same distance one-quarter of an inch, the same as the piston was on the other side, then place triam at the same counter punch mark, and then to the lowest point of the fly wheel make anothr temporary mark. Divide the distance between these two temporary marks on fly wheel, make a counter punch mark in the center; turn the fly wheel back until the triam will hook in the counterpunch mark on the fly wheel, and on the frame of the motor, then you are ready to place the exact dead center mark on the fly wheel at top even with the center of the cylinder, and a mark on the center of the cylinder to correspond with the mark on the fly wheel.

Question. What is a triam?

Answer. A triam is a quarter-inch rod cut 15 inches long, each end sharpened to a sharp point, one inch of each end bent to an agle of 90 degrees.

Question. How do you figure the degrees of a fly wheel?

Answer. Measure the circumference of the fly wheel in inches, and divide the number of inches into 360, giving you the degrees of 1 inch.

Question. What degrees does the exhaust valve close, and the intake valve open?

Answer. The exhaust valve closes between 5 and 10. The intake valve opens between 6 and 12.

Question. How do you set the cams on the cam shaft to make the valves open and close at the proper time?

Answer. By first adjusting the push rods so you can slip a business card between them, while the cams are in the clear, then turn the exhaust

mark even with the center of the cylinder, turn the exhaust cam up till it raises the push rod against the stem ready to leave, slip the gear on, then turn the intake degree mark even with the center of the cylinder, turn the intake cam up till it raises the push rod against the stem ready to open, and you have your cams properly set.

Question. How do you adjust a Schebler carburetor?

Answer. For a 20-H. P. motor, open the needle valve ¾ of a turn. For a 30-H. P., one turn; 40-H. P. 1¼ of a turn. Adjust your air valve till you have about ½ of its tension tightened. Start motor; leave spark retarded while the motor is running slow. Adjust the air valve till the motor hits regular, then open the throttle wide open. While the motor is running at high speed, adjust the needle valve until your motor hits regular, then throttle down and touch up your low speed again with the air valve.

Question. How do you adjust the Model F Schebler with a water jacket?

Answer. Open needle valve one turn. Tighten your air valve spring up about one-half, then start your motor; close your needle valve then till motor starts to missing, then open again till the motor hits regular on all cylinders; then adjust air valves till motor runs perfect at low speed; then open throttle half way, adjust the first adjustment screw on throttle till motor runs perfect; then open throttle wide open, turn the last screw on throttle till motor runs perfect at high speed.

Question. How do you adjust a Stromberg carburetor?

Answer. Let the gasoline fill up about ⅔ in the float chamber, by the adjustment screw above; then start the motor; tighten the light air valve spring about ½; then adjust gasoline till it stands about ½ while motor is running; open throttle wide open and adjust heavy air valve spring till motor runs perfect at high speed; then throttle your motor down till you almost count the explosions, adjust the light air valve spring till motor runs in perfect tune.

Question. What two things should be in first-class shape before undertaking to adjust a carburetor?

Answer. First see that your gasoline is flowing free and the ignition system is in first-class shape.

Question. Name the sound received from too rich a mixture or too weak a mixture?

Answer. When too rich, you have a sluggish, puffing sound; but when too weak, you have a low, hollow tone sound.

Question. Name the color of blaze we receive from too rich or too weak a mixture.

Answer. If too rich, we receive a red, smoky blaze; if too weak, we receive a yellowish green blaze.

Question. Name the proper color of blaze and the proper sound we should receive from the proper mixture.

Answer. We should receive a deep blue blaze and a sharp report, like two pieces of boards being slapped together.

Question. What is a vaporizer?

Answer. A vaporizer takes the place of a carburetor, can only be used on stationary gasoline engine satisfactorily.

Question. What is a "Homo" fuel mixer?

Answer. It is a device to mix air and gas more thoroughly; resembles a fan. Is found in the intake manifold just above the carburetor.

Question. What causes a pound, and what should you do when you hear it?

Answer. A pound is caused from something coming loose or broken. You must stop as soon as possible.

Question. If a motor runs nice on a level road, but knocks on a hill, what is the trouble?

Answer. Your spark is carried too far advanced. Retard your spark.

Question. What should a man do before undertaking to start a motor?

Answer. Heed this question! See that your lever is in neutral. This may save your life.

Question. What should you do going down hill if you come to an icy, slippery place?

Answer. In seeing this place ahead of you, release your clutch and brakes, and let your car coast over.

Question. What is the pressure of a horse power?

Answer. The pressure of a horse power is the pressure that will raise 33,000 pounds one foot high in one minute.

Question. How do you figure the horse power of a gasoline engine?

Answer. Square the diameter of the piston in inches, multiply 4-10 times the diameter, times the diameter, times the diameter, times the number of cylinders gives you the pressure of the horse power.

Question. How do you prevent carbon from gathering too fast?

Answer. By putting No. 1 and No. 4 cylinder on dead center, and squirting coil oil in the head of those two cylinders, leave stand over night, next night do the same with 2 and 3.

Question. How do you grind valves?

Answer. By taking a very fine emery dust, or powdered glass and mix it with oil until it is like a salve, then place it on the valve seat, turn the valve back and forth, raise the valve up every dozen turns, give it one-quarter turn, keep this up till you have a perfect seat, and the pits are ground out. Don't ever turn a valve round like you would a bit.

Question. How do you fix a broken shaft temporarily?

Answer. Place four pieces of iron or wood on each side, then wrap with wire tight, the same as a broken arm in splints; then fasten a wire or rope to the front universal joint, and wrap in the opposite direction from the way the shaft turns, and fasten to the back universal point, and you can drive home.

Question. How do you get in with transmission gears stripped out?

Answer. High is a speed that can't be stripped out on the most of transmissions. Throw into high speed, leave the clutch in easy, hold the speed of your motor high, till you get your car started, drive home on direct drive.

Question. How do you get in with the connecting rod broken?

Answer. Take off the cylinder, remove the piston and broken connecting rod; take out the intake push rod, put your cylinder back on, drive home on what cylinders you have left.

Question. What is the cycle of a four-cycle motor?

Answer. The cycle of a four-cycle motor is one which completes four duties in two revolutions.

Question. What is the cycle of a two cycle motor?

Answer. The cycle of a two-cycle motor is one which completes four duties in one revolution.

Question. What is the duties of a gasoline engine?

Answer. Exhausting, suction, compressing and explosion, one power stroke and three idle strokes.

Question. How do we scrape inbearings?

Answer. Take Persian blue paint and paint your shaft just as light as you possibly can get it on, place the shaft in the bearing or the bearing on the shaft, turn it around, then take it off, scrape off all points on bearings that paint rubs off on. Do this until the paint will rub even all over the bearings.

Question. How do you fix a cracked cylinder temporarily?

Answer. Get a powder that is called smoothon, mix with water till it is like mortar, rub it in the crack and smooth it over. When this become dry it gets hard like iron.

Question. How can you tell if the water is circulating?

Answer. By taking hold of the top hose on the raditor you can feel the water going through. Take off the radiator cap, sometimes you can see the water pumping in.

Question. How can you tell if your water pump is working?

Answer. Place a screw driver to the pump in your teeth, plug up your ears with your fingers, and you can hear if the pump is running or not.

Question. What is an air lock and where is it found?

Answer. An air lock is air lock between pipes by water, is found in the radiator, and caused by pouring water in too fast.

Question. What trouble does an air lock give, and how should we remove it?

Answer. It causes the water to boil and motor runs hot. The best way to remove it is to leave the water out and leave motor run while water is running out; fill your radiator slow.

Question. How do we loosen the piston on a motor that is stuck by gum, which is caused by poor lubricating oil?

Answer. If you have wood alcohol, pour it in the cylinders, work them up and down by hand till they turn free. If alcohol cannot be had, use coal oil; if not coal oil, use gasoline. Remove oil from crank case and pump, fill with a good grade of oil.

Question. How many pounds pressure should we pump a tire up?

Answer. 28x3, 30x3, 32x3, 60 lbs.
30x3½, 32x3½, 34x3½, 36x3½, 70 lbs.
30x4, 32x4, 33x4, 34x4, 35x4, 36x4, 37x4, 80 lbs.
34x4½, 35x4½, 36x4½, 37x4½, 42x4½, 90 lbs.
35x5, 36x5, 37x5, 100 lbs.
32x5½, 110 lbs.
41x6, 120 lbs.; in real hot weather make this about 8 lbs. less.

Question. What is an anti-freezing process and how do we mix it?

Answer. One-third wood alcohol, about one pint of glycerine, and the balance water; it is a solution we use in the radiator in winter to prevent it from freezing.

Question. How many kinds of intake valves have we?

Answer. Mechanical and automatic.

Question. If a motor runs strong on the level but fails on a short hill, what is the trouble?

Answer. Poor adjustment of the carburetor.

Question. What are the cams used for on a cam shaft?

Answer. To open the intake and exhaust valve.

Question. How do you fix a friction clutch temporarily if it was slipping on the road?

Answer. By driving something thin such as hack saw blades under the leather, you will be able to drive in.

Question. How do you equalize the brakes?

Answer. By jacking the car up, and tightening your brake rods just so that when the brake is locked a little it is just as hard to turn one wheel as it is the other.

Question. What causes tires to rot?

Answer. Setting in the light, driving over oily boulevards or allowing oil to gather on the casing.

Question. How should you turn a corner on a slippery street?

Answer. Release your clutch and allow car to coast.

Question. How should you cross street car crossings or other dangerous points?

Answer. Slow your car down until you have it under control. Look both ways and see that you have the clear, then cross over.

Question. Driving in a hilly country, what precaution should you take to keep your motor running cool?

Answer. After climbing the hill starting down the next, drop into first or second speed, throw off the switch and let the vehicle drive the motor, the water is circulating, the fan is running, the cylinders drawing in cold air, and the motor is cooling; just before reaching the bottom turn on switch. Your motor will start again.

Question. How do you vulcanize a blow-out?

Answer. The casing must be cut out in layers on the inside, build in from the bottom up with fire brick, then the outside must be built over with prepared gum, then it is ready for curing.

Question. How much heat should you carry on an electric vulcanizer?

Answer. Carry your heat at 260.

Question. How much heat do you carry on a steam vulcanizer?

Answer. 45 to 50 lbs., it depends on the kind of gum you use.

Question. If you break a rear wheel down how would you get home?

Answer. Put a pole under the rear axle, fasten it to some part of the motor which does not interfere with the working parts, tie the broken wheel to the pole, and the other wheel has got to turn. That way you can drive home on low speed.

Question. Can we run with coal oil and gasoline mixed?

Answer. Yes, half and half, but it is not practical.

Question. In getting in a mud hole, what would you do if you had no mud chains?

Answer. Throw a lap robe, hay or grass under your wheels.

Question. If you come to a muddy road where your car gets one wheel on dry land and the other in the mud, what would you do to get through?

Answer. Take the pin out of the brake rod of the wheel that is on dry land, and lock your brake just enough so that both wheels will have to turn, and drive on through.

Question. How can you tell low, intermediate and high speed and reverse speed on a selective type transmission?

Answer. A short slot of the shifting guide is always high, straight across from it is first speed, at the other end of it is second speed, angle ways across is reverse. With one without the guides the high will never shift back as far as the other three points, with the shifting lever.

Question. Describe the difference between a live and dead axle?

Answer. A live axle is one which turns, a dead axle is one used on trucks or double chain drives.

Question. Explain the difference between a semi-floating axle and a full floating axle?

Answer. The semi-floating axle cannot be removed without taking the axle out from under the car and taking the differential apart; the weight of the car is carried on the rear axle. The full floating axle can be removed by removing the hub cap and pulling the axle out the way the car is carried upon the housing of the rear axle, for your axles have nothing to do but the driving.

Question. What causes pre-ignition?

Answer. Pre-ignition is caused from carbon getting hot and igniting the gas from its condensed heat.

Question. What causes black and white smoke?

Answer. Black smoke is caused by too much gasoline; white smoke is caused from too much lubricating oil.

Question. How many different shorts can occur in a spark plug? Name them.

Answer. Grease or dirt, or cracked porcelain.

Question. If a motor runs good and hits on four cylinders when running idle, but misses on one when pulling, what is the trouble?

Answer. You have a slightly cracked porcelain in which the current jumps through on heavy compression.

Question. How should you carry the spark on the road?

Answer. From one-half you should advance it to as far as you possibly can. It depends upon the speed you are running.

Question. How do we clean a dirty magneto?

Answer. By taking it off and sousing it in a bucket of gasoline until you have all the grease washed out. Let it dry, oil its bearings and put back on.

Question. Should a magnet be set on an iron frame?

Answer. No, it should be set on brass, aluminum, copper, or some non-conductor.

Question. How do you test a unit?

Answer. Remove the unit that is not working, place one of the units that is working in the place of the one that is not working, and place the one that is not working in the place of the one that is working, and see if they will work *vice versa*.

Question. How do you adjust vibrator springs?

Answer. Short circuit your timer points one by one, and adjust each vibrator until you get a rich honey bee hum.

Question. A continued buzz in the vibrator, back firing in the carburetor, what is the trouble?

Answer. A continual buzz in the vibrator, back firing in the carburetor, the trouble is found in the commutator; is caused from the short at the timer, oil soaked wires, insulation broken, dirt built across the points of the timer, or wire laying on the frame of the motor.

Question. Give four causes of back firing through the carburetor?

Answer. Short in the timer, pre-ignition, improper valve timing, carbon under intake valve, weak mixture.

Question. How can you tell when the timer slips?

Answer. Your motor will lope or will not run at all, which can be told by putting No. 1 cylinder on compression stroke dead center, and see if your timer is just ready to make contact on the No. 1 point.

Question. What trouble does a worn-out timer give?

Answer. It makes the motor run irregular, more so when the motor is running fast; can be told by placing the finger on the end of the timer.

Question. What breaks a coil down?

Answer. Using more batteries than necessary.

Question. What causes a coil to burn completely out?

Answer. Too much voltage and the condenser not taking care of the current.

Question. What is a condenser for?

Answer. A condenser is to take care of the unnecessary current of the primary circuit, and to take care of the points of breaking and to prevent them from pitting.

Question. Do all coils have condensers?

Answer. No, only induction.

Question. What steps the current highest, induction coil or spark coil?

Answer. The induction coil.

Question. What is the difference between a spark coil and induction coil?

Answer. A spark coil has but one single winding. An induction coil has two, the primary and secondary.

Question. What causes a high tension current?

Answer. The primary current flowing over the wire creates a line of force, the breaking of the line of force creates a high tension current.

Question. How many dry cells should we use on a vibrating coil?

Answer. Not more than six.

Question. How many dry cells should we use on a magneto coil box?

Answer. Four is plenty.

Question. What do we test dry cells for, amperes or voltage?

Answer. Amperes.

Question. How do you test storage batteries and why?

Answer. We test a storage battery with a voltmeter; in testing it any other way we cause a current to rush out too fast and discharge the battery so fast that it would ruin your plates.

Question. How many amperes does a dry cell test when new?

Answer. Thirty amperes.

Question. How much voltage does a dry cell test when new?

Answer. One and three-tenths.

Question. What does a storage battery test to the cell?

Answer. Two and two-tenths.

Question. How do you time a magneto in itself?

Answer. Set the interrupter so it breaks one-sixteenth of an inch when it is broken in its full distance, then turn back till it is just ready to break; set the distributer one-third on, have the spark retarded, then slip gears on.

Question. Do we use batteries on high tension magnetos?

Answer. Not unless they have a coil box in connection.

Question. Will a Splitdorf magneto run without brushes on the magneto?

Answer. No because the current is fed from the magneto through the brushes.

Question. Will the magneto run on the batteries without brushes?

Answer. Yes, for the battery current does not pass through the brushes.

Question. How do you test the priming wires on a vibrating coil box?

Answer. Fasten the wires to the terminals of the units, and short circuit them one by one, and this way you can tell which wire is connected to which unit you desire to wire to your timer point.

Question. How can you tell the ground wire from a brush wire and the interrupter wire apart if the colors on a Remy coil would not show up?

Answer. Fasten the two battery wires together; turn your switch on the battery, strike your colored wires on your battery on the zinc and carbon; the only two that will spark together is the brush and interrupter wire,

the other wire is the ground. Take your ground wire and hold it in your hand or mark it, then turn the switch on the magneto, then place your ground wire on the zinc, and strike one of the other wires with it on the carbon, the wire that will spark with it is the interrupter wire, the other wire is the brush.

Question. How do you set the magneto when putting it on a motor?

Answer. Retard the spark; set your distributer one-third on, and set the interrupter just ready to break; put your No. 1 cylinder on compression stroke and set the magneto on, and secure it fast.

Question. How do you set a Uno sparker?

Answer. By having your No. 1 cylinder on compression stroke dead center, set the timer so it is ready to make contact with the spark retarded, then place the fiber lid over the top, place the distributer brush on and notice the direction it is pointing in and place the distributer on and the terminal it points to is No. 1.

Question. What is the difference between a make and break and a jump spark?

Answer. The make and break, the current is made and broken, the spark taking place at the point of breaking, and the coil not having a condenser. The jump spark is created by an induction coil, jumping across points.

Question. What is a magnetic spark plug, a make and break or a jump spark?

Answer. It is a make and break spark, the primary current passing through the plug creates a line of force in the plug causing a plate to become magnetized in the plug, breaking the points apart at the plug, breaking the line of force, produces a spark at the plug.

Question. Would it be a good plan to put two new dry cells with four old ones?

Answer. No, the four old ones would spoil the two new ones.

Question. Does it make any difference which side of your battery you connect to the ground?

Answer. No, it does not.

Question. What is the ground of an automobile?

Answer. The frame of the motor.

Question. Do we have to have ground on all systems?

Answer. We do, for the high tension current to travel back.

Question. How many different kinds of propelling vehicles are there?

Answer. Three—steam, gasoline, electric.

Question. Who invented the first four-cycle gasoline engine?

Answer. Booty Roe.

Question. What is a dual system?

Answer. Any two-circuit system.

Question. What is a complete dual system or double ignition system?

Answer. Two complete systems; if one may be wrong, the other is ready for work.

Question. Do two sets of spark plugs ever give trouble?

Answer. Yes, they become smutted up from not being used.

Question. What is meant by neutral?

Answer. Neutral is a point in which your lever stands when it is not in any speed whatever.

Question. Where do you locate the push rods?

Answer. Right below the valve stems.

Question. What causes back firing in the muffler?

Answer. Cracked porcelain, oil shorts in plug, carburetor not properly adjusted, worn out timer, platinum points, anything that will cause missing at the cylinder.

Question. What is a timer for on an automobile?

Answer. A timer is a device to time the time when sparks should take place in cylinder.

Question. What is an interrupter?

Answer. An interrupter is a device to break the primary current when the spark should take place in the cylinder.

Question. What is a distributer?

Answer. A distributer is a device to distribute the high tension current to the different cylinders as they should fire.

Question. What is a jump gap?

Answer. A jump gap is a device to take care of the high tension current in case a high tension wire comes off.

Question. Where are jump gaps found?

Answer. In high tension magnetos and some magneto coil boxes such as the Splitdorf.

Question. What are the magnets on a magneto for?

Answer. To give off a line of force to cross the armature, so a low current can be started by breaking the line of force.

Question. What voltage is there in six dry cells, hooked in series?

Answer. Seven and eight-tenths.

Question. What voltage is there in six dry cells hooked in multiple?

Answer. One and three-tenths.

Question. How many amperes do six dry cells test hooked in series when new?

Answer. Thirty.

Question. What are the one to two gear and the two to one gear used for?

Answer. The one gear drives from the crank shaft to the two gear on the cam shaft and the two gear drives to the one gear on the magneto.

Question. From what part of the cycle do we get power on a four-cylinder motor?

Answer. The power stroke only, which may be the first and it may be the last, it depends on where you start in.

Question. What is the definition of a cycle?

Answer. The definition of a cycle is anything completing the same number of duties, coming back to the same point of starting, has completed a cycle.

Question. In climbing a steep hill what do you want, force or power?

Answer. We want power.

Question. What are the essential parts of a gasoline car?

Answer. Power, plant, carburetor, magneto, or iginition system, transmissions, oiling system, differentials, radiator.

Question. What made the gasoline engine famous?

Answer. The timer.

Question. How is the body attached to the car?

Answer. Generally from four to eight bolts through the frame.

Question. How is the speed changed and checked?

Answer. By advancing and retarding the throttle.

Question. What is the principle of the differential gears?

Answer. The differential gears are so that one wheel can stand still and the other one run twice as fast in turning corners.

Question. What is to be done with a leaky float or oil soaked float?

Answer. If a copper float, take it out and solder it; if a cork float, take it and dry it and dip in shellac.

Question. How many different kinds of cooling systems are there? Name them.

Answer. Air, oil and water.

Question. How many water cooling systems are there?

Answer. Two.

Question. Name three kinds of transmissions?

Answer. Selective, progressive and planetary.

Question. Name four types of rear axle?

Answer. A dead axle, semi-floating, full floating, three-quarter floating.

Question. Name three types of differential?

Answer. Spur gear, bevel gear, universal.

Question. Where is the differential located in a double chain drive?

Answer. It is located in the center of the car, but you will find the differential and transmission together.

Question. What is the principle of a fly wheel?

Answer. To hold the vibration steady and to help your cranks over dead center, to hold your speed steady to help carry through the idle strokes.

Question. What is a two to one shaft?

Answer. A cam shaft to the crank shaft.

Question. What is meant by a mechanically operated valve?

Answer. A valve which is operated by some mechanical part of a machine, which is forced open.

Question. How is the mixture drawn into the cylinders?

Answer. By the suction of the piston.

Question. Name some carburetor troubles?

Answer. Leaky float, dirt in spray nozzle, pipe line stopped up, water in gasoline.

Question. How many speeds has a planetary transmission?

Answer. Two ahead and one reverse.

Question. What is a propelling shaft?

Answer. A shaft which drives from the differential to the transmission.

Question. What is the drive shaft?

Answer. A shaft with a sliding gear and a transmission.

Question. Where is the torsion radius rod used?

Answer. Beside the propeller shaft, from the transmission to the differential.

Question. What is meant by tappets?

Answer. Push rods.

Question. When an engine is hard to start, what is usually the trouble?

Answer. Not good compression.

Question. What is liable to be the sudden stoppage of an engine?

Answer. Primary wire coming off which breaks the primary current or the main high tension feed wire.

Question. How many valves has each cylinder?

Answer. Two, intake and exhaust.

Question. What advantage is there, if any, in reversing the current?

Answer. There is none.

Question. Name some of the simple magneto troubles?

Answer. Primary wires getting broken in two, weak batteries, batteries disconnected, bad platinum points, dirty magneto, weak magneto, magneto not timed properly, high tension wire coming off, poor connections in switch.

Question. Describe a T head motor?

Answer. A T head motor is the shape of a T with exhaust valves on one side, and intake valves on the other.

Question. Why would a motor pull on low speed and not on high?

Answer. The spark disconnected, carburetor not properly adjusted, spark not properly set, valves not properly adjusted.

Question. Why will an engine pull good on high speed and not on low?

Answer. Loss of compression, poor adjustment of carburetor, spark not set properly, weak magnetos.

Question. Why will a storage battery short out quicker than a dry cell?

Answer. A storage battery has no resistance.

Question. What is meant by a three-point extension?

Answer. A motor which is carried on three points.

Question. What is a primary current?

Answer. A primary current is the first current that flows.

Question. What is a secondary current?

Answer. A secondary current is the second current which is produced through the breaking of the line of force.

Question. How much of an air gap would you give a spark plug?

Answer. One thirty-second of an inch.

Question. What speed does a timer turn on a four-cycle engine?

Answer. One-half the speed of the motor.

Question. When is the master vibrator used?

Answer. It is generally used on vibrating coils; can be used on any system that is operated by a timer.

Question. What causes a motor to over-heat?

Answer. Poor circulation of water, poor circulation of oil, bad oil, or no oil at all, carrying spark too low, carbon.

Question. What indicates misfiring and finally stopping of the engine?

Answer. A gasoline pipe line being stopped up from the carburetor to the gasoline tank, the carbon getting under two or three valves, timer slipped.

Question. If the engine does not start what may be the matter?

Answer. No gasoline, no compression, no spark, timer not set right, spray nozzle stopped up, water in gasoline.

Question. How is the magneto grounded to the engine?

Answer. Through the frame or shaft.

Question. Explain how to reverse a motor?

Answer. By changing your cams on your cam shaft, to make them work in the reverse, which would not be a practical thing to do by no means.

Question. If an outer casing blows out on the road, what can be done?

Answer. If rope can be gotten, wrap the rim with rope and run in on the rope; if not, run on the rim.

Question. How is faulty valve timing made known?

Answer. Back firing through the carbureter, or in the muffler, the motor has no power.

Question. If your car should catch fire what would you do?

Answer. Smother it with dirt or rags; don't ever throw water.

Question. How do you clean carbon out of a cylinder?

Answer. By using carbonizer or taking the cylinder out, and scraping them out.

Question. How does the engine transmit power to the rear wheels?

Answer. From the fly wheel to the clutch, to the jack shaft, to the drive shaft, to the propeller shaft, to the master gear, to the bevel pinions, to the bevel side gears, to the rear axle, to the rear wheels.

Question. What is meant by changing speed gears?

Answer. Changing from first speed to second, and from second to high, which is direct drive.

Question. How are different speeds changed?

Answer. By going to first speed we release the clutch clear out, but from first to second and second to high we only release the clutch far enough to release the clutch from the motor power.

Question. Can the gears be changed when the engine is running?

Answer. Yes.

Question. Why does the clutch slip?

Answer. To prevent the car from starting suddenly.

Question. What is meant by direct drive?

Answer. Direct drive means the same as one shaft connected from the fly wheel to the master gear.

Question. Is there anything to make a brake hold if it is slipping on the road?

Answer. By tightening your brake rods or throwing Fuller's earth on the legging.

Question. Is there any other means of checking a car on a steep hill?

Answer. Yes, by filling it in low speed, and turning off the switch, running again compression.

Question. How are the cranks of two, four and six cylinders arranged?

Answer. The two cylinder cranks are 180 degrees straight across, four cylinders are 180 degrees, one and four together and two and three together, six cylinders are 120 degrees apart; one and six together, two and five together, three and four together.

Question. Explain the action of a pneumatic tire?

Answer. When the car is traveling, the air is traveling in the opposite direction, and if you strike any small object on the road the air gives back absorbing the shock.

Question. How are the tires kept on the rim?

Answer. Some are kept on by clinchers, and some are kept on by rings.

Question. Does the tire get hot when running on the road and what causes it?

Answer. Yes. It is caused from the hot sun and roads, and the friction of air.

Question. Can you fix a puncture inner tube temporarily on the road?

Answer. Yes, with a cement cold patch.

Question. How long should the cement be left to dry before the patch is put on?

Answer. Fifteen minutes.

Question. Is there any other way of mending inner tubes?

Answer. Yes, with a button that is made for the purpose, and by vulcanizing.

Question. Are light tires better than heavy tires?

Answer. They are for light cars, but not for heavy cars.

Question. Which will last the longest, the one with the air or the one with the punctureless process?

Answer. The one with the punctureless process will last twice as long.

Question. Will it ride as easy?

Answer. No.

Question. Can it be used over?

Answer. Yes, as many times as you like.

Question. Is it safe to run with a tire down?

Answer. No, it will ruin your inner tube and casing.

Question. May not this injure the steel rim?

Answer. Not if you don't drive fast.

Question. What sometimes causes radiators to leak?

Answer. Sometimes from the motor being hot and the radiator cooling off too quick allows the tubes to shrink from the tube sheet, loose radiators cause the solder to be jarred loose.

Question. Should a man think he knows all about an automobile when he has these questions learned?

Answer. No, not with a thousand on top of them.

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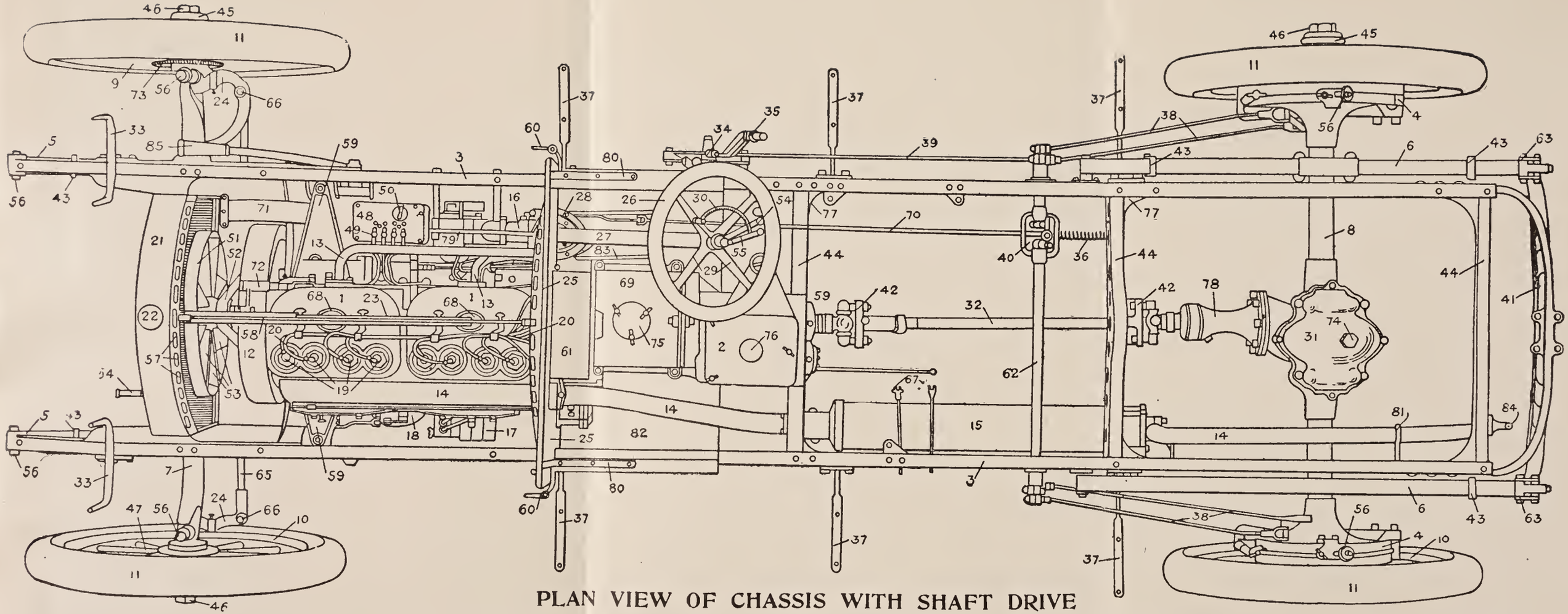

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