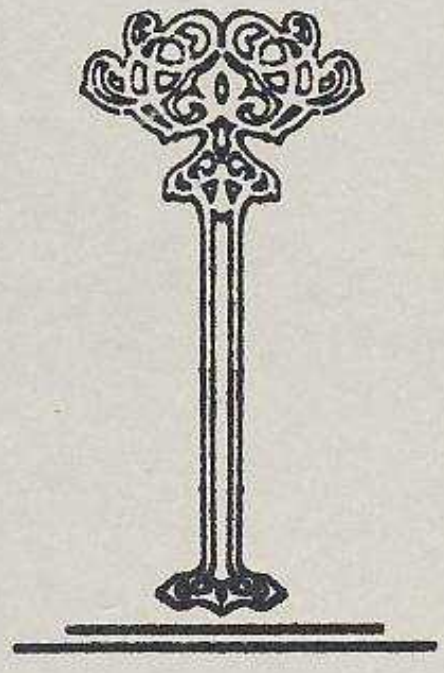
BRUSH

MODEL D

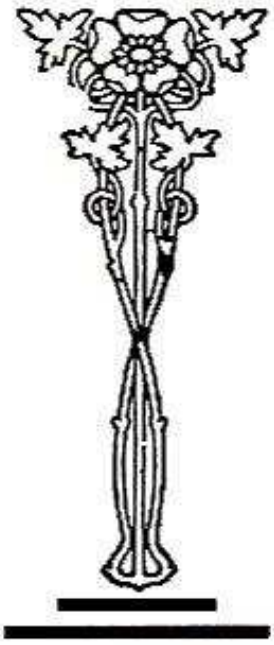
INSTRUCTION BOOK



Instructions for the Care and Maintenance of the

BRUSH

Brush Runabout Company
Detroit, - - Michigan



INTRODUCTORY.

The information and instructions contained in this book, together with a study of the car itself should give you a good working knowledge of your machine. We know from experience that it is very difficult to impart to a novice complete working information about an automobile by means of an instruction book, much less is it possible to tell, in any volume of reasonable size, all the things there are to know about automobiles. We suggest, therefore, that you not only familiarize yourself thoroughly with this book, but also get in touch with motor car users, experts if possible, and particularly with Brush owners, in order to learn as much as possible about your car.

Many of the points covered in this book may seem foolish to you if you have driven a car, but for the beginner they are absolutely essential.

The important points in the care of a car are,: to keep it sufficiently lubricated, particularly the motor; to clean up occasionally; to go over it at least once a week to see if any nuts, screws, wires, etc., are getting loose; to clean the cylinder and grind the valves once or twice a season; to keep it supplied with water and gasoline; to renew the batteries when they become weak, and last but not least, to treat it with due consideration. Do not tinker with any part of your machine unless you are reasonably sure it needs adjustment.

No motor car or other piece of machinery is proof against mis-treatment and while the Brush has fewer parts to be attended to than almost any other car, yet these must have attention to give the best results.

Again let the question of oiling be emphasized. A motor will only run a short time without oiling and all other parts need oiling more or less frequently.

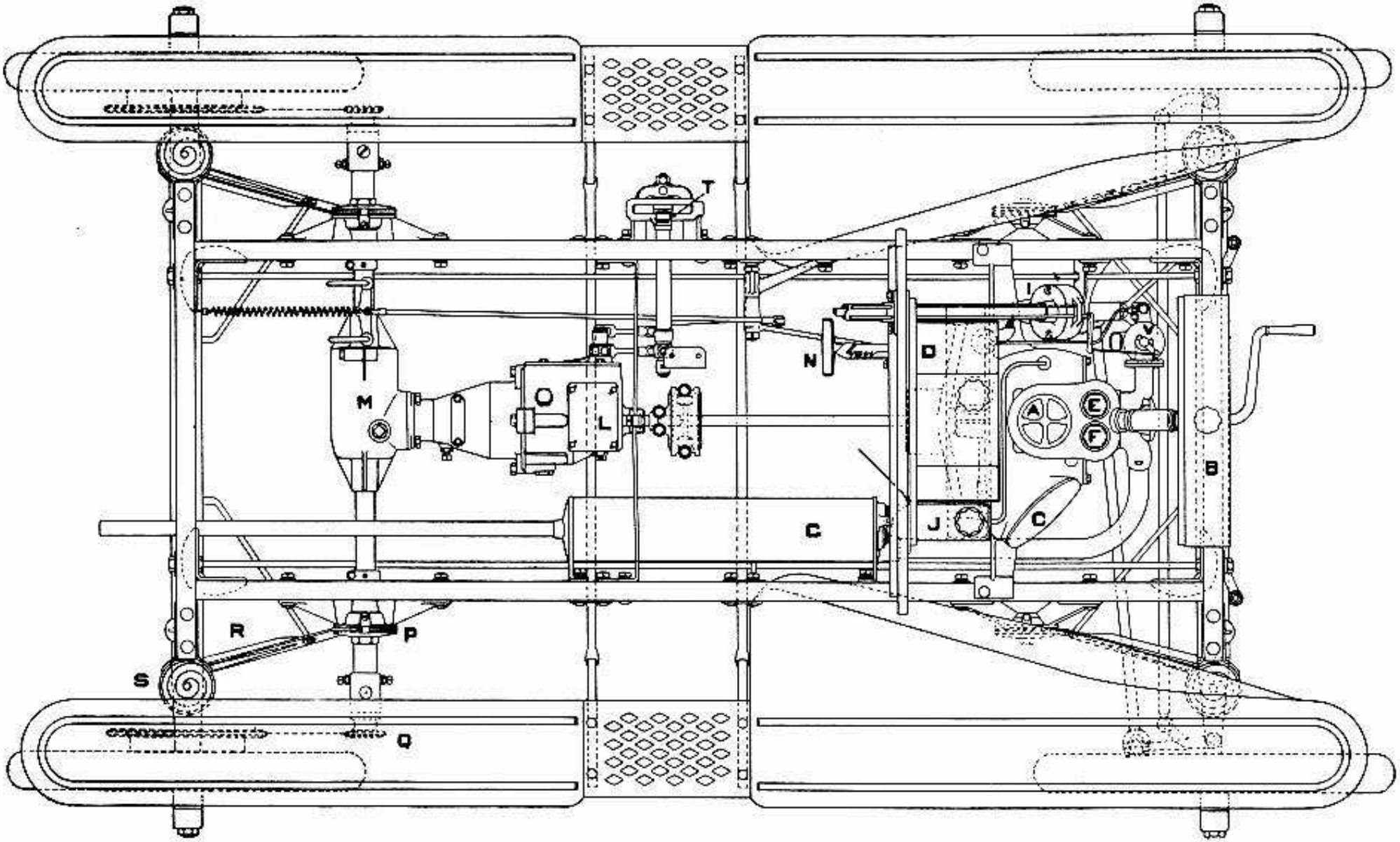
Before taking long and difficult journeys, become familiar with the operation of the car. Operating it will soon become as natural and instinctive as using your knife and fork.

For climbing a hill or going through mud or otherwise putting a hard load on the engine, open the throttle, that is, move the throttle lever forward and at the same time retard the spark, that is pull the spark lever backward. This point is explained further on and simple as it appears to those familiar with automobiles, we have found it a frequent source of misunderstanding on the part of a complete novice.

Remember the lubrication. Remember that the radiator must be kept supplied with water. Remember that the car will not run without gasoline nor with gasoline which contains much dirt or water. Remember that batteries play out in time.

Finally remember that every trouble has its cause, which may be more or less definitely regulated by the process of elimination. For example, if the piston sticks in the cylinder so that it is difficult to turn the engine over, this must be due to lack of lubrication and could not possibly be caused by the carburetor. If this happens you cannot fix it (as we have seen attempted) by adjusting the carburetor.

The spark coil is one of the last things likely to give trouble, at least until it becomes old and worn. It should not be tinkered with unless you are sure it needs it. The carburetor likewise should not be tinkered with unless you are confident it is necessary. It is not wise to adjust it without understanding the principles on which it works.



Chassis of the Brush. Fig. 1

Key to Sketch of Chassis.

A Cylinder Head (removable).
B Radiator.
C Hand-hole Cover on Crank-case.
D Gasoline Tank.
E Spark-plug Cap (removable) over Inlet Valve.
F Removable Cap over Exhaust Valve.
G Muffler.
H Starting Crank.
I Steering Gear.
J Lubrication Tank.
L Transmission Case.
M Differential Gear Case.
N Brake Pedal.
P Adjustable Friction-joint of Radius Rod.
Q Driving Sprocket.
R Radius Rod.
S Spring.
T Gear and Clutch Lever.
V Carburetor.

TREATMENT OF THE NEW CAR.

Water—On receiving your car from the factory and **before you have made any attempt to start the motor,** fill the radiator. In temperate weather use pure soft water. At the very approach of cold weather put a good anti-freeze mixture into the radiator. One of the simplest and best is a mixture of 40 per cent. wood alcohol and 60 per cent. water. In replenishing the evaporation use half and half. This mixture is safe down to about zero weather. Below that use more alcohol. Leave this in until the last danger of frost in the spring. Should the water in the radiator and cylinder jackets be allowed to freeze, both engine and radiator might very

easily be ruined. Water containing alkali is not fit to use for cooling purposes, as it will leave a coating in the cylinder jackets and radiator tubes.

To fill gasoline tank always be sure there is no dirt or water in the gasoline, as both of these are very troublesome. This trouble will be overcome by always straining gasoline through a chamois skin.

Fill the dash oiler with a good grade of high fire test gas engine cylinder oil.

Put a little over half a pint of cylinder oil in the crank case before starting for the first time. More than this will do no damage but will be blown out through the valves and make things more or less greasy. After that about 7 or 8 drops a minute from the dash oiler will be sufficient for the engine lubrication for ordinary speeds, say 16 or 17 miles per hour. In running the motor faster for a continuous period, let the oil drop faster. The oil feed is by gravity. Pulling the little lever on top of the dash oiler up into a vertical position turns the oil on. **Be careful to turn it off when you stop.** Adjustment of the flow is by turning the knurled round nut.

Transmission should be lubricated as follows: On receiving car (although same has been filled with oil before leaving the factory) put about a half pint to a pint of engine oil into the transmission by taking off the square lid. In hot weather, or in case the clutches are a little too abrupt, non-fluid oil (not dope) may be used. Put more oil in occasionally, say every 500 miles. Inspection will tell when it is needed. There should never be more than a pint in the case. Clean out occasionally with kerosene, and drain through the plug underneath.

The differential is filled with grease when it leaves the factory and will not have to be filled for some time. When it needs filling, the plug may be removed from the top of the case. The grease cups

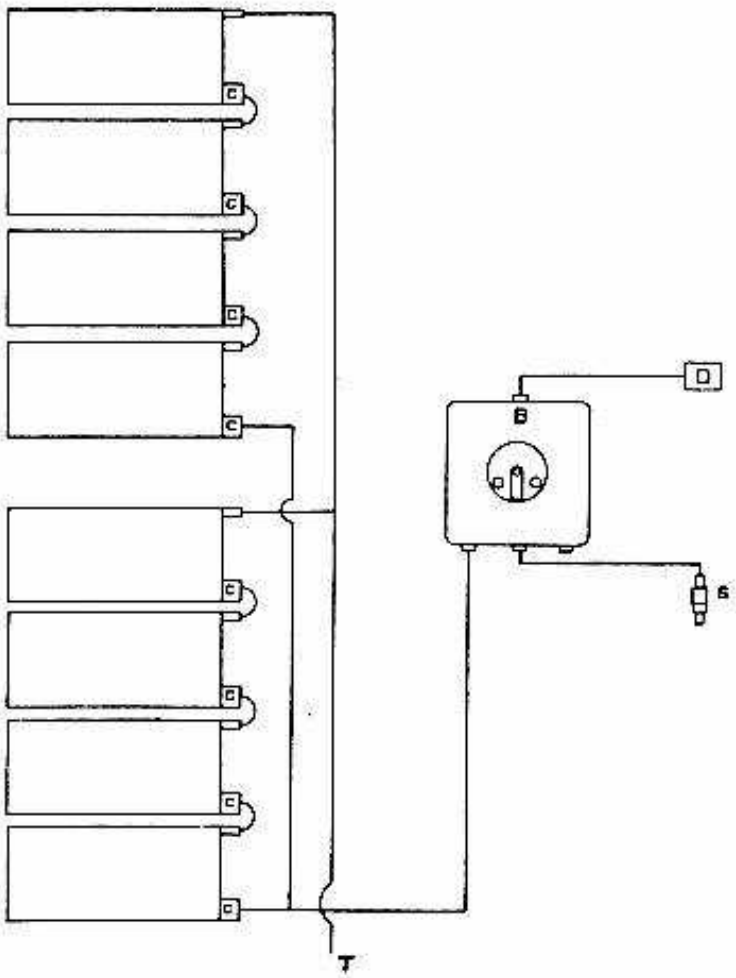
over the friction joints at the radius rod brackets should be kept filled. The grease cups on each side of the differential, on the right hand side of the transmission and elsewhere should be filled and screwed down a couple of turns. When the car is in use, they should be given a couple of turns every fifty to seventy-five miles, and when turned down as far as they will go, should then be removed and filled again.

The oil cups in the steering knuckles should be kept well oiled. Occasionally put a drop of oil in the notch on the front side of the hub just under the steering wheel. Put grease in the steering gear by removing the plug in the top of the steering gear housing. Put oil in the oil cup at the lower end of the steering post, and the oil cups in the brake shields. The brake equalizer consists of two rods running across the car below the jackshaft, and telescoping one with the other. Oil the joint through a hole on top.

Wherever there is a compression cup, use grease. In spring closed cups use oil. There are numerous places with no cups where a drop of oil occasionally is a good thing, such as the joints of the pull rods, spark and throttle levers, etc. In general **use oil wherever there is friction.**

Use plenty of oil and grease. Too much oil can do no more than gum things up or soot the spark plug. Too little oil will cause a great deal of damage. Therefore, until you are familiar with the right quantities, use rather too much than too little.

When you have stocked up with gasoline and water **and have oiled everything in sight,** see that the wiring is in accordance with diagram.



Wiring Diagram

B is the coil box on the dash, CC carbon terminals of the batteries. D commutator, S spark plug and T the ground wire connected to the engine base. Go over all connections, making sure that they are secure, and you are ready to start the motor.

THE MAGNETO.

Model D Roadsters are regularly equipped with Bosch Magnetos, and any model D engine may be equipped with magneto by taking the motor out of the car and putting on a side plate with gears

to drive the magneto and a bracket to support it. Magneto equipment can be furnished with Model D Runabouts if so ordered.

Battery and magneto systems can be used at the same time.

The magneto runs at the speed and in the same direction as the motor.

The gears and their bearings are oiled by the splash of the engine and require no attention.

The magneto armature has ball bearings and four to six drops of oil should be put into the oil holes covered with brass plates marked "Oil" about once a month. A little oil should also be put on the coupling between the armature and its driving shaft.

The magneto has **two electrical connections,** one from a post on the coupling end of the magneto, and one from a post on the breaker box on the front end of the magneto to a switch on the floor board near the dash. When this switch is open the magneto will produce a spark at the spark plug if the engine is running or being turned over 60 or 75 revolutions per minute by the starting crank. Close the switch to stop the engine. The magneto spark can be advanced and retarded and, in starting a motor with the magneto, it is necessary to advance the spark about half way on the quadrant, as a spark is not produced so quickly when the motor is running very slowly.

The distance between the points of a spark plug when used with a magneto should be not less than a sixty-fourth nor more than a thirty-second of an inch.

On the front end of the magneto is a brass cover held in place by a flat spring and post. Turn the spring, remove the cover and rotate the armature slowly and observe the movement of the make and

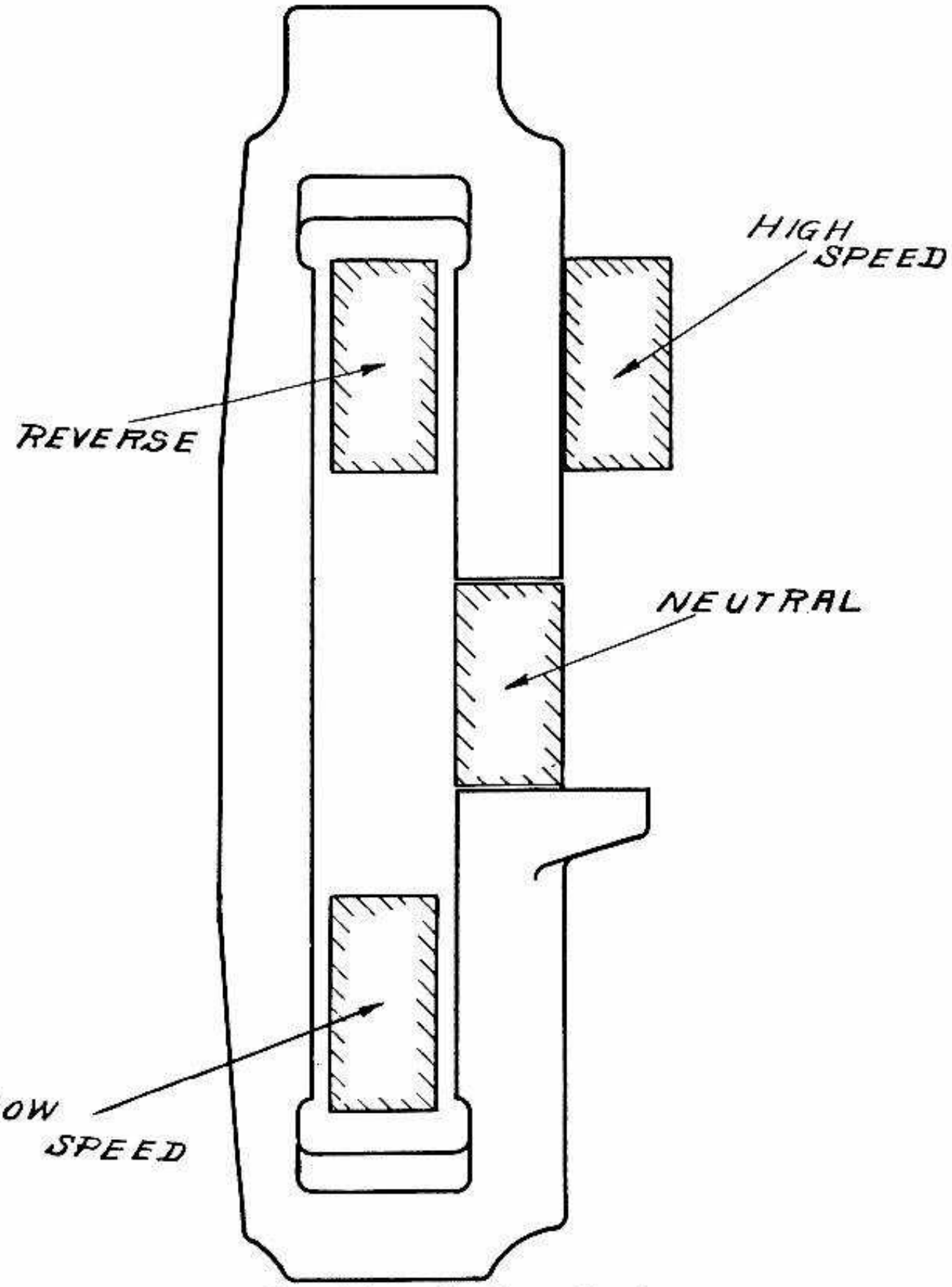
break arm. The distance between the points when the contact is broken should be about one one-hundredth of an inch or about the thickness of a business card. Be sure that the points make contact when they come together. Oil or water on the points will prevent the magneto from working as there must be a clean break at the points to get a good spark at the plug. The spark at the plug occurs at the instant that the break is made. In timing the magneto the spark control should be retarded the full amount allowed at the breaker box, the piston being on the upper dead center and the break should occur immediately. The magneto gives a spark at each revolution of the motor, one of which is used to ignite the charge, the other occurs just before the exhaust valve closes and is wasted.

To use every spark made by the magneto it would be necessary to run half the motor speed, which would be too slow to give a good spark for starting the engine.

Keep the magneto clean and dry—should it then give trouble, take it to a competent repair man to put it in order.

CONTROL.

Before driving the car or even starting the motor, make sure that you understand the action of the selective hand lever, foot brake, throttle and spark levers. The hand lever, beside moving forward and back, moves sidewise, and operates as follows: Outside back is low speed; outside forward reverse; inside forward, high speed. When released from any position the hand lever should throw itself into neutral, which is half way between the inside and the outside position, and in such a place that it can



Control Lever Positions. Fig. 2

be pushed **neither** forward nor back. Try shifting this lever into each position several times, especially shifting from low speed position into high. After a little practice you will find it easy to do with one push forward and in.

Try the action of the foot brake until your foot finds it readily.

The spark and throttle controls are on opposite sides of the steering staff, the throttle being on the right hand side and spark on the left. When the two levers are pushed back towards the seat as far as possible, the throttle is closed and the spark retarded. The throttle is opened and the spark advanced by pushing the respective levers forward.

Pushing the foot pedal part way forward releases the clutch, allowing the car to coast. Letting the foot pedal back, allows the high speed clutch to engage again. Pushing the pedal all the way forward sets the brakes. Always do this with some care, not abruptly.

TO START THE MOTOR.

To start the motor, close the switch, push the spark lever as far back towards the seat as possible, and push the throttle lever nearly back. See that the change speed lever is in neutral position and **that the brake is locked.** Notice that this motor cranks counter-clockwise, that is, as you stand in front, facing the radiator, the crank turns in a direction opposite to the movement of the hands of a clock.

Push the starting crank in, turn it slowly until you are sure the ratchet has caught securely. Turn the motor over until you begin to feel compression, then pull up sharply past compression but without jerking. If the motor fails to start on the first ef-

fort, turn it over quickly three or four times. There is a little knack to cranking, soon attained with practice. Don't crank the motor with the spark advanced (that is with the spark lever forward) as in that case the explosion will occur before the piston reaches the top of its stroke and the engine will kick back.

Always crank with the right hand. If you keep your knees out of the way, there is practically no danger from a possible back kick, for it would only throw your hand out of the way instead of in, as would happen if you were to crank with the left hand. Incidentally it was to get the use of the right hand in cranking and at the same time make it practically impossible to get hurt in case of a back kick that the motor was designed to run counter-clock wise, that is, just the opposite direction from most motors.

In cold or wet weather, if there is trouble in starting the motor, prime the carburetor by a few pulls on the wire that pushes the cork float down and allows more gasoline to flow through.

If that does not work, pour a tablespoonful of gasoline into the cylinder by removing the valve cap or spark plug. Heating the cylinder by putting hot water into the radiator will cause it to start easily.

With different motors, different positions of the throttle may be more favorable for starting. A little experience determines this.

As soon as the motor starts, advance the spark. A late or retarded spark heats the cylinder unnecessarily, and, if continued for any length of time, will prove very detrimental. It also wastes gasoline.

For proper driving (the condition best for the motor and most economical of gasoline) the spark should be advanced as far as possible without getting a knock.

DRIVING.

To start the car, release the brake, open the throttle slightly—thus speeding up the motor a little—and pull the hand lever gently out and back until you feel the slow speed clutch begin to engage. Very gradually put more pressure on the hand lever until the car is well under way. As soon as the car is well started throw out of low speed into high, that is push forward and in at the same time, being careful not to go by mistake into reverse, which is forward and out. It would be difficult to tell you just what speed to attain before going into high. Experience will teach you. You may stall the motor a few times at first, and if you do, set the hand lever in neutral position, retard the spark, set the foot brake and take a fresh start. After a little practice you will be able to throw in the high speed clutch after the car has gone two or three times its own length. In driving, regulate the throttle and spark so as to attain the desired speed and at the same time have the motor running smoothly.

To stop the car, pull the hand lever into neutral position and apply the brakes. Apply them gradually in either case, for they are very powerful, and by clamping them and skidding the wheels, not only are tires worn out needlessly, but the effect of the brakes is lost.

When the wheels are locked and begin to slide there is less stopping action for the car than when the wheels are turning slowly but are being retarded by the brakes, therefore when the wheels lock and skid, release the brake and engage it again less violently.

To reverse—Having first come to a dead stop, release the brakes and with motor running about the same speed as in starting, gradually push the hand lever into reverse position.

When coming to a standstill from low speed or reverse, be careful to release the clutch before applying the brake. The brake pedal interlocks **only with the high speed clutch,** not with low or reverse.

To stop the motor open the throttle and as the motor accelerates, throw off the switch. In leaving the car standing, whether the motor is running or not, always be sure that the brakes are set and the hand lever in neutral position. Some Brush owners stop merely by setting the brake and leave their cars temporarily with the hand lever not in neutral position, but merely held back by the foot pedal. This is bad practice. Put the hand lever in neutral. When you leave the car at the curb with motor running, close the throttle, and see that the spark is in such a position that the motor runs quietly and easily.

Do not begrudge a few moments spent at first making starts, using the brakes, reversing, turning corners, and in short familiarizing yourself with the entire operation of the car before attempting a run of any length. You will not fully appreciate motoring until you have become so thoroughly acquainted with the car that its operation is second nature to you. This will take a surprisingly short time if you go slowyly at first and study the behavior of the car carefully. Control the speed of the car by means of the throttle and spark and by slipping or temporarily releasing the high speed clutch in preference to using the low gear. The high gear or direct drive is easier on the engine and entire car.

Take ordinary grades at a comfortable speed on the high gear, opening the throttle as you reach the grade. Do not rush hills, but if you find the grade too steep for the high gear and that you are overworking the motor, resort to the low gear. A little practice will tell you when to use the low.

The steering gear is so nearly irreversible that a very slight touch on the steering wheel is all that is necessary, except in turning corners when a firmer hold is necessary.

Use care and moderation when rounding corners.

Care in avoiding sharp stones, suspicious sticks that may have nails in them, broken glass, switch points and rail joints in car tracks, etc., will prolong the life of your tires. Keep oil and heat away from tires as much as possible. Keep them well blown up. Go over the little cuts in them and pick out the flinty pieces of stone that lodge in these cuts. If the car is to stand in a barn for some weeks, jack it up and deflate the tires.

From time to time examine the brakes and see that they are adjusted alike. Tires are spared by careful use of the brakes and moderate driving, especially around corners.

The **Brush motor** is of the four-cycle type, with a single cylinder having a bore of 4 in. and a stroke of 5 in. Both inlet and exhaust valves are mechanically operated. The four-cycle engine is often spoken of as a 4-stroke engine; i. e., there are four strokes or two revolutions to every explosion. The first stroke down the inlet valve opens, gas is admitted to the cylinder; the second stroke is up, compressing this gas. At the end of this compression stroke the gas is exploded, pushing the piston down, thus making the third stroke the working or expansion stroke. The fourth is the exhaust stroke, during which period the burned gases are forced out through the open exhaust valve. The first, second and fourth strokes are carried by flywheel momentum.

The time of events in the Brush motor is as fol-

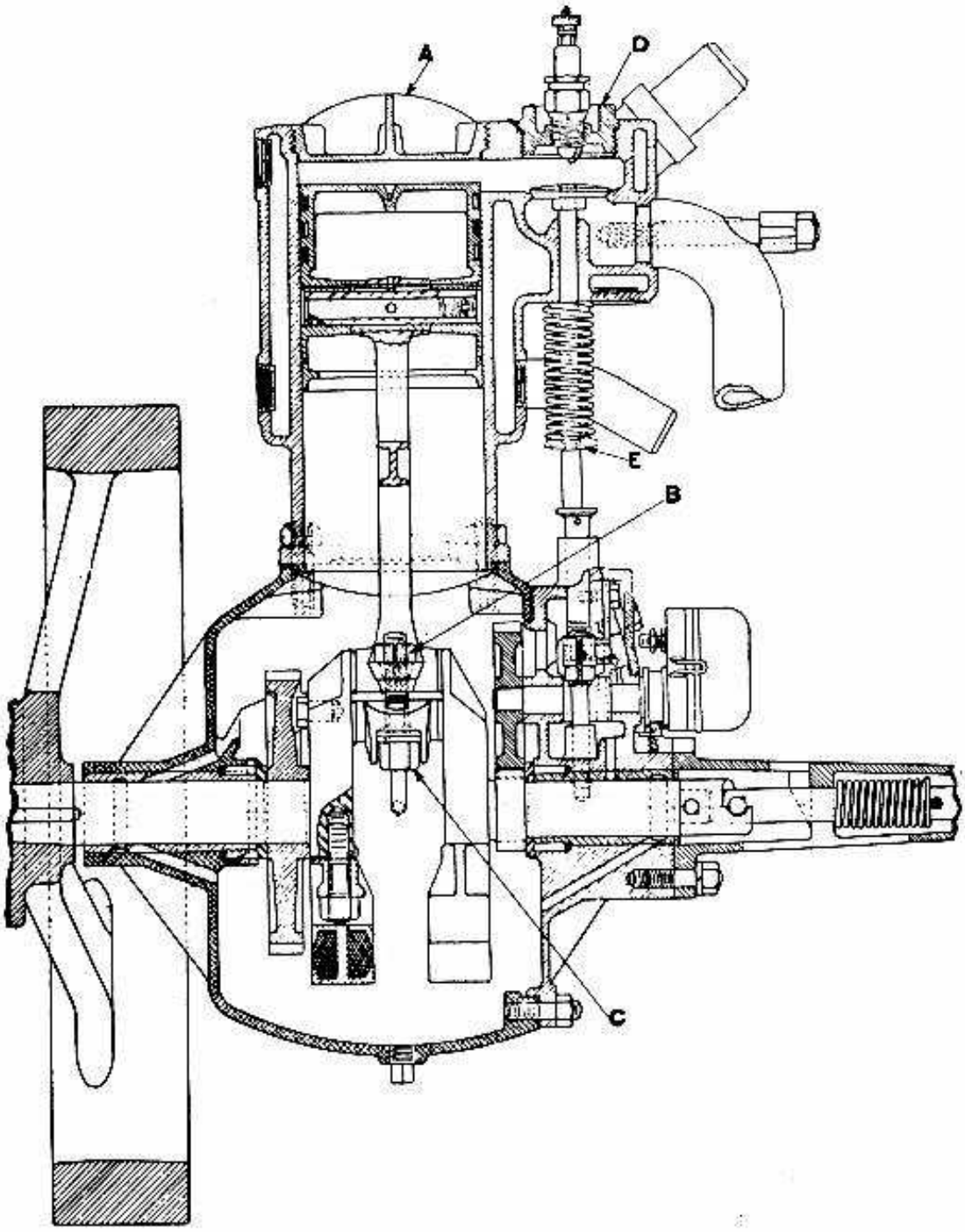


Figure 3.

Sectional View of the Brush Motor.

lows: Inlet valve opens after the piston has moved down 1-16 inch past dead center and closes when the piston has moved up 13-16 of an inch on the second stroke. The spark should occur a little before or after the end of second stroke, depending on the speed of the motor and regulated by the position of the spark lever.

The exhaust valve opens 7-16 of an inch before the end of the third stroke and closes 1-16 inch after the end of the fourth stroke; i. e., just before the inlet valve opens.

When the piston is moving slowly, as when the engine is being started, should the explosion take place before the piston has reached the top of its stroke it will kick the piston back, making the shaft revolve once or twice in the wrong direction. This is the back kick which occurs when the operator tries to crank the motor with the spark too far advanced, that is, too early. However, it takes a certain length of time for the spark to ignite the charge in the cylinder, and for that reason when the engine is running fast it is necessary—for economy and maximum power—that the spark should take place well before the top of the stroke so that the explosion will occur immediately after the piston has passed dead center, in other words, at the point of highest compression. If the explosion occurs when the piston has traveled a quarter or half way down, the gas has already expanded to such an extent that the explosion has much less energy in it and at the same time has less stroke in which to exert its power. Hence the lack of power on a late spark. Aside from causing a loss of power the late spark overheats the motor.

The lubrication of the engine is accomplished by means of a gravity feed lubricator on the dash, through the sight feed on the dash and then through

the single lead and through a ball check valve to the left side of the crank case. From here the oil is carried by a channel cast in the crank case to both sides of the engine. On one side the lead is direct to the crank shaft bearing. On the other side the oil is fed into the cam case (thus keeping the cams thoroughly lubricated) and from there the oil leads to the other crank shaft bearing. The surplus oil from these two bearings drips into the crank case and by the splash system is distributed to the connecting rod bearings and the cylinder. In case oil does not feed through from the sight feed, take out the ball check valve and wash with **gasoline.**

If at any time it is desirable for any reason to see the inside of the cylinder, the cylinder head "A Fig. 3" may be removed by merely unscrewing. Put a piece of round steel ½" dia., about 6" or 7" long, against the **reinforced portion** of one of the ribs and strike it till the head is loosened. If it is obstinate, tap it a few times on top with a hammer. The piston and connecting rod may at any time be taken out through the top of the cylinder. To do this, take off the hand hole cover "C Fig. 1," unscrew nut "B Fig. 3," remove the cap screw "C Fig. 3," and the piston and connecting rod may be taken out.

If the cylinder head leaks a little, tighten it while the engine is still hot.

To adjust the connecting rod bearing, loosen lock nut "B" a couple of turns and while rocking the flywheel back and forth an inch or two, tighten up screw "C" till the bearing begins to bind very slightly. This can be very readily detected by means of the flywheel. When the bearing begins to bind, back the cap screw off 1-6 of a turn and lock the nut "B," the bearing will then be in proper adjustment.

To inspect the spark plug, disconnect the wire and remove plug and inlet valve cap intact "E" Fig. 1. To avoid the necessity of removing spark plug from a hot cap, an extra cap with a clean spark plug in it may be carried.

The exhaust valve cap "F Fig. 1," may be removed in the same manner as the inlet valve cap. In replacing either of these caps merely screw down until they seat firmly. No great pressure is required as the seats of both caps are ground in.

In replacing the cylinder head or valve caps, use a little powdered graphite on the threads so that they will not burn tight.

The exhaust or inlet valve may be removed in a few seconds as follows: Remove the cap above it as described, and then having the valve closed, raise the spring retainer on the lower end of the valve stem, and remove the slotted washer "E Fig. 2." When this is done the spring and spring retainer will drop off the valve stem and the valve may be removed through the opening directly above it.

Should it be necessary to grind a valve, great care should be used. Mix a little finely powdered glass or very fine emery dust with enough oil to form a thin paste. Use a small quantity of this to grind in the valve, being very careful not to get any in the cylinder or on any bearing; also use great care to apply pressure only to the center of the valve so that it will not be ground unevenly. Wash carefully afterward.

CARBURETOR.

An understanding of how and why a carburetor works is very valuable.

Liquid gasoline is not explosive; it must be vaporized and mixed with air to become so. Gasoline

is so volatile that when air passes across it, the air carries vapor from the gasoline along with it, thus forming an explosive mixture.

A carburetor consists of:

(1) A vertical tube or jet containing gasoline, and open at the top;
(2) Means for maintaining a constant level of gasoline in this jet;
(3) Means for increasing or restricting the quantity of gasoline that may flow through the jet;
(4) Means for causing the air to pass across the jet, thus carrying gasoline vapor into the motor with it;
(5) Means for increasing or restricting the flow of air past the gasoline jet;
(6) Means for regulating the total amount of the final mixture which may go into the cylinder.

A constant level of gasoline in the jet is maintained by reason of the jet having a passage-way connecting it with a constant level fuel cup. The level of gasoline in the fuel-cup is maintained by means of a cork float, which is connected with a little valve in the pipe from the gasoline tank. As the gasoline level in the fuel cup rises, it carries the float up, and the float closes the valve, and thus cuts off the supply. As the gasoline level goes down, the float lowers and opens the valve, thus letting in more gasoline.

The amount of gasoline that may flow through the jet is varied by means of a needle-valve, that comes up through the center of the top of the carburetor. Turning this valve to the left permits more gasoline to flow through the jet, and the mixture becomes richer. Turning it to the right has the opposite effect.

The regulation of the amount of air flowing past the jet also changes the quality of the mixture—more air moving slowly making a leaner mixture, and less air moving faster, a richer mixture. The faster a given volume of air moves past the jet, the more gasoline it takes up. This adjustment is very difficult for an amateur to make, and seldom requires any change from the way it left the factory.

A greater amount of air should pass the jet at high motor speed than at low motor speed. This is because, as stated above, fast moving air makes a richer mixture; consequently as the motor runs faster and pulls the air through faster, the volume of air must be increased or else the mixture will be too rich. This is generally regulated by some automatic means, interconnected with the throttle, (which controls the total amount of mixture that goes into the cylinder) so that as the throttle is opened, the quantity of air that flows past the jet is also increased.

If this were not so adjusted, when the throttle is open the extra speed with which the air must pass through would make the mixture too rich.

As stated above, the air regulation should not be changed by the amateur.

Adjustment of the gasoline, however, is easy, and should be made to meet varying climates and seasons; usually one setting for a somewhat leaner mixture for summer, and another setting for a slightly richer mixture for winter, are all that is necessary.

The proper adjustment of the needle valve is usually about three-quarters of a full turn from dead shut. To get this adjustment just right, start the motor. If it will not start at three-quaretrs of a turn of the needle-valve, try different positions until it does start. Then open the throttle

wide, retard the spark, and adjust the needle-valve very gradually one way or another, until you get it to a point where the motor runs at the maximum speed. Then lock it in place.

Symptoms of too rich a mixture are:

A smoky exhaust (not oil smoke);
Sluggishness;
Lack of snap;
Inability to pick up promptly;
Inability to run fast;
Tendency to choke up and stop when the throttle is opened suddenly.

Symptoms of too lean a mixture are:

Difficulty in starting;
Back firing, or explosions in the carburetor and muffler;
Inability to pull well at low motor speed;
Liability to stop, if throttled down.

Continuous cranking and priming when motor is balky, often floods the carburetor. This is seen by gasoline dripping down from the bottom of it. In this case, either wait until the gasoline has evaporated or else close the needle valve and then crank the motor. When enough of the excess of gasoline has been carried away, it should start. As soon as is starts, adjust the needle valve as above instructed.

INSTRUCTIONS FOR ADJUSTING CARBURETOR.

After having connected Carburetor to motor, start motor, advance spark lever one-fourth of its travel, move throttle lever to high speed and adjust needle valve so that motor gives best results with least consumption of gasoline.

Should motor start hard, close butterfly in air

intake by means of priming rod ("O Fig. 1") while cranking. This will make it possible for a rich charge to be taken through the manifold to the cylinder, thereby insuring easy starting.

For cold weather a tube may be used between the air intake of Carburetor and the exhaust pipe or any other place where warm air can be taken.

To remove transmission, disconnect the cross shaft from the interlocking device. Remove the cap screw in the coupling next to the transmission. The transmission may then be removed from the car by merely removing the nuts from the four studs which hold it to the differential. If there are any gaskets between transmission and differential, take care not to lose them and be sure they are replaced when the transmission is put back in the car. Should these gaskets be lost, the alignment of the bevel gears would be changed and they would probably run noisily.

In case it is at any time necessary to take the transmission apart, first remove the high speed clutch yoke through the hand hole in the top of the transmission case, then by merely taking the nuts from the four studs which hold the two halves together, the front half may be lifted off and the gears, shaft and clutches removed as a unit. In doing this be very careful not to lose the small steel thrust washer at the end of the straight propeller shaft and inside of the bearing in the gear mount. In reassembling be exceedingly careful to put every part back in its original position, especially this **thrust washer.** When the transmission has been reassembled and placed in the car be sure to fill it with non-fluid oil before using the car.

To remove the differential, take off the chains. Remove the two set screws from the sleeve immediately inside of the small sprocket, thus freeing the

jack-shaft-bearing bushing. This allows the jack-shaft with sprocket and bushing to be drawn out as a unit. Then remove radius rod and bracket on left side and slide the differential out on that side.

To dampen the action of the spring, tighten the nut on the outside of the radius rod bracket. In the case of the front spring, there is a lock nut on the inside of this bracket which must be loosened before the adjustment can be made, and tightened afterwards.

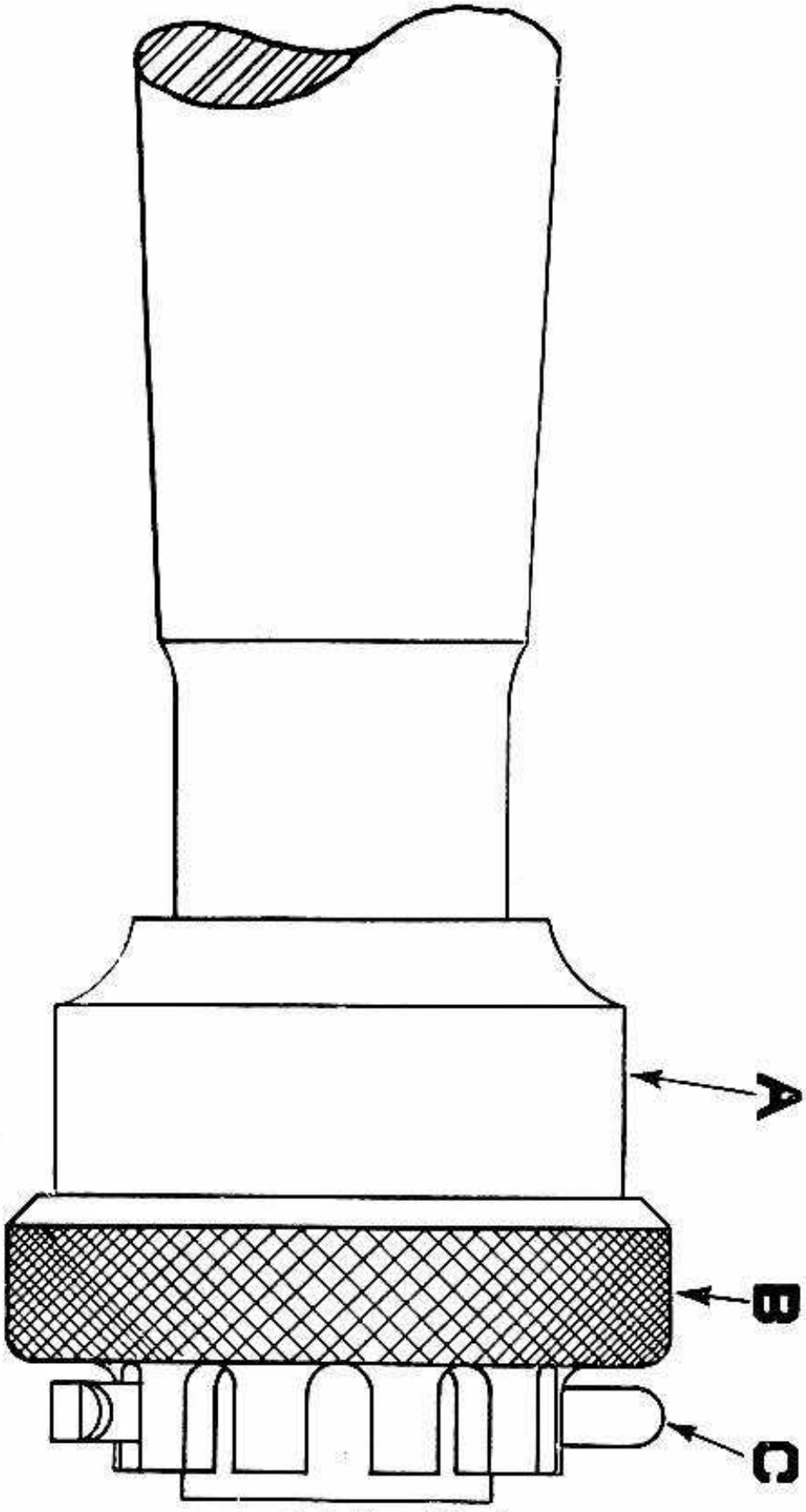
Adjustment of the chains is made by means of two set screws on the rear skeins. When the chains are properly adjusted, see that these set screws are locked in position by means of their jam nuts. Be sure that both set screws on **both** sides are always tight against their seat. If one is loose a jerk might break either a set screw or the lug against which it sets.

The brakes will have to be adjusted now and then and always after adjusting chains. If both brakes are equally loose, remove the pin from the yoke in the long pull rod attached to the foot pedal and screw this yoke onto the pull rod several turns before replacing in position. If, however, one brake bears more than the other, adjust by means of the side pull rods in the same manner.

SPINDLE ADJUSTMENT.

This is necessary when you put back the wheels, after taking them off for greasing, which is done once or twice a season. It may also be necessary through wear. You can tell this by pulling and pushing the wheel sideways; if there is any play, the bearing should be adjusted.

To remove wheel, unscrew the hub cap, remove



Spindle. Fig. 4

pin "C Fig. 4," unscrew the round nut "B Fig. 4," pull off the wheel, and with it the cone "A Fig. 4." The balls remain in the wheel.

After putting the wheel back, put back the cone, being careful to have offset slide into slot on the spindle, screw up the nut with the fingers to such a position as permits no shake in the wheel, but it still will revolve freely. Then put the pin through the slot and hole which are nearest in line with each other.

On account of there being ten slots in the nut and four holes through the spindle end, a very fine adjustment is obtainable. The wheel must revolve freely when the adjustment is made.

Be careful not to get dirt or sand in the bearing. If you have occasion to take the wheel off, inspect both cones and the balls to see that they are all right.

POSSIBLE SOURCES OF TROUBLE.

A dirty spark plug is common. It is remedied by removing the plug and cleaning it with gasoline and an old tooth brush, or a piece of cloth. It is well to take the plug to pieces. If the core is cracked or leaky, it will have to be thrown away. The points should be a little less than 1-16 inch apart for battery system and about 1/64 inch if magneto is used.

A plug may be short-circuited by carbon or leakage, but still show a spark between the points when it is out of the cylinder and under atmospheric pressure, while under the compression, inside of the cylinder, it would not spark.

Certain kinds of spark plugs do not work well in a high-speed motor like the Brush. Those that come with the car are the best kind we can find for

the purpose. Occasionally, however, some users, under their own conditions, get better results out of some other form of plug.

Carburetor trouble is most annoying. Troubles due to poor adjustment are described under the explanation of the carburetor. Other troubles are due either to dirt or water in the gasoline, or else to air leakage in the joints. Water in the gasoline is very frequent. It is betrayed by sputtering and missing, and is corrected by draining the contents of the carburetor. It is well in all cases in filling the tank to strain through a chamois.

In case there is a leaky joint anywhere between the carburetor and the motor, the excess of air thus introduced will cause trouble.

If the transmission becomes sluggish, so that the clutches will not hold or engage promptly, it should be carefully cleaned out. First drain through the plug in the bottom. Then pour in kerosene and turn the motor over a few times, or let it run slowly for a minute or two. Drain again, then pour in a little gasoline; turn it over a few times and drain again; then put in fresh oil and the trouble should be over. If still sluggish, take out the clutch plates and pass a fine file over them enough to remove the glaze from the surface but not enough to reduce them appreciably in thickness. In time these plates may be worn out, necessitating new plates.

It is also possible that the series of levers extending from the hand lever to the inside of the transmission may become disconnected, which would result in one or all of the speeds not holding.

HOW TO LOOK FOR TROUBLE.

The most frequent trouble is that the car will not start, or will not run. Should this happen, it must be due to some definite cause or causes. Blind

tinkering will do no good. Go at it systematically, one thing at a time, for if you do two things at a time, you do not know what you have done, and you may in correcting one thing put something else out of adjustment.

Let us assume now that we have before us a car which will not start: First we look in the gasoline tank, then we see if there is gasoline in the carburetor, by pushing down the float stem once or twice. The trouble is not due to lack of gasoline.

We turn the engine over. If it turns extremely hard, it is out of oil. If it turns easily all the way, there is no compression. The valves are leaking or broken, or there is a leak somewhere. Once or twice each season the valves need adjusting. Occasionally a speck of carbon or dirt gets under the valve, preventing it from seating or an excess of carbon may work down along the valve stem, causing it to stick. Washing with kerosene or gasoline corrects this.

The trouble is most likely to be with the ignition. Turning on the switch, we turn over the engine, and listen for the buzz of the coil. If there is no buzz, then there is no current through the coil, or the coil is defective. We go back over the wiring from the coil to the batteries, and see whether the insulation has rubbed off or something else has happened to cause the short-circuit. We examine and feel of all of the connections between the batteries; if one of them is loose, there is, of course, no current. If we have an amperemeter in our kit (which we should have), we test each cell for ampereage. New cells register nearly 20, and when they get below 10, they are not worth much. If we find one or more dead cells in the circuit, we cut them out, and couple up without them.

If we have no amperemeter, and find the con-

nections are tight, and there is no evidence of water or other damage to the coil, we **guess** that the batteries are weak, and replace them.

If the batteries are right, and the coil does not buzz, we look over the wiring to the motor, and see that our commutator is working, and then we experiment with the coil by seeing if the buzzer is stuck, and, if not, by changing the adjustment of it.

If we get a buzz in the coil, and still the motor will not start, we take out the spark plug and lay or hold one side of it against the cylinder, being careful, however, that the wire attached to the top does not touch the cylinder. We turn the engine over, and look for a spark in the spark plug. If there is no spark in the spark plug, but the coil buzzes, then there must be a short-circuit between the coil and the spark plug. This will have to be searched out by following the wires.

If the spark is good in the spark plug, then the trouble is not with the ignition.

In that case, we expect to find the carburetor totally out of adjustment. If so, we must start with the carburetor and set it approximately right, and then, after we have started the motor, adjust it as nearly right as possible.

There are, thus, three groups of places to look, in case the motor does not start:

First, The Ignition System
Second, The Valves and Cylinder
Third, the Carburetor.

There may be two different parts out of order, which is more confusing. When one has had a little experience, he will be able to tell definitely that certain things are not the matter, and thus arrive at the fault by a process of elmination.

All Automobile Dealers are familiar with the experience of sending a repair man miles away to

bring in a crippled car, only to find that the sole trouble is lack of gasoline, or failure to turn on the switch.

In case you run out of gasoline, any kind of alcohol will do, also kerosene oil, if the motor is warm, although with kerosene oil it is very difficult to start with a cold motor. We have even heard of cars running a few miles on whiskey, or in fact anything that contains a high percentage of alcohol.

A POUND OR KNOCK IN THE MOTOR.

There are several kinds of knocks familiar to all automobile users. The spark knock is a sharp metallic sound, and is due to having the spark too far advanced or to a too sudden opening of both spark and throttle.

It may be also due to premature explosions, caused by an overheated cylinder, or an overheated spark plug. When the cylinder becomes hot, through lack of oil, or lack of water, or an excess of carbon deposit, thereby decreasing the compression space, either the spark plug, or particles of carbon, or little points of iron inside the compression chamber may become red hot, causing premature explosions.

All other forms of knock are generally dull sounds. They may be caused by a loose connecting rod, a loose fly-wheel, a worn crank shaft bearing, or a faulty balance gear bearing.

TO ADJUST BALANCE GEAR IN MOTOR.

Should this gear ever require adjusting, it is done by turning the shaft, which runs through the hub in the crank case to the right. Near the end of this shaft, on which the gear runs, it is eccentric with

the part in the crank case, so that revolving the part in the crank case throws the gear nearer to or further away from the other gear.

These gears are set slightly tight when they leave the factory, and have a tendency to hum a little. This tendency soon wears out, particularly when the motor is warm. Should these gears become so loose that they rattle, they may be adjusted closer together in accordance with the above instructions.

Should the balance gear ever be taken off, be careful in putting it back to have the bearing adjusted as snugly as possible without binding, in the same way that the spindle adjustment is made.

The weight on the balance gear when reassembled must be on the lower side when the piston is on the top center.

IMPORTANT.

When orering repair parts, be sure to give **catalogue number of Part, number on Cylinder** and **Model of Car.** Otherwise you may be liable to vexatious delays.

Order repairs from your Dealer.

DONTS.

Don't attempt to start the motor unless the spark is retarded and the switch closed.

Don't attempt to run without water, oil and gasoline.

Don't adjust the carburetor or vibrator until you are sure they are the cause of the trouble and not something else.

Don't spend a lot of time cranking the engine if it fails to start after a few trials. Look for the cause of the trouble.

Don't jam the change speed lever from slow to reverse or vice versa until the car has come to a dead stop, and then apply it **gently.**

Don't race across car tracks, rough streets or around corners.

Don't drive fast or apply the brakes suddenly on wet pavements.

Don't fail to use plenty of oil and grease where needed before starting on any trip and do not use a cheap grade of oil or grease at any time.

Don't race the engine when the car is idle. See that the brakes are set, throttle closed and the spark advanced.

Don't neglect necessary adjustment and repairs until it is too late and you are laid up by the roadside.

Don't fail to examine electrical connections, gasoline and oil pipe and bolts and nuts occasionally to see that everything is intact.