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Spindle Assembly.—Consists of the wheel axle, steering arm, inner or stationary cone, the outer cone, the steel washer and hex castle nut. The steering arm and ring cone are tight fits and must be pressed into place, the arm held by a hex castle nut and cotter pin. In order that the bolt may slip easily through the tie rod yoke and steering arm, the hole in the arm for this purpose is lined up carefully after the arm is secured. The right hand spindle is threaded left hand and the left hand spindle the opposite way. The right spindle is controlled by the steering device, the other moves accordingly, being joined to the first by a tie rod which is adjustable. The tie rod is placed back of the axle where it is better protected.

The Radius Rod.—Prevents the axle from misalignment, keeps it from being turned over and receives the drive or push of the car, transmitting it directly to the front axle.

The Tie Rod.—Or connecting rod connects the two spindle arms. The drag link is the rod connected to the yoke of the right spindle arm by a ball and socket joint, and to the ball arm of the steering device by a ball and socket joint.

Alignment of Wheels.—*Camber* is the outward flare of the wheels at the top, which is 3 deg. on the Ford car. It is measured by the angle of each spindle below horizontal. The camber is not adjustable as it is provided for in the forging of the spindle.

Gather is the toe in of the wheels at the front, measured on a plane horizontal with the axle. It ranges from ⅛ to ¼ inch on the Ford car. The amount of gather may be changed by turning the yoke at the left end of the tie rod. The gather may be lost by a bent tie rod.

Castor is the effect obtained by tilting the front axle backward at the top, 5 1-2 deg. in the Ford Front Axle. It makes steering easy, helps the car to hold the road and gives added strength.

CHAPTER II

ASSEMBLY AND REPAIR OF THE FORD MODEL "T" ENGINE

Summary of Ford Engine Construction.—The Ford Model T Motor is a 4 cylinder, 4 cycle, internal combustion gasoline engine, with a 4 in. stroke and a 3¾ in. bore. Valves are of the poppet type arranged on one side of the cylinders, known as L head construction. Cylinders are cast en bloc and water jacketed, the upper part of the crankcase containing the crankshaft bearings, being integral with the cylinders. The water jacketed cylinder head containing the combustion chambers is removable from the cylinder case. The engine and transmission are a unit and this unit power plant is supported in the chassis frame on the three point principle.

Cylinder Case.—The cylinder case is an iron casting containing the four water jacketed cylinder bores, 8 valve parts with manifold passages, valve spindle guides, camshaft bearing bushing supports and, crankshaft bearing supports. The cylinder head containing the combustion chambers is cast separately from the case and is bolted thereto by 15 bolts threaded into the top of the case.

Cylinder Rolling.—The cylinder bores in which the pistons are to slide, after the boring and reaming operations vary in diameter from 3.748 inches to 3.479 inches. They are then rolled to a diameter of 3.750 in. with a special power driven rolling tool. This tool cylindrical block with small hardened steel rollers pivotally fitted around its circumference at an angle of 12 degrees from vertical. In operation, when the tool is revolved

Diameter at 2nd ring 3.743 in.—3.745 in.
Diameter at top 3.738 in.—3.740 in.
Ring grooves ¼ in. wide by 13/64 in. deep.
Diameter of piston bushings.740 in.—.741 in.
Diameter of wrist pin .740 in.—.741 in. Length of pin 3 1-2 in.

Before fitting the piston in the cylinder case the bores are carefully wiped out and the crank bearings are guaged. If the crank bearing is slightly undersize, the cap edges may be filed to compensate. No more than .004 nor less than .003 clearance should be allowed between cylinder and skirt of piston, yet the piston must move freely when pushed back and forth in the bore. It may be necessary to file burrs from piston or to tap out a slight distortion of the skirt with a rawhide hammer in order to secure free travel. The piston rings before assembling are guaged and divided into three classes.

1. .003 in. gap when ring is compressed, used as No. 1 or top ring on piston.

2. .005 in. gap when ring is compressed, used as No. 2 or middle ring on the piston.

3. .008 in. gap when ring is compressed, used as No. 3 or bottom ring on the piston. The piston rings are tapered around the circumference, the smaller diameter of the taper being the side marked either with a machined groove, "FORD" in script, or a punch mark. When rings are assembled to the piston these marks should be toward the top of the piston. A tapered ring scrapes the cylinder walls of excess oil. Also the ring will wear quickly to conform with irregularities in the cylinder walls because of the smaller bearing surface. After fitting pistons in cylinders, the cap and corresponding side of the connecting rod shank are notched with a file on the wrist pin clamp bolt side of the rod. Thus "I" for the piston is number one cylinder, "II" for the piston is number two cylinder, etc. This precaution is taken so that caps will be reassembled on

Meaning of "Actual" Horse Power.—Actual horse power is the amount that would be available if there were none absorbed by friction within the engine itself, and the total energy of the explosion was transmitted without friction or other losses to the shaft.

Meaning of Indicated Horse Power.—(I. H. P.) Indicated horse power is measured by taking an indicator diagram, which shows the "mean effective pressure" of the explosion in pounds per square inch.

For high speed engines an optical device is used which plots out the pressure line on a photographic plate. From this the "mean effective pressure" during the stroke can be calculated.

Total horse power of an engine is the same as its indicated horse power.

If an engine develops on brake tests, seven brake horse power and it takes three horse power to drive itself it is therefore properly called a ten indicated and seven actual or brake horse power engine.

Bore		Horse Power			
Inches	Millimeters	1 Cyl.	2 Cyl.	4 Cyl.	6 Cyl.
2½	64	2.5	5.0	10.0	15.0
2⅝	68	2.8	5.5	11.0	16.5
2¾	70	3.0	6.0	12.0	18.1
2⅞	73	3.3	6.6	13.2	19.8
3	76	3.6	7.2	14.4	21.6
3⅛	79	3.9	7.8	15.6	23.4
3¼	83	4.2	8.4	16.9	25.3
3⅜	85	4.6	9.1	18.2	27.3
3½	89	4.9	9.8	19.6	29.4
3⅝	92	5.3	10.5	21.0	31.5
3¾	95	5.6	11.2	22.5	33.7
3⅞	99	6.0	12.0	24.0	36.0
4	102	6.4	12.8	25.6	38.4
4⅛	105	6.8	13.6	27.2	40.8
4¼	108	7.2	14.4	28.9	43.3
4⅜	111	7.7	15.3	30.6	45.9

of the clutch shift collar. Pressure is applied to the rear end of this collar by means of a heavy coil spring supported by a cup shaped spring support pinned to the drive plate sleeve.

Q. What is the tension of the clutch spring.

A. 90 lbs.

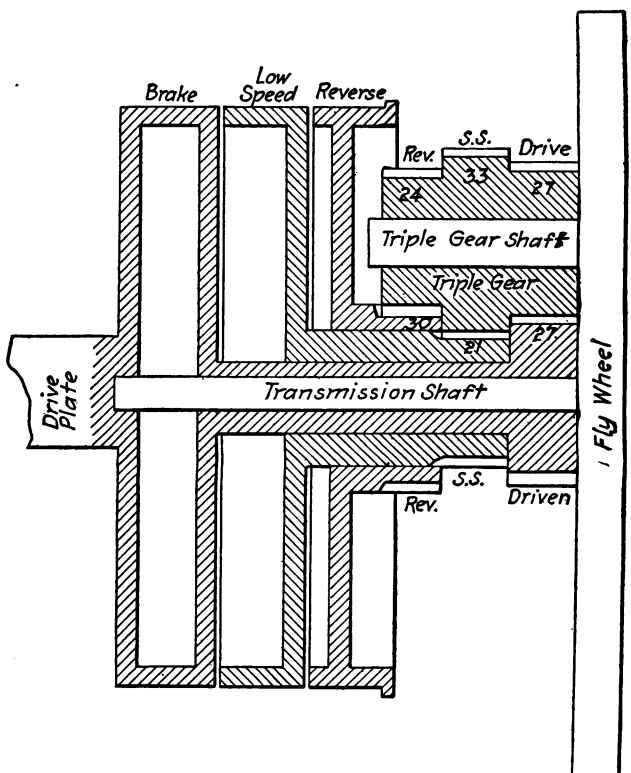

Fig. 5.

Q. How is it adjusted to secure proper tension?

A. By means of the three adjusting screws in the clutch fingers.

Q. What pressure does the clutch spring impart to the clutch disc through the leverage of the clutch fingers?

A. 324 lbs.

are the only two gears whose action is considered in reversing the car. In one revolution of the flywheel, the 24-tooth triple gear will make one revolution around the 30-tooth gear held stationary. When the 24-tooth gear completes a revolution, around the 30-tooth gear held stationary, it travels 30 teeth which is a gain of 6 teeth on the 24 teeth of the triple gear. 6 teeth in 24 is 1-4 of a revolution gain for that 24-tooth gear, and since the three gears of the triple are riveted together, it is 1-4 of a revolution gain for the 27-tooth drive gear of the triple assembly. The driven gear of 27 teeth meshed with the 27-tooth drive gear will be driven back just as much as the drive gear gains since they are the same size. Therefore, the driven gear will be turned back one quarter of a revolution in one revolution of the flywheel. To turn the driven gear back one revolution, the flywheel must be turned four times. Every four revolutions of the engine, when reverse drum is held stationary produces one backward revolution of the driven gear, brake drum and drive plate since they are keyed together. (See Fig. 7)

Path of Power.—The path of power in high speed is from crankshaft to transmission shaft, small disc drum, small discs, large discs, brake drum, drive plate and sleeve, universal joint, to drive shaft. This is the only time the clutch is engaged. No gears are in use on high speed, the drive being direct, with the transmission revolving as a unit.

In slow speed the power is transmitted through planetary gear pin on the flywheel, slow speed planetary gear, slow speed drum gear, planetary drive gear and the driven gear which is keyed to the brake drum sleeve, drive plate and sleeve, universal joint, to drive shaft.

In reverse the course of power is just the same except that we use the planetary reverse gear and reverse drum gear instead of the slow speed gears.

Ratio of Engine to Rear Axle.—The ring gear has 40 teeth and the drive shaft pinion has 11 teeth therefore the drive shaft

other half of the differential case is next placed over the gear on the end of the other shaft. The two differential gears are then placed in mesh with the pinions on the spider, and the two halves of the case are then drawn together by three studs 3-8 in. x 24 threads and 2 1-2 in. long. Thus, the differential proper is assembled with the two axle shafts keyed thereon. The large ring gear or drive gear has to be bolted to the left half of the differential case and it is ready to be put into the axle housings.

Bearings—Definition.—A bearing is that part of a mechanical arrangement which, besides carrying the load imposed upon it by the shaft associated with it, allows the shaft freedom to revolve.

Bearings—Why Necessary.—Before the advent of the bicycle and the motor driven vehicles there was no necessity for such anti-friction devices as ball and roller bearings. About the most commonly used bearing at that time was the babbitt lined cast iron or steel box in machinery, and the common wagon bearing lubricated by a good grade of axle grease. The machinery was not subjected to the heavy duty strain of the present day efficient factory. The wagon, if it had a heavy load, moved very slowly. A buggy or other lightly loaded conveyance, while going at a greater speed, needed only a little more attention given to the application of axle grease, but when the high speed modern automobile was developed it became an absolute necessity to contrive some method of reducing resistance, which of course meant a saving in fuel and at the same time must be of such quality that little attention need be given them to keep them in good running order—hence the ball and roller bearing of today.

On the rear axle shafts proper there are four roller bearings. The roller bearings are placed at the flange ends and also at the bell ends of the axle shaft housings. It is necessary to have a hardened sleeve on the axle shaft for these bearings to run upon for the load is divided between the several bearings.

holding sleeve,
Thrust bearing collars,
Ball bearing assembly,
Drive shaft 1 3/32 in. x 53 5/8 in.,
Drive shaft sleeve, 1.022 in. bore, 3 1/16 in. long,
Roller bearing 2 5/8 in. long,
Drive shaft pinion key, pinion and castle lock nut 5/8 in. x 18,
Drive shaft tubing .50 1/2 in. long,
Universal joint assembly and pin.

Q. How would you dismount a drive shaft assembly after it is removed from axle assembly?

A. To disassemble the drive shaft from its tubing:
Remove plugs from ball castings,
Drive out universal joint pin,
Remove universal joint assembly,
Pull out drive shaft from tubing,
Remove castle nut and drive off pinion,
Take off drive shaft bearing casings.

Q. What is the purpose of the thrust ball bearing in drive shaft assembly?

A. To compensate for the end movement of the drive shaft, a special ball bearing assembly is used. The end motion is caused by the driving reaction on the angular teeth of the ring gear producing an end thrust against the pinion shaft. The roller bearings care for the side motion and the special ball thrust bearing cares for the end thrust.

Q. If too much play exists between the pinion gear and ring gear how may it be adjusted?

A. Excessive play between pinion and bevel gears when caused by end play of drive shaft and tubing may be adjusted by inserting a new front bushing in the drive shaft housing. This bushing is of babbitt, 1 in. bore and 1 3/4 in. long. This play is sometimes caused by wearing of differential thrust plate against the left face of casting. Be sure to measure up thickness of new thrust plate before installing. It should be .0875—.0885 in. on assemblies prior to July 1916 and .085 in. to .087 in. subsequent to that date

Q. What is the reason for using a universal joint coupling?

A. The universal joint coupling permits rotating the drive shaft

drilled holes, only about a third of the test springs break at this point.

Care of the Springs.—Springs should be lubricated frequently with oil and graphite. To do this disassemble the leaves and rub bearing surfaces smooth with emery cloth; pack them with graphite and reassemble. To prevent rust from accumulating paint the springs with a quick drying black paint. By doing these things you will greatly improve the riding qualities of the car and also insure longer life of the parts.

Repairs.—If the axle is bent and the proper jigs for straightening are available, it is all right to straighten it in service work. Never heat the axle to a red heat to straighten for fear of distempering.

Rebush or replace the spindles. If rebushed ream them to size. Replace wheel bearings in the cones. Repair ball joints at end of tie rod and drag link. See that all bolts and nuts are tight and cotter pinned and all moving joints well lubricated.

The constant level splash system is the simplest of all satisfactory systems in use today. Even this system is divided into several classes, most of which employ some kind of pump. Every oiling system may be said to be a splash system to some extent, as the oil must in each circulate over the interior of the engine. It would appear then that the more simple the system (consistent with performance) the greater its advantages.

The Ford Model T System.—The oiling system employed on the Ford Model T car is known as the "constant level" circulating splash system. The oil is poured into the breather pipe at the right side of the front of the engine, from which it flows over the connecting rod troughs of the crank case lower cover (leaving them full) and into the lowest part of the crankcase under the flywheel. When the engine is running the oil in the bottom of the crankcase is carried by the flywheel and magnets near the top of the transmission cover. Here a portion of it drips into the funnel shaped upper end of the oil pipe where it flows by gravity down to the timing gears, returning once more to its original position under the flywheel. The oil pipe mentioned is the only one used. No pump is required in the Ford system. All moving parts of the engine are kept well oiled by this system. The only opening into the crankcase is the breather pipe. Any oil which may be "pumped" to the top of the push-rods is automatically drained back into the crankcase by two small holes, one just inside each valve door. The Ford oiling system is highly efficient, has proved satisfactory over a long period of years, and is more fool proof than any other in use today. The only attention required, other than replenishing the oil supply from time to time, is to wash out the crankcase every 1,000 miles. The oil level should be kept between the two pet cocks at the rear of the crankcase.

Laboratory Tests of Oils.—The following are a few tests by which the various oils are judged as to their suitability for certain conditions.

um'' between the hot and cold engine, or he must install a thermostat to control the temperature and flow of water. In the former case the thermal efficiency is nearly always too low; in the latter the complication of parts necessary adds to the care and attention required. In any force circulation system some style of pump is required; also gears, shafting, extra piping, gland nuts, packing, grease cups, etc.

The thermo-syphon system permits of a more efficient cooling and a system which is vastly simpler, requires none of the engine's power and is not affected by the speed of the engine. The principle of the natural or thermo-syphon circulation is that hot water is of a lower density than cold water, and will, therefore, seek a higher level than cold water. As the water in the jackets is heated by contact with the combustion chamber walls it rises to the top of the syphon tanks. Here it flows over the tops of the radiator tubes, and enters them to displace the cooler water which is descending. Hot water is lighter than cold water and rises to the top, just as oil rises to the surface when poured into a vessel of water.

Thermo Syphon Efficiency.—Gasoline engines operate most efficiently when the cooling water is just below the boiling point. We have seen how impractible it is to use forced circulation to attain this end. The thermo-syphon system, however, as found on the Model ''T'' engine overcomes the difficulties of the forced system, and maintains as nearly as possible the desired temperature. So as soon as the engine is started the water begins to circulate, due to the heat of the combustion chamber walls. However, at the beginning it is scarcely perceptible; in fact there is very little circulation until the water reaches 180 deg. F. It is obvious that an engine cooled in this way will ''warm up'' to the best working temperature much sooner than one in which cold water is forced around the combustion chamber at a high rate, absorbing much of the expansive energy of the hydro-carbon gases. In hot and cold weather alike, the cooling tempera-

Function of Carburetor.—Before we take up the carburetor let us define it and consider what a carburetor really does.

A good carburetor should fulfill the following general conditions:

1. It should form a mixture of air and hydro-carbon vapor in fairly constant proportions.
2. It should function to any desired extent.
3. It should perform its duty under the varying conditions of—
   1—Atmospheric or suction pressure.
   2—Speed
   3—Temperature
   4—Power

The Jet Spray Type.—The ultimate form of the carburetor, that is to say the form in use today, is known as the jet spray type.

The fuel in a liquid form passes from the fuel supply tank to carburetor bowl which is in reality a small auxiliary tank, where the level is more or less constantly maintained by means of a float which operates a supply valve by means of one, two, or even more levers. In some types this valve is operated in the same manner as the ordinary valve in a toilet tank. This float may be made of any substance which is lighter than gasoline, i. e., cork or sheet brass soldered so as to make an air tight float. From this bowl, or float chamber as it is often called, the gasoline is sprayed by means of a needle valve into what is known as a mixing chamber. Here air is also admitted and thus the mixture of air and hydro-carbon vapor is effected. The passage of the air and gasoline vapor through this mixing chamber into the firing chamber of the cylinder is caused by the suction from the piston as it descends in the cylinder. There is a butterfly valve which may be adjusted to regulate the supply of air admitted into the mixing chamber.

chamber, to spray nozzle where it mixes with air in the mixing chamber, past throttle, through inlet manifold and inlet valve into cylinder.

Methods Used to Prime Carburetor.—Or give more gasoline for starting:

(a) By choke valve; to use, close valve and crank engine. The suction draws gasoline out of the nozzle cup through low speed tube into cylinders.

(b) A device on dash to open spray nozzle while engine is being cranked. Priming is necessary as it enables one to draw a rich mixture into the combustion chamber making it easier to start. Ordinary cranking without using the choke valve will not draw out enough gasoline to make an explosive mixture unless the engine is already well warmed up.

Preparatory Rules for Adjusting a Carburetor.—

1. See that compression is all right.
2. See that timing and spark are all right.
3. See that there are no air leaks around the intake manifold.
4. See that a full clear stream of gasoline flows from the tank to the carburetor.
5. Allow the engine to warm up.

Adjustment of the Ford (Holley Model G) Carburetor.—The Holley, being an automatic float feed type carburetor, having no weights, springs or other moving parts, has only one adjustment for quality of mixture—the spray needle valve which also controls the low speed or idling.

Open the needle valve about 7-8 of a turn, though cases have occurred in which 3-4 of a turn was satisfactory, and on the other extreme 1 1-8 turn was necessary.

Instructions for Adjusting.—

1. Loosen adjusting needle locknut until needle turns easily.
2. Screw needle clockwise until it touches the seat (use light pressure).

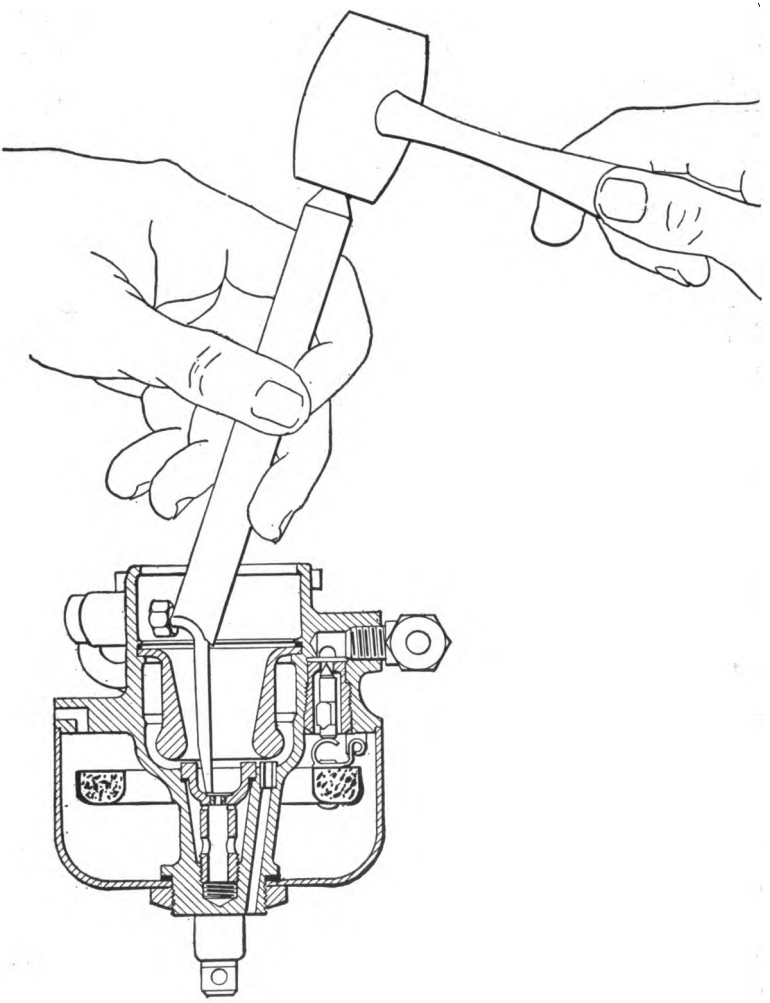

Fig. 28.—Setting Low Speed Tube

magnets which are in contact with the flywheel does not cause the magnets to be shorted.

Magnet Poles.—The relation of affinity of one magnet to another is a peculiar yet a very important thing. A magnet pole, either north or south, will attract a piece of iron or steel provided it is not magnetized. If it is magnetized only opposite poles attract each other,—a north pole will attract a south pole or vice versa. Two north poles or two south poles will repel each other. This is very important when assembling the magnets on the flywheel. They should be placed so they repel each other.

With electro magnets the influence or flux remains only while the electric current is flowing through the coil. With a permanent magnet the magnetic current if flowing all the time, as long as the magnet remains a magnet. This flow of flux is always in the same direction in regard to the pole (either permanent or electro) i. e., from north to south in the field and from south to north through the magnet itself.

In producing an electro magnet if the current is sent through the coil the core will be magnetized with a certain polarity. If the current is reversed through the coil the polarity of the core will be changed, also if a coil is passed through a magnetic field one way it will cause a current to flow through the coil in a certain direction, but if the coil is moved through the field in the opposite direction the current will flow the other way through the coil. This is what causes the Ford magneto to produce alternating current.

Relation of Electricity to Magnetism.—By sending a current of electricity through a coil wound around an iron core we produce a magnet. By moving a coil of wire through a magnetic field we produce electricity. If we have one we can produce the other. We learned before that silver and copper were the best electrical conductors but these metals will not conduct magnetism, in fact iron and steel are the only two common magnetic conductors. This is why the screws and spools under the ends

Engine Misses at High Speed.—
Bad spark plug.
Sticking valve.
Loose electrical connection.
Weak valve spring.
Spark plug gaps are not set correctly.
Commutator case rough, causes roller to jump.

Engine Misses at Low Speed.—
Weak exhaust valve spring.
Bad spark plug.
Exhaust valves need grinding.
Leak in intake pipe or connection.

Engine Lacks Power.—
Late spark.
Poorly fitting piston rings.
Valves sticking.
Leak in intake pipe or connection.
Engine full of carbon.
Clogged gasoline line.

To Locate Cylinder.—Which is misfiring, short circuit spark plugs with screw driver. If it changes the running of the engine or sound of the exhaust it is a live cylinder, if it makes no change it is a dead cylinder.

To locate a cylinder that is misfiring on a vibrator system, hold down all vibrators, but one and see if remaining cylinder is firing. Hold down one vibrator at a time and see if it changes the running of the engine or sound of exhaust. If it makes no change it is a dead cylinder.

Conditions Necessary for Engine to Start and Run.—
Proper ignition.
Proper carburetion.
Sufficient lubrication.
Good compression.

wire comes in contact with any metal part of the car, a short circuit occurs which will cause premature explosion of gas. The engine will pound and lag because of the premature explosions. One of the coil units will usually buzz steadily when this condition exists. Care must be taken in starting an engine in this condition as the short causing the premature explosion is apt to result in a vigorous kick-back.

SPARK COIL UNITS

Q. What is the function of the Ford spark coils? Why are there four spark coil units in the Ford car?

A. The spark coil is an electrical instrument used to transform the low tension current of the flywheel magneto to current of high enough voltage to cause a spark to jump at the spark plug gap. One coil is used for each cylinder to avoid the use of a distributor, necessary where a single coil is used.

Q. Of what does a spark coil consist?

A. Each spark coil consists of a primary coil winding, a secondary winding and a condensor; also a soft iron core for the primary coil and vibrator arm.

Q. Describe the primary coil. Describe the secondary coil.

A. The primary coil is a coil of 220 turns of comparatively coarse wire, #19 B & S gauge, wound around a soft iron core. The primary current from the magneto passes through this winding. The secondary coil is a coil of 16,400 turns (about a mile in total length) of very fine wire #39 B & S gauge. The secondary current is induced in this winding from the primary coil winding.

Q. How is the Ford primary electrical current produced? Trace the primary current.

A. A magnet passing close to a coil of wire causes an electric current to flow through the coil of wire. The 16 magnets on the Ford flywheel revolve close to the 16 coils of wire on the stationary coil unit and create an alternating low tension current in those wires. The primary current is carried from these coils to the magneto contact post and from there by a wire connection to the coil box in the dash and passes through the primary coil of the spark coil unit. Wires from the coil box connections on the dash carry the current to the commutator and the circuit is completed back through the frame of the motor to magneto, whenever the commutator brush is in contact with the metal contact points in the commutator.

other end of the coil is connected to a commutator segment which is the eleventh segment around the commutator from the one to which the first end of the coil is connected or almost diametrically opposite on the commutator. It may be seen that with 21 coils and 21 slots in the commutator each slot has one of two different coils in it.

The Brushes.—There are three carbon brushes in the generator; two large or main brushes and one small or third brush. One of the main brushes and the third brush are positive brushes. The other main brush is negative.

The Brush Holders.—Each brush is held in a metal socket called a brush holder. These holders are supported by a metal ring called a brush ring. One of the main brush holders, the positive and the third brush holder, are insulated from the brush ring. The other main brush holder, the negative, is grounded to the brush ring.

Brush Springs are used to press the brushes against the commutator.

Pigtails, or small flexible cable, form better electrical connections between the brush holder and the brush.

Placing of Armature Coils.—The coils are placed on the armature core in succession or one after the other all the way around. With the 21 coils all in place and connected up there is an electrical connection through the whole armature. It is for this reason that when the test wire is put on one segment of the commutator and the other point placed on the adjacent segment the test light will burn. This should not be taken for a short circuited commutator.

Explanation of Action.—Nearly everyone understands that the generator produces the current which lights the lamps and charges the battery, but, few understand how it is produced.

If you recall the three things which are necessary to produce an electric current, i. e. magnetic field, number of turns in

on the generator armature, then to the negative brushes which are grounded, through the ground or metal of the car to the negative side of the battery completing the starting circuit.

As the current flows through the circuit it passes through the field coils magnetizing the cores, it then passes on to the armature coils and as the current passes through them poles are set up in the armature core, the same as in the generator only much stronger. It is the strength of the magnetic attraction and repulsion of the field poles to the armature poles that causes the armature to revolve.

When the starting motor is running light or without a load it will draw about seventy-five amperes or less, depending upon the internal condition of the starting motor. When the armature is connected to the flywheel by the bendix, it requires a current of from 250 to 600 amperes to overcome what is known as the stall torque. The current flow depends upon the compression in the cylinders and the stiffness of the engine bearings. It is for this reason that the starting motor is connected to the battery with a heavy cable, because as stated in the electrical principles, the carrying capacity of a wire depends upon its cross-sectional area. Judgment should be used in using the starting motor to start the engine. With only an 80 ampere hour battery and using from 250 to 600 amperes to start the engine it may readily be understood that a continued pressure on the starting switch would discharge the battery very quickly.

Troubles.—Ninety per cent of the trouble with the starting motor is due to the condition of the battery. If the starter fails to operate, the battery should be tested, see that all connections are clean and tight, and the starting switch in good condition. If connectors or terminal posts are corroded, scrape them and coat them with vaseline. Test the battery with a hydrometer and volt-meter, if found to be O. K. short across foot switch terminals, this will determine if the trouble is in the foot

one ampere to flow; and one additional ampere will flow from each 32 candle power lamp that is cut in. Therefore, if a battery is to be charged at a five ampere rate, five 32 C. P. lamps should be used.

Questions And Answers On The Starting And Lighting System

Q. How many units are there in the F. A. Starting and Lighting System?

A. The F. A. is a two unit system.

Q. Is it a single or a two wire system? Explain and give the advantages.

A. It is a single wire system. Which means just one wire goes to each piece of equipment and the return circuit is through the ground or metal of the car. The advantages are—simple, saving of material.

Q. Which is the Starting Motor and how is it distinguished from the Generator?

A. The starting motor is located on the left side and is attached to the transmission cover. The motor can be distinguished from the generator by the long shaft which the Bendix assembly is attached to.

Q. Define the following—volt, ampere, ohm, watt, high tension, low tension, direct and alternating current.

A. The volt is the unit of electrical pressure or amperes times ohms. The ampere is the unit of current strength or flow, or volts divided by ohms. The ohm is the unit of electrical resistance, or volts divided by amperes. The watt is the unit of electrical power, or volts times amperes. High tension is high voltage. Low tension is low voltage. Direct current is current flowing steadily in one direction. Alternating current flows to and fro, or reverses its direction twice per cycle.

Q. Which side of the system is grounded?

A. The negative side of the Ford system is grounded.

Q. What is the difference between a ground and a short?

A. A ground may be a short if it permits the current to return to the source without doing the intended work or in other words the ground may be unintentional. An intentional ground is a permanent connection to the metal of the car to permit the current to return to the source without using an individual

ment and returns through the metal of the car to the ground side of the battery.

Q. Why are there only nine terminals onthe back of the new coil box?

A. On the old style there were ten terminals on the back of the coil box, the top four are for the loom wires which conduct the primary current to the commutator, the four just below the top four are the terminals to which the secondary wires are attached which carry the high tension current to the spark plugs. Below there are two more terminals; the left one is the terminal to which the magneto wire is attached, and the right one is to connect to the battery if one is used. This is done so the battery current will not be sent through the magneto coils which would demagnetize the magnets in certain positions. On the new system the battery and magneto current is taken direct to the switch and the different connections are made in the switch, and in this way the extra terminal on the coil box can be dispensed with.

Q. Trace the horn circuit. Can you sound the horn with the battery? Why?

A. The horn is operated by the magneto current, which flows from the magneto up the steering column to the switch and when the button is pressed there is a metal contact made which closes the circuit, then the current passes down through the horn wire to one of the terminals on the horn and the other terminal is grounded. The horn cannot be operated by battery current because it is direct current, while the magneto current is alternating and as the current alternates, or builds up and dies out and builds up again in the opposite direction, this causes the core of the coil to be magnetized and demagnetized, which attracts and releases the diaphram. If a direct current is used the diaphram is attracted and held.

turns at a time until the engine reaches its highest speed and no more smoke comes from the exhaust. This usually takes about one-half turn from the point at which misfiring occurs. After the best adjustment has been found the driver should observe the angle of the adjusting rod on the dash so that he may readily secure the same adjustment without several tests, after opening the needle slightly when starting.

Cold Weather Adjustment.—In cold weather it will probably be found necessary to open the adjusting needle about one-quarter turn more than is needed for warm weather operation as a smaller amount of the fuel will flow past the adjusting needle when it is cold, particularly before the engine has been thoroughly warmed up.

Running on Gasoline.—If it is desired to run on gasoline instead of kerosene, the gasoline should be put in the main fuel tank and should be used through the float chamber and vaporizing tube exactly as though it were kerosene. It will be found necessary to close the adjusting needle slightly as gasoline flows more easily than kerosene.

Under no circumstances should the engine be run on gasoline from the small tank through the shifter valve for more than the very short time required to heat the vaporizing tube sufficiently so that it will handle the fuel from the float chamber.

If the main tank runs dry and it is necessary to run on the gasoline in the small tank, it should be transferred to the main tank and used in the regular way. This is to prevent damage to the vaporizing tube through overheating, which might occur if the engine is operated for any great length of time on gasoline from the small tank through the shifter valve, without the rich mixture passing through the vapor tube.

USE GASOLINE THROUGH THE SHIFTER VALVE FOR STARTING PURPOSES ONLY.

Exhaust Shunt Valve.—To enable the driver to control the amount of heat supplied to the vaporizing tube in accordance