No. 1999

HANDBOOK OF THE

TWO-TON TRUCK CHASSIS
NASH MODEL
4017-A AND 4017-L

(SEVENTY-FOUR - PLATES)

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WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
WASHINGTON, July 3, 1918.

This manual is published for the information and government of the Regular Army, National Guard, and National Army of the United States.

By order of the Secretary of War:

C. C. WILLIAMS,
Brig. Gen., Ordnance, N. A., Acting Chief of Ordnance.

TABLE OF CONTENTS.

CHAPTER I.

SPECIFICATIONS, OPERATION AND CARE.

CHAPTER II.

ENGINE AND ENGINE ATTACHMENTS.

CHAPTER III.

CONTROL DEVICES, LEVERS AND STEERING SYSTEM.

CHAPTER IV.

CLUTCH.

CHAPTER V.

TRANSMISSION, UNIVERSAL JOINTS AND PROPELLER SHAFTS.

CHAPTER VI.

AXLES.

CHAPTER VII.

WHEELS AND TIRES.

CHAPTER VIII.

FRAME AND SPRINGS.

CHAPTER IX.

EQUIPMENT.

CHAPTER X.

NOMENCLATURE.

INDEX.

LIST OF PLATES.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

CHAPTER VIII.

CHAPTER IX.

CHAPTER X.

NOMENCLATURE.

SPECIFICATIONS, TECHNICAL DATA, DIMENSIONAL INFORMATION, PARTS NUMBERS AND DESIGNATIONS, CARE AND REPAIR OF

TWO-TON CHASSIS NASH MODELS 4017-A AND 4017-L.

These chassis models are alike except as follows:

Model 4017-A has electric generator and storage battery lighting.

Electric searchlight and electric side and tail lamps.

Magneto without impulse starter.

Model 4017-L has acetylene generator and searchlight. Oil side and tail lamps.

Speedometer.

Magneto fitted with an impulse starter.

Other than changes mentioned, the specifications for both models are identical. Where information or data applies only to one model it is so stated in the proper place.

HANDBOOK OF THE TWO-TON TRUCK CHASSIS NASH MODEL 4017-A AND 4017-L

CHAPTER I.

WEIGHTS AND OUTLINE SPECIFICATIONS.

Rated load capacity	pounds	4,000.00
Body weight allowance	do	1,200.00
Weight of chassis only	do	6,700.00
Maximum gross weight (including chassis, body and pay load)	pounds	11,900.00
Percentage of chassis weight on front tires (without load)		66.66
Percentage of chassis on rear tires (without load)		33.33
Percentage of load weight on front tires		30.00
Percentage of load weight on rear tires		70.00
Percentage of gross weight on front tires		45.00
Percentage of gross weight on rear tires		55.00
Overall length of chassis (without body)	inches	202.50
Overall width of chassis (at widest part)	do	78.50
Chassis wheelbase	do	124.00
Length of frame back of driver's seat	do	117.13
Width of frame (outside dimensions)	do	38.13
Height of rear end of frame from ground loaded	do	35.50
Height of rear end of frame from ground unloaded	do	38.50
Diameter of turning circle	feet	50.00
Tread of front wheels	inches	60.50
Tread of rear wheels	do	60.50
Road clearance under front axle (lowest point)	do	14.75
Road clearance under rear axle (lowest point)	do	14.75

ENGINE.—Four-cylinder, 4-cycle; L-head type, cylinders cast en bloc, with integral head. Bore 4.25 inches, stroke 5.5 inches. Horsepower 28.9, N. A. C. C. rating.

COOLING.—Water, centrifugal pump circulation.

LUBRICATION.—Force feed, using drilled crankshaft; spray to cylinders.

RADIATOR.—Tubular type with fins, removable cast iron headers.

IGNITION.—Eisemann high-tension variable spark magneto, type G4-II Edition. Model 4017-L fitted with an impulse starter.

CARBURETOR.—Type M-2, 1.25-inch Stromberg, plain-tube type, with hot-air connection.

FUEL FEED.—From main tank of 27 gallons capacity to auxiliary tank, holding two quarts, from latter to carburetor by gravity.

GOVERNOR.—Fly ball type, drives through flexible shaft from camshaft and is mounted between carburetor and short external inlet manifold.

CLUTCH.—Single-plate, dry-disc, fitted with clutch brake.

TRANSMISSION.—Selective, sliding-jaw clutch type, combined with silent chain reduction. Four speeds forward—one reverse.

DRIVE.—Drive from transmission through two propeller shafts fitted with Spicer universal joints, then to bevel ring gear in axles and through axles to internal gearing in four wheels. Torque absorbed through springs. Full Hotchkiss drive.

FRAME.—Channel section pressed steel. Six cross members. Five standard Ordnance transoms. Ordnance pintle at rear, towing hooks in front.

SPRINGS.—Front and rear semi-elliptic with auxiliary coil springs.

AXLES.—Front and rear identical. Bevel pinion and gear with M. & S. locking type differential at propeller shaft and internal gear at wheels.

BRAKES.—Two sets of brakes. Pedal-operated service brake of internal expanding type in wheel brake drums. Hand-lever operated emergency brake of external contracting type on transmission; hand-brake applies foot brakes also.

WHEELS.—Cast-steel disc wheels, all four identical. Wheels have brake drums cast integral. Wheels fitted with taper roller bearings.

TIRES.—36 inches x 6 inches, solid tires, pressed-on type.

STEERING.—All four wheels used for steering. Vertical steering column. Steering gear of screw and split nut type. Hardwood steering wheel.

CONTROLS.—Left hand steer. Change gear and emergency brake levers in front of driver's seat to right of steering column. Spark and throttle lever operated on sector clamped below steering wheel on front of steering column. Ignition ground wire switch on left side dash. Carburetor choke control on steering column. Clutch and service brake pedals left and right respectively. Accelerator pedal to left of change gear lever.

MAIN GASOLINE TANK.—Galvanized steel tank, 27-gallon capacity.

AUXILIARY GASOLINE TANK.—Steel tank, two quarts capacity.

EQUIPMENT.—Pyrene fire extinguisher; non-skid chains, complete in chain box; eyes for non-skid chains; hand-operated horn; odometer; hand flashlight; *Model 4017-A, fitted with speedometer;* electric searchlight, electric side lamps, electric taillamp, Bijur generator, storage battery. Model 4017-L, acetylene searchlight, acetylene generator, oil side lamps, oil tail lamp and speedometer.

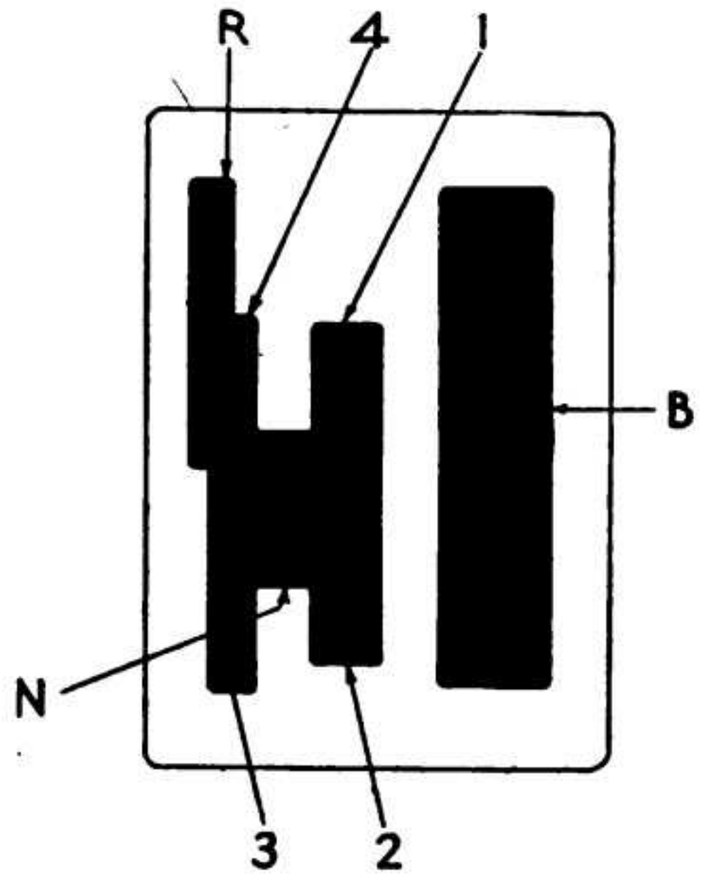
BRIEF DESCRIPTION NASH MODELS 4017-A AND 4017-L.

With the exception of a few details of equipment these models are identical. The Model 4017-L uses an impulse starting device on the

magneto shaft, while the 4017-A model has none; it uses acetylene lighting while the 4017-A model employs an electric generator and storage battery system; it is fitted with a speedometer in addition to an odometer, while the Model 4017-A has only an odometer.

The chassis is one of 124 inches wheelbase and is fitted with a four-cylinder engine, dry-disc clutch, four-speed transmission, and a drive

Plate No. 1



CHANGE-GEAR AND HAND BRAKE QUADRANT SHOWING POSITION LEVER SHOULD TAKE FOR DIFFERENT SPEEDS.

1—First speed.
2—Second speed.
3—Third speed.
4—Fourth or direct speed.

B—Emergency brake lever slots.
N—Neutral position.
R—Reverse.

to all four wheels, through shafts and internal gear-drive axles which are identical front and rear.

The engine is a standard design L-head, of Buda make, using force-feed lubrication, pump cooling, and fitted with a Stromberg carburetor feeding through cored manifold cast integral with cylinder block, an Eisemann magneto, and on the Model 4017-A only, with a Bijur generator.

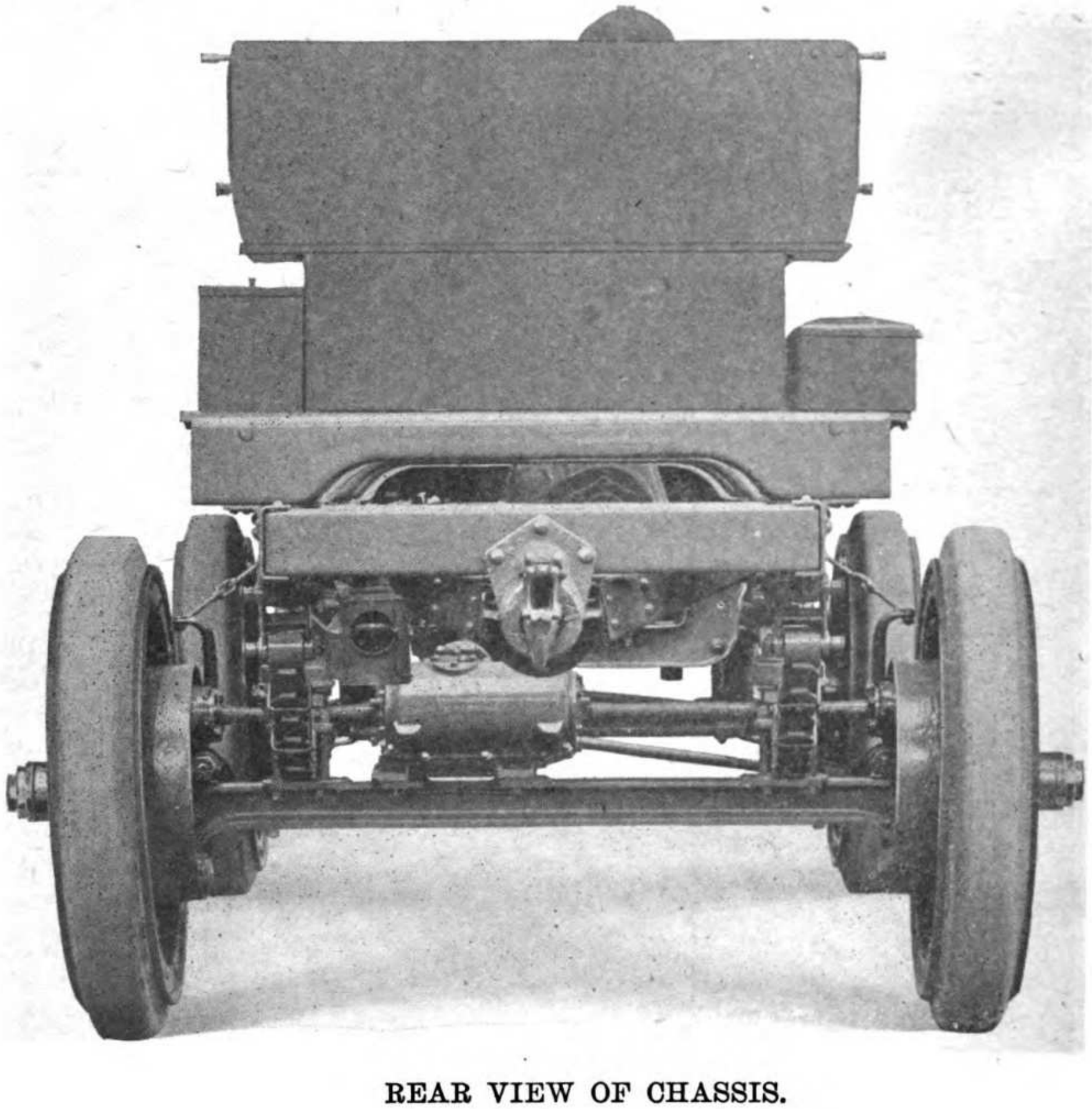
The clutch is of the dry-plate type and the drive from it is through an open two-joint propeller shaft to a four-speed, sliding jaw clutch type transmission. From the latter extend two two-joint propeller shafts, one forward and one rearward, to identical internal gear-drive axles. The live member has exposed axle shafts extending from it, and the ends of these shafts are each fitted with a universal joint and a spur pinion, the latter meshing with an internal gear bolted to a disc steel wheel. All the wheels are interchangeable and are all driving and steering wheels.

BRIEF OPERATING INSTRUCTIONS.

PRELIMINARY TO STARTING ENGINE.

See that gear shift lever is in neutral.
Set emergency brake.
Advance gas lever one-third travel.
Advance spark lever one-fourth.
Turn ignition switch to "MAGNETO" position.
Crank engine by spinning rapidly.
Pull up air choke lever for rich mixture, if necessary.

Plate No. 2



REAR VIEW OF CHASSIS.

AFTER ENGINE STARTS.

Advance spark.
Regulate auxiliary air control lever to secure smooth engine operation.
Close throttle lever until engine runs slowly.

TO START TRUCK.

Release hand brake.
Disengage clutch.
Engage low speed gear.
Increase engine speed slightly.
Slowly engage clutch.

GEAR CHANGES.

As truck gains momentum, disengage clutch, close throttle, shift to intermediate speed, open throttle slightly and engage clutch. When momentum is gained again disengage clutch, close throttle and engage next higher gear. Repeat operation until fourth speed is reached, after which truck speed can be controlled by accelerator (or hand lever).

GEAR CHANGES TO LOWER SPEEDS.

In changing to lower speed, necessitated by heavy loads or steep grades, disengage clutch, accelerate engine slightly, instantly shift to lower gear, engage clutch and open throttle to gain speed.

TO REVERSE TRUCK.

Reduce engine speed, disengage clutch, apply foot brake. When truck has stopped, engage reverse gear, release brake and engage clutch. Never engage reverse gear when truck is moving forward.

TO STOP TRUCK.

Reduce engine speed, disengage clutch, apply brake, place gear shift lever in neutral, engage clutch, set emergency brake.

TO STOP ENGINE.

Turn ignition switch to "OFF" position. Advance gas lever slightly to supply initial charge to assist for next start. In winter, pull up air choke when stopping.

DETAIL OPERATING INSTRUCTIONS.

PREPARATION OF TRUCK FOR SERVICE.

UNLOADING FROM SHIP OR CAR.

Great care should be exercised in unloading the truck, as carelessness may cause serious loss later. A thorough inspection should be made of the equipment sheet, comparing it with the equipment received. The box of tools and parts should be opened and checked over before being receipted for, and any movable parts that might be stolen or lost from the truck should be checked up. All seals on governor, transmission, differential and other places should be intact and if any have been tampered with make a careful inspection of the place where the seal belonged and note whether any damage might have been done to important parts. A

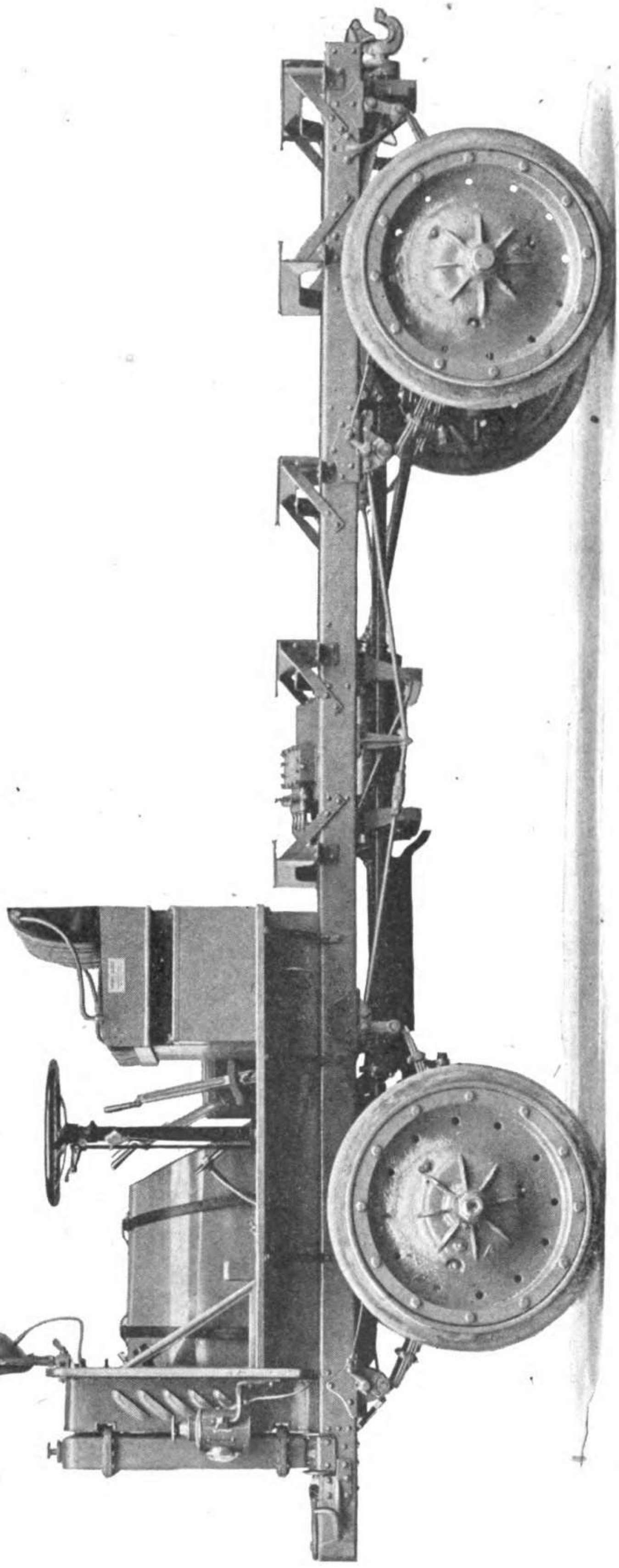
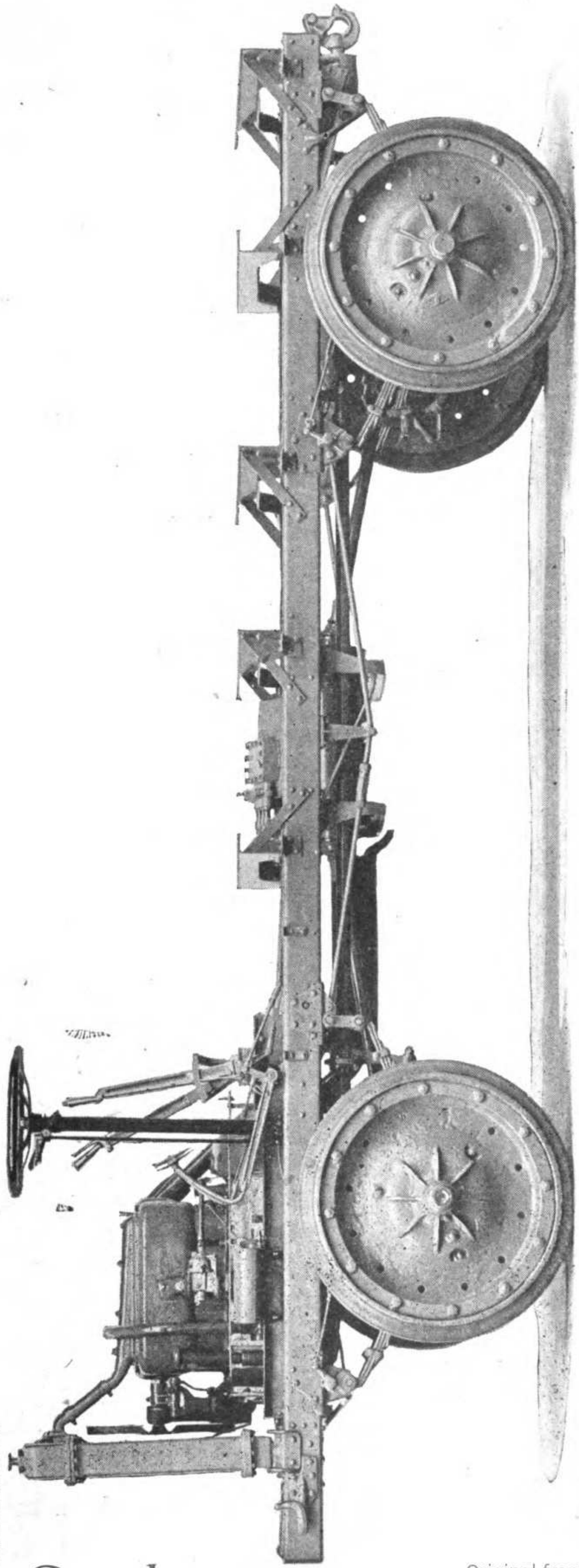


Plate No. 3

LEFT SIDE OF CHASSIS WITH DRIVER'S SEAT AND ENGINE HOOD IN PLACE



LEFT SIDE OF CHASSIS, ENGINE UNCOVERED AND MINUS DRIVER'S SEAT, SHOWING FIVE STANDARD ORDNANCE TRANSOMS MOUNTED ON FRAME.

Plate No. 4

nut or broken bolt slipped into the transmission may completely ruin a truck or cause loss of life, and these things should be watched carefully.

After the inspection of the shipment, so far as completeness goes, see that the drain cocks under radiator and water pump and the plug in cylinder water jacket are closed, and that all hose connections are tight. The radiator should then be filled with clean water to within two inches of the bottom of filler neck on radiator and all connections and joints tested. Care should be exercised in selecting water, get soft water, if it is procurable. The radiator and cooling system holds about seven gallons of water.

The crankcase of the engine should be examined and the specified grade of heavy oil put in so that the gauge on the left side of the engine indicates the proper level. The grease cups on the water pump glands should be turned down. Note if there is a water leak at that point. The spark plugs should be removed, and with a squirt can, about a tablespoonful of motor oil should be squirted on to the top of each piston, and the engine revolved by hand a number of times after replacing plugs, so that the oil will lubricate the cylinder walls. While turning the engine over notice whether there are any compression leaks around the cylinder head pet cocks, and have them closed.

Dampness and moisture may get to the working parts, and on arrival they may be rusted badly, grease may be lost out of important places, and equipment stolen or lost. In the former case the engine should be handled very carefully, because the pistons might have rusted fast or valves seized in the guides. Kerosene applied with an oil can to the tight parts will loosen them. A little kerosene in the clutch will make it function better, and prevent grabbing in case it has rusted on the plate. After the engine has been cranked freely by hand the gasoline tank lever should be turned to main supply with the long end of the lever down inclined at an angle of about forty-five degrees to the left. Fill gasoline tank with clean gasoline, being sure funnel and receptacle gasoline is carried in is thoroughly grounded on tank or explosion may occur, and after a sufficient quantity has been put in, unscrew the end of the gasoline pipe near carburetor and drain out a quart or so to clear line and tank of dirt before it reaches the carburetor.

Open the plug on the side of the transmission case and note oil level. If oil does not flow, fill to proper height with grade specified in lubricating instructions. Note oil level of differential housings and fill, if necessary, with specified grade.

A careful inspection should be made of the amount of grease in the wheels and on spindle bearings.

The pinion shaft roller bearings should be looked at in case they may have rusted or broken. If one of these bearings fail, serious damage might result.

After all spring bolts are oiled and grease cups have been turned down

to the limit and refilled with fresh grease, every universal joint on the truck should be opened and, if necessary, packed with grease. The propeller shaft joints should be given the greatest attention.

PRELIMINARY TO STARTING.

Before attempting to start be certain you have enough fuel, oil and water for the run. See that the crankcase level is correct, and that all lubricating instructions (see under lubrication, page 34) have been carried out. Make a superficial examination to see that nothing about the truck is broken or out of place; look underneath and notice if there is dripping which indicates a leak, except in the case of water coming out through the radiator overflow. You can tell by the feel and odor whether it is water, oil or gasoline. See that any danger is removed from driving, by an excessively loose part of the running gear or controls, such as steering knuckles, tie rod, drag link, wheels, etc.

The engine should then be started and let run idle without any load for from one-half to one hour before starting the truck. After standing on freight cars or on board ship for a long time piston rings may gum fast, valves rust in or the gasoline line clog up, and this preliminary running in will repay for the trouble in the time saved on adjustment later on.

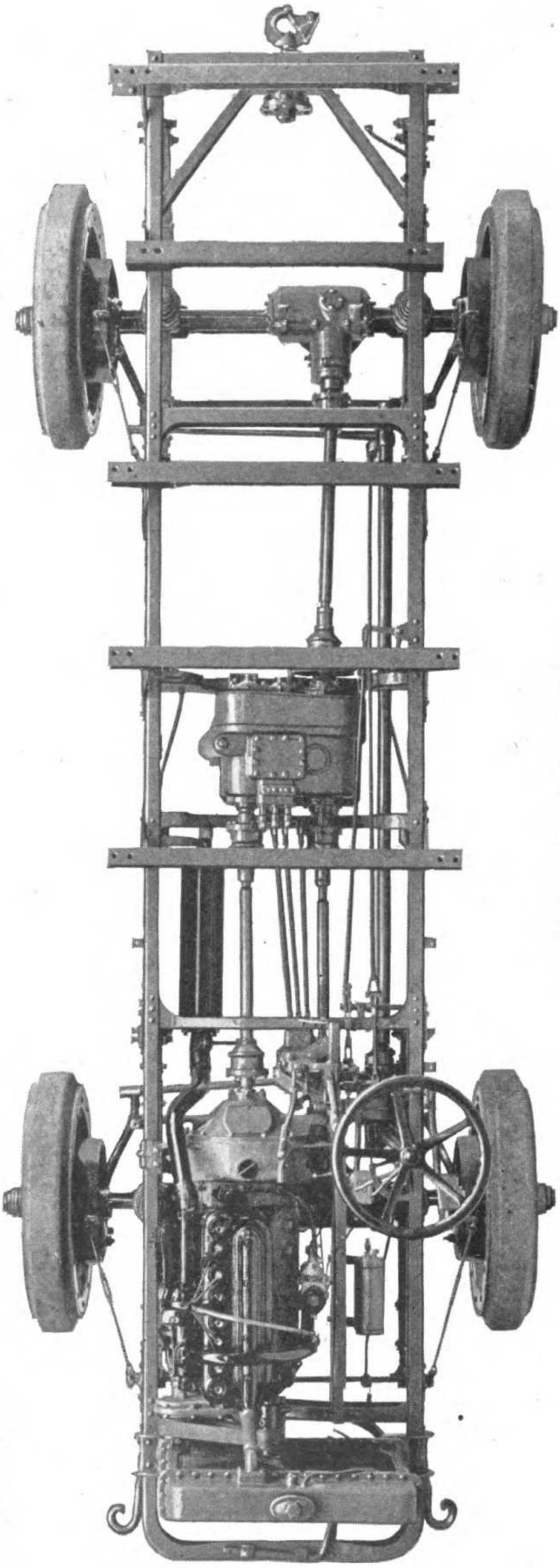
After going into service the truck should be driven very carefully for the first week in order that the various parts may work into place and the rough edges wear off. The first five hundred miles are the most important in the life of the truck, and abuse early will surely result in poor efficiency probably later on, when the best will be required of the truck.

STARTING.

Before cranking the engine always see that the gearshift lever is in neutral position and the hand brake set. If you make a practice of setting the hand brake every time you shift into neutral when stopping you will be on the safe side. When stopping set the spark one-quarter advance and set the hand throttle lever one-quarter open. This sets these for the next start. Get into the habit of doing these things automatically.

Turn ignition switch to "mag" and then crank engine.

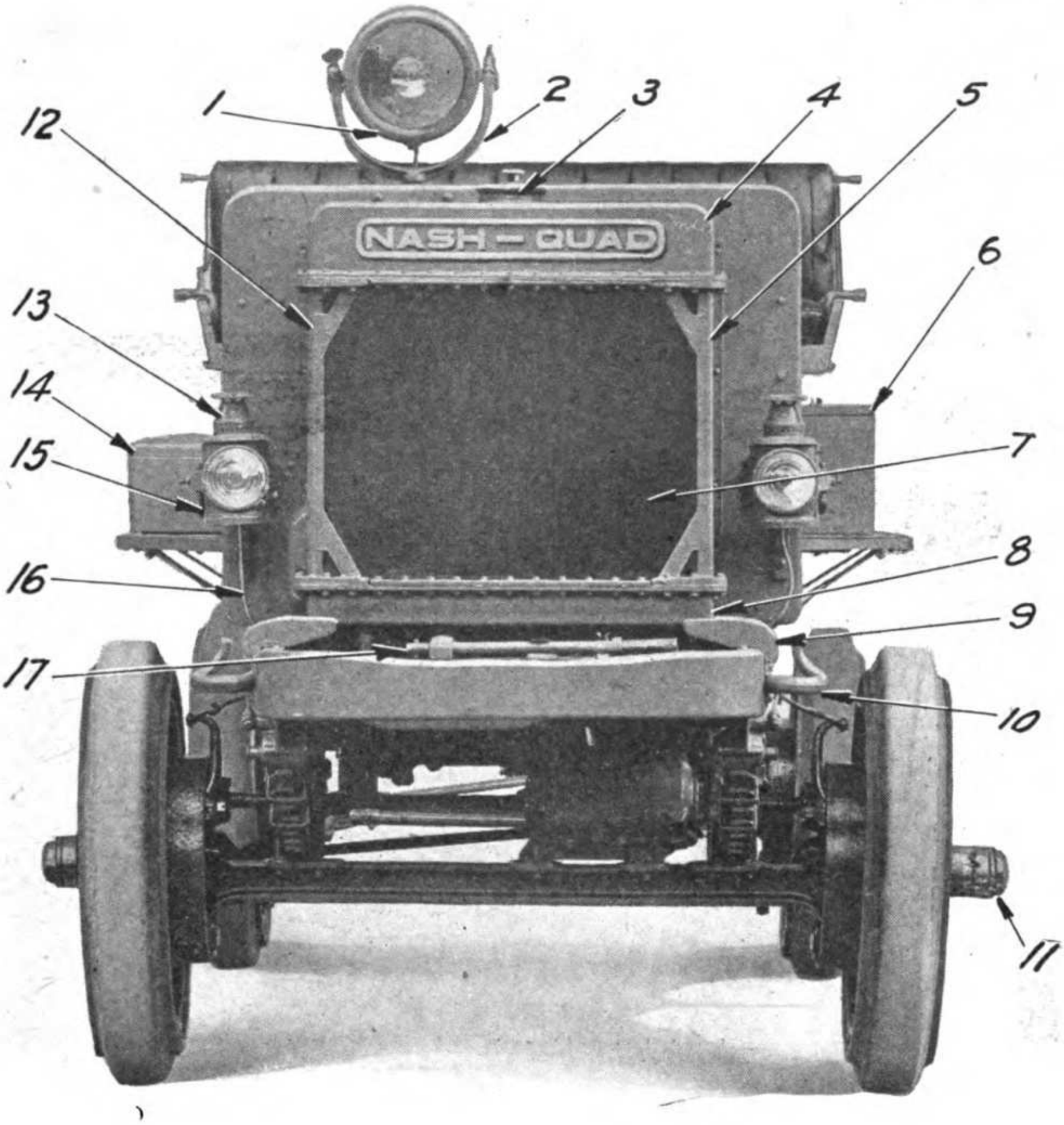
After the engine has started firing advance the spark as far as it will go and get a good idling position for the throttle lever. In the winter time it will be necessary to pull up the carbureter air choke before cranking so that a rich mixture is drawn into the cylinders. Do not keep the air choke pulled up longer than necessary. That means as soon as the engine starts firing push the choke down gradually until the engine runs and pulls smoothly. If it starts to backfire and spit keep the choke on full or part way as needed. It will require only a minute in the cold weather to get smooth running with the choke closed, that is, up.



PLAN VIEW OF CHASSIS.

Plate No. 5

Plate No. 6

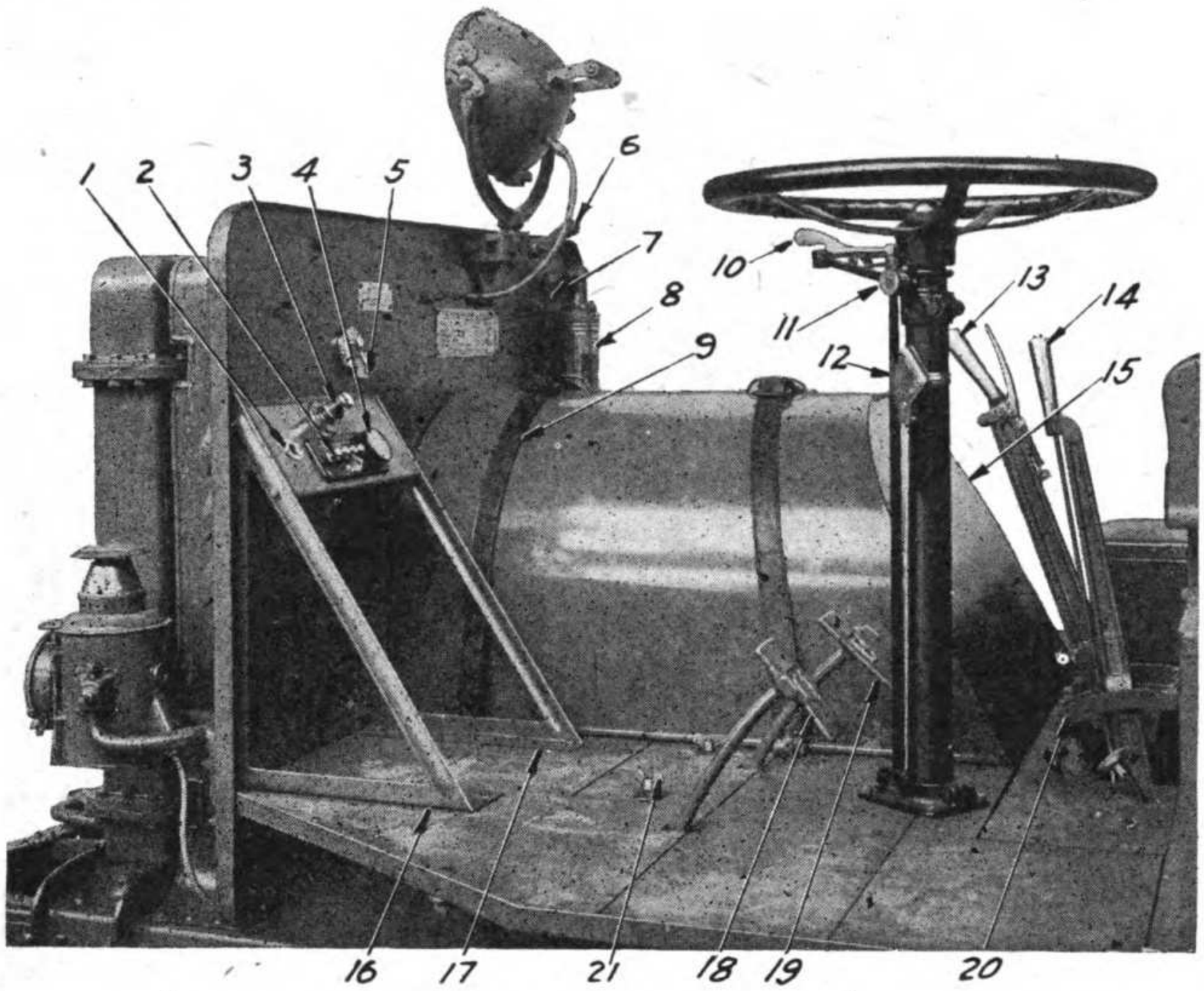


FRONT VIEW OF CHASSIS. MODEL 4017-A ONLY.

Ref. No.	Part No.	Name of Part.
1	37057-A	Searchlight.
2	35259-A	Searchlight bracket, complete.
3	32183-A	Radiator filler cap.
4	32186-A	Radiator top tank.
5	32178	Radiator side member.
6	35836-A	Battery cover.
7	32171	Radiator core, complete.
8	32185	Radiator bottom tank.
9	31087	Radiator bracket.
10	32530	Tow hook (left).
11	32713	Wheel odometer and hub cap.
12	32178	Radiator side member.
13	35327-A	Head lamp complete (Adlake).
14	32620-A	Tool box.
15	35339	Head lamp bracket.
16	35723	Side lamp wire.
17	32674	Starting crank.

Note.—Special instructions for Model 4017-L. This engine should be easier to start than in the 4017-A, because of the use of an impulse starting device fitted to the magneto. This impulse starter gives a very quick turn

Plate No. 7



DRIVER'S COMPARTMENT. MODEL 4017-A ONLY.

Ref. No.	Part No.	Name of Part.
1	35871	Trouble lamp socket.
2	35287-A	Lighting switch, complete.
3	35284-A	Instrument board lamp, complete.
4	36839	Ammeter (Weston).
5	35902	Magneto switch (Kick type).
6	36636	Searchlight bracket lever.
7	35281	Fire extinguisher bracket.
8	35249	Fire extinguisher.
9	35305-A	Hood strap (left).
10	33778	Spark lever.
11	CU-113	Steering column grease cup.
12	33662	Carburetor control.
13	32206-A	Hand brake lever.
14	35404-A	Change gear lever assembly.
15	32880-A	Hood, complete.
16	33042	Dash brace (upper left).
17	33043	Dash brace (upper center).
18	32651	Clutch pedal pad.
19	32650	Brake pedal pad.
20	32317	Gear shifted lever quadrant (outer).
21	NU-1006	Floor board clamp nut.

to the magneto armature, causing a good, hot spark to occur with only a single turn of the crank. It is not necessary to spin the engine to get the needed good spark, but it may be to get a good mixture.

If in cranking the engine it does not respond in a reasonable time, investigate instead of wasting energy cranking further. Go at the work systematically, keeping in mind all the time that there are three important systems, the failure of which will cause engine failure. These systems are: The fuel system, the ignition system and the valve system. If there is fuel and spark and the valves are working properly the engine should start, other things being equal. See page 104 for further information about failure to start.

If on cranking, the engine turns over only part way, stopping suddenly at one point and not going beyond, make an investigation to find an obstruction. In the winter a frozen water pump might cause this. Breakage of a timing gear or interference with free movement of any moving part of the engine will cause stoppage of this kind. Use your judgment, based on the previous run of the truck, recalling whether it was run with proper amount of oil, or if any unusual noises were heard.

In the winter time cranking may be more difficult than in warm weather, because of the thickening of the oil around the interior moving parts. Once the engine is started in cold weather let the engine idle for a while, until the oil has become sufficiently thin to circulate properly. Cold oil is like cold molasses, it will not flow readily.

RUNNING.

PRELIMINARY ADVICE.

Remember that in the first few hundred yards of running you should keep your eyes, ears and sensory system at work. Test the brakes to make sure they are working, instead of finding out in an emergency. Be satisfied that everything is running right.

THE CONTROL SYSTEM.

The control system consists of those parts necessary to start the engine, shift the gears, accelerate and keep the truck moving forward, and those needed to stop the truck. Thus the complete system consists of clutch and brake pedals, hand or emergency brake lever, spark and throttle levers, accelerator pedal, ignition switch, and carburetor air control.

THE CONTROLS AND THEIR USE.

STEERING WHEEL.

The steering wheel controls the direction of the truck. Turning the wheel to the right turns the truck to right and vice versa. Do not at-

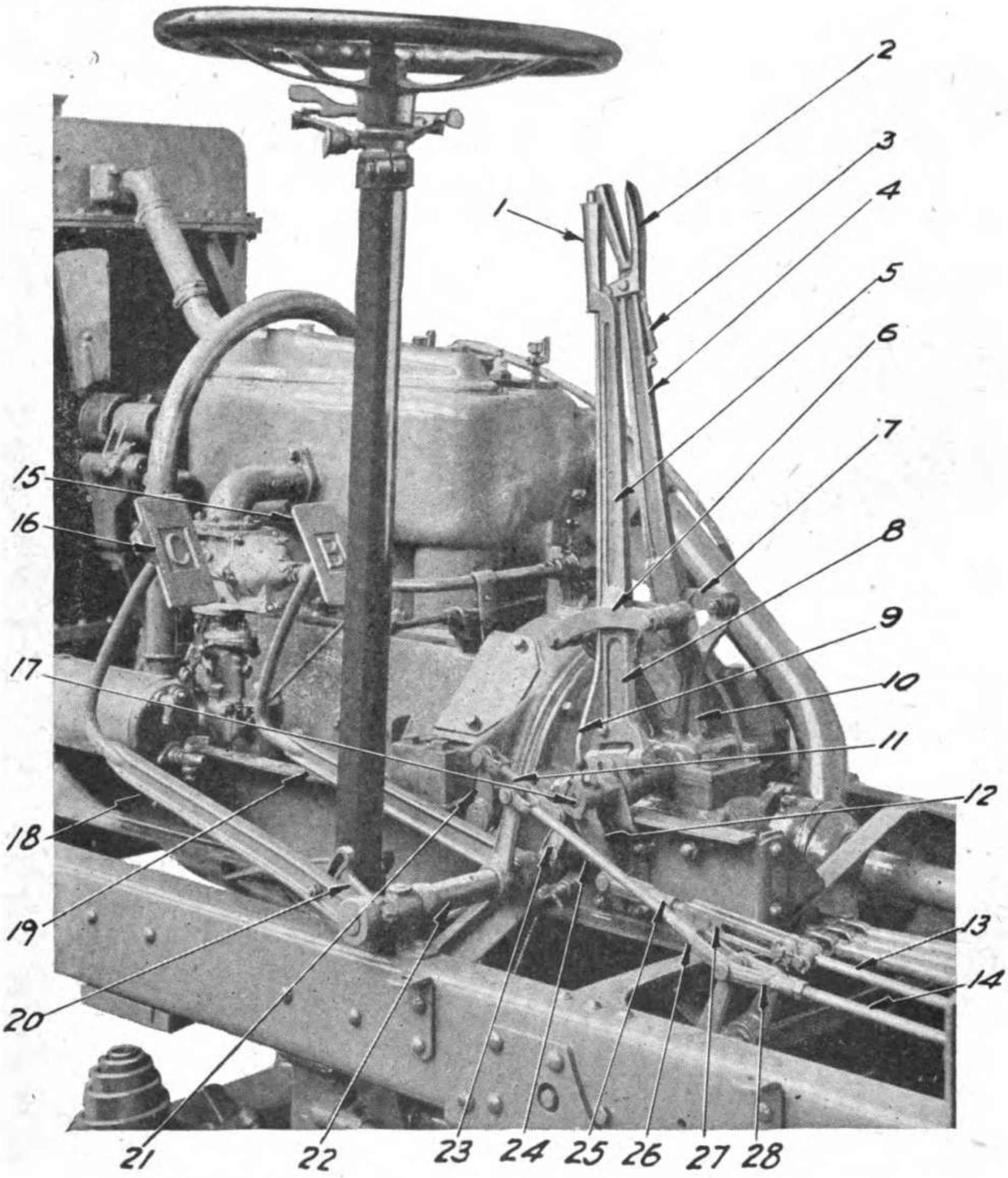
tempt, however, to turn the wheel forcibly when the truck is at rest. This throws needless strain on the steering connections. If you wish to observe the movement of the wheels, jack up the truck.

PEDALS.

CLUTCH PEDAL.

In front of the driver are two pedals. The one on the left is the clutch pedal. The one on the right is the wheel brake pedal. It is ordinarily used and without much pressure will lock all wheels. The clutch pedal, untouched, is in normal position, and in that position the clutch is engaged. When depressed the clutch is disengaged, i. e., independent of flywheel movement.

Plate No. 8



FRONT END OF CHASSIS, DASH REMOVED.

BRAKES.

The foot brake pedal, untouched, is in normal position, and in that position the brakes are not applied. When the pedal is depressed the foot brakes (one acting on each wheel) are applied. The hand brake, or emergency brake lever, when forward all the way releases the brake on the transmission countershaft. This hand brake, when pulled back all the way, sets all the brakes, the four-wheel brakes and the brake on the transmission countershaft as well.

ACCELERATOR PEDAL.

At your heel is the foot accelerator plunger which controls the throttle and speed of the engine.

GEARSHIFT AND HAND BRAKE LEVERS.

In the center of the foot-board are mounted two hand levers. The one at the left is the change-gear lever. The one at the right is the brake lever. Pulling it toward you the brake lever applies brakes on all wheels and transmission (five brakes). To release, compress the handle and return the lever to the front end of the quadrant, being sure that it is in the most forward position before starting the truck. It is well to occasionally use your emergency brake lever in order to determine that it is in proper operating condition, applying brakes on all four wheels and transmission. Grasp the handle of the change-gear lever lightly and

FRONT END OF CHASSIS.

Ref. No.	Part No.	Name of Part.
1	35404-A	Change gear lever assembly.
2	32329	Brake lever trigger.
3	32330	Brake lever trigger spring.
4	32325	Brake lever.
5	35385	Gear shifter lever.
6	32317	Gear shifter lever quadrant (outer).
7	32323	Hand brake lever quadrant.
8	35385	Gear shifter lever.
9	34750	Gear shifter lever reverse lock rod.
10	32324	Quadrant bracket.
11	32580	Clutch pedal shaft and throwout shift connecting rod.
12	32664	Hand brake shaft lever.
13	32412	Brake rod.
14	32409	Brake rod (rear).
15	32650	Brake pedal pad.
16	32651	Clutch pedal pad.
17	32331	Brake lever shaft.
18	31265	Clutch pedal.
19	32542-A	Brake pedal and tube, complete.
20	31674	Clutch pedal adjusting hub.
21	32770	Clutch throwout shaft lever (outer).
22	31263-A	Clutch pedal shaft, complete.
23	32572-A	Clutch throwout shaft lever (right).
24	36324-A	Brake rod inter-connecting (complete).
25	32390	Brake rod adjusting yoke.
26	32390	Brake rod adjusting yoke.
27	32391	Hand Brake and rocker shaft connecting link.
28	32411	Brake rod adjusting yoke.

move it backward and forward until you have become thoroughly familiar with its movements (engine not running). If you grip the lever hard, the muscles of the wrist become rigid and you lose the flexibility necessary for proper shifting of gears. Never move the gear shift lever unless the clutch is fully disengaged.

GEARSHIFT LEVER.

The gearshift lever is moved into the following positions in order to make the necessary gear engagements in the transmission. The illustration on page 15 of the quadrant shows where the lever ought to be for the different speeds.

First speed, push lever away from you to first notch ahead. Second—lever away from you to the extreme rear. Third—center to the extreme rear. Fourth—center to the front. Reverse—toward you to the extreme inner front. Button on top of lever must be depressed before reverse is engaged. Neutral—in center where lever may be moved easily to left or right.

IGNITION SWITCH.

The ignition switch has two positions—"Magneto" and "Off."

CARBURETOR AIR CHOKE.

The carburetor air control is located on the steering post. To enrich mixture for easy starting in cold weather, or after car has been idle for some hours, pull up. As engine fires properly, gradually work to the lowest point of adjustment. Do not keep this choke applied any longer than necessary. See page 21 concerning use of choke in winter.

SPARK AND THROTTLE LEVERS.

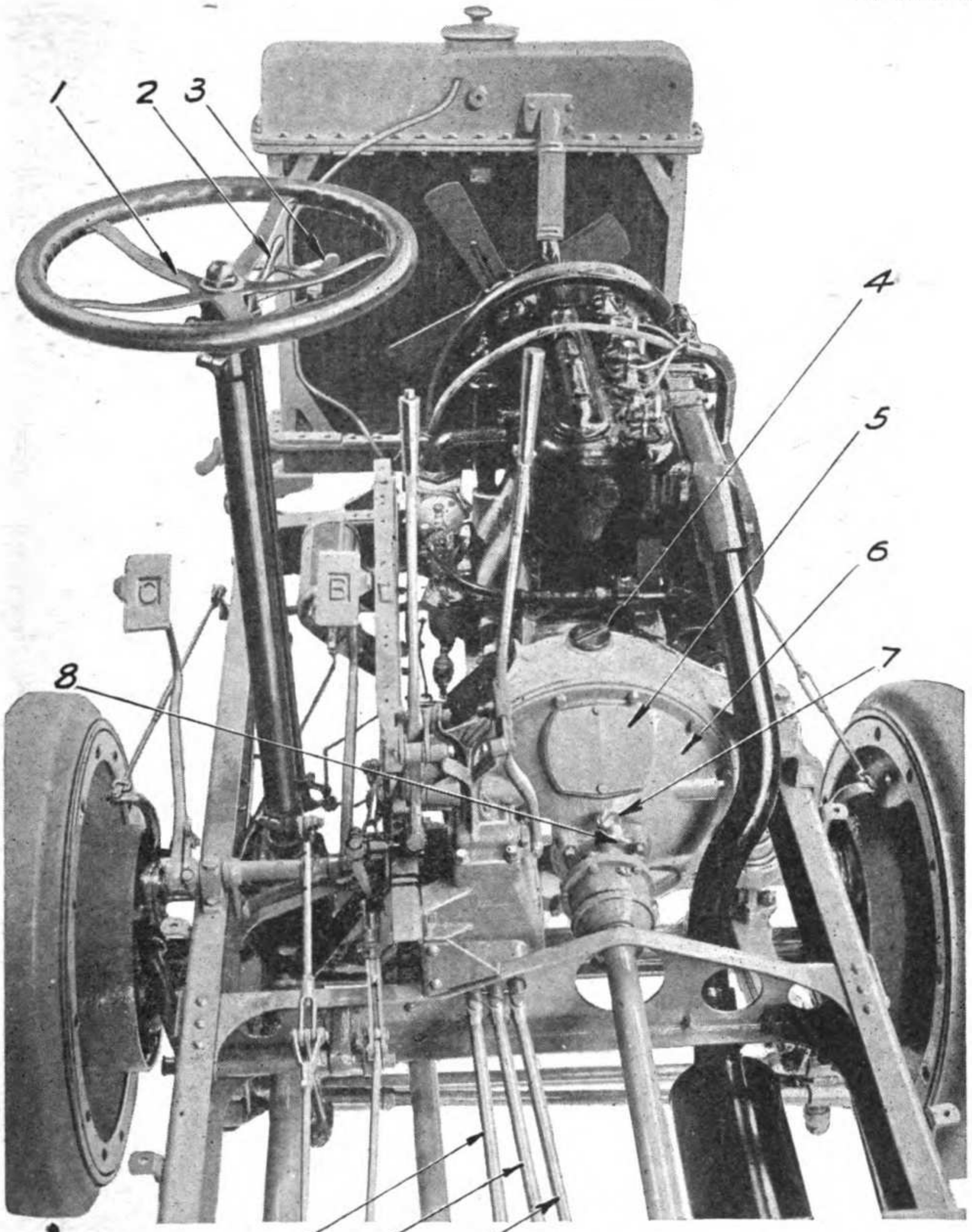
The spark lever on the steering post is the shorter of the two. For starting, usual position is one-quarter way up on quadrant. When the engine is running the spark lever must be advanced as far as possible without causing a spark knock (which must be avoided).

The throttle lever on the steering post is the longer of the two. For starting advance about two inches. When engine starts, return to normal position. Best results will be obtained by using accelerator pedal entirely, thus giving the use of both hands for the control of the truck.

GASOLINE SHUTOFF OR CONTROL VALVE.

The gasoline shutoff valve is located at the bottom of the gasoline tank. Looking at this valve from the front, the lever should stand at about a 45-degree angle to the right for reserve, and the same angle to the left for supply, and should be in an up-and-down position with the long end of the lever toward the top at about 45 degrees from center for "off" position.

Plate No. 9



VIEW FROM CENTER OF CHASSIS FORWARD, DASH REMOVED

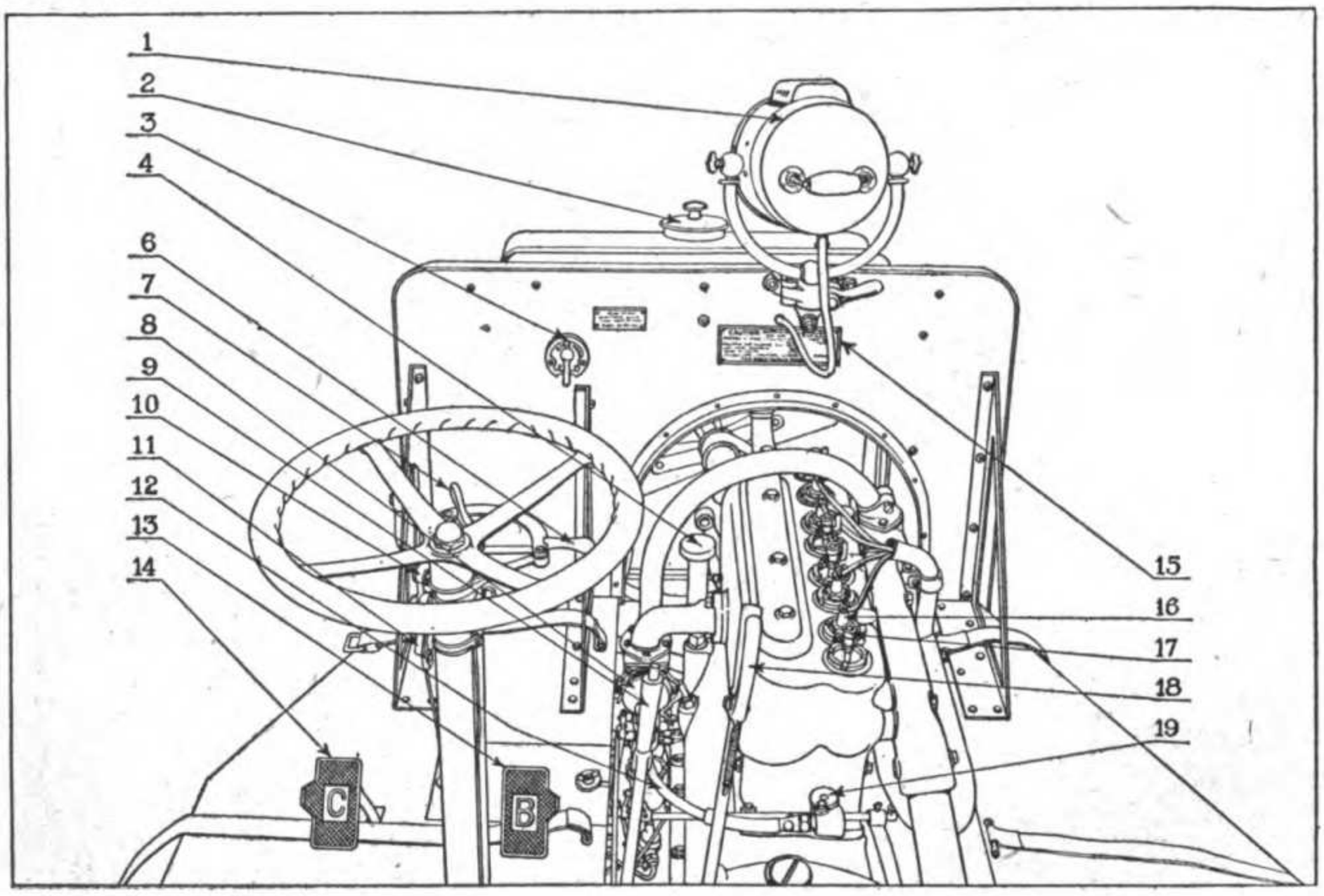
Ref. No.	Part No.	Name of Part.
1	36372	Steering wheel.
2	33779	Spark control lever.
3	33783	Throttle control lever.
4	34413	Flywheel housing cap.
5	30370	Clutch housing hand hole cover.
6	32583-A	Clutch housing assembly.
7	CU-209	Clutch shaft bearing retainer grease cup.
8	32472	Clutch shaft rear bearing retainer.
9	32166-A	Transmission operating tube assembly.
10	32166-A	Transmission operating tube assembly.
11	32166-A	Transmission operating tube assembly.

The gasoline tank is so constructed that before the gasoline will flow from the tank with this valve on reserve position, there must have been more than five gallons of gasoline in tank.

DRIVING.

In ordinary running keep the spark advanced as far as possible without causing the engine to knock. When knocking occurs retard the

Plate No. 10

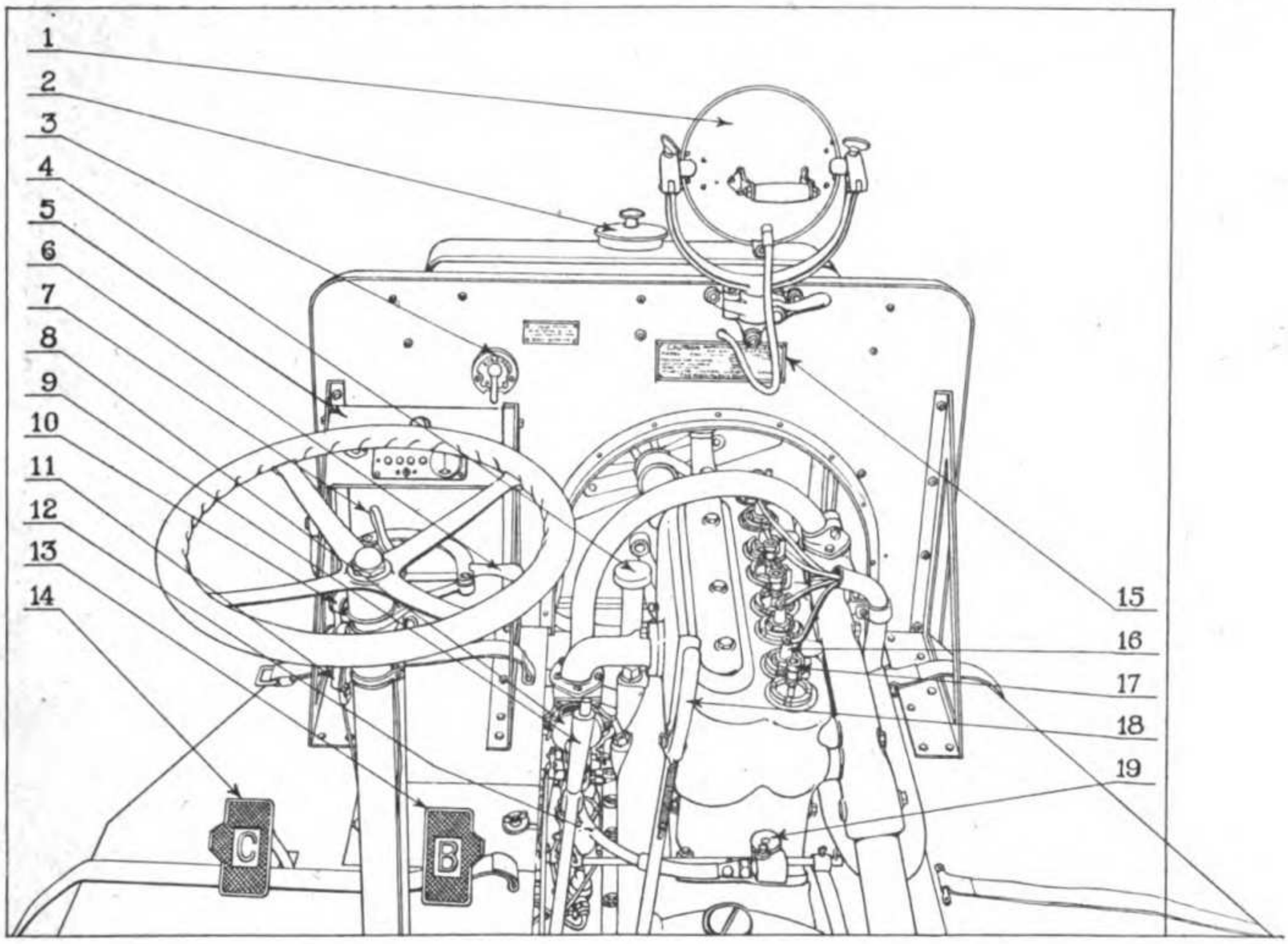


DRIVER'S COMPARTMENT. MODEL 4017-L ONLY.

Ref. No.	Part No.	Name of Part.
1	37058-A	Search lamp.
2	32183-A	Radiator filler cap.
3	35902	Ignition switch.
4	34395	Motor oil filler cap.
6	33784	Throttle lever.
7	33778	Spark lever.
8	31801-A	Governor.
9	35404-A	Change-gear lever.
10	CU-113	Steering column grease cup.
11	33662	Carburetor control.
12	32991	Governor drive casing.
13	32650	Brake pedal pad.
14	32651	Clutch pedal pad.
15	37105	Caution plate.
16	31946	Spark plug.
17	34359	Relief cock.
18	32206-A	Hand-brake lever.
19	35705-A	Governor drive gear housing.

spark. The engine speed may be controlled either by the accelerator pedal or the hand lever, the long one, under the steering wheel. In using either of these bear in mind the sensitiveness of the throttle, and do not

Plate No. 11



DRIVER'S COMPARTMENT. MODEL 4017-A ONLY.

Ref. No.	Part No.	Name of Part.
1	35270-A	Search lamp and bracket assembly.
2	32183-A	Radiator filler cap.
3	35902	Ignition switch.
4	34395	Motor oil filler cap.
5	35764-A	Instrument board.
6	33784	Throttle lever.
7	33778	Spark lever.
8	31801-A	Governor.
9	35404-A	Change-gear lever.
10	CU113	Steering column grease cup.
11	33662	Carburetor control.
12	32991	Governor drive casing.
13	32650	Brake pedal pad.
14	32651	Clutch pedal pad.
15	37105	Caution plate.
16	31946	Spark plug.
17	34359	Relief cock.
18	32206-A	Hand-brake lever assembly.
19	35705-A	Governor drive gear housing.

open the throttle wide suddenly, but gradually. Get accustomed to using the accelerator pedal, using the hand lever only for an idling point and also for traveling at a fixed speed.

SHIFTING GEARS.

Remember that the clutch should be engaged gradually, that is, allow the pedal to return to normal position slowly instead of quickly. Gradual engagement means less shock to the whole power transmitting mechanism.

You may find in starting up that after the clutch has been released the shift into first cannot be made. If this is the case engage and disengage the clutch again and try to shift. In other words, let the clutch in and out once or twice until the clutch jaws are in proper position. After meshing, engage clutch slowly to avoid starting the truck with a jerk.

To shift to any gear (or speed), the rotative speed of the two parts of the gear clutch which are to be engaged must be as near uniform as possible. When starting the truck (from a fixed position) the speed of the driving member is reduced to zero (otherwise the teeth of the clutch would clash), as the speed of the driven member is zero. This is attained by disengaging the clutch fully, at which position the clutch brake is effective. The function of the clutch brake is to overcome the inertia and internal friction of the clutch, which, otherwise, would "spin" for some time. The speed of the driving member in the transmission is therefore dependent upon the relative position of clutch disengagement, time, of course, being considered in all cases.

SHIFTING INTO FIRST SPEED.

From neutral to low, press clutch pedal down fully. Place change-gear lever in first-speed position, letting clutch in gradual, at the same time slightly speeding up engine. The change from first to second is made best at a speed of from three to six miles an hour by disengaging clutch, but not so far as to apply clutch brake, and pulling back gearshift lever quickly into second speed position, increasing engine speed (by opening throttle) to secure additional power, and engage clutch slowly. The entire operation must be completed before the truck speed has decreased materially. The change from second to third can be made best at truck speed of from six to eight miles per hour. The change from third to fourth can be made best at a speed of about ten miles per hour.

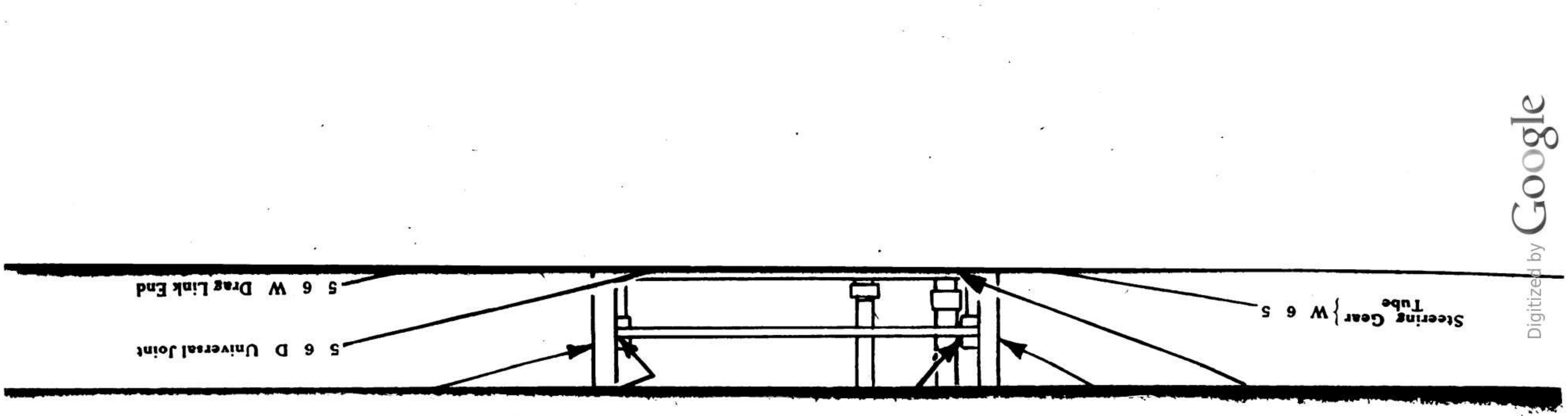
CHANGING FROM FOURTH TO THIRD.

In changing from fourth to third, disengage clutch sufficiently to shift into neutral, then engage clutch (meanwhile speeding up engine) to increase speed to that of the third speed gear, then quickly disengage clutch, engage third gear and engage clutch slowly.

In making changes from any gear to a lower one the motor should be speeded up with clutch engaged during the changing operation in order that the clutch speed may pick up to the transmission speed, thus rendering engagement easy.

WHEN TO CHANGE TO LOWER GEAR.

Fourth speed is direct drive in the transmission, no gears delivering power. It is the speed usually used on level roads. Do not attempt to change from a higher to a lower speed until the truck has slowed down to that speed. Do not try to climb steep grades or pass over heavy sandy roads



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on high gear. When the engine labors, change to a lower speed. This will save the moving parts and prolong the life of the engine.

DRIVING UP AND DOWN GRADES.

In driving down grade there are three forms of resistance that can be used to control the speed of the truck. Its momentum can be arrested by means of the brakes, the gears may be shifted into a lower speed, or the engine may be used as a brake by shutting off the ignition. The lower the gear used the greater resistance, so that the greatest possible resistance in the transmission is had with the gears in the first speed. Added resistance may be had by shutting off the ignition, and, of course, still more by using the brakes. All three forms (the gears in first, the ignition off and brakes applied) hardly need be used. The object is to refrain from using the brakes because keeping them applied wears the linings.

In ascending a grade use judgment about the ability of the truck. If it is very steep, shift to a lower gear before you get on the grade. If you think it can be done in high without the engine knocking do not shift. Make as quick a shift as possible, if it is necessary to do shifting on an upgrade. If you happen to stall the engine on the grade, shift immediately into neutral and apply the hand brake, at the same time cramping the wheels.

"RIDING" THE CLUTCH.

In driving along do not "ride" the clutch, that is, do not keep your foot on the clutch pedal. Even slight pressure on the clutch pedal causes excessive wear of the clutch bearings and may cause slight slippage.

STOPPING.

In slowing the truck down always slow down the engine first and anticipate your stop, so as to avoid excessive use of the brakes.

After the truck has been brought to a standstill, the gears shifted into neutral and the hand brake applied, turn the ignition switch to "Off" postion, retard the spark lever to one-quarter position and the throttle lever to one-quarter open, placing these controls ready for the next start.

LUBRICATING INSTRUCTIONS.

PRELIMINARY ADVICE.

Study the lubricating chart inserted after page 32 for parts that require attention. Perfect and continuous lubrication means less wear of parts, less trouble and a better running truck. Lubricant is of little value mixed with dirt, so before you oil or grease a part make sure there is no dirt on the surfaces, that not even the smallest speck of dirt gets to a moving part. Cleanliness of moving surfaces is absolutely essential. Use clean cloths to wipe these surfaces after they have been cleaned by means

of gasoline or kerosene. Make periodic lubrication a habit. Attend to certain parts daily, as indicated on the chart, to others weekly and others monthly. These are maximum periods.

SPECIFICATIONS OF LUBRICANTS.

After each part mentioned in lubricating instructions, and indicated on the lubricating chart (see chart after page 32), will be found a figure which indicates the kind of oil or grease best suited to the lubricating needs of that part. The meaning of the various figures is explained below:

2A. Motor oil, medium, specification No. 3502.
2B. Motor oil, heavy, specification No. 3502.
4. Heavy, straight mineral gear compound, specification No. 3504.
5. Light cup grease, specification No. 3505.
6. Medium cup grease, specification No. 3506.
8. Heavy, straight mineral oil, specification No. 3508.
9. Steam cylinder oil, specification No. 3509.

ENGINE.

2A. Winter.
2B. Summer, capacity 9 quarts, to be brought to level daily.

CRANKCASE CAPACITY.

Nine quarts of reserve oil are carried in the bottom of the crankcase. The amount of oil is indicated by the position of the indicator rod located on the left hand side of the engine. By unscrewing this indicator rod a few turns it may be lifted out, and the depth of the oil in the crankcase noted on the lower end of rod.

WHEN AND HOW TO DRAIN CRANKCASE.

The drain cocks and drain plugs should be inspected from time to time, as they become loose, and consequently cause loss of oil.

The crankcase is of course brought to level daily, but after about 1,000 miles of running the crankcase oil has lost some of its lubricating qualities due to the breaking down of the oil and also to contamination by water, a product of combustion, working its way past the rings. The poor oil will have a black color and will be much thinner (of lower viscosity) than fresh oil. The more frequently crankcase oil is changed, the better, but there is no need to make a useless change. The object is not to permit running for any length of time on poor oil and changes at 1,000-mile intervals usually suffice.

When the engine is cleaned and drained of its old oil, a gallon of kerosene should be introduced through the combined filler and breather cap, located at the front of the left hand side of the engine, after which the engine should be run slowly for a few seconds. Drain same thoroughly and refill with nine quarts of fresh oil as specified.

CLEANING OIL PUMP SCREEN OR STRAINER.

To clean the oil pump screen or strainer, the oil pump must be removed. Make sure that the joints and pump packings are tight, and that the oil pump is running properly after replacement. Should be cleaned each 1,000 miles.

GOVERNOR.

No. 2A weekly.

To lubricate, remove the oil filler screw, and fill chamber with lubricant. This should be done weekly. Every month remove the drain screw. Be sure the two screws below the governor shaft are kept tight to prevent oil leaking. (See page 88, Care and Adjustment of Governor.)

MAGNETO.

No. 2 every other week.

Twenty drops off the end of a toothpick of light clean mineral oil, every two weeks, distributed as follows:

One drop of oil in the oil hole on side of breaker box most convenient, lubricating surface between magneto frame end and movable breaker box, five drops of oil in the small hole at the driving end of magneto, lubricating the distributer wheel bearing, and fourteen drops in the large hole at driving end, lubricating the shaft bearing which takes all the driving load.

For small engine parts see chart inserted after page 32.
For operation of engine lubricating system see page 63.

CLUTCH.

No. 6 daily.

The clutch itself, being of the dry-plate type, needs no plate lubrication, but on the rear of the clutch housing there is a large grease cup, which lubricates the rear bearing of the clutch. This should be kept filled with fresh cup grease. A second grease cup is located on the universal joint to the rear of the clutch housing. It lubricates the clutch shaft bearings.

PROPELLER SHAFT UNIVERSAL JOINTS.

No. 6 daily.

Since all the propeller universal joints are of the same construction, they are lubricated in the same manner. To lubricate them, remove the plug at the top of each. Clean monthly with kerosene and repack with cup grease.

TRANSMISSION.

Summer, 33% of No. 2B and 67% of No. 4
Winter, 50% of No. 2B and 50% of No. 4
} every other week.

To renew the lubricant in the transmission, remove the top cover. The level of oil should reach to half the depth of the transmission.

FRONT AND REAR AXLES.

Internal drive gears { 50% of No. 6 / 50% of No. 8 } every two weeks.

To lubricate the internal gear pinion bearings of both axles, remove the outer plugs on the webs of the front and rear wheels, and fill with lubricant as above specified.

WHEEL SPINDLE BEARINGS.

{ No. 6 in summer / No. 5 in winter } weekly.

To lubricate the wheel spindle bearings, remove the inner of the two plugs, and fill with grease.

STEERING KNUCKLES.

{ No. 9 in summer / No. 2A in winter } daily.

To lubricate the lower steering pins, turn down the cups. At the top of the steering knuckle pins there are oil cups for lubricating the upper bushings.

AXLE UNIVERSAL JOINTS.

{ No. 6 in summer / No. 5 in winter } weekly.

To lubricate the axle universal joints remove the plug on the axle just inside the universal joint flanges. It is necessary to completely dissemble the axle to clean these joints.

DIFFERENTIALS.

{ 60% of No. 4 and 40% of No. 5 in summer / 25% of No. 4 and 75% of No. 5 in winter } every two weeks.

Remove the cap on top of the differential housings on the front and rear axles to inspect, and insert new lubricant. In order to clean, remove the top half of the differential housings. Remove all old lubricant, thoroughly clean with kerosene, and fill to level with new lubricant.

STEERING GEAR.

{ No. 6 in summer / No. 5 in winter } weekly.

To lubricate, remove a plug which is near the lower end of the steering column housing, and inject lubricant freely.

CONTROL SET.

No. 2A weekly.

A few drops of oil should be placed in the foot lever bearings. They should be oiled through the oil holes provided for the purpose.

SPRINGS.

Once every two months jack up the frame, and by removing the spring clips the spring leaves may be pried apart. Lubricate between the leaves with graphite. Should leaves be excessively rusted, it is well to dismantle the spring, remove the rust, and paint the leaves with graphite paint.

MAINTENANCE ROUTINE.

DAILY MAINTENANCE ROUTINE.

ENGINE.

Tighten all wiring terminals.
Tighten any loose nuts.
Clean exterior of spark plug porcelains.
Clean magneto externally.
Note tension of fan belt.
Inspect oil pump for performing its function.
Fill radiator (twice).
Fill gasoline tank.
Inspect all gasoline, oil and water lines and connections for leaks.

BRAKES.

Examine, and adjust brakes (if necessary).

GENERAL.

Clean, trim and fill all lamps and generator.
Inspect springs for breakage.
Report any breakage.
Check tool equipment.
Inspect wheel alignment and all steering connections.

LUBRICATION.

See chart after page 32.
Fill oil squirt can.

WEEKLY MAINTENANCE ROUTINE.

ENGINE.

Inspect all wires for proper support and freedom from damage.
Thoroughly clean engine externally.
Inspect for oil leaks.
Inspect control connections.
Inspect all water connections for leaks.
Remove, clean and adjust all spark plugs.

Remove magneto distributor cover and clean with gasoline and clean cloth.

Drain water and dirt from water trap in gasoline line.

Inspect carburetor control connections and connections with governor.

Do not attempt to alter adjustment of carburetor or governor unless this is shown to be necessary when truck is in service.

Inspect engine oil drain cocks and drain plugs for loss of oil.

BRAKES.

Inspect and thoroughly clean all brake connections.

SPRINGS.

Inspect center bolt of spring and spring clips for apparent tightness.

WHEELS.

Inspect tires for undue damage.

TRANSMISSION.

Clean and inspect all control connections.

WHEEL UNIVERSALS AND DRIVING PINION BEARINGS.

Inspect wheel universal joints and drive pinion bearings for excessive looseness, by inserting a screwdriver between the spring clip bolts and the axle shafts. If considerable vertical movement is possible universal joints should be examined and the proper adjustment of pinion bearings made by removal of shims from between the bearings cage and the knuckle body.

BODY AND EQUIPMENT.

Inspect body bolts, hood fasteners and all similar bolts for apparent tightness.

Inspect tool equipment for completeness.

LUBRICATION.

(See chart after page 32 for parts needing weekly attention.)

MONTHLY MAINTENANCE ROUTINE.

ENGINE.

See page 103, under Carbon Removal, for method of doing the work, and how to determine if carbon is present in quantity in the engine.

Examine and inspect engine for loose parts, leaks, noises.

Clean oil strainer.

Grind valves if necessary. See page 55 for instructions on doing the work.

IGNITION.

Clean magneto collector ring, file and adjust breaker points.

CLUTCH.

Thoroughly clean and inspect all pedal connections.

TRANSMISSION.

Clean externally and inspect for leaks, particularly in bearing covers at the front and rear ends around shafts.

STEERING.

Put two jacks under front and rear axles, near wheels, and lift wheels slightly off from the ground, then inspect all connections for wear or undue looseness.

SPRINGS.

Thoroughly clean and inspect spring shackle connections.
Inspect springs, replacing any defective parts.

DIFFERENTIALS.

Clean and inspect all differential housing for oil leaks.
Inspect all bolts for tightness.

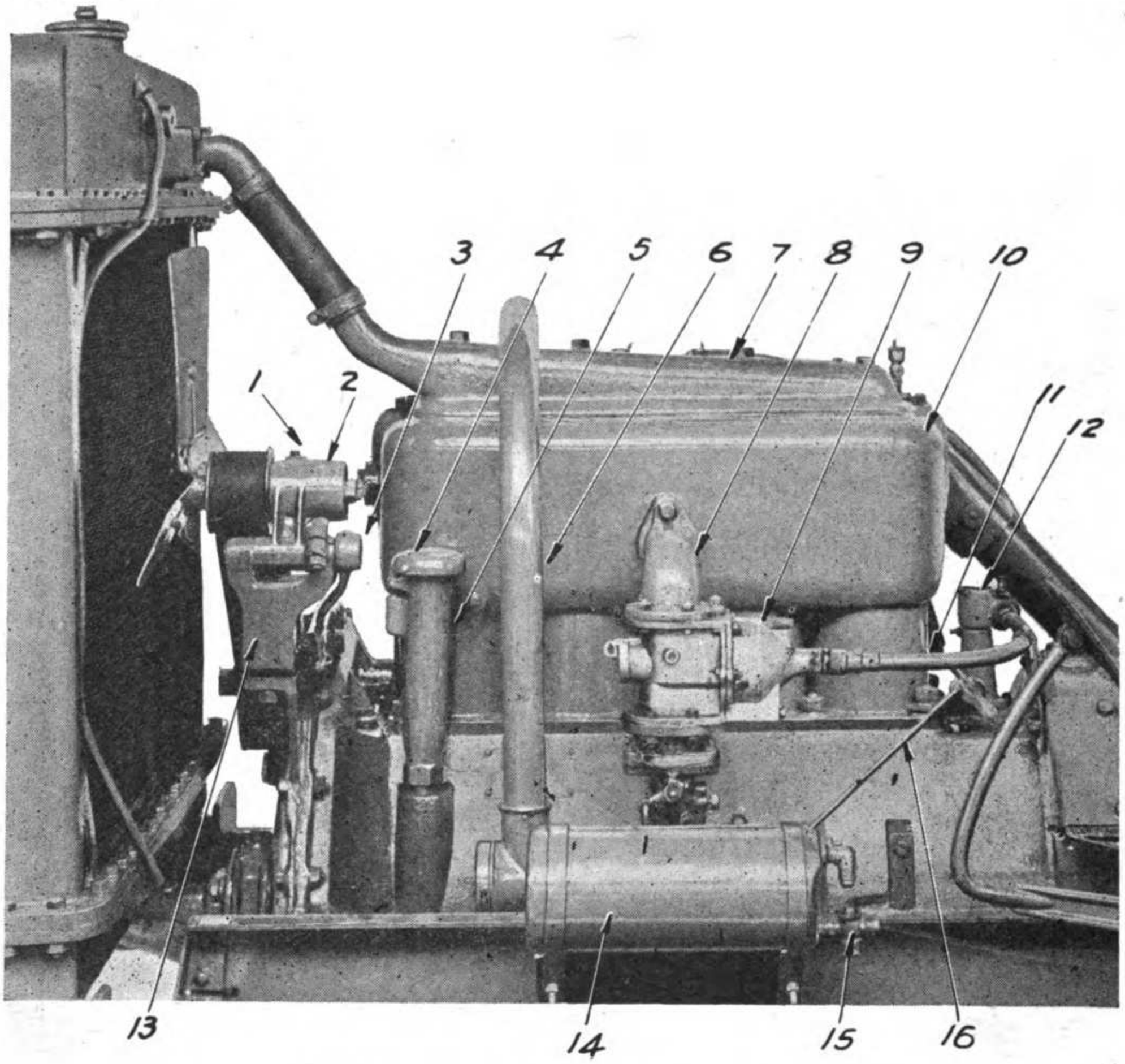
WHEELS.

Remove hub cap and inspect for supply of lubricant.
Inspect all wheels for proper relative alignment.

GENERAL.

Inspect drip pan for security.
Inspect speedometer drive for reliability.

Plate No. 13



LEFT SIDE OF ENGINE.

Ref. No.	Part No.	Name of Part.
1	PL-102	Fan shaft bearing grease plug.
2	32721	Fan shaft bearing.
3	32724	Fan belt tightening spring lever.
4	34395	Breather body cap.
5	34394	Breather body.
6	33051	Carburetor hot air tube.
7	32456	Water jacket top cover.
8	33297	Intake pipe.
9	31801-A	Governor (duplex).
10	34555-A	Cylinder.
11	32291	Governor drive cable casing.
12	35705-A	Governor spiral drive gear housing.
13	32720	Fan shaft bearing bracket.
14	33500-A	Auxiliary gasoline tank.
15	35839	Auxiliary gasoline tank shut-off cock,
16	32830	Spark rod.

CHAPTER II

ENGINE AND ENGINE ATTACHMENTS.

DESIGN, CONSTRUCTION AND OPERATION IN BRIEF.

The engine is a standard design of Buda make, having four block-cast, L-head cylinders with heads integral. The block is mounted on a cast-iron crankcase, which is in two halves, horizontally split. The cylinders are 4.25 inches dia. bore by 5.25 inches stroke, cooled by centrifugal pump circulation; lubrication is by force-feed and splash; ignition is by Eisemann magneto, and carburetion by a vertical outlet Stromberg carburetor fed by gravity. The engine is equipped with a governor. The valves and valve operating mechanism are on the right, together with the water pump, driven from the timing gears; the magneto driven by an extension of the pump' shaft, and the lighting generator with a drive taken between the pump and magneto. On the Model 4017-L there is no electric lighting generator.

ENGINE OPERATION.

The engine operates on the four-stroke cycle which is the same as that of all truck and passenger car engines made in the United States. There are four distinct strokes of the pistons necessary for the completion of a cycle, these four strokes being called: Intake, compression, power and exhaust.

Upon being cranked by hand, a piston descends while its intake valve is open, and draws into the cylinder through the carburetor and the intake pipe, a charge of gas. When piston is just past the bottom of its stroke, and again returning upwards the intake valve closes, and as the exhaust valve is at this time also closed, the gas is trapped within the cylinder and compressed by the piston's upward motion.

When piston reaches top of its stroke, the spark occurs and explodes the mixture which, due to its increase in pressure, drives down the piston with considerable force, thus storing up energy in the flywheel for the succeeding strokes.

When the piston nears the bottom of its stroke the exhaust valve opens, allowing the expanded, and now useless gases to escape, and stays open during the following upward movement of the piston, allowing the ejection of the remaining burned gases.

DESIGN, CONSTRUCTION AND OPERATION IN DETAIL.

CYLINDERS.

MATERIAL AND CONSTRUCTION.

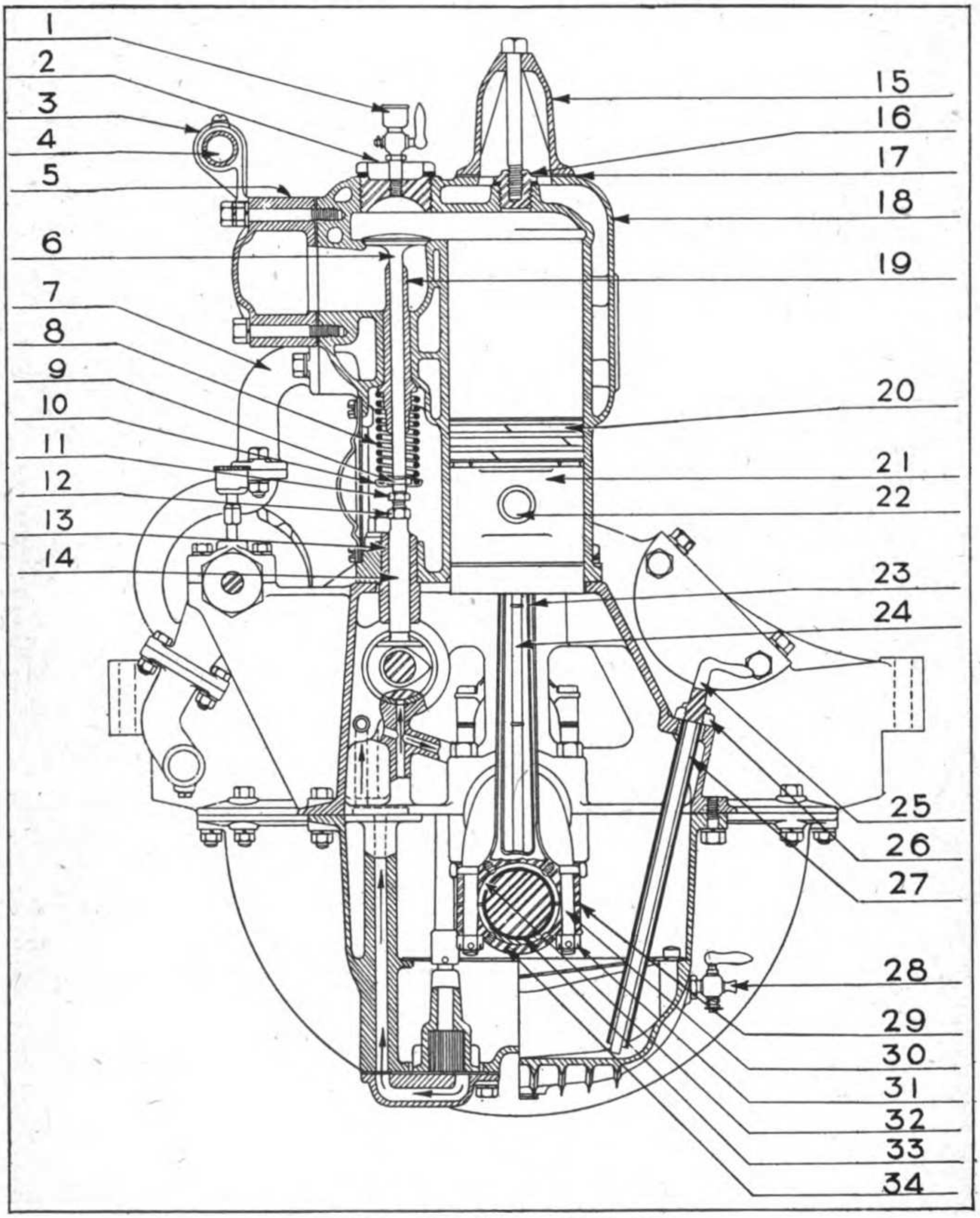
The cylinders are of gray iron, cast in block, and bolted to a cast-iron crankcase. The cylinder casting has the inlet passages cored out so that

the carburetor attached to a short external elbow, or manifold, on the left, feeds across the block through the cored passages. The block has an integral head, but uses valve plugs, so that removal of the valves is possible when the plugs are removed. The water jacket top cover with a portion of the water outlet pipe is a unit bolted to the top of the casting.

PRIMING CUPS.

There are four priming cups screwed into the valve plugs. These cups may be used for priming in winter or for testing the firing and compression.

Plate No. 14



END SECTION OF ENGINE.

IF JACKET IS CRACKED.

If a cylinder water jacket is cracked, emergency repair can be made by calking or by shellac saturated cloth strips pasted over crack, and permitted to dry before filling cooling system with water.

CYLINDER SCORED.

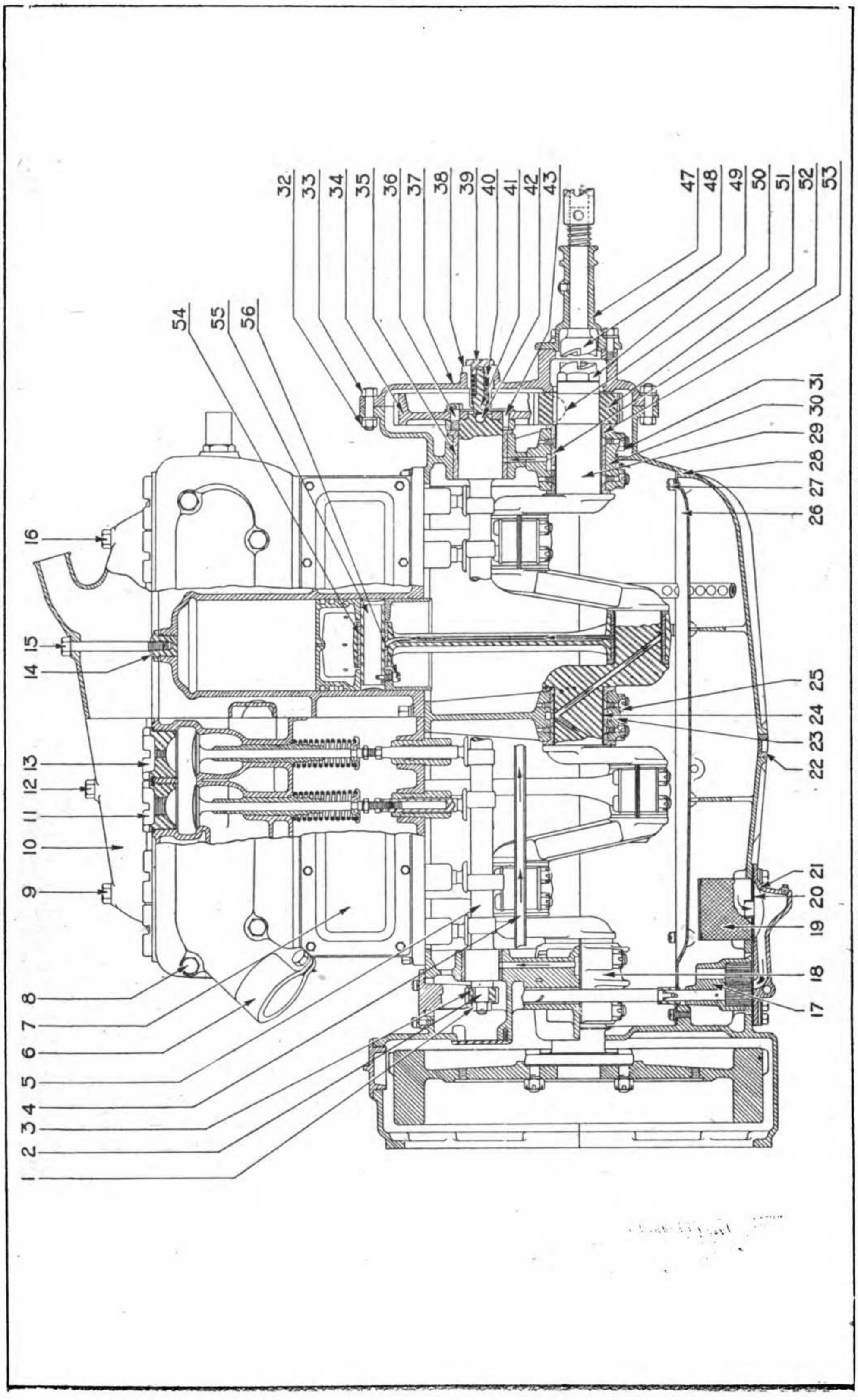
Cylinders may become scored because of engine operation for long periods when overheated, lack of lubrication, tight pistons, loose or broken wrist pin, piston out of round, connecting rod out of alignment, broken piston rings, connecting rod bearing tight (frozen), water or dirt in lubricating oil, burr on piston.

PISTONS.

The pistons are of cast iron of the usual design, with flat top, and using three diagonally-split rings. The ring grooves are 0.250 inch wide. The piston diameter at the top is 4.23 and 4.246 inches at the bottom with a top clearance of 0.020 and at the bottom 0.004 inch. The piston is 5.375 inches long. The difference in clearance between the top and bottom of the piston is due to the difference in expansion at top and bottom, the top

END SECTION OF ENGINE.

Ref. No.	Part No.	Name of Part.
1	34359	Priming cup.
2	34368	Valve chamber plug (exhaust).
3	32982	Wiring manifold bracket.
4	32981	Wiring manifold.
5	34370	Exhaust manifold.
6	35564	Valve.
7	34407	Water pipe from pump to cylinder.
8	34387	Valve spring.
9	34389	Valve spring retainer lock
10	34388	Valve spring retainer.
11	34381	Valve tappet adjusting screw.
12	34382	Valve tappet adjusting screw nut.
13	34391	Valve tappet guide.
14	34380	Valve tappet.
15	32456	Water jacket top cover.
16	34377	Water jacket plug.
17	34366	Water jacket top cover gasket.
18	34555-A	Cylinder.
19	34390	Valve stem guide.
20	34476	Piston ring.
21	34474	Piston.
22	34485	Piston pin.
23	34490-A	Connecting rod.
24	34481	Oil duct.
25	34402	Oil level gauge handle.
26	34401	Oil level gauge tube and nut.
27	34402	Oil level gauge blade.
28	CO-116	Oil level pet cock.
29	34482	Connecting rod bearing shims.
30	34484	Connecting rod bolt.
31	NU-352	Connecting rod bolt nut.
32	34479	Connecting rod bearing (upper).
33	34480	Connecting rod bearing (lower).
34		Connecting rod bearing cap.



SECTIONAL VIEW RIGHT SIDE OF ENGINE.

Plate No. 15

SECTIONAL VIEW RIGHT SIDE OF ENGINE.

Ref. No.	Part No.	Name of Part.
1	NU-354	Oil pump drive gear lock nut.
2		Shoulder for oil pump drive gear.
3	34457	Oil pump drive gear.
4		Oil distributing tube.
5	34560-A	Camshaft.
6	34370	Exhaust manifold.
7	34383	Cylinder side plate.
8	34362	Exhaust manifold screw.
9	34360	Water jacket top cover screw (rear).
10	32456	Water jacket top cover.
11	34367	Valve chamber plug (intake).
12	34362	Water jacket top cover screw (center rear).
13	34368	Valve chamber plug (exhaust).
14	34377	Cylinder water jacket plug.
15	34363	Water jacket top cover screw (front center).
16	34361	Water jacket top cover screw (front).
17	34529	Oil pump body.
18	34493	Crankshaft rear bearing cap.
19	34539	Oil pump screen.
20	34540	Oil pump screen cover gasket.
21	34528	Oil pan sediment filter.
22	PL-125	Oil pan drain plug.
23	34497	Crankshaft center bearing cap.
24	34498	Crankshaft center bearing (lower).
25	NU-354	Crankshaft center bearing cap lock nut.
26	34527	Oil pan trough.
27	SC-603	Oil pan trough screw.
28	34542	Oil pan.
29	34492	Crankshaft.
30	34495	Crankshaft front bearing cap.
31	NU-354	Crankshaft front bearing cap lock nut.
32	NU-124	Gear case cover bolt nut.
33	SC-3404	Gear case cover bolt.
34	34463	Camshaft gear.
35	34521	Camshaft front bearing.
36	SC-245	Camshaft gear screw.
37	34557-A	Gear case cover.
38	34451	Camshaft thrust spring housing.
39	34453	Camshaft thrust spring nut.
40	34452	Camshaft thrust spring.
41	34454	Camshaft thrust spring plunger.
42	BA-105	Camshaft thrust ball.
47	34550	Starting crankshaft bracket.
48	34551	Starting crank clutch.
49	34507	Crankshaft jaw.
50	KE-114	Crankshaft pinion key.
51	34505	Crankshaft pinion.
52	34509	Crankshaft front bearing (upper).
53	34496	Crankshaft front bearing (lower).
54	34478	Connecting rod bushing.
55	34485	Piston pin.
56	34486	Piston pin set screw.

getting much hotter, hence expanding more. Below the bottom ring groove are six holes, 0.156 inch diameter, equally spaced around the circumference. These holes are for draining excess oil, scraped off cylinder wall by bottom ring, back into the crankcase.

The piston bosses are reamed 1.125 inches diameter and the outer circumference of the piston at the piston pin is relieved a depth of 0.0156 inch.

PISTON TROUBLES.

The piston moving up and down in the cylinder must constantly be lubricated by a film of oil otherwise both it and the cylinder wall will be scored. If run without oil the piston will seize in the cylinder. The usual piston trouble encountered is due to excessive piston ring wear which permits oil leakage into the combustion chamber and gas leakage downward into the crankcase. Piston pin wear is not unusual. This latter causes knocking. Both are brought about by lack of or insufficient lubrication. Piston and rod may be removed through the crankcase.

PISTON PIN (OR WRIST PIN)

The piston pin is the means of fastening the upper end of the connecting rod to piston. The piston pin is held in place by a set screw, screwed into a piston boss, through which the piston pin passes. The set screw is 0.312 inch in diameter. The piston pins are of case-hardened steel 3.75 inches long and 1.125 inch in diameter, drilled hollow, inside diameter 0.8125 inch long. A hole 0.234 inch in diameter is drilled at one end of the piston pin to receive the end of the set screw previously referred to.

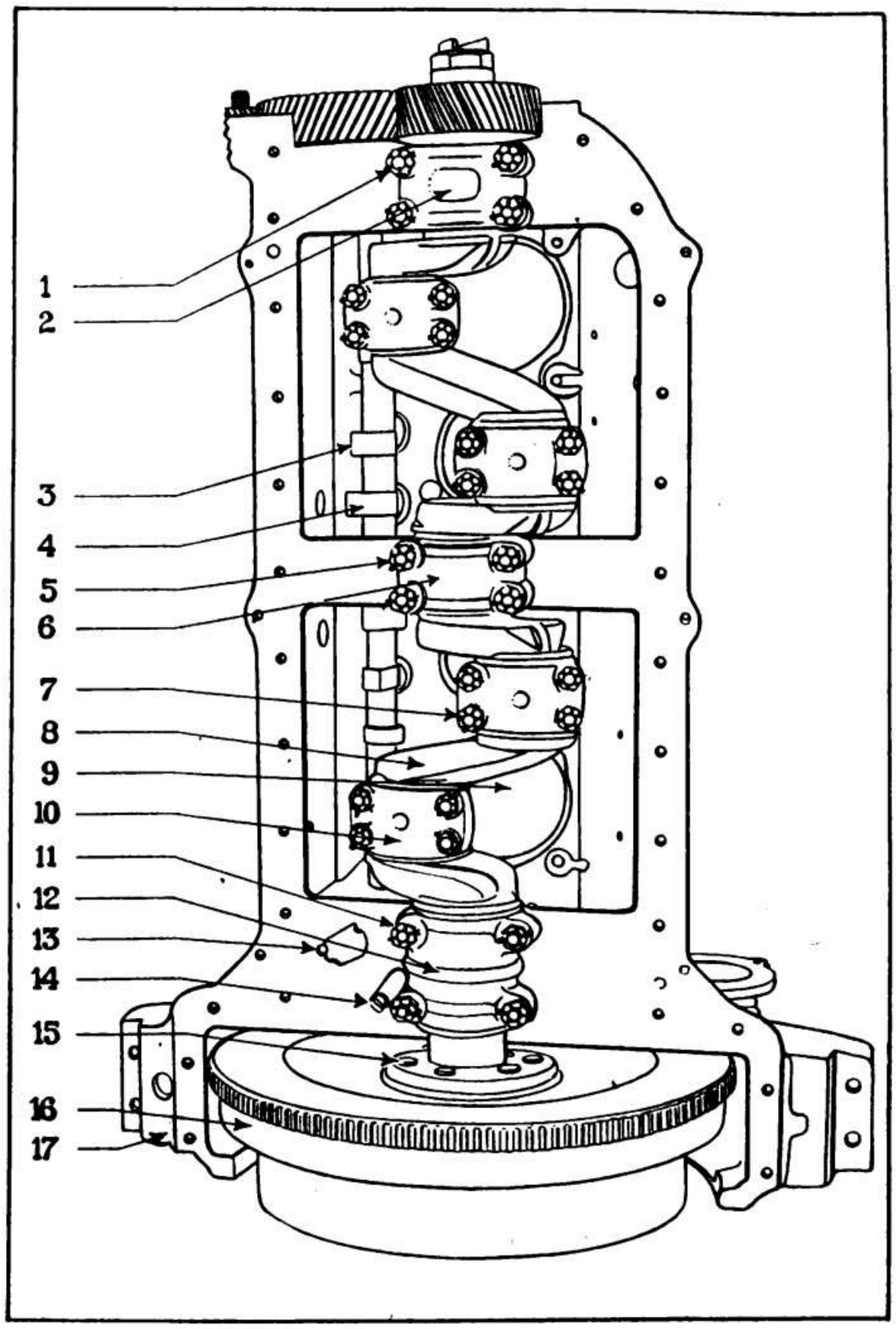
TO LOCATE WEAR OF THE PISTON PIN BEARING.

If the piston is in place in the engine and the lower half of the crankcase is down, remove a valve cap, turn engine over so that piston is on top dead center in such a position that a screw driver may be inserted in the valve cap pocket, then pry down on top of the piston, while with a bar the piston may be pushed upward from under the side of case, then by alternately moving piston up and down, any play may be detected.

TO ALIGN PISTON AT RIGHT ANGLES TO CRANKSHAFT.

With the cylinder removed and the connecting rod and piston in position, a level may be used to ascertain parallelism between the top of the piston and the top of the crankcase, which is parallel to the center line of the crankshaft. Or a pair of calipers may be used to determine uniformity of distance between the top of the crankcase and the underside of a piston ring on all sides of the piston. Or with a straightedge laid across the top of the piston lengthwise of the engine, the distance to the crankcase under straightedge may be measured at its ends.

Plate No. 16



VIEW OF ENGINE FROM BOTTOM WITH LOWER HALF OF CRANKCASE REMOVED.

Ref. No.	Part No.	Name of Part.
1	NU-354	Front bearing lock nut.
2	34495	Front bearing cap.
3		Cams.
4		Cams.
5	NU-354	Center bearing lock nut.
6	-34497	Center bearing cap.
7	NU-352	Connecting rod bearing lock nut.
8	34508-A	Crankshaft.
9		Cylinder opening.
10		Connecting rod bearing cap.
11	NU-354	Rear bearing lock nut.
12	34493	Rear bearing cap.
13		Oil lead to distributing tube.
14	34467	Oil pump shaft.
15	34473	Flywheel bolts.
16	34561-A	Flywheel.
17	34556-A	Crankcase (upper).

PISTON RINGS.

The piston rings are of cast iron, and being flexible, press against the cylinder wall and form a gastight joint, preventing the leakage of gas downward and oil upward. There are three diagonally-split, eccentric rings per piston. When compressed in the cylinder the ring has 0.016 inch clearance between the ends. Wear, resulting from service or abuse, increases this clearance. The ring dimensions are as follows: Width, 0.249 inch; thickness, 0.1875 inch; eccentricity, 0.031 inch.

INSTALLATION OF PISTON RINGS.

The piston rings should be placed up into the cylinder before they are applied to the piston, and fitted (filed), if necessary, to secure the proper gap between the ends of the ring.

Before the rings are installed on the piston they should be rotated around the piston in the piston ring grooves to insure a proper clearance up and down, which is about .001 of an inch.

The rings should be placed in grooves over skids made of three or four pieces of very thin, light gauge sheet metal, about 2 inches long by .375 inch wide, the rings being pushed down evenly all around to prevent any twisting of the ring, which might result in distortion and uneven bearing on the cylinder wall.

In fitting piston rings be sure that each ring moves freely in its groove and still has .001 inch clearance up and down. Also make certain that all dirt is removed from the groove and ring and that before the piston with rings is inserted in the cylinder, that all the ring ends are not in alignment, thus preventing a free downward path for the gas.

LAPPING RINGS.

In order to get a good piston ring fit in the ring groove it may be necessary to lap the ring on a level plate lightly sprinkled with fine emery moistened with oil. After lapping for a few seconds, clean the ring in gasoline and try for fit. Lap more, if necessary, rather than grind it too small at one operation.

PISTON RING TROUBLES.

After fitting the piston rings into the cylinder, caution should be exercised not to push up the piston too high into the cylinder, for if this is done, the top ring will expand out into the combustion chamber, and the piston cannot be pulled down again.

If this happens, the valve caps should be removed and the piston ring compressed as much as possible with the aid of screw drivers or similar tools until the piston can be pulled down past. In case it is found impossible to compress the ring sufficiently to permit the removal of the

piston down to its proper place again, the piston ring may be broken and the pieces removed.

If the rings are not stiff enough, or have insufficient wall pressure, the oil will work up past them into the combustion chamber. The bottom edge of the piston ring must in all cases be very sharp and square to scrape the oil off the cylinder wall as a piston comes down.

REMOVING PISTON RINGS.

In removing piston rings they may be slid off over skids, see page 48, or a ring spreader may be used to spread the ring after which it may be lifted over the piston top.

CONNECTING ROD.

MATERIAL AND CONSTRUCTION.

The connecting rod is used to connect the piston with the crankshaft.

The connecting rod is an I-beam forging attached at its lower end to crank pin of the crankshaft, and at its upper end to the piston pin. The upper end of the connecting rod is bored 1.375 inch to admit a bushing of phosphor bronze, which is bored 1.125 inch in diameter to admit the piston pin. The bushing is 2.125 inches long.

CONNECTING ROD BEARING.

The lower end of the connecting rod is bored 2.5 inches to receive a bearing. This bearing is of phosphor bronze, lined with white metal. Its bore is 2.125 inches. The connecting rod is 12.25 inches long center to center of bearings.

The lower end of the connecting rod is split horizontally, the bottom piece being called a cap, which holds half of the rod bearing; the other half is in the upper portion of the rod. The cap is bolted to the rod proper by means of four alloy-steel bolts and castellated nuts.

CONNECTING ROD OIL TUBE.

Along the side of the connecting rod is banded an oil tube which carries oil from the connecting rod bearing to piston pin bearing.

TO REMOVE CONNECTING ROD.

To remove connecting rod and piston, drain off oil, and remove oil pan, turn engine over by hand until lower end of connecting rod to be removed is down; remove connecting rod bearing nuts, turn engine over until rod end is under camshaft with cranks about horizontal, open pet cock, take off cap and lower rod and piston down carefully to prevent piston ring breakage.

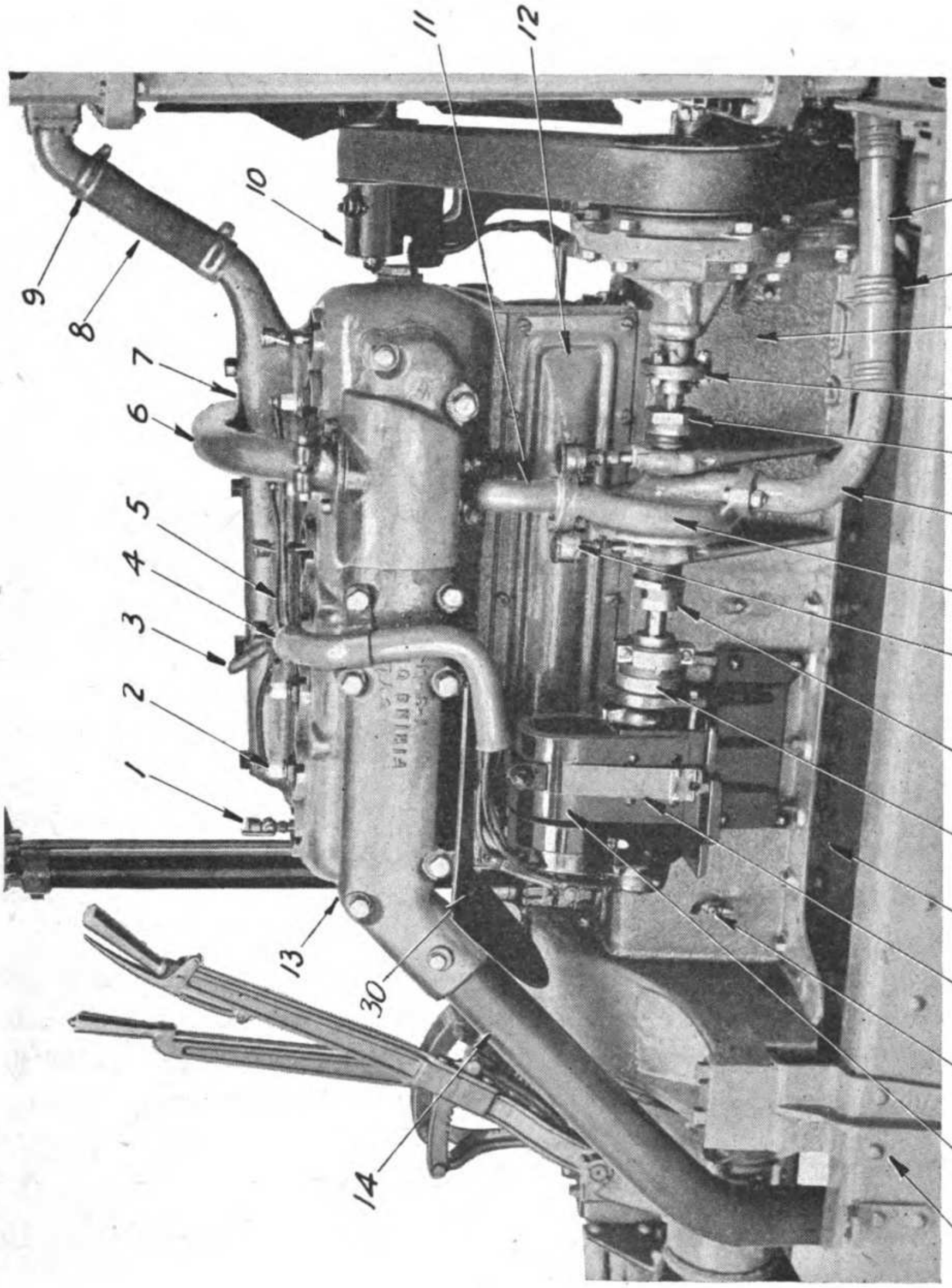


Plate No. 17

RIGHT SIDE OF ENGINE, EXTERIOR VIEW, MODEL 4017-L ONLY.

RIGHT SIDE OF ENGINE, EXTERIOR VIEW,
MODEL 4017-L ONLY

Ref. No.	Part No.	Name of Part.
1	34359	Priming cup.
2	31946	Spark plug.
3	34180-A	Magneto to sw
4	32981	Ignition wiring
5	33809	Ignition wire (
6	33051	Carburetor hot
7	32456	Water jacket t
8	32454	Radiator inlet
9	33022	Radiator inlet
10	32721	Fan shaft bear
11	34407	Water pump c
12	34383	Cylinder side I
13	34370	Exhaust manif
14	33653	Exhaust pipe.
15	32444	Motor rear sup
16	36773-A	Magneto.
17	CO-118	Oil distributin
18	35334-A	Magneto faster
19	34542	Oil pan.
20	36930	Impulse starte
21	30521	Water pump p
22	34415	Water pump g
23	35477-A	Water pump a
24	32463	Water pump i
25	34420	Water pump p
26	34444	Water pump d
27	34556-A	Crankcase, com
28	33023	Radiator outle
29	33086	Radiator outle
30	35273-A	Magneto shield

switch wire.
ing tube.
e (Cyl. No. 2).
hot air tube.
et top cover.
let hose.
let hose clamp.
bearing.
p connection to cylinder.
e plate.
nifold.
pe.
support bracket (right).
ting pipe pet cock.
stening strap (brkt. half).
rter.
p packing nut (rear).
p grease cup.
p assembly.
p inlet connection.
p packing nut (front).
p drive coupling flange.
complete.
utlet hose clamp.
tlet tube.
ield.

TO REPLACE CONNECTING ROD BEARING.

To replace a connecting rod bearing, remove oil pan, disconnect connecting rod bearing and pull out piston; take out bearing by removing countersunk screw which holds bearing in place in connecting rod and cap; replace new bearing and fit to shaft, leaving enough end play, but no looseness up and down.

In replacing connecting rod bearings (if the crankshaft is out of the crankcase) it is best to place the crankshaft in a vise and adjust the bearings to the shaft while in this position, as the work can be done more readily.

The ends and round corners of the connecting bearings may be sized before they are placed in the rod or cap. In case an end flange should be broken off the bearing liner, it may be soldered on with half and half solder, care being taken to prevent melting the bearing with the soldering iron.

The sides of the bearing (liner or bronze back) next to shaft should be filed or scraped down about .25 inch to prevent contact with crankshaft and prevent side pressure, also to aid lubrication.

After the connecting rod has been so fitted, the piston should be lined up with the top of crankcase. When the bearing has been scraped in and bears well all over, it should be adjusted just so tight that the piston and rod (when same are at an angle of 45 degrees to the vertical) will just maintain their position and slight pressure down will cause them to fall (rotate).

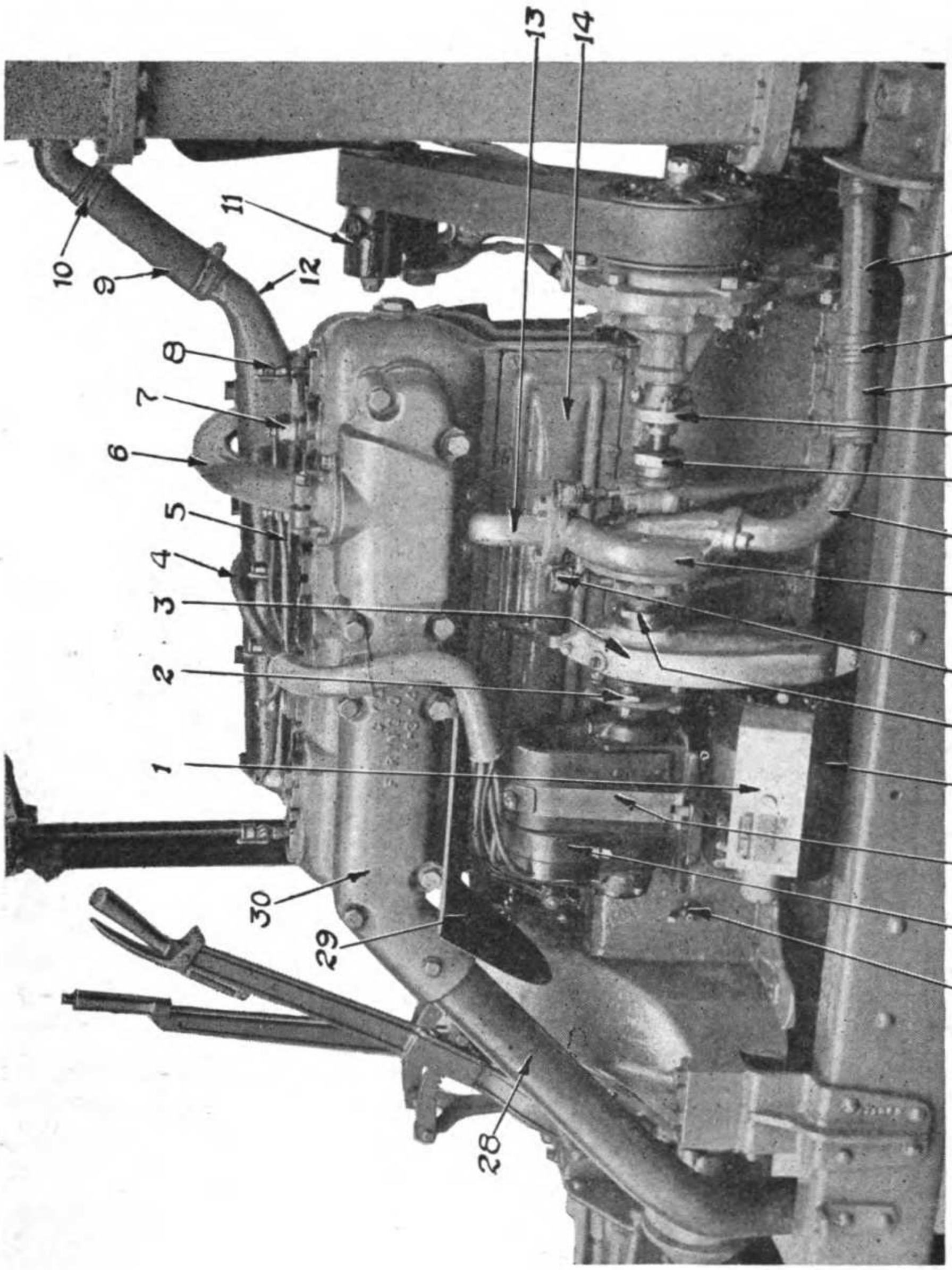


Plate No. 18 RIGHT SIDE OF ENGINE, EXTERIOR VIEW, MODEL 4017-A ONLY.

RIGHT SIDE OF ENGINE, EXTERIOR VIEW,
MODEL 4017-A ONLY.

Ref. No.	Part No.	Name of Part.
1	36028	Voltage regulator.
2	34106	Magneto coupling disc.
3	{ 33122 } { 33123 }	Generator drive chain housing.
4	34180-A	Magneto to switch wire.
5	33809	Ignition wire.
6	33051	Carburetor hot air tube.
7	31946	Spark plug.
8	34359	Priming cup.
9	32454	Radiator inlet hose.
10	33022	Radiator inlet hose clamp.
11	32721	Fan shaft bearing.
12	32456	Water jacket top cover.
13	34407	Water pump connection to cylinder.
14	34383	Cylinder side plate.
15	33086	Radiator outlet tube.
16	33023	Radiator outlet hose clamp.
17	32462	Radiator outlet hose.
18	34444	Water pump drive coupling flange.
19	34420	Water pump packing nut (front).
20	32463	Water pump inlet connection.
21	35477-A	Water pump assembly.
22	34415	Water pump grease cup.
23	30521	Water pump packing nut (rear).
24	35117-A	Generator.
25	35334-A	Magneto fastening strap (brkt. half).
26	36252-A	Magneto.
27	CO-118	Oil distributing pipe pet cock.
28	33653	Exhaust pipe.
29	35273-A	Magneto to shield.
30	34370	Exhaust manifold.

CONNECTING ROD BEARING SHIMS.

The tightness of the bearings is controlled by the thickness of the shims against which the caps are drawn up snug after a bearing has been properly scraped in and every nut must be tightened up (drawing the caps against the shims solidly) but never strained. If a castellated nut is tight when in such a position that cotter pin hole does not line up, the nut should be removed and light cut taken off face of nut (with a file), permitting its being turned to a proper position, so that the cotter pin can be inserted when tight.

TO ADJUST CONNECTING ROD BEARINGS.

The work of properly adjusting a connecting rod bearing simply by dropping the lower half of the crankcase should be done carefully. Remove the bearing cap and an equal thickness of shims from each side, and replace caps, tighten all nuts securely and crank engine to determine tightness of bearing. Adjust but one at a time, then loosen cap before adjusting another, to insure uniform tightness.

VALVE GEAR.

The valve gear or valve system includes every part from the camshaft to the valve head, thus the system consists of camshaft, push rods, valves with spring, etc.

CAMSHAFT.

MATERIAL AND CONSTRUCTION.

Since the valves are all on one side they are opened by the action of a single camshaft having eight cams.

The camshaft is of case hardened steel. Its length is 28.125 inches. There are three camshaft bearings: The front bearing is 2.06 inches in diameter by 2.25 inches long; the center bearing is 2.03 inches in diameter by 1.50 inches long, and the rear is 1.623 inches in diameter by 1.50 inches long.

The valve tappets have mushroom followers which rest upon eight cams forged integral with the camshaft, and are actuated when the camshaft rotates. The camshaft is driven by means of a large helical gear on its forward end, meshing with a helical gear on the crankshaft. (See page 62 for description of gear.)

The forward end of the camshaft is flanged to permit the attachment of the camshaft driving gear. Its rear end is threaded to receive a nut, which clamps the oil pump driving gear in place.

ADJUSTMENT FOR CAMSHAFT END PLAY.

Since the teeth of the driving gear of the camshaft are helically cut, the whole shaft has a tendency to thrust forward when in motion. To offset the thrust the front end of the shaft is bored to receive a .5 inch steel ball, which rests against the flanged end of a steel plunger, which is held against the ball by a spring. The latter is fastened to the front end of the crankcase, and is adjustable from the outside.

TO REMOVE CAMSHAFT.

To remove camshaft the motor should be taken out of chassis, then take off timing gear housing cover, and cylinder block. Drive the camshaft out through the front, as the rear bearings are made smaller than the front.

VALVES.

There are two valves of the poppet type to each cylinder—one intake valve and an exhaust valve. Their names are indicative of their functions. The valves, including their stems, are of tungsten steel, with heads 2.125 inches in diameter. The valve stems are .435 inch in diameter and 7.5625 inches long from underneath the valve heads to the bottom of the stem. The head is .281 inch thick. One quarter inch from its lower end each valve stem is groove cut, .265 inch wide and .309 inch bottom diameter. Into the grooved space there is slipped a split washer, over which the bottom end of the valve spring rests on valve spring retainer. The stems move in cast iron guides, not bushed.

VALVE SPRINGS.

The valve springs are 5 inches long when free, and have an outside diameter of 1.375 inch. They are made of twelve coils of No. 9 gauge wire (0.148 inch diameter).

VALVE TAPPETS (OR PUSH RODS).

Each valve is actuated by a case-hardened steel valve tappet (adjustable as to affective length) with a mushroom follower on bottom end, which bears on the cam. The overall length of the tappet is 3.9375 inches. The diameter of the mushroom head is 1.46875 inches, and of the stem .625 inch.

The end of the tappet is drilled and tapped for a .375 inch adjusting screw, by means of which the tappet-to-valve clearance may be varied.

VALVE TAPPET GUIDE.

The tappet functions in a cast iron guide, which is forced into place in the cylinder block from the bottom. The guide is 2.75 inches long. The guide is formed of two diameters, the lower 1.25 inches in diameter by 1.25 inches long, and an upper section which is 1.127 inch in diameter and 1.5 inch long.

VALVE CLEARANCE.

The proper clearance between valve stems and the tappet is .006 inch for the intake valves, and .008 inch for the exhaust.

It is important that the valve clearance be ample. An insufficient amount of clearance would prevent them closing, and cause loss of compression.

VALVE STICKING.

A valve may stick because of an overheated stem or guide caused by tightness, carbon, lack of lubricant or a bent stem.

GRINDING VALVES.

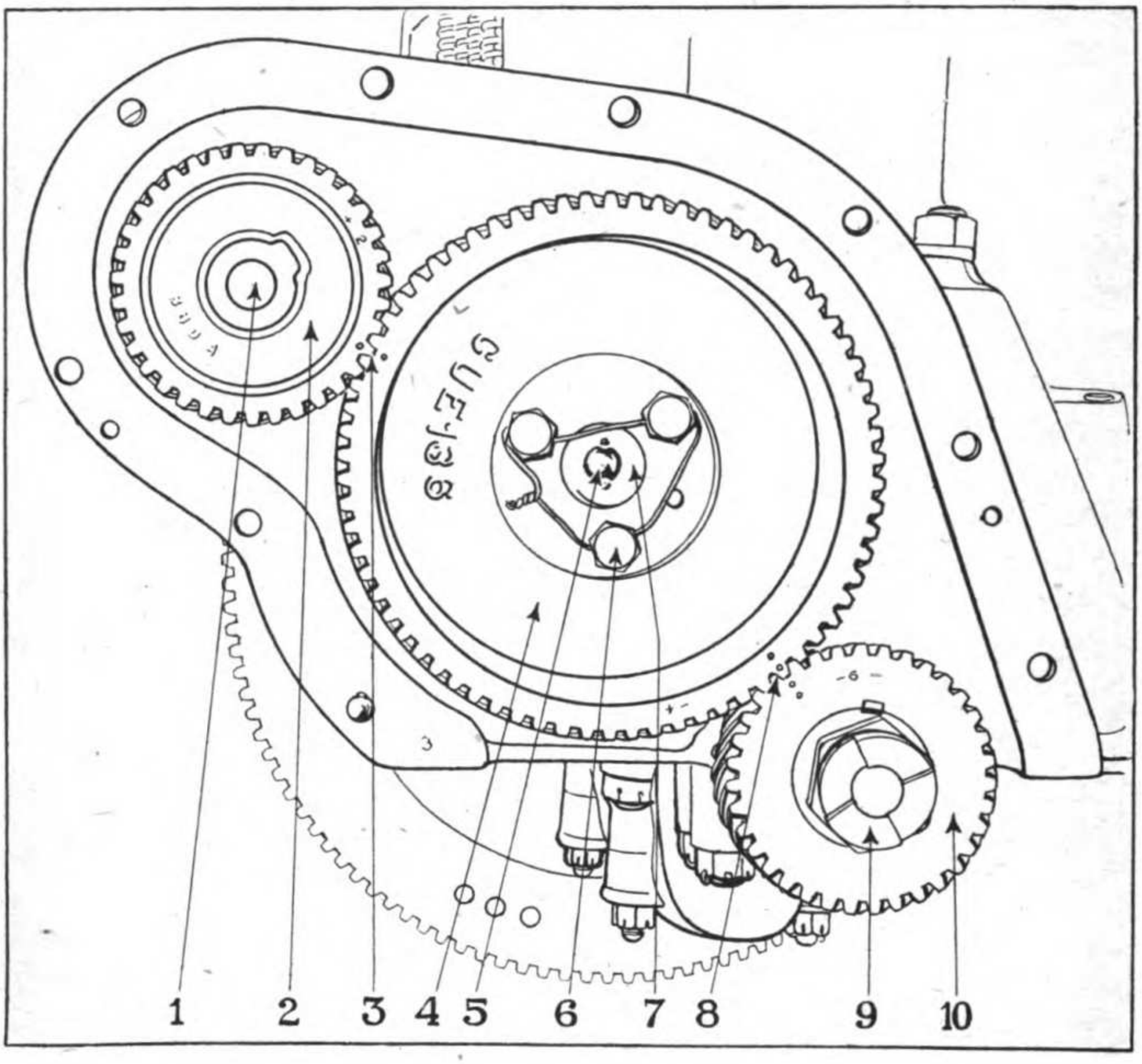
In order to maintain gas-tight joints the valve faces must fit their seats perfectly. If they do not, there will be a loss of compression resulting in a loss of power.

When valves or seats become dirty or pitted, they should be ground. To remove them take out all spark plugs. Take out all priming cups and with special wrench, which accompanies every tool kit, take out the eight valve chamber plugs. Lift up springs with spring compressor, and take out split washers at end of valve stems. Take out valves and remove springs and washers. Turn down push rod, adjusting screw to allow clearance between the stem and the push rod. Close the valve ports with a clean cloth. Mix a little oil with emery or powdered carborundum. Place a little of this grinding compound on the valve face. Place the valve in its own position. Mark the valves, if necessary, so you can tell where each belongs. Insert a screwdriver into the slot in the valve head; then turn with a semi-circular movement of the screwdriver, exerting no pressure. This can be done easily by holding the handle between the palms of the hands. Occasionally lift the valve from the seat,

turn half way round and continue. When done correctly a light silvery color will be given to both seat and face.

In case the valves are very badly pitted, and grinding until the pits

Plate No. 19



FRONT END OF ENGINE WITH GEAR CASE COVER REMOVED.

Ref. No.	Part No.	Name of Part.
1	34447	Pump shaft.
2	34446	Pump gear.
3		Marks for timing.
4	34463	Camshaft gear.
5	BA-105	Ball for adjusting end play.
6	SC-245	Camshaft gear cap screw.
7		Camshaft gear flange.
8		Markings for timing camshaft.
9	34507	Crankshaft extension.
10	34505	Crankshaft gear.

were removed would grind the valve seat down too deeply, the valve should be faced off. It should also be faced in case a ridge has been worn on valve face by the constant operation. In facing valves in lathe, a drill

chuck should be used in which to chuck the valve stem as it is self-centering, the center hole in valve head being cleaned free of carbon and a tail center run into the hole, holding valve securely. In case valves are so hard that facing with a tool is impossible, they may be ground on an emery wheel, but should not be ground down beyond the ridge, it serving as a guide.

After the valves have been ground the surface of the valve and seat is a series of high and low points. After the engine has been run for several hours this surface will have hammered smooth and the valve tappet clearance will have decreased, therefore excessive clearance should be allowed immediately after grinding the valves, and finally adjusted after the engine has run several hours.

Then readjust tappets to .008 inch on exhaust and .006 inch on intake.

Do not grind valves more frequently than necessary. An occasional application of kerosene on the valves and stems is beneficial and often saves grinding.

Intake valves seldom need grinding. Exhaust valves are subjected to greater heat and require attention more frequently.

VALVE TIMING.

The proper operation of the engine demands that the valves open and close with reference to the location of the piston in its cycle of movement with considerable accuracy. The rotation of the camshaft is "timed" with reference to the rotation of the crankshaft by means of a proper meshing of the gears which connect the two.

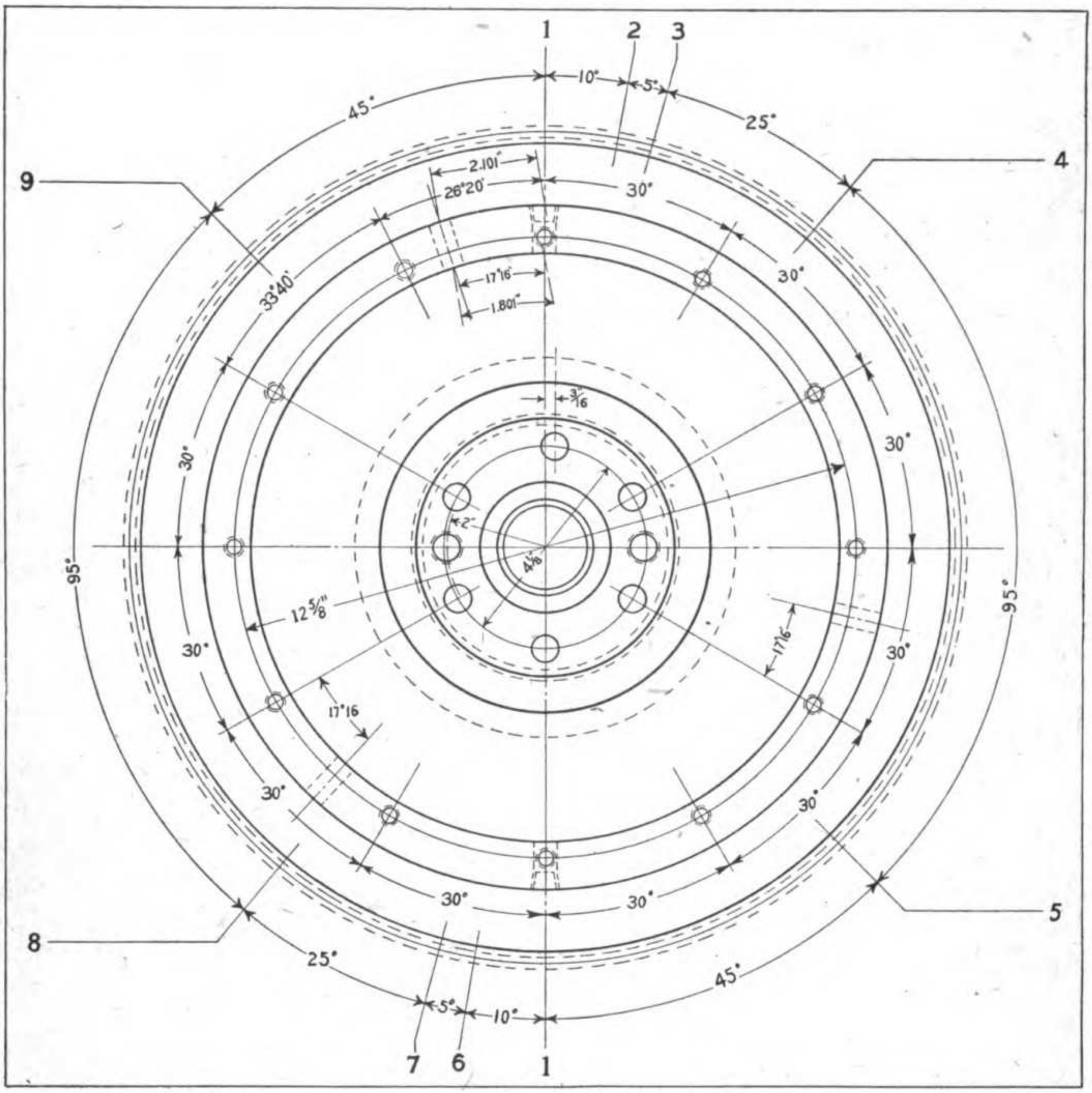
If it is desired to check the valve timing it is necessary to make use of the marks on the rim of the flywheel. These flywheel marks may be observed through an opening in the top of flywheel housing. A threaded plug is removed from the opening and the flywheel rim may be seen underneath. The flywheel is marked as follows (each mark having a vertical line next to it):

DC 1 and 4—meaning dead center for pistons 1 and 4, that is, pistons 1 and 4 are at the top.
DC 2 and 3—meaning dead center for pistons 2 and 3, that is, they are at the top of the stroke.
N-Op —Inlet valve opens.
N-Cl —Inlet valve closes.
X-Op —Exhaust valve opens.
X-Cl —Exhaust valve closes.

When the line across the flywheel face at the mark DC 1 and 4 is directly in the middle of the hole in the flywheel case, pistons 1 and 4 are at the very top of the stroke — dead center. The engine fires cylinder No. 3 firing after No. 1, and No. 4 after No. 3, and No. 2 after No. 4, and then No. 1 again and so on.

Starting with cylinder No. 1, have someone crank the engine while you observe through the hole. When inlet valve of No. 1 cylinder starts to open the line next to mark N-Op should be right in the middle of the hole. Similarly when the engine is cranked further until the line N-Cl

Plate No. 20

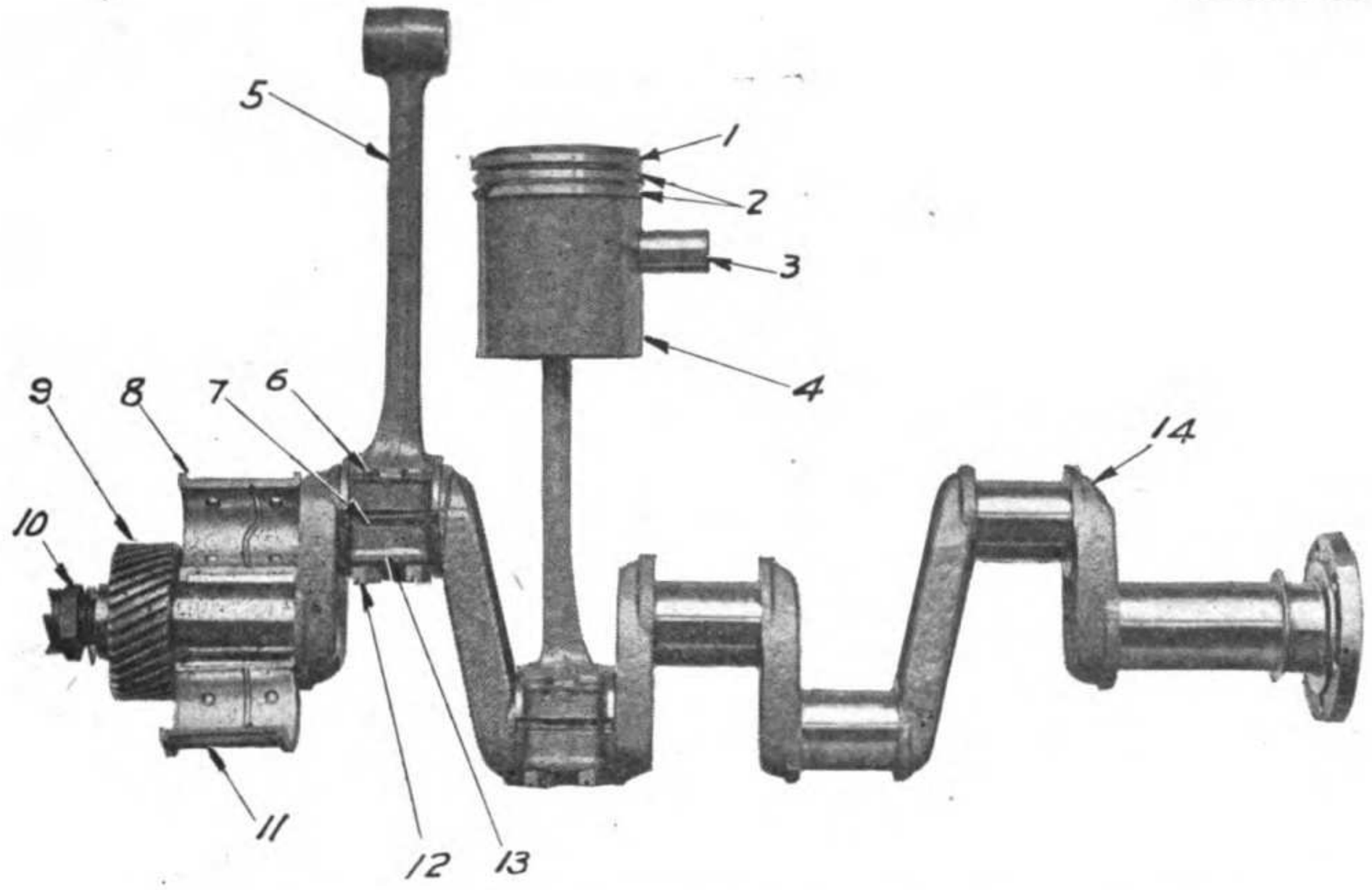


VALVE TIMING DIAGRAM.

1—Dead center.
2—Exhaust closes 1 and 4
3—Intake opens 1 and 4
4—Intake closes 2 and 3
5—Exhaust opens 1 and 4
6—Exhaust closes 2 and 3
7—Intake opens 2 and 3
8—Intake closes 1 and 4
9—Exhaust opens 2 and 3

appears in the middle of the hole the inlet valve should just close. If the valves do not open and close at the right time, a tappet adjustment may be made so they will open and close just as the opening and closing lines pass the center of the observation hole.

Plate No. 21



CRANKSHAFT WITH CONNECTING ROD AND PISTON.

Ref. No.	Part No.	Name of Part.
1	34476	Top piston ring.
2	34475	Second and bottom piston rings.
3	34485	Piston pin.
4	34474	Piston.
5	34489-A	Connecting rod.
6	34484	Connecting rod bearing bolt.
7	34483	Connecting bearing shim laminated.
8	34509	Crankshaft front bearing (upper).
9	34505	Crankshaft pinion.
10	34507	Crankshaft starting crank jaw.
11	34496	Crankshaft front bearing (lower).
12	NU-352	Connecting rod bearing bolt nut.
13		Connecting rod cap.
14	34492	Crankshaft.

The valve timing figures, that is, the time of valve opening and closing with relation to the position of the piston, are as follows:

Inlet valve opens 15 degrees or 2.159 inches on the flywheel rim after top dead center.
Inlet valve closes 40 degrees or 5.759 inches on the flywheel rim after bottom dead center.
Exhaust valve opens 45 degrees or 6.473 inches on flywheel rim before bottom dead center.
Exhaust valve closes 10 degrees or 1.439 inches on flywheel rim after top dead center.

These points or distances before and after top dead center are not stamped in figures on the flywheel, but instead, the thing that happens at the point is marked. Thus, at 15 degrees after top center the mark N-Op appears.

TIMING GEAR MARKS.

If, for any reason, the camshaft is removed, it must be returned to exactly the same position it occupied before. This is done easily since both camshaft and crankshaft gears are stamped, as shown in the illustration on page 56, and when these stamps or punch marks coincide the gears are in proper mesh.

CRANKSHAFT.

The crankshaft is the means of converting the reciprocating motion of the piston into rotary motion. The crankshaft rests in bearings in the upper half of the crankcase. To the shaft are attached connecting rods which have pistons at their upper end.

The straight-cheek crankshaft is of manganese steel, and is 32.0625 inches long, while its overall height is 8 inches. The crankshaft is mounted in three bronze-back babbitt bearings. The front bearing is 2.124 inches in diameter by 3.156 inches long. The center is 2.249 inches in diameter by 2.75 inches long, and the rear bearing is 2.374 inches in diameter by 4.2187 inches long. The rear end of the crankshaft is flanged to receive the fly-wheel, which is bolted to the flange. The front end is drilled, and tapped to receive half the starting crank clutch. This end is also key seated for a No. B Woodruff key, which keys the crankshaft gear in place.

CRANKSHAFT BEARING CAPS.

The crankshaft is held up in the main bearings by means of caps. These are of malleable iron, and are held in place by .5 inch studs.

The bearings are held in place by shoulders in the bearings themselves, and by flat head brass machine screws, which screw through the bearings, and into the malleable iron caps.

The connecting rod bearings are lubricated by oil carried from the main bearings by centrifugal force through holes drilled through the crankshaft cheeks, as shown in the illustration on page 44.

KNOCKS IN BEARINGS.

The center bearing is most liable to develop looseness, because it carries a greater load than the other two bearings. The bearing next to show signs of wear is the front one, while the rear bearings show longest life in service.

TIGHTENING CRANKSHAFT BEARINGS.

Should the crankshaft bearings knock, usually the removal of a lamination of the shims placed between the bearing halves returns them to proper adjustment. In removing the laminations it is necessary that an equal number be taken from each side of the bearing cap.

If one or more layers are removed and that is found to be too much, substitute a thin shim of paper for one of the metal layers removed.

TO SCRAPE-IN CRANKSHAFT BEARINGS.

In "scraping in" the bearings, the first consideration is the proper meshing of the timing gears; the front bearing controls the position of the crankshaft and its gear, consequently, it should be fitted and scraped in first, the other end bearing being lined up with it at the same time. Then the middle bearing fitted in line.

In scraping in crankshaft or connecting rod bearings, the area of contact of bearing surface is the important factor. If the shaft does not bear well all over, the high spots are scraped and the cap will have to be tightened, but if the shaft bears well and evenly, the bearing need not be clamped so tightly. One bearing should be adjusted at a time, then loosened and another bearing adjusted. In this way, any chance of one bearing being too tight and another too loose is avoided. Always relieve the bearings at the upper part at the sides to prevent binding. If a bearing must be raised up a thin shim or paper should be used. A thin paste made of lamp black and oil should be rubbed on the shaft to mark its contact with the bearings so the high spots will be marked. When the three main crankshaft bearings have been adjusted and tightened, one should be able to revolve the shaft by grasping the flywheel firmly.

When the crankshaft bears evenly in its bearings, and a bearing cap becomes loose, the shaft will spring down under the impulse of the explosion, and on the return of the piston to the top dead center the shaft will spring back, hammering out or upsetting the bearing. The result of this is not only a wearing away or hammering out of the top bearing, but the wearing and the hammering out of the lower bearing as well. This condition can only be remedied by the removal of the engine from the chassis. The shaft should be removed from the engine, the bearings scraped in and readjusted. The shaft should not be sprung, but in repose when it is finally fixed in its bearings.

CRANKCASE.

The crankcase is a cast iron unit forming the body of the engine. The cylinder rests upon the top of the crankcase and the crankshaft and camshaft operate inside. At the forward end of the crankcase are the timing gears.

This crankcase is of cast iron, and is made in two parts called, respectively, upper half and lower half. The upper half contains the crankshaft and camshaft bearings, so that by detaching the lower half the bearings can easily be inspected or adjusted.

The lower half of the crankcase acts as an oil reservoir and also holds the gear oil pump. This pump is bolted in place at the lowest point in the crankcase on the right rear side. The pump is mounted above a bowl which collects all sediment from the oil which might filter through the screen. A pipe plug in the side of this bowl makes it possible to remove any sediment collected.

CRANKCASE LEVEL COCK.

On the left side of the lower half of the crankcase is a petcock for indicating oil level in the oil reservoir.

VENT AND BREATHER TUBE.

The vent and breather tube is of cast iron, and is slightly tapered. It is 9 inches long with a diameter of 1.875 inch at its upper end, and 1 inch at its lower end. The tube is screwed into the left hand front side of the crankcase, and serves to admit oil into the crankcase and relieves the air tension caused by the piston's movement.

Two conical screens, one inside the other, are placed in the breather tube. These effectively prevent the entrance of foreign matter, and in addition serve as oil strainers. Twelve .375 inch holes are drilled into the sides of the tube, which is 10.625 inches long over all and .625 inch in diameter.

TIMING GEARS (HEAD GEARS).

The timing gears are mounted in the forward part of the crankcase and are covered with a plate, called a timing gear cover. The timing gears are provided for connecting the crankshaft with the various other engine shafts, such as the camshaft and the magneto and pump shafts.

CAMSHAFT GEAR.

The camshaft gear is located on the front end of the camshaft, and meshes with the crankshaft gear. The gear is made of cast iron, and has 70 teeth (10 pitch). These teeth are cut right hand helical at an angle of 26 degrees 32 minutes. The gear has a pitch diameter of 7.824 inches, and an outside diameter of 8.024 inches, and a face 1.5 inch. It is bolted to a flange on the camshaft, the bolt holes being slotted to permit the adjustment of the gear to the proper position on the shaft. A hole is drilled through the face of the gear, and through the camshaft after adjustment. In this hole there is inserted a pin for the purpose of maintaining the adjustment.

CRANKSHAFT GEAR.

The crankshaft gear is keyed to the front end of the crankshaft, and actuates the camshaft gear. It is made of carbon steel and has 35 teeth, cut left hand helical at an angle of 26 degrees 32 minutes. The pitch diameter of the gear is 3.912 inches. Its outside diameter is 4.112 and face 1.5 inch wide. The gear is bored 2 inches, and is key seated .3125 inch wide for a Woodruff key.

MAGNETO AND PUMP GEAR.

The water pump and magneto are driven by the same shaft, the pump being direct connected and the magneto driven by an extension of the pump shaft.

The water pump and magneto helical gear meshes with the camshaft gear, and so actuates both the water pump and the magneto. The gear is keyed to the front end of the pump shaft, and is identical in all respects save bore and key seat with the crankshaft gear. It is bored .9375 inch and key seat .1875 inch wide.

OIL PUMP GEAR.

The oil pump helical gear is keyed to the rear end of the camshaft, and meshes with a similar small gear near the top of the vertical shaft which drives the oil pump. It has 12 teeth cut right angle helical at an angle of 45 degrees. The gear has a face .75 inch, and is bored .625 inches, and made of case hardened steel.

LUBRICATING SYSTEM.

OPERATION OF SYSTEM.

The lubricating system is the pressure type (operating at a maximum of 35 pounds) operated by a gear oil pump drawing oil from reservoir through wire screen to pump through a vertical tube to horizontal distributing tube inside of crankcase. This tube feeds oil to ducts running to crankshaft bearings and camshaft bearings. The crankshaft is drilled through the crankshaft cheeks, oil being forced through the holes to the connecting rod bearing, and from there through a copper tube on the outside of connecting rod to the wrist pin bearing. The oil forced out from the bearings by pressure lubricates cylinder walls, pistons and valve push rods and falls down into the base and back to the oil reservoir. The overflow through the check valve at the front of engine goes to the timing gear housing, and from there by gravity back to the oil reservoir and so through oil screen to pump.

ACTION, FUNCTION AND CONSTRUCTION OF OIL PUMP.

The oil is drawn from the crankcase bottom into the pump at one end, and is carried around between the teeth of both gears, next to the sides of the pump body to the other end of the pump body.

The oil is prevented from returning by the teeth of the two gears meshing together (as one gear drives the other). It escapes through the pump outlet passage into a pipe connection with a main oil passage in the crankcase.

The oil pump is of the gear type, and is bolted to the bottom of the left side of the crankcase oil base. It is driven from the camshaft by a pair of spirals, through a vertical shaft made of cold-rolled steel. The shaft is .625 inch in diameter and 13.5625 inches long. It revolves in a cast iron guide lined with a die-cast white metal bushing. The bottom of the shaft is flattened and fits into the upper end of the oil pump gear

shaft. The upper end of the shaft extends through the top of the crankcase and is notched to receive the driving end of the governor flexible shaft.

The two spur gears in the pump are of hardened steel—one is forged integral with the pump gear shaft, the other with a small shaft on which it runs in the body of the pump. These gears have each 12 teeth (12 pitch)—a pitch diameter of 1 inch, outside diameter 1.166 inch and a face of 1.25 inch.

OIL FILTER.

Below the level of the oil pump and bolted to the crankcase there is a cast-iron oil pan sediment filter, over the top of which is placed an inverted cylindrical screen. The oil flows into the pump from the filter, thus allowing sediment to settle at the bottom. A .5-inch plug is provided to allow the sediment to be drained off periodically.

WORN BEARINGS AFFECT PRESSURE.

In a pressure system of lubrication it is important to keep bearings tight so that oil pump passages will not leak at this point, and so prevent full quantity of oil reaching all parts of system—not only to prevent other bearings from being starved, but to prevent cylinders and over loose bearings receiving an excess of oil (middle main bearing especially).

REGULATING OIL PRESSURE.

The oil supply and pressure are regulated by adding or taking away washers under oil pressure valve screws, which increases or decreases spring tension on ball check. To ascertain if oil pump is working, open pet cock, on right side of engine, near flywheel.

WATER COOLING SYSTEM.

OPERATION OF SYSTEM.

The cooling system is necessary primarily to prevent the oil in the engine from burning up completely and thus causing the moving parts to seize. By passing water around the hot parts and keeping that water always below the boiling point the heat is carried off by the water.

The cooling system consists of water jackets around the cylinders, a centrifugal pump for forcing the water around the system, a radiator for receiving the water for cooling and a fan for causing an air draft through the radiator so that the water in the radiator tubes can impart its heat to the passing air. There are, of course, the necessary connections between the radiator and the pump and engine, so that pump can force the water around so the hot water enters the top of the radiator, and leaving, after being cooled, through a hose connection at the bottom.

CENTRIFUGAL PUMP.

The pump is located on the front right side of the engine, and is mounted on brackets cast integral with the crankcase. It is of the centrifugal type, inclosed in a cast-iron housing, and has a bronze rotor.

The rotor is 3.994 inches in diameter and is .875 inch wide. It is keyed to its shaft which is .75 inch in diameter and 10.312 inches long.

The pump is provided with two glands each projecting .875 inch. These are integral with the bronze bushings. These bushings support the pump shaft, which is driven by a coupling from the pump gear shaft.

There is keyed to the rear end of the shaft, half of the flexible coupling which drives the magneto. About 5 inches from its end the shaft is drilled to receive a No. 3 taper pin and key seated to permit the attachment of the pump rotor.

WATER PUMP GEAR SHAFT.

The water pump gear shaft is made of carbon steel. It is 9.531 inches long, and its largest diameter is 1.375 inches. The extreme front end of the shaft is key seated to permit the keying to it of the lower fan pulley. This end is also threaded to receive a nut, which clamps the pulley in place.

The rear end of the shaft is drilled and key seated for the attachment of one-half of coupling. The other half of this coupling is keyed to the water pump shaft.

The shaft is supported in bearings cast in the upper half of the crankcase and the gear case cover. These bearings are lined with a die cast babbitt bushings.

TO PACK WATER PUMP GLANDS.

The water pump glands (packing boxes of the shaft) should be packed with a good grade of waterproof asbestos, or compounded packing. If asbestos loose twisted rope packing is available, untwist one strand, soak it thoroughly with cylinder oil, and cover with as much fine graphite as it will retain.

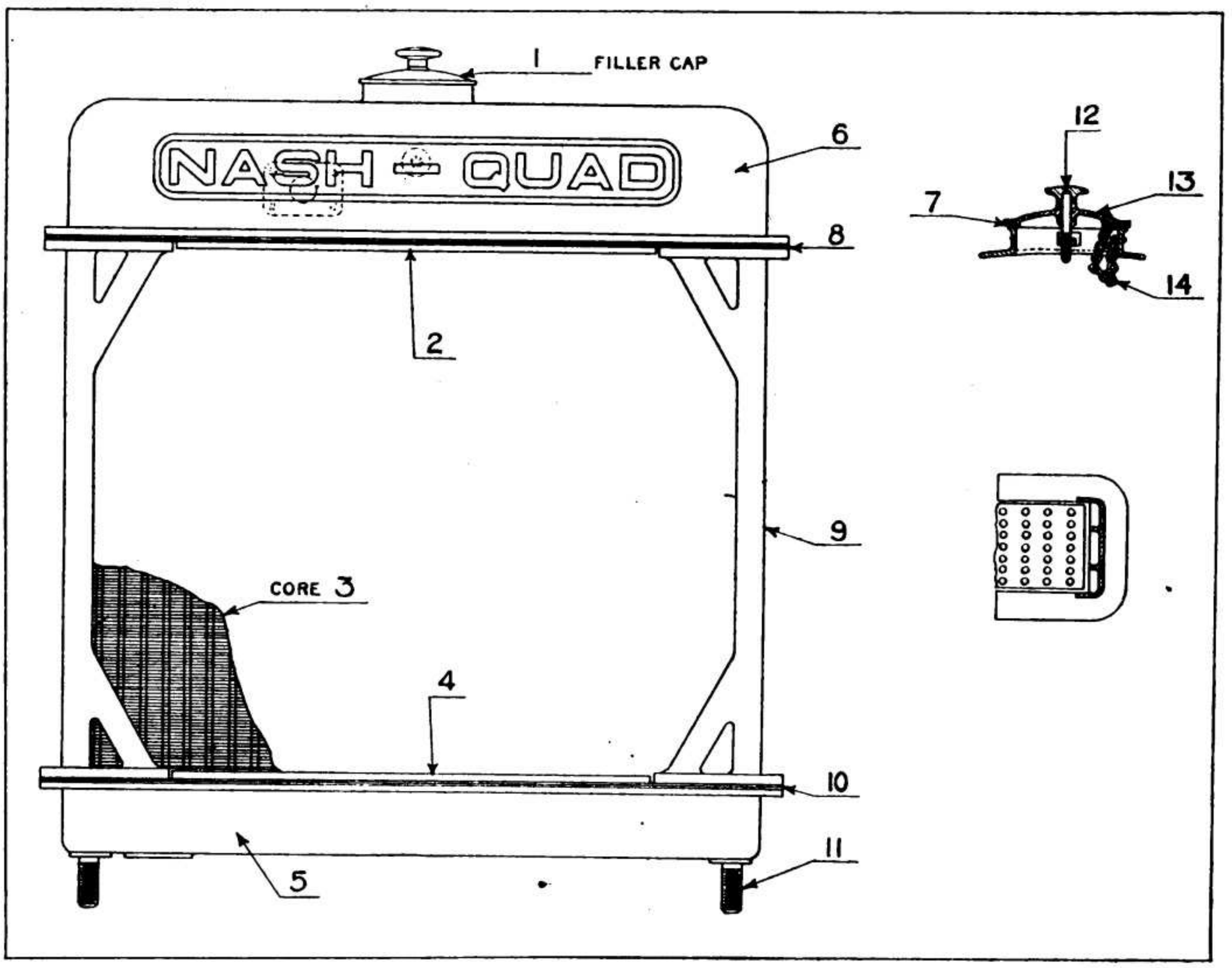
Always coil the packing around the shaft in the direction of rotation of the packing nut, so it will not tend to unwind when the packing nut is screwed on.

If only square or round braided packing of too large a size is available, cut off a piece of about the desired length, place it between the jaws of a bench vise, squeeze it out flat, and then cut off a strip of the desired width with a pair of tin snips or heavy scissors. The gland nuts should not be tightened any more than necessary to prevent leakage of water.

TO TEMPORARILY REMEDY DEFECTIVE WATER PUMP.

In case of a damaged or inoperative pump, the water pump rotor should be removed from the pump to prevent its obstructing the passage. The cooling system must be full to insure circulation (by thermo-syphon)

Plate No. 22



RADIATOR.

Ref. No.	Part No.	Name of Part.
1	32172	Radiator filler cap.
2	32169	Radiator bottom tank to core clamping strip.
3	32171	Radiator core.
4	32169	Radiator bottom tank to core clamping strip.
5	32185	Radiator bottom tank.
6	32186-A	Radiator top tank.
7	32176	Radiator filler cap gasket.
8	32170	Radiator tank gasket.
9	32178	Radiator side member.
10	32170	Radiator tank gasket.
11	31470	Radiator bottom tank support stud.
12	32183-A	Radiator filler cap stud and knob.
13	32172	Radiator filler cap.
14	32177	Radiator filler cap chain.

under these conditions. Necessarily this is a temporary arrangement, the passages being too small to supply sufficient volume at the reduced pressure.

TO THAW FROZEN PUMP.

During cold weather, after an engine has been stopped for a sufficient time to permit any water in the cooling system to freeze, the engine should not be turned over with a crank until it is ascertained that no water has collected in the water pump, and frozen the pump rotor to the pump housing. The pump may be warmed with a gasolene blow torch, hot

water, or cloths soaked with gasoline may be applied to the pump and lighted to thaw the ice.

To avoid freezing in winter use an anti-freeze solution, or cover the lower portion of the radiator with cardboard to obstruct air flow. The lower portion is always colder than the top because water settles to a lower level as it cools. The water, as it enters the top of the radiator, is hot, having just come from around the cylinders.

RADIATOR.

The cylinder walls are cooled by water (pumped into the water jacket) absorbing the heat. This heat is then radiated away from the water while in the radiator by the radiating fins on the vertical tubes through which the water passes on its return to the water pump, the fins being cooled by the air drawn past them by the fan behind the radiator. The tubes and radiating fins are made of copper, because of its conductivity.

The radiator consists of a core, the largest unit, which is composed of finned copper tubes running vertically, on top of this core is the upper tank, a cast iron member having the filler neck and water inlet attached. Between the tank and the core is a rubber gasket. At the bottom of the core is the lower tank, a cast iron member from which the water passes into the water inlet pipe. This bottom tank has the drain attached and also studs which run through the frame to hold the radiator in place. There is a similar gasket between core and bottom tank. The sides of the core are fitted with cast iron pieces bolted in place. A steel clamping strip, 0.375 by 1 inch, extending between the radiator side members, is bolted to back (opposite gasket) of core header plate, to stiffen same and prevent leakage.

COOLING FAN.

The fan is bracketed in front of the engine and driven by a flat belt from a pulley on the right-hand side. The fan shaft is carried on ball bearings. Tension of the fan belt is secured by a spring on the fan adjusting arm. The fan bearings are lubricated by removing pipe plug on top of the fan shaft bearing and injecting lubricant.

The fan assembly is bolted by two .5 inch bolts to a shelf or bracket that is an integral part of the engine gearcase cover (the covering over the timing gears). The fan is of the conventional built-up type; four sheet-steel blades being riveted to a stamped-steel spider with a riveted-in steel hub. To the hub is riveted a machine steel shaft, 7.6875 inches long, and 2.125 inches wide between its two flanges.

FAN PULLEYS.

Behind the fan there is keyed on the shaft a cast-iron belt pulley, 3 inches outside diameter and 2.1875 inches wide between flanges. It is bored 0.875 inch.

FAN BELT.

The fan is driven by a 2-inch by 0.156-inch endless flat leather belt, 43.75 inches long. The pulley that drives this belt is keyed to the forward extension of the water pump gear shaft. It is 5.5 inches diameter and 2.187 inches wide between its two flanges. It has an offset hub that is bored .75 inch in diameter.

FAN ASSEMBLY SUPPORT.

The fan, with its bearings and pulley, is carried by the cast fan shaft bearing spring retained to maintain proper tension of the fan belt. This bearing is hinged to the fan shaft bearing bracket.

The fan shaft bearing that carries the fan shaft ball bearings has a short arm with a hub 1.984 inch long and bored 0.875 inch to receive the hinge shaft to which it is pinned by a 0.25 inch pin. This shaft is 0.875 inch diameter and 5.375 inches long, is drilled at its center to receive the 0.25 inch pin, and keyseated and drilled at its rear end to receive a lever to the end of which is attached the fan belt tightening spring.

FAN SHAFT BEARING BRACKET.

The fan shaft bracket bearing shaft is clamped in the forked fan shaft bearing bracket, which is bolted to the engine gearcase cover. This bracket is 4.875 inches high, measured from its base to the center of its forked bearing. Each bearing is bored 0.874 inch and is 1.125 inch long. One of them is split and fitted with a clamp bolt.

The spring lever is a steel forging, 4.75 inches from center to center of its ends. One end is bored 0.875 inch, keyseated and drilled for a 0.1875 inch pin. The other end is drilled 0.25 inch to receive one end of the spring.

FAN BELT TIGHTENING SPRING.

The tightening spring consists of 22 coils of No. 12 wire (.1055 inch), wound close, and has a hook at each end. It has an outside diameter of .75 inch.

REASONS WHY FAN BELT JUMPS OFF PULLEY.

The fan belt may jump off a pulley if it is too loose, if the two pulleys are not in the same plane, or if the ends of the belt are not cut squarely, thus causing the belt to be curved. Should the fan blades strike the belt it will jump off, or an uneven place in the belt may cause it to leave the pulley.

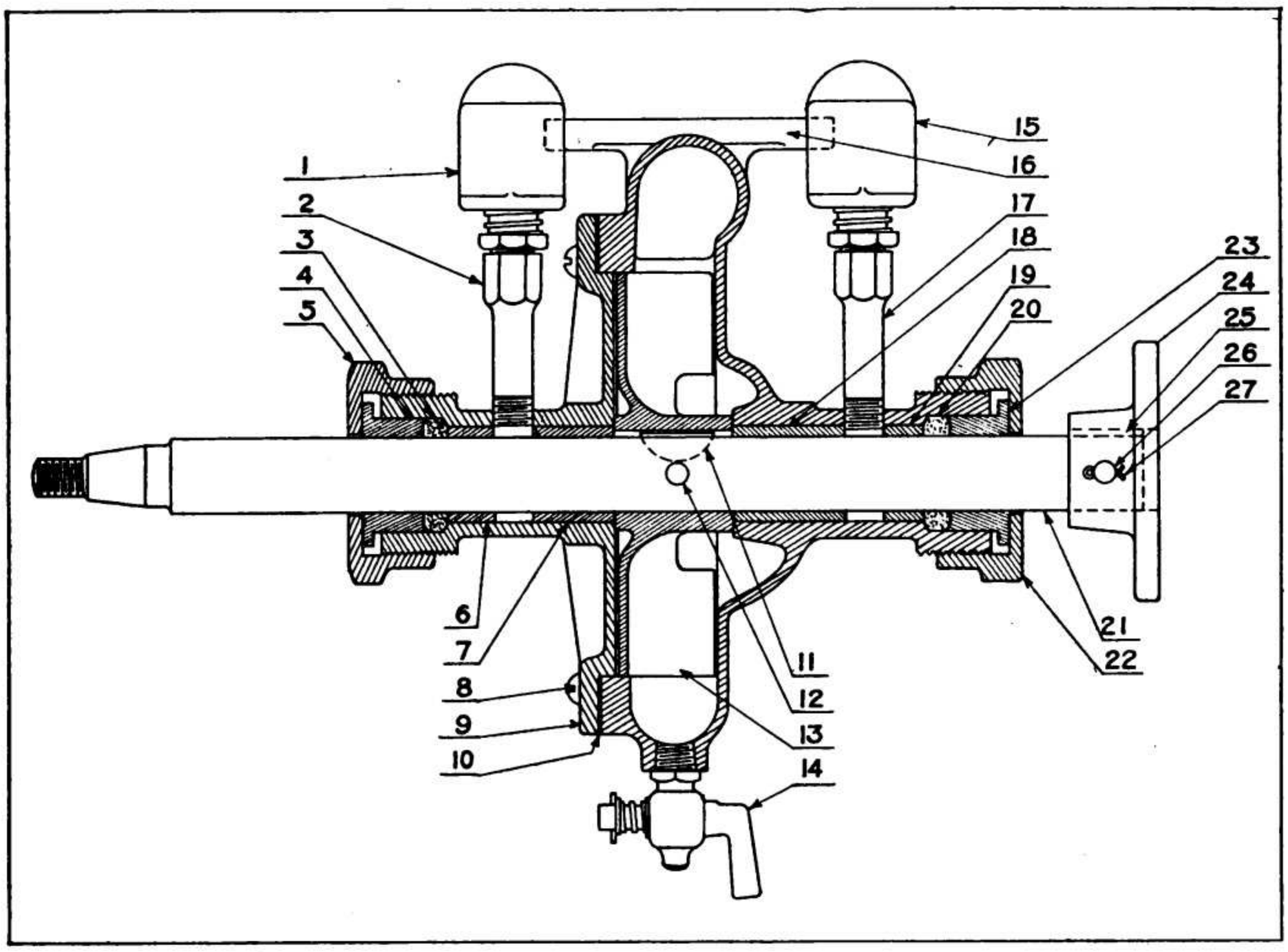
REASONS FOR FAN BELT SLIPPAGE.

A fan will not run at proper speed if the belt is oiled or greasy, if the belt is too loose, or if the fan is too tight in the bearing.

TO CLEAN COOLING SYSTEM.

The water circulating system may be cleaned by uncoupling the hose connections and thoroughly flushing the radiator and cylinder jackets

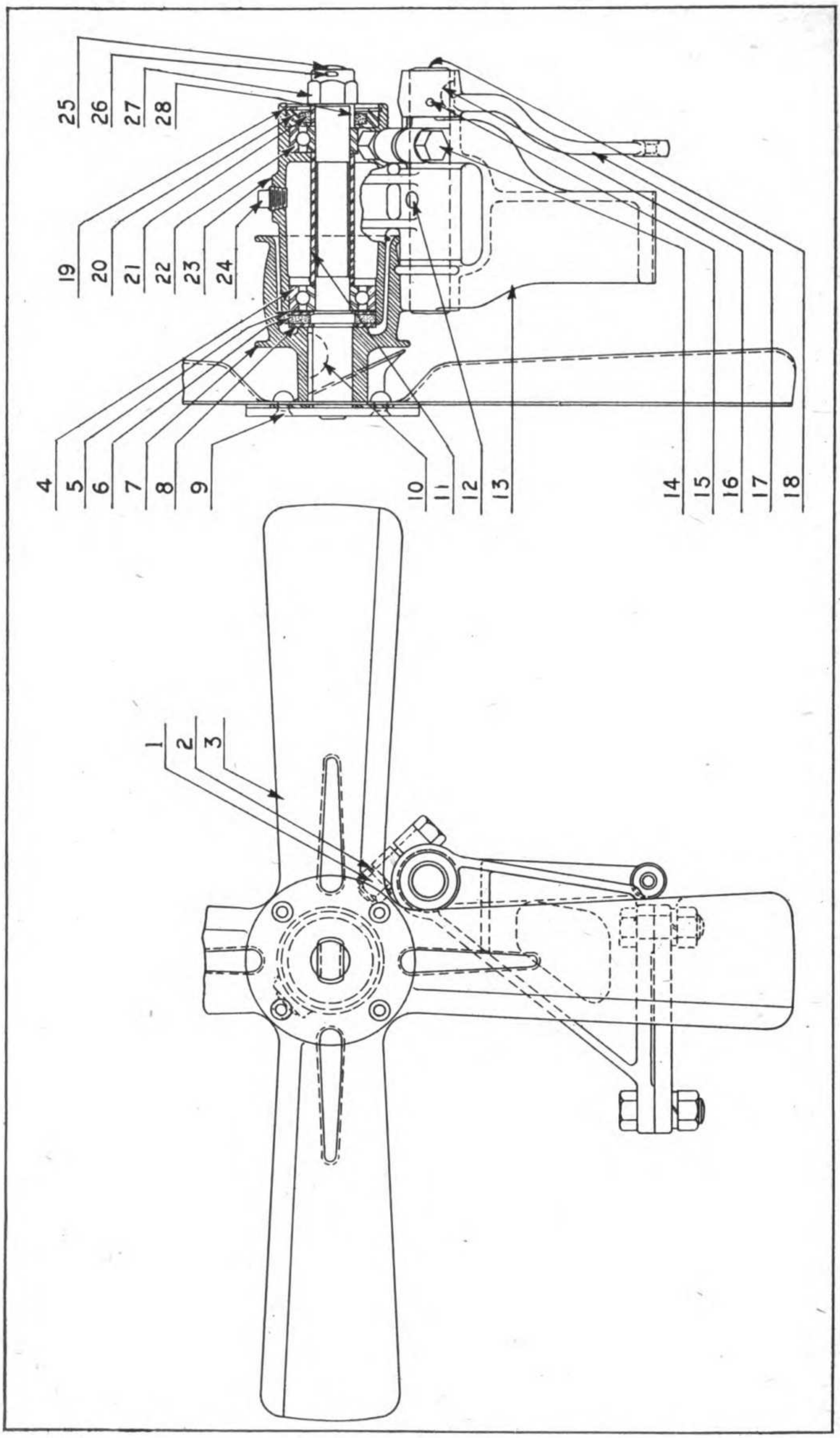
Plate No. 23.



WATER PUMP ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	34415	Water pump grease cup.
2	34416	Water pump grease cup extension.
3	34443	Water pump packing.
4	35999	Water pump packing gland (rear).
5	30521	Water pump packing nut (rear).
6	34438	Water pump cover bushing (short).
7	34441	Water pump cover bushing (long).
8	SC-405	Water pump cover screw.
9	34445-A	Water pump cover complete.
10	34442	Water pump cover gasket.
11	KE-118	Water pump impeller key.
12	PI-314	Water pump impeller pin.
13	34434	Water pump impeller.
14	CO-118	Water pump drain cock.
15	34415	Water pump grease cup.
16	34439-A	Water pump body complete.
17	34416	Water pump grease cup extension.
18	34437	Water pump body bushing (long).
19	34438	Water pump body bushing (short).
20	34443	Water pump packing.
21	30524	Water pump shaft.
22	34420	Water pump packing nut (front).
23	34433	Water pump packing gland (front).
24	34418	Water pump driven coupling.
25	KE-107	Water pump driven coupling key.
26	PI-315	Water pump driven coupling pin.
27	PI-402	Water pump driven coupling pin cotter.

Plate No. 24



FAN AND FAN BRACKET ASSEMBLY.

FAN AND FAN BRACKET ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	NU-135	Fan shaft bearing bracket clamp bolt.
1	WA-147	Fan shaft bearing bracket clamp bolt nut lockwasher.
3	32765-A	Fan blade.
4	32646	Fan shaft ball bearing.
5	32727	Fan shaft washer.
6	WA-731	Fan shaft felt washer (front).
7	32722	Fan pulley key (small).
8	33509	Fan shaft felt washer retainer.
9	RI-207	Fan hub rivet.
10	KE-111	Fan pulley to shaft key.
11	32733	Fan shaft spacer.
12	PI-213	Fan shaft bearing to shaft pin.
13	32720	Fan shaft bearing bracket.
14	SC-3535	Fan shaft bearing bracket clamp bolt.
15	PI-241	Fan belt spring lever pin.
16	KE-105	Fan belt spring lever key.
17	32724	Fan belt spring lever.
18	32723	Fan shaft bracket bearing shaft.
19	32725	Fan shaft bearing ret. lock ring.
20	32726	Fan shaft ball bearing retainer.
21	WA-704	Fan shaft felt washer, rear.
22	32646	Fan shaft ball bearing.
23	32721	Fan shaft bearing.
24	PL-102	Fan shaft bearing grease plug.
25	32735	Fan shaft.
26	PI-411	Fan shaft nut cotter.
27	NU-532	Fan shaft nut.
28	32728	Fan shaft collar.

with water under pressure. The cylinder jackets may be cleaned by removing the upper manifold and scraping or dissolving the sediment or by pouring hot washing soda solution (saturated) into the cooling system.

CARE OF COOLING SYSTEM.

When filling the radiator, use clean water as free from impurities as possible, and fill to a depth of about three inches above the top of the ribs.

Do not pour cold water into the radiator when the system is nearly dry and the motor is hot.

Empty the radiator occasionally through the drain cocks on the pump and radiator, flushing out to remove sediment.

The fan draws air through the radiator. Keep the spaces free from mud and dirt.

CAUSES OF OVERHEATING.

Overheating may be caused by insufficient water in the system, clogged passage in the radiator, water jackets, hose connections or other part of the system, running too long on retarded spark, slipping clutch, poor mixture, lack of oil, carbon deposits in cylinders, fan slipping or inoperative, dragging brakes, water pump inoperative due to sheared key, broken rotor, etc., frozen water line or portion of water in radiator frozen. See also list on page 105.

Overheating may cause severe knocking on the slightest grade and possibly on level road. If you have some distance to travel pour an excess

of oil into the crankcase to make sure that the moving parts will not stick, due to rapid burning of the oil.

IF RADIATOR TUBE BREAKS.

If outside tubes are broken in radiator in field, for quick repair pinch together or roll each end of break with pliers. To take tube out and plug holes it is necessary to remove upper and lower tanks.

SOLDERING.

TO PREPARE RADIATOR PARTS FOR SOLDERING.

If a tube becomes broken it may be soldered. Before soldering copper, the parts must be cleaned until bright, with a wire scratch brush, scraper, file or emery cloth, then they must be coated with a soldering flux to remove all grease and foreign material.

Soldering flux is sometimes referred to as "cut acid," since a very satisfactory flux can be prepared by dissolving zinc (from an old dry battery, if necessary) in muriatic acid, until all gasing ceases. If extra strength muriatic acid is used in making cut acid, it should be diluted with about 25% its volume of water before adding the zinc. If the gasing does not occur at once, heating the acid will assist the action.

In this connection, always pour acid into water, but never pour water into acid, as, if the acid is very strong, a rapid sputtering will throw acid.

SOLDERING TIN.

Clean, bright tin can be soldered by using powdered resin or tallow for a flux.

SOLDERING IRONS AND STEELS.

Cast iron, malleable iron, steel and black iron, or sheet iron, should be scraped bright, then cleaned with sulphuric acid before applying the cut acid. This being done, solder as for copper. In the case of cast iron the parts being soldered must be heated.

The essentials of good soldering are sufficient heat, cleanliness of the parts to be soldered and of the soldering copper, or "iron," as it is usually called, and purity of flux or "cut acid."

The soldering iron should be filed bright, then tinned with solder, after being cleaned with salamoniac. If salamoniac is unavailable rosin will work fairly well.

Always have the soldering iron hot enough to heat the work, but never permit it to get red hot, since that will cause the solder to attack the copper, producing "hard solder" which only melts at near a red heat, and is useless for soldering purposes. In case an iron is "burnt," file it clean.

The best solder for most jobs is known as "half and half," being composed of equal parts of tin and lead.

IGNITION SYSTEM.

The ignition system is the means of producing an electric current and causing that current (one of high-voltage and low amperage) to be sent across a gap in the spark plug so that the heat of the spark can ignite the compressed mixture in the cylinders. The ignition system consists of a current generating machine, called a magneto, a switch for diverting the current to the ground, spark plugs, one in each cylinder, for receiving the current, and the necessary wiring to and from each unit to the other.

MAGNETO.

BRIEF DESCRIPTION OF OPERATION.

A magneto is an alternating current generator which supplies current to cause a spark at the spark plug terminals, which spark fires the explosive mixture at the proper time.

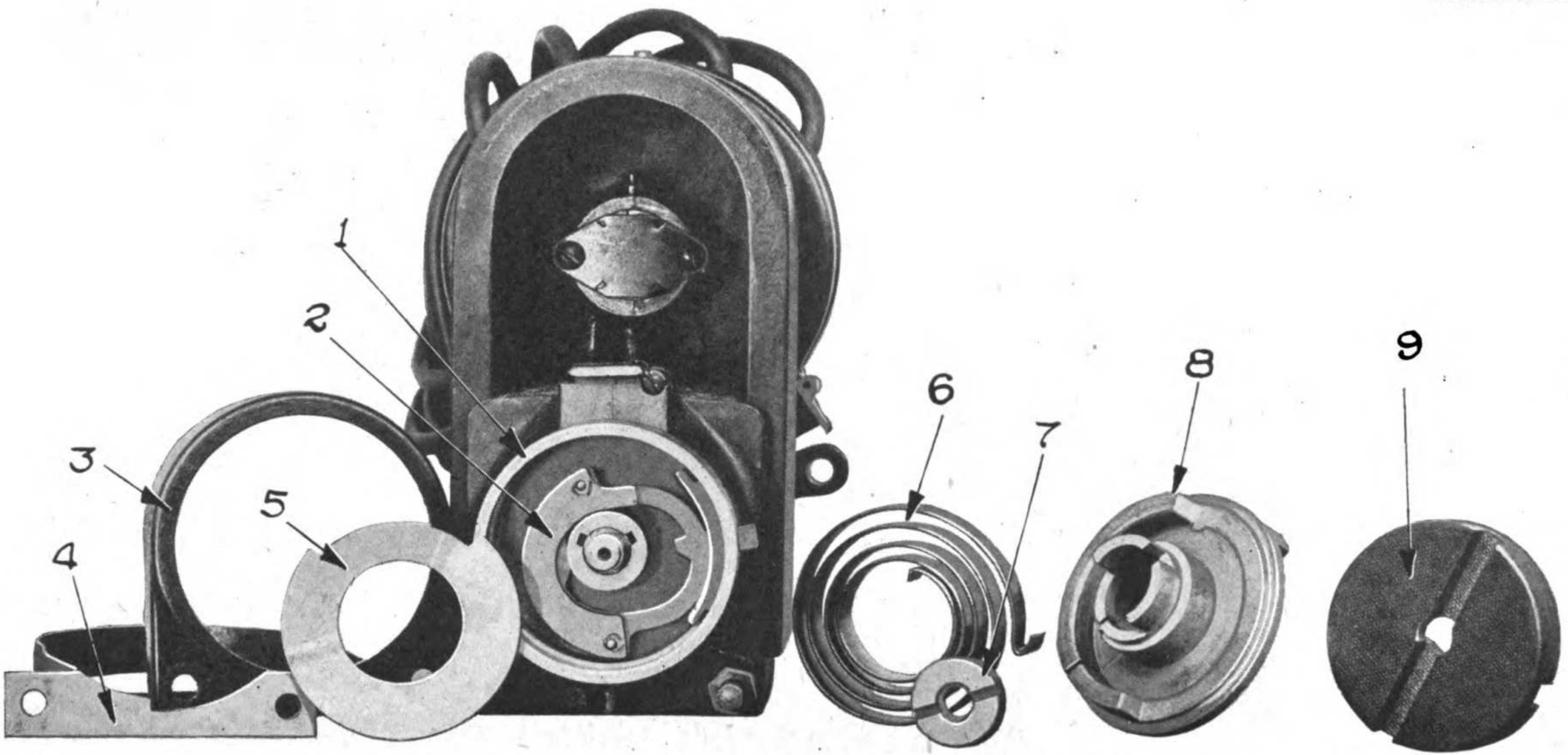
The magneto used in this truck is an Eisemann high-tension type, that is, one which does not employ an outside coil for stepping up the voltage. Both primary and secondary windings are on the armature shaft and both windings have a grounded end. The armature shaft revolving in the magnetic field existing between the permanent magnets, causes a low voltage current to be induced in the primary winding. This winding is connected with the breaker or interrupter, so that the current flow of the primary may be broken or interrupted in order to induce a current of high-voltage in the secondary winding. At the instant of interruption of the primary the secondary is induced and this is the current which flows to the distributor and thence through cables to the spark plugs.

When you throw the switch to "on" position no current passes through the switch. The primary current path after generation is through the primary winding, through the interrupter, and to ground, thus returning.

The secondary winding also is grounded at one end. The induced high-voltage current flows through the secondary winding to the distributor to the spark plugs in order, thence to ground, and the secondary winding being grounded the circuit is completed through the metal parts of the engine.

MAGNETO TIMING.

As the spark occurs when the primary circuit is broken by the opening of the platinum contacts on the breaker mechanism, it is necessary that the magneto will be so timed that, at full retard position of the timing lever body, the platinum contacts will open shortly after the respective piston of the engine has reached its highest point on the compression stroke. Turn engine by hand until piston of No. 1 cylinder is just past dead center (firing stroke), remove the distributor plate from the magneto and turn the armature shaft until the setting mark on the distributor disc is in line with the setting screw, as shown in illustration on page 76. With



MAGNETO WITH IMPULSE STARTER ASSEMBLY, MODEL 4017-L ONLY.

the armature in this position, the platinum contacts are just opening and the metal insert of the distributor disc is in connection with carbon for No. 1 cylinder. The driving medium must now be fixed to the armature shaft without disturbing the position of the latter, and the cables connected to the spark plugs in their respective order.

MAGNETO MAINTENANCE.

Aside from lubrication, as mentioned in the following, there is little attention required. Eisemann Type G-4-II Edition should receive 20 drops of light mineral oil every two weeks, distributed as follows: One drop in the oil hole (one most convenient) on side of breaker box, 5 drops in the small hole and 14 drops in the large hole at the driving end of the magneto.

TO CLEAN BREAKER POINTS.

The platinum contacts of the breaker mechanism should be occasionally cleaned with gasolene, and for obvious reasons, thoroughly dried before starting the motor. The distributor disc and collector ring should likewise be cleaned once or twice each month with a cloth moistened with gasoline.

WHEN TO REPLACE IGNITION CABLES.

In order to obtain the best results, the cables should be at once replaced if they show signs of cracking or wearing. After a year of normal service, it is advisable to carry in reserve a few carbons for the distributor plate, as well as a contact spring and an adjustable contact screw.

IMPULSE STARTER.

Used on Model 4017-L Only.

This device mounted on the armature shaft outside of the magneto proper is simply a means of giving the armature a quick, fast turn. The impulse starter contains a spring whose stored up energy is released by tripping (by means of a dog) a ratchet to which the spring is attached. The Eisemann impulse starter eliminates the necessity of an auxiliary ignition system for starting, as this device causes the magneto to produce a hot, fat spark, regardless of how slow the engine is cranked.

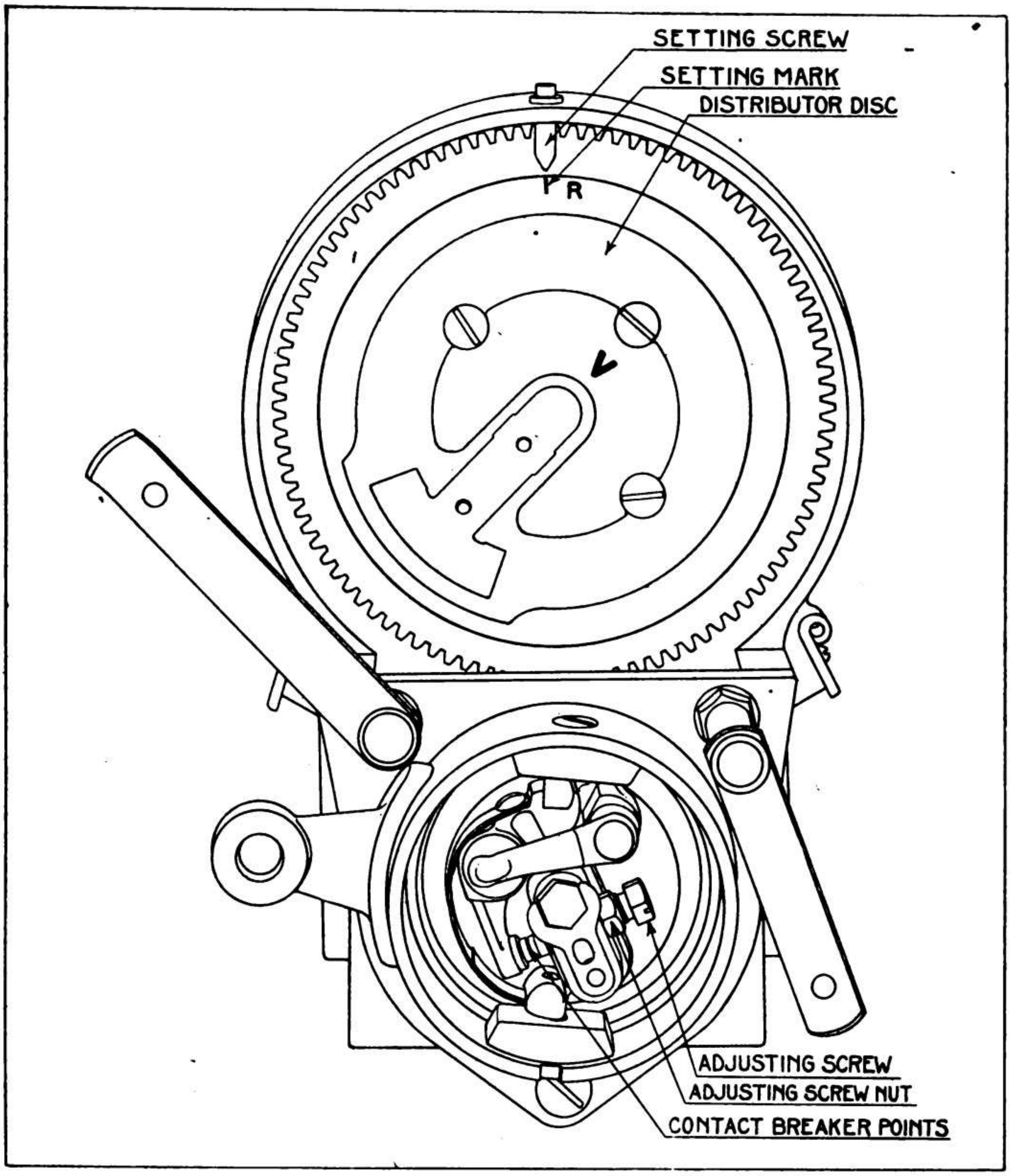
The device does not have to be set by hand and above 180 R. P. M. is automatically drawn out of action.

IGNITION TROUBLES AND HOW TO REMEDY THEM.

If the engine misfires or refuses to start, and the ignition is suspected, it should be found out first whether the trouble lies in the magneto or in the spark plugs. The latter should be examined first, as they are the most frequent cause of trouble.

If the engine misses, the corresponding spark plug should be examined to see that the gap is not too large. This gap between the electrodes

Plate No. 26



END VIEW OF MAGNETO SHOWING DISTRIBUTOR AND BREAKER MECHANISM.

should be approximately 0.032 inch. Also the spark plug may be short-circuited through carbon or oil, or the insulation may be cracked. Cleaning with gasolene or replacing is the remedy.

The wiring should be carefully examined and checked in accordance with the firing order of the engine. If cables are cracked, or worn, they should be replaced. All connections must be kept clean and tight.

Clean breaker contact with gasolene until the contact surface appears quite white, or if pitted, use a fine file—but very carefully—so that the surfaces remain square to each other. For this purpose a manicure file

may be used, or a special magneto file. The correct gap of the contact points is 0.010 inch and in no case should it be more than 0.012 inch. As these contacts wear away in time, they should be adjusted by giving the adjustable screw a forward turn, care being taken to securely tighten the lock nut. This can be accomplished without removing the timing lever or make-and-break mechanism.

If the platinum contact riveted to the contact arm, or that of the adjustable screw should be worn down entirely, it would necessitate a change of either or both. When the adjustable screw is replaced or adjusted, care must be taken that the lock nut is securely tightened in place.

If, after following these instructions, the engine still refuses to start, the magneto should then be tested by removing the distributor plate and resting a screwdriver on the gear casing, holding same about 0.125 inch from the collector ring. Then if, upon rotating the armature, a spark jumps across the .125-inch gap, it shows that the trouble does not lie in the magneto.

But if a spark does not jump across the .125-inch gap previously mentioned, the magneto is at fault. See page 104 for further information on ignition troubles.

A re-magnetization of the magnets will only be necessary if these have been removed from the magneto and allowed to remain a long time without both ends of the magnets being connected with a piece of soft iron—a so-called keeper. The same thing occurs if the armature is taken out of the pole pieces without a conducting rod of iron being laid across both poles. This piece must remain on the poles until the armature is again placed between the pole pieces. Often the magnets, after being removed, are put back in the wrong position and in this way the magnetic power is neutralized. To prevent this mistake all magnets are marked—the north pole being designated by the letter "N" stamped in the magnet. When replacing magnets care should be taken to place the same poles on the same side.

TO CHARGE MAGNETS.

Ordinary magnets will not become discharged, except after a long period of service, or, if they have been removed from the magneto without taking the precaution of placing an iron keeper or magnetic conductor across the two ends of the magnet.

When a magnet must be recharged and no electro-magnet for charging purposes is at hand, the work may be done with the aid of a storage battery and a length of insulated wire from 10 to 25 feet long, and of most any gauge between No. 8 and No. 22.

Attach one end of the insulated wire to the positive terminal of the storage battery and wind half the wire in the clockwise direction around the North pole of the magnet, and in an anti-clockwise direction around the south pole of the magnet (looking at the free ends of the magnet).

To charge the magnet, the free end of the wire should be touched to the (negative) battery terminal for about 2 seconds (not longer), then withdrawn, this operation being repeated about a dozen times. Striking the magnet when the current is on with a piece of hardwood, or a small piece of lead or soft brass, will materially assist in increasing the degree of magnetization that will be attained.

A keeper with cross section about equal to cross section of the magnet should be put across the ends of the magnet immediately after charging. Do not remove the keeper until the magnet is mounted on the magneto with the armature in place.

TO PREVENT REVERSAL OF POLARITY.

If the magnet is charged by the above method, there will be no danger of a reversal of polarity, but if the magnet is to be recharged with an electro-magnet it should be suspended above the electro-magnet by a string tied at the top or bend in the magnet so that the ends will hang down toward the ends of the electro-magnet. The magnet to be charged will assume its choice of position above the electro-magnet, the North pole of the electro-magnet attracting the South pole of the magnet to be charged. The current should be switched on and off about a dozen times. The magnet being tapped lightly, as mentioned above.

THE CONDENSER.

The condenser, which is connected across the platinum breaker points, absorbs the current of the primary coil away from the breaker points when they separate, thereby minimizing the tendency for the current to continue flowing across the gap between the separated points, greatly diminishing the arcing, and consequently burning and pitting of the platinum breaker points. This charging of the condenser contributes to a very quick interruption of flow of the primary current, which sudden change (in potential) is necessary for the induction of the desired high voltage in the secondary circuit. When the points come together again, the condenser discharges the voltage that has been impressed on it (as the points separated), this discharge assisting in quickly establishing the flow of current in the then closed primary circuit. The Secondary voltage produced without a condenser is only about 5 per cent normal.

WHEN CONDENSER IS PUNCTURED.

When a condenser becomes punctured, a temporary adjustment frequently overcomes the difficulty. Close the spark plug gaps as closely together as possible without actually permitting them to touch each other and the engine will frequently run.

It may be necessary, however, to improvise a condenser, which may be done by using two ten to twenty-foot lengths of insulated wire (of from 25 to 35 B. & S. gauge), doubling each wire and bringing its two ends

together and connect (as one wire) to a condenser terminal. Do likewise with the other length of wire, then roll or ball both lengths of wire together, forming a series of condenser surfaces.

TO TEST FOR SHORT CIRCUIT.

To test the ignition switch and wiring for a short circuit, simply remove the breaker box and cap with wire, and if a spark can then be secured, difficulty will be in the part removed.

TO CLEAN DISTRIBUTOR.

The distributor may be cleaned of carbon and dirt, with several drops of lubricating oil rubbed on, either with a finger or a bit of waste or cloth. This will loosen the carbon, after which the distributor may be wiped clean with a small piece of waste.

TO TIME DISTRIBUTING FINGER.

If the distributor wheel has been removed, it should be replaced with care. The distributing finger should be so timed that regardless of the amount of breaker box advance, or retard, the spark will always occur while the finger is under a carbon brush. This may be set by advancing the breaker box .5 of its full travel and rotating armature shaft in the direction of rotation (anti-clockwise) until the platinum breaker points just begin to separate. The distributor wheel should then be replaced so that the center of the distributor finger comes directly under the center of a carbon brush.

BREAKER ADJUSTMENT.

The correct opening of the circuit breaker points is from .010 inch to .012 inch. If set too wide, result will be weak spark, as the low tension winding does not have time to "build up."

TO INSTALL NEW BREAKER POINTS.

When the platinum points have been worn down by service, or excessive filing, and new ones must be installed, if it is possible to secure them already mounted, such should always be done.

If unmounted points only can be secured for replacement, they are usually supplied with a small, round teat .063 (1/16) inch diameter on the back of point. To mount point, drill a .063 (1/16) inch diameter hole, .094 (3/32) inch deep in the mounting, and solder point on (sweat on), filing off any excess solder. If soldering equipment is not at hand, the point may be mounted temporarily by squeezing teat out of round with a pair of pliers and forcing into hole.

The point should be soldered in at the first opportunity, as it may work loose and cause trouble, which is very difficult to find. After the points have been mounted they should be adjusted with a maximum break of .012 inch and the points must bear evenly all over on their face (i. e.,

in contact with each other), being filed, if necessary, to secure square contact.

TO MAKE A TEMPORARY MAGNETO BRUSH.

A temporary magneto brush can be made from a piece of carbon taken from the positive terminal of an ordinary dry battery or an old electric light carbon, or may be made from any soft metal, or by rolling very tightly a small strip of brass wire cloth.

IGNITION TROUBLE DUE TO OVERPRIMING.

Over-priming or choking with gasolene usually results in the excess gasolene condensing on the insulated terminal of the spark plug and draining down and forming a drop across the air gap, or mixing with the carbon deposited thereon and forming a path for the current from the center electrode up along the insulation to the ground. This path, offering far less resistance to the flow of the current than the air gap between the points of the plug, the current naturally flows over this path, no spark resulting.

EXCESS OIL IN MAGNETO.

In the primary circuit of the magneto oil acts as an insulator. For instance, if oil works on to the platinum points it will prevent a flow of current from one point to the other, except in a very restricted area where the oil may have been squeezed out as the points snapped together. The resistance will raise as the area decreases to a point where the oil will be burned, leaving a carbon deposit on the points further increasing the resistance and burning until no current flows through.

It will be noticed from the above that oil is an insulator, especially in the primary circuit, where the voltage is insufficient to overcome the insulating properties of the oil. In the secondary circuit the voltage is sufficiently high to overcome the resistance of the oil, and as dust (either road, metallic, or carbon) is always in the surrounding atmosphere, it settles on the oil and the whole acts as a conductor for the high tension current (resulting in a short circuit).

CARBURETION SYSTEM.

The carburetion system is the means of supplying the engine with an explosive mixture of gasoline and air. The system consists of a carburetor which receives gasoline from a supply tank and mixes it with air in proper proportions, and a system of passages from the carburetor to the inlet valves or the ones which control the passage of the mixture into the cylinders.

CARBURETOR.

The engine is equipped with a type M, size 2 (1.25 inch) plain tube Stromberg carburetor, which is bolted to the underside of a flanged cast iron connection to the governor.

A carburetor is a metering device whose function is to mechanically blend a liquid fuel with the proper amount of air to produce a mixture in such proportions that it will readily explode when compressed within the engine cylinder.

As the name implies, a plain tube carburetor is one in which both the air and gasolene openings are fixed in size; and in which the gasolene is metered automatically, without the aid of moving parts, by the suction of air velocity past the jets.

The mixture proportioning is properly maintained by the use of what is termed "the air bled jet." See illustration on page 84.

The gasoline leaves the float chamber, passes the point of the high speed adjusting needle, and raises through the vertical channel "C." Air is taken in through the air bleeder (dotted in on cut) and discharges into the main gasoline supply channel "C" through small holes located just above top of accelerating well. This air which is discharged from the air bleeder, breaks up the flow of gasoline and produces a finely divided emulsion before it reaches the jet holes in the small venturi tube "I." Upon reaching the jet holes of this small venturi tube, this emulsion is discharged into the high velocity air stream in the form of a finely divided mist.

A venturi tube is used to produce a maximum air velocity at the jet and at the same time not cause undue restriction. This high air velocity creates the suction necessary to properly atomize the gasoline. The use of a double venturi tube construction, in which the mouth of the smaller tube is located at the throat of the larger one, develops the highest degree of atomization, and at the same time the air restriction is minimized.

To prevent a lean mixture during a period of acceleration, an accelerating well is used. The reason for the necessity of its use is as follows: On suddenly opening the throttle the suction is increased at the end of the manifold through which particles of air and gasoline are flowing (to the suction). Due to the difference in inertia of air and gasoline, the flow of the air would be accelerated very much faster than the (heavier) gasoline. This would result in the air rushing ahead of the gasoline particles, increasing the proportion of air to gasolene until the inertia forces had been overcome and the gasoline particles responded completely to the increased suction.

When the engine is idling, or running at a speed which does not utilize the maximum flow of gasolene from the float chamber, the accelerator well or space "M" fills with gasoline.

When the throttle is opened, increasing the suction in the venturi tube and drawing gasoline from the main supply channel, atmospheric pressure at the bleeder exerts itself on the gasolene in the accelerating well "M," forcing it down to join the regular flow of gasoline up through "C" and out into the high velocity air stream through the small venturi tube. While the above action takes place the flow of gasoline is

more than double the normal rate of flow, thereby compensating for the lagging of the gasolene referred to previously.

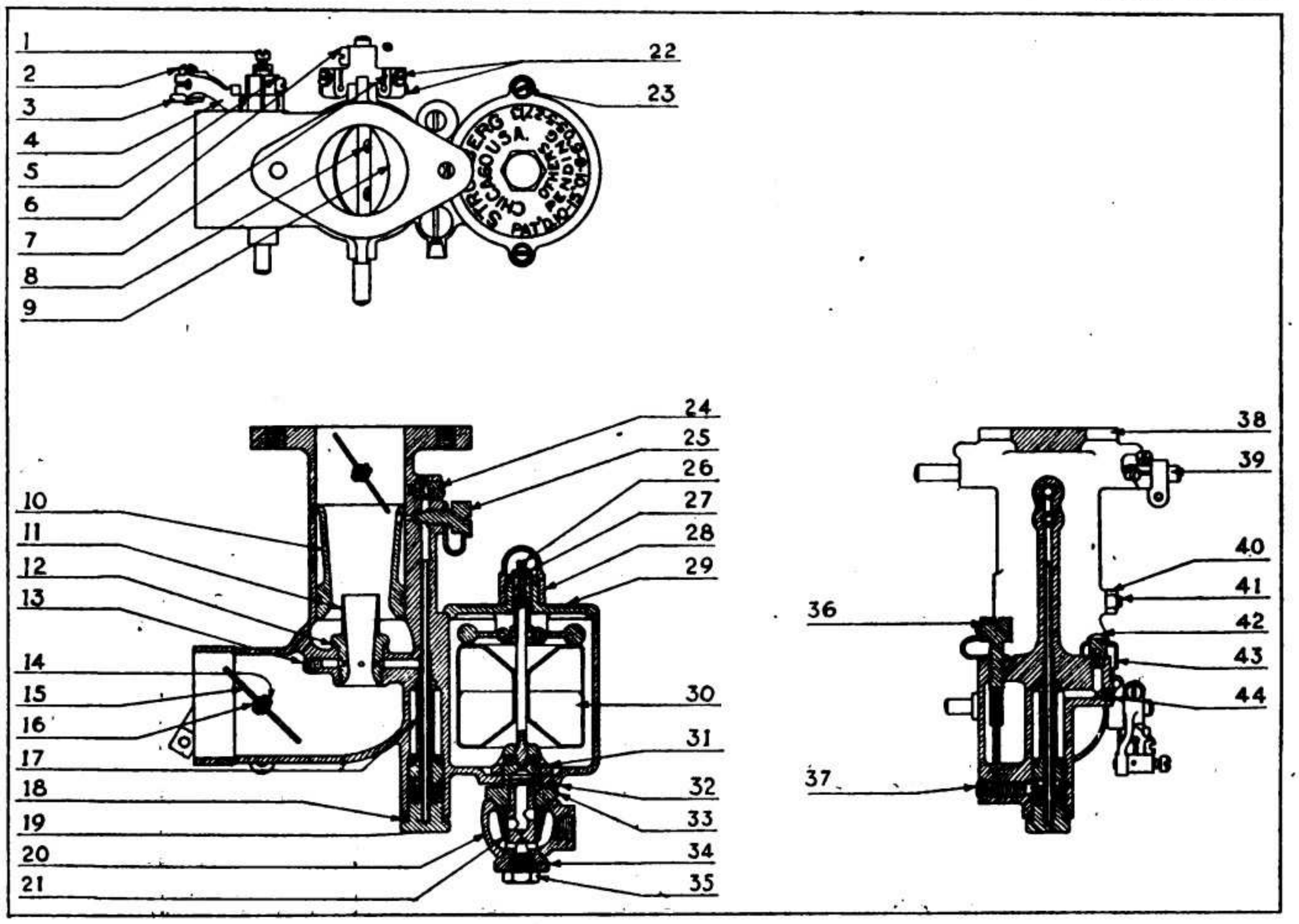
A series of air bleeder holes "H" down the inner wall of the accelerating well connect to the main supply channel, permitting a direct passage of air from the bleeder to the gasoline, giving the air bled jet feature explained above.

The smaller and fewer these holes, the faster will the well empty, due to the suction, and the larger and more holes, the slower will the well empty, as air will be bled thru them as soon as uncovered by the level of the gasoline. It is therefore apparent that the rate of discharge of the well can be regulated to suit individual requirements by inserting wells having a different number and size of holes drilled therein. The action of the well is also dependent upon the size of the hole in the air bleeder, because it is the relative areas of the bleeder hole, and the well holes, which determine the rate at which the well will empty.

When the engine is idling, i. e., when the throttle is practically closed, the vacuum existing above the throttle valve, amounting to about 8 pounds per square inch, pulls the gasoline up through the idling tube (from the float chamber passage), which is concentric and inside the main supply channel, to the idling jet "K." The position of the throttle prevents sufficient vacuum in the small venturi mouth drawing any gasoline through the main supply channel, therefore, but air exists below the throttle. The vacuum above the throttle valve which draws gasoline up through the idling tube, also draws an amount of air controlled by the position of the low speed adjusting screw, from below the throttle. This air mixes with the gasoline to form a finely divided emulsion, which is drawn into the manifold and highly atomized by the high vacuum at the idler jet. It is apparent from the above, that the idling mixture is controlled by the position of the low speed adjusting screw.

As the throttle is slightly opened from the idling position some vacuum is transferred to the mouth of the small venturi, and when the throttle is opened fully the vacuum there greatly exceeds that at the idle jet. At some intermediate position of the throttle there is a time when the suction at the idle jet is equal to that at the small venturi, and therefore at this particular time the gasolene will follow both channels to the manifold. This condition exists but a very short time, because as the throttle is opened wider, the suction at the small venturi rapidly becomes greater than that at the idle jet. The result is that the idling tube and idling jet are thrown entirely out of action, the level of the gasolene in the idling tube dropping, and all gasolene enters the manifold through the holes in the small venturi tube.

Plate No. 27



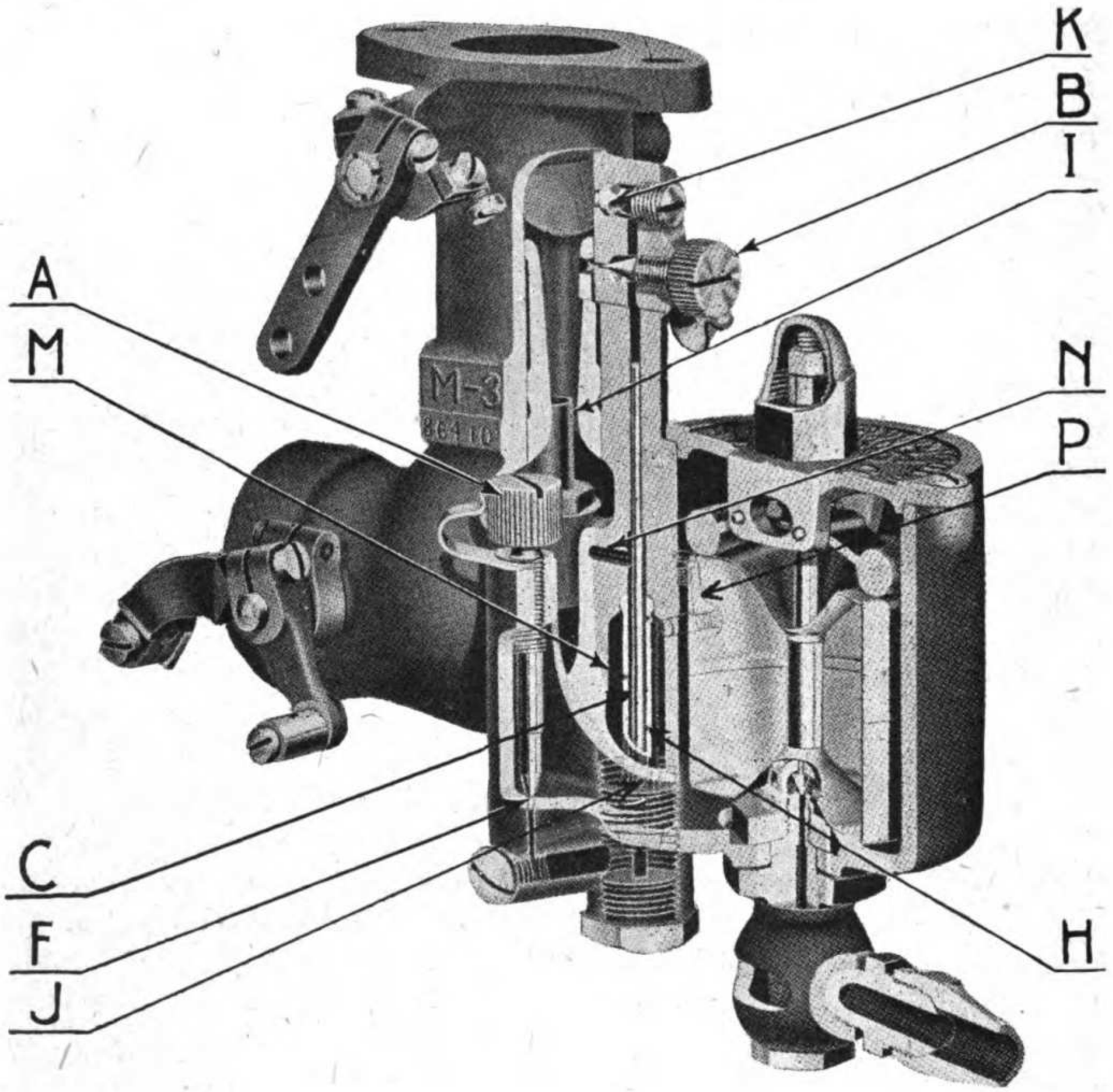
CARBURETOR ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	32932	Air lever with connection screw.
2	32971	Mixture regulator tube clamp screw.
3	NU-935	Mixture regulator tube clamp nut square.
4	30639	Mixture regulator tube holder with screws.
5	30525	Air horn lever and connection with screw.
6	32931	Throttle stop clamp screw.
7	32967	Throttle stop.
8	32969	Throttle valve screw.
9	32968	Throttle valve.
10	32972	Large venturi tube.
11	30640	Small venturi tube.
12	32975	Small venturi tube gasket.
13	32927	Air bleeder channel plug.
14	32969	Air horn valve screw.
15	32934	Air horn volve.
16	30634	Air horn stem.
17	32977	Accelerating gas well.
18	32963	Idle tube gasket.
19	32962	Idle tube with holder.
20	32950	Strainer body.
21	32949	Strainer.
22	32966	Throttle stop set screw.
23	32931	Float chamber cover screw.
	WA-122	Float chamber cover screw lock washer.
24	32960	Idle discharge jet.
25	32961	Idle needle valve.
26	32943	Needle valve.
27	32944	Needle valve lock nut.
28	32945	Needle valve cap.
29	32942	Float chamber cover with levers.
30	32941	Float.
31	32948	Needle valve seat nut.
32	32947	Needle valve seat gasket.
33	32946	Needle valve seat.
34	32953	Strainer body stud.
35	32951	Strainer body drain plug.
36	30637	High-speed needle valve.
37	32958	Main gas channel plug.
38	60638	Main body.
39	30666	Throttle bell crank stem.
40	30670	Large venturi tube set screw nut.
41	32973	Large venturi tube set screw.
42	30619	Air bleeder.
43	30631	Air bleeder dirt shield.
44	32927	Air bleeder channel plug.

CARBURETOR ADJUSTMENT.

There are two adjustments on this new Stromberg, shown in the illustration below: A, the main adjustment, controls the gasoline supply from the float chamber and regulates the mixture through the whole driving range. Turning nut A anti-clockwise, or to the left, raises the needle and gives more gas; clockwise, less. If an entirely new adjustment is necessary, turn nut A clockwise (to the right) until needle just seats, then open A three complete turns (to the left), which should give a mix-

Plate No. 28



CUT-AWAY VIEW OF STROMBERG MODEL M-3 CARBURETOR

A—High speed adjusting needle.
B—Low speed adjusting screw.
C—Main supply channel.
F—Needle valve seat.
H—Air bleeder holes (for high speed only).
I—Small venturi.
J—Opening through which gasoline passes into idling tube.
K—Idling jet.
M—Accelerating well.
N—Passage to discharge holes in small venturi.
P—Air bleeder.

ture considerably rich. After starting and warming up the engine this adjustment may be regulated, as necessary, for the best driving mixture.

The gasoline for idle is taken in above the throttle and diluted with air from the inside of the carburetor, as regulated by screw B, which should be between .5 and 1.5 turn to the left, or anti-clockwise, from the seating position. After the engine is warm this may be regulated, as necessary, turning to the right, or clockwise, for more gas and to the left, or anti-clockwise, when less gas is required. Note that idle adjustment is effective only when throttle is nearly closed.

For starting and warming up with the present-day fuel, it is absolutely necessary to use the air choke until proper operating temperature is attained. Ordinarily, the engine will start readily with the control closed one-half to three-fourths of the way. In very cold weather it may be necessary to pull the control up all the way, but this should be done only for an instant, as this cuts off all the air and delivers raw gasoline only. For hand cranking in cold weather the control should be almost completely closed, while the throttle should be one-fourth to one-third open.

After starting the control should be adjusted, as necessary, and, allowing the motor a moment to steady itself, should be set at a point where the engine will have full power and yet not too rich a mixture for smooth running. As the engine warms up the control may be lowered. Instead of setting the mixture permanently rich, it is much better to use a moderate setting and then to give intelligent attention to the operation of this control. For winter use it is advisable to partly cover the radiator, as a water temperature of 130 degrees F., or above, is absolutely necessary if an engine is to show its normal flexibility and power.

Under such conditions the full supply of hot air should, of course, be used. In the warm months the season adjustment shutter on the air horn may be opened to admit cold air, if necessary.

TO DETECT AND REMEDY A LEAKY FLOAT.

A leaky float will be detected by gasoline overflowing when engine is stopped. To remedy this, either a new float should be installed or the old float repaired. To repair, heat the float slightly until the gasolene therein is expanded to a point where the pressure will force the vapor out of the very small hole, through which the gasolene has leaked into the float, thus identifying its location. As soon as this hole is found, enlarge same slightly, so the gasolene may be drained out. After drying the float the hole should be soldered up, the outside filed off smooth. Avoid unbalancing or change of weight. For a temporary repair, soft soap or shellac may be used in place of solder.

If the float valve leaks, the trouble will probably be caused by a small dent in the float valve seat, or dirt on the seat preventing the float valve making contact over the entire surface of seat, or a ridge on the float valve.

HOW A RICH MIXTURE AFFECTS THE EXHAUST.

A rich mixture is slow burning and will cause a high temperature of the exhaust, a dark red flame at the priming cocks, if opened, a black smoke at the muffler outlet, lack of power and a strong odor of the exhaust.

TO DETECT AND REMEDY INTAKE MANIFOLD LEAKS.

If gasolene is applied to the leak while the engine is running, with a squirt can or thoroughly saturated piece of waste, enough gasolene will be sucked in to stop the missing. Oil put on the leak will be sucked in and disappear. Intake joint gaskets should be shellacked on both sides.

DETECTION OF AND RESULTS FROM INSUFFICIENTLY HEATED AIR.

The incoming air which enters the carburetor through the air horn at the bottom should always be heated, as the hot air passing around the gasolene well, below the primary nozzle, will increase the temperature of the well, the primary nozzle, and the gasolene contained herein, thereby assisting the vaporization of the gasolene. This warm mixture passing through the intake manifold naturally warms the manifold and prevents condensation of the vapor on the inner walls. Insufficient heat, permitting condensation can be detected by the engine "loading" after same has been idling and the throttle is opened quickly, as the vapor which has condensed and adheres to the manifold in drops, is picked up by the incoming air as the throttle is opened, enriching the mixture sufficiently to cause engine to miss fire until manifold has been cleaned of condensed vapor. The incoming air is heated by passing around the outside of the exhaust pipe. Exhaust gas cannot be used as it contains a large percentage of carbon monoxide, preventing combustion of the fresh charge.

HOT AIR BOX OR STOVE.

The incoming air is heated by the hot air box, or stove, which receives hot air from around the outside of the exhaust pipe.

DETECTION OF WATER IN GASOLINE.

If the container is clean, the water will appear like large bubbles in the bottom of the container, as water and gasoline will not mix.

Any exposed iron in the gasolene tank will rust after a short time and discolor any water coming in contact with it, aiding detection.

TO PREVENT WATER IN CARBURETOR.

The strainer body drain plug in the bottom of the carburetor should be removed occasionally, and any accumulated water and dirt drained out, preventing any possibility of trouble.

TO PREVENT WASTE OF GASOLINE BY CARBURETOR FLOODING.

Shut off the gasoline at the tank when the truck is left standing on a steep grade, because the carburetor float may bind against the stud, due

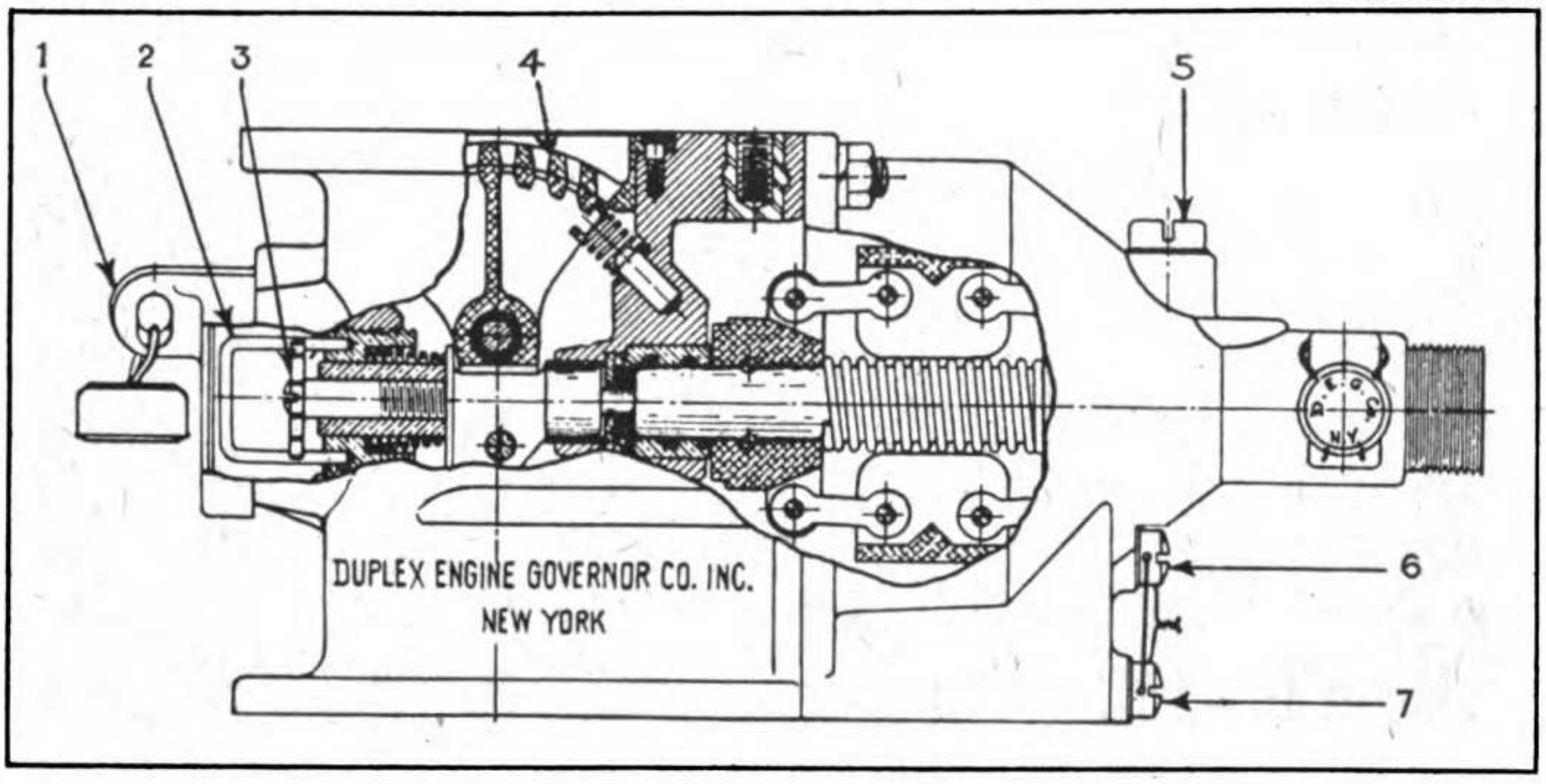
to the angle of the truck, and hold the needle valve open when the gasoline will leak out through the nozzle, and, if a truck stands with the front end downhill the nozzle openings may be below the level of the gasoline in the carburetor float chamber, then the gasoline would leak out.

GASOLINE TANK AND LINE (FUEL FEED SYSTEM).

The gasoline system or fuel feed system consists of a main tank (27 gallons) mounted under the driver's seat, feeding to an auxiliary tank (2 quarts) mounted on the left front side of engine from whence the flow is by gravity to the carburetor.

The main tank is of tern plate and is divided by means of a wall extending part way up the middle. This wall is high enough so that the volume on either side is five gallons. Each side has a .375-inch brass pipe

Plate No. 29



CUT-AWAY VIEW OF SIMPLEX GOVERNOR.

Ref. No.	Part No.	Name of Part.
1	34073	Locking pin.
2		Yoke.
3		Hand wheel.
4	34044	Valve seat.
5	34330	Oil filler screw.
6		Oil discharge.
7		Oil level.

running to a three-way control valve. When the control valve arrow points toward the line running from the control to the auxiliary tank the fuel from the main tank is shut off. The line from main tank to auxiliary also is of .375-inch brass tubing. This pipe enters near the top of the auxiliary tank and extends across the tank. The auxiliary tank is fitted with a vent which runs up the steering column. From the auxiliary tank there is a .375-inch tube with a shut-off valve and strainer in the line. This strainer consists of an iron bowl and a brass cap with fine mesh screen between them.

IF GASOLINE LINE IS BROKEN.

If gas line is broken in two, it could be temporarily repaired by taping, by reaming out one end of broken tube and fitting other end in, or using potato, apple, etc., as a connection, slipping ends of tube into a hole bored through it.

REPAIRING SMALL TANK LEAK.

A small hole leak in gasoline tank can be temporarily repaired with chewing gum, soap, wooden plug, or a piece of cloth.

TANK VENT MUST NOT BE CLOGGED.

The gasoline tank is vented to prevent a vacuum in the tank, by air displacing the gasolene which flows from the tank to the supply tank on engine. If vent became plugged the gasoline would not flow.

INTAKE MANIFOLD AND PASSAGES.

There is only a short intake manifold which acts as a union between the governor and the cylinder block. This external portion is just a means of conveying the gas mixture to cored passages in the casting. The gas feeds across the cylinder block to the inlet valves on the opposite side (the right).

GOVERNOR.

FUNCTION AND CONSTRUCTION.

In order to automatically limit both the vehicle speed and speed of engine at all times, a governor is provided. It is called the Simplex governor and limits the speed of the truck to 15 m. p. h.

The governor safeguards the truck.

Briefly, the governor consists of a grid valve controlled by the action of four balls or weights. The weights are mounted about a movable shaft which operates through a sleeve. Centrifugal force which results from the whirling of the balls around the shaft causes them to pull away. This action forces the shaft through the sleeve and against the grid valve, cutting down the supply of fuel.

As these weights are raised and lowered by the engine they regulate the flow of gas according to the needs of the moment. When the engine is turning over 1,191 revolutions, the governor automatically cuts off all the fuel, thus restricting the engine and consequently the vehicle speed.

CARE AND ADJUSTMENT OF GOVERNOR.

To lubricate, remove the oil-filler screw (5) and fill chamber weekly.

Use medium cylinder oil, and in winter add to it an equal amount of light machine oil.

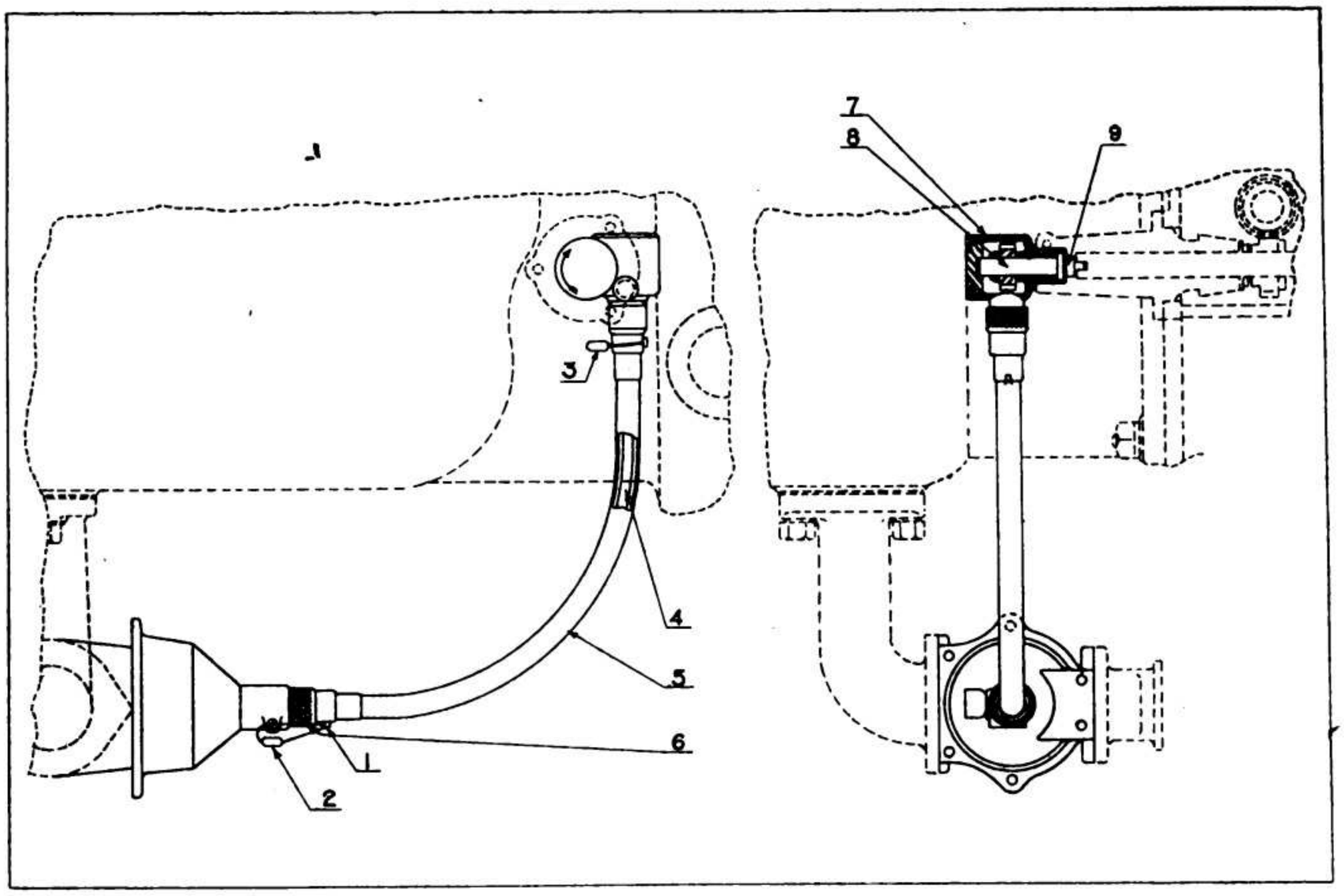
Every 1,000 miles remove screw (6), shown on page 87, fill half full of machine oil, run for ten minutes to clean interior and drain. Refill the chamber with cylinder oil as above described. Be sure that the governor does not run without oil, as it might injure its bearings. Keep screws 6 and 7 with copper washers tight to prevent oil leakage. Connect with wire to prevent losing them.

To clean governor valve, if necessary, pour kerosene into air inlet of carburetor while engine is running, varying the speed of the engine from high to low, thus opening and closing the valve.

If it surges it may result from one of three causes: Governor lubrication is bad; the governor valve is dirty; or the cable drive is not steady and free from backlash.

Never reset governor without specific instructions. To set the governor turn the hand wheel (3) (page 87) out for higher, and in for lower, speeds. Do not fail to lock the hand wheel with the yoke (2) after setting,

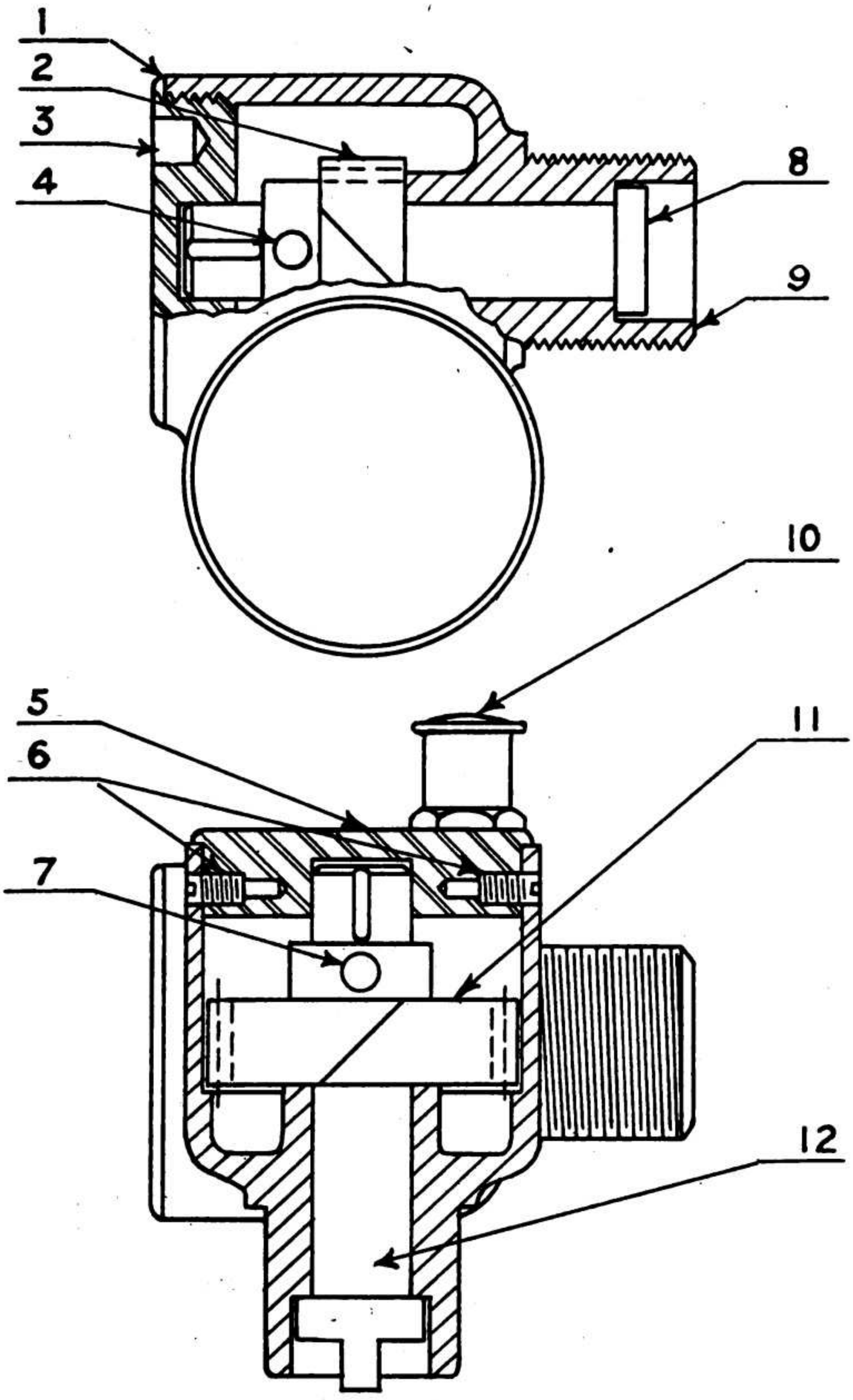
Plate No. 30



SIMPLEX GOVERNOR DRIVE ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	34678	Drive cable casing end screw.
2	34649	Drive cable casing screw seal.
3	34649	Drive cable casing screw seal.
4	32990	Drive cable.
5	32991	Drive cable casing.
6	34677	Drive cable casing end.
7	35705-A	Spiral drive gear housing.
8	35713	Spiral drive gear shaft-drive.
9	34654	Spiral gear driving connection coupling.

Plate No. 31



GOVERNOR DRIVE HOUSING ASSEMBLY.

No. Ref.	Part No.	Name of Part.
1	35709	Housing cap gasket.
2	35711	Spiral drive gear.
3	35710	Housing plug.
4	PI-507	Spiral drive gear pin.
5	35707	Housing cap.
6	35708	Housing cap screw.
7	PI-507	Spiral drive gear pin.
8	34652	Spiral drive gear shaft driven.
9	35706	Housing.
10	OI-101	Housing oiler.
11	35712	Spiral drive gear.
12	35713	Spiral drive gear shaft drive.

if a locking spring is not provided, and see that the yoke does not bind on hand wheel.

The locking pin and seal (1) are for the protection of the governor and the engine. Do not touch the valve screws (4).

IF GRID VALVE STICKS.

If grid valve of governor is jammed shut or open, clean out with kerosene. It is caused by particles of grit or dirt becoming lodged between grids.

EXHAUST SYSTEM.

The exhaust system is that which takes care of the burned gas after it leaves the combustion chamber. The system consists of an exhaust manifold bolted to the cylinder block and which first receives the gas after it has passed the exhaust valves; an exhaust pipe which takes the gas from the manifold and carries it back to a muffler which reduces the gas pressure so there will be no noise. In the exhaust pipe line is a cutout, or device for deflecting the gases from the muffler, so that if necessary the gases can be let out directly into the air, making a noise, of course, but permitting of a slight gain in power due to reduced gas back pressure.

EXHAUST MANIFOLD.

The exhaust manifold is made of cast iron and forms a passage for the egress of the burned gases. It is bolted to the cylinder casting, and connects with all four cylinders. From center to center of the end cylinder openings it is 20.1875 inches, and has an inside diameter of 3.3125 inches.

A stove or heat collecting device is cast integral with its front end. By means of a tube this stove connects with the carburetor air inlet and so expediates gas vaporization. The rear end of the exhaust manifold connects with the exhaust pipe, which conveys the burned gas to the muffler.

MUFFLER CUT-OUT.

At the end of the exhaust pipe near the muffler is a cut-out or device which lets the exhaust gas into the atmosphere avoiding the muffler. This cut-out is hand-operated. It is simply a valve which when open lets the gas out into the air instead of permitting it to pass through the muffler. It reduces back-pressure in the exhaust line slightly by giving free egress to the gas and in this way there is a slight reduction in power loss.

ELECTRIC LIGHTING SYSTEM *ON MODEL 4017-A ONLY.*

The electric lighting system consists of a constant-voltage generator driven from the water pump extension shaft, a battery, lamps, switch and wires connecting these units (see page 96). The generator

is a machine for generating electric current to supply the load (the lamps) and charge the battery. When the engine is operating the generator is generating current. At five miles per hour truck speed generator is automatically disconnected from the battery and the latter feeds the load, but above five miles per hour the generator feeds the load directly and sends the excess to the battery, thus charging it. The cutting in and out of generator from battery is accomplished automatically by a device called a cut-out which is mounted together with the regulator in the aluminum box on top of the generator case.

The generator has a drawn steel case or housing cylindrical in shape and having the ends in separate parts known as end plates. Inside the case are four field windings held in place separately by two screws. These screws run through the central portion of each winding to the pole shoes made of soft iron. Thus the fields are held in place firmly between the pole shoes and the casing. The fields are connected in series and must be removed as a unit. The two ends of the field unit are soldered to posts of a terminal block, which posts run from the outside of the generator casing through the casing, making an inside connection easy. There is a third terminal on the inside of this block and this connects with one of the collecting brushes of the armature, while the other brush connects with another terminal. Thus the first post has soldered to it one end of the field and one brush, the middle post has a field wire attached and the third post the other collecting brush.

One of the end plates contains two brush holders easily removable by means of screws. The brush rests in a brass support and after the brush is inserted a spring holds it down firmly so making good contact with the commutator. The other end plate simply acts as a cover and ball bearing holding. The end plates are held in place by means of screws.

The armature has a laminated core and is of conventional design. It runs on ball bearings.

The terminal block with its inside connections to the brushes and field has at its top three openings into which the terminals of the regulator box fit. The regulator is connected in series with the field and the ammeter (which shows the charging rate) is in series with the battery line.

The generator is bracketed to the right side of the engine and is driven by a silent chain from the pump shaft. The generator bracket has slotted holes to allow for the adjustment of the drive chain. Mounted on the top of the generator is an aluminum box held in place by a single knurled screw. This box contains the automatic switch or cut-out for opening and closing the circuit between the battery and generator and also contains the automatic voltage regulator.

Projecting from the rear end of this box, and fitting into a receptacle on the box, is a disconnecting and reversing plug. The wire

which connects the regulator to the battery circuit is soldered in this plug.

You will find upon close investigation of this disconnecting plug that one segment is grounded by a screw to the side of the plug. This makes it possible to use one wire from the generator to the battery.

Due to the reversible characteristics of this machine no attention need be paid to the polarity of the battery when the connections between the two are made. If wrong connections are made, the generator will instantly reverse itself and charge the storage battery in the proper direction. This is a valuable feature, for should the generator be removed from the car for any cause and replaced, no electrical skill is necessary in making replacement.

Plate No. 32

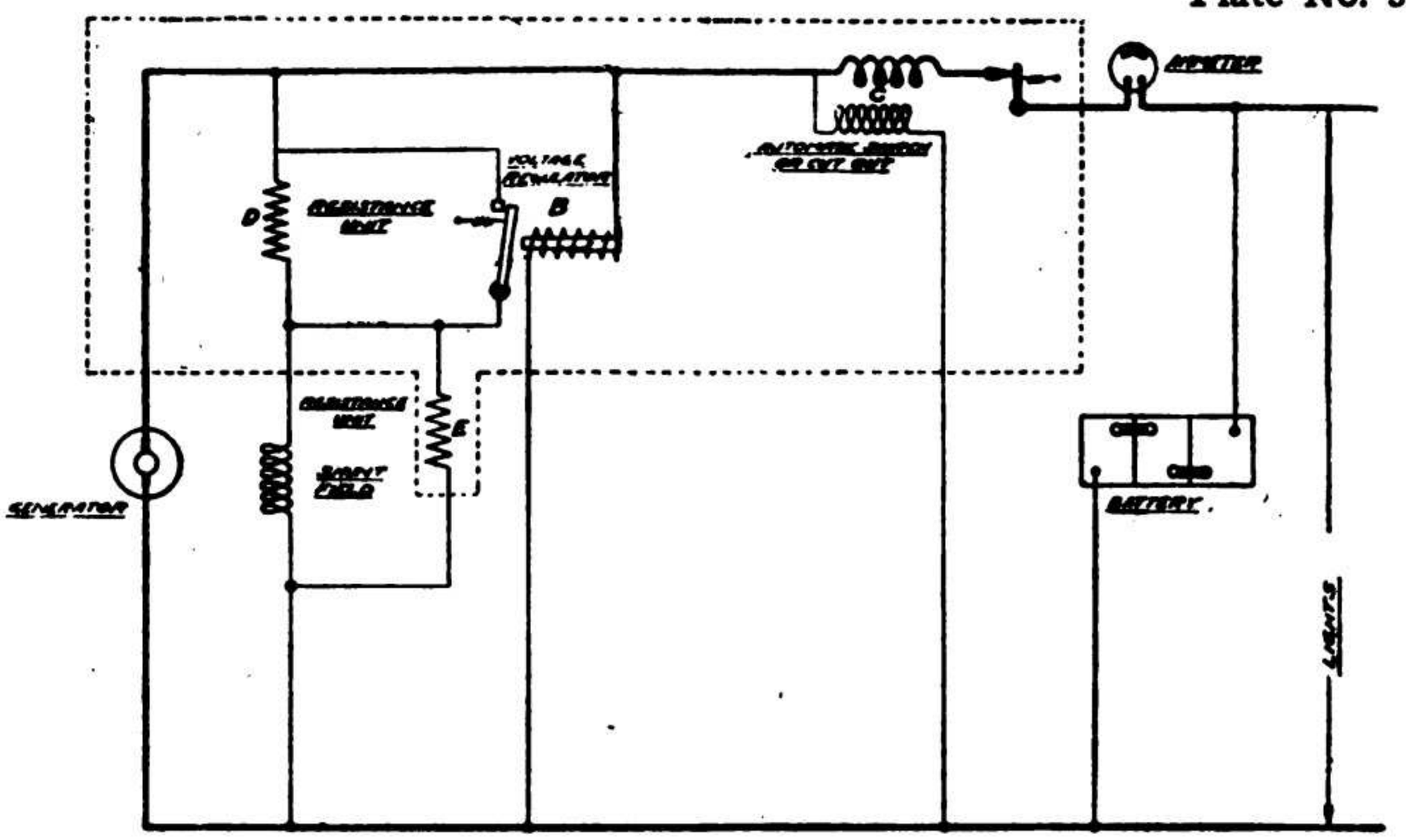


DIAGRAM SHOWING ARRANGEMENT OF UNITS IN BIJUR LIGHTING SYSTEM, ALSO CONNECTIONS OF CUT-OUT AND REGULATOR, MODEL 4017-A ONLY.

Should any trouble arise with the generating equipment which the following suggestions will not remedy, it will not be necessary to remove the generator. The demountable regulator box need only be removed and replaced by a new one if necessary. The cover of the regulator box is sealed to prevent tampering with its adjustments, which are correct when leaving the factory, and the manufacturers are not responsible for its functioning if the seals are broken.

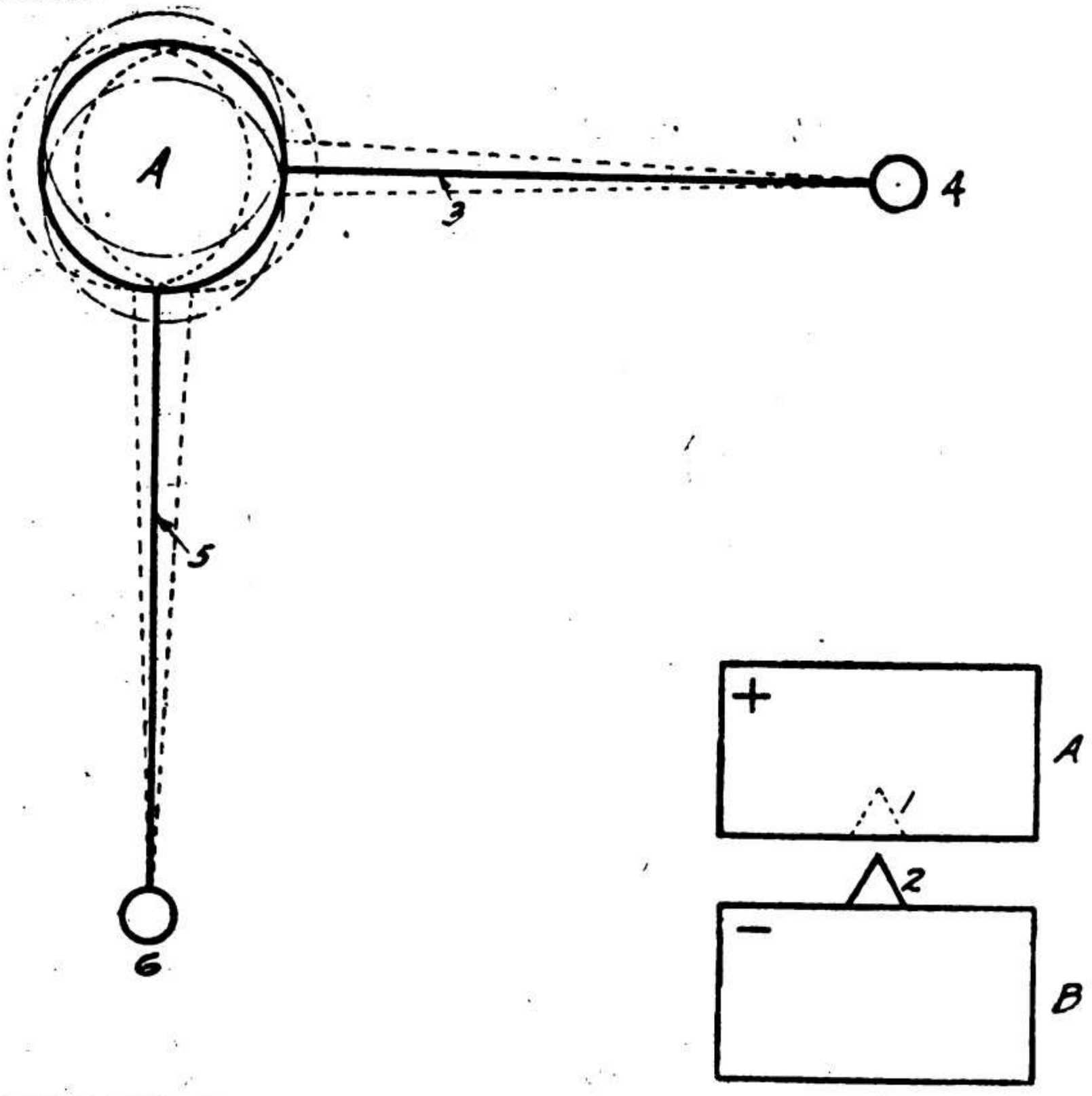
OPERATION OF THE CUTOUT.

The cutout, or automatic switch is mounted on the inside of the regulator box and automatically connects and disconnects the generator to the battery or lamp load. When the generator is at rest the switch

is held open by a tension spring on one end of the cutout armature. When the generator attains a speed sufficient to develop a voltage of 6.5 volts the cutout is automatically closed and the generator is connected to the battery and to its lamp load.

The cutout, shown on page 93, at (C) consists of an iron core having two windings thereon, namely, a shunt and a series winding. The shunt winding is connected across the generator so as to receive the full voltage of the generator across its terminals, and when the machine attains a

Plate No. 33.



DIAGRAMMATIC ILLUSTRATION OF VOLTAGE REGULATOR USED IN BIJUR LIGHTING SYSTEM ON MODEL 4017-A.

speed at which it develops 6.5 volts the shunt winding is sufficiently energized to close the cutout. When the cutout is closed a small current is caused to flow in the series winding connected in the main circuit from the generator to the battery or lamp load, and this coil is energized. The pull due to the series winding, which is much greater than that of the shunt, reinforces the pull, due to the shunt winding, and firmly holds the armature of cutout in its closed position.

When the speed of the generator is decreased to a value at which its voltage is lower than that of the battery, or when the generator is at rest, a momentary discharge of the battery, through the series winding, takes place and demagnetizes the coil. The instant the coil is demagnetized

the tension spring attached to the cutout pulls its armature away from the core and opens the circuit.

OPERATION OF THE VOLTAGE REGULATING UNIT.

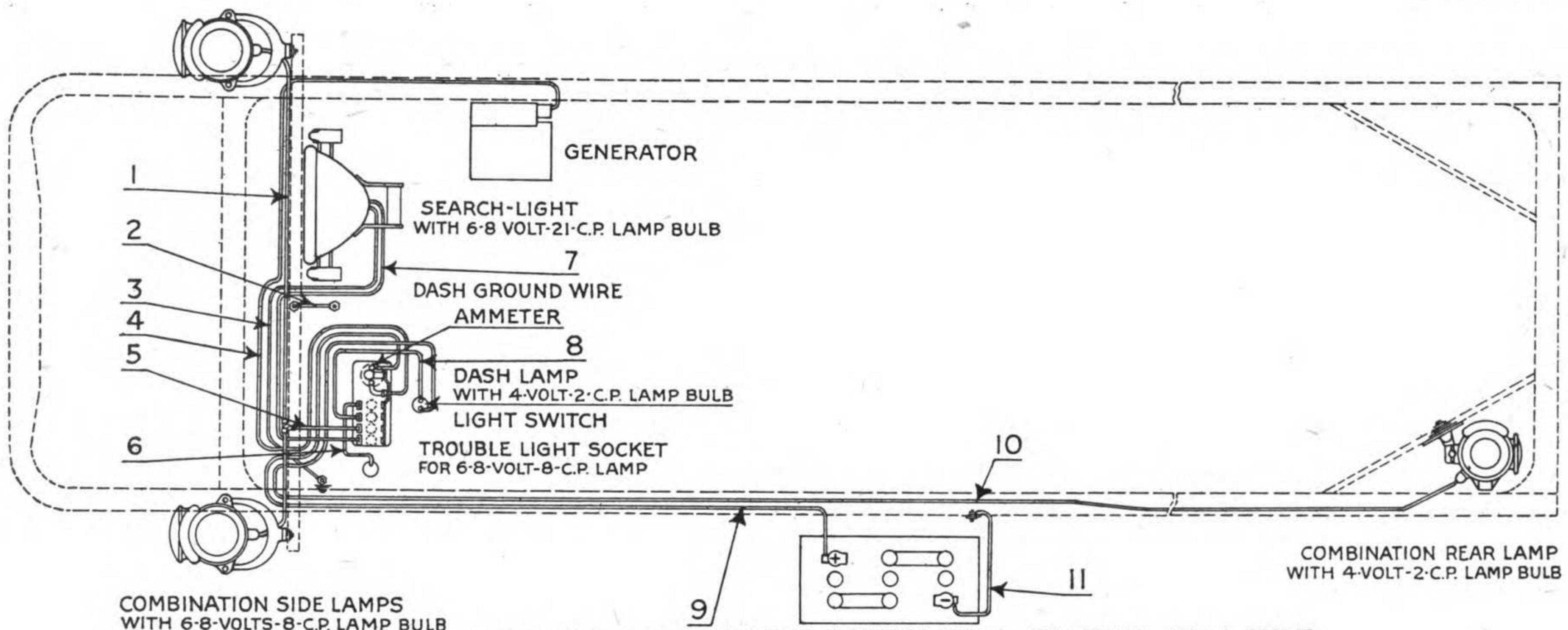
The voltage regulating unit, as shown on page 93, at B, consists of a core having a single winding, this winding being connected across the generator. The current in the winding and the resulting magnetic pull of the core will depend upon the pressure developed by the generator. Opposite one end of the core is a vibrating armature which is spring retracted away from the core. When the armature is spring retracted away from the core it makes contact so that there is a by-pass around the resistance (D), which is in series with the field winding of the generator. With the vibrating armature in this position the shunt field winding receives the full pressure developed by the generator. With increasing generator speed the voltage increases until the armature develops 7.75 volts, and at this electrical pressure the regulator begins to function and will maintain 7.75 volts across the generator brushes at all higher speeds.

With increasing generator speed the voltage will tend to rise above 7.75. If, however, this value is exceeded by a very small amount, the increased pull on the armature of the regulating unit will overcome the spring pull and the armature will be drawn towards the core, thus opening the contacts and inserting the resistance in the generator field circuit. The added resistance in the field circuit decreases the exciting current in the field winding and the voltage developed by the armature tends to drop below the normal value of 7.75 volts. If the voltage drops slightly below the normal the pull of the spring on the regulator armature predominates, and the armature moves away from the core and closes the cutout, which short circuits the resistance and permits the exciting field current to increase. This cycle of operations is repeated at rapid intervals and maintains the generator voltage constant at all speeds above the critical value at which it develops 7.75 volts with the resistance cutout of the field circuit.

There is nothing slow or haphazard in the way the above operations take place, nor is there any marked change in voltage necessary to make the regulator operate.

The rapidity of vibration depends, to a large extent, upon speed, but in general the regulator armature vibrates in the order of one hundred to one hundred and fifty times per second. The actual voltage developed by the generator is made up of a series of very fine ripples above and below a straight line, the mean value of these ripples being 7.75 volts, the constant value for which the regulator is adjusted.

It is obvious that increasing the tension of the regulator spring will increase the constant voltage which the generator will maintain. Under no circumstances should the regulator spring tension be increased in an attempt to have a generator charge at a higher rate at low speed.



WIRING DIAGRAM ELECTRIC LIGHTING SYSTEM USED ON MODEL 4017-A ONLY.

Ref. No.	Part No.	Name of Part.
1	35723	Side lamp wire.
2	35751-A	Dash ground wire complete.
3	35755-A	Searchlight ground wire complete.
4	35719-A	Generator to switch wire complete.
5	35722-A	Sidelight wire to switch wire.
6	35748-A	Trouble lamp to switch wire.
7	35744-A	Searchlight to switch wire.
8	35848-A	Dash lamp to switch wire.
9	35715-A	Battery to ammeter wire.
10	35741	Tail lamp wire.
11	35753-A	Battery ground wire.

The generator cannot begin to charge until the cutout closes and the closing of the cutout is independent of the action of the regulator. The cutout closes after the generator reaches a speed at which it develops 6.5 volts, and no adjustment of the regulator or cutout can change the speed characteristics of the machine. Increasing the tension of the regulator spring so that the generator will develop a constant voltage in excess of 7.75 volts will result in excessive current to the battery, overcharging it or causing the generator to overheat with the possibility of burning it out.

In addition to the resistance in series with the shunt field winding, there is another resistance (E) which is connected in parallel with the field winding. The function of this resistance is to absorb the field energy when the regulator contacts are opened and reduce sparking at the contacts.

As shown on page 94, the regulator is shown in a diagrammatical form only. The actual construction is such that the armature itself does not constitute one of the contacts. Actually there are two contacts, A and B (see page 94), each mounted on a thin flexible brass reed, 3 and 5, the end of the reed opposite the contact being held in a fixed position. Due to vibration, each contact oscillates through a small arc with the fixed end of the reed as a center. The contact reeds are mounted at an angle of 90 degrees so that when the regulator is in operation the two contacts are continually shifting, with the result that the actual point of contact is coninually shifting over the surface of the two contact faces. This shifting of the point of contact prevents the formation of minute projections on the surface of the negative contact (B) and corresponding recesses in the positive (A) and thus removes the possibility of the contacts sticking or freezing.

In the Bijur system the ammeter is provided with a central zero and is connected so that the meter needle indicates to the right of the central zero when the generator is in operation. Should the meter indicate to the left of the central zero when the generator is at rest, the indications are:

1. A short in the line between the meter and the cutout.
2. A ground on the cable between the meter and the generator.
3. That the cutout has failed to open and the battery is discharging through the generator.

HOW TO REMOVE REGULATOR BOX.

In case the regulator box is to be removed, do not insert a screwdriver or any other object between the generator and regulator box to pry the latter off. Loosen the knurled screw on top of the regulator box and lift the box by grasping with both hands.

The lights may be supplied direct from the battery with the generator or its regulator box, or both, removed from the car, without having to make any additional electrical connections.

After the engine reaches a speed equivalent to a car speed of approximately five miles per hour on fourth gear, the generator will generate and maintain a constant voltage or electrical pressure at all higher speeds and will also maintain this pressure constant at all loads.

OUTPUT OF GENERATOR.

The current output from the generator at any time will depend upon the condition of the storage battery and the number of lamps in use.

If a car has been left standing for some time with the lights burning, the storage battery will become more or less discharged and its voltage lowered. Under these conditions the generator voltage or pressure will be higher than that of the battery, forcing a comparatively high charging current into the battery. This current may be from 15 to 20 amperes and the battery will rapidly approach the fully charged condition.

As the battery becomes charged its voltage increases, reducing the difference in pressure between the generator and battery and decreasing the charging current to the battery. With a fully charged battery and with no lights in operation the current from the generator may decrease to four or five amperes.

THE AMMETER.

Current from the generator passes through the ammeter on the dash and this meter shows the current being supplied to the battery and the lights, or to the battery only, when no lights are in operation.

This ammeter will stand at zero when the motor is running at speeds equivalent to approximately five miles per hour or less. The ammeter should always indicate when the engine is running at speeds equivalent to ten or more miles per hour on fourth speed.

FAILURE OF LAMPS.

Failure of a single light to burn may be due to burnt-out bulb, bulb making poor contact in its socket, or loose connection at lamp.

Failure of all lights to burn may be due to completely discharged battery or a leaky battery cell, permitting all the solution to leak out and thus open the battery circuit. Running the generator, if disconnected from the battery, will burn out lights unless the generator regulator is removed.

Failure of the contact fingers in the lighting switch to make proper contact will also prevent the lamps from burning.

Note—In making any repairs to the wiring or before removing an engine, a generator or a starting switch, the positive lead terminal should be disconnected from the switch.

REVERSING POLARITY.

It is necessary to reverse the polarity of the generator to prevent one point from building up at expense of the other, it also equalizes wear and condition of surface of points. It is accomplished by reversing polarity bayonet socket switch on the end of the regulator which is mounted on top of the generator, and should be done every one or two weeks.

USING LIGHTS DIRECT FROM GENERATOR.

The lights can be used direct from the generator by disconnecting battery and taping direct regulator leads, care being taken not to short circuit. *Caution*: Generator will be burned out if run without battery, unless the lights are turned on, or the regulator removed.

STORAGE WILL NOT FEED IGNITION.

The engine can not be run off storage batteries if magneto breaks down, because there is no connection between the ignition and lighting circuits, being entirely independent.

GENERATOR SILENT CHAIN.

The generator silent chain is lubricated through a plug at top of housing about once a week.

STORAGE BATTERY *ON MODEL 4017-A ONLY.*

A storage battery produces an electric current as a result of chemical action. It is used so that electricity is available for lights when the engine is stopped.

CONSTRUCTION.

A storage battery is composed of cells or units contained in hard rubber jars. There are three cells each of 2.5 volts in the Quad battery and it has a capacity of 80 ampere-hours. This is known as a six volt battery though it measures 7.5 volts. The battery cells are composed of lead composition plates formed into grids and immersed in a solution of sulphuric acid and distilled water. The open spaces in the grids are filled with a lead compound called the active material. There are positive and negative plates alternating and between each two plates of a cell is a wooden separator. This separator prevents the plates from touching and thus shorting and at the same time allows action on the plate active material.

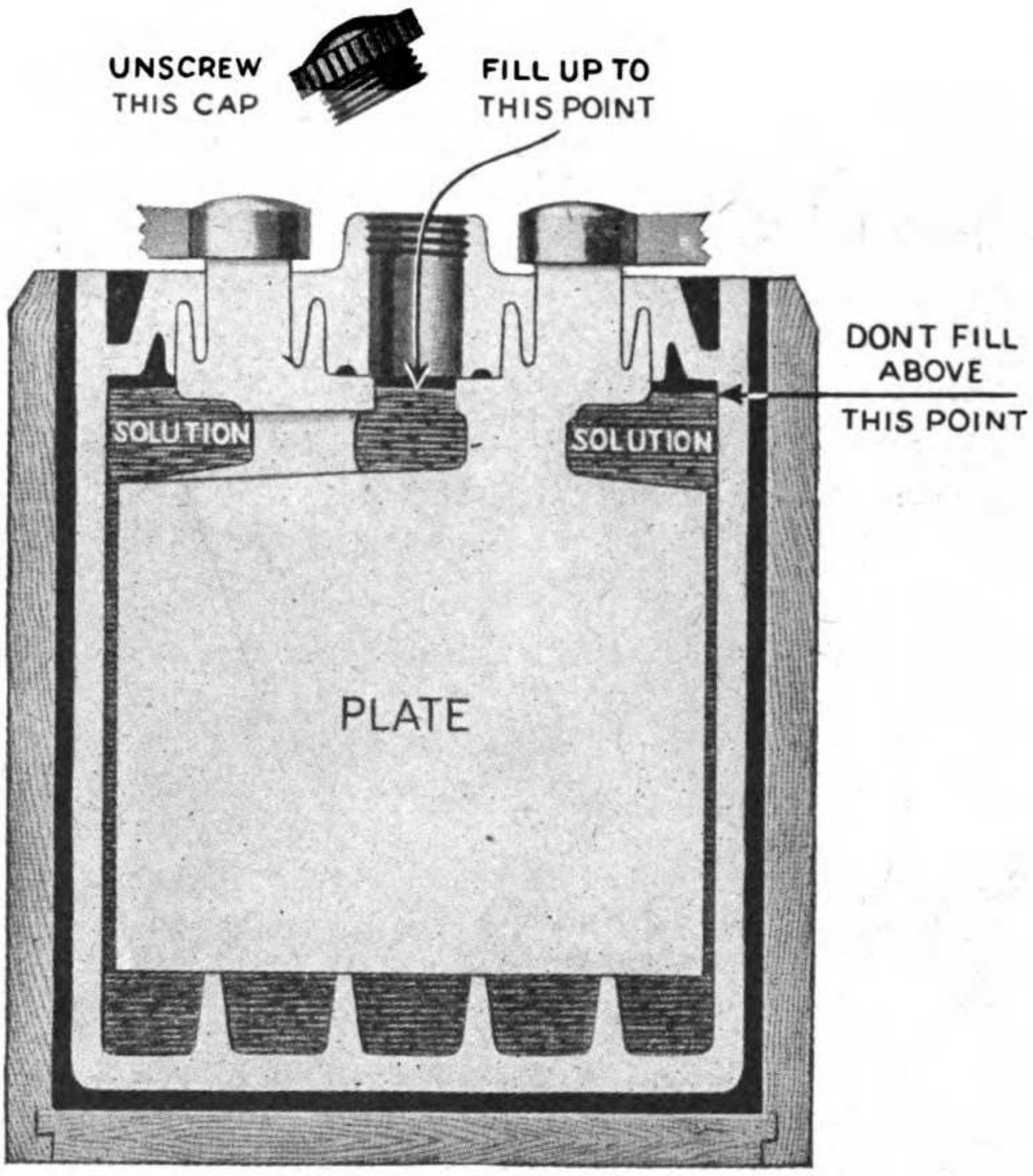
The three cells connected in series form the battery.

Many are under the impression that a storage battery receives and stores up the actual electricity used in charging it. On the contrary, the charging of the battery causes an electro-chemical action between the positive and negative plates in the presence of a medium

known as electrolyte or battery solution. This does not actually store up electricity, but produces a chemical change in the plates. When a circuit is established between the elements, the active material of the plates changes back to its original condition and an electrical current is generated.

Immediately upon receipt of the truck, the vent plugs in the cover of

Plate No. 35



SECTION THROUGH STORAGE BATTERY SHOWING CORRECT LEVEL OF ELECTROLYTE.

each cell should be removed to see that the solution fully covers the tops of the plates. If it does not, add distilled water. Do not fill the cells so full that the solution bubbles out of the vent plugs. Wipe off any excess which may appear.

Use only clean non-metallic vessels for handling and storing water to be used for battery purposes.

Never add acid of any kind to the battery to replace evaporation, because only water and not acid evaporates.

Water for battery purposes should be distilled. The water must be free from alkali, iron or other impurities.

The battery should be kept clean and free from dirt.

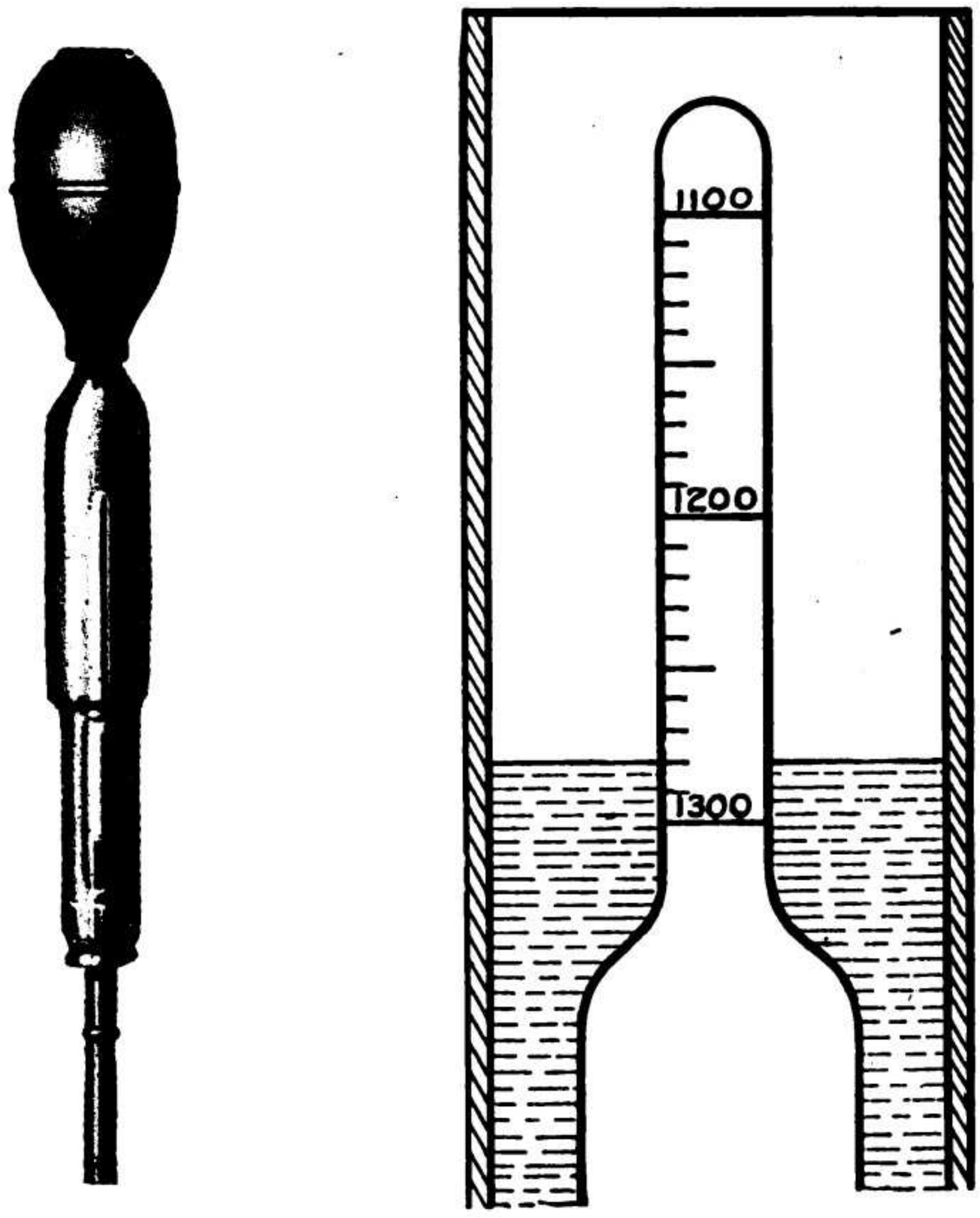
ELECTROLYTE GRAVITY.

The state of charge of a storage battery is indicated by the specific gravity, or density, of the solution.

HYDROMETER SYRINGE FOR BATTERY TESTING.

The illustration below shows a hydrometer syringe used for taking specific gravity readings, the filler or vent plug in the top of a battery cell is removed and the rubber tube of the hydrometer

Plate No. 36



LEFT: AN HYDROMETER SYRINGE. RIGHT: SHOWING HYDROMETER FLOAT REGISTERING 1280.

syringe inserted in the cell so that the end of the tube is below the level of the solution. Then squeeze the rubber bulb and release slowly, drawing the solution into the acid chamber until the hydrometer floats.

The reading on the graduated stem at the point where it emerges from the solution is the specific gravity, or density, of the solution.

The illustration above shows an enlarged section of the hydrometer floating so that the reading on the graduated scale is 1.280 at the point where it emerges from the solution. This reading gives the specific gravity of the solution and is an indication of solution strength.

After testing, the solution must be returned to the cell from which it was taken.

Never take specific gravity readings immediately after adding water to the cells.

The specific gravity readings are expressed in "points," thus the difference between 1.275 and 1.300 is 25 points.

When all cells are in good condition the specific gravity will be approximately the same in all cells and the difference should not be greater than 20 points.

WHEN BATTERY IS FULLY CHARGED.

With a fully charged battery the specific gravity of the solution will be from 1.280 to 1.300.

Specific gravity readings above 1.200 indicate battery more than half charged.

Specific gravity readings below 1.200, but above 1.150, indicate battery less than half charged. Gravity below 1.150 indicates battery discharged or "run down."

Should the gravity fall below 1.150 the engine should be given a long run with all lights turned off to restore the battery.

This condition may result from leaving truck standing for prolonged periods with all lights in use and with insufficient running of the engine in between these periods to replace the current taken to supply the lights.

When the specific gravity shows the battery to be half discharged, the lights should be used sparingly until the gravity rises to approximately 1.275.

If the specific gravity of one cell is much lower than that of the others, and if successive readings show the difference to be increasing, this indicates that the cell is not in good order.

If one of the cells regularly requires more water than the others (continually lowering the specific gravity), a leaky jar is indicated. Leaky jars should be replaced promptly.

GRAVITY DROP DUE TO INTERNAL SHORT-CIRCUIT.

If there is no leak and the specific gravity falls 50 or 75 points below that of the other cells in the battery, an internal short circuit is indicated and should be remedied.

Where a battery is to remain out of active service for long periods, it may be kept in good condition by giving it a freshening charge at least once a month, by running the engine, or from an outside source.

AFTER BATTERY HAS BEEN OUT OF SERVICE.

After a battery has been out of service for some time it should be given a thorough charge before it is placed in service again.

If the engine can not be run to give a freshening charge, the battery

should be removed from the car and taken to a charging station. This charge should be 4¾ to 5 amperes for twenty-four hours.

TO AVOID BATTERY FREEZING.

In order to avoid freezing, the battery should be kept in a fully-charged condition, as a fully-charged battery will not freeze except at extreme temperatures. As a battery discharges, the specific gravity of the solution decreases, and the specific gravity of a fully discharged battery will be approximately 1.120. Battery solution of this low gravity will freeze at 20 degrees Fahr. above zero, whereas the density of the solution, in a battery approximately three-quarters charged will be 1.260, and solution of this density does not freeze until 60 degrees Fahr. below zero.

GENERAL INFORMATION ON ENGINE MAINTENANCE AND REPAIR.

CARBON REMOVING.

Despite all precautions, carbon deposits on the piston top and cylinder head. When the accumulation is excessive it usually can be detected by the following combination of symptoms. The motor lacks power, it overheats readily, it may misfire and backfire and probably run after the ignition switch is turned to off position. The carbon deposit as a result of imperfect combustion, the breaking down of any cylinder oil that gets into the combustion chamber, and the deposit of dust and dirt taken in through carburetor. By keeping the mixture correct and preventing over-lubrication much of the carbon is kept out of the cylinders.

Once it is determined that carbon has formed in appreciable quantity it should be removed immediately. There are three methods usually employed. Either kerosene or a proprietary compound is used, the carbon is scraped out by means of scrapers, or the carbon is burned out by means of oxygen. The use of proprietary compounds is not very helpful when the accumulation is excessive, but often gives good results to remove small particles which become incandescent. The use of these compounds, some of which are good and others not, tends to loosen the carbon and not dissolve it. The use of too much compound in a cylinder is bad, especially if the rings do not fit well, because the compound then flows down into the oil, partly destroying its lubricating qualities.

In the oxygen method, oxygen gas contained in a tank is led in a stream into the combustion chamber, by means of a nozzle directed through a spark plug opening. A lighted match is dropped into the cylinder before the oxygen is turned on. In this atmosphere the carbon burns to carbon dioxide and by carefully directing the nozzle all the carbon can be burned away.

The scraping method is possible in the Buda motor, through the valve plug openings, though it may be found a little inconvenient. The work is best done with the cylinder block removed and in this case one can see the

work. There are special scrapers for doing this work. It is the usual thing to grind the valves after scraping carbon. (See page 56 for grinding valves.)

One precaution is necessary in scraping carbon off piston heads, and that is to cover the openings of the crankcase when the cylinders are off. If this is not done, particles of carbon are likely to fall into the bottom and mix with the oil, exerting a cutting action on the moving parts.

ENGINE TROUBLES.

The engine may misfire for the following reasons:

1. Broken spark plug insulator.
2. Spark gap too wide or close.
3. Poor carburetor adjustment.
4. Air leak through valves, or through intake manifold.
5. Circuit breaker points pitted, burned, short circuited, or out of adjustment.
6. Valves riding on tappet.
7. Valve clearance too great.
8. Leaky valves.
9. Sticking valves.
10. Poor compression.
11. Too much oil in combustion chamber.
12. Break in high tension circuit.
13. Poor magneto connections.
14. Broken, or loose, or disconnected high tension wire.
15. Weak magneto.
16. Water in fuel.
17. Restricted fuel flow, not filling float chamber.
18. Fouled spark plugs.

It may be impossible to start engine for the following reasons:

1. Switch not on.
2. Empty gas tank.
3. Gas line clogged.
4. Water in carburetor.
5. Float sticking.
6. Poor compression.
7. Fouled spark plugs.
8. Weak magnets.
9. Punctured high-tension winding.
10. Air leak in intake manifold, by valves, over priming, lack of lubrication.
11. Distributor wire off.
12. Poor mixture.

There may be difficulty starting the engine for the following reasons:

1. Magneto magnets weak.
2. Spark plug electrodes too far apart.
3. Carburetor set for too lean mixture.
4. Poor compression.

5. Magneto breaker points sticking.
5. Magneto breaker points dirty.
6. Low test gasoline.
7. Gasoline too cold.
8. Air leak in manifold.
9. Air leak in manifold gaskets.
10. Valve stem guides worn.
11. Ignition wire connections off.

The exhaust may be smoky for the following reasons:

1. Oil feed too great.
2. Oil too thin.
3. Pistons, piston rings or cylinders worn.
4. Mixture too rich (black smoke).

The engine compression may be poor for the following reasons:

1. Valves leak compression.
2. Valve plugs, priming cocks or spark plugs leak compression.
3. Piston rings or cylinder walls worn or scored.
4. Valve warped.
5. Valve not seating.
6. Valve stem bent.

Explosions will occur in the muffler for the following reasons:

1. Rare mixture.
2. Exhaust valve sticking.
3. Exhaust valve riding.
4. Dirty or sooty muffler.
5. Magneto improperly wired to plugs.
6. Accumulated unburned gases in muffler.

An engine will overheat for the following reasons:

1. Lack of water.
2. Fan belt broken or slipping.
3. Pump not working.
4. Air pocket in water line.
5. Rusty or scaly radiator.
6. Clogged water jacket.
7. Defective water hose.
8. Valves out of time.
9. Magneto timed late.
10. Poor lubrication.
11. Faulty carburetor adjustment.
12. Driving with retarded spark.
13. Excessive carbon.

An engine will knock for the following reasons:

1. Loose main bearings.
2. Loose connecting rod bearings.
3. Loose wrist pin.
4. Piston slap.

5. Spark too early.
6. Pre-ignition.
7. Spark too far advanced for load.
8. Carbon.
9. Engine overheated.
10. Lack of oil.
11. Engine supports loose.
12. Camshaft bearing worn.
13. Timing gear back-lash.
14. Loose flywheel.
15. Worn piston ring.
16. Tight bearings.
17. End play in camshaft or crankshaft.

The following may cause truck to lose power:

1. Dragging of brakes.
2. Incorrectly timed magneto.
3. Lack of compression.
4. Engine overheated.
5. Wheels out of line.
6. Lack of lubrication.
7. Carbonized cylinders.
8. Improper mixture.
9. Faulty magneto point adjustment.

CHAPTER III

CONTROL DEVICES, LEVERS AND STEERING SYSTEM.

FUNCTION, CONSTRUCTION, OPERATION AND CARE.

Sitting in the driver's seat all necessary controls are within easy reach. At the right of the driver's seat is the gearshifting and hand brake control set operating in their respective quadrants. In front of the driver's seat is the vertical steering post with spark and throttle levers, and carbureter air choke. On the dash is the ignition control and also, in the case of the model 4017-A only, a switch panel for the electric lights. On the floorboards just forward of the steering column are the pedals, the one on the left with the letter C on it for clutch operation and the other with B on it operating the wheel brakes.

GEARSHIFT LEVER.

Of the two levers to be found at the left center of the front platform, the one on the left is the gearshift lever. It may be distinguished from the other because of a spring button in the top of the handle. Near the base of this lever is a quadrant which limits the movement of the lever forward and backward. At the extreme forward end of the quadrant will be found the marks "1, 4, R," which respectively signify first speed, fourth speed, and reverse. At the opposite end of the quadrant are the figures "2, 3," which indicate the positions for second and third speeds. At the center of the quadrant is a cuplike depression in the quadrant plate, into which fits a ball located on the side of the gearshift lever.

When the lever is at the center of the quadrant so that this ball fits into the cup and the lever may be moved freely in all directions on its base as a pivot, it is in the neutral position.

USE OF GEARSHIFT LEVER.

In starting, the clutch pedal is depressed and the gearshift lever rocked to the right thrown forward and into first position, designated by the figure "1" on the quadrant. The clutch is then engaged, and when enough momentum has been gained by the truck to change into second speed, the clutch is again depressed. The gearshift lever is pulled straight back past center, or neutral position (straight back toward the figure "2") to the end of the quadrant.

To change to third speed, the clutch is operated as before, while the gearshift lever is again brought to center and then thrown back to the extreme left. The last change into high or direct speed is accomplished

by disengaging the clutch as before and moving the gearshift lever past center and straight ahead toward the "4" at the front of the quadrant.

In order to place the lever in the reverse position it is necessary to depress the button in the top of the handle. This releases a latch on the bottom of the lever, permitting it to be rocked to the left and thrown forward to the "R" at the front of the quadrant. This safety latch prevents the operator from throwing the gears into reverse position by accident.

WHAT OCCURS WHEN GEARSHIFT LEVER IS MOVED.

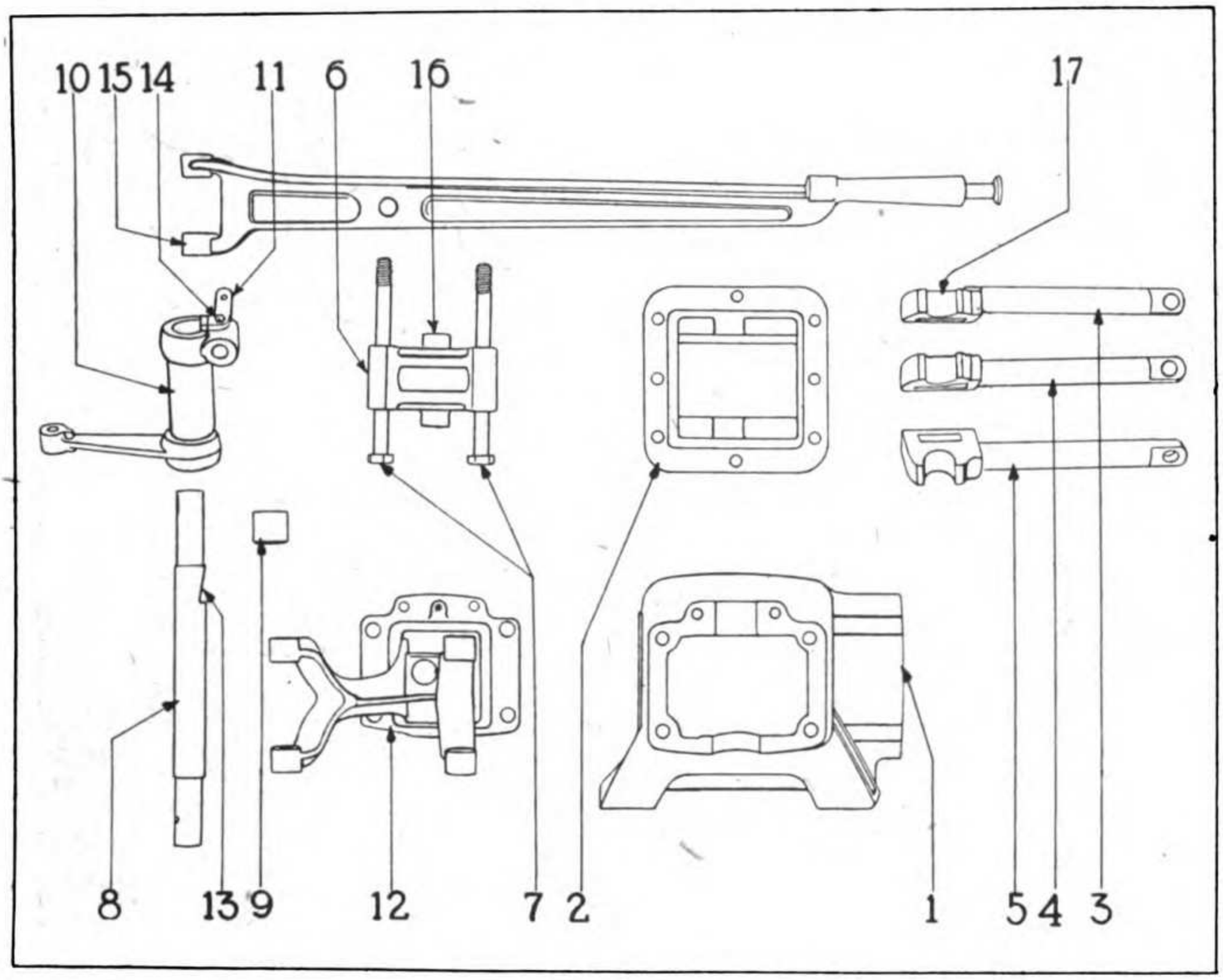
Refer to the illustration on page 109.

Operating lever (15), mounted on bracket (12), is suspended on ball bearing and connected to control shifter lever tube (10), which, in turn, slides freely on brake shaft (8). In the base of shifter case (1) are placed three shifting yokes: (3) reverse speed shifting yoke; (4) third and fourth speed shifting yoke; (5) first and second speed shifting yoke. These are placed in the order indicated in the illustration in the shifter yoke guard (2), care being taken that they move freely and without obstruction. Immediately above the shifting yokes and mounted on two bolts (7), shifter yoke interlock (6) is suspended. When quadrant bracket (12) with the operating shifter lever tube (10) and brake shaft assembly (8) are placed in position on shifter case (1), the projecting arm of control shifter lever tube (10) is placed in an aperture at the center of the shifter yoke interlock (6). The movement of operating lever (15) to the right or left moves the shifter yoke interlock (6) laterally across the notches (17) of the three shifter yokes, permitting the selection of any particular one. The one selected may be operated by moving the lever either forward or backward on the quadrant. In whatever position they may be placed, due to the lateral movement of the interlock, they will at all times retain two of the shifting yokes in stationary or locking position, permitting the operation of but one at a time.

The reverse shifter yoke can be operated only by depressing the button on the upper end of operating lever (15). This button releases the reverse lock (11) by lifting it from the depression (13), which is cut in the upper side of the brake shaft. The release of lock (11) permits the operating lever to be thrown to the extreme left position, and the engagement of the arm on control tube (10) with shifting yoke (3). Connected to the projecting ends of the three shifting yokes are the operating rods which transmit the desired speed selection of the shifting box on the transmission case. These operating rods should be adjusted to such length by means of the yokes on their ends that when the transmission gears are in neutral position and the hand operating lever in neutral position, the pins on the rod yokes may be easily inserted with no tendency toward the release of the lock devices.

Mounted on the upper side of the transmission case is the gearshifting

Plate No. 37



HAND CONTROL GEARSHIFTING MECHANISM DISMANTLED.

Ref. No.	Part No.	Name of Part.
1	34133-A	Shifter case.
2	32354	Shifter yoke guide.
3	32352	Reverse speed shifting yoke.
4	32351	Third and fourth speed shifting yoke.
5	32350	First and second speed shifting yoke.
6	32355	Shifter yoke interlock.
7	32597	Shifter yoke interlock bolt.
8	32331	Hand-brake shaft.
9	32322	Hand-brake shaft bushing.
10	35405-A	Control shifter lever tube.
11	34748	Operating lever reverse lock.
12	32324	Quadrant bracket.
13		Reverse notch.
14	34747	Operating reverse lock screw.
15	35385	Operating lever.
16		Lugs on interlock.
17		Notch in shifting yoke.

device. Its function is to permit the shifting of and to retain in engagement such gears as are selected by the hand-control lever. Operating rods with adjustable yokes from rigid connection between the control levers and shifter case.

GEAR SHIFTER CASE.

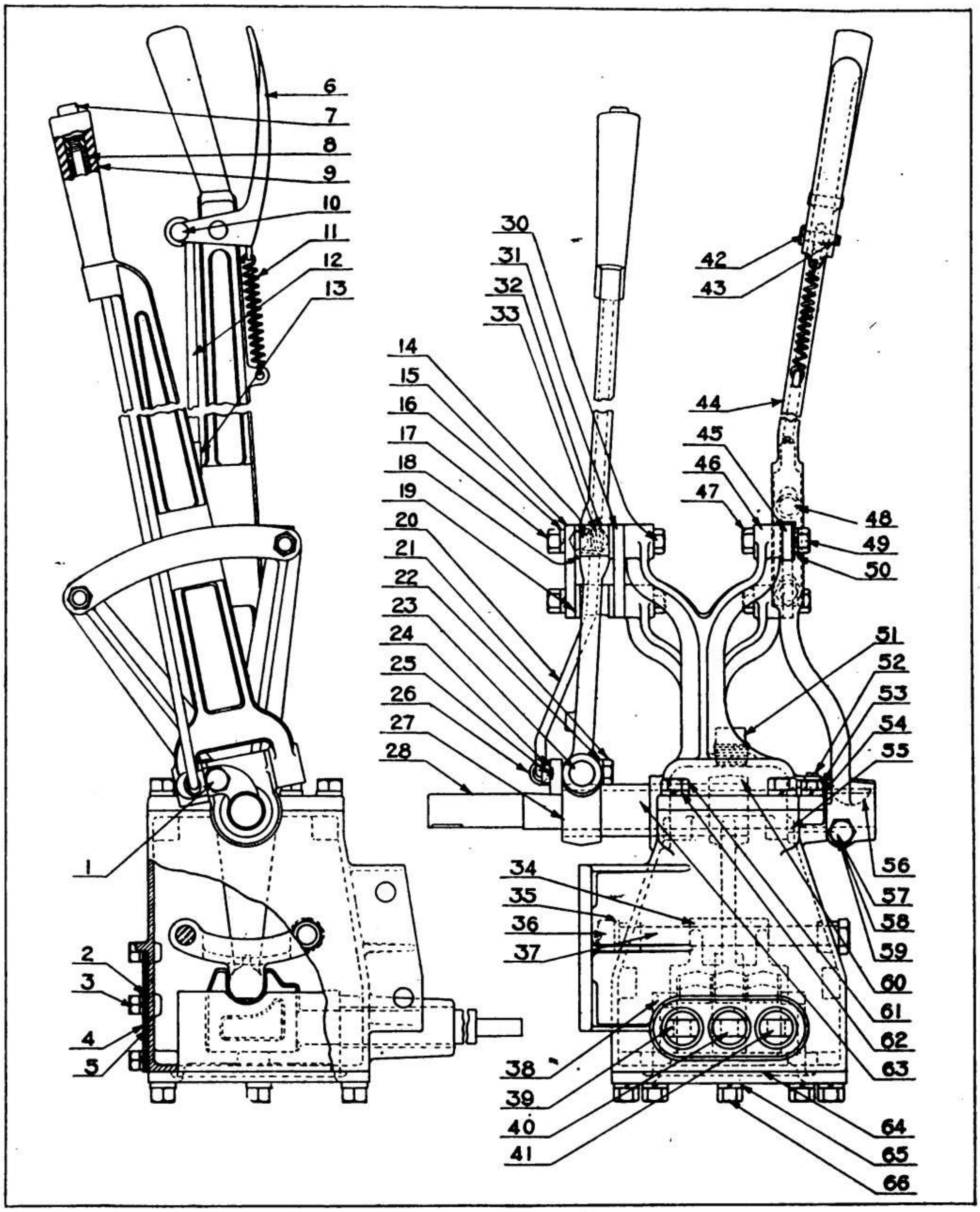
Beneath the gearshift lever is a cast iron case which contains three shifter yoke guides and the interlocker which prevents any two of the

yoke guides from moving when the third is being shifted. From the gearshifter box three rods afford a connection with the transmission dog clutches. One rod controls the first and second speed, the center one the third and fourth speed, and the other rod controls the reverse.

CONSTRUCTION OF SHIFTER CASE.

By means of the illustration on page 113 the operation of the component parts of the shifter case can be readily understood. Shifter tube

Plate No. 38



CONTROL LEVERS ASSEMBLY.

CONTROL LEVERS ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	34747	Gear shifter lever reverse lock screw.
2	WA-144	Gear shifter case front cover screw lock washer.
3	SC-3201	Gear shifter case front cover screw.
4	32348	Gear shifter case front cover.
5	32349	Gear shifter case front cover gasket.
6	32329	Brake lever trigger.
7	32340	Gear shifter lever button.
8	31530	Gear shifter lever button spring.
9	35385	Gear shifter lever.
10	PI-116	Brake lever latch rod pin.
11	32330	Brake lever trigger spring.
12	36746-A	Brake lever dog and trigger rod.
13	36746-A	Brake lever dog and trigger rod.
14	BA-105	Gear shifter lever finder ball.
15	32317	Gear shifter lever quadrant (outer).
16	WA-146	Gear shifter lever quadrant bolt nut lock washer.
17	NU-128	Gear shifter lever quadrant bolt nut.
18	32320	Gear shifter lever quadrant spacer (rear).
19	32319	Gear shifter lever quadrant spacer (front).
20	34750	Gear shifter lever reverse lock rod.
21	NU-112	Gear shifter lever reverse lock screw nut.
22	WA-145	Gear shifter lever reverse lock screw lock washer
23	34749	Gear shifter lever trunnion pin.
24	WA-309	Gear shifter lever reverse lock rod washer.
25	PI-402	Gear shifter lever reverse lock rod cotter.
26	34748	Reverse lock.
27	34742	Gear shifter lever trunnion block.
28	32331	Brake lever shaft.
30	BO-1510	Gear shifter lever quadrant bolt.
31	32318	Gear shifter lever quadrant (inner).
32	32346	Gear shifter lever finder bushing.
33	32316	Gear shifter lever finder ball spring.
34	32355	Gear shifter yoke interlock.
35	WA-148	Gear shifter yoke interlock bolt lock washer.
36	NU-149	Gear shifter yoke interlock bolt nut.
37	32597	Gear shifter yoke interlock bolt.
38	32354	Gear shifter yoke guide.
39	32350	Gear shifter yoke (first and second speed).
40	32351	Gear shifter yoke (third and fourth speed).
41	32352	Gearshifter yoke (reverse speed).
42	PI-117	Brake lever trigger fulcrum pin.
43	PI-117	Brake lever trigger fulcrum pin.
44	32325	Brake lever.
45	32323	Hand brake lever quadrant.
46	32324	Quadrant bracket.
47	SC-3433	Hand brake lever quadrant bolt.
48	32327	Brake lever latch screw.
49	NU-128	Brake lever to shaft bolt nut.
50	WA-146	Brake lever to shaft bolt nut lock washer.
51	PL-104	Quadrant bracket grease plug.
52	SC-2135	Quadrant bracket set screw.
53	SC-3303	Quadrant bracket to case screw.
54	WA-145	Quadrant bracket to case screw lock washer.
55	32322	Hand brake lever shaft bushing.
56	KE-111	Brake lever to shaft key.
57	SC-3435	Brake lever to shaft bolt.
58	WA-146	Brake lever to shaft bolt nut lock washer.
59	NU-128	Brake lever to shaft bolt nut.
60	32333	Gear shifter lever.
61	SC-3502	Quadrant bracket to case screw (large).
62	WA-147	Quadrant bracket to case screw lock washer.
63	32332	Gear shifter lever tube.
64	35288	Gear shifter yoke guide gasket.
65	WA-146	Gear shifter yoke guide screw lock washer.
66	SC-2453	Gear shifter yoke guide screw.

(32), controlling the third and fourth speed shifter fork (30), is inserted in the center opening of shifter case (1). It is then screwed into shifter fork (30) far enough to permit lockwasher (12), and locknut (13) to be placed behind it. Bushing number (4) should be inserted in shifter case, so that it is located in that portion of the case directly between the center and left-hand holes. Next interlock plug (3) is inserted, care being taken that the notch or depression (16) on shifter rods (18 and 32) is so disposed that the interlock plug enters same. Plug (2) merely closes the opening after the insertion of these parts. Shifter tube (18), controlling the first and second speed, shifter fork (11) may next be inserted in the case in the hole to the left of the center. Unlike the previous assembly, locknut (13) and lockwasher (12) are first placed on the tube, after which it is screwed into shifter fork (11). The locknut should not be secured until the proper adjustment of the gears is assured.

REVERSE ROCKER SHAFT TUBE ASSEMBLY.

Reverse rocker shaft tube assembly (28), mounted on shaft (26), between two bushings (27), which are mounted in the case, the whole assembly is retained by two hexagon nuts (25). Reverse shifter tube (31) being inserted in the remaining hole in shifter case, locknut (13), lockwasher (12), and, finally, shifter tube arm (29) are in turn placed on the tube. The insertion of the three sleeves (5) in the holes on the upper portion of the shifter case, permits the assembling of the shifter lock balls (6), followers (7), and shifter lock springs (8), with the three additional followers (7), after which plate (9) is secured by two cap screws and the shifter lock spring adjusting screws (10) inserted immediately above the spring followers.

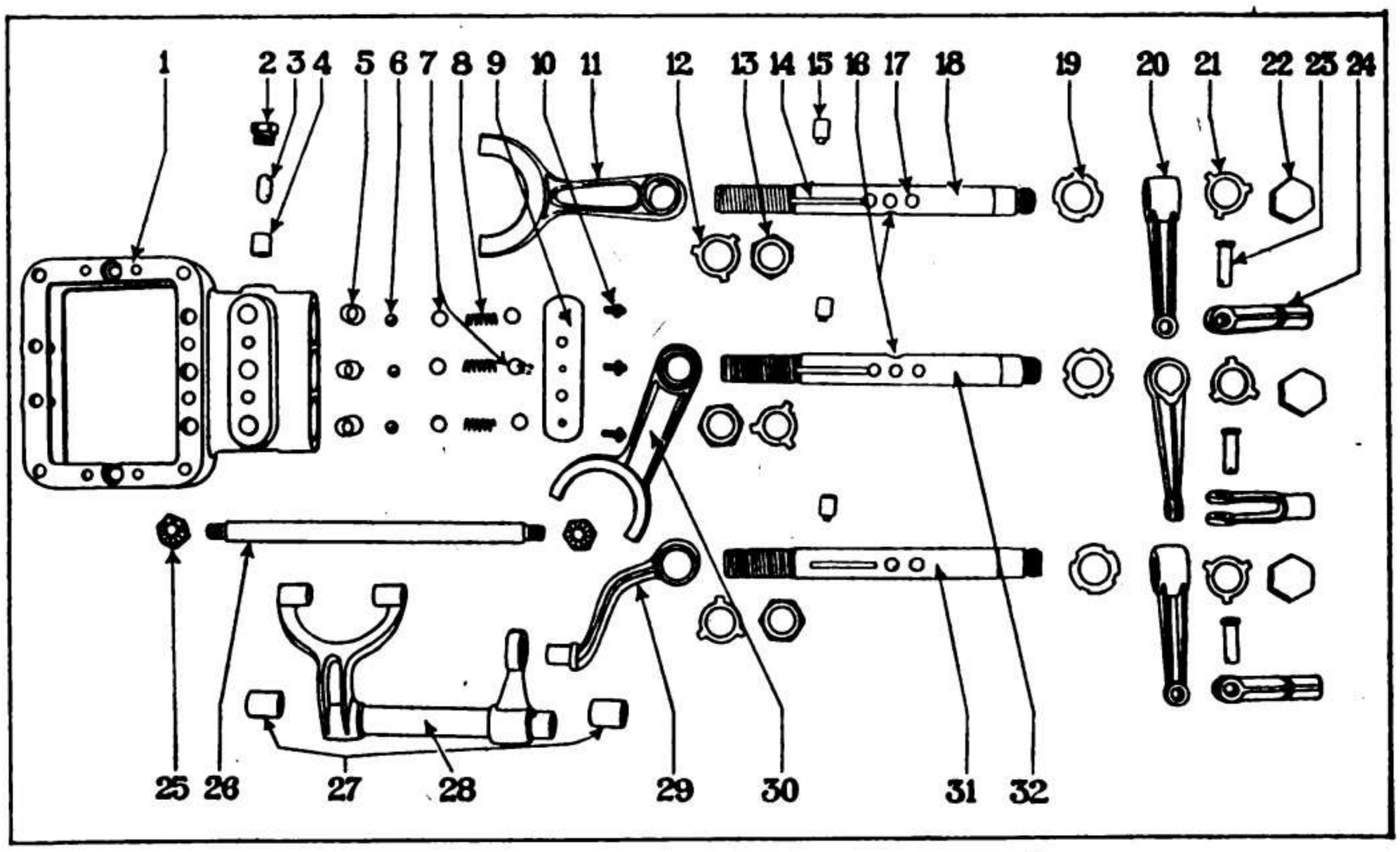
SHIFTER FORK ASSEMBLY.

Slight tension should be placed on the springs until accurate adjustment of the shifter forks is obtained. The adjustment of the shifter forks is best accomplished by removing the transmission case cover. Note illustration of transmission assembly, page 136. Reverse gear assembly (50) should be disposed at the farthest forward position.

In the illustration on page 113, the reverse shifter tube (31) should be turned in or out of shifter tube arm (29) until shifter lock ball (6) is accurately located in the first notch or depression nearest the key slot in the shifter tube.

Having ascertained that these two conditions exist, namely, that the gears are in the farthest forward position, and the lock ball is located in the first notch from the inner end of the tube, the tube should be so turned that the key slot is uppermost and directly under the hole into which shifter tube guide (15) is to be inserted. Shifter tube guide is a projecting portion of identical width with the slot in the tube. Care

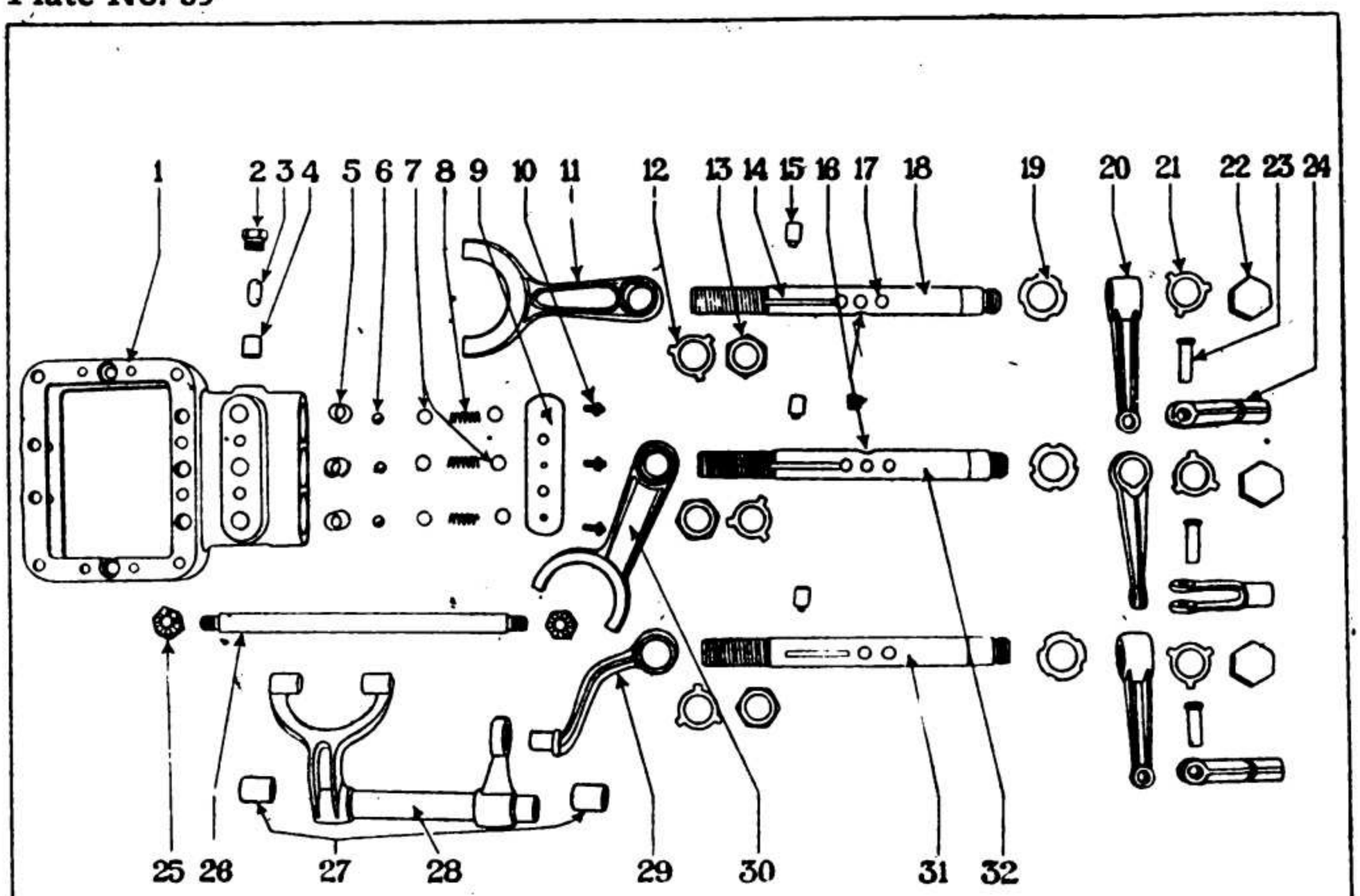
Plate No. 39



TRANSMISSION OF GEARSHIFTING MECHANISM DISMANTLED.

Ref. No.	Part No.	Name of Part.
1	32219-A	Transmission shifter case.
2	32260	Shifter interlock plug.
3	32259	Shifter interlock.
4	32281	Shifter interlock bushing.
5	32280	Shifter lock ball bushing.
6	BA-105	Shifter lock ball.
7	32247	Shifter lock spring follower.
8	32246	Shifter lock spring.
9	32248	Shifter lock retaining plate.
10	SC-3332	Shifter lock adjusting screw.
11	32257	First and second-speed shifting fork.
12	32255	Shifter nut lock washer.
13	NU-173	Shifter nut.
14		Shifter tube guide slot.
15	32256	Shifter tube guide.
16		Interlock plug notch.
17		Shifter lock ball notch.
18	35377	First and second-speed shifting tube.
19	32245	Shifter packing gland.
20	32253	Shifter tube lever.
21	32255	Shifter tube lock washer.
22	NU-508	Shifter tube lever nut.
23	KE-108	Clevis pin.
24	32378	Operating tube adjusting yoke.
25	NU-312	Reverse rocker shaft nut.
26	32241	Reverse rocker shaft.
27	32313	Reverse rocker shaft bushing.
28	32282	Reverse rocker shaft tube.
29	32252	Reverse speed shifting tube arm.
30	32258	Third and fourth-speed shifting fork.
31	35379	Reverse speed shifting tube.
32	35378	Third and fourth-speed shifting tube.

Plate No. 39



TRANSMISSION OF GEARSHIFTING MECHANISM DISMANTLED.

1	32219-A	Transmission shifter case.
2	32260	Shifter interlock plug.
3	32259	Shifter interlock.
4	32281	Shifter interlock bushing.
5	32280	Shifter lock ball bushing.
6	BA-105	Shifter lock ball.
7	32247	Shifter lock spring follower.
8	32246	Shifter lock spring.
9	32248	Shifter lock retaining plate.
10	SC-3332	Shifter lock adjusting screw.
11	32257	First and second-speed shifting fork.
12	32255	Shifter nut lock washer.
13	NU-173	Shifter nut.
14		Shifter tube guide slot.
15	32256	Shifter tube guide.
16		Interlock plug notch.
17		Shifter lock ball notch.
18	35377	First and second-speed shifting tube.
19	32245	Shifter packing gland.
20	32253	Shifter tube lever.
21	32255	Shifter tube lock washer.
22	NU-508	Shifter tube lever nut.
23	KE-108	Clevis pin.
24	32378	Operating tube adjusting yoke.
25	NU-312	Reverse rocker shaft nut.
26	32241	Reverse rocker shaft.
27	32313	Reverse rocker shaft bushing.
28	32282	Reverse rocker shaft tube.
29	32252	Reverse speed shifting tube arm.
30	32258	Third and fourth speed shifting fork.
31	35379	Reverse speed shifting tube.
32	35378	Third and fourth-speed shifting tube.

should be taken that the tube moves freely after the guide is inserted. The guide may be removed by the insertion of a small screw in the threaded hole on its upper end. Next the shifter box packing gland (19), together with packing, should be inserted, followed by the key and shifter tube lever (20), lockwasher (21), and nut (22). Shifter fork locknut (13) may now be firmly secured against shifter tube arm (29), care being taken to place a large wrench over the shifter tube lever (20) while making this adjustment, to prevent the possibility of breaking the projecting portion of shifter tube guide (15). The reverse gear shifting mechanism is now properly adjusted. See page 114.

Third and fourth speed gear (10) should next be placed at a point exactly equal distant from the engaging clutches of gears (7) and (11). See page 136. Then referring to the illustration on page 113, the shifter rod (32) should then be so turned in or out of shifter fork (30) that the shifter lock ball (6) is located in the central of the three notches or depressions. The insertion of shifter tube guide (15) can be followed by the placing of parts (19), (20), (21) and (22). Locknut (13) can then be promptly secured, as previously described, thus completing the adjustment of the third and fourth speed shifting device.

First and second speed gears (30) and (32), in the illustration on page 136, should next be disposed with their jaws equal distance from those of gears (29) and (34), respectively. Shifter tube (18) (page 113) so turned in or out of shifter fork (11) that lock ball (6) is located in the central of the three notches or depressions. The assembly of shifter tube guide (15) operates (19), (20), (21) and (22), together with the securing of locknut (13),.followed as on the previous tube. The entire shifting mechanism is now properly adjusted. Lock springs (8) may be given further attention and the adjusting screws (10) firmly locked.

Adjusting yokes (24), which are placed on the end of the operating rods, should be so tightened or loosened as to permit the easy insertion of clevis pins (23), assuming, however, that the shifter lever control mechanism has been properly adjusted.

GEAR SHIFTING FORKS.

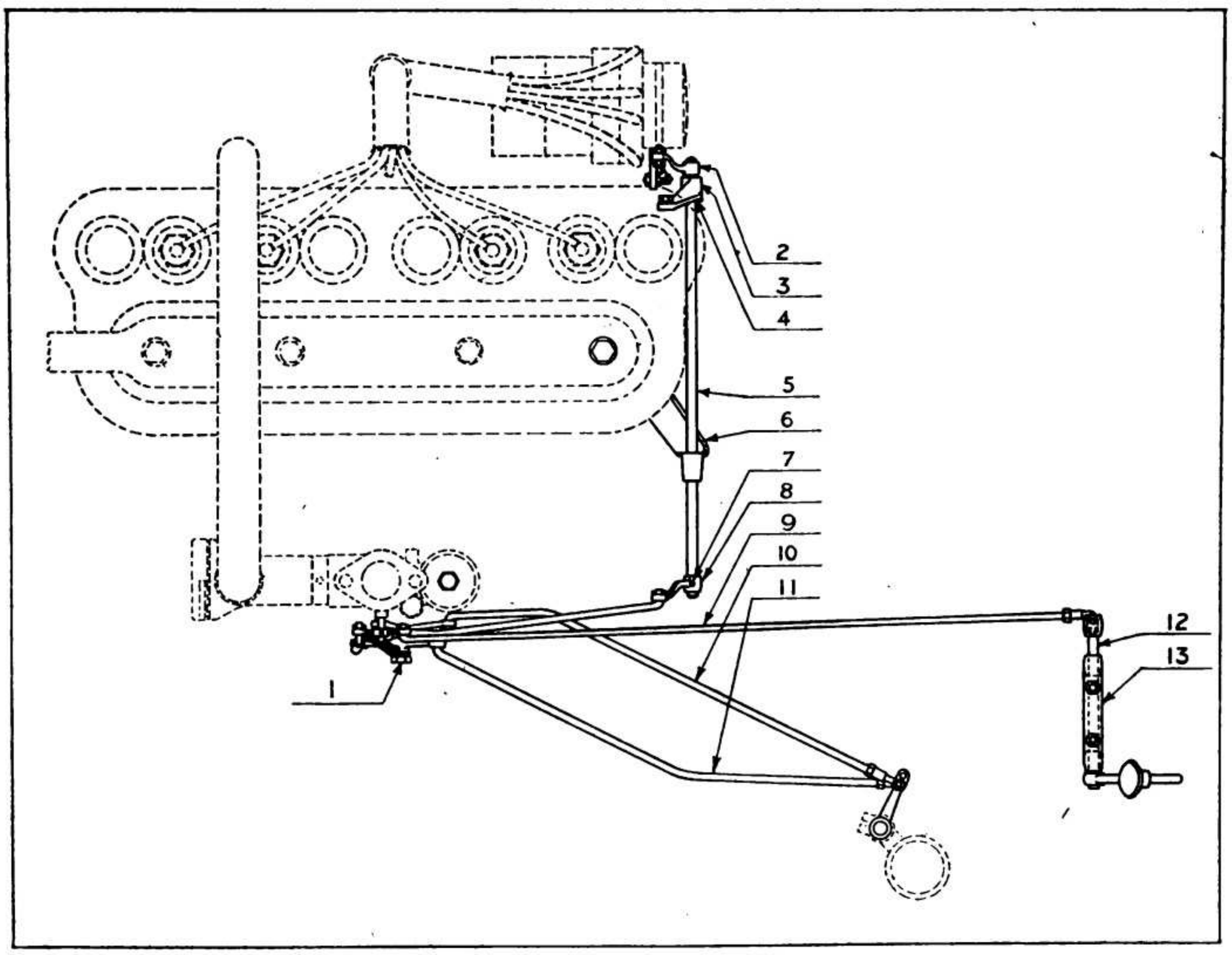
Directly in front of the transmission the gear shift rods connect with three tubes which enter the transmission case at the top. Inside the case these tubes are connected with three shifting forks, two of which are provided with two fingers each, while the third has but one. The fingers of one fork fit in slots at the side of the first and second speed gears. These gears are always held close together, although they rotate independently. Third and fourth gears are on the splineshaft and are further apart. The fork with but one finger connects with a rocker shaft tube in the bottom of the transmission case, and operates the reverse gear.

BRAKES.

HAND BRAKE.

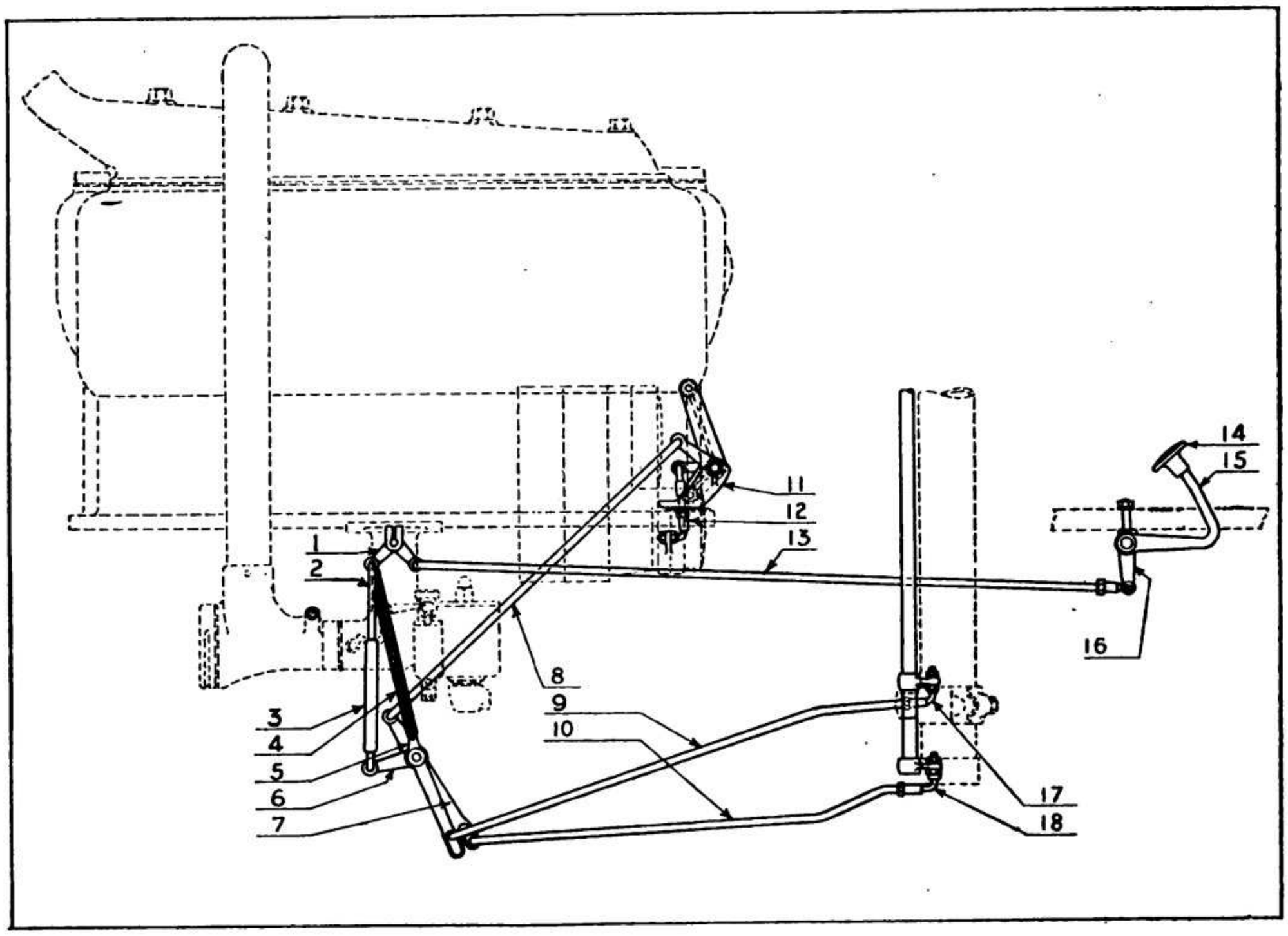
The right-hand lever in front of the driver's seat is the hand or emergency brake. It operates the four wheel brakes ordinarily applied by the foot pedal, and in addition actuates a brake on the propeller shaft immediately behind the transmission. See pages 142 and 148 for construction of this brake. Behind the handle of the lever is a latch which is released by pressure, so as to lift a ratchet and permit movement of the brake lever forward and backward within the limits of a quadrant at its base. In the forward or normal position the brake is released and in the position at the extreme rear end of the quadrant the brake is

Plate No. 40



SPARK AND THROTTLE CONTROL ASSEMBLY (TOP VIEW).

Ref. No.	Part No.	Name of Part.
1	32825	Spark and throttle control stud.
2	32795	Spark control shaft lever.
3	36081	Spark control bracket (right).
4	PI-403	Spark rod shaft cotter pin.
5	32794	Spark control shaft.
6	32793	Spark control bracket (left).
7	PI-301	Spark control shaft levers taper pin.
8	32795	Spark control shaft lever.
9	33556-A	Accelerator rod, complete.
10	33454-A	Spark rod.
11	33456-A	Throttle rod.
12	32835	Accelerator pedal shaft.
13	32836	Accelerator pedal shaft bracket.



SPARK AND THROTTLE CONTROL ASSEMBLY (SIDE VIEW).

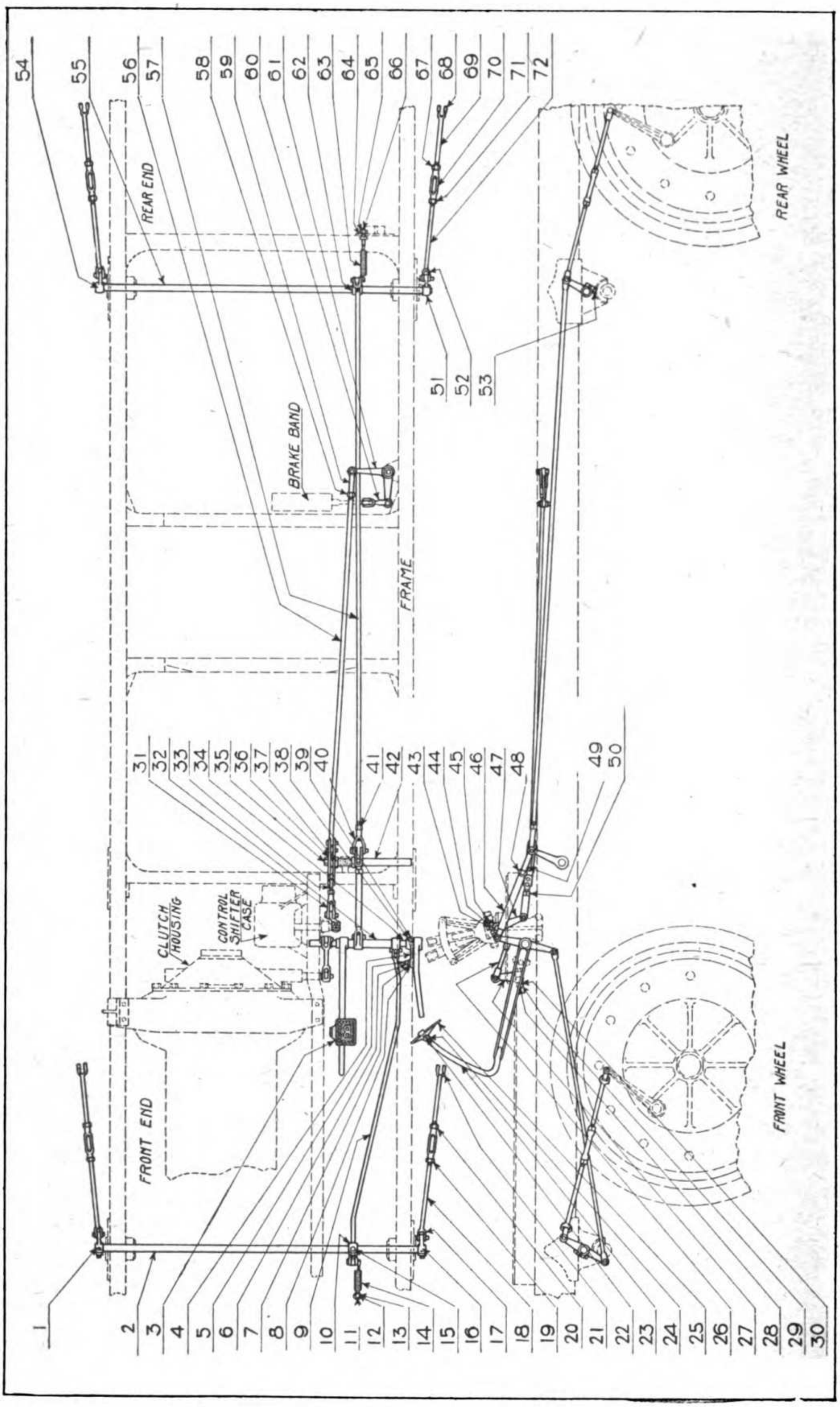
Ref. No.	Part No.	Name of Part.
1	32842	Throttle bell crank.
2	32828	Throttle rod.
3	31775-A	Throttle control tube.
4	33554	Carburetor spring.
5	32417	Carburetor spring plate.
6	32799	Throttle control bell crank.
7	32798	Spark control bell crank.
8	32830	Spark rod.
9	33456-A	Throttle rod.
10	33454-A	Spark rod.
11	32793	Spark control bracket (left).
12	32831-A	Spark control rod.
13	33556-A	Accelerator rod.
14	32989	Accelerator pedal pad.
15	32834	Accelerator pedal.
16	31372	Accelerator pedal shaft lever.
17	BJ-102	Throttle control rod ball joint.
18	BJ-102	Spark control rod ball joint.

applied. A rod connects the lever with the external contracting emergency brake behind the transmission. About the middle of this rod is a slot into which is fitted another rod connecting with the wheel brakes. The slot permits the latter rod to move freely when operated by the foot brake.

FOOT BRAKE PEDAL.

The foot brake pedal is at the right of the driver's seat and is designated by the letter "B." Two rods connect the pedal with rocker shafts

Plate No. 42



FOOT AND HAND BRAKE ROD ASSEMBLY.

FOOT AND HAND BRAKE ROD ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	31189	Brake cross shaft lever.
2	32198	Brake cross shaft.
3	32650	Brake pedal pad.
4	31674	Clutch pedal adjusting hub.
5	SC-3334	Clutch pedal adjusting hub bolt.
6	NU-112	Clutch pedal adjusting hub bolt nut.
7	WA-145	Clutch pedal adjusting hub bolt lock washer.
8	WA-1008	Clutch pedal hub bolt washer.
9	32602	Brake rod (front).
10	32197	Brake cross shaft lever (center).
11	32601	Brake pull back spring hook (front).
12	NU-128	Brake pull back spring hook nut (⅜"-24x9/16").
13	WA-146	Brake pull back spring hook lock washer.
14	32200	Brake pull back spring (front).
15	SC-3432	Brake cross shaft lever screw (⅜"-24x1¼").
16	31189	Brake cross shaft lever (outer).
17	32199	Brake rod clip.
18	32381	Brake rod end (right).
19	NU-1265	Brake rod end nut (right-hand).
20	NU-1266	Brake rod end nut (left-hand).
21	32199	Brake rod clip.
22	BO-601	Brake pedal pad bolt (⅜"-16x1⅜").
23	31265	Clutch pedal.
24	NU-303	Slotted hexagon nut (⅜"-16x11/16").
25	32651	Clutch pedal pad.
26	32580	Clutch pedal shaft and throwout shaft connecting rod.
27	32770	Clutch throwout shaft lever (outer).
28	SC-3435	Clutch throwout shaft lever bolt (⅜"-24x2").
29	NU-128	Transmission brake drum to hub bolt nut (⅜"-24x9/16").
30	WA-146	Transmission brake drum to hub bolt nut lock washer (⅜").
31	32390	Hand-brake and rocker shaft connecting rod yoke.
32	32542-A	Brake pedal and tube, complete.
33	32389	Hand-brake and rocker shaft connecting rod.
34	31263-A	Clutch pedal shaft, complete.
35	NU-149	Brake rocker shaft nut (½"-20x¾").
36	32391	Hand-brake and rocker shaft connecting link.
37	32716	Brake rocker shaft lever.
38	NU-128	Brake pull back spring hook nut (⅜"-24x9/16").
39	SC-3434	Hand-brake shaft lever bolt (⅜"-24x1¾").
40	32411	Brake rod adjusting yoke.
41	NU-135	Brake rod nut (7/16"-20x⅝").
42	32167-A	Brake rocker shaft, complete.
43	WA-146	Brake pull back spring hook lock washer (⅜").
44	NU-128	Brake rocker shaft bracket bolt nut (⅜"-24x9/16").
45	SC-3435	Clutch throwout shaft lever bolt (⅜"-24x2").
46	36324-A	Brake rod—interconnecting, complete.
47	32664	Hand-brake shaft lever.
48	NU-135	Hand-brake and rocker shaft connecting rod nut (7/16"-20x⅝").
49	32390	Hand-brake and rocker shaft connecting rod yoke.
50	NU-135	Hexagon nut (7/16"-20x⅝").
51	31189	Brake cross shaft lever (outer).
52	32199	Brake rod clip.
53	SC-3432	Brake cross shaft lever screw (⅜"-24x1¼").
54	31189	Brake cross shaft lever (outer).
55	32198	Brake cross shaft (front or rear).
56	32412	Brake rod rocker shaft to transmission.
57	32409	Brake rod (rear).
58	NU-135	Hand-brake and rocker shaft connecting rod nut (7/16"-20x⅝").
59	32390	Brake rod adjusting yoke.
60	35164	Transmission brake bell crank link.
61	32706	Transmission brake bell crank.
62	32197	Brake cross shaft lever (center).
63	32201	Brake pull back spring (rear).
64	WA-146	Brake pull back spring hook lock washer (⅜").
65	NU-128	Brake pull back spring hook nut (⅜"-24x9/16").
66	32601	Brake pull back spring hook (rear).
67	NU-1266	Brake rod end nut (left hand).
68	32199	Brake rod clip.
69	32382	Brake rod end (left).
70	32383	Brake rod turnbuckle.
71	NU-1265	Brake rod end nut (right-hand).
72	32381	Brake rod end (right).

mounted in the front spring hangers of both front and rear springs. From the rocker shaft other rods effect a connection with the brake bands on each of the four wheels. When the brake pedal is depressed, the bands are expanded so that they are forced against the inside of the drums on the wheels. It will be seen from this that the foot brakes are internal expanding. Turnbuckles on all brake rods afford a ready means of adjustment.

BRAKE BANDS.

The brake bands on the four wheels are 2.5 inches wide and their lining 48 inches long. Raybestos lining is used, and it is fastened to the band by 28 rivets. The emergency brake lining is also 2.5 inches in width and is 26.5 inches long. It is fastened by 16 rivets.

Should the brake band lining become considerably worn, due to service, or become saturated with grease or other foreign substances which impair its usefulness, it will be necessary to replace it. This can best be done by removing the entire brake band assembly, punching out the rivets and applying new lining of proper thickness. The rivet ends should be deeply imbedded in the brake lining to prevent scoring of the brake drum. It will no doubt be necessary to lengthen brake rods to insure proper clearance between brake drum and band after relining.

CLUTCH PEDAL.

The clutch pedal is at the left of the driver's seat and is designated by the letter "C." Like the brake pedal, it is mounted on a shaft which runs from the engine side girder to the left side member of the frame at the clutch housing at the rear of the engine. Downward pressure on the pedal disengages the clutch. The clutch mechanism is so designed that a slight release of pressure on the clutch pedal permits an even application of engine power to the driving mechanism resulting in an absence of jerking.

ACCELERATOR.

Directly behind the brake pedal and close to the seat body is a small round pedal, which is operated by the driver's heel. This is the accelerator. It is connected by linkage with the throttle at the carburetor. The hand control is independent of the accelerator, except that opening the throttle control lever sets a limit on the closing of throttle valve by the foot.

HAND CONTROLS OF SPARK AND THROTTLE.

Just beneath the steering wheel is a quadrant with two brass levers. The upper, short one is the spark control, and the lower, longer one is the throttle. Both are marked so as to be readily identified. The rods by which these controls are connected with the magneto and carburetor are not enclosed in the steering post, but run alongside it through the truck floor. The throttle lever is connected directly with the carburetor by means of a short rod. Halfway up the steering post is a nickel-plated lever, the "choke," which may be raised or lowered. When raised it excludes air from the carburetor, and when lowered into the normal position it admits air.

STARTING CRANK.

The starting crank is made of .875 inch diameter hot rolled stock and is mounted above the frame in front. There is a swivel attachment so that after the engine has been cranked the starting crank may be turned around to rest on top of the frame channel instead of hanging down in the cranking position. When turned so as to rest on top of the frame a steel spring clip holds it in place.

STEERING SYSTEM.

GENERAL CONSTRUCTION.

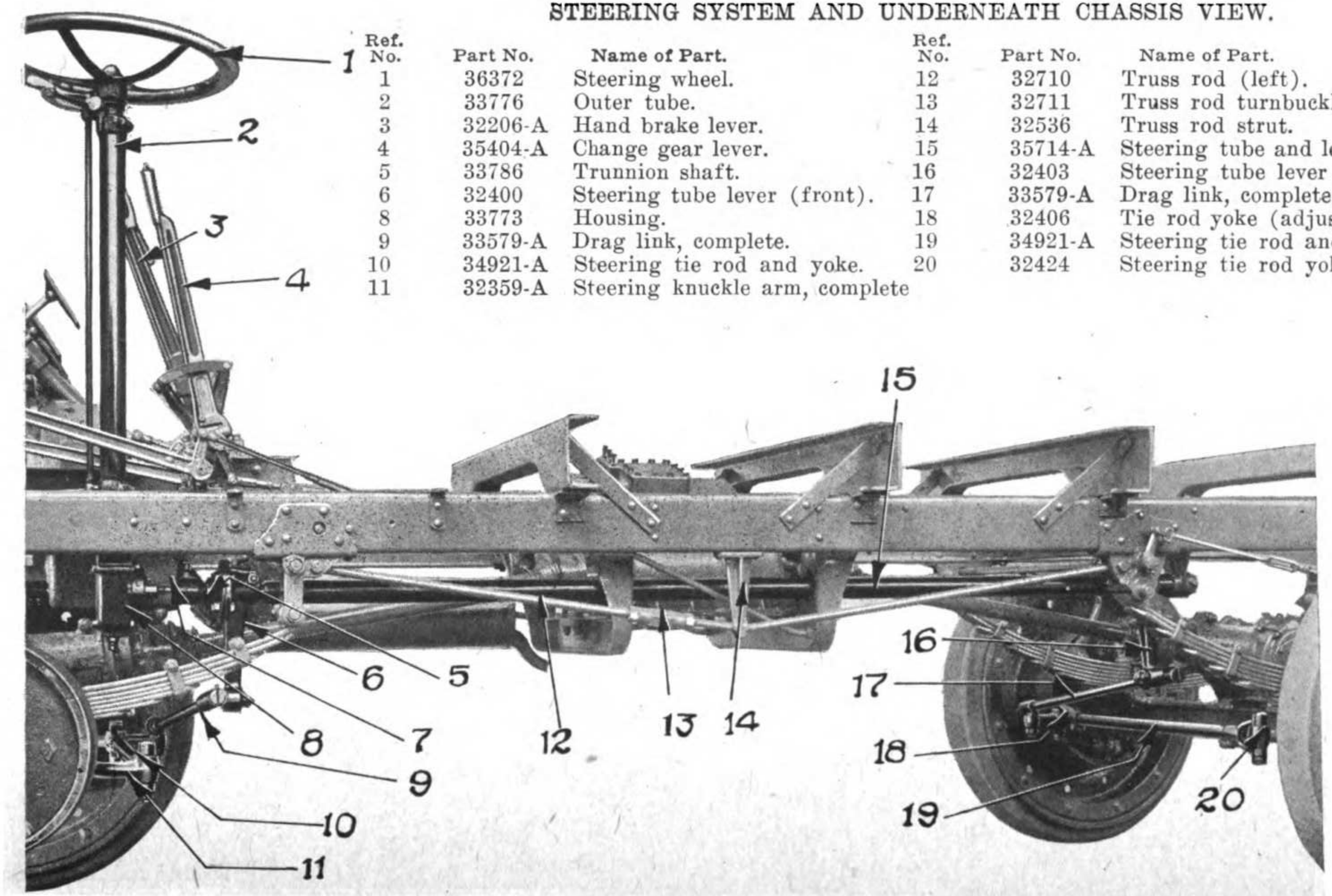
The steering column is vertical to allow a longitudinal steering tube to lead to the rear axle. The main steering arms for both the front and rear axles are connected to this longitudinal tube. Drag links connect these arms to the steering knuckle arms on the right side of the truck on both front and rear axles. The two knuckle arms on each axle are connected by a tie rod.

The tie rod and drag link for the front axle are behind and above the bottom of the axle and the tie rod and drag link for the rear axle are in front and above the bottom of the axle. The axles thus afford a very good protection to the lower steering mechanism. From this it is obvious that because the lower steering mechanism behind the front axle and that in front of the rear axle are both connected to the main steering gear through the longitudinal steering tube, the wheels must turn in the same radius.

The tie rods, tie rod bolts, drag links and drag link connections of the front steering mechanism are interchangeable with those on the rear. The working parts are all made of alloy steel heat treated. The tie rod bolts are hollow, acting as oil reservoirs to take care of the lubrication. The steering knuckle arms on to which these bolts fasten the tie rod are brass bushed, so that any wear may be taken up in the bushing, thus protecting from wear the tie rod and steering arm.

STEERING SYSTEM AND UNDERNEATH CHASSIS VIEW.

Ref. No.	Part No.	Name of Part.	Ref. No.	Part No.	Name of Part.
1	36372	Steering wheel.	12	32710	Truss rod (left).
2	33776	Outer tube.	13	32711	Truss rod turnbuckle.
3	32206-A	Hand brake lever.	14	32536	Truss rod strut.
4	35404-A	Change gear lever.	15	35714-A	Steering tube and lever.
5	33786	Trunnion shaft.	16	32403	Steering tube lever (rear).
6	32400	Steering tube lever (front).	17	33579-A	Drag link, complete.
8	33773	Housing.	18	32406	Tie rod yoke (adjustable).
9	33579-A	Drag link, complete.	19	34921-A	Steering tie rod and yoke.
10	34921-A	Steering tie rod and yoke.	20	32424	Steering tie rod yoke pin.
11	32359-A	Steering knuckle arm, complete			



DETAIL ACTION OF STEERING MECHANISM.

The steering gear used is of Lavine make, and of the screw and split nut type. When the steering wheel is turned the screw shaft inside the steering tube or column turns, causing one side of the split nut at the bottom to move upward and the other half to move downward. This is made possible by right threading the inside of one-half of the nut and left threading the inside of the other half. Near the lower end of each half nut is a slot or wide groove to take the forked end of a trunnion shaft which connects with the longitudinal steering tube. This trunnion shaft is at right angles to the steering gear case. When one-half of the nut moves up and the other half moves down, the fork end of the trunnion shaft revolves and this movement is transmitted to the longitudinal steering tube to which the steering arms are attached. These steering arms are secured to the steering tube about the center of which they move. Movement of the steering arms is transmitted to so-called drag links, one attached to each arm by means of a ball joint. These drag links extend across the chassis at a slight angle to the rear axle and connect by means of ball joint with the right steering knuckle arms. By means of the yoked tie rods the opposite steering knuckle arms are connected.

TRUNNION SHAFT.

This shaft is made of steel and is supported in a forged hanger. It connects the steering gear with the longitudinal tube. The rear end of the trunnion shaft is splined to receive the splined end of the steering tube. The trunnion shaft is suitably supported on non-adjustable bronze bearings.

STEERING TUBE.

This tube extends from the trunnion shaft back to a rear support slightly forward of and above the rear axle in the form of a malleable iron bracket. The tube is made of steel and has the front steering arm clamped to it and the rear arm pinned.

STEERING ARMS.

These are forgings fitted at the bottom end with a ball which fits into a socket at the end of each drag link. This forms the conventional type of ball steering joint in which the socket is made up of two blocks spring backed and locked in place. Leather boots cover these grease-packed ball joints.

DRAG LINKS.

The two drag links have ball joints at each end, the joints on the left taking the ball of the tube or main steering arms. The joints on the right take the ball on the right steering knuckle arms.

TIE RODS.

The tie rod connects the steering knuckle arms of an axle, so that movement of both knuckles takes place simultaneously and at the same angle. The tie rod is yoked at either end, one of the yokes being adjustable by movement along the threaded portion of the tie rod. The yokes are attached by means of a pin to the steering knuckle arms. The adjustment may be necessary to take up play or to effect front wheel alignment.

STEERING KNUCKLE ARMS.

There are four steering knuckle arms forged of steel. Those on the right side of truck are provided with a ball stud, in addition to the hole for tie rod yoke attachment. These arms are not interchangeable.

TO ADJUST TIE ROD.

To make adjustment, loosen locknut for adjustable ball socket (on left side), remove socket plug on stationary (right side), and detach the drag link from the knuckle arm, then turn the rod in or out, as required, to make wheels track and replace all parts properly. Care must be taken not to set the ball socket adjusting plugs up too tight, as this will cause the truck to steer hard. The adjusting plugs are held in place by cotter pins, which fit into the slotted head of the plug.

TO REMOVE END PLAY IN POST.

If through wear and tear end play in the steering post has been caused, the same can be taken up by loosening the steering gearshaft locknut (No. 40, shown on page 126) and turn the steering gearshaft adjusting screw (41) up far enough to take out the play and then lock it again.

STEERING SYSTEM ADJUSTMENT.

The steering system is adjusted, after steering radius adjustments have been made and tie rods and drag links set to give the proper toe and alignment of wheels. First turn steering wheel as far as it will go to right and turning back about 1.25 turns, then attach main steering arm to splined end of trunnion shaft so that arm is in center between spring and drive shaft. This is done so that in turning the main steering arm will hit spring or drive shaft before split nuts are forced down and through housing.

The steering tie rod bolts should not be tightened too much, as yoke will be clamped to knuckle. This makes steering hard and causes unnecessary wear of parts.

STEERING PARTS WHICH WEAR MOST.

The parts of the steering system most subject to wear are the worm and trunnion blocks, steering arm bushings and knuckle pin.

REMOVING STEERING SHAFT PLAY.

End play on the steering shaft is taken up by means of an adjusting screw and locknut at the bottom of the split nut housing.

STEERING SYSTEM LUBRICATION.

The steering shaft assembly is lubricated by forcing medium weight cup grease through pipe plug into split nut housing about once a month; also by applying oil through oiler tube at top of steering post.

The trunnion shaft is lubricated by means of a grease cup on top of housing sleeve.

The top end of steering shaft is lubricated through oil hole. It is important to keep same well lubricated.

TO INSTALL NEW STEERING COLUMN.

In installing a new steering column, first disconnect air vent tube, gas and spark connections, remove plate fastened to floor boards, remove floor boards, disconnect trunnion shaft from pitman arm, unbolt from bracket, remove and replace, making necessary adjustments so that pitman arm will be proper distance from spring.

DIFFICULT STEERING.

The steering may be difficult because of wheel out of alignment, wheel bearings too tight or broken, steering knuckle arms badly bent, tie rod bent, drag link bent, dead head bent, hard-working gear at bottom of steering column, lack of lubrication, or depressions in knuckle pin roller bearing cup, due to lack of lubricant and improper adjustment.

STEERING SYSTEM FAILURE.

If steering wheel fails to steer truck, first see if splined end of trunnion shaft is O. K. Shearing is possible here if not kept tightly clamped to shaft, then examine drag links.

TIGHT STEERING SYSTEM.

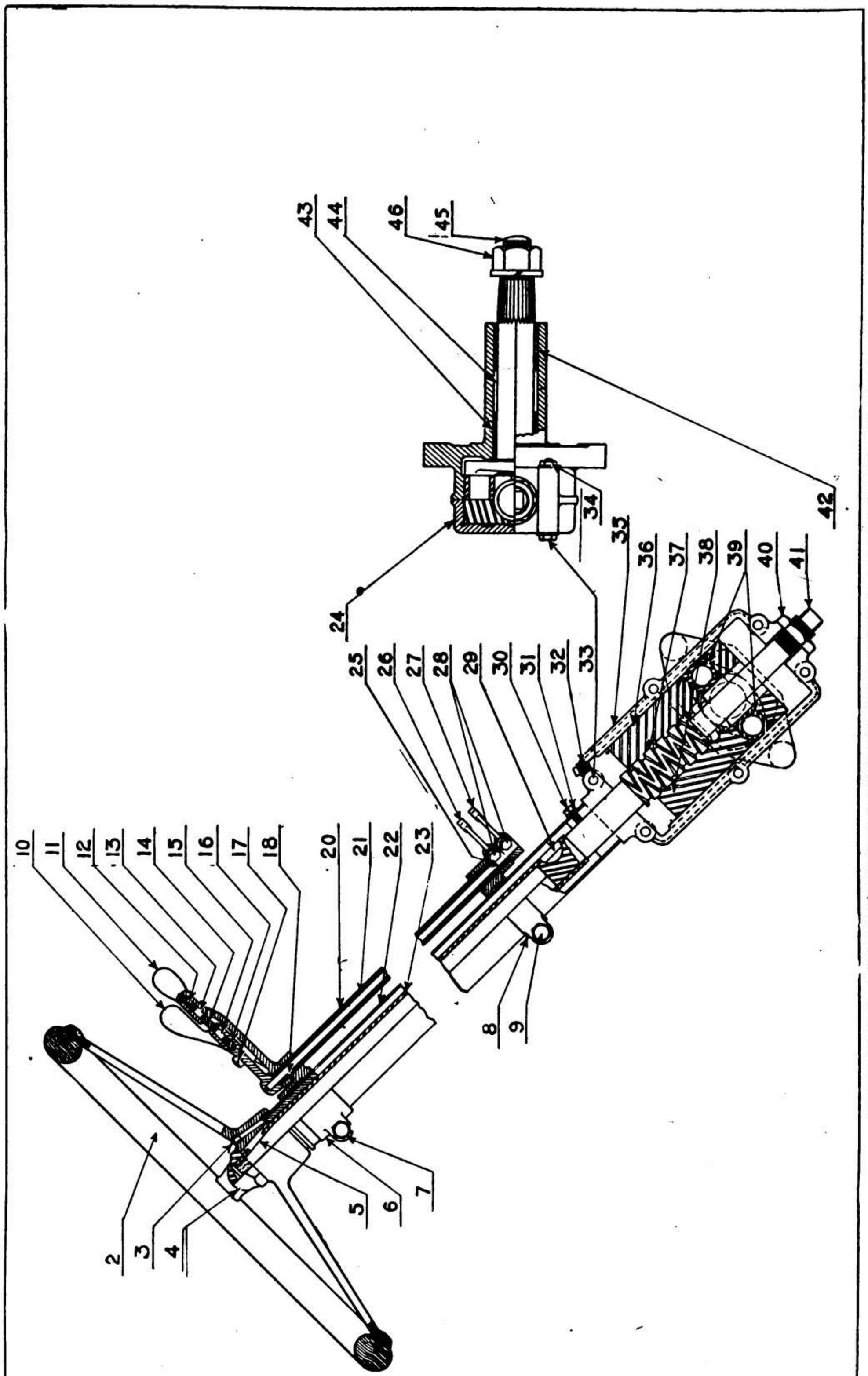
If truck steers hard, first check up adjustment of top of steering column, then look over steering knuckle pins, then to the rods and drag link to see if they are too tight.

It is dangerous to hit a curb with front or rear wheels, as it might cause damage to steering spindle or arms, bend tie rods or other steering connections.

ALTERING TURNING RADIUS.

If the 50-foot turning circle is not small enough, the set screw which limits the turn of wheels on each of the knuckle plates may be turned in, but in no case should they be turned so close that truck will turn in less than 48 feet. If truck is in such a position that in steering away from an object or edge of a road, the rear wheels may have a tendency to run too close to the object, the end of the drag link should be discon-

Plate No. 44



STEERING ASSEMBLY INCLUDING COLUMN AND TRUNNION SHAFT.

STEERING ASSEMBLY INCLUDING COLUMN AND TRUNNION SHAFT.

Ref. No.	Part No.	Name of Part.
2	36372	Steering wheel.
3	OI-122	Oiler.
4	33789	Wheel nut.
5	KE-222	Wheel key.
6	32770	Control rod bracket (upper).
7	SC-3404	Control rod bracket clamp screw.
8	33771	Control rod bracket (lower).
9	SC-3404	Control rod bracet clamp screw.
10	33779	Spark control lever (upper).
11	33784	Throttle control lever (upper).
12	33781	Throttle control lever plunger spring.
13	33780	Throttle control lever plunger.
14	33777	Sector.
15	33780	Spark control lever plunger.
16	33781	Spark control lever plunger spring.
17	SC-321	Sector screw.
18	36841-A	Spark control lever & rool assembly.
20	33785	Oil tube.
21	33782	Spark control rod.
22	33776	Outer tube.
23	33790	Worm & tube.
24	33775	Housing cover.
25		Throttle tube bushing (lower).
26	33783	Throttle control lever (lower).
27	33778	Spark control lever (lower).
28	SC-3302	Spark and throttle lever clamp screw.
29		Worm tube key.
30	SC-601	Outer tube to housing screw.
31	WA-144	Outer tube to housing screw lock washer.
32	PL-103	Housing cover grease plug.
33	SC-226	Housing cover bolt.
34	NU-118	Housing cover bolt nut.
35	33773	Housing.
36	33791	Worm nut (R. H.).
37	33790	Worm & tube.
38	33792	Worm nut (L. H.).
39	33787	Trunnion shaft blocks.
40	33769	Adjusting screw nut.
41	33768	Adjusting screw.
42-43	33774	Housing bushing.
44	33786	Trunnion shaft.
45	PI-413	Trunnion shaft nut—cotter.
46	NU-515	Trunnion shaft nut—castle.

nected and the set screws turned out to the point where they will bear on the stops on the axles, keeping rear wheels parallel with frame and using front steer only. Immediately on clearing the object the rear steer should be hooked up and proper adjustment of set screws made again.

STEERING WITH TWO WHEELS ONLY.

Should it become necessary at any time to steer either on the front or rear wheels only, it is possible to do so. By disconnecting the lower steering mechanism from the longitudinal steering tube, that steering unit which is to remain stationary may be easily locked by set screws.

CHAPTER IV

CLUTCH.

FUNCTION, CONSTRUCTION, OPERATION AND CARE.

The clutch is a device which serves to connect and disconnect the engine from the power transmitting mechanism. It clutches or presses against the flywheel when engaged and when disengaged (released) by means of a pedal, it is drawn away, allowing the engine to revolve freely, doing no work to drive the truck. The clutch is necessary in order to remove the driving force of the engine when gear changes are made. The clutch is located in the flywheel and is suitably housed by a cast iron case, which is bolted to the flywheel housing.

CONSTRUCTION (REFER TO ILLUSTRATION, PAGE 130).

The clutch is of the dry plate type and consists of a malleable iron driving disc engageable with two driven fiber rings, the disc being between the two rings.

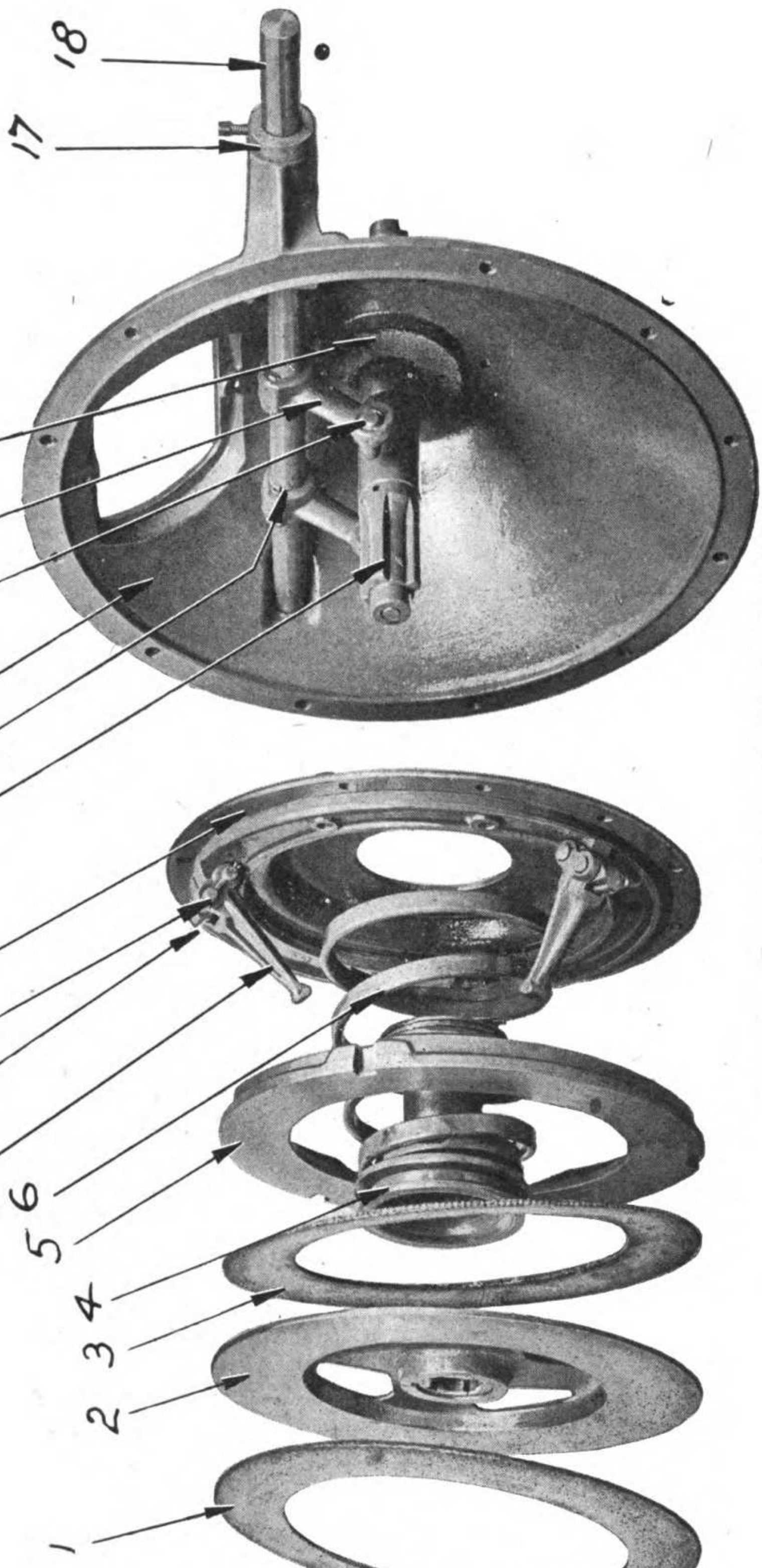
The iron disc or driving member is mounted on the spline end of the clutch shaft. When the clutch is engaged, all of it revolves as a unit, providing the engine is running.

The rear fiber ring is next to the clutch adjusting ring, which is connected by three levers to the clutch operating collar. Resting against this collar is a heavy conical spring, which supplies the pressure to keep the rings and the disc engaged. The rear end of the spring is supported by a heavy steel disc known as the clutch cover, which bolts to the rear rim of the flywheel.

Supported by the center of the shaft there is the clutch throw out sleeve, which has a ball bearing mounted on either end. The forward bearing presses against the clutch lever operating collar; the rear bearing against a ring secured on the threaded portion of the clutch throw out sleeve. This ring in turn connects with the clutch pedal, which operates the clutch. The back end of the ring further acts as a clutch brake, operating by revolving against a lining riveted to the inside face of the clutch housing hub. The brake prevents clutch spinning on disengagement.

CLUTCH DRIVE PLATE.

The drive plate is of malleable iron 11.875 inches outside diameter, .156 inch thick, and is bored 1.875 inch. It has two key seats which permit of it being keyed to a steel bushing called the drive plate center.



CLUTCH AND CLUTCH HOUSING ASSEMBLY.

Plate No. 45

CLUTCH AND CLUTCH HOUSING ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	33077	Clutch flywheel.
2	32999	Clutch drive plate.
3	33077	Clutch flywheel.
4	33078	Clutch lever operating collar.
5	32996	Clutch adjusting ring.
6	31305	Clutch spring.
7	33121	Clutch lever.
8	31647	Clutch lever thrust block.
9	31648	Clutch lever thrust block pin.
10	32998	Clutch cover.
11	32550	Clutch shaft.
12	KE-111	Clutch throwout shaft lever key.
13	32476	Clutch housing.
14	32470	Clutch throwout shaft lever pin.
15	32572-A	Clutch throwout shaft lever (right).
16	32471	Clutch brake lining.
17	34032	Clutch throwout shaft collar.
18	32579	Clutch throwout shaft.

The outside of this center is grooved to fit in the key seats notched in the drive plate. The inside of the drive center is key seated in four places to fit on the splined end of the clutch shaft.

CLUTCH SHAFT.

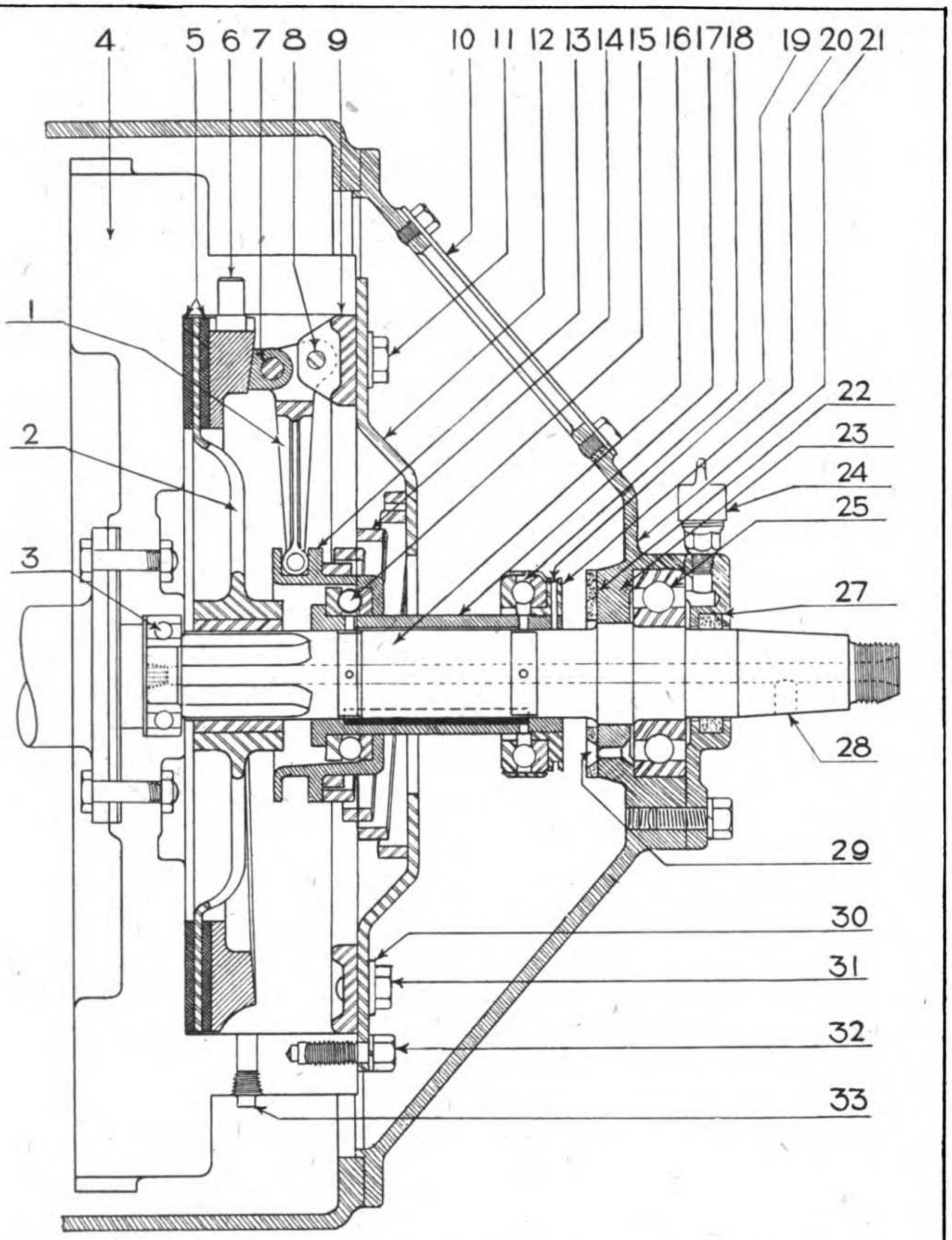
The shaft is of steel and is 12.375 inches long. The clutch shaft is the driving shaft of the clutch, connecting at its rear end through two universal joints with the transmission. Its front end is splined for a distance of 1.75 inch.

The entire center of the shaft is drilled out to a diameter of .312 inch for the distribution of grease. This grease, which lubricates the shaft, seeps through two holes, each .187 inch in diameter and 2.812 inches apart, drilled in the shaft 3.312 inches from its front end. It is on this end of the shaft that the drive plate is placed.

The front end is turned down to enter the bearing carried in the hub of the flywheel.

The rear end of the shaft is threaded and connected through a universal joint and propeller shaft with the transmission. The hole drilled through the entire center of the shaft is plugged at this end to prevent leakage of the grease. The end is also tapered for 1.875 inch, and the tapered portion is key seated .375 inch wide by .187 inch deep to receive the key holding the universal joint in place. A key .25 inch wide, 3.312 inches from the end of the shaft, keys the clutch throw-out sleeve to the shaft, preventing rotation of the sleeve on the shaft, but permitting free movement lengthwise.

Plate No. 46



SIDE SECTIONAL VIEW OF CLUTCH.

FIBER RINGS.

There are two fibre rings, one next to the flywheel, the other against the clutch adjusting ring. They are .11.875 inches outside diameter, 8.375 inches inside diameter, and .125 inch thick.

CLUTCH ADJUSTING RING.

One face of the clutch adjusting ring rests against the fiber ring; the other face, which constitutes three incline planes, rests against the three cast iron clutch lever thrust blocks.

SIDE SECTIONAL VIEW OF CLUTCH.

Ref. No.	Part No.	Name of Part.
1	33121	Lever.
2	32999	Drive plate.
3	31843	Clutch shaft and flywheel bearing.
4	34561-A	Flywheel.
5	33077	Facing.
6	33029	Flywheel and clutch pin.
7	31648	Clutch lever roller pin.
8	31648	Clutch lever pin.
9	32997	Clutch adjusting ring.
10	30370	Hand hole cover.
11	SC-237	Clutch lever supporting ring clamp screw.
12	32998	Clutch cover.
13	33078	Clutch lever operating collar.
14	31305	Clutch spring.
15	33079-A	Lever operating collar bearing.
16	32550	Clutch shaft.
17	33115	Clutch throwout sleeve.
18	33119	Throwout sleeve thrust bearing.
19	33117	Brake flange lock ring.
20	33116	Brake flange.
21	32476	Clutch housing.
22	32471	Clutch brake lining.
23	32476	Clutch housing.
24	CU-209	Rear bearing grease cup.
25	32261	Rear bearing.
27	WA-413	Clutch shaft felt washer.
28		Oil hole for clutch shaft and bearings.
29	R-1306	Clutch brake lining rivet.
30	31644	Lever support screw washer.
31	SC-237	Lever support screw.
32	SC-3402	Clutch cover screw.
33	PL-102	Clutch drain plug.

This ring, by pressing against the fiber ring, engages the clutch.

It is of cast iron, 11.875 inches outside diameter and 8.375 inches inside diameter.

The outside rim of the clutch adjusting ring is notched in three places, .500 inch by .3125 inch to receive keys, which hold it in place inside of the flywheel rim.

THRUST LEVER CLUTCH BLOCK.

The thrust lever clutch blocks, of which there are three, rest against the rear face of the clutch adjusting ring. The three clutch levers are attached to them by .375 inch pins. These levers are 3.75 inches long, and have two .375 inch holes drilled .75 inch apart to allow the attachment of the lever to the clutch lever thrust block, and to the clutch supporting ring. The bottom ends of the levers are rounded to fit in the groove cut in the lever operating collar. These levers serve to actuate the clutch lever thrust blocks in the clutch lever adjusting ring.

CLUTCH SUPPORTING RING.

The rear upper ends of the levers just mentioned are attached to the clutch supporting ring by means of lugs cast on the ring. The ring is

bolted to the clutch cover by .437 inch bolts. This ring is of malleable iron 11.984 inches outside diameter, 9 inches inside diameter, and .468 inch thick.

CLUTCH LEVER OPERATING COLLAR.

The lower or rounded end of the clutch levers slip into a groove in the clutch operating collar, which collar is supported by a ball bearing on the clutch throw out sleeve, and serves to operate the levers and so the clutch.

It is made of malleable iron, cup shape with a groove .468 inch wide cut around its entire circumference at its forward end. The collar is 4.25 inches in diameter at its grooved end and 3.06 inches bore.

CLUTCH SPRING.

The forward end of the clutch spring rests against the shoulder of the clutch operating collar, and its rear end is supported by the clutch cover. The pressure of the spring keeps the clutch in engagement.

The spring is conical in shape, 7.25 inches long when free, has an outside diameter at its rear end of 6.50 inches, and an inside diameter at its forward end of 3.625 inches.

CLUTCH COVER.

The clutch cover bolts to the flywheel and to the clutch supporting ring. It is made of steel .187 inch thick, an outside diameter of 13.375 inches, with its center bored out 4 inches.

Two slotted holes 10.5 inches from center to center are cut through the face of the clutch cover. They are .5 inch wide by 4 inches long. The bolts which attach the clutch supporting ring to the cover pass through these slots.

The means of adjusting the friction power of the clutch is provided by these bolts. By moving them in either direction the clutch supporting ring is rotated, which in turn moves the clutch levers and thrust blocks on the incline planes of the clutch adjusting ring, and so either relieves or increases, as the case may be, the pressure of the clutch spring.

CLUTCH THROW-OUT SLEEVE.

The clutch throw out sleeve is keyed to the center portion of the clutch shaft in such a manner as to allow longitudinal motion on the shaft. Its rear end is threaded to receive a nut, which holds in place a ball thrust bearing, against which the clutch throw out shaft lever bears.

When this lever is operated to throw out the clutch, it slides the sleeve backwards, compressing the clutch spring and so disengages the clutch.

The sleeve is 4.0625 inches long, is made of malleable iron, and has a 1.5 inch inside diameter.

HOW TO REMOVE CLUTCH.

First remove hand hole cover. It will then be necessary to loosen the clutch by disengaging and then "lock out" the spring by placing a space block between the cover and throwout bearing.

Next remove screws which hold clutch cover to flywheel.

It will then be necessary to disconnect the front universal of the propeller shaft. Then remove cap screws holding the clutch housing to the engine. When these are taken out the clutch throw-out sleeve can be removed by taking out the clamp bolts in the clutch throw-out yoke. The clutch can now be removed.

The clutch pilot bearing (the one nearest the engine) is not provided with any method of lubrication, except that it is packed with grease when installed. It only comes into use when clutch is disengaged.

The clutch shaft should be set in direct line with the crankshaft, the two shafts having space enough between to make it impossible for them to come in contact.

TO ADJUST CLUTCH.

To adjust clutch open plate in housing, disengage clutch, loosen two adjusting cap screws in slots, and turn adjusting plate clockwise to tighten, and counter clockwise to loosen, about a half inch at a time is usually sufficient; tighten adjusting cap screws and replace plate in housing. Further adjustment is obtained after slot adjustment is used up by moving cap screws to next holes. There are three in each slot.

TO CLEAN CLUTCH.

To clean clutch, squirt kerosene from oil gun through hand hole cover over plates with clutch disengaged. Turn engine over by hand and let clutch in and out to cleanse thoroughly. Drain through plug hole in flywheel drum and flush out with kerosene. Use kerosene rather than gasoline, as it does not cut lubricant on pilot bearing or injure surface of Raybestos plates.

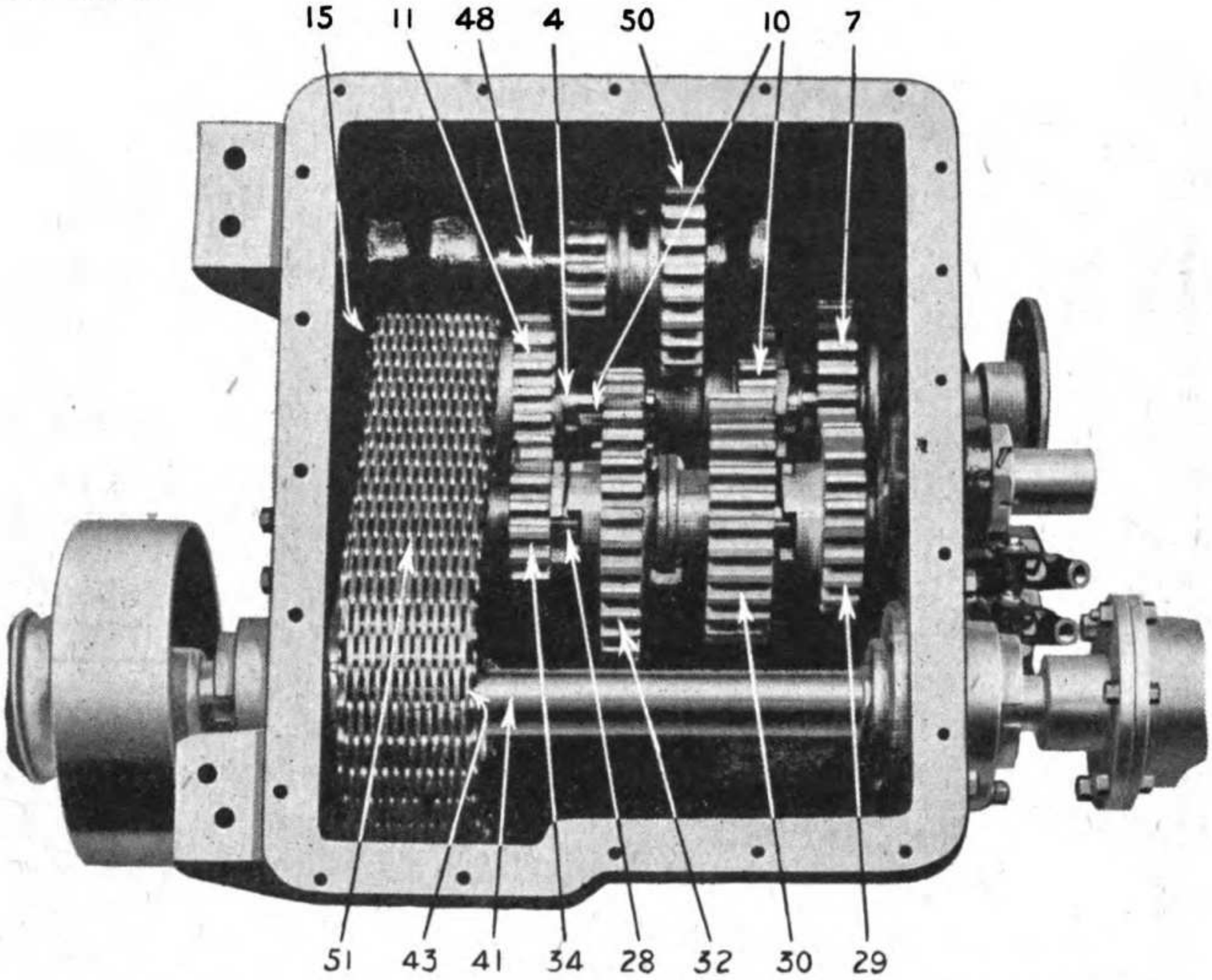
CLUTCH SLIPPING.

The clutch usually slips because of gum or oil on the friction surfaces, but slipping also may be caused by worn bearings, insufficient spring pressure, worn discs, clutch out of alignment with flywheel, improper adjustment.

CLUTCH GRABBING.

When the clutch grabs it takes hold suddenly, starting the truck with a jerk and putting unncessary strain on the power transmitting mechanism. The grabbing may be caused by too much spring pressure, facings dry and rough, end play in the crankshaft, out of alignment of clutch shaft, adjustment too tight, or engaging too suddenly.

Plate No. 47



TRANSMISSION WITH COVER REMOVED SHOWING CONSTRUCTION.

Ref. No.	Part No.	Name of Part.
4	35037	Splineshaft.
7	32221-A	Transmission third-speed drive gear.
10	32265	Transmission splineshaft sliding gear.
11		Transmission drive sprocket gear (included with 35040-A).
15	35040-A	Splineshaft drive sprocket.
28	32287	Transmission layshaft.
29	32289	Transmission layshaft third-speed gear.
30	32224-A	Transmission layshaft second-speed gear.
32	32223-A	Transmission layshaft first-speed gear.
34	32288	Transmission layshaft drive gear.
41	35315-A	Transmission countershaft.
43	32303	Countershaft drive sprocket.
48	36247	Reverse gear shaft.
50	32217-A	Reverse gear.
51	32226	Silent drive chain.

CHAPTER V

TRANSMISSION, UNIVERSAL JOINTS AND PROPELLER SHAFTS.

TRANSMISSION.

The transmission unit consists of a combination of gears mounted on shafts, the whole contained in a case. The function of the transmission is to alter the tractive effort of the road wheels by changing the ratio of engine revolutions to wheel revolutions. Gears might be considered as levers and in the transmission different "leverages" are obtained, depending on the tooth ratio of the particular gears in action. The leverage gained in the transmission is again multiplied by the gear reduction of the driving bevels in the axles and the internal gears in the axles and wheels.

The transmission is of the constant-mesh, sliding-jaw clutch type, meaning that the gears always are in mesh and the engagements made by means of sliding-jaw clutches controlled by the gearshift lever.

The different speeds are obtained by the shifting of the sliding clutches into engagement with their respective gears, except the reverse speed, which is obtained by the sliding of gears into mesh with other gears.

RELATION OF TRANSMISSION SHAFTS AND GEARS.

The transmission consists of four shafts—the main drive, or the spline shaft, the transmission lay-shaft, the transmission countershaft, and the transmission reverse gear shaft. These shafts are mounted in a cast-iron housing.

On the first two there are mounted the necessary gears and clutches to effect proper gear reductions for the necessary speed changes.

No gears or clutches are mounted on the countershaft, but instead it has affixed to it a sprocket, known as the countershaft drive sprocket. A Link Belt silent chain connects this sprocket with a sprocket on the spline shaft.

The reverse-gear shaft carries the sliding gears necessary for the obtaining of reverse speed.

All the forward speed gears are always in mesh, and all the shafts, except the reverse shaft, revolve, except in third speed, when all the shafts revolve.

The power from the engine is applied to the front end of the transmission spline shaft, and from there is transferred, depending upon the speed desired, to the lay shaft back to the spline shaft, and from there

by means of the silent chain to the countershaft. The countershaft connects with the front and rear propeller shafts through universal joints.

OPERATION OF TRANSMISSION.

By referring to the illustration of the transmission on page 136, the exact operation of the transmission will become clear. The power from the engine is applied to the propeller shaft end of splineshaft (4), upon which is mounted splineshaft sliding gear (10). This unit consists of two gears, each of which, on its outward end, is provided with a clutch of four jaws. In continual mesh with splineshaft gear (10) are gears (30) and (32), which rotate freely with their bronze bushings on layshaft (28). Gears (29) and (34) are securely fixed on layshaft (28) by means of square steel keys. Sprocket gear (11) is bolted to the face of splineshaft drive sprocket (15), which is suspended on two ball bearings. Gear (7), third-speed driving gear, is free to turn with its bronze bushing on splineshaft (4), but is in constant mesh with gear (29).

Chain (51) forms a positive drive between splineshaft drive sprocket (15) and countershaft drive sprocket (43). Reverse gear (50), with its bronze bushing mounted on reverse gear shaft (48), is inoperative, except when transmission is in reverse speed, or when splineshaft sliding gear (10) is in third position.

ACTION IN SHIFTING TO FIRST SPEED.

Moving gear shift lever to first speed position (see page 136), through the intermediary connections, moves gear (32) on layshaft (28), to a position where the four clutches on gears (32) and (34) are fully engaged. The transmission is now in the first-speed position, the power being transmitted from splineshaft by gear (10) to gear (32), to gear (34), gear (11) to sprocket (15), through chain (51) to propeller shaft sprocket (43). From the universal joint connections on each end of countershaft (41) the power is delivered directly to the differential units on both front and rear axle systems and applied to the wheels.

ACTION IN SHIFTING FROM FIRST TO SECOND SPEED.

The change from first to second speed can best be accomplished at a speed of from three to six miles per hour by releasing the clutch and pulling the shift lever directly to the rear. These two operations should be made in unison. The clutches on gear (30) (page 136) are now engaged with those of gear (29). Due to the fact that shifter fork operating gears (30) and (32) are so disposed as to shift both gears at the same time, gear (32) is disengaged from gear (34) as the second-speed shift is made. The power from the splineshaft by gear (10) is delivered to gear (30) with which it is constantly in mesh, thence to gear (29) through the clutch jaws to layshaft (28) and gear (34). From gear (34) to gear (11), sprocket (15) to (43), and, as previously noted, to the drive wheels.

ACTION IN SHIFTING FROM SECOND TO THIRD SPEED.

Moving gear-shift lever through neutral to the left and backward in unison with a depression of the clutch pedal, third speed is attained. This shift is best made at a speed of from six to eight miles per hour.

Gear (30) (page 136) is now released from engagement with gear (29). Sliding gear (10) is moved forward, engaging its clutches with those of gear (7). In this position the power from the splineshaft by means of gear (10) is transmitted to gear (7) and (29), splineshaft (28), gear (34) to gear (11), and from chain sprockets to countershaft and wheel drive.

Third speed is the one which should be used for practically all driving when truck is operated with load or climbing grades, which are not too steep. The fourth speed is usually used on level roads, but should not be attempted on poor roads, sand, inclines, or with unusual loads.

ACTION IN SHIFTING FROM THIRD TO FOURTH SPEED.

The shift from third to fourth can best be made at a speed of approximately ten miles per hour, by quickly pressing the clutch pedal and moving shift lever forward into fourth position. This movement of the gear-shift lever disengages clutches on gear (10) from those on gear (7) and into engagement with the clutches on gear (11). The transmission is now in the fourth speed or direct driving position. The power from the engine through splineshaft gear (10), in connection with gear (11), drives directly without intermediate gears through chain and sprockets from propeller shaft to wheel drives.

The reversal of truck direction is accomplished by depressing the button on the upper end of the shift lever and moving lever from neutral position to the left, passing through the fourth-speed position into the extreme forward position. Care should be taken that the truck is stationary when attempting this shift.

TRANSMISSION SHAFTS.

TRANSMISSION SPLINE SHAFT.

The splineshaft is made of steel, and is 19.875 inches long, and 1.862 inch at its largest diameter. The rear end of the shaft is threaded, and drilled to receive a castellated nut, which clamps a ball-bearing in place. A cotter pin is inserted in the drilled hole, to hold the nut. The shaft is splined 5.1875 inches from the rear end, extending for 7.4375 inches. A sleeve carrying two gears, having clutches on each end, and known as the spline shaft sliding gears, slides on the spline section.

The front end of the shaft is tapered and threaded to receive a universal coupling flange. The threaded portion of the shaft is 1 inch in diameter and .75 inch long. A hole .158 (5/32) inch in diameter is drilled into the ends of the shaft for the insertion of a cotter pin, which holds a lock nut in place.

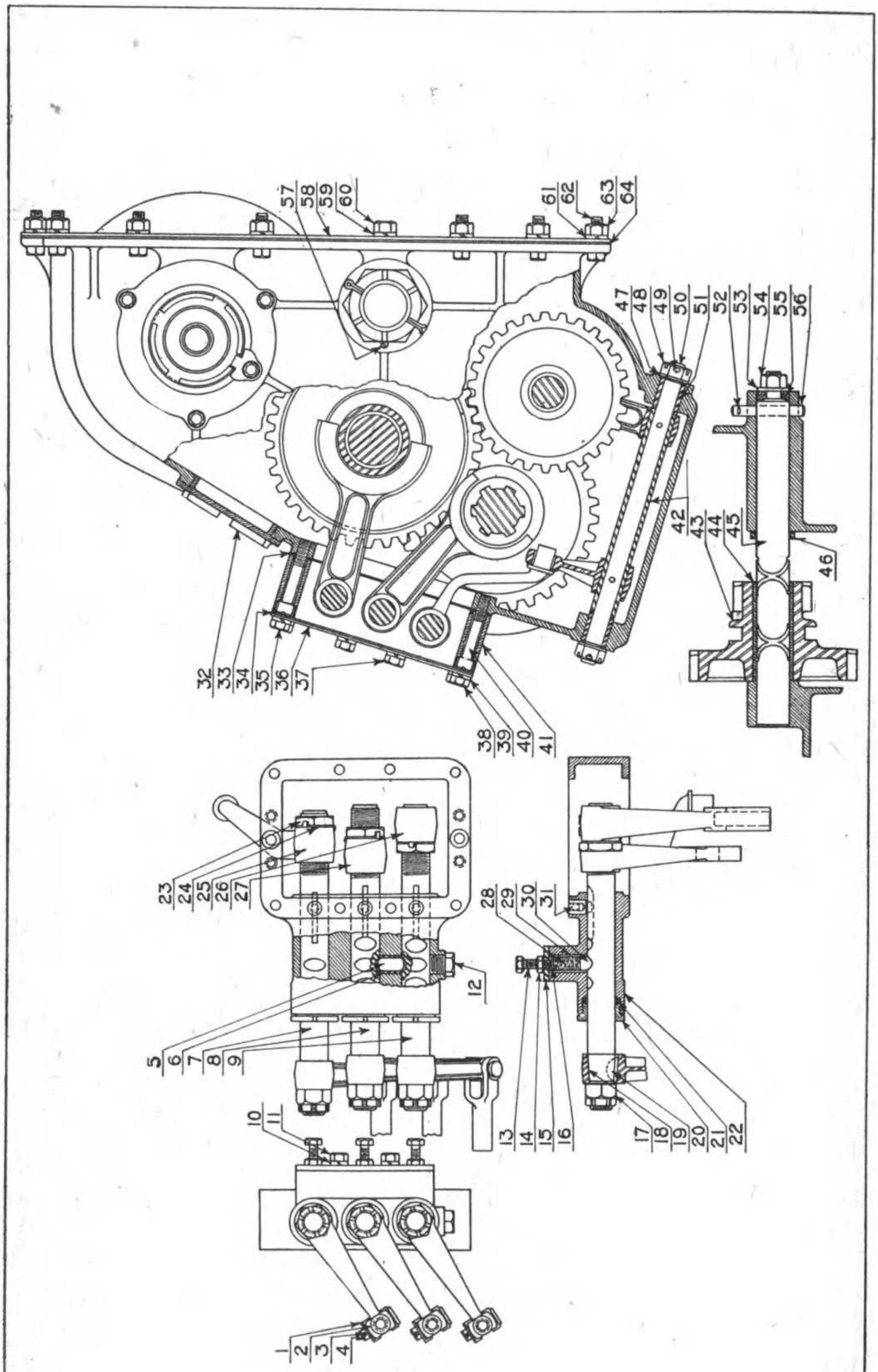


Plate No. 48

TRANSMISSION ASSEMBLY—OUTSIDE VIEW.

Ref. No.	Part No.	Name of Part.
1	WA-1030	Transmission operating tube pin washer.
2	32378	Transmission operating tube yoke (adjusting).
3	PI-407	Transmission operating tube pin cotter.
4	PI-118	Transmission operating tube pin.
5	32259	Transmission shifter interlock.
6	32281	Transmission shifter interlock bushing.
7	35379	Transmission shifter rod (reverse).
8	35378	Transmission rod shifter (third and fourth speed).
9	35377	Transmission shifter rod (first and second speed).
10	WA-146	Transmission shifter lock retaining plate screw lock washer.
11	SC-3401	Transmission shifter lock retaining plate screw.
12	32260	Transmission shifter interlock plug.
13	37247	Transmission shifter lock ball spring adjusting screw.
14	NU-112	Transmission shifter lock ball spring adjusting screw nut.
15	32248	Transmission shifter lock retaining plate.
16	32247	Transmission shifter lock ball spring follower.
17	NU-508	Transmission shifter rod lever nut.
18	32253	Transmission shifter rod lever.
19	KE-108	Transmission shifter rod lever key.
20	32245	Transmission shifter case packing gland.
21	WA-716	Transmission shifter case felt.
22	32219-A	Transmission shifter case.
23	NU-173	Transmission shifter fork nut.
24	32255	Transmission shifter rod lock washer.
25	32252	Transmission shifter rod arm (reverse).
26	32257	Transmission shifter form (first and second speed).
27	32258	Transmission shifter rod fork (third and fourth speed).
28	32246	Transmission shifter lock ball spring.
29	32280	Transmission shifter lock ball bushing.
30	BA-105	Transmission shifter lock ball.
31	32256	Transmission shifter rod guide.
32	32307	Transmission case grease plug.
33-34	32243	Transmission shifter case gasket.
35	32244	Transmission shifter case cover vent screw.
36	32242	Transmission shifter case cover.
37	SC-226	Transmission shifter case screw.
38	SC-3401	Transmission shifter case cover screw.
39	WA-146	Transmission shifter case cover screw lock washer.
40	SC-614	Transmission shifter case screw.
41	32219-A	Transmission shifter case.
42	32218-A	Transmission reverse rocker tube.
43	32217-A	Transmission reverse gear.
44	36904	Transmission reverse gear bushing.
45	36247	Transmission reverse gear shaft.
46	32467	Transmission reverse gear shaft spacer.
47	WA-355	Transmission reverse gear shaft washer.
48	NU-312	Transmission reverse rocker shaft nut.
49	PI-408	Transmission reverse rocker shaft nut cotter.
50	32241	Transmission reverse rocker shaft.
51	32313	Transmission reverse rocker shaft bushing.
52	PI-406	Transmission reverse gear shaft cotter pin.
53	WA-355	Transmission reverse gear shaft washer.
54	NU-149	Transmission reverse gear shaft nut.
55	36079	Transmission reverse gear shaft packing.
56	36249	Transmission reverse gear shaft pin.
57	SC-2136	Transmission front support trunnion set screw.
58	36945	Transmission case cover.
59	WA-146	Transmission case cover screw nut lock washer.
60	SC-3401	Transmission case cover screw.
61	WA-146	Transmission case cover screw.
62	SC-3403	Transmission case cover screw nut.
63	NU-124	Transmission case cover screw nut lock washer.
64	32225	Transmission case cover gasket.

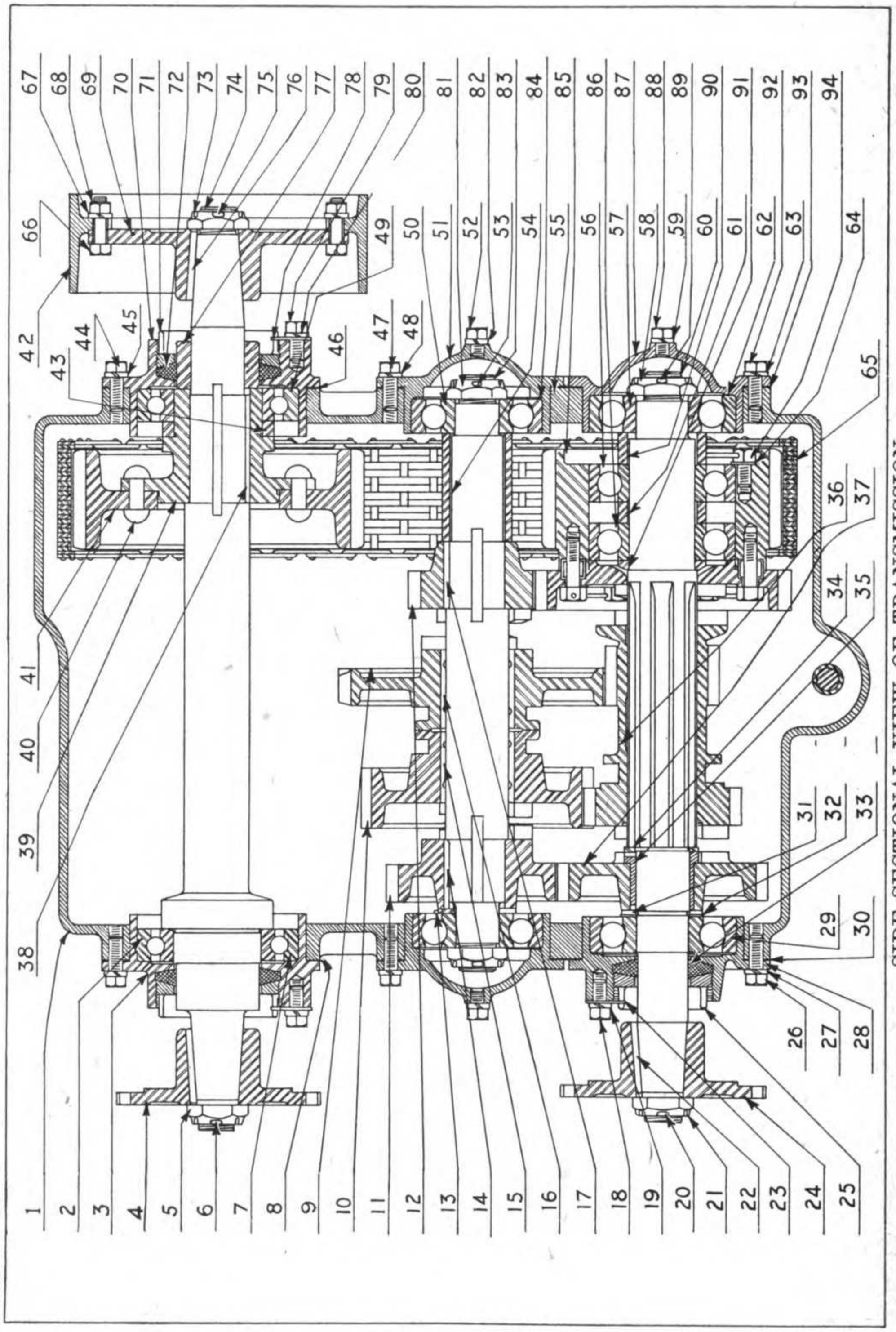


Plate No. 49. SIDE SECTIONAL VIEW OF TRANSMISSION.

Ref. No.	Part No.	Name of Part.
1	32212-A	Transmission case.
2	34571	Transmission countershaft ball bearing.
3	32229	Transmission countershaft bearing cap.
4	32273	Transmission universal joint companion flange.
5	NU-512	Transmission splineshaft nut.
6	PI-413	Transmission splineshaft nut cotter.
7	34170	Transmission countershaft bearing cap adjusting shim.
8	32230	Transmission countershaft bearing cap gasket.
9	32223-A	Transmission layshaft first speed slide gear.
0	32224-A	Transmission layshaft second speed slide gear.
1	32289	Transmission layshaft third speed drive gear.
2	32288	Transmission layshaft drive gear.
3	33483	Transmission layshaft front bearing spacer.
4	KE-211	Transmission layshaft third speed drive gear key.
5	32298	Transmission layshaft second speed slide gear bushing.
6	32296	Transmission layshaft first speed slide gear bushing.
7	KE-211	Transmission layshaft third speed drive gear key
8	SC-164	Transmission countershaft packing gland lock screw.
9	WA-146	Transmission countershaft packing gland lock screw washer.
0	PI-413	Transmission countershaft nut cotter.
1	NU-512	Transmission countershaft nut.
2	KE-213	Transmission brake drum hub key.
23	32232	Transmission countershaft packing gland lock.
24	32273	Transmission universal joint companion flange.
25	32272	Transmission splineshaft bearing cap gland.
26	SC-3402	Transmission splineshaft bearing cap screw.
27	WA-146	Transmission splineshaft bearing cap screw lock washer.
28	32271	Transmission splineshaft bearing cap (front).
29	32268	Transmission splineshaft ball bearing (front and rear).
30	32270	Transmission splineshaft bearing cap gasket.
31	33482	Transmission splineshaft third speed gear washer (rear).
32	WA-875	Transmission splineshaft third speed gear shim.
33	35474	Transmission splineshaft bearing cap packing.
34	32266	Transmission splineshaft third speed gear washer.
35	32277	Transmission splineshaft third speed drive gear bushing.
36	32265	Transmission splineshaft sliding gear.
37	32221-A	Transmission splineshaft third speed drive gear.
38	KE-209	Transmission driven sprocket hub key.
39	32304	Transmission driven sprocket hub.
40	RI-147	Transmission driven sprocket to hub rivet.
41	32303	Transmission driven sprocket.
42	32315	Transmission brake drum.
43	34558	Transmission countershaft ball bearing spacer (rear).
44	SC-3402	Transmission countershaft bearing cap screw.
45	WA-146	Transmission countershaft bearing cap screw lock washer.
46	32230	Transmission countershaft bearing cap gasket.
47	SC-3402	Transmission countershaft bearing cap screw.
48	WA-146	Transmission countershaft packing gland lock screw washer.
49	34170	Transmission countershaft bearing cap adjusting shim.
50	32290	Transmission layshaft ball bearing (front and rear).
51	32237	Transmission layshaft.
52	SC-161	Transmission layshaft bearing cap plug.
53	PI-413	Transmission layshaft nut cotter.
54	32291	Transmission layshaft rear bearing spacer.
55	32238	Transmission layshaft bearing cap gasket.
56	35041	Transmission drive sprocket bearing.
57	32268	Transmission splineshaft ball bearing.
58	NU-511	Transmission splineshaft nut (rear end).
59	WA-146	Transmission bearing cap gland lock screw lock washer.
60	35037	Transmission splineshaft.
61	35038	Transmission drive sprocket bearing spacer.
62	34165	Transmission splineshaft rear bearing cap adjusting shim.
63	WA-146	Transmission splineshaft bearing cap plug lock washer.
64	WA-1020	Transmission drive sprocket bearing retainer screw washer.
65	32226	Transmission chain (Whitney) (No. 1259, 62 links).
66	SC-3432	Transmission brake drum to hub bolt.
67	WA-146	Transmission brake drum to hub bolt nut lock washer.
68	NU-128	Transmission brake drum to hub bolt nut.
69	32314	Transmission brake drum hub.
70	32229	Transmission countershaft bearing cap.
71	32231	Transmission countershaft bearing gland.
72	35473	Transmission countershaft bearing cap packing.
73	NU-512	Transmission countershaft nut.
74	35315-A	Transmission countershaft.
75	PI-413	Transmission countershaft nut cotter.
76	KE-213	Transmission brake drum hub key.
77	32302	Transmission countershaft rear bushing.
78	32232	Transmission countershaft packing gland lock.
79	SC-164	Transmission splineshaft bearing cap gland lock screw.
80	WA-146	Transmission bearing cap gland lock screw lock washer.
81	NU-511	Transmission splineshaft nut.
82	WA-146	Transmission splineshaft bearing cap screw lock washer.
83	32287	Transmission layshaft.
84	34167	Transmission layshaft bearing cap adjusting shim.
85	35040-A	Transmission splineshaft drive sprocket.
86	35041	Transmission drive sprocket bearing.
87	32269	Transmission splineshaft bearing cap (rear).
88	SC-161	Transmission splineshaft bearing cap plug.
89	PI-413	Transmission splineshaft nut cotter.
90	35420	Transmission splineshaft bearing spacer (rear).
91	35421	Transmission drive sprocket collar.
92	SC-3402	Transmission splineshaft bearing cap screw.
93	32270	Transmission splineshaft bearing cap gasket.
94	SC-2853	Transmission splineshaft drive sprocket bearing retaining screw.

The tapered section of the shaft is key-seated for 1.875 inch, to receive a key, which drives the universal joint.

Near its front end there is located the splineshaft third speed gear, and near its rear end are mounted two sets of ball-bearings. These support the drive sprocket.

TRANSMISSION LAY-SHAFT.

The shaft is of steel 15.875 inches long and 1.734 inch at its largest diameter. Both ends of the shaft are turned to 1 inch, and threaded for .75 inch to receive nuts for the support of bearings.

In each of the threaded portions there is drilled a 5/32 inch hole for the reception of cotter pins, which hold the nuts for supporting bearings in place.

The shaft is key-seated 1.8125 inch from its front end and 4.375 inches from its rear end for .313 inch by .313 inch keys. These attach both the lay-shaft third speed gear and the lay-shaft drive gear to the shaft.

The center portion of the shaft is occupied by two other gears known as the lay-shaft first speed gear, and the lay-shaft second speed gear.

TRANSMISSION COUNTERSHAFT.

This shaft is made of steel, and is 24.4375 inches long and projects from both ends of the transmission housing, connecting by means of universal joints with the propeller shaft.

Both of its ends are tapered and threaded. The threaded portions are .75 inch long, and receive nuts, which hold in position the universal joint flanges.

Towards its rear end the shaft is key-seated for 3 inches to receive a key .25 inch by .25 inch for the attachment of the transmission drive sprocket.

The rear end of the shaft is supported by a ball-bearing, as is also the front end. The rear end bearing rests in a collar formed 5.625 inches from the rear end of the shaft. This collar is 3 inches in diameter by .750 inch wide.

REVERSE-GEAR SHAFT.

The reverse gear shaft is of steel and 12.4373 inches long by 1.123 inch in diameter. Its rear end is turned to .5 inch, and threaded for .75 inch. The threaded portion fits into the transmission housing, and is held there by a nut.

TRANSMISSION GEARS, SPROCKETS AND CHAIN.

TRANSMISSION THIRD SPEED DRIVE GEAR.

The transmission third speed drive gear is located at the front end of the splineshaft. It is made of hardened steel, has 27 teeth, and runs loose on the shaft on a bronze bushing. The pitch diameter of the gear is 5.4 inches. Its outside diameter is 5.6858 inches, its face 1 inch and its bore 1.6885 inch.

A four-jaw clutch made integral with the gear projects from its rear.

TRANSMISSION SPLINESHAFT SLIDING GEAR.

The transmission splineshaft sliding gear is located on the splineshaft, and consists of a case hardened steel hub, with gears cut on either end. Both gears have four-jaw clutches on their outside faces integral with them.

The front one of the two gears has twenty teeth (5-7 pitch), a pitch diameter of 4 inches, an outside diameter of 4.2858 inches, a bore of 1.5 inch, and a 1-inch face.

The rear gear has 14 teeth, a pitch diameter of 2.8 inches, an outside diameter of 3.0858 inches, and a bore of 1.5 inch.

The outside surface of the hub of the gears is grooved to hold a shifting fork.

TRANSMISSION DRIVE SPROCKET GEAR.

The transmission drive sprocket gear is of case hardened steel, and has 33 teeth (5-7 pitch). The pitch diameter of the gear is 6.6 inches. Its outside diameter is 6.8858 inches, its bore 1.906 inches.

A four-jaw clutch integral with the gear is located on its front side. Its flange is drilled to receive six .50 inch bolts. These are used to bolt the gear to the transmission drive sprocket.

The earlier type of drive sprocket gear was drilled for six .375 inch diameter bolts and counter-bored for dowel bushings (same holes). Although the units (gear and sprocket together) are interchangeable, the parts of the units are not.

TRANSMISSION DRIVE SPROCKET.

The transmission drive sprocket is mounted on ball-bearings on the rear end of the splineshaft, and drives the silent chain. As above mentioned, it is bolted to the transmission drive sprocket gear. Both are free on the shaft, and are driven by the engagement with the clutch hub on the drive sprocket gear with the clutch hub on the transmission splineshaft sliding gear when in fourth speed. It is driven by lay drive gear when in first, second and third, and by reverse gear when in reverse.

The sprocket has 27 teeth .75 pitch. Its face is 3.25 inches wide, its outside diameter 6.46 inches, and its bore 3.94 inches.

TRANSMISSION LAY-SHAFT THIRD SPEED GEAR.

This gear is keyed to the front end of the shaft. Integral with its rear side is a clutch hub, and a four-jaw clutch. The gear has 23 teeth

(5-7 pitch), has a pitch diameter of 4.6 inch, an outside diameter of 4.885 inches, a face 1 inch wide, and bore 1.5 inch, and is made of case-hardened steel.

TRANSMISSION LAY-SHAFT SECOND SPEED GEAR.

The clutch of this gear engages with the clutch of the gear just mentioned. The gear rides loose on the shaft. Its hub is grooved to receive a shifting fork which also operates the first speed gear.

The transmission lay-shaft second speed gear is made of case-hardened steel, and has 30 teeth (5-7 pitch). The gear has a pitch diameter of 6 inches, and outside diameter of 6.2858 inches, a bore of 1.996 inch, and a face 1.625 inch wide.

Integral with the gear at its forward side is a four-jaw clutch.

TRANSMISSION LAYSHAFT FIRST-SPEED GEAR.

The transmission lay-shaft first speed gear runs loose on the shaft on a bronze bushing. It is made of case-hardened steel, and has 36 teeth (5-7 pitch). The pitch diameter of the gear is 7.2 inches. Its outside diameter is 7.4858 inches, its bore 1.996 inches, its face 1.0625 inch.

The hub of the gear is grooved to receive a clutch shifting fork.

Integral with the rear hub of the gear is a four-jaw clutch.

TRANSMISSION LAY-SHAFT DRIVE GEAR.

The transmission lay-shaft drive gear is keyed to the rear end of the lay-shaft. A four-jaw clutch is integral with the hub on its front side.

The gear is made of case-hardened steel, and has 17 teeth (5-7 pitch). It has a pitch diameter of 3.4 inches, outside diameter 3.6858 inches, a bore 1.5 inch, and a face 1 inch wide.

TRANSMISSION REVERSE GEAR.

The transmission reverse gear is mounted at the front of the reverse shaft. It really consists of two integral gears cut on the same piece of material with an intervening grooved hub to receive a shifter arm.

The larger or front gear has 27 teeth. Its pitch diameter is 5.4 inches. Its outside diameter is 5.6858 inches, its face 1.0625 inch, and its bore 1.375 inch.

The smaller or rear gear has 12 teeth (5-7 pitch). Its pitch diameter is 2.4 inches, its outside diameter 2.6858 inches, its face 1.0625 inch, and its bore 1.375 inch.

The gears revolve loose on the shaft.

COUNTERSHAFT DRIVE SPROCKET.

This sprocket, over which the silent chain rides, is riveted to a steel hub, which is keyed to the countershaft. Six .375 inch rivets are employed for the purpose. The hub is bored 1.5 inch and key-seated quartering for .25 inch by .25 inch keys. The hub is 3 inches long.

The sprocket has 33 teeth (.75 inch pitch). Its pitch diameter is 7.89 inches, and its face 2.6875 inches.

SILENT DRIVE CHAIN.

The silent drive chain is a Whitney chain No. 1269. The chain runs over the two previously mentioned sprockets, and so conveys the power from the splineshaft drive sprocket to the transmission drive sprocket.

TRANSMISSION HOUSING.

The transmission housing is made of cast iron .21875 inch thick. Integral with it are cast two arms, which are bolted to the cross members of the frame by four .5 inch bolts. The housing is provided with a readily detached cover.

TO REMOVE TRANSMISSION.

In removing the transmission in the field it is best to first take off or slide body back—then disconnect propeller and drive shafts, shifter tubes, etc. Loosen bolts holding transmission to frame and lift out.

TO REMOVE TRANSMISSION CHAIN.

It is not necessary to remove transmission from the frame to replace silent chain, as chain rivet can be removed and chain worked out and new one installed.

TO REMOVE TRANSMISSION SHAFTS.

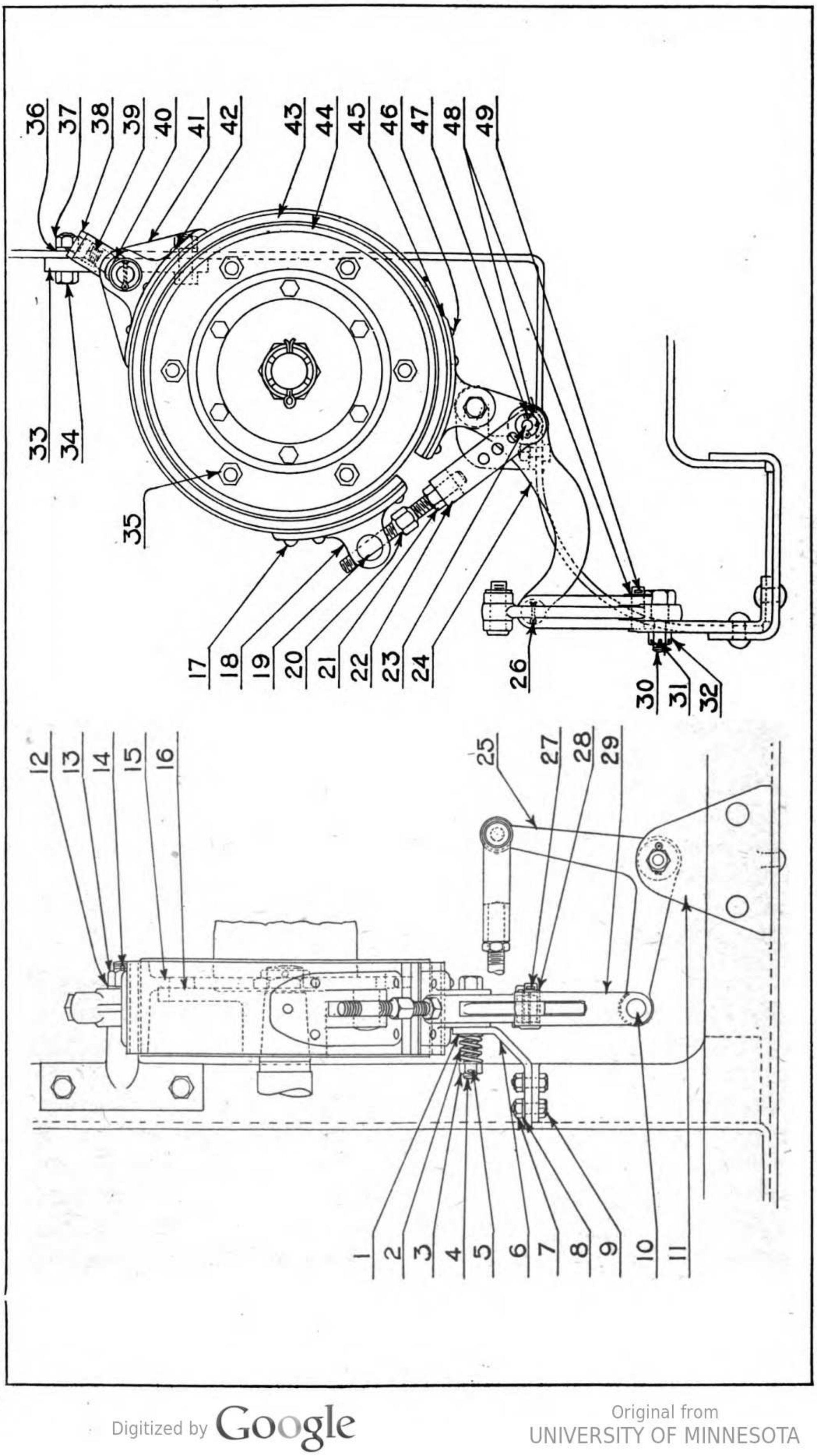
To remove lay-shaft from transmission, take off bearing caps at rear and front of case, work shaft back an inch or two, raise up, pull back and then up and out towards front.

To remove splineshaft, take off rear and front bearing caps, take off cotter pin and nut, remove three cap screws holding sprocket gear ball-bearing in place. This may be loosened up and pulled out by placing a pinch bar against transmission splineshaft sliding gear and prying. When this bearing is out, flange on other end of shaft must be taken off and shaft driven out. Splineshaft can be taken out without removing lay-shaft. If spline gear and shaft is to be taken out, it is first necessary to remove lay-shaft.

TRANSMISSION BRAKE.

The brake is located back of the transmission and is mounted on rear end of the transmission countershaft. It is operated by the lever at the driver's right.

The flange to which the brake drum is bolted is keyed and held on a taper by means of a nut on the threaded end of the countershaft. Surrounding this brake drum, or wheel, is the brake band which is lined with Raybestos and is operated by the emergency brake lever. The band is supported at the top by a bracket attached to the cross member supporting the rear of the transmission on the bottom by a forged bracket bolting to this same member. Because of the angularity of the pull on the actuating connections to this brake, the bolt which attaches it to the bottom, or forged bracket, is cushioned with a coil spring which allows



TRANSMISSION BRAKE ASSEMBLY.

Plate No. 50

TRANSMISSION BRAKE ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	WA-1020	Transmission brake bell crank link pin washer.
2	32705	Transmission brake band lever tension spring.
3	NU-124	Transmission brake band lever bolt nut.
4	BO-219	Transmission brake band lever bolt.
5	PI-410	Transmission brake band lever bolt cotter.
6	35230	Transmission brake band end bracket.
7	NU-103	Transmission brake band end bracket bolt nut.
8	WA-144	Transmission brake band end bracket bolt nut lock washer.
9	SC-3231	Transmission brake band end bracket bolt.
10	PI-115	Transmission brake bell crank link pin.
11	32531	Transmission brake bell crank bracket.
12	WA-1035	Transmission brake anchor washer.
13	NU-316	Transmission brake anchor nut.
14	PI-412	Transmission brake anchor cotter.
15	32315	Transmission brake drum.
16	32314	Transmission brake drum hub.
17	RI-114	Transmission brake band end rivet.
18	32374	Transmission brake band end (upper).
19	32702	Transmission brake band adjusting clip fulcrum.
20	32701	Transmission brake band adjusting clip stud.
21	NU-124	Transmission brake band adjusting clip stud clamp nut.
22	35216	Transmission brake band lever adjusting clip.
23	PI-102	Transmission brake band lining adjusting clip end.
24	32703	Transmission brake band lever.
25	32706	Transmission brake bell crank.
26	PI-115	Transmission brake bell crank link pin.
27	PI-403	Transmission brake bell crank link pin cotter.
28	WA-1020	Transmission brake bell crank link pin washer.
29	35164	Transmission brake bell crank link.
30	BO-105	Transmission brake bell crank bolt.
31	PI-407	Transmission brake bell crank bolt cotter.
32	NU-306	Transmission brake bell crank bolt.
33	32697	Transmission brake anchor.
34	SC-3432	Transmission brake anchor bolt.
35	NU-128	Transmission brake anchor bolt nut.
	WA-146	Transmission brake anchor bolt lock washer.
36	WA-146	Transmission brake anchor bolt lock washer.
37	NU-128	Transmission brake anchor bolt nut.
38	32698	Transmission brake band fulcrum plug.
39	32700	Transmission brake band fulcrum spring.
40	32699	Transmission brake band fulcrum plunger.
41	32372	Transmission brake band anchor brand.
42	RI-114	Transmission brake band end rivet.
43	32371	Transmission brake band lining.
44	32370	Transmission brake band.
45	32373	Transmission brake band end (lower).
46	RI-114	Transmission brake band end rivet.
47	PI-407	Transmission brake bell crank bolt cotter.
48	WA-1020	Transmission brake bell crank link pin washer.
49	PI-403	Transmission brake bell crank link pin cotter.

for some twisting. The bearing riveted on top of the brake band which attaches to the rear bracket has a coil spring in it which holds the brake band away from the drum when in released position.

TRANSMISSION BRAKE DRUM.

The drum is of cast iron 8 inches diameter, 2.625 inches face, bolted to flange on propeller shaft by six .375 inch bolts. The brake band which surrounds it is of sheet steel. It is 2.625 inches wide and is lined with brake lining.

GEAR REDUCTIONS AND ENGINE-TO-WHEEL RATIOS.

Since the transmission is a means of changing driving wheel tractive effort, the gears acting as levers, the leverage is in proportion to the tooth ratios of any pair. Thus, if one gear has 20 teeth and the one driving it 5 teeth the ratio is 20 ÷ 5 or 4 to 1. In the transmission the ratios are as follows:

First speed	6.10 to 1
Second speed	3.55 to 1
Third speed	2.02 to 1
Fourth speed	1.22 to 1
Reverse	6.46 to 1

However, in the drive from the transmission to the wheels there is further reduction, the first one by the bevel gears in the axles which is 27 to 15 or 1.8 to 1, and the second by the internal gear and pinion in the wheel drum. This is 54 to 14, or 3.86 to 1, making a total reduction in the axle of 1.8 by 3.86 or 6.95 to 1. In order to obtain the actual ratio of engine revolutions to wheel revolutions in the various speeds the factor 6.95 must be used in every case. Thus, when in first speed the total reduction, or ratio of engine revolutions to wheel revolutions, is 6.1 times 6.95, or 42.3 to 1. In second speed the total reduction is 3.55 times 6.95, or 24.7 to 1. In third the total reduction is 2.02 times 6.95, or 14.04 to 1. In fourth speed the total reduction is 1.22 times 6.95, or 8.48 to 1, and in reverse 6.46 times 6.95, or 44.9 to 1.

CARE AND INSPECTION OF TRANSMISSION.

The transmission assembly is treated like any enclosed gear train, getting a constant supply of clean lubricant at specific intervals. The transmission housing, or case, should be drained, flushed with kerosene and refilled with lubricant every 1,000 miles. It is not necessary to fill the case, so do not fill above level, but merely enough that gears will dip.

The transmission rarely gives any trouble, except when not lubricated, or when injured, due to poor driving. The usual troubles are due to wear of the shaft bearings, out of alignment of shafts, chipped gears and jumping out of a speed position.

IF SHIFTER LEVER JUMPS OUT OF SPEED POSITION.

Drivers may be careless in shifting gears, due to haste in getting away, or inexperience, and do not realize the enormous leverage between the upper end of the gear shift lever and the transmission. Forcing a gear in place may bend the shifter fork in the transmission, in which case the gear has a tendency to jump out of mesh, especially under load. When this jumping out of mesh is noticed, and before opening transmission, look at the small shifter interlock ball which is held in place by a spring controlled set-screw over each of the three shifter tubes entering the transmission, and note whether the ball is correctly registering with the notches in shifter tube. It may be that the spring will gum and hold ball out of the notch, or that the notch may require additional filing. There is a small guide under large plate base over top of transmission that has a nib on end intended to fit slot in shifter tube to prevent it turning, and if this nib breaks off the tube may turn, preventing the interlock ball registering with notch. If the interlock seems to be in operation, then remove bottom of transmission and with a crowbar or long pry straighten the bent shifter fork.

IF TRANSMISSION CHAIN BREAKS.

Should the chain in the transmission break it is not necessary to completely take down transmission. Note should be made that there is no excessive wear, and if this is the case a new chain may be necessary. When putting in a new chain always include two new chain sprockets, as a new chain on old sprockets will not be satisfactory, and causes undue wear on both parts. The sprocket shaft may be withdrawn through end of transmission without removing transmission from truck.

IF TRANSMISSION GETS TOO HOT.

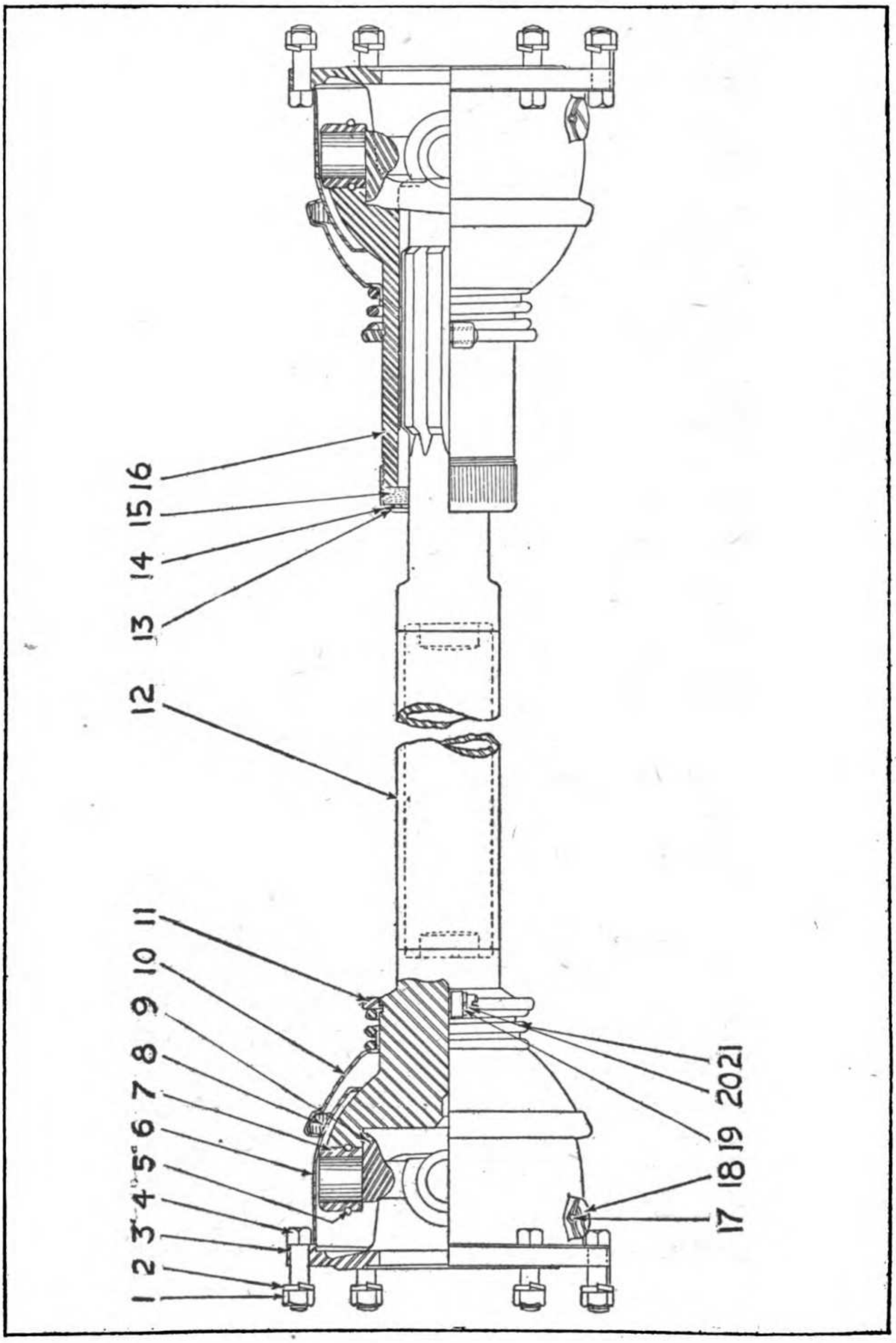
If heat is noticed in transmission the vent hole in set-screw should be opened to give ventilation, and as heat is an indication of improper lubrication the grease level in the transmission should be noted. Insufficient grease will cause wear between gears, and the plug on side of case should be opened, and the proper amount of proper lubricant added to run out of hole. Too much lubricant will heat, and due to expansion, will force out through felt washers at ends of shafts, and at shifter tubes. With the vent open loss of lubricant may be prevented, although the heated air in transmission may force grease through vent screw. In this latter case, open plug on side of case and let lubricant drain to that level.

TRANSMISSION GRINDS.

Grinding noises coming from the transmission may be caused by lack of lubricant, insufficient lubricant, too thin a lubricant, shafts out of alignment, bearings worn or broken, chips in transmission case.

Plate No. 51

TRANSMISSION UNIVERSALS AND PROPELLER SHAFT (SPICER TYPE)



TRANSMISSION UNIVERSAL JOINT AND PROPELLER SHAFT (SPICER TYPE).

Ref. No.	Part No.	Name of Part.
	36556-A	Transmission universal joint and propeller shaft, complete (includes 1—36677-A; 1—36683-A; 12—36685; 12—NU-1213; 12—WA-124).
	36677-A	Transmission universal joint permanent end and shaft (includes the next 14 items).
1	NU-1213	Transmission universal joint flange bolt nut.
2	WA-124	Transmission universal joint flange bolt lock washer.
3	33003	Transmission universal joint flange yoke.
4	36685	Transmission universal joint flange bolt.
5	33011	Transmission universal joint casing spider bushing retainer.
6	33004	Transmission universal joint casing (inner).
7	33010	Transmission universal joint casing spider bushing.
8	33007	Transmission universal joint casing packing.
9	33009	Transmission universal joint casing spider.
10	33006	Transmission universal joint casing (outer).
11	36680	Transmission universal joint casing spring retaining nut.
12	36678	Transmission universal joint ball yoke and shaft.
13	33015	Transmission universal joint sleeve yoke dust cap.
14	33016	Transmission universal joint sleeve yoke dust cap spring washer.
15	WA-423	Transmission universal joint sleeve yoke dust cap felt washer.
16	36681	Transmission universal joint casing sleeve yoke.
17	PI-408	Transmission universal joint casing oil plug cotter.
18	33005	Transmission universal joint casing oil plug.
19	WA-123	Transmission universal joint casing spring retainer nut screw lock washer.
20	SC-604	Transmission universal joint casing spring retainer nut screw.
21	36679	Transmission universal joint casing spring.
	36683-A	Transmission universal joint (slip end assembly).
	33004	Transmission universal joint casing (inner).
	33005	Transmission universal joint casing oil plug.
	33006	Transmission universal joint casing (outer).
	33007	Transmission universal joint casing packing.
	36679	Transmission universal joint casing spring.
	36680	Transmission universal joint casing spring retainer nut.
	33003	Transmission universal joint casing flange yoke.
	33009	Transmission universal joint spider.
	33010	Transmission universal joint spider bushing.
	33011	Transmission universal joint spider bushing retainer.
	PI-408	Transmission universal joint spider oil plug cotter.
	SC-604	Transmission universal joint casing spring retainer nut screw.
	WA-123	Transmission universal joint casing spring retainer nut screw lock washer.

DIFFICULT TRANSMISSION GEAR CHANGES.

Often one may find it difficult to go from one speed to another. On starting up this might be expected and is easily remedied by engaging and disengaging the clutch a few times. If it occurs in going from first to second or second to third, it may be caused by worn clutches, or worn surface upon which clutches slide, dragging clutch caused by inoperative clutch brake or gummed plates or too tight a clutch adjustment, insufficient clutch release.

PROPELLER SHAFTS AND JOINTS.

LOCATION.

Power from one unit to another is transmitted by shafting, called propeller shafting. Thus, the power of the engine is taken by the clutch and transmitted through a shaft to the transmission. From the transmission one propeller shaft extends to the front axle and another to the rear axle. These three propeller shafts are each fitted with two universal joints of exactly the same design.

FUNCTION OF UNIVERSALS.

Universals are necessary in power transmission lines to prevent stresses due to misalignment. Thus, an axle moves up and down, due to inequalities in the road, altering its up-and-down relation to the transmission. If a propeller shaft were rigidly connected to both transmission and axle it would bend or break with movement of the axle. The universals allow the propeller shafts to move up and down or sideways, if necessary (universal movement, or movement in any direction).

PROPELLER SHAFTS.

The propeller shafts extending from the transmission to the axles are identical and interchangeable. These shafts are solid, 1.375-inch in diameter, with upset ends to receive splines which are hardened. The universals are fitted to the ends of the propeller shafts.

CONSTRUCTION OF UNIVERSALS.

The outside ends of the two joints are identical and consist of drop forged steel plates with lugs, or forks, formed on one side. These plates are bolted to the flanges which are secured on the tapered ends of the clutch shaft and transmission splineshaft. The inner parts of these joints are identical as to forked portions, but the forward one is forged integral with the propeller shaft, while the rear one has a long hub which is key-seated to fit the splined end of the propeller shaft and slides freely on this shaft.

This type of universal joint consists mainly of two pairs of forks with open ends. A spider having four arms slips into these open ends. These

arms fit loosely in the fork and a bushing, which fits each snugly, is slipped into the forks from the outside. These bushings fit the open forked ends so closely that they cannot come out through the open side. Thus, they hold the spider in place. A small wire spring fits in a groove cut into the bushing and into a groove in the fork, in this manner holding the bushing from sliding out of place.

The plate portions of the joints are of drop forged steel 5.5 inches O. D. with 6 holes drilled for .315-inch bolts, which bolt it to the flanges attached to clutch and transmission shafts.

The forked portions are drop forgings, the forward one is welded to the propeller shaft. The rear one has a hub formed on it. This hub is about 6 inches long and is splined to fit the splined end of the propeller shaft. Its forward end is threaded on the outside onto which is screwed a cap containing felt packing. This is to keep the grease from working out at this end.

UNIVERSAL HOUSING.

A pressed steel housing encloses each of these joints for the retention of grease. It is made in two portions. The outside part has a groove formed in it containing a felt ring. A spring fitting around the hub of the forked end pushes this outside portion of the housing up onto the inner portion, thus keeping the felt washer always in close contact with the inner housing. The outside ends of these inner housings are bolted to the plate ends of the joints. The inner ends of outside housings fit around the hubs of the forked portion of the joints. The functions of the propeller shaft is to carry the power from the clutch to the transmission through universal joints. The propeller shaft is a hollow steel tube, except at its ends. The front end as before mentioned, is welded to the forked end of the forward universal, the rear end is welded to a piece of solid steel which is splined to fit the rear universal. The tube is 1.75-inch O. D. with a .134 inch wall, the solid portion at the rear is 1.375 diameter. The outside of the splined end is 1.75 inch diameter. The propeller shaft is 28.75 inches long, center to center of forked ends. The whole assembly from face of forward universal plate to face of rear universal plate is 33.125 inches.

CARE OF UNIVERSALS.

Too much cannot be said on lubrication in general, and of the universal joints in particular. These universal joints, ten in number, of which four are under the greatest stresses at all times, must be kept filled with grease. They are easily accessible, can be filled without trouble and in a short time, and they need grease. By either unscrewing nut and drawing back dust cap, or removing plug and using a grease gun, grease can be introduced in them quickly. At least once a day, when operating, this should be done. The wheel joints and main drive shaft may not need this daily care, although it is suggested that all ten universal joints be filled at the

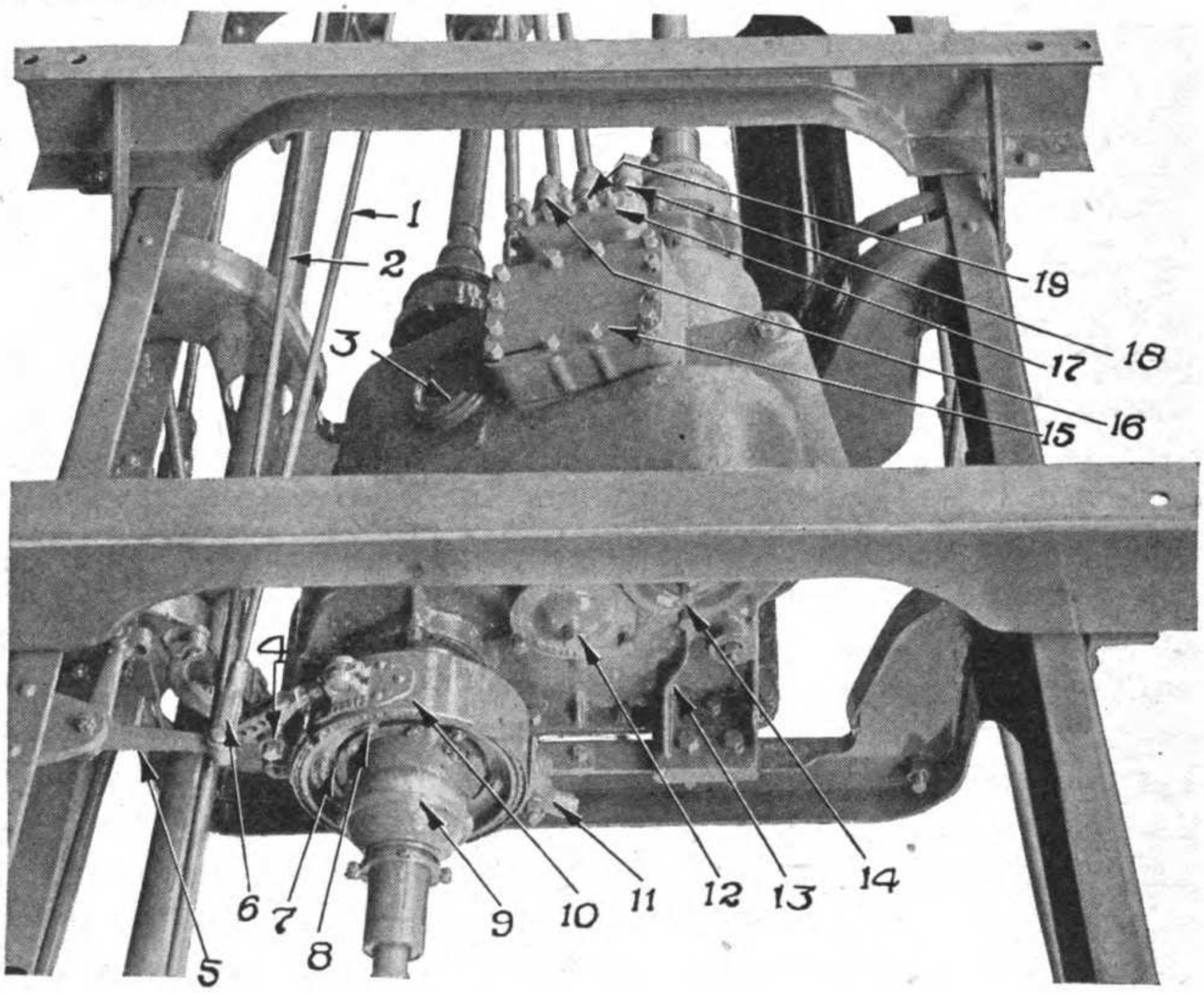
same time each day. Should a rattle occur it shows that the joint cover has slipped back and the grease may become lost while running.

IF A UNIVERSAL SHOULD FAIL TO OPERATE.

In service a propeller shaft universal joint may fail, and in this case unbolt the shaft and joints from flanges at differential and transmission and continue the trip, using the end of the truck still intact. The front drive is just as efficient as the rear, but should not be used for a long period of time.

TRANSMISSION MOUNTED IN FRAME.

Plate No. 52



TRANSMISSION MOUNTED IN FRAME.

Ref. No.	Part No.	Name of Part.
1.	32151-A.	Brake rod—rocker shaft to transmission, complete.
2.	32152-A.	Brake rod (rear), complete.
3.	32307.	Transmission case, grease plug.
4.	32373.	Transmission brake anchor bolt.
5.	32706.	Transmission brake bell crank.
6.	32390.	Brake rod adjusting yoke.
7.	32371.	Transmission brake lining.
8.	SC-3432.	Transmission brake drum hub bolt.
9.	36676.	Transmission universal joint.
10.	32374.	Transmission brake band (upper).
11.	32698.	Transmission brake band fulcrum plug.
12.	32237.	Transmission layshaft bearing cap.
13.	32310.	Transmission front support trunnion.
14.	32229.	Transmission countershaft bearing cap.
15.	32276-A.	Transmission case cover.
16.	32378.	Transmission operating tube yoke.
17.	32219-A.	Transmission shifter case.
18.	35379.	Transmission operating tube.
19.	SC-3232.	Tranmission shifter case lock ball spring adjusting screw.

CHAPTER VI

AXLES.

FUNCTION, CONSTRUCTION, OPERATION AND CARE.

The front and rear axle are of the internal gear-drive type, in which there are two distinct members to each axle. One member is an I-beam axle, a dead (non-moving) member which carries the load. This member has steering knuckles attached to its ends. Above this dead axle is the live member, consisting of a differential and drive pinion assembly, suitably housed, and shafts extending out to the wheels. Each of these shafts has a universal and spur pinion at its outer end and the spur pinion drives the wheel through the internal gearing. Front and rear axles are identical.

DEAD AXLE MEMBER (AXLE BED).

This is a forging with so-called reverse Elliot ends. This means that the ends, instead of being yoked with a knuckle operating between the yoke ends, are straight and carry a yoked knuckle. Front and rear axle beds are identical.

The axles are 3.5 inches deep, with a flange 2.25 inches wide, .8125 inch thick. The spring pads are drilled for four .75 inch spring clip bolts, and are drilled in the center .6875 inch. The pads for the differential case are drilled for two .5 inch bolts. The bosses at the ends are 5.255 inches deep, and are drilled 1.249 inch for the insertion of the steering knuckle pin. At right angles to this hole is drilled another hole .765 inch in diameter. This hole cuts into the knuckle pin hole a small amount, and is for the purpose of securing the steering pin from turning.

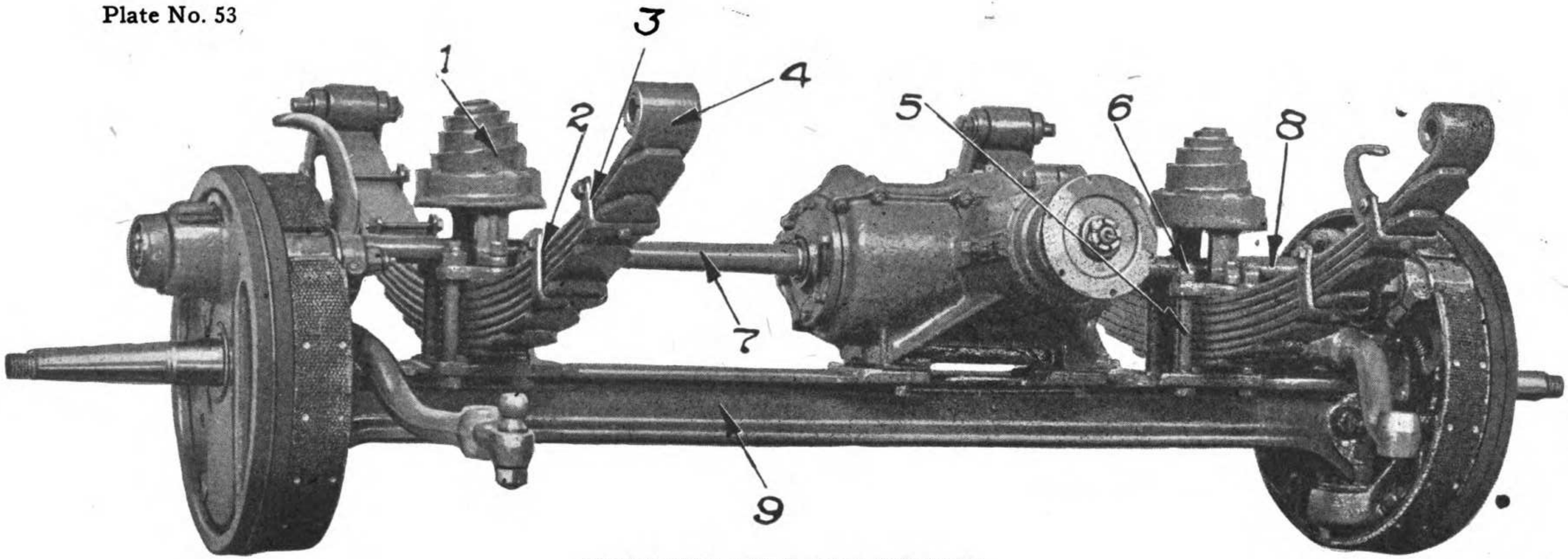
STEERING KNUCKLE.

The steering knuckle is the movable member of the axle bed and is the last unit in the steering system. The wheels are mounted on bearings resting on the part of the knuckle known as the spindle. Movement of the knuckle moves the wheel.

STEERING KNUCKLE SPINDLE.

The steering knuckle spindle is of steel. It is 1.125 inch diameter on one end and threaded and keyseated for a distance of 1.25 inch. It has a hub formed on its inner end at right angles to length of the spindle which is bored 1.563 inches, through which passes the knuckle pin for attaching wheel to axle. Another hub is formed on the upper end of, and

Plate No. 53



COMPLETE AXLE AND SPRINGS.

Ref. No.	Part No.	Name of Part.
1	35370	Bumper spring.
2	36722	Rebound clip (5th leaf) (front).
3	36721	Rebound clip (3rd leaf) (front).
4	36084-A	Spring, complete (front).
5	35034	Spring clip bolt.
6	NU-536	Spring clip bolt nut.
7	33582	Axle drive shaft (right front).
8	33583	Axle drive shaft (left front).
[illegible]	33578	Axle bed.

at right angles to, the above hub. It is bored taper (No. 11 B. & S.), small diameter 1.384 inch and keyseated for the insertion of a steering connection known as the steering arm. As an integral part of the spindle at its rear end is a flange which is drilled for four .5-inch rivets for riveting it to the steering knuckle body. The spindle is 10.9375 inches long from threaded end to face of flange. This spindle is supported by Timken bearings. The outer one being cone No. 4361, 1.5 inch bore, 2.027 inches long; cup No. 4320, O. D. 3.4843 inches, 1.3125 inches long. The inner one cone No. 5563, 2.125 inches bore, 2.035 inches long; cup No. 5520, 4.7343 inches, O. D. 1.4375 inch long.

STEERING KNUCKLE BODY.

The steering knuckle body to which the spindle is riveted is of cast steel. The hub which supports the roller bearings that the drive pinion shaft is carried on is bored out 4.001 inches and 2.861 inches for the reception of these two bearings. The hub or cup which holds the step or pedestal bearing is bored 3.4815 inches for 1.125 inch for the bearing and is threaded for a distance .75 inch for the insertion of a steering knuckle body plug.

The body is bored 3.5005 inches to fit the spindle and is drilled for four .5 inch rivets for riveting the spindle to the body. The outside of the body is turned to a thin fin, .125 inch thick, .75 inch wide. Through this fin are drilled the nine .2656-inch holes for attaching the felt retainer rings. This retainer ring is of pressed steel U-shape section 16.625 inches O. D., 15.525 inches I. D., the felt used is .5625 inch by 1 inch by 50.375 inches long. Near the outer edge of the body are two bosses (cast on), both on the inside and opposite each other. The upper one is drilled and tapped for a 1.125-inch pin, which acts as the brake cam stud; the lower is drilled and tapped for a 1-inch pin, which acts as the brake anchor. This steering knuckle body is made in two ways, either right or left-hand, for use on either side of the truck. The difference lies in the position of the bosses mentioned just before, they being located on opposite sides of the center line for the different sides of truck.

THE STEERING KNUCKLE PIN.

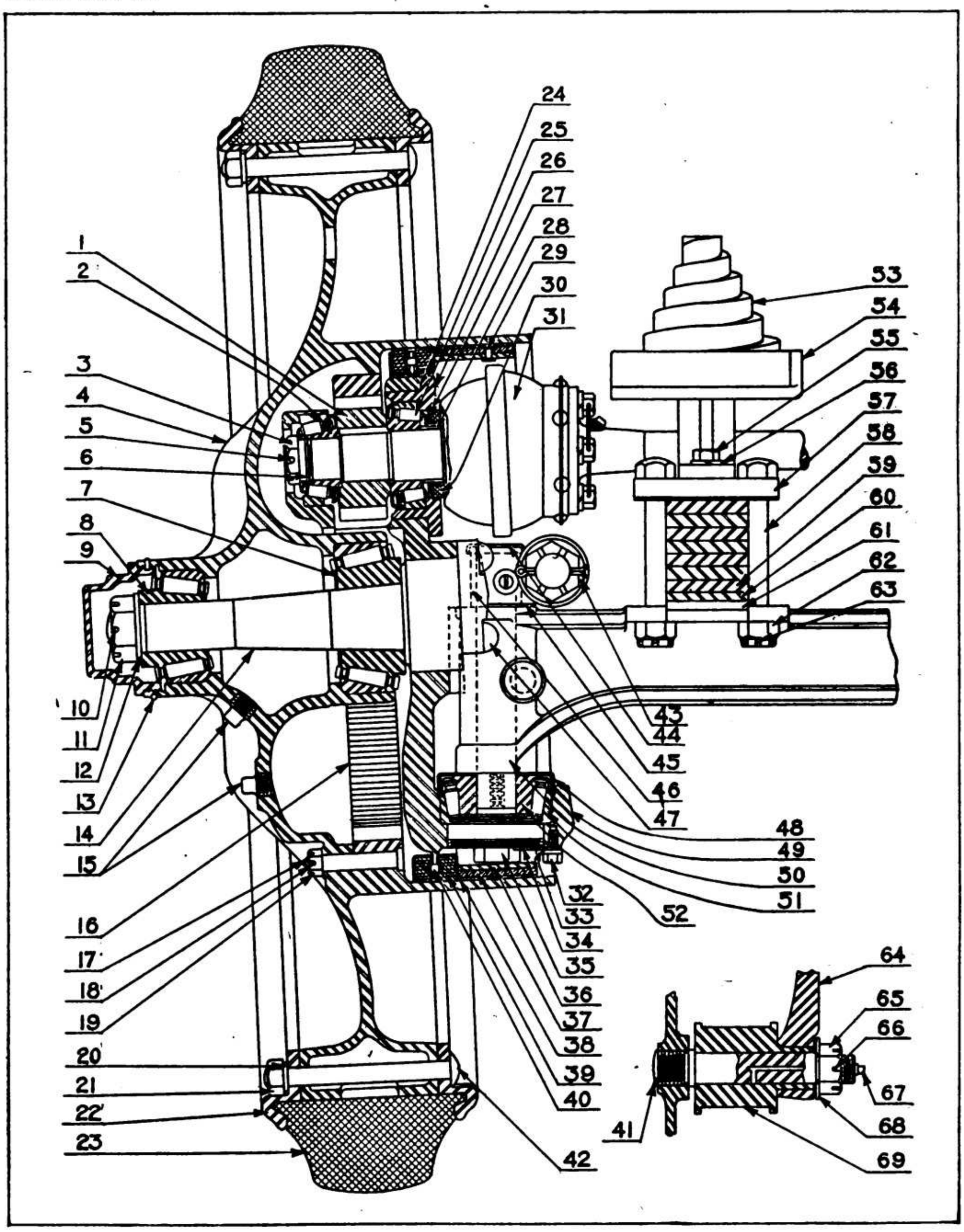
This is for attaching the wheels to the axle through the steering knuckle body, and is made of steel with the upper end hardened. This upper end is also grooved for lubricant. The pin is 8.21875 inches long, 1.248-inch diameter; 4.1875 inches from the upper end there is cut the groove into which fits the pin holding it from revolving. The lower end is drilled and tapped 1 inch deep for a .4375 bolt.

TO REMOVE STEERING KNUCKLE PINS.

The steering knuckle pin (50) in the illustration on page 160 is retained in the axle bed by means of bolt (32684). After removing this

bolt, knuckle body plug (35) should then be removed. A bolt approximately three inches long, seven-sixteenths of an inch in diameter, with a fourteen thread, should then be inserted in the threaded hole in the lower end of the knuckle pin. By inserting a fork or wrench over the head of this bolt and gently tapping downward, the knuckle pin can easily be withdrawn from the axle bed. This pin should be liberally covered with graphite grease before insertion, that it does not rust in position. If, however, the pin has already become rusted in place, a more complete

Plate No. 54

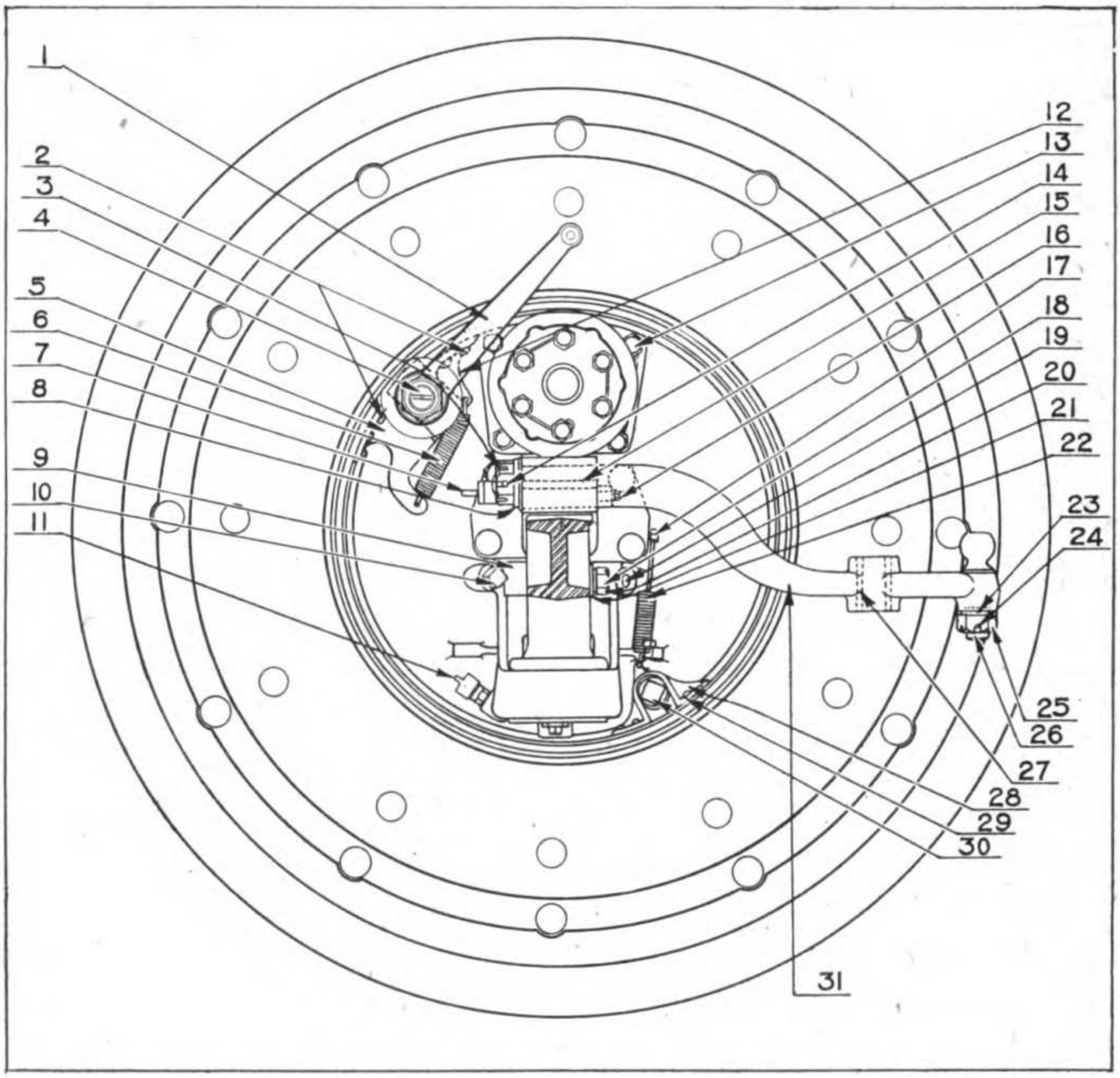


WHEEL AND AXLE END ASSEMBLY.

WHEEL AND AXLE END ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	31097	Wheel drive pinion.
2	31114	Wheel drive pinion cone.
3	31099	Knuckle and pinion shaft nut.
4	33864	Wheel.
5	PI-412	Knuckle and pinion shaft cotter.
6	WA-202	Knuckle and pinion shaft nut washer.
7	32117	Wheel bearing cone (large).
8	32120	Wheel bearing cone (small).
9	32712	Wheel hub cap.
10	PL-419	Steering knuckle spindle cotter.
11	33481	Steering knuckle spindle nut.
12	WA-204	Steering knuckle spindle nut washer.
13	32714	Wheel hub cap lock wire.
14	36688-A	Steering knuckle spindle (front, right).
	36689-A	Steering knuckle spindle (rear, left).
15	PL-104	Wheel grease plug.
16	32073	Wheel internal gear.
17	32074	Wheel internal gear bolt.
18	PI-408	Wheel internal gear bolt cotter.
19	NU-522	Wheel internal gear bolt nut.
20		Tire bolt nut lock washer.
21	35180	Tire bolt nut.
22	35178	Tire flange.
24	32055-32056	Universal joint to body shim.
25	31111	Wheel drive pinion bearing roll and retainer.
26	30590	Bearing cage.
27	31206	Bearing cage felt washer retainer.
28	31098	Wheel drive pinion bearing cone spacer.
29	RI-305	Brake lining rivet.
30	31205	Bearing cage felt washer.
31	30595-A	Wheel universal joint.
32	SC-3302	Steering knuckle body plug lock screw.
33	WA-145	Steering knuckle body plug lock screw washer.
34	32681	Steering knuckle body plug lock.
35	32680	Steering knuckle body plug.
36	32393	Brake band.
37	32397	Brake band lining.
38	30632	Steering knuckle felt retainer.
39	32053	Steering knuckle felt.
40	RI-232	Steering knuckle felt retainer rivet.
41	30621	Brake cam stud.
42	35179	Tire bolt.
43	33558	Steering knuckle arm nut.
44	32054	Steering knuckle spindle bushing cap.
45	WA-857,	Steering knuckle spacing washer.
46	30626	Steering knuckle spindle bushing.
47	R-159	Steering knuckle spindle rivet.
48	32407	Steering knuckle pin bearing dust cap.
49	32052-RT	Steering knuckle body.
50	32682	Steering knuckle pin.
51	32063	Steering knuckle pin bearing cone.
52	32064	Steering knuckle pin bearing cup.
53	35370	Bumper spring.
54	32588	Bumper spring pedestal.
55	SC-238	Bumper spring pedestal screw.
56	WA-147	Bumper spring pedestal screw lock washer.
57	35267	Spring plate (upper).
58	35034	Spring clip bolt.
59	32660-A	Spring (front).
60	32661-A	Spring (rear).
61	35574	Spring plate (lower).
62	NU-536	Spring clip bolt nut.
63	PI-412	Spring clip bolt cotter.
64	36339-LT	Cam lever.
65	NU-330	Wheel brake cam stud nut.
66	PI-413	Wheel brake cam stud cotter.
67	PL-101	Wheel brake cam stud grease plug.
68	WA-339	Wheel brake cam stud washer.
69	36338	Cam.

Plate No. 55



STEERING KNUCKLE AND WHEEL ASSEMBLY.

disassembly will be necessary. By removing the spring and axle shaft the wheel universal joint may be removed from the knuckle body. This will permit the removal of small knuckle pin cap (44). Placing a small brass rod on the upper end of the knuckle pin, it may be driven downward and removed. Its upper bearing is provided with a grease cup, which should be frequently filled and turned daily. The lower knuckle pin bearing should be cleaned thoroughly before replacing. The adjustment of this bearing is taken up by the placing of shims (45) between the axle bed and the upper pin bearing in the knuckle body. The lubrication of this bearing is also provided for by a grease cup inserted in the lower portion of the knuckle body and should be turned daily.

AXLE HOUSING AND DIFFERENTIAL.

(LIVE AXLE MEMBER INCLUDING DRIVING BEVELS).

The axle housing and differential assembly consist of a pinion at the end of the propeller shaft and the ring gear, a spiral gear differentiat-

STEERING KNUCKLE AND WHEEL ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	36384-A	Wheel brake cam assembly.
2	RI-115, 116, 371	Brake band end rivets.
3	33558	Steering knuckle arm nut.
4	30621	Brake cam stud.
5	32395	Brake band end.
6	32416	Wheel brake release spring.
7	CU-209	Steering knuckle spindle grease cup.
8	WA-353	Steering knuckle arm nut washer.
9	32683-A	Steering knuckle pin locking bolt.
10	36331	Steering knuckle body stop screw.
11	CU-209	Steering knuckle body grease cup.
12	32396	Brake band end.
13	SC-2312	Universal joint to body screw.
14	PI-414	Steering knuckle arm nut cotter.
15	KE-208	Steering knuckle arm key.
16	PL-101	Steering knuckle spindle grease plug.
17	SC-2303	Steering brake anchor spring screw.
18	PI-408	Steering knuckle pin locking bolt cutter.
19	SC-2412	Steering knuckle body screw hole plug.
20	NU-316	Steering knuckle pin locking bolt nut.
21	WA-1035	Steering knuckle pin locking bolt washer.
22	32715	Wheel brake anchor spring.
23	WA-399	Steering knuckle arm ball nut washer.
24	PI-413	Trunnion shaft nut cotter.
25	NU-334	Steering knuckle arm ball nut.
26	30616	Steering tube rear lever ball.
27	30615	Steering knuckle arm bushing.
28	32394	Brake band anchor.
29	RI-115	Brake band anchor rivet.
30	30617	Brake anchor pin.
31	32356-A	Front right steering knuckle arm.
	32359-A	Front left.
	32358-A	Rear right.
	32357-A	Rear right.

ing mechanism and suitable housing for the mechanism and axle drive shafts.

These are the units, identical front and rear, which transmit the power from the propeller shafts to the wheels. Since the four wheels are driving and steering wheels, the end of each live axle shaft extending from the differential must be fitted with a universal as well as a wheel driving pinion. The function of the differential assembly is to drive the wheels, compensate for different wheel speeds in making turns and, because of the use of a spiral-gear differential, give comparatively uniform wheel speed regardless of traction.

BEVEL PINION SLEEVE.

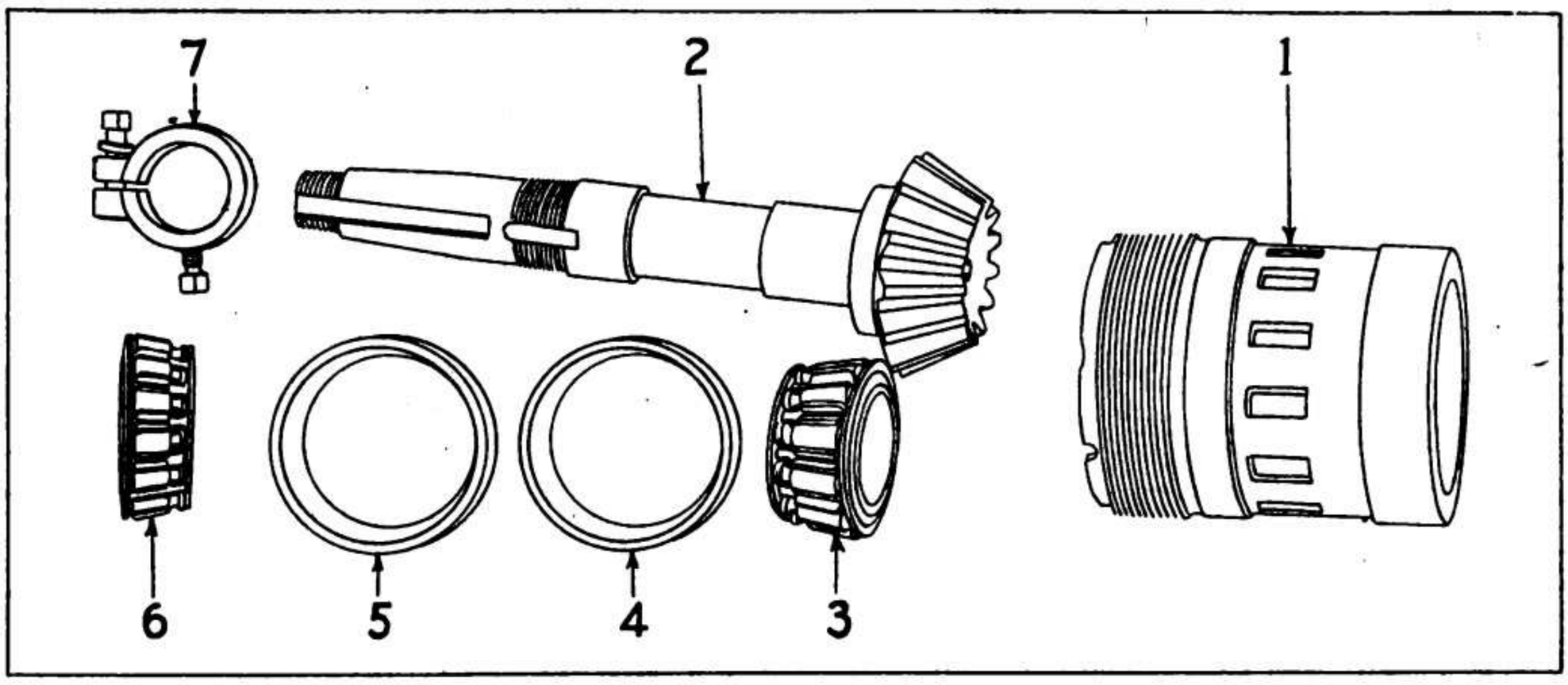
The pinion sleeve assembly consists of the pinion and shaft (to which the propeller shaft is attached through a universal joint), the necessary roller bearing for supporting the shaft and sleeve, which is screwed into the differential housing and which supports the roller bearing cages.

The pinion sleeve is of cast iron of 4.625-inch diameter, 3-inch average inside diameter, 5.25 inches long, with twelve slots cut around the center to permit the locking of the sleeve in place. The forward end is threaded so that the sleeve can be screwed into the differential case.

BEVEL PINION SHAFT.

The pinion shaft is of drop-forged steel with integral bevel pinion on rear end. The shaft is 11.375 inches long over all, average diameter 1.375 inch, forward end tapered for 1.875 inch. The extreme forward end is threaded for .859 inch and is 1-inch diameter. The universal joint drive shaft flange is secured on this tapered portion by a key and by a nut screwed on the threaded end. About 3.75 inches in from the front end the shaft is threaded for about .75 inch. On this portion is screwed the nut which locks the roller bearings in place. The bearings supporting the shaft are Timken roller bearings. The one nearest the pinion is No. 420 cone, 1.5748 inches bore, 1.145 inches long; the cup for the same is No. 414, 3.4843 inches outside diameter, .875 inch long.

Plate No. 56



DRIVING PINION SLEEVE ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	32093	Pinion bearing sleeve.
2	32092	Pinion and shaft.
3	32127	Pinion roller bearing (inner).
4	32126	Pinion roller bearing cup (inner).
5	32130	Pinion roller bearing cup (outer).
6	32129	Pinion roller bearing (outer).
7	32094	Pinion shaft bearing lock nut.

BEVEL PINION SLEEVE ASSEMBLY.

The assembling of these parts will be clear by referring to the illustration shown above. On the shaft (2) is mounted bearing (3), which fits into cup (4), mounted in the sleeve (1). After the insertion of cup (5) in the outer end of sleeve (1), bearing (6) is placed on shaft (2) and adjusting locknut (7), so adjusted as to permit only a sufficient looseness to insure the proper operation of the bearings. The clamp screw on locknut (7) should be tightened after the set screw has been secured in the key slot in the shaft. A lock wire should be placed in the set screw to prevent its loosening. The unit can then be placed in the axle housing and adjusted as described on page 167.

MESHING GEARS.

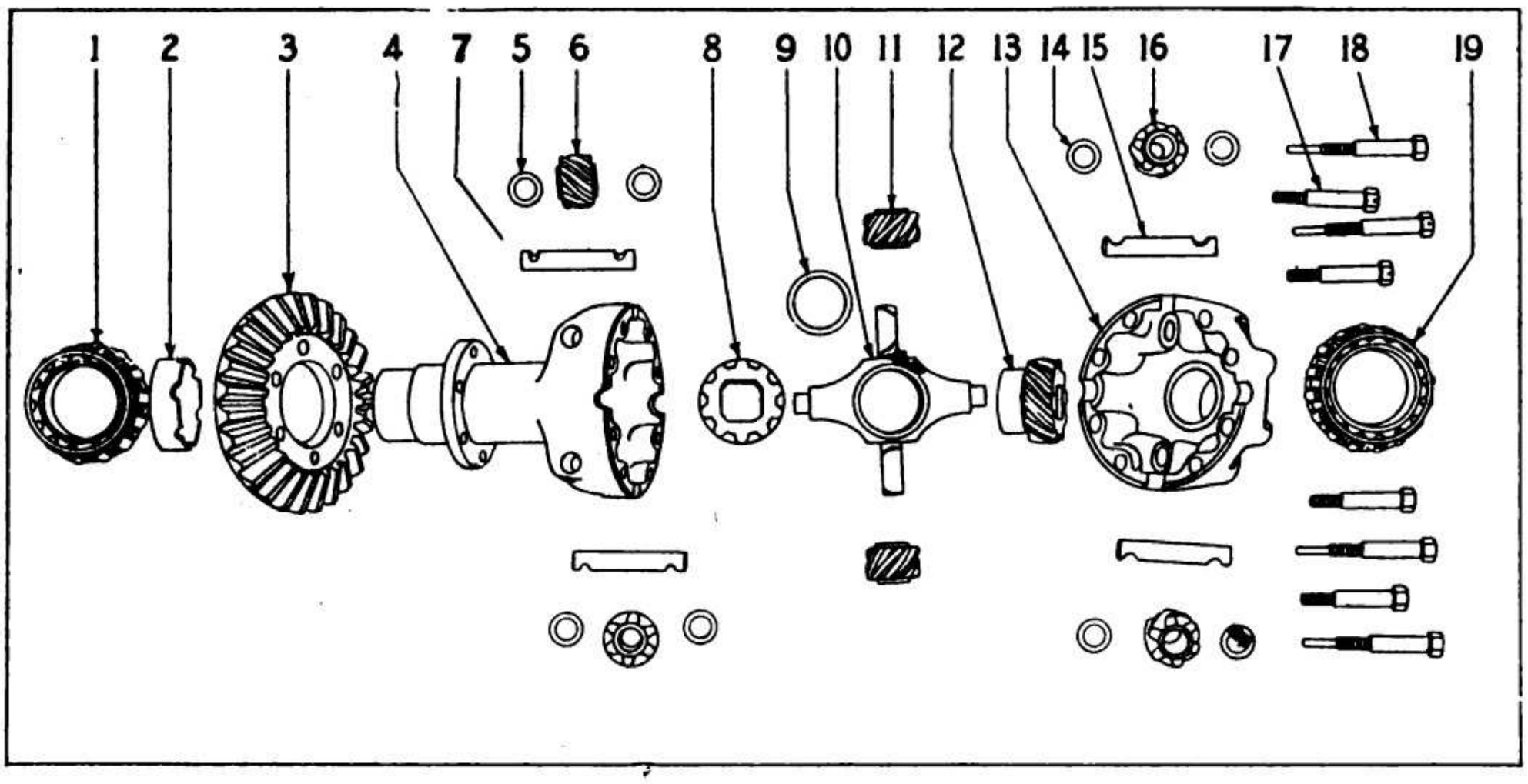
The two bevel gears should mesh closely with a maximum clearance of .006 of an inch. After this adjustment has been obtained, secure all the locking devices on the assembly, including the insertion of pinion sleeve lock screw (9), shown on page 168, and the installation of (5) pinion bearing sleeve nut with universal joint flange and flange nut.

ADJUSTMENT.

When only the adjustment of these parts is necessary, it can be accomplished without the removal of parts by merely loosening the locking devices and making such adjustments as are necessary to eliminate the excessive looseness due to wear. Care should be taken that the felt retainers in the packing glands are removed occasionally and the gland nuts kept tight to prevent the leakage of oil.

The gear housing cover is provided with a gasket to prevent oil leakage. In removing, care should be taken that it is not mutilated.

Plate No. 57



DIFFERENTIAL ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	32133	Differential roller bearing (long).
2	32077	Roller bearing spacer.
3	32076	Drive gear.
4	32075	Differential case (long).
5	32084	Equalizer gear thrust washer.
6	32083	Equalizer gear.
7	32086	Differential side gear pin (left).
8	32081	Differential center gear.
9	32082	Differential center gear washer.
10	32087	Differential spider.
11	32083	Equalizer gear.
12	32081	Differential center gear.
13	32078	Differential case (short).
15	32085	Differential side gear pin (right).
16	32083	Equalizer gear.
17		Differential bolt.
18		Differential bolt and pin lock.
19	32136	Differential roller bearing (short).

DIFFERENTIAL DRIVE GEAR (RING GEAR).

The differential drive gear or ring gear is a bevel gear, outside diameter 6.944, with 27 teeth, 4-5 pitch, riveted to differential housing hub by six .4375-inch rivets and six .315-inch rivets.

AXLE HOUSING.

The case which contains the differential and drive pinion shaft is known as the axle housing and is made in two parts of malleable iron. The lower portion contains all the gearing, etc., the upper serving merely as a cover. Bolted on to the ends of the housing are caps known as the axle housing cap short and axle housing cap long. Mounted close to the ends of the housing in a support integral with it and held in place by caps going over the tops of the cages and bolted to the lower half of the housing are the roller bearings which support the differential. The axle housing cap long which is bolted to the end of the housing on the right hand side has a number of thin steel shims placed between it and the housing for purposes of adjustment of the meshing of the pinion and drive gear. It has a gland placed in its outer end for packing the axle shaft against leakage of grease. Its inner end presses against the roller bearing. The axle cap short which is bolted to the left-hand side of the housing has a similar gland and serves no other purpose than to retain the grease. The roller bearing of this right hand side is mounted in a sleeve which has a threaded inner end. The sleeve slips into the support in the housing and a nut screwed on the end of the sleeve bears against the support and is used to adjust the lateral movement of the differential bearings.

DIFFERENTIAL ASSEMBLY.

The assembling of the unit is easily accomplished, but should, in all cases be supervised by a thorough mechanic. Referring to the illustration on page 165, the drive gear (3) is riveted to the differential case (4), after which are placed spacer (2) and bearing (1). In the interior of case (4) are mounted gears (6), together with spacer washers (5) at either end on shaft (7), the notches in shaft (7) coinciding with the guide holes into which are inserted bolts (18). In case (13) are similarly disposed gears (16) with their spacers (14) at either end on shaft (15), the notches of which also coincide with the guide holes for the insertion of lock bolts (18).

The central assembly consists of gears (8) and (12), the bearing portions of which fit into the center of spider (10), separated only by thrust washer (9). On the projecting pins of spider (10) are placed worms (11). The assembly is then placed in case (4), and the coinciding end of case (13) secured to same by means of bolts (17), after which bearing (19) is placed on the end of the case. The assembled unit can now be

placed in the axle housing in the roller bearing cages and the end adjustments made.

COMPLETE AXLE HOUSING AND DIFFERENTIAL ASSEMBLY.

Having completed the assembling of the differential units, they may be placed in the roller bearing cages in the axle housing and the pinion sleeve inserted in the forward end of the housing. The differential assembly is supported in bearing cage (12), shown on page 168, and the outside end of the case. Bearing case (12) is adjustable, that the proper amount of lateral movement can be secured for the roller bearings. Their adjustment should be such that no appreciable end play is noticed and they do not bind on the cones. The bearing adjustment nut (11) should then be securely locked and the retaining lock (18) inserted with (19) lockscrew. The pinion sleeve assembly should next be secured into the housing and so adjusted that the bevel ring gear and pinion mesh, with their outer surfaces coinciding. If the longitudinal adjustment of the pinion sleeve does not bring about this position of the gears, it will be necessary that the lateral position of the differential unit be changed. This can be obtained by adding or removing shims (31) between the housing cap (30) and the axle gear housing, making the necessary readjustment of bearing cage (12).

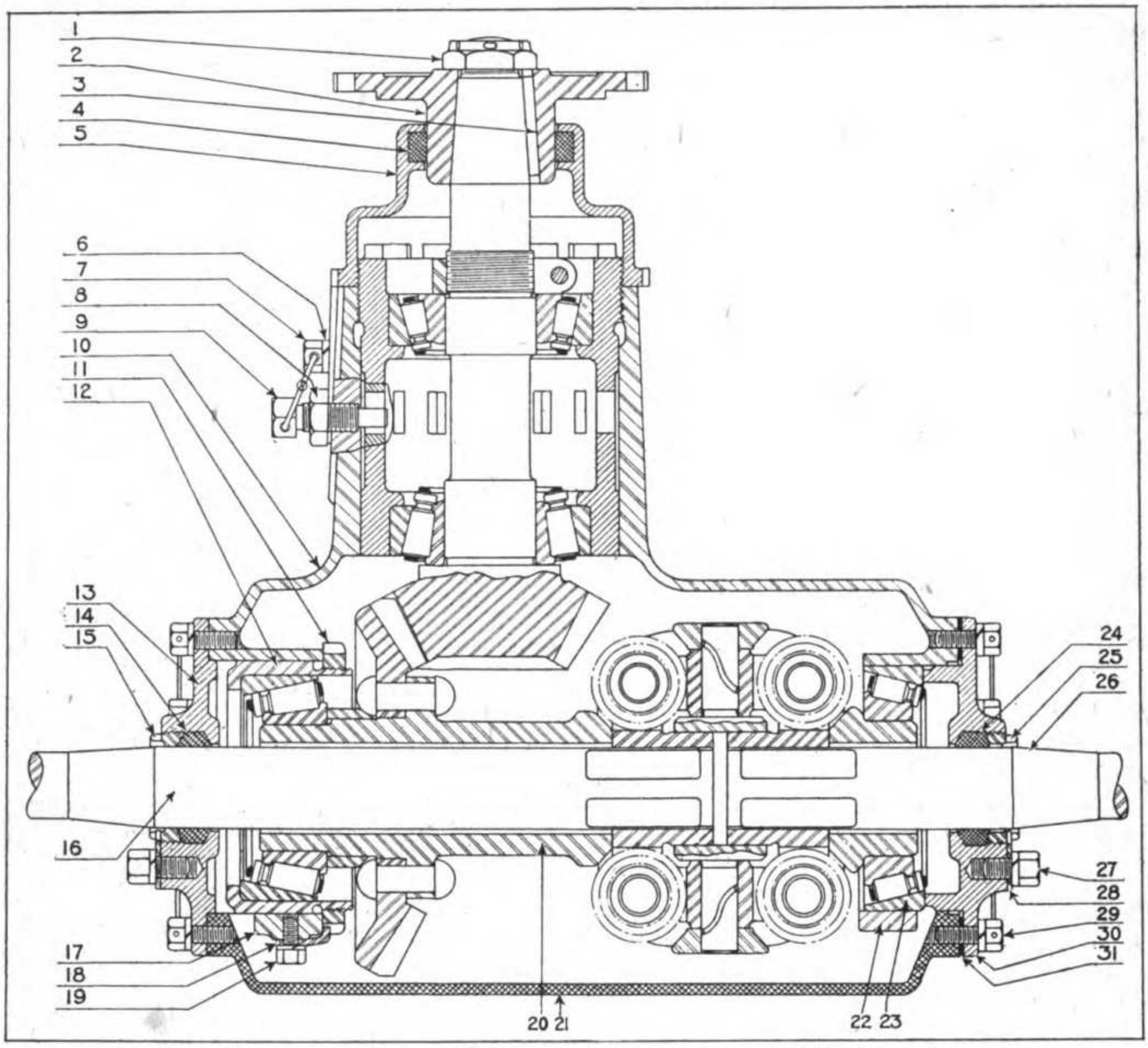
DIFFERENTIAL ACTION AND CONSTRUCTION.

The spiral gear differential is, with the exception of the type of gears, much like the conventional bevel gear type. Forty-five degree spiral gears are used, because it is by the use of this type that equal power is delivered to both wheels of an axle. In the bevel gear differential when one wheel is on slippery ground power is wasted through the lack of traction. By means of the M. & S. spiral gear differential both wheels get equal power, regardless of the road conditions. The action is caused by friction between the gears.

The differential is contained in the differential case, which is made in two parts bolted together. A spider with four arms is secured in this case and on each of two arms is mounted a spiral pinion (C) and (C^1), shown on page 169. These engage with spiral pinion (B) (B^1) (B^2) (B^3), four in number, which are mounted on shafts held in the case at right angles to the arms of the spider, that the first pinions (C) are mounted on. The second gears (B) also mesh with large gears (A) and (A^1), known as crown gears. These crown gears have a large square hole in them into which fit the square ends of the driving axles. These crown gears also have projecting hubs which fit into the hubs of the spider before mentioned.

When road resistance is sufficient to give traction to each driving wheel, both wheels are equally driven, the crown wheels "A," to which they are attached, being carried bodily round by the worms "B," in which they are in engagement, just as, with an ordinary differential, they are

Plate No. 58



AXLE HOUSING AND DIFFERENTIAL ASSEMBLY.

carried round by the pinion "C." But when road resistance upon the wheel is reduced to a point at which it loses traction, and would, with the ordinary differential, start spinning, nothing of this kind happens, because the angle of the worms "B" is such that, while the crown wheels "A" can drive the worms "B," the worms cannot drive the crown wheels, and, as a consequence, the differential is locked so far as any movement of the wheel in relation to the differential is concerned. The axle becomes for all practical purposes a solid one, and all the drive is taken up by both wheels.

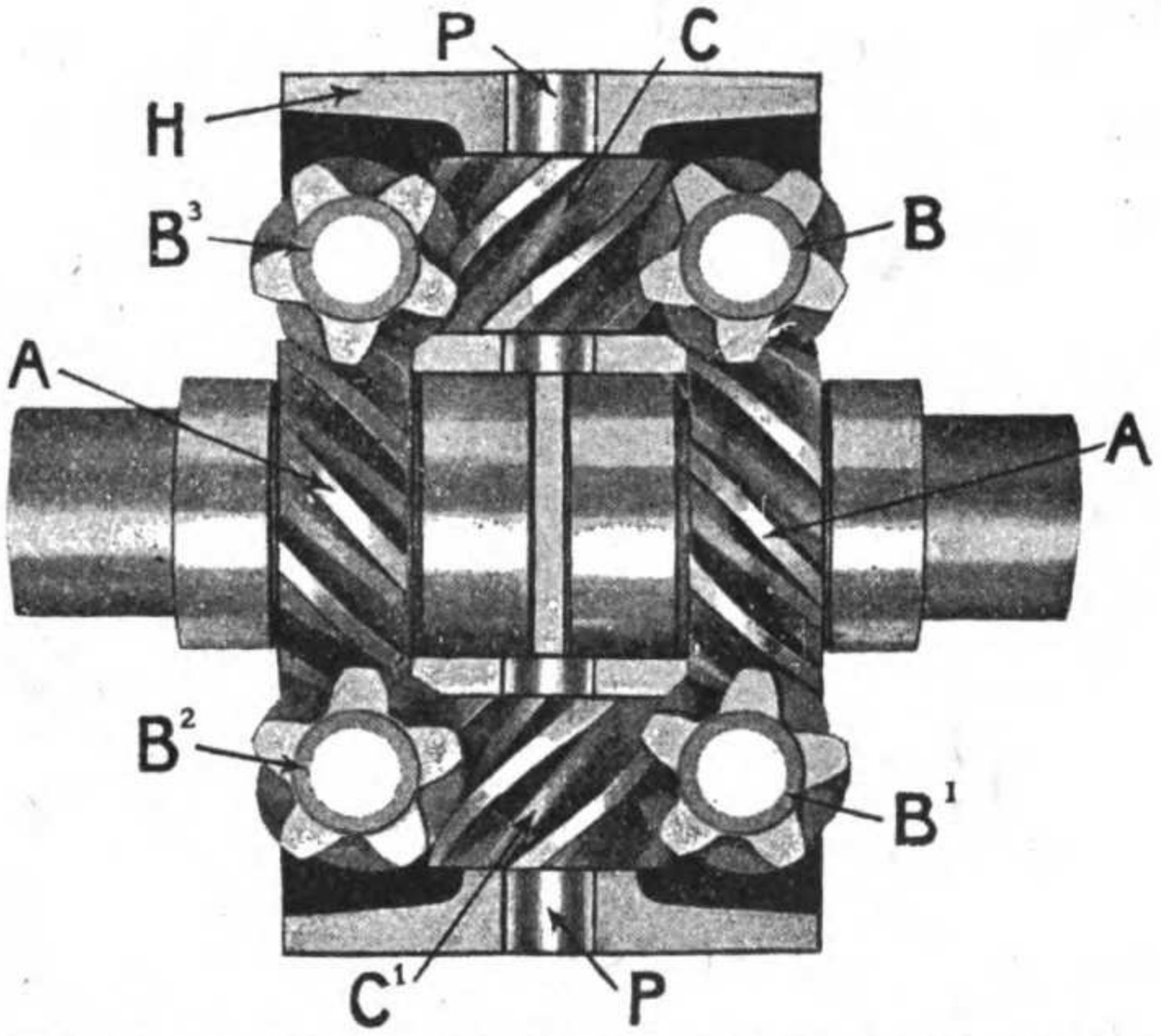
When both wheels are on firm ground and the car traveling freely, the differential is enabled to act in the usual manner when turning corners, by reason of the fact, already alluded to, that the crown wheels "A" can drive the worms "B." Each driving wheel is attached to its respective crown wheel, and when a curve in the road is followed, the outer wheel is forced by its contact with the road to travel a greater distance than the inner one. The outer wheel, therefore, revolving faster than the differential, turns the worm "B" in connection with it and

SECTIONAL VIEW AXLE HOUSING AND DIFFERENTIAL ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	NU-512	Universal joint companion flange nut.
2	32273	Universal joint companion flange.
3	KE-304	Universal joint companion flange key.
4	WA-454	Pinion bearing sleeve nut packing.
5	32110	Pinion bearing sleeve nut.
6	WA-145	Pinion shaft bearing lock nut screw lock washer.
7	SC-3301	Pinion shaft bearing lock nut screw.
8	NU-140	Pinion shaft bearing sleeve screw nut.
9	32112	Pinion shaft bearing lock set screw.
10	32089	Axle gear housing.
11	32098	Differential roller bearing cage nut.
12	32088	Differential roller bearing cage (long end).
13	32104	Axle housing cap (short).
14	35511	Housing cap felt washer.
15	32105	Housing cap gland nut.
16	33580	Axle drive shaft.
17	32091	Differential case bearing cap (left).
18	32099	Differential roller bearing cage nut lock.
19	SC-3201	Differential roller bearing cage nut lock screw.
20	32075	Differential case (long).
21	32106	Axle housing cover.
22	32090	Differential case bearing cap (right).
23	32136	Differential roller bearing cup.
24	35511	Housing cap felt washer.
25	32105	Housing cap gland nut.
26	33581	Axle shaft.
27	SC-3401	Housing cap gland nut lock screw.
28	32232	Housing cap gland nut lock.
29	SC-2406	Housing cap screw.
30	32100	Housing cap (long).
31	32103	Housing cap shim.

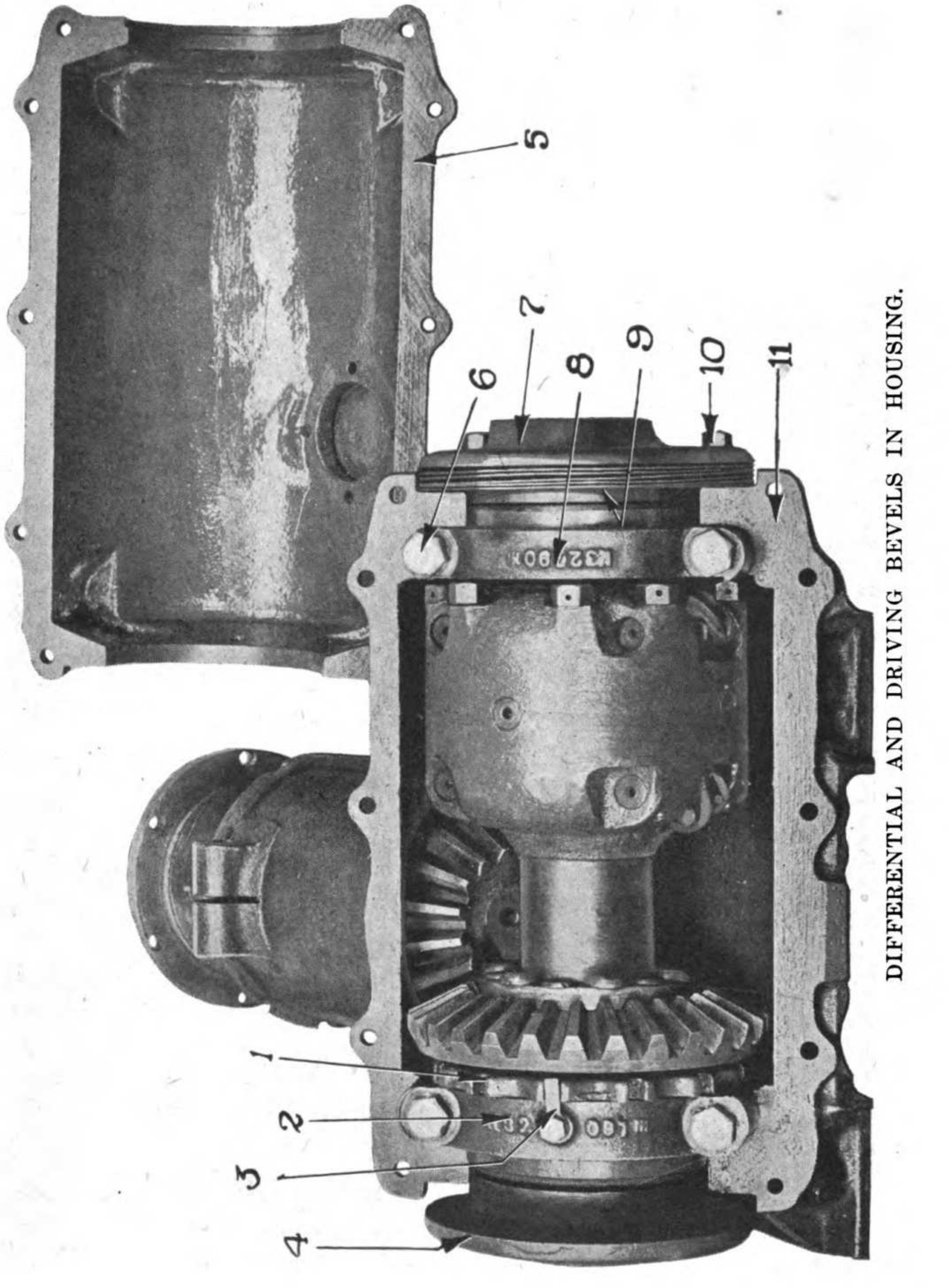
so enables the central pinions "C" to act and react on the opposite worms "B" with a differential action and to distribute the power to each wheel in

Plate No. 59



RELATION OF GEARS IN M. & S. DIFFERENTIAL.

Plate No. 60



DIFFERENTIAL AND DRIVING BEVELS IN HOUSING.

DIFFERENTIAL AND DRIVING BEVELS IN HOUSING.

Ref. No.	Part No.	Name of Part.
1	32098	Differential bearing cage nut.
2	32091	Differential bearing cap—left.
3	32099	Differential bearing cage nut lock.
4	32104	Differential housing cap (short).
5	32106	Differential housing cover.
6	SC-255	Differential housing cap screw.
7	32100	Differential housing cap (long).
8	32090	Differential bearing cap—right.
9	32102, 32103	Differential housing cap shim (thick and thin).
10	SC-2406	Differential housing cap screw.
11	32089	Differential housing.

the usual manner. It will be seen that the action is the same in either direction, so that the gear functions equally well whether the car is going forward, reversing, or is driving the engine.

DIFFERENTIAL CASE.

The differential case holds the differential, bevel ring gear, etc. It is made in two parts. The right-hand or short side has only a short hub on which is mounted the roller bearing supporting this end. The right hand or long hub side has the roller bearing supporting it mounted on its extreme end; close to this end is a flange, to which is riveted the main drive bevel gear or bevel ring gear. The two halves are bolted together and contain the differential gears.

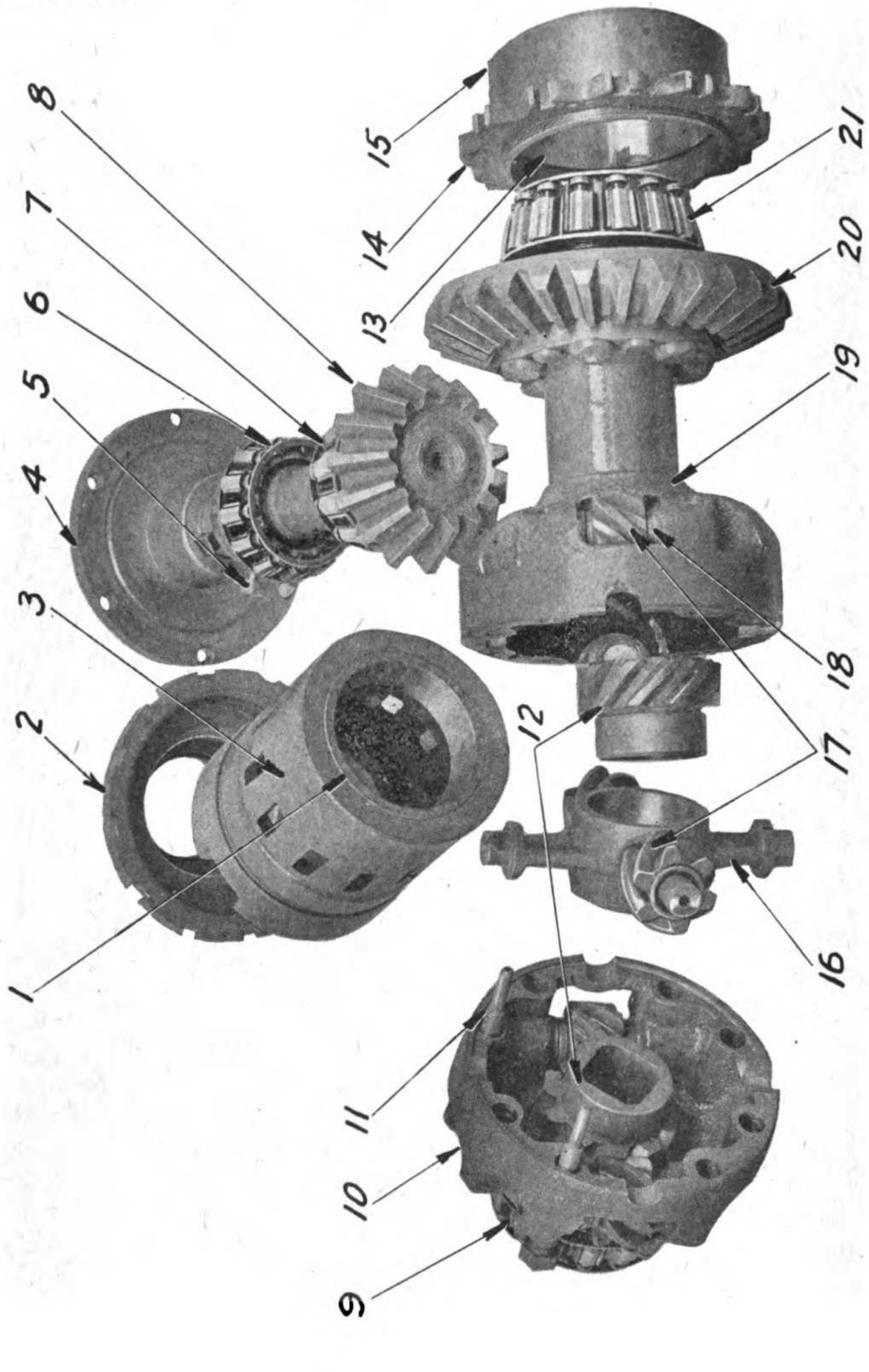
The roller bearings used are Timken No. 397, cup No. 393, on the right-hand side and Timken No. 462, cup No. 4520. The sleeve which contains the right-hand bearing is 4.5 inches outside diameter, 3.98 inches inside diameter, 2.1875 inches long, threaded on inside end for .6875 inch on a diameter of 4.3125 inches made of cast steel. The housing cap long has an overall diameter of 6 inches, a threaded gland in the center 2 inches in diameter and projecting hub .75 inch long, 4.33 inches diameter on inner side. Housing cap short is similar in respect to outside diameter and gland, but the projecting hub is only .125 inch long, 4.5-inch diameter. Both of these are made of cast iron.

GEAR CASE.

The differential gear case (the case in which the differential gears proper are housed) is of cast steel, the long hub side known as the differential case long, has a total length of 8 inches, hub 2.375 inches, diameter 5.46875 inches. From its inside end is the flange formed on the hub; it is 3.9375-inch diameter and 5 inches thick. Through it are drilled the twelve rivet holes for holding the drive gear. The right-hand extreme end is 2.252-inches diameter and fits into the roller bearing cone. Fitting over the hub of the case is a spacer sleeve, which fits in between the bevel gear and the Timken bearing.

The short hub side of the case is known as the differential case short;

Plate No. 61



DIFFERENTIAL AND BEVEL GEAR DRIVE ASSEMBLY.

DIFFERENTIAL AND BEVEL GEAR DRIVE ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	32126	Pinion inner bearing cup.
2	32110	Differential pinion sleeve nut.
3	32144-A	Pinion shaft sleeve and cups.
4	32273	Universal joint companion flange (rear).
5	32094	Pinion shaft outer bearing lock nut.
6	32130	Pinion shaft outer bearing cone and rollers.
7	32127	Pinion inner bearing cone and roller.
8	32092	Pinion and shaft.
9	32136	Differential case bearing cone and rollers (short).
10	32078	Differential case (short).
11	32079	Differential case bolt.
12	32081	Differential center gear.
13	32132	Differential roller bearing cup.
14	32098	Differential bearing cage nut.
15	32140-A	Differential bearing cage.
16	32087	Differential spider.
17	32083	Differential equalizing gear.
18	32085	Differential equalizer gear pin.
19	32075	Differential case (long).
20	32076	Differential drive gear.
21	32133	Differential case bearing cone and rollers (long).

is 3.4375 inches long, with a hub 2.3634-inches diameter, .9375 inch long. On this hub is mounted the roller bearing. These two halves are bolted together with four hex head differential bolts, 3.1875 inches long, 0.5-inch diameter, threaded end, .375-inch diameter.

DIFFERENTIAL SPIDER.

Contained inside of the gear case is a four-arm spider. The arms fit into bearings in the case which are formed when the two halves are bolted together. On two of the arms a differential equalizing gear is mounted. The spider is made of drop-forged steel. The arms are .6235-inch diameter. The total length over all of the arms is 5.875 inches. Hub bored 2 inches, outside diameter of hub 2.375 inches. Arms on which gears fit are grooved for lubricant.

CENTER GEARS.

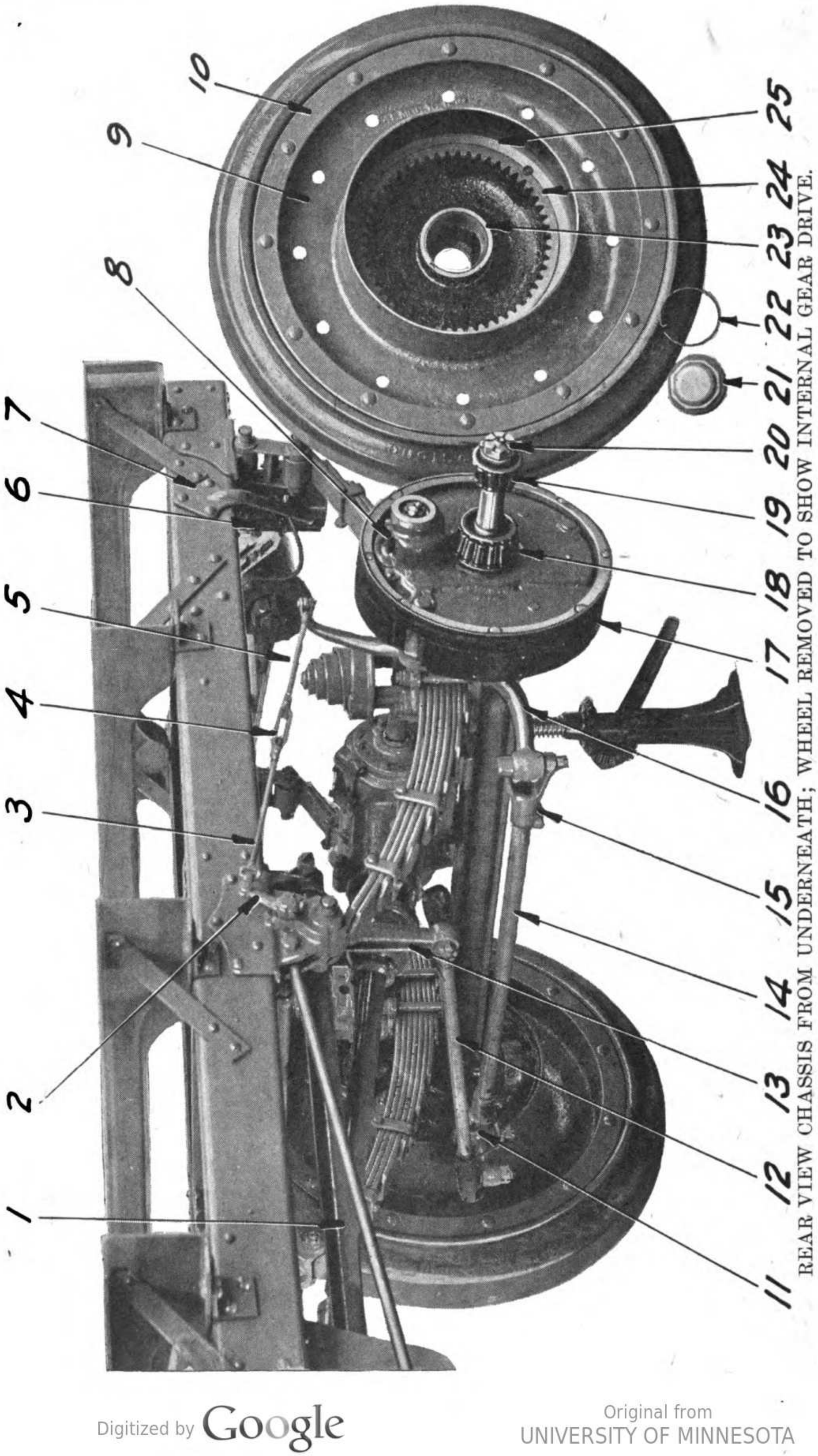
Fitting into the hub of the spider are hubs on the differential center gears, or crown wheels. These gears have ten teeth, six pitch 45 degrees, spiral, 2.357 inches pitch diameter, 2.357 inches outside diameter, face .8125 inch, material hardened steel. Length through gear and hub 1.75 inch. Hub diameter, 1.994 inch. The gears mounted on the spider have six teeth, 6-8 pitch 45 degrees spiral, 1.414 inch P. D., 1.6640 inch outside diameter, .6255 inch bore, 1.1885 inch total length, .9375-inch face, material hardened steel.

EQUALIZING PINIONS.

The four equalizing pinions which are mounted on pins supported in the case are similar in every way with the two above. The pins on which they are mounted are at right angles with the pins on which the above two gears are mounted.

The pins are of hardened steel 3.5 inches long, .6235 inch diameter.

Plate No. 62



REAR VIEW CHASSIS FROM UNDERNEATH; WHEEL REMOVED TO SHOW INTERNAL GEAR DRIVE.

That on the left side known as the differential side gear pin left has notches cut in it close to the ends .28125 inch in diameter. The other known as the differential side gear pin right has notches cut in it close to the ends .53125 inch in diameter. The pins are secured by the bolts which fasten the differential case together by the ends of the bolts fitting into these notches.

Between the hubs on the center gears is placed a steel thrust washer 1.984-inch diameter, hole 1.5625 inch., .298 inch thick.

AXLE DRIVE SHAFTS.

The axle drive shafts connect the differential to the wheels through universal joints and gears and thus serve to transmit the power. They are identical in every way, except as to length. The inner end of each is 1.237-inch square for a distance of 2 inches. The outer end has a flange formed integral with it 4-inches diameter, .375 inch thick. To this flange is bolted the axle universal joint by six .4375-inch bolts. A hole for grease is drilled in the flanged end of the shaft. The lengths are rear left-hand side 19.375 inches long, rear right-hand side 24.0625 inches long. Front left hand 11.5 inches long. Front right hand 31.9375 inches long. The material used is steel.

AXLE DRIVE SHAFT UNIVERSALS.

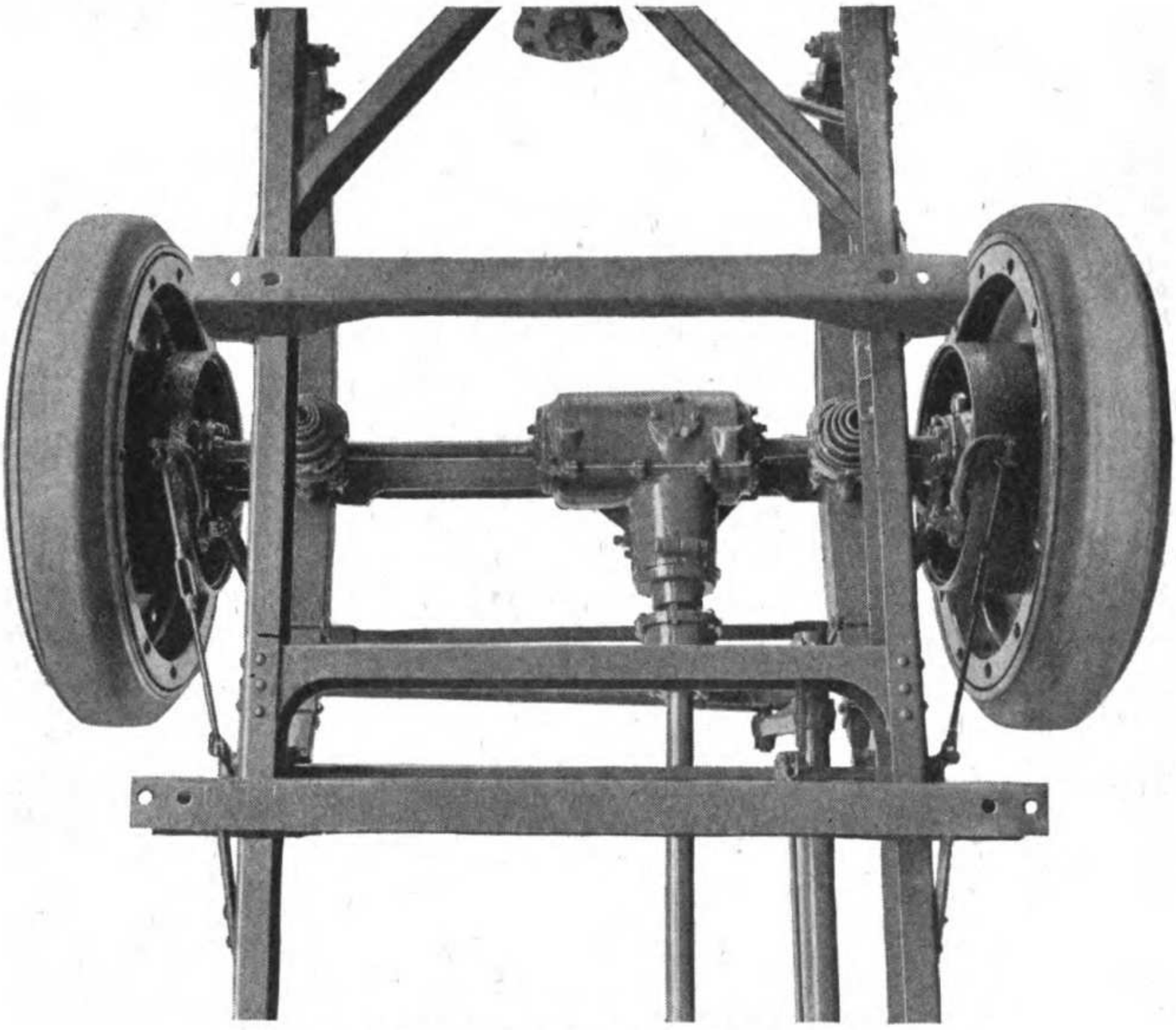
The drive shaft end of these axle universals is formed by a plate with forks as described above. The plate is 4-inch diameter, .375 inch thick.

REAR VIEW OF CHASSIS FROM UNDERNEATH; WHEEL REMOVED TO SHOW INTERNAL GEAR DRIVE MECHANISM.

Ref. No.	Part No.	Name of Part.
1	35714-A	Steering tube and lever.
2	31189	Brake cross shaft lever (outer).
3	32381	Brake rod end (right).
4	32383	Brake rod turnbuckle.
5	32382	Brake rod end (left).
6	35184-A	Tail lamp, complete (Adlake).
7	35865	Tail lamp bracket.
8	36689-A	Steering knuckle body and spindle (rear left).
9	32894-A	Wheel, complete, less tire.
10	35178	Tire side flange (Goodrich).
11	32406	Tie rod yoke (adjustable).
12	33579-A	Drag link, complete.
13		Steering tube rear lever (integral part of steering tube).
14	34921-A	Steering tie rod and yoke.
15	32406	Tie rod yoke (adjustable).
16	32358-A	Steering knuckle arm, complete (rear left).
17	32393	Brake band.
18	32117	Steering knuckle spindle bearing cone and rollers (inner).
19	32120	Steering knuckle spindle bearing cone and rollers (outer).
20	33481	Steering knuckle spindle nut.
21	32712	Wheel hub cap.
22	32714	Wheel hub cap lock wire.
23	32116	Wheel bearing cup (Timken) (large).
24	32073	Wheel internal gear.
25	32894-A	Wheel, complete, less tire.

Distance back of plate to center of hole through forks 2.125 inches. Hole in forks 1.251 inches diameter for bushing. Plate bolted to axle end by six .4375-inch bolts. The pinion end of these universals is formed on the end of a shaft. The distance from end of shaft to center of hole in forks is 6.625 inches. Hole is 1.251 inches diameter for a bushing. The shaft is turned three different diameters and threaded at end; 1.5743 inches next to fork, 1.4995 inches second size, .9995 inch third size. End .875 inch diameter and

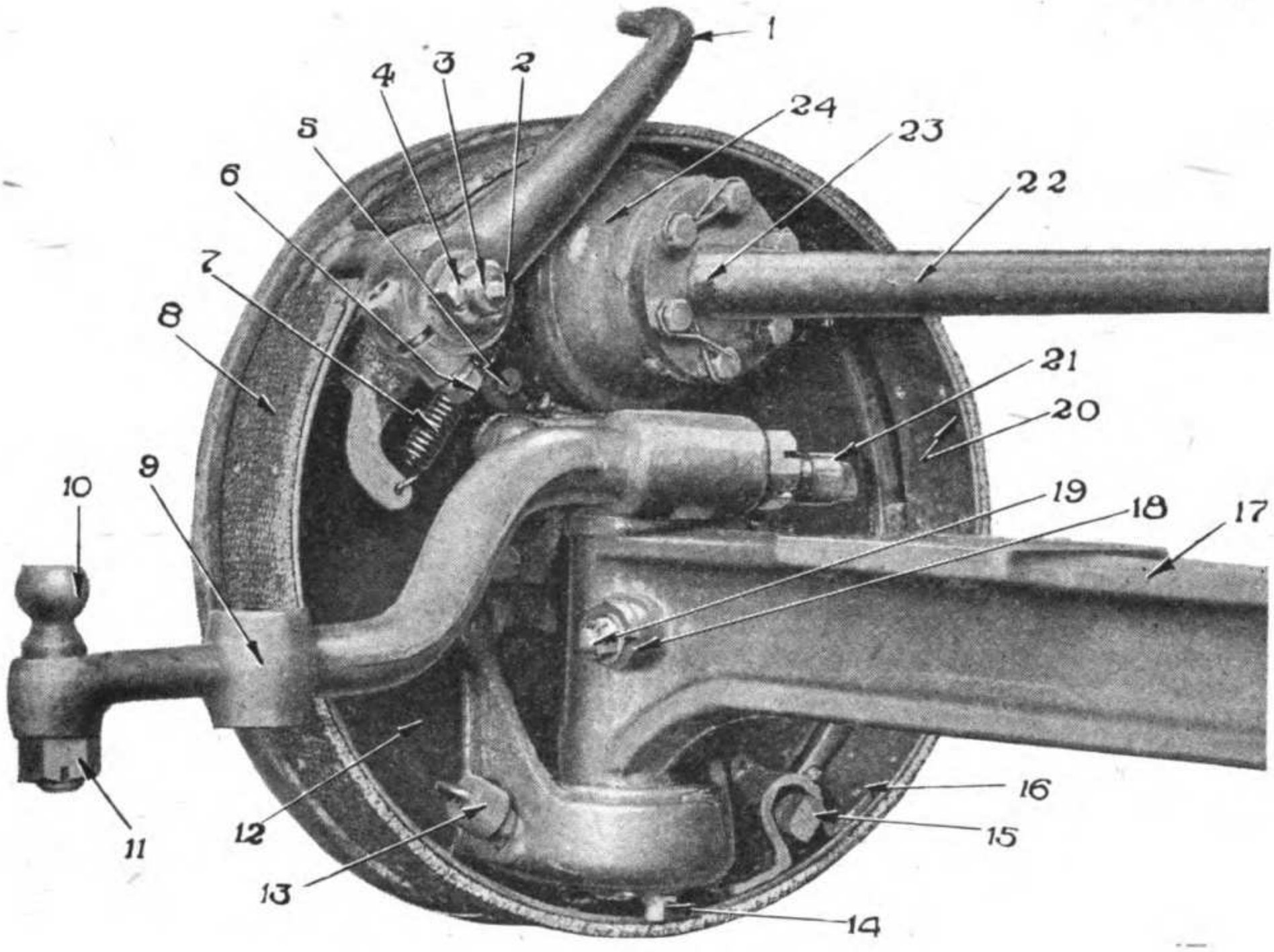
Plate No. 63



PLAN VIEW, REAR OF CHASSIS

threaded. End keyseated and middle diameter keyseated. This shaft is supported on two roller bearings and has the drive pinion keyed to it and is made of hardened steel. The male universal pin is .871 inch diameter, 4 inches long, of hardened steel, has a .265-inch hole through it at its center. Has slots cut across the ends and two oil grooves 1.125 inches long on each end. The universal joint pin female is 4 inches long, 1.247-inches diameter at the center, with ends turned down to .870-inch diameter. It is drilled lengthwise .265 inch for a locking pin. Through its center is drilled a .891-inch hole to allow the male pin to pass through. Material hardened steel. Both of these pins pass through the center of a hardened

Plate No. 64



AXLE BED AND WHEEL BRAKE.

Ref. No.	Part No.	Name of Part.
1	36339	Wheel internal brake cam lever (left).
2	PL-101	Wheel brake cam stud grease plug.
3	30621	Wheel brake cam stud.
4	NU-330	Wheel brake cam stud nut.
5	SC-2312	Universal joint to body screw.
6	BO-1555	Wheel internal brake cam lever clamp screw.
7	32416	Wheel brake release spring.
8	32397	Wheel brake band lining.
9	32359-A	Steering knuckle arm, complete (front left).
10	30616	Steering knuckle arm ball.
11	NU-334	Steering knuckle arm ball nut.
12	36687-A	Steering knuckle body and spindle (front left).
13	CU-209	Steering knuckle body grease cup.
14	SC-2817	Steering knuckle body plug lock screw.
15	30617	Wheel brake anchor pin.
16	32394	Wheel brake band anchor.
17	33578	Axle bed (front or rear).
18	NU-316	Steering knuckle pin locking bolt nut.
19	32683-A	Steering knuckle pin locking bolt.
20	32393	Wheel brake band.
21	CU-209	Steering knuckle arm grease cup.
22	33583	Axle shaft (left front).
23	PL-101	Axle drive shaft grease plug.
24	30595-A	Wheel universal joint assembly.

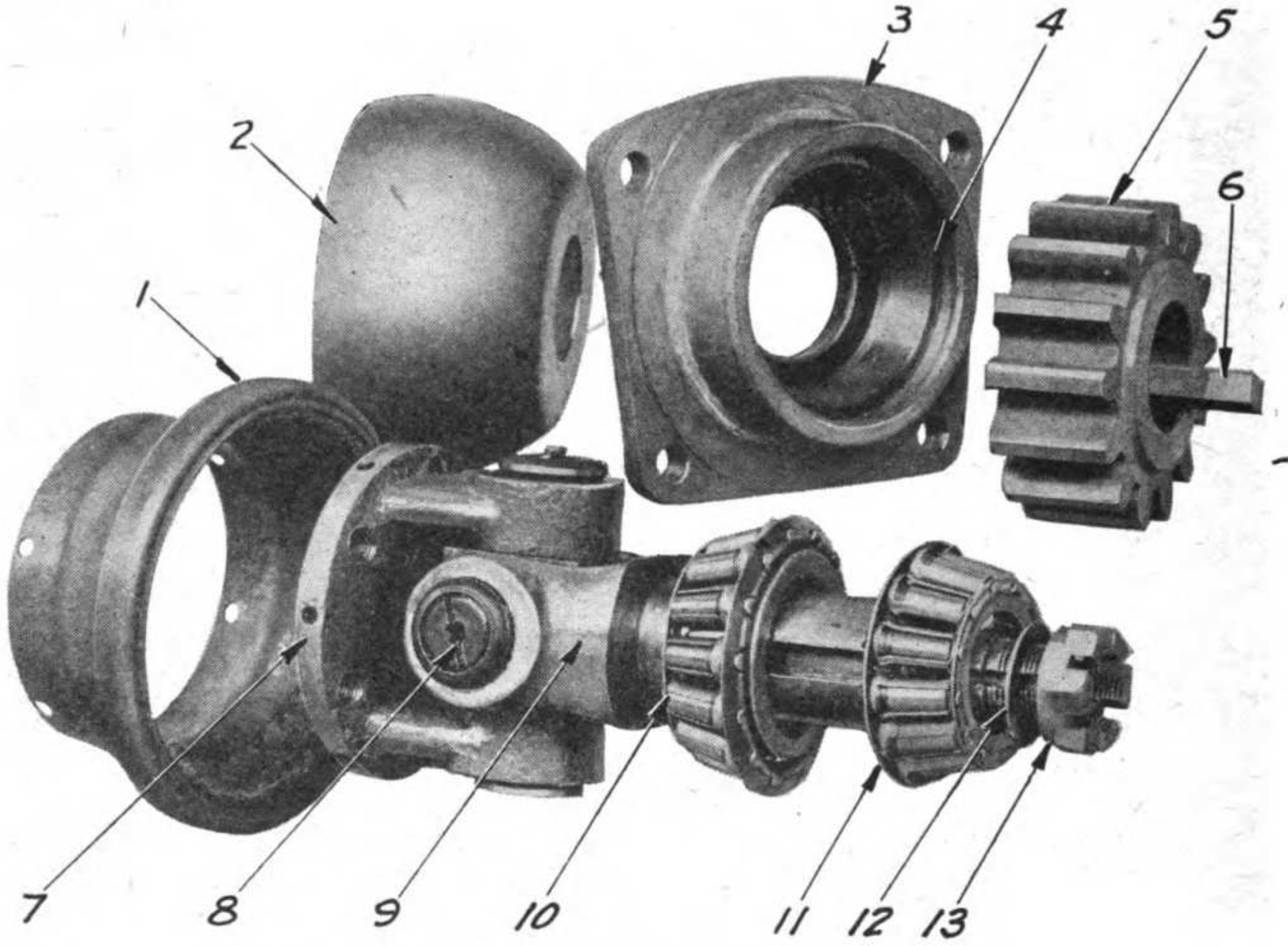
steel block, which fits between the forks. It is 1.75 inches square with the necessary 1.251-inch hole and .875-inch hole drilled through it. The bushings for the forks are of hardened steel 1.125-inch diameter with a .8755-inch hole through them with a .1875-inch groove cut .25 inch from one end. The locking pin is of steel, 4.078 inches long, with a No. 40

hole drilled .125 inch from either end. The pinion keyed on the universal joint end is 4-5 pitch, fourteen teeth 1.5 inches face, bore 1.625 inches long, 3.5 inches pitch diameter, 3.9 inches O. D., 1.5-inches bore, keyseated .374 inch by .188 inches.

AXLE DRIVE SHAFT UNIVERSAL (WHEEL UNIVERSAL) SPLINDLE BEARINGS.

The bearings used at the outside end are Bock No. 315, held in place by nut on end of spindle against a shoulder on the spindle. The inner

Plate No. 65



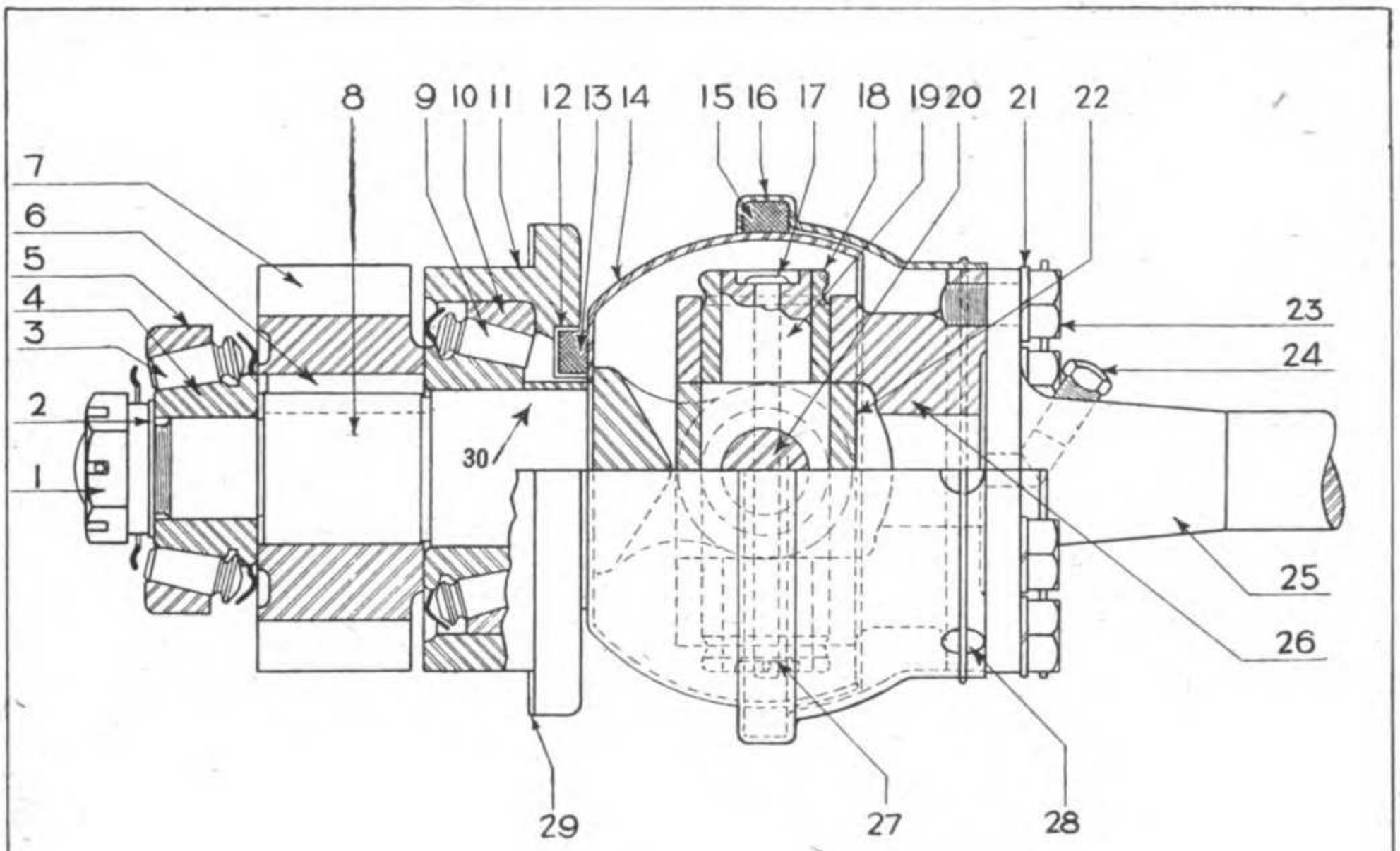
WHEEL UNIVERSAL JOINT ASSEMBLY.

Ref. No.	Part No.	Name of Part.
1	30597	Wheel universal joint cover (outside).
2	30596	Wheel universal joint cover (inside).
3	30590-A	Wheel universal joint bearing cage.
4	31109	Wheel universal joint bearing cup.
5	31097	Wheel drive pinion.
6	KE-212	Wheel drive pinion key.
7	32061	Wheel universal joint knuckle (drive shaft end).
8	32068	Wheel universal joint knuckle and pinion shaft pin (male).
9	31096	Wheel universal joint knuckle and pinion shaft.
10	31111	Wheei drive pinion bearing roller and retainers (large).
11	31115	Wheel drive pinion bearing roller and retainer (small).
12	WA-202	Wheel universal joint knuckle and pinion shaft nut washer.
13	31099	Wheel universal joint knuckle and pinion shaft nut.

roller bearing is Bock No. 357. This is contained in a bearing cage which bolts on to the steering knuckle body. A steel sleeve slips over the spindle and bears against shoulder at the inner end and against the cup of the bearing, keeping the bearing in place. The bearing cage is a steel casting bored 3.31 inches to receive the bearing. It is 1.5 inches thick

and is bored on its inside end 2.8755 inches to receive the packing. The flange by which it is attached is .375 inch thick and is drilled for four .4375-inch bolts. The packing used is of flax .375 inch square, approximately 15.75 inches long.

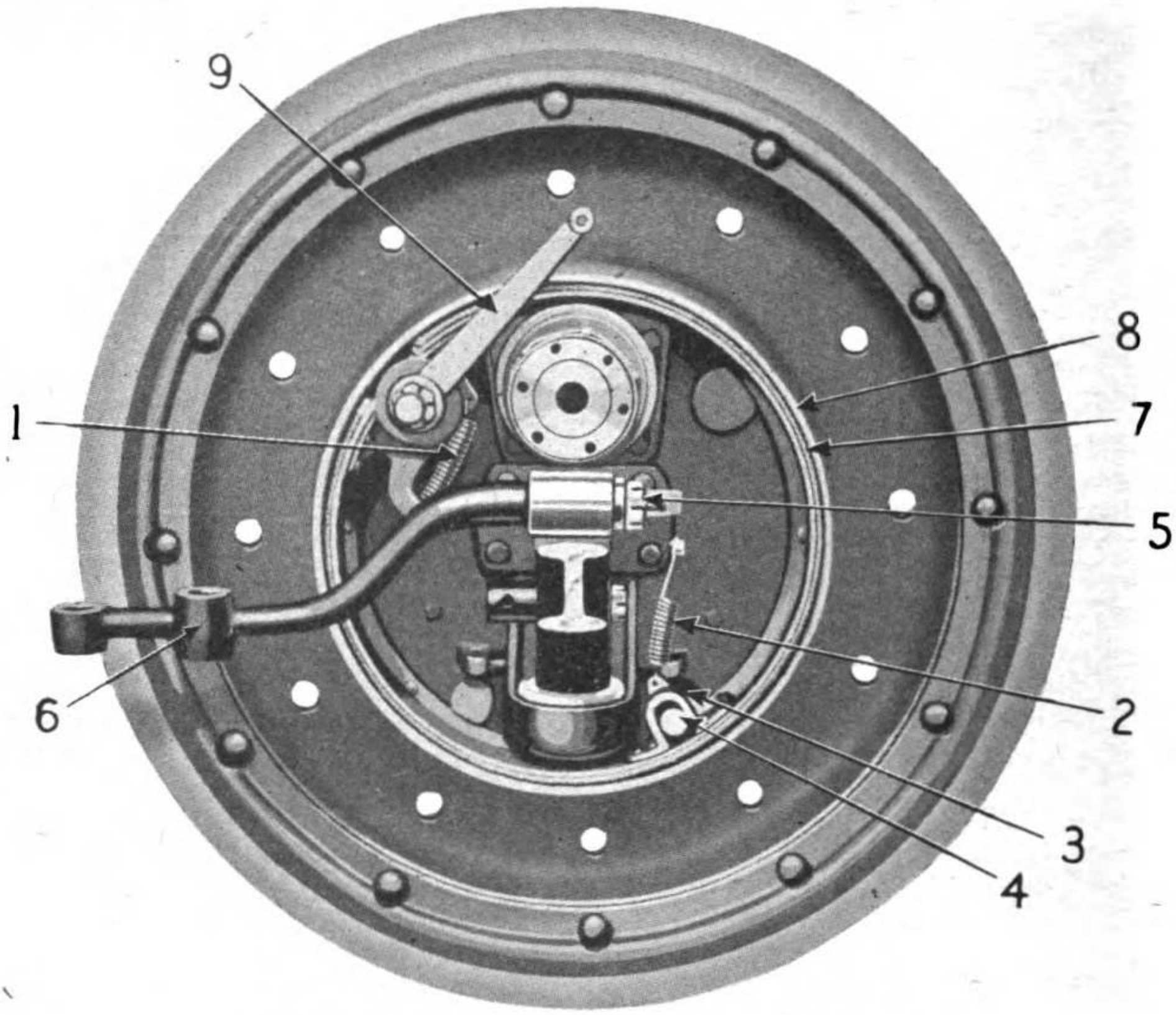
Plate No. 66



WHEEL UNIVERSAL JOINT.

Ref. No.	Part No.	Name of Part.
1	31099	Knuckle and pinion shaft nut.
2	WA-202	Knuckle and pinion shaft nut washer.
3	31115	Wheel drive pinion bearing.
4	31114	Wheel drive pinion bearing cone (small).
5	31113	Wheel drive pinion bearing cup.
6	KE-212	Wheel drive pinion key.
7	31097	Wheel drive pinion.
8	31096	Knuckle and pinion shaft.
9	31111	Wheel drive pinion bearing roller and retainer (large).
10	31109	Wheel drive pinion bearing cup (large).
11	30591	Bearing cage.
12	31206	Bearing cage felt washer retainer.
13	31205	Bearing cage felt washer.
14	30596	Cover (inside).
15	30598	Cover packing.
16	30597	Cover (outside).
17	32070	Knuckle and pinion shaft pin lock pin.
18	32069	Knuckle and pinion shaft pin bearing.
19	32067	Knuckle and pinion shaft pin (female).
20	32068	Knuckle and pinion shaft pin (male).
21	WA-147	Axle drive shaft screw lock washer.
22	32066	Knuckle and pinion shaft pin block.
23	36328	Axle drive shaft screw.
24	PL-101	Universal joint grease plug.
25	33582-33583-33581-33580	Axle drive shaft.
26	32061	Knuckle drive shaft.
27	P-1401	Universal joint pin lock pin washer.
28	SC-733	Cover screw.
29	32055	Steering knuckle roller bearing cage shim.
30	31098	Bearing spacer.

Plate No. 67



WHEEL STEERING KNUCKLE AND BRAKE.

Ref. No.	Part No.	Name of Part.
1	32416	Brake band release spring.
2	32715	Brake anchor spring.
3	32394	Brake anchor.
4	30617	Brake anchor pin.
5	33558	Steering arm nut.
6	32356	Steering arm, right.
7	32393	Brake band.
8	32397	Brake band lining.
9	36384-A	Brake control lever.

WHEEL UNIVERSAL JOINT ASSEMBLY.

This unit consists of a wheel universal joint, together with a pinion drive and bearing. It is secured to the knuckle body by means of four bolts. Between the knuckle roller bearing cage (11) (see page 179) and knuckle body are a number of shims which permit the lateral adjustment of the pinion bearing. The looseness in these bearings may be ascertained by placing a screwdriver between the axle shaft and the top spring plate. An excessive movement at this point indicates that the bearings are in need of adjustment and should receive same immediately to prevent their rapid deterioration. The universal joint is lubricated by the removal of plugs (24). The universal joints on the truck should receive attention daily as due to the angularity at which they operate their frequent lubrication is necessary.

TO REMOVE WHEEL UNIVERSAL.

To take off a wheel universal joint disconnect universal joint from axle drive shaft, remove wheel assembly, disconnect universal joint from steering knuckle body and lift out, or disconnect universal joint from axle drive shaft and steering knuckle body, unbolt axle gear housing and lift up enough to allow universal joint to be taken out.

IF AXLE SHAFT BREAKS.

If axle shaft is broken it would be possible to proceed by driving with one pair of wheels.

JERKING DUE TO AXLE TROUBLE.

When the truck on the road tends to jerk or the rear end has a tendency to overrun the front with a jerky action, it is usually an indication that the front end drive is out of operation. The fault may be a broken axle drive shaft, key on pinion shaft sheared, teeth on ring gear in wheel, or on differential stripped or failure in differential. When the rear end fails the front, in driving the truck, will tend to jump in a heavy pull, and will cause truck to steer away from a straight line. Should any of the other parts break, remove propeller shaft and axle drive shafts and continue to a shop on the end that remains in operation.

LIVE AXLE NOISES.

Noises coming from the live axles may be caused by poor adjustment of the driving bevels, bevel gears out of round or warped, differential bearings worn or broken, broken gear tooth, chips in housing.

CHAPTER VII

WHEELS AND TIRES.

CONSTRUCTION AND CARE OF WHEELS.

The four wheels are identical and interchangeable. All wheels serve the double purpose of propelling and steering the truck. They are so constructed that the power delivered by the drive axles from the differential acts through a universal joint, driving a pinion which engages with an internal gear in the wheel.

The wheels are steel disc castings, with the brake drums cast integral. They are turned to a diameter of 30 inches for the reception of the solid tires and are bored for the insertion of roller bearings which support them. They are also bored 15.243 inches for the reception of the internal gears which drive them. This gear is pressed into the wheel and bolted in place. The brake drums are bored 16.75 inches for the brake bands which fit inside. The face of the wheels is 5.25 inches. Each wheel has twelve 1-inch holes on a 23.5-inch bolt circle drilled through it. These are for the tire chain bolts. They also have twelve .5625 bolt holes drilled through the rims for bolts for attaching the tire plates.

INTERNAL GEARS.

The internal gear used in each wheel is a steel ring turned 15.243-inches diameter. Face 1.5 inches. It has 54 teeth, 4-5 pitch, 13.5 inches P. D., 13.1 inches I. D. It has three .5-inch holes drilled half into its rim and half into the wheel casting.

WHEEL BEARINGS.

The wheel is supported on two roller bearings which are mounted on a shaft known as the steering knuckle spindle. Riveted to a flange on the rear end of this spindle is a cast steel plate known as the steering knuckle body. Formed on one side of this plate near the edge is a cage for the roller bearings which support the drive pinion shaft. Directly across and on the other side of the plate is a cup which is a container for the step or pedestal roller bearing which carries the end of the axle bed and hence the weight. Around the periphery of the steering knuckle body are placed two felt retaining rings, into which are inserted large felt bands. These bands fit inside of the brake drum, which is part of the wheel casting. They serve the purpose of retaining the grease for lubricating the internal gear and wheel bearings and for excluding the foreign substances which might work in.

HOW TO ADJUST WHEEL BEARINGS.

All wheels have to be jacked clear of the ground before one may be turned after axle shafts are connected. To properly adjust wheel bearings the spindle nut should be turned up tight against wheel bearings and then backed off one-half turn and pinned.

REASON FOR REMOVING WHEEL.

After driving for a long time in the mud or in the sand the wheels should be removed and the dirt cleaned out of brake bands and internal gear mechanism and new grease used in wheels. While this may appear extravagant, but bearings may grind out or the brakes fail when needed most, if dirt and grit are permitted to accumulate.

TO REMOVE WHEEL.

The removal of the wheel ordinarily requires the services of two men. After removing the hub cap, spindle nut and washer, two bars about seven-eighths of an inch in diameter should be inserted through the mud chain bolt holes in the wheel. These bars should be at least two feet long. One man on either side of the wheel may lift the wheel from the spindle easily. The axle bed should be firmly mounted on suitable jacks or wooden blocks to safely sustain the weight of the truck during this operation.

TO REPLACE WHEEL.

Before replacing the wheel, internal gear chamber should be thoroughly cleaned of all oil, grease and dirt, the bearings washed in kerosene and both bearings and ring gears liberally supplied with lubricant. If new felts have been inserted in the packing retainers, it may be necessary to place a piece of tin or strap iron around the felts to so decrease their diameter as to permit the brake drum of the wheel easily passing over them. The wheel bearings should be tightened firmly and then released one turn, this giving the necessary freedom to the bearings and eliminating the possibility of their breakage.

If the following precautions are taken in the removal of wheels, very little difficulty wil be experienced:

1. Don't use a pipe wrench for the removal of hub caps. Use special wrench in tool equipment, furnished for this purpose. If this is not available, use a square-jawed monkey wrench.

2. Don't place bearings and lock nuts on ground. Put them in a clean box or in a clean cloth.

3. Don't attempt to remove wheel by forcing with a crowbar or other leverage against some part of the axle or frame. If wheel sticks, disconnect brake rod, thereby releasing brake band entirely.

4. Don't put bearings back in place unless they are absolutely free from dirt or grit, and see that they are thoroughly lubricated.

5. Don't put bearing in place without examining carefully to see that it is intact and no parts broken.

6. Don't depend on brake to hold a truck that is jacked up. Block the wheels resting on the ground.

DO NOT TURN WHEELS WHEN STANDING.

The wheels should never be turned by the steering wheel while the truck is standing still, as this puts undue strain on the entire steering mechanism, and may result in stripping the splines from the steering trunnion shaft.

The upper ends of the four wheel brake levers should be directly over the center of the steering knuckle pin. This is important because if they are not correctly located brakes will be applied whenever wheels are turned.

TO ADJUST WHEEL BRAKES.

To adjust brakes throw emergency brake control lever forward. See that brake levers are centered over steering knuckle pins, cams lying flat and no pull exerted on them. If too loose, tighten all four turnbuckles; if too tight, loosen, so that there is equal amount of play in each.

RELINING BRAKES.

Should the brake band lining become considerably worn, due to service, or become saturated with grease or other foreign substances which impair its usefulness, it will then be necessary to replace it. This can best be done by removing the entire brake band assembly, by punching out the rivets and riveting on new lining of proper thickness. The brake rods will have to be lengthened to insure proper clearance between brake drum and relined band.

WHEEL GATHER OR TOE IN.

Wheels are toed in or gathered .375-inch to facilitate steering and counteract tendency of wheels to toe out when truck is in motion.

WHEELS OUT OF ALIGNMENT.

Wheels may be thrown out of alignment because of poor tie rod adjustment, steering knuckle arm bent, axle bed bent.

TO ALIGN THE WHEELS.

To align the wheels turn the steering wheel so that the wheels are approximately parallel with the frame. Then with a piece of string or stick measure the distance between the inside edges of the rear of the front tires. If the wheels are properly aligned the inside edges of the front of the tires will measure .375-inch less, which is the proper amount the wheels should be toed in. Should there be a difference of more or

less than .375-inch, shorten or lengthen the tie rod between the two steering arms until the wheels toe in the proper distance.

Excessive tire wear will result if the wheels are not properly aligned, and steering will be very difficult if the wheels toe out in front. As the natural tendency of the front of the wheels is to toe or spread out while traveling, the adjustment must be made so that they will not toe out (beyond a straight line). The alignment of the wheels should be inspected (and adjusted if necessary) every week.

TIRES.

REMOVAL, APPLICATION AND CARE.

APPLICATION OF PRESSED-ON TIRES.

There is no ruling by which the maximum pressure required to apply a tire can be determined, as this is contingent on many conditions, such as small variations in the outside diameter of wheel or inside diameter of tire.

EQUIPMENT NECESSARY TO APPLY PRESSED-ON TIRES.

The equipment necessary for the application of a pressed-on tire includes hydraulic tire forcing press, spacing ring of proper diameter, supporting band of proper diameter and lubricant, such as any thin oil.

REMOVAL OF PRESSED-ON TIRES.

To remove the base ring of a useless tire cut it in two with a cold chisel, cape chisel, hacksaw, or with an acetylene torch. The use of the hacksaw is the simplest and easiest, while the acetylene torch is by far the quickest.

In preparing a tire for cutting with the acetylene torch, a section at least 6 inches long in the tread rubber should be removed as near to the steel base as possible. The burner should be held at a sharp angle as the remaining hard rubber on the base when heated has a tendency to form into cells and when the gas explodes these cells, the molten rubber is apt to clog the burner of the torch.

The greatest danger in the use of the acetylene outfit is the possibility of damaging the wheel.

REMOVING BY HYDRAULIC PRESS.

Presses of heavy tonnage have been provided at the permanent bases. To use this method place a supporting band of proper diameter centrally on the lower platen of the press, then place wheel on this band. Next place the follower band in the edge of tire and start pump. If the tire does not start after the pressure has been pumped up to maximum, give the base of the tire several sharp blows with a sledge. After the "freeze"