

of trouble but will avoid getting into trouble, which is much better. The old adages "A stitch in time saves nine," and "an ounce of prevention is worth a pound of cure," are doubly true in the care of a tractor.

In studying the instructions in this book, do not only try to remember them but try to *understand why* it is necessary to take care of a certain part in a certain way and you will be surprised how fast and easily you will get acquainted with your machine.

### A FEW SUGGESTIONS WORTH REMEMBERING.

Do not adjust your push rods so as to take out all the slack when motor is hot, for the cylinders being hot and the push rods cold, the cylinders will shrink the most, leaving the rods too long when the motor cools down, and you will find it impossible to start, as the valves will not seat properly.

Don't adjust clutch when it is out. Always adjust clutch while in, so you can adjust each shoe or block alike—if blocks are not alike it will cause clutch to wear much faster.

Don't race the motor—it is hard on all wearing parts in crank case and cylinders.

Don't advance the spark or throw open the carburetor lever too quickly, this is also hard on a motor.

Don't forget to close off valve of fuel tank when leaving tractor. The float in carburetor might fail to hold and leak and you would lose all your fuel in tank.

Don't forget to close off gravity oiler to gears, its not automatic.

Don't forget grease cups—fill each one twice a day. Grease is cheaper than repairs and the time required to replace.

Don't run tractor over ditches and rough places full speed, a little slowing down may save a break.

Don't think because motor is running nicely that it doesn't need watching, life wears out of all things, quicker in some than in others because the watchman is not on guard.

Don't allow any of the bearings to pound. If connecting rod shaft bearings are loose, remove crank case cover and take up the lost motion. Dangerous to run motor with any pound in these bearings.

Don't pour gasoline in a supply tank with fire burning anywhere near the machine.

Don't try to solder a leaky gasoline tank until first filling it full of water, and allowing to stand for some time before attempting to repair.

Don't light a fire near wagon tank, or try to thaw out a faucet with a flame, as several have been killed in this way.

Remember that it is the empty tank like the unloaded gun that is most dangerous. It is impossible to explode gasoline liquid, but a tank which is empty will be full of air mixed with a certain amount of gasoline vapor which is very explosive, and will blow the tank into fragments if ignited.

Don't take needless chances in any way with the machine as it often results in disaster, remember "Safety First" is a mighty good motto.

Don't forget to drain the water out of the radiator as soon as cold weather begins, for you will be surprised at how little cold it takes to freeze and burst the radiator tubes and water jackets.

Don't use a file too freely on the contact points on the breaker box if you expect them to last: just file enough to clean them off and smooth them up.

✓ Don't crank your motor for half a day, for if it does not start in a few minutes, there is something wrong and you will make better time by investigating and finding out what is wrong. In cold weather it is oftentimes due to the gasoline not vaporizing freely. By using warm gasoline, it will help in starting in cold weather.

Don't try to run your Tractor one more run when the oil is low in the crank case.

Don't walk in front of your Tractor while it is in motion.

Don't think this covers all the ground. Study your instructions thoroughly and study your Engine as well.

Don't forget to use a little kerosene on your valve stems occasionally. This will cut out the gum and carbon and will make your valve work freely.

Don't forget to oil the end of your valve stems frequently.

Don't forget that in cold weather by placing a board or pail over the stack of your radiator will cause the warm exhaust air to pass out through the tube and keep the water from freezing. If the weather is very cold, wrap a blanket around the radiator. Remember with the wind blowing cold and the radiator tube being so small, it is liable to freeze even while the motor is running if some precaution is not taken.

## GENERAL DESCRIPTION OF THE INTERNAL COMBUSTION MOTOR OR GAS ENGINE.

The internal combustion motor, or, a motor driven by burning the fuel inside of the cylinder instead of under the boiler, as in the case of a steam engine, is one of the simplest machines known for the purpose of transforming chemical energy into mechanical energy for the purpose of doing work. It is also a first cousin to the steam engine, as it derives its energy from the same source, namely, heat, and is truly a heat motor.

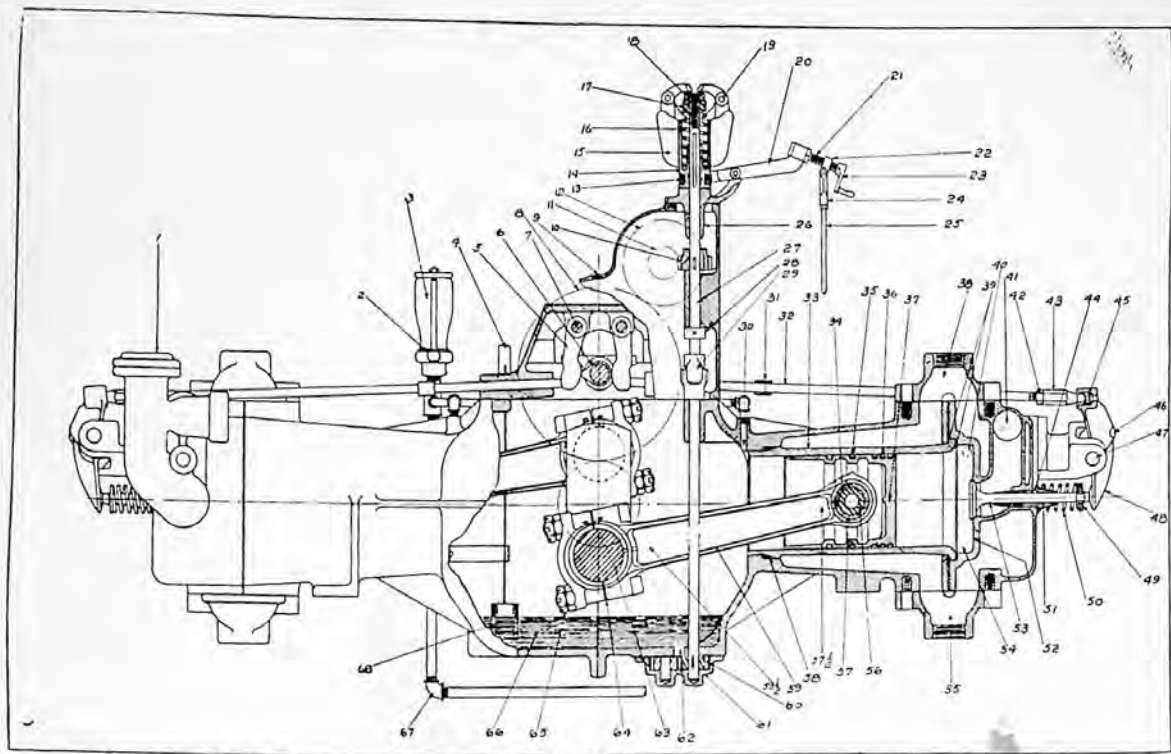
As nearly everyone at this time is more or less familiar with the construction and principle of the steam engine, we will make a few comparisons in the way of illustrations, to give the reader as clear and concise an understanding as possible of the fundamental or basic principles upon which the motor operates.

**Principle of operation** To intelligently care for any piece of machinery, we must first have a reasonably good understanding of the principle of operation. In a steam engine coal is burned under the boiler, which liberates heat and causes the water to expand into steam, giving us what we call pressure. This pressure is allowed to exert its forces against a flat surface called the piston. This in turn, being connected to a crank or crank shaft, is permitted to move and in so doing imparts its energy to the shaft and belt wheel. In the gas engine, exactly the same conditions exist, only they are obtained in a different way. Referring to cut on page 6. We have a cylinder (No. 33) similar to the steam engine, also a piston (No. 37), working inside the cylinder, connecting rod (No. 59), and crank (No. 63).

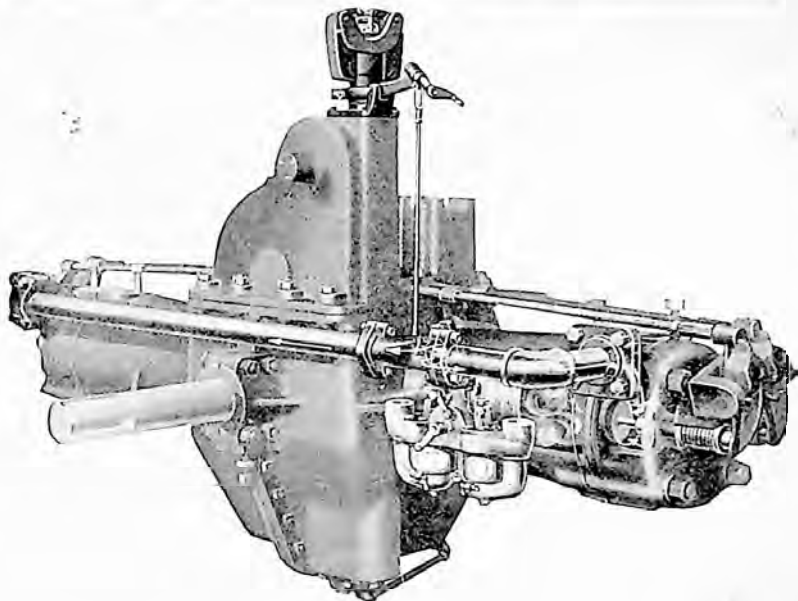
The fuel, which is in this case gasoline, is vaporized by the carburetor and is mixed with a certain proportion of air. This proportion being such that the charge taken in is very inflammable or is what is called an explosive mixture. This mixture is carried through the intake manifold (No. 41) to the explosion chamber (No. 54), (which is an extension of the cylinder area), and is kept from escaping as the piston recedes back toward the end of the cylinder by cylinder head (No. 52), which also contains the intake valve (No. 53) and exhaust valve. At the time at which the piston is nearest to the cylinder head, this fuel is ignited or set on fire by an electric spark occurring at the spark plug (No. 40). As the fuel burns, the heat generated causes an enormous pressure to exist in the cylinder. This pressure is brought to bear upon the head of the piston, which, as in the case of the steam engine, moves ahead, and through the medium of the connecting rod transmits the energy due to the pressure to the crank shaft.

**Cycle of operation** We will now take up the cycle of operation. Referring to cut (No. 27, page 59) you will see the motor shown in four different positions which it goes through during its operating cycle. The rotation of the crank shaft is depicted by an arrow and we will start at the beginning of the cycle, which is the beginning of the intake stroke. As the crank shaft rotates the piston (No. 2) will be drawn out away from the head, which causes a partial vacuum to exist in the cylinder and explosion chamber. As soon as the piston starts on its travel, the intake valve is mechanically opened by the rocker arm and push rod, operated by cam shaft and gear, thus permitting

(Continued on page 7 underneath italics.)



Cut No. 1  
Cross Section of Avery Motor.



Cut No. 2

*In the above cut our artist has endeavored to show the path the fuel takes when leaving the carburetor, passing up through the governor valve and intake manifold, thence through the intake valve, as shown in the right hand cylinder and following up the piston as the piston is drawn in, after which the intake valve is closed, and as the piston returns, this charge of gasoline and air is compressed and then ignites at the proper point.*

*This cut also shows the governor and adjusting crank on governor arm; also the oil cavities in rocker arms which should be filled with waste to retain the oil.*

the air to be drawn through the intake manifold and carburetor, where it is mixed with the proper amount of gasoline until the piston reaches the position as shown in cylinder No. 1, cut No. 27.

At this point the intake valve is allowed to close. Thus it will be seen we have a cylinder and explosion chamber full of a very inflammable mixture of gas and air. As the shaft continues to rotate, the piston is forced back against the air or mixture, and as air is very elastic, it is compressed in the chamber and the pressure is raised to a considerable amount until the crank and piston is in the position shown by cylinder No. 4. At this point the magneto causes an electric current to pass between the points of the spark plug, which ignites the mixture and the pressure due to the extreme heat and expansion of the air forces the piston out again, imparting its energy to the crank, as before stated. As

the shaft continues to rotate further, the exhaust valve cylinder (No. 4) is opened at the point indicated in No. 3, the piston is forced back into the cylinder, expelling the burnt gases through the exhaust passage and getting the cylinder ready for a new charge to be taken in the next time the piston is drawn out. Thus, it will be seen that the crank shaft must make two complete revolutions to complete cycle of operation.

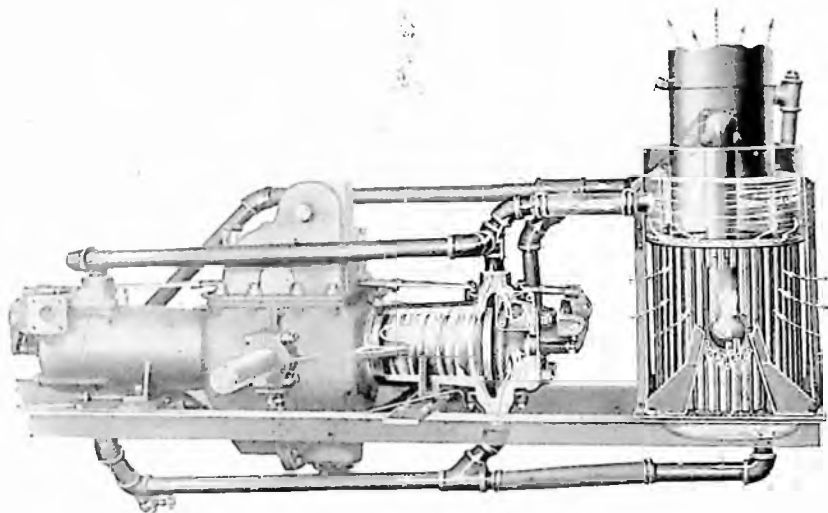
**4-cycle motor** The term "4-cycle motor" is somewhat misleading, as it should be called "the 4-stroke cycle," the piston making the intake stroke, compression stroke, power stroke and exhaust stroke in the order named. If you have followed this closely, you will have observed that the crank shaft makes two revolutions, while the cam shaft is making one. Therefore, it is necessary to time the cam shaft gear or put the teeth together when the motor is assembled in such a way that the valves which are actuated by same will open and close exactly at the proper time. This is what is termed "valve timing." It is also necessary that the magneto produces its spark at the proper instant, for if the charge is ignited a little too early or too late, the pressure upon the piston and the work done are greatly changed. This point of ignition is regulated by a lever in easy reach of the operator, which is called the advance and retard lever and is in connection with the magneto.

**Why water is necessary for cooling** Referring to the (cut No. 1) you will notice the water space (No. 38) around the cylinder and cylinder head and valve chambers. This is for the purpose of keeping the cylinder walls from overheating, also the piston and valves. As the piston works back and forth in the cylinder at a very rapid rate, making about 1000 strokes per minute, it is necessary that there be perfect lubrication between the cylinder walls and the piston, which would be impossible to maintain if the cylinder walls became too hot. The valves also would burn out in a very short time if it were not for the cooling water passing around them and taking away the surplus heat. The piston becomes quite hot and expands to a certain extent. Therefore, it must be made somewhat smaller than the bore of the cylinder. This would allow the air to pass between it and the walls of the cylinder were it not for the packing rings (No. 36) which are small rings set in the grooves of the piston and cut at one place, which allows them to expand and fit snugly against the cylinder walls. This with the help of the lubricating oil makes an airtight joint. The lubrication of the piston, cylinder walls, connecting rod bearings (No. 64), and crank shaft bearings, is effected by the means of an oil circulating pump. There is a quantity of oil

**Oil Pump** carried in the crank case (No. 66) which is drawn into the oil pump (No. 61) and is carried through the oil pipes (No. 67) to the sight feed (No. 3), which is merely an ordinary milk bottle inverted, which allows the oil to be seen as it flows through the bottle and is discharged onto the cranks and connecting rods at points marked (No. 30). This oil is thrown from the cranks and connecting rods onto the walls of the cylinder and the crank shaft bearings, also onto the cams and the cam shaft bearings. The oil pump is operated by a shaft and gear (No. 10), which in turn is driven by the cam shaft and magneto shaft gears (No. 11) and (No. 12). Thus it will be seen

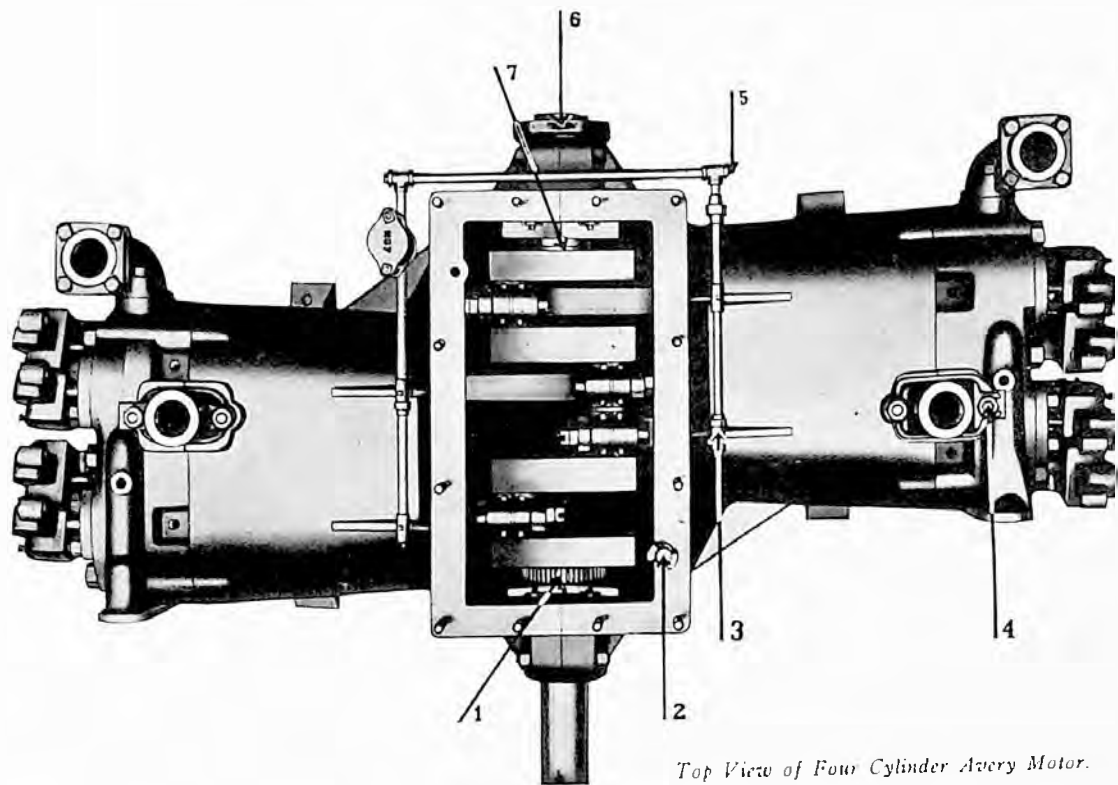
that the oil pump takes care of all the internal oiling of the motor, the only parts which have to be oiled by hand being the rocker arm (No. 46) and (No. 45), the valve stems (No. 44) and governors (No. 18).

**Cooling System** As before referred to, at the time at which the fuel is burning in the cylinder, during the working stroke, there is a great deal of heat generated and if not carried away would in a very few moments ruin the cylinder walls and piston. Provisions have been made, however, to take care of this with what is termed the cooling system.



Cut No. 3  
*Showing Cooling System.*

Referring to sectional cut of motor, cut No. 3, you will note the pipes leading to the bottom of cylinder and water space around cylinder and cylinder head. As the heat is generated in the cylinder it passes through the walls and head, heating the water surrounding the cylinder and cylinder head. This water becoming lighter than the water in the radiator, the cold or heavier water forces it up through the pipe to the radiator, at which point it flows through a great number of copper tubes and as there is air being drawn through around these tubes, due to the action of the exhaust, the heat is taken away from the water and it flows down through the radiator and back to the cylinder again to carry away more heat. In other words, motors are all air-cooled directly or indirectly. The water radiator and circulating system simply being a means by which we can present a great amount of surface for the air to act upon, thus getting rid of a greater amount of heat.

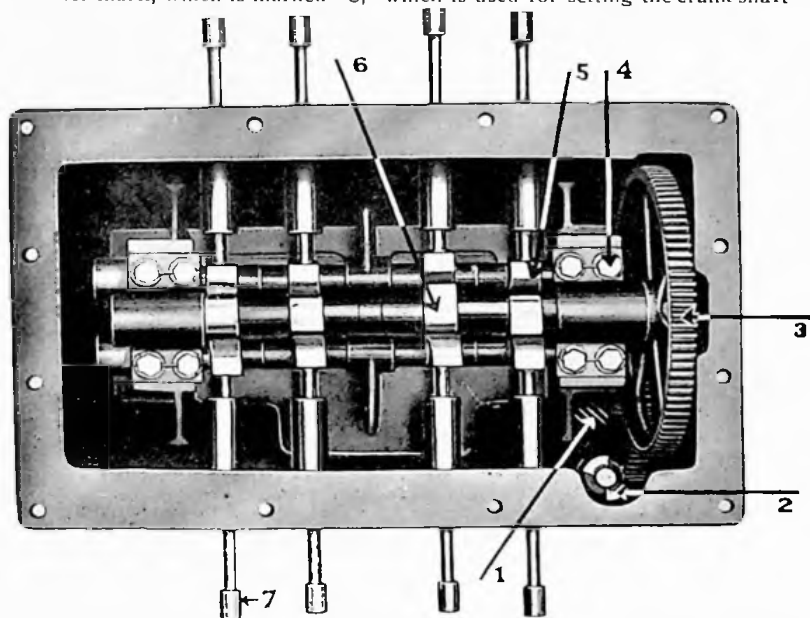


*Top View of Four Cylinder Avery Motor.*

**Valve gears,  
cams and push  
rods, etc.**

The cut on previous page shows the Avery Light Weight Tractor Motor of a 4 cylinder type, with crank case cover removed, showing the crank shaft, connecting rods and cam shaft gear, also the oiling system, rocker arms and water, exhaust, and intake manifold flanges.

No. 1 shows the cam shaft gear; No. 2 the pump shaft connection; No. 3 a point on the oiling system where the oil enters one of the cylinders or crank cases. No. 4 shows the water manifold connection. No. 5 shows a plug in the oiling system which may be removed for the purpose of cleaning out the pipes. No. 6 shows flange on crank shaft. Upon this flange will be found the marks for valve timing and also the dead center mark, which is marked "C," which is used for setting the crank shaft



*The above cut illustrates the crank case cover, inverted to show the gearing, the cams and cam shafts, cam shaft gears and bearings, together with the valve tapit hangers and push rods.*

*No. 1 shows a spiral gear which drives the Governor and pump shaft. No. 2 shows the pump shaft connection; No. 3, the cam shaft gear; No. 4 the bearing, No. 5, the hanger, and No. 6, the cams.*

on center when replacing the crank case cover. By placing this mark to correspond with the split in the crank case, the crank shaft will be on dead center. In this position, if the cam shaft gear is turned so that the tooth marked XXXX can be seen through the one inch hole in top of crank case cover in this position the cams, valve and magneto will be perfectly timed.

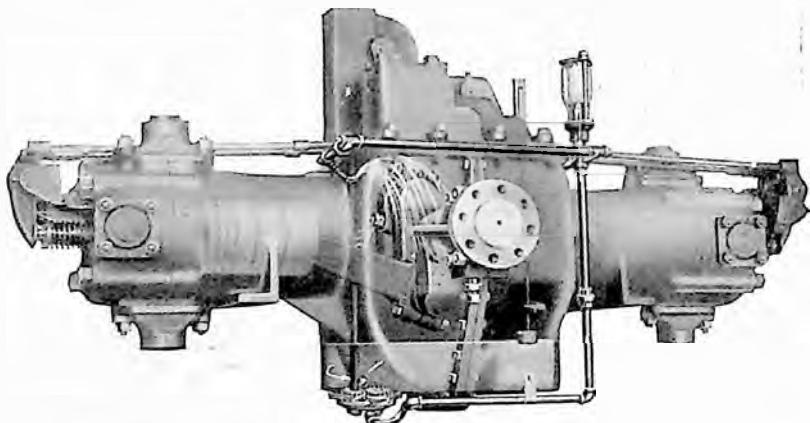
## CARE OF THE GAS TRACTOR.

**A Collection of Units**      The Tractor is commonly spoken of as consisting of nine units, namely: Motor, Oiling System, Cooling System, Ignition System, Fuel System, Clutch, Transmission, Frame and Wheels.

We will take up the different units in the order named, as this is also the order of their importance.

**Operating Motor**      In operating the Motor you must always bear in mind that it is a machine and nothing else. It must be treated as a machine and handled as a machine. There is nothing human or intelligent about it, nothing superhuman, and consequently, it will simply work itself to death or tear itself to pieces when anything goes wrong, if not properly cared for.

## OILING SYSTEM.



Cut No. 4

*The above cut shows the oiling system of the Avery "Light-Weight" Tractor Motor. Our artist has very clearly shown the oil pump in bottom of crank case and the arrows indicating the route the oil takes, flowing up the  $\frac{1}{2}$ " pipe to the bottle. At this point the operator can see the oil plainly flowing through the bottle, after which it flows down through the flanges to each of the cylinders and is sprayed on to the crank shaft and connecting rods, as indicated in the left hand cylinder of this cut. The depth of oil is also shown in the crank case as well as the cork float and indicator at top of crank case.*

The first and most important part in caring for the Motor is to at all times see that all the parts are properly oiled or lubricated, not only with oil but with the best oil that is recommended for the different parts. It is the height of folly to think that one can economize in the expense of operating a tractor by using an inferior grade of oil. Not that the most expensive oil is the best, but the best is always the cheapest. As this is a very important question, we naturally have made a great many experiments at the factory regarding the proper lubricant to use for this purpose. Therefore, we wish to urge the use of such oils as are recommended by us.

The reason why oil or lubrication is necessary is to prevent wear between the parts of the machine which work one upon another. Where one piece of metal is caused to work across the surface of another piece of metal, friction is caused, and if there is no substance like oil to remove this friction, the surface of one metal comes in close contact with the surface of the other metal and they interlock in such a way that small particles are very rapidly carried away, causing what is known as wear. This also generates heat and is the cause of the bearings running hot.

There is a great deal of difference in lubricating different kinds of bearings, such as are found on the gas tractor. For instance, the cylinders and pistons are working under a very much different condition than the axles and gears. The heat which is present at these points has a very marked effect upon the oil or lubricant and for that reason we must have an oil that is especially prepared to stand this heat and still retain its body or what is called "viscosity," therefore an axle grease may lubricate a gear perfectly and a gas engine cylinder oil may lubricate the same bearing as well, but the axle grease would hardly do to lubricate the cylinder with. The oil we would recommend would be Mobiloil "B", Extra Heavy Polarine or an oil fully equal to either of these, for summer use; for cold weather Mobiloil "A", Heavy Polarine or an oil equal to these would give good results. For the gears a cheap black oil will give very satisfactory service in the gravity oiler. Also if the gears are gone over with a little axle grease two or three times a week, it will be found very beneficial, as it will help to hold the oil on the gears and prevent it running and dripping.

The lubrication of the cylinder, connecting rods, crank shaft and bearings and all the internal working parts of the motor is accomplished by a gear driven circulating pump, which draws the oil from the bottom of the crank case and forces it up to and through a common milk bottle, thence to the branch pipes leading to the different cylinders, at which point it is sprayed into the crank case on to the connecting rods and crank shaft, which being in rapid motion throw the oil onto the walls of the cylinder and other working parts, so that all parts are working in a bath of oil. The pump handles a great deal more oil than is used by the motor, the surplus falling directly into the bottom of the crank case, where there is a reservoir for holding the oil. It will therefore plainly be seen that the motor will be perfectly lubricated at all times providing there is a supply of oil maintained in the bottom of the crank case, also that the pipes and passages through which the oil must pass are kept clean.

Also the oil must be kept clean in the crank case. This is done by drawing off through a hole in the bottom of the crank case about once a week or as often as the oil gets black and dirty. At

**Oil must be kept clean in crank case**

the time at which the oil is drawn off, the operator should pour from one-half to one gallon of kerosene into the crank case, through the filler plug, and while there start the motor and let it run from fifty to one hundred revolutions, *not longer*. This is to permit the circulating pump to force the kerosene through all the tubes and also spray it onto the connecting rods and inside of the crank case, thus completely washing and cleaning the interior. The kerosene should be

**Quantity of oil** drained off and the proper amount of new oil placed in the crank case, according to the size of the tractor.

The proper amount of oil is, 1 gallon in the 8-16 H. P., 1½ gallons in the 12-25 H. P., 1½ gallons in the 18-36 H. P., 2 gallons in the 25-50 H. P., and 2½ gallons in the 40-80 H. P.

Referring to the cut on page 12 you will observe a float in the oil chamber, with a wire running up to a graduated dial on the side of the crank case, which indicates the amount of oil in the

**Oil Float**

This should be closely watched at all times by the operator and never allowed to get down to the point marked "empty." The operator should also watch the sight feed, or the oil passing through the milk bottle, as any time that oil is not passing through, the motor will not get oil and serious damage will be done in a very short time.

**Clean crank case**

Whenever, for any reason, the operator has the crank case cover off, he should always drain the oil out of the crank case and clean out the sediment from the bottom, which gradually forms in a thick heavy substance which will not wash out and in time will become so deep that it will bother the pump from getting the oil.

**Rocker Arms and Valve Stems**

The rocker arms and valve stems are two other parts which need careful attention in the way of oiling, as these parts get a great deal of heat from the cylinders, the oil does not stay on as long as it would in a cold place. In each rocker arm there is a small cavity which should be filled with clean waste and this waste kept saturated with oil. The same oil as used inside of the motor will do. The valve stems have similar pockets arranged over the stems to receive waste and should be treated in the same manner. If the valve is neglected or dirt allowed to blow in and work into the stems, they fit so closely that they will stick and are liable to cause broken parts, such as rocker arms and valve gear.

**Governors**

The governors also should receive careful attention in the way of oiling, as the smooth operating of the motor depends so much upon this part that it is necessary that it work perfectly free, which result can only be obtained by a thorough and careful lubrication.

**Levers**

All small parts such as carburetor adjusting lever, throttle rods and levers, also the levers which shift the gears and frame of tractor should receive a few drops of oil at each of the moving points occasionally.

**Oil Sliding Frame** Also the sliding frame should be lifted up slightly with a crowbar and oiled occasionally. This will make shifting the gears much easier and will also prevent rust from forming between the frames.

**Oiling Gears** The oiling of the gears is accomplished by the means of a gravity oiler, which is simply a can which contains oil, with pipes running from it to the different gears, these pipes containing valves for the regulation of the flow of oil. There is also a main valve located directly under the tank, which always should be closed upon stopping the tractor. In warm weather the operator can adjust each of these valves so that the oil will

drip onto the gears in the required amount and after once adjusted may be left in that position, using the main valve for turning on and off, but in cold weather it is better to open the valves wide open, or nearly so, opening the main valve for a short time, flooding your gears, which will last for an hour or two and then the valves may be opened again for a few moments. The oil strained from crank case at time of cleaning can be used up through this gravity oiler and makes very good gear oil.

The differential gear is another part that needs careful attention in the way of oiling, as it is somewhat intricate, there being several small pinions and the spider of the differential gear running over the other parts. Also the bull pinion on the right hand side must turn on the shaft when the engine is turning a corner, thus making it necessary to supply lubrication between the shaft and it. By looking over the differential gears carefully, on one side will be found a small gas pipe running down through the gears to the center. If the proper amount of oil is used in this pipe it will

take care of all the bearings except the pins upon which the small pinions revolve. These can be oiled through holes in the differential spider near the end of the pin and can be easily found. The bull pinion has three holes drilled through in the bottom of the cogs, so that almost in any position the tractor may stop, one of the holes is in such a position that oil can be very easily poured into it. The front and rear axles and countershafts are supplied with hard oil cups and also with pipes running from the gravity oiler so that soft oil may be used on them. It is well to put in about a quart of oil into the

rear axle and countershaft bearings at a time. This will last for a day or two and by turning down the compression cups occasionally will prevent the soft oil from running out of the bearings too rapidly. The left driving wheel is fastened to the axle and for that reason needs no oil cup. The right rear wheel turns on the axle slightly in turning corners and is supplied with a hard oil cup. The front wheels also are provided with oil cups, which while doing traction work should be turned down one or two turns twice a day.

In selecting a cup grease or hard oil, never select too hard or too solid an oil, as a softer oil will flow freer, work through the cups easier, and will give much better satisfaction.

**Oiling Clutch** The clutch should be looked after carefully. The hard oil cup on the collar which throws the clutch into engagement and out will require attention more often than any other bearing on the motor. This cup should be filled from two to three times a day. Also put a little oil on the clutch arm pins occasionally to make them work freely and to prevent rusting. However, do not get oil upon the rim of the fly-wheel or clutch shoes, as this will prevent the shoes from sticking and will let the clutch slip.

**Crank shaft pinion** The crank shaft pinion (except on the 8-16) which is equipped with hard oil cup, is provided with three oil holes drilled in the bottom of the teeth and should be oiled frequently and thoroughly, as all the strain of the motor comes upon this gear, which squeezes the oil out very fast and if allowed to become dry and the belt wheel left standing still for some time, with the crank shaft rotating inside, it will seize or stick to the shaft and may cause considerable inconvenience in removing.

**Steering shaft** Also oil carefully all the bearings on the steering shaft and chain drum, including the worm gear. This will make the tractor steer much better and easier.

**Don't Suppose —be certain** CAUTION—Never suppose that you have plenty of oil in the crank case. Never suppose that any bearing has plenty of oil, but make sure, as a great deal of damage and expense may be incurred in a very few moments, due to carelessness upon the part of the operator along this line. Whatever else may be neglected, the tractor must have oil.

## COOLING SYSTEM.

**To keep cooling system in good shape** The Cooling System is just as essential to the proper working of a motor as any other part and must receive a certain amount of intelligent care in order to keep it in proper working order. The radiator and water manifolds should be drained out occasionally, say once or twice a week and more often if water is bad. This should be done while the motor is still hot, as the dirt and sediment will be carried off much better at that time, before it has time to settle and become hard. As the radiator is for the purpose of bringing air into contact with the hot tubes in order to carry away the heat, it is very necessary that these tubes be cleaned inside and out at least once a season, or, better, twice. The inside of the tubes may be cleaned by using a force pump and hose. Removing the top of the radiator will permit the operator to direct the nozzle of the hose into each of the tubes in turn and in this way thoroughly wash the tube out. The outside of the tube may be cleaned with waste and gasoline. This should be done as often as the grease and dirt collect on the outside of the tubes. Remember, copper is one of the best conductors of heat, but if covered with a coating of dirt and grease becomes very poor and thus the motor will overheat and use too much water.

**To clean radiator**

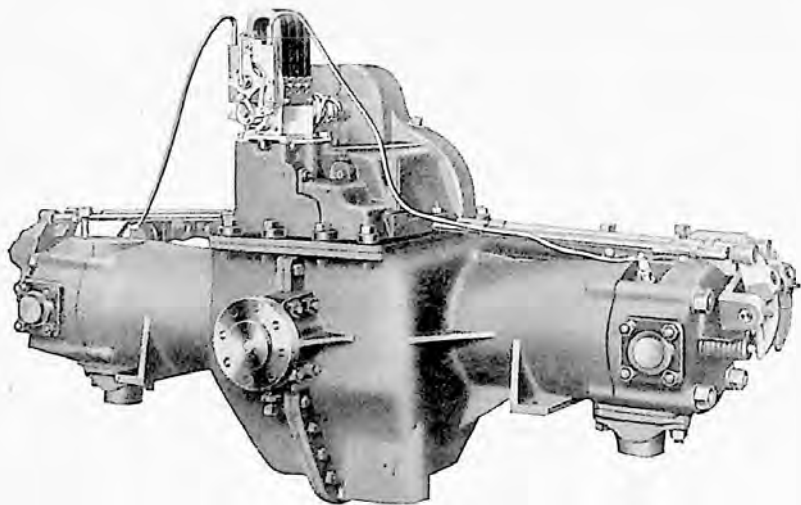
**To prevent freezing** Never leave water in the circulating system when the temperature goes down to or below freezing as very serious damage may be done with very slight freezing, as the water will freeze in the cylinder walls, and expanding will burst the water jackets and possibly necessitate the replacement of both cylinders and radiators. An anti-freezing solution may be used in cold weather, several of which are upon the market and can be procured at a reasonable price from any garage or drug store. 25% wood alcohol, 8% glycerine, 67% water gives a very good solution and will stand a temperature of zero. Kerosene is also being used and will give good results. Of course there is always a certain amount of fire risk with the latter.

### TO REPAIR RADIATOR.

**To Stop Leaky Tubes** To stop leaks if they occur at any time,—mark leaky tubes, draw off water, remove all bolts and take radiator off tractor frame. Handle carefully so as not to bend brass tubes. Now remove bolts and take off bottom pan. In each brass tube there is a tapered steel bushing and after you locate the leaky tube, drive bushing further into tube and this will tighten tube in tube sheet and will accomplish what a tube expander will do in a boiler tube. After you have driven bushing in leaky tubes, put back the bottom pan, tighten up bolts, set radiator right side up and fill with water and let stand for a while. If still leaking, locate leaks and mark, drain off water, remove pan and drive in bushings in tubes leaking. This is the way that we proceed to take care of leaks in radiator. Sometimes we have to put in new tubes and if necessary you can do the same. Or, if you haven't extra tubes you had better drive in a wood or steel plug and stop off the tubes. Hard water is the main cause for tubes leaking in radiator. Use clean, soft water whenever possible. A little boiler water compound added to hard water will help. Radiator needs cleaning same as a boiler. Give it good care and you will not have trouble with leaks.

**How to Put in Tubes**

**Use of Boiler Compound**



Cut No. 5

*This shows the 2 cylinder Avery "Light-Weight" Motor, 12-25 H. P. It is equipped here with a K-W Magneto and the cut shows plainly how simple the wiring is on this motor. The 1" plug over the cam shaft is shown very plainly in this cut, to which reference is made in article on Re-timing Valve Gears.*

*This cut also shows very plainly the flange on crank shaft to which the fly wheel is bolted. Upon the outer edge of this flange you will find the marks for timing of the valves. When the mark "C", is exactly opposite the split in crank case, the crank shaft is on the outer dead centers, then if the gear tooth marked xxx is in the center of plug hole in gear case, the front or left hand cylinder will be on firing center.*

## IGNITION SYSTEM.

The Ignition System is for the purpose of igniting the mixture of air and fuel inside of the cylinder and is accomplished by means of an electric generator called a magneto, wires and spark plugs.

**Magneto Construction** Referring to the cut on page 20 you will find a cross section cut of the K-W Magneto with numbers referring to the different parts. You will note a coil of wire at bottom center of the machine, marked No. 114, which is the primary or low tension coil, one end of which is connected with the frame of the magneto and the other end connected with the flat piece of steel No. 14 running from the post near the center to the bolt and nut No. 55, thence down through the yoke No. 1, passing down to the screw No. 56 and through the flat spring No. 189 to the center of cap upon breaker box, the current passing through this to the breaker down to the screw No. 79, passing through there to the insulated block on the inside of the breaker box No. 191, this piece being insulated from the rest of the breaker box. When the breaker box No. 190 comes in contact with the platinum point on the screw attached to the block No. 191, the low tension current flows

**Breaker Box** through the breaker arm to the frame of the magneto and thus completes its circuit. At the time the cam on the armature shaft No. 67 reaches the point indicated on page 20 the platinum points of the breaker arm are forced apart, thus breaking the primary or low tension circuit. This causes a very high tension current to be generated in the outside winding No. 113, which passes up through the center of the hard rubber post directly over the coil to the flat strip of steel No. 186, passing to the right it passes through the bent wire No. 100, down to the center of the distributor box and then by the distributor to the different segments, which are in connection with the different wires leading to the different cylinders. The little porcelain cover at the left, No. 118, with a brass rod running down and nearly coming in contact with a

**Safety Cap** small post on No. 126 is a safety cap. This is for the purpose of supplying a path for the electric current to flow through in case the wire should come off the spark plug or in any other way that the high tension circuit should be broken, the current will flow between these points and prevent the breaking down of the insulation on the high tension winding. Therefore, this porcelain cup must always be in its place and be kept clean, as dirt upon its surface will allow the electric current to

**Keep Clean** flow through it and partly short circuit or prevent the proper working of the machine. The thumb screw No. 55 also should be kept very tight at all times, as this makes an electric circuit for the low tension current and should it become loose the current cannot pass freely through the yoke to the breaker box. The thumb screws No. 55 and No. 79 also should be kept tight at all times, as these are both electrical connections and the instrument will not work perfectly if they are not tight.

**Keep Nuts Tight**

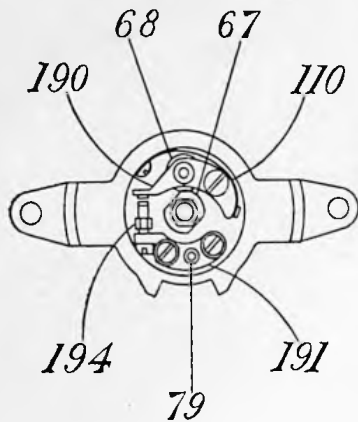


Diagram D.  
Circuit Breaker.

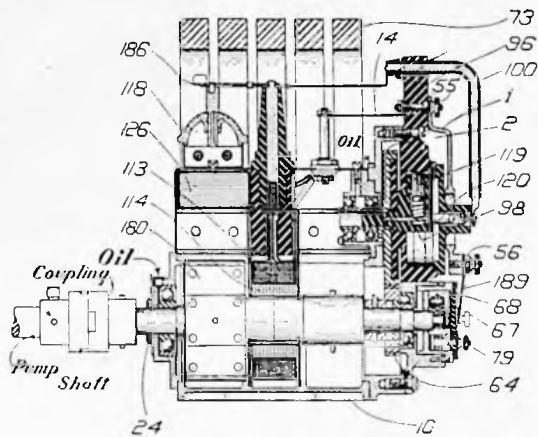


Diagram A.  
Cross-Section of K-W Magneto.

## CROSS-SECTION OF K-W MAGNETO.

(See Impulse Starter on page 23.)

Diagram "A" shows a longitudinal sectional elevation of type "H" and "HT" Magnetos. By referring to the numbers in the following instructions some idea can be obtained of the function of the various parts.

## THE K-W CIRCUIT BREAKER.

The entire Circuit Breaker is removable. Release spring No. 189 by pushing it aside with knob on end. Pull out complete Breaker Box and remove cover nut No. 79. This allows removal of circuit breaker cap and gives access to breaker parts. The same type of circuit breaker is used on all K-W High Tension Magnetos and is shown by Diagram "D". It is arranged to have 30 degrees of advance or retard.

When the points fail to separate or when the distance is too far apart, adjust Part 194 (Diagram D) with small screw driver inserted through hole for that purpose in housing. The proper distance apart is 1/64 of an inch. A gauge is sent with every Magneto.

While there is no guarantee on the Platinum Iridium Points, they should, with proper care, last about 5,000 miles or more on auto engines and give equal service on large stationary or tractor engines.

Don't fill the circuit breaker box with oil or grease. Once a month oil the wick in roller "68" on upper contact arm. See that no oil gets on contact points as oil destroys the contact and makes hard starting. See full directions under "A Few Don'ts" and "Care of Magneto."

The firing point of the magneto is just when the points are beginning to open or break circuit, not when they touch.

## TO OPEN THE DISTRIBUTOR.

Remove the High Tension Lead "100" by turning it to right, unfastening it at bottom. Unscrew nut "55" and remove the bridge or spider "I", thus releasing cap on distributor block and giving view of distributor and brush "B" No. "119".

## STARTING.

In starting the engine up with this Device, the circuit breaker should be placed nearly in retard position so that when engine comes up to its normal speed the spark can be advanced by advancing the circuit breaker to the proper point. If the engine was started with the circuit breaker in too much of an advanced position, it would still not fire the engine until after it had passed dead center as long as the engine was below speed and the tripping device was operated at every explosion, but as the tripping device goes out of action so that the spark would occur at the time the circuit breaker was set for, the engine would get its spark too early. Therefore, it is best to operate tripping mechanism with circuit breaker in nearly retarded position and advance spark when the engine comes up to speed as required.

### A FEW DON'TS.

Don't take off the magnets. When dis-assembling a magneto, a keeper must be placed across the magnets before removal from the magneto. Remagnetizing K-W Magnetos is not necessary unless a battery current has accidentally been shunted through them. If for any reason it should be necessary to remagnetize or repair a magneto, would advise having the instrument returned to us unless the service of a competent magneto man can be procured.

Don't fill the breaker box with grease, vaseline or oil. See oiling directions under the heading, "Care of Magneto", and follow them carefully.

Don't solder new contacts to the old parts as solder spoils the contacts. In replacing contacts get entire parts.

Don't get busy to adjust the breaker box as soon as trouble develops. The trouble is very rarely found in the adjustment of the circuit breaker of the K-W Magneto and if you take the time to check up the system complete, in nine cases out of ten the difficulty will be located elsewhere.

Don't tinker with the circuit breaker adjustment unless the points either fail to separate or the gap is too great. The proper distance of the points is about 1/64 of an inch.

When sending magneto in to us for repairs don't fail to prepay express and mark your name on box as well as write a letter giving serial number of the magneto returned to us.

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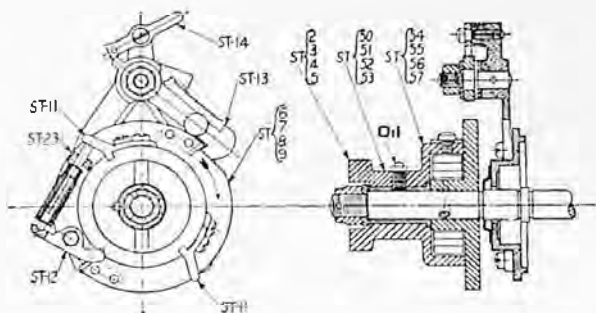
### CARE OF MAGNETO.

Once a month clean out the distributor with a soft cloth, removing any carbon dust that may have worn off the carbon brush.

Once a month remove the circuit breaker (Diagram D) and clean out any surplus oil, then oil the wick in the roller on the upper contact arm with two or three drops of good oil. Make sure that the contact points are clean and that no oil had lodged on them. Oil on the breaker points is an insulation and will cause hard starting and probable missing at low speed. Replace the circuit breaker box. Be sure that the contact spring, No. 189, has been properly replaced, and nut No. 79 is tight.

Once a month place a few drops of oil in each of the three bearings. One bearing is located on each side of the motor shaft and one bearing on the distributor shaft.

## INSTRUCTIONS ON K-W IMPULSE STARTER.



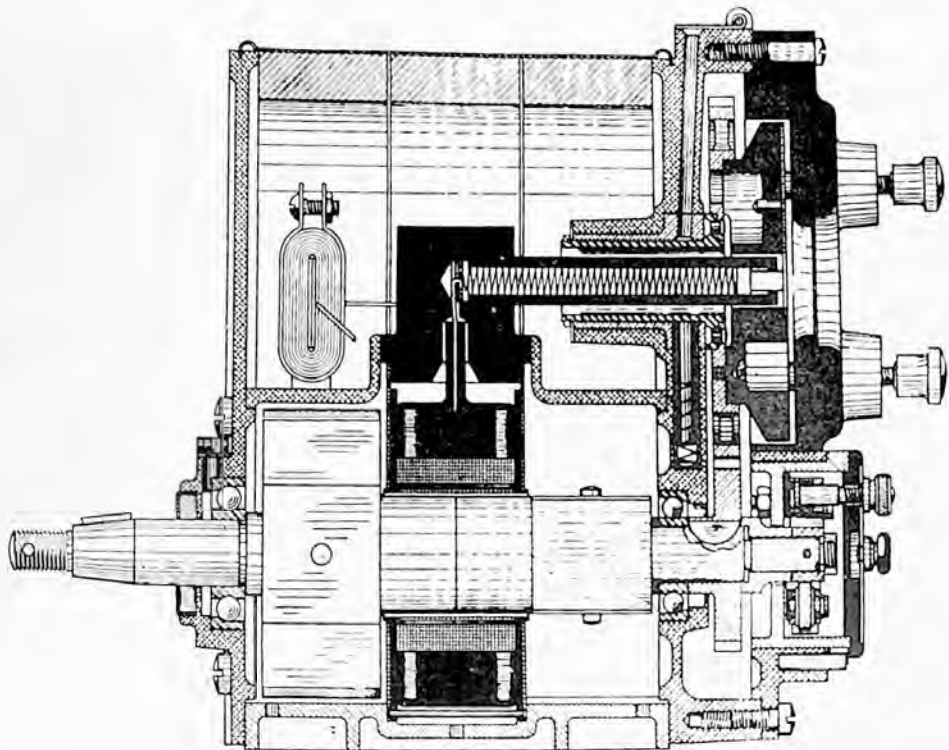
Cut No. 8  
Impulse Starter.

## TO PUT NEW SPRING IN IMPULSE STARTER.

FIRST—Remove the cushion spring barrel from ratchet discs (ST-6, ST-7, ST-8 or ST-9), leaving, however, the flattened stud which guides or holds the cushion spring in position. Also remove both knock-off cams (ST-11), remove the locking dog (ST-12), remove nut which holds the spring barrel (ST-2, ST-3, ST-4, ST-5) in position. Pull spring barrel, as above mentioned, off from the shaft and remove the broken spring.

SECOND—Take the new spring, and place its center eye in the notch cut in the arbor that is on the ratchet disc. Then take the spring barrel, as above mentioned, and place the outer eye of the spring in the notch that is about 1" from the V-notch in the outer side of the spring barrel that the locking dog (ST-12) trips into. This notch that the spring eye fits in will be about 1" to the right of the notch that the locking dog fits in.

This locking dog notch is between two of the notches that the outer eye of the spring fits in, and it always should go in the one furthest from the V-notch. You can just enter the point of this spring eye partly into this notch until you wind the spring barrel up about one turn, then you can slip the spring all the way into the spring barrel, place the spring barrel on where it belongs and put on the retaining nut which holds the spring barrel from slipping endways and then wind the spring up just a little more than one turn, holding it in this position while you attach one of the knock-off cams, the one which has just gone past the flat stud on ratchet disc which holds the cushion spring, then replace the cushion spring and other parts as taken off, and the starter is ready for use. In order to hold the Magneto from turning while winding up the spring barrel, you will have to engage the hook (ST-13) into one of the ratchet notches on the ratchet plate and you will have to catch the spring barrel, either by its gear wheel that fits on it or else by its flange which goes into the coupling, firmly so as to get sufficient power to wind up the spring.



Cut No. 9

*Model (T) K. W. Magneto.*

## INSTRUCTIONS FOR CARE AND OPERATION OF THE MODEL T K-W MAGNETO

The Model T K-W Magneto shown on opposite page is in general construction exactly like the HK shown on another page, except that it is enclosed in a weatherproof housing, which prevents the oil and water reaching the working parts and causing trouble. The magneto should be oiled once a week with a good grade of oil—about three or four drops in each oil hole. The breaker box should be taken off once a week and the wick in the center of the roller pin should have a drop or two of good oil, also a drop of oil on the screw or pin on which the breaker arm hinges.

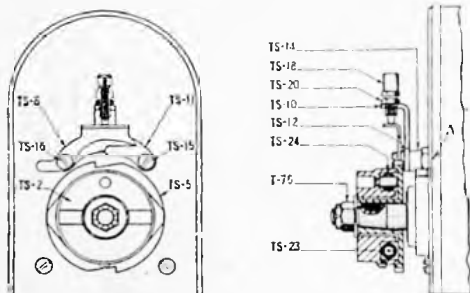
Once in about two weeks take off the distributor box cover and wipe it out carefully with a clean dry cloth. Be careful to remove all carbon dust which may form therein. In replacing the breaker box, be sure that there is no oil between the points and that the points are properly adjusted. The break should be  $1/64$  of an inch. After replacing the cover, be sure to push the clip down over the knob firmly on the cover plate, also making sure that the nut which holds this clip in place is tightened up sufficiently to make the clip move hard. This is an electric connection on the low voltage current and must be tight in order to let the electricity flow through the joint freely.

After the magneto has been used for some time it may be found necessary to file the points slightly and in case of faulty ignition this is one of the first things to look at. Any time the platinum points become black or pitted you will not get good ignition until the points are filed smooth and true again and adjusted so that they come together square, so as to make a good, large bearing surface. Never adjust the screw after filing, for it is the filing which makes them straight. If it is found that these points give too much trouble and have to be filed too often, it is an indication that the condenser is not working properly. By taking the breaker box cover off and connecting a wire across from the nut that holds the clip to the pin on the insulating block in the breaker box and operating the magneto or the motor, if the condenser is bad you will find considerable of a flash or spark between the breaker points. By removing the housing of the magneto the magnets can be very easily lifted off. Care must be used in taking the magnets off and handling them. A keeper or piece of iron should be placed across each magnet as it is drawn off and left there until the magnet is replaced in its position. Never bring two magnets together while they are off the magneto unless you understand handling magnets and know which poles to bring together, for if you should put them together the wrong way you would partially discharge each magnet and they would have to be remagnetized before your magneto would work properly again.

To install a new condenser, which is very plainly shown in the illustration, after removing the magnets, take out screw which holds one end of the condenser connection, loosen the two top screws in the clip holding condenser, unsolder the connection on the other side, remove condenser and install new one, being careful to solder the connection carefully on the left hand side of magneto when facing the breaker box, also tighten the screw down firmly which holds the other connection of condenser and be sure that the wire which is the grounded end of the low tension

circuit is also fastened under this screw. These electrical connections must be made up clean and tight. Then replace magnets in the same position they were in before removing. You will find the magnets are marked by a little oval ground in the end of each magnet. These marks should all be on one side of the magneto, it does not matter which side.

Sometimes after a magneto has been in service for a long time the breaker box becomes worn in shifting back and forth when retarding and advancing the spark and when this becomes loose to any great extent it will cause poor ignition, from the fact that in shifting the breaker box it will cause the breaker arm to break to a greater or less degree. In some instances you will find it will not break at all in one position and perhaps will not come together in the other position. In this case a new breaker box is necessary.



Cut No. 10

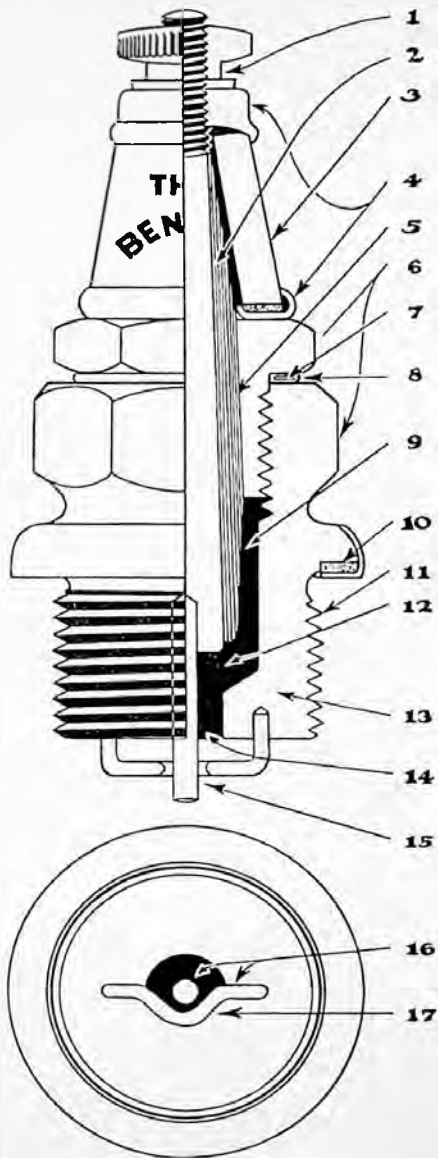
### INSTRUCTIONS FOR OPERATING IMPULSE STARTER MODEL T K-W

Cut No. 10 represents the impulse starter used on the Model T, K-W Magneto. The operation is as follows: By pressing down on the outer end of TS-6, it will raise the lever and let the little dog TS-11 drop into the notch of disc TS-5. This holds the armature stationary until the coupler TS-2 revolves far enough to wind up the spring which is inside of the barrel of the starter. At this time the cam raises the dog and lets the armature be rotated at a high speed, which generates a very hot spark. The part TS-18 contains a coil spring. This spring is to adjust the lever so it will throw out of action at the proper time, which should be about 200 or 250 revolutions per minute. Should the impulse continue or stay in operation after the motor has got up the speed, it will be because the spring is so stiff it will not work. Lock nut TS-20 is for the adjustment of this spring. Should the impulse go out of action before the motor reaches sufficient speed to generate a good spark at crank shaft speed, loosen the jam nut TS-20 and turn the barrel TS-18 down a little until the impulse is thrown out of action at the proper speed. Never let your impulse work up a full speed, for this necessitates a terrific strain of the dog and armature and is liable to break something. Also wash the impulse off with kerosene or gasoline occasionally to keep the heavy, gummy oil off or it will not operate successfully.

## IGNITION TROUBLE.

- Ignition trouble causes** Ignition trouble is caused by several different things and as the motor acts very nearly the same, no matter what the cause is, it is quite hard at times to find just what is causing the trouble and this necessitates going at it in a systematic manner and using the process of elimination. For example, dirty spark plugs, spark plugs set too far apart or too close, broken wire, dirty distributor in magneto, dirty or faulty safety gap in magneto, magneto breaker points set too close or too far apart, a leaky gasket in intake manifold either at carburetor or flange on motor cylinder. A leak around the governor valve stem will make the motor miss, and any of these things act very much the same. although the magneto may be working perfectly.
- Plugs set bad**
- Leaky gaskets**
- To find which of these are causing the trouble** Now, to determine which one of these things is causing the trouble, it is necessary to start in and be sure that your spark plug is cleaned and properly adjusted. What we mean by clean is keeping the insulating material which is shown in the cut of the plug on page No. 32 clear from the lock nut No. 6 in which it is pressed and from the lower edge of this to the point that passes through the insulating material. If carbon or moisture is allowed to collect on this to any extent, it forms a path for the current to pass over and it will not jump the gap. It is also necessary for the plug to be clean on the outside from the cap No. 4 to the lock nut No. 6, as dirt on the porcelain cover No. 3 will permit the current to pass through it and in this way put the plug out of commission. The points Nos. 16 and 17 on the plug should be adjusted not more than  $1/32$  of an inch apart and not less than  $1/64$ , to get the best results. As the plug is used continually the metal wastes away between these two points and in time it is necessary to set center electrode No. 16 up closer to the outside electrode No. 17, to bring it back to its normal position again.
- Carbon**
- Moisture**
- Set Plugs from 1/32" to 1/64"**
- Be sure that each thing you go over is perfect** When you are satisfied that the plug is in perfect order, test your high tension cables or wires by turning the motor over by hand with the impulse in operation and holding the wire  $3/8$  of an inch from any part of the motor. If you get a good spark at the end of this wire, that will prove that the magneto and the wire is in perfect condition. This will eliminate the trouble being in the magneto or spark plug. However, if you do not get a spark at the end of the wire, that will show that the trouble is somewhere in the magneto or the cables.
- Look up care of Magneto**
- Look at Valves** The next move to make is to be sure that your valves are operating properly, as a great many times valves do not set properly, due to sticking of the stems. This can be determined by cranking the motor over and observing if the compression is perfect. If not, investigate and locate the trouble. Again, one of the push rods may be so long that it will not permit the valve to close. When you have put these matters right, you have eliminated any trouble from this source.
- Test Valves by cranking Motor**

- Test Gaskets in Manifold with waste soaked in Gasoline** Now, then, it must be in the manifold or carburetor. A very good way to determine if there is a leak in the manifold or governor valve stem or carburetor throttle stem is to wrap considerable waste around these parts and saturate with gasoline. If it is a leak that is causing the trouble, the waste saturated with gasoline will correct the mixture and the motor will run all right. It will be understood that a leak in the manifold lets fresh air be drawn in and makes the mixture so weak that it cannot be fired.
- How to tell which end of Manifold Leak is in** If your motor is a two cylinder motor and the leak is at one end of manifold, only one cylinder will bother or miss fire. If the leak is at the carburetor or governor valve, it will affect both. If a four cylinder motor, a leak at either end will affect the two cylinders at that end, and if at the carburetor or governor, will affect all four cylinders.
- Be sure Fuel flows freely to Carburetor** When any trouble that may exist in these parts has been corrected, you must have found your trouble, for there is nothing else that will cause ignition trouble. Remember it may be your carburetor has failed, the adjustment may not be right, or there may be dirt in the fuel line which does not permit the fuel to flow into the carburetor fast enough, thus causing the motor to lose power and miss. This trouble, however, is usually accompanied by spitting or back firing through the carburetor. It sometimes happens that the magneto in some way has become retarded, either been put on the tractor not properly timed or something has slipped, making the spark occur too late. The motor will run under these conditions, but it will not develop its full amount of power and sometimes misses firing badly. This can be very easily checked up by turning the motor over until the impulse device unhooks and observe if the crank shaft is on dead center or near dead center. It should be about 5 degrees past center.
- Test Timing of Magneto by placing Cranks on Dead Center** If too much oil is placed in crank case,—that is, enough so that the crank and the connecting rods are permitted to strike the oil—it will throw too much oil into the cylinders and it will work back and foul the plugs. In this case the plugs will have to be taken out and cleaned free from oil. Sometimes the oil will burn into hard substances which forms scales on points of the plugs. It will also cause the motor to smoke badly. Therefore, one should be very careful never to put oil enough in the crank case to permit the crank to dip in same.
- Be careful not to put too much Oil in Crank Case**
- Look for Cracks if using Porcelain Plugs** It sometimes occurs, when using porcelain plugs that the porcelain becomes cracked very slightly, in fact, a crack so small that it is invisible to the eye will do the trick. In this case, the motor may run all right on no load, running idle, but as soon as the load is applied, so that the motor gets a high compression, the resistance becomes so great at the plug points that the current is forced through the little crack instead of jumping the gap. This is one of the reasons we do not recommend porcelain plugs for use in the Avery Tractor.
- Be sure Plug goes through Cylinder well** Another cause of possible trouble is too short a plug. A plug must reach down and through the cylinder well into the cylinder cavity, so that it will be surrounded with a perfect mixture, or it will not fire properly.



Cut No. 13  
 Cross Section of Spark Plug.

## SPARK PLUGS.

**What the Spark Plug is for** The spark plug is for the purpose of carrying the electric current inside of the cylinder, where it is made to jump across a small gap and in so doing heats the air which it passes through to a white heat, thus if this air contains gasoline vapor, it will become ignited or set on fire. It will be readily seen, by referring to the cut on page 6 that one end of the plug is located in such a manner as to receive the total amount of pressure which is developed inside of the cylinder, also the terrific heat. Therefore, you will see that a plug must be constructed of the proper material and in a sturdy manner to stand up to the work that is required of it in tractor service.

**Construction of Spark Plug** Referring to the cut on page 29 is shown a Spark Plug, such as used in the Avery Light-Weight Tractor. No. 1 is the binding post where the wire is connected. No. 2 is the wire or center electrode which carries the current down through the plug inside of the cylinder and is insulated from the shell of the plug by several sheets of mica, No. 5, rolled around the pin or wire. This mica is for the purpose of preventing the electric current from passing to the shell of the plug in any other point except the spark gap at the lower end of the plug. No. 6 is the shell of the plug into which the lock nut No. 6 is screwed which holds the mica and insulated electrode in place. No. 8 is a metal gasket which makes the joint air tight. No. 3 is a porcelain sleeve placed over the upper end of the insulating material for the purpose of preventing moisture and dirt from accumulating on same, as moisture and dirt are both a conductor of electricity and would injure the proper working of the plug. The only care that the spark plug needs is to see that the lock nut is tightened down sufficiently tight to prevent any leak at the

**Care of Plug** gasket, also to be sure that the gap at the end of the plug is not too great or too small. The proper setting for this is  $\frac{1}{32}$  of an inch. If it is set any wider the voltage required to cause the electric current to jump across this gap will be so great that there will

**Setting the Points** be danger of its breaking down the insulation in some other point along the line and thus escaping without performing its duty at the spark gap. If the gap is made less, the spark formed at the plug points will be so short that the amount of heat generated will not be sufficient to cause proper ignition to take place.

In all motors there is a certain amount of soot and waste lubricating oil which gradually gather upon the surface of the piston and explosion chamber, also upon the inside walls of the spark plug and insulating material and is called carbon deposits. If this becomes too great upon a spark plug, it will form a path for the current to flow through from

**Do Not Throw Plugs away—When Dirty Clean them**

No. 2 to No. 6 and in this case there will be no spark at all. Do not throw your plug away when it becomes thus coated but clean it by loosening the lock nut No. 6 which will permit the removal of the center electrode and insulating mica, and can be cleaned with a knife or

sand paper in the manner indicated. Be sure and remove all soot or carbon, but do this carefully so as not to remove too much mica at the same time. After this is done, wash the plug in kerosene or

**Porcelain breaks too Easily** gasoline and replace, tightening up the jam nut thoroughly and be sure to observe the gap, as in taking the plug down and replacing the parts, this will change and have to be reset, which can be done by taking a screw driver or small tool and bending the wire one way or the other as the case may need.

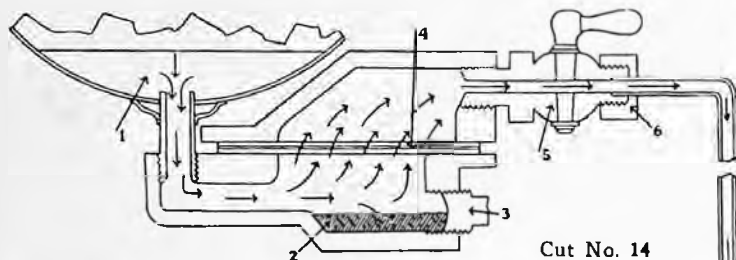
Do not attempt to use a porcelain plug in these tractors, as we have found the porcelain will not stand the heat and pressure generated in the cylinder and will crack, thus forming a path for the current to short circuit.

### TROUBLE WITH SPARK PLUGS.

**To find Plug That is Missing** A good way to look for trouble on spark plugs is to take a wooden handled screw-driver or a hammer will do. In case one cylinder is missing, place one end of the hammer on the cylinder wall and bring the other end up close to the binding post at the top of the plug. If the plug is working, just before the tool comes in contact with binding post the spark will jump across at this point and will be seen very clearly by the eye. Also when the tool comes in contact with the plug it will short circuit the plug and put it out of commission, thus causing two cylinders to miss instead of one, providing this is a good plug. However, if this happens to be the plug that is defective, if you get a large spark to jump from the binding post to the hammer or screw driver, whichever you may be using, but the plug does not fire the cylinder, by removing the plug you will find the points set too far apart. The current will jump a great deal further outside of the cylinders than it will inside, due to the resistance of the air under high compression, in fact, it takes from 8 to

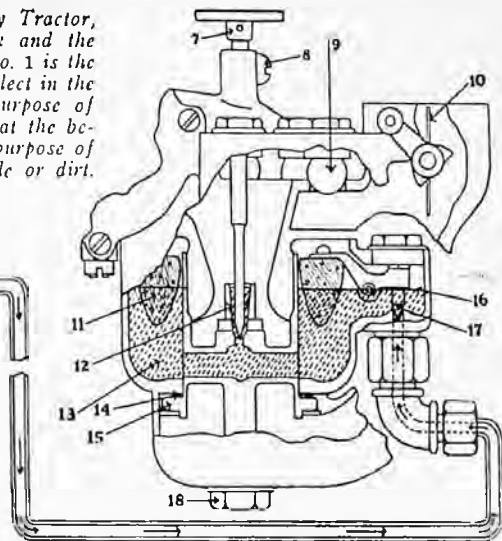
**How Plugs Short Circuit** 10 times as much pressure or voltage to force the current across the spark plug under full compression as it does in the open atmosphere. If in testing the plug, by removing it and placing it with the metal shell against the motor leaving the wire attached while you crank the motor over, if you get no spark at all or a very weak one, it will prove that the plug is in some way short circuited either by carbon deposit upon the insulating material, which is the mica, or the points are so close together that carbon is formed across, or possibly they touch each other. This trouble can be remedied in the way described above.

This illustration is a cross section of the fuel system of an Avery Tractor, showing the fuel tank, the trap or strainer, fuel valve under the tank and the carburetor, showing the different parts. Referring to the illustration, No. 1 is the fuel in the tank; No. 2 represents dirt or sediment, which in time will collect in the bottom of the fuel trap. The plug, No. 3, is to be removed, for the purpose of cleaning this sediment out. This should be done frequently, especially at the beginning of the season or with a new motor. No. 4 is a screen for the purpose of straining the gasoline and taking out any foreign substance, such as scale or dirt.



Cut No. 14

Water will also collect in this trap, and for this reason the plug should be taken out occasionally. No. 5 is the fuel valve, which shuts the fuel off from the carburetor, and should be closed when the tractor is not at work. No. 6 is a union, by which the fuel line or tubing is connected to the valve. No. 7 is the needle valve thumb nut, by which the needle valve is regulated. No. 8 is a screw, which must be loosened up when adjusting the needle valve, and after valve is properly adjusted this screw should be tightened up again, which will keep the valve in its adjustment. No. 9 is one of the balls which act as auxiliary air openings, and takes the place of a valve in other makes of carburetors. No. 10 is a butterfly valve in the intake pipe. This valve may be closed when cranking the motor for starting, and if this is used it will not be necessary to prime the motor through the priming cups, as this will cause the gasoline to be drawn up into the manifold, due to the suction of the motor. No. 11 is a cork float, which regulates the height of fuel in the carburetor. No. 12 is the spray jet, which also has the seat of the needle valve at the bottom end. No. 13 illustrates the fuel in the bowl of carburetor. No. 14 is a metal gasket under the nut, No. 15, which holds the carburetor together. No. 16 is the float valve lever and No. 17 the float valve, which regulates the flow of gasoline into the carburetor bowl. No. 18 is a hex. nut, which holds the intake pipe in position. This nut must be taken off before the air pipe can be removed, in order to get at the large hex. nut which holds the carburetor together, when it is necessary to take the carburetor apart.



## FUEL SYSTEM.

**Fuel-Trap** The Fuel System consists of gasoline tanks, trap and strainer, copper tubing which carries the fuel to the carburetors.

Care must be taken to never pour in dirt or sediment into the tank with the gasoline. Water should also be prevented from entering the tanks. Underneath the tank there is a trap or a collecting chamber for

**Never Put  
Dirty Fuel  
in Tanks**

sediment and water, also a strainer, which if properly cleaned from two to three times a season, will prevent any dirt or foreign substance getting to the carburetor, thus preventing trouble at this point. It is also a good plan to take tanks off once a season and wash out thoroughly with gasoline, as often scale and other substance form in the bottom of the tanks, which will prevent the gasoline from reaching the carburetor as freely as it should.

**Fuel Valve**

There is a valve at the bottom of the tank, which is to be used for shutting off the gasoline from the carburetor nights or at any other time when the motor is not being operated for any length of time. Never trust a carburetor to keep the fuel from leaking, as a very little dirt under the valve would permit a great deal of fuel to be lost during the night.

**Carburetor**

The Avery "Light-Weight" Tractors are provided regularly with a dual or double carburetor for the purpose of burning either gasoline or kerosene.

**Keep Fuel in  
Both Carburetors**

It is necessary that fuel be kept in the bowl of each of these carburetors to keep the working parts in proper condition, for if one carburetor is left empty, the vibration of the machine will ruin the float and valve in a very short time.

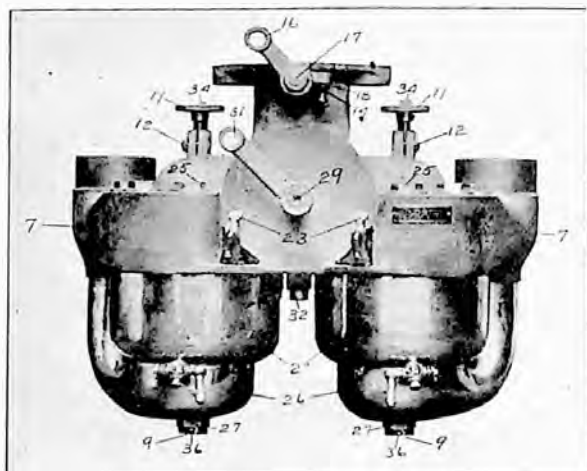
The carburetors are also provided with hot air pipes, which draw the air around the exhaust pipe, heating same and causing the gasoline or kerosene to be vaporized to a greater degree, thus economizing in fuel

**Hot Air Pipes**

and also preventing trouble in running on light load or idle. There is an opening in the hot air pipe which may be opened in hot weather when the motor is working on heavy load, as the hot air is not essential at this time, but to get the best results on a light load or any load in cold weather the hot air must be used.

**Dual Carburetor**

Referring to cut, on page 34, of the Kingston Carburetor, which is used on the Avery "Light-Weight" Tractor it will be seen that gasoline, motor spirits, kerosene or distillate may be used by the shifting of lever No. 31, which operates the fuel switch valve No. 20 from one side to the other.



Cut No. 15

### KINGSTON DOUBLE CARBURETOR.

**Important**—Fuel must be connected to both bowls from both tanks when operating Tractor. Don't neglect this.

#### General Instructions.

This carburetor is so constructed that either Gasoline, Motor Spirits, Kerosene or Distillate may be used by the shifting of lever No. 31, which operates fuel Switch Valve No. 29 from one side to the other. The construction of Carburetor with two bowls allows Gasoline fuel to be supplied to one bowl and Kerosene, Motor Spirits or Distillate to the other, so after starting Motor on Gasoline and after Motor is warmed up, a switch to the other fuels can be made instantaneously by the shifting of lever No. 31. Then if Motor refuses to pick up load a switch back to Gasoline can be made at once. By being able to make these changes instantaneously no time is lost and better results are obtained than from the use of a Carburetor with one bowl in which the fuel has to be switched instead of the mixture, as in case of the Single Carburetor. The Double Carburetor with two bowls and two needle valves, which after being adjusted once require no further adjustment, makes the operation of Carburetor very simple.

## ADJUSTMENT OF CARBURETOR.

The fuel supply to each bowl is controlled by Needle Valves No. 11. The method of adjusting is to turn Needle Valve No. 11 to the right (first loosen lock screw No. 12) until it is down on valve seat. Then turn back to left one and one-half complete turn for preliminary starting. To adjust needle valves correctly, motor must be running up to speed set the spark in the retarded position and follow out these operations: First turn the needle valve slowly to the right until the Motor starts to back-fire through Carburetor. Now slowly turn needle valve to the left until the Motor picks up maximum speed. Also notice the exhaust coming from stack. After motor warms up and proper adjustment has been made the exhaust should show up clear, no smoke to speak of. Too much fuel produces black smoke. When motor is operating right, tighten lock screws No. 12. The needle valve lock spring No. 34 is intended to hold adjustment of needle valve, but to make doubly sure that needle valve is held in proper adjustment the lock screw No. 12 should be set up tight. The needle valve is the only adjustment on the Kingston Carburetor. The auxiliary air is controlled automatically by the ball valves No. 24, which takes care of the mixture at all speeds above or below normal speed so that after the adjustment is once made on the needle valves no further adjustments are required.

Valves No. 33 should be opened up each day before starting so as to draw off any water that may have settled in Bowl or Float Chamber No. 2 and each time after using carburetor in cold weather.

**To Clean Float Chamber.** To clean Bowl or Float Chamber No. 2, remove Cotter Pin No. 36, loosen and remove nut No. 27, then take off Hot Air connection No. 26. When this is done center member or post No. 9 should be unscrewed and Bowl or Float Chamber No. 2 can be removed and any dirt or settlings can be cleaned out. Make sure that needle valve opening is clean. After this is done parts can be assembled, making sure that all parts are put together right and tightened up, as parts are liable to jar loose, especially if Tractor is traveling over rough or uneven ground.

**Don't Abuse Tractor** When traveling over very rough places in road, Throttle Valve No. 17 should be closed and Motor allowed to slow down. Doing this will add to the life of all parts of Tractor.

All fuel connections to Carburetor should be up tight, because if fuel is allowed to leak it will be wasted, and fuel leaking around causes a great fire risk.

**Keep Valves Under Tanks Closed When Tractor is Not Working** Stop valves at each of supply tanks should be shut off when tractor isn't being operated. The Float Valve in Carburetor might stick or fail to keep supply of fuel Bowl or Float Chamber cut off, and it would mean that the Carburetor would flood and fuel would run out and be wasted.

## TO BURN KEROSENE WITH DOUBLE CARBURETORS.

Same adjustments as for burning gasoline and probably about  $\frac{3}{4}$  to  $\frac{1}{2}$  turn more on needle valve will be required. When proper adjustments are made, tighten lock screw on needle valve. Water should also be used through copper tube from water manifold and is taken in through hot air tube direct with air supply to carburetor. This is to prevent a preignition of gas in cylinders, also prevents cylinders from overheating, also helps to keep carbon off valves and pistons.

### How to Use Water

Motor should be started on gasoline and run until motor is sufficiently warm before switching to kerosene. This is done by switching a 3-way valve and should be done quickly as possible. Also be sure the 3-way valve is completely open on the kerosene carburetor and closed on the gasoline side when switch is made. This will sometimes avoid trouble that would be hard to locate at first. Do not use water when starting to burn kerosene. A thumping sound in cylinder will denote a preignition. Then use just enough water to prevent this and no more as too much may hinder the ignition. Always shut this water valve before closing down or stopping motor.

### Always Close Water so Cylinders Can Dry Out before Stopping

We find, with a moderate or average load, that it is advisable not to use any water at all in burning kerosene, in fact, many of our tractors run day after day without a drop of water. It is only necessary to use water when the load becomes excessive and the motor starts to pre-ignite or pound. However, just a little water may have a beneficial result at all times, inasmuch as it helps to cool the exhaust valve and has a tendency to keep the cylinders free from carbon. We would advise changing oil in crank case twice a week when burning kerosene. To keep crank bearings and piston and cylinders in good condition, it is necessary to keep clean, fresh oil in the crank case at all times. The oil drawn off from the crank case can be used in the gravity oiler on the gears.

## CLUTCH.

**Care of Clutch** Referring to cut No. 17, you will note we have a three-armed clutch. Now to properly adjust this clutch it is necessary that the bearing be evenly distributed to each of these arms, otherwise the efficiency of the clutch will be lowered, also it causes a strain upon the different parts, which is very hard for them to work under. These arms hinge on a pin, which should receive a drop of oil occasionally, and are forced out against the rim of the band wheel by the toggle bolt. This is a bolt with a hex. shoulder and jam nut for holding tight. To adjust

### To Oil

this clutch, first push the collar in until it comes up against the side of the arms of the spider. If the bolts are too long to allow this collar to

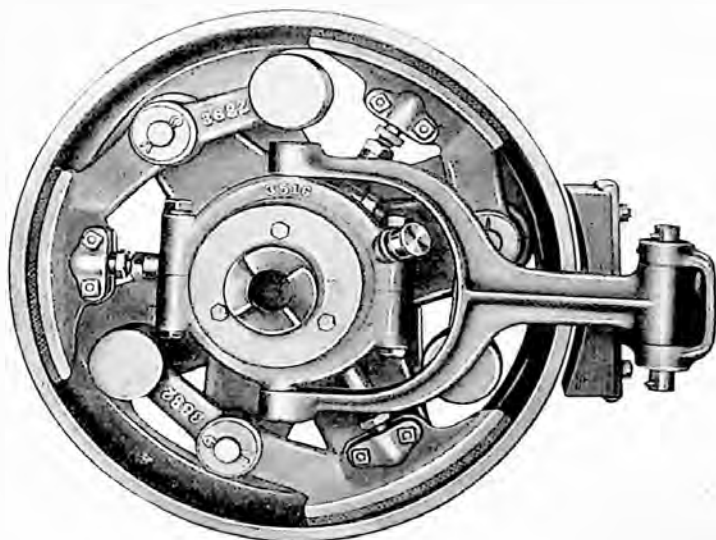
**To Adjust**

come clear over, loosen up the check nuts and screw them back until it will throw the clutch lever clear ahead. Now then, tighten the clutch by turning the bolts to left until you cause a light strain to exist on the arm, due to the pressure of each bolt. Get this just as near even as you can, then tighten the jam nuts which hold the bolts from working loose and turning.

Now take the clutch lever and pull the clutch out. If you have the bolts too tight you will not be able to pull the clutch out. In this case, loosen slightly. In the other case, if the clutch does not

**To Test Clutch**

hold to pull the tractor, the bolts are not quite tight enough and the adjustment should be made in the way stated above, screwing each bolt out a very little until the proper adjustment is obtained.



Cut No. 17

*Clutch and Belt Wheel Brake.*

**CAUTION**—Never adjust the clutch arms so that the collar will not go clear in against the arms of the clutch when the tractor is working, for if you do, you will have to hold the clutch in with the lever, which causes enormous strain to be brought to bear upon the clutch collar and this will get so hot that it will burn up in a short time. Also never run slow by slipping your clutch, for this wears the shoes very rapidly and you can obtain the same result by throttling down the motor, unless it is in extreme cases like coupling up to a machine or through ditches or in cases of that kind.

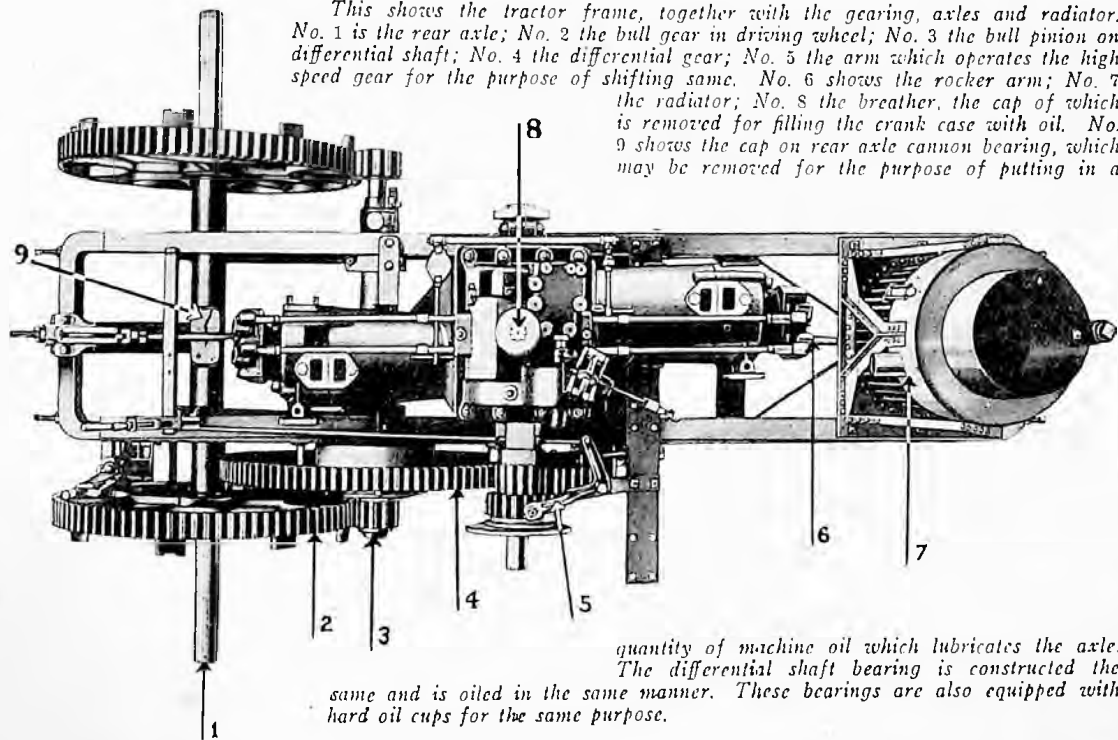
Clutch may be removed from shaft by removing pin which will allow clutch arm to be removed. Then by taking out the three small bolts

**To Remove Clutch from Shaft** in the cap this will expose the keys, which may be readily removed with the key puller, the clutch can be pulled out and lifted off very easily. Also the band wheel and crank shaft pinions. In case the rod running from the clutch lever to the clutch arm becomes

so short that it does not push the clutch clear in when the lever is thrown clear ahead, it may be lengthened by disconnecting at the clutch arm end and turning the connection to the left, which will run it out on the threads and make the rod longer and can be shortened in the same manner should it be too long.

**To Replace Keys in Clutch** In replacing keys in clutch, do not drive too tight. Drive both in evenly and just far enough to allow the cap to be replaced. Be sure that all dirt is wiped off the keys, also clean out the keyways, for a very little grit or dirt will cause these keys to stick and be very hard to take out the next time. These keys should be well oiled or white leaded when being replaced.

*This shows the tractor frame, together with the gearing, axles and radiator. No. 1 is the rear axle; No. 2 the bull gear in driving wheel; No. 3 the bull pinion on differential shaft; No. 4 the differential gear; No. 5 the arm which operates the high speed gear for the purpose of shifting same. No. 6 shows the rocker arm; No. 7 the radiator; No. 8 the breather, the cap of which is removed for filling the crank case with oil. No. 9 shows the cap on rear axle cannon bearing, which may be removed for the purpose of putting in a*



*quantity of machine oil which lubricates the axle. The differential shaft bearing is constructed the same and is oiled in the same manner. These bearings are also equipped with hard oil cups for the same purpose.*

**Cut No. 18**

## FRAME AND TRANSMISSION.

**Sliding Frame** Referring to cut No. 19, it will be seen that the motor is mounted upon a sub or sliding frame built of angle iron, which fits upon the top of the channel beams of the main frame of the tractor, permitting the motor and other parts of the power plant to be slid forward and backward for engaging and disengaging the gears.

You will notice a small block (Cut No. 20) with a set screw against two sides. This block is for the purpose of adjusting the sub-frame to take out the side play and hold the frame perfectly rigid. There are six of these blocks underneath the sub-frame and they act as guides. Now, at any time there is any perceptible side movement to the sub-frame to which the motor is fastened, it will be necessary to get underneath the tractor with a wrench and screw the set screws out, forcing the blocks out against the main frame until the looseness is taken up. At the time of making these adjustments, by taking a pinch bar and prying under the sub-frame, you will find if there is any play up and down. If there is, this same block, by being forced up with the lower set screw, will remedy this. Care should be taken to not set these blocks too tight, for if you do, it will make the motor shift hard on the main frame.

Referring to the same cut (Cut No. 20) you will see two rods running from the main gear lever on the platform to the under part of motor. These rods are the ones that shift the motor forward and back and it is necessary that their length be very accurately adjusted, for if they are too short, the gears will mesh too deep and make unnecessary noise.

**To Adjust Gears** On the other hand, if too long, the gears will not mesh deep enough and also be noisy. On each side of the part of the motor that these rods go through you will find a nut and washer. If you wish to shorten the rods, turn the nuts back on the rod nearest the lever and then draw the ones on the other side up tight again. If you wish to lengthen these rods, proceed in the opposite way. By a little careful adjusting at this point, you will be able to get your gears to run very nicely.

Another thing that must not be lost sight of, is the set screws at the end of the main frame of tractor. The front set screws should be set in such a way that when the motor is thrown ahead and the gears disengaged, the sub-frame will come snugly up against these bolts. The way to make this adjustment is to turn these set screws back until you have the shift lever rods the proper length so that your gears mesh properly, then throw the motor ahead and see that the lever dog is in the quadrant notch, then turn the set screws up until they come snugly up against the end of the sub-frame. To adjust the rear set screws, proceed in the same way, excepting the motor should be thrown back with the gears in mesh when these set screws are set up. It is always well to set these set screws tight enough so that a little extra pressure is necessary to throw the lever over far enough so the lever will engage the quadrant notch. This is important, for the reason that it puts a strain on the lever and rods and holds the sub-frame rigidly in its place.

Cut No. 19 shows a side view of the Avery Tractor and illustrates very clearly the sliding frame feature, together with the position of the gears. No. 1 shows the bull pinion which is upon the counter shaft and is driven by the bevel gear by means of the differential pinions. This bull pinion turns slightly on the shaft when rounding corners, but in going straight ahead turns with the shaft. For this reason many operators forget to oil this pinion and we wish to emphasize the necessity of properly oiling the differential gearing. At the end of the arrow marked No. 1 in the bottom of the cogs there is a hole drilled through the pinion to the shaft—in fact, there are three of these holes, so that no matter where the tractor is stopped one of these holes is in a position to receive oil.

No. 2 shows the adjustment of the lever which operates the reverse gear. This adjustment should be such that the reverse gear is thrown fully into mesh and brought up snug against the stop.

No. 3 shows the set screws at front end of tractor which acts as a stop to the sliding frame and should be set up snug when the motor is in a forward position.

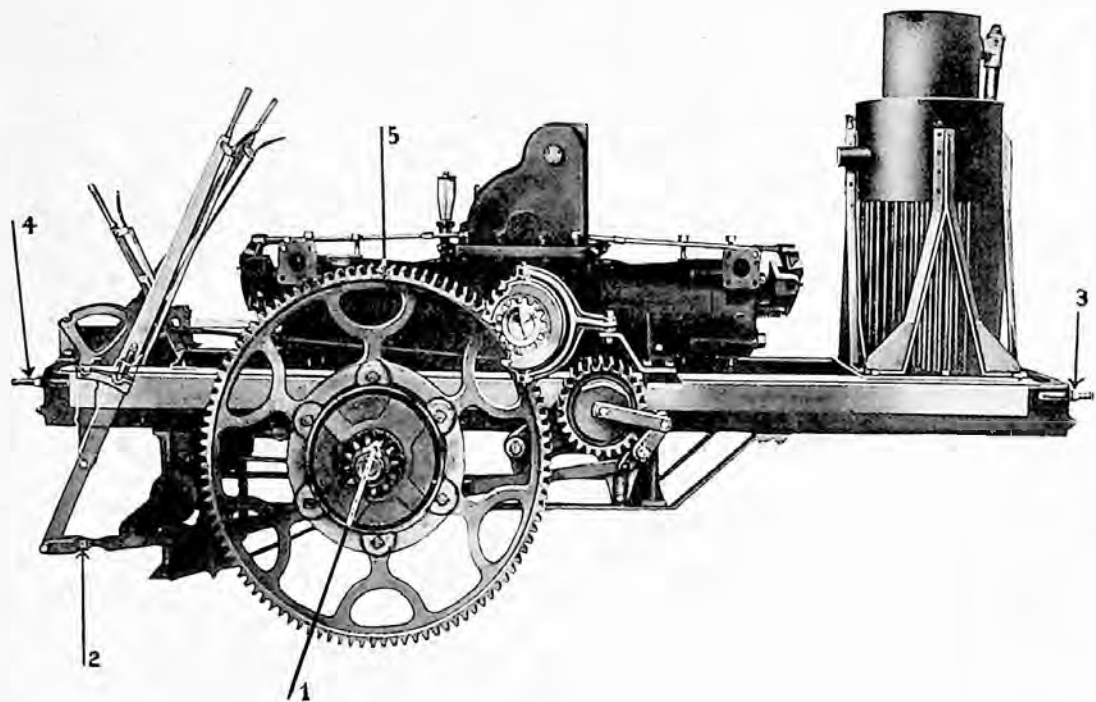
No. 4 shows the set screws at the rear end of the frame and should also be set up snug against the sub-frame when it is in the rear position, or when the low speed gear is engaged.

No. 5 shows the ring gear which is detachable from the differential spider, making it possible to renew this gear without the necessity of renewing the differential gear.

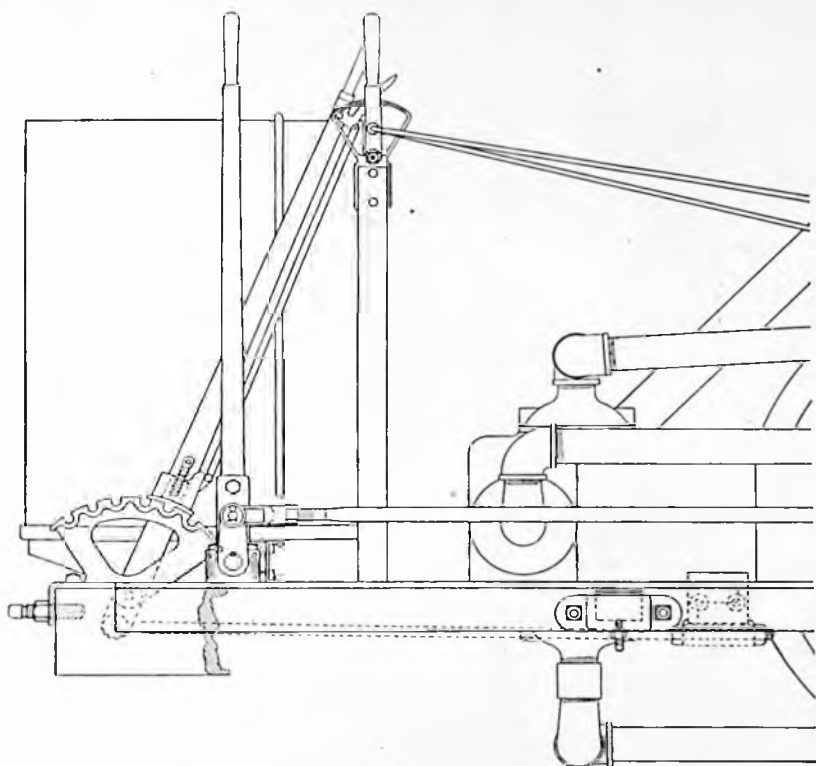
## OPERATING THE TRACTOR.

**Be Sure There is Enough Oil** The first thing to do when starting to operate the Tractor is to be certain that there is a sufficient amount of good oil in the crank case. Also that all grease cups are filled with good cup grease. Next, fill the gravity oiler with an oil with fairly good body. This does not necessarily have to be an expensive oil but should have body enough to not run off the gears too freely. Then proceed to oil all bearings such as are found in the differential gear, differential pinions, bull pinion on countershaft, steering roll bearings, rocker arms and valve stems, governors and control levers. Now, fill the small fuel tank with gasoline and in so doing, be sure that it is clean. It is always best to strain gasoline and, if convenient, through a chamois skin. This will take out any water which may be in the bottom of the cans. Now open the valves at the bottom of the fuel tanks. This will permit the carburetor bowls to fill up. Place spark plugs in the cylinders. Attach high tension wires to magneto and spark plugs (see cut No. 27).

(Continued on Page 45.)



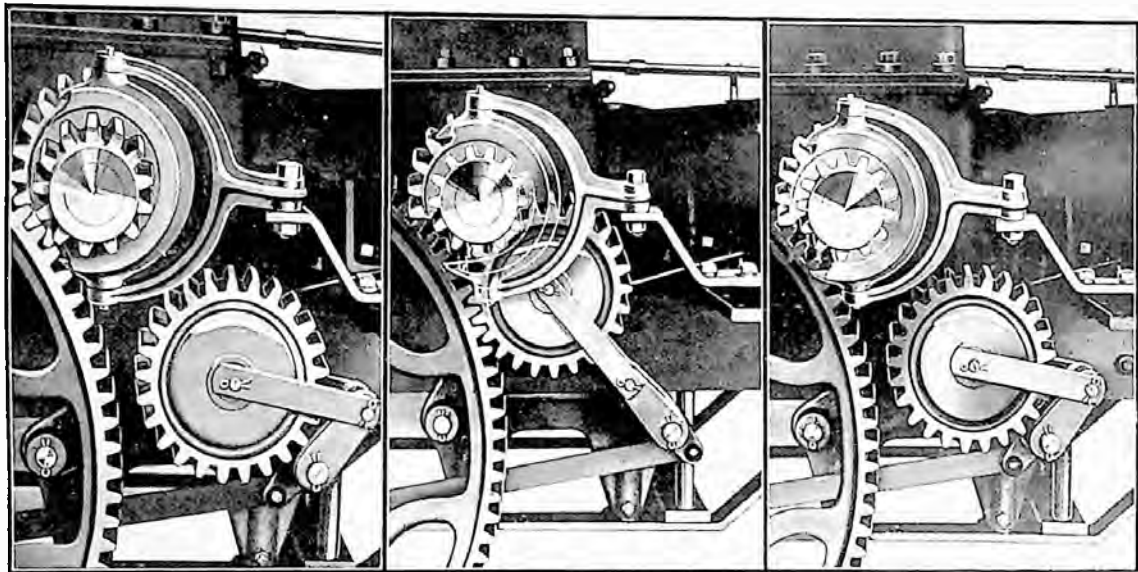
Cut No. 19  
*Showing Sliding Frame on Avery Tractor.*



Cut No. 20

*Showing Shifting Levers and Adjusting Blocks.*

*Cut No. 21 illustrates the crank shaft pinion, reverse gear and differential gear in their different positions. The first cut at the left shows the high speed gear in mesh. The middle cut represents the motor slid ahead and the reverse gear brought up in mesh with the low speed pinion. The cut on the right represents the motor in the same position with the reverse gear disengaged, as used in bell work.*



Cut No. 21

## INSTRUCTIONS FOR STARTING AND OPERATING MOTOR.

Then fill radiator with clean water, soft if convenient.

**Use Clean Water** Now, put priming cups in the holes in the manifold just outside the cylinders, which are for this purpose, and you are now ready to start the motor. Now pour in about two tablespoonsful of gasoline into each of the priming cups. If this is allowed to remain a few minutes before trying to start the motor, it will give the gasoline time to vaporize and you will be more sure of getting a start the first time.

**Set Throttle and Spark Levers** Now, trip the little dog on the side of magneto (this is absolutely necessary) which operates the impulse device. Set your spark control lever just far enough ahead so that the spring on the side of magneto breaker box, is separated from base of magneto, if you are using an HK magneto, and if you are using an HT-KW magneto set your spark control lever about one-third of its throw ahead. Now, by taking the crank and turning the motor over past the compression points, you will get a start. The best way to crank a motor is to

**Trip Impulse Dog** turn it over slowly until you come to the place it turns the hardest and then give it a quick pull past this point.

This breaks the circuit quick in the magneto and also delivers a little momentum to the fly wheel, which helps to turn the motor over past the next compression.

It is always best to have your throttle valve only partly open in starting, although you can start your motor with it wide open. After the motor is started and comes up to speed, advance your spark control lever to the full extent, using the throttle lever to control the speed of motor. Never let your motor run under full speed while it is idle or not doing work, for it is entirely unnecessary and you are throwing just that much fuel away.

**Never Crank Motor with Gears Engaged** Never crank the motor while the gears are engaged and also never try to start a cold motor with a heavy belt on the belt wheel. You will find it much easier to crank the motor with the clutch engaged so that the band wheel revolves with the motor.

In starting your tractor to do traction work, pull your clutch lever back and hold it until the wheel stops revolving. It is impossible to engage any of the gears while band wheel is moving and if you try to do so, you will surely break your gears.

After engaging the gear you wish to use, either high or low, according to the load you are going to pull, throw your throttle lever wide open and engage your clutch slowly, that is, not so slow as to let it heat up or burn, but not so quick as to cause the tractor to jump or jerk, as this is hard on gearing and also on the machinery you are pulling.

**Never try to Shift Gears while Belt Wheel is Running** In traveling on the road or around in close places where it is necessary to slow down at points, use the throttle.

If backing up to hitch on to a separator or machinery, where it is necessary to go very slow and only an inch at a time, do this by using the clutch, letting it slip slightly, but do not let the clutch slip for any long period of time.

On traction work, when climbing hills or hauling excessively heavy loads, where the load is so great that it brings the motor speed down considerably, it is necessary to retard the spark. The motor will indicate this point by a thumping sound in the cylinders, caused by the spark occurring too quickly, or what is called pre-ignition.

**Slow Down at End of Field** In coming to the end of a field, when plowing, and making your turn, always close down your throttle and let the motor run slower around the end, as it will give you a great deal better opportunity for handling the plows or other machinery and also for steering, as it is very hard to steer a tractor around corners at full speed.

Always watch a new tractor very closely for a few days, as in new machinery the bearings are very tight and are apt to run warm. This is especially true with the clutch collar and main bearings. A new machine always needs a great deal more oil and needs it oftener than it does after all the parts are smoothed up by running for some time.

**Keep Plenty of Water in Cooling System** Also watch the water very closely, as in warm weather the water vaporizes and if it gets below the line on radiator, circulation will stop and the water will soon boil away.

Never run a tractor until the oil is all or nearly gone from the crank case, as it is much better to add a little oil often and keep the supply well up, for when the oil gets low, it gets very thick and does not lubricate well.

Read instructions under Lubrication for changing oil in crank case and cleaning crank case.

Another important point to remember, is that a gasoline or kerosene motor does its best work at the speed at which it is designed to run, so that in running different machinery, the pulley upon the different machines should be a size that will permit the motor to run at its normal speed when the machine you are operating is running at its normal speed. To find the size of pulley needed to operate your different machines with the motor running at its proper speed, refer to table on following page, by which, if you know the number of revolutions per minute your machine should make, you can find in a minute just what size pulley you will need.

**See Table of Sizes of Pulleys to Use on Machines** In plowing heavy soil or plowing very deep, be careful to not overload your motor. It is always better to raise a plow or possibly two plows and walk right along with the rest of the load than it is to drag a motor down below its normal speed by pulling an overload.

This heats the motor badly and causes undue wear and strain upon the motor and in fact shortens the life of the motor materially.

SIZE OF TRACTOR	REVOLUTION OF DRIVEN PULLEY								
	600	700	800	900	1000	1100	1200	1300	1400
8-16 H. P.	DIAMETER OF DRIVEN PULLEY								
12-25 "	18½"	15¾"	13¾"	12¼"	11"	10"	9"	8½"	7¾"
18-36 "									
25-50 "									
40-80 "	21½"	18½"	16¼"	14½"	13"	11¾"	10¾"	10"	9¼"

TABLE OF SIZES OF PULLEYS TO USE  
ON DIFFERENT MACHINES

*The above table which shows the sizes of pulleys to be used on different machinery when driven by Avery Tractors, is to be used as follows: For example, if you have a 12-25 H. P. Tractor and want to drive a machine of which the shaft should travel 900 R. P. M., by following out the line to the column in which the 900 is placed, you will find 12¼" will be the size of pulley to use. If it were a 40-80 H. P. Tractor, the pulley, you will note by following out the line opposite the 40-80, would be 14½", and so on down the line to whatever number of R. P. M. your machine should make.*

#### To Avoid Trouble in Soft Places

If, while plowing, a soft place is found in the field or the tractor begins to go down and the wheels slip, you may avoid getting in bad by stopping in time. There is nothing gained by trying to force a tractor through the soft places, for you only go deeper and deeper. The thing to do is to stop immediately, raise your plows and if you have not gone down much, you will be able to pull out. If you have, it is better to unhitch from your plows and run out and then back up and hitch to your plows again. By so doing you will pack the earth down, making it quite hard,

#### Use Cable

and will give you a much better chance to pull out the second time. However, a better way is to have a 25 to 50-ft. cable strong enough to pull the plows through, run across the soft spot with tractor, then pull the plows through, back up and hitch on and go on again. This will permit you to plow through the soft place and will not make a balk. This also works very nicely in crossing coolies or ravines

#### To Climb Cooley Banks

where the banks are too steep for the tractor to climb hauling its load. Also remember that a couple of good fence posts or pieces of plank will often get one out of a bad hole if used in time before the tractor has dug itself down too deep.

### Carburetor Adjustment

In operating the tractor, after you have got it on its load is the best time to make carburetor adjustments. Turn the needle valve down or to the right gradually and shut off the fuel until the motor backfires or flashes in the carburetor. Then turn to the left about one-half turn, watching the motor carefully, giving a little time between each movement of the needle valve so as to let the mixture be corrected in the manifold and leave the adjustment where the motor will handle the load the easiest and does not miss.

### Black Smoke Means Too Rich Mixture

Any time that black smoke comes out of the smoke stack while the motor is running steadily on the load, it is a sign that you are using too much fuel and should be shut down slightly.

If burning motor spirits or kerosene, it may be necessary to use water with the kerosene through the little pipe running into the kerosene carburetor from the cooling system. This is especially true with kerosene and you will get better results with motor spirits if the motor is under a heavy load by using a little water. Turn the water on gradually and watch the results. As soon as the motor smooths down and runs smoother, you have enough water, but if the motor starts to miss or fuss, you have to reduce water. A little practice will tell you just how much to use by the action of the motor. However, never turn the water on the motor until it is thoroughly heated up or it will cause it to miss badly, perhaps stop.

### To Use Kerosene

As soon as the motor smooths down and runs smoother, you have enough water, but if the motor starts to miss or fuss, you have to reduce water. A little practice will tell you just how much to use by the action of the motor. However, never turn the water on the motor until it is thoroughly heated up or it will cause it to miss badly, perhaps stop.

### Turn Water Off Before Stopping and Shift to Gasoline Carburetor

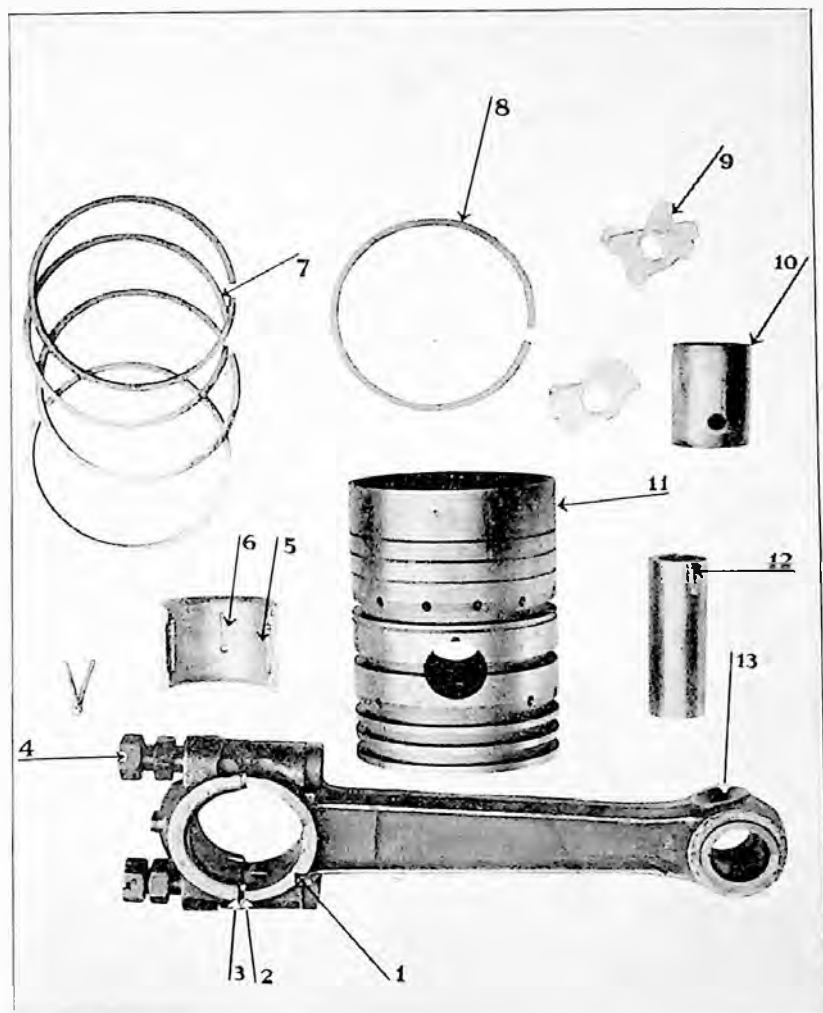
If it becomes necessary to change gears while on a hill, if it is not too steep you can hold the tractor by standing on the brake while shifting your gears, but if you are in a very steep place, it will be much safer to block the wheel or your tractor may start down the hill while you are changing gears and in that case it would be impossible to engage the other gear and an accident might occur.

Always look your tractor over thoroughly at noon and at night, making sure that all the bolts and nuts are tight, also that every part is being properly lubricated. Too much emphasis cannot be laid upon lubrication. In fact, the whole operation of the motor is dependent upon the lubrication, for a motor would not run three minutes without oiling. It is also wise to open crank case by removing cover and examining the crank bearings occasionally, say every two to three weeks—different motors wear differently and in many cases these motors will run through a complete season without the crank bearings being adjusted, but in other cases, due to an inferior grade of oil or several other things which have a direct bearing upon the wearing of the cranks, it will be necessary to take up the bearings oftener or as often as there is a perceptible knock in the bearing. Read how to adjust crank shaft and crank pin bearings under that head. Always watch the sight feed oiler closely and also keep an eye on the gearing. A great deal of damage may be done in a short while to gears if they are neglected and not watched and kept lubricated. Always drain the radiator and cooling system out at least once a week, replacing with fresh, pure, clean water. Do this while the motor and radiator is still hot and it will carry the sediment out much better. Never leave a radiator with water in it when

### Don't Guess About Oil—Be Sure

run through a complete season without the crank bearings being adjusted, but in other cases, due to an inferior grade of oil or several other things which have a direct bearing upon the wearing of the cranks, it will be necessary to take up the bearings oftener or as often as there is a perceptible knock in the bearing. Read how to adjust crank shaft and crank pin bearings under that head. Always watch the sight feed oiler closely and also keep an eye on the gearing. A great deal of damage may be done in a short while to gears if they are neglected and not watched and kept lubricated. Always drain the radiator and cooling system out at least once a week, replacing with fresh, pure, clean water. Do this while the motor and radiator is still hot and it will carry the sediment out much better. Never leave a radiator with water in it when

### Look Out for Freezing Weather



Cut No. 23

*Showing Piston, Connecting Rod, Rings, Etc.*

the temperature is anywhere near freezing, for a great deal of damage may be done. If necessary to run the tractor in freezing weather, use an anti-freezing mixture, which is described in another chapter of this book.

## REPAIRING AND ADJUSTING.

The best thing you can do for a tractor is to give it good care. The second best is to make your repairs and adjustments promptly. All machinery, even with the best of care, will wear in certain places, making adjustments necessary, and all machinery is subject to breakages, due to accidents and other causes. Whenever a part of the motor is discovered to be cracked or fractured, then is the time to make the repair. Whenever a bearing or any part of the motor becomes loose by wear, etc., then is the time to make the adjustments. It is a very good practice to go over the tractor once a season and take apart such parts as seem to be worn and examine them closely. However, we do not advise the tearing down of a motor unless it is absolutely necessary. Nearly all the parts can be inspected without taking out of the pistons or connecting rods and we do not advise the removal of the pistons from the cylinders unless for the purpose of repairs.

The valves will need grinding on an average tractor about once a season, although if they leak sooner than that, they should be ground promptly, for a little leak in a valve will soon cause the valve to burn out and also burn the seat considerably, which necessitates the putting in of a new valve usually. Read instructions for grinding valves under this head.

Referring to cut No. 23, which shows the crank end of the connecting rod together with the bearings, bolts, shims and cotter keys, note the cotter key which locks the nut No. 4 in position. These bolts hold the cap

**Crank Bearings** No. 3 and should squeeze the shims No. 9 very tightly. There must be no pressure brought to bear upon the pin itself. After the motor has run for some time there will be a perceptible looseness of the bearing. By taking the nuts off and removing the cap, take out one of the thin metal shims from each side, replacing both cap and the nuts on the bolts. Now draw the nuts up good and snug, then take hold of the balance wheel of the motor and by turning the crank shaft until the pistons are on dead center or the cranks are level, by rocking it back and forth at this point you can easily determine if the bearing is too

### To Tighten Bearings

tight by the resistance offered to the movement of fly wheel. By placing the crank on top and rocking the wheel back and forth, it will easily be seen if there is any lost motion or looseness to the box. If so, take apart and take out another shim. Proceed this way until you have a nice, snug fit, but not tight, to the crank. It is sometimes necessary to file the shim slightly, as by taking out one pair more it will make the box too tight and by

### To Get Nut To Come Right

taking out one pair less it will still be too loose. If when putting the nuts back on the bolts and drawing them up tight, it is found that the cotter keys cannot be gotten in the holes, due to the different positions the nut takes from removing the

shims, by placing the shims which have been removed between the nut and the cap, it will restore the old position and the cotter key will be found to go in the same as at first.

It is sometimes necessary to put in new bearings in the connecting rods. These bearings are brass lined with a very fine grade of babbitt metal and in replacing old bearings with new ones, it will be necessary to file the edges No. 2 and 3 down level with the surface of the connecting rod and cap. This is so the shims can reach through to the pin and come between the ends of the bearings. This will hold the bearings firmly in place and also prevent them from turning with the pin. This must not be lost sight of. In fitting new bearings it is also necessary to scrape them, as they do not fit perfectly. By rubbing oil over

#### How to Replace Old Bearings

the pin, placing the bearing upon the pin and moving it back and forth with the hand a few times, then remove the bearing and it will show very plainly where it touched the pin by the oil which is left. By using an ordinary scraping tool, it will be an easy matter to scrape the bearing to a good fit. Always be sure that there is a little end play, for if the bearing fits perfectly to the pin and still is tight at the end, it will cause it to heat badly.

To replace the main crank shaft bearings, it is necessary to take all the bolts out that hold the crank case together with the large bolts through the bearings. Then after removing the water and gas manifolds, loosen up the motor from its bed;

#### To Replace Crank Shaft Bearings

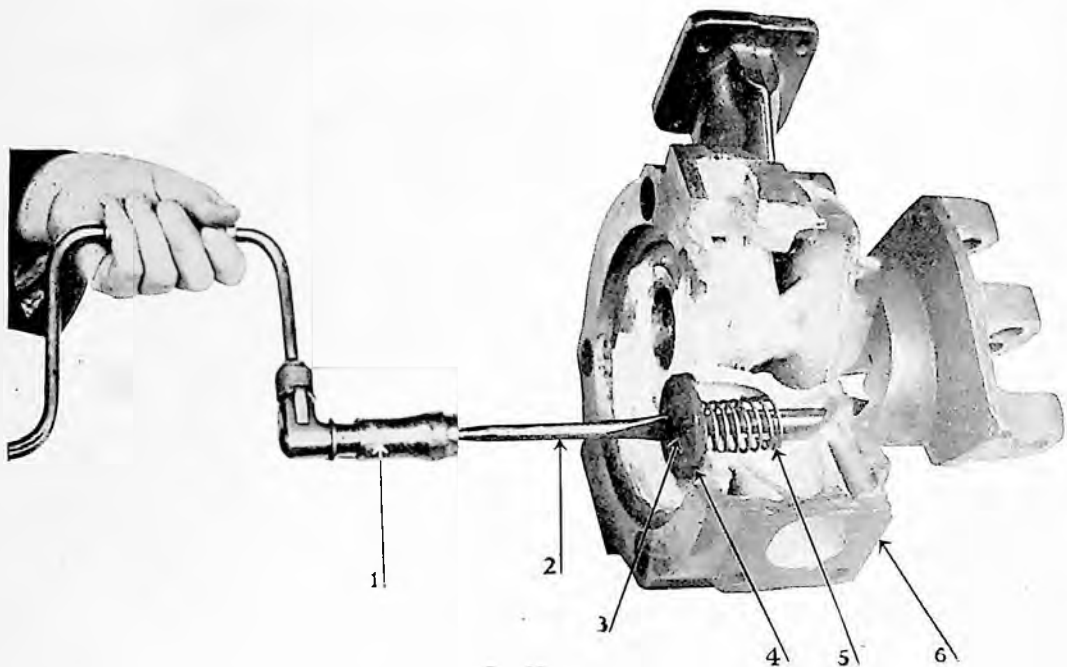
one set of cylinders may be moved either forward or back, opening up the motor. The old bearings then may be removed and replaced by new ones. These are die cast of a very fine quality of high duty babbitt metal and fit very accurately, although it will be found necessary to scrape them to fit. In fitting, proceed the same as with the crank bearings. After the bearing is scraped until it fits the shaft, push the motor together again, being careful that the bearings are in place and fit over the dowel pins properly so as not to bend the bearing when the motor is drawn together. In

#### Gasket between Joints in Crank Case

putting in new bearings in a motor, it is always wise to use a gasket or packing where the crank case goes together a little thicker than that used before. A good grade of tar paper or light roofing material makes a very good gasket for this purpose and has the good quality of being flexible enough so as the bearing wears in, it can be drawn up with the bearing so that you may leave the bearing not too tight in the beginning and as the bearing wears in, draw up occasionally on the large bearing bolts. Also tighten the small bolts up afterward that go through the crank case. In this way there will be no danger in burning out your new bearings. Always watch the bearings very closely for a few hours after new ones have been put in.

#### Oil Float Must Work Freely

This same material can be used in the crank case cover and in replacing the crank case cover, always be very sure that the oil float is working properly. This can be determined by pressing down the wire several times after the crank case is filled with oil and if the wire comes up again freely, it is working all right, but if not, the crank case cover must be taken off and the wire straightened.



Cut No. 24

*This shows the tools necessary for grinding valves. No. 1, an ordinary bit brace; No. 2, screw driver; No. 3, valve; No. 4, valve seat; No. 5, light spring to lift the valve off its seat when you ease the pressure off the screw driver so more grinding compound will flow under the valve, then grind again.*

**Manifold  
Gaskets Must  
Be Tight**

In replacing manifolds after taking the motor down, it is always better to use new rubber gaskets in the water connections and be very sure that the gaskets in the intake manifold are good, as a small leak here will let fresh air into the manifold and spoil the effect of the carburetor, thus the motor will not idle well but will miss on one or more cylinders.

## GRINDING VALVES.

First, remove the manifolds. Then remove the nuts from the cylinder head bolts and by driving a cold chisel or pinch bar between the cylinder head and cylinder, it will be very easy to start the head off. After getting the head off, lay it with the valves down on a bench or a plank and then remove the rocker arms, replacing the pins. Now, by using an ordinary end wrench, you can spring down the spring retainer washer and remove the spring washer holder. This will allow you to take the spring off and remove the valve, by using a light spring under the valve, one that will just raise it off its seat nicely, it will be much easier to grind the valve.

**How to Get  
the Valve Out**

the spring washer

remove the valve, by using a light spring under the valve, one that will just raise it off its seat nicely, it will be much easier to grind the valve.

**What to Use**

To grind the valve, it will be necessary to have some valve grinding compound, which you can procure at almost any garage. However, if this cannot be obtained, get No. 100 Carborundum for starting the grinding. Use this first until the valve is ground down true and smooth, then use No. 200 or 220 grain for polishing or finishing. This will leave the valve very smooth and also the valve seat. If the carborundum is used, it will be necessary to mix it with an amount of cylinder oil or any oil that may be handy, placing a little at a time on the valve and turning the valve back and forth, not round and round, but halfway round or more and then reverse, as if the valve is rotated round and round you are liable to cut grooves in grinding the valve, also let the spring raise it off the seat now and then so the oil and carborundum will flow under. As soon as it stops grinding, let it raise and more run under. You will soon tell by the feeling of the tool when it is necessary to raise the valve. Emery of the same grain as the carborundum may be used. After the valve shows perfect all around the bearing surface, examine the valve seat thoroughly to determine if that is also perfect. If there are little black spots or creases in either, continue the grinding until they disappear. It will be necessary to wash the valve and seat at the time of inspection, with gasoline, to determine if the surfaces are perfect. After finishing grinding, wash the valve and seat out thoroughly with gasoline. Then oil well with a good oil, before replacing.

**How to Grind  
the Valve**

in grinding the valve, also let the spring raise it off the seat now and then so the oil and carborundum will flow under. As soon as it stops grinding, let it raise and more run under. You will soon tell by the feeling of the tool when it is necessary to raise the valve. Emery of the same grain as the carborundum may be used. After the valve shows perfect all around the bearing surface, examine the valve seat thoroughly to determine if that is also perfect. If there are little black spots or creases in either, continue the grinding until they disappear. It will be necessary to wash the valve and seat at the time of inspection, with gasoline, to determine if the surfaces are perfect. After finishing grinding, wash the valve and seat out thoroughly with gasoline. Then oil well with a good oil, before replacing.

**How Much  
to Grind**

perfect all around the bearing surface, examine the valve seat thoroughly to determine if that is also perfect. If there are little black spots or creases in either, continue the grinding until they disappear. It will be necessary to wash the valve and seat at the time of inspection, with gasoline, to determine if the surfaces are perfect. After finishing grinding, wash the valve and seat out thoroughly with gasoline. Then oil well with a good oil, before replacing.

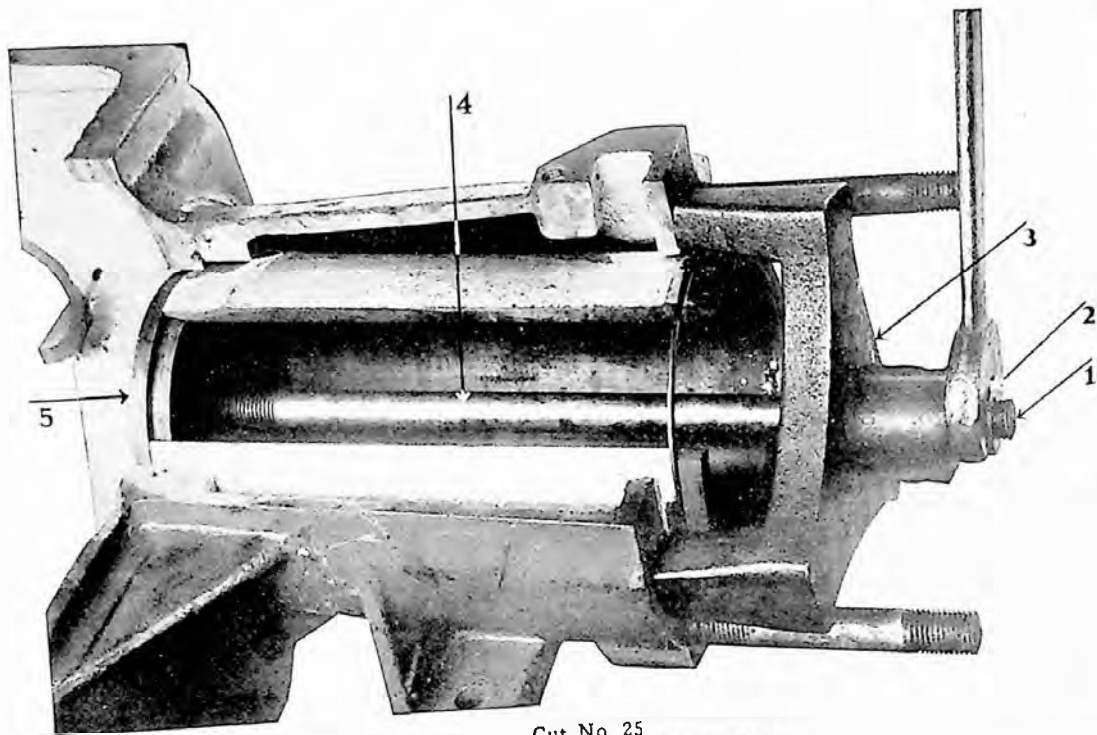
**Wash Off  
with Gasoline**

It will be necessary to wash the valve and seat at the time of inspection, with gasoline, to determine if the surfaces are perfect. After finishing grinding, wash the valve and seat out thoroughly with gasoline. Then oil well with a good oil, before replacing.

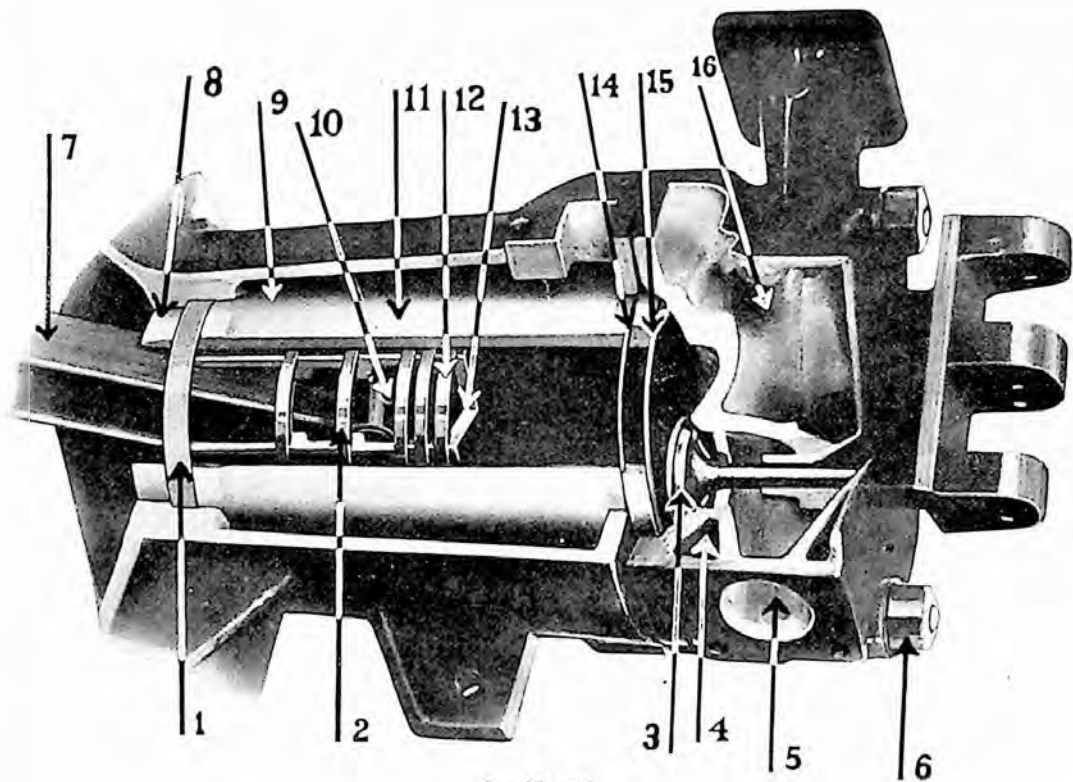
To replace the valve, put it back in the head, put the head on a plank or bench. Take the spring, put it in a vise and squeeze it tight together.

**To Replace  
Spring**

Then take a piece of wire and wire it in three places making end wire fast, then let loose with the vise and this wire will hold the spring compressed so that all you have to do is place it on the valve stem, place the retaining washer on top and then the locking device in the groove of



Cut No. 25  
Removing Inner Cylinder Wall—See Page 60.



Cut No. 26  
*Showing Cylinder Construction and Renewable Inner Wall.*

the stem. Now cut the wire and pull the ends out, and proceed to the other valve as described here.

The exhaust valves usually need grinding about twice a season, sometimes oftener, but the intake valve, as it does not get the heat that the exhaust valve does, only needs grinding about once to the exhaust valve three or four times. Never grind the valve more than is necessary to get the surface perfect.

After grinding the valves, replace the head, first making sure that the copper asbestos gaskets are good. Always put oil on these gaskets when replacing them, as it helps them to seat better.

**Putting Back the Head** Draw up the nuts on the cylinder head bolts very tight and after the motor is heated up, go over them again.

This will many times prevent the blowing out of the gasket. After grinding valves, it will make the stem longer and the

**Adjust Push Rods** push rod will have to be shortened slightly, unless there has been a great deal of slack in same. At any rate, this is the time to make the adjustment on the push

rod and after running an hour or so, it will be necessary to lengthen the rod again slightly, as the different parts take their positions again.

*Cut No. 26 illustrates a cylinder on the Avery "Light-Weight" Tractor with a portion of the walls cut away to show the internal construction of the cylinder walls, valves and seats, the water spaces around the cylinder and cylinder head, together with the piston, piston rings, connecting rod, etc. Referring to the numbers on above cut. No. 1 is the rubber gasket at the front end of cylinder wall, which makes a water tight joint between the water space and the crank case. No. 2 is a ring which passes over the end of the piston pin, preventing the possibility of the pin working end-ways and coming in contact with the cylinder wall and causing damage. No. 12 is a compression ring, the same as the two to the left and the one at the extreme left. These rings are the ones that make the joint between the piston and the cylinder walls. No. 3 is the exhaust valve and is shown partly open. No. 4, water space surrounding the exhaust valve seat. No. 5 is the exhaust port or passage. No. 6 shows one of the cylinder head bolt nuts which hold the cylinder head in position. No. 16 shows another water space which surrounds the intake valve, which is not shown in the illustration. No. 8 shows the machine surface of the cylinder wall which comes in close contact with the crank case and makes a snug fit, thus holding the cylinder wall rigid. No. 7 is the connecting rod. Nos. 14 and 15 are the metal gaskets which make a tight joint between the cylinder head and the cylinder wall and between the cylinder wall flange and the water jacket flange. The cylinder wall being removable, it is pressed into position, then the cylinder head is put on and the cylinder head bolts being tightened draw the head up firmly against these two metal gaskets, holding the cylinder wall rigidly in position and making a tight joint. No. 13 merely shows the end of the piston cut away to show the thickness of the head. No. 11 shows the cylinder wall; No. 10 oil hole in top of connecting rod which oils the piston pin and connecting rod bearing.*

## HOW TO REMOVE CYLINDER WALL.

The cut No. 25 shows the method of removing the cylinder wall of the Avery Light-Weight Motor. The way to prepare for removing the cylinder wall is by first removing the manifolds and cylinder head. Then by removing the crank case cover and disconnecting the connecting rod at the crank end, the piston may be drawn out through the rear end. Then by applying the pulling bar and bracket which is illustrated in the cut, the cylinder wall can be very easily drawn out of water jacket. (Avery Company will have one or more of these instruments at each of their branch houses, which will be loaned to customers for this use.)

In replacing the old cylinder wall or putting in a new cylinder wall, a new rubber gasket should be used at the crank case end. It is also advisable to use new copper asbestos ring gaskets at the rear end, both for the water and the gas joint. The portion of the cylinder wall which passes into the crank case proper is machined to a close fit and should be thoroughly oiled before forcing into place. This will make the operation much casier and will prevent the iron from rusting and thus making it hard to remove.

There are several reasons for removing the cylinder wall. The first and main reason is, accidents to same, such as scoring from lack of lubrication or any other cause. Second, all things wear out in time and when the cylinder wall has become worn by actual wear, it can be removed and replaced by a new one. Again, in certain localities it is necessary to use very bad water. (Always use soft water, if possible.) Any water containing any amount of mineral matter will form a deposit on the cylinder wall, which increases very rapidly and which is a very poor conductor of heat. For example,—a sixteenth of an inch of scale like you will find on a boiler flue or the inside of a tea-kettle will retard the passage of the heat through the cylinder wall more than one inch of cast iron. By examining the condition of the wall through the water outlet at top of cylinder, by removing the manifold, one can easily judge the condition of the cylinder walls. So when the scale gets to any perceptible thickness, it will be wise to remove the cylinder wall and clean it from scale by scraping. If this is looked after about once a season, you will find that the cooling of your motor will be just as perfect ten years from the present time as now.

If it is found inconvenient to get one of these pullers from a branch house, one can be very easily made by an ordinary machinist or blacksmith. All that is necessary is the 1" rod No. 4 threaded at one end, No. 1, for about 6", and any piece of iron heavy enough to stand the pull placed across the inside of end of cylinder wall No. 5. Also a similar piece placed on the rear end of cylinder, No. 3, which can be blocked up to give space for pulling the cylinder wall or may be held by the nuts on the cylinder head bolts.

## RETIMING VALVES AND GEARS.

**Operation of Valves** In taking up the subject of valve timing, it will be necessary to make a little explanation regarding the operation of the valves. For example, the intake valve must open near the beginning of the intake stroke and close near the end of the intake stroke. The exhaust valve must open at a point about 50 degrees before the end of the power stroke, and remain open during the exhaust stroke and close at or near the beginning of the intake stroke. Thus you will see that the closing of the exhaust valve and opening of the intake valve are very near simultaneous. The exact point at which these valves should open and close is marked on the flange on the end of the crank shaft to which the fly-wheel is bolted. If you wish to determine if a valve is opening or closing at the proper time, turn the motor over until this particular valve starts to open or has just closed, as the case may be, and then observe the position of the mark on the flange. For example, if you want to determine the accuracy of the closing of exhaust flange on No. 1 cylinder, turn the motor over by hand until this valve closes. At the exact point at which the valve seats, observe if the mark on flange of crank shaft indicated by arrow **IO Intake opened** No. 6, Page 10, is exactly opposite the split in crank case, which is plainly shown in this illustration. The mark on flange will be marked **E-X-C**, meaning "exhaust closed." The mark for the intake valves opening is marked **I-O**, meaning "intake valve open," etc.

**Marks on Crank Shaft Flange**

**To determine the exact point at which a certain valve opens or closes.**

**Meaning of marks:**

**IO Intake opened**

**IC Intake closed**

**EXO Exhaust opened**

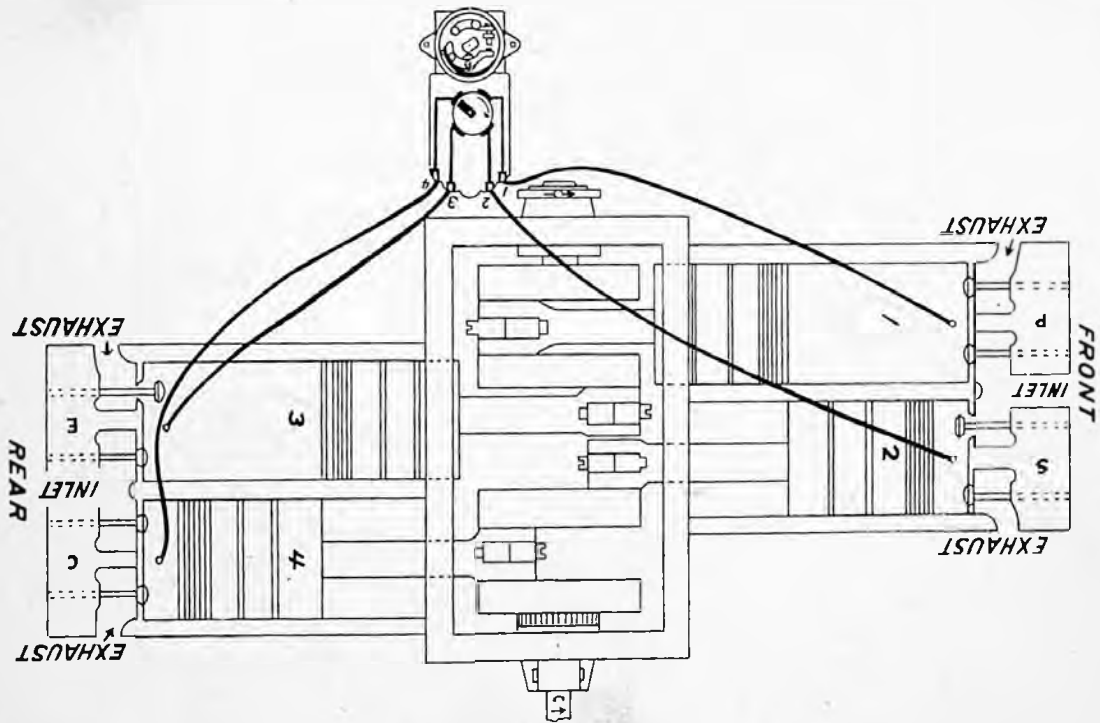
**EXC Exhaust closed**

Referring to illustration No. 27, which represents an Avery 4-cylinder Motor, looking into the crank case, this illustration shows the crank shaft in the exact position in which it should be at the time of replacing the crank case cover. This position will be attained by placing the mark -C- on the flange, exactly opposite to the split in crank case. This will put the right hand rear cylinder, which is No. 4, in the firing position.

**Take plug out of crank case cover** Now by taking the 1" plug out of top of crank case, immediately over the cam shaft gear as shown in cut No. 28, which is a cross section of the crank shaft and arrangement of the gears, by looking through the hole and turning the gear slowly by means of the governor, a tooth will be found, marked XXX. By holding the wheel with this marked tooth directly under center of the hole, then placing the crank case cover in position, the gears will be perfectly timed, also the Magneto, as the Magneto should not be taken off from its base when removing the crank case cover. After the cover has been dropped into place, before putting nuts on the bolts, it is best to check up the timing, by looking at your mark on crank shaft flange and see if it is still in line with the split in crank case; also if the marked

**Find tooth marked XXX**

**Don't remove Magneto from Cover**



Cut No. 27

**Correct by adjusting push rods** tooth on cam shaft gear is exactly under center of hole in crank case cover. This puts the gears in perfect time, and if the valves do not open and close exactly according to the marks on the crank shaft flange, this slight error may be corrected by adjusting the push rods.

**Should any lengthening that** particular valve close too quick and open too late, however, not to run the push rods too loose, even if the valves do not open exactly at the marks, for after the cams have become worn it will be impossible to get the movements exactly correct, and as it is a fact that several degrees change in the action of the valves do not affect the operation of the motor materially, it is best to run the push rods with just slack enough to allow the valves to seat properly.

**Keep closure of valves right** The point to keep in mind in timing valves is the closing of the exhaust and intake valves, as the exact point of opening of these two valves does not affect the operation of the motor to any extent. In case a cam shaft or a gear is broken, making it necessary to replace same with a new part, the new gear may come to you without being marked. In this case remove the old gear from shaft and place the new gear (same side out) against the old gear. Then by turning the new gear until the keyways exactly match, and marking the tooth that corresponds to the marked tooth on old gear, you will have your new gear marked correctly. In this case it will be necessary to retine the Magneto gear. The simplest way to do this is, before removing the cam shaft and gear, to turn the gear in the position indicated in Cut No. 28, then marking a tooth upon the cam shaft gear and also one upon the gear that drives the Magneto shaft. Then by marking your new gear to correspond with the old one and placing these teeth together correctly, you will find your Magneto will be in time again.

**To mark new Gears**

**Mark Magneto Shaft Gear**

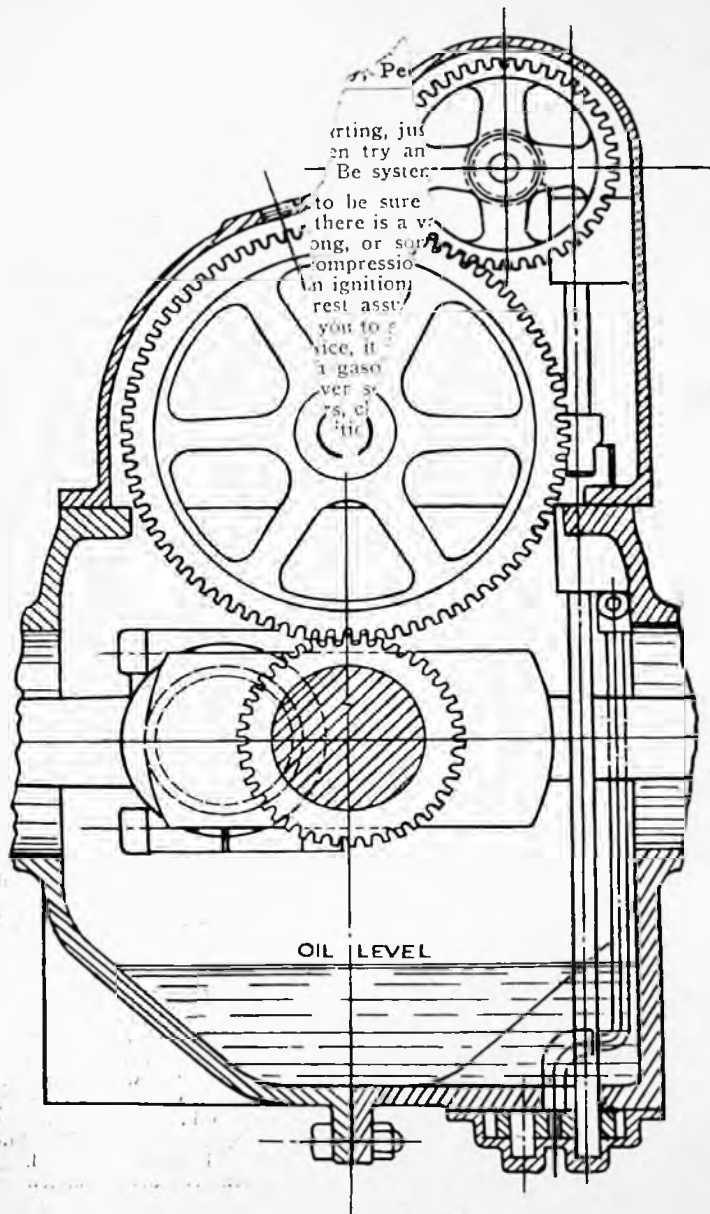
by marking your new gear to correspond with the old one and placing these teeth together correctly, you will find your Magneto will be in time again.

**Magneto Drive Gear Broken**

In case the magneto drive gear is broken, first remove the cam shaft with gear and put magneto drive gear on shaft and shaft in place. Put the magneto coupler on the drive shaft after placing the magneto in its place. Turn the magneto until the distributor arm is on the lower right-hand segment and the contact points, in the breaker box are just beginning to separate, with the breaker box in a retarded position. Then place in your own shaft gear so the mark "Tooth" will be directly under the center of the 1-inch hole in the crank case cover. The crank case cover can now be bolted in its place. Care must be taken that the crank shaft is set with the mark "C" in a perpendicular position so that the cam shaft and crank shaft will also be properly timed.

**To check up timing of Magneto**

To check up the timing of the magneto, unhook the impulse starter and turn the motor over until the center mark on flange of crank shaft marked "C" will be in a vertical position: now turn the motor forward until the impulse unhooks. The mark "C" should be about five degrees past the vertical position. This will place the magneto armature in the



Cut No. 28

Showing Position of Crank Shaft and Gears When Replacing Cover.

proper position, but the distributor shaft (which is shown in Cut No. 9) may be one-half a revolution out of place, and revolving the distributor if necessary to bring the distributor to the proper segment or plug wire lead (as shown in Fig. 7), then replacing the magneto on its base and bolting up the valve cover. By moving the magneto out of place, and revolving the distributor to the proper segment or plug wire lead (as shown in Fig. 7), then replacing the magneto on its base and bolting up the valve cover, you will find this magneto will be in perfect time.

If the instructions have been followed correctly, after replacing the crank case cover, your motor will run with the rear right-hand rear cylinder (which is No. 4) in firing order. Beginning with No. 4, our firing order is:

No. 4, right-hand rear clutch side

No. 1, left-hand front fly-wheel or magneto

No. 2, right-hand front clutch side

No. 3, left-hand rear fly-wheel.

Referring to the Cut No. 27, which is a cross section of the 4-cylinder Motor, showing the positions of the crank shaft and pistons, also the valves, together with the magneto breaker box and distributor, this shows very clearly the position of all these parts.

**Be sure Oil Pump in Proper Position** In replacing the crank shaft cover, care must be taken to place the oil pump coupling in such a position that it will connect properly with the end of the governor shaft when the case is lowered. Care must be used also in handling oil float wire; as this is rather delicate it is very easily bent, and will not work properly if in any way deranged. After the cover has been lowered, before tightening down, it is well to place oil in the crank case and try the float, by pushing the wire down to the bottom of the gauge, and see if it rises quickly and freely. If it does not, the cover must be taken off again and the bend in the wire straightened.

This is important, for if the float should happen to stick in the "up" position, you might run your motor dry of oil, and in this way ruin it.

**Difference Between 2 and 4 Cyl. Magneto** If your motor is a 2-cylinder instead of a 4, by using No. 1 and No. 3 cylinders it will give you the exact position of the parts in a 2-cylinder motor, as you will find the holes in the top of the distributor on magneto for a 2-cylinder motor, the No. 2 and No. 4 outlets have been plugged, using No. 1 and No. 3.

## HOW TO LOOK FOR TROUBLE.

In case of trouble with a Gas Tractor, the first thing for the operator to do is to sit down on the foot board and think of that old railroad crossing sign, "Stop, Look, Listen." Insert in the place of the word "Listen," "Think." The internal combustion motor's operation depends entirely upon three principles. First, a compression of the mixture, which means tight valves and tight pistons. Second, an inflammable mixture of gasoline and air, which means a proper proportion of air and gasoline. Third, an electric spark. Any engine having these three features or fundamentals is bound to start.

Now, if you have trouble in starting, just think for a moment before you tear your machine down. Then try and locate which one of these three conditions that is not right. Be systematic.

First turn your motor over, to be sure that it has compression. If it has not, it is quite probable that there is a valve sticking open from some cause, or push rod may be too long, or some foreign particle may have gotten under the valve. If the compression is good, try for a spark in the manner described in chapter on ignition trouble, page 30. If you get a fairly good sized spark, you can rest assured that that part of the apparatus is all right. Then it is up to you to see if you have a mixture. Quite often in starting a motor by a novice, it is overprimed or the mixture becomes too rich by using too much gasoline. In this case, take out your spark plugs and turn the motor over several times with them out. This will draw fresh air into the cylinders, cleaning out the fuel charge and will put the machine in the same condition as it was when you started, so you may begin all over again.

It sometimes occurs that sediment or dirt will be carried to the carburetor needle valve. In this case, you will get a good flow of gasoline at the connection between carburetor and supply pipe but it does not flow into carburetor sufficiently fast to supply the motor. By taking the small nut off the bottom of carburetor, the air tube or pipe may be taken off, exposing a large hex. nut, which if taken off, will let the bowl of the carburetor drop down, exposing all the internal parts. You may then clean the needle valve passage, also the bowl of carburetor, after which replace same, screwing the large hex. nut up very tight to prevent any leaking at this point.

However, if the carburetor does leak after being taken down, remove the nut again and take wrapping card and wind two or three turns under the nut and then screw the nut up on to this, which will make a tight joint.

Our service men have been called upon many times in the past to visit tractors which the owner claimed would not develop sufficient power, also claiming motor ran very good on light load but as soon as heavy load was applied, it would backfire, die down and sometimes stop. In fact, this has been a very common trouble. Now, in the majority of these cases the trouble has been the fact that some foreign substance had been put in the supply tanks with the gasoline. In other cases, scales had collected at the bottom of the tank from the sides of same, clogging the supply pipe that flows to the carburetor, causing the gasoline to flow to the carburetor very slowly. By loosening the gasoline pipe that conducts the gasoline from the tank to the carburetor at both ends and blowing through same, you can very easily determine if this pipe is clear. Now open valve at bottom of tank and observe if fuel flows freely from same. If not, it will be necessary to remove valve and sometimes trap under tank and if scale is found in these parts, it is advisable to take the tank off and thoroughly clean it by washing it out with gasoline.

Sometimes in cold weather, trouble may occur with the spark plugs being damp. It is very advisable, in cold weather, to take the spark plugs out of the cylinder and in some way warm them thoroughly before trying to start. Also thoroughly clean the plugs, especially the porcelain or mica part, which forms the insulation of the electrode. Also clean the points at which the spark is formed. This sometimes scales over with an insulating scale and prevents the spark from jumping across.

If these precautions are observed in cold weather, you will seldom, if ever, have trouble in starting. However, the gasoline of today is of such a low grade, that it is very advisable to take your priming can, place it in a pail of hot water, bringing the gasoline temperature up to where it will vaporize freely. This will cause the gasoline to mix readily with the air and many times help in starting a cold engine.

It is also necessary to open the carburetor needle valve about one turn in cold weather and leave it so adjusted until the motor is warmed up, as the fuel being so cold it is not readily vaporized, therefore the engine gets too lean a mixture and will back-fire through the carburetor. After the engine is thoroughly warmed up, set your needle valve back to the old position.

On a tractor equipped with the high tension magneto with an impulse starter, if trouble is had in starting, observe if the action of the impulse is quick and lively. If not, take a little gasoline and pour over these parts, washing heavy oil off. Do this until when the cam is released, it will throw over very quickly. This is important, as it is the speed of the armature that generates the spark—the greater speed, the hotter the spark.

It is also good practice in very cold weather to get five gallons of a high grade gasoline such as used in lighting, 84 test or as near that as can be procured. This will facilitate starting. Use it only for priming and it will go a long ways.

Don't get up and call for an expert the first time the motor does not start—conquer it right there and you will have won a victory and learned something that will be of value to you as long as you have the machine. And don't forget that five minutes of good solid thinking is worth more right here than all the tools in Christendom.

## INSTRUCTIONS FOR OPERATING ELECTRIC STARTER ON AVERY TRACTOR.

The Starting Outfit consists of five units each complete in itself.

1. The Generator, the source of electric power.
2. The Battery, the storage place of power.
3. The Motor, which changes electric power into driving power.
4. The Switch, that connects the motor and battery.
5. The Relay, or electric valve which connects the Generator and battery.

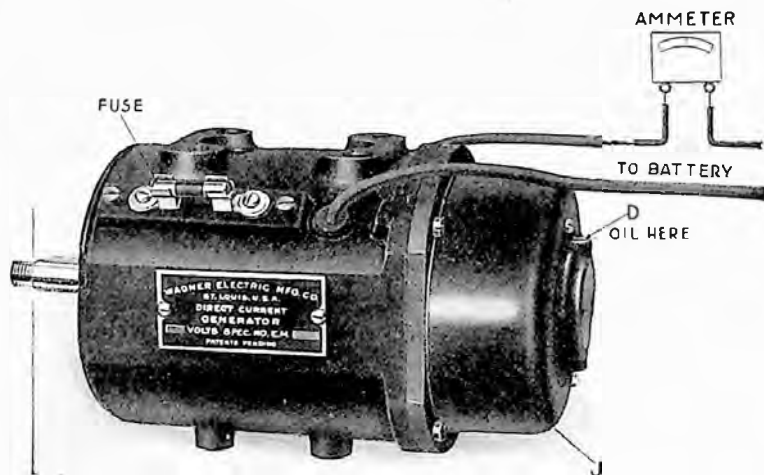


FIG 1 GENERATOR

The Generator, Fig. No. 1, is mounted on top of the engine near the magneto and is chain driven from the magneto shaft. The generator is equipped with ball bearings on both front and rear end and these bearings should be kept lubricated with a good quality of machine oil, using about 5 drops once a week. The rear bearing gets sufficient lubricating from the driven mechanism.

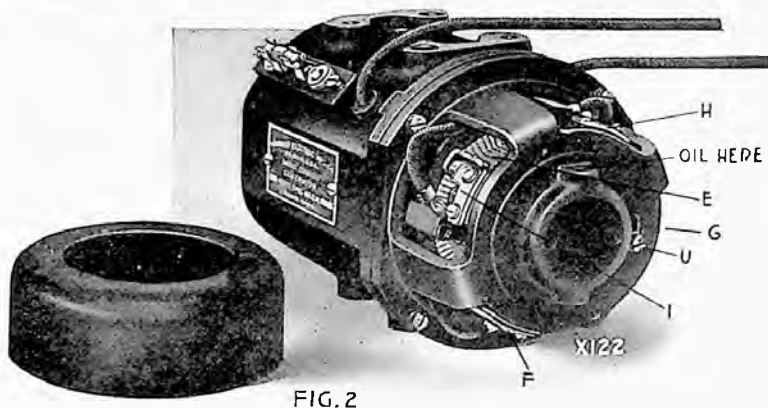


FIG. 2

Fig. No. 2 shows the generator with the cover removed. If the commutator "E" becomes rough or dirty, smooth it by holding a piece of fine sand paper on its face while the machine is running. If the brushes, F, G, H and I, become dirty they can be lifted out and cleaned with gasoline. Use care to see that all the gasoline is removed before starting the machine.

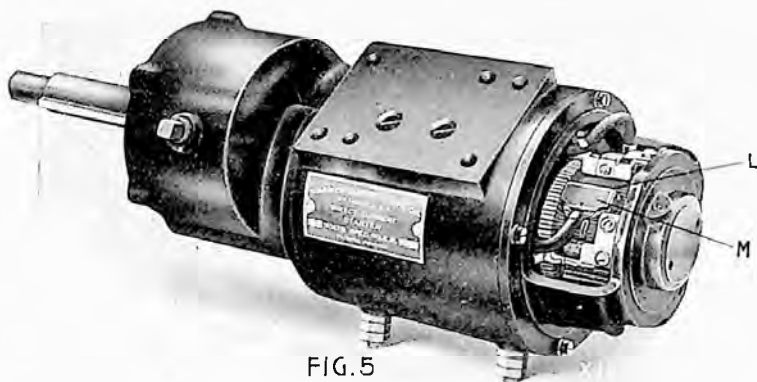


FIG. 5

The Electric Motor, or starter, is located at the side of the engine over the flywheel. This machine is used only for the starting. It should be oiled with a good grade of machine oil about once a month, and the gear case filled with grease once or twice during the season. The metal cap at the end should be removed at the beginning of the season and the brushes and commutator cleaned of carbon and copper dust.

## STARTING SWITCH.

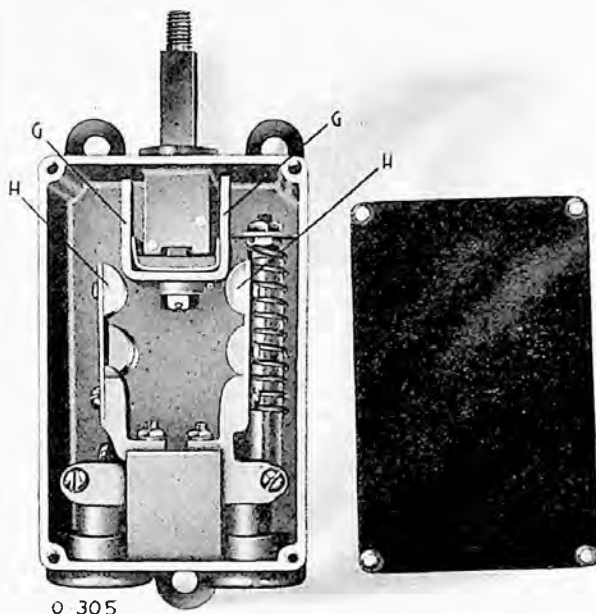


FIG. 4 (STARTING SWITCH)

The Starting Switch is shown in Fig. 4. To clean or inspect the switch, remove the plate and rubber gasket which covers the top of the switch box. The contact fingers should be kept clean and free from "bubbles" of copper, but should they become dirty or burned, the points should be removed and dressed with a file and smoothed with sand paper. With ordinary care the contacts will require no attention during the season.

The first contact is for starting only, and should the motor pull the engine on this contact, the starting coil, in the switch box will be burned out. When the gears are engaged, pull on the starting lever firmly and the motor will receive full power from the battery.

## RELAY.

The Relay, or Electric valve, is mounted on the end of the battery box. It is automatic and requires a little attention at the beginning of the season to see that all the points are clean.



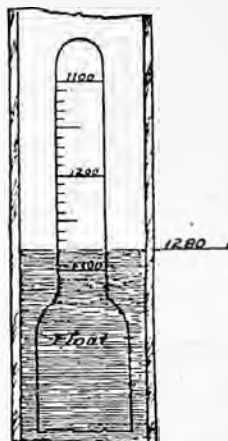
FIG. 3

In case the battery is removed or disconnected, the driving chain of the generator must be taken from its driver to prevent the generator from running. If the generator is not disconnected a large current will be generated and burn out the machine.

The battery consists of a standard six cell battery, giving a pressure of 12 or 14 volts. Each cell is a separate unit. The hard rubber jar contains the lead plates which are separated by wood separators, and all are covered with a solution of sulphuric acid and water, called electrolyte. The solution must always cover the plates and when the solution is low distilled or pure rain water should be added. The solution should be tested by means of the hydrometer as furnished.



*Hydrometer  
Syringe*



*Enlarged Section of Hydro-  
meter showing float resting at  
1.280, which shows that the  
Battery is fully charged.*

To take a reading of the gravity of the cells, insert the end of the rubber tube in the cell. Squeeze the rubber bulb and then slowly release, drawing the electrolyte from the cell until the hydrometer floats. The reading on the graduated stem of the hydrometer at the point where it emerges from the solution is the specific gravity of the electrolyte.

Return all electrolyte to the cell by squeezing the bulb. The gravity should test the same in each cell.

Reading 1.280 charged battery.

Above 1.150 half charged.

Below 1.150 run down.

When the battery readings are low, use the battery sparingly, see that the generator is working right and that all connections are tight. In case the battery continues to run down it is best to remove the battery and charge it from some direct current source.

When the gravity is low in one cell, this cell must receive special attention by an experienced battery man.

Should one cell require more water than the others, look for a leaky cell.

In case of a short circuit in a cell, the gravity will remain the same during charge. A short circuit must be taken care of at once.

When the battery is fully charged all the cells will bubble freely and the gravity will show no further rise during an hour's charge. If the battery has been neglected for some time it is necessary to give it a prolonged charge, to bring it up to capacity.

When the battery is to be idle for some time, it should be given a charge, and then a freshening charge at least once a month. Before putting it in commission again it should be given a long soaking charge.

If it is not possible to give the battery proper care on the machine it should be removed and taken to a garage which makes a business of recharging batteries. Here it should be charged once a month.

A fully charged battery will not freeze in ordinary temperatures, as shown by the following table.

- Sp. Gr. 1.150, battery empty 20° above zero.
- Sp. Gr. 1.180, battery  $\frac{3}{4}$  discharge freeze 0°.
- Sp. Gr. 1.215, battery  $\frac{1}{2}$  discharge freeze 20° below.
- Sp. Gr. 1.250, battery  $\frac{1}{4}$  discharge freeze 60° below.

To start the engine, retard the magneto, release the automatic trip on the magneto, open the throttle, examine the spark plugs and prime the motor. Unlock the starting lever and pull out on the starting lever until the starter turns over and the gears are in the right position to engage the teeth on the fly-wheel, then pull the lever over firmly, forcing the gears into full mesh, and giving full power to the starter. As the engine turns over, the magneto should fire the charge and start the engine. Release the lever and lock it in place.

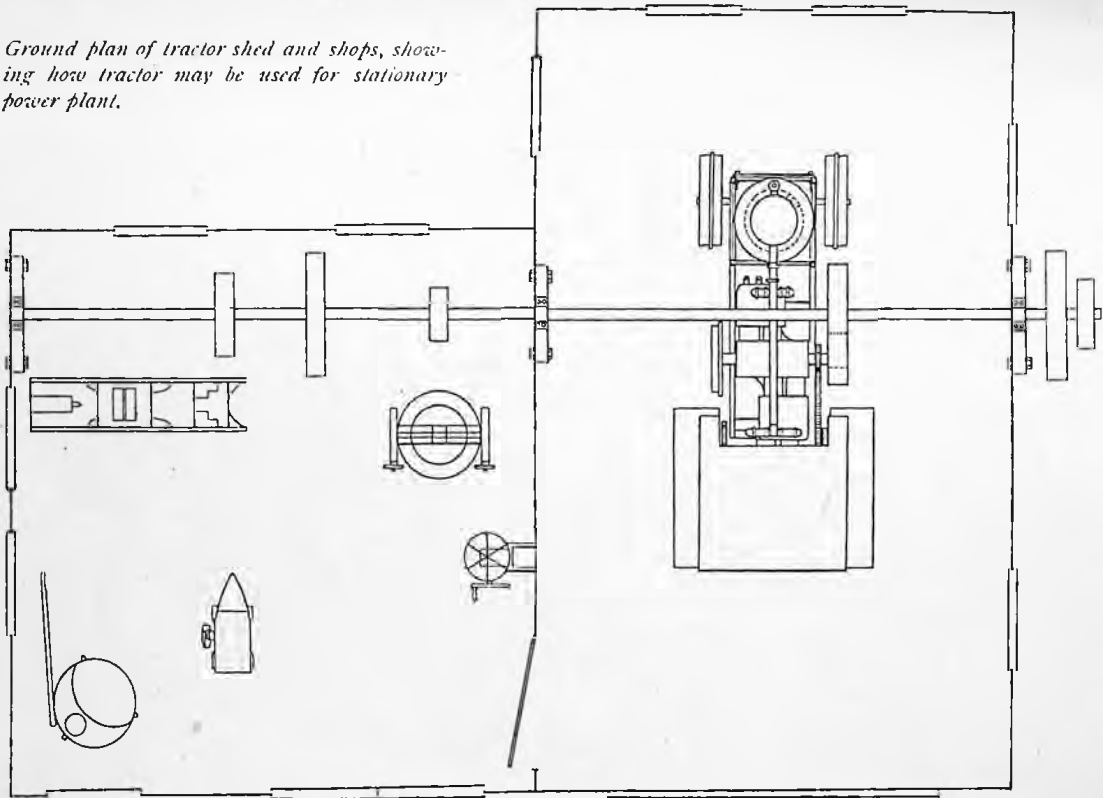
Should the engine fail to start when turning over, do not run down the battery by keeping the starter at work, but examine the engine, spark plugs and gas lines, and see that all are in good shape. Then operate the starter again. In cold weather it is best to prime through spark plug holes, and be sure plugs are clean and dry.

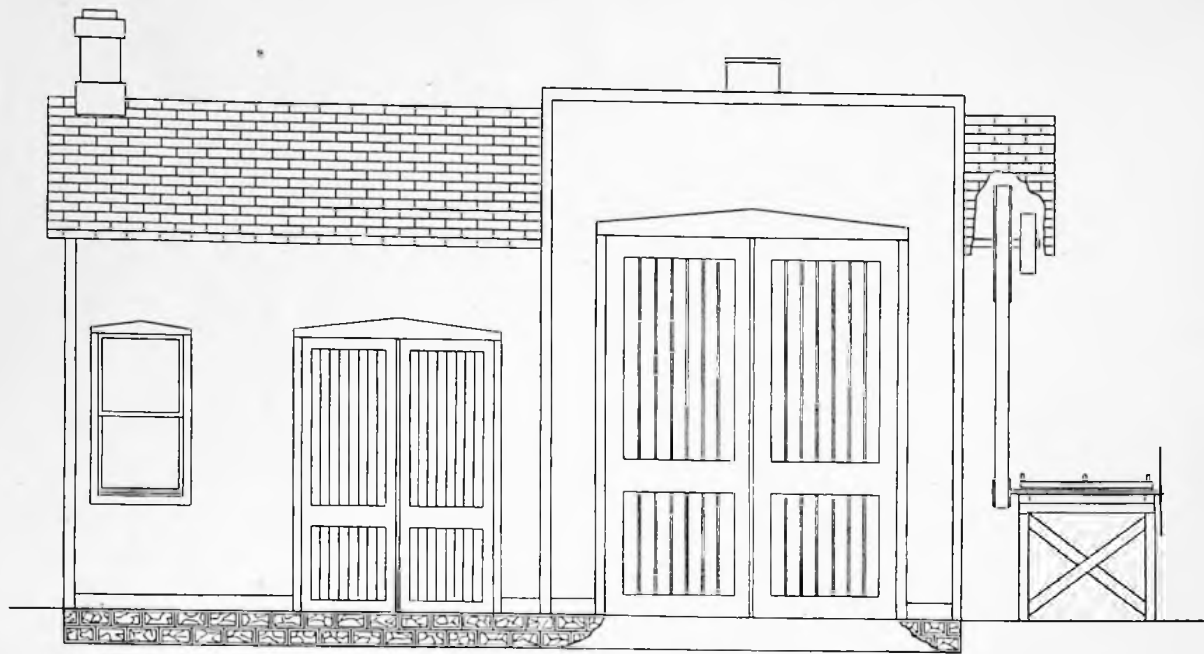
## CARE AND USE OF THE TRACTOR.

In the following chapter we have endeavored to help our customers to help themselves, so that they may realize more fully the great advantage and benefits that are possible in the tractor. If one is to make an investment, the first thing to figure is what the returns will be. Now, then, if you had one thousand dollars to invest at 6% interest and some one would tell you where you could get 8% instead with no greater risk, you would in all probability hasten to make the change. An Avery "Light-Weight" Tractor is an investment and our object is to tell you how you can make it earn a larger amount of interest.

An Avery tractor will earn you money every day it is run, so the more days it runs the sooner you will get your money back and the less interest you will have to charge up against your investment and in that way will net you a greater profit than if run less and last longer.

*Ground plan of tractor shed and shops, showing how tractor may be used for stationary power plant.*





*Side Elevation of Tractor Shed showing how machinery may be run outside of shed by means of an extended shaft.*

In the following pages of this book, we have endeavored to show several of the numerous hitches which are being used by our successful customers for operating of different machines upon the farm in connection with the tractor. These hitches are very simple in construction and the material used can be found on nearly every farm, also the tools for constructing same. It has been proven many times to the user's satisfaction that such work as drilling, discing, harrowing, packing, pulverizing of the soil can be done quicker and better with a tractor than with horses. Tractors have also been used to very good advantage for hauling hay loaders, mowers, binders, loaded wagons, potato diggers, lime and fertilizer spreaders, etc. A great many tractors also have been used on road levelers, graders and ditching machinery, also for the purpose of grubbing or pulling up trees, stumps, rocks, etc. Any farmer with very little ingenuity can find almost constant work for his tractor during the season. We would, therefore, urge you to use your tractor for as many of these purposes as your locality and situation will permit.

First of all we would like to impress upon you the advisability of housing your tractor. No machine will last as long, give as perfect satisfaction and be as great a pride to the owner if it is allowed to stand out and take the ravages of the elements. The motor, especially, is a very finely built machine and the parts are so accurately machined that a little rust in certain places would affect the work of the machine materially; also the ignition system should be protected from the weather when the tractor is not at work. However, it does no harm to a tractor to be working in bad weather, either rain or snow, because while it is working the parts are thoroughly oiled and there is enough heat generated to dry all the parts before rust commences. On the previous pages we offer a suggestion as to how a tractor can be nicely housed and in this way can be made to do a great deal of work, while it is being housed, as a stationary machine.

If our customers would spend a little time and money in figuring out what is adapted for their conditions, many times the tractor can be made doubly as efficient as it would be otherwise. By putting up a line shaft, as indicated in the sketch, it will be very easy to drive any machinery that may be upon the farm, such as feed crusher, silo fillers, wood saws, etc., without taking the tractor out of the shed. It will also be found that a great many of the machines on a farm have pulleys that are not the right size for convenient driving direct from the tractor. This can be overcome with the line shaft, from the fact that any size pulley required may be mounted upon it, thus getting the speed desired on the machine driven.

It is very desirable to have a pipe large enough to go down over the top of the radiator to carry the gas from the tractor out through the roof.

In connection with the tractor shed, we would advise the construction of a shop as illustrated. Few people realize the actual value of a small shop upon a farm, equipped with sufficient tools to do ordinary work, such as forge, anvil, drill press, grinder, etc. This shop and tractor shed also comes in very convenient when it is necessary to overhaul the tractor, which should be done about once a year. If when building the tractor shed a good strong beam is put across the position in which the tractor

will stand, it will be found very convenient in handling the heavy parts of the tractor with a rope and block, when it is necessary to take the machine apart. Such parts as the fly wheel, clutch, gears, rear wheels and motor parts are very heavy and awkward to handle in any other way, but can be very easily handled if provisions are made for that purpose.

The success of the Tractor on any size farm will be greatly increased if the owner will just take a little pains in shaping his farm and his fields to fit the Tractor. This could be very easily and cheaply done. For instance, a farm that is cut up into small square fields is not adapted to the use of a Tractor as well as a farm with the fields or different plots laid out the full length of the 160 acres or whatever size the farm may be, so that each trip the tractor makes can be as long as possible. The average size tractor cannot be turned in as short a distance as a team can be turned. It also requires time to make the turns. Therefore, a long, narrow field can be plowed or harvested with fewer turns than a square field. The same holds true in the cultivating of corn or in discing or harrowing. There is little or no trouble in going straight ahead, pulling a number of machines such as Drills, Harrows and Packers. The difficulty is all experienced at the turns.

We are quoting an article from Bulletin No. 18 of the Twentieth Century Farmer of Omaha, Nebraska, under date of Nov. 1, 1915, which illustrates this very nicely.

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### TRACTORIZING A 160-ACRE CORN-BELT FARM.

From present indications, 80,000 people will attend the National Power Farming Demonstration at Fremont, Neb., August 9-14. Of these 80,000, between 10,000 and 20,000 will be asking themselves the question, "If I spend a lot of money for a tractor, can I use it to advantage on my 160 acres and make it pay me dividends?" Many of these men will purchase machines and put them to work on their farms with varying degrees of success and failure. The Twentieth Century Farmer is confident that most of the instances will be recorded as successes and that many of the partial failures can with a little effort and thought be made into successes.

The old adage that you cannot fit a square peg into a round hole is very applicable here as well as in business life. One should not expect to be able to take a tractor onto the farm and have it fit right into the old order of things any more than he would expect to get good results working in a garden plot with a four-horse team. The tractor is one of the best of servants, but it has a few peculiarities upon which it is very set. It refuses to turn a short square corner or to turn a corner as fast as it will travel along the row. In these things it is a good plan to humor it. To do this requires a little effort and oftentimes a little outlay, but the money invested in the changes will pay dividends.

A farm in southern Nebraska which is to be tractorized has come to our attention. The present arrangement is as shown in the accompanying illustration. The fields are nearly square and as a result the rows are short, and to plow or cultivate the crops requires considerable turning. None of the fields gives more than two-thirds of the possible length of row. In the new plan every field will have full length rows and can be cultivated with a minimum amount of lost time. The plots are to be unfenced, which will result in the greatest economy of space and a maximum of flexibility for a scheme of rotation.

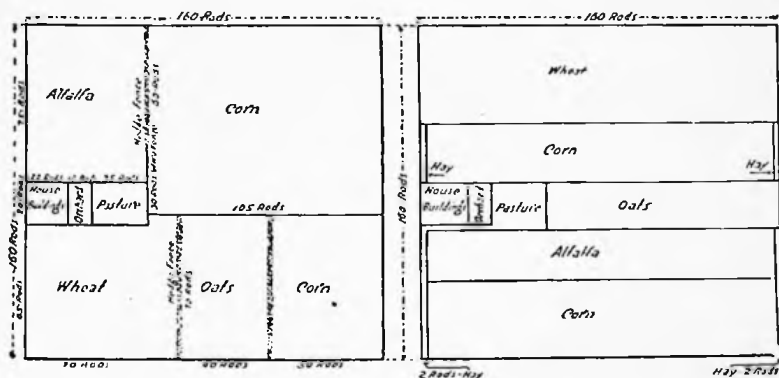


Diagram showing method of tractorizing a farm to the best advantage.

A strip of hay two rods wide is to be left at either end of the plots, in which a crop needing cultivation is to be grown. The owner is thus providing for turning space for his tractor and also a convenient lane for reaching his fields. The tractor can then plow or cultivate clear to the end of the row and not knock down any of the growing stalks.

The work of remodeling this farm according to this plan is not going to be a difficult proposition. The tractor will represent abundant power to tear out the old hedge fence and pull up the posts of the old wire fence.

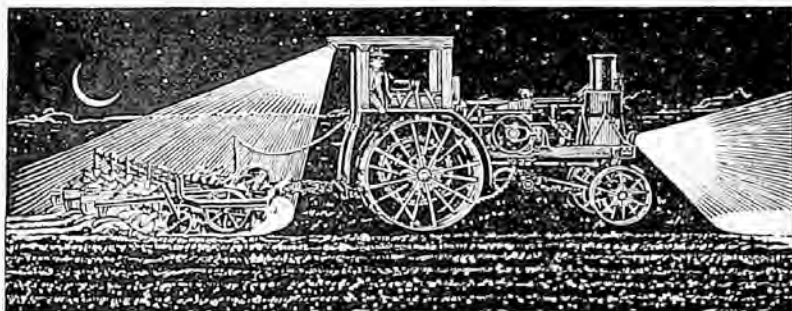
Of course, the lay of the land will be the deciding factor in tractorizing the farm. For instance, a farm with a deep draw or a stream across it will need to be treated differently from the above case. The things which must be borne in mind are that the best results will be obtained in tractor farming if the fields are made as long as possible and a turning space is left at the ends of the rows.

## WHAT OUR CUSTOMERS ARE DOING.

On the following pages we have placed a few cuts made from photographs sent in by some of our customers, as suggestions to the new owners of tractors of what may be accomplished with same.



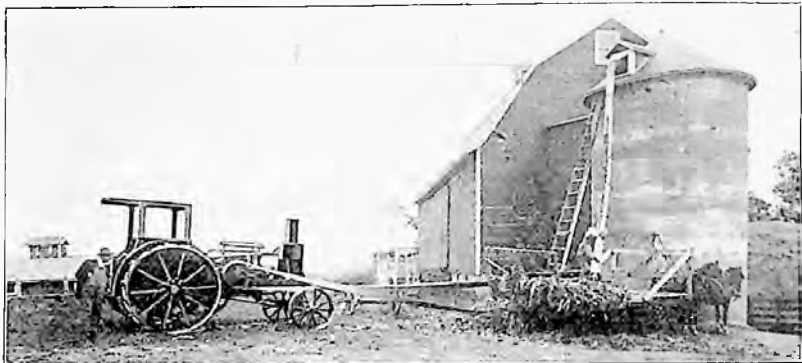
*The Tractor not only furnishes abundant power for operating this machine but also will move it from place to place.*



*Electric equipped Tractor running night and day.*



*The Tractor cannot be beat for heavy hauling.*



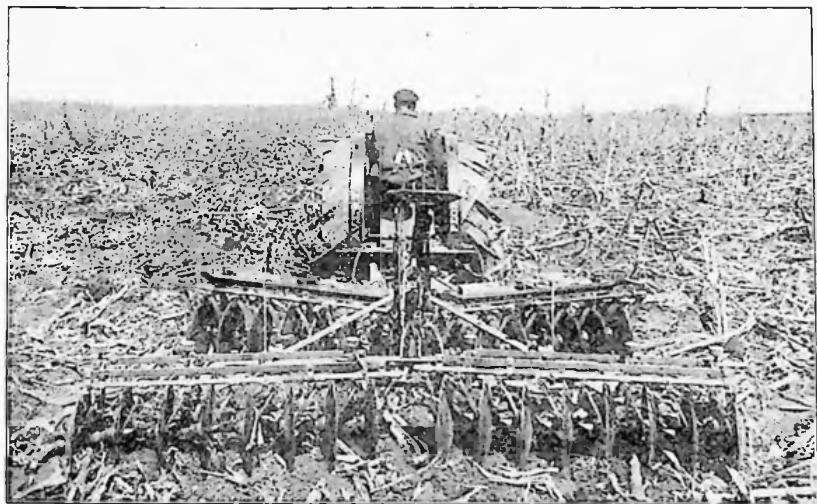
*Let your Tractor take the place of your stationary power plant. This is work that cannot be accomplished with horses.*



*The Tractor keeping the orchard in the best of condition when it is too hot for horses to work.*



*Road hauling with an Avery Tractor.*



*How would you like to tackle this with a bunch of horses?*



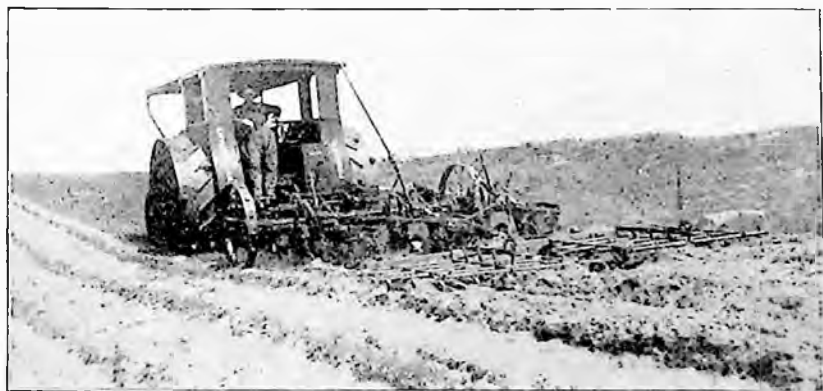
*There are many combinations of machinery that you can work out if you try.*



*You can run this outfit as many hours as you like, getting double service out of your machinery.*



*When time is money, let your Tractor help save the grain.*



*Lister at work doing a fine job.*



*Let your Tractor help build your home by sawing the lumber for building your buildings.*



*Good roads are one of the answers to the Farm Power problem. This is the way to make them.*

## THE SCIENCE OF LAYING OUT AND THE ART OF PLOWING WITH POWER.

It has been discovered that a great deal of time and useless travel and turning the machine when idle can be saved by taking a little care and time laying out the field that is to be plowed.

Suppose a field to be square in shape, or approximately so. Set stakes 100 feet from the fence or edge of the field on all sides, as indicated by the following diagram.

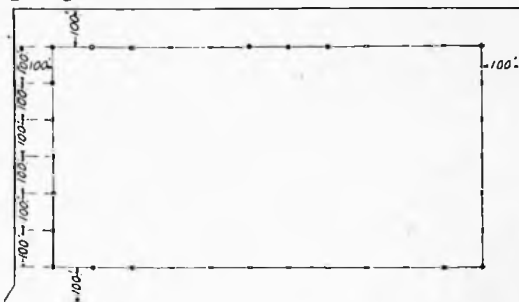


FIGURE 1.

Starting at one corner, run a single furrow (throwing the furrow in) on the end. This is to serve as a guide to go by in raising and dropping the plows.

Then with all the plows down, 100 feet from the side of the field, run through to the other end, again throwing the furrow in.

Then plow the other end with one furrow, throwing it in as directed above.

Then with all plows down, plow the other side, again throwing the furrow in.

After so doing, the following diagram will illustrate the field.

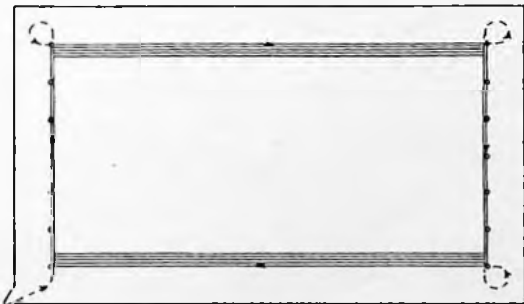


FIGURE 2

Take note of the dotted lines in the corner showing the way the outfit is turned.

Then stake off the center in approximately 100-ft. sections and plow through on each line, making turns as indicated by the dotted lines, and the field will be laid out as shown by the following diagram:

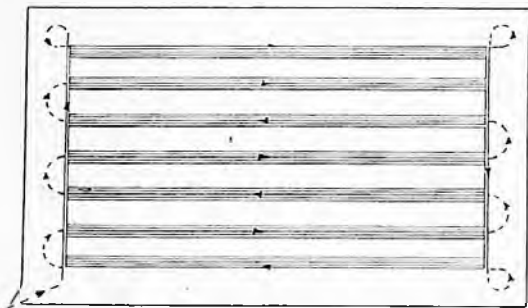


FIGURE 9.

Now plow the other side of the head-land in the reverse direction as shown by the following diagram:

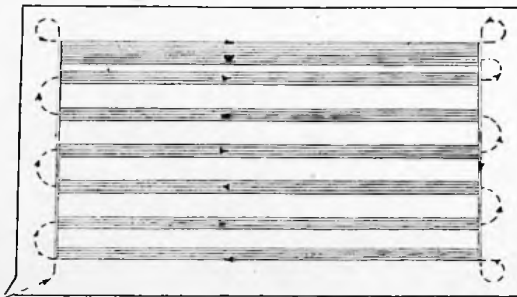


FIGURE 4.

You are now ready to plow out between the lands in almost any way you choose, but keep going across from one land to the other until they are wide enough to go round the end.

Having plowed all the centers, you will then proceed to plow round the whole field, as per the following diagram:

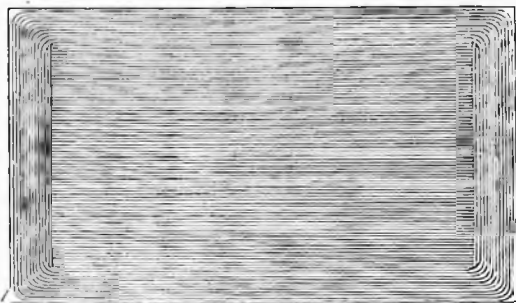


FIGURE 5

You will readily see that any shaped field can be handled in this way, and for illustration we give below two diagrams, one representing a field with an irregular side and the other a field that is wedge-shaped:

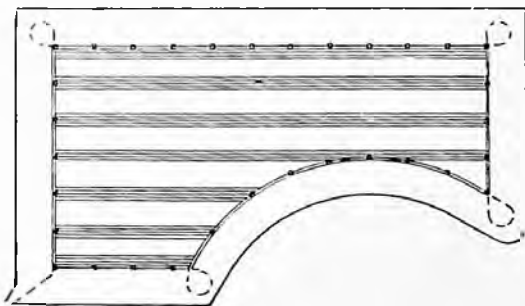


FIGURE 6.

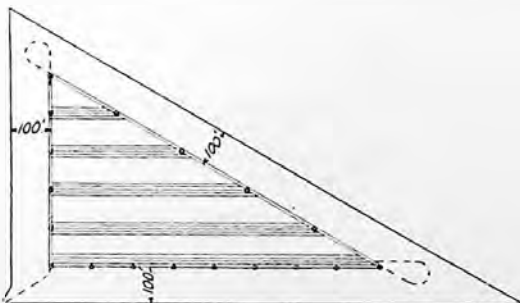


FIGURE 7.

It will be seen, by careful study of this plan, that, first of all, the whole field can be plowed without the use of horse plow, unless it be a very sharp corner of an irregular shaped field, but the most important part is that the engine will not have to lose time idling around turning or running too far across the ends empty, and finally, when you come to plow around the whole field you make the very best time because you are plowing all the time and that is the object of leaving the space of 100 feet all around the field.

This same plan can be worked out, using a smaller space, down to 26 feet.

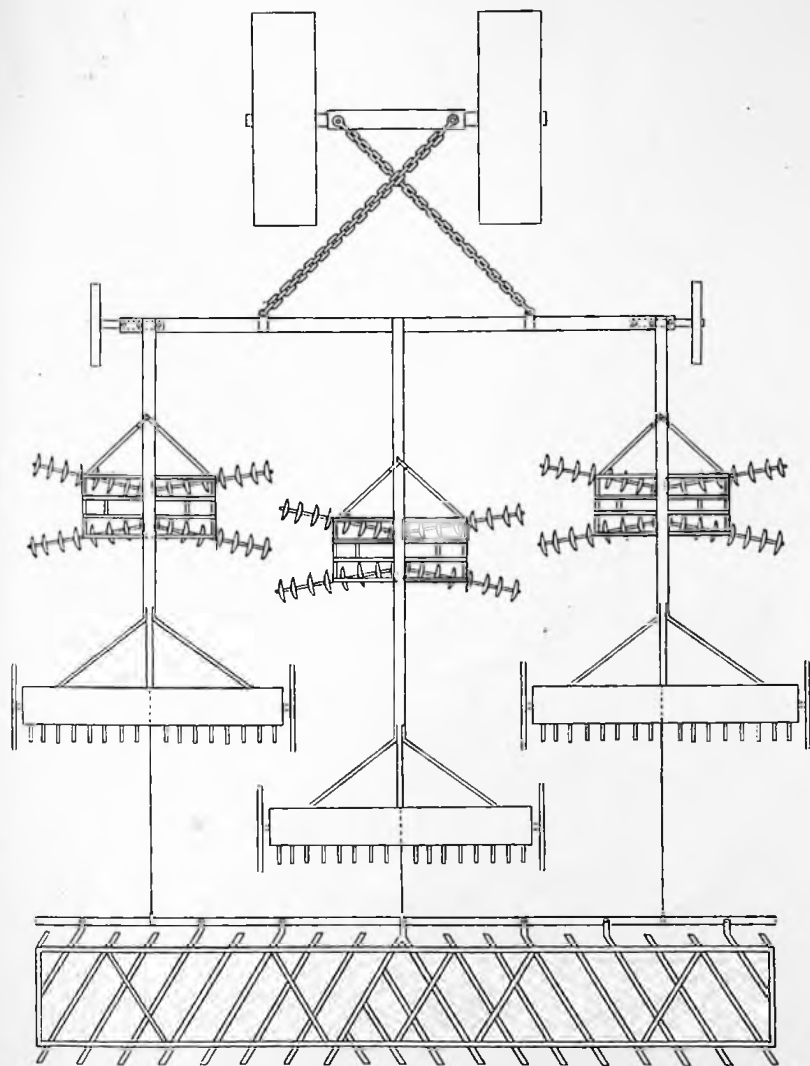
If, for any reason, it is desirable to throw the dirt out in going round the field, all that is necessary to do is to reverse the last operation and go round the field the other way.

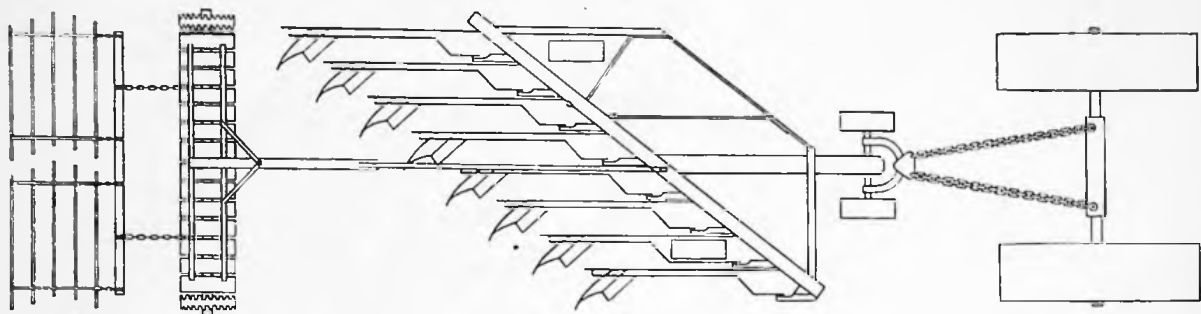
If an "A" frame be constructed of light material, say about 1 inch square and about 6 feet long, with the lower ends set at the exact width that your plow cuts and this "A" frame or divider used for measuring off the lands, you will find that no matter what size land you lay out, the last trip you make will cut the land out, thus eliminating the necessity of going across the field with only two or three plows working, as will be the case where the width of the lands is laid out hap-hazard.

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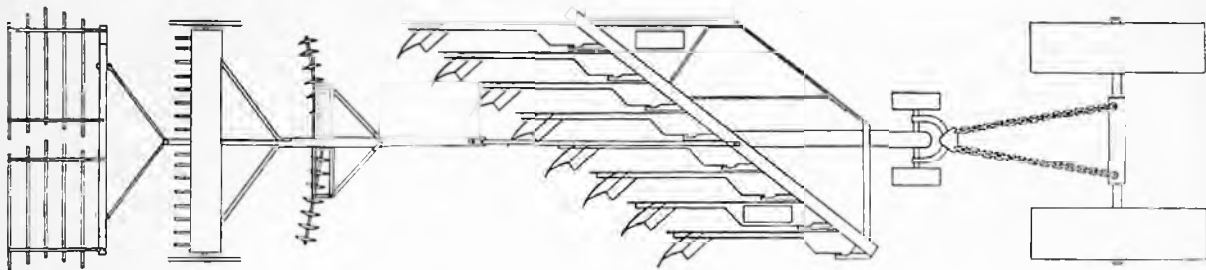
## TRACTOR HITCHES.

The cut on the opposite page illustrates a 40-80 Avery tractor, operating 3 double discs, 3 drills, and a smoothing harrow. The harrow is connected by chains to the drills and the drills are fastened to the double discs either by chain or with clevis. The disc tongue may be fastened to the 4x6 cross bar either by clevis or straps and bolts. The wheels used can be picked up on nearly any farm, as it is immaterial as to the exact size or shape. The important thing to observe in assembling a number of machines to be operated at one time is to so space the machines that the end of the field may be turned without the machines jamming or being caught one with the other.



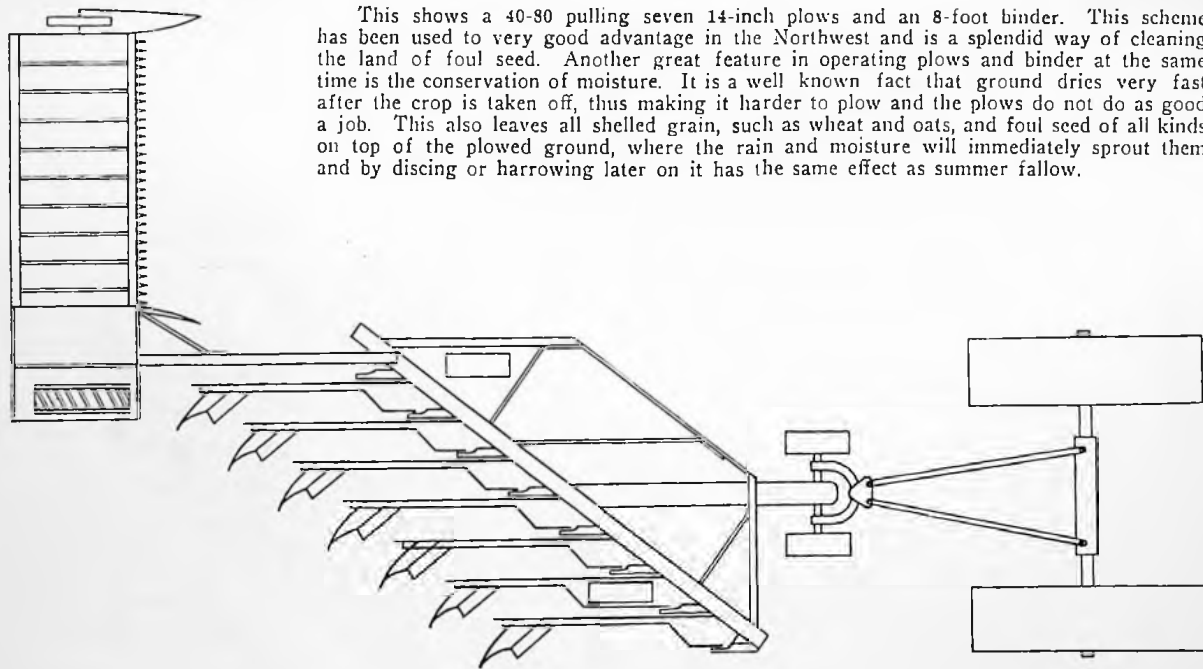


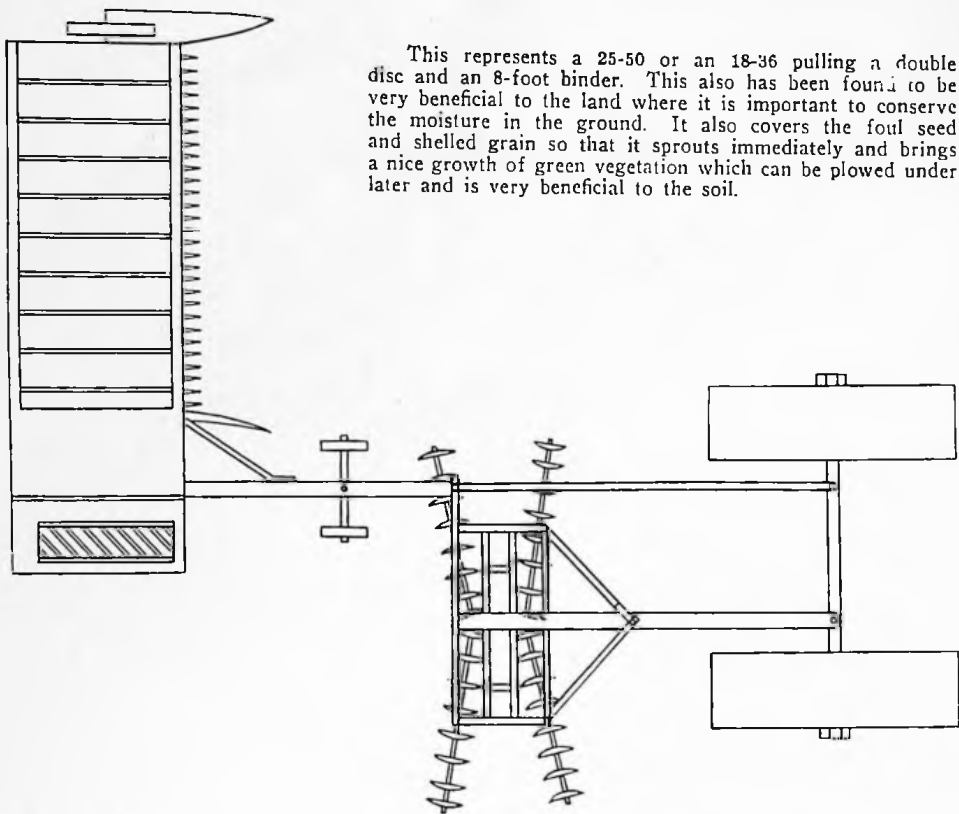
This shows a 40-80 Avery tractor pulling eight 14-inch plows with a packer and harrow behind. These are simply fastened one to the other by chains.



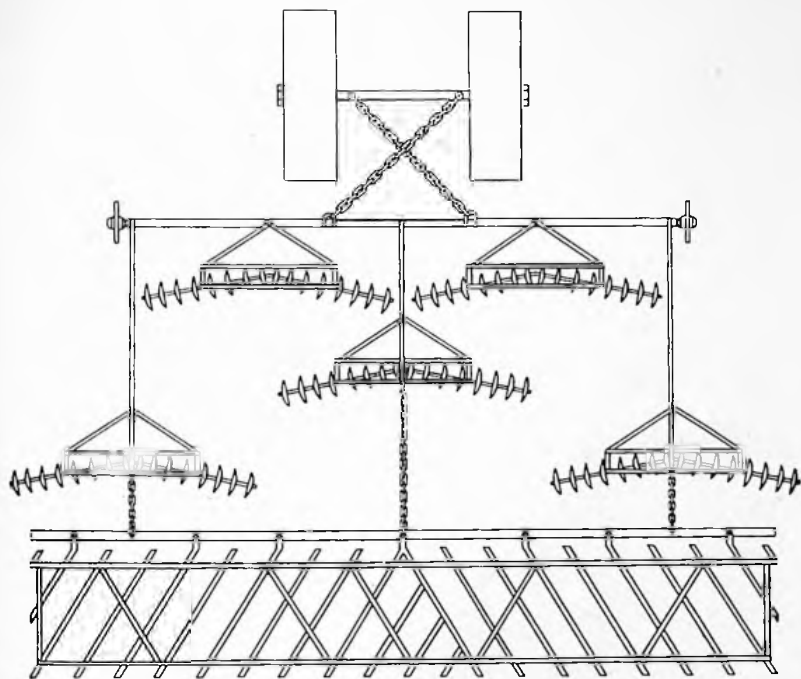
This shows how it is possible to plow, disc, drill and harrow at one operation. This is very commonly done in the Northwest, and, in fact, is one of the best ways to put in small grain.

This shows a 40-80 pulling seven 14-inch plows and an 8-foot binder. This scheme has been used to very good advantage in the Northwest and is a splendid way of cleaning the land of foul seed. Another great feature in operating plows and binder at the same time is the conservation of moisture. It is a well known fact that ground dries very fast after the crop is taken off, thus making it harder to plow and the plows do not do as good a job. This also leaves all shelled grain, such as wheat and oats, and foul seed of all kinds on top of the plowed ground, where the rain and moisture will immediately sprout them and by discing or harrowing later on it has the same effect as summer fallow.

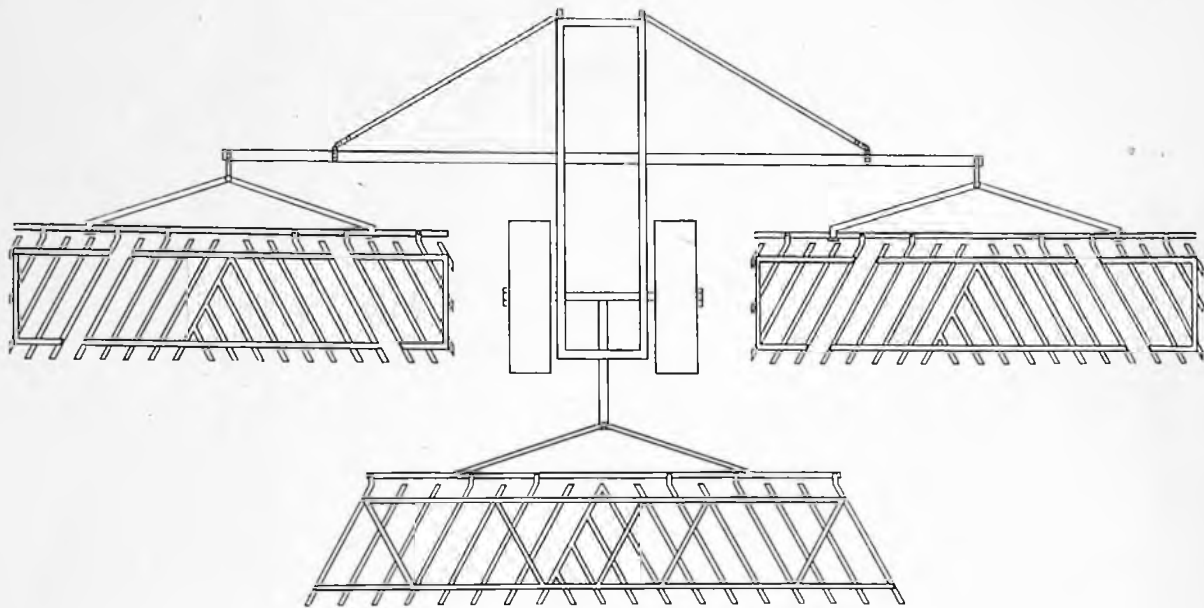




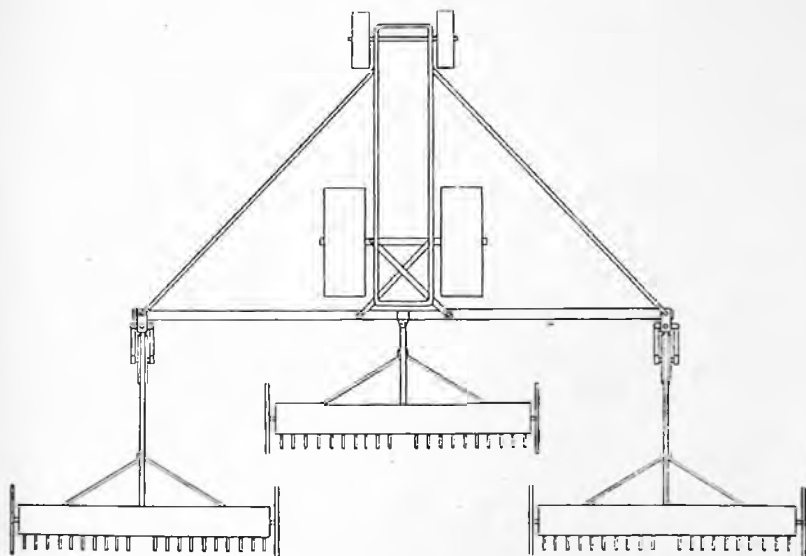
This represents a 25-50 or an 18-36 pulling a double disc and an 8-foot binder. This also has been found to be very beneficial to the land where it is important to conserve the moisture in the ground. It also covers the foul seed and shelled grain so that it sprouts immediately and brings a nice growth of green vegetation which can be plowed under later and is very beneficial to the soil.



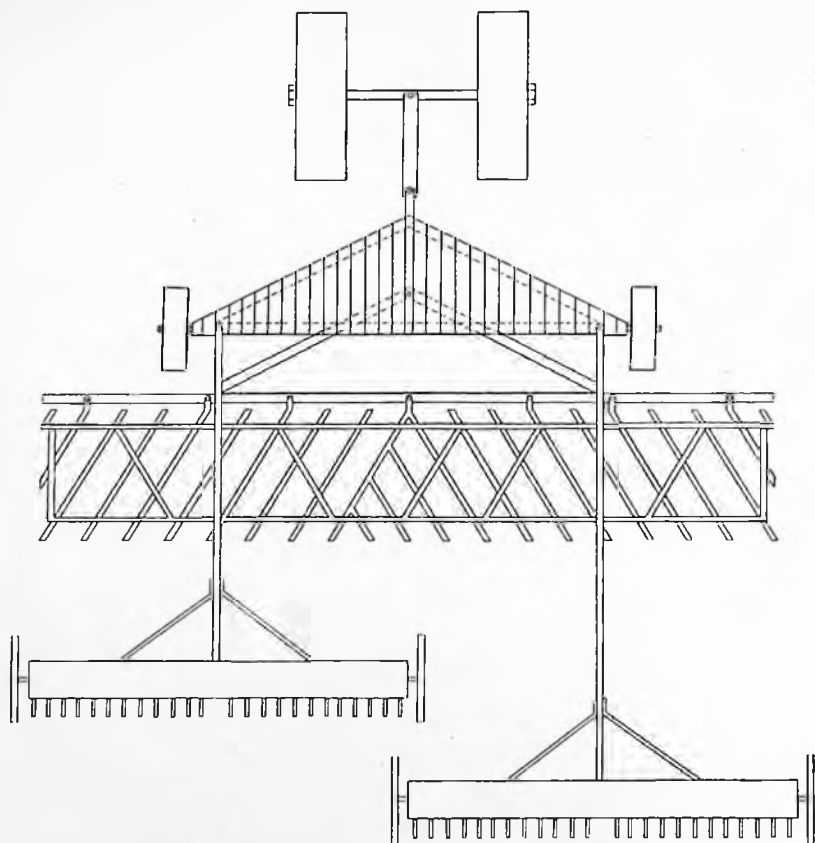
This shows a 25-50 or 40-80 preparing sod or hard ground for seed bed. This is a very simple construction. The only thing to observe is the spacing of the machines so they will not congest or interfere with each other at the turn.



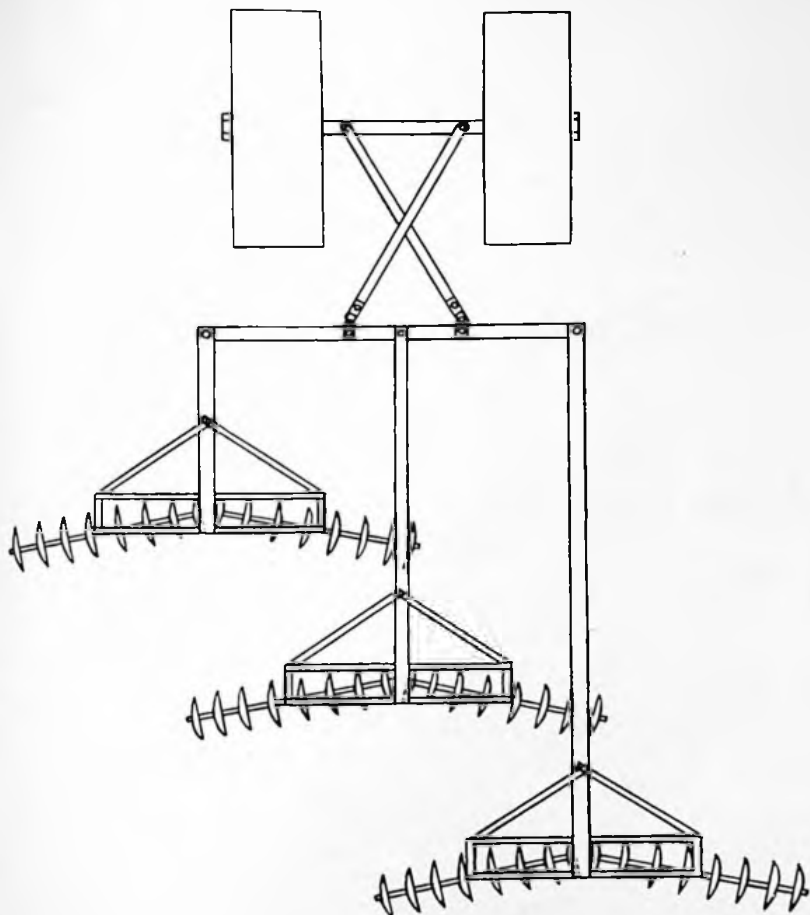
This shows a 12-25 handling harrows. This system of handling the harrow enables one to turn very short and to carry the harrow very closely to the corner of the field.



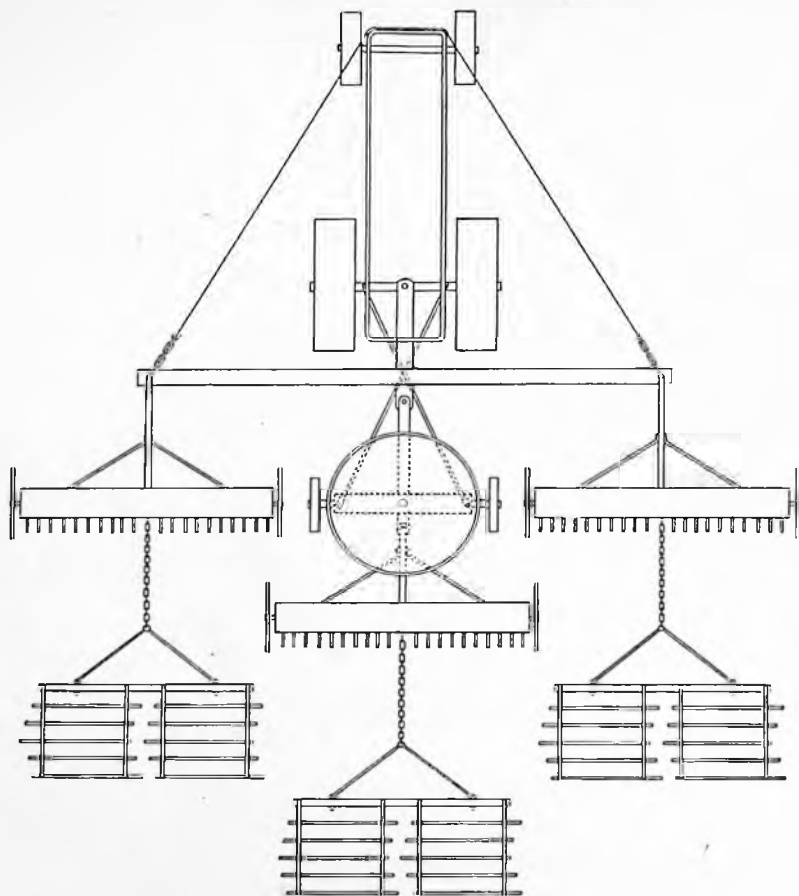
This shows a 12-25 pulling 3 drills. Harrows may also be hitched behind these drills and a splendid job made with one operation. As a tractor will travel from 20 to 30 miles a day, it will be very easy to figure the amount of work that can be done by knowing the length of the drills or harrows you are using.



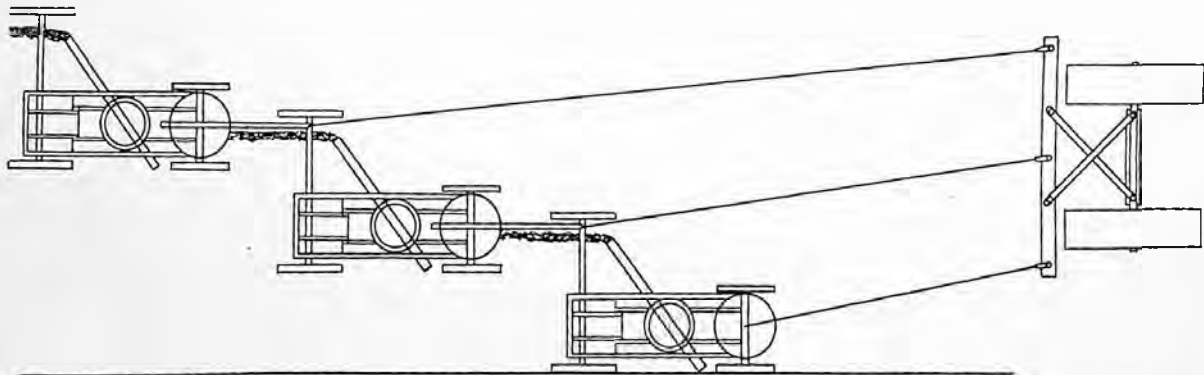
This shows a 12-25 pulling harrow and drills with the harrow hitched on the drills. This is advisable where the ground is rough and it makes a better seed bed and eliminates the necessity of harrowing ahead of the tractor. A smoothing harrow also may be hitched behind the drills in this case.



This illustrates a 12-25 tractor with 3 discs arranged in such a manner that the ridge or furrow, whichever the case may be, in the center of the discs is entirely cut out by the following disc. In this way if the first disc is properly lapped over the previous swath, the field will be left perfectly smooth, which is quite an advantage.



This represents a drill hitch, which some of our customers in Kansas have had very good success with, and is drawn by a 25-50 or larger tractor. The cross beam is a 2 x 8 oak, held in position by straps running from the platform of tractor back to same. The round object in the center of the illustration is a tank mounted upon two wheels, for the purpose of carrying the seed grain. You will observe that the axle of this tank is pivoted in the center and that it is guided with cross chains running to the hitch of the tractor. In this way it follows the tractor nicely and does not interfere with the machinery.



This shows a 25-50 or 40-80 tractor hauling road grader and this opens up a wonderful field for the tractor. There is a great agitation at the present time for good roads and the tractor owner will find very desirable employment for his tractor, in many cases, by operating it on road machinery; in fact we have a good many tractors that have been bought by the County Commissioners of different localities and are used for nothing else.

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