# KOHLER OF KOHLER

# POWER and LIGHT

110 VOLT D. C.

Instructions for
Installation, Operation
and Care

—

(1500 Watt Models)

KOHLER CO.
KOHLER, WIS.

# K O H L E R  P O W E R  A N D  L I G H T  U N I T S

AUTOMATIC
MANUAL
GAS

110 VOLT DC

## INSTRUCTIONS FOR INSTALLATION

## OPERATION AND CARE OF MODELS

D-AUTOMATIC, GASOLINE
E-MANUAL, GASOLINE
DA-AUTOMATIC, GAS
EA-MANUAL, GAS

1500 WATTS

KOHLER CO.

KOHLER WIS.

MAY, 1924.

SHIPPING POINT SHEBOYGAN, WIS.

KOHLER CO. BRANCH OFFICES

Kohler Co.,
84 N. Pryor St.,
Atlanta, Ga.

Kohler Co.,
427-445 Commercial St.,
Boston, Mass.

Kohler Co.,
763 McCormick Bldg.,
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544 Second Street,
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123 Jackson Street,
Seattle, Wash.

Kohler Co.,
329 High Holborn, W.C. 1,
London, England

Mountain States Supply Co.,
316 West Second South St.,
Salt Lake City, Utah.

Kohler Automatic users are urged to get in touch with the Branch Office nearest to them in case advice or assistance is needed.

Kohler Co.,

Kohler, Wis.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## FOREWARD

It is our aim to turn over to our customers a correctly designed well-built, high-class isolated electric power and light unit, free from unnecessary and trouble-making complications.

## GUARANTY

"The Kohler Co. of Kohler, Wisconsin U.S.A., guarantees and will replace, free of charge, for a period of three months from date of delivery of plant to original purchaser, all parts of Kohler Power and Light Units proven defective in manufacture.

"The Kohler Co. will not be responsible for damage resulting from improper installation, abuse, neglect, or failure to follow the installation and operating instructions.

"No person is authorized to make any guarantee other than the above, and the Kohler Co. will not be bound by any other guarantee."

## IMPORTANCE OF FOLLOWING INSTRUCTIONS.

We have built these Units to operate with a minimum of attention and care, but like everything in the nature of machinery, certain wants must be supplied if the Kohler Automatic or Manual Unit is to give the fullest service. This attention and care after the machine leaves our factories is plainly the duty of the new owner.

We advise a careful study of this book of instructions in connection with the installation and operation of your Unit. Make the regular inspections outlined and carry out faithfully all the recommendations made herein. They are based on the knowledge of men who have had many years experience in the operation of gasoline engines and electrical machinery, and are given for the reason that the Kohler Co. most earnestly desires the user to receive the efficient and satisfactory results that are assured if the instructions are followed, and which cannot be expected if they are ignored. To this end, we suggest that this book of instructions be hung near the plant where it is convenient for ready reference.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## RECEIVING THE UNIT

### UNPACKING

Kohler Power and Light Units come carefully packed in a substantial crate. The starting battery is crated separately, (except in export packages) and comes fully charged ready to be connected to the plant. In unpacking, be careful not to allow any metal to come in contact with the battery. Do not remove the taping from battery terminals until ready to connect battery to the plant.

Packed with every Kohler Automatic leaving our factories are the following:

1 Book of Instructions covering the installation, care and operation of the Unit.
1 Foundation Template
4 Anchor Bolts, 1/2" x 7"
1 55 gallon fuel storage tank. (U.S. only)
1 Supply Line, 12 feet, 3/8" copper tubing with fittings
1 Overflow Line, 12 feet, 1/2" copper tubing with fittings
1 Exhaust pipe drain assembly.
1 A-827 Socket Wrench fro Cylinder Head Nuts and 5/16" S.A.E. Cap screws
1 A-831 Spark Plug Wrench
1 A-858 "S" Wrench for Adjusting Valve Tappet Nuts
1 A-849 Fan Shaft Nut and Magneto Shaft Nut Wrench
1 A-870 Magneto Wrench
1 B-894 Switch Wrench
1 B-909 "S" Wrench for Gasoline Connections and Switch Terminal Nuts
1 B-911 5/16" Screw Drive
1 B-913 Thickness Gauge .006" for adjusting valve clearance
1 B-915 Tool Bag
(If it is desired to order tools, the letter, number and name of tool must be given.)

NOTE: The front end of the Unit is the crank hole end, or the end opposite the generator. No. 1 cylinder is that cylinder farthest from the radiator.

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1 A-851 Spark Plug Wrench
1 A-858 "S" Wrench for Adjusting Valve Tappet Nuts
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1 B-894 Switch Wrench
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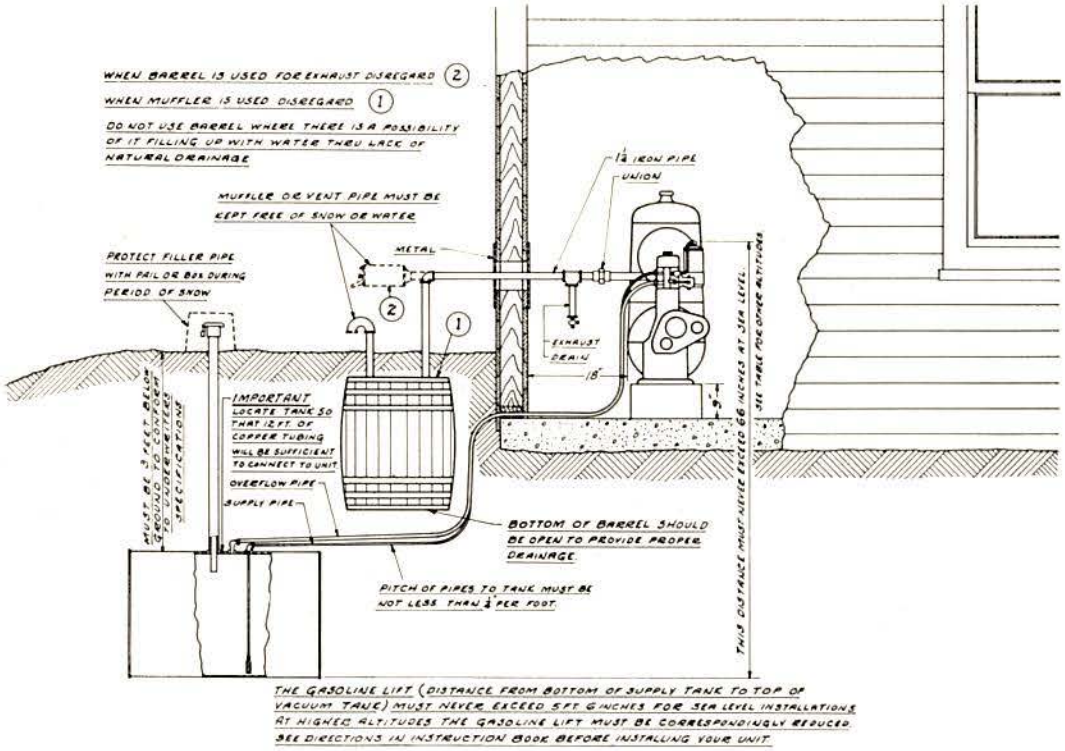
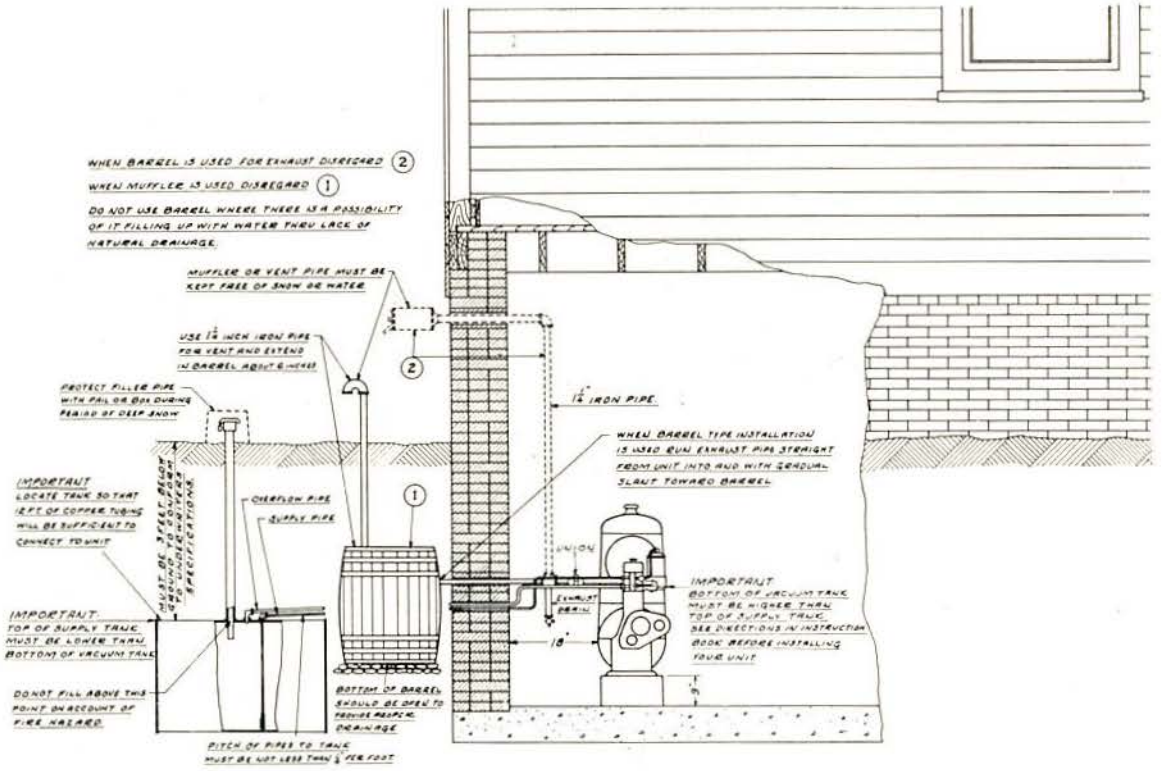
WHEN WRITING GIVE MODELAND SERIAL NUMBER OF YOUR UNIT.




**INSTALLATION OF KOHLER UNIT ABOVE SURFACE OF GROUND**

Figure 1




**INSTALLATION OF KOHLER UNIT BELOW SURFACE OF GROUND**

Figure 2

# INSTALLATION

## LOCATION

The successful operation of any piece of machinery, particularly an electrical generating set driven by a gasoline engine, depends very largely on its being installed under conditions that are favorable for its economical and efficient operation. It will amply repay the dealer or user to carefully consider the location for a lighting unit and supply tank, as the conditions under which the plant operates will determine to a considerable extent on whether or not it will function in a satisfactory manner. The proper location of the fuel tank in relation to the Unit is very important. (See Figures land 2).

## TEMPERATURES

The gasoline engine is a heat engine and does not deliver its maximum efficiency until it has reached a temperature of about 180 degrees Fahrenheit. For this reason temperature conditions play a very important part in its operation. Gasoline does not vaporize readily at low temperatures and if the Unit is located in a place where the temperature falls near or below the freezing point, the engine will not start as easily when cold on account of improper carburization of the fuel. Anyone familiar with automobiles appreciates the difficulty of starting them in cold weather. This is particularly noticeable if low test gasoline is used. Regardless of the difficulty in starting the engine when located in a cold place, it is poor economy to do so for the reason that the colder the engine the more fuel is dissipated in briningup the temperature of the engine and the cooling water to a running heat.

Neither should the plant be located where the temperature rises above 120 degrees as the engine is liable to overheat. So in choosing the location for your plant, give due consideration to the temperature under which it will operate and if possible, select a location where the temperature does not fall below freezing in winter or above 120 degrees in summer. A warm, clean, dry, well ventilated basement having an average temperature of about 50 to 70 degrees makes an ideal location for a Kohler Power and Light Unit.

## VENTILATION

Adequate ventilation is also very important in the operation of a gasoline engine. The fuel is burned by being mixed with the proper amount of oxygen in the atmosphere, and as the burned products of combustion are exhausted out of doors thru the exhaust pipe it is necessary to admit sufficient air into the room in which the Unit is located to carry on the process of combustion of the fuel.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

Proper ventilation is also a very important factor in the cooling of the engine. The excess heat generated by the fuel is carried away from the radiator by currents of air which are drawn thru it by means of the ventilating fan. As the generator is also air cooled sufficient ventilation must be provided for this purpose.

CLEANLINESS

The plant must be located where it will not be exposed to flying dust or dirt, for if the air which is drawn in thru the generator and radiator by the ventilating fan is laden with particles of dust and grit it willhave an abrasive effect on the commutator, and in a very short time the commutator will become cut and scored and the brushes worn down, and inefficient operation will result. If dirt and dust is drawn thru the carburetor it will in time score the cylinders and cause the valves to leak. The air passages thru the radiator may become clogged and greatly reduce the efficiency of the cooling system.

Neither should the plant be located where it is exposed to dampness, or water dripping on it as the insulation of the wiring, field coils, armature or magneto will become saturated with moisture, perhaps to an extent of causing short circuits or ignition troubles which will interfere with the proper operation of the plant. Do not locate the plant under a stairway where dirt will sift down on it or where water will drip on it.

Dirt, oil, grease and water are very detrimental to the operation of any type of electrical machinery, and every precaution must be taken that a generating set be protected.

KOHLER UNITS APPROVED BY FIRE UNDERWRITERS

The Kohler Power and Light unit bears the stamp of the National Board of Fire Underwriters, which means that it has been subjected to the severest of tests to determine its safety, and has been declared free from fire hazard if properly installed.

Our instructions for installing the plant conform to the Fire Underwriters specifications, and if complied with will result in its being put in under the best possible conditions for its safe, dependable, economical and satisfactory operation.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## RULES OF NATIONAL BOARD OF FIRE UNDERWRITERS GOVERNING INSTALLATION OF FUEL TANKS WITH ISOLATED ELECTRIC UNITS

First: Top of fuel tank must always be below the bottom of the carburetor.

Second: If the fuel tank is installed outside of the building it must be covered with not less than 3 feet of earth, The earth may be heaped over the tank if the slope at sides is not less than 3 to 1.

Third: The fuel tank must be buried to a depth so that its top will be below the lowest floor of any basement or building within a radius of 10 feet.

Fourth: If the fuel tank is located inside of the building, it must be buried at least 2 feet below the floor level. The floor must be of reinforced concrete at least 9" thick, and extend at least 12" beyond outline of tank in all directions.

Fifth: If it is not practicable to bury the tank below the level of floors within a radius of 10 feet, the tank must be encased in 6" of solid concrete. This type of installation should be used only in cases where it is impossible to conform to the Underwriters requirements in any other manner.

Sixth: Exhaust Pipe Installation.
When passing through a combustible wall it must be fitted with a metal thimble permitting 2" of air space between the pipe and combustible material.

Seventh: Exhaust pipe outlet must be far enough from filler pipe to prevent any danger of ignition.

Illustrations of Installations made in conformity with the Underwriters requirements are shown in Figures 1 and 2. The type of installation that will best meet your condition should be used.

If installed in a community where the location of gasoline containers are governed by local ordinances or insurance companies' specifications, the tank should be so located as to conform to these requirements.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

GASOLINE STORAGE TANKS.

A galvanized iron tank constructed to meet the requirements of the National Board of Fire Underwriters Ass'n., is furnished for each installation of a Kohler Power and Light Unit. (Tanks not supplied with export shipments.)

This tank is galvanized inside and outside, given an exterior coat of black asphaltum and guaranteed to be liquid tight. Each tank is fitted with a combination filler and vent pipe with hinged cover and with openings for overflow and supply lines.

The overflow connection is for 3/8" threaded pipe and is located on top of the storage tank. The supply line connections are of brass, threaded for 1/4" pipe and extend to within on inch of the bottom of the tank and is screened at lower end.

Tanks are furnished in three sizes of 55, 100 and 200 gallons capacity as follows:

55 gallon size, 22½x34", fitted with one supply line connection for installation of one unit only.

100 gallon size, 28½x42", fitted with two supply line connections for installation of two Units only.

200 gallon size, 28½x84", fitted with four supply line connections for installation of three or four Units. When three units only are used, one supply line connection must be plugged.

LOCATION AND INSTALLATION OF FUEL TANKS.

When making an installation of a Kohler Power and Light Unit, consideration must be given to the proper location of the fuel tank in relation to the Unit, the following are very important.

FIRST.

The bottom of fuel tank must not be more than 5 ft. 6 inches below the level of top of vacuum tank for installation at sea level. For installations above sea level see instructions on another page for heights which Unit will lift its fuel at different altitudes. If these distances are exceeded the suction created in the vacuum tank will not be sufficient to draw up the fuel when the Unit is operating at full load. (see figures 1 and 2.)

SECOND.

The top of the tank must be below the level of the carburetor and the overflow pipe have a continuous pitch to provide proper drainage from the carburetor to the fuel tank.

All tanks should be tested by filling with water to make sure they do not leak from being damaged in transit. After testing, the tank must be thoroughly drained before installing.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## GASOLINE LIFT AT VARIOUS ALTITUDES

The height of gasoline lift in the Kohler Power and Light Units decrease as the ampere load of the unit is increased because the butterfly valve in the carburetor will open more as the load is increased. This reduces the vacuum and results into a proportionately less gas lift.

Following are the maximum heights that our Unit will lift gasoline at various altitudes. (Height of gasoline lift is measured from top of vacuum tank to bottom of container holding main supply of gasoline.)

| Altitude | Height of Lift |
|---|---|
| Sea Level | 5 ft. 6 in. |
| 1000 ft. Above | 5 ft. 3 in. |
| 2000 ft. Above | 5 ft. 0 in. |
| 3000 " " | 4 " 6 " |
| 4000 " " | 4 " 3 " |
| 5000 " " | 4 " 0 " |
| 6000 " " | 3 " 6 " |
| 7000 " " | 3 " 0 " |
| 8000 " " | 3 " 0 " |

If the height of lift exceeds that given in the table, the suction at full load at given altitudes will not be strong enough to lift the gasoline.

## FOUNDATION

Having chosen a location which is favorable, the next thing is to provide a suitable foundation on which the unit may rest.

The Kohler Automatic is 34¾" high, 33½" long and 14" wide at its widest point. The bolt holes in the engine base are spaced 10-1/16" wide between centers, and 13-3/8" long between centers.

We recommend a concrete foundation 14" wide, 22" long and 9" high. In setting the foundation, place the exhaust side of the engine to the outside wall. AND NOT LESS THAN 18" FROM IT. On the other three sides of the engine, allow enough room to give the operator an opportunity to work around the engine.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

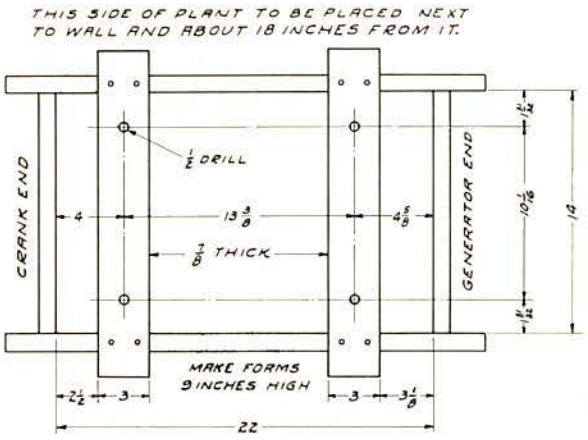



Figure 3
Plan for Making Concrete Form

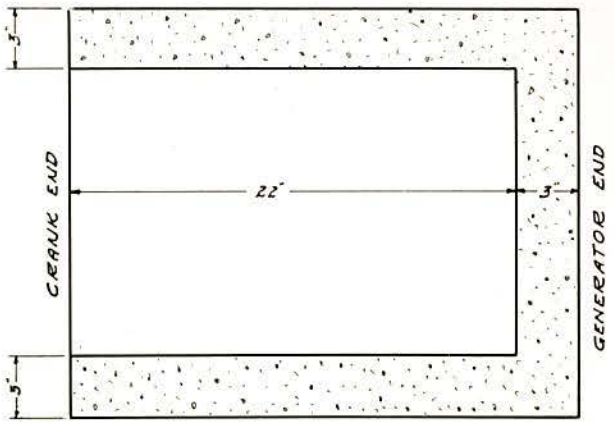



Figure 4
Showing Three Inch Shoulder on Three Sides where Foundation is built on Ground

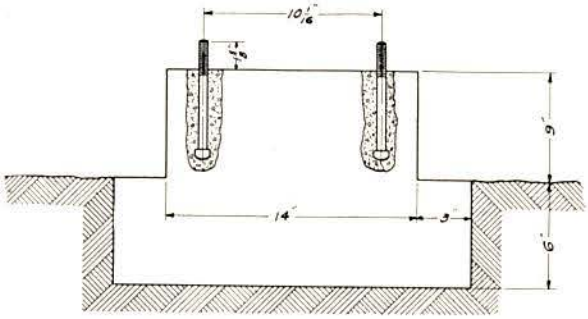



Figure 5
How to build Foundation on Concrete Floor

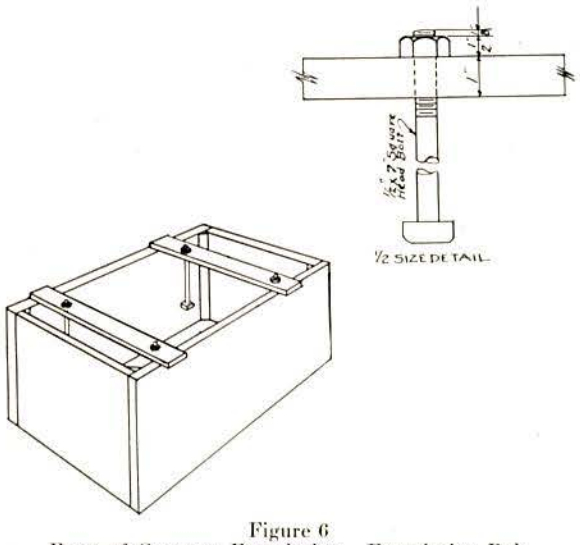



Figure 6
Form of Concrete Foundation. Foundation Bolt Detail. (When building foundation for installation of gas units. Models "DA" or "EA" suspend foundation bolt to project 2" above concrete.)

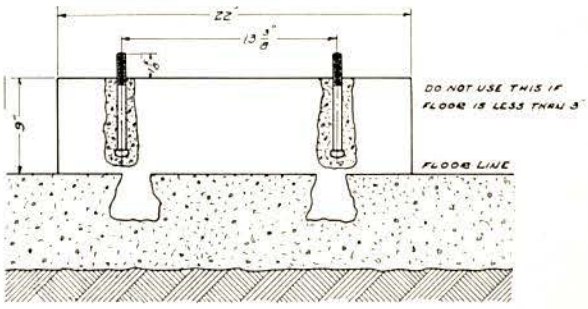



Figure 7
How to build Foundation into Ground

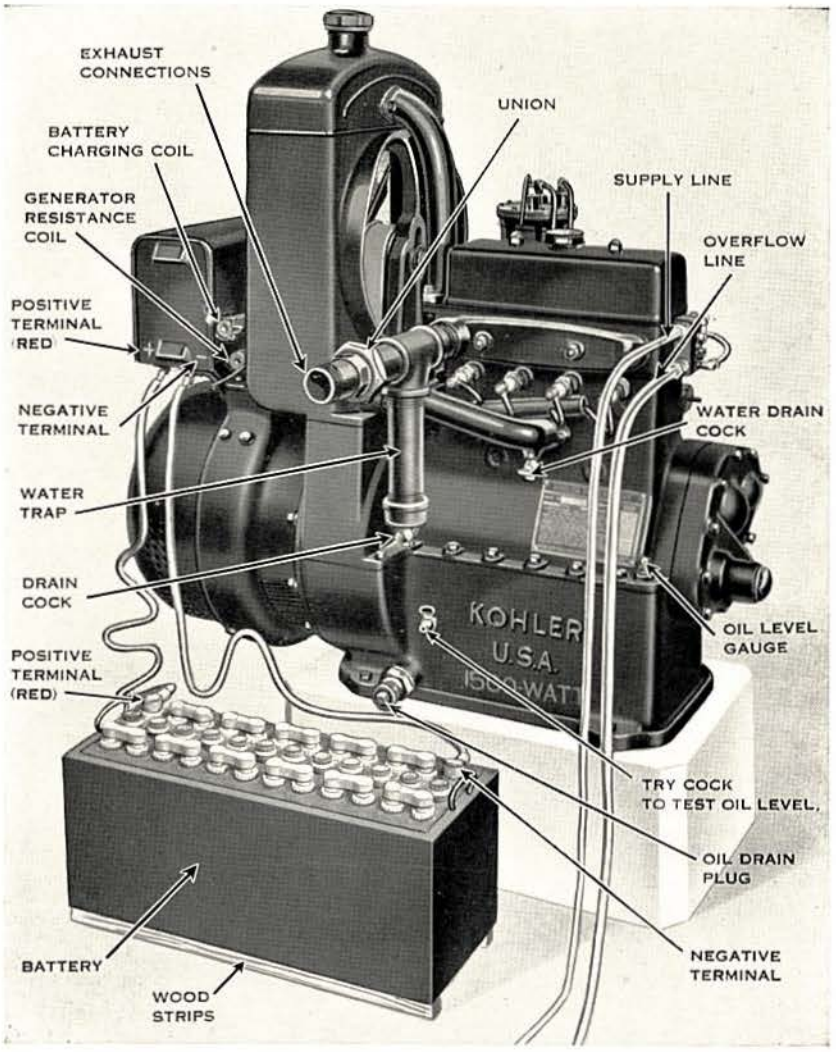



Figure 8
Exhaust Side showing Battery, Exhaust, Fuel and Overflow Connections

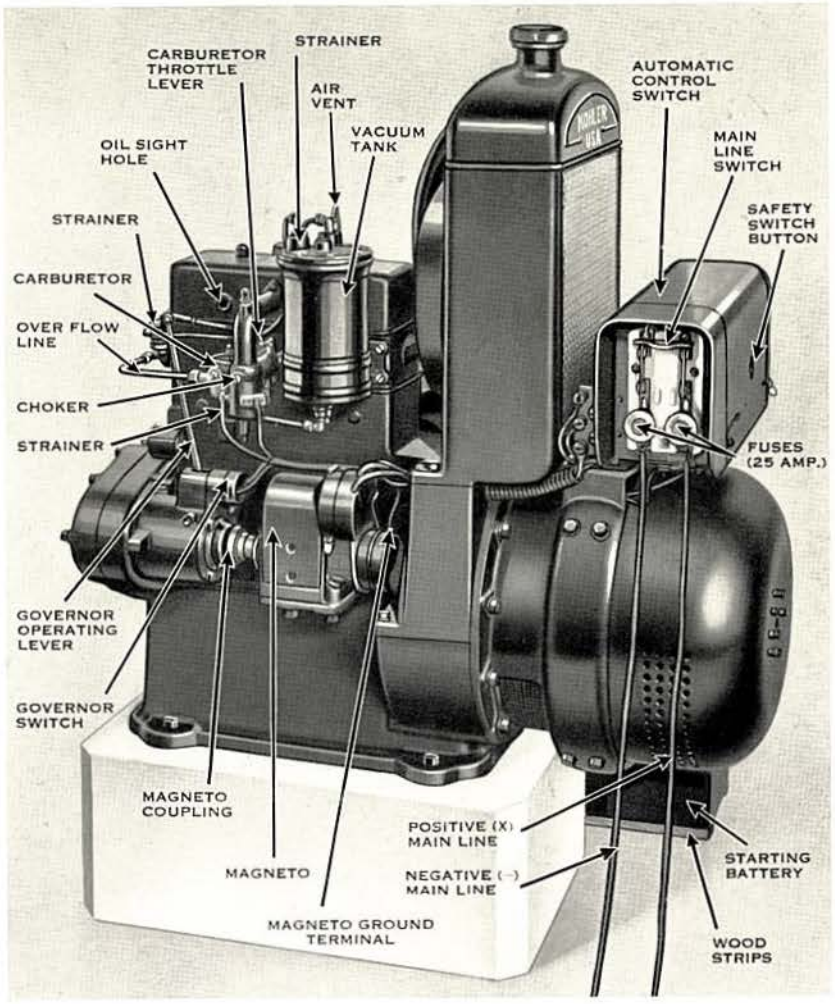



Figure 9
Magneto Side showing Main Line Connections

Figure 10
Filling Radiator

Figure 11
Filling Vacuum Tank

Figure 12
Filling Oil Base

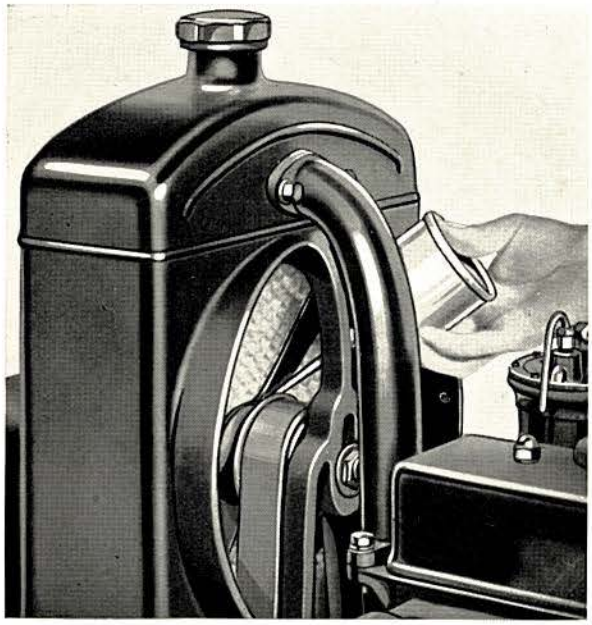


Figure 14
Oiling Fan Bearing

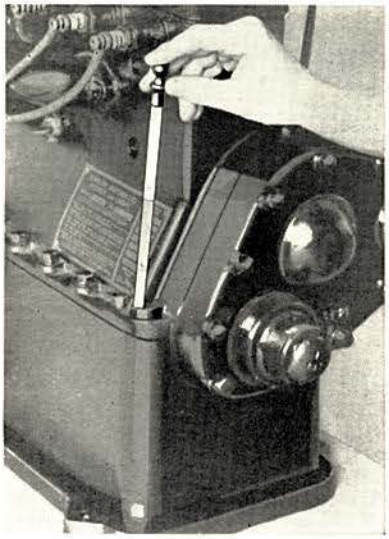


Figure 15
Testing Oil Level—Use of Oil Gauge

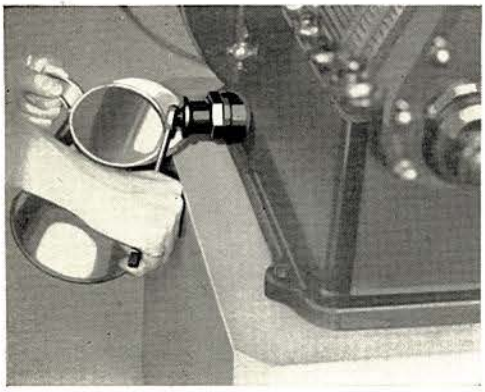


Figure 16
Removing Oil Plug to Drain Oil

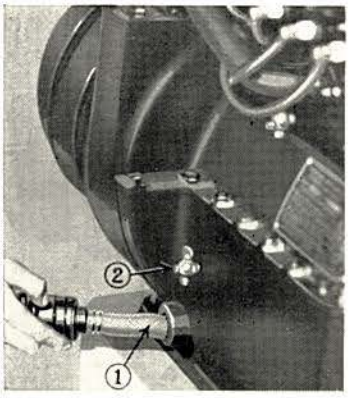



Figure 17
(1) Oil Strainer
(2) Oil Drain Cock

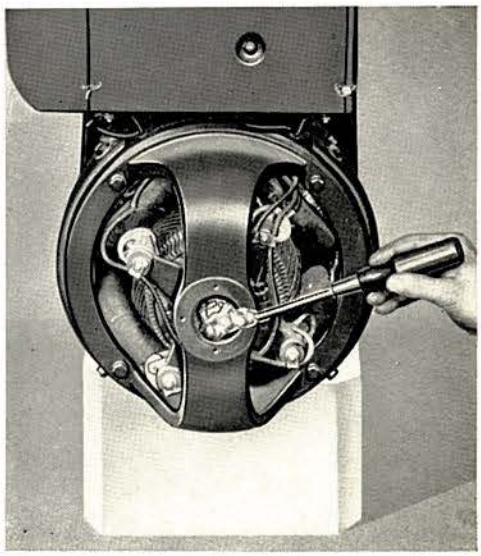


Figure 18
Lubrication of Generator Ball Bearing

TEMPLATE

A paper template giving exact spacing of foundation bolts is furnished with every unit. This template comes folded and is inserted in this book of instructions.

FORM FOR FOUNDATION

The method of constructing the form to be used in building the concrete foundation is shown in Figs. 3, 4, 5, 6 and 7.

FOUNDATION BOLTS FOR GASOLINE UNITS.

After the form has been built, locate the bolt holes by means of the template. Then insert the anchor bolts through the holes so that they will hand head down. The threaded end of the bolt should project 1-5/8" above the top of the concrete, and should be suspended accordingly and held in this position by means of the foundation bolt nuts while the concrete is poured.

FOUNDATION BOLTS FOR GAS UNITS.

When installing one of our units, which is equipped for burning natural gas it will be necessary to have the threaded end of foundation bolts project at least 2" above the top of the concrete.

MIXING CONCRETE

It requires about 50 lbs. of cement (1/2 of a sack), 100 lbs. of sand (.4 cu. yds.) and 225 lbs. of gravel or crushed stone (.10 cu. yds.), to make the foundation for the Kohler Automatic where the foundation is sunk in the ground to a depth of approximately six inches. Where this is not necessary, the materials required will be about two-thirds of this amount.

We recommend a mixture of one part cement, two parts sand and four parts of gravel or crushed stone. Add water and mix thoroughly.

Pour concrete into form, being careful to make the top of the concrete perfectly level. Allow concrete to set or harden for at least three days before installing the unit.

BUILDING FOUNDATION ON GROUND

Whenever the foundation is built on a dirt floor, allow a three inch shoulder on three sides of foundation and extend into ground at least six inches. (See Figs. 4 and 7).

BUILDING FOUNDATION ON CONCRETE FLOOR

In order to provide an anchorage for the foundation when it is built on a concrete floor or platform, chisel two holes five inches in diameter and four inches deep into the concrete where foundation is to be placed. Enlarge holes at bottom (Fig.5). The template and form are used in the same manner as described above.

USING FOUNDATION ALREADY BUILT

Where it is desired to use a foundation already in existence, chisel 1" holes in the concrete of sufficient depth to receive the foundation bolts. Widen these holes somewhat at the bottom; then determine by use of the template the exact spacing for the bolts. They must be held rigidly while molten lead is poured into the holes. When lead hardens, the bolts will be held securely in position.

SETTING ON FOUNDATION

Before unit is put on foundation, place a wedge near each foundation bolt. These four wedges should be made with a thin, easy taper and should be cut from hardwood. Make them four or five inches long.

UNIT MUST BE LEVEL

Next set the unit over the foundation bolts so that the base rests on the four wedges. Then by means of an ordinary spirit level placed on the cylinder head (it is necessary to remove the cylinder head cover to level machine properly) make sure that the machine is LEVEL, using the wedge to raise or lower the unit where necessary.

After unit is resting level, wet the top of foundation thoroughly with water and then with a thin grouting mixture (water, cement and sand mixed thin enough to run) build up between the base and the foundation. Use a trowel, thin piece of wood or piece of wire to push the grouting mixture under the base. Trim and smooth with a trowel and allow mixture to harden for 24 hours before operating unit. Chisel surplus wood from wedge after cement has hardened.

EXHAUST CONNECTIONS

The exhaust manifold is threaded for 1½" standard iron pipe. This can be secured from any steamfitter or plumber. Avoid all unnecessary turns and run the exhaust pipe to the outside air by the shortest route. The size of the exhaust pipe should be increased one size for each ten feet of its length.

UNION IN EXHAUST LINE

A union, preferably a flange union, should always be placed in the exhaust line so that the cylinder head can be removed without taking down the entire exhaust line. Great care should be taken in putting up exhaust lines that the connections may come fair and true to avoid springing the pipe when connecting up the unions, for if there is a heavy strain on the exhaust pipe it may cause a leak to develop in the cylinder head gasket. (See Figures 1 and 2).

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

WATER TRAP IN EXHAUST LINE

The trap to drain the water of condensation in the exhaust line should always be installed. If this is not done, this water will run back into the cylinder head and cause rusting. Any accumulation of water in the cylinders will seriously interfere with the starting and operation of the Unit. A water trap made with a "T" connection, and a short length of pipe provided with a pet cock is furnished with each unit.

EXHAUST PIPE INSULATION

If the exhaust pipe is passed through a wood wall, it must be properly insulated. One method is to make a six-inch opening over which is nailed a piece of sheet metal with a liberal hole in the center for the exhaust pipe. The exhaust pipe should always be properly supported by hangers.

It is also possible to run the exhaust pipe through a wood wall if pipe is carefully wrapped with a good heavy coat of asbestos and an air space is allowed between wood and pipe.

EXHAUST LINE DISCHARGE

The outer end of exhaust pipe should lead to the open air, and be fitted with the muffler provided. The exhaust discharge should be at sufficient distance from the filler pipe to prevent any possibility of ignition.

A barrel buried beneath the surface of the ground into which the exhaust pipe may be lead is a good method of installation. The bottom of the barrel should be bored to provide drainage and it should be vented to the atmosphere with 1¼" pipe in such a manner that no water can enter the barrel or the exhaust pipe. It must be so installed that free escape of the exhaust gases are permitted, as any restriction to their escape will cause a back pressure, resulting in an accumulation of carbon in the pipe making it impossible for the Unit to function properly. (See Fig. 1 and 2).

STARTING BATTERY CONNECTIONS

The starting battery furnished with the Kohler Automatic may be located near the unit, and should rest on a wooden platform or grating to keep it up clear of the floor. The terminals of the battery should be connected to the terminals on the right side of the switch box as shown in Figure 8.

The positive (p) terminal on the battery which is painted red must be connected to the insulated terminal on switch box, also painted red. When connecting the terminals to the automatic switch tighten nuts securely and make sure that the positive and negative battery terminals do not touch each other, form a short circuit and run down the battery.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## SIZE OF WIRE REQUIRED FOR 110 -VOLT SERVICE

| Load in Watts | | Distance between Plant and Load in Feet and size wire required. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 |
| 100 | No. | 24 | 20 | 18 | 18 | 16 | 16 | 16 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 |
| 200 | " | 22 | 18 | 16 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 10 |
| 300 | " | 20 | 16 | 16 | 14 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 |
| 400 | " | 18 | 14 | 14 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 |
| 500 | " | 16 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 |
| 600 | " | 16 | 14 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | | |
| 700 | " | 16 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | | | | |
| 800 | " | 14 | 12 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | | | | | | |
| 900 | " | 14 | 12 | 10 | 8 | 8 | 6 | 6 | 6 | | | | | | | |
| 1000 | " | 14 | 12 | 10 | 8 | 8 | 6 | 6 | | | | | | | | |
| 1250 | " | 12 | 10 | 8 | 8 | 8 | 6 | | | | | | | | | |
| 1500 | " | 12 | 10 | 8 | 6 | 6 | | | | | | | | | | |

NOTE: The size of wire to be used depends on the following factors:
1st. Load to be carried in watts or amperes.
2nd. Distance between load and power plant.
3rd. Strength of wire to withstand strains imposed by weather conditions.
Not less than No. 10 wire should be used for all out of door leads; while a smaller wire may carry the load it will not posses sufficient strength to withstand strains imposed by weather conditions. Not less than No. 14 wire should be used for leads where protected from weather conditions. No. 6 wire is the largest size commercially practicable. The above wire sizes are based on a voltage drop of not more than 5% between the power plant and the load, or in other words, if voltage at plant is 110, voltage at end of line will be about 105 volts.

## FUSES, WIRING AND MAIN LINE CONNECTIONS

BE SURE THAT MAIN SWITCH IS OPEN BEFORE MAKING CONNECTIONS. DO NOT CLOSE SWITCH UNTIL YOU ARE READY TO START UNIT.

A knife switch with two binding posts is attached to the left end of the switch box. The wires which lead to the main circuit of the wiring system must be attached to these binding posts.

Two 25 ampere fuses are found on the main line switch. They are to prevent any damage to the unit or circuit from lightning. The unit will not operate if these are removed or burned out. A supply of extra 25 ampere fuses should be kept on hand to replace any which might be burned out.

To secure the fullest use of the current generated by a Kohler Power and Light Unit it is absolutely essential that the wiring be of right size and properly installed. Too often the proper consideration is not given to the possible uses to which power will be put, and when more current is used than the circuits were designed to take care of the wires will be overloaded.

Only a competent and experienced electrician should be engaged to install the wiring. Before the work is begun, the electrician should know how the current is to be used, in what quantities, and in what buildings, so that he can plan his installation accordingly.

In laying out the wiring, careful consideration should be given to the problem so as to provide a sufficient number of outlets for all purposes. This is particularly true in the home. It is advisable to provide a number of outlets in the base board of each of the principal rooms of the house. In studying this problem, due consideration should be given to the possible needs such as the flat iron vacuum cleaner, washing machine, toaster, etc., even though the acquisition of these conveniences may be still in the future.

The flat iron, for instance, consumes approximately 600 watts of current, almost as much as a one horse-power motor. This single accessory consumes as much electricity as 24 lamps of 25 watts each. Because of this heavy current consumption, special circuits of heavier wire should be provided to take care of the load. The same reasoning will apply where movers or other power appliances will be used. It should be borne in mind that a light wire cannot carry a heavy load, and that circuits should be laid out with wire of the proper size to carry the heaviest loads which will be carried at any future time. The wiring circuits must be properly insulated to make certain there are no grounds short or open circuits in the external wiring system.

The Underwriter's specifications should always be observed and carefully followed in installing a wiring system. On another page find wiring table giving correct size of wire for various loads at given distances.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## EFFECTS OF DEFECTIVE WIRING OR POWER APPLIANCE

### OPEN, GROUNDED OR SHORT CIRCUITS IN WIRING SYSTEM.

An open circuit, a grounded circuit or a short circuit in the wiring system will cause a unit to function improperly. If your unit refuses to start or function properly, first ascertain whether or not the trouble is in the unit or the wiring system. To do this pull out the Main Line Switch and hold a 110 volt lamp of not less than 25 watts across the upper contact of the main switch. If the Unit starts and functions properly, the trouble is in the wiring system or power appliance motor.

### OPEN CIRCUIT

The Unit will not start automatically if there is an open circuit in the line between the Unit and the light or appliance that is turned on for starting. An open circuit in the external wiring will not effect the operation of the Unit except that no light will be obtained beyond the point where the circuit is broken.

### GROUNDED CIRCUIT

The Units described in this manual are parallel-wired and therefore a ground will not affect its operation, unless there should be a ground on both the positive and negative sides which would then form a short.

### SHORT CIRCUIT

A short circuit is a condition where the large part or whole of the current which the unit generates passes directly from the positive to the negative wire.

### TRACING DEFECTS IN WIRING SYSTEM

If the defect is due to an open circuit the location of the trouble is usually easily found by tracing out the various circuits, turning on different lights until by a process of elimination the place where the circuit is broken can be located, which will usually be found to be a broken wire or a loose connection which is easily repaired. If the trouble is due to a short circuit it is not so easily detected. If there be several circuits try them separately and watch the performance of the unit which will usually indicate on which circuit the defect is located. After determining in which circuit the trouble occurs, carefully examine the wiring at all points to find where the wires touch each other, the ground, or some substance which is a conductor of electricity. The trouble will usually be located at some point where the insulation is worn off by chafing against some other substance, or if the wires run thru metal or a wooden conduit or should there be junction boxes on the line where moisture is liable to collect, the difficulty will usually be found at one of these places.

The procedure to be followed in all cases will depend on how the system is wired up, and defects of this nature can only be discovered by careful examination of the different points where trouble is likely to occur.

## POWER APPLIANCE MOTORS

110 volt direct current motors up to 2 H.P. capacity which do not use more than 14 amperes may be operated with current from the Power and Light Unit.

We recommend the use of compound wound motors in connection with Kohler Power and Light Units, as past experience proves them to be more satisfactory and economical than either shunt or series wound motors.

## DEFECTIVE POWER APPLIANCE MOTOR

If the Kohler unit operates satisfactorily when only lights are in use, but fails to function properly when a power motor is in use, it is sufficient evidence that the motor is defective. Second hand motors should always be carefully tested out before being put in service. Motors within these limits may be used for various purposes such as pumping water, operating milking machines, ventilating fans, feed grinders, etc.

## STARTING RHEOSTATS

When the Kohler unit is to be started automatically by means of motors of more than 1/2 H.P. a starting rheostat should always be used to bring the load on gradually, thus permitting sufficient time for the gasoline engine to properly warm up and come to speed before a heavy demand for power is made. The starting rheostat will also protect the power appliance motor from possible damage.

If a starting rheostat is not provided and a motor of more than 1/2 H.P. is switches on the line suddenly, the demand for current will be so heavy at the start that the Kohler Unit will not have an opportunity to attain sufficient speed to carry the load. The result will be that the unit will go through repeated cycles of cranking, starting and stopping until the safety switch disengages. Starting rheostats, which gradually bring on the load by mechanical means are obtainable at all electrical supply houses, and should be used in all cases where motors of more than 1/2 H.P. are used.

## PREPARING MACHINE TO OPERATE

Having set up the machine, installed the fuel tannk, connected the wiring and attached the battery as directed in the preceding pages, it is necessary to observe the following instructions before trying to operate the machine.

## FILL RADIATOR

The cooling system is filled through the filler hole on the radiator. In filling radiator use soft water (preferably clean rain water). Fill to one-half inch below bottom of filler hole. Never allow the water in radiator to drop below the level of baffle plate visible when radiator cap is removed.

LUBRICATING OIL

The engine base of the Kohler Automatic holds about seven quarts of oil, and is filled through the hole found on top of the cylinder head cover. This is marked "Fill Oil Here". See article on LUBRICATION. Oil level should be between marks H and L on oil level gage (see Fig. 15). In extremely cold weather the oil should be heated until it flows freely before filling oil base.

OIL FAN

Remove filler plug from fan hub and oil fan. (See Fig. 14). Be careful not to drop plug inside of flywheel housing, as it will be difficult to recover.

FILL VACUUM TANK

When starting the Kohler Unit for the first time, fill the vacuum tank with gasoline through the opening in the top of the tank. Be sure to tighten the pipe plug carefully, as the tank will not function properly if the vacuum is destroyed through an air leak.

The vacuum tank should always be refilled in the manner described whenever plant stops because of lack of gasoline.

COVER FILLER PIPE

Water sometimes gets into the supply tank through the filler pipe and cap in the winter when there is snow on the ground. It is desirable to cover the projecting filler pipe with a pail or box, which will prevent the melting snow from running into the tank. Care should also be exercised, whenever the tank is being filled, not to allow any dirt to get into the tank. Do not fill tank so that gasoline will stand in filler pipe as the gasoline may leak out of carburetor on to the Unit and cause damage.

TO START ENGINE

Before attempting to start the engine under its own power; EXAMINE THE GOVERNOR BY WORKING THE ARM BACK AND FORTH BY HAND. Be sure that the governor is operative and that the throttle valve is free to close. This precaution is necessary, for in case of damage or bent throttle valve or governor mechanism preventing throttle from closing when the motor comes up to speed, it might race and damage the Unit.

Crank the engine a few times with the hand crank to make sure that nothing has been damaged or jammed in transit and that the mechanism turns freely. If the plant does not turn over quite freely, it is desirable to inject a small quantity of cylinder oil in each cylinder through the spark plug hole.

Now close the main line switch and turn on one or more lights (not less than 25 watts) or accessories on the circuit. If all the electrical and fuel connections have been made as directed, the Unit will be cranked by the starting battery and will begin to function at once.

A new motor will be somewhat stiff when first started. This is a natural condition, which will disappear after it has been in service a short time. When first started, a black smoky vapor will be discharged from the exhaust pipe. This is caused by the explusion of a rust-preventing solution called "No-Oxide", which will disappear within a few minutes.

OIL SIGHT HOLE

When first starting a new plant, observe through the small hole in the cylinder head cover, whether the oil pump is working and delivering oil. A small stream of oil discharging from the copper tube visible through this hole, indicates that the lubricating system is in proper working order. In case oil does not circulate thru tube within a few minutes tap lightly on oil base beneath magneto with a small hammer or prime oil line at rocker arm shaft or as a last resort the oil may be drawn off and heated.

## OPERATION AND CARE

CAUTION

Always disconnect the battery before making adjustments or doing repair work of any kind on the Unit. This will avoid all possibility of electric shocks and sparks, the latter which might be the cause of fires or explosions if they come in contact with gasoline from the carburetor or fuel lines.

OVERLOADING

If properly installed and cared for the Kohler Unit can be depended on to furnish 110 volt current up to its rated capacity. There is a tendency on the part of some plant owners to put a far greater load on the plant then it was ever designed to carry. This should not be done. While the Kohler Unit is a very rugged and substantially built machine, continued overloading is certain to cause trouble and expense.

SHORT CIRCUITS OR GROUNDS

Short circuits or grounds in the external wiring system will damage the plant. If the plant begins to act erratically, and the voltage fluctuates, causing the lights to dim and bright alternately you are either overloading the plant or there is something wrong with the wiring or some of the power appliances in use. The plant should be STOPPED IMMEDIATELY and an investigation made. The trouble should be remedied before the plant is again operated.

One of the most important factors in the successful operation of any automotive equipment is proper lubrication. There are certain other parts of the machine which require attention at different periods: such as, adding water to the battery and radiator. The best results are obtained by establishing a definite routine and the periodical inspections listed below are suggested. These inspections are based on an average running period six hours daily. If your plant operates a greater number of hours, the inspections should be correspondingly more frequent.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## WEEKLY INSPECTION
## BASED ON RUNNING PERIOD OF SIX HOURS DAILY

COOLING SYSTEM.

Observe amount of water in radiator weekly. Do not allow it to sink below level of baffle plate. When filling fill to 1/2" below bottom of filler hole. Use soft, clean water only.

FAN BELT

See that it is not so loose that it is slipping, or so tight that it is placing an undue strain on the fan belt and shaft.

LUBRICATING OIL

Pull up oil gauge and see that oil is not above "H" nor below "L". Make this inspection only when a unit is not operating, and wipe the gauge before using.

BATTERY

Remove filling plugs from all cells. Fluid should not be allowed to fall below top of plates. Fill, if necessary, with distilled water to level of bottom of tube.

FAN

Refill fan hub with a good quality, heavy grade of lubricating oil. Be careful not to drop plug inside of flywheel housing for it will be difficult to remove. Replace tightly.

## MONTHLY INSPECTION
## BASED ON RUNNING PERIOD OF SIX HOURS DAILY

Examine fuel line, overflow line, and all water connections to see that they are tight. An air leak in fuel line will prevent your Unit from functioning properly.

MAGNETO

Oil carefully according to direction given in folder published by Fisemann Magneto Corporation enclosed with this book. (See Fig. 20.)

COMMUTATORS

Remove generator cover and clean commutator with a clean piece of cloth by holding it against the commutator while unit is operating. Do not use any lubricant on the commutator.

## QUARTERLY INSPECTION
## BASED ON RUNNING PERIOD OF SIX HOURS DAILY

OIL BASE

Drain all old oil from base. Clean oil strainer. Refill with 7 quarts of good grade gas engine oil. See article on Lubrication, for viscosity of oil to use.

VALVE CLEARANCE

Remove cylinder head cover. Check clearance between valve stem and rocker arms with thickness gauge supplied. Adjust to between .004 and .006" when unit is hot. When checking clearance, make sure that valves are properly seated. (See Fig. 26).

SPARK PLUGS

Remove each of the spark plugs. Clean with kerosene and, if necessary, adjust gap to .025 inches, about the thickness of a worn dime. (See Fig. 22).

COOLING SYSTEM.

Drain and flush out radiator thoroughly with fresh water, then fill with soft rain water free from all impurities.

GENERATOR BALL BEARING.

Lubricate by applying a good grade of unmedicated vasoline, Be careful not to put on an excess quantity. Do not allow grease to get on commutators. (See Figs. 18).

COMPRESSION

Try compression of each cylinder by slowly rotating the engine with the hand crank. If compression is weak on one or more cylinders, the valves need grinding. (See Fig. 25).

FUEL STRAINERS

There are three strainers in the supply line: one at cylinder head bracket, one at top of vacuum tank and one at bottom of carburetor. (see Fig. 9). Remove, examine and clean if necessary.

BATTERY CHARGING COIL

The upper of the two coils in the back of the automatic switch is a 100 ohm resistance coil, used for charging the battery when the unit is in operation. This coil shunts a portion of the current generated, amounting to .8 of an ampere into the battery, keeping it charged ready for use.

FIELD RESISTANCE COIL

The lower of the two coils on the back of the switch is known as the field resistance coil and its purpose is to provide a variable resistance from the negative line to the shunt windings of the generator.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## SAFETY SWITCH

The safety switch is provided for the purpose of protecting the battery from complete discharge by cranking, if the engine does not start. After approximately one minute of continuous cranking, the battery circuit is automatically broken and black button in the front of the switch-board will project out of the hole about one-half inch, stopping the cranking function.

Whenever the safety switch is released, a search should be made at once to determine why the unit did not start.

The switch is brought to the operating position again by pressing the button flush with the box. It is necessary to wait at least one minute before returning the button to its normal position. UNIT WILL NOT START IF SAFETY BUTTON IS OUT. (see Figs. 28 and 29.)

## GOVERNOR SWITCH ADJUSTMENT

The governor switch contact points must be together when the unit is stopped. As soon as a speed of 850 R.P.M. is reached, the mechanical governor arm moves forward and the contact points in the governor switch are separated by the plug, breaking the cranking circuit.

If the Unit does not start when a lamp or appliance is turned on and the governor switch is suspected, try short circuiting between Nos. 3 and 4 terminals on the fibre panel located on the Automatic Switch box. If the unit starts, the trouble is in the governor switch contact points, and is due to dirty contact points, or contact points being out of adjustment. The contact points may be cleaned by inserting a small file which can also be used for cleaning the points in the Automatic Switch. If the Governor Switch Contact Plug is out of adjustment, it may be regulated by means of the adjusting screw. A hexagon socket wrench designed to be used with a thin screw driver is provided for making this adjustment. With the unit stopped, turn on a light or appliance, loosen the lock nut with the socket wrench, then with a screw-driver turn out the adjusting screw till the governor switch terminals close. This will be indicated by a click in the switch box and the unit will immediately begin cranking. Turn back the adjusting screw one turn beyond the point where the unit started and lock it securely in this position. The governor switch points should separate when the governor is about half way on its stroke.

Care must be taken not to back out the adjusting screw too far or the Governor Switch Contact Plug will not break the circuit the next time the unit is started till the safety switch disengages. If this occurs the unit will not start automatically till the safety switch is pushed in.


Figure 19
Timing Ignition—Magneto Setting Showing (1) Setting Notch

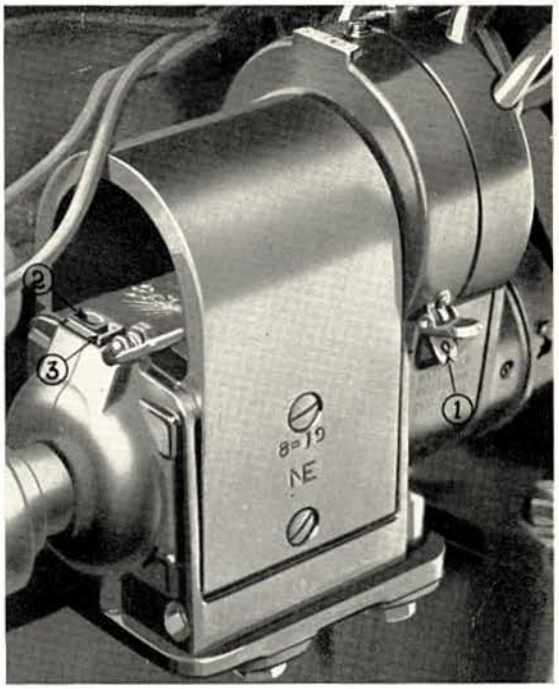



Figure 20
Lubrication of Magneto. Hole (1) at Breaker End; Large Hole (2) at Driving End; Small Hole (3) at Driving End

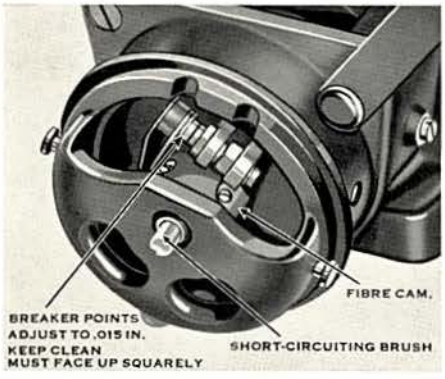



Figure 21
Magneto Breaker Mechanism


Figure 22
Spark Plug

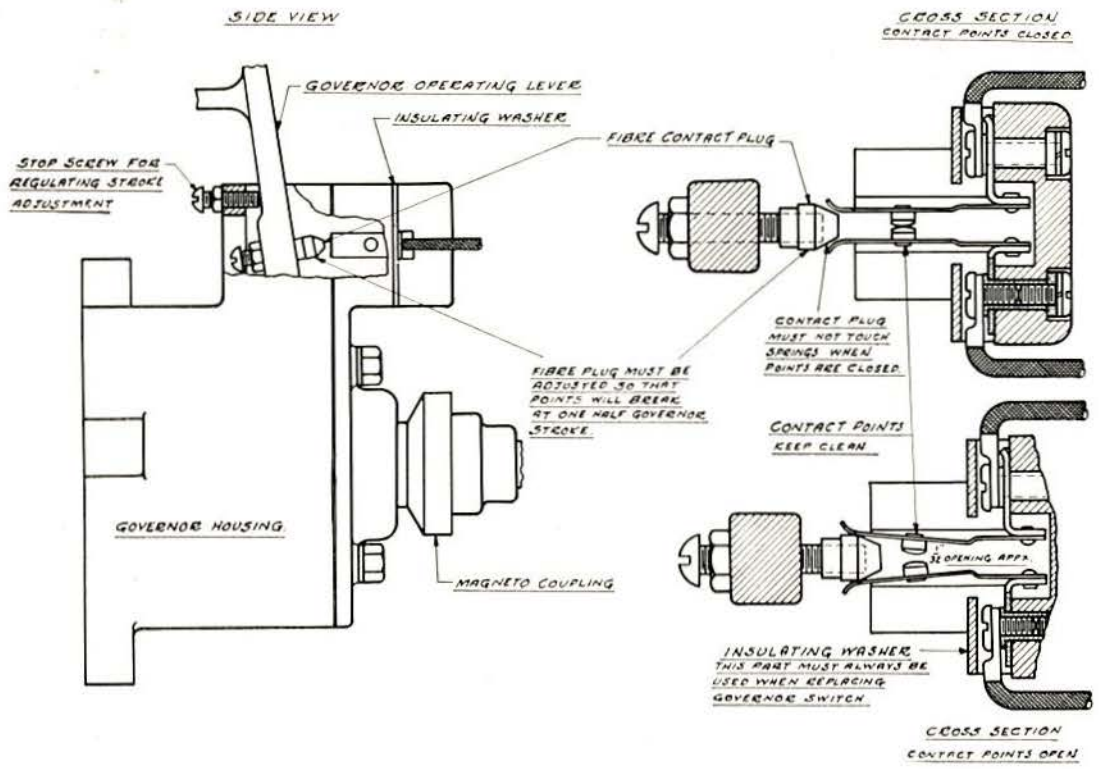



Figure 23
Governor Switch and its Adjustments

If it is desired to remove the governor switch body, it may be done by taking out the holding screw and withdrawing it from the governor housing cover. The governor switch body is made of bakelite and while it is amply strong for its purpose, must not be subjected to rough handling or it may break. The contact points are held together by the tension of the springs to which they are fastened. The spring tension is so adjusted that the contact points will just separate when subjected to a pressure of a 3 oz. weight. When replacing, be sure and insert the fibre washer between the switch body and the governor housing cover. (see Fig. 25.)

## CARE OF BATTERY

Batteries require very little attention, but the attention that is needed they must have, and if disregarded, the life and efficiency of the battery will be reduced greatly.

The battery should rest on strips of wood and kept clear of the wet and moisture of the basement floor. All smallarticles, especially of metal should be kept away from the battery. Do not lay any article on top of the battery or allow a coating of dust and dirt to accumulate on top of it, as this will form a short circuit which will exhaust the battery and perhaps injure it. If any of the solution is slopped over the top, wipe it off with a rag wetted with ammonia water or use water and small whisk broom. Keep the battery clean.

Pure distilled water or clean rain water caught in crock or glass vessels must be added to the battery cells at sufficient intervals to keep the tops of plates covered. Do not use hard water or any water that has come in contact with any metallic substance. Use only glass or earthenware vessels. Plugs must be removed to add water, then replaced and tightened after filling.

## STARTING BATTERY AUTOMATICALLY CHARGED

The battery has 12 cells, 24 volts. It is for starting purposes only and is kept automatically charged. The charging rate is less than one ampere; this is a low rate and one that is very beneficial for the battery. Should it ever be necessary to disconnect a battery to be charged from anoutside source, be sure to use only direct current and not to charge at a higher rate than two amperes. A higher charging rate will ruin the battery.

## TO TEST BATTERY

The best way to ascertain the condition of the battery is to test the specific gravity (density) of the solution in each cell with a hydrometer. This should never be done just after adding water.

Gravity of a fully charged battery is between 1.280 and 1.300.
Gravity above 1.250 indicates battery more than half charged.
Gravity below 1.200 indicates a complete discharged condition of the battery.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

The gravity readings of all cells should be approximately the same. A difference of more than 25 points indicates a partial short circuit in that cell which should receive prompt attention from a Battery Service Station.

CARE OF BATTERY IN FREEZING WEATHER

There is no danger of freezing even in coldest weather if battery is kept fully charged and water is added only before plant is to be operated. When fully discharged, the battery solution will freeze at 20 degrees Fahr. above zero, while if approximately three-quarters charged 1.260, the solution will not freeze until 60 degrees Fahr. below zero.

HOW TO OPERATE WITHOUT STARTING BATTERY

Should the starting battery be damaged in any time, the plant may be used without it, though for the time that the battery is disconnected, the unit ceases to be automatic and must be started each time by means of the hand crank.

HOW TO OPERATE WITHOUT STARTING BATTERY

1. Disconnect the magneto ground wire from No. 5 terminal on fibre panel.
2. Crank the machine by means of the hand crank.
3. If engine is cold, it may be necessary to choke. This is done by holding up the plunger which projects through the choking coil. This should, of course, be released as soon as the engine begins to operate. (see Fig. 9).

TO STOP AFTER BATTERY IS DISCONNECTED:

1. If magneto ground wire is reconnected after the unit begins to operate, the last lamp or accessory turned off will stop it.
2. The unit can always be stopped by grounding the magneto. This is accomplished by making a connection between the brass screw which projects upward from the breaker box of the magneto and engine frame. A screwdriver or any other piece of metal can be used for this purpose. There is no danger of shock in doing this.

RECORDING INSTRUMENTS

WATT HOUR METERS SHOULD NOT BE USED WITH AUTOMATIC UNITS.

It is not practicable to use any current measuring instruments that are connected across the external wiring circuit with an Automatic Kohler Power & Light Unit. A watt hour meter of any make for measuring current consumption is always connected between the negative and positive lines of a wiring circuit and there is a constant flow of current thru the instrument sufficient to start the Unit or prevent it from stopping.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

In some cases the Unit will start satisfactorily but will not stop when the last light or appliance is turned off as the resistance of the meters across the line would be sufficient to keep the main relay coil energized and the plant running. With this type of instrument there would be a continual flow of current from the battery which would in time show its effects.

USE AMPERE HOUR METERS.

Whenever it is necessary to install measuring instruments our suggestion is to use an Ampere Hour Meter installed in series with the positive side of the circuit. This would not interfere with the satisfactory operation of the Kohler Unit. The amperage reading could be taken periodically, then multiplied by a standard or average voltage of about 110 volts, the result being the watt hour consumption of electricity. This arrangement would not place any unnecessary strain on the starting battery and would serve the same purpose as a watt hour meter for determining current consumption.

CHOKER

The Kohler Automatic is equipped with an automatic choker which consists of a solenoid inside of which is an armature attached to a valve on the air intake manifold. During the time the engine is being cranked by the battery, a circuit is closed, permitting current to flow which energizes the solenoid coil, attracts the armature and shuts off the air supply, causing the motor to receive a rich mixture for starting purposes.

If your motor is slow in starting, especially in cold weather, examine the choker. To be effective, the valve in choker must be closed tight while the engine is being cranked.

There is a small vent hole in the bottom end of choker sleeve for draining off moisture, which must be kept open or the choker will not function properly.

The choker is adapted to meet both cold and hot weather conditions by means of a 1/4" vent hole opposite the carburetor air intake. For cold weather operation this vent hole must be kept closed by a screw provided for that purpose, thus assuring a richer mixture for starting purposes. For hot weather operation this vent screw may be removed, allowing a small amount of air to enter when choker is closed, giving a leaner mixture for starting. In replacing the 1/4" screw, care must be taken that it does not project too far or it will prevent the valve from seating.

If the unit is installed in a place where temperature of 70 degrees or higher prevails, it may be advantageous to disconnect the choker entirely. If disconnected from choker the ends of wires should be covered with tape to prevent any possibility of short circuit.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## SPARK PLUGS

Spark Plugs are the most common causes of misfires and in case of trouble they should be inspected first. If the points are covered with soot or oil, the plug should be cleaned with gasoline.

Beads of carbon which short-circuit the plug should be removed and the normal distance between the electrodes re-established. The latter should also be done if, on account of melting away or for some other reason, the distance between points has become excessive. This distance should be .025 (slightly less than 1/32 inch) inch, or the thickness of a worn dime. (see Fig. 22)

Frequently the insulation of the plugs becomes defective. The plugs should be taken apart and the porcelains carefully examined. If they are chipped or cracked, the porcelains must be renewed or new plugs put in.

## HOW TO TEST FOR SPARK

To test whether spark is being furnished, first disconnect magneto ground wire, then remove plug with cable attached. Next hold spark plug against engine frame (do not touch spark plug points to frame). If a spark is being furnished, it will jump across the gap when engine is cranked. If the spark plug is suspected, remove cable from plug, and hold end of cable 1/32 of an inch from engine frame. If magneto is functioning, a spark will be observed as crank is turned.

The spark plugs may also be tested when unit is operating by short circuiting between end of plug and engine frame. If the plug is firing, the speed of motor will be reduced. If shorting out the plug has no effect on engine speed, it indicates the plug is not firing. Be careful of shocks when testing in this manner.

## RADIATOR

If hard water or water with considerable sediment is used, the passages may in time become clogged with scale or dirt. To clean, dissolve one pound sal soda in water, fill radiator with this solution and operate until water becomes hot. Flush with clean water. Repeat this treatment until radiator is clean.

An accumulation of dust and dirst lodged in the honey comb section of the radiator will seriously interfer with its cooling efficiency and these air passages should be kept open and clean.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## ANTI-FREEZING SOLUTION FOR RADIATOR

Should the unit be located in a place where at any time it is exposed to a freezing temperature, precautions must be taken that the water in the cooling system does not freeze as this would damage the radiator or some portion of the passages through which the water flows.

We discourage the use of kerosene, lubricating oil or any of the patent compounds on the market, and recommend the use of a mixture of denatured alcohol of 186 proof, and water in the following proportions:

A solution of 15% alchohol to 85% water will protect the radiator from freezing in all temperatures above zero Fahrenheit.

A solution of 35% alcohol to 65% water will prevent freezing to temperatures of 40 below zero Fahrenheit.

The solution in the radiator will have to be strengthened from time to time as alcohol evaporates much more rapidly than water.

## FAN

The fan bearing is self-lubricating if the hub reservoir is kept filled with a good grade of gas engine oil. This reservoir is filled at the factory, but should be refilled every week by removing the pipe plug and squirting in a quantity of oil by means of an ordinary oil can. Be sure to replace pipe plug carefully and tighten; otherwise oil will be thrown out, allowing fan bearing to run dry. (see Fig. 14). The fan operates at a speed of about 2000 R.P.M.; to insure quietness of operation it must be properly lubricated. If this is neglected, the bearings will soon wear and become noisy and will necessitate putting in a new fan.

## HOW TO TEST FAN BELT ADJUSTMENT

A properly adjusted fan belt need not be taut, but it should not be so loose that it sags and slips. A slipping fan belt will cause the engine to heat.

## INSTALLING NEW FAN BELT

Should it become necessary to install a new fan belt, the automatic switch must be removed from the unit and the cap screws, which fasten the generator frame to the flywheel housing, removed. Raise the brushes clear of the commutator, and lift the generator frame from the machine. The nut holding fan shaft in position should be loosened and fan dropped to bottom of slot. Each fan belt is stamped with the legend "This side toward radiator" and care must be taken to put belt on as directed. The new fan belt can then be inserted between the end of the fan shaft and the radiator and properly fitted to the flywheel pulley and hub pulley on fan. In case there is not sufficient space between the radiator and the fan shaft, it will be necessary to remove the radiator from the unit.

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In replacing the generator on the machine, the brushes must be withdrawn in their holders sufficiently so they will not catch on the commutator when the generator is being placed in position. It is not necessary to remove the armature to put on a new fan belt.

## MECHANICAL GOVERNOR

The mechanical governor is encased in the housing to which the governor switch is attached and is driven by the shaft which operates the magneto. The governor arm projects upward through the housing cover. To this arm is attached the governor contact plug which separates the contact points in the governor switch, the adjustment of which is shown in Fig. 23. To the upper end of the governor fork is attached the carburetor operating lever by means of a ball joint. The bent end of the carburetor operating lever hooks into the carburetor throttle valve arm. Its length must be so adjusted that the unit will develop approximately 110 volts at about 1050 R.P.M., when operating on a 25 watt load. This adjustment should always be made when the unit is warmed up to a running heat.

The operating lever is correctly adjusted before leaving the factory and should not be changed so long as a standard voltage is maintained. The governor is lubricated by a spray of oil which is picked up inside the governor housing by the fly weights and does not require any alteration from the owner.

The motion of the governor mechanism must be free and without any friction as any binding or sticky condition will seriously interfer with the operation, causing poor voltage control.

## LUBRICATION

### KIND OF OIL TO BE USED

Only the very best grades of automobile crank case oil should be used in the Kohler Power and Light Units. For summer or hot weather operation we recommend what is known to the trade as a medium grade of oil. During the winter season or at any time when the unit is exposed to a low temperature only a light zero test oil should be used. If a heavy or a medium grade of oil be used during cold weather, it will thicken to an extent that it will make the motor very hard to crank and the battery will not revolve the motor at sufficient speed to cause the gas engine to start firing.

### CIRCULATION OF OIL

When the unit is in operation, oil will be forced from the oil return tube, dropping into the base, thus indicating that the oil pump is working satisfactorily and that oil is being circulated, insuring proper lubrication of the machine. The oil return tube is visible through the oil sight hole in the cylinder head cover.

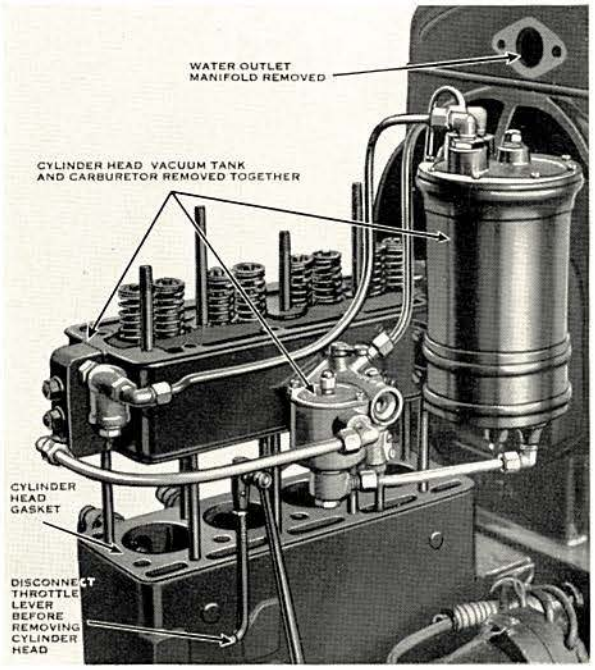


Figure 24
Removing Cylinder Head

Figure 25
Grinding Valves

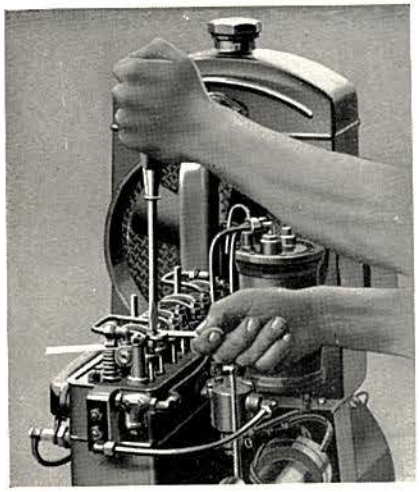

Figure 26
Adjusting Valve Clearance

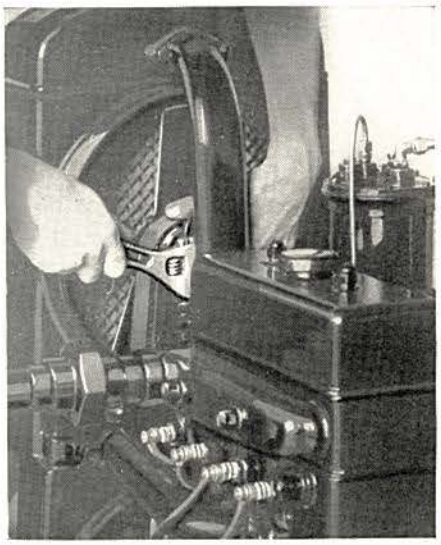

Figure 27
Adjusting Fan Belt

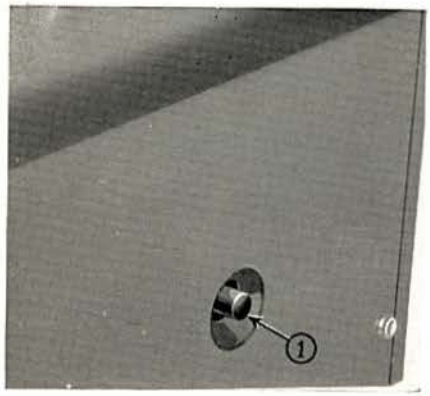


Figure 28
Safety Switch Button (1) "Out"

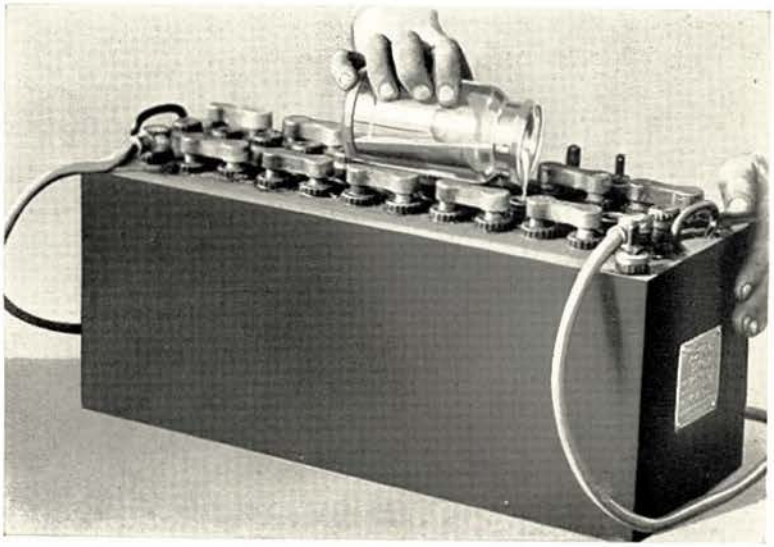

Figure 30
Filling Starting Battery with Distilled Water

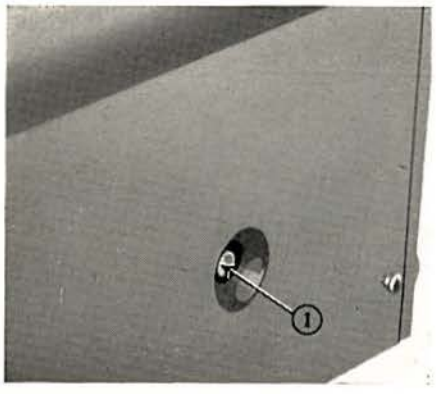


Figure 29
Safety Switch Button (1) "In"

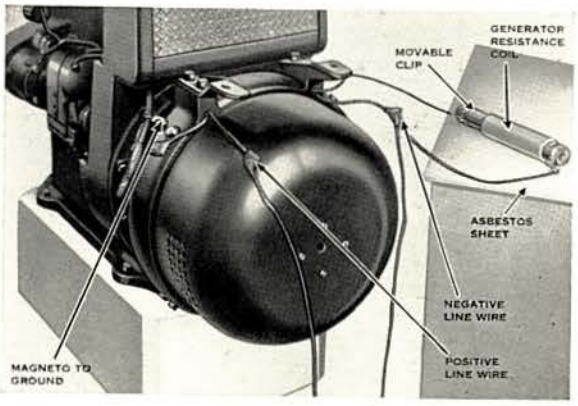


Figure 31
Operating without Automatic Switch

On all monthly inspections and whenever unit is visited, user should glance at the oil sight hole. If the intermittent stream of oil is not observed when unit is in operation, engine should be stopped until the cause of stoppage of the oil flow is ascertained and remedied.

GENERATOR BALL BEARING

Lubricate the generator ball bearing with a good grade of unmedicated vaseline at least once every three months. If the unit has exceptionally long hours and is in continuous service, lubricate the ball bearing more frequently. (See Fig. 18).

DRAINING OIL BASE

Every three months all the oil in the base should be drained. The oil drain plug is to be found in the left-hand lower rear corner of the base, near flywheel housing. Engines have to be drained more frequently in winter than in summer. Cold temperatures aggravate the dilution of the oil by raw fuel. Drain oil base, because the condensation in the cylinders, due to the cold weather, often results in the mixing of the oil with gasoline. To drain oil, first remove the small plug in the oil drain. (see Fig. 16) After the bulk of the oil is removed, loosen and remove the large plug to clean strainer. (see Fig. 17).

WATER IN OIL

Care must be taken not to allow any water to get in the crank case either by condensation or otherwise, as it not only impairs the lubricating quality of the oil but is liable to freeze in the bottom of the oil pump and damage it when engine is started.

CLEAN OIL STRAINER

Whenever the oil is drained, the oil strainer which is attached to the oil plug should be cleaned thoroughly by washing it with gasoline. (see Fig. 17).

DIRECTIONS FOR CHANGING AUTOMATIC UNIT TO MANUAL CONTROL UNIT

Remove all wires from Automatic Switch as per following directions (sse Fig. 31).

1st. All wires from fibre panel.
2nd. Both wires from terminals underneath left end of switch.
3rd. Wire with square terminal from negative post underneath right end of switch.
4th. Wire from clip on resistance coil on rear of switch.
5th. Remove 40 ohm coil from bracket by loosening nuts which clamp the coil in place.

TO CONNECT WIRING FOR MANUAL OPERATION

1st. Lay the 40 ohm resistance coil on a wooden box near the unit.
2nd. Connect the long thin wire with round terminal to clip on open end of resistance coil which you have laid on box.

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3rd. Connect short wire with square terminal, and negative lead wire from external circuit to other end of resistance coil.

4th. Connect positive lead wire from external circuit to the longer of the two wires with square terminals on left end of generator.

5th. All other loose wires should now be taped together with the exception of the magneto ground wire. (Wire with large brass hook), which can be used for stopping motor by touching hook to any part of motor, grounding the magneto.

## COMPRESSION

To test the motor for compression remove distributor plate; use the hand crank and by turning the motor very slowly it is possible toascertain whether or not compression is as it should be. If the compression is good there will be a noticeable resistance in rotating the motor as each of the pistons reach the top of their stroke and the crankshaft will have a tendency to kick backward if the compression is good. If the exhaust pipe be removed and the ear placed close to the exhaust opening while the motor is revolved by the handcrank it is possible to judge the compression in this manner, for if any of the valves or the piston rings are leaking the escape of the confined vapor will make a sort of hissing noise as it passes thru the leaky valve or by the piston rings.

Following are the causing of poor compression:

1. Leaky valves, particularly exhaust valves.
2. Improper valve clearance. A clearance of .004 to .006" should be maintained.
3. Leaky spark plug - cracked porcelain or leaky gasket.
4. Loose cylinder head - Leaky gasket - cylinder head not pulled down evenly.
5. Valves not seating properly due to excessive carbon deposits or sticky valve stems.
6. Worn or sticking piston rings.

The motor will not function properly or deliver its full power if the compression is not good, and in case it is found to be at fault, the valves must be reground, cylinder rings replaced or joints made tight, or spark plugs renewed as the case may require.

## REMOVING CYLINDER HEAD

Drain all water from cooling system after which remove all water and gasoline connections. The nuts holding rocker arm shaft to head should then be removed and the entire assembly lifted off. Remove the eight push rods and lay them out carefully so they can be replaced in their original position. Unscrew the nine nuts holding cylinder head and lift head, vacuum tank and carburetor clear of the unit. Be sure not to injure the copper asbestos cylinder head gasket. Do not pry the head up with a screwdriver. Use a block of wood tapping gently until head is loosened. (See Fig. 24).

GRINDING VALVES

Remove valves by depressing the valve spring and pulling keeper out of slot on the end of the valve stem. OBSERVE THE MARKS PUNCHED ON THE CYLINDER HEAD AND VALVES, ALWAYS REPLACE THE VALVES IN THEIR RESPECTIVE PLACES.

If valves or valve seats, after washing in gasoline, are pitted (show black specks) or are not seating properly they should be "ground in". Grinding compound for this use may be purchased from any store handling automotive supplies.

Using a brace or screwdriver, rotate the valve backward and forward in its seat, lifting it occasionally for inspection. DO NOT ROTATE IN A CONTINUOUS DIRECTION. (see Fig. 25).

CARBON

With the present day low grade of gasoline now used for fuel there is the every present possibility that carbon deposits will form in the combustion chambers, fouling the spark plugs, interfering with the ignition and destroy the efficiency of the motor. Excessive carbon deposits are usually indicated by a lack of power and back firing at the carburetor. If an excessive amount is allowed to accumulate it may cause a "knock" or "pound" in the motor. It will cause the piston rings to become sticky and often obstruct the free working of the valves. When such a condition occurs the only satisfactory means of correcting is to remove the cylinder head and scrape the carbon off the top of the cylinder and from the underside of the cylinder head.

We do not recommend the use of any of the carbon removers that are on sale for this purpose, for while some of them will remove the carbon they are usually injurious to the motor.

If the user will make a practice of occasionally removing his spark plugs and putting a tablespoon full of kerosene in each cylinder, then after replacing the plugs rotate the motor by hand a few times, any carbon deposit will be softened up and blown out the next time the motor is started.

Kerosene should be put in while the motor is hot and it should be allowed to stand for a few hours before being started.

REPLACING CYLINDER HEAD

To replace cylinder head reverse the method given for removing. Coat both sides of copper asbestos gasket with shellac being careful not to get too much around openings for cylinders. Replace the push rods in their original position being certain they enter in the socket in tappet. When replacing the nuts holding head to cylinder tighten down evenly as there is a danger of wrinkling the gasket causing a water leak. Replace all water and gasoline connections, coating gaskets with grease or vaseline and be careful to get connections water and air tight.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## TO ADJUST VALVE CLEARANCE

It is highly important that the proper clearance of .004 to .006 inch be maintained between the top of valve stem and face of rocker arm. If this distance is too great, the valves will open late and close early, while if it is too small, they will not close at all, thereby causing a great loss of power.

Before proceeding to adjust the valve clearance, tighten down the cylinder head and rocker arm bolts securely. The valve adjustment should be made only when the motor is hot; if made when cold it will not be accurate due to the change in temperatures when the motor warms up to a running heat. A .006 inch thickness gauge is furnished with all motors to be used in adjusting the valve clearance.

To adjust clearance, proceed as follows: Turn the crank until the cylinder you are working on is on the firing center and both valves are completely closed. Also make sure that valves are not being held open by carbon deposits or a sticky or dirty stem. Then insert a thickness gauge measuring .004 to .006 of an inch between the face of the rocker arm and top of the valve stem. The clearance is correct when this gauge or its equivalent can just be moved. If a thickness gauge is not available the covers of standard magazines such as the American Magazine, Literary Digest and Country Gentleman can be used as these are approximately .004 inch thick. It is also possible to use several thicknesses of ordinary farm journal paper, or newspaper as these are .002 thick. In making the adjustment necessary to secure the proper clearance, first loosen the upper or lock nut on the rocker arm. Then by turning the adjusting screw to the right or left the clearance can be decreased or increased. Be sure to lock the adjustment securely with the lock nut after adjustment is made. To do this, hold the screw tight with a screw driver, while the top nut is tightened. (see Fig. 26). VALVE CLEARANCE ADJUSTMENT should be made WHILE THE MOTOR IS WARM.

## MAGNETO

The spark generated to ignite the fuel in the cylinder and cause the explosion which creates pressure to operate the engine is produced by the magneto, which is driven directly from the motor by means of gearing. The magneto will require but little attention on the part of the user except that it should be oiled as directed at stated periods.

## LUBRICATION OF MAGNETO

It is impossible to place too much importance on the judicious oiling of the magneto. Hence, remember that the following instructions are of vital importance to the efficiency of the instrument in general, and to the life of the contact points in particular.

For lubricating the ball bearing at the breaker end, two oil wells with hinged covers are provided, one on each side of the housing just back of the breaker box. Both of these lead to the same bearing, and only the one which is most accessible should be used. This well should not receive more than two drops of clean cylinder oil every month. (see Fig. 20) DO NOT OVEROIL AT THIS POINT.

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At the driving end two oil holes will be found. The larger one leads to the plain bearing carrying the distributor shaft and should be given 15 drops every month. The smaller hole leads to the ball-bearing at the driving end and should receive 4 or 5 drops every month. (see Fig. 20). The above lubrication instructions are based on an average daily running period of six hours.

LUBRICATING MAGNETO COUPLING

At least once every three months the magneto should be loosened up and the coupling supplied with a good grade of vaseline. When replacing magneto be sure you mesh the coupling gears properly.

TIMING MAGNETO TO MOTOR.

First remove the cylinder head cover and tighten down the cylinder head and rocker arm bolt nuts securely. Next adjust the valve clearance as previously described.

The firing order is 1-3-4-2. The engine cylinder at crank end is No. 1 and numbered in consecutive order No. 4 being next to the radiator. To place the engine in position, crank the motor until No. 8 valve (First from radiator) has opened and is almost closed. Now take hold of No. 7 rocker arm (Second from radiator) and turn the motor very slowly, just keep jarring the handle slightly until the least bit of lost motion is felt in No. 7 and 8 rocker arms. The piston in No. 1 cylinder is now at the top of its stroke and in firing position. This can be verified by removing the spark plug from No. 1 cylinder and inserting the little finger, a wire or screw driver in the spark plug hole.

Next remove the distributor plate cover from the magneto and turn the distributor disc clockwise toward engine until the setting mark (Notch Marked R) is 5/16" or 3/8" past the firing pin. Mesh the coupling teeth together in this position and bolt the magneto in place, taking care that the magneto and governor shafts are in line and the coupling is not binding. When the magneto is properly located a very slight lost motion will be felt in the magneto coupling. The exact setting will vary slightly on different motors; If timed too late loss of power and overheating will result. The best results are obtained by advancing the timing until the engine begins to kick back, and then retarding the magneto one or two teeth.

It is absolutely necessary that the magneto be properly timed to the motor if proper functioning and efficient operation are to result. (see Figure 19.)

REMOVING AND REPLACING MAGNETO

The magneto may be removed and replaced without retiming the motor if desired.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

To do this remove distributor cover from magneto; with the hand crank turn the motor until the firing mark 1 (R) on the distributor is in line with the setting pin and leave the motor in this position. If the motor is not moved it will be in proper position when the magneto is replaced. When replacing the magneto turn the distributor cover until the firing mark 1 (R) on the distributor plate is again in line with the setting pin and mesh the couplings together in this position. If the motor has not been rotated since the magneto was removed it will have the same timing as before.

TO ADJUST MAGNETO BREAKER POINTS

After a period of use the breaker may require adjustment, the distance between the points when wide open should be .015" (about 1/64"). (see Fig. 21).

Take off magneto and remove end cap. Use magneto combination wrench which is riveted a metal gauge .015" thick. Turn armature slowly until breaker is wide open. Adjust breaker points so this metal gauge will slip in without much friction. Then turn armature one-half revolution and check breaker opening again. The contact points must make an even and perfect contact over their entire surface, if they do not, burning and pitting is sure to follow. The small lock nut on contact screw must be tightened securely after each re-adjustment. After making these adjustments put one drop of oil on felt at bottom between the two fibre breaker cams. If the breaker points do not separate the same distance on each cam, the higher cam must be dressed down until the points separate an equal amount on each cam.

CLEANING BREAKER POINTS

A film of oil or dirt may at times collect on the contact points which will prevent perfect short circuiting of the low tension winding. The points are best cleaned with fine sand paper or if necessary with a very fine file, taking care not to round off the edges. The points must face up squarely over their full area.

ATTACHING CABLES.

The firing order is 1-3-4-2. With magneto bolted in position and distributor cover in place, the long cable from outside attachment leads to No. 1 spark plug. Second from outside leads to No. 3 spark plug. Third from outside to No. 4 spark plug. Inside cable (next to engine) leads to No. 2 spark plug. If insulation on cables become worn or oil soaked they should be replaced.

MAGNETO BRUSHES

The tension of the magneto brushes is regulated by a small spiral spring. In case any trouble is experienced with the magneto these brushes may be examined to see that they work freely in the sockets, and that they make contact with the distributor plate, collector ring and ground plate when the magneto is assembled. Clean the distributor plate track and collector ring with a cloth dipped in gasoline. Do not operate till gasoline is evaporated as a spark will ignite it.

TESTING MAGNETO FOR SPARK

Remove the distributor cover, place a screwdriver so the metal part will rest on the casting on side of magneto. Hold the screwdriver at such an angle that its point will be 1/8" from the collector ring. Rotate the engine by hand, or if attached to the unit crank the motor by hand or turn it over with the starting battery. If a spark jumps from the collector ring to the point of the screwdriver as the magneto revolves the magneto is alright.

The magneto may also be tested when motor is in operation. To do this disconnect one cable from the spark plug. Start the motor under its own power and hold the end of detached cable within 1/16" of engine frame. The spark for each cylinder may be tested one at a time in this manner. A pair of pliers with insulated handles should be used for holding the cable when making tests with motor in operation or a slight shock or burn may result.

For further information see pamphlet on magneto.

MAGNETO REPAIRS

Do not attempt to make other than minor repairs or adjustments to magneto. If the magneto is clean, the breaker points properly adjusted and brushes all making good contact and the magneto still does not function properly, notify a Kohler Branch Office and it will be sent to an Eisemann Service Station for reconditioning.

CARBURETOR

The carburetor supplied with the Kohler Power and Light Units, is manufactured by the Zenith Carburetor Company, Detroit, Michigan. It consists of a float chamber, or bowl; a carburetor chamber, or barrel; and a system of fuel nozzles and air passages so combined as to function on the well known principles of the Zenith Compound Nozzle.

Gasoline from the tank enters at union body, passes thru filter screen and enters the float chamber thru needle valve seat. As soon as the gasoline reaches a predetermined height in the flat chamber (corresponding to the horizontal level line scribed on the outside of the bowl), the float rises and closes the needle valve stopping the flow of gasoline from the vacuum tank.

ADJUSTMENT OF CARBURETOR

The carburetor used on our unit is simple and positive in its action. The quality of the mixture is fixed at the factory and it is essential to the successful operation of the unit that none of the parts be tampered with or the size of jets altered by boring or hammering. The end of the main jet should be exactly in the center of the venturi tube, if too high the mixture will be too rich and the fuel consumption will be excessive. If too low the mixture will be too lean and the carburetor will back fire and motor will lack power when cold. NEVER TRY TO ADJUST THE CARBURETOR.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

DIRT OR WATER IN CARBURETOR

When gasoline is dirty, a tiny speck of dirt may clog the aperture of a jet, and though engine may continue towork it does so imperfectly, giving indications of defective carburization. The jets can be quickly cleaned out by holding the hand over the air intake for a few seconds when running the motor fast, or the jets can be taken out by removing the brass hexagon nuts under carburetor. Water may be removed from carburetor in the same manner, namely, removing brass hexagon nuts.

CARE OF THE CARBURETOR

Keeping the carburetor clean (free from dirt and water) is the only care necessary. This should be attended to periodically by removing union body retaining plug, dropping union body and cleaning filter screen. The lower plugs should be removed at the same time and any accumulation of sediment cleaned out. If necessary, the carburetor may be entirely removed from the motor, taken apart and replaced without fear of changing the adjustment. Care must be taken that jets are replaced in the same place from which they were removed. The long jet will extend up into the venturi tube, the small jet belongs in the compensating well. See Pamphlet.

VACUUM TANK

The only care required is to prevent dirt or water entering the tank and make certain that all joints and connections are tight.

It is very seldom that the vacuum tank requires any repairs and before attempting any make absolutely sure that the trouble is not due to some other cause.

Should it appear that the vacuum tank is inoperative when main supply tank contains gasoline, first examine all connections for leaks. It may be possible that the filler plug is loose or that the gasoline or vacuum line is cracked, causing a sericus leak in the system, which will make the tank inoperative, Also remove the strainer at gasoline inlet and clean of all dirt. If this does not remedy the trouble, remove plug in top of tank and pour about half a pint of gasoline in the tank. It may be possible that a small particle of dust is lodged under the flapper valve.

If vacuum tank floods over, it may be due to a leak in the float. This is made of sheet copper, nickel plated to withstand any corroding effects of the gasoline. To repair float, it is not necessary to remove tank. Remove only the top of the vacuum tank and lift float out with cover. If float is filled with liquid, punch a very small pin hole in float and empty it of gasoline. Solder the leak first, then the pin hole. Test in a pan of hot water for leaks. If no bubbles are seen the float is air tight and should be replaced.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

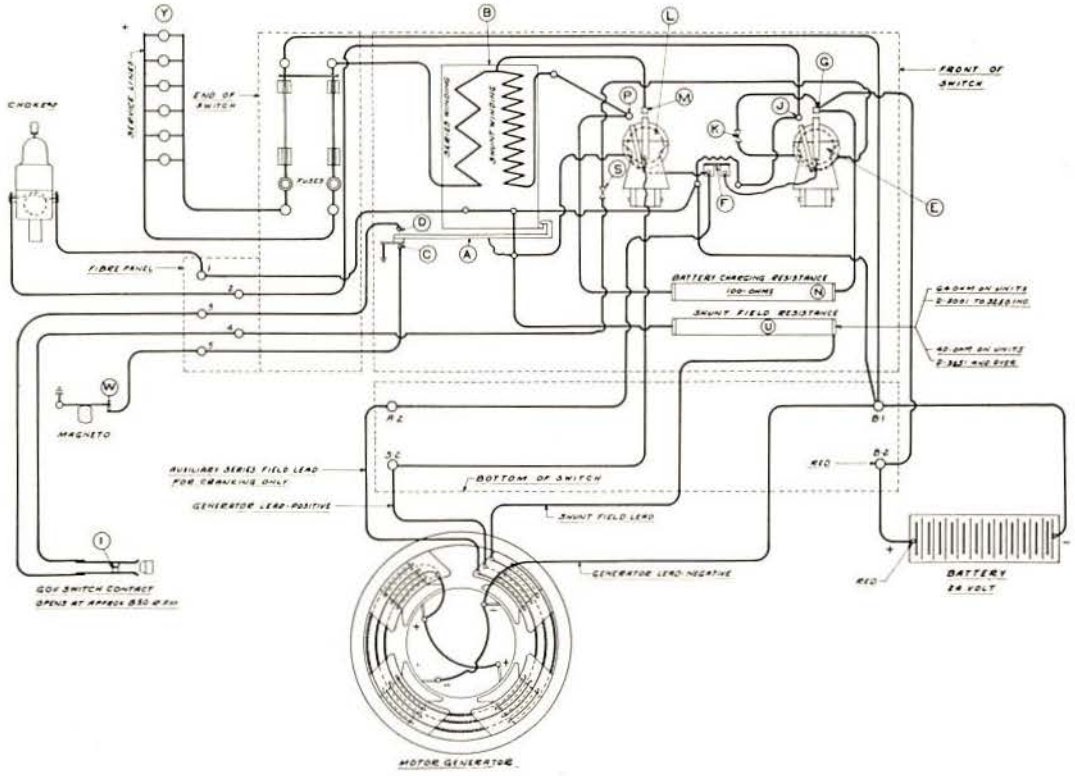



Figure 32
Wiring Diagram—Models "D" and "DA" Units

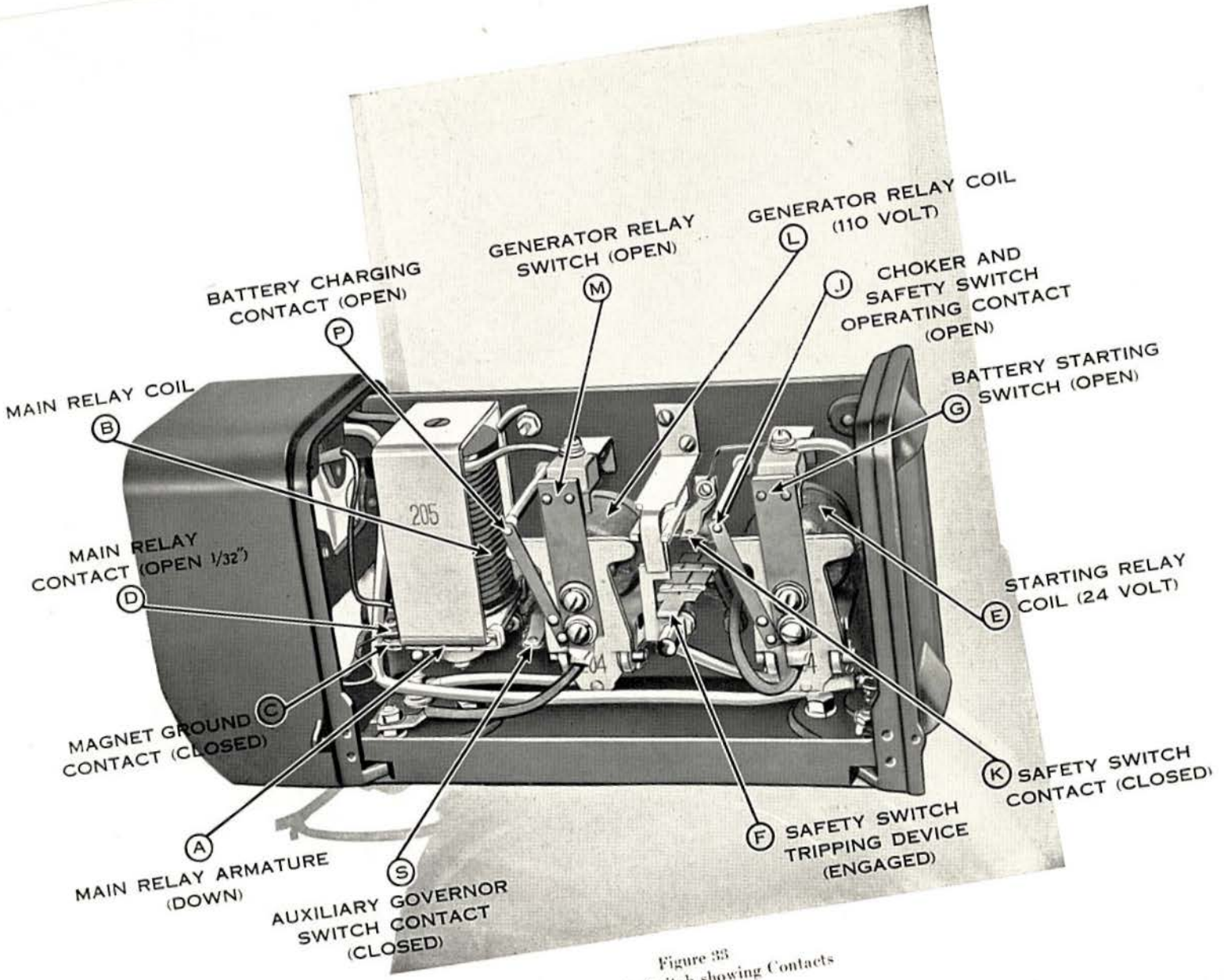



Figure 33
Automatic Switch showing Contacts
(Unit Idle)

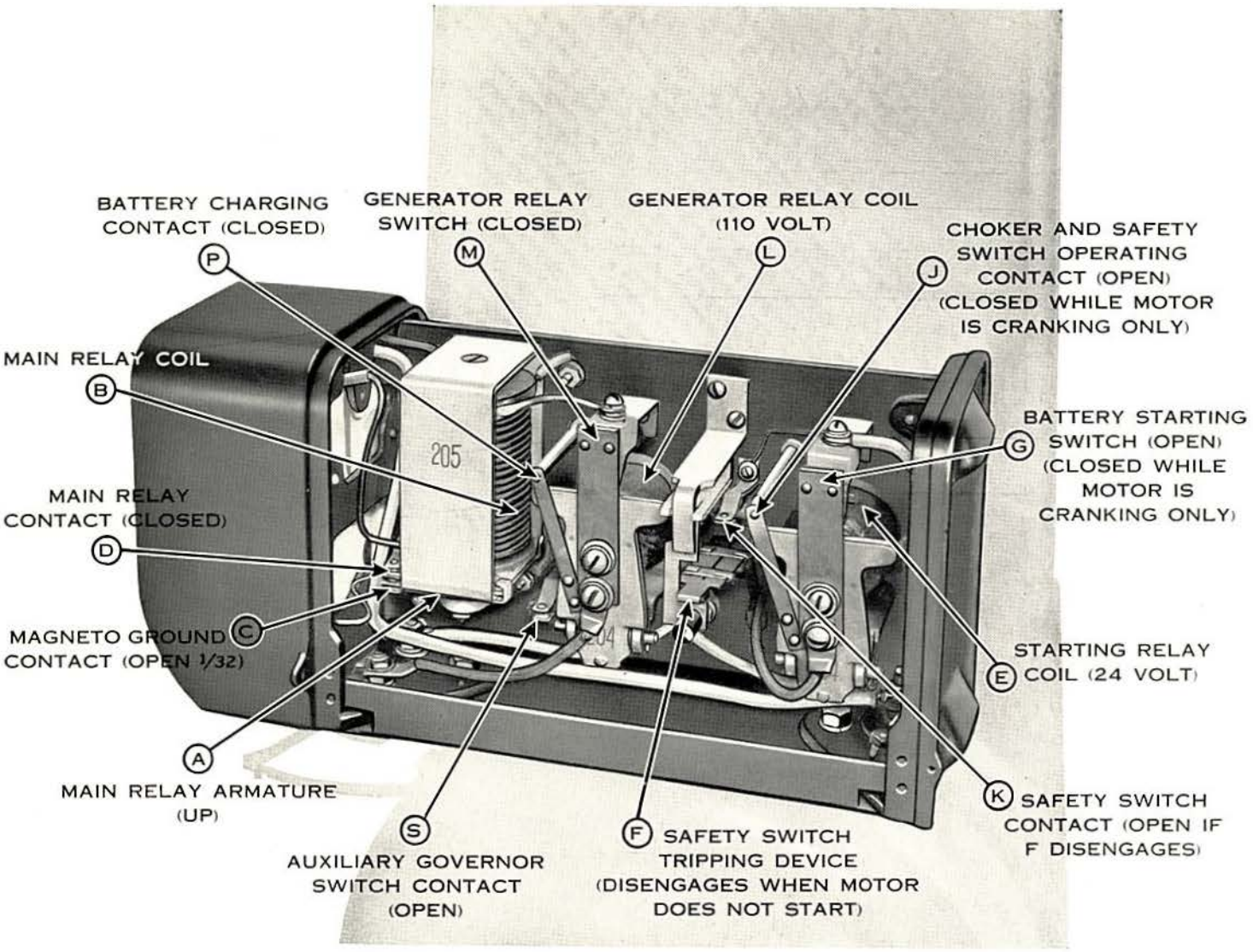



Figure 34
Automatic Switch showing Contacts
(Unit in Operation)

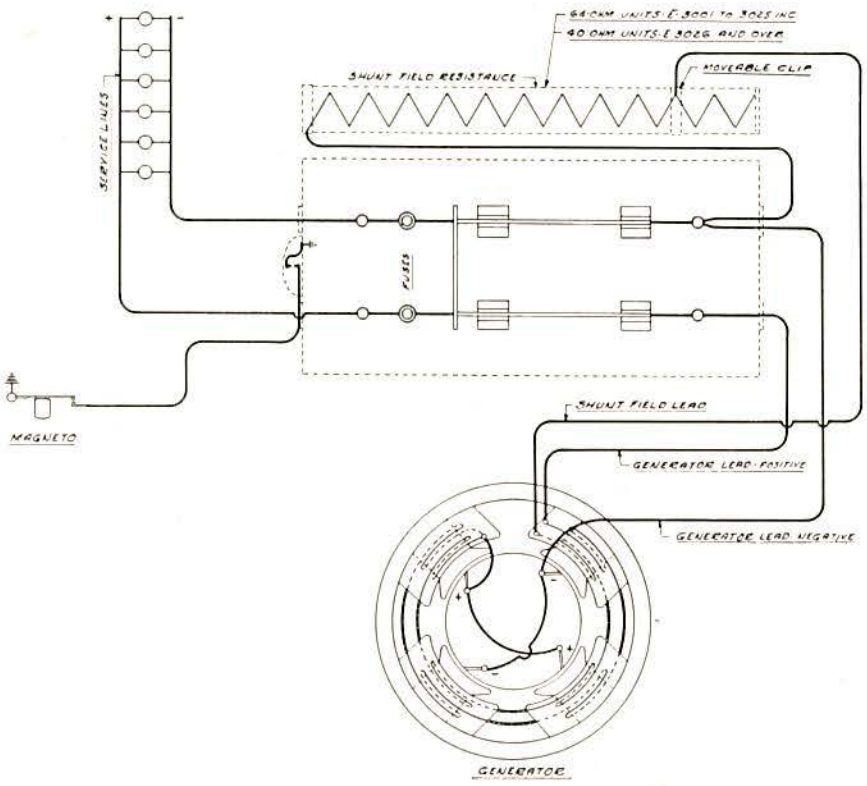



Figure 35
Wiring Diagram—Models "E" and "EA"

Some grades of gasoline contain certain ingredients which have a highly corrosive effect on the metal with which it comes in contact. This in time may cause the bottom of the inner shell to rust thru, causing an air leak which destroys the efficiency of the vacuum tank and seriously interferes with the gasoline lifting capacity of the unit. Should trouble of this kind be experienced remove the inner shell and examine for small pin holes.

In replacing top of vacuum tank be sure that gasket is intact and that air vent is not stopped up, and that vent holes are in line. See booklet on Stewart Vacuum Tank enclosed.

## GENERATOR

Should it be necessary by reason of grounds, short or open circuits to remove the generator frame, disconnect the wiring, remove the automatic switch, generator cover and then take out the cap screws which fasten the generator frame to the flywheel housing. After raising brushes clear of the commutator, lift the generator frame clear of the machine.

## TESTING GENERATOR FOR GROUND

This type of unit is parallel wound, neither side of the circuit is grounded to the frame and it is an easy matter to ascertain if a ground exists by alternately short circuiting between the positive brush holder and generator frame and between the negative brush and generator frame while unit is in operation. If a ground exists, which would be indicated by sparking, its location can be found by testing the field coils separately.

## HOW TO TEST FIELD COILS FOR GROUNDS

Remove all wiring from coil terminals; then ground to the generator from one end of a test wire having a battery and a bell or light in circuit and apply other end to coil terminals; if current flows one or more of the coils are grounded. To determine which, disconnect the coils from each other and try each coil separately. Coils will often show grounds when hot that are not in evidence when the coils are cold; this is due to the expansion of the coil when heated.

## HOW TO TEST FOR OPEN CIRCUITS

Remove allwiring from field coil terminals. Attach test wire to terminal on coil D-767, apply other end of test wire to terminal on coil D-764. If current flows the circuit is complete. If current does not flow there is an open circuit in one or more of the coils; to determine which, unsolder the pig tails and test out the winding of each coil separately. An open circuit is something that rarely occurs within the coil itself, unless the coil has been burned out as a result of a bad ground or a short circuit. They are more likely to occur where the pig tails are soldered together.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

## COMMUTATOR

The commutator is that part of the generator upon which the brushes make contact to collect the current generated. If conditions are not correct, it will be indicated by sparking at the brushes. The following are possible causes for defective operation in the commutator:

### HIGH BAR

Should one of the bars become loose and project above the level of the adjoining bars it will cause the brushes to jump as they pass over it. This can only be remedied by loosening the screws at the end of the armature and by using a wooden mallet or piece of hard wood gently drive the bar back in place. Then tighten the screws.

### LOW BAR

Should one of the bars be of softer metal than the adjoining bars it may wear more rapidly and form a low spot, causing the brushes to vibrate as they cross it. The remedy is to remove the armature from the machine and true it up in a lathe.

### HIGH MICA

Mica is used for insulating between the commutator bars. Where the armature is correctly constructed the mica is cut away to a depth of about 1/32 inch below the surface of the bars. In time the surface of the bars will wear down to the level of the mica. As the mica is harder substance than copper, it forms ridges which cause the brushes to jump, preventing them from making good contact with the commutator. If the mica is even with or projects above the bars it should be cut away to a depth of 1/32", a broken hack saw blade is a good tool for this purpose.

### BRUSHES

The brushes must fit in their holders so they are free to move without sticking or binding, yet not so loose that they will chatter or get out of alignment.

The end of the brush must be sand papered until it fits the radius of the commutator on which it rests. After a period of use a gummy substance will in time collect on the brushes, this comes from the wearing of the brushes and also from dirt and dust drawn into the generator. The brushes may be withdrawn from their holder and cleaned with gasoline or alcohol.

The spring tension should be sufficient to press each brush against the commutator with a uniform tension. It is very important that each brush have an equal pressure. If one of the springs is too weak the opposite brush will have to take more than its share of the load and sparking and damage to the commutator will result.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

CARE OF COMMUTATOR

The commutator and brushes are the only parts of the generator which are subject to wear. Under proper conditions of cleanliness and adjustment the commutator takes on a mahogany-colored polish which is highly desirable for satisfactory operation.

It is very necessary that the unit be protected from flying dirt or dust which would be drawn into the machine, collect on the commutator and brushes and cause them to wear rapidly. Dirt, oil and water are very injurious to any kind of electrical machinery.

The only care that the commutator should have is to keep it clean. Do not put oil or other lubricant on it. Wipe it off with a clean cloth occasionally. If the commutator gets gummy or sticky, it may be cleaned with a cloth dipped in gasoline or alcohol. Do not operate after cleaning with gasoline or alcohol until parts are dry, as a spark may ignite the volatile gases.

AUTOMATIC SWITCH

The automatic switch (by means of which the unit is started or stopped automatically by turning on or off a light or power appliance) is mounted on support brackets above the generator.

Figures 33 and 34 show the automatic switch with cover removed. The various coils, switches, contact points, etc. are indicated by letters and labels with arrows pointing to the parts designated. Figure 33 shows the position of the switches and contact points when the unit is Not Running. Figure 34 shows the position of the switches and contact points when the unit Is Running. Figure 32 is a wiring diagram of automatic switch and generator for D and DA units.

THE SWITCH FUNCTIONS AS FOLLOWS.

When the unit is stopped and a light or power appliance is turned on, the battery current passes thru the shunt windings of the Main Relay Coil (B) energizes it and attracts the Main Relay Armature (A). When the Main Relay Armature (A) raises, it separates the Magneto Ground Contacts (C) 1/32", thus allowing the ignition current generated by the magneto to flow to the Spark Plugs. As the Main Relay Armature (A) raises it also touches the Main Relay Contacts (D) permitting the battery current to flow thru the Governor Switch Contacts Fig. 32, thru Auxiliary Governor Switch Contacts (S), thru the Safety Switch Contact (K), and thru the Starting Relay Coil (E).

When the Starting Relay Coil (E) is energized it attracts the armature of the Battery Starting Switch (G) to which is also attached the choker contact (J). The closing of these contacts permits the battery current to flow to the generator and crank the motor. A small part of the battery current passes thru the contact (J), and operates the choker. Contact (J), must always close about 1/8" in advance of contact (G).

After a period of cranking the gas engine starts firing and as soon as it attains a speed of about 850 R.P.M. the contact points in the Governor Switch (See Figures 23 and 32) are separated by a fibre plug attached to the mechanical governor arm. The Starting Relay Coil (E) is no longer energized and the contacts (G) and (J) separate. Contacts (G) and (J) should be closed during the cranking period only.

The gas engine is now operating under its own power, and as soon as sufficient voltage is generated the Generator Relay Coil (L) is energized to attract its armature, thus closing the Generator Relay Switch (M) and the Battery Charging Contact (P). If for any reason the gas engine does not start firing after about one minute of cranking the Safety Switch Tripping Device (F) which contains a heat element, disengages and separates the Safety Switch Contacts (K) stops the cranking function and protects the battery from discharge.

The current generated can now flow out on the line thru the contact (M) to the lights or power appliance in use. A small portion is shunted thru the Contact (P) and thru the battery resistance coil (upper of the long coils on back of Switch Box) for keeping the battery charged. As the armature of coil (L) closes it operates a tripper which separates the Auxiliary Governor Switch Contacts (S) preventing further cranking in case the Governor Switch contact points again close while motor is running.

If the plant is installed under reasonably favorable conditions there should be no trouble experienced with the Automatic Switch. If for any reason the automatic feature fails to function, the switch box cover may be removed and the various contact points cleaned with a small file for this purpose. Do not alter the adjustment on any of the contacts, springs or switches unless absolutely sure the trouble is definitely located and then be sure they are adjusted as showin in Figures 33 and 34.

MARINE INSTALLATION, KOHLER AUTOMATIC POWER AND LIGHT UNIT.

On vessels under the jurisdiction of the Steamboat Inspection Service, the installation of the engines and their gasoline fuel containers, used for auxiliary light or wireless must be in accordance with the provisions of the General Rules & Regulations and meet the approval of the U. S. Local Inspectors.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

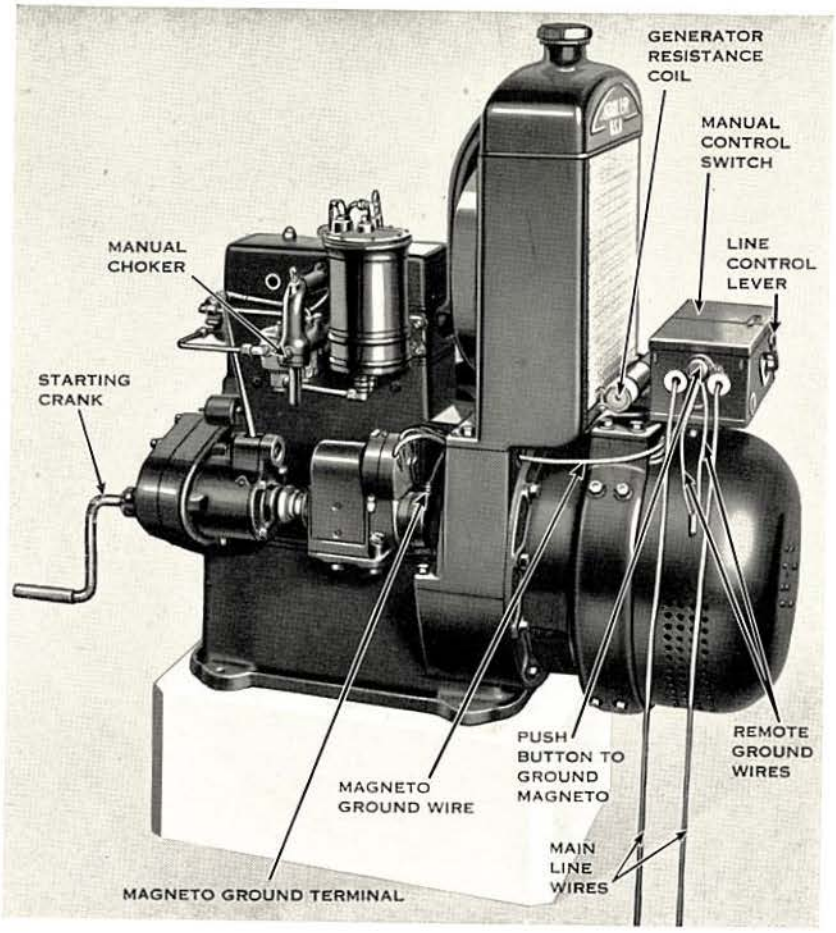



Figure 36
Manual Unit (Model "E") showing
Main Line Connections

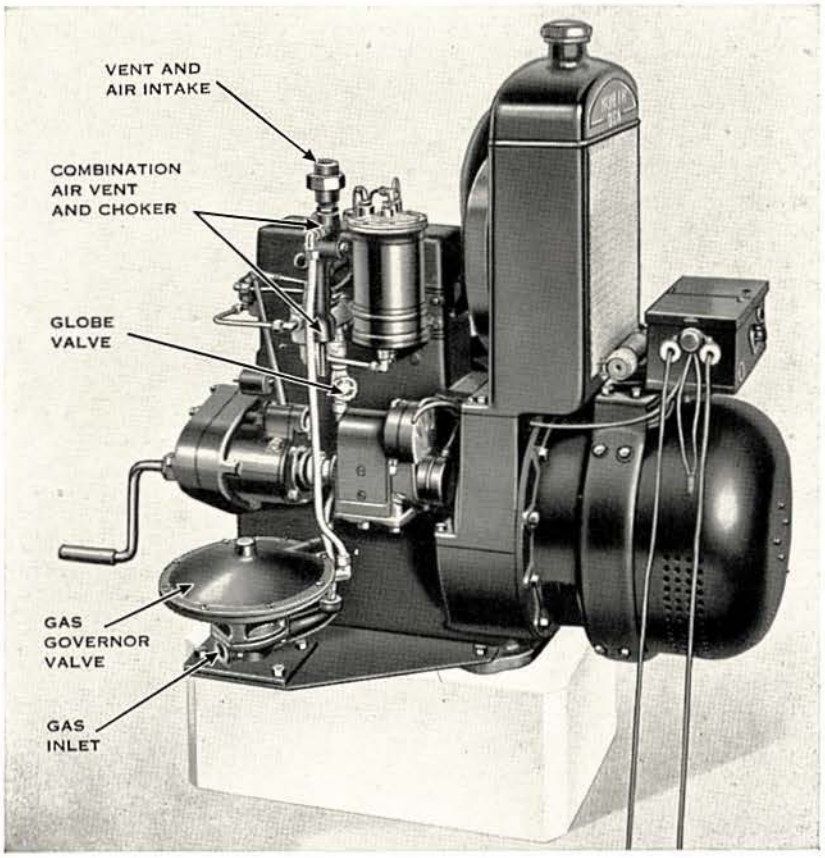



Figure 37
Manual Gas Unit (Model "EA") showing
Main Line Connections

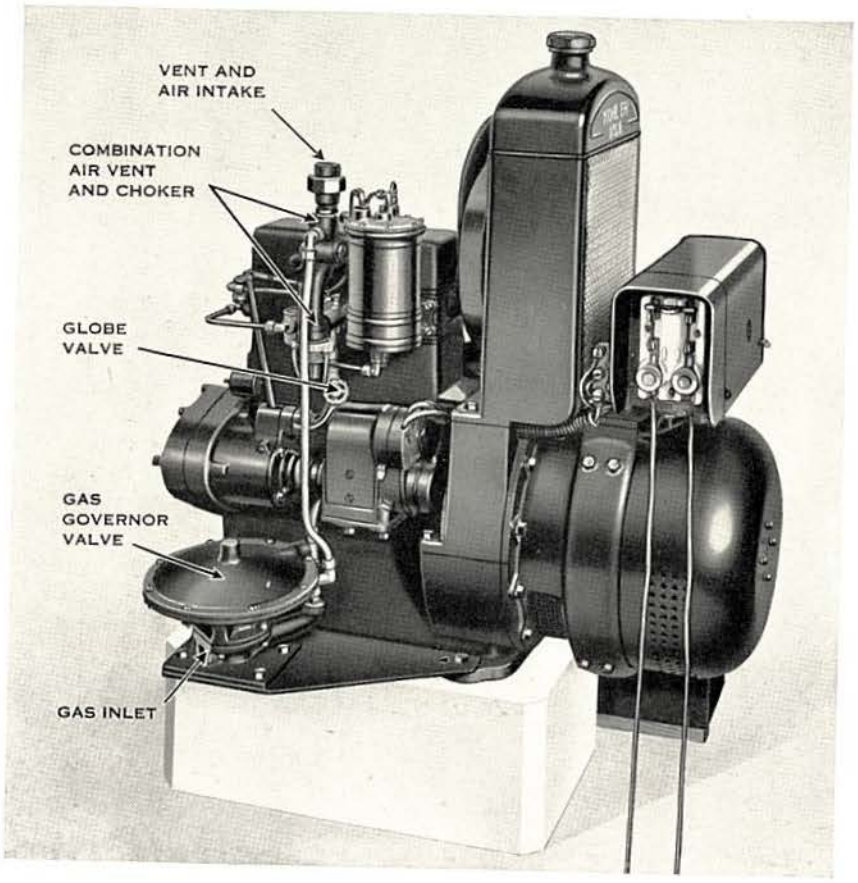
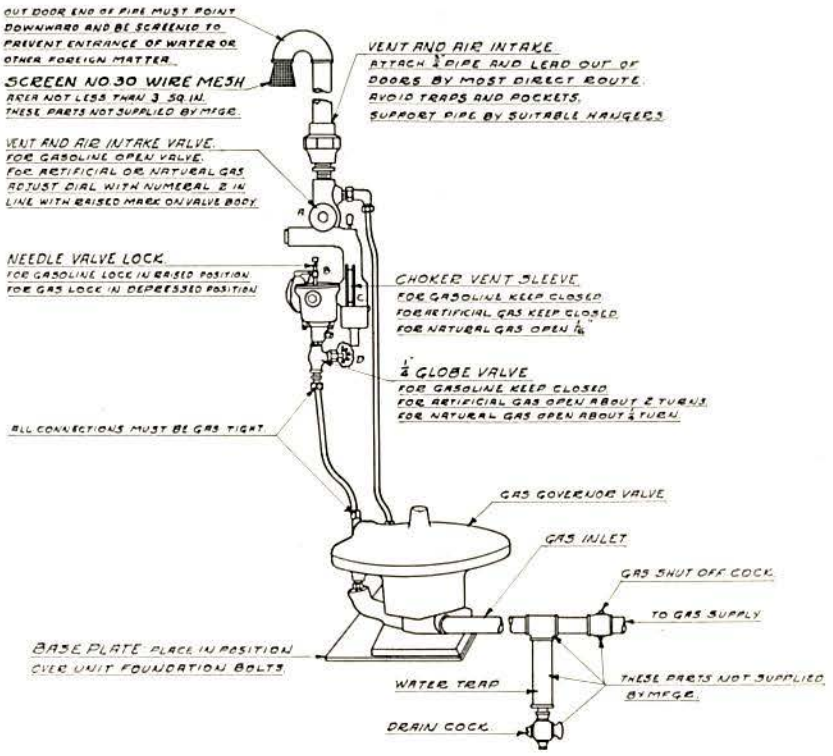



Figure 38
Automatic Gas Unit (Model "DA") showing
Main Line Connections

COMBINATION GASOLINE AND GAS EQUIPTMENT
FOR KOHLER AUTOMATIC POWER & LIGHT UNITS.




DIRECTIONS FOR ADJUSTMENT OF A-B-C-& D ARE FOR AVERAGE CONDITION. ADJUSTMENT WILL VARY SLIGHTLY DEPENDING ON QUALITY OF FUEL USED.
MINIMUM GAS PRESSURE 3 OZ. MAXIMUM GAS PRESSURE 24 OZ.
GAS MUST BE REASONABLY FREE FROM WATER. TO OBTAIN SATISFACTORY RESULTS TRAP AND DRAIN AS INDICATED SHOULD BE INSTALLED.
TO START MANUALLY. REMOVE MAGNETO GROUND WIRE. RAISE CHOKER AND PLACE THUMB OVER CHOKER VENT 'C'. SPIN ENGINE RAPIDLY WITH HAND CRANK TILL DIAPHRAM LIFTS AND GAS FLOWS TO CARBURETOR.

Figure 39
Sketch of Gas Governor Assembly

INSTALLATION OF LIGHTING UNIT.

We recommend the unit be located on the upper deck, preferably in the wireless room where in case of disaster its use will be available for light or power should the engine room be flooded. The starting switch should be in the pilot house under the control of the bridge officer who can start the plant quickly in case of necessity. Unit must be set parallel with ship's keel. If located above sleeping quarters install unit on a wood foundation about 9" high, built up of layers of 2" planks securely bolted to the deck by separate bolts from those that hold the unit in place. This willdeaden any noise the unit may make. It should be at least 18" from the nearest wall to permit free access all around the plant for making necessary adjustments. It must be protected from the elements and for satisfactory service and efficient operation should not be subjected to temperatures below 40 degrees Fahrenheit.

Use only clean, fresh (not salt) water in radiator and renew frequently if temperature in room rises above 100 degrees Fahrenheit.

INSTALLATION OF FUEL TANK

A special fuel tank constructed to meet the requirements of the General Rules & Regulations may be obtained for marine installations. The tank is made of 1/4" stell, galvanized inside and outside, tested to stand 300 pound pressure, and is 16" in diameter 40" long, and has a cubical capacity of 48 gallons. The filler pipe is so located that not more than 40 gallons of gasoline, can be put in tank at any one time. Openings for supply line, overflow line and vent pipe are provided. The supply line is screened on the lower end.

The tank must be installed on the upper deck, securely fastened in its saddles and so located that there willbe a free circulation of air all around it. The vent pipe must have no angles greater than 45 degrees and must extend to the atmosphere not less than 10 feet above the highest house, and its upper end must be provided with a "U" bend screened with wire gauze.

The bottom of the tank must not be more than six feet below the top of the vacuum tank or there will not be sufficient suction to draw up the fuel. As the overflow from the carburetor is a gravity drain only, the top of the tank must be below the top of the carburetor.

MANUAL TYPE UNIT.
(MODEL E)

DESCRIPTION

The Manual type Unit is of the same capacity 1500 watts, (Fig. 36) and the same voltage, 110 volts, and has embodied almost all the features of the automatic type except the automatic switch and starting battery.

WHEN WRITING GIVE MODELAND SERIAL NUMBER OF YOUR UNIT.

MANUAL TYPE SWITCH

The main line switch and fuse panel is encased in a pressed steel box. A control lever extends outward for opening or closing the knife switch without opening the box. A small push button is also provided on the end of the switch box for stopping the Unit. There are two extra wires leading from this button which can be lead to any remote place, away from the installation for stopping without necessitating a trip to the Unit. See Fig. 36.

STARTING UNIT.

When starting the Unit crank the gas engine by means of the hand crank and raise the choker knob shown in (See Fig. 36) until the Unit has commenced to fire, then release the choker and allow the Unit to function.

STOPPING A MANUAL TYPE UNIT.

Merely push in button (see Fig. 36) on switch or remote control button located away from the installation, this will ground the magneto and Unit will stop. Keep the button pressed IN until the Plant is actually stopped. If the button is released before the Plant is stopped it will start up again.

FAILURE TO GENERATE

If when first starting, Unit, it fails to generate current at a normal speed of about 1000 R.P.M. the cause will most likely be to loss of residual magnetism due to shocks and jars sustained during shipment. To restore the residual magnetism it is only necessary to form a momentary short circuit between one of the positive and one of the negative brushes on the machine. This can be done by holding a piece of wire so the ends of same will each touch a positive and negative brush, when the Unit is operating. The wire must be instantly removed as soon as current is generated.

The residual magnetism can also be restored by connecting the terminals of any low voltage battery between the positive and negative terminals. The battery connection must be removed immediately as soon as the plant generates.

GAS BURNING UNITS MODELS
MODELS DA & EA

Model DA and EA Units are equipped with the necessary attachments for using either gasoline, artifical or natural gas. If it is desired to equip a D or E gasoline Unit to operate on gas, additional equipment will be needed.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

MANNER OF SHIPPING

When ordering a Gas valve attachment for a gasoline Kohler Power and Light Unit the shipment will consistof the following parts disassembled for the purpose of convenience in packing.

Cylinder Head Cover
Carburetor for gasoline, natural or artifical gas.
Choker, combination vent and air intake.
Gas governor valve including plate for bolting down.
Copper connections.

HOW TO INSTALL

To install a gas governor to the Kohler Unit it will be necessary to remove the old choker, carburetor and cylinder head cover. These parts cannot be used with this attachment.

Then place the new cylinder head cover, carburetor and choker in the same position from which the others were removed.

Remove the nuts holding Unit to concrete block and place base plate in position over holding down bolts after which tighten nuts securely.

Insert copper tubing connections in their proper positions, and tighten all nuts making sure all connections are tight.

After these instructions have been carried out the attachment is ready for adjustment. See Fig. 39.

DESCRIPTION OF GAS GOVERNOR

Carburetor is provided with a needle valve lock, the position of which determines the kind of fuel to be used.

Choker is a combination vent and air intake so designed that the proper mixture can be attained for the most efficient operation of the Unit.

Gas governor valve is a regulator determining the amount of gas (artificial or natural) flowing to the carburetor. This control is actuated by the amount of vacuum produced by the Unit.

PARTS TO BE PROVIDED BY CONSUMER

Below the gas governor valve is a 3/4" pipe thread opening to which the gas supply line is attached. As most gas carries with it a certain amount of moisture, a trap of not less than 3 cubic inches, made of 3/4" tee and nipple with a pet cock for draining purposes should be put as close to the intake opening as possible. A shut off cock should be put in the gas supply line close to the trap. (These parts not supplied by manufacturer.)

Above the choker is a 3/4" pipe union; to this opening a 3/4" vent pipe should be connected and led out of doors by the most direct route. The outer end of this vent pipe must look downward to prevent water entering. As there is a strong suction thru this pipe its outer end should be protected by a screen of ample area to prevent foreign matter being drawn in. There should be no pockets or traps in this pipe and it must be well supported with hangers to prevent undue strain on cylinder head cover. (Piping, fittings, and screen not supplied by manufacturer.

ADJUSTMENTS FOR DIFFERENT FUELS.

Proper adjustment of the gas governor is essential before efficient operation of the unit is attained. This adjustment will vary somewhat, depending on the quality of the gas in the locality in which the unit is installed.

The following suggestions provide a basis on which to work while adjusting the gas governor valve. The letters appearing in the following instructions refer to Fig. 39.

GASOLINE ADJUSTMENTS

(1) The 1/2" vent and air intake valve "A" must be open so that the Numeral "0" will be in line with the raised mark on valve body.
(2) Carburetor needle valve lock "B" should be in raised position.
(3) Choker vent sleeve "E" should be closed.
(4) The 1/4" globe valve "D" should be closed.

ARTIFICAL GAS ADJUSTMENT.

(1) The 1/2" vent and air intake valve (A) should be turned until numeral 2 on dial is in line with raised mark on valve body.
(2) Carburetor needle valve lock (B) should be in depressed position.
(3) Choker air vent sleeve (C) should be closed.
(4) The 1/4" globe valve (D) should be open about two turns.

NATURAL GAS ADJUSTMENTS

(1) The 1/2" vent and air intake valve (A) should be turned until the numeral 2 on dial is in line with raised mark on valve body.
(2) Carburetor needle valve lock (B) should be in a depressed position.
(3) Choker air vent sleeve (C) should be open about 1/16 of an inch.
(4) The 1/4" Globe valve (D) should be open about 1/4 turn.

Each of these regulating devices, A, B, C and D. must be adjusted to secure the best results when starting from either a cold or hot condition and to secure the maximum power from the unit.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

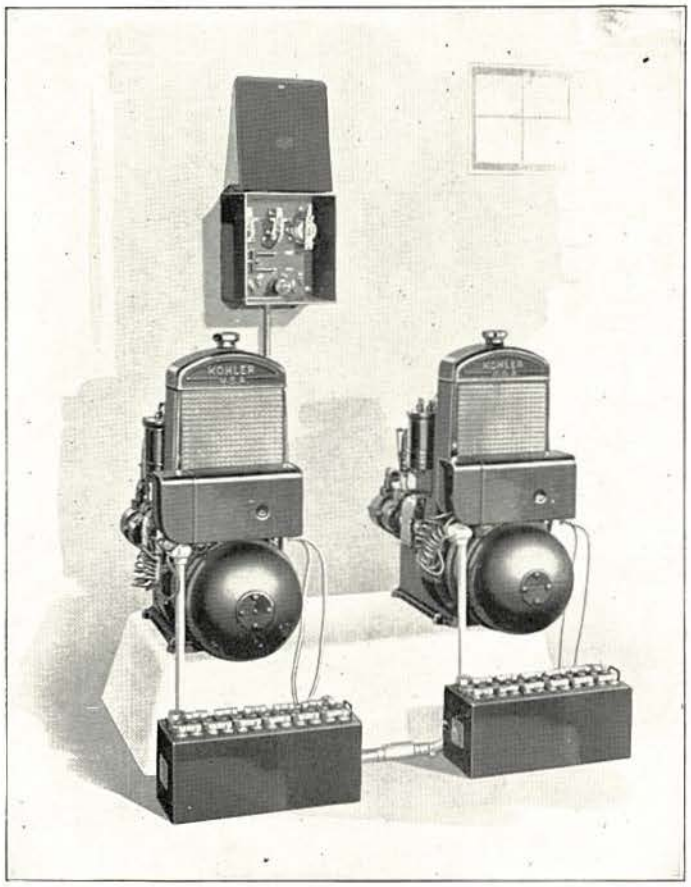



Figure 40
Units in Multiple

## MANUAL CONTROL GAS UNITS

The operation and adjustments of gas governor used on our manual type unit is practically the same as the automatic except that it is necessary to crank the unit by hand.

When cranking the unit manually, remove magneto ground wire, raise choker and place thumb over choker vent, (C). Then spin engine rapidly with hand crank until diaphram in governor valve lifts and gas flows to carburetor.

## IMPURITIES IN GAS (NATURAL AND ARTIFICAL)

In some localities natural or artifical gas contains a large percentage of tar or sulpher which is very detrimental to the successful operation of the unit. The mechanism of the gas governor will in time become inoperative by being coated with a gummy substance which will interfer with the proper regulation of the fuel. When tar is noticed in the fuel it is advisable to consult some local gas manufacturing plant regarding some method of removing these impurities.

## MULTIPLE SWITCH

The Multiple Switch is a device that automatically governs the starting and stopping of Automatic Controlled Units; and is installed when two, three or four Automatic Units are connected for parallel operation on the same line. See Fig. 40.

When one or more units are installed for multiple operation the first unit is started automatically by turning on a light or power appliance. When the load on the first unit increases to about 14 amperes, and induction coil mounted on the multiple switch is sufficiently energized to attract its armature, the closing of this contact causes the second unit to automatically start up and assume its share of the load. The third and fourth units are started in the same manner, the multiple switch functioning and automatically starting additional units as the load increases until all units are in operation, each of which will carry its proportional share of the load.

As the load decreases the Multiple Switch functions in the same manner stopping the units automatically when their services are no longer required to supply the amount of current used, the first unit stopping when the last light or appliance on the line is turned off.

## OPERATION OF AUTOMATIC CONTROLLED UNITS IN MULTIPLE

By means of the Multiple Switch above described two, three or four units may be installed for parallel operation to work in unison on the same circuit. The capacity of one unit is 1500 watts and the total capacity willbe 3,000, 4,500, or 6,000 watts depending upon the number of units installed. Each unit is provided with a starting battery and the starting and stopping of the units is cared for automatically according to the amount of load carried on the line.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

OPERATION OF MANUAL CONTROLLED UNITS IN MULTIPLE.

Any number of Manual Controlled Units may be connected in parallel for operation in unison on the same line. Manual Controlled Units are not started and stopped automatically, and Multiple Automatic Controlled Switches cannot be used. Where two or more Manual Units are to be operated on the same line they must be connected with an equalizer wire in which is a single throw knife switch. Each unit must be started manually as required and the knife switch in equalizer line closed as soon as the units are thrown on the line. The units must be stopped manually.

Full instructions for the installation and connecting up of two or more units in parallel with Automatic or Manual Control will be sent on request.

## DIAGNOSIS OF TROUBLE AND THEIR REMEDIES KOHLER POWER AND LIGHT UNITS. MODEL D & E.

Kohler Power & Light Units are correctly designed and constructed of the best material by skilled mechanics under the supervision of engineers who have had years of experience in the construction of gasoline motors and electrical machinery. Each unit is thoroly tested before shipment from factory.

If installed under proper operating conditions and given the care which all machinery of this kind must have, they will give long, dependable and economical service to their owners.

If, however, the unit is not properly installed under conditions that are reasonably favorable for its operation, or does not receive proper care, satisfactory results cannot be expected, and sooner or later trouble will be experienced.

If conditions are not right and the unit is not functioning as it should, certain symptoms willappear. In the following pages are given various symptoms and the cause that is responsible for it and the remedy to apply.

Do Not Proceed Blindly. If the unit does not operate as it should, note carefully how it acts. Turn to the symptom exhibited, find the cause and apply the correct remedy. Remember that dirt in supply line strainers or carburetor jets, water in the gasoline, fouled spark plugs or choked exhaust pipe or muffler is responsible for most of the difficulty experienced with gasoline engines.

I UNIT FAILS TO CRANK AUTOMATICALLY

1. Safety Switch disengaged, indicated by the fact that the black button on front of switch box projects outward about 1/2 inch. The safety switch protects the starting battery from exhaustion in case the engine fails to start. Failure of engine to start may be due to a number of causes, among which are: (1) lack of gasoline; (2) water in gasoline; (3) fouled spark plugs; (4) weak spark; (5) magneto wires improperly connected to spark plugs; (6) improper valve adjustment.

   If engine fails to start in about one minute, the safety switch will break the cranking circuit. When this happens, first ascertain the cause for failure to start. When the matter has been remedied, then push button in before attempting to start. See Fig. 28.

   Safety Switch may disengage if bearings are too tight or if lubricating oil is congealed, putting an unusual drain on the cranking circuit.

2. Weak Battery. Starting battery under normal conditions should be kept charged by the generator, a portion of its current being shunted into battery. It should register 1.280 when fully charged. If gravity falls below 1.200, battery is discharged and needs attention.

3. Defective lamp or appliance. In case plant does not start automatically when lamp or appliance is turned on, test out with others to make sure that the fault does not lie with the lamp or appliance.

4. Corroded or loose battery connections.

5. Open circuit in wiring system. Examine for loose connections, broken wires, open switch and burnt out fuses. If fuses are burnt out, ascertain cause.

6. Governor Switch out of order. (see Figure 23) Governor Switch contact points should be together when the plant is idle, so the battery circuit can flow across the contact points and thus crank the plant. The following causes may stop the flow of the current and prevent closing of battery circuit: (1) dirty contact points; (2) bent or weak governor switch springs; (3) loose governor contact plug; (4) broken switch body; (5) stop screw for governor arm advanced too far; (6) broken or improperly connected governor switch wires. A common cause of failure of governor switch to function is that stop screw is in too far so that switch points cannot close.

7. Generator not functioning properly. The following are causes for non-functioning of the generator: (1) dirty commutator; (2) worn, broken or sticking brushes; (3) broken brush springs; (4) broken or loose wires; (5) ground, short circuit or open circuit in armature. Grounds and short circuits in the armature are caused by rough handling, water or oil soaking insulation, defective insulation in coils, crushed lead wire or foreign substances lodging between commutator bars. An open circuit may be caused by wires being burned due to short circuit, leads not soldered properly or solder broken away.

8. Automatic Switch In-operative. The following might cause failure of switch to operate: (1) relay coil burnt out. This coil lifts Armature "A" when plant is started; (2) the battery charging coil burnt out; (3) contact Point "D" in switch making poor contact with armature "A"; (4) contact points "K" and "S" have poor connection; (5) magneto ground plate inoperative, due to binding, dirt, foreign substances or from being bent. (See Figures 33 and 34 illustrating) (6) open circuit in 3rd circuit.

9. Engine does not turn freely, due to: (1) pistons corroded and seized; (2) water in cylinder; (3) crankshaft out of alignment; (4) foreign matter between armature and generator; (5) tight bearings; (6) congealed lubricating oil.

II. MOTOR CRANKS BUT FAILS TO START

1. Lack of fuel. Failure of plant to receive a supply of fuel may result from the following causes: (1) water in gasoline; (2) no gasoline in the supply tank; (3) leaky or punctured supply tank; (4) clogged supply line, due to dirty strainers in the supply tank, carouretor, vacuum tank or at cylinder head; (5) air leaks in supply line connection. (6) leak in bottom of inner shell of vacuum tank caused by corrosion. If main fuel tank is not properly vented, --fuel will not be drawn freely.

2. Clogged Carburetor: (1) sticking of needle valve in the carburetor; (2) excessive choking due to sticking, rusted or bent valve or stem; (3) clogged main or compensating jets due to foreign substance in fuel. Avoid use of varnish or paint cans as fuel containers.

3. Vacuum Tank In-Operative, due; (1) dirty or bent valve or stem; (2) jammed or leaky vacuum tank float; (3) clogged suction or air vent pipes; (4) flapper valve or air valve not seating; (5) leak in bottom of inner shell of vacuum tank caused by corrosion.

4. Defective magneto due to: (1) over-oiling, which causes dirty distributor brushes; (2) dirty rotating disc; (3) dirty collector ring; (4) worn or improperly adjusted breaker points; (5) loose or defective cables; (6) short circuit between brushes caused by crack in distributor plate.

5. Defective, cracked or fouled spark plugs. Points not adjusted to 1/32" gap.

6. Excessive choking due to (1) bent or unadjusted choker valve stem; (2) body of choker out of alignment; (3) screw in hot air manifold not removed in hot weather, (4) choker manifold out of alignment.

7. Improper timing. Instructions are given elsewhere for timing. Check motor in accordance with directions given.

8. Spark plug wires not connected to magnetc cables properly. Motor fires 1, 3, 4, 2.

9. Improper valve adjustment due to (1) worn or bent push rods (2) worn or broken rocker arm adjusting screws; (3) broken rocker arm support bracket; (4) sticky rocker arms; (5) loose cylinder head. Check valve clearance in accordance with instructions given elsewhere in book.

10. Motor too cold, combined with use of a low grade of fuel.

11. Water in cylinders due to (1) leaky cylinder head gasket; (2) cracked cylinder block or head; (3) condensation from a long exhaust line not fitted with a water drain.

III. MOTOR CRANKS SLOWLY UNDER BATTERY CURRENT

This may be due to the following causes: (1) weak battery; (2) use of too heavy motor oil; (3) partial ground in the armature; (4) open or short circuit in armature or field coil; (5) short circuit in third circuit of automatic switch.

IV. MOTOR STARTS BUT MISFIRES.

Caused by the following: (1) dirty, defective or unadjusted spark plugs; (2) defective or crossed magneto cables (firing order is 1-3-4-2); (3) defective magneto; (4) improper timing - (check timing in accordance with instructions.) (5) poor compression caused by scored cylinders, leaky valves, worn or defective piston rings, leaky spark plug gaskets, defective cylinder head. When replacing cylinder gasket, shellac both sides before replacing, but be careful not to use too much shellac, especially around the opening for the cylinders. (6) tappets out of adjustment, giving too much or too little clearance for the valves; (7) weak or broken valve springs; (8) bent, worn or sticking valve stems; (9) air leak between intake manifold and carburetor; (10) water in gasoline; (11) excessive lubrication; (12) mixture too lean, (main compensating jet or spray nozzle should be set in center of venturi tube); (13) choker valve caught up, causing too rich mixture; (14) vacuum float inoperative; (15) water in cylinder.

V MOTOR ALTERNATELY CRANKS AND STARTS

Caused by (1) small arm marked "Battery Charging Contact" (P) in automatic switch not making proper contact. This arm should make contact 1/8" prior to time contact marked Generator Relay Switch (M)close See Fig. 34. (2) air vent in vacuum tank obstructed.

VI MOTOR BACKFIRES THROUGH CARBURETOR

The following are some causes for backfiring: (1) cold motor; (2) mixture too lean due to clogging or improper setting of main compensating jet; (3) poor grade of gasoline; (4) air leak between the carburetor and cylinder head; (5) dirty gasoline; (6) leaky or improperly adjusted intake valves due to bent or worn push rods, broken rocker arm adjusting screws, bent or defective valve stems, excessive carbon deposits on valve seat or stem; (7) improper timing (see article on timing); (8) water in gasoline; (9) choker not functioning properly; (10) obstruction in exhaust line due to collection of carbon or foreign matters, frozen or condensed water, or exhausting of gas into closed area; (11) spray nozzle not in center of venturi tube of carburetor.

VII MOTOR KICKS BACK WHEN BEING CRANKED BY HAND

This condition may be caused by the following: (1) magneto advanced too far; (2) improper meshing of crankshaft gears and marking within the letters "O" and "S" which should coincide with the crank and cam gears; (3) water in cylinder.

VIII ENGINE KNOCKS

Knocking in engine may be due to the following causes: (1) excessive carbon in cylinders from using poor grade of fuel, obstruction in exhaust line, leaky piston rings or defective spark plugs; (2) magneto incorrectly timed; (3) connecting rod or main bearing burned or worn; (4) loose wrist pin or bushing; (5) loose piston; (6) loose generator ball bearing due to lack of lubrication, wear or improper alignment; (7) loose gears on crankshaft, camshaft or magneto drive shaft; (8) loose magneto coupling; (9) heavy overload; (10) weak spring in oil pump; (11) weak valve springs.

IX MOTOR LACK POWER

The following may cause this condition: (1) mixture too rich, due to obstructions of needle valve, leaky float, or bent or worn needle valve or axle; (2) mixture too lean, due to partial obstruction in gas supply; (3) low grade or dirty fuel; (4) cold motor;

(5) poor compression; (6) excessive carbon; (7) improper valve adjustment; (8) choked exhaust pipe or muffler; (9) defective or broken spark plugs; (10) defective magneto; (11) weak or broken valve springs; (12) bent or sticking valve stem or rocker arm; (13) lack of lubrication because of no oil, oil lines clogged or pump not operating; (14) tight bearings; (15) carburetor lever adjusted so as to run unit slowly.

X ENGINE OPERATES BUT SPEEDS UP AND SLOWS DOWN ALTERNATELY

This may be due to the following causes: (1) partial obstruction in the gas supply; (2) cold motor; (3) leak between carburetor and cylinder head; (4) punctured vacuum tank float; (5) governor mechanism sticking or out of line; (6) clogged vacuum tank air vent.

XI UNIT RUNS BUT FAILS TO GENERATE

Test for the following: (1) poor brush contacts on the commutator due to dirty commutator, sticking or worn brushes or high mica between bars; (2) open circuit in the internal wiring system; (3) open circuit in field coils; (4) open circuit in automatic switch in coil "L", (See Figures 33 and 34); (5) open circuit in automatic switch at contact point "M"; (6) shorted commutator bars due to material lodged in slots.

XII LIGHTS FLICKER AT NORMAL SPEED

The following are causes for this condition: (1) dirty or rough commutator; (2) sticking or tight brushes; (3) high mica; (4) faulty ignition due to defective spark plugs or defective magneto; (5) high or low commutator bar; (6) hole in oil fuel intake on top of vacuum tank too large.

XIII MOTOR FAILS TO STOP

When all appliances are turned off and if you have checked carefully to make sure that no appliance is still in use, look for the following: (1) magneto ground brush, corroded or dirty or not making contact; (2) spring in ground brush weak; (3) ground wire leading from automatic switch to magneto broken or disconnected; (4) contact points "C" of automatic switch (see Figure 33) not making contact with magneto ground plate; (5) magneto ground wire disconnected or broken; (6) armature "A" does not drop when last lamp or appliance is turned off due to the fact that the hinged pin is bent or residual magnetism remaining in the coil holds up the plate; (7) contact "P" is not complete due to being burnt off or bent; (8) short circuit in the external wiring system due to worn insulation.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

XIV LOW VOLTAGE

(1) Cold motor; (2) speed too low, due to carburetor operating lever not being adjusted properly; (3) excessive back pressure in exhaust line due to muffler being clogged with carbon; (4) binding or sticking condition in governor mechanism preventing throttle valve from moving freely; (5) overload, short circuit or ground.

XV MOTOR RUNS TOO FAST

(1) A sticky or binding condition of throttle valve mechanism preventing the governor from giving accurate control. (2) carburetor throttle lever not adjusted properly.

XVI MOTOR CONTINUES TO CRANK WITH SERVICE SWITCH OUT

Points "C" and "D" in the automatic switch, making contact with armature "A" cause the unit to crank until the safety switch disengages. (See Figures 33 and 34).

XVII ENGINE OVERHEATS

This may be caused by the following: (1) lack of water in radiator; (2) poor circulation in radiator due to deposit of mineral scale. (This scale may be removed from radiator by use of a solution of sal soda and water and flushing). (3) fan belt slipping and fan blades bent; (4) excessive carbon causing preignition; (5) improper timing; (6) lack of lubrication; (7) air passages clogged with dirt and dust.

XVIII PISTONS PUMPING OIL

This may be due to (1) leaky valves; (2) oil level too high; (3) piston rings sticky, broken, or ineffective due to loss of tension; (4) cylinder walls scored or worn; (5) rings fit too loosely in piston; (6) oil dip of connecting rods too great; (7) poor quality of oil or dilution of oil by fuel; (8) defective ignition either spark plugs or magneto.

XIX MOTOR RUNS AT SLOW SPEED

This condition may be due to: (1) misadjustment of throttle arm to carburetor feeding insufficient gas; (2) poor compression; (3) retarded spark; (4) defective ignition; (5) obstruction in gas supply.

WHEN WRITING GIVE MODEL AND SERIAL NUMBER OF YOUR UNIT.

# I N D E X

# I N D E X (Cont'd).