Instruction Manual for...

SOUTHERN CROSS

A.C. GENERATING SET

Fig. 3124, 15 K.W. (18.75 K.V.A. at .8 P.F.)

240/415 Volt.

SOUTHERN CROSS

15 K.W. (18.75 K.V.A. at .8 P.F.) 240/415 VOLT

A.C. GENERATING SETS

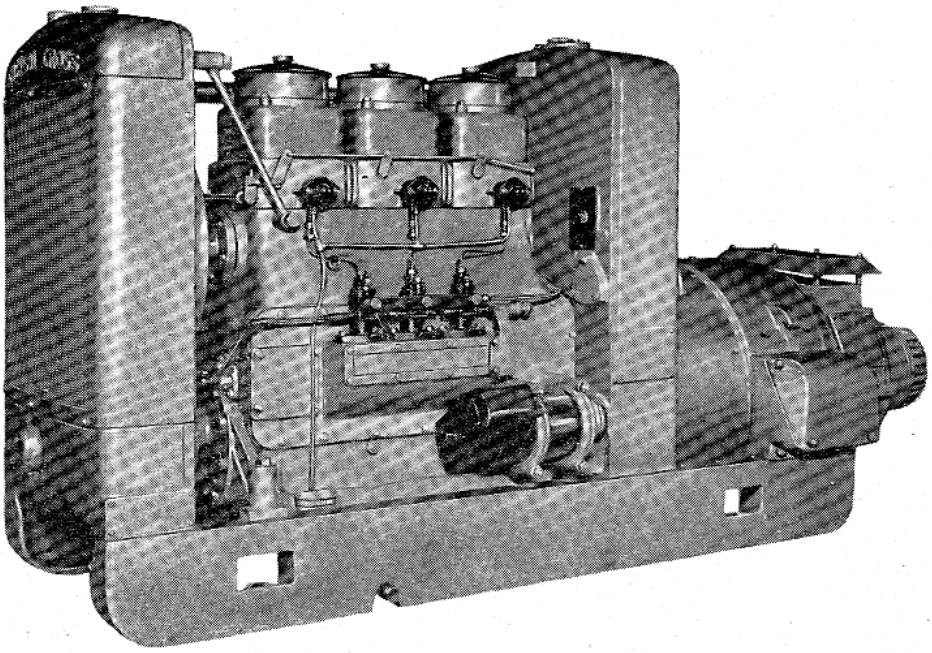


Fig. 3124—15 K.W. (18.75 K.V.A. at .8 P.F.) 240/415 Volt A.C. Generating Set (Illustrated with Electric Starting).

Installation

Foundation

In order to obtain the best results from this unit it must be set up on an absolutely firm foundation. The most satisfactory foundation is a good block of concrete. The size of the base and shape of the mould is shown on pages 3 and 4.

To Make Concrete Base

1. Construct a wooden mould as shown in the illustration, "Mould for Concrete Base" on Page 4.
2. Nail two cross boards on the ends of the mould so that it can be supported over the hole in the ground.
3. Take the special foundation hole cross boards with the square wooden blocks nailed on to them. Open out the cardboard cartons and tack the cartons to the square blocks. Stuff the cartons with paper to stop them collapsing when the concrete is put in the mould. These cartons make square holes in the concrete to permit grouting the foundation bolts.
4. Having decided where the set is to be installed, sink a hole in the ground, 1 foot to 2 feet deep and to the sizes shown on the General Arrangement illustration. The depth of the hole depends on the type of soil but always make the block larger for preference.
5. Place the mould over the hole and nail the special foundation hole cross boards on top of it in the positions shown on the mould illustration. Then adjust the setting of the mould so the top is level in both directions.
6. Mix a batch of concrete using 2 parts sand, 4 parts sharp stone or rubble, and 1 part cement. See that the stone and sand are clean and do not contain any clay or dirt. If they do, wash carefully before mixing. A block 2 feet deep will require approximately 1 yard of sand, 2¼ yards of metal, and 14 bags of cement.
7. Fill the hole to ground level and the mould up to the top and at the same time, place some old bolts or iron pipe in to act as reinforcement.
8. Allow concrete to set for a day.
9. Next day remove the cross boards which hold the cartons in position and **dig the cartons out.**
10. Place the foundation bolts, with nuts removed, in the holes in the block.
11. Lift the set on to the block by means of two slings through the holes in the side rails. Use bags to prevent the slings damaging the paint.
12. As the set is lowered on to the block, guide the foundation bolts into the holes in the side rails and when the set is resting on the block, screw the nuts on a full nut.
13. Insert wooden wedges under the side rails and raise them slightly off the block and at the same time, level the set in both directions.
14. Using a mixture of two parts clean sand and one of cement, grout in the foundation bolts. When the holes are full, work the grouting under the side rails so they will sit on a firm, level foundation.
15. Next day remove the wedges, tighten the foundation bolts, and with the same mixture, clean up the surface of the block.
16. On the following day the engine may be started. It is essential that the block be allowed to set for about four days before the engine is run.

Speed

The correct speed for the Generator is 1,000 R.P.M. The set is adjusted to this speed before it is supplied.

Rating

The full load rating of the Fig 3124 A.C. Generating Set is 15 K.W. at sea level, and 62 degrees Fahrenheit for a 12-hour day. A reduction in output of 4 per cent. must be made for every 1,000 feet above 250 feet and a 2 per cent. reduction for every 10 degrees above 62 degrees F. Where the set is required to run for more than 12 hours per day then the output must be reduced by a further 10 per cent.

The set will supply full output voltage on loads from unity to .8 Power Factor.

When fully loaded at unity Power Factor the Ammeter will read 20.8 Amperes and at .8 Power Factor the Ammeter will read 26 Amperes.

Mark CT-C Governor Control

When the set is supplied from the Factory the governor control is set for 50 cycles per second.

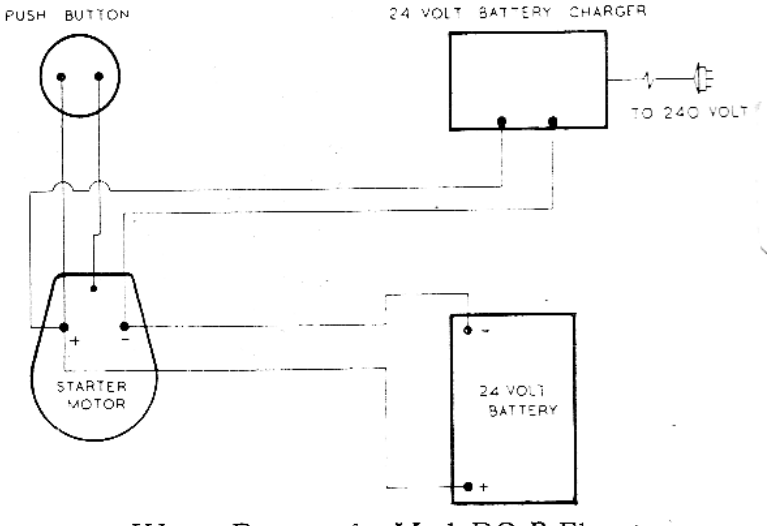
Where sets are to run in parallel, **fine adjustment** of up to about 2 cycles per second faster or slower can be obtained using the governor control. If it is ever necessary to make bigger adjustments the speed of the engine should be altered as set out in section "Running Instructions" in the Engine Instruction Manual.

Mark DO-B Electric Starting Equipment (if fitted)

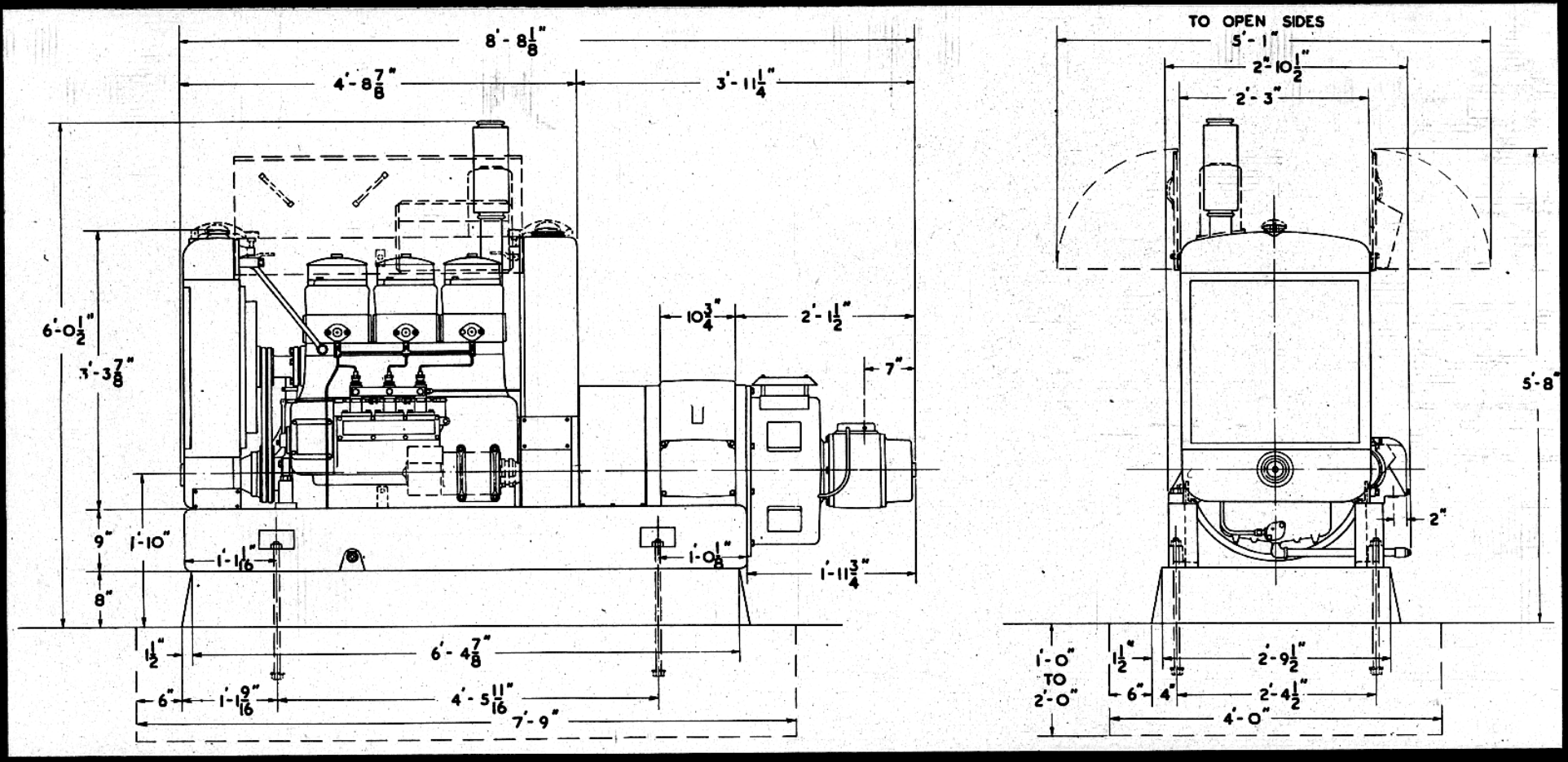
On a set which is fitted with Electric Starting, the Battery Charger and Battery have to be connected to the set as shown in the illustration, "Wiring Diagram for Mark DO-B Electric Starting Equipment." Use 2/7/.029 Nylex Cable between the Starter Motor and Battery Charger and 360/.012 Dynamo Flexible Cable between the Starter Motor and Battery.

Sit the four batteries in a convenient position as close as possible to the Starter Motor and using the connection provided, connect them in series, i.e. negative terminal of one to the positive terminal of the next.

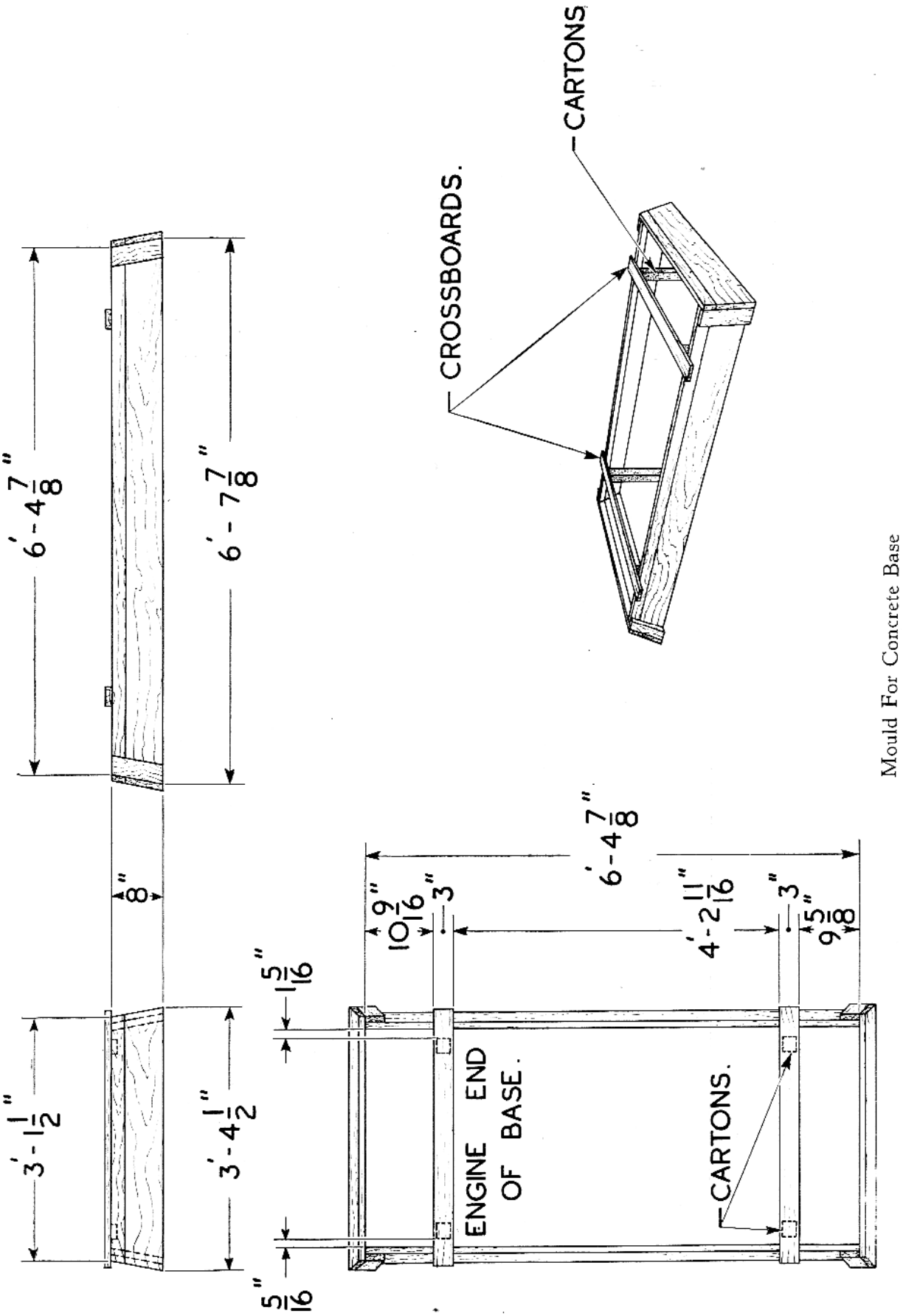
The Starter Motor requires regular lubricating as shown in the Engine Instruction Manual under "Running Maintenance." Also, the level of the electrolyte in the batteries should be checked regularly and topped up, if necessary, using pure distilled water.



Wiring Diagram for Mark DO-B Electric Starting Equipment



General Arrangement of Fig. 3124—15 K.W. (18.75 K.V.A. at .8 P.F.) 240/415 Volt A.C. Generating Set



Mould For Concrete Base

Mark CV-F A.C. Voltage Regulator

Specification

The Mark CV-F A.C. Voltage Regulator is designed for use only with the Southern Cross Mark AT-U A.C. Generator. It includes both a Manual and an Automatic Control, the desired position being selected by a switch.

On Automatic the regulator is designed to control the voltage of the A.C. Generator from no load to full load at between unity and .8 P.F. lagging with reasonably balanced loadings per phase. The regulation of the regulator from minimum to maximum field current under these conditions will not exceed 4 per cent. The regulator has an inverse temperature characteristic, i.e., when cold the voltage is lower than when hot by about 5 per cent. With reasonable ventilation the time to reach operating temperature is 10 to 15 minutes.

The regulator is of the vibrating contact type and includes a "Points Reversing Switch" on the front panel which, if operated once a day will considerably lengthen the life of the contacts.

Mounting

The regulator should be mounted on the switchboard where it will be free from vibration. The mounting of the switchboard may require special attention to reduce vibration. The mounting of the regulator can be made as follows:

(a) Entirely in front of the switchboard panel.
or—
(b) Almost flush with the panel.

The size and position of the mounting holes are shown in the diagram on Page 6.

Provision is made for §in. conduit to be run to the regulator if necessary.

Mounting Method (a)

1. Drill the four holes for the mounting studs in the switchboard panel.
2. Bolt the regulator in place on the switchboard.
3. Undo the four cap nuts holding the regulator panel in place and remove it.
4. Run §in. conduit to the hole in the perforated sheet cover of the regulator from the back of the switchboard.
5. Run four 1/.044 VIR wires and an earthing wire through the conduit.
6. Holding the regulator panel horizontally in front of the regulator frame, connect the wires to the regulator terminal strip as marked.
7. Replace the regulator panel on the frame, making sure the wires are clear of any parts.

Mounting Method (b)

1. Cut a hole in the switchboard panel to the size shown on the diagram, and drill holes for mounting studs.
2. Remove the back cover and perforated sheet cover from the regulator, place the regulator in position on the switchboard, and replace the perforated cover and the back cover on the studs of the regulator at the back of the board. Tighten the regulator in position.
3. Continue from paragraph 3 above, "Mounting Method (a)."

Connections

On Page 6 is a diagram showing the connections to and the internal connections of the regulator. This diagram shows the complete connection between the generator and regulator.

It should be noted that the A.C. connections may be made between any phase and neutral.

Operation

Before starting the plant for the first time, make sure the regulator points are open by turning the Automatic Control anti-clockwise until the points are seen to be open by looking through the perforated cover.

Move the "Manual" "Automatic" switch to the "Manual" position and then turn the "Manual" control to "O."

Start up the generator on no load and wait until the voltage settles down.

Using the "Manual" control, raise the voltage to 240 Volts or 415 Volts, depending on the metering used. This indicates that the regulator is correctly connected.

Return the "Manual" control to "O."

Switch to "Automatic" operation.

Slowly turn the Automatic Control in a clockwise direction until the voltage rises to 240 Volts or 415 Volts, depending on the metering used.

After several minutes' operation the voltage will be noticed to have risen slightly. Reset the "Automatic" control to bring the voltage correct.

The regulator is now correctly adjusted and load may be applied to the generator.

To stop the plant, remove the load from the generator and stop it.

When starting up from cold again the voltage of the generator will be low for several minutes until all parts of the regulator reach operating temperature. Do NOT readjust the regulator. Wait until the voltage rises itself.

Each day, when starting up the plant, reverse the position of the points reversing switch. This switch reverses the direction of the flow of current in the points and a regular reversal makes for greatly increased life of the regulator.

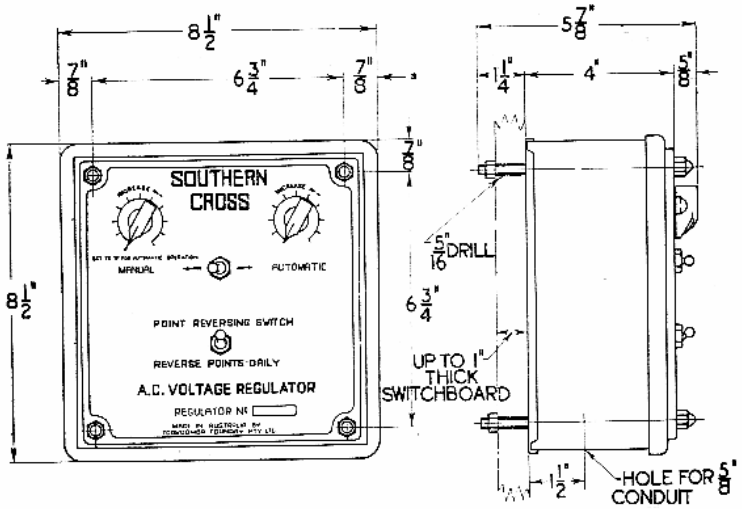
Care of Voltage Regulator

Good regulation can only be expected from a voltage regulator which is properly maintained.

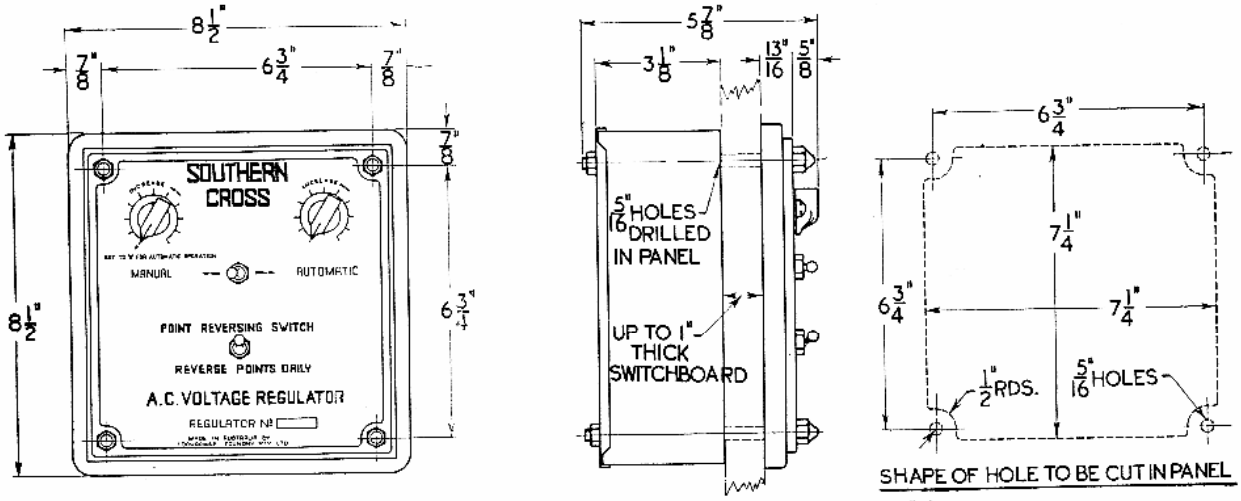
The points should be cleaned when necessary by using a magneto points file between them. If the set has been standing idle for a period, the regulator might not regulate well when started. This is probably due to a coating forming between the points, and can be overcome by cleaning them.

The points reversal switch should be operated daily as set out above under "Operation."

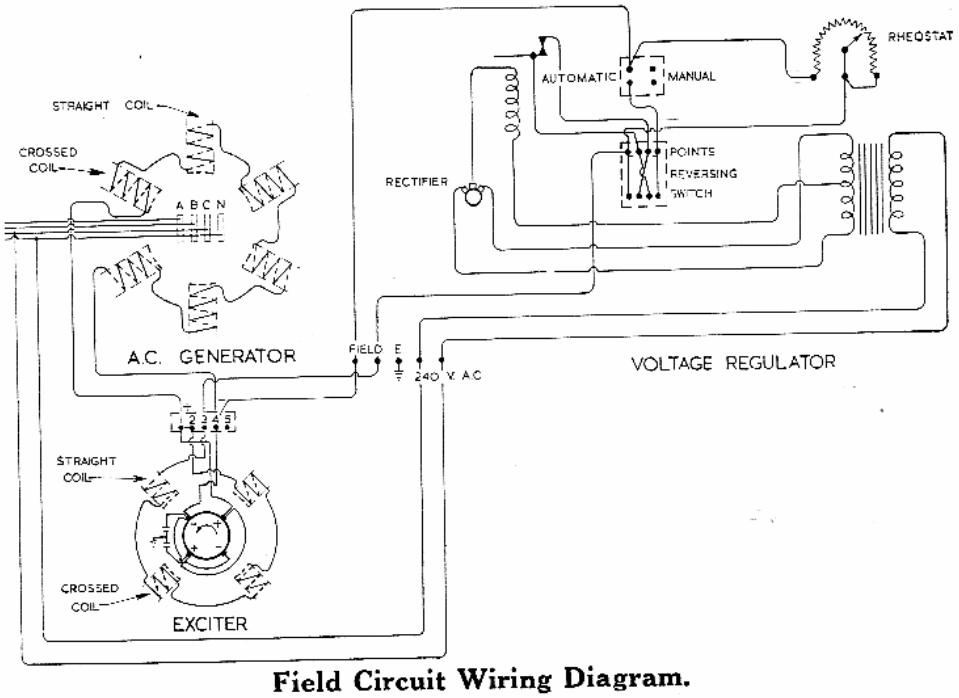
It should not be necessary to make any other adjustments to the regulator.



A.C. Voltage Regulator Mounting Method (a).



A.C. Voltage Regulator Mounting Method (b).



Field Circuit Wiring Diagram.

Care of A.C. Generator

In order to ensure trouble-free operation of the generator it is necessary to observe a certain maintenance routine.

Cleaning

Keep all parts of the generator clean. It is most important that the commutator be kept free from dust and dirt. The Sliprings, Brushes, Brush Holders and Spindles, Windings and Terminals should be periodically wiped down with a clean, dry rag.

Bearings

When the Generator leaves the works the bearings are packed with grease, and do not require further attention before the plant is put into operation.

However, it is advisable to remove the end caps from the bearings at least once a year to examine them. The balls and races should be clean and show no signs of rusting. There need only be a smear of grease on the bearing. If necessary, grease should be added to the bearing. Only fill the bearing cage, don't fill the cap with grease.

The faults arising from over-lubrication are far greater than those occurring from under lubrication. Under no condition must oil or grease containing graphite be used.

Recommended greases are:

> **Southern Cross Grease,** or if this is not available, any Ball Bearing Grease as recommended by a reputable oil company.

Commutator and Sliprings

Keep them clean and bright. Do not allow carbon dust to collect on the insulation between the sliprings, nor about the junction of the armature windings with the rings.

If burnt spots are noticed on the slip rings, the armature should be removed from the generator and the slip rings machined to a good smooth finish. When the armature is replaced, check to see that the brushes are free in their holders. Also, check to see that there is sufficient brush spring tension, as insufficient tension probably caused the burnt spots on the slip rings.

Brushes

Keep the brushes free in their holders and all even in pressure. When worn down to less than $\frac{5}{8}$in. long they should be replaced with new brushes of the size and grade stamped on the name-plate.

To Fit New Brushes

The brush rocker on the Exciter is set in the neutral position, and this position is marked with white paint.

It may be loosened by slackening off the clamp screw and loosening off the Commutator End Bearing Cap.

This permits the Brush Rocker to swivel around to expose each Brush Holder.

Remove the old brushes and try the new brushes of the size and grade stamped on the name plate in the Brush Holder.

They should slide freely without sticking. If they are tight, ease them down carefully by rubbing the tight side lightly on a flat sheet of fine sandpaper, until they will just slide in the holder.

With the new brushes in position, bed them on the commutator or sliprings with a piece of sandpaper between the brush and the commutator.

Draw the paper backwards and forwards until the brushes assume the correct curvature, and be careful to keep the cloth around the commutator so that a flat is not formed on the brush. When the process is nearly completed, fine glass paper should be used to obtain a very smooth finish.

After bedding, carefully clean away every trace of dust from the commutator or sliprings, brushes and holders. Make sure no specks of abrasive material are embedded in the face of the Brush.

Reassemble and shift Brush Rocker to correct position and retighten screws.

The set may be started up again, but it is advisable to run it on light load for a few hours before putting on full load to enable the brushes of the exciter to settle down properly.

Sparking at Brushes

The commutator must be examined occasionally while the plant is running. It should be practically sparkless at all times. If sparking does occur, steps should be taken immediately to cure it or serious trouble may arise in a short time.

The sparking may be due to several causes:

1. Brush rocker not in neutral position (check markings).
2. Overloading of Generator.
3. Jumping of brushes due to vibration or incorrect pressure on the Brush Pressure Arm.

When the generator is supplied the pressure on the exciter brushes is correct. As the Brushes wear it may be necessary to increase the pressure by screwing up the knurled adjusting nut.

Parallel Operation of A.C. Generators

In applications where the load is too great for one A.C. Generating Set, it is common practice to use two or more sets to feed into the same power lines.

The following instructions refer to the paralleling of a generating set with another which is already running. Where two or more sets are already running in parallel and an additional set is to be connected in parallel, the procedure is the same.

Synchronising

Before a Generating Set can be connected in parallel with a set which is already running, the following conditions must be fulfilled:

(a) The voltage of the generator must be made the same as the power lines to which it is to be connected.

(b) The frequency of the generator must be the same as that of the generator which is already running.

(c) The voltages of the generators must be in phase. Also the wiring must be connected so that the phase rotation is correct. Once the wiring has been checked and corrected, if necessary, the phase rotation can be forgotten.

When the above conditions are fulfilled, the paralleling circuit breaker is closed and the sets will be running in parallel.

The process of doing this is known as synchronising.

Simple Synchroscope

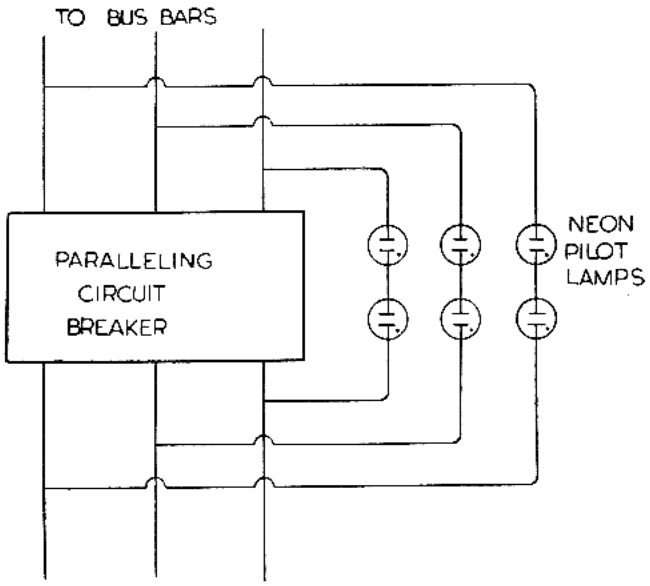
It is possible to purchase expensive equipment for automatic synchronising but, instead, synchronising is usually done using a synchroscope and by manually closing a circuit breaker at the correct moment. A Synchroscope shows when the sets are running in synchronism.

A simple and efficient synchroscope can be made by installing 2—240 Volt Neon Pilot Bulbs in series in each of the phases, and shunted across the paralleling circuit breaker as shown in the illustration, "Wiring Diagram for Simple Synchroscope" on this page. This equipment should be installed on the switchboard for every set, together with the Automatic Voltage Regulator and other instruments. Instructions are given in next column for an improved form of this synchroscope.

Phase Rotation

Before the paralleling of the sets can be carried out the phase rotation must be correct. This means that each phase of each generator has to be connected through the circuit breaker to the corresponding phase of the switchboard busbar. Using the synchroscope, this may be checked as follows:

1. When all connections are made, the circuit breakers are opened.
2. The engines are prepared for running and then started.
3. The voltage of each set is adjusted to normal voltage using the Automatic Voltage Regulator.
4. The paralleling circuit breaker for one set is closed,



Wiring Diagram for Simple Synchroscope

5. It will be noticed that the synchroscope lamps on the other set are flickering.
6. If the phase rotation is correct, the six lamps for the other set should light and go out together.
7. If they do not, stop the engines and without altering the lamp connections, reverse two of the leads from the generator to the circuit breaker. The phase rotation should then be correct.

Operation of Synchroscope

The synchroscope shows when the voltages of the running generator and the additional generator to be paralleled (incoming generator) are in phase. When they are in phase, the voltage on either side of the circuit breaker is the same, and therefore the lamps are extinguished and the paralleling circuit breaker can be closed. When the voltages are out of phase, the lamps are alight indicating that the circuit breaker should not be closed.

Improved Synchroscope

Another type of synchroscope can be made, which, in addition to showing whether voltages are in phase, as shown by the "Simple Synchroscope," will also indicate whether the incoming set is running faster or slower than the set already connected to the power line.

Three of the lamps shown in the illustration "Wiring Diagram for Improved Synchroscope," on Page 9, are mounted on the front of the board in the form of a triangle. The other three lamps are mounted behind the board, or instead of these three lamps, separate resistances of suitable size for the lamps can be used.

The top lamp in the triangle is the only one which is connected to the same phase on either side of the circuit breaker, and therefore it is the only one which will be extinguished when the generators are synchronised. The other two lamps remain alight.

When the incoming generator is not at the same speed as the running machine, all three lamps will light and go out very quickly at different times. This gives an illusion that the dark lamp (the one momentarily extinguished) is rotating in one direction or the other. When the machine is faster than the running machine, the rotation is in one direction, and in the opposite direction when it is running slower. The difference in speed is indicated by the speed of rotation of the dark lamp, so that the governor setting of the engine can be easily adjusted to alter the speed of the set.

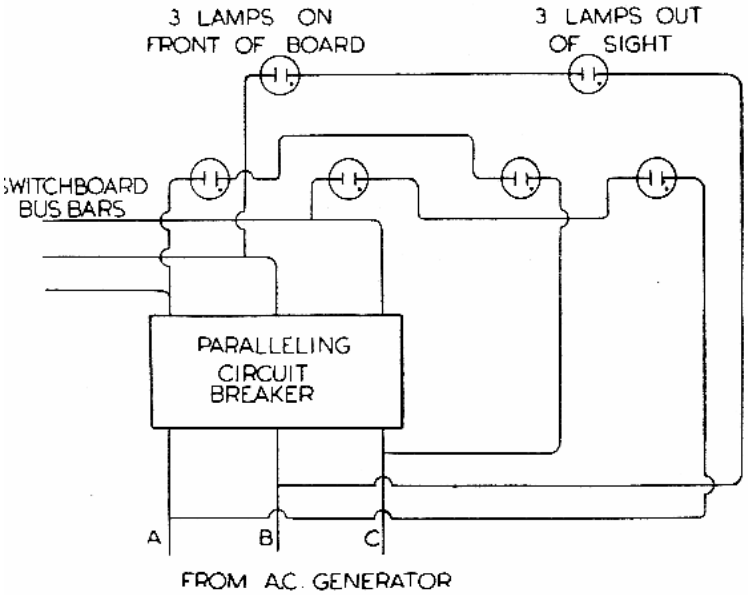
For checking phase rotation, the leads from the lamps have to be reversed on phases A and C on the generator side of the paralleling circuit breaker, i.e., the lamps are connected as for the "Simple Synchroscope." Now if the same check is made as shown on Page 8 under "Phase Rotation" and the three lamps on the board light and go out together, the phase rotation is correct. After checking the phase rotation, alter the leads to the original connections.

Neon Pilot Bulbs are recommended for synchronising lamps. Filament type lamps may be used in an emergency but are not as suitable for this application, as the filaments do not cool off sufficiently fast to indicate clearly the flickering effects necessary for synchronising. It is essential that the lamps used should be of the same wattage and rated at 240 volts.

Paralleling On No Load

The process of paralleling A.C. Generating Sets on no load is carried out as follows:

1. All circuit breakers, including the main circuit breaker are opened.
2. Start the sets which are to be paralleled and allow them to operate for 10 to 15 minutes to enable the voltage regulators to reach operating temperature.
3. The voltages of the sets should be checked, and if necessary the automatic voltage regulator should be adjusted.
4. The frequency on no load for a full load frequency of 50 cycles is approximately 52 cycles, and this should be checked on a frequency meter.



Wiring Diagram for Improved Synchroscope

5. Check the frequency and voltage for one set to see that they are correct, and then close the circuit breaker connecting the generator to the busbars.
6. It will be noticed that the synchronising lamps on the other set are flickering.
7. Check the voltage of the second set and then carefully adjust the Manual Governor Control on this set until the flickering of the lamps has slowed down. A good guide is that the six synchronising lamps on the "Simple Synchroscope" or the top lamp on the "Improved Synchroscope" should remain out for two seconds.
8. Return to the switchboard and check the voltage. Then during a period when the synchronising lamps (lamp on "Improved Synchroscope") are out, close the paralleling circuit breaker.
9. There may be a slight flicker of the ammeter needle as the sets settle down together. If there is a large fluctuating reading the sets are not correctly paralleled. In this case the circuit breaker should be immediately opened, and the above procedure be repeated.
10. The sets are then paralleled.
11. The same procedure is then followed for the third and successive sets, if there are any.
12. When the sets are paralleled, the Main Circuit Breaker can be closed and the load applied to the plant.
13. It is preferable not to have a number of sets operating in parallel on no load.

Paralleling a Set With One or More Sets Already On Load

It often happens that the load is increasing on one or more sets so that another set has to be paralleled to help carry the load. Generally it is undesirable to remove the load from the other sets so that the additional set can be paralleled on no load, so the following procedure should then be adopted.

1. Start the set and adjust the automatic voltage regulator so that the voltage is the same as the other sets already on the line.
2. Adjust the manual governor control on the engine until the flickering of the synchronising lamps slows down.
3. Close the paralleling circuit breaker when the synchronising lamp/s are out. The ammeter needle may flicker slightly, but if there is a large fluctuating reading the set is not correctly paralleled. In this case, immediately open the circuit breaker and repeat the above procedure.
4. Adjust the manual governor control on the new set until it is carrying its share of the load.

Removing a Set from Load When Paralleled with Another Set or Sets

When the load is decreasing slowly it is sometimes necessary to remove a set while keeping the other set or sets on load. This may be done as follows:

1. By adjusting the manual governor control, reduce the speed of the set to be removed until it is carrying little or no load as shown on the ammeter.

2. Open the paralleling circuit breaker for the set to be removed.
3. Shut down the engine.

Operating Sets In Parallel

When A.C. Generating Sets are operated in parallel, two points which should be carefully watched are:

1. The division of load as shown by the ammeter for each set. This can be altered by adjusting the manual governor controls on the engines. Read section "Load Control" on this page.
2. Excessive heating of generators due to circulating currents between them. To correct, adjust the excitation of the generators so they are the same. Read "Power Factor Control" on this page. As load is applied to the sets, check for circulating currents by varying the excitation and setting it for the minimum ammeter reading.

As the load changes it will be necessary to periodically repeat the above adjustments.

Circuit Breakers

We recommend that the paralleling circuit breakers be of a type similar to the majority of miniature circuit breakers with a toggle action like that on an ordinary 5 Ampere Tumbler Switch. These breakers may be obtained in a number of different ratings, but it will be necessary to use one of about twice the current rating of the A.C. Generator to provide sufficient allowance for load and circulating current, without the breaker tripping. As an alternative, A.C. Contactors may be used instead of the above type of circuit breaker.

Load Control

Where a number of A.C. Generating Sets are being operated in parallel the proportion of the total load which is carried by each set is determined solely by the engine governor characteristics and setting. To enable the load to be distributed equally between sets and also for correcting the speed for synchronising, a manual governor control is fitted to the engine.

If the manual governor controls on a number of sets in parallel are correctly adjusted and the sets are equally sharing the load, the ammeters for each set will indicate equal current.

Power Factor Control

The Power Factor of the total load is determined by the nature of the load itself, and nothing can be done by adjusting the Generating Sets to change it.

Where the load is shared by two or more A.C. Generating Sets, the power factor for each set may differ. This can be controlled by adjusting the exciting currents of the generators.

If the paralleled generators are equally sharing the load and the excitation of each generator is the same, the power factor of each generator will be the same, as well as being the same as that of the total load. If the excitation is not the same for each generator, a generator with a high excitation will have a high leading power factor and the generator with a low excitation will have a low lagging power factor compared with each other, even though the power factor of the total load will remain unchanged. **The ammeters on generators with different excitations will indicate a higher total current than the ammeter on the load line.**

The increased ammeter readings are caused by a circulating current which has been set up between the machines.

Circulating current will cause a generator to overheat so care must be taken to see that the current of each generator as shown on the ammeter is kept within the rating shown on the generator nameplate.

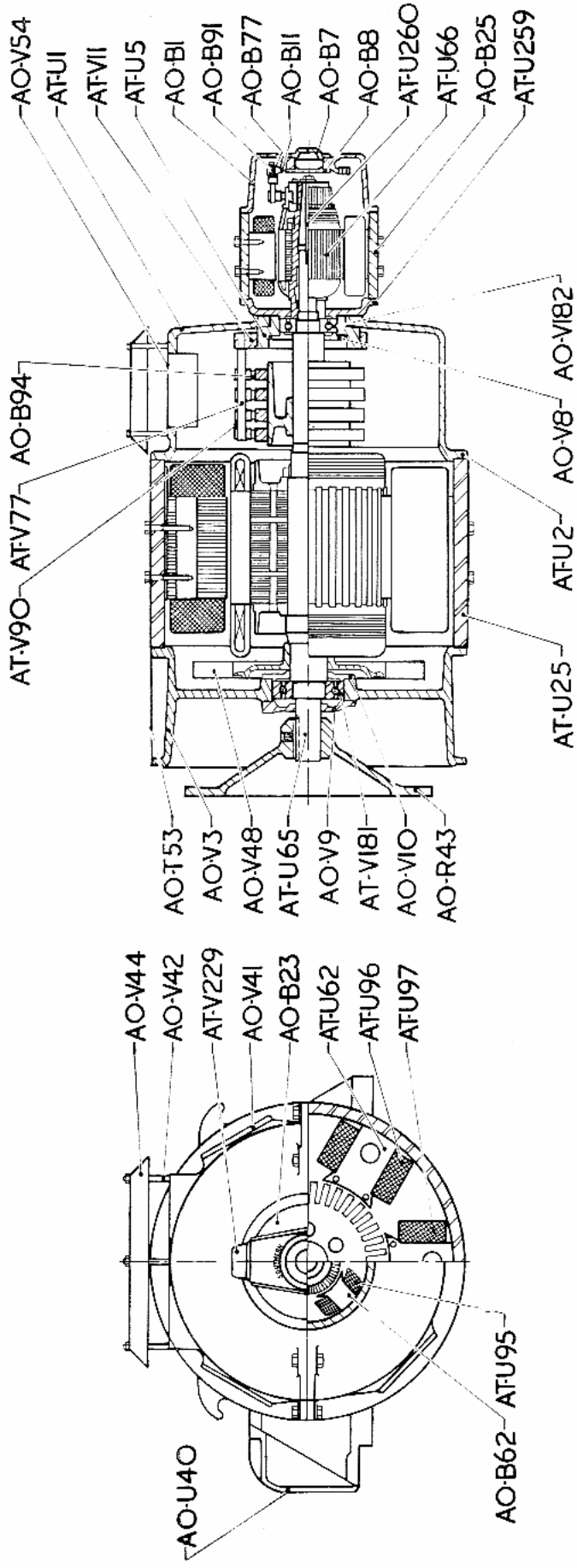
Excitation

The automatic voltage regulator which is supplied with each A.C. Generating Set has positions for manual and automatic control. When a set is used by itself the automatic voltage regulator will control the voltage of the generator within 4 per cent. between no load and full load without further adjustment.

The generators and voltage regulators are not identical in their characteristics, so that when sets are operated in parallel, there may be a difference in the excitation as the load is applied, causing circulating currents between the sets. A small difference in excitation may set up large circulating currents between the machines, and these currents should be minimised to prevent overheating of the generators.

The control of the circulating currents may be made by readjusting the automatic setting of the regulator for the altered conditions under load. It will be found that the regulator is very sensitive to adjust, and often the following method is easier to use:

1. One set is operated with the automatic voltage regulator on "automatic" to maintain line voltage.
2. Other machines are operated on "manual," the setting being made to show minimum current on the ammeter for a particular load. Load changes of about 15 per cent. will require a new setting of the manual control.
   This method of operation serves quite well where surges of circulating current are limited to about 25 per cent. of the capacity of the plant.



Mark AT-U 15 K.W. (18.75 K.V.A. at .8 P.F.) 240/415 Volt A.C. Generator—Sectional View

Southern Cross Generating Sets—PARTS LIST.

IMPORTANT:—When ordering a part for a Generator, please supply the following information from the Generator Nameplates:

(a) Mark ..... Generator. **(c) Exciter No. .....**

(b) Generator No. ..... **(d) Name and Symbol Number of Part.**

Mark AT-U 15 K.W. A.C. Generator

No. Off	Sym. No.		Name of Part.
1	AT-U	1	Commutator End Endshield—Top Half.
1	AO-B	1B	Exciter Commutator End Endshield.
1	AT-U	2	Commutator End Endshield—Bottom Half.
12	BQ-D	2	Flexible Coupling Pin.
1	AO-T	3	Drive End Endshield.
1	AT-U	5	Commutator End Bearing Housing.
1	AO-B	7	Exciter Commutator End Bearing Cap—Outside.
1	AO-B	8	Exciter Commutator End Bearing Cap—Inside.
1	AO-V	8B	Commutator End Bearing Cap—Inside.
1	AO-T	9	Drive End Bearing Cap—Outside.
1	AO-V	10C	Drive End Bearing Cap—Inside.
1	AT-V	11	Brush Rocker.
1	AO-B	11	Exciter Brush Rocker.
2	DB-C	17	Terminal Cover Conduit Coupling.
1	KN	22	Suppressor Condenser.
6	AO-V	22B	Field Coil Terminal Assembly.
2	AO-B	23B	Exciter Commutator End Endshield Cover.
1	AT-U	25C	Body.
1	AO-B	25B	Exciter Body.
1	AO-U	40B	Terminal Box Cover.
4	AO-V	41C	Endshield Inspection Plate.
6	AO-V	42	Drip Cowl Stud and Distance Piece.
1	AO-R	43	Generator Shaft Coupling.
1	AO-V	44B	Commutator End Drip Cowl.
1	AO-V	48	Fan.
1	AO-T	53	Drive End Endshield Cover.
1	AO-V	54	Commutator End Screen.
1	AT-U	60	Slipring Assembly.
1	AT-U	61	Exciter Commutator.
6	AT-U	62	Main Pole.
4	AO-B	62	Exciter Main Pole.
1	AT-U	65B	Armature.
1	AT-U	66	Exciter Armature.
2	AT-V	77B	Brush Holder Rod.
4	AO-B	77C	Exciter Brush Holder Spindle.
	AW-D	86	Gearbox Packing Shim.
2	AT-V	90B	Brush Rod Insulation.
8	AO-B	91B	Exciter Brush Holder Spindle Insulating Washer.
12	AO-B	94	Brush.
4	AT-U	95	Exciter Shunt Coil.
3	AT-U	96	Field Coil—Straight.
3	AT-U	97	Field Coil—Crossed.
1	AO-B	128	Exciter Terminal Insulating Strip.
1	AO-B	129	Exciter Terminal Strip.
5	AO-B	130	Exciter Terminal Bridge.
10	AO-B	131	Exciter Terminal Clamp.
1	AO-F	132	Exciter Terminal Connecting Link.
4	AO-B	133	Exciter Brush Holder Spindle Nut.
1	AT-V	181	Drive End Bearing.
1	AO-V	182	Slipring End Bearing.
5	AT-U	186	Field Coil Connection.
4	AT-U	187	Alternator Terminal Connection.
2	AT-U	191	Field Coil to Exciter Connection.
1	AT-U	203	Exciter Name Plate.
1	AT-U	205	Alternator Name Plate.
1	AT-U	208	R.H. Base Rail.
1	AT-U	209	L.H. Base Rail.
1	AT-V	229	Terminal Cover.
1	AT-U	230	Endshield Conduit Coupling.
4	AT-V	233B	Bridge for Bush Holder.
1	AT-U	259	Exciter Drive End Flange.
1	AT-U	260	Exciter Armature Locking Bolt.
1	AT-U	261	Exciter Armature Sleeve Washer.
4	YF	264B	Foundation Bolt.
4	BD-C	265	Foundation Bolt Square Washer.
1	AT-U	265	Exciter Armature Shaft Sleeve Driving Pin.
2	AT-U	306	Template for Base Rails Foundation Bolts.
1	YE-B	415	Shaft Coupling Locking Screw.
2	AT-V	502	Exciter Terminal Cover Stud.
12	YC	400	Flexible Coupling Rubber Bush.
12			Brush Holder, Morgan Crucible Type MF62.
10	AO-T	511B	Main Pole Setscrew—Large, 3⅝in. x ⅝in. Whit.
2			Main Pole Setscrew—Small, 3in. x ⅝in. Whit.
14			Drive End Endshield Cover Setscrew, ½in. x ¼in. Whit.
4			Terminal Box Cover Setscrew, 1¼in. x ⅜in. Whit.
16			Drive End Endshield to Flywheel Housing Setscrew, 1¼in. x ⅜in. Whit.
4			Radiator Foundation Setscrew, 1¾in. x ⅜in. Whit.
2			Flywheel Housing Foundation Stud, 1¼in. x ⅝in. Whit.
2			Crankcase Foot Fountain Stud, 6in. x ⅜in. Whit.
4			Generator to Base Rail Setscrew, 2⅝in. x ⅜in. Whit.
8			Exciter Endshield to Body Setscrew, 1in. x 5/16in. Whit.
8			Exciter Main Pole Setscrew, 1½in. x ⅜in. Whit.
4			Exciter End Race Cover Setscrew, 1¼in. x ¼in. Whit.
12			Fan to Fan Boss Setscrew, ⅜in. x ¼in. Whit.
16			Inspection Plate Setscrew, 1in. x ¼in. Whit.
4			Drive End Bearing Cap Setscrew, 2½in. x 5/16in. Whit.
7			Endshield to Body Setscrew, 1½in. x ⅜in. Whit.
8			Drive End Endshield to Body Setscrew, 1⅝in. x ⅝in. Whit.
4			Endshield Setscrew, 2⅝in. x ½in. Whit.
4			Slipring End Bearing Cap Setscrew, 2½in. x 5/16in. Whit.
6			Slipring End Bearing Housing Setscrew, 2½in. x 7/16in. Whit.
4			Cable Connection Setscrew, ½in. x ¼in. Whit.
1			Brush Rocker Setscrew, 1⅝in. x ⅜in. Whit.
2			Exciter Suppressor Condenser Screw, ¾in. x 3/16in. Whit. Brass Cheese Head.
4			Exciter Brush Holder Spindle Connection Screw, ⅝in. x ¼in. Whit. Brass.
4			Exciter Commutator End Endshield Cover Screw, 1¼in. x ¼in. Whit. Cheese Head.

No. Off	Sym. No.	Name of Part.
12		Field Coil Terminal Screw, ½in. x 3/16in. Whit. Brass Cheese Head.
1		Exciter Brush Rocker Clamping Screw, 1¼in. x ¼in. Whit Cheese Head.
10		Exciter Terminal Screw, ¾in. x 3/16in. Whit. Brass Round Head.
1		Slipring Support Locking Screw, ⅝in. x 5/16in. Whit. Cup Point.
1		Fan Boss Locking Screw, ⅝in. x 5/16in. Whit. Cup Point.
4		Brush Rocker Spindle Locking Screw, ⅝in. x 5/16in. Whit. Cup Point.
10		Exciter Terminal Screw Nut, 3/16in. Whit. Brass.
2		Exciter Terminal Cover Stud Nut, ¼in. Whit.
4		Alternator Cable Connection Setscrew Nut, ¼in. Whit.
4		Endshield Nut, ¼in. Whit.
4		Nut for Engine Foundation Bolt, ¾in. Whit.
2		Flywheel Housing Foundation Stud Nut, ⅝in. Whit.
2		Crankcase Foot Foundation Stud Nut, ⅜in. Whit.
6		Drip Cowl Stud and Distance Piece Locknut, 5/16in. Whit.
2		Exciter Terminal Cover Stud Washer, ¼in. Plain.
4		Exciter Brush Holder Spindle Washer, 7/16in. Plain.
16		Exciter Terminal Screw Washer, 3/16in. Brass.
4		Cable Connection Setscrew Washer, 5/16in. Brass.
4		Exciter Terminal Strip Washer, ¼in. I/D. x 15/32in. O/D. x ⅛in. thick.

No. Off	Sym. No.	Name of Part.
12		Fan to Fan Boss Setscrew Washer, ¼in. x 1/16in. x 1/16in. Spring.
1		Brush Rocker Setscrew Washer, ¼in. x 1/16in. x 1/16in. Spring.
14		Drive End Endshield Cover Washer, ¼in. x 1/16in. x 1/16in. Spring.
4		Commutator End Bearing Cap Setscrew Washer, 5/16in. x 3/32in. x 3/32in. Spring.
4		Drive End Bearing Cap Setscrew Washer, 5/16in. x 3/32in. x 3/32in. Spring.
4		Terminal Box Cover Setscrew Washer, ⅜in. x 3/32in. x 3/32in. Spring.
6		Bearing Housing Setscrew Washer, 7/16in. x ⅛in. x ⅝in. Spring.
27		Endshield Washer, ½in. x ⅛in. x ⅛in. Spring.
8		Endshield Washer, ⅝in. x 5/32in. x 5/32in. Spring.
4		Generator to Base Rail Setscrew Washer, ¾in. x 3/16in. x 3/16in. Spring.
4		Radiator Foundation Setscrew Washer, ½in. x ⅛in. x ⅛in. Spring.
2		Flywheel Housing Foundation Stud Washer, ¾in. x 3/16in. x 3/16in. Spring.
2		Crankcase Foot Foundation Stud Washer, ¾in. x 3/16in. x 3/16in. Spring.
1		Fan Boss Key, 1¼in. x 5/16in. x 5/16in. Plain Parallel.
1		Armature Key, 9½in. x ⅝in. x ½in. Plain Parallel.
1		Slipring Support Key, 3in. x ⅝in. x ½in. Plain Parallel.
1		Drive Key, 2½in. x ⅜in. x 5/16in. Plain Parallel.
1		Grease Nipple, ⅛in. B.S.P.

NOTE.—For Parts of Engine, refer to separate Engine Instruction Manual.

Mark CV-F A.C. Voltage Regulator

No. off	Sym. No.	Name of Part.
1	CV-F 1B	Regulator Frame.
2	CV-F 7B	Regulator Fixed Contact Insulator.
1	CV-F 9B	Regulator Fixed Contact Screw Insulation.
1	CV-F 14B	Regulator Coil.
1	CV-F 15B	Regulator Adjusting Nut.
1	CV-F 16B	Regulator Adjusting Spring.
1	CV-F 18B	Regulator Adjusting Screw.
1	CV-F 19B	Regulator Adjusting Screw Bush.
1	CV-F 20	Rheostat Distance Washer.
1	CV-F 21B	Panel.
1	CV-F 22	Panel Frame.
1	CV-F 23	Case.
1	CV-F 24	Back Plate.
1	CV-F 26	Fixed Contact Support Screw Insulation
1	CV-F 27B	Regulator Bobbin Assembly.

No. off	Sym. No.	Name of Part.
1	CV-F 29B	Regulator Armature Assembly.
1	CV-F 30B	Regulator Fixed Contact Sub-Assembly.
1	CV-F 31	Transformer.
1	CV-F 32	Rheostat.
1	CV-F 33	Points Reversing Switch.
1	CV-F 34	Manual-Automatic Switch.
2	CV-F 35	Control Knobs.
1	CV-F 36	Terminal Strip.
1	CV-F 38	Rectifier.
4	CV-F 39	Mounting Stud.
1	CV-F 40	Regulator Moving Contact Spring Spacer.
1	CV-F 41	Regulator Bobbin Locating Bracket.
1	CV-F 42	Regulator Base.
1	CV-F 43	Regulator Mounting Washer.
1	CV-F 44	Regulator Unit.

Mark CT-C Manual Governor Control

No. off	Sym. No.	Name of Part.
1	CT-C 1	Governor Control Bracket.
1	CT-C 2	Governor Control Adjusting Screw.
1	CT-C 3	Governor Control Adjusting Screw Locknut.
1	CT-C 4	Governor Control Plunger.
1	CT-C 5B	Governor Control Spring.