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# The Transverter

Interesting Facts Concerning its Development and Instructions for its Use by the Projectionist.

Manufactured Exclusively By

**The Hertner Electric Co.**

**Cleveland, Ohio, U. S. A.**

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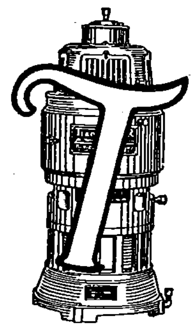
# TransVerteR



THE growth of the electrical industry has attained a point where it is rapidly becoming specialized. This does not mean simply that one manufacturer is, for example, making nothing except motors and generators. He may be producing only fractional horsepower motors, or electric welders, or starting and lighting equipment. Any one of these fields is a study in itself and each calls for certain electrical characteristics in the product that makes it differ from the others.

We set out some twelve years ago to build generating sets for motion picture projection. We realized that this is a field which entails careful study since the requirements are peculiar and quite rigid. The unit must have qualities not always found in similar machines used for other purposes and its correct design is the result of close application, experience, and ceaseless care.

We were not the first in the field. We did, however, pioneer some of the most successful and revolutionary advances. Our output is, we believe, by far the most extensively used in this Country and enjoys a widespread demand in other parts of the world.

It is our purpose to continually increase our production in volume and in quality. We expect, at all times, to be able to give service and supply parts for even our earliest machines. Being specialists in this line, we believe we can best serve our customers and ourselves by paying the closest attention to the needs of the industry.

Our production of motor generators for projection is not incidental to other major activities. It is our most important and largest product. We are in the business to stay, and do not intend to drop out to possibly resume operation at a future date. We are not middlemen, but we make all our parts with the exceptions of field regulators and meters, in our own factory. We intend to keep up with, and as far as possible anticipate, developments in the industry.





## GENERAL

The design of motor generator sets for the theatre has undergone a number of very marked changes which are due not so much to progress in the electrical industry but to changes in the condition and demands of the theatre.

Going back to the earliest day of the industry. The first electric arc used was carried on either a direct or an alternating current supply line, whichever was obtainable. With the former a rheostat was used for ballast, with the latter some form of choke coil was soon substituted for the rheostat.

The superiority of direct current over alternating brought about a call for a means of converting the latter and introduced into the field the mercury arc rectifier, the rotary converter, and the motor generator. Recently some experimenting has also been done with a commutator rotated by a synchronous motor.

The motor generator stands alone from the standpoint of performance and satisfaction. Its current is not only uniformly direct and constant, which is also true of the rotary converter, but it has the distinct advantage of being positive in its polarity and particularly of being much more independent of sudden line fluctuations.

Rectifiers, whether they are electro-physical as is the mercury arc and the hot cathode type, or mechanical as the synchronous commutator, are intermittent in their output, the current coming in surges, dropping to zero twice every cycle, producing more or less flicker and being susceptible to synchronizing with the shutter, besides being extremely sensitive to line fluctuations.

The exhibitor is selling projection. To be sure, the patron requires comfort, good chairs, lighting, ventilation, and cleanliness. Beyond this, he wishes to see the picture perfectly projected. Beautiful decorations are attractive, but they lose their drawing power for the individual in a short time. The new house with its super-excellent art effect will not bring the patron back night





after night. It is the projection that exercises that power. In truth such is its effect that the desire of the patron to visit such a theatre grows rather than diminishes with repetition.

The early type of generator was of the constant potential design, the voltage being maintained at from 70 to 80 and a resistance ballast held the arc at about 55 volts. The considerable loss of power in the ballast, amounting as it did to from 20 to 30% of the energy generated, meant quite an expense to the theatre especially, as in general, the power rates were higher then than they are today. This lead to the introduction in 1915, by this Company, of the series type of generator.

Over quite a period of time—about ten years—the average theatre consumed current at the projectors of from 50 to 125 amperes and the series type generator maintained its popularity. Requiring no ballast, it gave the owner the highest possible efficiency and insured an absence of change in current value in going from one projector to the other, which results in the least noticeable screen disturbance. Its performance is shown in Figure 1.

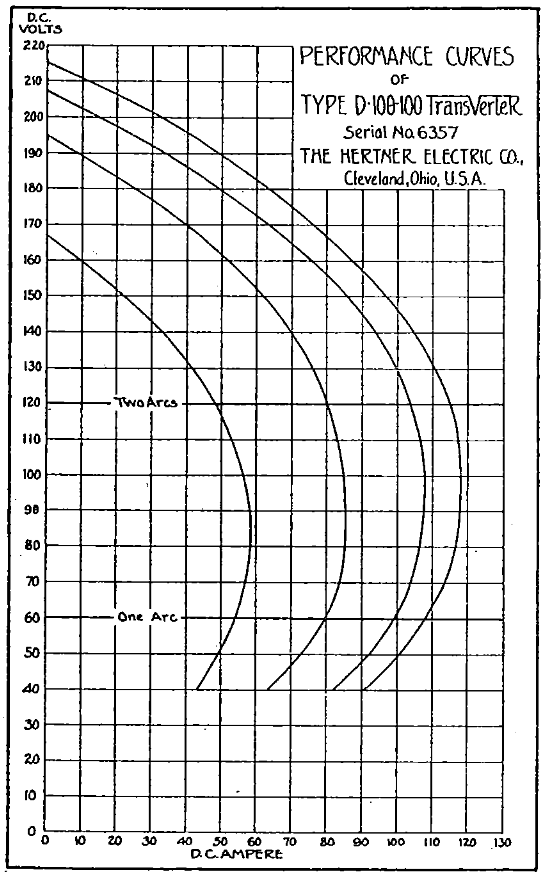



FIGURE 1





The past few years have seen the rapid introduction of the reflector arc which made possible the reduction of the current requirement to about one-third of its former value so that the amount needed for projection is often materially less than for the spots, flood lighting and the like, and the generator that operated projection arcs only was no longer adapted to the needs of the other apparatus. This condition brought about the re-appearance of the multiple type of generator.

We are now manufacturing a line of such units from the smallest, which carries one 20 ampere arc continuously or two at change-over, to generators as large as may be demanded up to 100 kilowatt or 1000 amperes at 100 volts. The smaller machines are so compounded as to make their voltage the same at the two points of demand, the single and the two arcs. The large generators which may be called upon to operate three or more arcs at one time or any amount of current from a small load up to an overload are made flat throughout. Figure "2" shows the performance of a small machine, Figure "3" is that of a large unit.

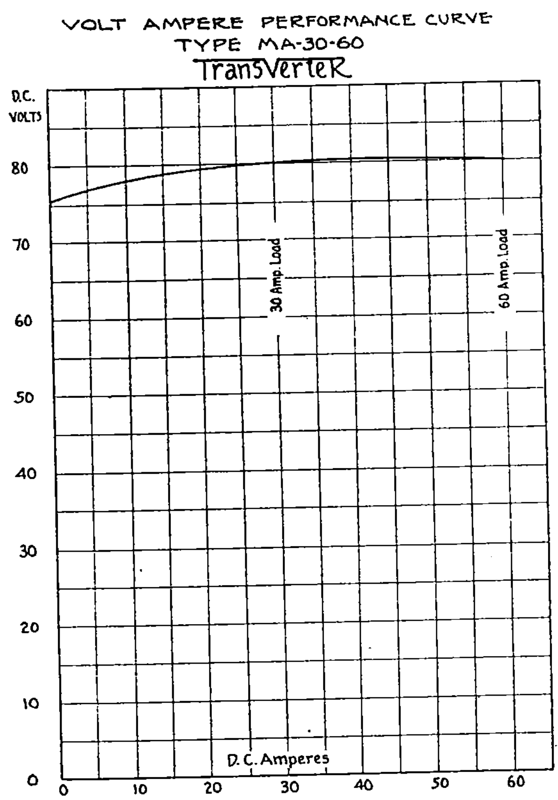



FIGURE 2





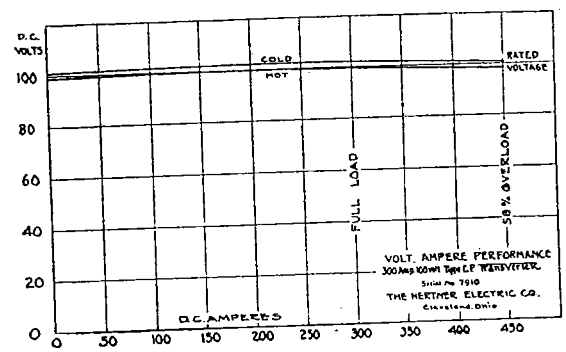



FIGURE 3

The greatest advantage of the multiple unit is that any number of appliances, taking various amounts of current, can be operated at one time and if the performance curve is sufficiently flat, no one of them will be affected by the removal or addition of any of the others. During the change-over period the two projectors are in use and it is quite possible to burn in a spot or flood light at the same time. The convenience and flexibility thus afforded compensates for its lower efficiency as compared with the series type.

## THE PERFORMANCE CURVE OF THE SERIES ARC TYPE TRANSVERTER

When the field regulator is completely cut out the current delivered at 60 volts or single arc voltage is 108 as per Fig. 1. Opening the second arc causes the generator voltage to rise, the maximum current being delivered when the combined voltage of the two arcs is about 100. With both lamps operating normally the voltage is approximately 120 and the amperes 115.

Suppose the field regulator is set to obtain 100 amperes at 60 volts on No. 1 arc. When the second arc is opened the voltage across the generator rises and the current reaches a maximum value of 108, decreasing to 104 when the voltage reaches the working value of 120. On dropping back from a high voltage to a lower one, the retentivity of the iron causes the current to remain slightly greater than on a rising voltage. This latter is not shown on the curve since it was made on increasing values of voltage only.

This machine will deliver more than 100 amperes when warm so as to provide an excess amount of current to be





used in case it is necessary to obtain more light for dark films.

With additional resistance inserted in the field circuit by means of the field regulator the output of the generator can be reduced but it should be noted that at the weakest field setting shown in Figure 1, the current at single arc voltage of 60 volts is 48.

This regulation is inherent in the machine—there are no external devices necessary to give this constancy of current at the varying voltages.

## THE PERFORMANCE CURVE OF THE MULTIPLE ARC TYPE TRANSVERTER

The volt ampere performance of the small machine shown in Figure 2 can not be made as flat as on the larger machines. The open circuit voltage it will be noted, is lower than the operating voltage. In Figure 3 the open circuit voltage is very near the operating voltage. This condition is due to the fact that it is commercially impossible to design a small machine which will have as constant a voltage with change of load as the larger types.

## DESCRIPTION

Being built electrically in two types, the series and the multiple, the choice of generator depends upon the conditions under which it is to operate.

## THE SERIES TYPE

The series type of generator is intended primarily to operate two arcs of the same size, generally the arcs of a pair of projectors. It carries the two in series using no ballast and effects a saving over the multiple unit of the same size of approximately 30 per cent in the power used.

It produces a steady current and a quick settling down of the arc.

It is easy to raise or lower the value of the current produced.

It gives a constant screen illumination during change-over.

It gives the greatest degree of protection from the effect of line fluctuation.

No danger of blowing a fuse due to overload as the generator cannot be made to draw more than a safe amount of current.





## THE MULTIPLE TYPE

The multiple type of generator, as already stated, is most suitable where a variety of apparatus is to be operated and is designed to provide a constant voltage of from 30 to 50 per cent higher than the arc voltage, which difference is dissipated in the ballast.

The demands of the theatre are so different both as to the current requirements and the type of generator adapted to its needs, and the service conditions vary so much with the numerous line voltages, frequencies, and phases that it has necessitated the production of a quite extensive range in size and kind of units and in type of driving motor. With the restricted space alloted to the motor generator in the early days—usually in the projection room—the demand sprung up for a vertical unit as well as the horizontal type of motor generator. Having specialized in this line, we are prepared to furnish sets of any size and to fit the needs of any commercial line service.

## CONSTRUCTION

It seems almost superfluous to mention here, at any length, the specifications of the material used in constructing these units.

## GENERATOR

Commutating interpoles, fixed brush position, proper qualities of carbon in the brushes and the use of the proper grade of mica between bars of hard drawn copper in the commutator are thus found in our product as they are in most any high grade electrical machinery today. We have, we believe, taken greater pains than usual in combining them along the lines of the best designs, handling them in a manner conforming to the best practice, by highly competent workmen.

## MOTOR

The motors used in these sets deserve mention on account of their reliability and sturdy design. The stators are baked after winding so as to eliminate every vestige of moisture from the coils, are then bodily immersed in a special insulating varnish, allowed to remain until thoroughly impregnated, and again baked.





The rotors are fitted with a squirrel cage of copper bars—no alloy—which are brazed into copper end rings. There are no bolted connections which are often the cause of much heating and loss of power. Air vanes are an integral part of the end rings, eliminating the possibility of damage arising where these parts are assembled mechanically —ruining the windings if they let go.

## BEARINGS

The bearings are thoroughly protected against dirt and dust, both in the ball and in the oil bearing types. The former are closed by a seal which is recommended practice with the ball bearing manufacturer. In the case of the oil bearing, the outer openings are protected by a pressed steel shell.

In order to provide additional oiling and to guard against the possibility of the sticking of an oil ring, two such rings are put into each bearing, and on account of its peculiar construction, the bearing itself is self aligning which is a great advantage over the usual pressed sleeve found in most machinery of this kind. The same bearing construction is used in both motor and generator.

The greatest care is exercised in securing vibrationless running. Each rotor and each armature is balanced dynamically in a Gisholt balancer and extreme accuracy is assured. Following the test run at full load each unit is brought up to approximately twice the speed at which it is destined to run. If there is any tendency for the windings to lose their balance from the effect of centrifugal force such readjustment will take place at once and can readily be corrected.

Correct balance not only minimizes the noise and vibration when running, but also prolongs bearing and commutator life.

## UNPACKING

Before installing motor generator equipment, read these instructions. Before attempting to operate it, read them again. Mistakes are most often made by neglecting some of the seemingly trivial things that are likely to slip the





mind and which, after the damage has occurred, appear self-evident.

Care should be taken to check all parts of the shipment when uncrated as it sometimes happens that parts are overlooked and thrown aside with the pieces of the broken crate, waste paper, and excelsior, only to be missed when they are needed in the course of installation or subsequent operation. The customer naturally believes that they were never received.

Transverters are built of ample mechanical strength either as a close coupled unit that cannot get out of line unless dis-assembled, or in the case of the four bearing type, the motor and generator are assembled on a base of sufficient stiffness and with a flexible coupling so that no fear need be entertained of springing the shaft or otherwise causing damage through handling. Care should be exercised in the use of the crowbar or other tools when opening the crate so as not to jab them into the windings or drop them on the commutator or brushholders.

A word of caution relative to the panel. This mounts a pair of meters. They are instruments of precision. They are the best of their type that we can buy and are tested by the maker and by us. Permitting the panel to drop will very likely injure the meters. Rough handling is likely to cause damage. They deserve consideration.

If the motor generator is wet or has been long stored in a very damp place, it is well to let it dry out for a while before operating it. Normal operation will keep a machine dry but it is unwise to subject a thoroughly wet machine to full voltage, because such a voltage will have a deteriorating action on the insulating material.

## INSTALLATION—LOCATION

Of the three usual locations for the set: basement, projection room, or separate generator room, the choice depends largely upon conditions. Any location is satisfactory that is dry, clean, and accessible and has sufficient ventilation so that the generator will not overheat. There should be enough space so that the





unit can be approached from all sides. Nothing contributes as much to neglect as to have the unit set into a dark corner so close to the wall that it is approachable only from the front and so close to the floor as to be inconvenient to reach, besides getting all the dust which is raised by the broom.

In some of the largest theatres where the basement is a spacious, dry, well ventilated room that contains other apparatus which is in charge of a competent attendant, there is no reason why it should not house the generating set, preferably in a separate enclosure and arranged with remote control. In such a case, the run to the projection room is a long one and care must be taken, as hereinafter explained, to install wiring having sufficient capacity.

The generator room can be arranged to be located near to the projection room. In theory, this is an admirable location; however, it must be remembered that very often the spot chosen for this room is on a balcony floor near the projection room, and that this floor carries seats and extends forward towards the center of the theatre. The process of insulating against sound and vibration is thus more difficult, particularly if the floor construction is not specially adapted to the purpose.

Location in the projection room is advisable only in the case of small installations, and if the unit is larger than a 20-40, we would recommend the vertical type. This location has the advantage that the unit is under the projectionist's eye but has the disadvantage that it adds to the other noises in the projection room which necessarily has direct openings into the theatre.

## INSTALLATION—FOUNDATION

In the case of new theatres, it is quite easy to arrange for a suitable foundation for the generator set. In the case of horizontal machines a heavy, firm foundation is more essential than in the case of the vertical type as the vibration of any revolving mass is at right angles to the length of its shaft so that with the shaft lying horizontally, the vibrations are readily transmitted into the supporting foundation or flooring.





Where a vertical type is standing on a comparatively small base the effect on the flooring is less since the vibrations in this case are in a direction parallel to the floor and are largely absorbed in the mass of the generator itself.

A foundation is necessary, too, under a horizontal set so as to raise it as much as possible out of the dust. With concrete floors especially there is always more or less grit that will be scattered by the broom or by air currents. We recommend that a foundation be constructed at least 18 inches high so as to bring the shaft level two feet or more above the floor.

Where the floor construction is concrete, the foundation should be built of this material to a height permitting of placing a layer of cork between it and the planking immediately under the generator base. This planking spreads the weight of the set more uniformly over the cork.

Where a proper location cannot be provided, or where it is inadvisable to go to the expense of such a foundation, or where the location is temporary and on a floor that permits the carrying of vibration to the interior of the theatre, a plan may be used of placing the unit on a "bridge" as follows:

Select two planks of good clear material about 4 feet longer than the base of the unit. They should be of a thickness and width so that with the set placed thereon—the planks running lengthwise of the unit and supported at their ends by two by fours laid crosswise—the planks will show considerable sag at their midpoints.

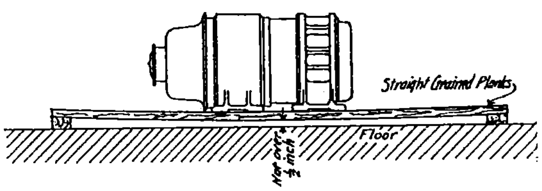



FIGURE 4

By this means the vibration is absorbed by the resiliency of the wood. The structure is inexpensive and is much more readily built and more effective than the helical springs or rubber sometimes used.

If space is limited, the planks can be shortened and elasticity retained by





resting the unit on a pair of three quarter inch cross pieces placed on the planks and carried in from the extreme ends of the base.

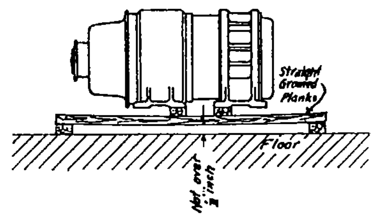



FIGURE 5

With ball bearing mountings, it is not so essential to have the foundation perfectly level as in the case of oil bearings where the shaft must be substantially horizontal.

## INSTALLATION—CAUTION

The motor carries a name plate showing the voltage, frequency, phase, and amperes; and it is well to check this with the line service to see whether the proper unit has been ordered. Two and three phase motors of the smaller sizes are usually permitted to be thrown on the line by the simple closing of a switch. In the case of larger motors, a compensator or resistance starter is required. Where the starter is located outside of the projection room the push button or remote control type should be used.

The smaller units can be operated on single phase and these machines are furnished with a split phase starter and an auxiliary winding that converts the motor into a sort of two phase unit during the starting period.

## INSTALLATION—WIRING

Wire sizes are governed by a number of considerations. Too often a wire is chosen when it conforms in carrying capacity with the Underwriters' specifications but without regard for anything else.

Besides this, however, the following must receive attention:

1—The voltage loss in the wire and its effect on performance. 2—The possibility of future need of current in excess of the immediate requirements and providing enough capacity for it. 3—The cost of the electricity wasted in the wiring as against the cost of wire.





TABLE I ALLOWABLE CARRYING CAPACITIES OF WIRES.

| B. & S. Gage | Diameter of Solid Wires in Mils | Area in Circular Mils | Table A Rubber Insulation Amperes | Table B Varnished Cloth Insulation, Amperes | Table C Other Insulation Amperes |
|---|---|---|---|---|---|
| 18 | 40.3 | 1.624 | 3 | | 5 |
| 16 | 50.8 | 2,583 | 6 | | 10 |
| 14 | 64.1 | 4,107 | 15 | 18 | 20 |
| 12 | 80.8 | .6,530 | 20 | 25 | 25 |
| 10 | 101.9 | 10,380 | 25 | 30 | 30 |
| 8 | 128.5 | 16,510 | 35 | 40 | 50 |
| 6 | 162.0 | 26,250 | 50 | 60 | 70 |
| 5 | 181.9 | 33,100 | 55 | 65 | 80 |
| 4 | 204.3 | 41,740 | 70 | 85 | 90 |
| 3 | 229.4 | 52,630 | 80 | 95 | 100 |
| 2 | 257.6 | 66,370 | 90 | 110 | 125 |
| 1 | 289.3 | 83,690 | 100 | 120 | 150 |
| 0 | 325. | 105,500 | 125 | 150 | 200 |
| 00 | 364.8 | 133,100 | 150 | 180 | 225 |
| 000 | 409.6 | 167,800 | 175 | 210 | 275 |
| | | 200,000 | 200 | 240 | 300 |
| 0000 | 460. | 211,600 | 225 | 270 | 325 |
| | | 250.000 | 250 | 300 | 350 |
| | | 300,000 | 275 | 330 | 400 |
| | | 350,000 | 300 | 360 | 450 |
| | | 400,000 | 325 | 390 | 500 |
| | | 500,000 | 400 | 480 | 600 |
| | | 600,000 | 450 | 540 | 680 |
| | | 700,000 | 500 | 600 | 760 |
| | | 800 000 | 550 | 660 | 840 |
| | | 900,000 | 600 | 720 | 920 |
| | | 1.000.000 | 650 | 780 | 1,000 |

The voltage loss is of importance where the run from the generator to the projection room is so long that, with one lamp in service and the second one struck, the line drop causes the first lamp to lose current with a consequent dimming of the screen. It is a safe rule to never allow more than one volt, or better, a half volt drop in the run.

This applies to the multiple type Transverter only and not to the series type, the latter will take care of any reasonable drop. It does not apply to the motor wiring except in extremely long runs.

The possibility of increased current requirements in the future is a very important consideration, especially in theatres built of substantial construction and where the wiring is run in conduit imbedded in concrete. The expense involved in increasing the capacity of the conductors once installed is entirely out of proportion to the cost of supplying the extra copper at the start.

The cost of electrical energy wasted deserves thought and is generally given too little consideration. It depends upon the unit cost of power, but it can be taken for granted that usually a saving will result if a larger wire is installed than is specified by the Underwriters.

Power lost in the run between the switchboard and the lamps in a multiple system can be considered a part of the necessary ballast loss and need not be figured on this basis. The line loss in





a series generator or in the driving motors is susceptible of economy of this kind.

A further refinement in the wiring of a multiple system that can be adopted in some cases is to have each piece of apparatus in the projection room fed through its own line from a point near the generator. In such cases, the Underwriters' tables can be rigorously adhered to and the loss will be the equivalent to part of the ballast loss. If the generator is perfectly flat in its performance each arc will be absolutely independent of the others.

As an example, 50 amperes continuously and 100 amperes at change-over are to be carried 250 feet, using 500 feet of wire. The Underwriters' tables, Figure 10, call for No. 1 wire. There would be a line drop of 3 volts on 50 amperes, and 6 volts on 100 amperes so that as soon as the second arc is struck, the first arc if on an 80 volt flat compounded generator, would drop about 12 per cent or to 44 amperes. Were the two lamps to be fed by separate wires, these could be No. 6 each and the drop in the circuit be simply a part of the ballast, each lamp being entirely unaffected by the other while the amount of copper would be a minimum. From a standpoint of satisfactory performance, if both lamps are to be operated off the one set of leads these leads should be about 500,000 circular mils with a half volt drop on 50 amperes and one volt drop on 100 amperes,—less desirable results with ten times the amount of copper.

We will be glad to advise the customer as to what is the best layout of wiring to fit his particular needs. The matter is so important that it is well to get as much information from every source as is possible.





## OPERATION—MULTIPLE TYPE

Consider the set placed and wired, Figure 6. If a horizontal ball bearing unit, no attention need be given the greasing of the bearings for at least six months as they have been packed at the factory. If vertical, it is advisable to put some grease in the bearings as storage in a warm place with the machine in a horizontal position may have caused the grease to run out of the housings.

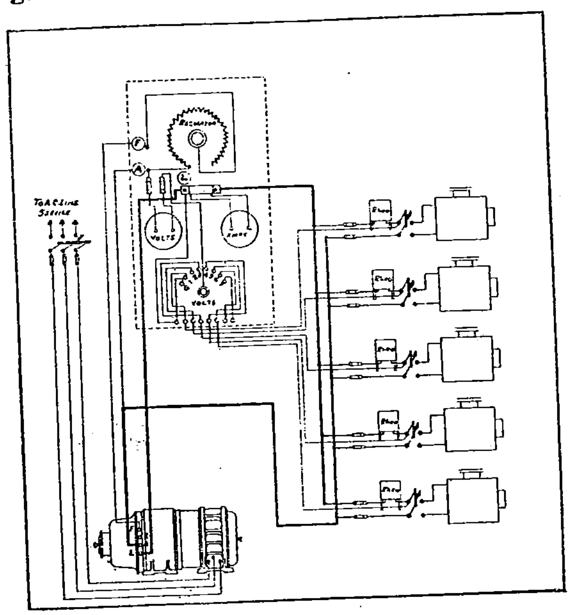


FIGURE 6

If an oil bearing set, remove the covers over the oil rings, turn the rotating element slightly to see that the rings revolve freely—there are two oil rings in each bearing. Fill the bearings with a good grade of dynamo oil until the level in the overflow cup stands a little below full. This supply of oil should last three months.

Close the switch, and if a hand starter is provided, bring it to the "start", allow the unit time to accelerate and then to the "run" position. If a single phase unit, it is particularly essential to permit the armature time to come well up to its running speed before the handle is thrown over to the side marked "run".

The proper direction of rotation is shown by an arrow on the generator. This direction is counter clockwise when viewing the generator from the commutator end. If run in the wrong direction, it will not generate.

To reverse the direction of rotation in the case of a three phase unit, interchange two of the three motor leads. In the case of the two phase motor, re-





verse the wires of either phase. In the case of a single phase unit, the wires are brought out so as to assure correct rotation, care must be taken however to have each wire going to the proper point on the starter.

If the direction of rotation is correct, the generator will build up to the operating voltage which is dependent on its size, as the larger arcs and particularly the high intensity need higher voltage than the smaller ones.

At this point, if the machine is of the OIL BEARING type, it is well to inspect the bearings to see that the rings are all freely revolving and carrying the oil in the proper manner. A slight lengthwise floating of the shaft indicates that the foundation has been correctly placed.

Strike the arc. In the smaller values of current, it is general practice to leave the ballast at its normal setting. On the larger arcs a separate shorting switch is often used, which at the start, is left open to increase the ballast resistance so as to keep the amperes somewhat near normal when striking and while the arc is short and the arc voltage low. After a few seconds this switch is closed because the arc can now be drawn to normal length.

A short time before the first film is run off, the second arc is started in the same manner and as soon as the second film is in operation the first arc is cut off. It is during this period that the unit is called upon to carry the double load.

When operating off a multiple generator there is a definite relationship between arc length and arc amperes on the one hand and rheostat capacity and generator voltage on the other.

The correct voltage across a mirror arc is between 50 and 55 volts. Across the vertical or standard arc it is 55 to 60 volts. Across the high intensity it is 65 to 70 volts. If the generator operates at 80 volts on a reflector arc at 55 volts, the ballast will have a drop of 25 volts and its elements must be made to diffuse the lost energy without overheating. Should the lamp be operated down to 40 volts, the ballast drop would





be 40 and the heat liberated would be greater in the ratio of 40 x 40 to 25 x 25 or about as 2.5 to 1.0, which would result in a temperature proportionally higher.

On the other hand there are cases of trying to operate a high intensity lamp off an 80 volt generator through a ballast designed for a 25 volt drop. In such a case, if the arc is held at 65 volts, only 15 are left for the ballast which will permit only 60 per cent as much current to flow as it was intended to carry. The obvious remedy for this is to raise the generator voltage or to get a special rheostat.

All the above is to point out the necessity of being sure to order the proper ratings of generator and rheostats for the lamps to be operated.

In the multiple type generator of the small sizes the voltage will climb somewhat if the field regulator is set to deliver the desired voltage before the arc is struck so that the voltage will be high after the arc is burning. The open circuit voltage may be disregarded and the regulator adjusted to the proper point after the arc is struck.

In order to parallel two multiple generators it is necessary to have a connection between them called an equalizer.

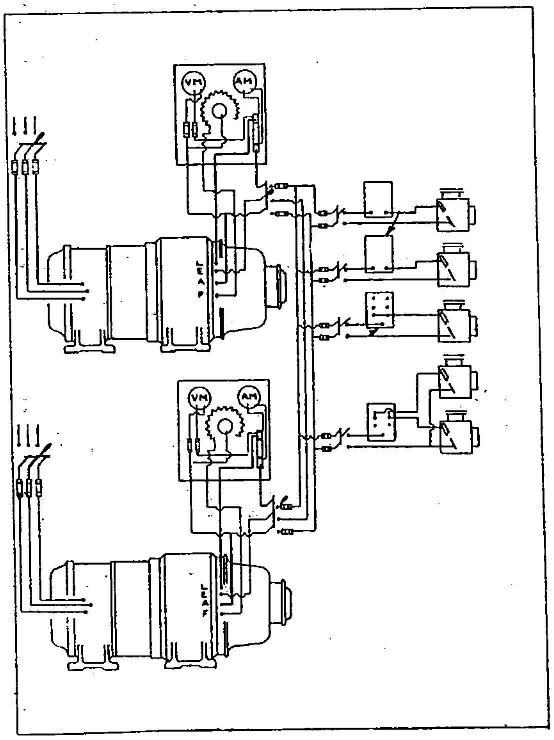


FIGURE 7





The reason for this is easy to see. In order to get constant potential performance compounding is required and this compounding differs on various sizes and designs of machines, in fact it may vary somewhat on two machines of identically the same design and even changes in a given machine with change in operating voltage or brush position.

Supposing two generators are set for parallel operation and are balanced as to their compounding, having the proper equalizer connection. If one of these generators is started and operated over a period of time till it warms to a fair degree before the second one is started, this second generator will be thrown on with its voltage adjusted to match that of the first unit. As the second machine warms its voltage will drop and it will lose part of its load which the first unit will take. The field of number two must be strengthened by hand regulation to make up for this loss.

Usually two generators of the same design will parallel nicely if they are equalized but will need some attention at the field regulators so as to properly divide the load.

If they are of different design it may be necessary to have a competent person bring the two units to the same performance characteristics. This is accomplished by the insertion of the proper shunting resistances in series and in shunt with the series fields so that, with the same shape of performance curves, the drop between the equalizer and main bus connection will be the same on the two machines when they are equally loaded.

Satisfactory performance in parallel presupposes an equalizer connection of extremely low resistance. The use of a three pole switch for each generator with the equalizer connection through one of the three blades is satisfactory if the lines to the generators are short and heavy and the switches in good condition. In no case should the equalizer circuit be fused.

It would be much better from a practical standpoint to eliminate the switch connection entirely and connect the equalizers directly by a heavy conductor





running from the "E" lead of one generator to the "E" lead of the other.

For the most successful operation and freedom from operating difficulties we recommend that two units be connected to separate bus bars and the wiring arranged as shown in Figure 8.

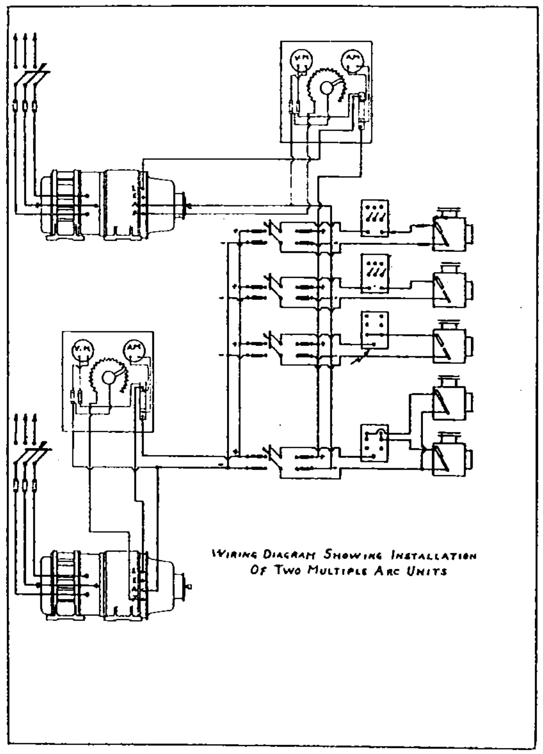



FIGURE 8

## OPERATION—SERIES TYPE

After the unit is placed and wired, Figure 9, and is ready to start, close the short circuiting switches on the arcs.

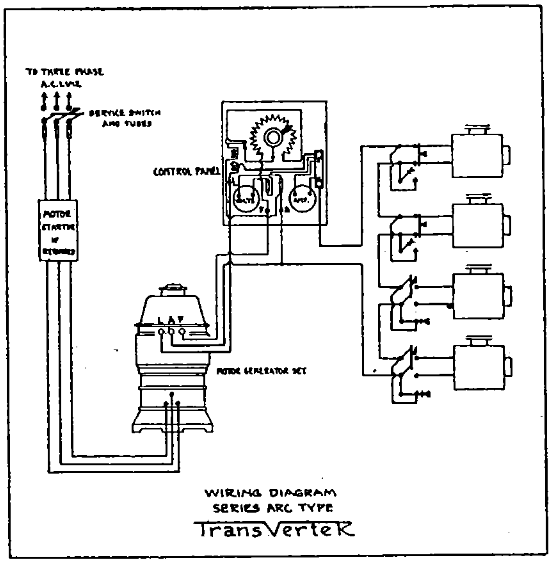



FIGURE 9

In these units, no attention need be given the greasing of the ball bearings for at least six months as they have been packed at the factory.

Close the service switch. If a hand starter is provided, bring it to the starting position, giving the unit time to accelerate and then to the running position. If a single phase unit, it is particularly essential to permit the armature time to come well up to its running speed before the handle is thrown over to the side marked "run".





If the direction of rotation is not correct, reverse as already explained in connection with the multiple unit.

If the direction of rotation is correct, the generator will build up as soon as the short circuiting switch of either arc is opened, provided the carbons are apart.

If the carbons are now brought together, the arc will be struck and can be opened to its proper length. The field regulator can then be set for the required current value.

When the film of projector No. 1 is about run out, touch the carbons in projector No. 2 and open the shorting switch. The carbons will, at once, begin to glow and the arc can be opened without further delay. As soon as No. 2 is in operation the shorting switch of No. 1

can be closed and the carbons brought together. Some projectionists reverse this process, closing the carbons first and the switch afterwards with the idea of a somewhat smoother change over.

## GENERAL CARE

In a general way, there are only three parts of the unit subject to wear; the commutator, brushes and bearings. The commutator, if properly cared for, will last many years. It should take on a polish which needs only an occasional wiping with a canvas, having previously had a very slight application of vaseline. Use only the brushes recommended by the factory.

Sometimes a commutator will get rough. In this case it can be cleaned up with a commutator stone if bad or with fine sand paper if only slightly rough. If the commutator is badly out of round the use of the commutator stone will not give permanent results because the stone will follow the surface, for while any abrupt irregularity is removed, the eccentricity remains. In this event two courses are open. One plan is to take





the armature out of the machine and turn the commutator in a lathe. The turning operation is a trifling one but the time and expense of removing and returning it are serious, especially if a large unit. A less expensive plan and one that produces excellent results is to raise the brushes and turn the commutator in place, using a rather sharp round nose diamond tool at full running speed. This is followed by a light stoning and will produce a surface that is almost absolutely true.

The brushes have been adjusted to their proper position at the factory and this location is plainly marked. Shifting them will over or under compound a multple unit and will cause the series machine to either go to a higher or lower maximum as well as upset the constancy of its performance.

To fit brushes they should be set into position on the commutator and a piece of medium sandpaper drawn back and forth under them and held close against the commutator surface. As soon as they show a contact completely across their face, it is well to finish with fine sand paper, drawing it **only in the direction of rotation.** The brushes should never run on the micanite. The micanite is under cut at the factory and the commutator should run for a long time without reaching the point where more undercutting need be done. If however the commutator is turned, the probabilities are that more micanite must be removed. This should be done to a depth of from 1-32 to 3-64 inch.





## MECHANICAL DETAILS

Figure 10 shows a cross section of of the standard Hertner Oil Bearing.

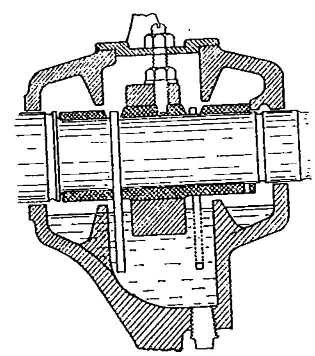


FIGURE 10

Bronze bushings are used in most of the sizes. They have a free mounting, being supported for only 20 per cent of their length. This allows the bearing to follow any slight deflection that may occur in the shaft. It also permits it to align itself in case of a mis-alignment of end yokes.

The bronze bearing is kept from turning by means of a headless set screw. This same screw acts as a means of holding down the oil well cover.

In removing the bearing cover it is of the utmost importance that this screw remain tight, the nut alone being loosened.

These bearings should be lubricated with a good grade of light dynamo oil.

In the larger sized machines babbit lined bearings are used instead of the bronze.

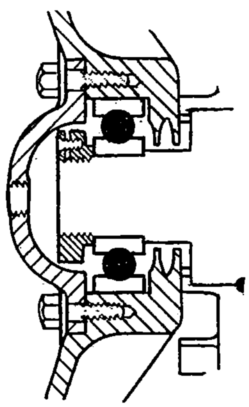


FIGURE 11

Figure 11 shows the motor end bearing in which the inner ball race is clamped by means of a slotted nut. This nut is locked on the shaft by means of a set screw.

The commutator end bearing of the horizontal machine is of exactly the same construction.





Figure 12 shows the center bearing and coupling construction of a horizontal Transverter.

The coupling is of the flange bolted type and the halves are driven on the stub end of the shafts. The coupling is bolted together with the fan between the two halves.

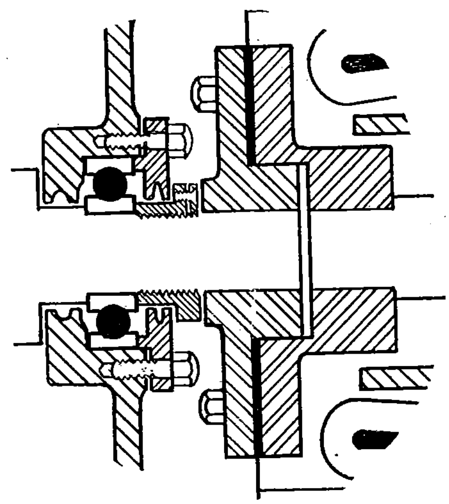


FIGURE 12

Figure 13 shows the construction of the bottom bearing of the Vertical Transverter. The bearing retainer screw has a left hand thread so that it will not back out in operation.

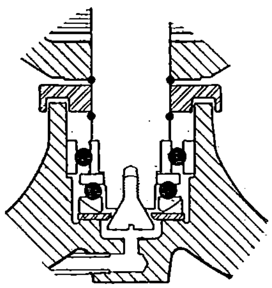


FIGURE 13

The inner ball race of the annular bearing is held on the shaft by the thrust load. The retainer washer and retainer screw serve to keep the assembly intact when the rotor is removed from the base.

Figure 14 shows the construction of the top bearing of the vertical Transverter. The outer bearing housing consists of a rolled steel cup placed on the end of the armature shaft, making a grease receptacle in which the bearing runs. The bearing itself is mounted with the inner ball race fitted on a steel stud, and the inner ball race is locked against the top cap by means of the locking nut on the top of the machine.





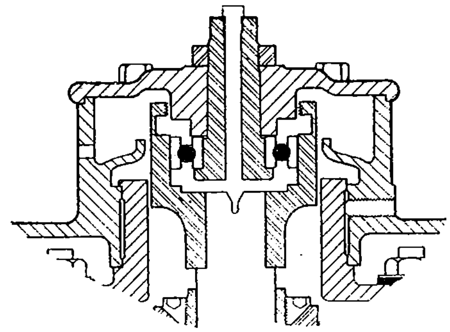


FIGURE 14

The bearing is in a grease tight housing and the presence of any grease on the outside of the machine indicates clearly that a surplus amount of grease is being forced into the bearings. This surplus grease mixed with carbon dust or dirt will cause serious trouble by grounding the windings of the machine.

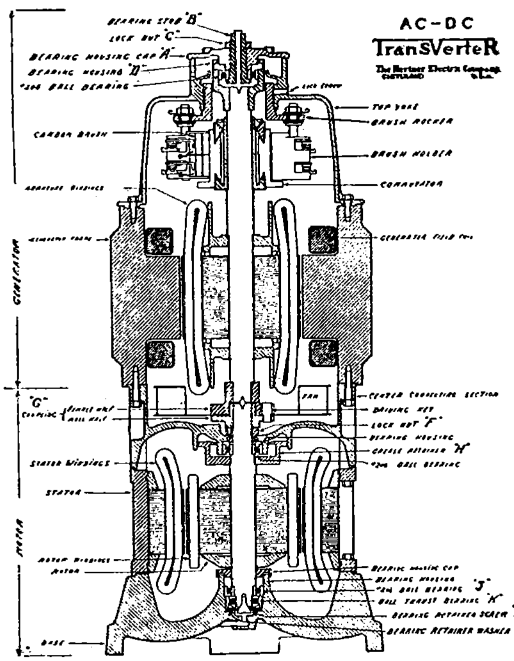



FIGURE 15

Figure 15 shows the construction of a three bearing Vertical machine.

It is simply constructed: note the coupling is not bolted or held together in any way except by the weight of the armature.





## PANELS

The panel A, which is standard for the series type Transverter, consists of a steel box. Mounted on the cover is a voltmeter, ammeter, and generator field regulator. Within the box are mounted the ammeter shunt, the voltmeter fuses, and a field protecting relay. The voltmeter indicates the generator voltage which in the case of a series machine is also the arc voltage or the combined voltage of the two arcs, if these arcs are connected in series and operating simultaneously.

On Transverters larger than the Type D-30-30 an externally shunted ammeter is used and this shunt is mounted in the panel. It is of the utmost importance that connections to the shunt be clean and tight, as any undue heating of this shunt will cause an error in the indication of the ammeter.

The relay in the panel has absolutely nothing to do with the constant current performance of the Transverter. The open circuit voltage of a series arc

Transverter is from 220 to 240 volts. Under normal conditions of operation the voltage generated is only 55 with short periods of operation at 110 volts. It would be possible to design the shunt fields to withstand the full open circuit voltage of the machine, but this is not desirable. The field protecting relay is arranged so that when the voltage across the shunt field coils reaches 150 volts, it operates and inserts a resistance in the shunt field circuit thereby reducing the voltage across these field coils to a safe value.

The only care this relay needs is that the contacts be kept clean.

The multiple arc type Transverters are now being furnished with a panel D. This panel consists of a steel cabinet having mounted on the door a voltmeter, ammeter, generator field regulator, and voltmeter selector switch. Within the cabinet are suitable terminal boards and the shunt of the ammeter when the shunted type instrument is used.

The voltmeter registers the generator voltage, and the ammeter the total load





current of the machine. In the series arc Transverter the panel voltmeter indicates the arc voltage and gives the projectionist an easy means of checking his arc control. With the multiple type Transverter, however, it is necessary to use the voltmeter selector switch in order to obtain arc voltages. The only additional wiring to connect in this panel over the previous types, is that it is necessary to run a small wire from the arc side of each rheostat back to the voltmeter terminal board in the panel. The generator field regulator provides a means of adjusting the generator voltage.

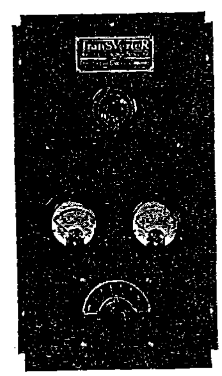


FIGURE 16

## BALLAST RHEOSTATS

An electric arc connected across a constant voltage supply line without a ballast resistance is unstable. If it were possible to strike an arc and get one burning, any change in the conditions of this arc which would tend to increase the current would decrease the arc resistance with a corresponding increase in current. The temperature of the arc stream is increased and as this stream has a negative temperature co-efficient, the arc current would tend to increase indefinitely if the generating equipment would continue to supply an unlimited amount of current with constant voltage at the arc.

In order to make parallel operation of arcs possible, it is necessary to use a constant voltage supply. In the case of direct current, a ballast rheostat must be used in series with each arc. This ballast rheostat must be designed to carry continually the current required by the arc and to give the voltage drop necessary to insure stable operation of the arc. With the ordinary vertical





arc or the reflector type arc, the arc voltage is generally between 53 and 55. If the generator voltage is less than 75 volts, any change in the arc length will make a considerable change in the current flowing. If the supply voltage is increased and the amount of ballast resistance increased, the change in the current with change in arc length becomes less pronounced. There is a growing tendency toward operation at higher D. C. voltages even at a loss of over-all efficiency.

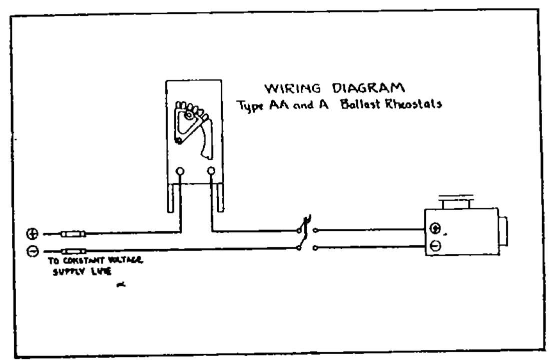



FIGURE 17

Figure 17 shows the connections of a ballast rheostat and the projection arc. This rheostat is built without any provision for increasing the resistance when the arc is struck. It has been found that this feature is not necessary on small capacity rheostats.

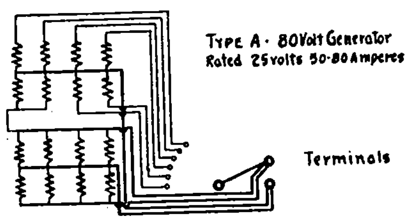



FIGURE 18

Figure 18 shows the internal connections of one of these rheostats. It will be noted that this rheostat is of the parallel type, the units being wound of nickle-chromium wire and carry 5 amperes each. There is a sufficient number of units connected across the terminals permanently to obtain the minimum current as given in the rating. The adjusting handle gives six 5 ampere steps of increased current.





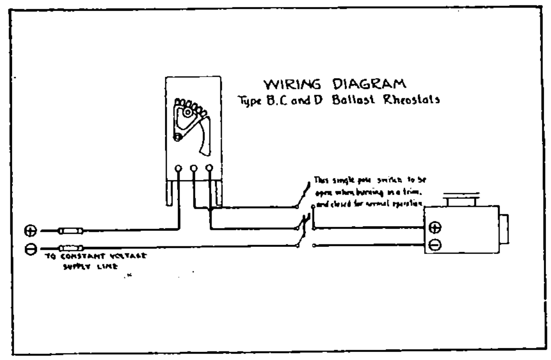



FIGURE 19

Figure 19 shows the connections between D. C. line and lamp of a rheostat with special provision for increasing the ballast resistance when the arc is struck, or when burning in a new trim.

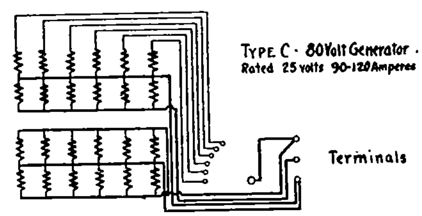



FIGURE 20

Figure 20 shows the internal connections of a rheostat of this same type.

The variation of arc voltage becomes a serious matter in connection with the ballast rheostats used with arcs. In building rheostats we have assumed that the arc voltage for the reflector arc and the vertical arc is 55 volts and of the high intensity arc 65 volts, this in accordance with the recommendations of carbon manufacturers. The voltage drop across the ballast rheostat is the difference between the arc voltage and the generator voltage. If a rheostat is designed to operate on an 80 volt generator and is used with a reflector lamp at 55 volts, the ballast rheostat is designed for a 25 volt drop. However, if the generator voltage is run up to 90 and the projectionist insists on a short arc of only 40 volts the rheostat drop will be 50 volts and even at the same current the heat dissipated by the active part of the rheostat will be four times that for which it was designed.

It must be remembered that a ballast rheostat is essentially a power absorbing piece of apparatus generating heat so that any rheostat will throw off considerable heat while in operation. They are all designed so that they may operate at a red heat without damage, but any operated at the proper rating will not run red hot.





## TROUBLES

### Failure To Start

Test with a suitable lamp or voltmeter to see that the leads to the motor are actually alive. Be sure to test between the fuses and the motor.

If this is clear, go over the starter carefully and see that the contacts are all in good working order. If possible test again between the starter and motor; in fact the best place to begin testing is at the motor terminals, using a voltmeter and seeing that there is the proper sequence of phases. There have been cases where a two phase unit had both its sides connected to a single phase at the transformer.

### Failure To Generate

If the unit runs but does not excite, make a connection between "A" and "F" at the generator. "A" is the lead from the brushholder and "F" from the shunt field. In the majority of cases of failure to excite the trouble is somewhere in the shunt field circuit to the panel.

A connection between "A" and "F" at the generator eliminates this uncertainty.

If the unit still fails to operate, disconnect "L" from the wiring so as to eliminate the possibility of a short between "L" and "A" which in a shunt machine will cause failure to build up.

Sometimes after a commutator has been turned and the mica undercut, copper particles will bridge two or more bars. These "niggers" will either blow out when the machine builds up on running or they will prevent its building up. Sometimes they result in a burned out coil before their presence is detected. The commutator should be carefully examined and such copper removed before attempting to run a generator that has been repaired.

If the commutator and brushes are in good shape and the above has not produced results, the trouble is in the generator and indicates a broken or a shorted shunt field. This can be checked by separately exciting from some other source of current.





Some of our multiple units have a terminal "E" between "L" and "A". Figure 6. This is used for paralleling it with one or more other generators and is not connected or used under any other conditions.

Occasionally a generator will lose its residual. This is most often true of a machine in which practically all the magnetic circuit is steel. Separate excitation even if with only a few cells of battery will generally overcome this trouble, as increased pressure in the brushes or a shorting of the machine through a fuse, if compounded, may have a like effect. To one experienced with trouble work, a low reading voltmeter is of the greatest service because a generator will always produce enough voltage to show a deflection on a 1 1-2 volt scale and the trouble can usually be found very quickly, care being taken not to ruin the meter when the voltage comes up.

All our machines are given 8 hours run at an overload and the following day are run for 4 or 5 hours after which the final brush setting is made. An improper connection of the field coils or armature is impossible to get out into a shipment, but a loss of residual, a short or an open circuit might occur if the machine is roughly handled.

If a machine has been rewound outside of the factory, it may show any one of a large number of faults due to some discrepancy in its repair or reassembly. Field coils may be reversed, the connections to the commutator may be shifted or crossed or coils may be shorted internally. In any such cases, the best plan is to write to the factory explaining, in detail, the symptoms of the trouble and giving the serial number of the unit.

### Heating

All generating apparatus will heat and the rules of the American Institute of Electrical Engineers are such that a heat may be attained which is entirely unbearable to the hand but still will be within the normal permissable limits. It is particularly noticeable in warm weather when the hands are moist with perspiration and are the most sensitive to heat, for then the room temperature is likely to be 90° F. or more and a rise





of 40° C. or 72° F. which is permissible brings the generator temperature up to 162° F. which will feel extremely hot.

The most important item in the care of a motor generator unit, is to keep it clean and dry. Dirt, grit particularly metallic, water and grease are all enemies of a good commutator.

It is well to wash off the brushes and brushholders periodically, say once in three months, with a little kerosene on a rag and at the same time examine the brushholder fingers to see whether they work freely and have sufficient pressure. A great many commutators give trouble from lack of these precautions. As already stated it is our practice to undercut the mica which improves commutation but affords a lodging place for the impurities listed above. Their tendency is to short circuit a coil and to start a burning away of the mica insulation between the segments. This has been the cause of burned out armatures and for this reason the matter of cleanliness demands attention.

# TransVerteR

The foregoing data is given with the desire to assist those interested to quickly grasp in lay language the various conditions for which The Transverter is designed.

Doubtless there are additional details not covered in this booklet—questions which may require specific explanation or individual attention.

Our Engineering and Research Department is always at the service of those who now have or may be contemplating the acquisition of Transverter Equipment.

The Hertner Electric Co.
Cleveland, Ohio, U. S. A.

Printed in the U. S. A.



**Table of Contents**