CHAPTER 4

POWER UNITS, Types 114 and 115

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LIST OF ILLUSTRATIONS

POWER UNIT, Type 114

(Stores Ref. 10K/350)

Introduction

1. This power unit is designed to provide a smoothed, direct current output from single phase, 50 c/s A.C. mains of any voltage between 200 and 250. It is intended for either home or tropical use at temperatures up to 50 deg. C. (122 deg. F.) or down to —20 deg. C. (—4 deg. F.).

2. It is made in two sections fitted with carrying handles. These sections are referred to as the transmitter unit and the main unit. The former provides 1,200 volts, 200 mA. for the high tension supply to transmitter T.1154 group when used on the ground, for training or demonstration purposes. The main unit gives an output of 7·3 volts, 13 amps. for the transmitter T.1154 and receiver R.1155 group L.T. requirements, when similarly employed, and 210 volts, 110 mA. for the receiver H.T.; rectification is effected, throughout, by full-wave bridge-connected rectifiers of the selenium type.

3. The main section has the following dimensions:—height 1 ft. 7 in., width 1 ft. 7 in., and depth 1 ft. 1 in. This section weighs approximately 65 lb. The transmitter section weighs approximately 55 lb. and has the following dimensions:—height 1 ft. 7 in., width 1 ft. 7½ in. and depth 10½ in. The general appearance of the two sections is illustrated in fig. 2.

DESCRIPTION

4. Fig. 1 shows both units with their interconnection and the interlocking of the units with the transmitter and receiver equipment.

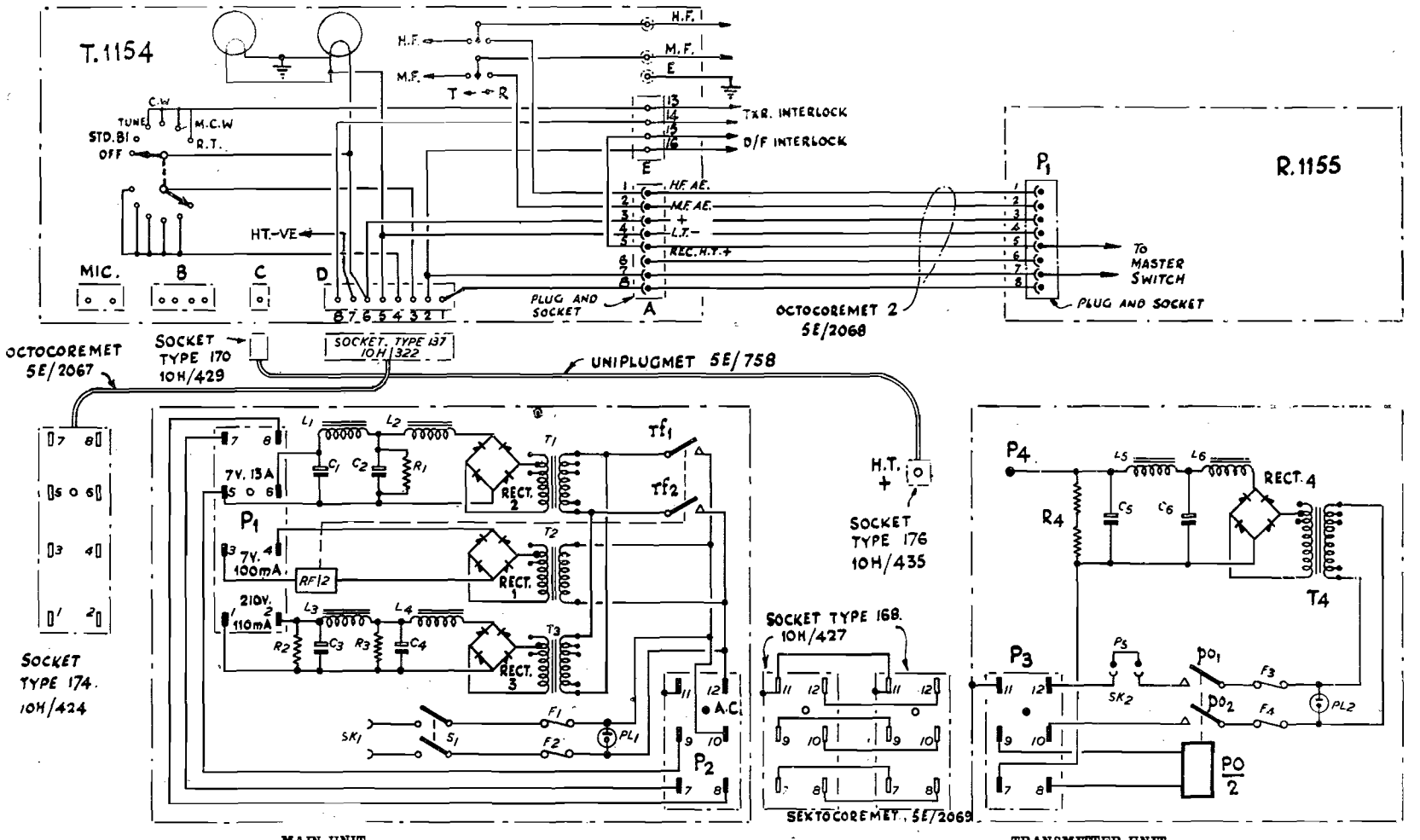


Fig. 1.—Circuit diagram, type 114

5. The main section contains a double-pole main switch S_1 controlling the A.C. power supply to both sections. It embodies two output circuits, the L.T. power supply and the H.T. power supply, each of which consists of a double-wound transformer, a bridge connected selenium metal rectifier and a smoothing unit consisting of two stages of choke-capacitance with bleeder resistances. A separate transformer supplies a rectifier which energises a relay $\frac{RF}{2}$ which is operated externally. When this relay operates it closes the contacts connecting the incoming A.C. power supply to the transformers which supply the L.T. and receiver H.T. circuits.

6. The transmitter H.T. section comprises a double-wound transformer, a full-wave rectifier, and a two-stage smoothing circuit comprising choke-capacitance with a bleeder resistance to restrict the open-circuit voltage. A relay, included in this section, derives its coil current from the L.T. rectifier in the main section. When this relay is energised, its contacts close and complete the circuit from the incoming A.C. mains to a transformer supplying the transmitter H.T. circuit. An interlock is provided on the H.T. transmitter section whereby the removal of the cover, which carries a shorting plug, breaks the relay coil circuit, and thus isolates the transformer and subsequent components from the mains.

7. The input from the A.C. mains is applied at a socket SK_1 in the main unit and thence through two 5-amp. fuses F_1 and F_2 and a bridging neon pilot lamp PL_1 to the primary of a transformer T_2. The induced secondary voltage from T_2 is rectified at a full-wave rectifier $RECT_1$ and a D.C. supply of 100 mA. at 7 volts is provided for actuation of a two-contact relay $\frac{RF}{2}$. The theory of metal rectification can be found in A.P.1095G, Vol. I, Sect. 4, Chap. 4.

8. The circuit associated with T_2 is a control circuit which is operated by the transmitter at its master or operational switch, in positions other than OFF. The voltage is developed across the points 3 and 4 of an eight-way Jones plug P_1 in the main unit and is taken through an octocoremet cable connector, normally used in airborne installations, between the transmitter and the power unit. Complete circuit diagrams of the transmitter and receiver can be found in Sect. 1, Chap. 7, and Sect. 3, Chap. 6 of A.P.1186. A skeleton diagram of the inter-connection is included in fig. 1.

9. The control circuit associated with $\frac{RF}{2}$ serves to economise cathode and heater current during the OFF condition of the transmitter. When the circuit is closed and the relay contacts rf_1 and rf_2 are made, the A.C. power is applied to the primary of a transformer T_1. The secondary voltage from T_1 is rectified at $RECT_2$. Some measure of voltage regulation is afforded by two choke coils L_1 and L_2, the value of which may be between 0·004 and 0·006H, in conjunction with a 10-ohm bleeder resistance R_1. The resistance R_1 permits the current to remain at a level higher than the critical value at which the output voltage would begin to take a sharp upward trend.

10. Smoothing of the output voltage is provided by a two-stage choke-capacitance filter comprising the chokes L_1 and L_2 with two condensers C_2 and C_1. The condensers are, physically, each composed of two parallel condensers of 2,000 μF. The D.C. output of 7 volts, 13 amps. appears across the points 5 and 6 of the plug P_1 and constitutes the cathode and heater supply for both transmitter and receiver.

11. When the contacts rf_1 and rf_2 are made, the A.C. input is also applied to the primary of a transformer T_3 in parallel with the primary of T_1. The secondary voltage from T_3 is applied to a rectifier $RECT_3$ and smoothed through a circuit arrangement similar to that described in para. 9 and 10. The component values are of course, different, the choke coils L_4 and L_3 having an inductance value of 10 to 12H at 110 mA. and the condensers C_4 and C_3 being each of 4 μF. The resistances R_3 and R_2 are each 50,000 ohms. The circuit associated with T_3 delivers 210 volts at 110 mA. across the points 1 and 2 of P_1 and this constitutes the receiver H.T. supply.

12. The 7-volt D.C. obtained from the T_1 circuit, is also used to actuate, through a six-way plug P_2, a sextocoremet cable connector (used in the airborne installation for inter-connection of the rotary transformer power units), and a plug P_3 of the transmitter unit, a relay circuit consisting of the two-contact relay $\frac{PO}{2}$. Closing of the contacts po_1 and po_2 of this circuit, permits application of the A.C. supply from the points 10 and 12 of P_3 to the primary of a transformer T_4. via two 5 amp. fuses F_3 and F_4, and a neon pilot lamp PL_2.

13. The secondary voltage of 1,200 from T_4 is rectified at $RECT_4$, and smoothed through a two-stage choke-capacitance filter consisting of two choke coils L_5 and L_6, each of 12 to 14H at 200 mA. with two condensers C_5 and C_6, each of 8 μF. A bleeder resistance R_4 of 50,000 ohms is across the output, the positive of which is applied to the transmitter through a single-point plug P_4 and the uniplugmet connector normally employed in the airborne installation. The negative returns through the point 7 of P_3.

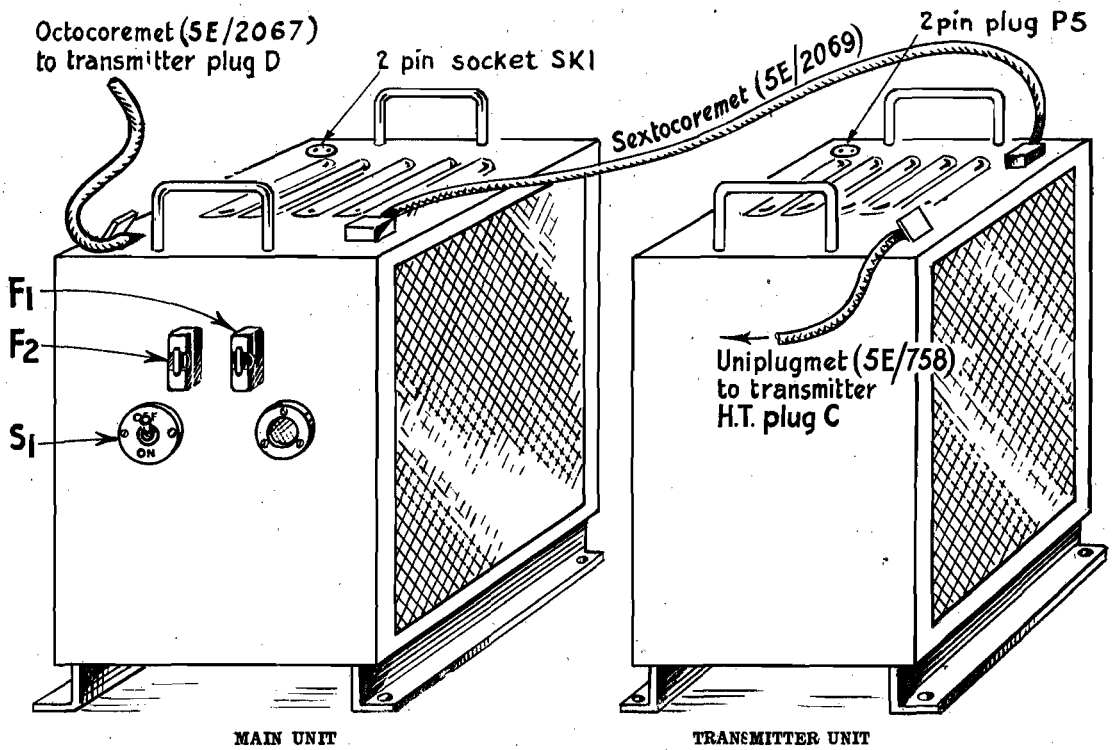


Fig. 2.—Power unit, type 114

CONSTRUCTIONAL DETAILS

14. The power unit is made in two sections fitted with carrying handles. Both sections are constructed of folded steel sheet with reinforced welded corners. It is designed for floor or bench mounting, four $\frac{3}{8}$ in. holes being provided on angle-iron spacer strips. The fixing holes are 1 ft. 0 in. between centres on the sides and 1 ft. $5\frac{3}{4}$ in. front to rear. The sides of the units are constructed of honeycombed wire mesh and the removable top covers are louvred for ventilation. The cases are brown standard anti-gas paint finished.

15. The front panel of the main unit contains the double-pole, tumbler type ON-OFF switch S_1, the two slide-lock 5-amp. B.S. fuse plugs and sockets and a viewing bezel for the pilot lamp PL_1. The input leads are wired to a two-pin socket SK_1 attached to the cover and this engages with a two-pin plug in the instrument when the cover is in position.

16. The eight-way output socket provides the following output leads:—

Points		
3 and 4	—	Control circuit to complete relay $\frac{RF}{2}$ circuit externally
5 and 6	—	L.T. to receiver and transmitter
1 and 2	—	H.T. to receiver
7	—	H.T. negative to transmitter
8 and 5	—	Control circuit of H.T. section to complete relay $\frac{PO}{2}$ circuit externally

The six-way plug P_2 (Stores Ref. 10H/426) affords the connection, via a connector, to the H.T. transmitter unit.

17. The main unit components are assembled in two compartments. The upper comprises three sub-assemblies, which, taken from front to rear of the instrument, are the pilot $\left(\frac{RF}{2}\right)$ circuit, the transmitter and receiver L.T. and receiver H.T. circuit and the H.T. filter circuit. The transformers, chokes, and condensers are grouped in the lower compartment.

18. The transmitter unit has a two-pin plug P_5 provided on the cover to mate with a two-pin socket SK_2 in the instrument when the cover is in place. A six-way input plug P_3 (Stores Ref. 10H/426) provides the following input leads from the plug P_2 on the main unit:—

Points		
10 and 12	—	Input
9 and 8	—	Input to relay $\frac{PO}{2}$
7	—	Transmitter H.T. negative
11	—	Earth

A one-way output plug P_4 (Stores Ref. 10H/430) provides the H.T. transmitter output to the uniplugmet cable connector. This plug is shielded by a small hinged door.

19. The transformer T_4 and chokes L_5 and L_6 are mounted in the upper compartment of the unit and the lower compartment houses the six units of the rectifier $RECT_4$. The pilot lamp PL_2 is mounted at the rear of the top compartment.

20. The transformer primaries of T_1, T_3, and T_4 are tapped for adjustment as to input voltage. Two taps, zero and 10, are situated at one end, and three, for 200, 220, and 240 volts at the opposite end of the winding. The transformer secondaries have three tappings, grouped at one end. Two of these are used as assembly tappings for varying rectifier characteristics and one serves as an "age" tap to compensate for any change in the selenium rectifier. There are no primary tappings on the transformer T_2.

INSTALLATION

21. Details of the correct Octocoremet, Sextocoremet and Uniplugmet cable connectors as used in the airborne installation of the transmitter and receiver can be found in Section 6 of the appropriate aircraft handbook. Input from the A.C. mains should be made with 7/0·029 in. cable.

22. The unit is designed for use indoors under conditions where the ambient temperature is between the limits of −20 deg. C. (−4 deg. F.) and +50 deg. C. (122 deg. F.). It is designed for tropical conditions, but should be used under as dry conditions as possible. When mounted on the floor or a bench there should be a clearance of 6 in. around all four sides and above.

23. It is not intended that the units should be used separately, that is to say, the main unit should not be used alone for receiver supply only, nor should two receivers be used with the main unit.

24. To make adjustment to suit the supply mains voltage, remove the cover and adjust the tappings of the control (T_2), low tension (T_1) and receiver H.T. transformer (T_3), as indicated in the accompanying table:—

Supply voltage	*Use taps*
200	0 and 200
210	10 and 200
220	0 and 220
230	10 and 220
240	0 and 240
250	10 and 240

The tappings of the transmitter H.T. unit transformer primary is similarly marked.

25. Do not sit on the power units or place anything on top or around them or the ventilation will be restricted. Should there be any danger of dripping water, the units may be protected by standing them beneath a roof placed a foot, or more, above them and so arranged that any water dripping from the roof falls clear of the units.

SERVICING

26. It should not be necessary to clean the relay contacts. To renew a fuse, slide the cover about ¼ in. upwards and then withdraw, replacing the blown fuse wire with 36 s.w.g. copper wire. To renew a pilot lamp, remove the cover and fit a neon indicating lamp arranged for a 250-volt supply. Always check the mains voltage before connecting the units to it. Switch off mains before connecting the units. Switch off mains before making any internal adjustment or replacement and before inserting the H.T. plug in the transmitter unit.

POWER UNIT, Type 115

(Stores Ref. 10K/351)

Introduction

27. This power unit is a constant-potential rectifying device designed for use with the transmitter T.1154, receiver R.1155 equipment and associated rotary transformer power units, type 33 and 35, which have a nominal 24-volt rating. The unit is intended for indoor use on home duty where the average temperature does not exceed 25 deg. C. (77 deg. F.) with occasional short periods up to 35 deg. C. (95 deg. F.). It is operated from the single phase, 50 c/s, A.C. mains at voltages from 200 to 250.

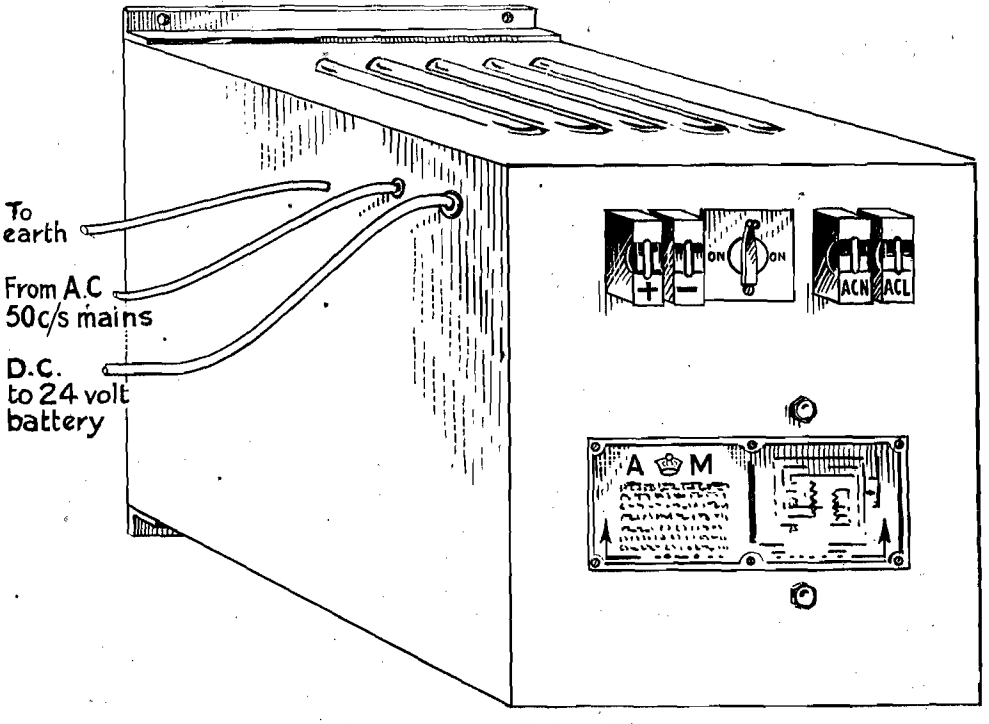


Fig. 3.—Power unit, type 115

28. It provides, automatically, for any current demand up to 26 amps. D.C. at 25 volts, irrespective of variations of ± 6 per cent, in the voltage or of ± 1 per cent. in the frequency of the A.C. supply or of the current drawn from the power unit. Rectification is effected by the use of a full-wave, bridge-connected rectifier of the selenium type and smoothing is provided by a floating lead-acid accumulator of 24 volts. Should the accumulator become discharged, the power unit automatically charges it and, when fully charged, will maintain its condition by a trickle charge.

29. The components are housed in a single folded sheet steel box, the general appearance of which is shown in fig. 3. The overall dimensions are:—height 1 ft. 11⅛ in., width 1 ft. 4⅞ in. and depth 1 ft. 8¾ in. The weight of the equipment is approximately 170 lb.

DESCRIPTION

30. The theoretical circuit diagram, fig. 4, represents the split-phase constant—potential system used. The circuit provides immediate compensation for transient changes in load and input voltage. Low percentage of ripple in the output voltage is achieved by the circuit providing constancy, both

of mean and instantaneous voltage, by a conversion of single-phase to three-phase power at medium and large loads and by the production of a flat-topped rectifier input wave at light loads and on open circuit. The power consumption on full load is, approximately, 950 watts at 0·95 power factor.

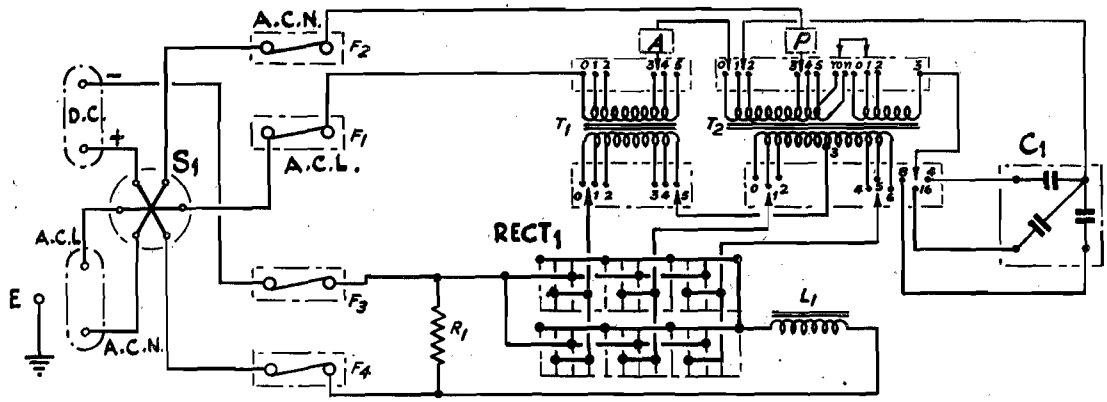
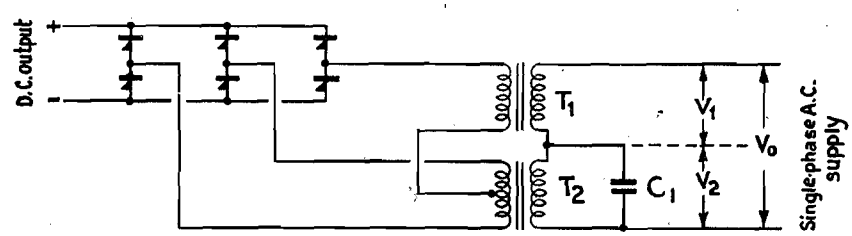
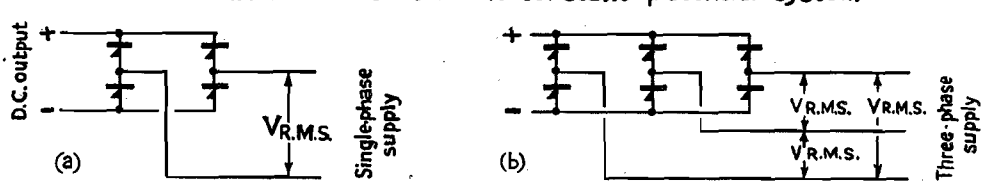


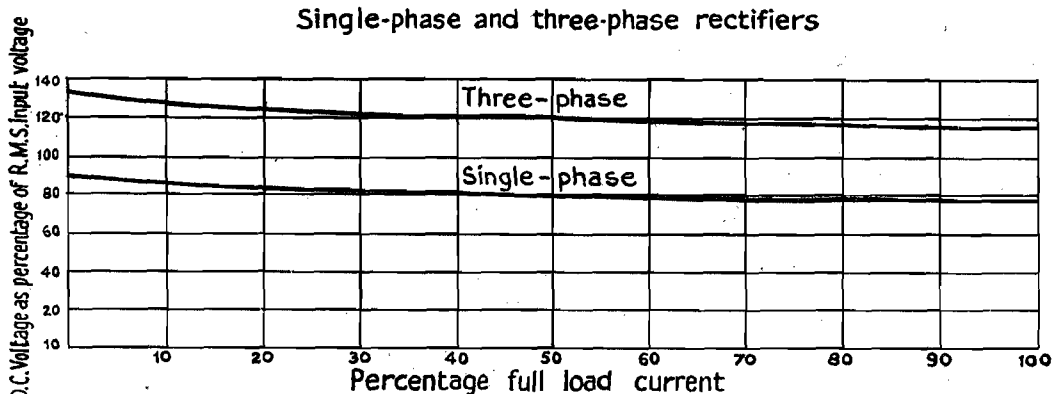
Fig. 4.—Circuit diagram, type 115



Fundamental circuit of the constant potential system



Single-phase and three-phase rectifiers



Comparative regulation curves for single-phase and three-phase bridge connected rectifiers

Fig. 5.—Simplified diagram of constant-potential system

31. The circuit, used to produce load compensation, consists of two transformers T_1 and T_2 having their primary windings connected, in series, across the incoming A.C. supply. A simplified diagram of this arrangement is shown in fig. 5. The primary winding of the transformer T_2 is shunted

by a condenser C_1, the capacitance value of which is determined at assembly adjustment, and which may be 40 μF, 40 μF + 16 μF, or 40 μF + 16 μF + 8 μF. The secondary windings of T_1 and T_2 are in Scott-connection. This is applied as a three-phase system to a selenium bridge connected rectifier $RECT_1$.

32. At small values of load current the one phase of the three-phase output is progressively lost as the load current is reduced. The circuit reverts to single-phase operation at no load. By this means a high degree of mains compensation is provided.

33. Voltage regulation curves, applicable to the type 115, are shown in fig. 6. for ± 6 per cent. fluctuation in the mains supply.

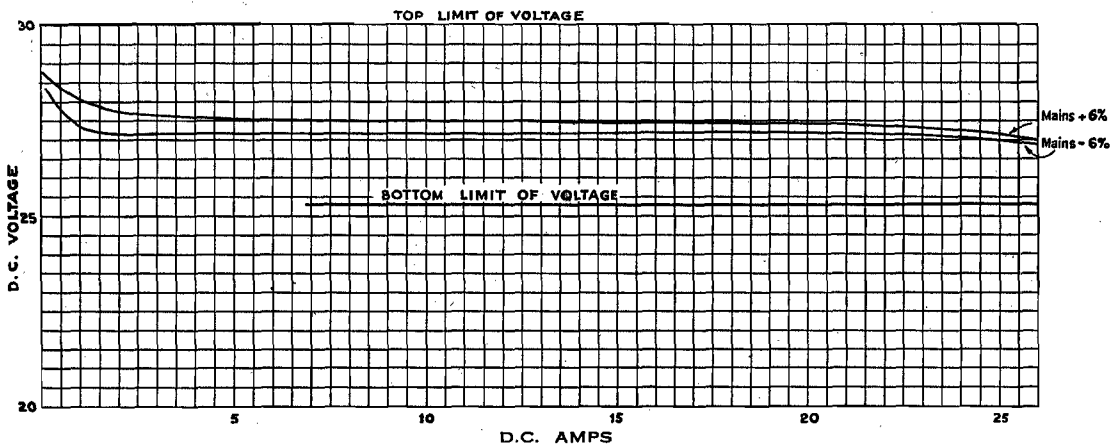


Fig. 6.—Voltage regulation curves, type 115

34. When the rectifier is not functioning as a three-phase one, that is, at light loads, the output is substantially single-phase full-wave rectified and whereas normally a ripple percentage of 50 per cent might be expected, this condition does not apply. The resultant A.C. input wave to the rectifier is not sinusoidal in these circumstances but is flat-topped and the R.M.S. output ripple percentage, even at open circuit, does not exceed 25 per cent. of the mean output voltage.

35. Under overload conditions there is a reversion to single-phase similar to that caused by a reduction in load and a rapid collapse of output voltage takes place. This affords protection for the rectifier and its associated components against severe overloading.

36. Due to transient variations in mains and load, it is necessary for any filter circuit to have a time constant which is long compared with the transient recovery time of the circuit. The filter output impedance, however, must be small when compared with the load impedance at the lowest frequency of load pulsation. A reservoir condenser is inadmissible on the output, as this would ruin the regulation.

37. An accumulator connected directly to the rectifier output would have the same effect as the condenser at light loads and it is, therefore, essential to use a filter choke L_1 with an air gap which is adjusted on test to determine performance on light load. By this means the performances of the unit can be adjusted to any desired characteristic.

38. By "floating" an accumulator having 12 lead-acid cells of 40 amp. hr. capacity at the 10-hr. rate, across the output, stability is maintained and easy adjustment of the output characteristic is preserved. The accumulator is maintained within the required voltage limits and the possibility of overcharging or discharging under all conditions of load and mains voltage is eliminated.

39. The power unit is designed to operate between the limits of 25·2 volts at 26 amps. and 30 volts at 0·2 amp. D.C.

CONSTRUCTIONAL DETAILS

40. The power unit, type 115, has a similar case construction to that utilized in the type 114. It is intended for wall fixing with two $\frac{3}{8}$ in. holes top and bottom spaced 12 in. horizontally between centres and 22 in. vertically. The front panel of the instrument contains the 30-amp. triple pole ON-OFF switch and the input and output fuses F_1, F_2, F_3 and F_4. The fuses are of the slide-lock holder variety. The fuse covers and bases are each marked with the circuit in which they are used, ACN, ACL, DC+ and DC−. The name plate will also be found on the front of the instrument. This is engraved with a theoretical circuit diagram.

41. On the side of the instrument there are two conduits with rubber grommets, one of $\frac{3}{4}$ in. for the A.C. input and one of 1 in. for the D.C. output. The input lines are attached to terminals mounted on porcelain terminal blocks and these are mounted inside the side panel. The two transformers T_1 and T_2 are mounted one above the other. The selenium rectifier $RECT_1$ is mounted to one side and the choke L_1 and the three-part oil-filled condenser C_1, which is rated at 320 volts working, are on the bottom panel.

INSTALLATION

42. The connections to the A.C. mains are made with 7/0·029 in. cable and the cable ends required are B.7607/2 with natural sleeve. This applies also to the earth connector. The D.C. output is made through 7/0·052 in. cable with B.7607/12 cable ends alone.

43. The temperature must be such that the average does not exceed 25 deg. C. (77 deg. F.) with occasional short peaks of 35 deg. C. (95 deg. F.). The equipment is designed for indoor use in a dry climate. Should there be any risk of condensation or leakage from above, the bare unit should be protected by means of a sloping roof placed 12 in. above it and so designed that any falling moisture is caught by the roof and falls clear of the unit. The unit is designed for wall mounting, a clearance of 6 in. being necessary beneath, with 12 in. clear above. Check the A.C. input voltage before connecting the apparatus and ensure that the leads A and P are on their correct tappings. On no account should any alteration be made to tappings except for this adjustment of A and P.

44. To adjust the input for voltages between 200 and 250, remove the top cover of the power unit and connect the two leads marked A and P to the appropriate tappings as listed in the accompanying table:—

Input voltage	*Connect wander tapping A to:—*	*Connect wander tapping P to:—*
200 210	A_3	P_3
220 230	A_4	P_4
240 250	A_5	P_5

There are other sets of terminals on the transformers T_1 and T_2 but these are assembly adjustment terminals and should on no account be touched.

45. Do not put anything on top of the power unit as this will restrict ventilation. This applies more particularly to the practice of placing accumulators on the instrument with the danger of spilling the electrolyte. Accumulators should not be stood immediately beneath the unit. On no account should water be allowed to drip on to the unit.

SERVICING

46. No servicing should be necessary on this equipment. Should it be necessary to renew a fuse, slide the holder cover about $\frac{1}{2}$ in. upwards and withdraw, using 24 s.w.g. pure tin wire for renewing the A.C. fuses and 25 s.w.g. copper for the D.C. fuses. The fuse covers and fuse bases are marked with their appropriate circuit and care should be exercised to ensure that the D.C. and A.C. covers are not replaced on the wrong fuse holders.

47. The floating accumulator will require no more than the periodical inspection to see whether the electrolyte level has dropped. In this case it should be topped up in the usual manner.