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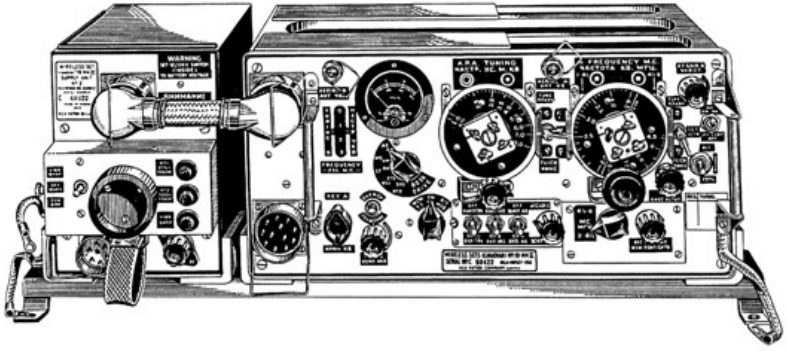

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ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS

TELECOMMUNICATIONS J 282

METAL RECTIFIERS

GENERAL DESCRIPTION

Note: This information is provisional and is supplied for guidance pending the issue of more complete instructions. All errors of a technical nature should be notified in accordance with Tels. A 009.

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GENERAL PRINCIPLES OF METAL RECTIFIERS

General

1. A rectifier may be defined as a device for converting A.C. to unidirectional current.

2. In practice, several types of rectifiers are available as follows:-
   (a) Vacuum tube rectifiers.
   (b) Electrolytic rectifiers.
   (c) Vibrators.
   (d) Metal rectifiers.

3. This regulation is concerned only with metal rectifiers of which there are two main types - copper oxide and selenium. The chief manufacturers of these are Messrs. S.T. and C. (selenium types) and the Westinghouse Brake and Signal Co. (copper oxide and selenium types) and data on these companies' products are given.

Principle of operation

4. If a thin layer of cuprousoxide is deposited on a copper plate and subjected to certain heat and electrical treatments, it is found that when the copper is positive with respect to the oxide, a very little current is passed compared with that passed when the copper is negative with respect to the oxide. This combination is referred to as a copper oxide rectifier.

5. In the case of a selenium rectifier, a layer of selenium is deposited on a carrier plate or disc, which may be of nickel-plated steel, and subjected to certain heat and electrical treatments. The selenium is then sprayed with an alloy of low melting point. Current will flow when this alloy is negative with respect to the selenium. When polarity is reversed very little current will pass.

Copper oxide rectifiers - construction

6. The general method of construction of this type of rectifier is as follows. Copper discs or washers of suitable size are heated in air to a high temperature, and a layer of cuprous oxide of uniform thickness (about 0.003 in.) is formed on them. When they are cooled to room temperature, a layer of black cupric oxide of uniform thickness (about 0.003 in.) is formed on them. When they are cooled to room temperature, a layer of black cupric oxide forms on top of the red cuprous oxide, but as this plays no part in the action of the rectifier, it is removed.

7. The discs (or elements) are usually mounted on an insulated spindle, and connected either in series or in parallel. It is possible to have almost any arrangement of elements which may be desired.

8. It is easy to make an electrical connection to the copper itself, but rather more difficult to get a satisfactory connection to the oxide layer. In some cases a lead disc is held firmly against the oxide surface by a strong spring, while in others, the oxide surface is coated with a thin layer of metal which is deposited by evaporation of the metal in a vacuum.

9. The ratio of the forward resistance to the reverse resistance may be as much as 10,000: 1, although in general it is somewhat less than this.

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10. Owing to the fact that the forward resistance is never zero, nor is the back resistance ever infinite, heat is generated when a current flows through a metal rectifier, and in many cases metal fins are inserted between the elements to dissipate this heat. As the temperature of a copper oxide rectifier increases, its forward and backward resistances fall, but since its reverse resistance falls much more rapidly, a temperature is eventually reached when for all practical purposes it ceases to rectify. Care should always be taken, therefore, not to place rectifiers in any position in a piece of apparatus where the heat generated cannot readily to dissipated.

Selenium rectifiers - construction

11. In the selenium rectifier, a thin layer (about 0.05 mm.) of selenium is applied to one side of nickel-plated steel disc (materials other than steel may be used). When first applied, the selenium has an almost black, mirror-like surface, but after undergoing carefully controlled heat treatment, it changes to a grey crystalline form. The heat treatment is intended to develop the rectifying properties of the selenium as much as possible. The edges and centre of the disc are then masked and the selenium surface is sprayed with a low-melting-point alloy which acts as the other electode. Rectification actually occurs between this alloy and the selenium.

12. In earlier types of construction contact was made to the alloy surface by means of slotted spring contact plates. In later versions a centre-contact type of construction was used, which allows any assembly pressure to be applied to the rectifier without damaging its rectifying properties. The former type is now obsolescent and should be changed whenever a replacement is necessary.

13. The selenium rectifier heats up when in use but must not be allowed to exceed a temperature of 70°C. If this temperature is exceeded, the reverse current rises very rapidly and eventually the metal alloy which was sprayed on the selenium melts, causing destruction of the rectifier. For efficiency reasons 55°C. is considered the most suitable maximum ambient temperature.

14. As the selenium rectifier has a negative temperature coefficient, its output may rise slightly until it reaches a steady temperature.

Ageing

15. All metal rectifiers undergo ageing when in use. This takes the form of a slight rise in forward resistance during about the first 10,000 hours of use. The rate and extent of ageing depends on the conditions under which the rectifier is used.

Circuits

16. The types of circuits which may be met are shown in Fig. 1001, together with the relevent figures for each type of circuit.

Mounting

17. (a) Mount the units with cooling fins vertical.
(b) Ensure that there is a very free passage of air from below the rectifier to the atmosphere above. Do not mount rectifiers near or above other hot components. Temperature must not rise above 70°C.
(c) Normally, connection is made to the rectifier by solder tags, but in the case of cooling fin units or heavy current rectifiers, bolted connections are made. Care must be taken when soldering that the solder and flux do not run down on to the rectifier elements. The spindle of the rectifier

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is insulated from the active portion, and the unit may be fixed to the frame by means of the spindle provided the voltage to earth does not exceed 500V.

WESTINGHOUSE METAL RECTIFIERS

Copper oxide types

18. Table 1 shows the current rating and use of Westinghouse copper oxide rectifier elements.

Max. current (at ambient temperature of 25°C.)	Type	Circuit	Normal use
0.1mA	WX WMX	Half-wave	Detection
0.25mA	W WM	"	Detection
1mA	Instrument	Bridge	Measuring instruments
5mA	Instrument	"	Measuring instruments
10mA	Instrument	"	Measuring instruments
2mA	J	Half-wave	High-voltage work
10mA	H	"	High-voltage work
30mA	C	"	H.T. supply
60mA	D	"	H.T. supply
120mA	B	"	H.T. supply
250xNmA	LT(LB)	Bridge (N No. of B type elements)	L.T. charging up to 12V
Over 120mA	A, B	"	General use

Table 1 - Current rating and use of Westinghouse copper oxide rectifiers

Coding of Westinghouse copper oxide rectifiers

19. The code indicates the mechanical arrangement of the rectifier. The meanings of the symbols used are as follows:-

(a) The first numeral gives the number of arms in the stack.
(b) The second numeral gives the number of series elements per arm.
(c) The third numeral gives the number of electrical paths per arm.
(d) A suffix letter may appear indicating type of element.
(e) Further suffix letters as follows may appear:-

N.F. No fins (A and B types only)
L.C. No fins, but long connectors (A and B types only)
S.F. Small fins 1 1/8 in. diameter (B type only)

S 1A, T 1A, K 1A — Signifying different types of construction (G and H types only)

MBH — See paras. 30 - 40

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20. The following are examples of the use of the code:-

1 - 20 - 1 B A half-wave rectifier having 20 type B elements in series.

4 - 4 - 1 A A single-phase bridge rectifier having four type A elements in series in each of four arms; a total of 16 elements in the complete stack.

2 - 30 - 1 D A voltage-doubled rectifier having 30 type D elements in series in each of its two arms.

6 - 10 - 1 A A three-phase bridge rectifier having 10 type A elements in series in each arm; a total of 60 elements in the complete stack.

21. A further code occurs on a number of rectifiers used by the G.P.O. The Westinghouse's equivalent of this is as follows:-

G.P.O. Code	Westinghouse Code (copper oxide rectifiers)
A	BNF
AA	B
C	H
E	W

22. This code is used as follows:-

G.P.O.	Westinghouse
4/6A	4 - 6 - 1 BNF
1/12A	1 -12 - 1 BNF
2/6A	2 - 6 - 1 BNF

23. It is to be noted that a half-wave 3-phase rectifier cannot be made on one spindle without putting in insulating washers. For examples of the code, see diagrams in Fig. 1002.

24. The series of rectifiers denoted by a letter and number, e.g., C.9, D.27, B.33 are all arranged as voltage-doublers. The number of discs per arm is the serial number less 1. Thus D.27 is arranged 2 - 26 - 1.

Westinghouse copper oxide elements

25. Type A Element size: 1 1/2 in. diameter.
Fin size: 4 in. diameter round fin or 3 3/4 in. square fin.

Note: ANF construction is A type elements without fins.
ALC construction is A type elements without fins but having large connectors.

26. Type B Element size: 3/4 in. diameter.
Fin size: 2 1/4 in. square.

Note: BNF construction employs B type elements and no fins.
BLC construction employs B type elements and no fins, but has large connectors.
BSF construction employs B type elements with fins having a diameter of 1 1/8 in.

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27. Type C — Element size: 3/4 in. diameter. Fin size: 2 1/4 in square.

This element has a higher forward impedance than type B.

28. Type D — Element size: 3/4 in diameter. Fin size: 2 1/4 in. square.

All assemblies employing D type elements are arranged as voltage-doublers. This element has a higher forward impedance than a type B.

Types F, WTF and 1mA instrument elements

29. Element size: 0.110 in diameter. Fin size: Not fitted.

The elements are mounted in a bakelized paper tube. This rectifier contains a maximum of four discs.

NOTE: Type WTF has F type elements, but contains a maximum of six discs which are assembled in a polystyrene body. The F type element is used in the 1mA meter rectifier which is a bridge type with one element in each arm. Connections to this rectifier are as follows:-

White indicates A.C connections
Red indicates positive
Black indicates negative

Types G, SG1A, TG1A, KG1A and 5mA instrument elements

30. All these use the G type element which is of 0.18 in. diameter and is without fins.

31. The KG1A supersedes the SG1A which was standard, and the TG1A which was intended for tropical use.

32. The letter A indicates that the oxide has a gold-sputtered surface. This is necessary because only a weak spring is used to hold the discs in contact, and a sputtered surface gives better electrical contact under these conditions.

33. The 5mA instrument rectifier is a bridge type with one element in each arm. Connections are as follows:-

White indicates A.C. connections
Red indicates positive
Black indicates negative.

34. The TG1A is equivalent to a SG1A totally enclosed in Neoprene, but, even so, is not fully tropicalized.

35. The KG1A is a plastic tube with a metal cap spun on to each end against a Neoprene gasket. The connectors are soldered to the metal caps. This is intended to be fully tropicalized.

Types H, SH1A, TH1A, KH1A, 101, 102, MBH and 10mA instrument rectifiers

36. These all employ the H type of element which has a diameter of 0.28 in. No fins are used with these elements.

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37. H type may contain from 1 to 176 discs in series. The over-all diameter of the assembly is $\frac{1}{2}$ in. Fixing bolts project 1/2 in. at each end and have a 2 B.A. thread. The positive end is coloured red.

38. Types SH1A, TH1A, KH1A

The KH1A now supersedes the SH1A, which was standard, and also the TH1A, which was tropicalized. The TH1A had a maximum of two elements, but the KH1A has a maximum of six. See section on types SG1A, TG1A and KG1A for constructional details.

39. Types 101 and 102

These consist of paper-lined copper tubes with bakelite ends. The copper tube is swaged over the end. The 102 is used mainly as a crash limiter for telephones.

40. Type MBH

In this type of unit the elements are assembled in a bakelite tube with a slot down one side. This permits connectors to be brought out at any point of the assembly. The tube holds a maximum of 16 elements. Insulators may be inserted to separate various sections, and each insulator occupies the same space as one element. In these assemblies the following colour code is used:-

Positive connectors are coloured red
Negative connectors are coloured black
Intermediate connectors are coloured white

It is not always possible to seal these assemblies to prevent the ingress of moisture.

41. 10mA instrument rectifiers

These contain four elements assembled in a bakelite holder and connected as a bridge. The connections are as follows:-

White indicates A.C. connections
Red indicates positive
Black indicates negative

Type J

42.

Size of element:	0.28 in.
Size of fin:	Not fitted

These are high-impedance elements used in circuits such as grid bias supply where the current consumption is small . The maximum number of elements in one assembly is 176, connected in series. The diameter of the assembly is $\frac{1}{2}$ in. and the 2 B.A. fixing bolts project 1/2 in. from each end. The positive end is coloured red.

Type W (Westector)

43.

	Standard	Miniature
Size of element:	0.08 in.	
Size of fin:	not fitted	not fitted
Length of assembly:	1.625 in.	0.5 in.
Diameter of assembly:	0.375 in.	.219 in.

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	Standard	Miniature
Weight of assembly:	1/6 oz. (approx.)	1/10 oz. (approx.)
Size of fixing bolts:	6 B.A.	wire ends
Colour of positive end:	red	red
Colour of negative end:	green	green

This type of element and assembly is suitable for use at frequencies of the order of 100 - 200kc/s.
The miniature assembly has a maximum of six elements. The polystyrene type will hold up to 20 elements.

WX type

44.

Size of element:	Originally 0.04 in. Now 0.08 in. specially treated to have the same characteristic as the 0.04 in. element.
Size of fin:	Not fitted.
Length of assembly:	1.625 in.
Diameter of assembly:	0.375 in.
Weight of assembly:	1/6 oz. (approx.)
Size of fixing bolts:	6 B.A.
Colour of cap at positive end:	red
Colour of cap at negative end:	black

This type of element and assembly is suitable for use at frequencies up to 1.5Mc/s.
The maximum number of elements in an assembly is six.

Types M3 and M9

45. Both these use B type elements.

M3
This is a bridge construction with one element per arm. It is of 3/4 in. in diameter and the tags protrude 1/8 in. The overall length is 27/32 in. There is a 0.113 in. diameter hole through the centre and this is tapped 6 B.A. to a depth of 1/4 in. at one end.

46. M9
This is more robust than M3 and is fitted with 1 1/8 in. square fins. Its over-all length is 1 5/8 in. A 2 B.A. fixing bolt projects 1/4 in. from one end.

Wiring of types M3 and M9

47. These rectifiers are supplied with four leads, each one 4 in. long, identified by the relative positions as follows:-

The end connections, joined together, form the positive terminal.
The mid connector forms the negative terminal.
The two intermediate connectors form the two A.C. terminals.

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WESTALITE (WESTINGHOUSE SELENIUM) RECTIFIERS - GENERAL

Coding

48. The rectifier elements are designated by a number followed by letter, e.g., 4 A. The number indicates the size of the element, while the letter indicates the cooling arrangement, if any, and hence its current carrying capacity and size of its fin. Since the maximum current which a rectifier can pass is limited by heating effects, the maximum current rating will depend upon the size of fin used.

Dimensions

49. The following sizes of rectifier elements are made:-

Element number	Size of element	Remarks.
1		Must be force-cooled. Not likely to be encountered.
2	3 in. x 3 in. square	May be used up to 5kW output
3	1 1/2 in. dia.	May be used up to 2.5A by connecting units in parallel
4	3/4 in. dia.	Use type 4A wherever possible
5	5/8 in. dia.	

Table 2 - Dimensions of rectifier elements

Mounting

50. (a) All rectifier units will withstand 500V R.M.S. between the electrical parts and the spindle, which may be mounted on an earthed framework. For voltage differences in excess of 500V R.M.S., the spindle should be insulated from earth.

(b) All rectifiers must be mounted with their spindles horizontal.

(c) Should the spindle of a rectifier be too long, the unwanted piece may be sawn off.

(d) The rectifiers are suitable for use in humid conditions within the temperature range -40°C. to +55°C. They should NOT be dismantled, or the protective finish will be destroyed.

(e) These rectifiers must not be mounted in such a position that they are subject to heating from valves, resistors or any other source. In no circumstances must the ambient temperature exceed 55° C. The rating must be reduced with rise in ambient temperature; Table 1004 gives ratings at 55°C. When checking the ambient temperature, the equipment should be run for some time on full load to allow all components to reach a steady temperature. The temperature of the air just below the hottest rectifier element may be considered as the maximum ambient temperature that will be reached, assuming that the equipment is being tested under conditions similar to those under which it will operate.

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Electrical connections

51. These should be made by soldering, but if a nut and bolt connection is made, the nut must be locked. When soldering, take care that solder does not run down on to the rectifier elements. Methods of making connections are as follows:-

(a) Type 2A. The terminals on this type of rectifier are suitable for soldered connections only but the lead may enter the terminal either parallel or perpendicular to the rectifier spindle. If parallel to the spindle, 16 S.W.G. tinned wire or a 1/16 in. strip mounted on the edge is suitable for insertion into the slot, the sides of which are then bent over and the joint soldered.

(b) Type 3A. As for type 2A.

(c) Types 4A and 4B. Connections may either be soldered as above or bolted, using a 4 B.A. bolt.

(d) Type 4C. Loop the conductor through the hole in the fin, and solder it or use a small bolt.

Arrangement code of Westalite rectifiers

52. Below is given an explanation of the arrangement code given in Col. 5 of Table 1003 showing the Service reference list of Westinghouse Westalite (selenium) rectifiers

(a) The figure and letter before the full stop (2A, 3A, etc.) indicate the type of element used in the rectifier. For further information on these, see paras. 51 - 65.

(b) The four groups of figures following the full stop and separated by hyphens indicate the arrangement of the elements as follows:-

(i) The first numeral indicates the number of A.C. terminals, and, if followed by P or N, indicates that the positive or negative D.C. tags are the outer.

(ii) The second numeral indicates the number of D.C. terminals.

(iii) The third numeral indicates the number of series elements in each arm of the rectifier.

(iv) The fourth numeral indicates the number of electrical paths per arm.

53. The key to the various assemblies is given below.

	Single-phase	Three-phase	Remarks
Half-wave	1-1-1-1	3P-1-1-1	N type to be considered standard
Voltage-doubler	1-2-1-1	No equivalent	
Bridge	2P-2-1-1 2N-2-1-1	3-2-1-1	P type to be considered standard

54. It will be noted that a half-wave three-phase rectifier cannot be made on one spindle without putting in an insulator. For examples of this code see diagrams in Fig. 1002.

Details of Westinghouse selenium elements

55. Type 2A

Size of element: 3 in. square

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Size of fin:	6 in. square
Maximum No. of elements:	42
Maximum No. of elements in series per arm:	42
Maximum No. of elements in parallel per arm:	42
Length between brackets:	1.95 + 0.31N inches (N is No. of elements)
Weight:	0.63 + 0.34N lbs. (N is No. of elements including spacers where these are used in odd series assemblies)
Allowance for lugs:	1/2 in. along one face.

This type of unit is assembled on a 3/8 in. Whitworth spindle.

56. Type 2L

Size of element:	3 in. square
Size of fin:	Not fitted
Maximum No. of elements:	50
Allowance for lugs:	1 in. along one face.

This element is obsolescent.

57. Type 3A

Size of element:	1.5 in. diameter
Size of fin:	3.75 in. square
Maximum No. of elements:	80
Maximum No. of elements in series per arm:	80
Maximum No. of elements in parallel per arm:	1 or 2
Length between brackets:	1.57 + 0.15N in. (N is No. of elements)
Weight:	0.3 + 0.115N lbs. (N is No. of elements)
Allowance for lugs:	3/8 in. along one side.

These units are assembled on a 3/8 in. Whitworth spindle. The form of assembly employs a fin to every pair of elements and when an odd number of series elements is necessary, a dummy element is added to retain the standard pitch of the fins.

58. Type 3AF

Size of element:	1.5 in. diameter
Size of fin:	3.75 in. square

Provision of connecting lugs. Connections are made to the corners of three fins. These fins may be recognized by the fact that one corner is not cut out, but is sharp. The fins are made of tin in contrast to the die-cast fins of type 3A. In all other respects this rectifier is identical with the 3A.

59. Type 3B

Size of element:	1.5 in. diameter
Size of fin:	2 7/8 in. square
Maximum No. of elements:	80

Similar to type 3AF in all other respects.

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60. Type 3C

This differs from the type 3 only in that its fins are 2 1/4 in. square and the connections are made to three of its fins as in the type 3AF.

61. Type 3D

This is similar to the type 3, but without fins.

62. Type 4A

Size of elements:	3/4 in. diameter
Size of fin:	2 1/4 in. square
Maximum No. of elements:	90
Maximum No. of elements in series per arm:	90
Maximum No. of elements in parallel per arm:	1 or 2
Length between brackets:	0.97 + 0.076N in. (N is the No. of elements)
Weight:	1.1 + 0.265N ozs. (N is the number of elements)

Connectors are made at one corner of each of three fins. The unit is assembled on a 2 B.A. spindle. The form of assembly employs a fin to every pair of elements so that when an odd number of series elements is necessary, a dummy element is added to retain the standard pitch of the fins.
NOTE: When calculating the weight of an assembly which as an odd number of series elements per arm, calculate on the next higher even number of elements per arm.

63. Type 4B

This differs from the 4A only in that it has fins which are 1 3/4 in. x 1 1/3 in.

64. Type 4C

This differs from the 4A in that its fins are 1 1/8 in. in diameter and the lugs project 1/4 in. at each of three corners.

65. Type 4D

This differs from the 4A in that it is without fins, and its tags project 1/4 in. towards three corners of a square.

66. Type 5B

Size of element:	5/8 in. diameter
Size of fins:	1 3/4 in. square
Maximum No. of elements:	48
Maximum No. of elements in series per arm:	48
Maximum No. of elements in parallel per arm:	1
Length between brackets:	0.78 + 0.065N in. (N is the No. of elements)
Weight:	0.44 + 0.07N ozs. (N is the number of elements)

Connections are made to three of the four corners available on the fins. The unit is assembled on a 4 B.A. spindle. The form of assembly employ a fin to every pair of

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elements so that if an odd number of elements is necessary, a dummy element is added to retain the pitch of the fins.

67. Type 5C

This differs from type 5B only in that it has 1 1/8 in. diameter fins, and that the lugs project for 1/4 in. at three corners.

68. Type 5D

Size of element:	5/8 in diameter
Size of fins:	Not fitted
Maximum No. of elements:	60
Maximum No. of elements in series per arm:	60
Maximum No. of elements in parallel per arm:	1
Length between brackets:	0.78 + 0.58N in. (N is No. of elements).
Weight:	0.32 + 0.07N ozs. (N is No. of elements).
Allowance for lugs:	1/4 in. at three corners, unless there is adequate space, when they may be made to lie on a straight line. The unit is assembled on a 4 B.A. spindle.

Double-voltage types of Westalite rectifier

69. The double-voltage type of Westalite rectifier is made in exactly the same sizes as the above-mentioned rectifiers, and is assembled to form similar units. These can be distinguished from the original type of Westalite rectifiers by the fact that the prefix 1 is added to the type and catalogue number. Thus a type 4A would become a 14A, while a 5B45 would become a 15B45. The double-voltage type will work at twice the voltage at which the older type will work, although its dimensions are the same. This has been made possible by a process which doubles the reverse resistance while leaving the forward resistance unaffected.

Procedure for testing Westalite rectifiers

70. It is to be noted that the test figures given below apply to both temperate and tropical conditions, but under tropical conditions the test must not be applied for more than a few seconds, or the rectifier may overheat, and as a result, fail to pass the test, although it would have passed the test had it not overheated.

71. ON NO ACCOUNT MUST A MEGGER OR SIMILAR HIGH-VOLTAGE GENERATOR BE USED FOR MEASURING THE RESISTANCE OF A RECTIFIER EITHER IN THE FORWARD OR REVERSE DIRECTION, AS THIS WILL LEAD TO SERIOUS DAMAGE AND WILL PROBABLY MAKE THE RECTIFIER UNSERVICEABLE.

Half-wave and voltage-doubler circuits

72. (a) A voltage-doubler rectifer comprises two half-wave rectifiers connected in series, so that it can be tested either as a single half-wave rectifier between its + and - terminals, or as two half-wave rectifiers, by testing between its + and A.C. terminals and between the A.C. and - terminals.

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(b) Disconnect any condensers connected across the D.C. output, and use a non-inductive, resistive load, adjusted to give the current values stated below, and measure the D.C. voltage. The effect of transformer regulation is to lower the D.C voltage; the allowance for transformer voltage drop is difficult to assess as the on-load voltage records the R.M.S. value of the loaded half-cycle and that of the unloaded half-cycle.
Apply 16V R.M.S. per series element. The D.C. mean output voltage should be 6.0V at the following currents:-

Element.	2A	3A	4A	5B	5D
Current.	3.5A	0.88A	0.21A	0.106A	0.106A

Bridge rectifiers

73. (a) Disconnect any condenser connected across the D.C. output, load the rectifier with a non-inductive resistance adjusted to give the current values stated below, and measure the D.C. voltage. Allow for transformer regulation by reading the R.M.S. on load voltage.
(b) Apply 16V R.M.S. per series element. The mean D.C. output voltage should be 12V at the following currents:-

Element.	2A	3A	4A	5B	5D
Current.	5A	1.25A	0.30A	0.15A	0.15A

D.C. blocking circuits.

74. Forward resistance test . Pass a known D.C. current (as shown in the table below) through the rectifier and measure the voltage drop across the rectifier. The maximum values of voltage drop per series element depend on the temperature. There is no minimum value for this voltage drop, and a good rectifier may show figures which are only 60% of the maximum.
Maximum values to be expected are as follows:-

Temperature	10°	30°	60°
Maximum mean value of voltage drop at specified test current (see below), given in volts per series element.	1.45	1.26	1.08

Currents to be used for test

Element	2A	3A	4A	5B	5D
Current	5A	1A	0.225A	0.130A	0.130A

75. Reverse resistance test. From a source of D.C. or rectified A.C. (ripple less than 5%), a reverse voltage of 15V per element is applied and the reverse current measured. The maximum value per series element is given in Table 3.
NOTE: Where three series or more elements are tested, the reverse current will probably be only half the figure given since it is unlikely that all will be only just inside the pass limit.

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Test temperature	20°C.				55°C.			
Type of element	2A	3A	4A	5B 5D	2A	3A	4A	5B 5D
Maximum reverse current per single series element (mean amps.)	0.37	0.077	0.017	0.011	0.74	0.154	0.033	0.022

Table 3 - Reverse currents

76. Insulation test. Short-circuit the output terminals of the rectifier and use a Megger to check the insulation from the spindle to the electrical parts, e.g., measure from the spindle to the short-circuited terminals. The resistance must be greater than 100MΩ. A Megger must NOT be used for any other test.

SENTERCEL (S.T. and C. SELENIUM) RECTIFIERS

77. The general remarks in paras.1 - 16 apply to these rectifiers as well as to Westalite rectifiers, since they all work on the same principle. The differences are in the size of the elements and the fins, and in the coding used for showing the arrangement. Table 1006 shows only those S.T. and C. rectifiers used by the Army and no cross references are available for the numbers allocated by other Services.

Arrangement code

78. (a) The standard code is arranged in five sections, as follows:-

(a)	(b)	(c)	(d)	(e)

(b) The sections have the following meanings:-

(i) Section (a). This indicates the arrangement of the elements in the rectifiers, and will contain one of the following letters:-

Single-phase		Three-phase	
H	Half-wave.	PH	Half-wave.
B	Bridge.	PB	Bridge.
V	Push-pull (full-wave).	PV	Push-pull.
D	Voltage-doubler (centre-tapped type).		

(ii) Section (b). This indicates the diameter of the rectifier element in millimetres and will contain one of the following numbers:- 18, 25, 35, 45, 67, 84, 112.

(iii) Section (c) indicates the number of series elements in each arm of the stack, and may be any number up to 60.

(iv) Section (d) indicates the number of electrical paths per arm, and may be any number from 1 - 60.

(v) Section (e) indicates the type of cooling, mounting brackets, construction, finish, etc., and may contain any of the following letters:-

F - circular cooling fin and wide spacing between elements (45, 67 and 84mm. elements).

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C - square aluminium cooling fins, heavy-duty connecting tags and wide spacing between elements (84 and 112mm. elements).
K - Square steel cooling fins for 84 and 112mm. elements.
A - cooling funnel, heavy-duty connecting tags and wide spacing between elements (84 and 112mm. elements).
HD - heavy-duty tags for making connection to bus-bars (67, 84 and 112mm. elements).
B1 - one mounting bracket per stack.
B2 - two mounting brackets per stack.
L - Stack with damp-proof finish and standardized dimensions.
R - Stack with close spacing of elements, damp-proof finish and standardized dimensions (18 and 25mm. elements).
LJ - As L but without damp-proof finish.
RJ - As R but without damp-proof finish.

(c) The letters and numbers indicated in this para. should be given in the order shown above.

Examples

79.

H 18 - 40 - IL	Half-wave rectifier, having 40 18mm. elements in series, standardized dimensions and damp-proof finish.
B 45 - 6 - IFL	Single-phase bridge rectifier, having six 45mm. elements in series in each arm, F type cooling fin arrangement, standardized dimensions and damp-proof finish.
D 25 - 10 - IL	Voltage-doubler rectifier, having ten 25mm. elements in series in each arm, standardized dimensions and damp-proof finish.
B 112 - 1 5 ALJ	Single-phase bridge rectifier, having five 112mm. elements in parallel in each arm, funnel cooling arrangement, heavy-duty connecting tags, standardized dimensions and without damp-proof finish.

General information on elements and on stacks containing elements of any one type

80. Since the arrangement code is rather more comprehensive than in the case of Westinghouse types, most of the mechanical details of a stack can be obtained by reference to its arrangement code. In the following paragraphs only the points not covered by the code are included.

81. 18mm. element assemblies

Maximum No. of elements per stack = 40
Maximum No. of elements per stack with cooling arrangement R = 60
Diameter 0.812 in.
Size of fixing bolt(s) 2 B.A.
Weight in oz. $1/4 + \frac{N}{8}$ (N = No. of discs).

82. 25mm. element assemblies

Maximum No. of elements per stack = 40
Maximum No. of elements per stack with arrangement R = 60
Diameter 1.0 in.
Size of fixing bolts 2 B.A.
Weight in oz. = $1/4 + 0.219N$ (N = No. of elements)

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83. 35mm. element assemblies

Maximum No. of elements per stack = 40
Diameter = 1.375 in.
Size of fixing bolts = 2 B.A.
Weight in oz. = 1/4 + 0.37N (N = No. of elements)

84. 45mm. element assemblies

Maximum No. of elements per stack = 40
Maximum No. of elements per stack with arrangement F = 30
Diameter = 1.75 in. Diameter of 45 - F = 2.50 in.
Size of fixing bolts = 2 B.A.
Weight in oz. = 1/4 + 0.55N (N = No. of elements)
Weight in oz. of 45 -F = 1 + 1.13N (N = No. of elements)

85. 67mm. element assemblies

Maximum No. of elements per stack = 40
Maximum No. of elements per stack with arrangement F = 30
Diameter = 2.625 in. Diameter of 67 -F = 3.312 in.
Size of fixing bolts = 5/16 in. Whitworth.
Weight in oz. = 2 + 2N (N = No. of elements)
Weight in oz. of 67 -F = 4 + 4.1N (N = No. of elements)

86. 84mm. element assemblies

Maximum No. of elements per stack = 40
Maximum No. of elements per stack arranged 84 -F = 30
Maximum No. of elements per stack arranged 84 -C = 24
Maximum No. of elements per stack arranged 84 -K = 8
Maximum No. of elements per stack arranged 84 -A = 24
Diameter of normal type = 3.312 in.
Diameter of 84 -F = 4.406 in.
Size of fixing bolts = 5/16 in. Whitworth.
Weight in oz. of 84 type = 2 + 3N = No. of elements)
Weight in oz. of 84 -F = 3 + 6.3N (N = No. of elements)

87. 112mm. element assemblies

Maximum No. of elements per stack = 40
Maximum No. of elements per stack arranged 112 -C = 24
Maximum No. of elements per stack arranged 112 -A = 24
Diameter of normal stack = 4.406 in.
Size of fixing bolts = 5/16 in. Whitworth
Weight in oz. of normal stack = 4 + 4.5N (N = No. of elements)

Note: The next page is page 1001

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Table 1001 - Service reference numbers of Westhinghouse copper oxide rectifiers.

M.O.S	M.A.P.	AD.	Westinghouse Cat. No.	Arrangement (see para. 18)
ZA 20871			WX.1	
ZA 21533			WX.2	
ZA 5877	1CD1178 10D1177	W.4067	WX.6 WX.12	1 - 6 - 1
W WESTECTORS:-				
ZA 4921			W.1	1 - 1 - 1
ZA 5938	10D96	Tag No. A. 8	W.6	1 - 6 - 1
ZA 5876		W.1088	W.6	1 - 6 - 1 with bracket.
ZA 3428			W.12	1 - 12 - 1
ZA 12151			W.112	2 - 1 - 1
F and 1mA:-				
ZC 10225 ZA 20387	10D10972	W.6355	1mA Inst.	4 - 1 - 1
ZA 15237	10D414		F-4	1 - 4 - 1
G and 5mA:-				
ZA 5875 ZC 10223	10D826	W.4941	5mA	4 - 1 - 1
H and 10mA and MBH:-				
ZA 11111		W.5552	10mA with	4 - 1 - 1
P8B/1019			12 in. leads	4 - 1 - 1
P8B/1089		A.6630	10mA	4 - 1 - 1
ZA 20388			101H	1 - 1 - 1
ZA 4171			102H	1 - 2 - 1
ZA 14609			SH1A	1 - 1 - 1
ZC 27361			TH1A	1 - 1 - 1
ZA 23892			WH1	1 - 1 - 1
ZA 17696			4 x H.1	1 - 1 - 1 each
H UNITS:-				
		W.4061	H.1	1 - 1 - 1
WY 1343	10D10521		H.2	1 - 2 - 1
ZA 12466			H.4	1 - 4 - 1
ZA 16207	10D10522		H.5	1 - 5 - 1
ZA 11511			H.6	1 - 6 - 1
	10D1521	Tag No. TA117 W.4772	H.10	1 - 10 - 1

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Table 1001 (contd.)

M.O.S.	M.A.P.	AD.	Westinghouse cat. No.	Arrangement (see para.18)
ZA 11042			H.12	1 - 12 - 1
ZA 3448			H.16	1 - 16 - 1
ZA 11301	10D9643		H.20	1 - 20 - 1
WY 1157	10D952	(W.6641?)	H.25	1 - 25 - 1
		W.1449	H.50	1 - 50 - 1
ZC/AY/W.3901				
ZC 12781		W.3901	H.75	1 - 75 - 1
ZC 10227			H.100	1 - 100 - 1
MBH ASSEMBLIES:-				
		AD.6832	MBH/2	-
ZA 23559			MBH/4	-
ZA 18196			MBH/17	-
ZA 10803			MBH/43	-
ZA 13434			MBH/55	-
		A.838	A.51311	-
J UNITS:-				
ZA 20506	10D13214		J.10	1 - 10 - 1
WY 2280	10D1215		J.20	1 - 20 - 1
ZA 20863			J.25	1 - 25 - 1
ZC 12262)		W.4306	J.50	1 - 50 - 1
ZA 11214)				
ZA 14060	10D617	W.2627	J.176	1 - 176 - 1
BNF UNITS:-				
ZA 5869			2/2A	2 - 2 - 1
ZA 21751			1/6A	1 - 6 - 1
ZA 4791			2/6A	2 - 6 - 1
ZA 20505			2P/6A	2 - 6 - 1
ZA 20509		Tag No. 16	2N/6A	2 - 6 - 1
ZA 20523	10D15		1/12A	1 - 12 - 1
ZA 3160			4-1-1 BNF	4 - 1 - 1 BNF
ZA 11041			4-1-3 BNF	4 - 1 - 1 BNF
ZA 21087			4-4-1 BNF	4 - 4 - 1 BNF
ZA 16185			4/1-3-1 BNF	4 separate 1 - 3 - 1 BNF
ZA 11374			1-80-1 BNF	1 - 80 - 1 BNF
ZA 5944			M.3	4 - 1 - 1
ZA 5874			M.4A	4 - 1 - 1
		A.2012	Varistor	
FINNED B and D UNITS:-				
	10D10536		HT.17(=B.31)	2 - 30 - 1B
ZA 10912			HT.16(=D.31)	2 - 30 - 1D
ZA 3701	10D60		HT.15(=D.19)	2 - 18 - 1D
ZA 20386			HT.14(=D.11)	2 - 10 - 1D

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Table 1001 (contd.)

M.O.S.	M.A.P.	AD.	Westinghouse cat. No.	Arrangement (see para.18)
ZA 10913			D.27	2 - 26 - 1D
ZC 8254			4-12-1B	4 - 12 - 1B
ZA 11640	10D8630	AP.2829	B.33	2 - 32 - 1B
ZA 16137	10D9632		LT.4	4 - 2 - 3B
	10D8070		LT.5	4 - 4 - 2B
	10D170	Spec.5096 Drg.20515	LT.6	4 - 2 - 6B
ZA 4951			LT.9	2 - 2 - 2
ZA 5890			4-2-1 BLC	4 - 2 - 1B
A TYPE UNITS:-				
ZA 24096			4-4-2A	4 - 4 - 2A
ZA 21219			4-12-1A	4 - 12 - 1A
ZA 15851			4-16-1A	4 - 16 - 1A
ZA 21218 (ZC/10D/572 (VD.3942	10D572		2-8-3A 4-8-2A	2 - 8 - 3A 4 - 8 - 2A
ZA 18244			LT.10	4 - 4 - 3A
	10D8629		4-4-4A	4 - 4 - 4A
	10D356		1-8-9A	1 - 8 - 9A
	10D16		4-8-1A	4 - 8 - 1A

Table 1002 - Westinghouse copper oxide element data

Element	A.C. supply	Circuit	Load	Working temperature	Max. R.M.S. input volts	Max. D.C. output (mA)	D.C. output volts at max. current
Type A	Single-phase	Bridge	Inductive	N	8.0	750	6.0
	Three-phase	Bridge	Inductive	N	7.0	1000	7.6
Type B BNF (C.P.O. I/RA type)	Single-phase	Half-wave	Capacitive	N	1.0	50.0	-
				T	0.75	50.0	-
		Bridge	Inductive	N	4.0	100.0	2.5
				T	3.0	100.0	2.0
			Capacitive	N	4.0	70.0	-
				T	3.0	70.0	-
Type H	Single-phase	Half-wave	Inductive	N	3.5	10.0	3.5
			Capacitive	N	3.5	10.0	3.6
				T	3.1	7.0	3.3
		Voltage-dblr	Capacitive	N	4.0	10.0	7.4 (pair)
				T	3.5	7.0	-

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Table 1002 (contd.)

Element	A.C. supply	Circuit	Load	Working temperature	Max. R.M.S. input volts	Max. D.C. output (mA)	D.C. output volts at max. current
Type J	Single-phase	Half-wave	Capacitive	N	7.4	2.0	8.5
				T	5.5	2.0	5.7
		Voltage-dblr	Capacitive	N	7.4	2.0	17.0 (pair)
				T	5.5	2.0	11.0 (pair)
Type W	Single-phase	Half-wave	Inductive	N	6.0 (peak)	0.25	-
			Capacitive	N	6.0 (peak) across rectifier	0.25	-
		Voltage-dblr	Capacitive	N	12.0 (peak)	0.25	-
Type WX	Single-phase	Half-wave	Inductive	N	6.0 (peak)	0.10	-
			Capacitive	N	6.0 (peak)	0.10	-
		Voltage-dblr	Capacitive	N	12.0 (peak)	0.10	-

	Working temperature	A	B (NF)	F	G	H	J	W	WX
Max. reverse voltage	N	6.0	4.0	4.0	4.0	4.0	6.0	3.0	3.0
	T		3.25	3.25	3.25	3.25	5.0	2.5	2.5
Max. forward current (amps)	N	350mA	50mA			10mA	2mA	0.25mA	0.1mA
	T		50mA			7mA	2mA	0.25mA	0.1mA
Max. forward voltage drop when carrying max. forward current (as above) subject to a tolerance of +25% -20%	N	0.7				0.7	2.0	2.0	2.0
Max. value of reverse current when the max. allowable reverse voltage is applied	N	8mA				300uA	400uA	50uA	15uA

NOTE: In column headed working temperature - N indicates normal, i.e., a working temperature of 25°C. average and 35°C. maximum.

T indicates tropical, i.e., a sustained working temperature of 45°C.

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Table 1003 - Service reference numbers of Westinghouse Westalite rectifiers

M.O.S.	M.A.P.	AD.	Westinghouse Cat. No.	Arrangement (see paras. 46 and 49)
Z3/ZC.35879			2A20 (B.8830/2...)	2A.2-2-1-1
	Type No.140		2A ?	Unknown
	Type No.175		2A38	2A.3-1-1-2
ZA 22039			2A163	2A.2-2-1-4
ZA 2980			2A808	2A.3-2-1-1 + 3-2-1-1
	Type No.143		2A282	2A.3-2-2-2
ZA 21528			2A468	2A.3-2-6-1
ZA 21527			2A510	2A.1-1-8-5
Type No. 9) ZC 12425)			A 51502	2L.2-2-3-1
ZC 12603			A 51539	2L.2N-2-3-1
ZA 28195			3A45	3A.2-2-2-2
	Type No.194) 10D2007)		3A68	3A.2-2-6-1
ZC 18559			3A97	3A.2-2-8-1
ZC 10226			3A193	3A.2-2-16-1
		AP1867	MT 45	3A.2-2-1-4
	Type No.132) 10D1214)		4A16	4A.2-1-2-2
Z3/ZC 26310			4A44	
ZC 8658			4A68	4A.2-2-6-1
	Type No.152		4A98	4A.2-2-4-2
		AP.52304	4A132	4A.1-2-24-1
ZC 12426			4A168	4A.2-2-14+1
	Type No.131) 10D1213)		4A210 (A.50935)	4A.3-1-12-2
ZA 13100			4A1041	4A.2-2-1-2
		Ap 52402	4A1079 (B.9234/72...)	4A.2-2-5-2
	Type No.139		4A ?	
	Type No.189) 10D2002)		LT.41../2	4A.2-2-2-4 short fixing.
	Type No.170) 10D1739)	AP 4451	LT.41../3	4A.2-2-2-4 long fixing.
	Type No.191) 10D2004)		LT.42../2	4A.2-2-1-4 short fixing.
	Type No.190) 10D2003)		LT.42../3	4A.2-2-1-4 long fixing.
	Type No.193) 10D2006)		LT.43../2	4A.2-2-1-8 short fixing.

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Table 1003 (contd.)

M.O.S.	M.A.P.	AD.	Westinghouse Cat. No.	Arrangement (see paras. 48 and 49)
	Type No.192 10D2005		LT.43../3	4A.2-2-1-8 long fixing.
ZA 3701		W 1288	HT.41../3	4A.1-2-20-1
	Type No. 147		HT.42	4A.1-2-36-1
	Type No. 177		4B18	4B.2-2-2-1
		AP 56719	4B53	4B.1-2-10-1
	Type No. 178		4B223	4B.1-2-40-1
ZA 13099			4B317	4B.1-2-8-1 + 1-2-8-1
		AP 56210	4B1054	4B.2-2-5-1
		W 9260	A 51174	4B.2-2-8-1
		AP 56209	4C3	4C.1-2-2-1
ZA 25909			4C12	4C.1-2-4-1
		AP 53433	4C18	4C.2-2-2-1
		AP 55822	4C44	4C.2-2-4-1
ZC 10224			4C79	4C.1-2-14-1
ZA 22843			4C82	4C.1-1-30-1
	Type No. 176		4C88	4C.1-2-16-1
	Type No. 171		4C124	4C.2-2-10-1
ZA 26398		AP 53632	4C132	4C.1-2-24-1
	Type No. 92		4C144	4C.2-2-12-1
	Type No. 218		4C193	4C.2-2-16-1
	Type No. 142		4C1804	Not known 4C1084 = 3-2-1-4
ZC 8254			A 51048	4C.2-2-6-1
	Type No. 141		(B.9249/48..) 4C?	
ZA 21394			4D3	4D.1-2-1-1
ZA 23598			4D6	4D.1-1-3-1
ZA 23755			4D52	4D.2-2-6-1
	Type No. 205	AP 54169	4D60	4D.1-2-16-1
ZA 11202			4D64	4D.1-1-36-1
ZA 11202			4D65	4D.1-2-18-1
ZA 27895			4D133	4D.2-2-1-1
	174/275		4D134	4D.1-1-30-1
	10D2109		A.52437	4D.1-2-16-1
		AP 56211	5D37	5D.1-2-8-1

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Table 1004 - Westinghouse Westalite element ratings when used in A.C. circuits

Element	A.C. supply	Circuit	Load	Working temperature	Max. R.M.S. input volts	Max. output current (amperes)	D.C. output volts at max. current
2A	Single-phase	Half-wave	Inductive	N	16.0	3.75	6.0
				T	15.5	1.65	6.0
			Capacitive	T	9.0		
		Bridge	Inductive	N	16.0	5.0	12.0
				T	15.5	2.0	12.0
			Capacitive	T	15.0		
		Voltage-dblr	Capacitive	N	9.0		
				T	9.0		
	Three-phase	Half-wave	Inductive	T	14.0	2.75	
		Bridge	Inductive	T	13.6	2.75	
	Six-phase	Half-wave	Inductive	T	14.8	4.0	
3A	Single-phase	Half-wave	Inductive	N	16.0	0.825	6.0
				T	15.5	0.45	
			Capacitive	T	9.0		
		Bridge	Inductive	N	16.0	1.25	12.0
				T	15.5	0.60	12.0
			Capacitive	T	15.0		
		Voltage-dblr	Capacitive	N	9.0		
				T	9.0		
	Three-phase	Half-wave	Inductive	T	14.0	0.84	
		Bridge	Inductive	T	13.6	0.84	
	Six-phase	Half-wave	Inductive	T	14.8	1.20	
4A	Single-phase	Half-wave	Inductive	N	16.0	0.220	6.0
				T	15.5	0.100	6.0
			Capacitive	N	9.0	0.125	10.0
				T	9.0	0.045	10.0
		Bridge	Inductive	N	16.0	0.300	12.0
				T	15.5	0.160	12.0
			Capacitive	N	15.0	0.205	15.0
				T	15.0	0.110	15.0
		Voltage-dblr	Capacitive	N	9.0	0.145	16.0
				T	9.0	0.060	16.0
	Three-phase	Half-wave	Inductive	T	14.0	0.220	
		Bridge	Inductive	T	13.6	0.220	
	Six-phase	Half-wave	Inductive	T	14.8	0.300	
		Half-wave	Inductive	N	16.0	0.125	6.0
				T	15.5	0.060	6.0
			Capacitive	N	9.0	0.070	10.0
				T	9.0	0.025	10.0

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Table 1004 (contd.)

Element	A.C. supply	Circuit	Load	Working temperature	Max. R.M.S. input volts	Max. output current (amperes)	D.C. output volts at max. current
5B	Single-phase	Bridge	Inductive	N	16.0	0.150	12.0
				T	15.5	0.080	12.0
			Capacitive	N	15.0	0.125	15.0
				T	15.0	0.065	15.0
		Voltage-dblr	Capacitive	N	9.0	0.080	16.0
				T	9.0	0.030	16.0
	Three-phase	Half-wave	Inductive	T	14.0	0.110	
		Bridge	Inductive	T	13.6	0.110	
	Six-phase	Half-wave	Inductive	T	14.8	0.150	
5D	Single-phase	Half-wave	Inductive	N	16.0	0.060	6.0
				T	15.5	0.030	6.0
			Capacitive	N	9.0	0.030	10.0
				T	9.0	0.015	10.0
		Bridge	Inductive	N	16.0	0.075	12.0
				T	15.5	0.040	12.0
			Capacitive	N	15.0	0.070	15.0
				T	15.0	0.040	15.0
		Voltage-dblr	Capacitive	N	9.0	0.040	19.0
				T	9.0	0.020	19.0
	Three-phase	Half-wave	Inductive	T	14.0	0.055	
		Bridge	Inductive	T	13.6	0.055	
	Six-phase	Half-wave	Inductive	T	14.8	0.075	

NOTES:
(a) Inductive load is taken to be the same as the resistive load.
(b) The above ratings do not apply when the rectifier is used for battery charging.
(c) Although some ratings are given for types 2A and 3A in half-wave, voltage-doubler and bridge with reservoir condenser circuits, these circuits are not economical for large currents.
(d) The normal output voltage at full load in half-wave, voltage-doubler and bridge with reservoir condenser circuits, is determined by the value of the reservoir capacity and the frequency of the supply. The output voltages given above are therefore typical values which could be expected in a normal well-designed circuit.
(e) The voltages given for 3-and 6-phase circuits are the phase volts.
(f) Ratings given are for single elements.
(g) In column headed Working temperature - N indicates normal, i.e., a working temperature of 25°C, average and 35°C. maximum.
- T indicates tropical, i.e., a sustained working temperature of 55°C.

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Table 1005 - Westinghouse Westalite element ratings when used in D.C. circuits

	2A	3A	4A	5B	5D
Max. reverse voltage (volts) at 35°C.	15.0	15.0	15.0	15.0	15.0
Max. reverse voltage (volts) at 55°C.	15.0	15.0	15.0	15.0	15.0
Max. forward current (amps.) at 35°C.	4.5	1.0	0.265	0.150	0.075
Max. forward current (amps.) at 55°C.	2.0	0.55	0.125	0.070	0.040
Max. forward voltage drop when carrying max. forward current (as above), subject to a tolerance of +25% - 20% at 35°C.	1.02	1.05	1.10	1.17	0.91
-do- at 55°C.	0.70	0.73	0.73	0.77	0.55
Max. value of reverse current (amps.) when the max. reverse voltage is applied at 35°C.	0.37	0.077	0.017	0.011	0.011
-do- at 55°C.	0.74	0.154	0.033	0.022	0.022

NOTES: (a) The value of reverse current given in the above table is the maximum to be expected from any individual element. When more than three elements are connected in series, it is unlikely that all of them will be just within the limits, and the value of the reverse current will probably be about half of that given in the above table. Similarly, when a number of elements are connected in parallel, the total reverse current is unlikely to be more than half the sum of the values given in the table.

(b) Ratings given are for single elements.

Table 1006 - V.A.O.S reference numbers of Sentercel (S.T. and C. selenium) rectifiers

Rectifier Selenium No.	V.A.O.S. reference	S.T. and C. 280/LU code	S.T. and C. arrangement code (see paras. 74 and 75)
1	ZA 5811	280/LU 666A	B18-2-1X
2	ZA 4920	" 167C	H35-1-2X
2A	ZA 26512	" 167C	H35-1-2X
3	ZA 4841	" 673A	V45-2-2X
4	ZA 3425	" 751A	D35-18-1X
5	ZA 3426	" 556B	D45-18-1X
6	ZA 3427	" 427B	H45-18-1FX
7	ZA 3429	" 679A	H25-16-1X
8	ZA 3430	" 714A	B18-6-1X
9	ZA 3198	" 417B	D18-18-1X
10	ZA 2981	Heayberd rectifr.	-
11	ZA 10006	" "	
12	ZA 11112	280/LU 404A	H45-50-1X
13	ZA 11202	" 518A	D18-15-1X

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Table 1006 (contd.)

Rectifier, selenium, No.	V.A.O.S. reference	S.T. and C 280/LU code	S.T. and C. arrangement code (see paras. 74 and 75)
14	ZA 11696	280/LU 433B	H25-18-1X
15	ZA 11818	" 1076A	H35-11-1X
16	ZA 12281	" 546B	D18-11-1X
17	ZA 12507	" 742A	H18-20-1X
18	ZA 12731	" 642B	B18-4-1X
18A Replaced by No.63	ZA 17642	" -	-
19	ZA 12732	" 670A	B45-1-2X
20	ZA 13068	" 608A	B18-10-1X
21	ZA 13069	" 393A	H18-3-1X
22	ZA 13070	" 607A	B25-6-1X
23	ZA 13328	" 353B	D18-5-1X
24	ZA 13471	" 423A	H45-24-1X
25	ZA 13472	" 427A	H45-18-1FX
26 (Refer No.19)	ZA 13473	" 670A	B45-1-2X
27	ZA 13474	Will be allocated if reordered	B45-10-1B2X
28	ZA 13435	280/LU 491A	D25-17-1X
29	ZA 14315	Will be allocated if reordered	D18-18-1B2X
30	ZA 14316	" "	D18-1-1X
31	ZA 14918	280/LU 528A	B45-4-1B2X
32	ZA 14602	" 793A	D45-10-1X
33	ZA 14603	Will be allocated if reordered	B45-1-1X
34	ZA 14604	" "	H18-6-1X
35	ZA 14751	280/LU 724A	B35-9-1X
36	ZA 15265	" 403A	H18-4-1X
37	ZA 15286	Will be allocated if reordered	B112-1-5AL
38	ZA 15406	280/LU 549A	H25-28-1X
39	ZA 15524	" 395B	H18-1-1X
39A	ZA 18653	" 395C	H18-1-1X
40	ZA 15811	" 757B	H18-22-1X
41	ZA 16069	" 708B	D18-9-1X
41A	ZA 18654	" 708C	D18-9-1X
42	ZA 16070	" 744A	H35-20-1X
43	ZA 16182	" 536B	H35-21-1X
44	ZA 16183	Will be allocated if reordered	H25-16-1X
45	ZA 16184	" "	B18-1-1X
46	ZA 16235	280/LU 725A	D35-9-1X
47	ZA 19606	Will be allocated if reordered	D67-10-1X
48	ZA 19607	" "	D112-3-2AL
49	ZA 19608	" "	D112-2-5AL

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Table 1006 (contd.)

Rectifier, selenium, No.	V.A.O.S. reference	S.T. and C. 280/LU code	S.T. and C. arrangement code (see paras. 74 and 75)
50	ZA 19756	280/LU 715A	H18-2-1X
51	ZA 19889	Will be allocated if reordered	B112-6-1AL
52	ZA 20041	" "	H45-40-1X
53	ZA 20058	280/LU 608A	B18-10-1X
Refer No.20			
54	ZA 20152	" 720A	D35-20-1X
55	ZA 20389	Will be allocated if reodered	B45-2-1X
56	ZA 20478	280/LU 725B	D35-9-1X
57	ZA 20479	" 537B	H35-26-1X
58	ZA 20588	Will be allocated if reordered	H25-32-1X
59	ZA 20589	" "	D25-14-1X
60	ZA 21079	280/LU 252A	B45-9-1X
61	ZA 21053	Will be allocated if reordered	B67-12-1X
62	ZA 21427	" "	D35-20-1X
63	ZA 22059	280/LU 691B	B18-4-1X
64	ZA 22524	" 692B	B84-1-3X
65	ZA 23560	" 643A	B18-3-1X
66	ZA 23561	" 644A	B25-6-1X
67	ZA 23562	" 532B	D18-12-1X
68	ZA 23563	" 642A	B18-4-1X
75	ZA 26201	" 417 D	D18-18-1X
	ZB 0281	" 186A	B112-5-1CX
	ZB 10984	" 443B	H112-12-2AL
	ZC 8254	" 650A	B25-8-1B2X
	ZC 10223	Westinghouse rect.	-
	ZC 10225	" "	-
	ZC 10227	" "	-
Rectifier, metal, No.7	ZC 12603	280/LU 545A	B84-2-1X
	ZC 18209	" 493A	D67-2-4FX
	ZC 18210	" 1195A	D84-10-1FX
Rectifier No.76	ZC 22110	" 13B	D25-1-1X
	ZC 22235	" 250A	B45-7-1X
	ZC 23083	" 812A	V84-7-1X
	ZC 23420	" 405H	H25-2-1X
	ZC 24733	" 478C	H18-25-1X
	ZC 25319	" 699A	H45-12-1E
	ZC 25329	" 818A	D25-2-1L
	ZC 25365	" 405F	H25-2-1L
	ZC 25555	" 845A	H18-48-1B2R
	ZC 25631	" 811A	H112-2-3X
	ZC 26309	" 835A	H84-17-1X
	ZC 26778	" 818C	D25-2-1X

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Table 1006 (contd.)

Rectifier, selenium No.	V.A.O.S. reference	S.T. and C. 280/LU code	S.T. and C. arrangement code (see pars. 74 and 75)
	ZC 27058	280/LU 801D	B25-3-1X
	ZC 27280	" 742C	H18-20-1B2L
	ZC 27461	" 571A	D18-13-1X
	ZC 27462	" 572A	B67-12-1PX
82	ZC/AM/10D/13184		
83	ZC/AM/10D 13185	" 417A	D18-8-1X
84	ZC/AM/10D/13186	" 444A	H18-70-1X
113	ZC/AM/10DB/1143	" 576A	B45-2-2FX
	ZC/AY/W3398	" 1004A	H18-36-1X
	ZC/AY/W3960	" 1035B	H18-36-1B2X
	XA 9436	" 22B	H35-6-2EB2
	XC.M.140	" 609B	B112-2-2X

NOTE 1: The 280/LU Code MUST BE USED when reference to a particular rectifier stack is made

NOTE 2: Rectifiers previously designated by X, E, E.T.F. are now replaced by those designated by L, but may still be obtained as replacements. L type dimensions are not identical with X, E, E.T.F.

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Table 1007
Sentercel (S.T. and C. selenium)
L type disc ratings in A.C. circuit

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Table 1007 - Sentercol (S.T. and C. selenium) L type disc ratings in A.C. circuits

Element	A.C. supply	Circuit	Load	Working temperature	Max. R.M.S. input volts	Max. D.C. output current	D,C. output volts at max. current	Min. resistance loading at max. input volts
18mm.	Single-phase	Half-wave	Inductive	N	18.0V	40mA	7.5V	184 Ω
				T	14.4V	19mA	6.0V	310 Ω
		Bridge	Inductive	N	18.0V	75mA	14.0V	184 Ω
				T	14.4V	35mA	11.0V	317 Ω
		Voltage-dblr *	Capacitive	N	18.0V	30mA	15.0V	
				T	14.4V	14mA	12.0V	
	3-phase	Half-wave	Inductive	N		100mA		
		Bridge	Inductive	N		110mA		
25mm.	Single-phase	Half-wave	Inductive	N	18.0V	75mA	7.5V	98.3 Ω
				T	14.4V	35mA	6.0V	169 Ω
		Bridge	Inductive	N	18.0	150mA	14.0V	92.2 Ω
				T	14.4V	70mA	11.0V	
		Voltage-dblr *	Capacitive	N	18.0V	60mA	15.0V	
				T	14.4V	28mA	12.0V	
	3-phase	Half-wave	Inductive	N		200mA		
		Bridge	Inductive	N		220mA		
35mm.	Single-phase	Half-wave	Inductive	N	18.0V	150mA	7.5V	49.4 Ω
				T	14.4V	70mA	6.0V	85 Ω
		Bridge	Inductive	N	18.0V	300mA	14.0V	46.5 Ω
				T	14.4V	140mA	11.0V	80 Ω
		Voltage-dblr *	Capacitive	N	18.0V	120mA	15.0V	
				T	14.4V	56mA	12.0V	
	3-phase	Half-wave	Inductive	N		400mA		
		Bridge	Inductive	N		450mA		
45mm Figs. in brackets are for 45-F	Single-phase	Half-wave	Inductive	N	18(18)V	300(500)m A	7.5(7.5)V	24.6(14.6) Ω
				T	14.4(14.4)V	141(235)mA	6.0(6.0)V	42(25) Ω
		Bridge	Inductive	N	18(18)V	0.6(1.0)A	14(13.5)V	23.25(13.42) Ω
				T	14.4(14.4)V	282(470)mA	11(11)V	40(23.3) Ω
		Voltage-dblr *	Capacitive	N	18V	250mA	20V	
				T	14.4V	118mA	16V	

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Table 1007 (contd.)

Element	A.C. supply	Circuit	Load	Working temperature	Max. R.M.S. input volts	Max. D.C. output current	D.C. output volts at max. current	Min. resistance loading at max. input volts
45mm. Figs. in brackets are for 45-F	3-phase	Half-wave	Inductive	N		0.8A(1.3A)		
		Bridge	Inductive	N		0.9(1.5)A		
67mm. Figs. in brackets are for 67-F arrangement	Single phase	Half-wave	Inductive	N	18(18)V	0.6(1.0)A	7.5(7.5)V	12.33(7.28)Ω
				T	18(18)V	282(470)mA	7.5(7.5)V	26.6(15.8)Ω
		Bridge	Inductive	N	18(18)V	1.2(2.0)A	14.0(13.5)V	11.62(6.75) Ω
				T	18(18)V	564(940)mA	14.5(14.0)V	25.4(15.0) Ω
	3-phase	Half-wave	Inductive	N		1.6(2.6)A		
		Bridge	Inductive	N		1.8(3.0)A		
84mm.	Single-phase	Half-wave	Inductive	N	16V	1.2A	6.5V	5.34 Ω
				T	16V	56mA	6.5V	11.6 Ω
		Bridge	Inductive	N	16V	2.4A	12V	4.89Ω
				T	16V	1.128A	12V	10.85Ω
	3-phase	Half-wave	Inductive	N		3.2A		
		Bridge	Inductive	N		3.6A		
84-F Figs. in brackets are for types 84 C, K or A	Single-phase	Half-wave	Inductive	N	16(16)V	1.5(3.0)A	6.5(6.0)V	4.25(2.05) Ω
				T	16(16)V	0.705(1.41)A	6.5(6.5)V	9.23(4.53) Ω
		Bridge	Inductive	N	16(16)V	3.(6)A	11.5(10.5)V	3.85(1.75) Ω
				T		1.41(2.82)A	12.0(11.5)V	8.6(4.12)Ω
	3-phase	Half-wave	Inductive	N		4.0(8.0)A		
		Bridge	Inductive	N		4.5(9.0)A		
112mm. Figs. in brackets are for types 112 C,K or A	Single-phase	Half-wave	Inductive	N	15(15)V	2.0(5.0)A	6.0(6.0)V	2.99(1.14) Ω
				T	15(15)V	0.94(2.35)A	6.0(6.0)V	6.47(2.52) Ω
		Bridge ≠	Inductive	N	15(15)V	4.0(10.0)A	11.0(10.0)V	2.71(0.98) Ω
				T	15(15)V	1.88(4.7)A	11.5(10.5)V	6.0(2.28) Ω
	3-phase	Half-wave	Inductive	N		5.3(13)A		
		Bridge	Inductive	N		6.0(15)A		

NOTES: (a) * Voltage-doubler circuits. The A.C. input voltage is dependent on the capacity used.

(b) D.C. output column gives volts per arm per disc, i.e., a rectifier consisting of a total of two discs, 1 per arm, will give 40V D.C. output from 18V R.M.S. input.

(c) Ratings given are per disc.

(d) The rating of 112C and K must be reduced to 80% of the above values when used on single-phase supplies for battery charging.

(e) In the column headed Working temperature - N indicates normal, i.e. a working temperature of 25°C. average and 35°C. maximum.
- T indicates tropical, i.e., a sustained working temperature of 55°C.

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Table 1008
Sentercel (S.T. and C. selenium) type elements
Test figures and D.C. blocking characteristics

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Table 1008 - Sentercel (S.T. and C. selenium) type elements.
Test figures and D.C. blocking characteristics

Element type	Performance at 35°C.												Performance at 55°C.											
	18	25	35	45	45F	67	67F	84	84F	84C K&A	112	112C K&A	18	25	35	45	45F	67	67F	84	84F	84C K&A	112	112C K&A
Max. reverse D.C. volts per disc	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Max. forward D.C. amps. for test and blocking purposes	.06	.12	.23	.47	.78	.9	1.5	1.8	2.3	4.5	3.1	7.5	.028	.056	.108	.22	.366	.422	.705	.845	1.08	2.115	1.46	3.52
Max. forward D.C. volts drop at max. current (volts)	1.44	1.44	1.06	1.08	1.44	1.08	1.42	1.03	1.27	1.8	1.02	1.76	1.01	.99	.86	.79	.96	.78	.95	.72	.76	1.14	.7	1.1
Max. forward D.C. resistance at max. current (Ω)	24	12	4.6	2.3	1.85	1.2	.95	.57	.55	.4	.33	.235	36	17.5	8	3.6	2.6	1.85	1.34	.85	.7	.54	.48	.313
Max. reverse * current at max. D.C. reverse volts (mA)	7	12	30	55	55	120	120	200	200	200	350	350	7	12	30	55	55	120	120	200	200	200	350	350
Min. reverse resistance at max. reverse D.C. volts (Ω)	1715	1000	400	220	220	100	100	60	60	60	34.3	34.3	1715	1000	400	220	220	100	100	60	60	60	34.3	34.3
Min. forward ≠ current at max. A.C. R.M.S. volts, using a load as in Table 7 in half-wave circuit (mA)	38	71	142	285	475	570	955	1140	1430	2850	1900	4750	18	33	66	134	223	268	446	538	670	1340	835	2230
Min. forward ≠ current at max. A.C. R.M.S. volts, using a load as in Table 7 in bridge circuit (mA)	71	142	285	570	950	1140	1900	2280	2850	5700	3800	9500	33	66	134	268	446	538	895	1072	1340	2680	1790	4460

NOTES: * (a) Values given in table apply 5 seconds after application of reverse voltage. The initial values depend on the previous history of the discs and are approximately 0.4 times the above figures.

≠ (b) Current measurements made with moving-coil instruments reading mea

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Table 1009 - Types of metal rectifier used in various Service equipments

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Aerial unit G (W.S. No. 33)	ZA 4920 ZA 5875		Selenium No. 2 5mA (Instr)
Amplifiers, R.F., No. 2, Mks. 1 and 2 (and Inductance, aerial tuning, No. 1)	ZA 5875 ZA 5938 ZA 17696		5mA (Instr) W.6 S.H.1.A
Apparatus, carrier telephone (1 + 4) Mks. 1 and 2 ZA 14603	ZA 1685 ZA 14604 ZA 16182 ZA 14603 ZA 16183 ZA 16184	3 3 4 1 8 2	4/1/3/1 Selenium No. 34 Selenium No. 43 Selenium No. 33 Selenium No. 44 Selenium No. 45
App., V.F. telegraph, 3-channel, duplex, No. 2	ZA 23560 ZA 25005 ZA 23561 ZA 23562	2 16 2 2	Selenium No. 65 Metal, W6, wire-ended Selenium No. 66 Selenium No. 67
App,, V.F. telegraph, S + Sx, No. 3	ZA 5877		W.X.6
App., V.F. telegraph, S + Dx, No. 1C	YB 01488 ZA 3428 ZA 5938 ZA 3429 ZA 3430	1 8 4 4	Rectifier assembly No. 1 W.12 W.6 Selenium No. 7 Selenium No. 8
App., V.F. telegraph, S + Dx, Nos. 2C and 2W	ZA 23560 ZA 25005 YB 03206 ZA 23559 ZA 23563 ZA 23562 ZA 23561	2 16 2 1 1 2 4	Selenium No. 65 Metal, W.6, wire-ended Rectifier, metal, F1, special Rectifier, metal, MBM4-2-1 Selenium No. 68 Selenium No. 67 Selenium No. 66
Amplifier, film recorder, No. 1	ZA 20506 ZA 20505 ZA 20507		J.10 2.P.6.A. 2.N.6.AY.
Apparatus, V.F. telegraph, 3-ch duplex, terminals, group 2	ZA 13069 ZA 13068 ZA 13070	24 4 8	Selenium No. 21 Selenium No. 20 Selenium No. 22

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Table 1009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Apparatus, telegraph, 2-tone, Mk. 2	ZA 10803	2	MBH/4-1-1/ 4-1-1.N.
	ZA 5873	1	4-4-1B
	ZA 5944	1	M.3
	ZA 5877	8	W.X.6
Apparatus, C.T. (1 + 1) C inert	YB 01847	1	Rectifier, bridge, No. 2
... ... active	YB 00470	2	Rectifier, bridge, No. 1
Amplifiers, R.F., No. 1, Mks. 1 and 2	ZA 14751	1	Selenium No. 35
Apparatus, selective carrier, No. 1	ZA 12731	1	Selenium No. 18
	ZA 27643	4	Selenium 280-LU-645A
	ZA 27644	2	Selenium 280-LU-646A
A.C.T. (1 + 1) No. 2W terminal, active	YB 00470	2	Rectifier, bridge, No. 1
	ZA 12507	4	Selenium No. 17
	ZA 11042	1	H.16
	ZA 25005	2	W.6 (wire-ended)
Amplifier, film reproducer, No. 1	WY 1157	1	H.50
A.C.T. (1 + 4)T, Mk. 2 terminals	ZA 14603	1	Selenium No. 33
	ZA 16182	4	Selenium No. 43
	ZA 16183	4+4	Selenium No. 44
	ZA 16184	1+1	Selenium No. 45
	ZA 14604	1	Selenium No. 34
	ZA 16185	1+2	Metal 4/1/3/1
	ZA 14604	2	Selenium No. 34
A.C.T. (1 + 1)E terminals, inert	YB 03027	1	Unit, rectifier, metal, H.I.D.
A.C.T. (1 + 1)E terminals, active	YB 03006	1	Unit, rectifier, selenium No. 17A
	ZA 12507	4	Selenium No. 17
	ZA 5938	2	W.6
	YB 03070	2	Unit, rectifier, SG1A
	ZA 11042	4	Rectifier, metal, H.16

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Table 1009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
App., L.S. Parmeko type No.5	ZA 20588 ZA 20589	4 2	Selenium No.58 Selenium No.59
A.C.T. (1 + 1)W terminals, inert	YB 01847	1	Rectifier bridge, No.2
A.C.T. (1 + 1)W terminals, active, Mk. 1	ZA 11042 ZA 5938 ZA 12507 YB 00470	4 2 1 2	H.16 W.6 Selenium No.17 Rectifier, bridge, No.1
App., V.F. telegraph, 3-ch, Dx, terminals, group 1	ZA 13069 ZA 13068 ZA 13070	24 4 8	Selenium No.21 Selenium No.20 Selenium No.22
Aerial coupling equipment aerial unit F	ZA 12018	1	Rectifier, meter
B.F.O. No. 1, Mk. 1 ... ... Mks. 1* and 2	ZA 5875 ZA 5875		5mA meter H.10 5mA meter
Battery charger, 12V, 30A, No. 1	ZA 10006		Selenium No.11
Battery charger, 240V, 10A, No. 2	ZA 29201	4	Selenium 2A/515
B.F.O. No. 5	ZA 5875		5mA meter
Battery charger, 60V, 10.5A No.1	ZA 21219 ZA 21218	6 6	Metal 4-12-1A Metal 2-8-3A
Bridges, test, Avo, No. 1 Mks.1 and 2	WY 1157 ZA 21533	1 (Mk.2 only)	H.50 W.X.2
Battery charger, 165V, 15A, No. 1	ZB 10984	8	Metal H112-12-2A
Battery charger, 24V, 10A, No. 1	ZA 19608	1	Selenium No.49
Battery charger, 110/220V A.C., No. 1 Battery charger, 110/220V A.C.,	ZB/M86/AX12 ZB/M86/AY12	4 4	Rectifier, metal, 4xH 84-3-2ATF Rectifier, metal, 4xH84-17-1ATF
Battery charger, 12V, 10A, No.1	ZA 2981	1	Selenium No.10
Charging set, lightweight, 80W	XC/M.140/280 LU 609B		Rectifier, iron, Se. type 280/LU 609B

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Table 1009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Electrolytic capacitance bridge No. 1			
Exchanges, C.B. multiple (W.D.)	ZA 5869	3	Rectifier, metal, 2/2A
Unit, type N positions	ZA 26475	1	Rectifier, metal, 4/6A
	ZA 20523	2	Rectifier, metal, 1/12A
	ZA 21751	1	Rectifier, metal, 1/6A
	ZA 26474	1	Rectifier, metal, 1/2A
Exploders, dynamo, condenser Mks. 1 and 2	ZA 11214	1	Rectifier, metal, J.50
Instruments, testing, Ferranti, universal 16-range, Mks. 1 and 1*	ZC 10225	1	Rectifier, metal Instr. 1mA, No.1
	or ZA 20387	1	Rectifier, metal, 1mA
Instrument, testing, Avominor, universal, 22-range	ZA 5875	1	5mA instr.
Instrument, testing, Avometer, universal, 40-range	ZA 11111	1	10mA metal.
	WY 1343	1	H.8
Instrument, testing, Avometer, universal, 46-range	ZA 5875		5mA instr.
	WY 1343		H.2
Keyboard, multiphone, AD 1316	ZA 5869		Metal 2/2A
Locator, mine, No. 1	ZA 15265	1	Selenium No. 36
Meter, output power, No. 1	ZA 20871	4	WX.1
Meter, output power, No. 2, Mk. 2	ZC 10225	1	Rectifier, metal instr. 1mA, No. 1
Meter, output power, No. 2, Mk. 1	ZA 20871	4	W.X.1
Meter, output power, No. 3, Mk. 1	ZC 10225	1	Rectifier, metal instr. 1mA, No. 1
Power supply units No. 5, Mks. 1 and 1*	ZA 18654	1	Selenium No. 41A
	ZA 18653	1	Selenium No. 39A

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Table 1009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Power supply unit, No. 1, Mk. 1	ZA 14798	1	Selenium 20/45/40/1 (Complete bank of 20 rects.)
Power supply unit No. 4, Mk. 2	ZA 22843	4	Selenium 4C/82
Power supply units No. 4, Mks. 1 and 1* (for W/S No. 22)	ZA 15406 or ZA 22843	4 4	Selenium No. 38 Selenium 4C/82
R.109	ZA 5944		Type M.3
R.109A, B and C	ZA 5944 ZA 20863 ZA 11202		Type M.3 Type J.25 Selenium No. 13
R.206, Mk. 1	ZA 5944		Type M.3
Repeaters, carrier telephone, No. 2T and No. 1T, Mk. 2	ZA 16070	4	Selenium No. 42
Repeater, C.T. (1 + 1) C, 2-wire	YB 02501	1	Unit, rect. selenium, No. 17
Reproducers, film wireless, No. 1, Mks. 1 and 2	ZA 20523		1/12A
R.104	ZA 5938	2	W.6
Repeater, telephone, 8-cct, Mk. 2	ZA 14602 ZA 14604	1 8	Selenium No. 32 Selenium No. 34
Repeater, ringing, No. 1	ZA 12731 ZA 12732	2 1	Selenium No. 18 Selenium No. 19
Repeater, telephone, 2-cct, No. 1W	ZA 12281	1	Selenium No. 16
Radio link S.R. - As for Wireless set No. 11 Repeaters, C.T. (1 + 1)W, 2-wire Mks. 1 and 2 also No. 2W also (1 + 1)E	ZA 12507	4	Selenium No. 17
Reception set, Marconi D.F.G.20	ZA 15237	1	Rect., Metal, F.4
R.208(P.S.U.No. 17)	ZA 11696	4	Selenium No. 14
Repeaters, V.F. telegraph, No. 1 Mks. 1 and 2	ZA 16069	1	Selenium No. 41

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Table L009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Reproducer, film wireless, No. 1 Mks. 1 and 2	ZA 20523	1	1/12A
Recorder, film wireless, No. 1, Mk. 1	ZA 20523	1	1/12A
Repeater, C.T., No. 1, Mk. 2 Repeater, C.T., No. 2	ZA 16070 ZA 24759	4 4	Selenium No.42 Selenium No.69
R.308	ZA 25164 ZA 25165	1 1	Selenium No.70 Selenium No.71
Reception set, Marconi, RC.67	ZA 5877	1	W.X.6
Repeater, C.T., No. 1, Mk. 1	ZA 16235	1	Selenium No.46
Repeaters, telephone, 2-cct, No. 1C, Mks. 1 and 1*	ZA 12281	1	Selenium No.16
Supply unit, rectifier, No. 4	ZA 3425 ZA 3426 ZA 3427		Selenium No.4 Selenium No.5 Selenium No.6
Supply unit, rectifier, No. 13	ZA 22524		Selenium No.64
Supply unit, rectifier, No. 11	ZA 19606 ZA 19607		Selenium No.47 Selenium No.48
Supply unit, rectifier, No. 6	ZA 2980	1	Rect., metal, 2A/808
Switchboard, command, 200-line	ZA 4791 ZA 5869	20 1	Rect., metal, 2/6A Rect., metal, 2/2A
Switchboard, position, magneto $\frac{10+50}{60}$ No. 1 and Unit, switchboards, magneto, multiple, 360-line, No.1	ZA 4791 ZA 5869	10 1	Rect., metal, 2/6A Rect., metal, 2/2A
Switchboards, F and F, 20-, 40- and 60- line, Mk. 2	ZA 5869	1	Rect., metal, 2/2A
Switchboards, U.C., 6-line, Mk. 2, and 10- line, Mk. 2	ZA 21087	1	Rect., metal, 4/4/1 BNF
Supply unit, rectifier, No. 7	ZA 13100 ZA 13099	1 1	Rect., metal, A50935 Rect., metal, A50934

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Table 1009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Tester, T.M.S., No. 3	ZA 18196	1	MBH 4/1/1
Telephone set, A.A., No. 1	ZA 5869		Rect., metal, 2/2A
Tester, T.M.S., No. 1, Mk. 1 Tester, T.M.S., No. 1, Mk. 2	ZA 5938 ZA 11696	4	Rect., metal, W6 Selenium No. 14
Target control equipment, Mk. 2	ZA 16207	3	H.5
Test set, insulation, No. 3, Mk. 1	ZA 20387	1	Metal 1mA
Tester, valve, Avo, No. 1	ZA 21751	1	Metal 1/6A
Target control equipment, Mk. 1	ZA 5938	2	W.6
Units, signalling V.F., No. 3, Mks. 1, 2 and 3	ZA 21087	1	4/4/1.BNF
Unit, master oscillator, No. 1	ZA 21427		Selenium No. 62
Undulator, U.G.6A, No. 3	ZA 11374	4	Metal 1-80-1 BNF
Wireless set No. 33 (Aerial unit G)	ZA 4920 ZA 5875		Selenium No. 2 5mA
Wireless set No. 11	ZA 5877 ZA 5944		WX6 M.3
Wireless set No. 19, Mk. 2	 ZA 12151 ZA 4920		A.50962 W.M.112 Selenium No. 2
Wireless set No. 19, Mk. 3	ZA 5875 ZA 17696		5mA meter S.H.1.A.
Wireless sets No. 18, Mks. 1, 2, 3	ZA 5877 ZA 492C		W.X.6 Selenium No. 2
Wireless set No. 38	ZA 5877		W.X.6
Wireless set No. 5 (remote control unit) (keying units V.F.) Wireless set No. 5 L.P. (Plessey)	ZA 3448 ZA 3701 ZA 5873 ZA 4951	1 1 1 1	H.20 H.T.15 4/4/1B L.T.9
Wireless, remote control units, G Nos. 1 and 2	ZA 15524	3	Selenium No. 39

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Table 1009 (contd.)

Equipment	Rectifier		
	V.A.O.S. reference	Number per equipment	Type
Wireless sets No. 12, Mks. 1 and 2	ZA 11214 ZA 3198 ZA 20152 ZA 22059	1 2 2 1 (Mk. 2 only)	J.50 Selenium No. 9 Selenium No. 54 Selenium No. 63
Wireless sets No. 9, Mks. 1 and 1*	ZA 5875 ZA 5877	1 1	Rect., metal, 5mA W.X.6
Wireless set No. 78	ZA 28101	1	Rect., metal, W4
Wavemeter, class D,No. 1, Mks. 2 and 2*	ZA 13328	2	Selenium No. 23
Wireless set No. 36 line coupling unit	ZA 5877	1	W.X.6
Wireless sender H.S.1, Mk. 1 and associated units	ZA 13471 ZA 13472 ZA 13473 ZA 13474 ZA 14315 ZA 14316 ZA 14918	20 8 1 1 1 1 2	Selenium No. 24 Selenium No. 25 Selenium No. 26 Selenium No. 27 Selenium No. 29 Selenium No. 30 Selenium No. 31
Wireless, remote control unit, F 1 and2	ZA 19756	2	Selenium No. 50
Wireless set No. 22 (Inductance unit, R.F., No. 7)	ZA 5875 ZA 17696	1 1	Metal, 5mA SHIA
Wireless set No. 21	ZA 5944 ZA 4921 ZA 11202	1 1 2	M3 W.1 Selenium No. 13
Wireless senders S33, Mks. 1 and 2	ZA 5875 ZA 4920 ZA 11112	1 1 10	Metal, 5mA Selenium No. 2 Selenium No. 12
Wireless set No. 28	ZA 5877 ZA 5875	1 1	W.X.6 Metal, 5mA
Wireless set No. 5 H.P.	ZA 4951 ZA 5873	1 1	L.T.9 4/4/1B

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Fig. 1001
Metal rectifier circuits and data

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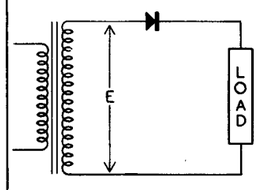
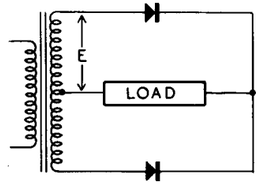
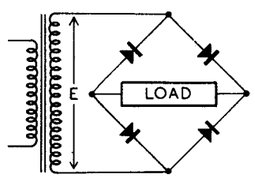
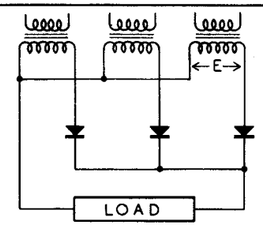
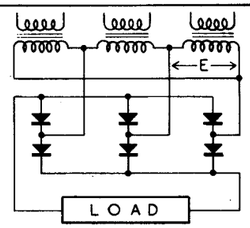
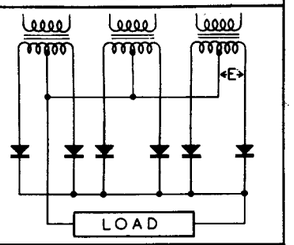
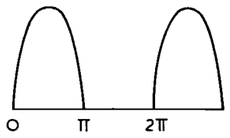
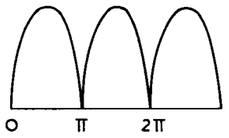
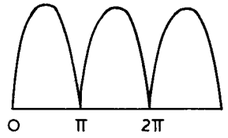
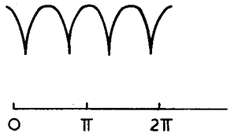
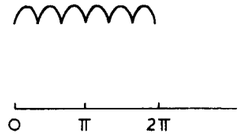
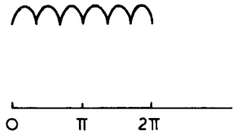
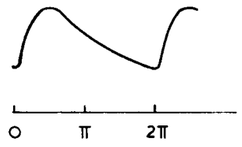
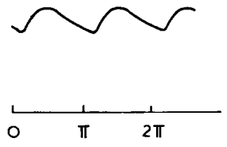
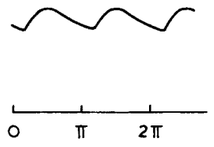
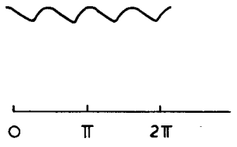
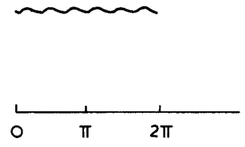
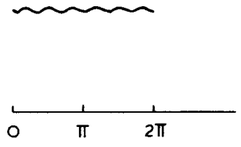
CIRCUIT	SINGLE-PHASE HALF - WAVE	SINGLE - PHASE CENTRE - TAP	SINGLE-PHASE BRIDGE	3-PHASE HALF-WAVE	3-PHASE BRIDGE	3-PHASE CENTRE - TAP
RECTIFIER CONNECTION						
RESISTIVE LOAD APPROXIMATE OUTPUT VOLTAGE WAVE FORM						
CAPACITIVE LOAD APPROXIMATE OUTPUT VOLTAGE WAVE FORM						
REQUIRED NUMBER OF PLATES IN SERIES WHERE E = APPLIED A.C. VOLTS (RMS) V = RATED VOLTS (RMS) PER PLATE	RESISTIVE LOAD $\frac{E}{V}$	RESISTIVE LOAD $\frac{2E}{V}$	RESISTIVE LOAD $\frac{E}{V}$	RESISTIVE LOAD $\frac{\sqrt{3}E}{V}$	RESISTIVE LOAD $\frac{E}{V}$	RESISTIVE LOAD $\frac{2E}{V}$
	CAPACITIVE LOAD $\frac{(1+\sqrt{2})E}{V}$	CAPACITIVE LOAD $\frac{2\sqrt{2}E}{V}$	CAPACITIVE LOAD $\frac{\sqrt{2}E}{V}$	CAPACITIVE LOAD $\frac{(1+\sqrt{2})E}{V}$	CAPACITIVE LOAD $\frac{\sqrt{2}E}{V}$	CAPACITIVE LOAD $\frac{2\sqrt{2}E}{V}$
THEORETICAL RIPPLE	121%	48·3%	48·2%	18·3%	4·2%	4·2%
MAXIMUM THEORETICAL OUTPUT EFFICIENCY $\frac{E_O^{DC} I_O^{DC}}{E_O^{AC} I_O^{AC}}$	40·5%	81·1%	81·1%	96·8%	99·8%	99·8%

T J·282 / 1-1001

Fig. 1001 - Metal rectifier circuits and data

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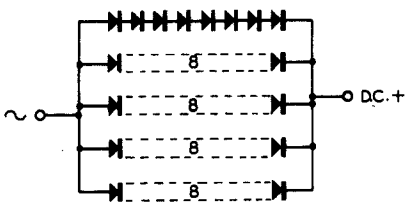
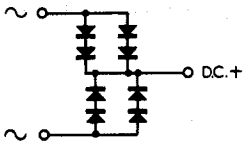
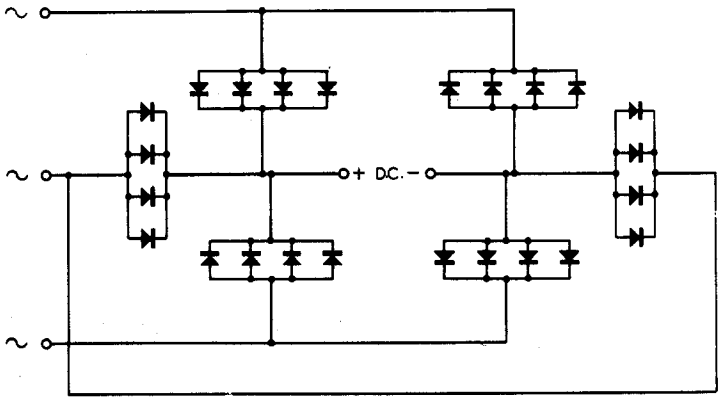


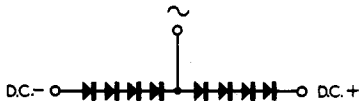
ARRANGEMENT 1-1-8-5 HALF-WAVE



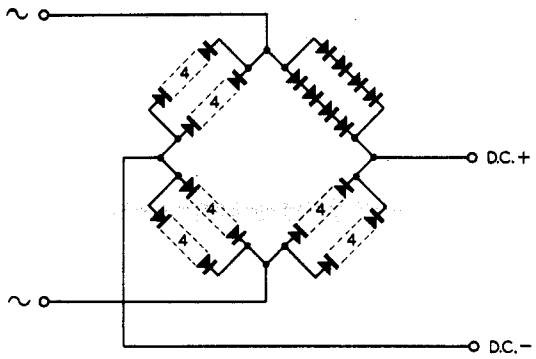
ARRANGEMENT 2-1-2-2
FULL-WAVE



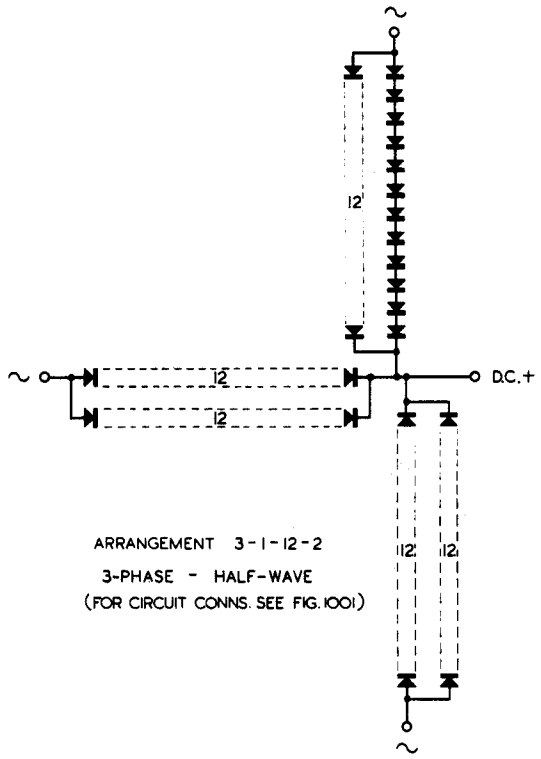
ARRANGEMENT 3-2-1-4
3-PHASE - BRIDGE



ARRANGEMENT 1-2-4-1
VOLTAGE DOUBLER



ARRANGEMENT 2-2-4-2 BRIDGE



ARRANGEMENT 3-1-12-2
3-PHASE - HALF-WAVE
(FOR CIRCUIT CONNS. SEE FIG. 1001)

T J·282 / 1-1002 NOTE: 1. IN THE ABOVE DIAGRAMS EACH SYMBOL ⊣⊢ REPRESENTS ONE RECTIFIER ELEMENT
2. ARRANGEMENT CODING REFERS TO WESTINGHOUSE WESTALITE RECTIFIERS

Fig. 1002 - Metal rectifier arrangements
END

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ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS
(By Command of the Army Council)

TELECOMMUNICATIONS
J 289 Misc Inst No. 1

METAL RECTIFIERS

TECHNICAL HANDBOOK - MISCELLANEOUS INSTRUCTION

Redesignation of EMERs

Information

1. To maintain the proper sequence of EMER numbers, it is intended that:-

   (a) all future issues of EMERs on this equipment will be published in the series Tels J 280 - J 289 and

   (b) the current EMERs will be redesignated.

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Action

2. The following EMERs will be redesignated as shewn.

	Present designation				New designation
	EMER designation (a)	Pages (b)	Issue No. (c)	Date (d)	(e)
1	Tels A 512	1 - 17 1001 - 1025	1 1	26 Jul 46 26 Jul 46	Tels J 282

57/Maint/6670

END