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

POWER
J 553

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LEAD ACID TRACTION BATTERIES

UNIT CARE AND MAINTENANCE

Note: This Issue 2, Pages 1-6 supersedes Issue 1, Pages 0, dated 7 Apr 61 and Pages 1-5 dated 7 Dec 55. New paras 5, 6 and 7 have been inserted.

SUBJECT - INDEX

LIST OF TABLES

GENERAL

1. This regulation sets out the unit care and maintenance of lead acid traction batteries. Care and maintenance of lead acid batteries differs in some details, eg, draining and refilling procedure, 'first charge rate,' and it is not possible to generalize on such points. In these instances, manufacturers' advice or handbooks must be used.

2. It should be read with Power J 090 and J 318.

3. Capacity (marked as 'number of cells/ampere hours' on side of battery case) depends, among other things, upon the rate of discharge and temperature of electrolyte. The basis for these batteries is the 5-hour rate at electrolyte temperatures of 80 F. They are usually selected to enable electrically propelled vehicles to give full service for an 8-hour day.

Life

4. It is assumed that charge-discharge cycles will not be more frequent than once each 24 hours. Guaranteed periods of life vary according to the manufacturer, and may be from 1-4 years. Actual life may be much in excess of this. Under normal conditions of service a battery should have a capacity of at least 80% of its rating, at the end of its guaranteed life.

Definitions

5. For the purpose of this instruction the following definitions will apply:-

(a) Cell - a single unit supplying a nominal 2V.

(b) Battery - a number of cells in one container
or
a number of cells in a monobloc container.

(c) Bank - an arrangement of batteries in series, parallel or series - parallel connections.

6. Traction batteries are normally purchased under a guarantee permit. A bank of batteries, once formed, will be maintained as an entity for the life period

Servicing

7. Batteries will be inspected in unit lines by REME tradesmen. Servicing as detailed in this regulation and Power J 318 will be carried out. Batteries which cannot be rendered serviceable by such servicing, must be back-loaded to a field workshop.

STORAGE

Charged batteries

8. Batteries already charged can be stored with the electrolyte in a cool dry place. Each month give an 'equalizing charge' (para 19). Every six months the battery will be given a discharge-charge cycle. Under this maintenance the battery life will remain unaffected up to two years storage.

Temporarily idle

9. Disconnect main bolted connections and open vehicle main switch. Store or park in cool, dry place and give an 'equalizing charge' (para 19) once monthly. Battery is fit for service without further charge after idle periods up to four weeks.

ELECTROLYTE

General

10. Information in Power J 090 and J 318 is applicable with respect to specification, mixing and specific gravity variation with temperature. Hydrometer and temperature measurements must be taken together. Specific gravity of a fully charged traction battery will be between 1270 and 1285. In tropical climates better results are obtained by working with an acid of specific gravity lower than that used in temperate climates. Low gravity acid is 30-40 points lower than normal, therefore, full charge specific gravity will be 1240-1255.

Freezing of electrolyte

11. There is an inherent protection against this actually occurring. The only circumstances under which it may happen, is leaving a battery which has been discharged in a warmer atmosphere, in a very cold atmosphere. Specific gravity of a fully discharged battery is about 1140, and Table 2 shows this will freeze at 8^{0}F.

12. With battery charged and operating in very low temperatures, the available capacity is reduced, which means the final specific gravity at discharge is above 1140, see Table 1. The denser the acid at the beginning of discharge, the lower is its freezing point. There is always a margin between electrolyte temperature, even though it may be low, and the final discharged state freezing temperature, which is always lower than the electrolyte operating temperature.

13. It is particularly important to give a charge when required and not as a matter of routine, also to ensure charge is correctly controlled. The most satisfactory operation is to discharge and charge once every 24 hours. Increase of battery life is obtained if discharge does not exceed about 90% of the capacity.

14. Regular charging after light duties will be avoided. Charge only as required, ie when discharge is almost complete. To enable maximum life to be obtained, an 'equalizing charge' will be given as a routine (para 19). For ventilation during charge, keep battery compartment open. Leave vent plugs in position.

15. With every electrically propelled vehicle a charger is provided, usually operating on a single-phase a.c. supply (para 20).

16. Periodically, hydrometer readings must be taken of all cells to show whether any are falling out of step (para 19).

Methods

17. Taper charge: This is the normal charge given and takes about 12 hours from the fully discharged state. The charging rate falls throughout the charge due to rising battery voltage. Relay time setting is three hours.

18. Two step charge: This is a quicker charge and takes about eight hours from the fully discharged state. It is the shortest time recommended. There is a higher starting rate and lower finishing rate. Relay time setting is four hours.

19. Equalizing charge (or gassing charge): This is given either as an extension to a normal charge once monthly for the purpose of equalizing the condition in all cells, or to a charged battery, (eg idle or in store) for maintaining full charge. In each case, charger is switched to SLOW or EQUALIZING and charging is continued or carried out under manual control at this rate, until cell voltage and specific gravity have remained constant for three successive hourly readings.

Charging equipments

20. A.C. chargers are supplied capable of giving either a taper or two step charge using a Metrovick MJV relay for automatic control. Equalizing charges can also be given by each equipment. Ampere hour meters, where fitted, on vehicles can also be used for automatic charge control in place of the MJV relay. Some trucks are fitted with a 'built-in' or 'wall mounted' charger, which has an automatic charge terminator made by the truck manufacturer.

21. One charger per vehicle or truck is supplied and is therefore matched to a certain size of battery in capacity and voltage. Chargers are not interchangeable unless each is matched with a battery of the same capacity.

BREAKDOWN

22. Caused through overcharge and over-discharge. Overcharge may be due to wrongly set relays on the charging equipment. An occasional deep discharge, when loading demands, has little adverse effect providing that it is adequately charged in the time available.

23. Any battery which is unable to perform a normal day's work without charging, is probably being overworked and a larger vehicle must be used.

PRECAUTIONS BY AND ADVICE TO OPERATORS

Charging

24. Select a pilot cell in the battery, or, if divided, select one in each half Keep compartment open during charging period, but do not remove vent plugs. Electro-

lyte temperature must not exceed 110°F. Clean off battery top after charge with cloth moistened with weak solution of washing soda (sodium carbonate). For regulations covering charging sites, see Regulations for Fire Service in the Army, para 430-434 inclusive.

Operating

25. Do not operate vehicle continuously at high temperature. Check that battery compartment is well ventilated. The vehicle will not be worked with electrolyte temperature higher than maximum charging temperature.

26. The capacity of a new battery increases during the first ten or twenty cycles of service, but no 'running -in' procedure is necessary. The capacity will be limited until full capacity is developed. Capacity of battery falls with low temperature, see Table 1.

EXTREMES OF LOW TEMPERATURE

Use and charging

27. Battery capacity is partly determined by electrolyte temperature and will be lowered appreciably as the temperature falls, see Table 1.

Storage

28. Battery in charged condition will require usual equalizing charges, but greater frequency, ie fortnightly, will be required to prevent electrolyte from falling to specific gravity which will freeze, see Table 2. Equalizing charges must be carried out in a warmer atmosphere.

EXTREMES OF HIGH TEMPERATURE

Use and charging

29. Low gravity acid is used (para 10). Electrolyte temperature must not rise above 125°F. If ambient temperature is at this figure, electrolyte must not rise much above it and may be kept low by forced ventilation and/or lower charge rate, or by temporarily suspending the charge.

Storage

30. Battery in charged condition can be stored up to 125°F, but life will be shortened and adverse effects will be aggravated by prolonged rise of temperature to 140°F. Frequency of equalizing charges must be increased to fortnightly, hence wear increases.

Electrolyte temperature	% of nominal 5-hour capacity available
80°F	100%
32°F	75%
0°F	50%
-25°F	25%

Table 1 - Capacity variation with electrolyte temperature

Sp. Gr. acid (corrected to 60°F)	Freezing point °F
1280	-96
1260	-80
1240	-50
1220	-32
1200	-17
1180	- 7
1160	+ 1
1140	+ 8
1120	+14
1100	+18

Table 2 - Electrolyte specific gravities and freezing points

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END

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LEAD ACID TRACTION BATTERIES

FIELD AND BASE REPAIRS AND MAINTENANCE

Errata

Note: These Pages 0-01, Issue 1, will be filed immediately in front of Page 1, Issue 1, dated 2 Apr 63.

1. Amend as follows:-

(a) Page 1, SUBJECT INDEX - GENERAL, Column 'Paras':-

Delete: '1'
Insert: '1-3'

(b) Page 6, para 28, line 3:-

Delete: '30'
Insert: '29'

Distribution - Class 194. Code No 6

(c) Page 6, sub-para 32 (a):-

Delete: '30'
Insert: '29'

(d) Page 7, sub-para 33 (a)

Delete: '30'
Insert: '29'

(e) Page 7, sub-sub-para 33 (b) (ii):-

Delete: 'In either case .....33 (b) (ii)'
Insert: 'An AFG 1043 will be issued as detailed in sub-sub-para 32(b) (ii) in respect of either the defective cells or the defective block.'

LEAD ACID TRACTION BATTERIES

FIELD AND BASE REPAIRS AND MAINTENANCE

Errata

Note: This Page 02, Issue 1, is to be filed immediately in front of Page 1, Issue 2, dated 2 Apr 63.

2. Amend as follows:-

Page 3, para 9:-

Delete in entirety.
Insert against STORAGE:-

'Shelf-life

9. Whilst, under correct storage conditions, shelf-life of traction batteries is practically indefinite, it should be noted that new batteries are not normally held in stock but are obtained as required.'

LEAD ACID TRACTION BATTERIES

FIELD AND BASE CARE AND MAINTENANCE

SUBJECT INDEX

LIST OF FIGURES

LIST OF TABLES

GENERAL

1. This regulation sets out information on care and maintenance of lead acid traction batteries for field and base workshops.

2. It should be read with Power J 318 and J 330, also J 553.

DELIVERY AND PREPARATION

Fully charged

3. After unpacking, examine electrolyte level. If loss has occurred, top up with acid of sp. gr. 1270. If cracks or leaks have occurred place plate groups in serviceable cell boxes and fill immediately with acid of the same specific gravity. After installation in the vehicle, give the battery an 'equalizing charge' (see Power J 553).

Dry condition

4. Examine cells for damage; strip sealing from vent holes; fill with acid to the level and the sp. gr., as described in manufacturers' handbooks.

5. Allow plates to soak for about 12 hours, then top up with acid of the same specific gravity. Give the battery a 'first charge' (para 15).

Drained condition

6. Examine as for 'dry condition', then treat each make as advised by the manufacturers who lay down particular treatment for their own makes. Treatment necessary for two common makes is given below:-

(a) Kathanode: As for 'dry condition'.

(b) Exide: Fill with acid of sp. gr. 1200 to levels given in para 4 and allow to soak for 12 hours, topping up as required. Charge at the 'finishing rate' (paras 12 and 16) for at least 24 hours until the volts per cell (v.p.c.) and sp. gr. have remained constant over five successive hourly readings.

(c) Draining is not advised at all for 'Crompton' batteries.

Transport

7. A battery or cell is transportable in fully charged, dry, or drained condition. See para 10 for draining procedure.

STORAGE

New battery (dry)

8. Store in a cool, dry place, vent plugs securely in position. There is no limit to the period stored 'dry' when separators other than wood are used. Batteries made with wood separators must be filled and charged not later than

two years after date of manufacture. Period may vary depending on conditions of storage.

Drained battery

9. Store in a cool dry place; fill and charge as given in para 6 not later than six months after draining.

10. Draining is a special procedure and is laid down by each manufacturer; no general procedure is applicable. The system for two common makes is given below:-

(a) Kathanode: From the discharged state, give the battery a normal charge (paras 11 and 13) but extended until volts per cell and sp. gr. have remained constant over six successive hourly readings. With electrolyte approximately at ambient temperature, drain cells for about 12 hours; clean top with sodium carbonate solution. Seal vent plugs with tape allowing a pin breather hole.

(b) Exide: Give the battery an 'equalizing charge' (para 13). Discharge until final sp. gr. is 1210. With electrolyte at ambient temperature, drain cells for 10 minutes; clean top and seal as in sub-para (a).

CHARGING METHODS

11. Taper charge: The maximum rate in amperes with the voltage at 2.5 v.p.c. is calculated at 1/12th of rated capacity. The figure for v.p.c. is approximately the average during the gassing stage of the charge. Charging rate must not be high during this stage, since a high rate will accentuate the gassing which has a deleterious effect on the active material of both plates; also highest temperature is reached at critical v.p.c. and a high charging rate would increase this.

12. Two step charge: For this type of charge the 'starting rate' is calculated in amperes as 1/5th of rated capacity of the battery which continues until voltage reaches the 'critical' value of 2.35 v.p.c. at which gassing begins. The 'finishing rate' is calculated in amperes as 1/15th of rated capacity.

13. Equalizing charge: This may be given as an extension to a normal charge once monthly or to stored or idle batteries. A taper or two step charger can give 'equalizing charges' by switch selection. The rate in amperes is calculated as 1/30th of the rated capacity.

14. Booster charge: A charge given in a shorter time at higher rate, and applicable to a fully, or partly discharged battery. Usually given to enable a vehicle to complete its duty or undertake emergency duty. Half the ampere-hourage discharged may be charged in the minimum period of one hour. It is recommended only as an emergency charge. Current values up to 3 or 4 times the 'starting rate' can be used, but voltage must not exceed 2.35 v.p.c. and electrolyte temperature must not exceed 110°F.

15. First charge: This is important procedure for new batteries, and manual control is used. Charge at rates as specified by manufacturers for their own batteries. Current, acid level and temperature must be checked frequently; charge may be interrupted for periods not exceeding eight hours. Continue charge until:-

(a) time (manufacturer specifies) is nearly complete

(b) gas is given off from each cell

(c) v.p.c. and sp. gr. of each cell have remained constant over three successive hourly readings.

Reduce the rate if temperature rise exceeds 110°F or temporarily suspend charge if high temperature persists. Adjust acid to specific gravity at full charge (1270 - 1285) if the readings at the end of the charge are below 1270 or above 1285.

CHARGING EQUIPMENTS

General

16. A general description of charging equipment is given in Power J 553. These equipments are not designed to give a 'booster or first charge' which will require other chargers, with which also the charge as described in sub-para 6 (b) should be carried out.

17. Specimen circuit diagrams of taper and two step single-phase chargers are shown in Figs 1 - 4. These do not apply to pedestrian controlled trucks, for which see makers' handbooks. Some points on the design of chargers to meet a particular requirement are described in paras 18 - 22. Manufacturers must be consulted for further details.

Choke

18. This is provided with tappings. If there is reduction in the maximum output from the full wave selenium rectifier, due to ageing, it will be necessary to re-adjust the choke tappings.

Relay - Metrovick Type MJV, Fig 5

19. Motor and switch: The Sangamo timing motor is completely enclosed but only sealed when used in the tropics. The motor operated switch may be mercury or metal to metal contact, and in both cases is trouble free providing it is operated within the current ratings given in Table 1. A contactor is used when higher current values than these are being broken, as shown in Figs 1 and 3.

20. One of several types of MJV relay may be used on a straight taper or two step charger and the circuit diagram for that particular relay must be used. Relays are matched to the characterictics of a charger and are not interchangeable unless the characteristics are identical.

21. The resistor internally will vary in value according to size of battery and rating of the 'Sunvic' tube; it may be fixed or variable. An external resistor is connected in the a.c. supply to the relay if the supply exceeds 250V. An external resistor is also connected in the battery supply to the relay if the number of cells exceeds 36. The rheostat values will vary according to the number of cells connected (para 26).

22. 'Sunvic' tube: There are several ratings of the tube to which the internal resistance must be matched considering also the number of cells in the battery.

The thermal element and relay switch in the tube are trouble free, and the tube is not repairable.

Time setting

23. The period for which the charge is continued during the gassing stage of a normal charge (taper or two step) is independent of the ampere-hours previously discharged, assuming at least ¼ capacity has been discharged. When critical volts are reached, about 90% of the rated capacity of the battery has been replaced, and an extra charge of about 15% of rated capacity is required to complete this in addition to the balance of 10%. A further 25% then of rated capacity must be replaced between the first operation of the relay and the end of the charge.

24. Manufacturers state in their data the maximum current at 2.5 v.p.c. for straight taper charge, and the 'finishing rate' stated gives a guide to the value for two step charge, therefore time period is calculable on the data above and para 23. The current values given increase proportionally with the rated capacity, therefore a uniform time setting is applicable to all sizes of battery. The two-step finishing rate is less than the value given at 2.5 v.p.c., hence the time setting is longer. The time setting can be increased, after operating experience, to allow for battery ageing and special local conditions.

Critical voltage setting

25. Correct setting, ie, the equivalent of 2.35 v.p.c., is very important. If this is 5% low, the relay will operate at the equivalent of 2.23 v.p.c., and at this point, amount of charge given is 40 - 50% of rated capacity; whereas a 5% high setting will produce only a directly proportional increase in charge.

26. To check the setting without a battery connected to the charger, insert a spare rheostat (up to 8-cell charger 300Ω; 9-cell and above 1000Ω) in the No 6 relay lead, and connect a voltmeter across Nos 4 and 6. Energize the circuit. The operating voltage of the relay is marked on the dial plate. By varying the current with the additional rheostat, the operating voltage can be read off when the motor starts to run. If this does not coincide with the stated value, adjustment must be made on the relay rheostat dial, and the procedure repeated.

SERVICING AND REPAIRS

General

27. Servicing and repairs are not specialized for traction batteries, and Power J 318 is applicable for servicing details except any reference to charging; also Power J 330 is applicable for external repairs only. Servicing and repair is not carried out on plate groups and a group is removed only to replace a container. Reconditioning and rehabilitation (Power J 330) is not carried out on cells, which will be replaced as units.

Spares

28. Normal spares are available (eg, containers, lids, inter-cell connectors, and tapping points) but in addition complete cells are available.

29. Cell replacement is a special aspect of repair of traction batteries. If a cell is found to be defective in a battery over two years old, an exhaustive examination of the remaining cells will be made to determine if any others are nearly in a similar state, using sp. gr. values as the main guide. If any cell is likely to prove defective at all, it will usually show during the first 12 months of service.

BREAKDOWN

30. Over-charge and over-discharge have deleterious effects on the plates, although an occasional deep discharge when loading demands has little adverse effect. Do not persistently deep discharge, the effect of which is to cause the active material on the positive plates to expand, distort, and lose contact with the grids.

EXTREMES OF TEMPERATURE

31. Details for operating and charging are contained in Power J 553.

32. Storage dry at low temperatures: Battery in dry condition will not be affected by a temperature of minus 80°F (minus 20°F for 'Crompton'). Remove to a higher temperature before filling and charging (see paras 8-10). Case and compound will be very brittle.

33. Storage dry at high temperatures: Battery in dry condition can be stored up to 140°F kept upright (compound softens). For putting into service, paras 8-10 apply. See Power J 553, Table 2 for specific gravities and freezing points of electrolyte.

<table>
<tr><th rowspan="2">Function</th><th colspan="2">Type of switch</th></tr>
<tr><th>Mercury
(standard)</th><th>Metal to metal
(non-standard)</th></tr>
<tr><td>Make and carry continuously</td><td colspan="2">20A at voltages up to
440V, a.c. and d.c.</td></tr>
<tr><td rowspan="4">Break</td><td>20A at voltages up to 250V, a.c. and d.c.</td><td>20A at voltages up to 250V a.c.</td></tr>
<tr><td rowspan="3">10A at voltages up to 440V, a.c. and d.c.</td><td>20A at voltages up to 60V d.c. (non-inductive)</td></tr>
<tr><td>10A at voltages up to 100V d.c. (non-inductive)</td></tr>
<tr><td>5A at voltages up to 125V d.c. (non-inductive)</td></tr>
</table>

Table 1 - MJV relay

Contact ratings of motor operated switch in the Metrovick type MJV relay

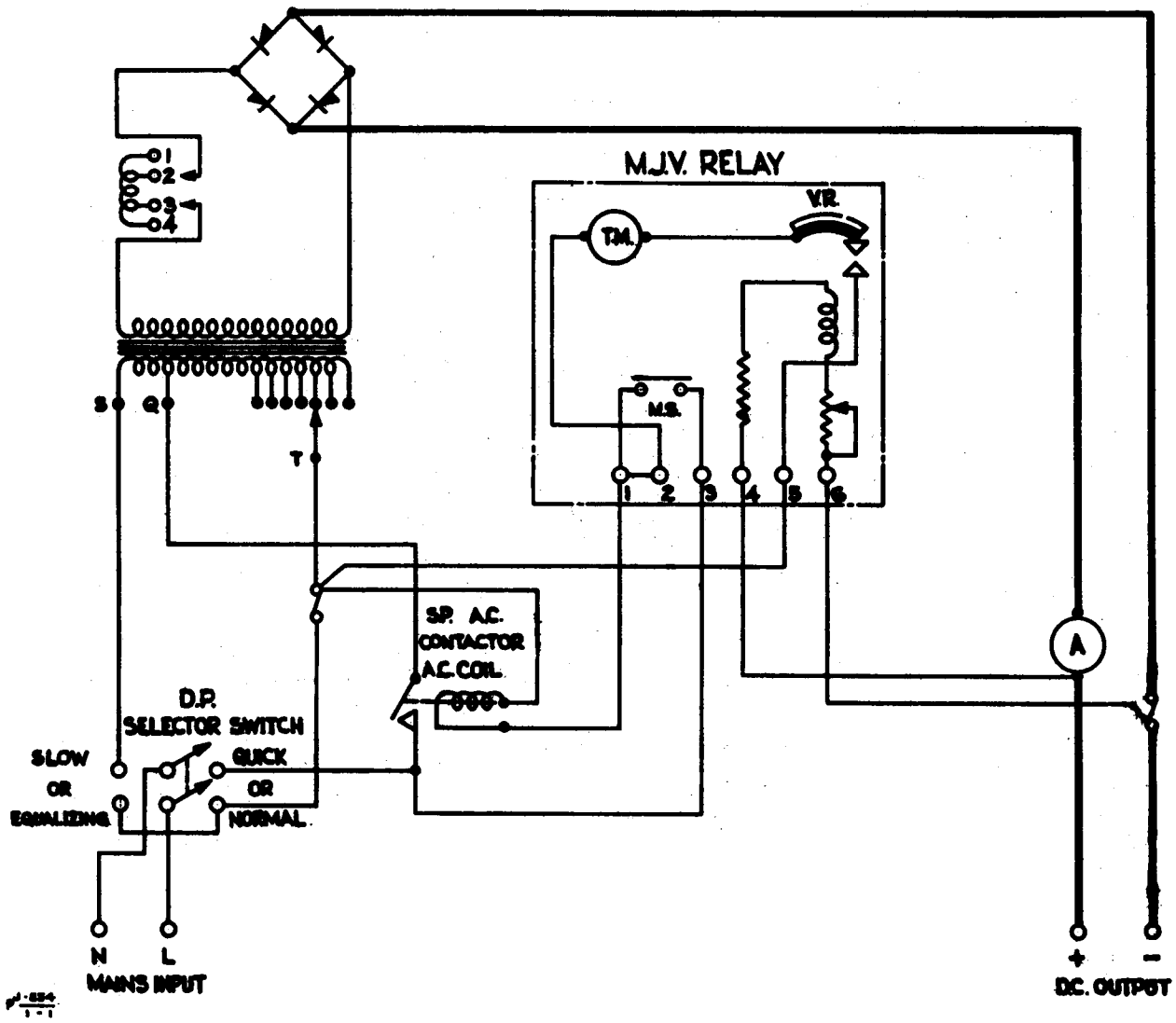

Fig 1 - Straight taper charger

(a) Relay operation in QUICK position only.
(b) Contactor used for current greater than 20A.

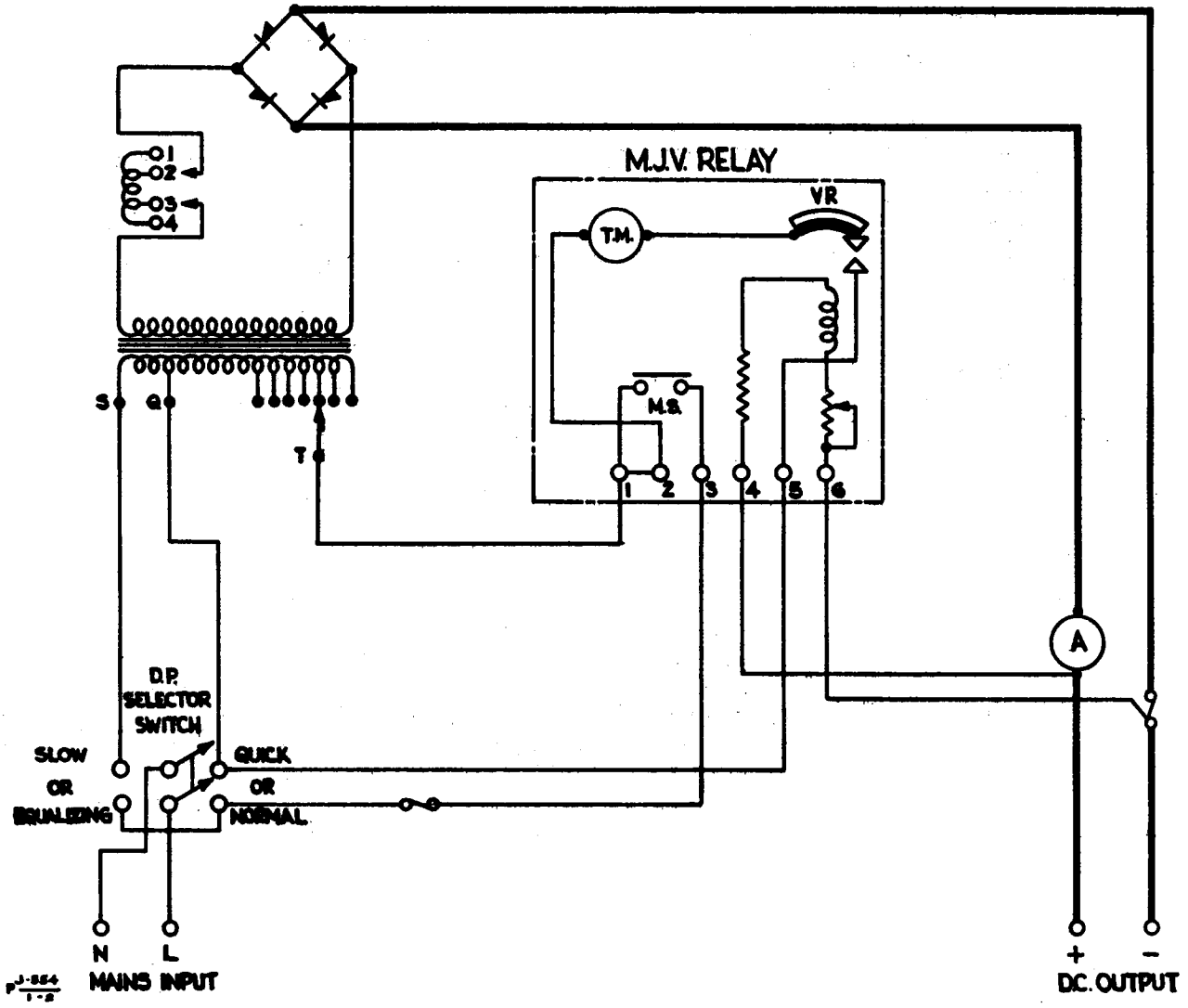

Fig 2 - Straight taper charger

Relay operation in QUICK and SLOW positions

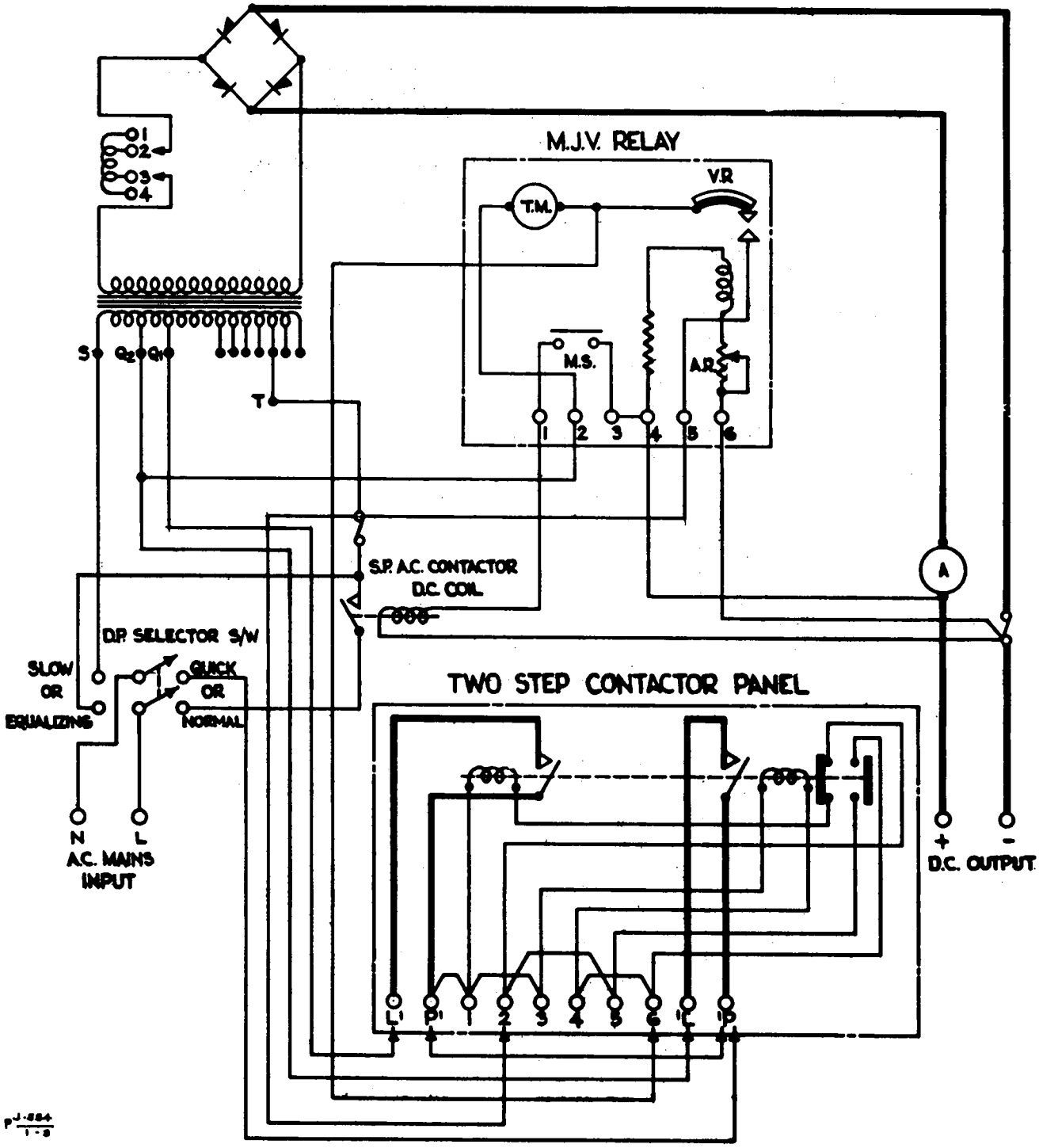

Fig 3 - Two step charger

(a) Relay operation in QUICK position only.
(b) Contactor used for current greater than 20A

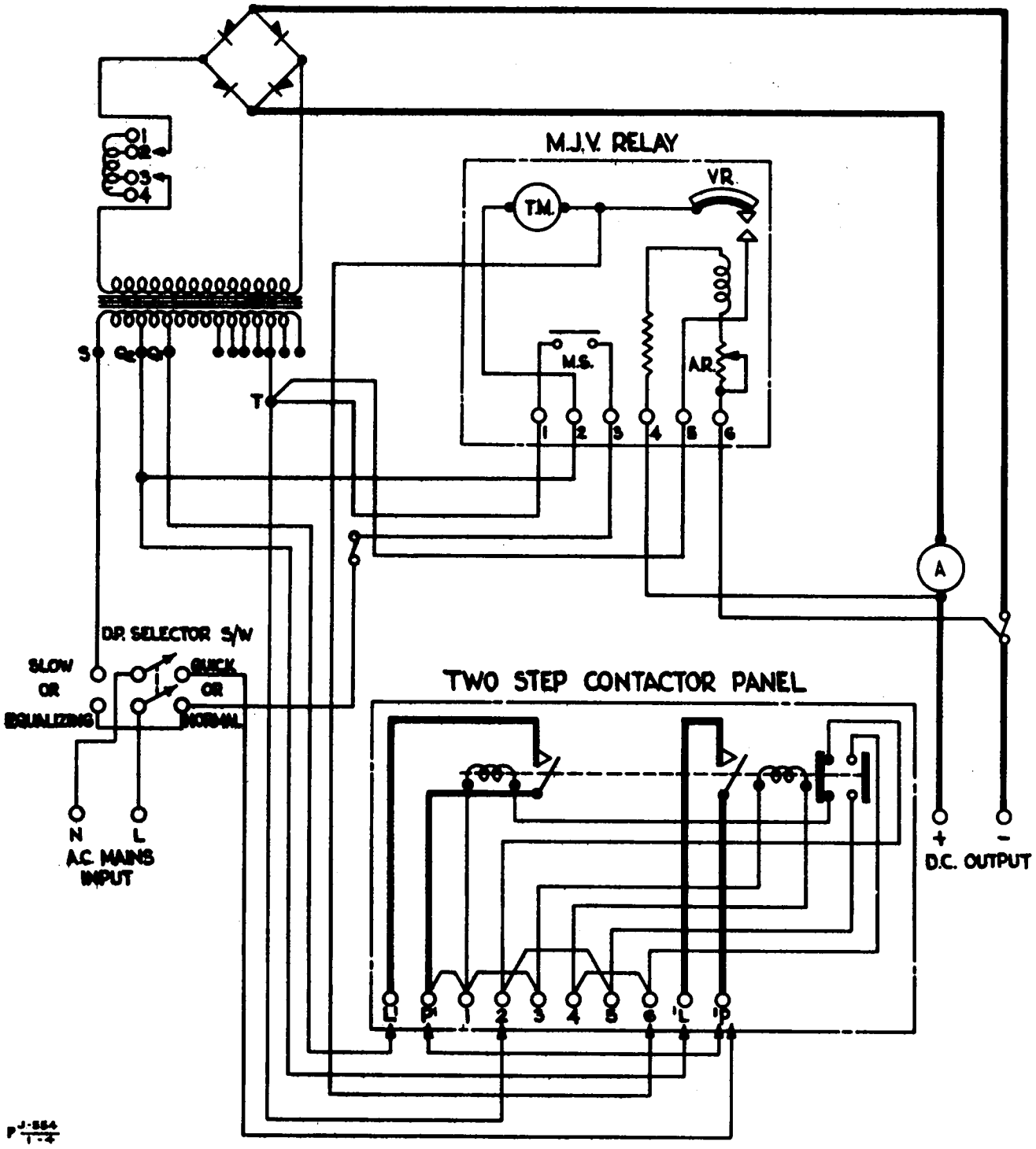

Fig 4 - Two step charger

Relay operation in QUICK and SLOW positions

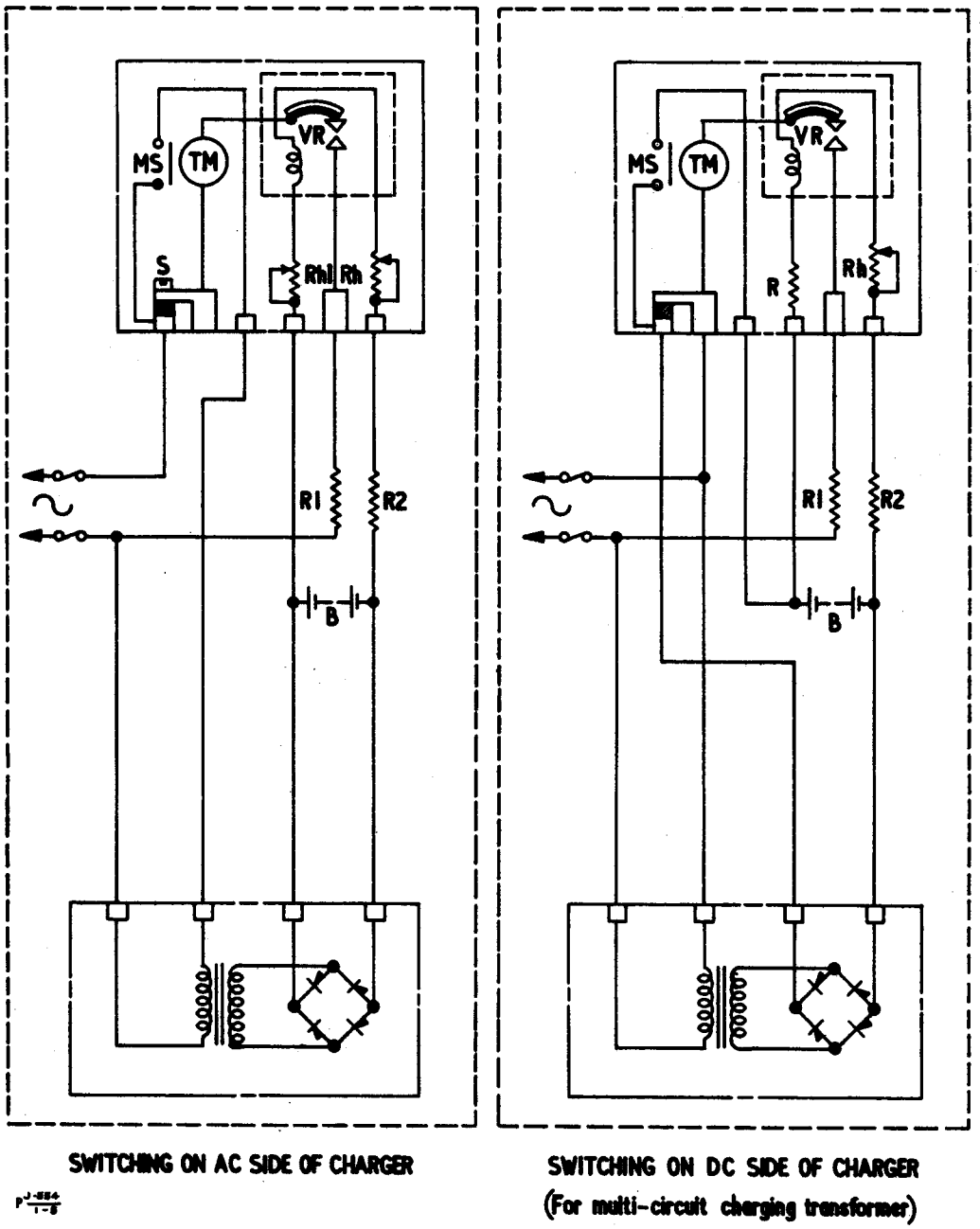

Fig 5 - Typical diagrams of connections for two types of MJV relay

B	Battery	R.1.	External resistance (above 250V, 50c/s)
MS	Motor switch	R.2.	External resistance (above 36 cells)
R	Internal resistance	S.	Shorting screw
Rh	Rheostat	T.M.	Timing motor
Rhl	Rheostat	V.R.	Voltage relay

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END