July 28, 1959 K. S. BUTT 2,897,420

RECTIFIER ASSEMBLY

Filed March 20, 1957

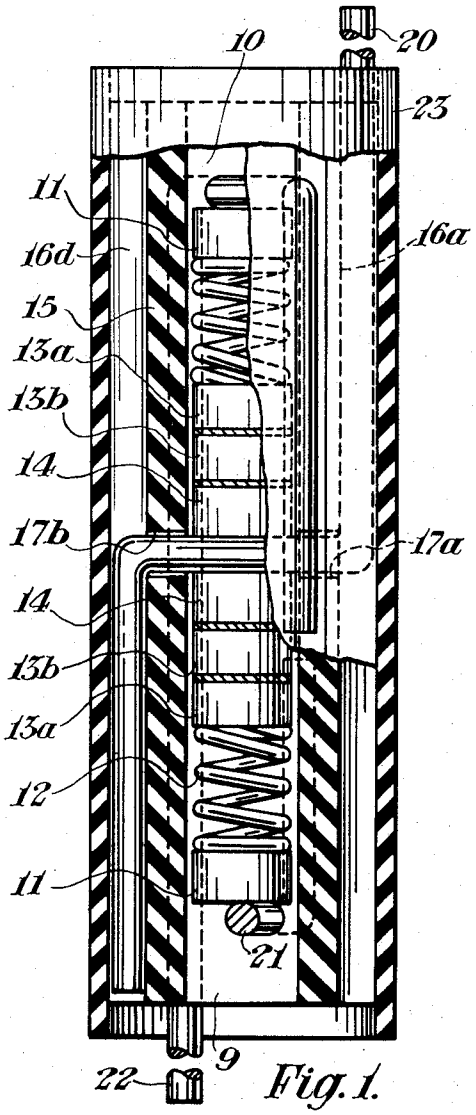


Fig. 1.

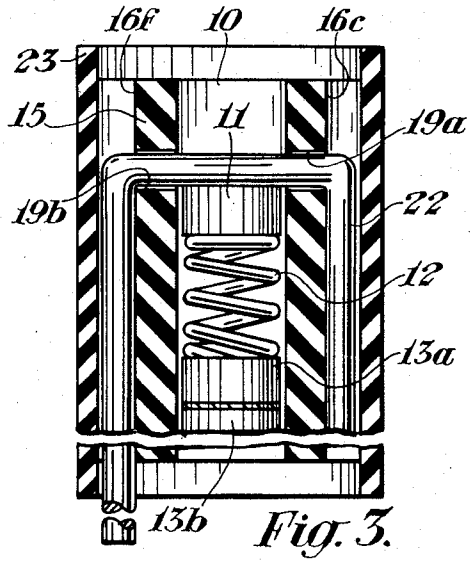


Fig. 3.

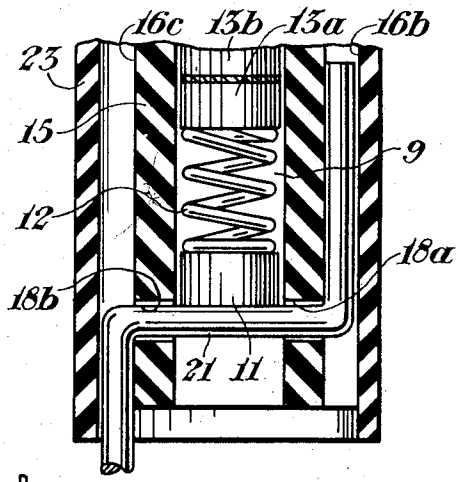


Fig. 4.

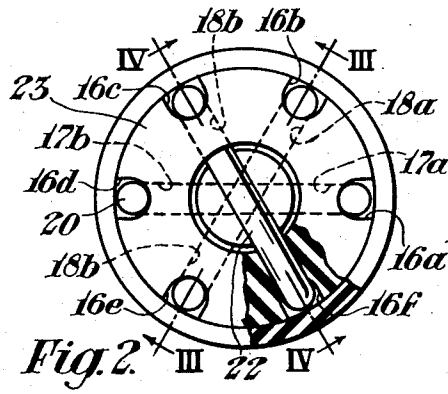


Fig. 2.

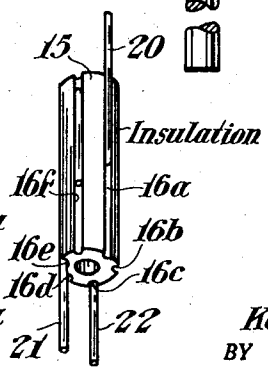


Fig. 5.

INVENTOR.
Kenneth Stanley Butt
BY W. L. Strut
HIS ATTORNEY

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RECTIFIER ASSEMBLY

Kenneth Stanley Butt, London, England, assignor to Westinghouse Brake and Signal Company, Limited, London, England

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9 Claims. (Cl. 317—234)

The present invention relates to dry metal rectifier assemblies wherein one or more laminar metal rectifying elements is or are juxtaposed with connectors, and such spacers, contact members and the like as may be required, to form a column or stack.

It is one of the objects of the invention to evolve a form of construction, applicable particularly to small size assemblies, which enables the assembly to be made quickly and easily and consequently lends itself to production by mass production methods.

According to the present invention, a stack including one or more laminar metal rectifying elements is held in position within a tubular case of electrically insulating material by connectors in the form of metal wires or narrow metal strips which pass through the walls of the case across the interior thereof and are constrained to lie externally of the case in grooves or recesses in the outer surface thereof. The grooves or recesses provide mechanical support for the portions of the connectors lying on the outer surface of the tubular case and thereby resist any tendency to disturb the electrical connections of the connectors with the stack due to movement of the connectors whilst connecting them to external circuits. The positioning of the stack by means of the connectors also reduces the number of components required in the assembly since means serving solely to fix the position of the stack are now no longer necessary.

The cross sectional shape of the tubular case is largely dependent on the outline of the rectifying elements in order that the elements may be a close fit therein, and may therefore be, for example, circular or rectangular. If the connectors are of a ductile metal such as copper, the constraint maintaining them in their respective grooves or recesses may be inherent as a result of their being deformed by bending, but otherwise a sleeve or outer covering preferably fitted over the tubular case may supply the necessary constraint besides completing the electrical insulation of the assembly. Such a sleeve or outer covering is therefore of an electrically insulating material and although it conveniently takes the form of a length of tube which can be slipped over the tubular case, it may alternatively be formed directly on the case by winding thereabout a tape or thread composed of electrically insulating fibre or even by applying thereon a coating of some electrically insulating hard-setting compound.

Preferably the tubular case is provided on the outer surface thereof with pairs of opposed grooves extending generally lengthwise of the case from one end thereof to the other and each of the connectors is associated with a different pair of the grooves, a blank end of the connector being bent down into the groove on one side of the case and the other "live" and being bent down into the other groove of the pair on the other side of the case and extending beyond one of the ends of the case in general alignment with the length thereof for connection to an external circuit. In a circular section tubular case the grooves may extend obliquely over the external circular

surface in the manner of a helix although manufacture is simplified if they extend longitudinally.

Thus, a long length of tubular insulating material may be preformed with the grooves and then be subdivided into the required lengths for use in the making of rectifier assemblies in accordance with the invention.

A method by which a dry surface contact rectifier assembly is made consists, within the scope of the invention, in positioning a stack including one or more laminar metal rectifying elements within a tubular case of insulating material preformed with pairs of opposed grooves extending longitudinally in the external surface thereof and forming a hole in the wall of the case at transversely aligned points in the grooves of one of the pairs where one of the connectors is to enter into contact with the stack and likewise, forming holes in the wall at appropriate intervals along the length of the case where the other connector or connectors are to enter, choosing in each case different pairs of grooves, and passing metal wires or narrow metal strips acting as connectors through the holes. Bending the ends of the wires or strips down into the grooves so as to leave, in respect of each such wire or strip, one of the ends projecting beyond one or other of the ends of the case for connection to an external circuit.

In describing the invention further reference will be made, by way of example, to one form of rectifier assembly constructed in accordance with the invention and illustrated in the accompanying drawings.

Fig. 1 is an elevation view, partially in cross section of an embodiment of the rectifier assembly in accordance with my invention;

Fig. 2 is a bottom view of Fig. 1;

Fig. 3 is an elevation view, partially in cross section, taken along lines III—III of Fig. 2, and having the center portion removed;

Fig. 4 is a partial elevation view, partially in cross section, taken along lines IV—IV of Fig. 2; and

Fig. 5 is a perspective view of the tubular case and the wires of Fig. 1.

Referring now to Fig. 1 the stack of rectifying elements is composed of two similar sections **9** and **10**, each section having, in sequence, a spacer or contact member **11**, a compression coil spring **12**, two rectifier elements **13***a*, **13***b* in the form of plates coated with semi-conductive and counterelectrode layers as indicated by the hatching, and a further spacer **14**. The components of the stack all have a circuit outline of subtantially the same diameter and the stack is a close fit within a circular section tubular case indicated generally by the reference character **15**.

The tubular case **15** is of insulating material and has pairs of diametrically opposed grooves designated **16***a*—**16***f*, respectively, extending longitudinally on the external surface of said case from one end to the other as best seen in Fig. 5. The length of the tubular case **15** is longer than the assembled length of the stack to be accommodated therein, and for ease of manufacture is preferably cut from a greater length of tube stock which is preformed with the grooves **16**. The tube may have the grooved shape imparted to it by extrusion through a suitable die as part of the process of formation or, subsequent to fromation, the grooves may be cut as by milling. It is preferred to make the tube stock of any suitable hard synthetic resin.

The grooves **16***a*—**16***f* are shaped to receive the full diameter of wire connectors **20**, **21** and **22** which are used in the manner now to be described to position the stack within the tubular case. One of the connectors is to make connection with the spacers **14** of the two sections **9** and **10** of the stack, the sections being inserted into the tubular case with the spacers **14** adjacent one another. The wall of the tubular case is drilled at

17*a* and 17*b* midway along the length of the case to form a passageway which extends diametrically from groove 16*a* to groove 16*b*.

Selecting a different pair of grooves, say grooves 16*b* and 16*e*, the walls of the case are drilled at 18*a* and 18*b* at a point where the outermost face of one of the spacers 11 is located when the adjacent spring 12 is sufficiently compressed. Likewise, the walls of the case are drilled at 19*a* and 19*b* in the remaining grooves 16*c* and 16*f* and in the region of the other spacer 11. The connectors 20, 21 and 22 are tinned copper wire and are preformed in suitable lengths with a main portion, and another portion, of greater length than the outer diameter of the tubular case 15, perpendicular to the main longer portion. One of the connectors, designated 20, is then arranged with the perpendicular portion passing through the holes at 17*a*, 17*b* and between the spacers 14. The blank end of the connector, being that amount of the perpendicular portion which protrudes externally of the case, is bent down to lie flat in the groove 16*d*; the longer portion of or "live" end of the connector lies opposite thereto in groove 16*a* and is of sufficient length to project well beyond the end of the case 15 toward which it is directed. The other two connectors 21 and 22 are inserted respectively through the pairs of holes 18*a*, 18*b* and 19*a*, 19*b* with their "live" ends projecting beyond the other end of the case in order to distinguish them from the conductor 20; the ends of connectors 21 and 22 are bent down towards the middle of the case as shown in Figs. 3 and 4, respectively. While inserting the connectors 21 and 22, the spacers 11 are held down against their springs 12, the connectors being located to maintain in the springs a degree of compression corresponding to the contact pressure required in the stack.

The assembly is completed by fitting a sleeve 23 of insulating material over the tubular case 15, the sleeve being of the same length as the case so that the "live" ends of the connectors protrude from beneath the sleeve at the ends of the case while the blank ends remain covered. The sleeve may be colord according to a code by which rectifier assemblies of differing characteristics may be recognized.

The construction in accordance with the invention can be adapted to numerous alternative arrangements of the connectors relative to the stack components and also of the stack itself, since it is only necessary to ensure first of all that there is an adequate number of grooves in the tubular case to accommodate the number of connectors required and then to drill holes at appropriate points in the grooves. Where, for instance, a common connection is to be made at two separate locations in the stack, a single wire connector may be made to execute two passes across the interior of the tube, one at each of those locations, and the blank end of the connector is then brought back to lie in the same groove as the "live" end of the connector. Instead of projecting from both ends of the case, as shown in the drawings, the connectors may, of course, project only from one or the other of the ends. As an example of an alternative form of stack which can be included in the assembly, there may be mentioned one in which a ball is included to act as a contact-electrode and so give to the rectifier assembly a high impedance characteristic.

The construction in accordance with the invention lends itself to incorporation in a sealed unit, in which the "live" ends of the connectors are all brought out at one end of the assembly which is housed wholly within a metal tube closed at one end, with the connectors projecting out of the other open end, the tube being sealed by a filling of a sealing material, for example, a synthetic resin such as an epoxy or polyester resin.

Having thus described my invention, what I claim is:

1. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including grooves in the outer surface thereof, connectors in the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, and a stack including at least one laminar metal rectifier element held in position within said tubular case by said connectors, said connectors having portions thereof constrained to lie in said grooves.

2. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including grooves in the outer surface thereof, connectors in the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in position within said tubular case by said connectors, said connectors having portions thereof constrained to lie in said groove, and an outer covering of an electrically insulating material surrounding said tubular case and those portions of said connectors lying in said grooves.

3. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including grooves in the outer surface thereof, said grooves extending in a direction generally lengthwise of the case, connectors in the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in predetermined position within said tubular case by said connectors, said connectors having portions thereof constrained to lie in said grooves, an outer covering of an electrically insulating material and in the form of a sleeve slipped over said tubular case and those portions of said connectors lying in said grooves, and respective ones of said connectors having portions protruding from beneath at least one of the ends of said sleeves.

4. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including pairs of opposed grooves in the outer surface thereof, said grooves extending generally lengthwise of the case from one end to the other end thereof, connectors in the form of metal wires or narrow metal strips arranged to passs through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in predetermined position within said tubular case by said connectors, each of said connectors associated with a different pair of grooves and having portions thereof constrained to lie in said grooves.

5. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including pairs of opposed grooves in the outer surface thereof, said grooves extending generally lengthwise of the case from one end to the other end thereof, connectors in the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in predetermined position within said tubular case by said connectors, each of said connectors associated with a different pair of grooves and having portions thereof constrained to lie in said grooves, and an outer covering of an electrically insulating material surrounding said tubular case and those portions of said connectors lying in said grooves.

6. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including pairs of opposed grooves in the outer surface thereof, said grooves extending generally lengthwise of the case from one end to the other end thereof, connectors in the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in predetermined position within said tubular case by said connectors, each of said connectors associated with a different pair of grooves and having portions thereof constrained to lie in said

grooves, the grooves of each pair being in diametrically opposed relation, one end of each of the connectors being bent down into a respective groove on said case and the other end of each of the connectors being bent down into said diametrically opposed grooves of said pair, and at least one of the ends of said connectors extending beyond the ends of said case for connection to an external circuit.

7. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including pairs of opposed grooves in the outer surface thereof, said grooves extending generally lengthwise of the case from one end to the other end thereof, connectors in the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in predetermined position within said tubular case by said connectors, each of said connectors associated with a different pair of grooves and having portions thereof constrained to lie in said grooves, the grooves of each pair being in diametrically opposed relation, one end of each of the connectors being bent down into a respective groove on said case and the other end of each of the connectors being bent down into said diametrically opposed groove of said pair, at least one of the ends of said conectors extending beyond the ends of said case for connection to an external circuit, and an outer covering of an electrically insulating material and in the form of a sleeve slipped over said tubular case and those portions of said connectors lying in said grooves.

8. A dry metal rectifier assembly comprising a tubular case of electrically insulating material, said case including pairs of opposed grooves in the outer surface thereof, said grooves extending generally lengthwise of the case from one end to the other end thereof, connectors in

the form of metal wires or narrow metal strips arranged to pass through the walls of said case across the interior thereof, a stack including at least one laminar metal rectifier element held in predetermined position within said tubular case by said connectors, each of said connectors associated with a different pair of grooves and having portions thereof constrained to lie in said groove, the ends of said connectors projecting beyond the same end of said case in a direction generally lengthwise thereof for connection to an external circuit, a metal tube closed at one end housing said case, said connectors projecting out of the open end of said tube, and a filling of sealing material sealing said tube.

9. The method of manufacturing a dry metal rectifier assembly having a tubular case of insulating material preformed with pairs of opposed grooves extending longitudinally in the external surface of said case, consisting of forming holes in the wall of said case at transversely aligned points in each of the pairs of grooves along the length of said case, said holes in each of said pairs of grooves being formed at predetermined spaced intervals with relation to the holes in said other pairs of grooves, positioning a stack including at least one laminar metal rectifying element within said tubular case, passing metal wire connectors through said formed holes for supporting said stack, bending down the ends of said wires into the respective grooves such that at least one end of each of said wires projects beyond one of the ends of said case for connecting to an external circuit.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,897,420 July 28, 1959

Kenneth Stanley Butt

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 16, for "preformed" read -- performed --.

Signed and sealed this 22nd day of December 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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