The present invention relates to unitary coil-rectifier structures in which the coil is supplied with a unidirectional current, after rectification from an A.C. source.

Briefly, the present invention provides various unitary structures wherein a rectifying system comprising rectifiers is integrally mounted as a component part of a coil structure which lends itself admirably to a multiplicity of uses such as, for example, relay coils, solenoid coils, coils for operating gas valves and the like. One of the features of the invention is that the rectifying system is compactly mounted on the coil structure and wired in relationship thereto so that the subsequent user needs only to connect two leads to an A.C. source to produce a unidirectional rectified current in the coil.

Another important feature of the present invention is that the composite coil-rectifier structure is such that a suitable heat sink is provided whereby small silicon-type diodes or rectifiers may be incorporated to thereby, in turn, achieve a structure of relatively small size considering the various elements mounted thereon and their particular functions and characteristics.

It is therefore a general object of the present invention to provide a unitary rectifier structure of relatively small size, simple and inexpensive construction.

Another specific object of the present invention is to provide a unitary rectifier structure which incorporates silicon-type diodes or rectifiers which have as their heat sinks a part of such unitary structure.

Another specific object of the present invention is to provide a structure of this character in which all of the component elements are suitably insulated yet with provisions for dissipating the heat developed therein, particularly the heat developed by silicon-type diodes or rectifiers which contribute substantially to the smallness and compactness of the composite structure.

Another specific object of the present invention is to provide a structure of this character in which the encapsulating material used, and in its makeup, the use of a standard type of coil form.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a perspective view of the preferred embodiment of the invention with a portion of the encapsulating material removed to show internal construction.

FIGURE 2 illustrates schematically the manner in which the various components in FIGURE 1 are interconnected as well as the manner in which the various components shown in the other figures are interconnected.

FIGURE 3 is a top plan view of the structure shown in FIGURE 4 but with the encapsulating material removed, and that FIG.-URE 5 is a cross-sectional view through the structure shown in FIGURE 4.

FIGURES 6 and 7 show another modification of the present invention, FIGURE 6 being a top plan view with the encapsulating material removed and FIGURE 7 being a transverse sectional view through the structure shown in FIGURE 6.

FIGURE 8 is a perspective view illustrating details of the construction shown in FIGURES 6 and 7.

FIGURES 9 and 10 disclose still another modification of the present invention, FIGURE 9 being a top plan view but with the encapsulating material removed and FIGURE 10 is a view in side elevation of the same with some of the outside insulating wrapping partially removed to indicate internal construction.

In FIGURE 1 a coil 10 is wound on a conventional coil form or spool 11 of insulating material and the wound coil is encapsulated with encapsulating or potting material 13 with the leads 15 and 16 of the coil extending through the material 14.

These leads 15 and 16 are electrically connected as, for example, by soldering, to soldering lug 17 and 18 in the form of tongues struck from corresponding arcuate-shaped metal strips or bars 19A and 20A upon the ends of which are electrically and mechanically mounted corresponding silicon-type diode rectifiers 19, 21 and 20, 22.

These metal strips or bars 19A, 20A serve as heat sinks for the corresponding pair of diodes 19, 21 and 20, 22 and for this purpose preferably the diodes are mounted near the ends of the strip and the soldering lug 17 or 18, as the case may be, is spaced midway between corresponding diodes. The manner in which the diodes are mounted on their metal strips or bars is indicated also in FIGURE 8 which shows a detail of a modified structure. The strips 19A and 20A are arcuate and have a curvature corresponding to the curvature of the encapsulated coil 10.

A small arcuate-shaped and rectangularly apertured frame member 25 with leads 26 and 27 passing through a circularly apertured portion 25A, 25B in opposite sides of the frame member 25 embraces the coil leads 15 and 16 and the four diodes and their mounting strips, much like a "window" frame. The lead 26 is electrically connected as, for example, by soldering to terminals of opposite polarity of the diodes 19 and 20 as indicated in FIGURE 2, and the other lead 27 is connected as, for example, by soldering to terminals of opposite polarity of the other two diodes 21 and 22 as indicated in FIGURE 2. FIGURE 2 also shows the heat sinks 19A and 20A, and it will be observed that these heat sinks connect diode terminals of like polarity.

It will also be observed that since opposite terminals 15, 16 of coil 10 are connected to corresponding heat sinks 19A and 20A, such heat sinks serve also to some extent as a heat sink for the heat developed as a result of current flowing through the coil 10.

After these various connections are made, the window of the frame member 25 is filled with encapsulating or potting material which embeds the various elements in such window and hermetically seals the same. The particular encapsulating or potting material is one which, of course, an insulating material but one which has good heat conductivity properties notwithstanding its electrical insulating properties. The frame member 25 may be of metal or of insulating material and it will be observed that it is maintained in place as a result of the wires 26 and 27 passing therethrough which are mechanically connected to the elements embedded in the window of frame member 25. The encapsulating material filling the window frame 25 is one which bonds itself to the encapsulating or potting material on the coil 10 and also to the frame

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member 25. Standard or conventional encapsulating or potting materials may be used for this purpose. The resulting electrical circuitry for the construction shown in FIGURE 1 as well as the other constructions illustrated herein is shown in FIGURE 2. It will be observed that the coil 10 is connected in a full-wave bridge-type rectifying circuit with the input leads 26 and 27 being connectible through a switch 30 to a source 31 of alternating current. When the switch 30 is closed, a full-wave rectified unidirectional current flows through the coil 10. This is so since the diodes 19, 20, 21 and 22 have the polarities as indicated in FIGURE 2.

The construction shown in FIGURE 3 is essentially the same as that described in connection with FIGURE 1. The four diodes are not mounted on metallic heat sinks but are simply embedded in the encapsulating or potting material filling the window of the frame member 25. The diodes 119, 120, 121 and 122 corresponding to the diodes 19, 20, 21 and 22 in FIGURE 1 have their leads or "pigtails" interconnected to form generally a circular pattern as illustrated in FIGURE 3 with the coil leads 15 and 16 being connected at diametrically spaced points; and similarly, the input leads 26 and 27 are also connected to diametrically spaced points of the circularly arranged rectifiers or diodes. These diodes in FIGURE 3 are interconnected with respect to the coil and the input leads as indicated in FIGURE 2.

In the modification shown in FIGURE 4 the four diodes 219, 220, 221 and 222 are again interconnected in a circular pattern with the coil leads 215 and 216 being connected at diametrically spaced points; and likewise, the input leads 226 and 227 are interconnected at diametrically spaced points on the circularly interconnected diode ring. In this case, however, as perhaps best seen in FIGURE 5, this assemblage of interconnected diodes is embedded in encapsulating or potting material 228 which fills the circularly grooved portion or end 250 of the specially constructed coil form or spool 251. The coil 210 is wound in conventional manner on the main portion of this spool 251 and has its leads 215, 216 extending upwardly through corresponding small apertured portions 253 and 254 in the flanged portion 257 for purposes of providing the aforementioned connections to the diodes. The leads 226 and 227 may extend simply out of the potting material 228 or, for purposes of better rigidity, may extend through small apertured portions of a circular wall defining a portion of the groove end 250. Here again, the diodes shown in FIGURE 4 are interconnected with respect to the coil and to the input leads in the manner shown in FIGURE 2.

In the modification shown in FIGURE 6 the arrangement shown therein is essentially that described in connection with FIGURE 4 but in this case metal strips or bars 319A, 320A serving as heat sinks mount corresponding pairs 319, 321 and 320, 322 of diode rectifiers of the silicon type. The particular form of these bars 319A and 320A is illustrated in FIGURE 8 which shows the truncated nature of one of the heat sinks 320A having mechanically and electrically mounted thereon the pair of diodes 320, 322 and having a tongue 318 struck therefrom to serve as a binding post or soldering lug for coil lead 216. This generally is also the arrangement shown in FIGURE 1 wherein corresponding heat sinks 19A and 20A are provided.

The modification shown in FIGURES 9 and 10 is essentially the same as that described in connection with FIGURES 4 and 5 but in this case the upper end of the coil form 351 is enlarged somewhat to provide a somewhat more enlarged grooved portion 350 and while in the case of the arrangement as shown in FIGURE 1 the diodes are interconnected in a circular pattern in such grooved portion, the diodes 219 and 221 are spaced closer together, the diodes 220 and 222 are spaced closer together and the input leads 326 and 327 are secured to the structure in a different manner.

The leads 326 and 327 extend downwardly through corresponding apertured portions 360, 361 in the grooved portion and extend downwardly substantially the full length of the coil 310 of insulated magnet wire. This portion of the lead 327 may also be of insulated magnet wire and is connected to the circuit as shown in FIGURE 10 to a thicker covered insulated wire. Insulating strips 370 and 371 are interposed between the coil wire and the lead 327 to prevent the possibility of short-circuiting, and then both the downwardly and upwardly extending portions of lead 327 are wrapped with suitable insulating wire so that the winding 354 may be coated with an encapsulating or potting compound. By these means the input leads 326 and 327 are securely fastened.

While as described it is preferred that the four rectifiers or diodes be provided and connected in a full-wave bridge rectifying circuit as shown in FIGURE 2, the invention in its broader aspects may be practiced using one or more rectifiers connected in a different fashion to achieve either a half-wave or full-wave rectification.

In all cases, however, a unitary structure results which prevents over-heating of the small compact constructions.

In order to give an indication as to the sizes involved herein, the overall length of the structure shown in FIGURE 10 may be 1½ inches long and have the same diameter, namely ½ inches, with the central apertured portion being approximately ⅝ of 1 inch.

Constructions such as shown in FIGURES 1 and 6 are preferred since they incorporate metallic heat sinks of relatively large dimensions from which heat may be conducted through the surrounding encapsulating or potting material to the exterior surfaces of the structure where the heat may be further dissipated by conduction, convection or radiation, without development of so-called "hot spots" in the coil itself. Indeed, because of the mass of metal connected externally to the coil leads, in all of the modifications shown herein the same provide a heat sink from which heat may be conducted to and through the surrounding encapsulating or potting material.

It will be understood that the term "enclosure means" for the rectifying means as used herein has reference to the surrounding apertured frame member 25 in FIGURES 1 and 3 and to the grooved portion in the upper end of the coil form in the other figures. This term is thus given a very general meaning as shown herein.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

1. A unitary construction including a coil and rectifying means, supporting means for said coil, enclosure means enclosing said rectifying means mounted on said supporting means adjacent to an external portion of said coil, input leads, electrical connections between said coil, said rectifying means and said input leads all in said enclosure means, said electrical connections comprising a part of a rectifying circuit which provides a unidirectional current flow through the coil when an A.C. voltage is applied to said input leads, and encapsulating material in said enclosure forming an external heat sink surrounding said electrical connections, said rectifying means and a portion of said input leads.

2. A coil as set forth in claim 1 in which said rectifying means comprises four rectifiers connected in a full-wave bridge-type rectifier circuit.

3. A construction as set forth in claim 1 in which said rectifying means comprises a silicon-type rectifier.

4. A construction as set forth in claim 1 in which said rectifying means is mounted on an elongated metal member.
5. A construction as set forth in claim 1 in which said supporting means comprises a spool, and said spool has a grooved portion at one end thereof forming said enclosure means.

6. A construction as set forth in claim 1 in which said enclosure means comprises an apertured frame member mounted adjacent a circumferential portion of said coil.

7. A construction as set forth in claim 6 in which one of said input leads extends through an apertured wall of said frame member.

8. A construction as set forth in claim 5 in which one of said input leads extends through an apertured portion of said grooved portion and adjacent to and longitudinally of the external surface of said coil, a layer of insulating material between said input lead and said coil, and an insulating wrapping around said lead and coil.

9. A construction as set forth in claim 4 in which a lead of said coil is connected directly to said elongated metal member for conducting heat away from said coil.

10. A construction as set forth in claim 2 in which said four rectifiers are disposed generally on the circumference of a circle and within the same plane.

11. A construction as set forth in claim 10 in which the coil leads are connected to diametrically oppositely spaced portions on said circle, and said input leads are connected to oppositely diametrically spaced points on said circle with rectifiers between said coil leads and said input leads.

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CERTIFICATE OF CORRECTION

Patent No. 3,131,331

April 28, 1964

William A. Ray

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

In the grant, lines 1 to 3, for "William A. Ray, of North Hollywood, California, assignor to General Controls Co., of Glendale, California, a corporation of California," read -- William A. Ray, of North Hollywood, California, assignor to International Telephone and Telegraph Corporation, a corporation of Maryland, --; line 12, for "General Controls Co., its successors" read -- International Telephone and Telegraph Corporation, its successors --; in the heading to the printed specification, lines 3 to 5, for "William A. Ray, North Hollywood, Calif., assignor to General Controls Co., Glendale, Calif., a corporation of California" read -- William A. Ray, North Hollywood, Calif., assignor to International Telephone and Telegraph Corporation, a corporation of Maryland --.

Signed and sealed this 27th day of October 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents
UNITED STATES PATENT OFFICE
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