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C. E. PETERS

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RECTIFIER

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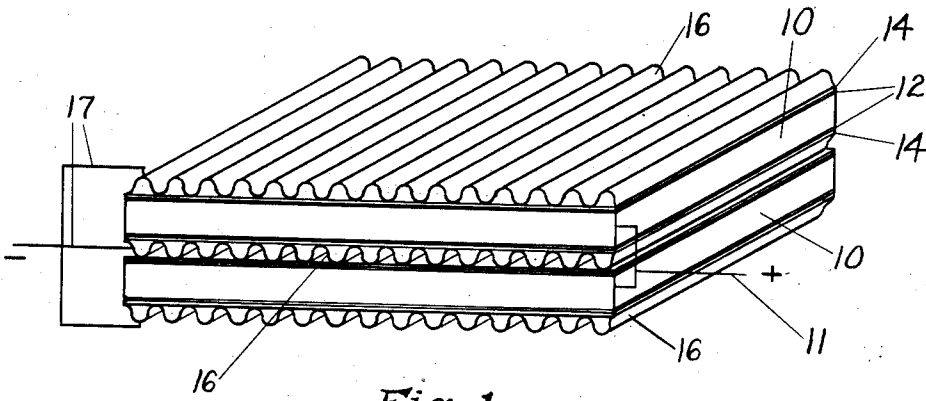


Fig. 1

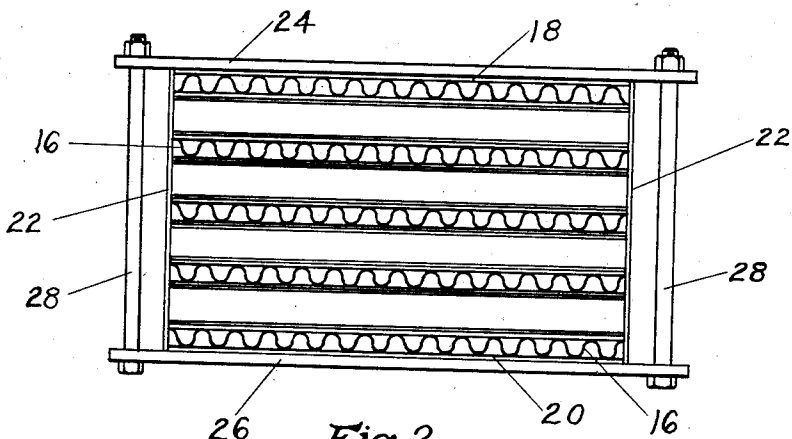


Fig. 2

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RECTIFIER

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3 Claims. (Cl. 175—366)

This invention relates to improvements in rectifiers. More particularly, the invention relates to improvements in methods of cooling dry disc rectifiers.

Dry disc rectifiers usually consist of a number of rectifying units that are held together in assembled relation. The rectifiers are usually cooled by cooling one part or element of each of the various units. This part of the various rectifying units is usually cooled by placing a heat radiating fin in contact with it. The heat radiating fin has a cross-sectional area that is larger than the cross-sectional area of each part or element of the unit, and has a relatively large area that is exposed to the air. This exposed area can readily radiate heat into the air surrounding the rectifier. The fin is usually a good conductor of heat and readily conducts heat from the part to be cooled to the fin's exposed area where the heat is absorbed by air. In the case of dry disc rectifying units that consist of an electropositive element and an electronegative element, the part in contact with the heat radiating fin is the electropositive element. In the case of dry disc rectifying units that consist of a layer of semi-conducting material, a base plate, and an electrode, the part in contact with the fin is the base plate. Occasionally the electropositive element of the first type of rectifying unit, and the base plate of the second type of rectifying unit, are cooled by spacing them apart from other units of the rectifier. This is usually done by the use of a cone-shaped washer or spacer that abuts against the electropositive element or the base plate. This permits air to contact at least a portion of the surface of the electropositive element or base plate, and absorb heat directly from it.

Neither of these methods of cooling is completely satisfactory. In the case of rectifying units that consist of an electropositive element and an electronegative element, the rectifying surface is on the surface of the electropositive element. Where a fin is used as the cooling means, the heat generated at the rectifying surface must be conducted through the electropositive element, through the contact surface between that element and the radiating fin, and through the fin to the periphery thereof before it can be dissipated into the air. The thermal conductivity of such a path is not as large as it should be. Where a cone shaped washer or spacer is used as the cooling means, a part of the surface of the electropositive element is covered by it, and cannot be contacted by the

cooling air. The portion of the element that is covered by the spacer does not receive sufficient cooling and may overheat although the rest of the unit is cool enough. From the above, it can be seen that these methods of cooling are not completely satisfactory with this type of rectifier. These methods of cooling permit overheating of the rectifier which is objectionable. In the case of rectifying units of the semi-conductor type also, these two methods of cooling are not satisfactory. In this type of rectifying unit, the rectifying surface lies between the electrode and the layer of semi-conducting material. It is, therefore, on that surface of the semi-conductor that is spaced away from the base plate. Where a fin is used as the cooling means, the heat that is generated at the rectifying surface must flow through the layer of semi-conducting material to the base plate, through the base plate, through the contact surface between the base plate and the fin, and then to the periphery of the fin before it can be dissipated. The layer of semi-conducting material as its name indicates, is not a good conductor of heat or electricity, and cannot conduct heat very rapidly. As a result, the flow of heat from the rectifying surface to the heat radiating fin is not rapid, and the temperature of the layer of semi-conducting material increases materially. This increase in temperature can be quite serious where, as is usually the case, the electrode in contact with the layer of semi-conducting material is composed of low melting point alloy. If the temperature of the layer of semi-conducting material increases unduly, the low melting point alloy will melt. This melting of the electrode may seriously impair, if not ruin, the efficiency of the rectifying unit. Where a cone-shaped washer or spacer is used as the cooling means, the rectifying units also do not get sufficient cooling. The washer or spacer covers a large portion of the surface of the unit and keeps air away from it. This may result in an overheating of the surface under the spacer although the rest of the surface is at a safe temperature. These two methods of cooling rectifiers can be seen, therefore, to be objectionable in the case of rectifiers of this type also. The invention obviates the objections outlined above by providing a rectifier that has a plurality of air passages adjacent the electrode or electropositive element. These air passages foster the dissipation of heat directly from the electrode instead of indirectly from the layer of semi-conducting material, the base plate and the radiating fin, or foster heat directly from the

electropositive element instead of indirectly from the radiating fin. Heat can be dissipated from the electropositive element itself more readily than it can be dissipated from the combined electropositive element and radiating fin. In the same way heat can be dissipated more rapidly from the electrode itself than it can be dissipated from the layer of semi-conducting material, the base plate and the fin, because the heat can flow directly through the electrode which is a good conductor of heat. Because of this the air passages, adjacent the electrode or electropositive element, maintain the temperature of the electrode or electropositive at a safe level. In the case of the semi-conductor rectifier, the air passages adjacent the electrode are particularly advantageous because they dissipate heat from the element that needs heat dissipation most. It is, therefore, an object of the present invention to provide a rectifying unit having a plurality of air passages adjacent the surface to be cooled.

Dry disc rectifiers usually consist of a group of rectifying units that are maintained in assembled relation and are electrically connected together by resilient means. Ordinarily, the resilient means is a cone-shaped washer or spacer that bears against opposing surfaces of the rectifying units. In the case of a rectifier having a layer of semi-conducting material, one of these surfaces consists of a layer of low melting alloy. As the elements of the rectifier expand and contract because of heating and cooling, the end of the cone-shaped washers move relative to the surfaces of the electrodes. This movement may injure the surfaces of the electrodes, and particularly is this likely where the electrode is composed of relatively soft low-melting-point alloy. The ends of the cone-shaped spacers or washers are relatively sharp and may penetrate the layers of metal that comprise the electrodes. This is objectionable since it materially shortens the life of the rectifier. The invention obviates this objection by providing an improved resilient means. The resilient means provided by the invention permits the units of the rectifier to expand and contract freely without injury. This means is a corrugated member of resilient material. The raised portions of the corrugated member that contact the surfaces of the unit are quite different from the ends of the cone-shaped washers. The raised portions of the corrugated member are rounded and cannot injure the surfaces of the units of the rectifier, as the relatively sharp ends of the cone-shaped washers may do. The use of the corrugated member of resilient material provided by the invention, therefore, may increase the life of the rectifier. It is, therefore, an object of the present invention to provide a corrugated member of resilient material for rectifiers.

The provision of corrugated members of resilient material for rectifiers is quite desirable. These corrugated members permit efficient cooling of the rectifiers, by providing a plurality of passages for air adjacent the surface to be cooled. These passages permit direct contact between the air and the surface to be cooled that dissipates the heat in that surface. Furthermore, the provision of these passages facilitates efficient cooling of the rectifiers without increasing the cross-sectional area of the rectifier. Where heat radiating fins are used in a rectifier to facilitate heat radiation, an increase is had in the cross-sectional area of the rectifier that is accompanied by a decrease in the rigidity of the rectifier. This is objectionable where the rectifier is cooled by

air that passes over the rectifier at high speed. This problem is encountered particularly in rectifiers for use on airplanes. In airplanes, a small stream of high velocity air is conducted to the rectifier and permitted to flow over the rectifier. The rush of this air past the rectifier at high speed, might bend the radiating fins whose peripheries extend out beyond the peripheries of the other elements of the rectifier. Such bending would short circuit some of the rectifying units. This is objectionable because it would materially decrease the capacity of the rectifier. The invention obviates this objection by providing a plurality of passages next to the surface to be cooled, that permit the making of a compact and strong rectifier. It is, therefore, an object of the present invention to provide a strong compact rectifier by having a plurality of passages therein for air.

The corrugated members of resilient material provided by the invention, are more desirable than the cone-shaped resilient spacers now in use. The cone-shaped spacers entrap air next to the surface to be cooled and since this entrapped air cannot escape it will continue to heat up. In the case of a rectifier having a layer of semi-conducting material, this heating may result in a melting of the low melting point alloy electrode under the cone-shaped washer, although the rest of the electrode is relatively cool. This cannot happen with rectifiers that are provided with the corrugated resilient member of the invention, because such a member prevents the entrapment of air.

Present day rectifying units of the semi-conductor type consist of a base plate that has one surface covered with a layer of the semi-conducting material and has the other surface bare for radiation purposes. The present invention provides a rectifying unit of the semi-conductor type having a base plate with a layer of semi-conducting material on both surfaces. This can be done because the invention does not rely on the base plate for heat radiation. Because the base plate has two layers of semi-conducting material on it, it has twice the rectifying capacity of present day base plates. It is, therefore, an object of the present invention to provide a base plate for rectifiers having a layer of semi-conducting material on each surface.

Other objects and advantages of the invention will appear to those skilled in the art from an examination of the drawing and accompanying description.

In the drawing and accompanying description, a preferred form of the invention is shown and described, but it is to be understood that the drawing and accompanying description do not limit the invention and the invention will be defined by the appended claims.

In the drawing,

Fig. 1 is a perspective view of a plurality of rectifying units, and

Fig. 2 is an end elevational view of a rectifier made in accordance with the principles of this invention.

Referring to the drawing in detail, the base plates of the rectifying units are denoted by the numeral 10. Supported on these base plates are layers 12 of a semi-conducting material. This semi-conducting material will preferably be selenium, but any suitable semi-conducting material having current-rectification properties may be used. On the surface of each of these layers 12 of semi-conducting material is an electrode 14 of

low melting point alloy. The rectifying surface of the rectifying unit lies between the electrode and the layer of semi-conducting material. This surface is cooled quite efficiently by the movement of air through the passages formed by the corrugated members 16 and the surfaces of the electrodes 14. Part of this air contacts the metal of which the corrugated member is composed, and absorbs heat from it. In this way, heat is removed directly and indirectly from the electrode, and the temperature of the electrode and the rectifier is kept at a safe level.

Each rectifying unit comprises a base plate 10, a layer 12 of semi-conducting material, and an electrode 14. In some cases as shown, a base plate 10 may have two layers 12 of semi-conducting material and two electrodes 14. These rectifying units must be held in electrical engagement, but must be permitted to move relative to each other as they expand and contract due to heating and cooling. The corrugated member 16 of resilient material is quite advantageous because it provides the necessary resilience as well as the necessary electrical contact.

The corrugated member is particularly useful because it has a large surface area for radiation purposes, and because its raised portions are rounded and can move relative to the surface of the electrode 14 without injuring it. As a result, the corrugated member 16 provided by the invention is more advantageous than the cone-shaped washers and spacers used heretofore. This corrugated member 16 should be a good conductor of electricity and should have a reasonable amount of resilience. Brass and copper can be used to advantage and a number of other metals can also be used.

The base plates 10 are connected together by suitable electrical leads that are indicated generally by the numeral 11, and the resilient members 16 are connected together by electrical leads that are indicated generally by the numeral 17. From this, it can be seen that the resilient members 16 not only serve as heat dissipators and resilient means, they serve as electrical contacts.

A number of rectifying units can be assembled to form a rectifier similar to that shown in Fig. 2. This rectifier is encased in a housing that consists of a top 18, a bottom 20 and sides 22, and is suitably insulated from the elements of the rectifier. The housing is encased in a frame consisting of plates 24 and 26 and nuts and bolts 28. The sides 22 of the housing are so dimensioned that when nuts 28 are tightened, the resilient members 16 will be compressed sufficiently to insure the maintenance of good contact between the rectifying units. This housing may be connected to an air duct that will conduct air to the rectifier. This air will cool the rectifier effectively by absorbing heat from the electrodes and the resilient members. The air will absorb heat directly from a part of the surface of the electrode, and indirectly from the rest of the surface of the electrode by absorbing heat from the corrugated member that is in contact with the electrode.

It will be noted that this construction obviates the use of the bolt usually found in the center of dry disc rectifiers. This bolt would interrupt the flow of air across the surface to be cooled and would cause a turbulence of air that would decrease the cooling effect given by the air. In the construction shown, there is no such obstruction to the flow of air and the air flows smoothly through the passages.

The size of the corrugations on the members 16 will be determined by the use to which the rectifier is put. For instance, if the rectifier is used on airplanes, the corrugations must be small and must be close together. In an airplane, the rectifier will be supplied with a small amount of air at relatively high pressure. Because the supply of air is small, the ratio of the surface area of the passageway to the volume of the passageway must be as large as possible; and the flow of air must be as smooth as possible, to permit maximum efficiency in transferring heat from the electrode to the air. Where larger volumes of air are available at lower pressures, the passages are made somewhat larger.

Although such rectifiers have not been shown in the drawing, the invention also contemplates the use of corrugated members of resilient material with rectifying units comprising electropositive and electronegative elements. These rectifying units will be separated from each other by the corrugated member of the invention, and can be cooled by air passing through the passages formed by the corrugated member and one surface of the rectifying unit. By use of the corrugated members, a strong, compact, and readily cooled rectifier can be made.

In the drawing and specification, a preferred form of the invention has been shown and described, but it is obvious to those skilled in the art that various changes may be made in the form of the invention without affecting the scope of the invention.

1. A rectifier comprising a plurality of rectifying units, a corrugated metallic member, and means to maintain the units and the member in assembled relation, each of said rectifying units comprising a base plate, at least one layer of semi-conducting material having one of its surfaces in direct contact with said base plate and at least one electrode of relatively low melting point metal in direct contact with the other surface of said semi-conducting material, said corrugated member being of resilient metal and having a plurality of smoothly rounded corrugations, said units and said member being assembled so the electrodes of said units face each other and directly contact the smoothly rounded corrugations of said corrugated member whereby said corrugated member electrically connects said electrodes while it resiliently spaces them apart to permit air to directly contact the major portion of the surface of the electrodes and to directly contact the corrugated member.

2. A high capacity, compact selenium rectifier comprising a plurality of selenium rectifying units, a corrugated metallic spacer and a frame maintaining said units and said spacer in assembled relation, each of said selenium rectifying units comprising a base plate, at least one layer of selenium having one of its surfaces directly in contact with said base plate and at least one spray metal electrode in direct contact with the other surface of the selenium, said corrugated spacer being made of resilient metal and being corrugated to be compressible, said units and said spacer being assembled so the units are oppositely disposed of said spacer and the electrodes of the units contact said spacer, said frame being dimensioned so said spacer is compressed, said spacer being arranged to electrically connect said spray metal electrodes and to resiliently space them apart so air can contact the major portion of the surface of said electrodes.

3. A rectifier comprising a plurality of rectify-

ing units, a corrugated metallic member, and means to maintain said units and said member in assembled relation under pressure, each of said rectifying units having at least one electrode of relatively soft metal, said corrugated member being made of resilient metal and being corrugated to be compressible and to have a plurality of smoothly rounded corrugations, said units and said member being assembled so the corrugated member provides a plurality of line contacts between the electrodes on said units, and so air

can directly contact the major portion of the surfaces of said electrodes, said smoothly rounded corrugations being arranged to permit relative movement between the electrodes and the corrugated member without injury to said electrodes, said pressure maintaining means being arranged to compress said corrugated member and thereby maintain pressure between said member and said units.

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