PATENT SPECIFICATION

Inventors: JAY WESLEY THORNHILL and EDMOND DONALD JACKSON

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COMPLETE SPECIFICATION

Improvements in or relating to Rectifier Units

We, TEXAS INSTRUMENTS INCORPORATED, of 6000, Lemmon Avenue, Dalla., Texas, United States of America, a corporation organized and existing under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a highly improved rectifier unit.

The heat dissipation of a rectifier is recognized as being a limiting factor with respect to the current load carrying capacity of a particular unit. If the operating temperature of a unit becomes excessive due to high load currents or high ambient temperatures, there exists the danger that the unit may break down partially or even completely from either the mechanical or electrical standpoint. Accordingly, the problem of heat dissipation is of paramount importance and special provisions must be made to insure adequate heat dissipation at the operational current load. Also, it is quite possible to promote the current carrying capacity of a rectifier unit by providing for increased or more efficient heat dissipation. The desirability of making available an efficient and economical current rectifier which will operate at high current loads is recognized by the art. Unfortunately, however, many prior constructions which have been devised for this specific purpose have been subject to numerous disadvantages and especially the inability to dissipate large amounts of heat which are generated incident to the operation of such devices as these at high current loads.

Accordingly, it is a principal object of the present invention to provide a novel rectifier unit which will operate efficiently and economically at high current loads and which will function to dissipate large amounts of heat expediently.

It is a further object of the present invention to provide an improved rectifier unit characterized by a cooling system whereby the unit can be operated at high current loads and when so operated will not be subjected to excessive temperatures which otherwise would cause a breakdown of the unit.

The invention will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a view in cross section through a rectifier unit according to the present invention;

Figure 2 is a view in perspective of the rectifier unit of the present invention mounted in a cooling bath; and

Figure 3 is a view in perspective of a bank of rectifying units mounted in a cooling bath.

Referring now to the drawings and in particular to Figures 1 and 2 there will now be described the preferred form of the rectifier unit of the present invention. As will be evident, the unit is composed of an annular base section 10 which is formed at its upper end with a flange 11 the outside surface of which is cut as a hexagonal nut. The external surface of the base section 10 below the flange 11 is threaded as indicated at 12. At the top surface of the flange 11 at its inner periphery is an annular recess 13. Seated in the annular recess 13 is an annulas 14 which is preferably made of a material known under the Registered Trade Mark "Pyrex" or other insulating material capable of withstanding relatively large changes in temperature without cracking. The upper and lower peripheral marginal edges of the annulus 14 are coated with a silver paste to form rings 15 and 16 at these points. The annulus 14 is fixed to the flange 11 by a solder joint indicated by the numeral 17. As will be evident, the solder 17 physically connects the silver ring 15, which directly abuts against shoulder 13, with the flange 11 and forms a hermetic seal. A cap 18, having a central hole 19 and a depending outer peripheral flange 20,

[*Price 3s. 6d.*]

is seated on the top of the annulus 14 with flange 20 lying outside of annulus 14 in abutting relation therewith. The cap is soldered or otherwise fixed to the annulus 14 as indicated by the solder joint 21 which forms a hermetic seal and which physically connects the depending outer peripheral flange 20 with the ring 16 coated onto the annulus 14. The cap 18 further carries a depending inner peripheral flange 22 which forms a shoulder with the inner surface of cap 18. Seated against the shoulder thus defined is the top of a sylphon bellows 23 which is closed at its lower end. An annular solder joint 24 which physically connects the sylphon bellows 23 and the inside surface of cap 18 functions to maintain the top of the bellows 23 against this shoulder and also as a hermetic seal.

Within the bellows 23 is a pool of solder 24 in which is embedded one end of a conducting cable 25. The cable 25 is brought out of the unit through the hole 19 in cap 18 and has its other end fixed to a terminal 26.

The bottom of the base section 10 has a central hole 27 in which is received a cooling element 28 preferably made of copper, aluminum, brass or other material having a high thermal conductivity. The hole 27 in the base section 10 is stepped and the top of the cooling element 28 is stepped in a complementary fashion. The cooling element 28 is soldered to the bottom of the base section 10 as indicated by the numeral 29. For this purpose, it is preferred that a silver solder be used. The outer surface of cooling element 28 is cut to define a series of equally spaced annular cooling fins 30.

Positioned between the bottom of bellows 23 and the top of cooling element 28 is a rectifier element. For purposes of simplicity the rectifier element is shown merely as a wafer 35. One example of a suitable rectifier element would be a germanium-indium wafer. It will be appreciated, however, that any rectifier element can be employed. A layer of solder 36 attaches the top surface of wafer 35 to the bottom of the bellows and a layer of solder 37 attaches the bottom surface of wafer 35 to the top of the cooling element 28. It is possible to use any suitable solder to attach wafer 35. In the case of a rectifier wafer of the alloy junction type it would be necessary to select a solder having a melting point lower than the alloy. Hence a laminated construction is provided with the bellows 23 connected to the top of the laminated construction, to thus provide the requisite freedom of movement of the laminated construction in a vertical sense due to thermal expansion. At the same time, the bottom of the laminated construction is in direct heat exchange relationship with the top surface of cooling element 28 and the bottom of base section 10 so that exceedingly good heat dissipation will be obtained.

As will be evident from the construction above described, an annular space 34 is defined between the sylphon bellows 23 on the one hand and the base section 10 and annulus 14 on the other which is hermetically sealed from the atmosphere. This annular space 34 is completely sealed from the atmosphere and is preferably filled with an inert gas such as nitrogen or helium. Accordingly, the rectifying elements will be sealed from the atmosphere and will function solely in the inert medium filling space 34.

The unit as described is mounted onto a tank 40 which has a threaded opening in its upper surface. For purposes of sealing the unit against fluid leakage, a lead gasket 36 underlies the flange 11, which provides a good electrical contact as well. The tank 40 is provided with an inlet pipe 41 and an outlet pipe 42 whereby a cooling medium, as for example water, can be circulated through the tank 40 around the cooling element 28 and more specifically around the cooling fins 30. A terminal 44 is mounted onto the tank 40 and functions as the cathode connection for the rectifier unit. The terminal 26 in the circumstances of the invention functions as the anode connection for the rectifier unit. If it is desired, the wafer can be inverted whereby terminal 44 becomes the anode and terminal 26 the cathode.

In Figure 3, there is shown an arrangement for mounting a plurality of rectifier units on a common tank. Each of the rectifier units is of identical construction to that shown in Figure 1, and the tank 50 defines a threaded opening for each of the rectifier units, in this case three. An inlet pipe 51 is provided to introduce cooling fluid such as water into the tank 50 and an outlet pipe 52 is provided for the cooling fluid to flow from tank 50. In the arrangement shown in Figure 3, the anode terminals 26 may conveniently be fixed to a bus-bar which will function as the anode for all the rectifying units and a terminal 53 is fixed to tank 50 to serve as the cathode connection. In these circumstances, the rectifier units will be mounted in parallel whereby their current outputs will be additive. If it is desired, the wafer in each unit can be inverted whereby the terminals 26 become cathodes and the terminal 53 the anode.

It has been found that a rectifier unit, constructed according to the principles of the present invention, when operated is capable of carrying a current load of 100 amp. or more while dissipating efficiently heat generated incident to operation. Thus, the rectifier unit is fully capable of operating at high current loads without the danger of becoming over heated.

WHAT WE CLAIM IS:—

1. A rectifier unit including a rectifier element for mounting on a fluid filled container which comprises an annular resilient bellow

is seated on the top of the annulus 14 with flange 20 lying outside of annulus 14 in abutting relation therewith. The cap is soldered or otherwise fixed to the annulus 14 as indicated by the solder joint 21 which forms a hermetic seal and which physically connects the depending outer peripheral flange 20 with the ring 16 coated onto the annulus 14. The cap 18 further carries a depending inner peripheral flange 22 which forms a shoulder with the inner surface of cap 18. Seated against the shoulder thus defined is the top of a sylphon bellows 23 which is closed at its lower end. An annular solder joint 24 which physically connects the sylphon bellows 23 and the inside surface of cap 18 functions to maintain the top of the bellows 23 against this shoulder and also as a hermetic seal.

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The bottom of the base section 10 has a central hole 27 in which is received a cooling element 28 preferably made of copper, aluminum, brass or other material having a high thermal conductivity. The hole 27 in the base section 10 is stepped and the top of the cooling element 28 is stepped in a complementary fashion. The cooling element 28 is soldered to the bottom of the base section 10 as indicated by the numeral 29. For this purpose, it is preferred that a silver solder be used. The outer surface of cooling element 28 is cut to define a series of equally spaced annular cooling fins 30.

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The unit as described is mounted onto a tank 40 which has a threaded opening in its upper surface. For purposes of sealing the unit against fluid leakage, a lead gasket 36 underlies the flange 11, which provides a good electrical contact as well. The tank 40 is provided with an inlet pipe 41 and an outlet pipe 42 whereby a cooling medium, as for example water, can be circulated through the tank 40 around the cooling element 28 and more specifically around the cooling fins 30. A terminal 44 is mounted onto the tank 40 and functions as the cathode connection for the rectifier unit. The terminal 26 in the circumstances of the invention functions as the anode connection for the rectifier unit. If it is desired, the wafer can be inverted whereby terminal 44 becomes the anode and terminal 26 the cathode.

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It has been found that a rectifier unit, constructed according to the principles of the present invention, when operated is capable of carrying a current load of 100 amp. or more while dissipating efficiently heat generated incident to operation. Thus, the rectifier unit is fully capable of operating at high current loads without the danger of becoming over heated.

WHAT WE CLAIM IS:—

1. A rectifier unit including a rectifier element for mounting on a fluid filled container which comprises an annular resilient bellow

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member attached to the top of the rectifier element, a cooling element provided with a plurality of cooling fins suitable for immersion in heat exchange relationship with said fluid attached to the bottom of said unit, a body surrounding said rectifier element and the annular resilient bellow member to form therewith a hermetically sealed annular space, and a threaded portion on the outer surface of said body for mounting said unit on said container.

2. A rectifier unit as claimed in Claim 1, wherein said body is shaped to provide a nut on its outer surface.

3. A rectifier unit as claimed in Claim 2, wherein a gasket is positioned between said nut and said container.

4. A rectifier unit substantially as described and as shown in the accompanying drawings.

5. A multiple rectifier unit comprising a container having a plurality of threaded openings in its top surface and an inlet and outlet and a rectifier unit as claimed in any of the preceding claims threaded into each of said threaded openings.

For the Applicants:
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings, Chancery Lane,
London, W.C.2.

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