

April 11, 1950

R. S. OHL

2,503,837

ELECTRICAL TRANSLATING DEVICE

Filed July 27, 1945

3 Sheets-Sheet 1

FIG. 1.

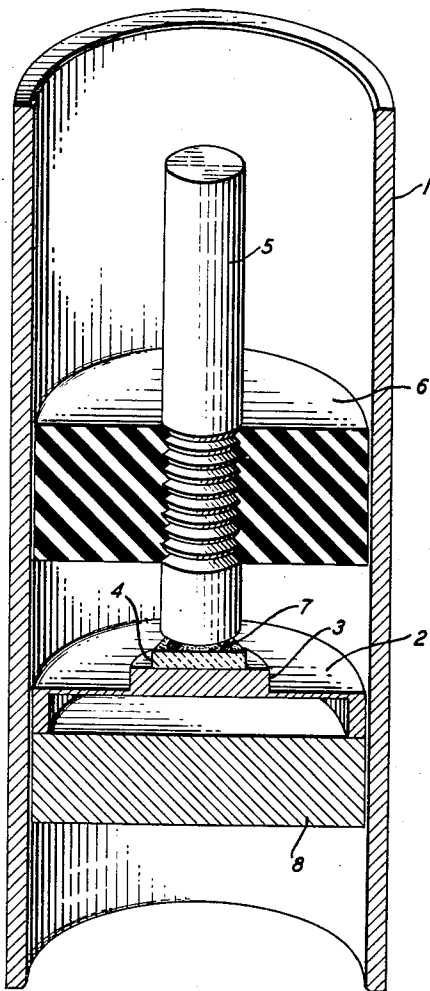


FIG. 2.

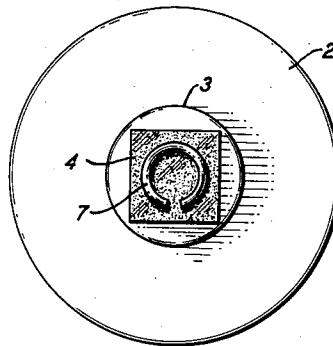


FIG. 3.

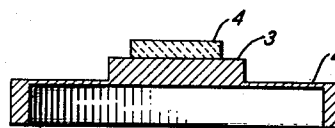


FIG. 4



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FIG. 5.

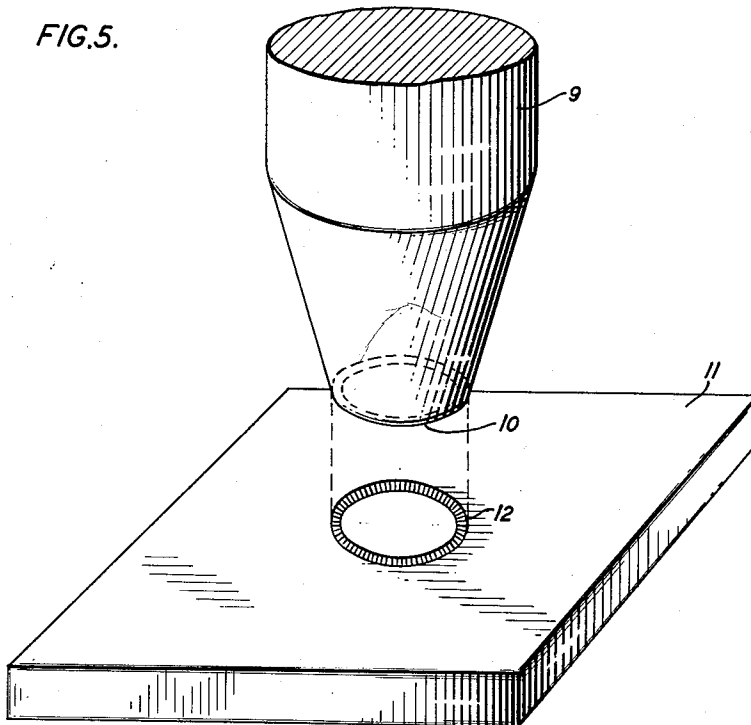
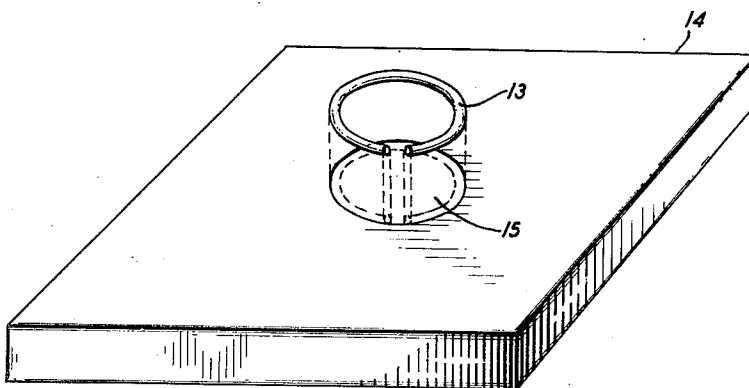


FIG. 6.



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FIG. 7.

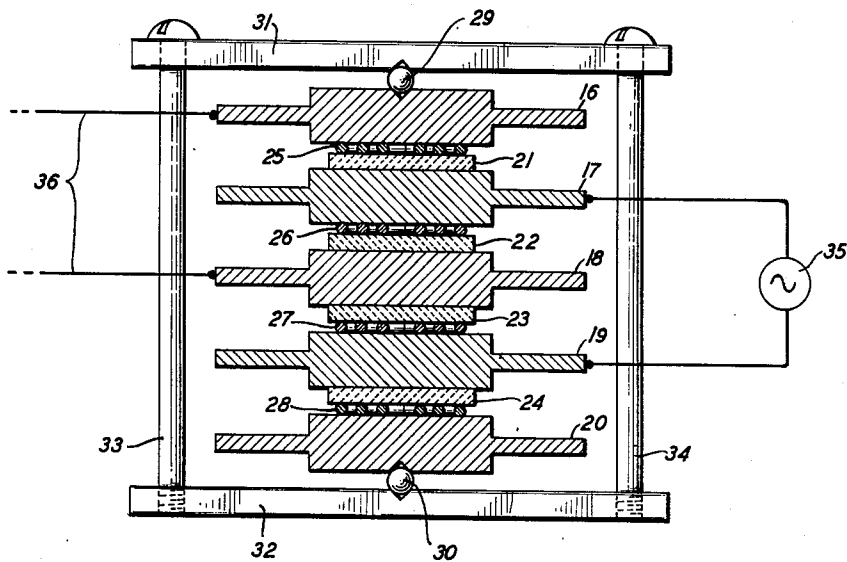


FIG. 9.

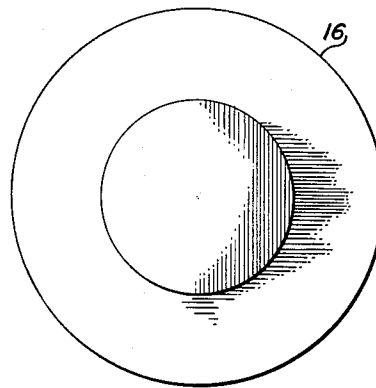


FIG. 8.

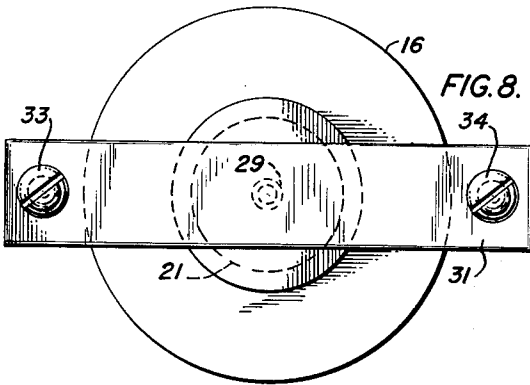


FIG. 10

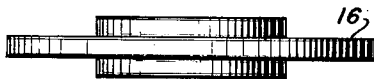


FIG. 11

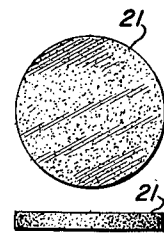
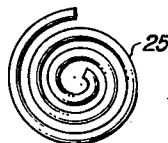


FIG. 12.



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2,503,837

ELECTRICAL TRANSLATING DEVICE

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Application July 27, 1945, Serial No. 607,427

4 Claims. (Cl. 175—366)

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This invention relates to electrical translating devices and particularly to devices of this kind having small areas of contact between different materials.

The objects of the invention are to increase the current-carrying capacity of translating devices, such as rectifiers; to minimize the area of contact between the rectifying elements; to reduce the loss due to capacity reactance; and in other respects to improve and to enhance the usefulness of devices of this character.

One of the problems encountered in the use of rectifiers of the point-contact type for frequencies in the ultra-high range has been the severe limitation on the magnitude of the currents these devices are capable of conducting. As the working frequencies have increased to higher and higher values, the tendency has been to reduce the size of the contact points to areas which are extremely small. While these minute contact areas give good rectification performance, the amount of current they are capable of passing is not sufficient for some purposes.

According to applicant's invention it is possible to increase the current-carrying capacity of rectifiers of this type while at the same time retaining the advantages that they are known to possess. In this connection applicant has observed that efforts to increase the current-carrying capacity of a point-contact rectifier by increasing the area of the contact have usually resulted in an impairment in performance. The reason for the poorer performance is attributable to the increased capacity reactance resulting from the enlarged area of contact between the rectifying elements. The larger the area of contact between the two elements, such as a contact wire and a crystal, the greater the reactance capacity; whereas the phenomenon of rectification is probably confined largely to the boundary area of the contacts where the electric field is known to be the strongest. With these considerations in mind, therefore, applicant has devised a rectifier in which a line-contact is formed between the two elements. One of the advantages of this form of rectifier is that the area of the contact is increased to enable a greater current-carrying capacity; yet all of the rectifying contact area lies in that part of the electric field having the greatest strength. Another advantage is that the detrimental effect of reactive capacity is greatly minimized.

A feature of the invention is a rectifier of the character above described in which a length of fine cylindrical wire is disposed in engagement

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with the surface of the rectifying element to form a line-contact therewith.

Another feature is a device of this character having a rectifying element with an extremely smooth surface, with which the contact wire makes engagement along a contact line that is highly uniform.

Another feature of the invention is a rectifier in which the contact wire is disposed in the form of a coil or helix, the several turns of which engage the surface of a rectifying crystal.

Another feature of the invention is a rectifier comprising a multiplicity of line-contact units assembled and connected to enable full-wave rectification of alternating currents.

Other features of the invention will be discussed more fully in the following detailed specification.

In the drawings accompanying the specification:

Fig. 1 is a perspective view partly in cross-section of an assembled rectifier unit incorporating the features of the invention;

Fig. 2 is a top plan view of the crystal support;

Fig. 3 is a side view in section of said crystal support;

Fig. 4 shows the wire contact element;

Fig. 5 illustrates the rectification contact area in a rectifier of the point-contact type;

Fig. 6 similarly represents the contact area in the rectifier of the present invention;

Fig. 7 is a plan view partly in section of a full wave rectifier assembly;

Fig. 8 is a top view of the assembly shown in Fig. 7;

Fig. 9 is a top view of one of the units of Fig. 7;

Fig. 10 is a side view of the unit shown in Fig. 9;

Fig. 11 illustrates the top and side views of the rectifier crystal; and

Fig. 12 illustrates a helical contact wire for use with the crystal shown in Fig. 11.

The rectifier structure of Figs. 1 to 4, chosen for the purpose of illustrating the invention herein, comprises an outer shell or housing member in the form of a cylinder, a crystal wafer assembly, and a contact wire assembly.

The cylindrical housing member 1, which serves both as a mechanical shield and as an electrical shield, is of any suitable metal such as steel, beryllium copper or brass. Preferably it is given a thin coating of tin.

The crystal wafer assembly comprises a circular diaphragm member 2 having a central boss 3 which supports the rectifying crystal element 4.

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The diaphragm 2 may be of any suitable metal, and the crystal element 4 is secured to the boss 3 by soldering or by any suitable means for making a good electrical connection.

The contact wire assembly of the rectifier consists of a metallic pin 5, preferably of nickel, an insulating cylinder 6 and a short length of tungsten contact wire formed in the shape of a ring or loop 7. A section of the pin 5 is threaded or corrugated and the insulating cylinder 6 is then molded around this section of the pin. Good results are obtained by the use of a molding material composed of quartz powder and a pure phenolic resin. The tungsten contact wire may be of any suitable diameter (in some cases as fine as .002 of an inch) and the loop 7 of this wire is secured to the end of the pin 5 preferably with cement, care being taken to obtain good electrical contact between the tungsten wire and the pin.

The parts are assembled by driving a brass cylinder 8 into one end of the housing shield 1, placing the diaphragm 2 with the crystal affixed on the cylinder 8, which serves as a support therefor, and driving the insulating cylinder 6 into the opposite end of the shield 1. A hydraulic press or any other suitable means may be employed for forcing these parts into the housing shell. Electrical indicating means may be used for determining when the contact wire 7 engages the surface of the crystal element 4, and suitable mechanical means may be employed for determining when the requisite degree of pressure has been obtained.

An important feature of the improved rectifier disclosed herein is the uniformity of the line of contact made between the tungsten contact wire 7 and the surface of the rectifying element 4. To secure this high degree of uniformity applicant preferably makes the crystal element 4 of rectifying materials such as high-purity silicon or germanium. If desirable certain other materials may be added to the silicon or germanium to give the resultant rectifier crystals the desired electrical properties. After the crystal elements are formed, their surfaces are polished to a high degree of smoothness, following which they may be subjected to certain heat treatment processes for the purpose of improving their rectification properties. Suitable processes for preparing these rectification elements are disclosed in the applications of J. H. Scaff, Serial No. 386,835, filed April 4, 1941, R. S. Ohl, Serial No. 530,419, filed April 10, 1944, and in the application of Scaff-Theuerer, Serial No. 545,854, filed July 20, 1944, now Patent Nos. 2,402,582, 2,437,269 and 2,485,069, respectively. A further provision for the maintenance of a uniform contact line between the wire 7 and the surface of the crystal element 4 is the resilience of the supporting diaphragm 2. The spring effect of the diaphragm holds the wire and crystal in engagement with each other at a substantially uniform pressure once the parts have been assembled.

The advantage of the line type of rectification contact, previously alluded to, is the increased area that is made available for rectification without the attendant increase in loss due to reactive capacity. This feature may be understood more clearly from a comparison of the rectification area formed by a line contact and the rectification area formed by a point contact. Fig. 5 illustrates a rectifier of the point-contact type. A fine contact wire 9 (diameter in the order of .002 to .005 inch) is ground to a conical point, and

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the end is flattened to present a small circular area 10 which engages the surface of the crystal 11. In the figure the contact wire 9 is withdrawn from the crystal 11 and the rectification contact area 12 is illustrated as a projection on the surface of the crystal. The magnitude of the current that the rectifier is capable of conducting depends more or less directly upon the area 12 of the rectification contact. That is to say, if it is desired to conduct more current it becomes necessary to enlarge the contact area. However, there is good reason to believe that the electron transfer between the contact wire 9 and the crystal 11, which causes the flow of current, is confined largely to the periphery or boundary of the contact, illustrated by the shading around the circumference of the area 12. This is the zone where the electric field is the strongest. Furthermore, the reactive capacity, which is a source of energy loss, varies as the area of the rectification contact. The larger the area 12 is made the greater the reactive capacity and the greater the energy loss. It will be seen, therefore, that the amount of gain made in current magnitude by increasing the contact area is a function of the perimeter of the contact whereas the amount of loss due to increased capacity is a function of the area of the contact. Accordingly, this method of increasing the current-carrying capacity of the point-contact rectifier has distinct limitations. It may be noted that the relatively strong electric field with its attendant increased electron activity occurs at the boundary of the contact. And this is the principle that applicant has taken advantage of in the design of his improved rectifier. By using a loop of wire 13 (Fig. 6) to form a line contact with the crystal 14 only the boundary of the area 15, where the electric field has its greatest intensity, is employed for rectification, and the reactive capacity is held to a minimum.

In Fig. 7 a full-wave rectifier of the line-contact type is illustrated. It comprises a plurality of metal spacers 16, 17, 18, 19 and 20 holding between them a corresponding number of crystal rectifying elements 21, 22, 23 and 24 and their associated contact wire units 25, 26, 27 and 28. Each of the metal spacers 16, etc., is a disc shaped as illustrated in Figs. 9 and 10; the rectifying crystals 21, etc., are also circular in form as shown in Fig. 11, and each contact wire unit, 25 and 26, is in the shape of a helix as shown in Fig. 12. The uppermost and lowermost spaces 16 and 20 are provided with indentations for receiving bearing balls 29 and 30. These two balls also fit into corresponding indentations in the upper and lower frame members 31 and 32 and these frame members are secured by stay bolts 33 and 34. The advantage of the ball type bearing is that the pressure exerted between each helical spring and its associated crystal is distributed in such a manner that uniform line contacts are obtained throughout the assembly.

If alternating current from a source 35 is applied to the rectifier spacers 17 and 19 as illustrated in Fig. 7, it will be seen that full-wave rectification takes place and that direct current will flow in the output circuit 36.

It will be understood that numerous variations may be made in the structure of these rectifiers and in the materials of which they are composed. For example, the contact wire which forms the line contact with the surface of the crystal may be rectilinear in form, or it may take a wide variety of curvilinear shapes. Also it may have various cross-sectional shapes. Further-

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more it may be made of materials other than tungsten.

What is claimed is:

1. The combination in an electric translating device of a supporting member, an element of rectifying material mounted on said supporting member, said rectifying element having a highly polished surface, a cylindrical tungsten contact wire formed in a loop and disposed to make a linear contact engagement with the surface of said element, and resilient diaphragm means for holding said contact wire and rectifying element in their relation of engagement.

2. The combination in an electric translating device of a hollow metallic cylindrical supporting member, a base member located within said supporting member, a flexible diaphragm member mounted on said base member, a rectifying element of crystalline material having a highly polished surface mounted on said diaphragm member, and a contact assembly supported within said cylinder and including an insulating member, a terminal member and a tungsten contact wire, said contact wire formed in a loop, secured to the end of said terminal member, and disposed to make a linear contact engagement with the surface of said crystalline element.

3. The combination in an electric translating device comprising an assembly of rectifying units, each unit including a metallic terminal element, a helical tungsten contact wire and a crystalline rectifying element having a highly polished surface, said units and the elements opposing them being mounted in superimposed relation, and a

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supporting frame for holding said units and for maintaining a uniform line of rectification between each helical contact wire and its associated crystalline rectifying element.

4. A unilateral electrical conducting device comprising an element of rectifying material having a highly polished surface, a tungsten contact wire formed into a loop and disposed to make contact along its length with the polished surface of said element, means for holding said wire against the surface of said element, and means including a resilient diaphragm supporting said element to maintain a uniform contact line between the wire and the surface of the rectifying element.

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