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VARIABLE RESISTANCE DEVICE

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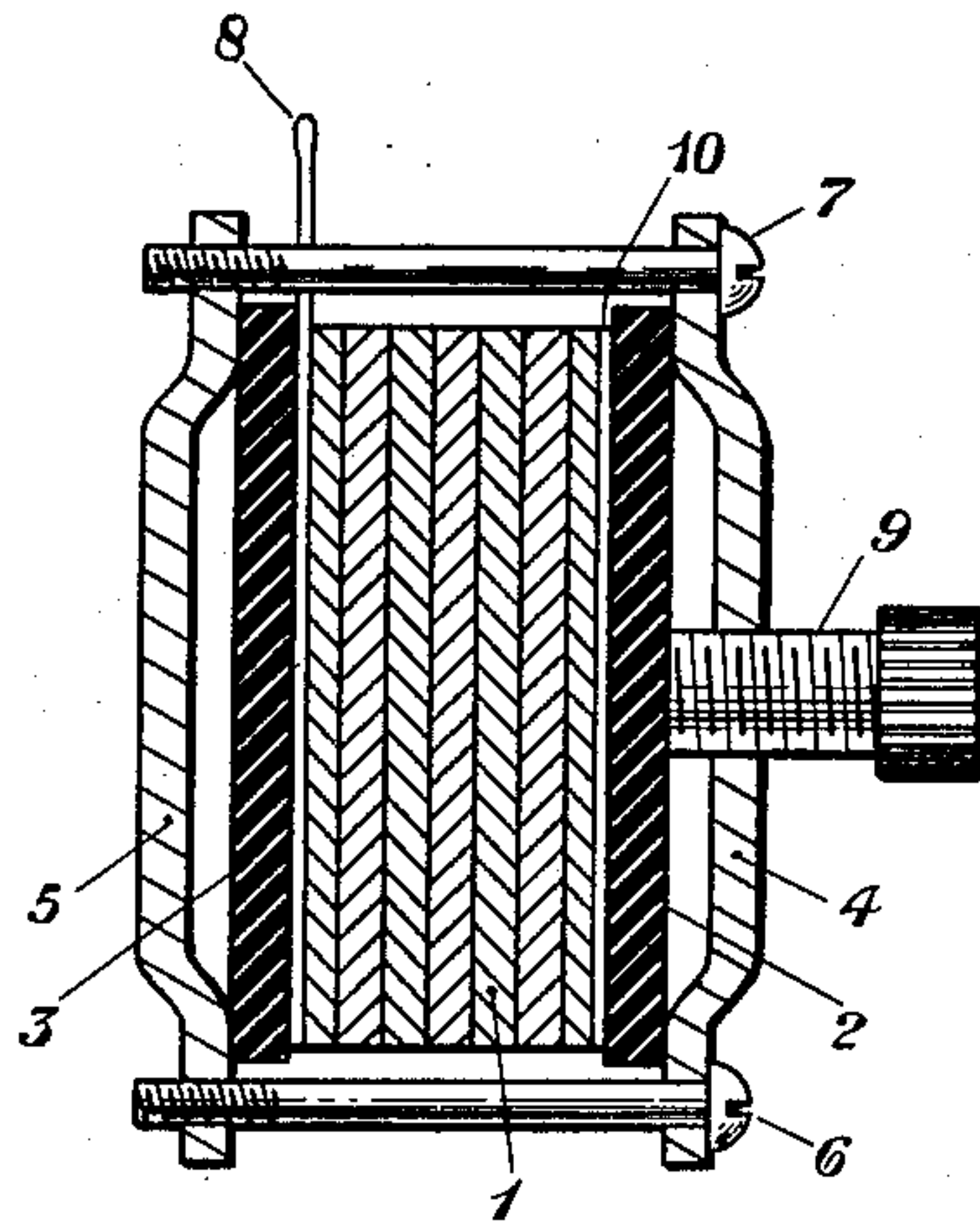


Fig. 1

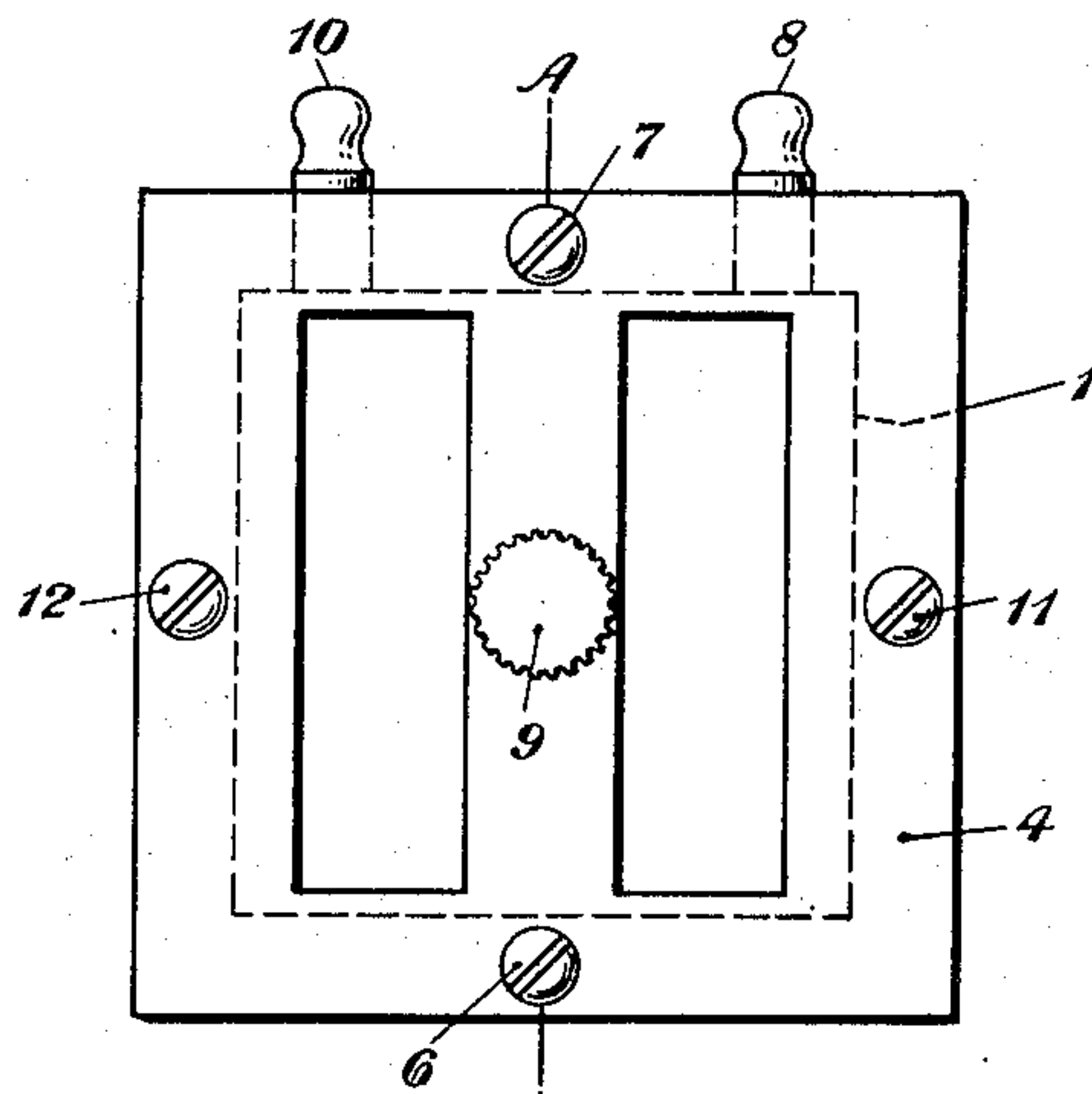


Fig. 2

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VARIABLE RESISTANCE DEVICE

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This invention relates to a method of and means for varying the characteristics of a device so that it may be utilized to control the resistance of a circuit.

5 In the operation of the arrangements of the invention, a device, such as a thin film rectifier, for example, a disk of copper and cuprous oxide, is included in a circuit and subjected to external stress. It has been
10 found that subjecting a device of this character to stress will vary its impedance in the circuit. In accordance with the arrangements of this invention, the stress to which the device is subjected is caused by mechanical means manually operated in an adjustable
15 manner. The arrangements of the invention thus provide a rheostat. Such a rheostat would be of inexpensive construction and might have a field of use analogous to that
20 of a carbon-pile rheostat, where absolute constancy of resistance under different current conditions is not essential. Furthermore, it would have the advantage over a carbon-pile rheostat of having comparatively constant
25 characteristics over a given period for a given deflection. The arrangements of the invention could also be utilized as an improved variable directional impedance element. Various combinations of the rectifier
30 disks or plates in series or in parallel could be utilized in the construction of the device of the invention.

For purposes of illustration it will be assumed that the element whose impedance is
35 to be varied by the method of this invention may be a rectifier of the well-known copper oxide type. However, other types of thin film or contact rectifiers may be utilized. One of the suitable methods of forming the
40 rectifier element might consist in heating a copper sheet about .005" thick to over 1000° C. until a thin closely adherent layer of cuprous oxide about one or two thousandths of an inch is formed. A heat treatment is
45 then administered at lower temperatures. The outer surface of the oxide may then be reduced to metallic copper by electrolysis. The impedance element in the circuit might be formed of one or more of such units.

50 At the junction of the bulk of the cuprous

oxide and the mother copper, there is believed to be a transition layer, wherein the copper oxide crystals match perfectly the copper crystals which they adjoin. This transition
55 layer is of high resistivity but in formation is made to match on to the copper in such a way (probably with considerable stress in the transition layer) as to reduce to a low value the work function of escape into it of electrons from the copper. However, it matches
60 on to the adjoining cuprous oxide in such a way as to make a large work function. There is no such effect between the thin metallic copper on the outer surface of the oxide as between the mother copper and the
65 oxide due to the different manner in which it is formed. Based on the theory of a transition layer depending upon initial stresses or on substantially perfectly matched crystals, it is proposed in accordance with the principles of this invention to vary the stresses in
70 this transition layer or the manner in which the crystals are matched and thus vary the work functions. Inasmuch as the oxide and surface coating of copper are very thin, the
75 transition layer is near the surface of the rectifier plate and is subject to approximately the maximum fibre stresses existing in the plate when it is flexed. Furthermore, when a portion of the plate bends in one direction, the transition layer has tension stresses superimposed on the initial stresses, and when bent the other way, has compression stresses added to it. It has been found by experiment that bending a plate so that the oxide
85 is placed in tension instantly increases the resistance in the reverse direction and that when placed in compression, the opposite occurs. It has also been found that variations in pressure cause variations in resistance in the conducting direction. Also, if kept within proper limits, it appears that this flexure can be continued indefinitely without deterioration of the disks.

95 The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1 and 2 of which the invention is illustrated. Fig. 1 is a sectional view of the de-
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vice of the invention along the lines A—A of Fig. 2, which is a front view thereof. Similar reference characters have been utilized to denote like parts in both of the figures.

In the drawings are shown a number of stressed thin film rectifier disks 1. These may, for example, be of the Liebel type or any other desired type. These disks will be held between two insulating members 2 and 3. The insulating members will in turn be held by the front and rear housing members 4 and 5. These housing members will be held by the clamping screws 6, 7, 11, and 12. The rectifier plates or disks may be connected into a circuit by the contact plates and terminal lugs 8 and 10. Cooperating with the front housing member is a clamping screw 9. This will bear against the central portion of the insulating member 2. When the screw 9 is operated, the rectifier plates or disks will be flexed or bent in one direction. If double flexure of the plates should be found desirable, an additional clamping screw might be provided and the position of the screws shifted. The bending of the plates superimposes compression or tension stress on the shrinkage stresses already existent in the rectifying film; thus causing a change in the resistance in both the conducting and reverse direction. Thus, the device may be used as a rheostat or as a variable directional impedance element. For example, it has been found that by utilizing a Liebel rectifier disk in this manner, a change in resistance from 380 ohms to 254 ohms was readily obtainable in the high resistance direction. By combinations of the disks in series or in parallel, different resistance ranges could be covered with approximately the same percentage change. The arrangements of the invention might also be used to improve the rectifying characteristics of thin film rectifier disks of various types.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many other and widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. The combination of a stressed thin film rectifier disk and manually operated clamping means for bending said disk.

2. The combination of a plurality of thin film rectifier disks, a housing member for holding said disks, and an adjustable clamping screw for bending and superimposing stresses on said disks.

3. A rheostat device comprising a stressed thin film rectifier element, means for connecting said element into an electrical circuit, and manually operated means for bending and superimposing stresses on said rectifier ele-

ment whereby its resistance in a circuit may be increased or decreased.

In testimony whereof, I have signed my name to this specification this 11th day of May 1929.

WILLIAM H. EDWARDS.

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