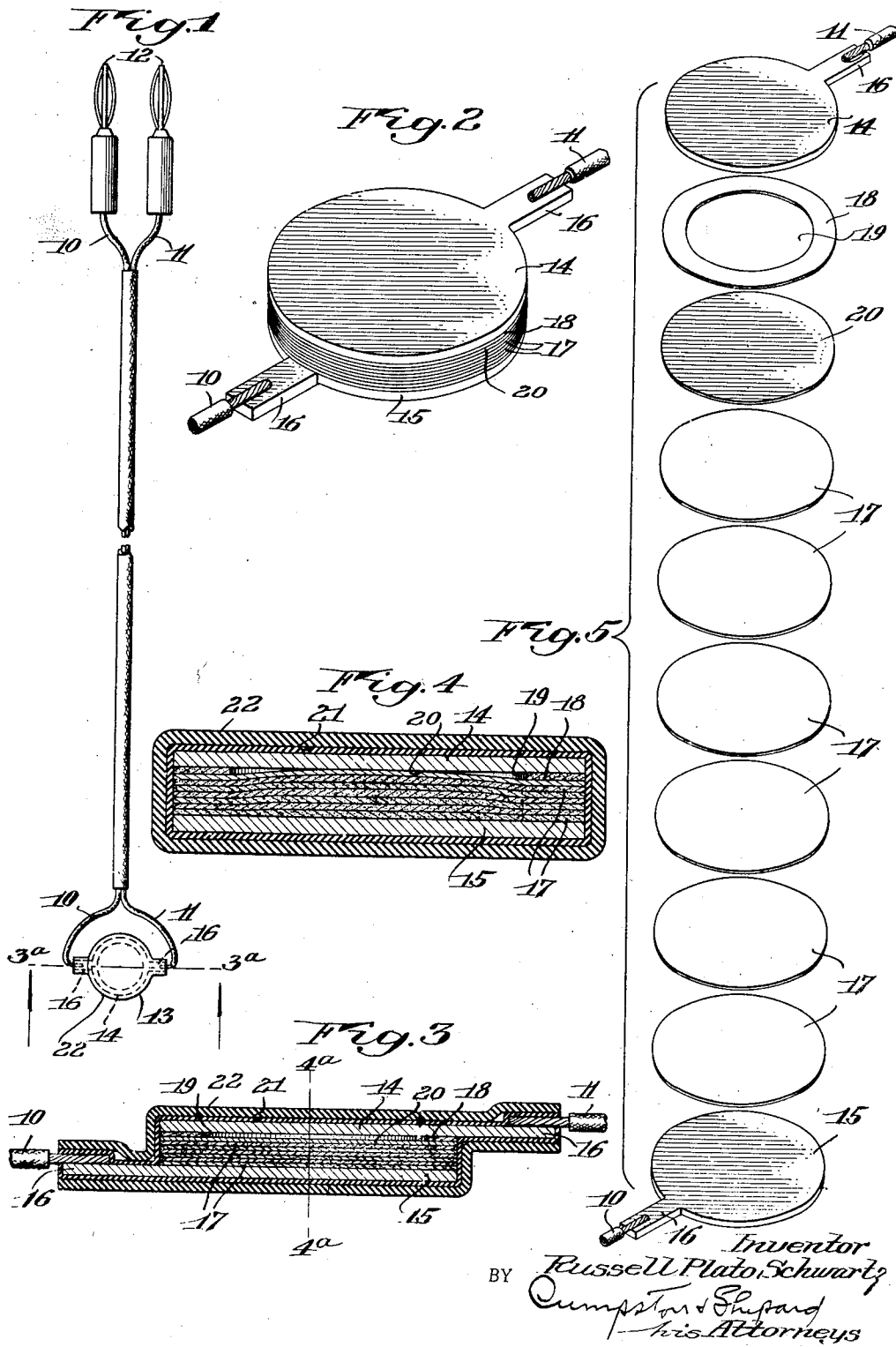


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R. P. SCHWARTZ
CIRCUIT CONTROLLING DEVICE

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CIRCUIT CONTROLLING DEVICE

Russell Plato Schwartz, Rochester, N. Y.

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7 Claims. (Cl. 201—51)

This invention relates to circuit controlling devices and more particularly to the variety of such devices which operate in response to the application of different pressures, one object of the invention being to provide a simple, accurate and efficient piezometric device capable of controlling the amount of current in the associated circuit in proportion to the pressures applied to said device, for indicating said pressures by current measuring means included in said circuit.

Another object is the provision of a device of the nature described including a pressure responsive switch means for establishing the flow of current in the associated circuit at a predetermined minimum pressure on said device.

A further object is to provide such a device in the form of a relatively thin, small disk or wafer capable of being strapped to a portion of the sole of a foot, with or without a shoe thereon, for obtaining an indication of the direction and duration of the weight imposed upon said foot portion in walking, as a means of analyzing the muscle functioning or gait of an animal.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawing:

Fig. 1 is a plan view of a portion of an electric circuit including the present invention;

Fig. 2 is an enlarged perspective view of a portion of the circuit embodying the invention;

Fig. 3 is an enlarged sectional view on the line 3a—3a in Fig. 1;

Fig. 4 is a similar view on the line 4a—4a in Fig. 3, and

Fig. 5 is a perspective view showing the several parts of the device.

This invention is in the nature of an improvement on the circuit controlling, piezometric device disclosed in my copending application for Letters Patent, Serial No. 222,380, filed August 1, 1938, Means for recording the gait and muscle functioning of animate bodies, although it will be evident that the invention may have various other useful applications. The invention is accordingly disclosed herein as included in a portion of an electric circuit formed by conducting wires 10, 11, each having at one end a plug 12 for connecting the same with other circuit parts. Wires 10 and 11 are each connected at the other end with a piezometric disk embodying the invention and indicated generally at 13, which is in the form of a relatively small flat disk or cap-

sule adapted to be strapped to the bottom of a human foot and actuated by the bodily weight applied thereto in walking, to vary the included resistance and flow of current in the circuit. The circuit in which wires 10 and 11 are connected includes a source of power and a current measuring and indicating device, for producing indications of the amount and duration of such pressures as an aid in studying the muscle functioning or gait of an individual, as more fully described in my said application.

The preferred embodiment herein disclosed, by way of illustration, comprises a pair of spaced contacts, 14 and 15, of phosphor bronze, or other suitable conducting material, preferably in the form of relatively small, substantially rigid plates or disks, as shown, having a diameter of say, half an inch and a thickness of, say 0.010 of an inch (Figs. 3 and 5). Each of these disks has a lateral terminal extension, as at 16, to which is soldered the corresponding circuit wire, as 11, these terminals being arranged on opposite sides of the device to avoid any inadvertent short-circuiting or other interference with each other.

Interposed between the spaced contacts 14 and 15 is a stack of plies 17 of sheet material, superposed one upon another, as shown. Plies 17 are preferably formed of disks of paper impregnated with a finely divided conducting substance, as powdered carbon, by which they are made more or less conducting, as well understood in the art. I have found that a very satisfactory material for the present purpose is afforded, for example, by the carbon paper which has been commonly employed by the Eastman Kodak Company for wrapping its photographic films to prevent fogging by static discharges, designated by the number 687R-129. Disks 17 are all alike and a sufficient number of them is employed to afford the desired amount of resistance.

A stack of the above described disks has some resilient compressibility and the greater the degree of compression, the higher the electrical conductivity of the stack becomes, such conductivity, with a suitable number of disks, being substantially proportional to the compressing force applied to the contact disks 14 and 15 and through them to the stack of disks 17. It has been found that such a construction provides a very satisfactory piezometric device for controlling the current in the associated circuit as a means of operating any known or suitable current measuring and indicating instrument for the purpose of indicating the amount of compressive force or weight applied against the disks 14 and 15.

In the use of such a device for the purpose described above, it is frequently desirable to strap the device to the sole of a foot, apply a shoe to the foot, and make the desired observations while the subject person walks, and in such case the pressure of the shoe against the foot tends to produce a preliminary compression and a corresponding preliminary indication, which represents merely the pressure of the shoe against the foot and is without useful significance. I have found, however, that this preliminary indication may be avoided by including in the device a switch mechanism which is closed and establishes electrical conductivity only on the application to the device of a predetermined minimum pressure greater than any mere pressure of the shoe but less than the pressure imposed by any subject person in standing on the foot.

This switch mechanism preferably comprises an annular ring 18 of non-conducting paper of about 0.003 of an inch in thickness, or other material, having substantially the same outside diameter as the disks 17, but with a substantial interior opening 19, as shown. This ring is preferably placed against one or the other of the contacts 14 and 15 and engages on its opposite side a disk 20 of suitable resilient conducting material such, for example, as a sheet of spring Phosphor bronze, having a thickness of, say, 0.003 of an inch. Disk 20 contacts on its opposite side with one of the carbon paper disks 17.

The switch parts are shown in their inactive position in Fig. 3, where it will be seen that disk 20 normally lies flat in a plane and is spaced by non-conducting ring 18 from contact 14, so that the electrical conductivity of the device is interrupted by the ring 18. The position of the parts when compressed by the weight of the subject on the foot is shown in Fig. 4, in which it will be seen that the pressure is first transmitted by the annular ring 18 to the peripheral portions of the disks 17 which are thereby compressed, or at least forced into more intimate contact with one another. The central portions of disks 17, being at first unimpressed, retain the initial thickness of the stack and so cause an upward dishing or bulging of the resilient metal disk 20 until its central portion, projecting through ring 18, makes electrical contact with the contact 14. The continued application of pressure then compresses also the central areas of the disks in proportion to the amount of the pressure.

By employing a suitable arrangement and proportioning of the parts, such as described, the amount of pressure at which the switch is closed to establish conductivity may be readily predetermined. The weight of the subject in walking, after closing the switch mechanism, applies a greater or less compressive force on the disks 17, to vary the conductivity of the stack of disks in proportion to the amount of pressure applied, as described above.

The assembled parts are preferably housed and protected by an envelope of suitable impervious material 21 such as the known "Scotch tape" and over that is applied an outer envelope of bicycle tape 22, the impervious inner tape serving to prevent any contamination of the conducting parts as by the impregnating substance carried by the outer tape.

It has been found that a piezometric circuit controlling device constructed as above described functions with substantial accuracy in controlling the conductivity in proportion to the applied force or weight, and reliably retains such ac-

curacy under varying conditions of moisture, temperature and the like, over a substantial period of time.

The invention thus accomplishes its objects, by providing a conveniently compact disk adapted to be strapped to the sole of the foot, for example, so that the subject may walk without discomfort during observation of the gait, with or without the application of a shoe. Owing to its small size, a plurality of such disks may be readily applied to different portions of the sole to obtain a complete analysis of the muscle functioning of different portions of the foot, as described in my said application. The device produces conductivity and resulting indications only upon application of the weight of the subject to the foot and thereafter controls the conductivity of the circuit in accurate proportion to the amount of the applied force or weight.

While the invention has been herein disclosed in its preferred form and in one of its useful applications, such disclosure is intended by way of illustration, rather than by way of limitation, as it is contemplated that various alterations of the construction and arrangement of the parts will occur to those skilled in the art without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A circuit controlling device for application to the bottom of a foot of an animate body for measuring the pressure thereof on the ground in walking comprising a pair of spaced contacts provided with means for connecting the same in an electric circuit, a stack of plies of sheet material superposed one upon another and all interposed between said contacts, said plies being impregnated with a finely divided conducting substance, and said stack as a whole being resiliently compressible to vary the pressure of said plies against one another, and a yielding envelope of insulating material enclosing said contacts and plies, said contacts being movable relatively to each other under pressure applied by said foot to said envelope to compress said stack and vary the conductivity thereof in proportion to the amount of said applied pressure.

2. A circuit controlling piezometric disk for application to the sole of a foot of an animate body for measuring the pressure thereof on the ground in walking comprising a pair of spaced contacts provided with means for connecting the same in an electric circuit, a stack of sheets of paper superposed one upon another and all interposed between said contacts, said sheets being impregnated with finely divided carbon and said stack as a whole being resiliently compressible to vary the pressure of said sheets against one another, and an envelope of flexible insulating material enclosing said contacts and stack of sheets in the form of a thin flat disk said contacts being movable relatively to each other under pressure applied by said foot to said envelope to compress said stack and vary the conductivity thereof in proportion to the amount of said applied pressure.

3. A circuit controlling device comprising a pair of spaced contacts provided with means for connecting the same in an electric circuit, a stack of plies of sheet material superposed one upon another and all interposed between said contacts, said plies being impregnated with a finely divided conducting material and said stack as a whole being resiliently compressible to vary the pressure of said plies against one another,

said contacts being movable relatively to each other under applied pressure to compress said stack and vary the conductivity thereof in proportion to the amount of said applied pressure, and a normally open switch interposed between said contacts and closed by a predetermined minimum pressure of said contacts on said plies for closing the circuit through said device.

4. A circuit controlling piezometric disk for application to the sole of a foot of an animate body for measuring the pressure thereof on the ground in walking comprising a pair of spaced contacts provided with means for connecting the same in an electric circuit, a stack of sheets of paper superposed one upon another and all interposed between said contacts, said sheets being impregnated with finely divided carbon and said stack as a whole being resiliently compressible to vary the pressure of said sheets against one another and an envelope of flexible insulating material enclosing said contacts and stack of sheets in the form of a thin flat disk, said contacts being movable relatively to each other under pressure applied by said foot to said envelope to compress said stack and vary the conductivity of said device in proportion to the amount of said applied pressure, and a normally open switch interposed between said contacts and closed by a predetermined minimum pressure of said contacts on said sheets for closing the circuit through said device.

5. A circuit controlling device comprising a pair of spaced contacts provided with means for connecting the same in an electric circuit, a stack of plies of sheet material superposed one upon another and all interposed between said contacts, said plies being impregnated with a finely divided conducting material and said stack as a whole being resiliently compressible to vary the pressure of said plies against one another, said contacts being movable relatively to each other under applied pressure to compress said stack and vary the conductivity thereof in proportion to the amount of said applied pressure, a ring of non-conducting material interposed between said contacts and a resiliently flexible ply of conducting material abutting one side of said ring and adapted to be dishd by said pressure so as to extend through said ring to make contact with a conducting part on the opposite side thereof and establish conductivity of said

device only at a predetermined pressure against said contacts.

6. A circuit controlling device comprising a pair of spaced contacts provided with means for connecting the same in an electric circuit, a stack of sheets of paper superposed one upon another and all interposed between said contacts, said sheets being impregnated with finely divided carbon and said stack as a whole being resiliently compressible to vary the pressure of said sheets against one another, said contacts being movable relatively to each other under applied pressure to compress said stack and vary the conductivity of said device in proportion to the amount of said applied pressure, a ring of non-conducting material interposed between said contacts, a resiliently flexible ply of conducting material abutting one side of said ring and adapted to be dishd by said pressure so as to extend through said ring to make contact with a conducting part on the opposite side thereof and establish conductivity of said device only at a predetermined minimum pressure against said contacts.

7. A circuit controlling device comprising a pair of spaced metallic disk contacts provided with means for connecting the same in an electric circuit, a stack of disks of paper superposed one upon another and all interposed between said metallic contacts, said paper being impregnated with finely divided carbon and said stack as a whole being resiliently compressible to vary the pressure of said disks against one another, said metallic contacts being movable relatively to each other under applied pressure to compress said stack and vary the conductivity of said device in proportion to the amount of said applied pressure, a ring of non-conducting material interposed between said contacts, a thin, resiliently flexible, metallic disk abutting one side of said ring and adapted to be dishd by said pressure so as to extend through said ring to make contact with a conducting part on the opposite side thereof and establish conductivity of said device only at a predetermined minimum pressure against said contacts, and a cover of insulating material for holding said parts assembled in a wafer-like form adapted to be secured to a portion of the sole of a foot, for controlling the current in the associated circuit in proportion to the pressure applied to said portion in walking.

RUSSELL PLATO SCHWARTZ.