

May 10, 1927.

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ELECTRIC CIRCUIT CLOSER FOR RELAYS

Filed April 17, 1922

3 Sheets-Sheet 1

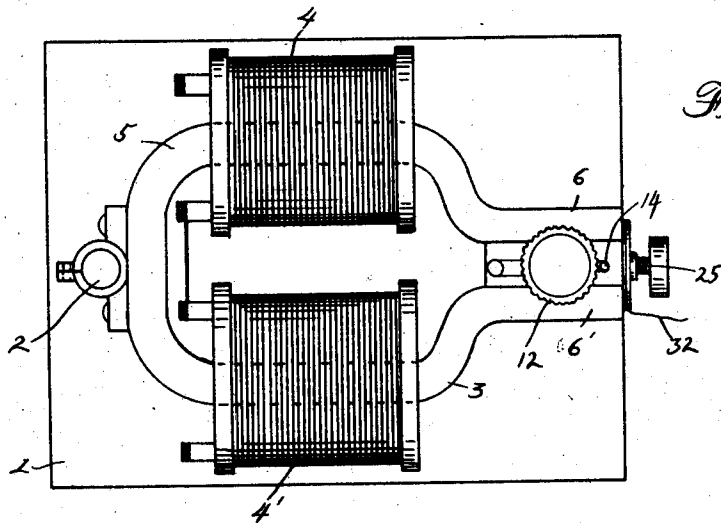


Fig. 1.

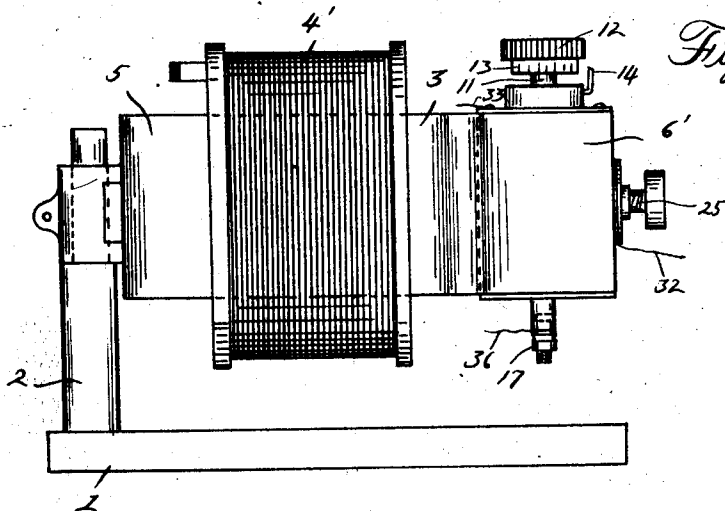


Fig. 2.

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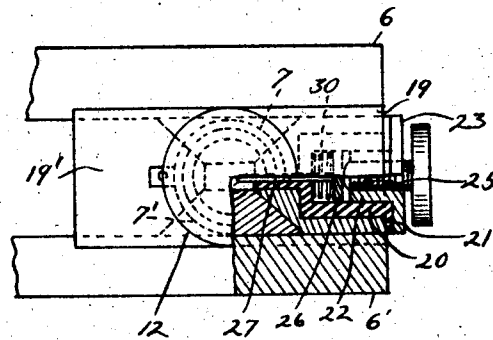
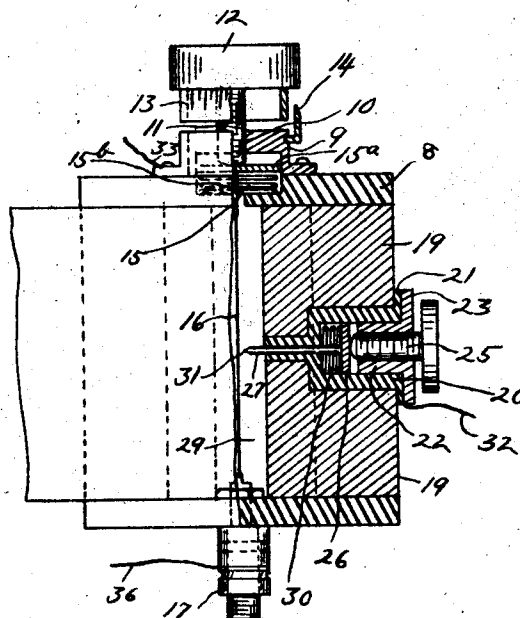
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3 Sheets-Sheet 2



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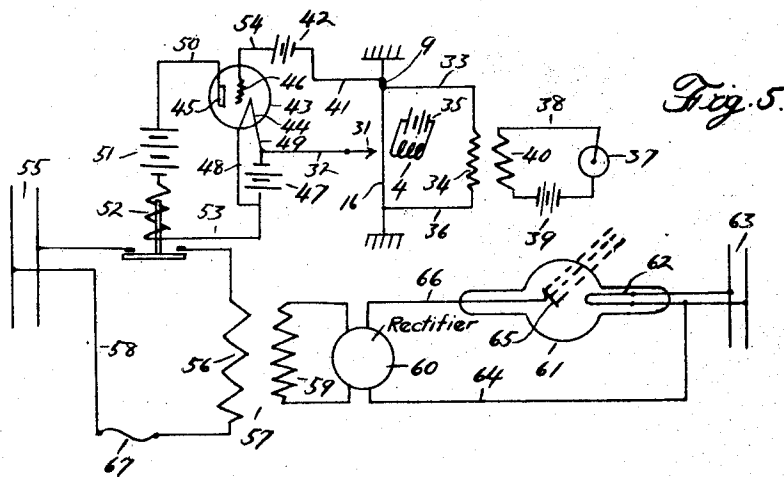
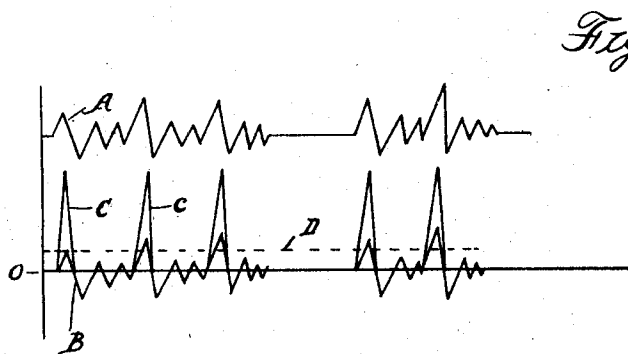
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ELECTRIC CIRCUIT CLOSER FOR RELAYS

Filed April 17, 1922

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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ELECTRIC-CIRCUIT CLOSER FOR RELAYS.

Application filed April 17, 1922. Serial No. 554,055.

The invention relates to electric circuit closers for controlling the operation of delicate electrical instruments and one of the applications is in connection with the control of an X-ray apparatus for photographing the heart at its maximum and minimum dilation. The sound produced by the beating of the heart occurs at the moment of maximum and minimum dilation and it is therefore possible to use a microphone for detecting the sound and operating the electric circuit closer. The circuit closer may then be connected to an amplifier and suitable relays for operating the X-ray apparatus to take the photograph.

While my invention may be advantageously used in controlling an X-ray apparatus there are many other uses to which it can be put and I wish it understood that in the subsequent description I am illustrating only one means of employing my invention.

In the drawings:—

Figure 1 is a top view of the electric circuit closer;

Figure 2 is an elevation thereof;

Figure 3 is an enlarged view partly in elevation and partly in section of the wire and contacting device;

Figure 4 is an enlarged top view partly in section of the same;

Figure 5 is a diagrammatic representation of the electrical system used in the operation of an X-ray apparatus.

Figure 6 represents graphically the current values in the circuits of Figure 5, the abscissæ representing time and the ordinates representing current value.

The electric circuit closer consists of a base 1 on which is mounted a vertical rod 2. Mounted upon the rod 2 is the horseshoe electro-magnet 3, comprising the solenoids 4 and 4' and the U-shaped core 5. The core 5 is preferably made of magnet steel and the ends 6 and 6' constituting the poles of the magnet are bent to bring them in close proximity and are provided with the lugs 7 and 7' which are of truncated V-form and are separated from each other by only a very small air gap. In this manner a strong magnetic field can be set up between the two poles 7 and 7' by passing a current through the solenoids 4 and 4'.

Mounted on top of the magnet ends 6 and 6' is a block of insulating material 8 on which is mounted a cap 9, provided with a

threaded aperture 10. A screw 11 engages with the threads in the aperture 10 and carries at its upper end a knurled knob 12. Extending below the knurled knob is the circumferential scale 13 which contains suitable graduations for indicating the position of adjustment of the knob. A pointer 14 is fastened upon the cap 9 and is adapted to point to the graduations on the scale 13. The lower end of the screw 11 bears against a disk 15^a which has a rod 15^b projecting downward from the center thereof. Fastened to the lower end of the rod 15^b is an electrical conductor 16 preferably a fine metallic wire which extends vertically between the poles of the magnet 7 and 7' and is secured at its other end to the binding post 17. A coil spring 15 supports the disk 15^a and provides a means for placing a tension upon the conductor 16. The tension may be regulated by means of the adjustment knob 12.

Extending between the ends of the magnet core 6 and 6' are wedge shaped blocks 19 and 19' made of non-magnetic material preferably brass, which together with the lugs 7 and 7' completely surround the space containing the conductor 16. Midway between the top and bottom of the wedge shaped block 19 is placed an insulating bushing 20 provided at one end with a flange 21. A metallic bushing 22 is inserted in the insulating bushing 20 and is provided with a flange 23 which abuts on the insulating flange 21. A screw 25 is in threaded engagement with the metallic bushing and the threads are preferably very fine to allow a delicate adjustment to be made. The screw 25 bears against a disk 26 which is yieldingly forced against the screw 25 by the coil spring 30. A rod 27 is fastened to the center of the disk 26 and projects through the insulating bushing 20 into the space 29 between the magnet posts 7 and 7'. A contact point 31 is provided at the end of the rod 27 which is preferably made of platinum and the contact point is so placed that it will be in the path of the conductor 16 when the conductor is deflected by the magnetic field. A wire 32 is electrically connected with the flange 23, a wire 33 is electrically connected to the metallic cap 9 and a wire 36 is electrically connected to the binding post 17. The wires 33 and 36 are connected to the source of current which is to operate the circuit closer and as diagram-

matically shown in Figure 5 they are connected to the secondary 34 of a repeating coil.

The solenoids 4 and 4' are connected to a source of current, such as the storage battery 35 illustrated in Figure 5. When the current from the storage battery flows through the solenoids a strong magnetic field is set up between the poles 7 and 7'. If now a current is caused to flow through the conductor 16 from the secondary of the repeating coil 34 the strong magnetic field causes the conductor to be laterally deflected and to make contact with the contact point 31 of the rod 27. The deflection of a wire carrying electricity through a strong magnetic field is a fundamental principle of electricity and it has been employed for many purposes for example the ordinary galvanometer. I have used the principle however in a novel way by causing the deflection of the wire to make a contact which can be used for the closing of an auxiliary circuit. It is evident that the amount of deflection of the conductor will depend upon four factors, the strength of the magnetic field, the current flowing through the conductor, the tension of the wire and the mass of the conductor.

In order to show a useful application of my electric circuit closer, I will now describe the electrical diagram illustrated in Figure 5. 37 is a microphone which is connected in a circuit 38 including a battery or other source of current 39 and the primary of a repeating coil 40. The secondary of the repeating coil 34 as has already been explained is connected in a circuit with the wire 16 of the electric circuit closer by means of the conductors 33 and 36. A storage battery 35 is connected to the solenoids 4 and 4' which set up the magnetic field between the poles of the electro-magnet in the circuit closer. The cap 9 is also connected by a conductor 41 to a battery 42. 43 is a vacuum bulb of the well known type containing a filament 44, a plate 45 and a grid 46. The filament of the bulb is connected to a battery 47 by means of the conductors 48 and 49. The contact point 31 is connected by means of the conductor 32 and the conductor 49 to the filament 44. The grid 46 is connected to the battery 42 by means of a conductor 54 and the plate 45 is connected by means of a conductor 50 to the positive terminal of the plate battery 51. A relay 52 is connected to the other terminal of the battery 51 and to the filament 44 by means of a conductor 53. The electric circuit including the relay is the utilization circuit and the relay may be used to operate the X-ray machine in any suitable manner.

As shown, however, 55 represents a source of current which is connected through the primary 56 of the transformer 57 and the

circuit 58 includes the relay 52. The secondary 59 of the transformer 57 is electrically connected to a rectifier 60. 61 is an X-ray tube having a filament 62 connected with a suitable source of current 63, one terminal of the rectifier 60 is connected to the filament 62 by a conductor 64 and the other terminal of the rectifier is connected to the cathode 65 of the X-ray bulb by means of conductor 66. 67 is a time fuse adapted to open the circuit 58 when the current through circuit 58 reaches a predetermined value; preferably, this time fuse allows a current to flow through the circuit for about 1/30 of a second.

The operation of the apparatus illustrated in Figure 5 is as follows: The X-ray tube 61 is placed in a position to photograph the heart and the microphone 37 is placed adjacent to the heart in such a position that beating of the heart causes a change in the resistance of the microphone and thus changes the current through the primary of the repeating coil 40. A current is therefore induced in the secondary 34 which flows through the conductor 16 and causes it to deflect and contact with the point 31. This completes the circuit of the grid battery 42 and places a large positive potential upon the grid 46 of the vacuum bulb. As is well known in the electric art this potential upon the grid 46 causes an increased bombardment of electrons from the filament 44 on the plate 45 which completes the circuit of the plate battery 51 through the relay 52. The relay closes the circuit 58 and the current from the source 55 passes through the time fuse 67 and the primary 56 of the transformer. The current through the primary is only momentary for the time fuse opens the circuit after a predetermined interval, for example 1/30 of a second. A momentary current is therefore induced in the secondary 59 which is rectified by the rectifier 60 and causes a direct current to flow between the cathode 65 and the filament 62 of the X-ray tube. X-rays will be given from the cathode during this interval of time which may be used to photograph the heart. Thus it will be seen that the sound produced by the bearing of the heart may be utilized to obtain an X-ray photograph of the heart at its maximum or minimum dilation.

As mentioned before the amount of deflection of a definite size of conductor 16 depends upon the strength of the magnetic field, the magnitude of the current through the wire and the tension of the wire. The latter may be adjusted by means of the knob 12 and the amount of deflection necessary for closing the auxiliary circuit through the contact point 31 and the conductor 16 may be varied by means of the adjusting screw 25. When both of these

adjustments have been set in the desired position. The operation of the circuit closer depends upon the strength of the magnetic field and the current through the wire 16 and either or both of these factors may be used to operate the instrument. As shown however, the strength of the magnetic field remains constant leaving the magnitude of the current flowing through the wire as the determining factor. Either direct or alternating current may be used but the instrument is especially adapted for use with an alternating current which is set up in the secondary of the repeating coil, due to an undulatory current in the primary of the repeating coil for it provides a means for closing an auxiliary circuit when the amplitude of the undulations reach a predetermined value.

In Figure 6 are plotted diagrammatically the current values in some of the circuits illustrated in Figure 5, the abscissa representing time and ordinates representing current value. A represents the modulated direct current in the microphone circuit 38 which passes through the primary of the repeating coil. B represents the current induced in the secondary of the repeating coil which is an alternating current having undulations similar in character to those in the microphone circuit, except that the current is alternating instead of direct. Since the deflection of the wire 16 depends upon the magnitude of the current B, the circuit closer will operate each time the value of the current reaches a predetermined amount D depending upon the adjustment of the instrument. The graph of the current in

the utilization circuit 53 is represented by C and is seen to be intermittent. When the undulations in the current B have amplitudes less than a predetermined amount no current flows in the utilization circuit C, but when the undulations have a greater amplitude than the predetermined amount, a current does flow through the utilization circuit C and the value of the current does not depend upon the current B. Thus it is possible with my circuit closer to operate an auxiliary circuit by means of a sound of a predetermined magnitude being impressed upon a microphone.

What I claim as my invention is:—

1. The combination with a circuit and a microphone controlling said circuit, of an auxiliary circuit means for reproducing and amplifying current conditions of the microphone circuit in the auxiliary circuit, an X-ray tube, a control circuit therefor, and a means for reproducing current conditions of the auxiliary circuit in the X-ray tube circuit.

2. The combination with a circuit and a microphone controlling said circuit, of an auxiliary circuit, means for closing the auxiliary circuit responsive to a predetermined rise in value of the current in the microphone circuit, a relay in the auxiliary circuit, an amplifying circuit controlled by said relay, a transformer having its primary included in the amplifying circuit, an X-ray tube and a control circuit for said tube including the secondary of said transformer.

In testimony whereof I affix my signature.
LLOYD L. CALL.