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ELECTRICAL CIRCUIT

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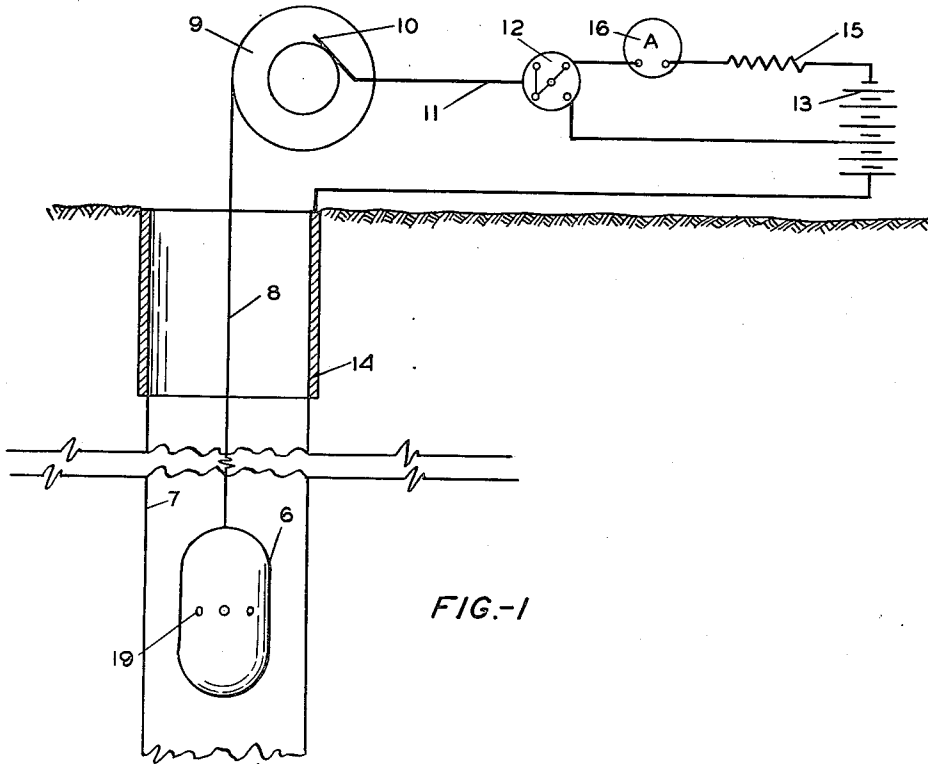


FIG-1

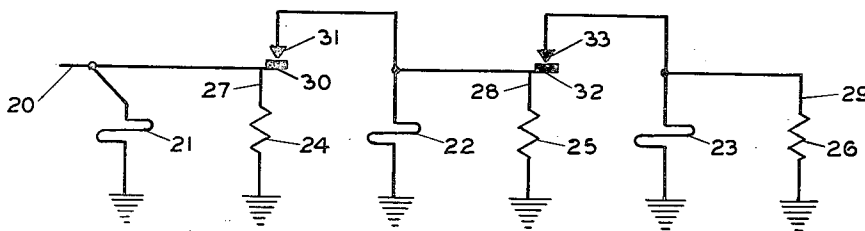


FIG-2

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ELECTRICAL CIRCUIT

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Original application April 15, 1940, Serial No. 329,810. Divided and this application February 16, 1944, Serial No. 522,674

4 Claims. (Cl. 219—20)

This invention relates to an electrical circuit that is adapted, among other things, to be employed to selectively fire one or more shots or markers in a well bore, and is a division of our copending application Serial No. 329,810, filed April 15, 1940.

While our present invention may be advantageously employed in various locales, as will be evident to persons skilled in the art, it is of especial utility when used with well equipment such as electrically operated gun perforators and the like.

It is the primary object of this invention to provide electrical means for consecutively energizing a plurality of heating elements.

Another object of the instant invention is the provision of means of the character indicated for electrically actuating apparatus associated therewith in a predetermined manner.

This invention has for a further object the electrical firing of a gun perforator or similar device.

These as well as other objects will be readily comprehended by reference to the following detailed description and annexed drawing which respectively describe and illustrate a preferred embodiment of the invention, and wherein

Figure 1 is a diagrammatic vertical cross-section through a well bore showing apparatus suitable for placing desired types of markers.

Figure 2 is a circuit diagram of an electrical circuit which is adapted to be employed in conjunction with the apparatus of Figure 1.

With reference to Figure 1 of the drawing, the numeral 6 designates a suitable gun for firing the markers in the form of bullets into the wall of the bore hole 7. An electrically conductive cable 8 which is carried by a reel 9 serves to position the marker gun in the well bore. A collector ring and brush 10 on the reel provides electrical contact between the cable 8 and a conductor 11 on the surface of the earth to which is attached a three-way switch 12. A battery 13, grounded to a suitable electrode such as the surface casing 14 in the bore hole, is connected in such a manner that it will deliver a low voltage to one point of contact of the switch 12 and a high voltage through the resistance 15 and an ammeter 16 to the other point of contact. The marker gun 6 is similar in construction and operation to guns used for perforating the casing in a well bore. The bullets which are to serve as markers are contained in the bullet chambers 19 together with gun powder and heater wires for electrical ignition.

Figure 2 illustrates diagrammatically an electrical circuit which may be used for selectively firing the various shots. Conductor 20 is in contact with and receives electrical energy from cable 8. A series of heating elements 21, 22, and 23, for igniting the charges of gun powder are connected in parallel with branches including resistors 24, 25, 26, and fuse wires 27, 28, 29, respectively. Each of the heating elements is designed to ignite a charge of gun powder upon being supplied with current from the low voltage contact of switch 12 and each fuse wire is designed to burn out upon being supplied with current from the high voltage contact of switch 12. Interposed between the heating element 21 and the heating element 22 is a switch comprising a pair of contact points 30 and 31 which are urged into closing position but are held open by the fuse wire 27 as long as it remains intact. A similar switch comprising contact points 32 and 33 is interposed between the heating element 22 and the heating element 23.

In operation, the marker in the bullet chamber containing the heating element 21 is fired into the formation by the operator by closing switch 12 on the low voltage contact. This sends current from the battery through the heating element which is destroyed upon igniting the charge. The current from the battery may then flow only through the resistance 24 and the fuse wire 27. The resistance 24 is high as compared with the total circuit resistance of the ground and of the cable 8 so that a higher battery voltage is required to burn out the fuse 27. This higher voltage is applied to the fuse wire by closing switch 12 on the high voltage contact. Upon the fuse 27 burning out, the contacts 30 and 31 are moved into closed position. The resistance 15 is high enough to prevent firing the second shot when the contacts 30 and 31 are closed. The second shot is fired by sending a large current at low voltage through the heating element 22 by closing switch 12 on low voltage contact. To illustrate, if the resistance of the cable 8 plus the resistance of the ground return from the gun to the grounded terminal of the battery is fifty ohms, the resistance of the heating elements 21, 22, 23, twenty-five ohms each, and the current necessary to fire the shot is one ampere, then it is necessary to apply seventy-five volts at the low voltage contact of switch 12. If the fuse wires 27, 28, 29, burn out at one quarter ampere and the resistances 24, 25, 26, are four hundred ohms each and the resistance 15 is four hundred ohms, then it will require about 212 volts at

the high voltage contact of switch 12 to burn out the fuse wire 27 and close contacts 30 and 31. Because of the four hundred ohms of resistance 15, the current flowing through the heating element 22 will not be sufficient to fire the second shot until the switch 12 is again closed on the low voltage contact. It is apparent that the operator may successively fire the bullets. By reading ammeter 16, the operator can determine when the contacts have closed preparatory to firing the next bullet. It is apparent that by making the values of the resistances 24, 25, and 26, different, each from the others, that the operator could also determine the shot number by noting the ammeter indication.

It is to be understood that the form of our invention, herewith shown and described, is to be taken as a preferred example of the same, and that various changes with respect thereto may be made without departing from the spirit of the invention or the scope of the subjoined claims.

We claim:

1. An electrical circuit for consecutively energizing a plurality of heating elements comprising a source of high electrical potential and a source of low electrical potential having a common side, a resistance element having one side connected to the other side of the source of high electrical potential, a line, a heating element connected between the line and the common side of the sources of electrical potential, a branch circuit connected in parallel with the heating element, the branch circuit including means for opening the same on the presence of a maximum current therein, a second heating element having one side connected to the common side of the sources of electrical potential, an electrical contact connected to the line, an electrical contact connected to the second heating element on the other side from that connected to the common side of the sources of electrical potential, the contacts being in spaced relation, means operable on the opening of the branch circuit to bring the contacts together and means for connecting the line to the other side of the resistance element from that connected to the source of high electrical potential, each heating element being so designed that it is destroyed only when connected across the source of low potential, the branch circuit being so designed that it opens only when the line is connected to the other side of the resistance element.

2. An electrical circuit for consecutively energizing a plurality of heating elements comprising a source of high electrical potential and a source of low electrical potential having a common side, a resistance element having one side connected to the other side of the source of high electrical potential, a line, a heating element connected between the line and the common side of the sources of electrical potential, a branch circuit connected in parallel with the heating element, the branch circuit including means for opening the same on the presence of a maximum current therein, a second heating element having one side connected to the common side of the sources of electrical potential, an electrical contact connected to the

line, an electrical contact connected to the second heating element on the other side from that connected to the common side of the sources of electrical potential, the contacts being in spaced relation, means operable on the opening of the branch circuit to bring the contacts together and means for connecting the line to the other side of the source of low electrical potential, each heating element being so designed that it is destroyed only when connected across the source of low potential, the branch circuit being so designed that it opens only when the line is connected to the other side of the resistance element.

3. An electrical circuit for consecutively energizing a plurality of heating elements comprising a source of high electrical potential and a source of low electrical potential having a common side, a resistance element having one side connected to the other side of the source of high electrical potential, a line, a heating element connected between the line and the common side of the sources of electrical potential, an electrical fuse branch connected in parallel with the heating element, a second heating element having one side connected to the common side of the sources of electrical potential, an electrical contact connected to the line, an electrical contact connected to the second heating element on the other side from that connected to the common side of the sources of electrical potential, the contacts being in spaced relation, means operable on the fuse burning out to bring the contacts together and means for connecting the line to the other side of the resistance element from that connected to the source of high electrical potential, each heating element being so designed that it is destroyed only when connected across the source of low potential, the fuse branch being so designed that it is burned out only when the line is connected to the other side of the resistance element.

4. An electrical circuit for consecutively energizing a plurality of heating elements comprising a source of high electrical potential and a source of low electrical potential having a common side, a resistance element having one side connected to the other side of the source of high electrical potential, a line, a heating element connected between the line and the common side of the sources of electrical potential, an electrical fuse branch connected in parallel with the heating element, a second heating element having one side connected to the common side of the sources of electrical potential, an electrical contact connected to the line, an electrical contact connected to the second heating element on the other side from that connected to the common side of the sources of electrical potential, the contacts being in spaced relation, means operable on the fuse burning out to bring the contacts together and means for connecting the line to the other side of the source of low electrical potential, each heating element being so designed that it is destroyed only when connected across the source of low potential, the fuse branch being so designed that it is burned out only when the line is connected to the other side of the resistance element.

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