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DETONATOR CIRCUIT FOR PERMISSIVE EXPLOSION SHOT FIRER

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3 Sheets-Sheet 2

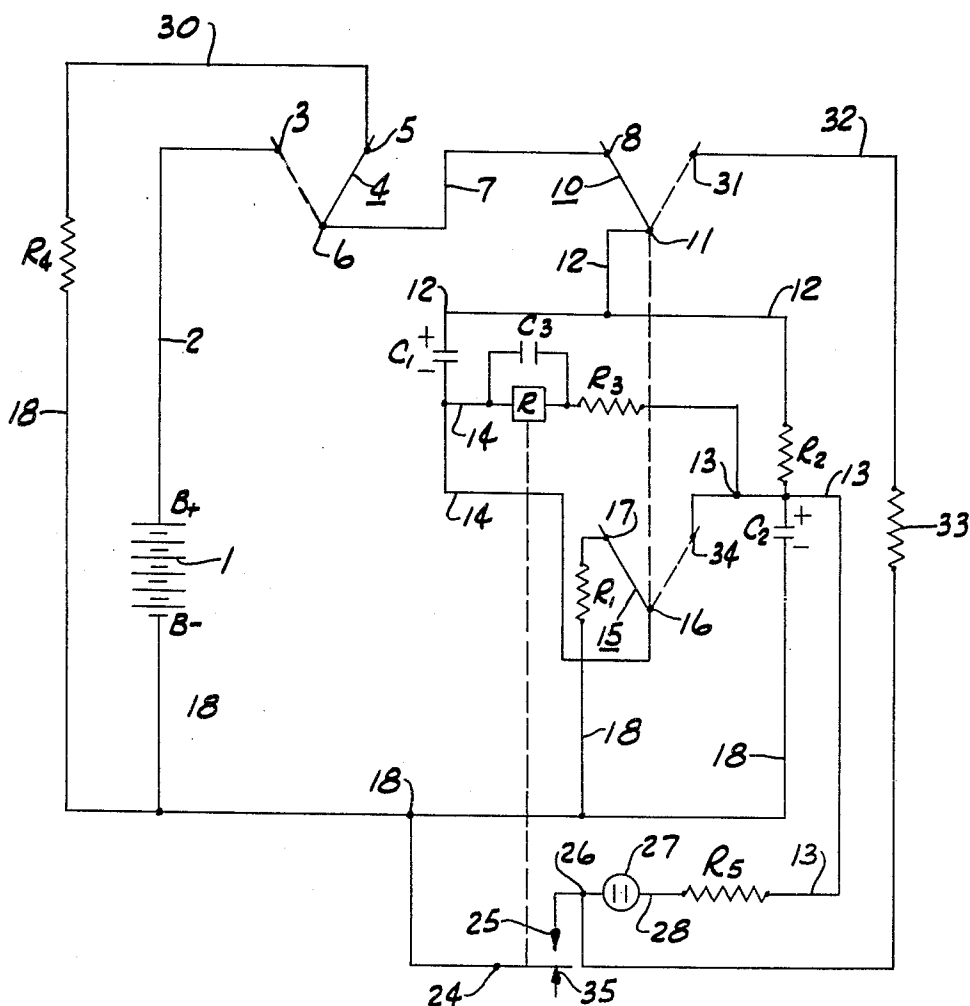


Fig. 2

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DETONATOR CIRCUIT FOR PERMISSIVE EXPLOSION SHOT FIRER

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This invention relates generally to detonator circuits and more particularly to a detonator circuit for permissive explosion of shot firers.

Detonator circuits for permissive explosion shots such as used in deep mines for breaking out coal frequently retain a potential across the detonating wires after firing which may, by ground or by short, create a spark setting off a gas or coal dust explosion, the gas or coal dust being developed immediately following the shot explosion. A combination of gas and coal dust or either provides a dangerous condition after the shot explosions.

To avoid any after and uncontrolled explosion danger the practice has been to employ condensers to supply the detonating voltage and these condensers are required to be shunted by a resistance to drain the charge from the condensers and thus reduce their voltage within a specified time.

The detonator circuit is thus robbed of energy by that amount absorbed by the shunting resistance. This requires a greater capacity in the condensers to supply this power loss and they are not as effective which represents considerable disadvantages.

Again a shunting resistance on a condenser shortens the time that the condenser loses its charge. This period of time is frequently long enough to permit the gas or coal dust to develop an uncontrolled explosive condition and a spark from the detonator circuit will set off the explosion before the resistors can completely discharge the condensers. Thus the time element is a very important factor in permitting the charge to leak from the condensers of a detonating circuit.

The principal object of this invention is the provision of a detonating circuit that overcomes the difficulties of previous detonator circuits that permitted the firing lines to remain charged.

Another object is the provision of a relay in a detonating circuit that limits the length of time that the firing voltage is impressed upon the firing terminals.

Another object is the provision of a circuit that will prevent the operation of a detonator circuit if the battery is below a predetermined amount.

Another object is the provision of a relay circuit that will prevent the closing of the detonator circuit until after the condensers used for the detonating voltage are properly charged.

Another object is the provision of a relay circuit that controls the length of time the detonating voltage is applied for firing which timing is controlled.

Other objects and advantages appear hereinafter in the following description and claims.

The accompanying drawings show for the purpose of exemplification without limiting the invention or claims thereto certain practical embodiments illustrating the principles of this invention wherein:

Fig. 1 of the drawings is a circuit diagram showing one form of detonator circuit having independent charge-discharge switch means.

Fig. 2 of the drawings is a circuit diagram showing one

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form of detonator circuit having one charge-discharge switch means.

Fig. 3 of the drawings is a circuit diagram showing one form of detonator circuit having a common charging and discharging resistance.

Referring to the drawings and particularly that of Fig. 1 the battery indicated at 1 is provided with a B+ and B-. B+ is connected through the line 2 to one end of the resistance R1, the other end of which is connected to the charge contact 3 of the charge-discharge switch 4, the blade of which is normally shown connected with the discharging terminal 5 and the heel 6 is connected to a line 7, the other end of which is connected to the charge contact 8 of the firing switch 10 which is in its normal position as shown. The heel 11 of the firing switch 10 is connected to the line 12 which is connected to the positive side of the condenser C1 and also to one end of the resistance R2, the other end of which is connected to the line 13 which in turn is connected to the positive side of the condenser C2. The negative side of the condenser C1 is connected by the line 14 to the second and independent switch 15 which is operated in conjunction with the firing switch 10 and is normally found in the position as shown wherein its heel 16 is connected to the charging contact 17, thence through the line 18 which is directly connected to negative battery and the negative side of condenser C2.

Line 13 is connected to one end of the resistance R3, the other end of which is connected directly to the coil of the operating relay R, the other side of the operating coil of which is connected directly to line 14. Thus the operating coil of relay R is connected in a series circuit with the resistances R2 and R3 which series circuits are in multiple with the condenser C1. This relay circuit with the single series resistance R3 is likewise connected in parallel with the condenser C2.

In the circuit of Fig. 1 an independent charge-discharge switch 20 is provided for the negative side of the battery wherein the heel 21 is connected to line 18 and its corresponding charging contact 22 is connected by line 23 to the heel 24 of the single contact on the relay R, the front contact 25 of which is connected by line 26 to the neon light 27. The other side of the neon light is connected by the line 28 to the resistance R5, the other end of which is connected to the line 13. Thus when the relay R is energized its single contact of the series circuit of the neon light 27 and the resistance R5 is connected in multiple with the condenser C2 and with the condenser C1 with the resistance R2 in the circuit as previously described.

The discharge contact 5 of the charge-discharge switch 4 is connected by the line 30 to one side of the resistance R4, the opposite side of which is connected to line 18.

The firing side of the firing switch 10 has contact member 31 connected to line 32 which connects one side of the fire load indicated at 33, the other side of which is connected to line 26.

The firing side of the firing switch 15 is provided with a contact 34 which in turn is connected to the line 13.

When the charge-discharge switch 4 and 20, which are locked together to operate as a single unit, are thrown to the charging contacts 3 and 22 respectively, current flows from the battery 1 of the B+ through line 2, resistance R1, contact 3 of the switch 4, to the heel 6, the line 7, charging contact 8 of the firing switch 10 to the heel 11 and thence to line 12 to charge condenser C1 and through resistance R2 to charge condenser C2. The negative side of C2 being connected directly to negative battery and the negative side of C1 being connected through line 14, switch 15 to the negative side of the battery.

Thus both condensers are charged in multiple to the voltage of the battery 1. Owing to the fact that relay R is connected in multiple with the condensers C1 and C2 this relay will become energized but it will not pick up until both condensers are fully charged owing to the selection of the resistance R3. When this relay does pick up the condensers are fully charged and the closing of the contact 24 connects the neon light 27 and its series resistor R5 in multiple with the relay R and its series resistance R3. The limiting resistance R5 of the neon light will prevent this light from glowing if the battery voltage is not suitable to properly charge the condensers for properly firing the shot. Thus the circuit is protected from an improper battery charging voltage owing to the limiting resistor R5 in series with the neon light 27.

After the neon light is lighted indicating that the condensers C1 and C2 are properly charged, these condensers may be discharged by throwing the switches 4 and 20 to the discharge position wherein a shunting resistance R4 is connected across the condensers C1 and C2, the relay R with its series resistance R3 and the neon light 27 and its series resistance R5. It will be again necessary to recharge the condensers in order to employ them to fire a shot.

If the condensers C1 and C2 are fully charged and the relay R is energized and the neon light glows indicating proper voltage the firing switches 10 and 15, which are mechanically tied together to operate as a unit, may be thrown to the firing position which places the condensers C1 and C2 in series with each other and supplies a detonating charge to the firing circuit through the lines 26 and 32 to the firing load indicated at 33. This circuit is traced from one side of the firing load 33 to the line 26, the front contact 25 of the relay R, the heel contact 24, line 23, charge contact 22 of switch 20, heel 21 to line 18, thence to the negative side of condensers C2 and from the positive side of this condenser through line 13 to contact 34, switch 15 to heel 16 from line 14 to the negative side of condenser C1, the positive side of which is connected through line 12, the heel 11 of switch 10, the firing contact 31 of the firing switch and line 32 the opposite side of the load. It will be noted that switch 15 when connected to its firing contact 34 shunts the relay R and its series resistance R3 which would cause the latter to drop out but for the addition of the condenser C3 which is connected in multiple with the operating coil of the relay R. Thus the choice of the capacity of the condenser C3 determines the length of time that the relay R will maintain its contact 24 connected with the front contact 25 to sustain the firing circuit. The choice of the condenser C3 thus determines the length of time that a detonating charge is supplied from the condensers C1 and C2 in series to the firing load 33 and at the termination of this time the relay R will become deenergized and its contact 24 will leave the front contact 25 and engage the back contact 35 which in the case of Fig. 1 is unused thereby opening the firing circuit and preventing the balance of the charge of the condensers C1 and C2 from being supplied to the lead lines 26 and 32 to the firing load. The gap of the contact 24 of the relay R is sufficiently great to prevent any arcing owing to the charge of the condensers C1 and C2 and since the whole of the control circuit with the exception of the lead lines 26 and 32 are within a closed and sealed container it is impossible for the foregoing circuit to accidentally discharge a leaking gas or coal dust in a mine.

Referring now to Fig. 2 the resistance 1 has been removed from between the line 2 and the charge contact 3 of charge-discharge switch 4 and replaced intermediate the charge contact 17 of switch 15 and the negative side of battery indicated by the line 18. Also this charge-discharge switch 20 has been removed thereby connecting relay contact 24 directly with line 18 which is the negative battery.

These two changes in the circuit of Fig. 1 places the resistance R1 only in series with the condenser C1 and at the same time the resistance R2 remains in series with the condenser C2. However when the firing switch 10 is thrown to firing position, resistance R2 remains in multiple with the condenser C1 but resistance R1 has been eliminated from the circuit. In the circuit of Fig. 1 the resistance R2 remained in multiple with the condenser C1 during the detonation period of the firing circuit. Otherwise the circuits of Fig. 1 and Fig. 2 are substantially the same.

Referring now to Fig. 3 the charge-discharge switch 4 is biased by the spring 40 to move with its arm in engagement with the contact 5 which connects line 30 with the back contact 35 of the relay contact 24 which is connected directly to the ground 18. This is the discharge position of both condensers when the firing switch 10 is to the left as indicated in the drawings and is urged by the spring member 41 to remain in this position which is the charging position.

When the charge-discharge switch 4 is held with its arm in the charge position, positive current flows from the battery 1 through the line 2, the charge contact 3 of the charge-discharge switch 4, the heel 6, the line 7, the resistor R1—R4, the charging contact 8 of firing switch 10, the heel 11, the line 12 to the positive side of condenser C1. The negative side of this condenser is connected by the line 14 to the heel 16 of the firing switch 15 and thence its discharge contact 17 to the line 18 and the return side of the battery 1. Current also flows through the line 7 to the resistance R2—R4, the charging contact 36 of the firing switch 37, the heel 38, the line 13 to the positive side of condenser C2, the negative side of which is connected directly to the line 18 or negative battery. This circuit is substantially the same as that of Figs. 1 and 2 and if the battery is fully charged, the resistance R3 permits the relay R to become energized thereby raising the contact 24 to engage the front contact 25 and thus energizing the neon light 27 through the resistance R5 and line 13' to contact 36 on switch 37 if the condensers C1 and C2 are properly energized owing to the selection of the proper resistance R5. It is then necessary to hold the charge-discharge switch 4 in the charged position during the time when it is desired to energize the condensers C1 and C2 in parallel. The spring biased switch 4 is held in the charge position until the neon light 27 lights. If it is desired to fire the shot the switch 4 is released and firing switch 10 is then thrown, which controls the three switches 10, 15 and 37, that are simultaneously moved to the firing position to connect their respective firing contacts 31 and 39.

Upon the energization of the firing load the relay R which is shunted out by the firing switch 37, will drop its contact after a timed delay selected by the choice of the condenser C3, regardless of how long the firing switch 10 is held in the firing position. Thus the firing load 33 receives sufficient energy for a sufficient length of time to discharge the firing load which is calculated by the selection of the capacity of the condenser C3 shunting the relay R. Contact 24 of relay R will open its engagement with the front contact 25 and close the back contact 35 to provide a closed or discharge circuit for the condensers when the firing switch is released and drawn to the position as shown by means of the spring 41. It is obvious that these switches 4 and 10 need not be provided with their spring return. However, this device adds a further safety to the circuit.

When the condensers are discharged through the discharge circuit in Fig. 3 represented by the line 30, it will be noted that both the condensers C1 and C2 must necessarily discharge through their respective resistances R1—R4, R2—R4. Thus the resistances R1 and R2 also become the discharge resistances R4 as illustrated in Figs.

Again we wish to point out that there are no resistances or relay circuits in multiple with the condensers when connected in series during the firing position of the firing switch. Thus the total energy of these condensers is employed directly across the firing load.

When the condensers C1 and C2 are charged by holding the switch 4 in the charge position with the switch engaging the charge contact 3 until the relay R is energized and it is desired to discharge the condensers, this may be accomplished by pressing the pushbutton 40 which shunts the operating coil of the relay R thus causing it to become deenergized thereby closing the contact 24 to the back contact 35 to discharge both condensers C1 and C2 through their respective resistances R1—R4 and R2—R4.

I claim:

1. A detonator firing circuit consisting of a battery and at least two condensers, a two-position manually operated switch means, lines connected to said battery and condensers to charge the latter in multiple when said switch means is in one position, a relay having a time delay in opening characteristic with its operating coil connected in multiple with said condensers during the charging of the latter, and a front contact on said relay to connect one side of the detonator circuit to one side of said condensers when said switch means is in said one position, said switch means opening said battery circuit and connecting said condensers in series with each other and with said front contact and to the other side of the detonator circuit to fire the same after said relay has been energized.

2. The detonator circuit of claim 1 characterized in that said switch means also includes a two position switch having a battery charging position and a condenser discharging position, the latter connecting a resistance across said condensers.

3. The detonator circuit of claim 1 characterized by a resistance connected in series with said relay the selected resistance of which prevents the closing of the relay until the condensers are up to charge.

4. The detonator circuit of claim 1 characterized by a third condenser connected in multiple with said relay the value of which latter condenser is chosen to regulate the time of drop out of said relay.

5. The detonator circuit of claim 1 characterized by a neon light in series with a resistor both of which are connected in multiple with the firing circuit, said resistor being chosen so that when the battery voltage is below a predetermined amount it will prevent the neon light from lighting thereby indicating a low voltage source of supply.

6. The detonator circuit of claim 1 characterized by a resistance connected in series with said condensers when said switch means is connected to charge said condensers.

7. The detonator circuit of claim 1 characterized by a resistor connected in series with one of said condensers

when the switch means connects said condensers for charging and in multiple with said other condenser when said switch means is connected for firing.

8. The detonator circuit of claim 1 characterized by a resistance inserted between the battery and one side of both of said condensers when said switch means is connected to charge said condensers.

9. The detonator circuit of claim 1 characterized by independent resistances connected in series with each of said condensers when said switch means is positioned in their charging position, said independent resistors being removed from said circuit when said switch means is connected to fire the detonator.

10. The detonator circuit of claim 1 characterized in that said switch means that connects said condensers in series also shorts out said relay.

11. The detonator circuit of claim 2 characterized by a resistor connected with said last mentioned switch means to be in series with said condensers when the said last mentioned switch means is in the charging position and a second resistor to shunt said last mentioned condensers when said switch means is in said discharge position and the firing position remains open.

12. A detonator firing circuit comprising condenser means, power means for charging said condenser means, a time delay in opening relay having its operating coil connected in multiple with said condenser means, a front contact on said relay connecting one side of the detonator firing circuit to one side of said condenser means, switch means to connect said power to energize said relay and charge said condenser means when in one position and when in another position to disconnect said power means and connect the other side of said detonator firing circuit to said condenser means and to shunt the operating coil of said relay.

13. The detonator firing circuit of claim 12 characterized in that said switch means includes at least two switches, one to open said charging circuit and close the detonator firing circuit and another independently operated switch means to disconnect said power means and connect a circuit across said condenser means to drain the same.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,961,583

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Andrew J. Sorensen

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 21, strike out "last mentioned" and insert the same before "switch" in line 22, same column.

Signed and sealed this 12th day of September 1961.

(SEAL)

Attest:

ERNEST W. SWIDER

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Commissioner of Patents

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UNITED STATES PATENT OFFICE
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