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CONTROLLER FOR ELECTRIC CIRCUITS

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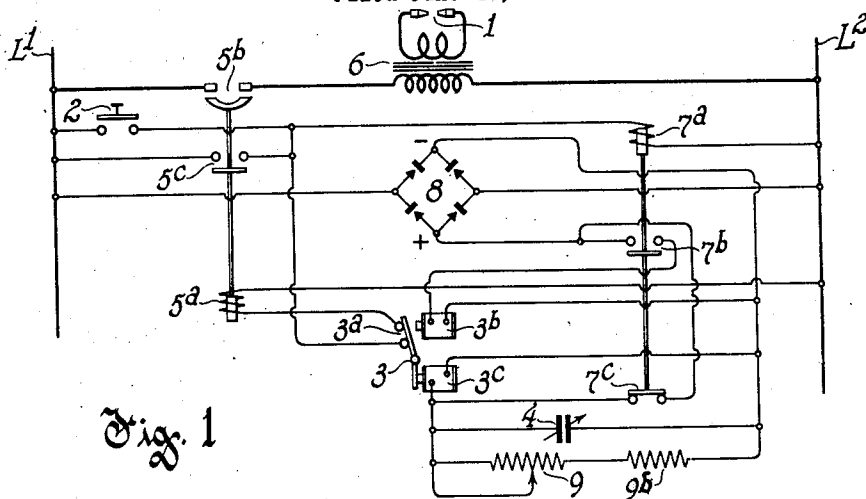


Fig. 1

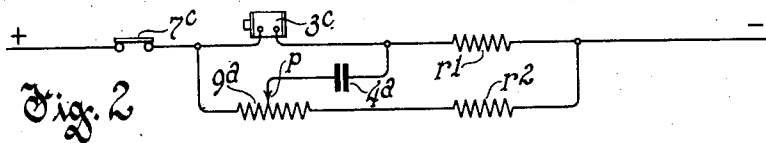


Fig. 2

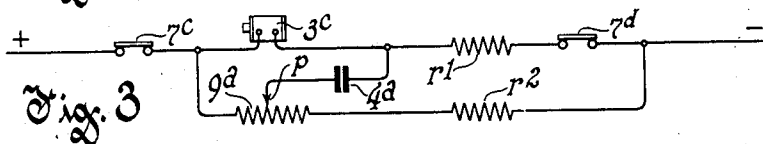


Fig. 3

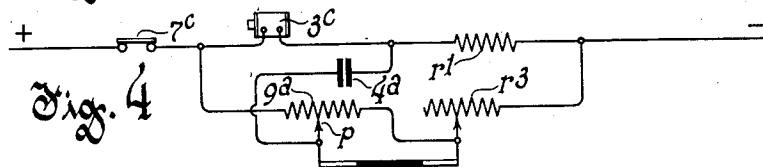


Fig. 4

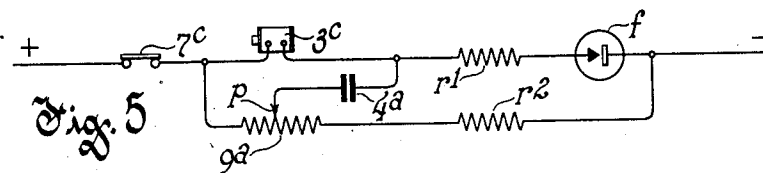


Fig. 5

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CONTROLLER FOR ELECTRIC CIRCUITS

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16 Claims. (Cl. 175-320)

This invention relates to electrical timing apparatus and refers particularly, but not exclusively, to apparatus for controlling electric circuits, such as electric welding circuits, which require to be energized for a given period and then deenergized automatically.

It has heretofore been proposed to provide an electrical timing apparatus comprising an electromagnetic relay having a control winding, and means whereby, upon the occurrence of a given operation, said control winding is energized by a current varying the charge of a condenser in series therewith so that when said current falls to a given amount said relay will respond accordingly, means being provided to vary the time taken, from the occurrence of said given operation, for said current to fall to said given amount. Such a prior device is shown in Fig. 1 of the drawing of this application. It is the object of the present invention to provide an improved apparatus of this kind in which, inter alia, certain of the parts, for example the condenser and some of the associated parts, may be smaller and in which more accurate and close control will be obtained.

In accordance with the invention the means for varying the time taken for said current to fall to said given amount comprise means for varying the potential range through which the charge of said condenser has to vary to reduce said current to said given amount.

In order that the invention may be the more clearly understood, a number of arrangements in accordance therewith will now be described, reference being made to the accompanying drawing, wherein:

Figure 1 illustrates schematically and diagrammatically a known form of electric welding controller.

Fig. 2 illustrates one example of my invention as applied to the timing apparatus for an electric welding controller of the character illustrated in Fig. 1 hereof.

Fig. 3 illustrates a slight modification of the arrangement shown in Figure 2.

Fig. 4 illustrates another modification of said arrangement shown in Figure 2, and

Fig. 5 illustrates still another modification of the arrangement shown in Figure 2.

Referring first to Figure 1 a welder 1 is adapted, upon momentary depression of a push button 2 to be energized from an alternating current source L^1 , L^2 for a given period, after which it is automatically de-energized.

The timing of the period is effected by means

of a relay 3 having normally closed contacts 3^a whose closure is necessary for the energization of the welder 1, and having also an operating winding 3^b and a restraining winding 3^c . The operating winding 3^b is connected across the lines L^1 , L^2 simultaneously with the energization of the welder 1, thus tending to open the contacts 3^a and de-energize said welder, but the restraining winding 3^c , which is normally connected across the lines in parallel with a condenser 4 and is disconnected from the lines simultaneously with the energization of the welder, maintains said contacts 3^a closed and thus delays the de-energization of the welder, for the period during which the condenser 4 is discharging through said restraining winding 3^c .

Describing the operation in detail, closure of the push button 2 establishes an energizing circuit, through said contacts 3^a for the winding 5^a of a relay having normally open contacts 5^b connected in circuit with the primary of a transformer 6 across whose secondary the welder 1 is connected. Said contacts 5^b accordingly close and the welder 1 is energized. Simultaneously, normally open auxiliary contacts 5^c on said winding 5^a close, thereby short circuiting said push button 2 which may accordingly be released after momentary depression.

Depression of said push button 2 also establishes an energizing circuit for the winding 7^a of a relay having normally open contacts 7^b and normally closed contacts 7^c . Contacts 7^b accordingly close thereby establishing, through a double wave rectifier 8, a direct current energizing circuit for the winding 3^b which tends to open the contacts 3^a .

It will be seen however that prior to the depression of the push button 2, the restraining winding 3^c was connected in a direct current circuit through the rectifier 8 and the contacts 7^c , and therefore the condenser 4 in shunt with said winding 3^c becomes fully charged. When therefore contact 7^c opens upon depression of the push button 2 and interrupts this circuit, the condenser 4 will commence discharging through said winding 3^c and the latter will not therefore be immediately deenergized but will be maintained energized until the charge of the condenser 4 is sufficiently exhausted.

At this point the operating winding 3^b will function and the contacts 3^a will open thereby breaking the circuit of 5^a , causing 5^b to open and de-energizing the welder 1.

In order that the welding period may be adjustable the condenser 4 is adjustable, and, more-

over, an adjustable resistance 9 is connected across said condenser 4 to afford a secondary discharge path of variable resistance, a safety resistance 9^b being also preferably included in the circuit of resistance 9.

Thus, in Fig. 1 said restraining winding 3^c, a variable condenser 4 and also a variable resistance 9 in series with a safety resistance 9^b are connected, in parallel with each other, across a source of direct current through said normally closed contacts 7^c. Normally the restraining winding 3^c is energized and the condenser 4 charged. When the weld is commenced, the normally closed contacts 7^c open, thereby disconnecting all three circuits from the source, so that the condenser 4 discharges through said restraining winding 3^c and also through the variable resistance 9 and safety resistance 9^b, and, when the discharge current through the restraining winding 3^c falls to a given amount, the relay 3 controlled by said restraining winding 3^c responds thereby stopping the weld. The variable resistance 9 and the safety resistance 9^b, by taking some of the discharge current, help to control the time taken for the discharge current through the restraining winding 3^c to fall to said given amount.

Referring to Fig. 2, this figure reproduces the restraining winding 3^c of Fig. 1 and the normally closed contacts 7^c through which said restraining winding is normally energized. Fig. 2 also illustrates the circuits directly associated with said restraining winding 3^c which are substituted for the corresponding circuits of Fig. 1. In all other respects the arrangement of Fig. 2 is identical with that of Fig. 1.

The device of Fig. 2 differs from the device of Fig. 1 in that, firstly, an additional resistance r^1 is included, between the pole of the source to which the safety resistance r^2 is connected and both the restraining winding 3^c and the condenser 4^a, but not between said pole and said safety resistance r^2 ; and, secondly, the variable resistance 9 of Fig. 1 is replaced by a fixed resistance 9^a connected between the other pole of the source and said safety resistance r^2 , and the connection of said condenser 4^a to said other pole is by way of a variably tapped point p of said fixed resistance 9^a.

In this case the time of the discharge is varied by varying the position of said tapped point p , which both varies the potential to which the condenser 4^a becomes charged and varies the amount of resistance in circuit with said condenser and the restraining winding 3^c during discharge.

The arrangement illustrated in Fig. 1 has the disadvantage that, since the adjustable rheostat 9 is connected, in series with the safety resistance 9^b across the source of supply (which in said Fig. 1 is by way of a rectifier 8), this rheostat 9, when set to a low or zero resistance value for shortening the discharge period of the condenser 4, will put a heavy load on the source (in this case the rectifier 8) or at least a much heavier load than when said rheostat 9 is set to a high resistance value. Thus, unless an exceptionally large rectifier is employed the voltage output will vary to some extent according to the setting of the rheostat. In any case it is necessary to make the rectifier sufficiently large to withstand such a heavy load condition for long periods. Also the rheostat 9 itself has to be able to carry fairly heavy currents especially when it is at a low resistance setting.

In the present arrangement above described,

since the rheostat 9 of Fig. 1 is replaced by a fixed resistance 9^a, the current taken by the circuit of said fixed resistance will be substantially constant regardless of the position of the tapped point p . This means that said fixed resistance 9^a can be much smaller because the current which it carries is constant and does not increase when short time intervals are required. Furthermore the total resistance can be of comparatively high value since its function is to charge up the condenser 4^a. Also the rectifier 8 (see Fig. 1) can be made smaller since its load is smaller not being increased by movement of the tapped point p . The condenser 4^a can also, for the reason described hereinafter, be made smaller.

As in the arrangement of Fig. 1, the condenser 4^a may be adjustable for varying the period of discharge, but normally a fixed condenser (as shown) is utilized, and variation of the tapped point p is employed to effect variation of the period of discharge.

It will be noted that the condenser 4^a has a second discharge path through the aforementioned additional resistance r^1 , the safety resistance r^2 and a portion of the variably tapped fixed resistance 9^a; but since said additional resistance r^1 is fairly high in value and remains constant, this second discharge path takes a comparatively small amount of current. Moreover, when the tapped point p is set for charging the condenser 4^a to its high values, a considerable amount of the variably tapped fixed resistance 9^a will be in said second discharge circuit, thus preventing a too rapid discharge therethrough. Thus the condenser 4^a can be made smaller than in the arrangement shown in Fig. 1 in which the second discharge path always takes a considerable proportion of the discharge current, the condenser being always fully charged before discharge.

Another advantage of the present arrangement over that shown in Fig. 1 is that, in the latter, owing to the condenser 4 always having the same voltage impressed upon it, it is found that regulation is rather coarse when using a rheostat with anything like a normal number of contacts, and a large number of contacts are required in order to give the necessary time periods ranging from a fraction of a second to several seconds; whereas with the present arrangement a closer adjustment is obtained with a normal number of contacts on the variably tapped resistance 9^a.

Referring now to Fig. 3, this is identical with Fig. 2 except that an additional set of normally closed contacts 7^d are provided, connected in said second discharge path as shown and adapted to respond in like manner as said normally closed contacts 7^c. Thus, these additional normally closed contacts 7^d open during the discharge period and positively interrupt said second discharge path. This arrangement gives a longer discharge period for the same potential charge. If desired the safety resistance r^2 may also be eliminated.

Referring to Fig. 4, this illustrates another alternative arrangement in which the safety resistance r^2 is replaced by a variable rheostat r^3 which varies its resistance in unison with the variation of the tapped point p of the fixed resistance 9^a so as to be at maximum value when said tapped point is adjacent the restraining winding 3^c and at zero value when said tapped point is remote from said restraining winding. This arrangement enables a variable voltage to be impressed on the condenser 4^a, and at the same time it provides an additional variable re-

sistance r^3 in the second discharge path. It will be seen that the higher the potential impressed on the condenser 4^a , the greater is the resistance r^3 inserted in the second discharge path, thus tending to keep constant the relationship between the voltage on the condenser and the resistance in said second discharge path. Consequently, the voltage impressed on the condenser 4^a will be more truly reflected in the time taken for said condenser to discharge through the restraining winding 3^c although recourse is not had to the additional normally closed contact 7^d of Fig. 3. Further, by employing this variable rheostat r^3 as stated, both said rheostat and the fixed resistance 9^a with a variable tapping point p can be smaller and lower in their ohmic values, since they act additively in increasing or decreasing the discharge period.

Referring to Fig. 5, this shows an arrangement which is very similar to Fig. 3 except that the contacts 7^d are dispensed with, and, instead, a rectifier f is provided in the second discharge path, said rectifier being arranged in such a sense as to give access to the current normally energizing the winding 3^c and charging the condenser 4^a , when the contacts 7^c are closed, but to prevent any discharge current from said condenser 4^a from flowing through said second discharge path. The effect of this rectifier is the same as that of the contacts 7^d of Fig. 3.

The arrangements described may be further modified in that the winding 3^c through which the condenser 4^a discharges need not be the restraining winding of a relay but could be the one opening coil of a normally closed relay. In this case the arrangement would be the same as above described except that the pull-in coil 3^b of Fig. 1 and also of course the normally open contacts 7^b thereof would be dispensed with, the relay 3 being biased to normally open the contacts 3^a , the bias being sufficiently strong to open said contacts when the discharge current through the opening winding 3^c falls to said given amount.

I claim:

1. Electrical timing apparatus, comprising an electromagnetic relay having a control winding, means to time the operation of said relay, said last mentioned means including a condenser connected in series with said control winding, means whereby said control winding is energized by the diminishing current varying the charge of said condenser, so that when said current falls to a given value said relay will respond accordingly, and associated means for varying the time taken for said current to fall to said given value, said last mentioned means including means for varying the maximum potential to which said condenser is charged.

2. Electrical timing apparatus according to claim 1, in which said relay also includes an operating winding which when the current in said control winding falls to said given value, causes said relay to respond.

3. Electrical timing apparatus according to claim 1, in which said electromagnetic relay times the period of energization of an associated electrical device, said relay acting upon response thereof to terminate said period of energization of said device.

4. Electrical timing apparatus according to claim 1, in which said relay also includes an operating winding which when the current in said control winding falls to said given value, causes said relay to respond, said relay acting to time the period of energization of an associated elec-

trical device, and said relay acting upon response thereof to terminate said period of energization of said device.

5. Electrical timing apparatus according to claim 1, in which the means for varying the maximum potential to which said condenser is charged comprises a potentiometer having a tapped point to which one terminal of said condenser is connected.

6. Electrical timing apparatus according to claim 1, in which the means for varying the maximum potential to which said condenser is charged comprises a potentiometer type resistor the resistance of which is of constant value, said potentiometer type resistor being connected in parallel with said control winding and having a tapped point to which one terminal of said condenser is connected.

7. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, the means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, and means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point.

8. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, the means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, and said potentiometer being so arranged that, as the maximum potential to which said condenser is charged is increased and decreased, so the aforementioned portion of said potentiometer resistance is decreased and increased.

9. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, the means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, and means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance.

10. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, the means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said con-

trol winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, and means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding.

11. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, the means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, and means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding, the terminal of said condenser remote from said potentiometer being connected to said circuit of said control winding at a point between said control winding and said additional resistance.

12. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, the means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding, the terminal of said condenser remote from said potentiometer being connected to said circuit of said control winding at a point between said control winding and said additional resistance, and means for including in the circuit of said potentiometer resistance across the source of power a safety resistance not included in said discharge circuit across said control winding.

13. Electrical timing apparatus according to claim 1, wherein said current varying the charge of said condenser is the discharge current there-

of, said means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding, the terminal of said condenser remote from said potentiometer being connected to said circuit of said control winding at a point between said control winding and said additional resistance, means for including in the circuit of said potentiometer resistance across the source of power a safety resistance not included in said discharge circuit across said control winding, and means whereby said additional resistance and said safety resistance are included in an additional closed circuit through which said condenser discharges.

14. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, said means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding, the terminal of said condenser remote from said potentiometer being connected to said circuit of said control winding at a point between said control winding and said additional resistance, means for including in the circuit of said potentiometer resistance across the source of power a safety resistance not included in said discharge circuit across said control winding, and means whereby the value of said safety resistance is varied in unison with the variation of the potentiometer, in such a way that the greater the potential to which the condenser is charged the greater is the value of said safety resistance.

15. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, said means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which one terminal of said condenser is connected, means whereby said discharge current flows through a

closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding, the terminal of said condenser remote from said potentiometer being connected to said circuit of said control winding at a point between said control winding and said additional resistance, means for including in the circuit of said potentiometer resistance across the source of power a safety resistance not included in said discharge circuit across said control winding, and associated means for preventing said condenser from discharging through the circuit including said additional resistance and said safety resistance.

16. Electrical timing apparatus according to claim 1, in which said current varying the charge of said condenser is the discharge current thereof, said means for varying the maximum potential to which said condenser is charged comprising a potentiometer having a tapped point to which

one terminal of said condenser is connected, means whereby said discharge current flows through a closed circuit including said control winding and the portion of the potentiometer resistance on one side of said tapped point, means whereby prior to the commencement of the timing period the control winding and the potentiometer resistance are connected in parallel circuit across the source of power, and, at the commencement of said timing period, said circuits are disconnected from said source, whereupon said condenser discharges through said control winding and said portion of the potentiometer resistance, means for including in the circuit of said control winding across the source of power an additional resistance not included in the discharge circuit through said control winding, the terminal of said condenser remote from said potentiometer being connected to said circuit of said control winding at a point between said control winding and said additional resistance, means for including in the circuit of said potentiometer resistance across the source of power a safety resistance not included in said discharge circuit across said control winding, and associated means for preventing said condenser from discharging through the circuit including said additional resistance and said safety resistance, said means comprising normally closed contacts in said last mentioned circuit, adapted to open upon the commencement of the timing period.

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