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ELECTRIC DELAY CIRCUITS

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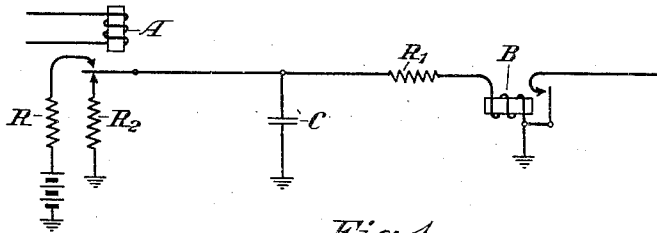


Fig. 1

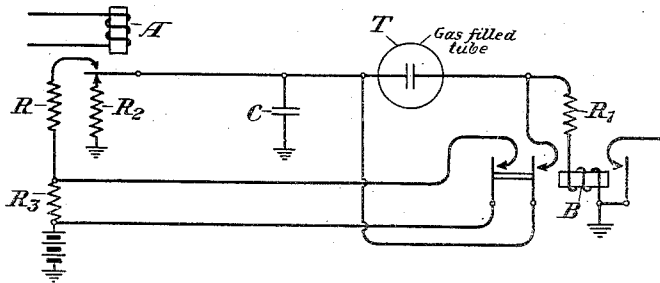


Fig. 2

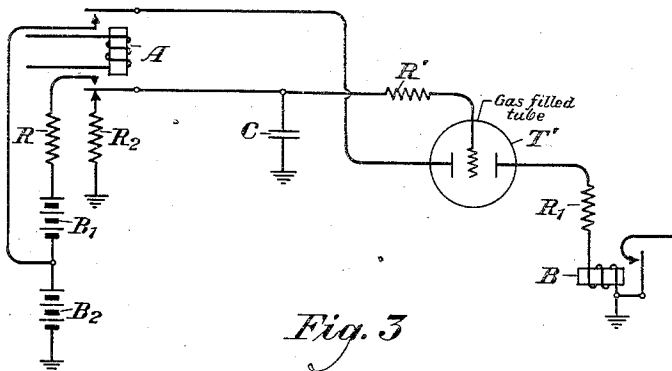


Fig. 3

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ELECTRIC DELAY CIRCUITS

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This invention relates to electrical circuits and more particularly to improved arrangements for introducing a delay or time lag in the operation of elements included in such circuits.

In electrical systems such, for example, as in a telephone plant, it is frequently necessary to have apparatus or circuits which will introduce appreciable time intervals between the operation of one part of a circuit and another. Heretofore, this has been accomplished in various ways, such as by relays which have been designed to be slow-operating or slow-releasing, and by circuits which depend upon the time required to charge or discharge condensers. With the condenser arrangements more uniform delays may be obtained than with relays alone, but these circuits have the disadvantage that the capacities required become rather large for the longer time intervals due to the fact that the charging resistance which may be used is limited to a value which will give sufficient current to operate the controlled relay with the battery voltage available. In other words, the time interval between the operation of the controlling relay and the controlled relay, is proportional to the product of the charging resistance and the capacity. The time interval also depends upon the adjustment of the controlled relay since this adjustment determines the magnitude to which the current through the relay must build up in order to cause its operation.

The arrangements of the invention have been provided to do away with the above disadvantages of prior arrangements. In the arrangements of the invention, a gas filled tube is added to the circuit of the controlled relay. The gaseous content of the tube may, for example, be neon. Tubes of this type are low in cost, require little or no maintenance, and can be made quite uniform in their breakdown voltage. The timing in a circuit of this type depends upon the time required to charge the condenser to a potential sufficient to cause the tube to break down, and is not dependent upon the adjustment of the controlled relay. When the tube breaks down, its impedance drops to a low value and per-

mits the condenser to discharge through it and operate the controlled relay. This relay, in addition to giving an indication to the external circuit to which it is connected, short-circuits the tube and changes the value of the charging resistance, and thus lowers the circuit resistance to a point where sufficient current will flow to keep the controlled relay operated. Under these conditions the condenser need only be of sufficient capacity to give a discharge current which is large enough to operate the controlled relay momentarily, and with this value established the timing may be changed by varying the charging resistance. It may be noted that these conditions are the reverse of those of the prior art arrangements referred to.

Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description, together with the accompanying drawing, in the Figures 1, 2 and 3 of which the invention is illustrated. Fig. 1 is a circuit diagram illustrating arrangements of the prior art. Fig. 2 is a circuit diagram embodying the arrangements of the invention. Fig. 3 is a modification of the arrangements of Fig. 2. Similar reference characters have been used to denote like parts in all of the figures.

In Fig. 1 are shown arrangements of the prior art in which a relay A controls the circuit of a relay B. This circuit includes a battery and a charging resistance R. A condenser C is bridged from this circuit to ground. When the relay A operates, the condenser C will charge, and as soon as the potential across the condenser has become sufficient to cause the current through relay B to reach the required amount, relay B will operate. The resistance R_1 is provided in the circuit to raise the impedance of the relay circuit to approximately that of R. The resistance R_2 is provided to limit the rate of discharge of the condenser C, when the relay A releases. In this circuit the time interval between the operation of relays A and B is proportional to the product of the resistance R and the capacity C. The time in-

terval also depends upon the adjustment of relay B since this adjustment determines the magnitude to which the current through the relay must build up in order to cause its operation. Such a circuit also has the disadvantage that the capacity, such as C, required becomes rather large for the longer time intervals due to the fact that the charging resistance R which may be used is limited to a value which will give sufficient current to operate relay B with the battery voltage available. The above arrangements are well known in the prior art.

To eliminate the disadvantages of the above circuit, the arrangements of the invention as shown in Fig. 2 are provided. In these arrangements a two-electrode gas filled tube T is added to the circuit. Such a tube would preferably be of the cold cathode type, and could be made quite uniform in its break down voltage. The gaseous content might, for example, be neon. Timing in this circuit depends upon the time required to charge the condenser to a potential sufficient to cause the tube to break down, and is not dependent upon the adjustment of relay B. When the tube breaks down, its impedance drops to a low value and permits the condenser to discharge through it and operate relay B. This relay, in addition to giving an indication to the external circuit to which it is connected, short-circuits the tube and resistance R_1 , and thus lowers the circuit resistance to a point where sufficient current will flow to keep relay B operated. Resistance R_1 , which may be wholly or partly included in the resistance of the winding of relay B, is required to slow down the discharging of the condenser through the relay B sufficiently to give it time to operate. Resistance R_2 serves to limit the discharge current of the condenser C upon the release of relay A, as in the arrangements of the prior art. The condenser C needs only to be of sufficient capacity to give a discharge current which is large enough to operate relay B momentarily, and with this value established the timing may be changed by varying the resistance R_2 . It is pointed out that these conditions are the reverse of those used in the arrangements of the prior art referred to. The arrangements of Fig. 2 might be slightly modified if desired. For example, it would not be necessary to short-circuit the tube when relay B operates if the values of resistances R , R_1 and R_2 are chosen so that the short-circuiting of resistance R_1 will lower the circuit impedance sufficiently to maintain the discharge through the tube. These arrangements would require fewer contacts on the relay B and would simplify obtaining a suitable relay for the purpose.

A modification of the arrangements of the invention is shown in Fig. 3. In this arrangement there is used a three-electrode gas filled tube T'. The gaseous content might,

for example, be neon. The operation is similar to that of the arrangements of Fig. 2, in that the time interval between the operation of relay A and relay B depends upon the time required to charge condenser C to a potential sufficient to cause the tube T' to break down. It differs from the arrangements of Fig. 2, however, in that relay B is operated by the cathode to anode current which is set up when the tube breaks down, instead of by the discharge of condenser C. The grid of the gas filled tube T' is connected to the condenser C and, depending upon the time interval required for the charging of the condenser C, will have its potential changed sufficiently to cause the tube to break down. The cathode to anode current will hold the relay B operated until the cathode to anode circuit is opened by the release of relay A, since in this kind of tube the grid loses control of the action as soon as the tube breaks down, and the cathode to anode current cannot be stopped except by removing the energizing potential. This, of course, makes it unnecessary to provide contacts on relay B to reduce the resistance of the circuit or short-circuit the tube in order to obtain sufficient current to hold relay B operated. The current through relay B is limited by the voltage of the battery B_2 , and the resistance of the tube after break down, and the resistance R_1 , which may be wholly or partly included in the resistance of the winding of relay B. Resistance R and condenser C, form the timing circuit, and battery B_1 furnishes the additional voltage required by the grid in order to make the tube break down. Resistance R' is provided to limit interaction between the grid and anode, and resistance R_2 is provided to limit the discharge current of the condenser C when relay A releases. When relay A operates the voltages of batteries B_1 and B_2 will be applied through resistance R and over the lower make contact of relay A to the condenser C and will charge it. When the condenser C is charged the potential on the grid of tube T' will be raised sufficiently to cause the tube to break down or discharge. Current will then flow over the following circuit: from battery B_2 , upper contact of relay A, from anode to cathode of tube T', through resistance R_1 , winding of relay B to ground. This will operate relay B. When relay A releases the above traced operating circuit for relay B will be broken at the upper contact of relay A. The condenser C will be discharged through resistance R_2 .

While the invention has been disclosed as embodied in certain specific forms which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A relay, a condenser, a charging circuit for said condenser controlled by said relay, two resistances in said charging circuit for limiting the potential applied thereto, a discharge circuit for said condenser, a gas filled tube in said discharge circuit adapted to be broken down after said condenser is charged, a second relay in said discharge circuit operated by the discharge of said condenser, means controlled by said second relay for short-circuiting the tube in said discharge circuit, and means controlled by said second relay for short circuiting one

of said resistances in said charging circuit.

2. A relay, a condenser, a charging circuit for said condenser controlled by said relay, a discharge circuit for said condenser, a three electrode gas filled tube having its grid connected to said condenser, an operating circuit for said tube controlled by said relay, and a second relay in the operating circuit of said tube.

In testimony whereof, we have signed our names to this specification this 16th day of June 1931.

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