

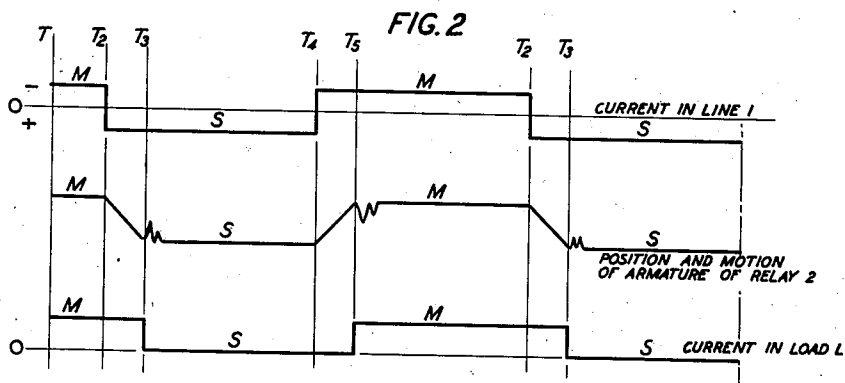
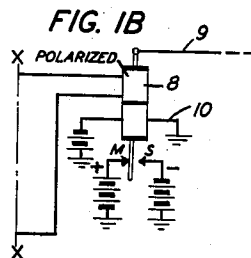
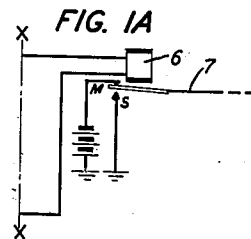
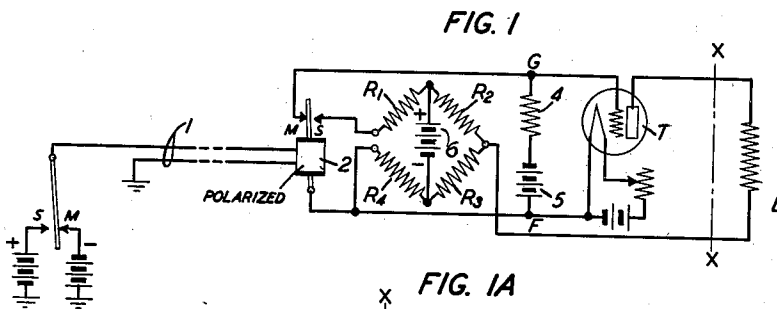
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IMPLUSE REPEATER

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IMPULSE REPEATER

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3 Claims. (Cl. 178—70)

This invention relates to impulse relaying devices of the type useful in telegraphic transmission by means of direct current impulses.

Among the objects of the invention are, first, to relay or repeat telegraphic impulses without distortion due to chatter of relay contacts and, second, without distortion due to introduction of bias in the relay process.

In accordance with an embodiment of the invention, an incoming circuit over which impulses are received is connected to a relay of the electromagnetic type and this relay is connected to the input circuit of a gaseous discharge tube in such a manner that four conditions are fulfilled as follows:

1. In one condition of the incoming line which we shall designate "marking" current flows in the output path of the gaseous discharge tube;

2. During the travel time of the receiving relay from marking to spacing condition the current in the output path of the discharge tube is not affected and continues to flow;

3. During the spacing condition of the incoming line circuit and its receiving relay the current in the output path of the gaseous discharge tube ceases to flow;

4. During the time of travel of the receiving relay from spacing to marking the flow of current in the output path of the discharge tube remains stopped;

5. Relay chatter caused by rebound of the receiving armature from the spacing contact constitutes the same condition as condition 4 noted above and does not start the current flowing in the output circuit;

6. Relay chatter comprising rebound from the marking contact constitutes the same condition as condition 2 above and does not stop the current flowing in the output circuit of the gas-filled tube.

The nature of the apparatus combined to form an embodiment of the invention and the operation thereof will be explained in further detail in connection with the accompanying drawing, in which:

Fig. 1 comprises a circuit arrangement useful for explaining the invention and comprising elements constituting an embodiment thereof;

Fig. 1A comprises a modification of the apparatus which may be placed to the right of the line X—X of Fig. 1;

Fig. 1B comprises other modified apparatus which may be substituted for part of Fig. 1 to the right of the line X—X; and

Fig. 2 comprises a series of curves used for explaining the operation.

In Fig. 1 a telegraph line 1, which typifies any path, circuit, or channel from which telegraphic impulses may be received, is supplied at contacts S, M of a sending relay with impulses of positive spacing current and negative marking current. In an arrangement such as that of Fig. 1 the incoming impulses may be feeble or distorted and it is desired to repeat them to a load device or more accurately to produce, in a load device L, corresponding impulses of current and no current with a minimum of further distortion. In other words, the impulses in load device L are to be a faithful reproduction in relative lengths of the incoming impulses. Such an arrangement may be useful, for example, in a test set for obtaining impulses which are as nearly rectangular as possible, for checking theoretical calculations, or for other purposes. The received impulses actuate a polar relay 2 which has marking and spacing contacts. The marking contact is connected directly to a point G comprising a grid terminal of a gas discharge tube which may be of the type sometimes known as "thyatron" (Reg. T. M.). The spacing contact of the relay is connected to a terminal of a resistance R1 of a bridge which consists of resistances R1, R2, R3 and R4, connected as illustrated. The armature of the relay is connected to a terminal of resistance R4 in such a manner that when the relay is in spacing position a direct connection is established through the armature between resistances R1 and R4; the armature is also connected to a point F connected to the filament of the tube T. The common point of resistances R2 and R3 is connected directly through the load device L to the anode of tube T. The resistance R4 is a high resistance and the battery 5 is poled negatively toward the grid and having a terminal electromagnetic force suitable for the particular tube employed.

When the relay 2 is on its marking contact, it will be seen that a circuit is established in such manner that a portion of the voltage of the battery 6 is included in the path from the point F comprising the filament of the tube T to the anode of the tube. Furthermore, a short circuit is established between the points G and F which removes the negative voltage from the grid of the tube and causes the flow of current in the anode-cathode path thereof through the load device L from a positive point on the bridge between the resistances R2, R3, and back to the filament.

On the other hand, when the relay 2 is in its spacing position, the full voltage of battery 5 is applied to the grid of the tube. Moreover, if the bridge comprising resistances R_1 , R_2 , R_3 and R_4 is balanced or suitably proportioned in a manner well understood in the art no potential or only a negligible potential will be supplied between the cathode and the anode of the tube, which will cause the current flow in the anode-cathode circuit thereof to cease. For an example of values $R_1=R_2=0$, $R_3=00$, R_4 finite, would do; however, this does not exclude other values in which all the resistances have finite values.

By means of Fig. 2 explanation will be made on the following six conditions:

(1) *Marking condition*

Let it be assumed that at a time T_1 the relay 2 has assumed a marking condition. In accordance with the upper curve of Fig. 2 current is flowing in the line 1 to hold the relay in the marking condition. At a time T_2 the current in the line 1 has reversed sufficiently to cause the armature to leave the marking contact and to proceed to the spacing contact. The time between T_2 and T_3 is, therefore, travel time. As we have stated above, current is flowing in the load device L during the marking condition to the points G, F to be connected by a short circuit and operating voltage is applied to the anode-cathode path 2.

(2) *Armature travel from marking to spacing*

During the travel time from point T_2 to T_3 current through the load device L, illustrated in the lower curve of Fig. 2, continues. The reason for this is that although the full potential of the battery 5 is applied to the grid of the tube T, it is ineffective to stop the current flow because of the well-known characteristic of tubes of the type in question that a negative grid potential of any value not exceedingly great is ineffective to stop the discharge through the tube.

(3) *Spacing condition*

When the armature of relay 2 strikes the spacing contact, the anode-cathode potential is moved from tube T and the discharge stops immediately as shown in the lower curve of Fig. 2.

(4) *Armature travel from spacing to marking*

At a time T_4 the line current reverses to cause the armature of relay 2 to move away from its spacing contact toward its marking contact. During the time it is in motion, represented by the time between T_4 and T_5 , the anode-cathode potential is applied to tube 2 but current cannot begin to flow because the grid is highly negative and remains negative until the armature reaches the marking contact of the point T_5 . Thereupon negative grid potential is moved and the discharge takes place through the tube.

(5) *Chatter by rebound from spacing contact*

It will be noticed in the middle curve of Fig. 2 that immediately after the time T_3 the relay armature is assumed to chatter, that is, to rebound from the spacing contact. It will be seen that this cannot affect the current flow through the load device L, which has ceased, because the negative grid voltage remains on the tube and prevents discharge. Consequently, the only way in which rebound could cause a false impulse would be for the armature to rebound to an extent sufficient to reach the marking contact.

(6) *Chatter by rebound from marking contact*

In the middle diagram of Fig. 2 the armature is indicated as rebounding from its marking contact just after time T_5 . When the armature has initially struck the marking contact, voltage has been removed from the tube T and current through the load device L initiated. Subsequent departure of the armature from the marking contact will not cause this current to cease because during current flow the grid voltage is ineffective to stop the discharge through the tube and the discharge will not be stopped unless the rebound carries the armature completely over to the spacing contact.

If the relay 2 is symmetrical in respect to the times required to move its armature from its marking to its spacing and its spacing to its marking being equal, the times illustrated on Fig. 2 as elapsing between T_2 , T_3 and T_4 , T_5 will be equal and consequently no bias will be introduced by the relaying system. Furthermore, chatter of the armature of relay 2 will introduce no bias or distortion.

In Fig. 2 the middle diagram has a slanting line during motion of the armature of relay 2 to indicate that the tongue of relay 2 makes neither contact. It is shown as making a clean and definite break away from the contact it is leaving. In an actual relay the instants of the start of travel time T_2 or T_4 are more or less indefinite and sometimes accompanied by chatter (not shown) before armature travel is begun. This is due to periodic vibration of the armature while on contact caused by the previous transition, and is consequently a function of previous intelligence transmitted. The uncertainty of the instant of breaking contact, or chatter at that time, contributes to transmission instability which would be appreciable on a long system built up of several such links. The instant of making contact is far more definite than that of break because the relay winding current has built up to a higher value and takes more positive control of the armature by the time make occurs. The repeater shown in Fig. 1 is not influenced by the uncertainty of the instant of break, because the current in load L does not change until relay 2 makes contact. Thus inequality in the times elapsing between T_2 , T_3 and T_4 , T_5 , or chatter at break, have no serious effect upon transmission when the arrangement of Fig. 1 is used.

In accordance with Fig. 1A, a non-polar relay 6 may be substituted for the load device L for further relaying the impulses into an outgoing circuit 7; in accordance with Fig. 1B, the polar relay 8 may be utilized to further relay the impulses into an outgoing line 9. These impulses may correspond with those received over the line 1 or they may be reversed in polarity if desired.

On first thought it may be assumed that there is no advantage in relaying the impulses received from the line 1 by a distortionless arrangement and immediately retransmitting them by a relay such as the relay 8. However, the impulses from the line 1 may be exceedingly feeble and distorted. Consequently the relay 2 may be of a highly sensitive type making it advantageous to introduce distortion-preventing means, whereas the relay 8 may be of a different design adapted to be actuated by exceedingly powerful currents which may be supplied by the tube T and a bias circuit 10.

Furthermore, the load device L may constitute the actuating or control element or may be con-

connected to the input circuit of a cathode ray tube, a recording galvanometer or a device of any type used or useful in observing the wave form of distorted impulses. Thus, for example, the wave form or distortion of waves to be received over incoming line 1 may be determined by calculation and the arrangement illustrated in Fig. 1 together with a suitable observing instrument may be utilized to observe the length of the impulses and thus check the actual received waves against the theoretical calculations. Furthermore, the device L may represent a selector magnet of the holding or non-holding type or device L may consist of a distributor of the vibrating relay type, of the rotary segmented ring type, or of the thermionic type by which the impulses may be distributed. Moreover, the load device L may be connected in the grid-cathode path, or in shunt to impedance elements in such path, of a thermionic repeater tube of the high vacuum or gas-filled type.

What is claimed is:

1. A relaying system for impulses comprising electro-mechanical means for closing one or the other of two paths in accordance with the impulses to be relayed, a discharge device connected to be controlled by and in accordance with the pulses, means whereby a definite current condition of the discharge device is established when the first of said paths is closed and remains established independently of the opening of that path until the second of said paths is closed, and means whereby a different definite current condition of

the discharge device is established when the second of said paths is closed and remains established independently of the opening of the second of said paths until the first is closed.

2. A relaying system for impulses comprising means for closing one or the other of two paths in accordance with the impulses to be relayed, a thermionic space discharge device connected to be controlled by and in accordance with the impulses, means whereby current in the output path of the discharge device is started when the first of the paths is closed and remains started independently of the opening of that path until the second of the paths is closed, means whereby the output current of the device is stopped when the second of the paths is closed and remains stopped independently of the opening of the second of said paths until the first is closed.

3. In a circuit comprising a discharge tube of the type in which reduction of negative potential upon the grid causes current flow in the output path after which the grid loses control and is unable to stop the current, comprising an input arrangement having two positions one of which removes negative potential from the grid and applies anode-cathode voltage to the tube, the other of which applies negative voltage to the grid of the tube in sufficient amount to prevent start of current flow in the output circuit if stopped, and also removes anode-cathode potential of operating value from the tube.

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