

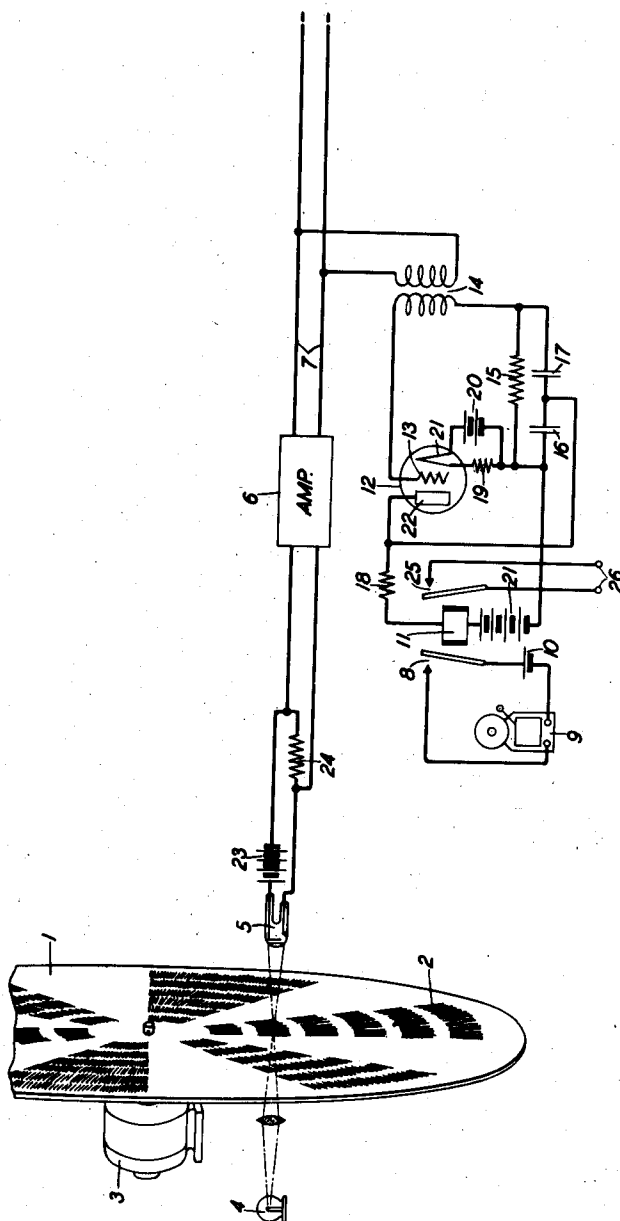
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C. P. STOCKER

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CONTROL CIRCUIT

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INVENTOR
C. P. STOCKER
BY *H. A. Burgess*
ATTORNEY

UNITED STATES PATENT OFFICE

CLOSMAN P. STOCKER, OF NEW YORK, N. Y., ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

CONTROL CIRCUIT

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This invention relates to electro-responsive devices and particularly to control of the responding interval of electro-magnetic devices such as relays.

It is an object of this invention to control the operation of circuits containing electro-responsive devices, more particularly the operation of circuits in which the functioning of a relay in response to an applied signal is to be delayed.

Several methods are available for controlling the delay in the response of a relay, some depending on the construction of the relay itself, others depending on the characteristics of the circuits with which the relay is associated. The present invention, which is of this latter general class, provides circuit means whereby the operation of a relay in response to control signals may be regulated, so that the relay will function at any predetermined time after signals are first applied, will hold its position as long as the signals continue, and will return to its original condition at a predetermined time after the signals cease.

In accordance with applicant's invention the relay which is to be operated is placed in the output circuit of a space discharge device. Signals applied to the input of such a device would ordinarily cause an immediate change in the impedance of the device with a resultant change in the output current passing through the relay; but means are provided whereby a change in the impedance of the tube produces on a control electrode in the discharge device a bias tending to oppose the change in impedance caused by the input signals. The bias set up by this action is gradually removed by means of a delay circuit and the output current finally assumes a value corresponding to the new conditions. At some time during this gradual change in output current, determined by the constants of the delay circuit and the adjustment of the re-

lay, the latter mechanism operates. A similar delayed action obtains when signals cease, as the change in condition of the output circuit is again transmitted to the control electrode where a gradually diminishing, opposing action is set up.

In the circuit used herein for purposes of illustration, the retro-action and delay are effected through a combination of resistance and capacity, which controls the energy transferred from the output circuit to affect a more sensitive part of the circuit. By use of such a combination, applicant is able to increase greatly the duration of the response interval and with a reduction in cost of apparatus.

The invention will be better understood by a consideration of the following detailed description, reference being made to the drawing, of which the single figure shows diagrammatically an embodiment applied to an alarm circuit in a call-announcing telephone exchange system.

In a call-announcing system several electrical channels are provided in each of which a spoken digit or letter is continuously repeated, and it is in connection with such a channel that an embodiment of the present invention will be described.

In the single figure of the drawing is shown one unit of the "telephone exchange system" more fully detailed in U. S. Patent 1,645,573, issued October 18, 1927, to H. M. Bascom. In each concentric circular channel on the transparent disc 1 is placed a film record 2 of a spoken numeral, which as the disc is rotated by motor 3 modulates the light passing from lamp 4 to photoelectric cell 5. The recorded numeral is thereby translated into equivalent electrical waves, which are then conducted to amplifier 6. The output of the photoelectric cell amplifier 6 delivered to channel 7 is therefore a succession of speech signals equivalent to the vocal repetition of a particular numeral, and

it is to be utilized in a part of the telephone exchange not shown in the drawing nor necessary to an understanding of this invention.

It is desirable to have an indication, as an audible one, when the above described circuit fails to function, and for this purpose an alarm circuit is provided, comprising a bell 9 and battery 10 adapted to be connected in operative relation when contact 8 is closed by the release of an armature associated with relay winding 11. The action of the relay is controlled by the output current of a space discharge device 12 whose control circuit is connected to channel 7. Normally, i. e., as long as the series of speech signals is being generated, the relay is maintained in an operated position, as shown. Upon failure of these signals the output impedance of the discharge device increases, the current passing through the relay diminishes and the armature of the latter falls back to complete the alarm circuit.

In order to prevent the relay from releasing during the interval between called digits, which may be of the order of a quarter of a second, means to retard the action of the circuit are provided. These latter means are found in the combination of resistance 15, condenser 16 and condenser 17. The anode circuit resistor 18 also has a part in the action.

When a series of signals passes through channel 7 the signals are impressed by means of transformer 14 on the input circuit of space discharge device 12, condensers 16 and 17 in series shunting the signals around resistance 15. The negative grid bias afforded by the voltage drop across the resistance 19 in the filament circuit of the discharge device, is adjusted so that the latter device operates as a plate circuit rectifier. That is, the negative bias is made so large that grid circuit rectification is negligible. With a signal present then, the output impedance of the discharge device, and therefore the voltage drop across it, is substantially less than it is with no signal present.

The electrostatic charge on condenser 17, which is determined by the direct-current voltage drop across the discharge device, increases with the increase of this direct-current voltage drop that attends cessation of input signals. The circuit through which the charging current of the latter condenser, 17, flows includes resistance 15 and the parallel resistances 18 and R_p , R_p representing the output impedance of the discharge device. Although the primary purpose of the other condenser, 16, is to shunt the incoming signal around resistance 15, its charging current also has some effect on the action of the relay as will be explained hereinafter. It will be seen from the diagram that the direction of the charging current of condenser 17

in passing through resistance 15 is such as to make the grid end of the resistance positive with respect to the filament end. The decrease in negative bias on the grid caused by this voltage drop tends to maintain the initial low impedance of the discharge device and to keep relay 11 operated. As the charge on condenser 17 increases and the charging current gradually approaches zero, the voltage drop in resistance 15 also decreases and its counteracting effect on the change in anode circuit impedance likewise gradually diminishes. Finally it becomes zero, the output impedance R_p reaches a high value determined by the grid biasing drop in resistance 19, and the output current becomes constant at a relatively low level. At some instant during this interval the output current becomes too weak to hold the relay, and the latter releases. The length of time between cessation of signals and the release of the relay may be accurately controlled by proportioning the capacity of condenser 17 and the resistance of its charging circuit, as these are factors determining the duration, or more precisely, the rate of decay, of the charging current.

A second armature and contact 25 associated with relay winding 11 may be used for any desired purpose, such as to cause a second digit-calling channel to be substituted when the first one becomes inoperative.

No attempt has been made to set forth the relative proportions of the various elements comprising the circuits of Fig. 1, inasmuch as considerable latitude must be allowed for those variable factors such as the amplitude of the incoming signal, the characteristics of the discharge device and the relay, and the amount of delay required. In one particular case the capacity of condenser 17 was two microfarads, that of 16, a half a microfarad, the resistance of 15, a hundred thousand ohms, and that of 18, twenty-four thousand ohms.

It has been hereinbefore noted that with the variation of anode circuit impedance, condenser 16 also charges and discharges, part of the current passing through the relay and tending to delay its operation. This action occurs entirely in the output circuit and of itself would cause only a comparatively short delay in the operation of the relay. The advantages obtained by the present invention in utilizing a large amount of energy released by a change in output circuit conditions to effect in control circuit conditions a change that can be considerably prolonged, is not present where the energy released is utilized directly in the apparatus to be controlled.

In the foregoing description the operation of the circuit after signals cease has been considered. Without going into detail, it is believed to be clear that when signals are

first impressed on the input terminals, the high impedance of the discharge device and the voltage drop across it tend to become low, discharge currents flow from condensers 16 and 17, respectively, that from the latter causing a decreasing negative drop to be created across resistance 15 in the grid circuit of the discharge device, the negative grid bias is thereby temporarily increased, and the actuation of the anode circuit relay is delayed.

It is to be understood that the call announcer and alarm circuits are only adjuncts to an embodiment of the invention, and that various elements and circuit combinations for associating output and control circuits other than the particular ones disclosed are within the scope of the invention as defined by the following claims.

20 What is claimed is:

1. A space discharge device having impedance control means, input and output circuits associated with said device, an element responsive to the current in said output circuit, means associating said output circuit and said control means whereby the effect of input signals on the action of said element is retarded.

2. A space discharge device having means for controlling the resistance of its discharge path, input and output circuits associated with said device, and means associated with said controlling means and responsive to current in said output circuit temporarily opposing the effect of input signals on said output current.

3. The combination with a space discharge device having an impedance control circuit and an output circuit, of means tending to produce sudden changes in the output current, a circuit containing reactance connected to receive a portion of the variable component of said output current, and means to apply to said control circuit a voltage from said reactance-containing circuit which is initially large and gradually diminishes, the direction of said voltage being such as to oppose the action giving rise to it.

4. The combination with a space discharge device having input, output and control circuits and whose direct current output impedance varies with the amplitude of signals applied to said input circuit, and an element controlled by the output current thereof, of a reactive circuit for translating the changes in output circuit condition occasioned by a change of input signal amplitude into a gradually diminishing control circuit potential, retarding said change in said output circuit condition.

5. The combination with a current operated element and a condenser-resistance combination for timing the operation of said element, of a three-electrode space discharge device having its space path included in the

energizing circuit of said element and effectively in shunt with said condenser-resistance combination, the control circuit of said discharge device being connected to derive a voltage from a portion of said resistance condenser combination.

6. A rectifier comprising a space discharge device, a condenser whose potential is determined by the output impedance thereof, a resistance in the charging circuit of said condenser, and means for controlling the output impedance of said device in accordance with the voltage across said resistance.

7. In combination, a three-electrode space discharge rectifying device, a current-operated element in the output circuit thereof, a circuit associating the output and control electrodes of said device and conducting to said control electrode a gradually diminishing bias opposing the effect on the conductivity of said rectifier of changes in the amplitude of an applied signal.

8. In combination, a three-electrode space discharge rectifying device, a current-operated element energized by the output current thereof, a condenser adapted to be charged in accordance with the voltage across the space path of said discharge device, and a resistance common to the control circuit of said device and the charging circuit of said condenser for timing the operation of said element.

9. The combination for delaying the functioning of a current-operated element comprising a three-electrode space discharge device adapted to operate as a plate circuit rectifier and having its space path included in the energizing circuit of said element, a circuit comprising resistance and capacity adapted to be charged or discharged in accordance with the change in the output impedance of said rectifier, the biasing potential for the control electrode of said device being obtained in part from a point on said resistance-capacity circuit.

10. The combination with a current-operated element and a condenser-resistance combination for timing the operation of said element, of a three-electrode space discharge device having greater resistance to direct current when no signals are applied to its input circuit than when signals are present, and having its space path effectively in shunt with said condenser-resistance combination and included in series with an external resistance and the energizing circuit of said element, the potential of the control electrode of said discharge device being in part determined by its circuit connection with a point on said resistance condenser combination.

11. The combination with a relay and a condenser-resistance combination for timing the operation of said relay, of a three-electrode space discharge device whose output

impedance decreases as signals are applied to its input electrodes and whose space path is effectively in shunt with said condenser-resistance combination and in series with an external resistance and an energizing winding of said relay, the control circuit of said discharge device being connected to derive a voltage from a part of said condenser-resistance combination.

10 In witness whereof, I hereunto subscribe my name this 10th day of July, 1930.

CLOSMAN P. STOCKER.

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