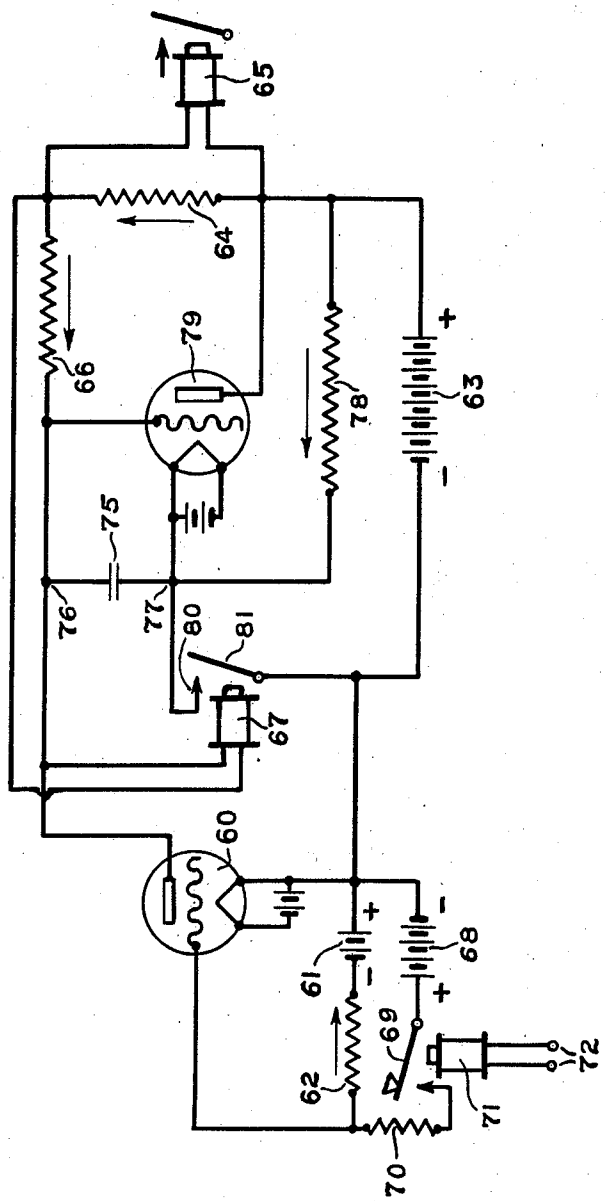
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THYRATRON CONTROL

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THYRATRON CONTROL

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2 Claims. (Cl. 250—27)

This invention relates to a timing system for controlling the operation of an electronic relay.

This application is a division of my copending application Ser. No. 85,283, filed June 15, 1936, Patent No. 2,164,939, dated July 4, 1939 for Timing control.

An object of the present invention is to provide a system for timing the operation of a Thyratron circuit.

Another object is to provide a system of the above type in which the timing may be easily adjusted.

Another object is to provide a relatively simple, dependable and efficient device for the above purpose.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself may be better understood by referring to the following description taken in connection with the accompanying drawing in which the figure illustrates the invention as applied to a circuit.

In the following description and in the claims various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit.

An example of the application of this invention to control of the operation of a Thyratron tube is shown in the figure.

A Thyratron is a gas filled device usually of the three electrode type, with the impedance from plate to filament controlled by grid potential. However, its operation differs from that of a "hard" electron tube in that when the grid potential is sufficiently raised, gaseous breakdown occurs, and plate current will continue to flow due to the production of ions and electrons in the plate filament branch, and cannot be checked by lowering the grid potential below the point at which the gaseous breakdown occurred.

One method of restoring or resetting the Thyratron to a condition of zero plate current is to open the plate circuit, thereby removing potential from across the plate to filament and prevent further ionization.

Another method is by making the plate voltage of the tube negative for a sufficient time. For example, if the plate circuit is supplied by an alternating current source the tube will automatically reset itself when the applied potential reverses in sign. However, with 60 cycle current, the operation of the system cannot be faster than 1/60 second.

The method here disclosed provides a reset system applicable to Thyratrons operated with direct current supply.

Briefly, the method consists of utilizing some of the output energy of the Thyratron to charge a condenser to a high D. C. potential difference. This charging is in such a manner that when fully charged the positive side of the condenser is at the potential of the positive side of the plate supply source, and the negative side of the condenser is connected to the plate. The voltage across the condenser when fully charged equals the potential drop across the D. C. work circuit path between the plate supply and the plate itself. This potential drop may be of the order of 80 per cent of the plate supply voltage. When the work circuit has fully operated and the condenser has sufficiently charged, a relay operates to transfer the positive side of the charged condenser from the positive side of the plate supply to the negative side of the plate supply and therefore to the cathode of the Thyratron to which it is connected. This impresses a high negative potential upon the plate with respect to the cathode, stops the ionization and reduces the plate current to zero. Thereupon the switching relay opens, and when the condenser has discharged completely, the circuit is ready for further operation.

The action may be illustrated with reference to the drawing. Here the Thyratron 60 is of the usual three element type, and gas filled to provide heavy plate current. The grid circuit is biased by battery 61, in circuit with control coupling resistor 62, the function of which will be subsequently described. In the absence of any control potential impressed upon the grid circuit, the grid is at negative potential, and the plate current is zero if the gas in the plate-cathode branch of the tube is in a de-ionized condition.

The plate circuit includes a plate supply battery 63, the negative side of which is connected to the cathode of the Thyratron, which may be grounded if desired. The positive side of the plate supply battery 63 is connected to the plate of the Thyratron through a load circuit comprising resistor 64 shunted by a work circuit such as power relay winding 65, and also an auxiliary resistor 66 shunted by a switching relay winding 67. The elements 64 to 67 make a network of D. C. impedance inserted between the positive side of the plate supply battery and the plate, so proportioned that when the gaseous ionization

current flows, the voltage from plate to cathode will be of the order of 20% of the plate supply voltage, assuming a 120 V. plate supply. The resistance of the windings of the relays are preferably higher than the resistance of the shunts on the relays, to prevent excessive inductive time lags in the building up of voltages across the relays.

For controlling the start of ionization which establishes heavy current flow in the plate circuit, there is provided means, such as battery 68, key 69, resistor 70 between the cathode and grid of the Thyratron. This key 69 may, if desired, be operated as the armature of a relay, from impulses is a relay winding 71 due to potential impressed upon terminals 72. When switch 69 is closed, current flows through resistor 62 in the direction of the arrow, causing a lowering of the grid bias upon tube 60, or even making the grid positive with respect to the cathode. This triggers off the plate circuit to establish heavy current flow. In place of the elements 68 to 72, any other source of control potential may be used, such as a D. C. amplifier, in which case resistor 62 operates as a coupling resistor. It will be understood that the purpose of the Thyratron is essentially as a power device in which a small amount of grid power is able to control the starting and flow of a large amount of plate power. Therefore it will be understood that its relay device 65 is a heavy duty device in comparison with any relay device used in the grid circuit.

It will be further understood that the Thyratron is not an exact repeater. For example, key 69 may be closed for a short duration of time to set up a grid impulse, and the relay winding 65 may pass current for a much longer time so that subsequent circuits may have time to operate.

For resetting the system after key 69 is opened, and after the plate current has flowed for a sufficient time to accomplish the operations desired, there is provided a condenser 75, such as a paper condenser (not electrolytic) one terminal 76 of which is connected to the plate of the Thyratron. This is arranged to be charged from plate supply source 63 to which the other terminal 77 is connected through resistor 78. In parallel with resistor 78 is a unidirectional impedance comprising hard vacuum tube 79 which can pass current only when the plate is positive with respect to the cathode, and therefore only when current is passing through resistor 78 in the direction of the arrow. When current passes through 78 in the reverse direction, no current will flow through tube 79. The plate of tube 79 is directly connected to the positive terminal of Thyratron plate supply source 63, and the cathode is connected to terminal 77 of the condenser 75. The grid of tube 79 preferably is connected to the terminal 76 of the condenser 75, and therefore to the plate of the Thyratron. The purpose of the tube 79 is to give a lowered impedance path from positive side of plate supply potential 63 to terminal 77 when the condenser 75 is being charged.

For utilizing the voltage produced across condenser 75 to make the plate of Thyratron 60 negative with respect to its cathode, the terminal 77 is connected to contact 80 of the switching relay 67, the armature 81 of which is connected to the cathode of tube 60. This armature will be closed when sufficient current passes through switching relay winding 67. When this occurs it will be noted that resistor 78 and tube 79 are bridged directly across the battery 63. For this reason resistor 78 must have a definitely high resistance value, and could not, for example, be made zero.

The operation is as follows:

Assume the key 69 is open, and that the gaseous ionization has been nullified so that little or no plate current passes through resistors 64 and 66 and relay windings 65 and 67 so that the contacts of these relays are open. Under these conditions there is slight or no potential across resistors 64 and 66, and therefore slight or no potential across terminals 76 and 77 of condenser 75. In any event, assuming no leakage of condenser 75, there will be no current through resistor 78 or tube 79, and therefore condenser terminal 77 will be at the positive potential of the plate supply source 63. This makes the plate and cathode of tube 79 at the same potential, and with little or no bias on the grid.

When key 69 is closed, batteries 61 and 68 cause current to flow through resistor 62 in the direction of the arrow, thereby making the grid of tube 60 more positive and causing a gaseous ionization current to flow from battery 63 to plate of Thyratron 60.

There are two paths for this current, one the D. C. path through elements 64 to 67 and the other the capacitive path through condenser 75, fed with charging current through resistance path comprising tube 79 and resistor 78 in parallel. It will be noted that at this stage of the operation, armature 81 is disengaged from contact 80. Further, it will be noted that presence of the condenser 75 delays the setting up of maximum current through resistors 64 and 66, since plate current for some considerable time is required for purposes of establishing the charges on the condenser. During this charging process the tube 79 is conductive since current passes through resistor 78 in the direction of the arrow, the potential of the plate of the Thyratron being negative with respect to the positive battery supply potential due to plate current drop through resistors 64 and 66. When the condenser 75 approaches maximum charge, current flow through the tube 79 and resistor 78 is diminished so that the plate of tube 79 is at little or no potential with respect to the cathode, and moreover, the grid becomes highly negative. Under these conditions the tube impedance of tube 79 is much higher than at the start of the charge. In other words, at the start of the charge, condenser 75 is fed from battery 63 through a low resistance path, and at the end of the charge it is fed through a much higher resistance path. When the condenser 75 is sufficiently charged, nearly the entire current from battery 63 to plate of the Thyratron 60 flows through the elements 64 to 67. Work circuit relay 65 operates on less current through the path 64 to 67, than does relay 67, so that there is sufficient time allowed for operation of the work circuit prior to utilization of the condenser charge to stop the plate current. This condition is readily met by suitable adjustment of the relays and their shunts. After operation of relay 65, the current through windings 65 and 67 continues to increase until relay 67 operates to connect contact 80 to armature 81, and therefore connect terminal 77 to the cathode.

Just prior to closure of the armature, there is a heavy charge on condenser 75, and a large voltage across its terminals. In particular terminal 77 is positive with respect to terminal 76 by per-

haps 80 per cent of the voltage of battery 63. Closure of contacts 80—81 transfers the absolute potential of the terminal 77 from that of the positive side of the battery to the negative side of the battery, that is to the potential of the cathode of the Thyratron 60. This transfer of absolute potential cannot immediately cause a change of voltage across the condenser since the condenser is not short circuited; hence the plate of Thyratron 60 momentarily becomes highly negative, stopping the ionization, and reducing the plate current substantially to zero.

Terminal 77 now being at the potential of the negative side of battery 63, and terminal 76 being even more negative and connected to the positive side of battery 63 through conductive network 64 to 67 current will continue to flow through the network in the direction shown, to make terminal 76 equal to or positive with respect to terminal 77. This delays somewhat the opening of relays 65 and 67. If relay 67 opens when terminals 76 and 77 are substantially equipotential, then there is no further delay in establishing equilibrium, but if relay 67 opens after terminal 76 has become positive with respect to terminal 77, condenser 75 will redischarge itself through network 64 to 67 in the opposite direction to the arrows, and through tube 79 and resistor 78 in the direction of the arrows. The circuit eventually will reach equilibrium as at the start of the operation.

The function of tube 79 is to provide a low resistance charging path for condenser 75 at the start of the charging, and a higher resistance charging path at the end of the charge. The resistance of the path during the charging constantly varies. On discharge prior to opening of relay contacts 80 and 81, the resistance elements 78 and 79 are out of circuit as they are bridged by the low impedance path of battery 63. Subsequent to opening of relay contacts 80 and 81, the path 79 is operative only provided the potential of terminal 76 is higher than that of terminal 77 at the time of opening.

It is to be noted that the tube 79 variably controls the charging rate of the condenser 75.

Obviously, the timing control may be applied to various other uses, such, for example, as in automatic radio frequency synchronizing equipment, radio broadcasting control systems, magnet energization systems, elevator levelling control systems, or, in general, in any system wherein increase and decrease in energy are involved. It may be used to reduce hunting in elevator control systems or the like by making the rates of increase and decrease of energy unsymmetrical.

While an embodiment of the invention has been set forth for purposes of illustration, it is to be understood that the invention is not to be limited thereto, but is only to be limited in accordance with the following claims when interpreted in view of the prior art.

What I claim is:

1. An impulse relay comprising a gaseous discharge tube of the type having an anode and a control grid for initiating discharge and in which the discharge continues regardless of the grid potential while the anode is at a given positive potential, a work circuit in the space current path of said tube, a condenser connected to receive a charge when current flows in said space current path, and means actuated in response to predetermined current flow in said work circuit to connect said condenser to oppose by its charge the normal positive potential of said anode whereby the anode potential is momentarily reduced to a value below that at which the discharge is maintained, a variable impedance device in the charging path of said condenser connected to initially provide a low impedance charging path, and means responsive to flow of space current in said tube to progressively increase the impedance of said device so that the rate of charge decreases as the charge is increased.

2. An impulse relay comprising a gaseous discharge tube of the type having an anode and a control grid for initiating discharge and in which the discharge continues regardless of the grid potential while the anode is at a given positive potential, a work circuit in the space current path of said tube, a condenser connected to receive a charge when current flows in said space current path, and means actuated in response to predetermined current flow in said work circuit to connect said condenser to oppose by its charge the normal positive potential of said anode whereby the anode potential is momentarily reduced to a value below that at which the discharge is maintained, said condenser control means comprising a resistance connected in the space current path of said tube and a relay connected to be actuated by the voltage drop across said resistance whereby the relay is actuated when the space current reaches a predetermined value.

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