Oct. 19, 1937. F. H. GULLIKSEN 2,096,427

REGULATING SYSTEM

Filed Dec. 12, 1934

Fig. 1.

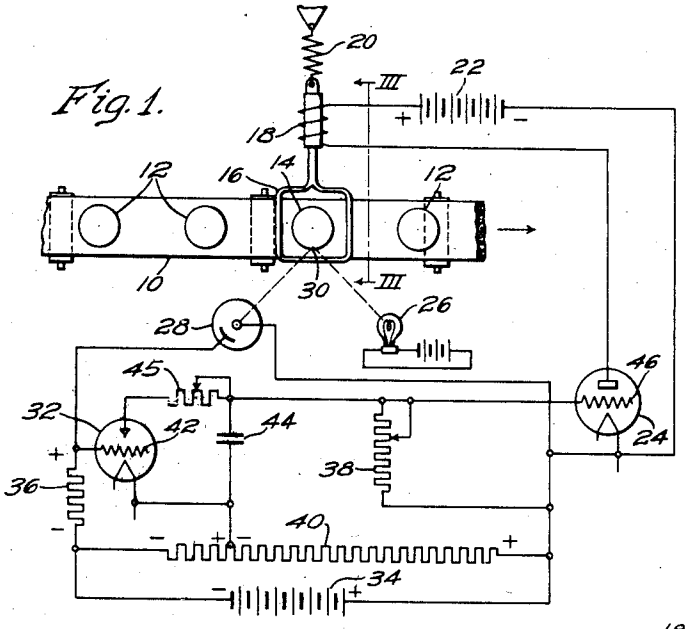


Fig. 3.

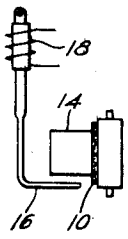


Fig. 2.

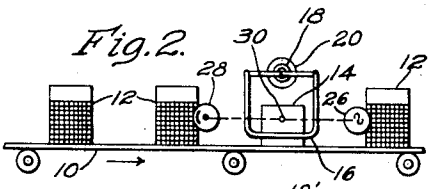


Fig. 4.

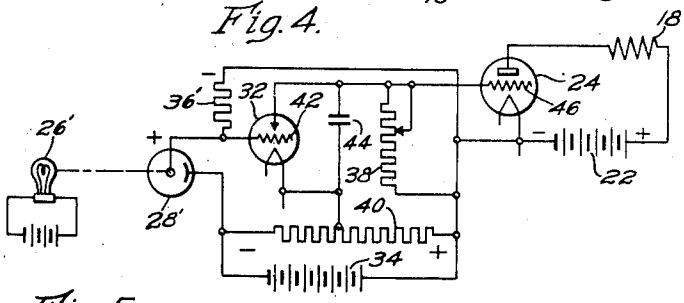
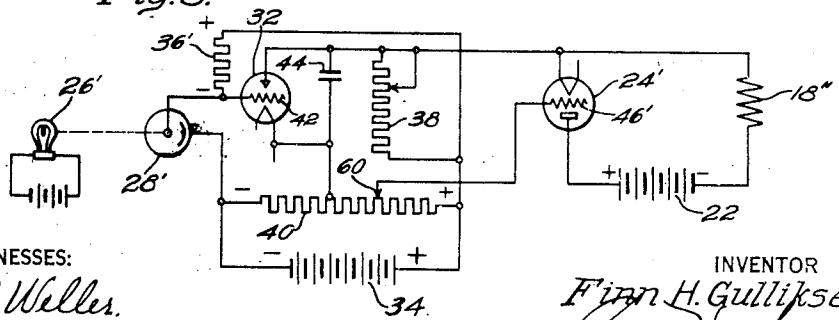


Fig. 5.



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REGULATING SYSTEM

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6 Claims. (Cl. 250—41.5)

My invention relates to electrical regulating and control apparatus, and it has particular relation to control systems in which a light-sensitive device is utilized to abruptly and for a predetermined short period change the current supplied to a solenoid or other type of actuating mechanism.

Systems of this type are useful in a number of industrial and other applications wherein an interruption or an establishment of a light beam is arranged to detect predetermined unusual or undesired conditions and to actuate equipment adapted to effect the correction or compensation thereof. Past systems of this type have required that there be interposed between the photo tube and the current-responsive actuator which it controls, time delay relay means, of the movable part or mechanical contact variety, in combination with one or more electronic-tube devices.

Generally stated, an object of my invention is to simplify this intermediate or interposed equipment and to render its operation more precise and effective.

Another object of my invention is to provide a control circuit in which no mechanical or other type of relay device is required to effect the desired time delay operation features.

An additional object is to so arrange the electronic-tube control circuits that following each impulse from the light sensitive device the tube will automatically return itself to a non-conductive state upon the expiration of a given time interval appropriate for the particular control application.

A further object is to provide a system of the type above characterized in which the length of this time interval may be adjusted throughout a relatively wide range.

In practicing my invention I utilize, between the photo tube and the actuator which it controls, an electronic tube of the gas-filled, grid-controlled type which is energized from a source of direct current supply. In shunt relation with the major elements of the tube I connect a capacitor which, when the tube is in the normally non-conductive state, is charged to the full tube energizing potential. When the photo tube receives a light impulse proper to render the gas-filled tube conductive and thereby effect an operation of the actuating mechanism to be controlled, the capacitor dissipates its charge through the tube. When the capacitor voltage attains a value below that required to maintain current flow through the tube, the tube is rendered non-conductive and effects a release of the actuating mechanism. By proper correlation of the capacitor with other elements of the control circuit of which it forms a part, the period of tube conductivity may be adjusted throughout a wide range of values.

My invention itself, together with additional objects and advantages thereof will best be understood through the following description of specific embodiments when taken in conjunction with the accompanying drawing in which:

Figure 1 is a diagrammatic view of apparatus and circuits illustrating the improved control means of my invention applied to a can sorting machine;

Fig. 2 is a view in side elevation of the conveyor, the can-withdrawing mechanism and the photo-cell and its illuminating lamp;

Fig. 3 is a sectional view taken on line III—III of Fig. 1 showing further details of the can-withdrawing mechanism;

Fig. 4 is a diagrammatic view of a modified control circuit combination in which the photo tube is arranged to control the actuating mechanism in response to an interruption of the light beam; and

Fig. 5 illustrates further circuit modifications showing how the actuating mechanism may be adapted for control in response to a current flow therethrough.

Referring to Figs. 1, 2 and 3 of the drawing, my invention is there depicted in association with a traveling conveyor 10 upon which cans or other articles 12 are fed for delivery to suitable receiving equipment (not shown). The majority of these receptacles are of similar size or character; however, from time to time one or more of different variety, indicated at 14, may find its way to the conveyor, and it is desired that these be removed therefrom before being delivered with those of the uniform variety indicated at 12.

For the purpose of effecting such removal, I have indicated a yoke structure 16 normally held in the position indicated in Fig. 1 by a solenoid device 18 which acts against a tension spring 20. An interruption of the energizing current of this solenoid, shown as being supplied thereto through a circuit which includes a unidirectional source of voltage 22 and a controlling electronic tube 24, allows this spring to withdraw the yoke 16 which removes the odd sized can 14 from the conveyor. This current interruption must, of course, be initiated at a time when this odd sized can is underneath the yoke as is shown in

the drawing, and must be discontinued as soon as removal has been effected in order that the yoke may return to the illustrated position before the can next in line moves in line therewith.

In the system of Figs. 1, 2 and 3, a light beam supplied from a light source **26** is directed upon each of the cans as it moves into the position registering with the yoke and if it strikes a bright or reflecting surface, as in the case of the can **14**, it is reflected upon a photo tube **28** which functions, in a manner to be explained, to effect a withdrawal of the can from the conveyor. In order that the cans of the desired character may not thus reflect the light beam, they may be covered, as indicated in Fig. 2, with dark colored paint which extends to an elevation above the point **30** at which the beam contacts them. The cans of other sizes are not so rendered non-reflecting and therefore serve to flash light upon the photocell whenever they come into line with the light beam.

Between the photo cell and the actuating device control tube **24**, which is illustrated as of the triode-vacuum or continuous-control type, is interposed an electronic tube **32** which is of the gas-filled or non-continuous-control variety. The photo tube and this electronic tube have associated with them control circuits which are energized from a source of unidirectional potential shown in the form of a battery **34**. The photo tube is energized by the full-voltage of this source through a circuit which includes a resistor **36** while the gas-filled tube **32** has impressed between the major elements thereof only a portion of the source voltage through a circuit which includes a resistor **38** and the right hand portion of a voltage dividing resistor **40**. The left hand portion of this resistor is connected to maintain the grid element **42** of the tube at a potential which is negative with respect to the cathode element thereof.

In shunt relation with the tube is connected a capacitor **44** which is normally charged to the full-tube energizing voltage. The resistor **38** is connected between the cathode and grid element **46** of the actuating device control tube **24** and thereby impresses upon the tube grid a potential determined by the current flow through this resistor.

In operation of the equipment just described, as long as no light is directed upon the photo tube **28**, the negative grid bias impressed upon the gas-filled tube **32** maintains this tube non-conductive and thereby prevents current from flowing through resistor **38**. This maintains the grid bias of tube **24** at such a value as to allow the tube to pass through the winding of the actuating device **18** a current sufficient to maintain the yoke member **16** in the illustrated position.

In the event that a can of odd size, as indicated at **14**, is moved into register with the withdrawing yoke, the exposed bright surface thereof reflects light upon the photo tube which illumination raises the tube conductivity. The increase in current flow through resistor **36** makes the grid bias of tube **32** sufficiently less negative to cause the tube to break down and pass current between its major elements. In flowing through resistor **38** this current sets up therein a voltage drop which makes the grid bias of tube **24** more negative and thereby reduces the current flow through the tube sufficiently to render the solenoid **18** ineffective in holding the yoke in the illustrated position. As a result the spring **20** withdraws the yoke and the odd sized can therebeneath from the traveling conveyor **10**.

In breaking down the tube **32** establishes between its major elements a discharge path for the capacitor **44**. The capacitor potential is accordingly dissipated through this path in a very short time, the length of which may be changed by varying the value of a resistor **45**, at the expiration of which the voltage across the major elements of the tube **32** has been reduced to below the value required to maintain the tube conductive. The tube may thus be rendered non-conductive almost immediately. A recharging current is then supplied through resistor **38** to the capacitor. As the capacitor charges this current decreases until tube **24** has its grid bias restored nearly to the normal value at which solenoid **18** is energized with sufficient intensity to overcome the opposing force of spring **20** and restore the yoke **16** to the illustrated position. All of this takes place within an exceedingly brief space of time, which is less than that required for the next can in line on the conveyor to move into registering position with the yoke.

It will be apparent that the length of time required to render the tube **32** non-conductive and to recharge the capacitor **44** may be adjusted throughout a wide range by varying the relative sizes of the capacitor, the resistor **38** through which it derives charging current, and the resistor **45** through which the capacitor discharges.

The improved timing scheme of my invention is not restricted to circuit combinations in which the photo tube must receive illumination to effect the desired control. It may, instead, as illustrated in Fig. 4, be applied to situations in which an interruption of a normally maintained light beam, as that which originates in lamp **26'**, will cause the photo tube **28'** to decrease its conductivity and thereby effect an appropriate change of current supplied to winding **18'** of an actuating device. In the system of Fig. 4, the details of the equipment for interrupting the photo tube light beam and the functioning of the actuating device have not been illustrated inasmuch as applications wherein such operation is desired are numerous and well known in the art.

The circuit combination of Fig. 4 is identical with that of Fig. 1 with the exception that the photo tube is connected between the negative terminal of the source of potential **34** and the grid **42** of the electronic tube **32** and the resistor **36'** is connected between the tube grid and the positive terminal of the potential source. In operation, as long as the light beam continues to fall upon the photo tube, it conducts current sufficient to render the tube grid at a negative potential with respect to the tube cathode. Upon interruption of this light beam, however, the photo tube conductivity greatly decreases and the character of the grid bias of the tube **32** changes to render the tube conductive. From this point on, the operation of the circuits illustrated in Fig. 4 is identical with that which has just been explained in connection with the circuits of Fig. 1.

Nor is it essential that the effect of a control impulse initiated by the photo tube should decrease the current supplied to the actuating device winding **18'**. In Fig. 5 I have illustrated circuits so modified that the controlling impulse serves to instead increase this current. This effect is obtained by reversing the connections to the major elements of the tube **24'** and normally

impressing upon the grid element 46' of this tube a bias sufficiently negative to practically discontinue tube conductivity. In the circuit illustrated, this bias is derived from a tap connection 60 along the voltage dividing resistor 40.

As soon as the tube 32 is rendered conductive, the resulting current flow through resistor 38 makes the grid bias of tube 24' more positive and thereby allows the tube to pass through the actuating device winding 18'' a current appropriate to effect operation thereof.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention is, therefore, not to be restricted except insofar as is necessitated by the prior art and by the scope of the appended claims.

I claim as my invention:

1. A control system comprising a photo-sensitive device, an electronic tube of the non-continuous control type adapted to be rendered conductive by said device, a device operatively controlled by said tube, and means, comprising a capacitor connected in shunt relation with said tube, for restricting each of said conductive periods to a given length.

2. In a system comprising a gas-filled grid-controlled electronic tube, a source of unidirectional energizing voltage therefor, and means in the form of a photo-cell adapted to render said tube conductive, the combination of means for restricting each of said conductive periods to a given length comprising a capacitor connected in shunt relation with the tube and an impeder series connected between the tube and the capacitor.

3. In a system comprising an electronic tube of the non-continuous control type, a circuit for impressing a direct-current voltage upon the tube, a resistor included in said circuit, apparatus operatively responsive to the voltage drop across said resistor, and a photo tube adapted to render said electronic tube conductive, the combination of a capacitor connected in shunt relation with said tube to restrict each of its conductive periods to a given length.

4. In a system comprising an electronic tube having an anode, a cathode and a control grid, a source of unidirectional voltage, a circuit including a resistor for connecting said source to impress a unidirectional voltage across the tube, a connection including a resistor between one terminal of said source and the control grid, a capacitor connected in shunt relation to said tube, apparatus operatively responsive to the voltage drop across the first-named resistor, and a photo-tube for connecting the other terminal of said source to said grid for controlling current flow through said tube and said first-named resistor.

5. In a system comprising an electronic tube having an anode, a cathode and a control grid, a source of unidirectional voltage, a circuit including a resistor for connecting said source to impress a unidirectional voltage across the tube, a connection including a resistor between one terminal of said source and the control grid, a capacitor connected in shunt relation to said tube, an electronic tube having a cathode and control grid connected to be responsive to the voltage drop across said resistor for controlling an electrical apparatus, and means for varying the control potential of the first-named tube for controlling current flow therethrough.

6. In a system comprising an electronic tube having an anode, a cathode and a control grid, a source of unidirectional voltage, a circuit including a resistor for connecting said source to impress a unidirectional voltage across the tube, a connection including a resistor between one terminal of said source and the control grid, a capacitor connected in shunt relation to said tube, and a variable resistor in the circuit between said capacitor and said tube, apparatus operatively responsive to the voltage drop across the first-named resistor, and means for controlling the grid potential for controlling current flow through said tube and said first-named resistor.

FINN H. GULLIKSEN.