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J. B. POWERS

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PHOTOELECTRIC CONTROL CIRCUIT

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Fig. 1.

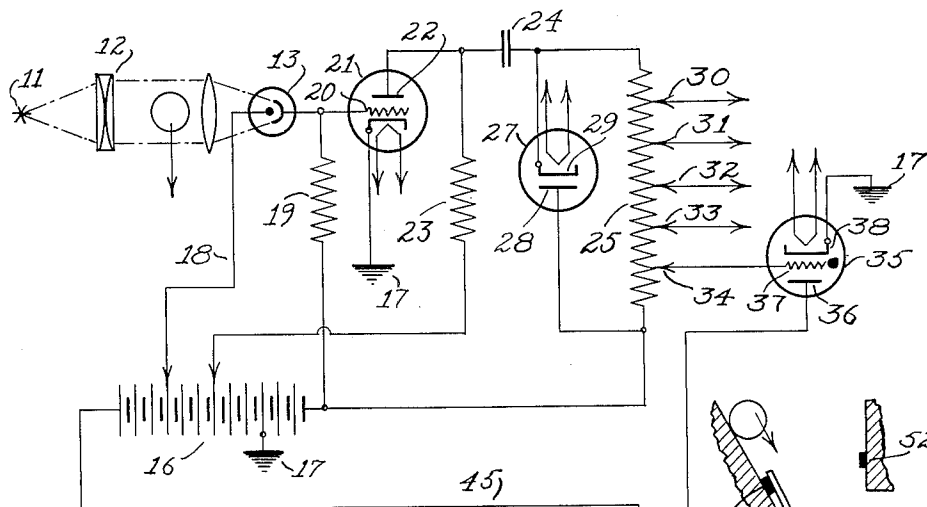
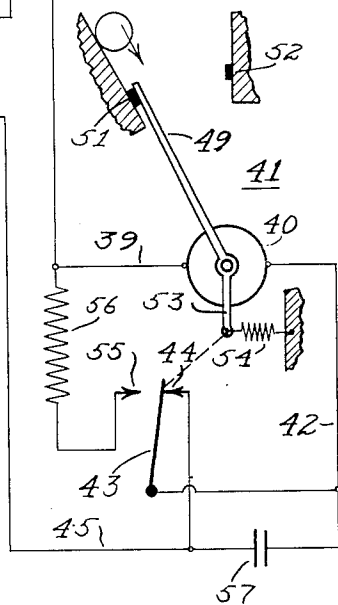
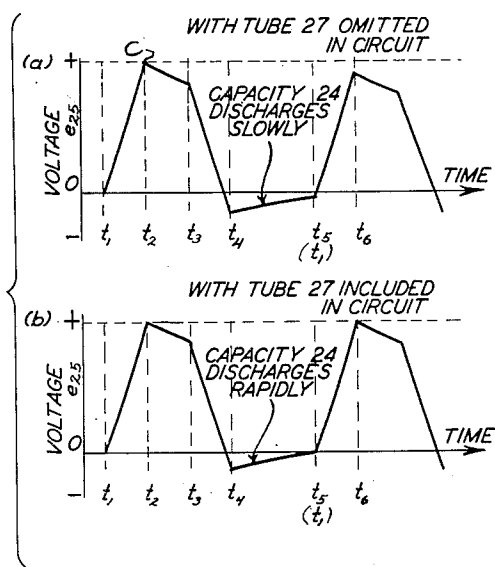


Fig. 2.



INVENTOR,

JOHN B. POWERS.

BY

Lippincott & Smith.

ATTORNEYS.

UNITED STATES PATENT OFFICE

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PHOTOELECTRIC CONTROL CIRCUIT

John B. Powers, Davis, Calif., assignor to The Regents of the University of California, Berkeley, Calif., a corporation of California

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1 This invention relates to electronic relay circuits and particularly to electronic relay circuits of the type adapted for use with sorting devices.

In the citrus region, particularly, it has been found desirable for the purpose of marketing certain products, such as lemons, to sort the articles particularly as to their weight and size, so that each shipment will consist of fruit of substantially uniform size characteristics.

It has become customary in the art to which this invention relates to sell the fruit in accordance with its size characteristics, so that a crate of lemons of one size would include an approximately certain established number of units, whereas a crate of lemons of a different grade-size would include more or less units, the number of which would be generally established.

Substantially spherical fruits, such as oranges, are easily graded by being passed through holes of the proper diameter. Other fruits, such as lemons and avocados, which have only a single axis of symmetry, cannot be graded in this fashion because the major axis may be but little longer than the minor axis, or it may be much greater. No set of grading holes or apertures can be made which will satisfactorily select fruit of the same weight or cross-sectional area where such differences of shape exist.

Where fruit may vary into ratio of length to diameter between, say, $1\frac{1}{2}:1$ and $2:1$ (and these are by no means absolute limits) it is obvious that the least variation in actual size or weight that can be expected is $33\frac{1}{3}\%$. If selection is made by comparing cross-sectional areas, however, this discrepancy can be greatly reduced.

Where a double selection can be made by grading the fruit having the same non-circular cross-section, and then regrading in accordance with its circular cross-section, fruit can be selected that has not only the same size but also substantially the same shape characteristics, with a result that the limits of any grade may be made as close as may be desired. With this invention the double grading can be accomplished both more speedily and more accurately than it can be by the most experienced operators using other methods.

In what follows this invention will be described as applied to the grading of lemons, but it is to be understood that it applies equally well to the grading of any objects into substantially uniform sizes, and that while it finds its greatest utility in connection with products having at least one non-circular cross-section it can

2 also be used with spherical products with equal accuracy.

The invention herein to be set forth and described is directed particularly to the electrical circuits by which the sorting operation is performed. In its essence the circuits herein to be described and set forth comprise arrangements serving to control the opening and closing operations of gate- or door-like mechanisms which move to different positions in accordance with the actual size of the units being sorted. In one preferred form of operation the sorting gate or door is arranged to be moved under the control of a motor, so that with motor energization the gate or door moves from one extreme position to another, in order thereby to guide the product to be sorted into one classification or another. In this connection it has been found that the operation of the gate mechanism conveniently can be accomplished through the energizing of the field winding of a control motor, where the rotation of the motor armature (or rotor) after or upon motor energization will serve to shift the position of the gate element between two limiting ranges. Mechanisms and circuits to effect this type of operation may conveniently be provided through the inclusion of the motor field coil winding as a part of the output circuit of a controlling form of thermionic device, such as a gaseous discharge tube, so that at time periods of current flow through the thermionic device a current flow will likewise be initiated through the motor field coil winding.

In the operation of such an arrangement the articles (such as the citrus fruits or lemons herein illustrated) are passed in such a way as to interrupt or eclipse a beam of light directed from an appropriate light source into a photoelectric tube. Such articles as pass through the light beam serve to eclipse the light directed to the phototube with the eclipse being measured as to amount by the cross-sectional area of the object in that the objects fall freely through the light beam, because they are subjected only to the gravitational acceleration of a falling body.

The control of the movement of the gate or door mechanism under the influence of the operation of a control motor is then established at different points in the system in accordance with the total amount of light reduction upon the photoelectric tube, serving to cause different controlling thermionic devices or gaseous discharge tubes to operate at different signal level indications. Any single control tube functions

in such a way that its load circuit normally includes a motor to control the sorting operation. This may be accomplished by including both the field winding of the control motor and the voltage source which serves to bring about an operation of the thermionic device as part of the control tube circuit. Current flowing through the motor then produces a torque which tends to open or close the gate or door member, as the case may be, against the force exerted by some suitable resilient mechanism tending to maintain the initial position of the element.

It is then desirable to provide ways and means by which the operative period of the thermionic device initiating the operation may be controlled and established. To this end the shift in position of the gate mechanism serves to operate a relay which, in turn, places a storage element in the output circuit of the thermionic device and the motor. The storage element charges in accordance with current flowing through the thermionic devices. If the thermionic device is of the gas discharge type it will be apparent that as the drop in potential across the storage element due to its contained charge approaches in magnitude the voltage of the source serving to maintain operation of the thermionic device, the difference in potential between the plate or anode and the cathode of the thermionic device will approach zero, thereby arresting its operation. Then, if provision is made for permitting the energy accumulated in the field winding of the control motor to leak away subsequent to an interruption of the operation, and if the gate member is biased normally and in the absence of other control forces to its first or initial position of operation, it becomes apparent that the gate member will soon operate to return to its initial state with the cessation of current flow through the thermionic device and the thereby controlled motor.

Various modifications of the system herein to be set forth are, of course, capable of being made, but the invention in one of its preferred forms has been set forth in the accompanying drawing wherein Fig. 1 is a schematic representation of one form of circuit for accomplishing the determinations and objectives of the invention and wherein Fig. 2 comprising parts (a) and (b) shows two curves to explain in further detail than the circuit alone the operation of the system and circuit herein set forth.

In the light of the showing herein to be presented, it will, of course, become apparent that the invention has as one of its primary objects that of providing a positively responding control relay unit which will function at a rapid rate to establish a sorting control. Another object is that of providing an accurate sorting of objects having only a single axis of symmetry which precludes sorting by means of size grading through the use of measuring apertures. A further object of the invention, naturally, becomes that of developing a circuit for controlling the operation of a sorting device where measurable differences in current values flowing will bring about a segregation of the sorted articles or units as to size. Further objects are those of developing a circuit of relatively simple nature which will function free of complexities and which will nonetheless perform the desired operating steps with a minimum of inconvenience. Other objects are those of providing a sorting control circuit of increased efficiency wherein a minimum tube complement

is required and wherein greater fidelity of operation is achieved.

With these points in mind, reference may now be made first to Fig. 1 of the drawings, wherein light from a source 11 is arranged to be projected through any appropriate optical system 12 upon a photoelectric tube 13. The articles to be sorted are arranged to pass by gravitational feed, for instance, so as to eclipse or interrupt the light beam reaching the phototube 13 from the source 11. The path of the articles is conventionally represented as being generally in the direction of the arrow, so that light falling upon the phototube 13 will be eclipsed or interrupted for time periods and in amounts which can be made a measure of the size or cross-sectional area of the falling article.

Preferred forms of the device call for arranging the optical system in such a way that a beam of light passing from source 11 to the phototube 13 be rendered, by an appropriate optical system, into a beam of generally parallel rays during at least a portion of its travel.

The phototube 13 is supplied with operating voltages from a voltage supply source such as the well-known voltage divider, or the illustrated battery 16. A suitable point on the battery connects to ground at 17. Positive voltage tapped at a selected point on the battery is supplied to the phototube anode by way of the conductor 18, while negative polarity voltage which is derived also from the battery and at the opposite side of the ground connection 17 is supplied to the photo-sensitive cathode by way of the connection of the battery to the phototube output resistor 19.

This same connection serves to apply bias upon the control electrode 20 of the phototube amplifier tube 21. The amplifier has its plate or anode 22 connected through the plate or load resistor 23 to a suitable positive voltage terminal on the supply or battery 16, as indicated. The output from the tube 21 is also supplied by way of the coupling condenser 24 to a second resistor or potentiometer 25, connected between the coupling condenser 24 and the negative terminal of the battery or voltage supply 16. A rectifying diode 27 having a plate element 28 and a cathode 29 is connected across the potentiometer resistor 25 in the manner indicated. Various taps connect the output points 30, 31, 32, 33 and 34 to various points on the potentiometer, so that the voltage effective at the connecting points may vary and represent different conditions of operation. Such voltage as is effective at the terminal points may then be transferred to suitable control thermionic devices, of which only the thermionic device 35 connected to the terminal point 34 is shown. The devices connected to the terminal points 30 through 33 inclusive may be regarded as being similar to that being connected at the terminal point 34, although the former will operate at different output levels, as will be apparent from what follows.

The thermionic tube 35 is generally in the nature of a gas-filled triode and thus may be a tube of the type known as the Type 884 or 885, for instance. This tube consists of a gas-filled envelope containing plate, a control electrode and a cathode element, 36, 37 and 38 respectively. The tube is usually of the indirectly heated type, although this is not in any way essential to the invention.

The illustrated connection of the invention shows the plate or anode of the gas-filled therm-

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ionic tube 35 as being connected through the conductor 39 to the conventionally represented field winding 40 of a motor, generally designated at 41. The other connection of the motor field winding is to a conductor 42 which connects through the relay switch arm 43 and the contacting point 44 to a conductor 45, which, in turn, connects with a point of positive voltage on the supply represented conventionally as the battery 16. The circuit is completed through the ground connection 17 and thence through the cathode element 38 of the thermionic gas discharge tube.

Thus, upon initiation of current flow through the thermionic tube 35, by a control pulse of positive polarity on its control electrode it will be seen that current flows through the tube and through the field winding 40 of the motor 41. By reason of the attachment in any suitable manner of a closure gate or door mechanism 49 to the motor it will be apparent that energization of the field winding 40 will serve to rotate the closure gate or door member in a clockwise direction from that shown by Fig. 1, so that its position is changed from resting upon and against the stop member 51 so that it rests against and upon the stop member 52. At such times as this shift in position occurs a follower arm 53 likewise tending to rotate clockwise, by reason of its attachment to the closure gate or door 49, moves over against the pressure of the spring member 54 to contact the relay arm or armature 43 and to move it away from the contact point 44 and over against the contact point 55.

Connected serially between the contact point 55 and the plate 36 of the gas-filled triode 35, is a resistor element 56.

The capacitor 57 connects between the conductor 45 through which plate voltage for the tube 35 is supplied and the conductor 42 leading to the motor field coil. This capacity 57 is sufficiently large to prevent a sudden change in the potential difference between the contact point 44 and the armature 43 of the switch as it operates, due to movement of the arm 53. Accordingly, the plate current in the tube 35 is maintained at a substantially constant value during the short interval of time within which the armature 43 moves between the contact point 44 and the contact point 55. This then prevents the generation of high voltage across the field coil 40 of the motor 41, which would occur if the field current were reduced rapidly. Such a high voltage would damage the tube 35.

It can be seen that after the armature 43 contacts the contact point 55 the voltage across the condenser 57 may rise rapidly as the condenser is charged by the plate current flow in the tube 35. However, as the voltage across the condenser approaches that of the battery or source 16 the drop in potential between the plate 36 and the cathode 38 of the tube 35 decreases to a value which will not support ionization within the tube 35, so that the plate current soon ceases.

The energy which has been stored in the magnetic field of the motor 41 is then dissipated as a current flowing through the field coil 40 of the motor and the resistor 56, the contact point 55 and the armature switch 43, which maintains the closure or gate member 49 over against the stop 52, until the current is reduced to a value such that the magnetic torque of the motor is insufficient to overcome the torque produced by

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the spring 54 connected with the arm 53, which tends to rotate the arm 53 counter-clockwise so as to move the closure or gate element 49 back over against the stop 51.

Now, to describe somewhat further the operation of the system herein set forth, it will be appreciated that in a quiescent state there is no interruption at all of light from the source 11 to the phototube 13, so that the phototube receives maximum illumination. Suppose, however, that an article to be sorted as to size, such as a lemon, falls from an appropriate point by gravity (so that all articles fall at like rate) so as to pass through the light beam between the source 11 and the phototube 13. It is apparent at once that the light reaching the phototube is reduced. The article itself functions as a light obturator as it passes before the phototube. This action then changes the instantaneous current flowing through the phototube and consequently the circuits connected thereto. In any device such as the phototube 13 the quantity of electrons emitted is substantially proportional to the intensity of the illumination of the device. Where the anode and cathode of the phototube are connected through an external circuit containing a source of voltage, as herein provided, which causes the phototube anode to assume a slightly positive potential with respect to the cathode, some of the emitted electrons from the phototube cathode are drawn to the anode and returned to the cathode through the external circuit. Increasing the potential differences between the anode and cathode causes an ever-increasing fraction of the emitted electrons to be drawn to the anode. Where substantially all of the electrons emitted reach the anode, the tube operates in a saturated state and the current through the external circuit becomes proportional to the radiant light flux which impinges upon the photocathode of the phototube and a voltage drop occurs through the resistor 19.

The amplifier tube 21 is generally of the conventional vacuum high-mu-triode type. It is connected in the circuit with the phototube 13 in such a way that its control electrode 20 is at all times maintained slightly negative with respect to its cathode, so that no current ever flows in the tube grid circuit. This is accomplished by selecting the bias voltage effective at the control electrode 20 of the tube 21, so that it is slightly in excess of the voltage drop occurring across the resistor 19, but it can be seen that where light falling upon the phototube 13 is reduced, the potential effective at the plate or anode 22 of the tube 21 becomes slightly higher due to decreased current flow in the tube 21.

In this connection it is desirable that the resistance 23 be of such value that it is at least equal to the plate resistance of the tube 21, in order that reasonably high voltage amplification may be attained. Nonetheless, the resistance value should be kept as low as practicable to promote the prompt return of the unit to a condition of operation maintained when there is no light interruption at all on the phototube 13. The value of the plate supply source should be as high as is practical without causing the plate power dissipation of the tube 21 to exceed reasonably safe limits, although the higher the plate supply voltage is chosen, the lesser will be the danger of plate current cutoff in the tube 21 with light interruptions upon the phototube 13. Whenever there is an interruption of light on the phototube 13 the control electrode 20 of the tube

21 becomes more negative and reduces the plate current flow through the tube, so that the potential at the tube anode 22 rises.

For conditions of operation where no interruptions of light reaching the phototube 13 are brought about, the condenser 24 blocks the flow of current from the plate of the tube 21 through the potentiometer resistance 25, because of the steady state of output of tube 21. Likewise, there is no appreciable current in the grid circuit of the tube 35, because the grid is maintained negative with respect to the cathode by the voltage of that part of the battery 16 connected to the right of the ground connection at 17, as indicated. Thus, no current flows in the potentiometer resistor 25 and no difference in potential is found to exist between the anode 28 and the cathode 29 of the diode 27, with a result that no current flows through the diode.

However, as a transition between a condition of steady illumination on the phototube 13 and a condition where light interruption occurs is brought about, it was already mentioned that the anode 22 of tube 21 rises in potential with respect to its cathode and this change in voltage is impressed across the resistor 23 and also across a circuit including the condenser 24 and the potentiometer resistance 25 in series, so that one component of the change in current appears across the resistor 23 and a second current component appears in the circuit consisting of the condenser 24 and the potentiometer resistance 25 in series. That current which flows through the potentiometer resistance 25 produces a drop in potential across the resistance, which is sufficient to cause the cathode 29 of the diode 27 to become positive with respect to its plate or anode 28, and under this condition of operation no plate current can flow through the diode, so that the diode may be disregarded in this portion of the circuit analysis.

The current flowing through the potentiometer resistance 25, however, causes the accumulation of a charge upon the condenser 24 with the result that a change in potential between the condenser plates is brought about, which tends to oppose the flow of current through the potentiometer resistance 25. By increasing the values of the condenser 24 and the potentiometer resistance 25, this voltage increment across the condenser may be reduced without limit. The value of the potentiometer resistance 25 is made several times that of the resistor 23 and the value of the condenser 24 is preferably such that the voltage increment developed across it is only a small fraction of the voltage increment appearing between the plate and cathode of the tube 21 during an interruption of the light beam on the phototube 13.

Accordingly, the condenser 24 may be considered generally of negligible effect, so that the current flow from the tube 21 divides between the resistor 23 and the potentiometer resistor 25 in parallel. Thus, since the values of the two resistances of the parallel network comprising resistor 23 and the potentiometer resistance 25 is nearly constant, as is the value of the resistance 19 and the plate resistance of the tube 21, as well as its amplification factor, it becomes clear that the voltage drop appearing across the potentiometer resistance 25 is approximately proportional to the current flow through the phototube and thus proportional to the change in illumination upon the phototube. Since the illumination upon the phototube is a measure of the size of the article to be sorted, in the assumed instance the

lemon, the voltage drop across the potentiometer resistance 25 is likewise a measure of the size of the article to be sorted.

Referring now to the control circuit of the gas-filled thermionic tube 35, it will be observed that the tube anode is maintained at a positive potential with respect to its cathode by reason of the connection from the source 16 through the contact point 44, the armature 43, the conductor 42, the field winding 40 of the motor 41, and the conductor 39 connected through to the tube anode 36, where the tube has its cathode 38 connected to ground 17. Under these conditions, however, no current flows through the tube 35 so long as the tube grid or control electrode 37 is kept sufficiently negative with respect to the tube cathode. This negative potential is applied, as above explained, by reason of the connection of the point 34 to a point on the battery or supply source 16, which is negative with respect to ground 17. However, as the tube control electrode 37 becomes less negative with respect to its cathode, a point is reached where ionization of the gas in the tube occurs and the tube plate resistance suddenly drops to an extremely low value, so that current flows in the plate circuit of the tube and through any load included therein, in this case the motor field winding.

As is the case with any gaseous discharge tube, the grid loses all control over the tube plate current as soon as ionization commences and current continues to flow in the plate circuit until the plate voltage is removed. In the instance described above, where the light beam to the phototube 13 is interrupted, a voltage drop occurs across the potentiometer resistance 25 and the polarity of that drop is such that the grid or control electrode 37 which connects to the point 34 becomes less negative with respect to the tube cathode. Thus, by setting the points of connection 34, 33, 32 and so on, voltages may be established which are barely sufficient at each point to initiate ionization of the gaseous discharge tube thereto connected. Where the points are once established and proper adjustment has been made, it will be appreciated that the passage of a unit to be sorted between the light source and the phototube 13, which is of less than a minimum size will be prevented from causing ionization of any of the gaseous discharge tubes. However, a somewhat larger object will initiate ionization only in that gaseous discharge tube which is connected at the terminal point 30, for instance, while still larger units will initiate ionization in other gaseous discharge tubes with the terminal point 34 being set so that it responds to the largest size of unit category to be selected. This is purely illustrative of the operation and where tubes operating in a manner like tube 35 are connected to other contacts the method of contact is like that above described.

Under conditions when current flow is initiated in the gaseous discharge tube 35, current flows in its plate circuit, as above explained, and as also was explained above, this current flow through the field winding 40 of the motor 41 moves the closure or gate member 49 in a clockwise direction over against stop 52 instead of stop 51.

It was also explained above in connection with the movement of the closure or gate member 49 how that element returned to its position as indicated. It accordingly now becomes appropriate to refer further to the function of the diode 27

in the circuit, since the above explanation pointed out that the diode cathode 29 became positive with respect to the anode 28, due to the voltage drop appearing across the potentiometer resistance 25, being of a polarity to bring about this result. It was likewise pointed out above that the condenser 24 accumulates a small charge during periods when the light directed to the phototube 13 is eclipsed by the falling article. Accordingly, as soon as the falling article has passed out of the light path to the phototube to permit full light to fall thereon, the charge on the condenser 24 must be reduced to a negligible value before it is possible again to operate the apparatus by permitting another falling article to eclipse the light beam directed to the phototube. If the residual charge were not dissipated the voltage produced in the control grid circuit of the gaseous discharge tube 35, for instance, as a result of any subsequent objects' reducing the light to the phototube 13 would be a measure of and would be dependent upon the size of the first object as well as the size of the second object, and so on, with the result that inaccurate sorting would result. Thus, immediately following the transition from a condition of light eclipse to a period when maximum light is permitted to fall upon the phototube 13, the condenser 24 will commence to lose the charge built up during the period of light interruption. Under these circumstances, if the diode 27 were to be omitted from the circuit, this charge would have to be dissipated by current flowing through the potentiometer resistance 25, the voltage supply source 16, and the shunt combination of the resistance 23 and the plate resistance of tube 21.

Because of the high total resistance in a circuit of this variety, the current would have to be low, as would the rate of dissipation of the charge, but by including the diode in the circuit the current resulting from the discharge of the condenser 24 is in such a direction as to cause the plate or anode 28 of the diode to become positive with respect to its cathode and the low plate resistance of the diode under these conditions serves for the moment effectively as a short circuit about the potentiometer resistor 25 and permits the condenser 24 to discharge through the relatively low resistance shunt combination thus provided. If the resistance of the potentiometer is made large in comparison with the equivalent resistance of resistor 23 and the plate resistance of the tube 21, the charge accumulated by the condenser 24 may be kept low and the diode 27 will then promote its rapid dissipation.

These effects have been shown particularly by the curves of Fig. 2, where the curve (a) represents the conditions obtaining in the circuit with the diode 27 omitted. In this case condenser 24 is not completely discharged at time t_3 (corresponding to t_1 in the first cycle of operation) and a back voltage remains which limits the charging current to a lesser value at time t_3 than it had at time t_2 . Since the voltage across the potentiometer 25 is proportional to the charging current it does not rise to its previous value even though the degree of eclipse is the same, as the figure shows, and a wrong selection results, especially since the effect is somewhat cumulative. Curve (b) shows how this effect is prevented by the use of diode 27.

Referring first to Fig. 2(a) the time period t_1 is that where the article falling through the light beam from the source 11 commences to interrupt the light to the phototube 13. By the time t_2 the

light is fully eclipsed and the condition is assumed to persist until a time t_3 at which the article has fallen to such a distance that the light from the source 11 is once more uncovered or revealed to the phototube 13 as the object falls. By the time t_4 the object has fallen to such an extent that the light from the source 11 and the phototube 13 is fully revealed and the article is fully outside of the light beam. This condition is maintained until a time t_5 whereupon a repetition of the conditions that started at time t_1 takes place. Thus, for reference purposes, times t_1 and t_5 may be considered alike.

Considering now the curves (a) and (b) of Fig. 2, it will be seen that on each the voltage at which current will start to flow (or ionization occur) in tube 35 is represented by the dotted line. This potential is reached between time t_1 and time t_2 , that is, between the time the article starts to eclipse the light passing between the source 11 and the phototube 13 and the time when the article is completely within the light beam. At this time, however, the condenser 24 continues to accumulate a charge due to current flowing through the potentiometer resistance 25. This continues while the article is completely within the light beam, but with the article moving beyond the region whereat the light beam is effective it is again apparent that the tube 21 will draw more current and the result is that the potential at the condenser 24 is reduced until at the time t_4 when the article has passed out completely from within the light beam the potential at the junction of condenser 24 and the cathode 29 connection of diode tube 27 is negative (as in Fig. 2b). If the diode 27 is not included in the circuit (as per Fig. 2a), then the charge on condenser 24 can only be dissipated by the current flow through the potentiometer resistance 25, the battery 16, and the shunt combination of the resistance 23 and the plate resistance of tube 21. Such a circuit has high total resistance and therefore the rate of dissipation of the condenser charge is low.

As shown by Fig. 2a where no diode is included, there still may be some residual charge in condenser 24 at the time t_5 (the next t_1) so that at time t_6 (the next t_2) the potential C' which should be the same as C, for a case of equal light interruption (same size object interrupting light) it is actually less than should be, unless each of two successive objects is going to have a different effect on the system. If this happened inaccurate sorting would result. But, where diode 27 is included in the circuit the current resulting from the discharge of condenser 24 is in such a direction that the plate or anode 28 of diode 27 is effectively positive relative to the tube cathode 29. Thus, the resistance of tube 27 becomes low and effectively short circuits the potentiometer resistance 25 and thus the condenser 24 is able to discharge through the relatively low resistance shunt combination of resistor 23 and the plate resistance of the tube 21. If the resistance of the potentiometer resistance 25 is much larger relative to the equivalent parallel resistance of resistor 23 and the plate resistance of the tube 21 the charge accumulated by condenser 24 may be kept relatively low and the diode 27 permits its rapid dissipation.

Having now described the invention, what is claimed is:

1. An electronic control device comprising a gate member, a motor for moving the gate in one direction between an open and a closed position

at time periods of current flow through the motor, a thermionic tube having its output circuit connected to include the motor to establish an operation of the gate in its selected direction of opening and closing to coincide with periods of operativeness of the thermionic tube, an electrical energy storage device, an intermittently operating control circuit for initiating a charging operation of the electric energy storing device under the control of the current flow through the output circuit of said thermionic tube subsequent to the gate operation for regulating the current flow and limiting the operative period of the said tube, means operative subsequent to a cessation of operation of the thermionic tube to return the gate member substantially to its initial position.

2. An electronic control device comprising a gate member, a motor for moving the gate in one direction between an open and a closed position at time periods of current flow through the motor coil, a thermionic tube having its output circuit connected to include the motor coil to establish an operation of the gate in its selected direction of opening and closing to coincide with periods of operativeness of the thermionic tube, an intermittently operating control circuit connected to initiate an operation of the thermionic tube, an electric energy storing means connected to be charged by the current flow in the output circuit of said thermionic tube subsequent to the gate operation to control and limit the operational period of the thermionic tube, means included as a part of the charging circuit of the electric energy storing means to dissipate the motor coil energy, and means to return the gate member substantially to its initial position.

3. An electronic control device comprising a gate member arranged to open and close to allocate objects directed thereto to one or another paths, a motor for moving the gate in one direction between its open and closed positions concurrently with current flow in the motor coil, a gaseous discharge tube having its output circuit connected serially with the motor coil to establish an operation of the gate in its selected direction of opening and closing to coincide with the initiation of operation of the gaseous discharge tube, an intermittently operating measuring control circuit for the gaseous discharge tube to initiate its operation, a condenser connected to be charged by the current flow through said gaseous discharge tube subsequent to the gate operation to control and limit the operational period of the gaseous discharge tube, means operative with a cessation of operation of the gaseous discharge tube to dissipate the motor coil energy, and means to return the gate member promptly substantially to its initial position.

4. An electronic control device comprising a gate member arranged to open and close to allocate objects directed thereto to one or another paths, a motor for moving the gate in one direction between its open and closed positions concurrently with current flow in the motor coil, a gaseous discharge tube having its output circuit connected serially with the motor coil to establish an operation of the gate in its selected direction of opening and closing to coincide with the initiation of operation of the gaseous discharge tube, an intermittently operating measuring control circuit for the gaseous discharge tube to initiate its operation, a condenser connected to be charged by the current flow through said gaseous discharge tube subsequent to the

gate operation to control and limit the operational period of the gaseous discharge tube, and means to return the gate member promptly substantially to its initial position.

5. An electronic control device comprising a gate member arranged to move between two limiting positions, a motor for moving the gate in one direction between the two limiting positions coincidentally with current flow in the motor coil, a thermionic tube having its output circuit connected to include the motor coil to establish a movement of the gate in its one direction of motion to coincide in time period with the initiation of operation of the thermionic tube, an intermittently operating photoelectric tube control circuit for the thermionic tube to initiate its operation concurrently with changes in light at the photoelectric tube, a condenser element connected to one terminal of the motor winding, means for normally establishing a short circuit about said condenser, a relay circuit connected to operate to remove the short circuit substantially coincidentally with initial gate operation and thereby to connect the condenser serially in the circuit including the thermionic tube and the motor coil to charge the condenser and to render the thermionic tube inoperative at substantially the time when the condenser becomes charged.

6. Electronic relay apparatus comprising a gate member positioned normally to remain in one of a closed and open state, a motor in cooperative association with the gate member to change the gate position substantially coincidentally with motor operation to the other of its open and closed states, an interruptedly operative thermionic device to initiate an operation of the motor concurrently with an initial flow of current through the said device, an energy storing device connected to receive a storage charge of energy through the thermionic device at a time subsequent to the initiation of motor operation and to control and limit the operative periods of the thermionic device, a circuit to dissipate the energy stored in the motor winding following an interruption of operation of the thermionic device, and means to return the gate member to its normal and initial position subsequent to a cessation of operation of the thermionic device.

7. Electronic relay apparatus comprising a gate member positioned normally to remain in one of a closed and open state, a motor in cooperative association with the gate member to change the gate position substantially coincidentally with motor operation to the other of its open and closed states, an interruptedly operative thermionic device to initiate an operation of the motor concurrently with an initial flow of current through the said device, an energy storing device connected to receive a storage charge of energy through the thermionic device at a time subsequent to the initiation of motor operation and to control and limit the operative periods of the thermionic device, and means to return the gate member to its normal and initial position subsequent to a cessation of operation of the thermionic device.

8. Electronic relay apparatus comprising a plurality of gate members each positioned normally to remain in one of a closed and open state, a motor in cooperative association with each gate member to change the gate position substantially coincidentally with motor operation to the other of its open and closed states, a normally inoperative thermionic device connected to initiate

with its own operation an operation of the motor concurrently with an initial flow of current through the said device, a plurality of energy storing devices connected to receive individually a storage charge of energy determined by the current flow through an individually associated thermionic device at a time period subsequent to the initiation of motor operation and during an operative period of the therewith associated thermionic device and to terminate the operative period with a charging of the therewith-associated energy-storing device, a light source and a photoelectric means, means to direct light from the source upon the photoelectric means to provide output current flow measured by the light reaching said means so that the current output is substantially a measure of the light quantity reaching the photoelectric means within a unit time period, means responsive to output charge from the photoelectric means to initiate an operation of selective and individual ones of the thermionic means in accordance with the output current magnitude from the photoelectric means, and means to return the gate to its initial position subsequent to a cessation of operation of the therewith associated thermionic means.

9. Electronic relay apparatus comprising a plurality of gate members each positioned normally to remain in one of a closed and open state, a motor in cooperative association with each of the gate members to change the gate position substantially coincidentally with an operation of the therewith associated motor to the other of its open and closed states, a separate gaseous discharge device to initiate an operation of each individual motor concurrently with an initial flow of current through the therewith associated gaseous discharge device, a photoelectric means connected to respond to eclipsing of a control light beam for variable time periods measuring objects intermittently and progressively passing within the light beam to modify a flow of current generated thereby, a control circuit to initiate operation of individual ones of the gaseous discharge devices dependent upon the time periods of light eclipse upon the photoelectric means, an energy-storing device connected with each gaseous discharge device to receive a storage charge of energy through the gaseous discharge device at time periods subsequent to the initiation of motor operation of the therewith associated motor and to limit the operative period of the said gaseous discharge device, a portion of the charging circuit being adapted to release the energy stored in the motor field following an interruption of operation of the gaseous discharge means, and means to control the time period of return of the gate member to its normal and initial position.

10. Electronic relay apparatus comprising a plurality of gate members each positioned normally to remain in one of a closed and open state, a motor in cooperative association with each of the gate members to change the gate position substantially coincidentally with an operation of the therewith associated motor to the other of its open and closed states, a separate thermionic device to initiate an operation of each individual motor concurrently with an initial flow of current through the therewith associated thermionic device, a photoelectric means connected to respond to eclipsing of a control light beam for variable time periods measuring objects intermittently and progressively passing within the light beam to modify a flow of current generated thereby, a control circuit to initiate

operation of individual ones of the thermionic devices dependent upon the time periods of light eclipse upon the photoelectric means, and a rectifier unit connected to shunt at least a part of the control circuit to restore it to an equilibrium condition following the operation of each individual thermionic device and prior to any subsequent operation thereof, an energy-storing device, means to connect the energy-storing device to the output circuit of each thermionic device under the control of current flow through the thermionic device at time periods subsequent to the initiation of motor operation of the therewith associated motor and during an operative period of the said thermionic device, said charging circuit including means to release the energy in the motor field following an interruption of operation of the thermionic means, and means to control the time period of return of the gate member to its normal and initial position.

11. Electronic article sorting apparatus for segregating articles having different length major and minor axes as to size, comprising a plurality of gate members each positioned normally to remain in one of a closed and open state; a plurality of gate operating motors each having its field winding connected in cooperative association with one of the gates to control upon motor energization a change in the gate position in one direction between its open and closed state; a thermionic device to initiate a current flow through individual motors in accordance with the article size instantaneously being measured; photoelectric apparatus and an activating light source therefor, the light reaching said photoelectric device from the light source being arranged to be eclipsed by articles to be sorted passing through the light beam with the light eclipses varying substantially in proportion to the size of the article instantaneously to be measured, thereby to control the output circuit to initiate an operation of individual motors dependent upon the degree of light eclipse between a minimum and that value approaching totality; energy-storing elements each having one terminal connected to a therewith-associated motor, relay means normally to short-circuit each energy-storing element, means operative coincidentally to the motor operation to remove the short-circuit of the energy-storing element and to connect the energy-storing element in the output circuit of the therewith-associated tube to charge said energy-storing element to a value to render the tube inoperative; and a gate operating control device for returning each gate to that of its closed or open positions in which it was located prior to energization of the motor and subsequent to an operation of the motor by the thermionic means.

12. Electronic sorting apparatus for segregating asymmetrical articles as to size comprising a plurality of gate members each positioned normally to remain in one of a closed and open state; a gate operating motor in cooperative association with each gate to control, upon motor energization, a change in the gate position in one direction between its open and closed state; a thermionic device to initiate an operation of individual motors determined in accordance with the time when current flows through said devices, photoelectric apparatus and an activating light source therefor, the light reaching said photoelectric apparatus from the light source being adapted to be eclipsed by articles to be sorted passing through the light beam with the light

eclipses varying substantially in proportion to the size of the article instantaneously eclipsing the light directed to the photoelectric apparatus, thereby to control the output current upon the photoelectric apparatus, a control circuit to initiate an operation of individual motors dependent upon the degree of light eclipse between a minimum and a value approaching totality, an energy storing device connected to be included in the circuit of each thermionic device subsequent to an initiation of motor operation, thereby to charge during periods of current flow through the thermionic device, a circuit to release the energy stored subsequent to an interruption of operation of the thermionic means, and a gate operating control device for returning each gate to that of its closed or open positions in which it was located prior to energization of the motor and subsequent to an operation of the motor by the thermionic means.

13. The electronic control device claimed in claim 3 comprising in addition a unilaterally conducting element connected in parallel with at least a part of the control circuit and connected to be energized by the current flow in the control circuit to restore the control circuit to an equilibrium state in the time interval between its states of intermittent operation.

14. The control circuit claimed in claim 4 comprising in addition a rectifier connected in shunt with at least a part of the gaseous discharge tube control circuit for restoring the control circuit to an equilibrium state during the inoperative periods thereof.

15. An electronic control device for sorting apparatus comprising a thermionic tube normally having a steady current flow therethrough, and means to modify the current through said tube under the control of the objects to be sorted, an output circuit for said tube including a first path including a resistive element and a second path in parallel with the first path, the second path including in series connection a capacitive and a resistive element across which a voltage drop indicative of the object controlling current flow through the thermionic tube is developed with modification of the current flow through said tube, a load circuit including at least one gaseous discharge tube having its input circuit connected across at least a part of the resistive element of the second path, an output circuit for said gaseous discharge tube including a motor coil winding and a source of operating voltage for the gaseous discharge tube, a gate mechanism connected to be moved from one to another of two limiting positions with initiation of motor operation, an electrical energy storage device, relay means operative in one position normally to

short-circuit the electrical storage device at times of motor inoperativeness and operative in a second position initiated coincidentally to motor operation to disconnect the motor coil from the gaseous discharge tube output circuit and to include in its stead a shunt path thereto comprising a series combination including the energy storage device and a coil energy-dissipating element, said last-named connection providing a charging circuit for said energy storage device through said gaseous discharge tube so that upon charge accumulation in said electrical storage device approaching the value of the source conduction through the gaseous discharge tube ceases, and means for restoring the gate mechanism and motor to an initial position following disconnection of the motor coil from the tube output circuit and the coil energy dissipation through the energy dissipating element.

16. The electronic control device claimed in claim 15 comprising, in addition, a diode connected in shunt to the resistive portion of the second output path of the thermionic tube, said diode being adapted to become conductive following a movement of the gate mechanism to restore an equilibrium condition of gaseous discharge tube operation.

17. An electronic control device as claimed in claim 15 comprising, in addition, a unilateral conductor connected in shunt to the resistive portion of the said second output path of the thermionic tube and connected to become conductive with restoration of a steady state output current flow from the said thermionic tube so that the operation of the gaseous discharge tube is restored to an equilibrium state following each operation of the gate mechanism.

JOHN B. POWERS.

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