

Jan. 1, 1946.

T. A. COHEN

2,392,229

CONTROL APPARATUS FOR COATING MACHINES

Filed Jan. 26, 1943

3 Sheets-Sheet 1

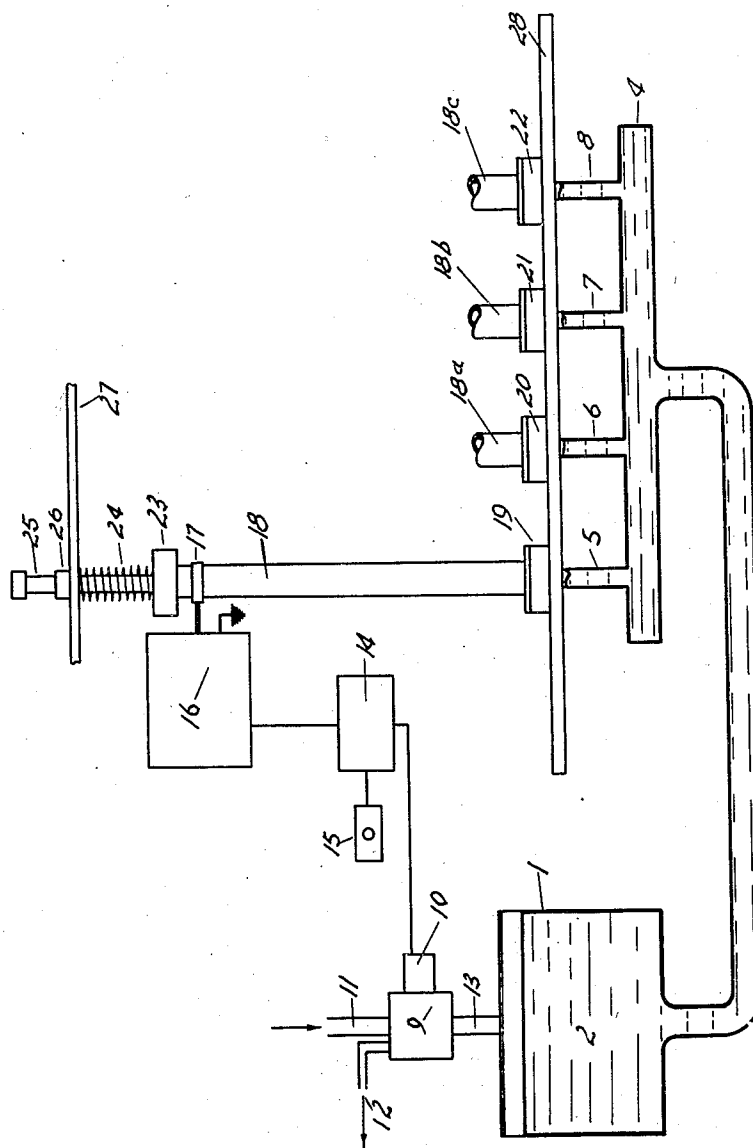


FIG. 1

Theodore A. Cohen, INVENTOR,

BY Theodore W. Miller,
Att'y.

Jan. 1, 1946.

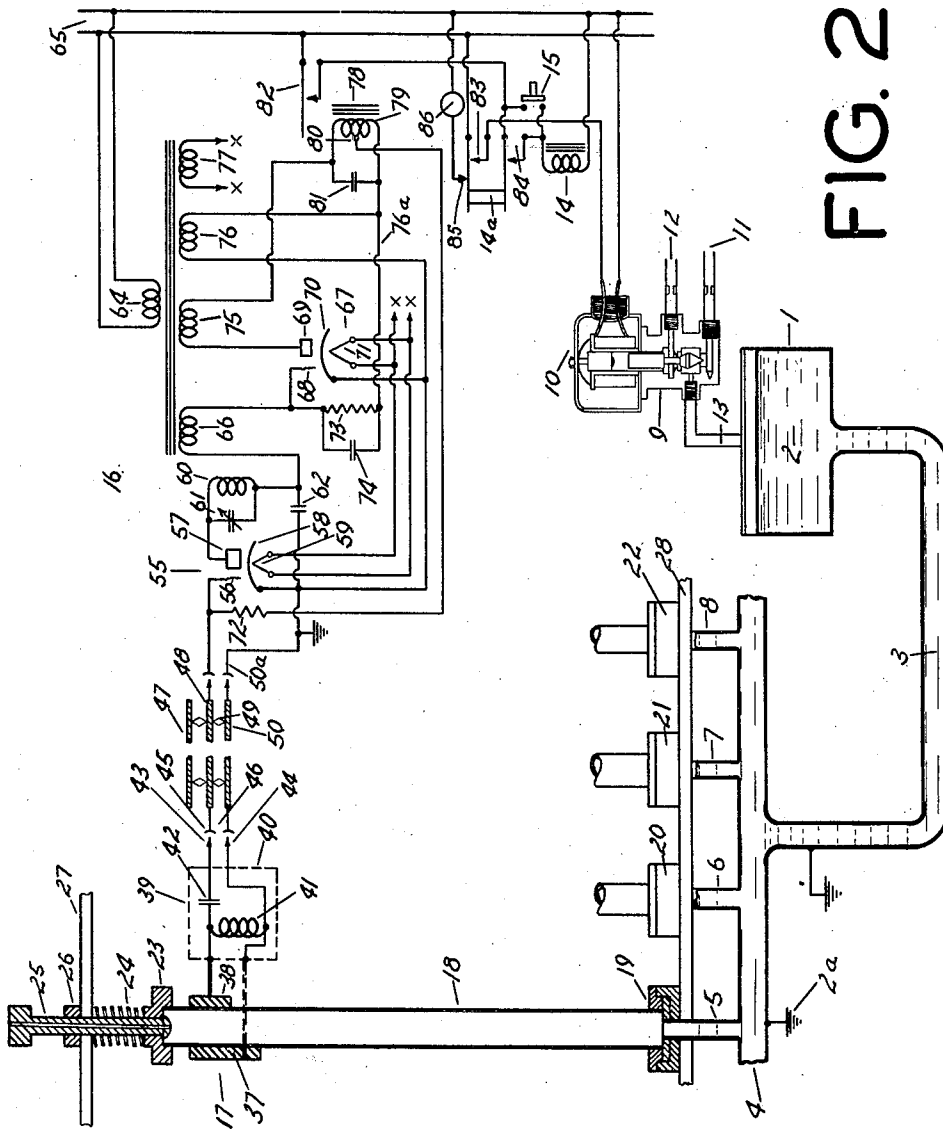
T. A. COHEN

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CONTROL APPARATUS FOR COATING MACHINES

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3 Sheets-Sheet 2



Theodore A. Cohen, INVENTOR,
BY Theodore W. Miller,
Att'y.

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3 Sheets-Sheet 3

FIG. 6

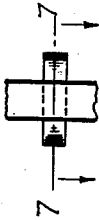


FIG. 7

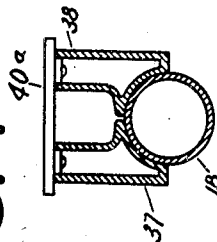


FIG. 5

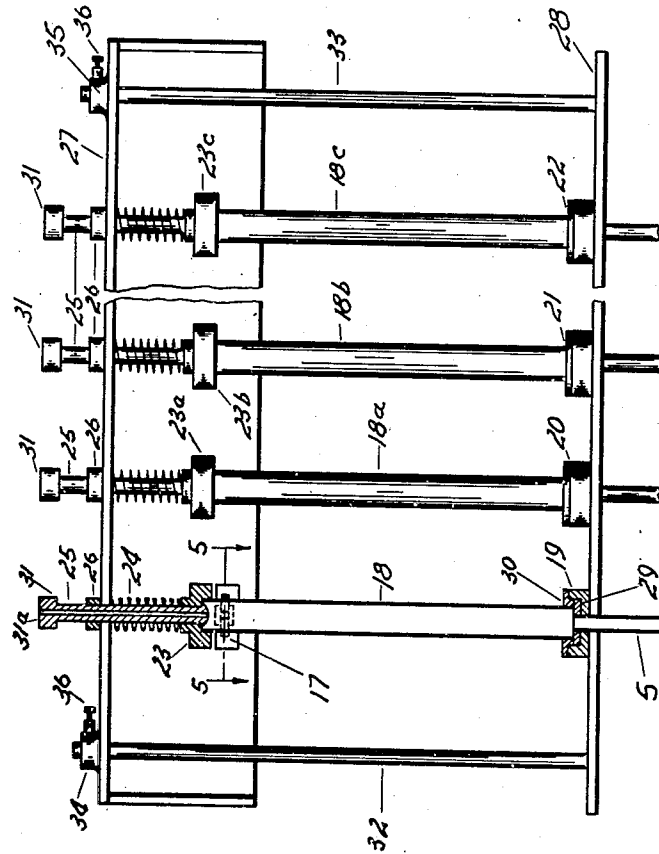


FIG. 3

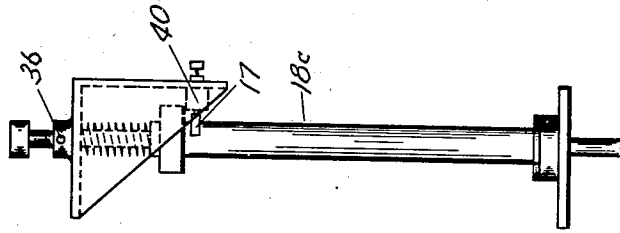


FIG. 4

Theodore A. Cohen, INVENTOR,
BY Theodore W. Miller,
Att'y.

UNITED STATES PATENT OFFICE

2,392,229

CONTROL APPARATUS FOR COATING
MACHINES

Theodore A. Cohen, Chicago, Ill., assignor, by
mesne assignments, to Wheelco Instruments
Company, Chicago, Ill., a corporation of Illi-
nois

Application January 26, 1943, Serial No. 474,042

23 Claims. (Cl. 91—18)

This invention relates to control apparatus and more particularly to a control apparatus for automatically controlling the admission and recession of a liquid vehicle for fluorescent powder, commonly used for coating the interior of fluorescent tubes, to and from the tubes.

One of the objects of my invention is to provide an apparatus for efficiently effecting and controlling the application of a liquid vehicle for fluorescent powders, such as above referred to, to the interior of the tubes to sharply and effectively stop the rising of the liquid in the tubes when it has reached a predetermined point therein and thereafter cause the recession of the liquid from the tubes to complete an application cycle. Other and further objects of my invention will be apparent as the same becomes better understood from an examination of the specification and claims in conjunction with the accompanying drawings wherein:

Figure 1 represents a schematic view of an apparatus embodying my invention;

Figure 2 is a diagrammatic view of the same;

Figure 3 is an enlarged, fragmentary, detail, elevational view, partly in section and with parts removed, showing the portion of the apparatus for mounting the fluorescent tubes to be coated by the powder carried by the liquid vehicle to be introduced into and withdrawn from them;

Figure 4 is a side elevation of same;

Figure 5 is an enlarged section at the line 5—5 of Figure 3;

Figure 6 is a modified form of pick up clip, and

Figure 7 is a section taken at the line 7—7 of Figure 6.

Referring to the drawings more particularly, reference character 1 designates a liquid container carrying a liquid vehicle 2 for fluorescent powder commonly used for coating the interior of fluorescent tubes, such as tubes 18, 18a, 18b and 18c are intended to be when completed.

A tube 3 connects container 1 with a manifold 4 having longitudinally spaced output tubes 5, 6, 7 and 8.

A three way air valve 9, having an operating solenoid 10, is connected by a tube 13 to deliver air to the top of container 1 to cause pressure, as desired, on top of the liquid 2 therein. A source of air 11, or connecting tube from same, and a separate exhaust pipe 12 to atmosphere is connected to valve 9.

A push button 15 is connected to a relay 14 to energize same through oscillator controlled contacts 32 and operate valve 9 to admit air to con-

tainer 1 to cause the rising of liquid 2 in the tubes 18, etc. When the liquid has risen to the point desired in said tubes an impedance change device 17 operates as will be hereinafter described to affect an oscillator apparatus 16 to open contacts 32 to cause deenergization of relay 14 to thereby deenergize valve 9 and exhaust air from container 1 to atmosphere.

The liquid is then permitted to recede in the tubes 18 etc., coating the interior of said tubes, as it recedes, with substance capable of rendering the tubes fluorescent when energized in the customary manner.

The details of the aforementioned parts and functions will now be described more particularly.

The tubes 18, 18a, 18b and 18c desired to be coated with fluorescent powder are mounted in holders 19, 20, 21 and 22, respectively, in which they may be readily inserted to be treated and thereafter removed to be replaced by other tubes when the process of coating their interiors has been completed.

The details of the mounting for the tubes 18, etc., being treated are shown more particularly in Figures 3 and 4, wherein holders 19, etc., are mounted upon a plate 23. Each holder 19, etc., is recessed to provide a rubber gasket 29 apertured to receive the upper end of the corresponding manifold tube such as 5, and seal the lower end of the corresponding tube to be treated, such as 18, in said holder. A flanged and apertured closure 30 surrounds the lower end of the tube 18 and holds the gasket 29 in position.

Yieldably and vertically movable top caps 23, 23a, 23b and 23c are provided for the upper ends of the tubes 18, etc., whereby these tubes may be readily inserted or removed from the holders 19, etc., as desired. These caps 23, 23a, 23b and 23c are each mounted upon the lower end of a stem or plunger 25 which extends through a bearing plate 27 and a bearing 26, each plunger being provided with an integral knob 31 and a spring 24 holding the cap down against the top of the corresponding tube to removably hold same in its corresponding holder. The bearing plate 27 is vertically and adjustably supported on vertical rods 32 and 33 attached to and extending up from plate 23. The rods 32 and 33 extend through bosses or bearings 34 and 35 on opposite ends of bearing plate 27 and are provided with adjustable set screws 36 so that adjustment may be made to accommodate tubes of different lengths.

The impedance change device 17 comprises a pair of metal plates 37 and 38 (Fig. 2) shaped

and mounted to fit laterally spaced positions on the tube 18 at the adjustable vertical position thereon at which it is desired to commence the coating of the interior thereof with the substance for rendering the tube capable of fluorescence. The plates 37 and 38 act as plates of a condenser, the capacity of which is increased as the liquid level rises in the tube 18 between said plates.

The plates 37 and 38 are connected to a self contained grid tank unit 39 for the oscillator 16. This unit 39 is mounted in a suitable housing 40 and comprises an inductance coil 41 and condenser 42 and together with the plates 37 and 38 forms a resonating circuit with said plates connected to opposite ends of said coil and said condenser connected to one end of said coil. A pair of male plugs 43 and 44 are connected respectively to one end of coil 41 and the condenser 42.

The male plugs 43 and 44 are adapted to connect with female connector elements 45 and 46, respectively, at one end of a concentric conductor cable 47 insulated from ground by an external rubber sheath or cover (not shown). The cable 47 comprises an inner conductor 48, separators 49 and an outer conducting sheath 50. The end of the cable opposite to the connector 43-46 is provided with a connector 50a similar thereto for connection to the input of an oscillator circuit 16 hereinafter described.

The concentric co-axial conductor cable 47 is constructed in well known manner with its core conductor fixedly and concentrically positioned within the conducting sheath. By properly choosing the values of the capacitive and inductive components of the resonating circuit in enclosure 40, the cable is properly terminated so that minimum power losses are obtained in the system due to the cable for any substantial length thereof. In this manner the remote control assembly just described may control the oscillator apparatus 16 hereinafter described without fear of transmission losses which otherwise would reduce the sensitivity of the apparatus if not actually prevent its operation.

The oscillator circuit includes a vacuum tube 55 connected to a plate tank comprising an inductance 60, variable condenser 61 for tuning to resonance, as will hereinafter be described, and grid bias resistor or grid leak 72 for said tube.

Alternating current voltages are obtained from a multi-winding transformer having a primary winding 64, connected to a suitable source of alternating current 65, and having a plurality of secondary windings 66, 75, 76 and 77 arranged to supply suitable voltages to the tube circuits. The tube 55 and repeater tube 67, hereinafter described, are self rectifying and therefore the operation will be described only with respect to the positive half cycles of the alternating current voltages.

The output section of the tube 55 may be traced from the left-hand terminal of the secondary winding 66 through the plate tank circuit 60, 61, the anode or plate 57, the cathode 58, the secondary winding 76, conductor 76a, a load impedance or resistor 73 and thence to the right hand terminal of secondary winding 66. By-pass condensers 62 and 74 are connected as shown and prevent the flow of high frequency oscillatory currents through the transformer windings and through the load impedance 73. The total voltage impressed across the anode circuit of tube 55 is the sum of the voltages of the secondary windings 66 and 76.

The output circuit for the repeater or amplifier tube 67 may be traced from the left hand terminal of the secondary winding 75 to the anode or plate 69, the cathode 70, the secondary winding 76, the voltage of which is in phase with the voltage of the winding 75, the operating winding 79 of the relay 78 and to the right hand terminal of the winding 75. A condenser 81 is connected as shown across the relay winding 79 and prevents chatter of relay by supplying energy to relay during negative or non-conducting portion of A. C. cycle. Transformer secondary winding 77 is connected to filaments 59 and 71 to heat cathodes 58 and 70, respectively, by wires X-X not completed. The grid bias for effecting proper operation of the repeater tube 67 is obtained by connecting the grid or control electrode 68 to one end of the load resistor 73, the remaining portion of this circuit extending from the cathode 70 to the secondary transformer winding 76, the conductor 76a to the opposite end of the load resistor 73. It will be apparent that the voltage across the winding 76 is opposite to and thus compensates for a portion of the voltage drop across the load impedance 73 and accordingly when the oscillator tube 55 is in oscillatory condition so that a plate current of low value flows through the load impedance 73, a minimum negative bias equal to the difference between the voltage of the winding 76 and the voltage drop across the load across the load impedance 73 is impressed on the grid 68. Under these conditions, and with proper voltages, the tube constants, and the value of the load resistance all so pre-chosen to provide a low negative grid bias, a high repeater plate current is obtained for proper operation of the relay.

A regenerative coupling is provided between the grid circuit of the tube 55 and the output of the repeater tube 67, as shown. The grid circuit for the oscillator tube 55 extends from the cathode 58, the transformer winding 76, the lower end of relay winding 79, the tap 80 and the grid bias resistor or grid leak 72 to the grid 56.

A fixed grid bias is applied, by the above circuit, to the grid 56 which is equal to the voltage drop across the relay winding 79 to tap 80 and is so chosen that with maximum current flowing in the output circuit of the amplifier or repeater tube 67 the maximum desired negative bias is applied to the grid 56.

The plate tank is tuned to predetermined resonance with condenser 61 so as to energize relay 78 when liquid in tube 18 is below the predetermined height to which it is intended to coat the interior of the tubes.

When the rise of liquid in tube 18 reaches the desired height, the oscillator circuit is detuned, causing its plate current to rise sharply, increasing the voltage drop across the resistor 73, which correspondingly increases the negative bias upon the amplifier tube 67 with a consequent drop in its plate current through the relay 79. The decrease in current through the relay 79 causes a decrease in the negative grid bias applied to the grid of the oscillator tube 55, which tends to further increase the plate current of the oscillator tube 55. This increase in the oscillator plate current further increases the voltage drop across the load resistor 73 and the negative bias upon the amplifier tube 67 with the consequent effect of rapidly dropping the amplifier plate current to the cut-off point, which causes approximately zero level in plate current and deenergizing of relay 79 to release air from container 1 as will be hereinafter more particularly described.

When the liquid recedes in tube 18 and the other tubes as well, it applies the fluorescent powder to the interior of the tubes as previously stated.

In order to initiate a coating cycle a clean tube 18 is placed in position as described. The oscillator circuit being in resonance because of the low capacity between plates 37—38 maintains the relay contact 82 closed. The push button 15 is now depressed energizing the relay 14 through 15 and 82. The armature 14a pulls down closing contact 83 to energize valve 10 to allow air pressure to chamber 1. The contact 84 closes to lock the relay 14 in closed position. The push button 15 may now be released. As the liquid rises in 10, due to air pressure in chamber 1, it will eventually reach the prechosen level whereupon the contact 82 will open to deenergize locked up relay 14. The contact 83 will open to deenergize valve 10 releasing the air pressure in chamber 1 to atmosphere whereupon the liquid in tube 18 will recede to leave tube coated. The contact 85 will close energizing the indicator 86 to indicate that a coating cycle has been completed. A new tube may then be placed in the holder.

When a new and clean tube 18 is placed in apparatus again after removal of coated tube the oscillator circuit is retuned and oscillator plate current drops, decreasing the drop across resistor 73, which decreases the negative bias on the amplifier tube 67; the plate current of the amplifier increases, increasing the drop across the relay 73, which increases the negative bias on the grid of the oscillator 55, aiding in dropping the oscillator plate current, which further tends to decrease the bias upon the amplifier 67, etc., with the result that the final positioning of the plate current of amplifier 67 is at saturation. By the judicious choosing of load resistance 73, of the resistance of the relay winding 79 and the proper apportioning of bias voltages as shown, the values of plate current between cut-off and saturation may be fixed at any desired value. The result is that large, abrupt, and rapid plate current changes are always obtained. The result obtainable is comparable to the triggering off of a "Thyratron" type hot cathode grid control rectifier without the necessity of using gasfilled tubes.

Study of the circuit arrangement will also bring out that the system is self compensating for changes in line voltage which prevents shiftage of the control point if the line voltage should change.

It is not necessary that the apparatus be limited to the use of separate vacuum tubes, each containing separate triode elements, since these separate tubes have been chosen only as a matter of convenience. Dual purpose tubes having triode elements in a common envelope may be operated in the same manner. Direct current voltages may also be used.

It will be noted that the plate supply for tubes 55 and 67 are obtained from windings 66 and 75, respectively, in series with 76. Should the line voltage fall the supply voltage from 75 would reduce and therefore the plate current flow in plate circuit of tube 67 would tend to decrease. However, since winding 66 supplies the plate circuit of tube 55 and since the negative bias on grid 68 is obtained from drop across resistor 73 due to plate current flow in plate circuit of tube 55, the plate current of tube 55 is also reduced with reduction of voltage from 66. Therefore negative bias on grid 68 is reduced keeping the plate

current flow in plate circuit of tube 67 substantially constant. The reverse result is obtained with rise in line voltage. This self compensating feature is important in electronic control apparatus since it prevents shift of the control point or level upon changes in line voltage. Aging of tubes is also compensated for in the same manner in conjunction with the regenerative connection between tap 80 and resistor 72.

In summary, the advantages of this circuit are manifest, inasmuch as a relay with a high throw-out percentage is not necessary, since the plate current changes through said relay are very rapid and very large. It is impossible to lose control of the oscillator, since, because of the fact that it is self-rectified, oscillations, no matter how minute, will always reoccur. Other variations of this circuit will readily occur to those versed in the art, such as the use of a common power supply, with a self-rectified circuit, instead of separate voltages as shown. Such circuits have been designed and are entirely feasible. The one shown being one of a family of such circuits and being chosen as the most descriptive of the above-explained operation.

As shown in cross section in Figure 5, the plates 37 and 38, symbolically shown in Figure 2, each partially circumscribes the tube 18 and are mounted upon a non-conducting portion 46a of the enclosure 40 of Figure 2.

In the previous embodiment two capacitor plates were used with the liquid acting as a dielectric to change the capacity between said plates as in Figure 5. In Figure 7 a single plate 17a is used to partly circumscribe the tube 18 which acts as one plate of the condenser while a ground connection at 2a in Figure 2 makes the liquid itself the other plate of the condenser since the liquid itself may be partly conducting.

I am aware that many changes may be made and details varied without departing from the principles of my invention and I therefore do not wish to be limited to the details shown or described.

I claim:

1. In combination, an apparatus adapted to perform an operation cycle having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the operation cycle, an oscillator circuit adapted to have its tuning changed by said device at the end of the first part of the cycle and means controlled by the oscillator, upon the change in tuning thereof, to reverse said means for performing the second part of the cycle of operation.

2. In combination, an apparatus adapted to perform an operation cycle having means upon being initiated, for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the condition of the cycle, an oscillator circuit adapted to have its tuning changed by said device upon the attainment of the condition of said cycle at the end of the first part thereof, and means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the performance of the second part of the cycle and retuning of the oscillator, said last means including initiating means interposed between said oscillator and first means for initiating the latter and for preventing the oscillator upon being

returned from again affecting the first means until the initiating means has been operated.

3. In combination, an apparatus for applying a substance to the interior of tubes by the introduction and withdrawal of a vehicle carrying the substance to and from the tube, means for introducing said vehicle and, upon reversal, for withdrawing the vehicle and applying the substance to the interior of the tubes, an impedance change device responsive to the position of the vehicle within one of the tubes, an oscillator circuit adapted to have its tuning changed by said device when said vehicle has been introduced a predetermined amount into the tube and means controlled by the oscillator, upon the change in tuning thereof, to reverse said means for causing the withdrawal of said vehicle and the application of said substance to the interior of the tubes.

4. In combination, an apparatus for applying a fluorescent substance to the interior of tubes, means in said apparatus, upon being initiated, for introducing a vehicle into the tube carrying said substance and, upon reversal, for withdrawing from the tube and applying the substance thereto, an impedance change device responsive to the position of the vehicle within the tube, an oscillator circuit adapted to have its tuning changed by said device upon said vehicle being introduced a predetermined amount into the tube and means controlled by the oscillator, upon the change of tuning thereof, for reversing the first means to cause the withdrawal of the vehicle to apply said substance to the tube, said last means including initiating means interposed between said oscillator and first means for initiating the latter and for preventing the oscillator upon being retuned from again affecting the first means until the initiating means has been operated.

5. In combination, an apparatus adapted to perform an operation cycle having means upon being initiated, for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the condition of the cycle, an oscillator circuit adapted to have its tuning changed by said device upon the attainment of the condition of said cycle at the end of the first part thereof, and means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the performance of the second part of the cycle and retuning of the oscillator.

6. In combination, an apparatus for applying a substance to the interior of tubes, means in said apparatus, upon being initiated, for introducing a vehicle into the tube carrying said substance and, upon reversal, for withdrawing from the tube and applying the substance thereto, an impedance change device responsive to the position of the vehicle within the tube, an oscillator circuit adapted to have its tuning changed by said device upon said vehicle being introduced a predetermined amount into the tube and means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the withdrawal of the vehicle to apply said substance to the tube and retune the oscillator.

7. In combination, an apparatus adapted to perform an operation cycle having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the operation cycle, an oscillator circuit adapted to have its tuning changed by said device at the end of the first part of the

cycle and retuned during the second part of the cycle, means controlled by the oscillator, upon the tuning change thereof, to reverse said first means, and means for initiating the first means when the oscillator is retuned and preventing the first means from being affected by the retuning of the oscillator unless the initiating means is operated.

8. In combination, an apparatus adapted to perform an operation cycle having means for performing one part of the cycle and, upon reversal of said means, for performing another part of the cycle, an impedance change device responsive to the operation cycle, an oscillator circuit adapted to have its tuning changed by said device at the end of the one part of the cycle and means controlled by the oscillator, upon the change in tuning thereof, to reverse said means for performing the other part of the cycle of operation.

9. In combination, an apparatus adapted to perform an operation cycle having means upon being initiated, for performing one part of the cycle and, upon reversal of said means, for performing another part of the cycle, an impedance change device responsive to the condition of the cycle, an oscillator circuit adapted to have its tuning changed by said device upon the attainment of the condition of said cycle at the end of one part thereof, and relay means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the performance of the other part of the cycle and retuning of the oscillator, a second relay and a push button therefor interposed between said oscillator relay and first means for initiating the latter and for preventing the oscillator upon being returned from again affecting the first means until the push button has been operated.

10. In combination, an apparatus adapted to perform an operation cycle having means for performing one part of the cycle and, upon reversal of said means, for performing another part of the cycle, an impedance change device responsive to the operation cycle, an oscillator circuit adapted to have its tuning changed by said device at the end of the one part of the cycle and retuned during the other part of the cycle, means controlled by the oscillator, upon the change in tuning to reverse said first means, and means for initiating the first means when the oscillator is retuned and preventing the first means from being affected by the retuning of the oscillator unless the initiating means is operated.

11. In combination, an apparatus adapted to perform an operation cycle having means upon being initiated, for performing one part of the cycle and, upon reversal of said means, for performing another part of the cycle, an impedance change device responsive to the condition of the cycle, an oscillator circuit adapted to have its tuning changed by said device upon the attainment of the condition of said cycle at the end of the one part thereof, and means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the performance of the other part of the cycle and retuning of the oscillator.

12. In combination, an apparatus adapted to perform an operation cycle having means upon being initiated, for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the condi-

tion of the cycle, an oscillator circuit adapted to have its tuning changed by said device upon the attainment of the condition of said cycle at the end of the first part thereof, and relay means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the performance of the second part of the cycle and retuning of the oscillator, a second relay and a push button therefor interposed between said oscillator relay and first means for initiating the latter and for preventing the oscillator, upon being retuned, from again affecting the first means until the push button has been operated.

13. In combination, an apparatus adapted to perform an operation cycle having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the operation cycle, an oscillator circuit adapted to have its tuning changed by said device at the end of the first part of the cycle and retuned during the second part of the cycle, relay means controlled by the oscillator, upon the change in tuning thereof, to reverse said means and second relay means for initiating the first means when the oscillator is retuned and preventing the first means from being affected by the retuning of the oscillator unless the initiating means is operated.

14. In combination, an apparatus adapted to perform an operation cycle having means, upon being initiated, for performing one part of the cycle and, upon reversal of said means, for performing the other part of the cycle, an impedance change device responsive to the condition of the cycle, an oscillator circuit adapted to have its tuning changed by said device upon the attainment of the condition of said cycle at the end of the one part thereof, and means controlled by the oscillator, upon the change in tuning thereof, for reversing the first means to cause the performance of the other part of the cycle and retuning of the oscillator, said last means including initiating means interposed between said oscillator and first means for initiating the latter and for preventing the oscillator, upon being retuned, from again affecting the first means until the initiating means has been operated.

15. In combination, an apparatus adapted to perform an operation cycle having means for performing one part of the cycle and, upon reversal of said means, for performing another part of the cycle, an impedance change device responsive to the operation cycle, an oscillator circuit adapted to have its tuning changed by said device at the end of the one part of the cycle and retuned during the other part of the cycle, relay means controlled by the oscillator, upon the change in tuning thereof, to reverse said means, and second relay means for initiating the first means when the oscillator is retuned and preventing the first means from being affected by the retuning of the oscillator unless the initiating means is operated.

16. In combination, an apparatus adapted to perform an operation cycle upon a physical medium and having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the operation cycle and situated in proximity to a predetermined point with respect to said medium, an oscillator circuit adapted to have its tuning changed by said device at the end of the first

part of the cycle and means controlled by the oscillator, upon the change in tuning thereof, to reverse said means for performing the second part of the cycle of operation, said means acting to perform the first part of the cycle from a predetermined starting point with respect to said medium spaced from the predetermined point in proximity to said device and, upon reversal, to perform the second part of the cycle from the last mentioned point back to said starting point.

17. In combination, an apparatus adapted to perform an operation cycle upon a physical medium and having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, a pair of capacitor plates and an oscillating circuit responsive to the operation cycle and situated in proximity to a predetermined point with respect to said medium, an oscillator circuit adapted to have its tuning changed by said plates and connected to said first circuit and means controlled by the oscillator, upon change in tuning thereof, to reverse said means for performing the second part of the cycle of operation, said means acting to perform the first part of the cycle from a predetermined starting point with respect to said medium spaced from the predetermined point in proximity to said plates and to perform the second part of the cycle from said last point back to said starting point.

18. In combination, an apparatus adapted to perform an operation cycle upon a physical medium and having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, a pair of capacitor plates and situated in proximity to a predetermined point with respect to said medium and an oscillating circuit, an oscillator circuit tuned to predetermined resonance with and including said oscillating circuit, a concentric conductor cable connecting said circuits, said oscillator circuit adapted to have its tuning changed by said plates at the end of the first part of the cycle and means controlled by the oscillator, upon the change in tuning thereof, to reverse said means for performing the second part of the cycle of operation, said means acting to perform the first part of the cycle from a predetermined starting point with respect to said medium spaced from the predetermined point in proximity to said plates and to perform the second part of the cycle from said last mentioned point back, upon reversal, to said starting point.

19. In combination, an apparatus adapted to perform an operation cycle upon a physical medium and having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, an impedance change device responsive to the operation cycle and situated in proximity to a predetermined point with respect to said medium, an electronic circuit adapted to be operated at the end of the first part of the cycle by said device and means controlled by said circuit, upon the operation thereof, to reverse said first means for performing the second part of the cycle of operation, said means acting to perform the first part of the cycle from a predetermined starting point with respect to said medium spaced from the predetermined point in proximity to said device and to perform the second part of the cycle from said last mentioned point back to said starting point.

20. In combination, an apparatus adapted to

perform an operation cycle upon a physical medium and having a valve, a pneumatic means controlled thereby for performing the first part of the cycle, and, upon reversal of said valve, for performing the second part of the cycle, an impedance change device responsive to the operation cycle and situated in proximity to a predetermined point with respect to said medium, an oscillator circuit adapted to have its tuning changed by said device at the end of the first part of the cycle and means controlled by the oscillator, upon the change in tuning thereof, to reverse said valve for performing the second part of the cycle of operation, said pneumatic means acting to perform the first part of the cycle from a predetermined starting point with respect to said medium spaced from the predetermined point in proximity to said device and, upon reversal, to perform the second part of the cycle from said last mentioned point back to said starting point.

21. In combination, an apparatus adapted to perform an operation cycle having means for performing the first part of the cycle and, upon reversal of said means, for performing the second part of the cycle, a liquid level responsive impedance change device responsive to a predetermined liquid level, an electronic circuit adapted to be affected by said device at the end of the first part of the cycle upon the attainment of said liquid level and means controlled by said circuit, upon it being affected by said device, to reverse said means for performing the second part of the cycle, said means acting to perform the first part of the cycle from a predetermined starting point to the attainment of said level and from the lowering of said level back to said starting point.

22. In combination, an apparatus for applying a substance to the interior of tubes by the introduction and withdrawal of a vehicle carrying the substance to and from the tubes, means for introducing said vehicle and, upon reversal, for withdrawing the vehicle and applying the substance to the interior of the tubes, an impedance change device responsive to the position of the vehicle within one of the tubes, an oscillator circuit adapted to have its tuning changed by said device when said vehicle has been introduced a predetermined amount into the tube and means controlled by the oscillator, upon the change in tuning thereof, to reverse said means for causing the withdrawal of said vehicle and the application of said substance to the interior of the tubes, and a stand for said tubes provided with a plurality of supports for the lower ends of tubes and a plurality of yieldably held caps for the upper ends of said tubes.

23. In combination, an apparatus for applying a substance to tubes by applying a vehicle carrying the substance longitudinally to the tube, means for moving the vehicle longitudinally of the tube and, upon reversal, for moving said vehicle in the other direction, an impedance change device responsive to the position of the vehicle with respect to the tubes, an oscillator circuit adapted to have its tuning changed by said device when said vehicle has attained a predetermined position with respect to the tube, and means controlled by the oscillator, upon a change in tuning thereof, to reverse said means for causing the opposite movement of said vehicle.

THEODORE A. COHEN.