July 29, 1958 J. J. O'CALLAGHAN 2,845,043

CATHODE-RAY TUBE MANUFACTURING APPARATUS

Filed July 30, 1956 6 Sheets-Sheet 1

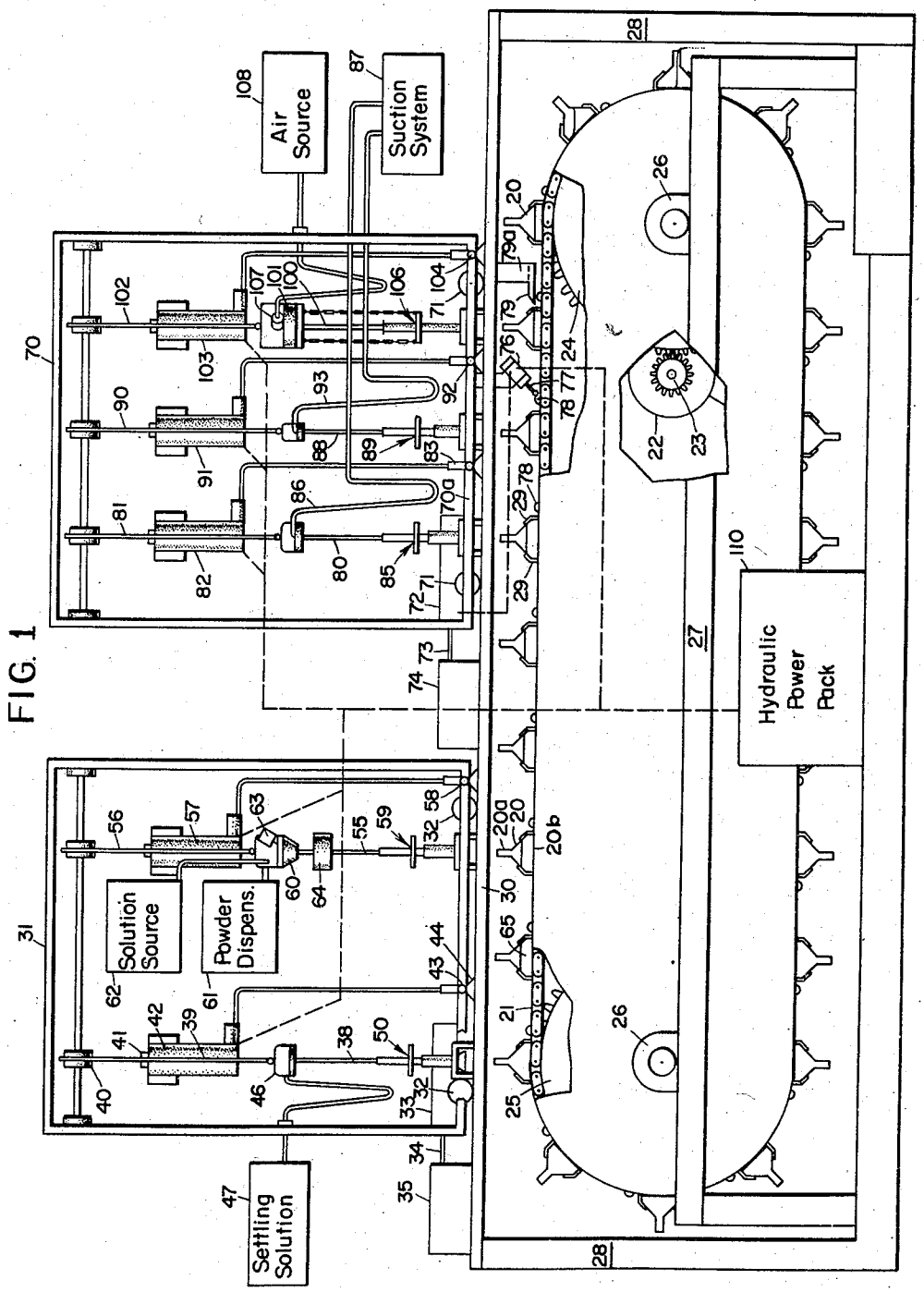


FIG. 1

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CATHODE-RAY TUBE MANUFACTURING APPARATUS

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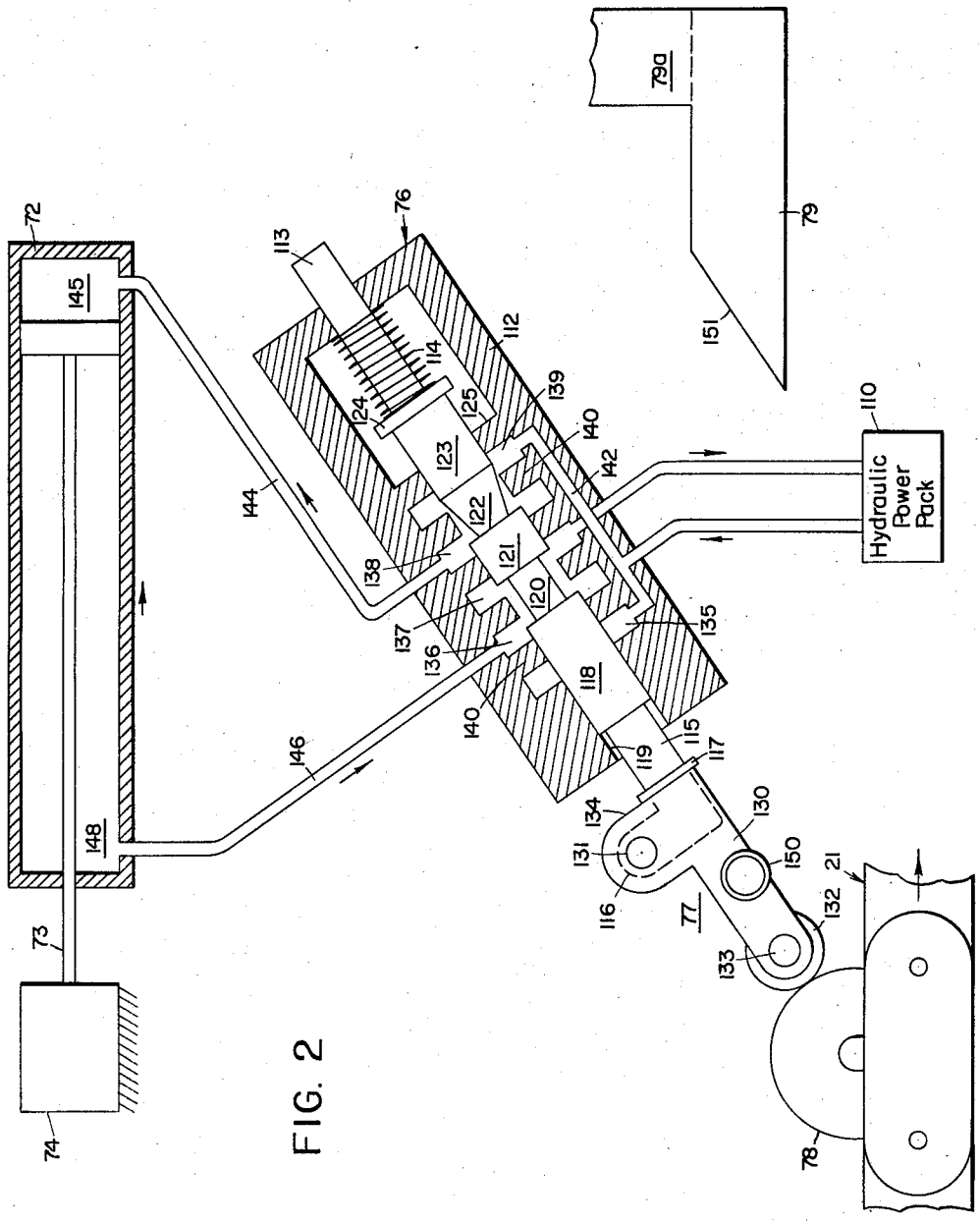


FIG. 2

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CATHODE-RAY TUBE MANUFACTURING APPARATUS

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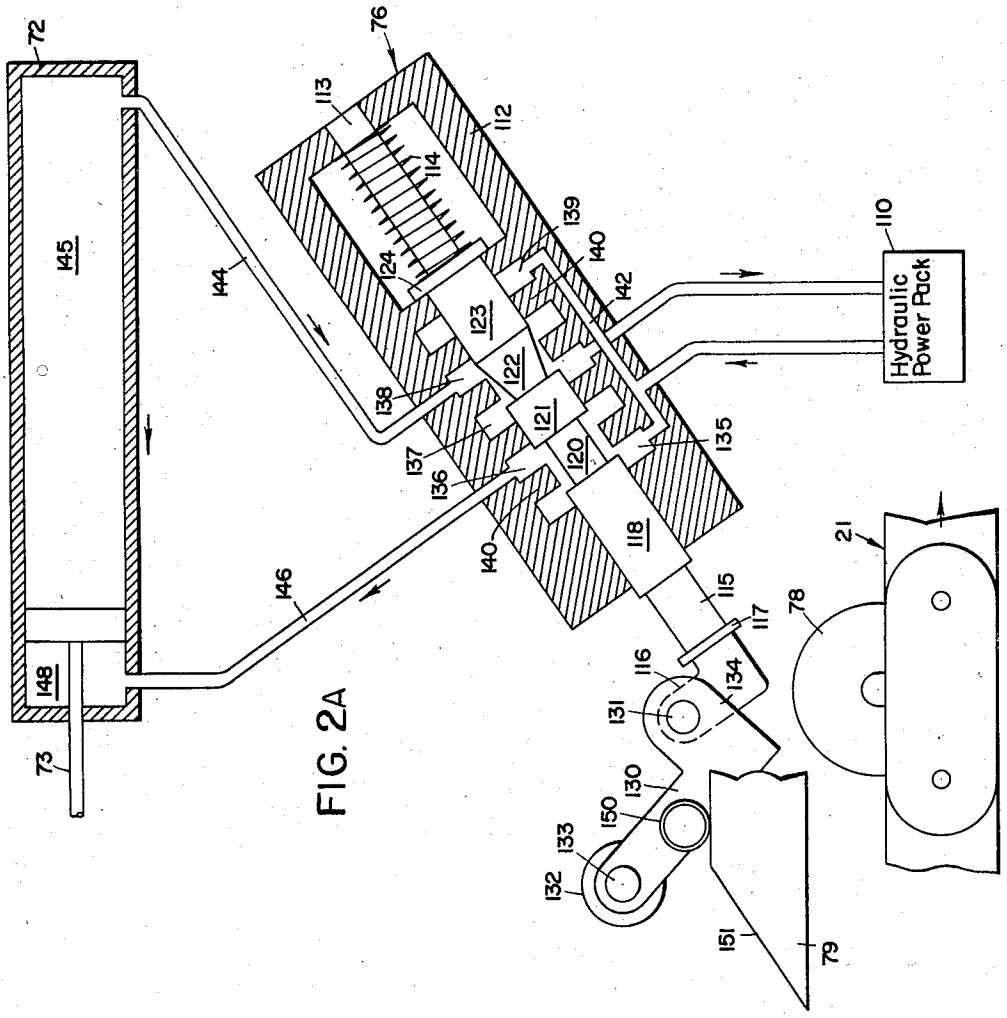


FIG. 2A

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FIG. 3

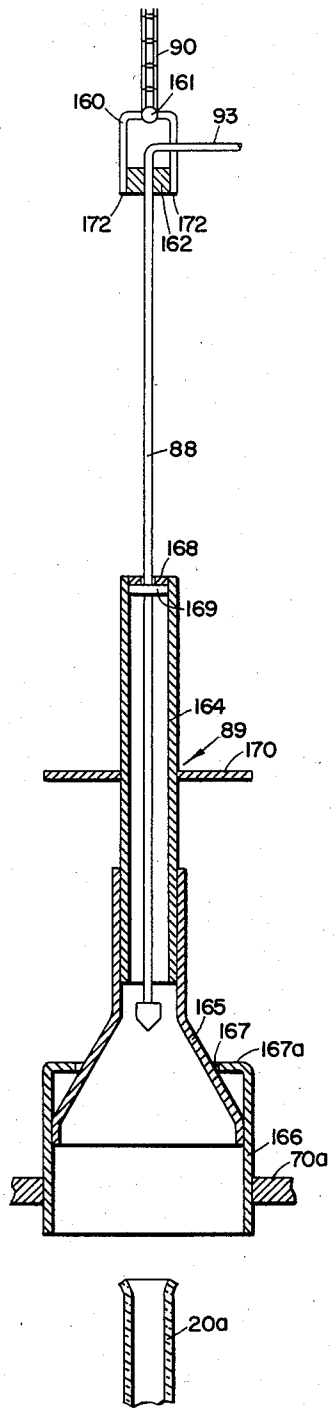
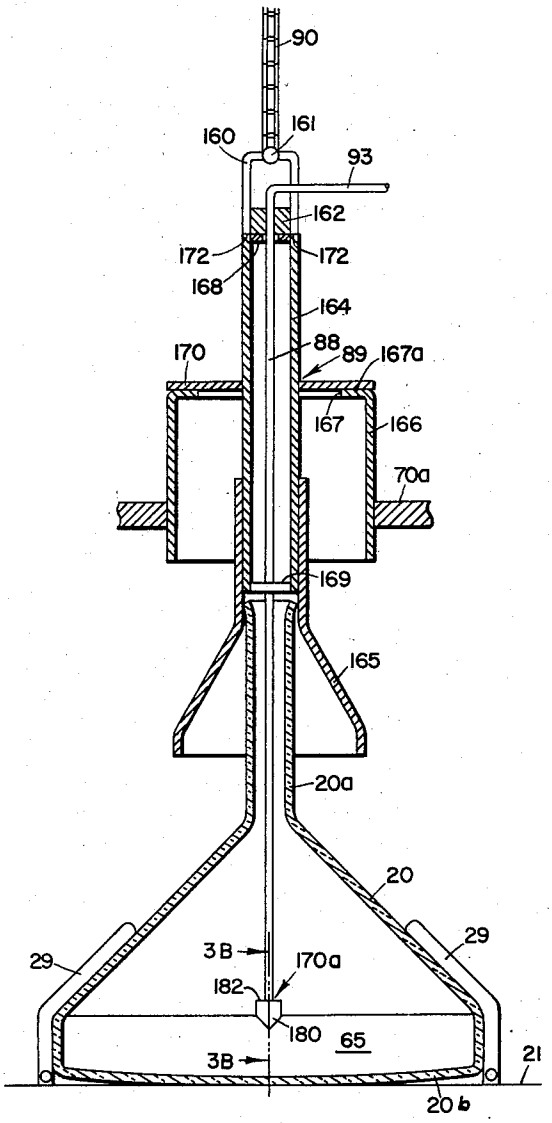


FIG. 3A



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CATHODE-RAY TUBE MANUFACTURING APPARATUS

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FIG. 3B

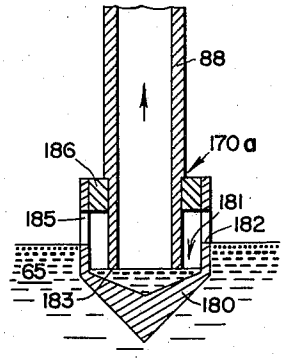


FIG. 4A

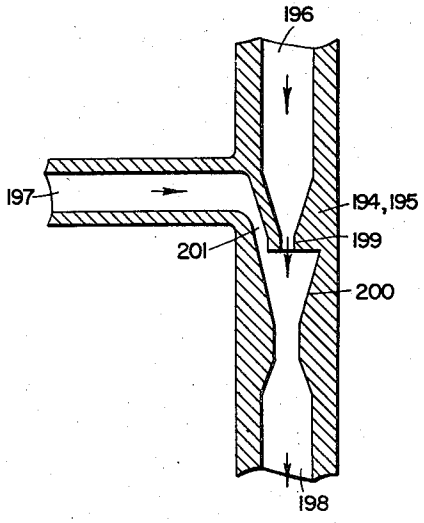


FIG. 4

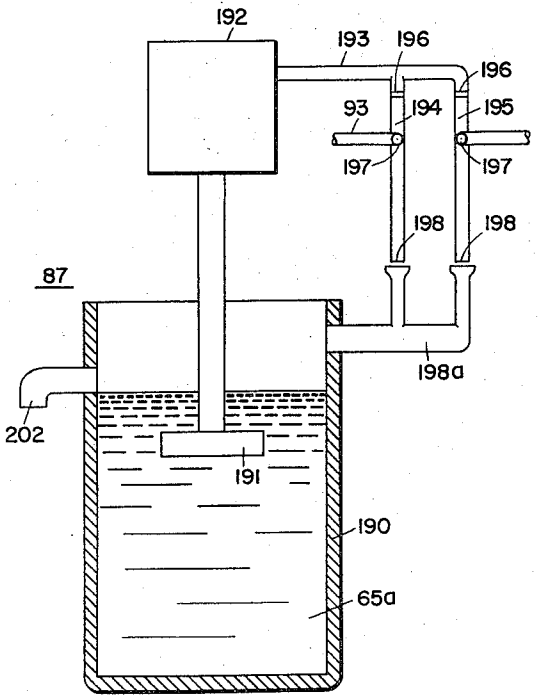
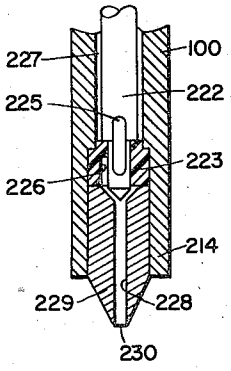


FIG. 5A



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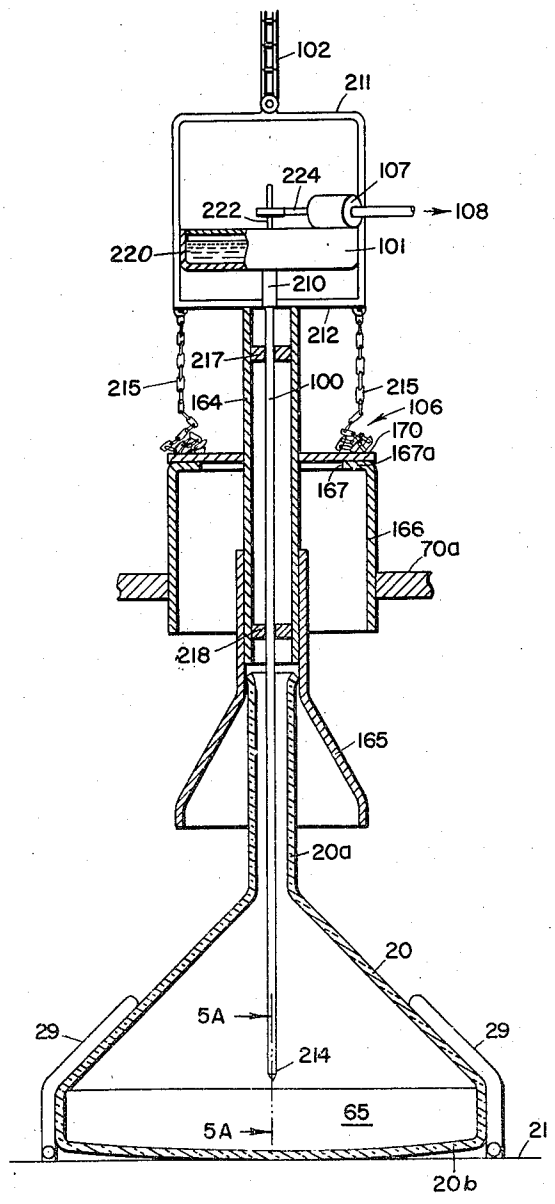
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FIG. 5



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United States Patent Office 2,845,043 Patented July 29, 1958

2,845,043

CATHODE-RAY TUBE MANUFACTURING APPARATUS

Jerome J. O'Callaghan, Skokie, Ill., assignor to The Rauland Corporation, a corporation of Illinois

Application July 30, 1956, Serial No. 600,851

23 Claims. (Cl. 118—408)

This invention relates to cathode-ray tube manufacturing apparatus; more particularly, it has to do with a conveyor apparatus on which a series of cathode-ray tube bulbs are successively screened and filmed automatically.

Numerous attempts to mechanize the manufacture of cathode-ray picture tubes have been carried out with varied degrees of success. The conventional methods of applying luminescent screens onto the faceplates of the cathode-ray tube bulbs have undergone considerable change since the advent of widespread commercial television; the continual striving for more economical tube production has resulted in the expenditure of large sums of money and man-power to the end of providing a machine which will carry out the process of applying a luminescent screen in a completely automatic manner and which will accomplish this result efficiently and dependably.

With the advent of aluminized television screens, it became desirable to apply a film of organic material over the back surface of the luminescent screen; it likewise is highly desirable that the film applying process be completely mechanized. It has been appreciated that this filming process could best be carried out on the same apparatus that is utilized to apply the luminescent screens, since more efficient and economical operation would result from the attendant reduction of bulb handling.

Various approaches at mechanization have been tried, usually involving the use of a continuously moving conveyor onto which the bulbs are loaded at one end, are carried slowly along beneath associated screening and filming apparatus, and finally are carried around and under the other end of the conveyor to decant excess settling solution out of the screen and filmed bulb. However, it has been found that the shrinkage rates tend to run excessively high; a shrinkage rate is a measure of the percentage of unsatisfactory tubes produced by the screening and filming apparatus. Rejection of the bulbs may be the result of any of various reasons, including uneven distribution of settled phosphors or of the film, lack of proper adherence of either the phosphor or the film, the application of either too heavy or too light a layer of the phosphor or the film, or breakage of the glass portions of the bulbs during their conveyance on the apparatus.

It is, therefore, a general object of the present invention to provide a new and improved cathode-ray tube screening apparatus.

It is also an object of the present invention to provide an improved cathode-ray tube screening apparatus which is capable of applying luminescent screens of good quality, which is automatic in its operation, and which is efficient and economical to operate by reason of its capability of producing screened and filmed cathode-ray tube bulbs at lower shrinkage rates than heretofore possible.

It is a corollary object to provide an improved cathode-ray tube screening and filming apparatus which is capable

of producing a large output of screen and filmed bulbs, in which the screening and filming operations are combined into one continuous operation with resultant savings in space and equipment, and which yet is simple to maintain and dependable in operation.

It is another object of the present invention to provide an improved apparatus of the above character in which breakage of the cathode-ray tube bulbs is effectively prevented.

It is a more detailed object to provide improved means for guiding conduits, coupled to associated screening and filming equipment, into and out of the bulbs.

It is a further object of the present invention to provide a novel system for moving the associated screening and filming equipment precisely in synchronism with movement of the bulbs on the conveyor.

Another object of the present invention is to provide an improved siphon system for removing settling solution from the cathode-ray tube bulbs and which is capable of continuous operation without corrosion or clogging of the parts of the system.

It is another object of the present invention to provide an improved dispenser for applying precise quantities of film solution evenly and smoothly onto the surface of the settling solution and which is capable of applying a uniform quantity of film solution over a long period of operation.

A still further object of the present invention is to provide apparatus for correlating the operation of the siphon and the film dispenser so that the latter is capable of always dispensing film solution with a minimum of disturbance to the settling solution.

In accordance with one aspect of the present invention, in which a carriage is utilized to carry the associated screening or filming equipment and is disposed adjacent the conveyor upon which the cathode-ray tube bulbs are moved at a predetermined speed, a system for moving the carriage in synchronism with the conveyor comprises a hydraulic actuator for moving the carriage, a valve coupled to the actuator, an operating member for the valve, and means cooperating with the operating member for effecting an increase in carriage speed when the latter lags behind the conveyor and for effecting a decrease in carriage speed when the latter leads the conveyor, so that the carriage is moved at the same speed as that of the conveyor.

Cooperating with the system whereby the associated screening and filming equipment, or parts thereof, are moved in synchronism with the cathode-ray tube bulbs, is an apparatus for accurately guiding conduits from the screening and filming equipment into the cathode-ray tube bulbs. This apparatus comprises an actuator coupled through a flexible linkage to the upper end of the conduit for vertically moving the same between an upper position above the bulb and a lower position at which the lower end of the conduit is below the neck portion of the bulb. Means adapted to telescope over the conduit is provided for guiding the lower end thereof into the neck, and the apparatus further comprises means including a lost motion connection between the guiding means and the conduit, for raising the former as the lower end of the latter is moved upwardly and, as the conduit is lowered, for limiting downward movement of the guiding means to a position about the neck while permitting continued downward movement of the conduit on into the bulb.

Another portion of the continuously operating screening and filming apparatus is a dispenser for applying film solution onto the surface of settling solution contained within the bulb. The dispenser comprises means for storing film solution under a substantially constant head of pressure, means for projecting and withdrawing a

conduit coupled to the storing means into and out of the bulb, and a valve disposed in the conduit for slicing laterally through film solution flowing therethrough in order to terminate the flow of the film solution without imparting increased velocity thereto.

The invention also contemplates a syphon system for removing settling solution from the cathode-ray tube bulb. The siphon system comprises fluid operated suction means in combination with a conduit adapted for movement to immerse one end of the same into the settling solution and coupled at its other end to the suction means. A reservoir, containing used settling solution, is coupled to the suction means to deliver solution thereto and to receive solution therefrom. Means is provided for driving the solution from the reservoir through the suction means to operate the same so that the same solution is utilized as a driving fluid in the suction means as is being drawn thereby from the bulb. Finally, the siphon system comprises means for removing excess solution from the reservoir.

In the siphoning of settling solution from the cathode-ray tube bulb, the invention contemplates drawing off the settling solution down to a very accurately determined level. This is accomplished by means comprising a conduit adapted to be vertically moved into and out of the bulb, together with means for producing suction at the conduit lower end. Means is provided for limiting downward movement of the conduit to a position at which the lower end thereof is at a predetermined level so that the solution is drawn out of the bulb only to the predetermined level. In order to prevent the flow of solution back out of the siphon conduit when the solution level drops below that of the conduit lower end, the apparatus further includes means for preventing such reverse flow of the siphoned solution in the conduit.

It is also contemplated to correlate the level of settling solution as accurately determined by the siphoning system with means for limiting downward movement of a conduit from the film dispenser so that the latter, in dispensing film solution onto the surface of the settling solution, has its lower end disposed only slightly above the settling solution surface, whereby the film solution flows evenly over the settling solution surface.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

Figure 1 is a side elevation, partially broken away and partially in schematic form, of an embodiment of the screening and filming apparatus of the present invention;

Figure 2 is a detailed fragmentary view; partially in cross-section, of the principal components of the synchronizing system embodied in the apparatus of Figure 1;

Figure 2A is similar to Figure 2 but with some of the parts in different positions;

Figure 3 is a fragmentary cross-sectional view of a portion of the siphoning system of the apparatus of Figure 1 and illustrates means for guiding a conduit accurately through the neck of the cathode-ray tube bulb;

Figure 3A is similar to Figure 3 but with the parts in different positions;

Figure 3B is a detailed cross-sectional view taken along the line 3B—3B of Figure 3A;

Figure 4 is a schematic view of the overall siphoning system of the apparatus of Figure 1 arranged to illustrate one aspect of the invention;

Figure 4A is a fragmentary cross-sectional view of a Venturi-tube utilized in the siphoning system of Figure 4;

Figure 5 is a fragmentary view, partly in cross-section, of a film dispenser constructed in accordance with the present invention and including a modified form of the guiding means shown in Figures 3 and 3A; and

Figure 5A is a detailed cross-sectional view taken along the line 5A—5A of Figure 5.

In the overall view of the embodiment shown in Figure 1 for purposes of illustration, a series of cathode-ray tube bulbs **20**, supported with their neck portions **20***a* uppermost and their faceplates **20***b* horizontal, are carried horizontally from left to right by a conveyor **21** moved at a uniform speed by means of a drive motor **22** coupled to conveyor **21** through a gear-unit **23** and a sprocket **24**. Sprocket **24**, at the right end of the apparatus, and a similar sprocket **25**, at the other end of the apparatus, are journaled in bearings **26** mounted upon a stationary horizontal beam **27**. Suitable conventional mechanism may be employed to maintain a constant tension in conveyor **21**. Bulbs **20** are secured to conveyor **21** by means of hinged clamps **29**.

Carried above conveyor **21** on a stationary track-way **30** supported by uprights **28** is a screening carriage **31** movably supported on track-way **30** by rollers **32**; track-way **30** is supported separately from conveyor **21** to minimize the transfer of vibration from one carriage to the conveyor. A piston cylinder **33** is mounted on carriage **31** and encloses a piston having a piston rod **34** affixed at its outer end to a block **35** secured to track-way **30**, extension of piston rod **34** being effective to move carriage **31** in the direction of movement of conveyor **21**.

Carriage **31** includes equipment for first dispensing a measured quantity of a settling solution into one of the bulbs **20** and then for dispensing a measured quantity of a slurry including a luminescent phosphor into the previously injected settling solution. For injecting the settling solution, a conduit **38** is supported for vertical movement by a flexible linkage **39** guided over an idler gear **40** and affixed to the piston rod **41** of a hydraulic actuator **42**. Hydraulic actuator **42** is operated only in response to engagement of a conventional cam follower **43**, moving from left to right, with a cam **44** supported by track-way **30**. On the upper end of conduit **38** is a conventional dispenser **46** for delivering a measured quantity of settling solution from a reservoir indicated at **47** and operated in response to suitable micro-switches (not shown) during the time that conduit **38** is lowered to a preset position within one of bulbs **20**. Mounted to telescope over conduit **38** is a neck-finder and guiding means **50** for accurately directing conduit **38** through neck portions **20***a* upon the down-stroke of conduit **38**; a more detailed description of guiding means **50** is given below in connection with other figures.

For dispensing the slurry of luminescent powder into the settling solution previously dispensed through conduit **38**, there is a conduit **55** suspended from a flexible linkage **56** for vertical movement by means of a hydraulic actuator **57** keyed to operate by action of a cam follower **58** engageable with cams **44** in the same manner as actuator **42**. A guiding means **59** is mounted on conduit **55** and is identical with guiding means **50**. At the upper end of conduit **55** is a mixing hopper **60** into which a measured quantity of powder is injected from a dispenser **61** together with solution from a reservoir indicated at **62**, the solution and powder being thoroughly stirred by a mixer **63** and then, upon operation of a magnetic valve **64** keyed by suitable micro-switches to open when conduit **55** is projected within a bulb **20**, the mixture or slurry is allowed to flow downwardly through conduit **55** into the body of settling solution **65** previously dispensed into bulbs **20**.

A second carriage **70** is carried on track-way **30** by means of wheels **71** and supports siphoning and film dispensing equipment. Carriage **70** is similarly driven by means of a hydraulic actuator including a piston cylinder **72** enclosing a piston from which a piston rod **73**

extends; piston rod 73 is affixed at its outer end to a block 74 supported by track-way 30. Carriages 31 and 70 are controlled in their movement along track-way 30 by means of a synchronizing system which includes a valve 76 (shown only in connection with carriage 70 for sake of clarity of the drawings, identical valves being employed for controlling the operation of actuators 33 and 72) having an operating member 77 engageable with one of a series of cams 78 affixed on conveyor 21, one cam 78 being provided for each of the bulbs 20; a detailed description of this synchronizing system is included below in connection with Figures 2 and 2A. Also cooperating with the synchronizing system is a stationary cam 79 carried on a frame-member 79*a* and which, as is described in more detail below, cooperates with valve 76 to limit movement of carriage 70 and cause reversal in its movement after a complete cycle of operation, as also described in more detail below. A similar cam (not shown) is provided in connection with carriage 31.

In the instant embodiment, carriage 70 supports equipment utilized in the filming portion of the overall process; included on carriage 70 are rough and fine siphon systems for removing a portion of settling solution 65 from bulbs 20, the rough siphon being capable of removing the settling solution at a high-volume flow rate and being operated to lower the solution level only approximately to a particular level desired in connection with the below-described operation of the film dispensing equipment. This rough siphon system comprises a conduit 80 supported from a flexible linkage 81 affixed to a hydraulic actuator 82 and controlled to effect reciprocation of conduit 80, in the same manner as for actuators 42 and 57, by means of a cam follower 83 engageable with cams 44. A guiding means 85 telescopes over conduit 80 in a manner identical with that of guiding means 50 and 59. Conduit 80 is coupled by a flexible hose 86 to a suction system indicated at 87 and described in more detail in connection with Figure 4. Spaced in the direction of conveyor movement beyond conduit 80 is a fine siphon conduit 88 provided with a guiding means 89 and suspended by a flexible element 90 from a hydraulic actuator 91 responsive to a cam follower 92, reciprocation of conduit 88 being initiated in the same manner as that above described with respect to conduit 38. If desired, reciprocation of both conduits 80 and 88 may be controlled by a single common actuator. Conduit 88 is coupled to suction system 87 by a hose 93 and is utilized for drawing off settling solution 65 down to a very accurately preselected level, about which more will be said in connection with Figure 3B.

Carriage 70 also supports a film dispenser for applying precisely measured amounts of film solution onto the surface of the settling solution remaining in the bulbs 20 after the siphoning steps and arranged to insure the formation of an even film over the settling solution surface. The illustrated embodiment of the film dispenser includes a conduit 100 depending downwardly from a reservoir 101 supported by a flexible element 102 attached to a hydraulic actuator 103 controlled by a cam follower 104 to operate in the same manner as that above described with respect to conduit 38, so as to lower conduit 100 successively into each of bulbs 20 during their movement by conveyor 21. Conduit 100 also includes a guiding means 106 which operates in a manner similar to that of guiding means 50 and the others but which includes a modified construction as is indicated below in connection with Figure 5. The film dispenser includes a valve of special construction for controlling the flow of film solution into bulbs 20, which valve is operated by an air cylinder 107 powered by an air source indicated at 108 upon the actuation of suitable microswitches which function in response to the lowering of conduit 100 to project its lower end into one of the bulbs 20.

Power of all of the hydraulic actuating devices is provided by a single hydraulic power pack indicated at 110, which may be of conventional construction including a reservoir of hydraulic fluid and a pump for maintaining hydraulic pressure in the system. Hydraulic power pack 110 is coupled to each of hydraulic actuators 42, 57, 82, 91 and 102; in addition, hydraulic power pack 110 is utilized together with valve 76 and the corresponding valve associated with carriage 31 to control the extension of piston rods 73 and 34 for moving carriages 70 and 31, respectively.

Portions of the above described apparatus are entirely conventional, and the general overall scheme of screening has heretofore been suggested. However, certain portions of the above described apparatus involve new and distinct departures from and improvements upon prior art apparatus of this type and, therefore, will be treated in substantially more detail below. Before proceeding further, it is desirable to understand the general operation of the apparatus shown in Figure 1. In operation, bulbs 20 are secured by clamps 29 onto conveyor 21 at the lefthand end of the apparatus. The bulbs are then carried smoothly and evenly from left to right while they undergo the several above mentioned operations. Initially, a measured amount of settling solution 65 is introduced into each of the bulbs 20 through conduit 38. During the initial filling period, conduit 38 is lowered to project its lower end within the bulb while the bulb continues its uniform movement, the synchronizing system being effective to move conduit 38 from left to right in precise step with the bulb movement. Subsequently, after conduit 38 has been withdrawn, carriage 31 is moved to the left to bring conduit 55 into a position where it is lowered into the bulb 20 previously filled with settling solution 65. Again, carriage 31, and hence a conduit 55 is moved along precisely in step with the bulb movement during a period of time when the powder slurry from hopper 60 is flowing through conduit 55 into settling solution 65.

After the powder slurry has been introduced into the bulbs 20, the powder settles through settling solution 65 during the time interval elapsing as conveyor 21 moves the bulbs progressively along toward a position beneath conduit 80 of the rough siphon. By the time conduit 80 is lowered to immerse its lower end into solution 65, a desired amount of phosphor has settled into adhering relation with faceplate 20*b*. After the rough and fine siphoning steps, respectively by means of conduits 80 and 88, film dispenser conduit 100 is lowered to a position at which its lower end is slightly above the surface of the remaining amount of solution 65, and film solution from reservoir 101 is floated over the settling solution surface. After withdrawal of conduit 100, the remaining settling solution is decanted from bulbs 20 out from under the solidified or partially solidified film layer during travel of the bulb around sprocket 24 at the righthand end of Figure 1. During the decanting, the film layer first affixes itself to the upper inside portions of the bulb near faceplate 20*b* and then, as the bulb is tipped outwardly, the film layer falls smoothly over the faceplate as the water is poured off out from under the film layer. After decanting of the excess solution, the bulbs are returned along the underside of the conveyor to the loading station, at the left end of Figure 1, from where they are removed.

The general advantages resulting from the moving of the bulbs 20 slowly and evenly along their path of travel are old and well known in the art; more accurate and even settling of the luminescent powder is obtained by preventing agitation or sloshing of solution 65. Hence, frame 28 is of rugged construction and the entire assemblage is constructed of heavy, strong materials and preferably is firmly secured to a suitable foundation. The settling solution and powder dispensers may be of previously known design and may be in any suitable form; however, the guiding means 50 and 59 cooperating therewith afford decidedly improved operation over that of

prior apparatus of this type by insuring that the conduit is projected within the bulb. In addition, it is desired to employ suitable conventional apparatus to prevent operation of the raising and lowering mechanisms in the absence of a bulb in a particular set of the clamps **29**.

Figures 2 and 2A taken in combination with Figure 1 illustrate the carriage synchronizing system of the present embodiment of the invention; for clarity, the size of valve **76** is greatly exaggerated with respect to the length of piston cylinder **72**. Valve **76** includes a valve body **112** enclosing a valve stem **113** biased by a compression spring **114** in a direction outwardly of the lower end of the valve. From left to right in Figure 2, valve stem **113** comprises a shank portion **115** bent upwardly at its outer end **116** and encircled by a collar **117**, a first enlarged portion **118** slidable snugly within the bore **119** of the valve body, a necked-down portion **120**, a second enlarged portion **121**, a throttling portion **122** of tapering diameter, and a final enlarged portion **123** terminating in a collar **124** limiting downward movement of valve stem **113** by abutment with a surface **125** on the internal portion of the valve. An L-shaped operating member **130** is pivotally mounted on a pin **131** through one leg of the L and outer shank end **116** of valve stem **113**. At the end of the other L leg is a cam-follower roller **132** secured thereto by a pin **133**. Normally, the base edge **134** of member **130** abuts against collar **117** so that pressure on the extreme outer end of operating member **130** tends to move valve stem **113** into the valve, compressing spring **114**.

Valve body **112** is provided with five valve chambers **135, 136, 137, 138** and **139**, respectively, from left to right in Figure 2. These chambers are formed by a respective succession of inwardly projecting annular lugs **140** having internal diameters that snugly receive the portions **118, 121**, and **123** of valve stem **113**. Chambers **135** and **139** are internally connected by a duct **142** which communicates with the hydraulic fluid input from power pack **110**. The middle chamber **137** is coupled to a fluid return line to power pack **110**. Chamber **138** is coupled by a line **144** to the righthand space **145** of piston cylinder **72**, while chamber **136** is coupled by a line **146** to the lefthand space **148** in cylinder **72**.

Valve **76** is of conventional four-way valve construction with one important exception: portion **122** is especially machined to provide a tapered throttling surface which cooperates with chambers **138** and **139**; portion **122** tapers evenly from the diameter of adjacent portion **123** down to a diameter substantially smaller than the next succeeding portion **121**. Valve **76** is affixed to carriage **70** so as to be movable therewith and is disposed to position roller **132** in the path of cams or rollers **76** as they are moved along by conveyor **21**. As shown, pin **133** lies below an imaginary line joining the center of cam-roller **78** and pivot pin **131** when roller **132** is engaged with the periphery of cam-roller **78**. A second cam-follower **150** projects outwardly from operating member **130** (upwardly from the plane of the drawing) and is disposed to come into engagement with cam **79** (disposed upwardly of the plane of the drawing with respect to valve **76**) whereupon the upwardly slanting cam surface **151** thereof deflects operating member **130** upwardly around pin **131**. There is thus provided a toggle mechanism which is locked when cam **78** pushes on roller **132** but which unlocks permitting member **130** to fly upwardly upon engagement of cam surface **151** with cam-follower **150**, whereupon valve stem **113** moves outwardly by the urging of spring **114**.

The positions of the parts in Figure 2 corresponds with that of Figure 1 wherein carriage **70** is just beginning its movement from left to right and shortly before actuators **82, 91**, and **103** are operated to lower their respective conduits downwardly into the respective bulbs **20**. In this position, a cam **78** has come into engagement with roller **132** to force valve stem **113** inwardly of valve body **112** whereupon a small opening exists between valve stem portion **122** and the adjacent lug **140** to provide communication between chambers **139** and **138**. At the same time, free communication is provided between chambers **136** and **137** by virtue of the position of reduced stem portion **120** which is spanning the lugs separating these two chambers. In this position, hydraulic fluid from power pack **110** flows through duct **142**, chamber **139**, chamber **138**, line **144**, and into piston space **145**. Returning from the other piston space **148**, a path is provided through line **146**, chamber **136**, and chamber **137** back to power pack **110**. As fluid is thus caused to flow into chamber **145**, piston cylinder **72**, and hence carriage **70**, is urged to the right. Any tendency of carriage **70** to move at a faster speed than that of the conveyor, and thus to lead the latter, permits movement of valve stem **113** in a direction downwardly out of valve casing **112** because of the urging of spring **114**. This outward movement of valve stem **113** moves its portion **122** slightly to the left further restricting the communication space between chambers **139** and **138** and thereby reducing the rate of fluid flow through those chambers to piston space **145**; thus, when carriage **70** tends to lead conveyor **21**, valve **76** instantly responds by reducing hydraulic fluid flow to reduce the carriage movement speed. On the other hand, if carriage **70** starts to lag behind conveyor **21**, roller **132** rides on cam **78** and thereby forces valve stem **113** inwardly against the biasing force of spring **114** to cause an instantaneous opening of the communication between chambers **139** and **138** to effect an increase in carriage movement speed. Therefore, it is seen that this system, which is very simple to construct and assemble, causes carriage **70** to move precisely in synchronism with conveyor **21** within the limits of piston travel.

After being synchronously moved along with conveyor **21** for a period of time sufficient to allow dispensing, siphoning, and retraction of the conduits, carriage **70** is caused to reverse its direction of movement and return to its initial starting position whereupon the cycle is repeated for the next succeeding bulb. This limiting of carriage movement occurs upon engagement of cam-follower **150** with cam surface **151** on cam **79**. The latter is positioned to deflect operating member **130** upwardly about pin **131** whereupon cam follower **132** is swung clear of cam **78** to permit spring **114** to force valve stem **113** to its completely extended position shown in Figure 2A. Cam **79** retains operating member **130** in its upward position until cam **78** has been moved by conveyor **21** on past and beneath cam-follower **132**, while at the same time carriage **70** has started its return movement so that, when cam-follower **150** is moved free of cam surface **151**, operating member **130** is by its own weight brought back to its normal position with its base surface **134** abutting agaianst collar **117**. In this position of operating member **130**, cam-follower **132** is in a position to be engaged by the next succeeding cam **78** which cam then pushes valve stem **113** back within valve body **112** to again establish the synchronized tracking of carriage **70** with conveyor **21**. The return stroke is caused upon extension of valve stem **113** by a different resulting combination of the valve chambers with the valve stem portions. In this instance, hydraulic fluid from power pack **110** is conducted through duct **142**, chamber **135**, chamber **136**, and line **146** to space **148**. This urges piston cylinder **172** to the left, the return fluid path being from space **145** through line **144**, chamber **138**, and chamber **137** back to power pack **110**.

Movement of carriage **31** is controlled by an identical valve and cam arrangement and therefore it is unnecessary to incorporate any detailed description of the synchronizing system for carriage **31**.

From the above, it will be evident that for each successive cathode-ray tube bulb, carriages **31** and **70** come into synchronous movement with the bulbs during a time interval in which various conduits are lowered, in re-

sponse to engagement of the different actuator cam-followers with their respective cams **44**, to project the conduit lower ends through neck portions **20***a* into the bulbs. Although the synchronizing system moves carriages **31** and **70** in precise synchronism with conveyor **20**, it is also necessary to insure accurate positioning of the reciprocating conduits with respect to the bulbs during projecting of the conduit lower ends into the bulbs. Such accurate positioning is accomplished in the present invention by utilizing the guiding means for insuring that each of the conduit lower ends is directed accurately within the necks **20***a*. Once a conduit has been lowered within the bulb, the synchronizing system maintains the movement of the conduit in step with bulb movement.

Although such a guiding means has been employed on each of the different vertically reciprocating conduits of the present embodiment, it is only necessary to provide a detailed description of one of them; Figures 3 and 3A show a detailed view of guiding means **89** employed on the fine siphon conduit **88**; guiding means **50**, **59**, and **85** may be of identical construction. At its upper end, where it is connected to hose **93**, conduit **88** is secured to flexible chain **90** by a U-shaped strap **160** pivotally connected to chain **90** by a pin **161** and secured about a bushing **162** clamped onto the conduit. Slidable over conduit **88**, in telescoping relation therewith, is a sleeve **164** affixed at its lower end to an inverted funnel-shaped member **165**. In Figure 3, the flared portion of member **165** is encased within a box **166** mounted upon the floor **70***a* of carriage **70**; a hole **167** is cut into the top portion **167***a* of box **166** through which the apparatus may be raised and lowered. The side portions of box **166** project downwardly toward bulbs **20**, the box being open on its underside and the lower edges of box **166** being spaced above neck portion **20***a* by a distance sufficient to permit lateral movement of member **165** when the latter is lowered to dispose the rim of its flared portion below box **166** (Figure 3A). Guiding means **89** is carried on conduit **88** by inwardly projecting lugs **168** rigid with sleeve **164** and, as shown in Figure 3, resting on the upper surface of a collar **169** affixed on conduit **88**. Downward movement of guiding means **89** is limited by engagement of a collar **170** rigid with sleeve **164** which, upon lowering of conduit **88**, abuts against box surface **167***a*.

The operation of guiding means **89** is best understood by a comparison of Figures 3 and 3A which show guiding means **89** in its raised and lowered positions, respectively. In Figure 3, chain **90** is pulled upwardly whereupon guiding means **89** is disposed in its upper position with its lugs **168** resting on collar **169**. When chain **90** is extended downwardly (by operation of actuator **91** in Figure 1), guiding means **89** is carried downwardly by conduit **88** until collar **170** lands on box surface **167***a*; conduit **88** then continues its downward movement on into bulb **20**. The flared portion of member **165** defines a downwardly and outwardly tapering cam surface which, as the entire assembly is lowered toward bulb **20**, engages with the upper end of neck portion **20***a* and guides the entire assembly into a centered position over bulb **20** so that, as conduit **88** continues its downward movement on into the bulb, its lower end **170***a* is disposed to enter neck portion **20***a*. If, upon lowering of guiding means **89** toward bulb **20**, the latter is not centered beneath conduit **88**, guiding means **89** is free to move laterally in any direction as soon as the outer rim of the flared portion clears the lower edge of box **166**; thus, accurate centering and alignment of conduit **88** with neck portion **20***a* is insured.

In order to remove solution **65** from bulb **20** to a precise level, it is first necessary to accurately relate the lengths of the various components, and the spacings thereof. This is accomplished in the present instance by accurately selecting the distance that conduit **88** projects below the free ends **172** of strap **160** to correspond with the precisely determined spacing of top surface **167***a* above conveyor **21**, against which faceplate **20***b* is disposed. As the entire assemblage is lowered, collar **170** first lands on top surface **167***a* and then strap end surface **172** abuts against the upper end of sleeve **164**. This accordingly limits downward movement of lower end **170***a* to a precise distance above conveyor **21**.

If a small diameter tube is utilized for conduit **88**, accurate siphoning is readily obtained. However, for more rapid operation, it is desirable to use a fairly large diameter conduit **88**, perhaps substantially larger than ¼ inch in internal diameter. With a large diameter conduit, siphoning proceeds satisfactorily until the desired level is reached and air is drawn up into the conduit along with the solution. It is a characteristic of large diameter siphon conduits that when air is sucked up along with liquid, the air tends to break up the solution column being pulled upwardly and allows solution already drawn into the conduit to run back out of it; thus, it is difficult to obtain a precise siphon level with a large diameter conduit. This problem is obviated by providing means for preventing the flow of siphoned solution back out of the siphon conduit when the settling solution level drops below conduit lower end **170***a*. While a conventional check-valve, a magnetic valve, and the like may be employed in accordance with the present invention, it is preferred to utilize a cup-shaped member **180** affixed to conduit lower end **170** as shown in Figure 3B. Member **180** is disposed with its open end **181** uppermost and in covering relation to conduit lower end portion **170***a*, the rim **182** of member **180** being above the extreme lower end **183** of conduit **88**. The cup-shaped member is affixed to conduit **88** by webs **185** affixed to a collar **186** pressed onto lower end portion **170***a*. The undersurface of member **180** preferably is tapered conically to a point to minimize dripping of the solution from the undersurface as member **180** is pulled out of the bulb by causing solution on the undersurface to rapidly drip off the point immediately as member **180** leaves the solution surface.

As solution **65** is drawn upwardly through conduit **88**, the level of the solution in the bulb drops until it is even with rim **182**; thereupon the level of solution within member **180** is decreased by the continuing action of the siphon. However, as soon as a small amount of air is drawn into the bottom end **183** of conduit **88**, the solution begins to run backwardly out of the conduit and again covers conduit end **183** whereupon an unbroken column of solution is re-established within the conduit. In operation, after the level of solution **65** within bulb **20** is brought down even with the level of rim **182**, the level of solution within member **180** continuously fluctuates just above and just below conduit end **183**; the solution within the conduit thus is prevented from running back out over rim **182**. A listener can hear a "slurping" sound as the solution column within conduit **88** is alternately disrupted and again re-established. It will be evident that the combination of distances selected as above described for accurately positioning the bottom end of conduit **88** at a selected distance above conveyor **21** likewise accurately positions the level of rim **182** above the conveyor. Therefore, the combination of cup-shaped member **180** with an exacting selection of dimensions renders the siphon capable of drawing off solution **65** down to a level spaced precisely above the conveyor.

While various types of suction pumps may be utilized in cooperation with conduits **80** and **88**, considerable difficulty has been encountered in maintaining operation of conventional siphoning systems because of the highly corrosive and precipitative effects of conventional settling solutions on the operating parts of the system. Figures 4 and 4A illustrate a siphon system which avoids chemical reactions between settling solution **65** and the driving solution utilized in a suction producing means. The very simple and economical arrangement shown in Figure 4

requires only a reservoir **190** containing used settling solution **65***a* and into which is immersed a pump **191** driven by a motor **192**. Solution drawn out of reservoir **190** by pump **191** is driven by way of a line **193** through parallel connected Venturi-tubes **194** and **195**. Each Venturi-tube has a drive inlet **196**, a suction inlet **197** and an outlet **198**. The suction inlet of Venturi-tube **194** is connected to hose **93**, while the suction inlet of Venturi-tube **195** is connected to hose **86** (Figure 1).

The operation of a Venturi-tube is well known; as shown in Figure 4A, the driving solution is forced through a restrictive nozzle **199** from which it emerges as a high-velocity stream which is directed through a converging chamber **200** toward outlet **198**. The action of the Venturi-tube is to produce a suction in a duct **201** communicating with chamber **200** and which in turn produces a suction at inlet **197**. Ordinarily, water from commercial mains is utilized to operate such a Venturi-tube siphon system; however, the settling solutions utilized in the screening steps chemically react with ordinary water to produce precipitants which quickly clog Venturi-tubes **194** and **195**. The present system avoids such chemical reaction by the expedient of using the same solution drawn from bulbs **20** as a driving solution for the Venturi-tubes. The driving solution is driven through Venturi-tubes **194** and **195** and is returned to the reservoir from outlets **198** through a duct **198***a* along with the freshly siphoned solution drawn through hoses **86** and **93**. Since the amount of solution in reservoir **190** is continually being increased, an overflow drain **202** is provided on the reservoir.

Figure 5 shows in detail the film dispenser mentioned above with respect to Figure 1 and comprising a conduit **100** suspended from a flexible linkage **102**. Figure 5 also illustrates a guiding means **106** which is a modified form of guiding means **89** shown and described with respect to Figures 3 and 3A. In this instance, guiding means **106** utilizes an identical sleeve **164** secured to an inverted funnel-shaped member **165** slidable within a box **166** affixed to floor **70***a* and having a hole **167** in its top surface **167***a*. Also, sleeve **164** has the same collar **170** adapted to land on surface **167***a* and which, in cooperation with the upper end of sleeve **164** and the different vertical dimensions, limits downward movement of first the guiding means and then conduit **100** to predetermined positions. The difference between guiding means **106** and **89** resides in the type of lost-motion connection between guiding means **106** and conduit **100**. In this instance, conduit **100** is carried at its upper end portion **210** by means including a housing **211** hooked onto flexible chain **102**. The bottom surface **212** of housing **211** abuts against the upper end of sleeve **164** to limit downward movement of conduit **100** and thereby to determine the lowermost position of the conduit lower end **214**. Flexible means such as chains **215** is connected between bottom surface **212** and collar **170**; as shown in Figure 5 wherein conduit **100** is in its lower position, chain **215** is slack, the excess links piling on top of collar **170**. However, as flexible linkage **102** pulls the conduit upwardly, chain **215** becomes taut after conduit lower end **214** is raised to a position above neck **20***a* and, as conduit **100** continues to move upwardly, guiding means **106** also is raised free of neck portion **20***a*, so that, after the withdrawal of conduit **100**, carriage **70** may be moved back to its initial position ready for the next cycle. For guiding conduit **100** within sleeve **164**, a pair of bearings **217** and **218** are secured respectively within the upper and lower parts of sleeve **164**.

More particularly with respect to the film dispenser itself, reservoir **101** is relatively wide as compared with its height, the upper end of conduit **100** being coupled into the bottom of reservoir **101** so that film solution **220** stored therein flows downwardly from reservoir **101** through conduit **100**. For controlling the flow of film solution **220** through conduit **100**, a special valve is disposed in conduit lower end portion **214**. As shown in detail in Figure 5A, this valve comprises a valve stem **222** which is journaled in the bore of and cooperates with a hollow valve cylinder **223** pressed within lower conduit end **214**. Valve stem **222** is an elongated rod extending through reservoir **101** and coupled at its top end by a lever **224** to air-cylinder **107** which, when actuated by compressed air from source **108**, causes valve stem **222** to rotate. Near the lower end of valve stem **222** is a longitudinal groove **225**. Another groove **226** is cut longitudinally partially along the bore of valve cylinder **223**; groove **225** is positioned on valve stem **222** to span the remaining, ungrooved portion of valve cylinder **223** when valve stem **222** is turned to vertically align grooves **225** and **226**. Valve stem **222** is of a diameter less than the internal diameter of conduit **100** so as to provide a space **227** which is filled with solution from reservoir **101**. With valve stem **222** turned as shown in Figure 5A, the flow of solution in conduit **100** is prevented; however, when valve stem **222** is turned to align grooves **225** and **226**, solution flows from space **227** through grooves **225** and **226** from where it is conducted downwardly through a duct **228** running through a plug **229** pressed into conduit **100** below valve cylinder **223**.

The above described film dispenser achieves success in its operation for several reasons. The problem is to very evenly and smoothly apply the film solution onto the surface of settling solution **65**. First of all, solution **65** is accurately siphoned down to a precisely controlled level which is controlled through the cooperation of accurate vertical dimensioning of conduit **88** and guiding means **89** and the similar accurate positioning of film dispenser conduit **100** by accurately dimensioning the latter with respect to the vertical dimensioning of guiding means **106** together with correlating the levels of top surfaces **167***a* associated respectively with each of the guiding means **85**, **89** and **106**. As a result of this cooperation between the siphoning and the positioning of lower conduit end **214**, the bottom end **230** of duct **228** is disposed only slightly above the surface of solution **65** so that film solution flows through duct **228** smoothly onto the settling solution and does not cause appreciable ripple on the latter. Another leading factor contributing to the success of the film dispenser is the valve comprising stem **222** and cylinder **223**; as stem **222** is rotated to move grooves **225** and **226** out of alignment and thereby terminate film solution flow, the column of film solution is sliced laterally. The result of cleanly severing the column of film solution is to terminate its flow without imparting increased velocity to the film solution remaining just below the valve, which increased velocity, if permitted, tends to propel the last drop or two of film solution into the settling solution whereupon uneven distribution of the film solution occurs. Another important aspect of the above described film dispenser is the maintenance of a substantially constant head of pressure on film solution **220**. In use, reservoir **101** is of a capacity to store solution for a long period of time, preferably for at least a regular work-shift of the attending personnel. The pool of film solution **220** contained in reservoir **101** is substantially greater in width than in height, while conduit **100** preferably is many times as long as the height of film solution in reservoir **101**; the length of conduit **100** preferably is well over an order of magnitude greater than the height of stored solution. As a result, the variation in the height of the film solution stored in reservoir **101** is but a very small percentage of the total length of the film dispensing apparatus and, hence, the pressure imparting downward movement to the film solution remains substantially constant during long periods of operation. Therefore, by controlling the action of air-cylinder **107** to hold the film solution valve in its open position for a constant time interval, a very closely controlled amount of film solution is always dispensed onto the settling solution surface. The control of the air-cylinder may be accomplished by any of numerous well known timing devices which may be either electrically or mechanically operated.

In a commercial embodiment of the invention which has been operated steadily for several months while producing screened and filmed cathode-ray tubes at a commercially profitable and competitive shrinkage rate, the following typical parameters are employed. Bulbs **20** are spaced approximately 20 inches apart on conveyor **21** which is moving uniformly at a speed of approximately 1¼ feet per minute. In the first step of the process, a conventional 21 inch cathode-ray tube bulb is filled with about 22.5 liters of a deionized water-electrolyte settling solution dispensed through conduit **38**. In the next step of the process, the powder slurry dispensed through conduit **55** is a mixture of 7.7 grams of commercial-grade fluorescent powder and 215 milliliters of potassium silicate in 500 milliliters of deionized water. Rough siphon conduit **80** is spaced from powder dispensing conduit **55** by a distance such that the powder is permitted to settle for approximately 14 minutes. The rough siphon then takes the settling solution level down to about 2¼ inches above conveyor **21** after which fine siphon conduit **88** removes the settling solution down to a precise level above conveyor **21** whereupon the depth of the remaining solution is about two inches. Film dispensing conduit **100** is subsequently lowered to dispose lower end **230** of duct **238** exactly ⅛ inch above the settling solution surface whereupon a few small drops, representing a fraction of one milliliter, of nitrocellulose lacquer, the film solution, is applied onto the settling solution surface. Reservoir **101** is approximately one inch in height and six inches in diameter, while conduit **100** is approximately 50 inches long. It must be emphasized that close attention to detail is required to produce satisfactory screening and filming.

Each of the above described features of the present invention contributes significantly to the overall success of the apparatus and all cooperate in the achievement of this success. The guiding means **50**, **59**, **85**, **89** and **106** not only accurately guide the different conduits into bulbs **20** but they cooperate with the conduits, particularly conduits **88** and **100**, to accurately control the spacing of conduit **100** above the level of settling solution **65** during the film dispensing step of the process. The synchronizing system enables each of the different conduits to be moved along uniformly with bulbs **20** during each of the different steps of the process. The recirculation suction system, wherein the solution used for driving the suction producing means is the same as that solution which is being drawn through the latter means, enables continuous operation of the suction system and hence of the entire apparatus since all parts thereof must be capable of sustained operation. It will thus be seen that there has been disclosed a screening and filming apparatus which is capable of producing cathode-ray tubes continuously day after day with only a minimum of attention and which requires only routine maintenance to moving parts.

While a particular embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. Accordingly, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a machine wherein a movable carriage member supports apparatus utilized for applying luminescent screens to a cathode-ray tube bulb carried on a conveyor member moving at a predetermined speed, a system for synchronizing movement of said carriage with that of said conveyor comprising: means including a hydraulic actuator for moving said carriage member; valve means coupled to said actuator; an operating element, movable with one of said members, for said valve means; and means, including a cam-surface movable with the other of said members and engageable with said operating element, for actuating said valve means to effect an increase in carriage speed when said carriage lags behind said conveyor and to effect a decrease in carriage speed when said carriage leads said conveyor.

2. In a machine wherein a movable carriage member supports apparatus utilized for applying luminescent screens to a cathode-ray tube bulb carried on a conveyor member moving at a predetermined speed, a system for synchronizing movement of said carriage with that of said conveyor comprising: means including a hydraulic actuator for moving said carriage; a valve operating element movable with one of said members; means, including a valve coupled to said actuator, responsive to movement of said operating element in a first direction for effecting an increase in the speed of movement of said carriage and responsive to movement of said operating element in a second direction for effecting a decrease in said carriage movement speed; and means defining a cam-surface, movable with the other of said members and disposed to come into engagement with said operating element, for moving the latter in said first direction when said conveyor is moving faster than said carriage and for moving said operating element in said second direction when said carriage is moving faster than said conveyor.

3. In a machine wherein a movable carriage member supports apparatus utilized for applying luminescent screens to a cathode-ray tube bulb carried on a conveyor member moving at a predetermined speed, a system for synchronizing movement of said carriage with that of said conveyor comprising: means including a hydraulic actuator for moving said carriage; valve means coupled to said actuator; an operating element, movable with one of said members, for said valve; means, including a cam-surface movable with the other of said members and engageable with said operating element, for effecting an increase in carriage speed when said carriage lags behind said conveyor and for effecting a decrease in carriage speed when said carriage leads said conveyor; and means, including a stationary cam-surface engageable with said operating element when said carriage reaches a limit position in the travel thereof, for causing a reversal in carriage movement direction.

4. In a machine wherein a movable carriage member supports apparatus utilized for applying luminescent screens to a cathode-ray tube bulb carried on a conveyor member moving at a predetermined speed, a system for synchronizing movement of said carriage with that of said conveyor comprising: means including a hydraulic actuator for moving said carriage; a valve operating element movable with one of said members; means, including a valve coupled to said actuator, responsive to movement of said operating element less than a predetermined amount in a first direction for effecting an increase in the speed of movement of said carriage, responsive to movement of said operating element in a second direction for effecting a decrease in said carriage movement speed, and responsive to movement of said operating element more than said predetermined amount in said first direction for effecting a reversal in direction of movement of said carriage; means defining a first cam-surface, movable with the other of said first members and disposed to engage said operating element, for moving the latter less than said predetermined amount in said first direction when said conveyor is moving faster than said carriage and for moving said operating element in said second direction when said carriage is moving faster than said conveyor; and stationary means defining a second cam-surface disposed to engage said operating element when said carriage reaches a limit position in the travel thereof for moving said operating element more than said predetermined amount in said first direction to cause a reversal in carriage movement direction.

5. In a machine wherein a movable carriage member supports apparatus utilized for applying luminescent

screens to a cathode-ray tube bulb carried on a conveyor member moving at a predetermined speed, a system for synchronizing movement of said carriage with that of said conveyor comprising: means including a hydraulic actuator for moving said carriage; a valve operating element movable with one of said members; means, including a valve coupled to said actuator, responsive to movement of said operating element less than a predetermined amount in a first direction for effecting an increase in the speed of movement of said carriage, responsive to movement of said operating element less than a predetermined amount in a second direction for effecting a decrease in said carriage movement speed, and responsive to movement of said operating element more than said predetermined amount for effecting a reversal in direction of movement of said carriage; means defining a first cam-surface, movable with the other of said members and disposed to come into engagement with said operating element, for moving the latter less than said predetermined amount in said first direction when said conveyor is moving faster than said carriage and for moving said operating element less than said predetermined amount in said second direction when said carriage is moving faster than said conveyor; and stationary means defining a second cam surface disposed to engage said operating element when said carriage reaches a limit position in the travel thereof for moving said operating element more than said predetermined amount to cause a reversal in carriage movement direction.

6. In an apparatus wherein a conduit carried on a movable carriage member is utilized to dispense a film solution onto a settling solution contained within a cathode-ray tube bulb carried with its neck portion uppermost on a conveyor member moving at a predetermined speed, a system for moving said conduit in synchronism with said bulb during dispensing of said film solution, said system comprising: means including a hydraulic actuator for moving said carriage; valve means coupled to said actuator; an operating element, movable with one of said members, for said valve; means, including a cam-surface movable with the other of said members and engageable with said operating element, for effecting an increase in carriage speed when said carriage lags behind said conveyor and for effecting a decrease in carriage speed when said carriage leads said conveyor, whereby said carriage is moved at said predetermined speed; means, including a conduit, for dispensing said film solution in substantially constant predetermined quantities; and means on said carriage for projecting and withdrawing the lower end of said conduit into and out of said bulb through said neck portion during movement of said carriage at said predetermined speed.

7. In an apparatus wherein a conduit carried on a movable carriage member is utilized to dispense a film solution onto a settling solution contained within a cathode-ray tube bulb carried with its neck portion uppermost on a conveyor member moving at a predetermined speed, a system for moving said conduit in synchronism with said bulb during dispensing of said film solution, said system comprising: means including a hydraulic actuator for moving said carriage; valve means coupled to said actuator; an operating element, movable with one of said members, for said valve; means, including a cam-surface movable with the other of said members and engageable with said operating element, for effecting an increase in carriage speed when said carriage lags behind said conveyor and for effecting a decrease in carriage speed when said carriage leads said conveyor, whereby said carriage is moved at said predetermined speed; means including a conduit for storing a body of said film solution under a substantially constant head of pressure; means on said carriage for projecting and withdrawing the lower end of said conduit into and out of said bulb through said neck portion during movement of said carriage at said predetermined speed; and valve means disposed in said conduit for slicing laterally through film solution flowing through said conduit to terminate the flow of said film solution without imparting increased velocity thereto.

8. An apparatus for dispensing a film solution onto the surface of a settling solution contained within a cathode-ray tube bulb supported with its neck portion uppermost, said apparatus comprising: means, including a conduit, for dispensing said film solution in substantially constant predetermined quantities; an actuator coupled through a flexible linkage to the upper end of said conduit for effecting vertcal movement of the lower end of said conduit between an upper position above said neck portion and a lower position below said neck portion; means, including a downwardly and outwardly tapering cam surface engageable with said neck portion, adapted to telescope over said conduit for guiding said lower end into said neck portion; and means including a lost-motion connection coupling said guiding means to said conduit for raising said guiding means as said conduit lower end is moved from said lower position to said upper position and, as said conduit lower end is moved from said upper position toward said lower position, for limiting downward movement of said guiding means to a predetermined position about said neck portion while permitting continued downward movement of said conduit to a position at which said lower end is a selected distance above said settling solution surface.

9. An apparatus for dispensing a film solution onto the surface of a settling solution contained within a cathode-ray tube bulb supported with its neck portion uppermost, said apparatus comprising: means including a conduit for storing a body of said film solution under a substantially constant head of pressure; an actuator coupled through a flexible linkage to the upper end of said conduit for effecting vertical movement of the lower end of said conduit between an upper position above said neck portion and a lower position below said neck portion; means, including a downwardly and outwardly tapering cam surface engageable with said neck portion, adapted to telescope over said conduit for guiding said lower end into said neck portion; means including a lost-motion connection coupling said guiding means to said conduit for raising said guiding means as said conduit lower end is moved from said lower position to said upper position and, as said conduit lower end is moved from said upper position toward said lower position, for limiting downward movement of said guiding means to a predetermined position about said neck portion while permitting continued downward movement of said conduit to a position at which said lower end is a selected distance above said settling solution surface; and valve means disposed in said conduit for slicing laterally through film solution flowing through said conduit to terminate the flow of said film solution without imparting increased velocity thereto.

10. In an apparatus for applying a luminescent screen to a cathode-ray tube bulb supported with its neck portion uppermost, the combination comprising: a conduit adapted to convey materials utilized in applying said screen; an actuator coupled through a flexible linkage to the upper end of said conduit for effecting vertical movement of the lower end of said conduit between an upper position above said neck portion and a lower position below said neck portion; means, including a downwardly and outwardly tapering cam surface engageable with said neck portion, adapted to telescope over said conduit for guiding said lower end into said neck portion; and means including a lost-motion connection coupling said guiding means to said conduit for raising said guiding means as said conduit lower end is moved from said lower position to said upper position and, as said conduit lower end is moved from said upper position toward said lower position, for limiting downward movement of

said guiding means to a predetermined position about said neck portion while permitting continued downward movement of said conduit.

11. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost, a siphon system for removing settling solution from said bulb comprising: a conduit disposed above said cathode-ray tube bulb; means coupled to said conduit for producing suction at the lower end thereof; an actuator coupled through a flexible linkage to the upper end of said conduit for effecting vertical movement of the lower end thereof between an upper position above said neck portion and a lower position below said neck portion; means, including a downwardly and outwardly tapering cam surface engageable with said neck portion adapted to telescope over said conduit for guiding said lower end into said neck portion; and means including a lost-motion connection coupling said guiding means to said conduit for raising said guiding means as said conduit lower end is moved from said lower position to said upper position and, as said conduit lower end is moved from said upper position toward said lower position, for limiting downward movement of said guiding means to a predetermined position about said neck portion while permitting continued downward movement of said conduit into said settling solution.

12. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost on a conveyor member disposed at a predetermined level, a siphon system for removing settling solution from said bulb comprising: a conduit disposed above said cathode-ray tube bulb; means coupled to said conduit for producing suction at the lower end thereof; an actuator coupled through a flexible linkage to the upper end of said conduit for effecting vertical movement of said lower end thereof between an upper position above said neck portion and a lower position below said neck portion; means, including a downward and outwardly tapering cam surface engageable with said neck portion, adapted to telescope over said conduit for guiding said lower end into said neck portion; means including a lost-motion connection coupling said guiding means to said conduit for raising said guiding means as said conduit lower end is moved from said lower position to said upper position and, as said conduit lower end is moved from said upper position toward said lower position, for limiting downward movement of said guiding means to a predetermined position about said neck portion while permitting continued downward movement of said conduit into said settling solution to a position at which said lower end is a selected distance above said predetermined level; and means for preventing siphoned solution flow in a reverse direction back out of said conduit.

13. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost, a system for removing settling solution from said bulb comprising: fluid operated suction means having a suction-inlet, a drive-inlet, and an outlet; a conduit coupled to said suction inlet and having its lower end adapted to project through said neck into said bulb; an actuator coupled through a flexible linkage to the upper end of said conduit for effecting vertical movement of said lower end of said conduit between an upper position above said neck portion and a lower position below said neck portion; means, including a downwardly and outwardly tapering cam surface engageable with said neck portion, adapted to telescope over said conduit for guiding said lower end into said neck portion; means including a lost-motion connection coupling said guiding means to said conduit for raising said guiding means as said conduit lower end is moved from said lower position to said upper position and, as said conduit lower end is moved from said upper position toward said lower position, for limiting downward movement of said guiding means to a predetermined position about said neck portion while permitting continued downward movement of said conduit to immerse said lower end into said settling solution; a reservoir, containing used settling solution, coupled to said drive-inlet to deliver solution thereto and coupled to said outlet to receive solution therefrom; means for driving used settling solution from said reservoir through said suction means to effect suction at said suction-inlet, whereby the same solution drawn from said bulb through said conduit is utilized as a driving fluid in said suction means; and means for removing excess used settling solution from said reservoir.

14. In an apparatus wherein a conduit carried on a movable carriage member is utilized to remove settling solution from a cathode-ray tube bulb carried with its neck portion uppermost on a conveyor member moving at a predetermined speed, a system for moving said conduit in synchronism with said bulb during removal of said solution, said system comprising: means including a hydraulic actuator for moving said carriage; valve means coupled to said actuator; an operating element, movable with one of said members, for said valve; means, including a cam-surface movable with the other of said members and engageable with said operating element, for effecting an increase in carriage speed when said carriage lags behind said conveyor and for effecting a decrease in carriage speed when said carriage leads said conveyor, whereby said carriage is moved at said predetermined speed; means on said carriage for projecting and withdrawing the lower end of said conduit into and out of said bulb through said neck portion during movement of said carriage at said predetermined speed; means coupled to said conduit for producing suction at said lower end thereof; means for preventing siphoned solution flow in a reverse direction back out of said conduit; and means for limiting downward movement of said conduit to a position at which said lower end is a selected distance above said conveyor member, whereby, when said lower end is disposed at said position, solution within said bulb is drawn out only to the level of said lower end.

15. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost on a conveyor member disposed at a predetermined level, a siphon system for removing settling solution from said bulb comprising: a conduit adapted for vertical movement to project and withdraw its lower end into and out of said bulb through said neck; means coupled to said conduit for producing suction at said lower end; means for preventing siphoned solution flow in a reverse direction back out of said conduit; and means for limiting downward movement of said conduit to a position at which said lower end is a selected distance above said predetermined level, whereby, when said lower end is disposed at said position, solution within said bulb is drawn out only to the level of said lower end.

16. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost on a conveyor member disposed at a predetermined level, a siphon system for removing settling solution from said bulb comprising: fluid operated suction means having a suction-inlet, a drive-inlet, and an outlet; a conduit coupled to said suction-inlet and adapted for vertical movement to project its lower end through said neck portion into said settling solution; means for preventing siphoned solution flow in a reverse direction back out of said conduit; a reservoir, containing used solution, coupled to said drive-inlet to receive solution therefrom; means for driving used settling solution from said reservoir through said suction means to effect suction at said suction-inlet, whereby the same solution drawn from said bulb through said conduit is utilized as a driving fluid in said suction means; means for removing excess used settling solution from said reservoir; and means for limiting downward movement of said conduit to a position at which said lower end is a selected distance

above said predetermined level, whereby, when said lower end is disposed at said position, solution within said bulb is drawn out only to the level of said lower end.

17. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost, a system for removing settling solution from said bulb comprising: fluid operated suction means having a suction-inlet, a drive-inlet, and an outlet; a conduit with one end adapted for movement to project said one end through said neck into said bulb to immerse said one end into said settling solution and coupled at its other end to said suction-inlet; a reservoir, containing used settling solution, coupled to said drive-inlet to deliver solution thereto and coupled to said outlet to receive solution therefrom; means for driving used settling solution from said reservoir through said suction means to effect suction at said suction-inlet, whereby the same solution drawn from said bulb through said conduit is utilized as a driving fluid in said suction means; and means for removing excess used settling solution from said reservoir.

18. In an apparatus for applying luminescent screens to a cathode-ray tube bulb supported with its neck portion uppermost, a system for removing settling solution from said bulb comprising: a Venturi-tube having a suction-inlet, a drive-inlet, and an outlet; a conduit with one end adapted to project through said neck into said bulb and coupled at its other end to said suction-inlet; a reservoir, containing used settling solution, coupled to said drive-inlet to deliver solution thereto and coupled to said outlet to receive solution therefrom; means for driving used settling solution from said reservoir through said Venturi-tube to create suction at said suction inlet, whereby the same solution drawn from the bulb through said conduit is utilized as a driving fluid in said Venturi-tube; and means for removing excess used settling solution from said reservoir.

19. In an apparatus for applying a film solution onto a settling solution contained within a cathode-ray tube bulb supported with its neck portion uppermost on a conveyor member disposed at a predetermined level, said apparatus comprising: a first conduit adapted for vertical movement to project and withdraw the lower end of said conduit into and out of said bulb through said neck; means coupled to said first conduit for producing suction at said lower end; means for preventing siphoned solution flow in a reverse direction back out of said conduit; means for limiting downward movement of said first conduit to a position at which said lower end thereof is a selected distance above said predetermined level, whereby, when said lower end is disposed at said position, settling solution within the bulb is drawn out only to the level of said lower end; means, including a second conduit, for dispensing said film solution in substantially constant predetermined quantities; means for projecting the lower end of said second conduit into said bulb after withdrawal of said first conduit therefrom; and means for limiting downward movement of said second conduit to a position at which said lower end thereof is spaced above said predetermined level by a distance slightly greater than said selected distance.

20. In an apparatus for applying a film solution onto a settling solution contained within a cathode-ray tube bulb supported with its neck portion uppermost on a conveyor member disposed at a predetermined level, said apparatus comprising: a first conduit adapted for vertical movement to project and withdraw the lower end of said conduit into and out of said bulb through said neck; means coupled to said first conduit for producing suction at said lower end; means for preventing siphoned solution flow in a reverse direction back out of said conduit; means for limiting downward movement of said first conduit to a position at which said lower end thereof is a selected distance above said predetermined level, whereby, when said lower end is disposed at said position, solution within said bulb is drawn out only to the level of said lower end; means including a second conduit for storing a body of said film solution under a substantially constant head of pressure; means for projecting the lower end of said second conduit into said bulb after withdrawal of said first conduit therefrom; means for limiting downward movement of said second conduit to a position at which said lower end thereof is spaced above said predetermined level by a distance slightly greater than said selected distance; and valve means disposed in said second conduit for slicing laterally through film solution flowing therethrough to terminate the flow of said film solution without imparting increased velocity thereto.

21. An apparatus for dispensing a film solution onto a settling solution contained within a cathode-ray tube bulb supported with its neck portion uppermost, said apparatus comprising: means including a conduit for storing a body of said film solution under a substantially constant head of pressure; means for projecting and withdrawing one end of said conduit into and out of said bulb through said neck portion; and valve means disposed in said conduit for slicing laterally through film solution flowing through said conduit to terminate the flow of said film solution without imparting increased velocity thereto.

22. An apparatus for dispensing a film solution onto a settling solution contained within a cathode-ray tube bulb supported with its neck portion uppermost, said apparatus comprising: means including a reservoir for storing said film solution in a pool substantially greater in width than in height; a conduit communicating with said reservoir and projecting downwardly therefrom, said conduit having a length at least an order of magnitude greater than the height of solution in said reservoir; means supporting said reservoir above said bulb and adapted to raise and lower the reservoir to project and withdraw the lower end of said conduit into and out of said bulb through said neck; and valve means disposed in said conduit for slicing laterally through film solution flowing downwardly therethrough to terminate the flow of said film solution without imparting increased velocity thereto.

23. In an apparatus for applying luminescent screens to a cathode-ray bulb supported with its neck portion uppermost, a dispenser for applying a film solution onto a settling solution contained within said bulb and having a vertically disposed conduit adapted to project and withdraw its lower end into and out of said bulb through said neck, said dispenser comprising: a reservoir, coupled at its bottom to the upper end of said conduit and substantially greater in width than in height, for storing said film solution; a valve disposed within said conduit for controlling the flow of film solution therethrough and comprising a hollow cylinder seated within said conduit and having a longitudinal groove in the bore thereof extending from one end of the cylinder partially along the length thereof, and a rod journaled in said cylinder and having a longitudinal groove extending along the surface thereof and adapted to span the portion of said bore between the groove therein and the other end of said cylinder; and means for turning said rod relative to said cylinder, whereby, a column of film solution flowing through said grooves when the latter are positioned in vertical alignment is severed laterally upon relative movement of said rod and cylinder to move said grooves out of vertical alignment.

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