The present invention relates to article-handling devices, and particularly to operating mechanisms for imparting special motions to such article-handling devices. The invention is especially advantageous for lifting and spinning television picture tubes during their manufacture to facilitate the application of internal conductive coatings to the tube envelopes.

The handling of television picture tubes has been a troublesome problem, particularly in mass production situations, since the tubes ordinarily include fragile materials such as glass in their structure. The problem is complicated by the odd configuration of the body, which usually includes an elongated, slender neck section for the support of an electron gun. With the recent advent of large size picture tubes having screens as large as 27" or 30" and weighing 40 pounds or more, the difficulties in transferring, lifting, and holding the tubes for various manufacturing steps have become more pronounced. These operations often necessitate resort to specially designed, complex mounting chucks, each commensurate in size with a given picture tube, and necessitate the employment of operators capable of lifting, positioning, and then manipulating the chuck locking arrangements. These as well as other disadvantages have established the need for simplified apparatus facilitating tube handling in a manner compatible with mass production of picture tubes at relatively low unit cost.

One such handling situation occurs during picture tube production at the station on the production line at which an internal coating of graphite in a colloidal suspension, referred to as "equadag," is applied to prescribed regions of the tube envelope. This coating step is ordinarily accomplished while holding the tube envelope inverted at an angle of approximately 45° with respect to the horizontal. Thereafter, while the tube is still spun about its longitudinal axis, an operator applies the coating to the interior of the tube envelope by means of a hand-held, elongated brush. Herefore it has been necessary to employ manual labor to transfer the tube envelope from a conveyor to a downwardly inclined chuck by which the envelope is received, held, and rotated during the coating operation.

The present invention eliminates many of the above described handling steps by providing novel mechanisms for automatically lifting the various sized picture tubes from a support, transferring the picture tubes to a coating position, axially spinning the so-transferred picture tubes, and then returning the coated blanks to the support from which they had been taken.

In accordance with one aspect of the invention, a lifting apparatus at the production line coating station is provided with a vacuum chuck which grips a picture tube blank with a suction force sufficient to hold it and to preclude inadvertent release by jarring, etc. The vacuum chuck is mounted for controlled movement away from the loading position at which the vacuum chuck grips the picture tube, to a coating position at which the picture tube is angularly disposed, appropriate mechanisms being provided for spinning the picture tube while in the angular position. Provision is made for return of the coated tube to the unloading position. As a specific feature, the picture tubes are initially supported in an inverted (truck down) condition on individual crate-like supports which preferably form part of an automatic conveyor for intermittently moving successive tubes into loading position relative to the vacuum chuck.

Once a given tube is in loading position at the coating station, mechanisms are provided for grasping the tube blank with the vacuum chuck and then moving the tube from the loading to the coating positions. The mechanism insures that the fragile depending neck of the cathode ray tube blank adequately clears the structure of the chuck and that the tube is then properly positioned for convenient application of the coating by a hand positioned brush.

In accordance with a further aspect of the present invention, a lifting motion for the vacuum chuck is obtained by the provision of structures imparting compound movements to the vacuum chuck. The rate of turning during a first interval of lifter is selected to assure removal of the picture tube without contact with the conveyor support, while the rate of turning during a second interval of lift is selected to obtain rapid displacement into the angularly offset coating position.

The above and still further features, objects, and advantages of the present invention will become more apparent upon reference to the following detailed description of an illustrative embodiment when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a view in elevation, with parts broken away and shown in section, showing a cathode ray tube handling unit embodying features of the present invention, with the vacuum chuck or head in a loading position relative to a conveyor-supported picture tube, and with an intermediate position of the apparatus during travel away from the conveyor support illustrated by the broken lines;

Fig. 2 is a fragmentary view in elevation showing the supported picture tube in an intermediate position of clearance with respect to the conveyor support, the position of the tube while in the loading position being illustrated by the broken lines; and,

Fig. 3 is an elevational view similar to Fig. 2 showing the picture tube angularly offset and in position for the coating operation.

Referring now to the drawings, and particularly to Fig. 1, there is shown a combined lift and spinning station 10 arranged to receive the picture tube blank P which is to be transported to the coating position. In the illustrative arrangement, the station 10 is associated with a conveyor 12 having tracks 13 along which a number of centrally permeated crate-like supports 12a carry individual picture tube blanks P with the picture tube faces f superposed and with the neck section n depending within the general outline of the conveyor 12. The conveyor 12 may be part of a production line having other cathode ray tube processing stations, such as screen setting and drying stations in advance of the coating station 10, and drying stations following the equadag coating station. In the interests of simplicity and clarity, further details of the conveyor 12 will be omitted. For the present purpose it suffices to point out that the conveyor 12 may be periodically indexed in timed relation to other operations, or under control of an operator, to bring successive picture tube blanks P into an appropriate position relative to the handling apparatus at the coating station 10.

The article handling apparatus at coating station 10 includes a vertical frame or standard 16 arranged at one side of the conveyor 12. A space 18 on the other side of the conveyor is kept free of equipment so as to pro-
vide an operator's station. The frame 16 of the illustrative embodiment is shown as having two vertical posts 16a interconnected by cross bars 16b.

The frame 16 supports a combined lift and spinning head 20 which is arranged in overlapping relation to the conveyor 12 and is mounted for movement along a prescribed path, as will subsequently be described. The combined lift and spinning head 20 supports a circular vacuum chuck 22 (shown here in cross-section along a diameter) which is mounted for spinning about its axis on a hollow shaft 24. The combined lift and spinning head 20 includes a box-like housing 26 having a front wall 27 which supports the forward-projecting bearings 28, the bearings being aligned to receive and support the axial vacuum chuck drive shaft 24.

The vacuum chuck or work holder 22 embodies flanged plate 23 anchored and hermetically sealed to the hollow shaft 24 and an annular elastic ring 25 mounted in an annular recess in plate 23. The ring 25, which may be made of rubber or other appropriate elastomer, may be provided with a lower face shaped to conform with the curvature of the face f of the picture tube. A partial vacuum is developed in the vacuum chuck 22 by a suitable pump and vacuum reservoir located at the aquadagging member of the housing 26 and journaled in the ends of the associated pivot arms or by means of a shaft common to the levers 32a, 32b and passing through the housing. The primary pivotal connection 36 to the combined lifting and spinning head 20 is located relative to the center of mass of the head 20 and associated supporting elements so as to cause the head 20 to exhibit a tendency to turn in a counter-clockwise direction relative to the pivotal connection 36. Rotation of the head 20 in counter-clockwise direction is limited, however, by the provision of suitable stops 38 or the like supported on the side walls of the housing 26 and engaging abutting portions of the pivot levers 32a, 32b. The position of the stops 38 relative to the abutting surfaces is selected to position the vacuum chuck 22 in horizontal abutment with the face f of picture tube P, when the pivot levers 32a, 32b are in their lowermost position.

The combined lifting and spinning head 20, maintained in the above described angular position relative to the pivotal connections 36 of the pivot levers 32a, 32b is moved along an arcuate path in a clockwise direction about the main pivot shaft 34 by means of a hydraulic lift mechanism 42 connected to the pivot levers 32a, 32b. This lift mechanism, of generally known type and as illustrated in Fig. 1, embodies a hydraulic cylinder 44 pivotally supported on the frame 16 and having a piston head (not shown) mounted therein for reciprocation. The piston head drives a piston shaft 46 which is pivotally connected to the cross shaft 48. Cross shaft 48 is common to the pivot levers 32a, 32b and is placed on the levers at a position intermediate the main rocking shaft 34 and the primary pivotal connection 36.

The lift mechanism 42 is incorporated in a closed hydraulic system, in accordance with principles and practices well understood per se. In the diagrammatic and illustrative showing of Fig. 1, the cylinder 44 is provided with appropriate conduits 49a, 49b which alternatively serve as inlets and outlets for the hydraulic fluid. The conduits are connected to a four-way valve, generally designated by the reference numeral 50, which includes double solenoid controls arranged to alternately permit the hydraulic fluid to enter the lower conduit 49a, with the upper conduit 49b serving as a fluid outlet, or to permit the fluid to enter the upper conduit 49b, while the lower conduit 49a serves as an outlet or return to the hydraulic drive system. The double-solenoid control valve 50 is operated by a control switch (not shown) arranged at the operator's station 18. The control switch for the hydraulic operating mechanism 42 may be disposed so that, upon depressing the foot treadle 52, the hydraulic fluid will enter the conduit 49a and drive the piston 56 upwardly to move the pivot levers 32a, 32b clockwise about the pivot shaft 34. This rocking motion will continue until such time as the operator removes his foot from the foot treadle, whereupon the lifting head 20 will be held in the position achieved at that instant (i.e. the coasting position of Fig. 3). At a later time, operation under control of the foot treadle 52 may be again instituted to allow the hydraulic fluid to enter the upper conduit 49b, returning the combined lifting and spinning head 20 to the tube pick-up position of Fig. 1. It is to be expressly understood that the control system 42 is illustrative and that numerous other systems may be employed. For example, in lieu of the worker at the operating location 18, the movement of the lifting and spinning head 20 may be appropriately coordinated into a completely automatic system.

In order to turn the combined lifting and spinning head 20 more rapidly after the neck of the cathode ray tube 51 is exploded, the foot treadle 52 is depressed. The foot treadle 52 is connected to the pump 53 by conduit 54. The conduit 54 is of air and gas permitting the foot treadle 52 to be relaxed without danger of explosion. The foot treadle 52 is arranged to close a switch 55 which in turn actuates the pump 53 to maintain the vacuum chamber 57 and associated components at a high vacuum level. Circuit 58 maintains a high vacuum level in the chamber 57 and associated components at a high vacuum level while the frame 16 is held in an intermediate position in the loading and unloading operations.
oted at one end on the pivot shaft 56 which extends trans-
versely of the frame 16 above the pivot arm pivot shaft 34. The pivot points 36 are pivot points 58 which, as seen in Fig. 1, are offset from the pivot arm pivot points 36. Each of the lost-motion linkages includes two slidably interconnected sections which cooperate, when not extended, to apply a turning movement to the lifting and spinning head 20, effective to cause rotation of the head about the pivot points 36. The interconnecting sections between the sections 54a, 54b of the collapsible links 54 are made by pins on the sections 54a received and free to travel within appropriate longitudinal slots on the sections 54b. The resulting structure produces a motion of the head which is the result of the pivot points 36 travelling along one arc, defined by the pivot arms 32a, 32b, and the link pivot points 58 travelling along another arc defined by the collapsed length of the sliding linkages 54.

Other types of lost-motion devices may be employed to effect delayed rotation of the head about its pivot points, the key requirement being that, after a given amount of travel of the head along an arc such as that provided by the pivot arms 32a, 32b, the head is then rotated about the pivot points 36 so as to increase the effective rate of rotation of the head away from its position of rest at the loading station. Such lost-motion devices would, for example, guide surfaces supported on either side of the head by suitable arms projecting from the standard 16. The guide surfaces would provide a track against which the link pivot shafts 58 would come to bear as the head was raised, and then would slidably guide the link pivot shafts along a prescribed path, as for example, a path having a fixed radius of curvatures about the point on the frame 16 presently occupied by the pivot shaft 56.

In any case, the location of the pivot shaft 58 on the head 20 is made considering the rate of turn of the head desired, and the action of the lost-motion device on the pivot shaft. In the illustrative embodiment, the rate of turn of the head 20 about the pivot points 36 is an inverse function (for any given rate of lift of the pivot arms 32a, 32b) of the distance between pivot points 36 and pivot shaft 58.

In the illustrative example, when the lifting and spinning head is in the loading position of Fig. 1, the lost-motion linkages 54 are inclined at an angle of approximately 25° with the horizontal. As the piston 46 of the hydraulic operating mechanism 42 drives the levers 32a, 32b, clockwise about the shaft 34, the head 20 is carried along without rotation about the pivot points 36. When the collapsible linkages 54 are carried to an approximately horizontal position, the respective linkage sections 54a, 54b are completely collapsed. At this point the head 20 is tilted at an angle of approximately 20° from the vertical and the depending neck n of the tube P has cleared the cradle-like support 12a. During the further travel of the pivot arms 32a, 32b through an angle of about 10°, the lifting and spinning head 20 is turned about the head pivot 36 as a result of pressure applied to the link pivots 58 by the linkages 54. In the illustrative example, the entire throw of the pivot arms 30a, 30b is approximately 30°, and the head 20 is pivoted to an angular offset position of approximately 45° with respect to the vertical. Thus, the picture tube blank is raised to the proper level and placed at the proper angle for the coating operation incident to contact with the support 12.

In order to axially spin the suction chuck 22 with the picture tube P supported thereon, a suitable drive motor 60 is supported on the movable head 20 and coupled to the drive shaft, as by the chain and sprocket drive 62. The motor is intermittently energized by circuitry (not shown) to effect spinning of the supported tube when in the coating position, the occurrence and duration of spinning being under control of the operator—as by foot pedal, for example. Since these details form no part of the present invention, further description is omitted.

An illustrative cycle of operation for the coating station 10 when employed for the application of aquadag to a television picture tube blank is substantially as follows:

With the picture tube indexed into the pick-up position illustrated in Fig. 1 by the individual support 12a of the conveyor 12, the operator standing at the station 10 operates the suctional pick-up operation of the treads 52. This operation activates a solenoid valve and connects the vacuum supply to the head 22 by means of the flexible conduit 29 appropriately coupled to the shaft 24. The picture tube lifting operation is then instigated by further depressing the foot treadle 52 which, through the four-way solenoid control valve 56, applies hydraulic pressure to the lower end of the cylinder 44 to drive the piston shaft 46 upwardly. During the first interval of turn of the head 20 about the primary rocking shaft 34, and while the lost-motion is allowed by the linkages 54, the head 20 remains in its original position relative to the pivot arms 32a, 32b. After arriving at the clearance position of Fig. 2, movement of the secondary control of the operating mechanism 42 continues and the head 20 begins to turn about the pivots 36 and relative to the pivot arms. When the head 20 reaches the tube coating position of Fig. 3, release of the foot treadle 52 interrupts the lifting motion and holds the tube firmly in place. Thenceforth, the operator, by depressing a further foot treadle or the like, causes axial spinning of the supported picture tube P about the axis of the shaft 24. When the coating operation is completed, spinning may be interrupted and the processed tube returned to the support 12a of the conveyor 12 by again depressing the foot treadle 52, releasing the pivot arms and returning the tube blank to the bulb carriage. When the coated tube blank has been restored to the support 12a with the appropriate coating thereon, the treadle 52 may be again operated to cause release of the tube P preparatory to indexing of the conveyor 12 to bring a further tube to the coating station 10.

What is claimed is:

1. In a picture tube processing machine, a support for accommodating a picture tube with the tube face uppermost, a head movable toward and away from said support, a vacuum chuck mounted on said head for axial rotation and engageable with said tube face in response to movement of said head toward said support, means for developing a suction force within said vacuum chuck when engaging said tube face, operating means connected to said head for moving said head away from said support and into a work position wherein the interior of said tube is accessible, and a drive including control means for periodically causing axial rotation of said vacuum chuck.

2. The combination with a conveyor including supports for moving a picture tube to a coating station, of a tube-lifting and spinning mechanism at said coating station for sequentially removing said picture tube from said support and imparting axial rotation to said picture tube, said mechanism including a head, a vacuum chuck including an elastomer gripping cup engageable axially of said picture tube, a hollow shaft fixed axially of and in communication with said vacuum chuck and mounting the latter on said head for spinning movement about an axis coinciding with the tube axis, means coupled to said hollow shaft for developing a partial vacuum within said vacuum chuck, actuating means on said head operatively connected to said hollow shaft for periodically spinning said vacuum chuck, and operating means connected to said head for moving the latter to a work position.

3. A station for applying a conductive coating to the inner walls of a picture tube having a picture face and a neck terminating in an open end comprising a cradle-like support accommodating a picture tube in inverted
condition, an assembly movable along a predetermined path for lifting said picture tube from said support and displacing said picture tube to an inclined position wherein the inner walls of said picture tube are accessible through the open end of said neck, said assembly including a vacuum chuck engageable against said tube face axially of said tube, a hollow shaft in communication with and mounting said vacuum chuck for rotation coaxially of said picture tube, means coupled to said hollow shaft for developing a partial vacuum within said vacuum chuck, and actuating means operatively connected to said assembly for moving same along said predetermined path, said actuating means including a standard adjacent to said support, and a lever arm turning on said standard having a pivotal connection to said assembly, a lost-motion linkage interposed between said standard and said assembly, and driving means operatively connected to said lever arm.

4. In a picture tube coating station, tube handling mechanisms for picking up a picture tube and moving said picture tube to a coating position, said picture tube handling mechanisms including a vacuum chuck adapted to be connected to exhausting means, and a head supporting said vacuum chuck and moving with it in compound rotational movement during movement into said coating position, a lever arm swingable about a first axis on said station and pivotably connected to said head, a lost-motion device on said station having a connection to said head, said lost-motion device being effective to turn said head relative to said lever arm after movement of said lever arm through a predetermined arc.

5. An article handling device for lifting an article from a support by a compound movement comprising a work holder adapted for engagement with said article, a lifting head attached in fixed relationship to said work holder, a standard, a linkage pivotly attached at one end to said standard and pivotly attached at the other end to said head for imparting arcuate displacement of the article from the support, and an arm pivotly attached to said standard at a point spaced vertically below said linkage and pivotly attached to said head vertically above said linkage for imparting a second arcuate displacement of the article from the support.

6. An article handling device for lifting an article from a support by a compound movement comprising a work holder adapted for engagement with said article, a lifting head affixed to said work holder, means mounted upon said head for axially rotating said work holder, a linkage pivotly connected to said head for imparting arcuate displacement of the article from the support, and an arm pivotly connected to said head for imparting a second arcuate displacement of the article from the support.

7. An article handling device for lifting an article from a support by a compound movement comprising a work holder adapted for engagement with said article, a lifting head attached to said work holder in fixed relationship, controllable means mounted on said head for axially rotating said work holder, a standard, an actuating device affixed at one end to the standard, a slideable linkage pivotly attached at one end to said standard and at the opposite end to said head for imparting arcuate displacement of the article from the support, and a bell crank lever, one point of said crank being pivotly attached to said standard, a second point of said crank being pivotly attached to the other end of said actuating device, and the third point of said crank being pivotly attached to said lifting head for imparting further arcuate displacement of the article from the support.

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