Oct. 17, 1961 H. C. WALTKE ET AL 3,004,649

TUBE INSERTION DEVICE

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Fig. 1.

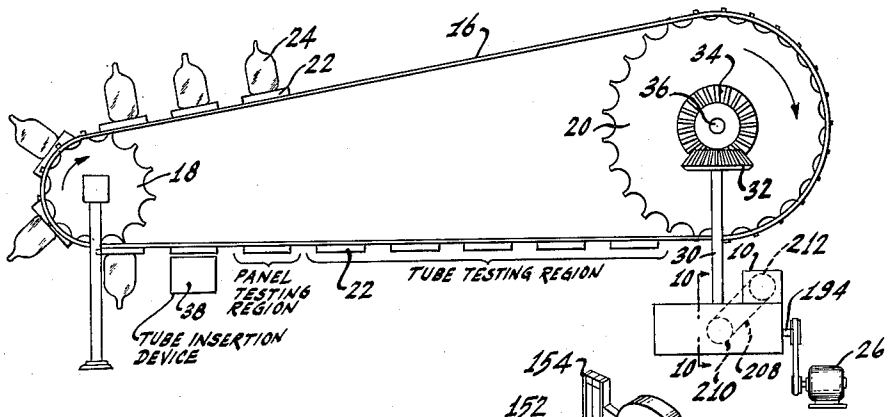
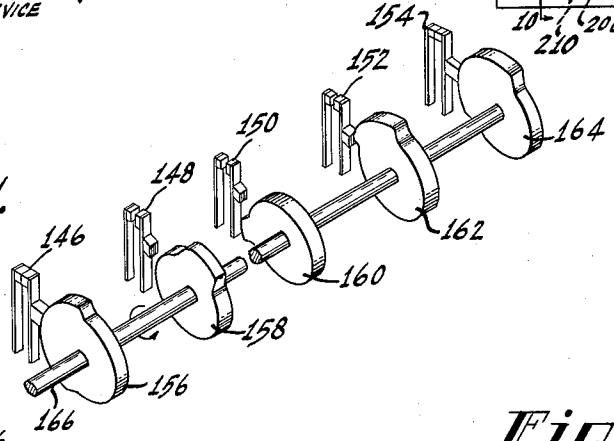


Fig. 11.



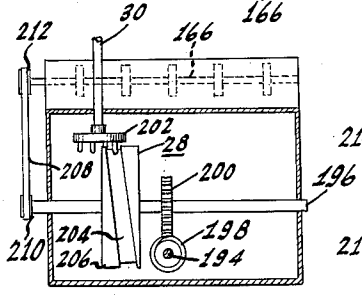
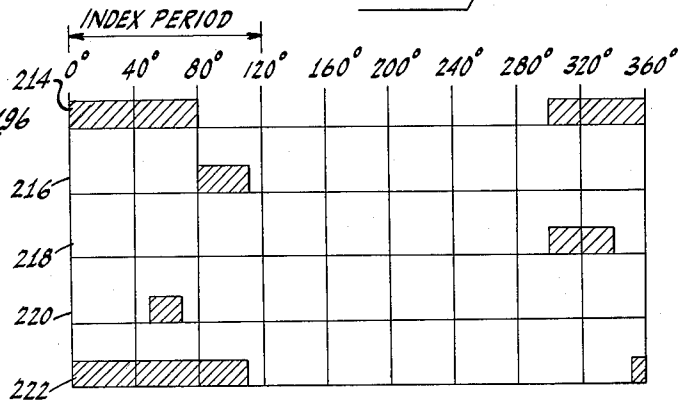


Fig. 10.

Fig. 13.



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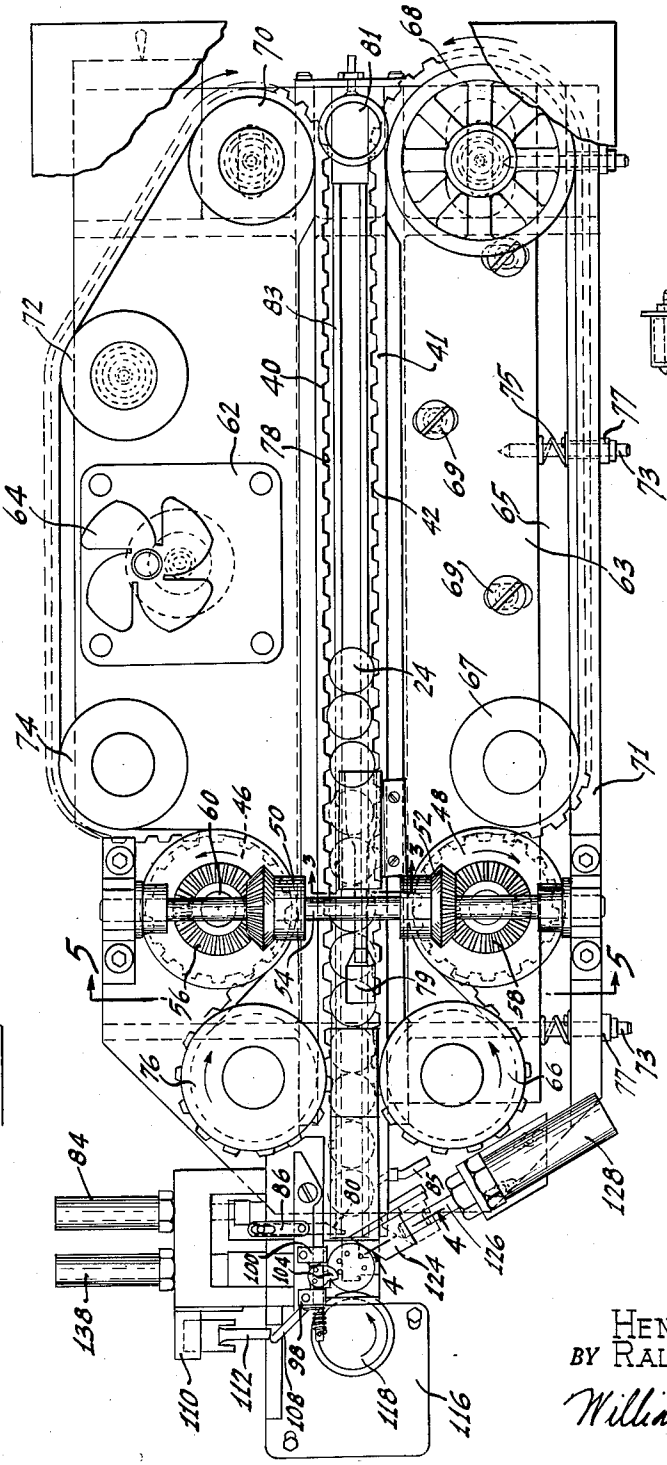


Fig. 2.

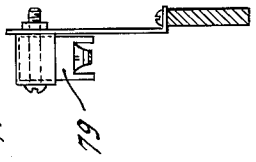


Fig. 3.

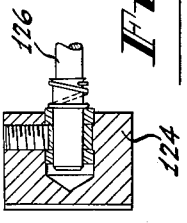


Fig. 4.

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Fig. 5.

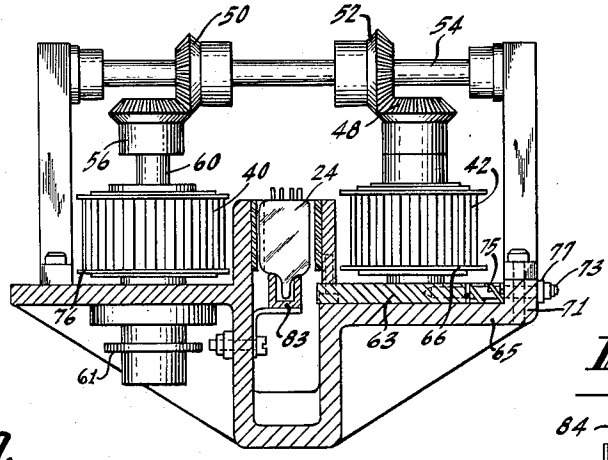


Fig. 6.

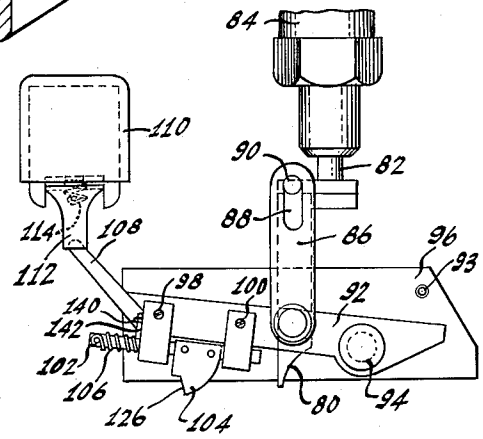
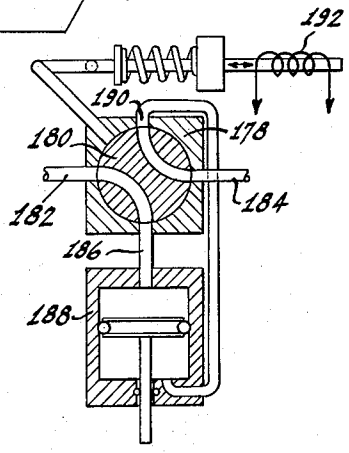


Fig. 9.



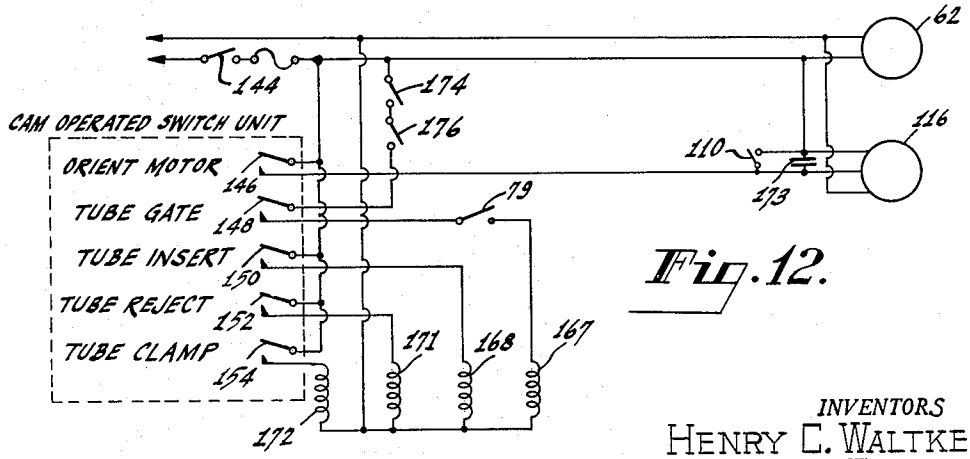


Fig. 12.

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Fig. 7.

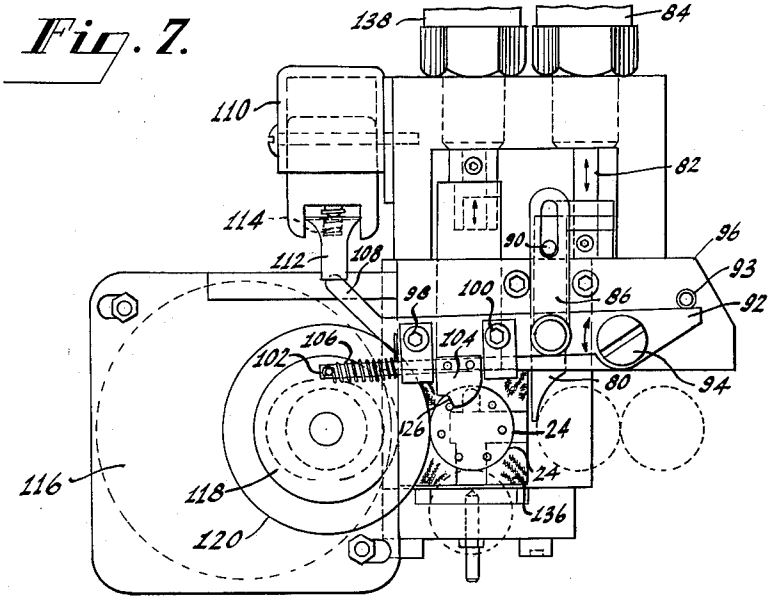
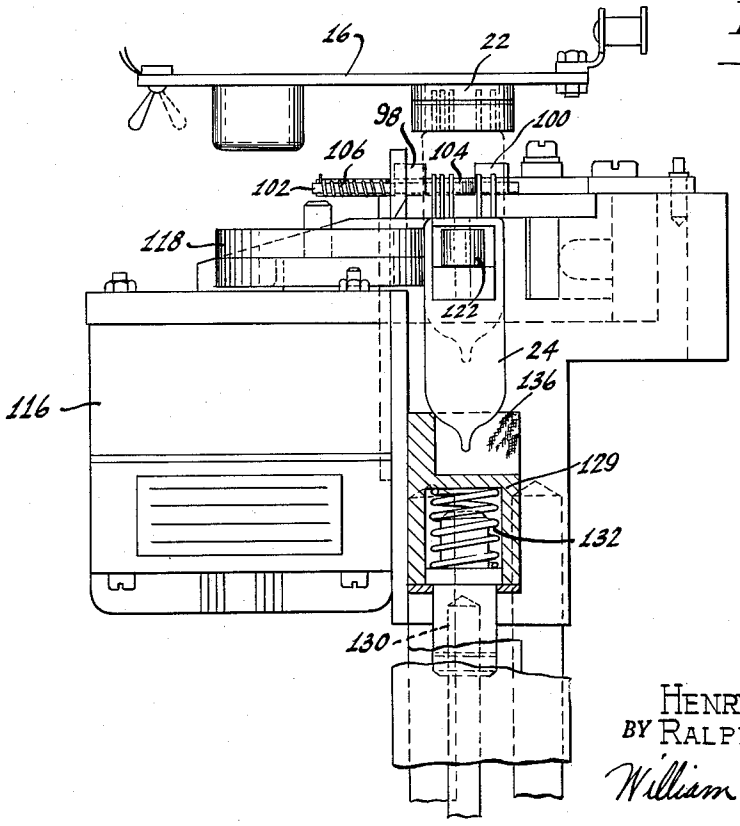


Fig. 8.



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United States Patent Office 3,004,649 Patented Oct. 17, 1961

3,004,649

TUBE INSERTION DEVICE

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Filed May 1, 1958, Ser. No. 732,298
15 Claims. (Cl. 198—33)

This invention relates to an apparatus for testing electron tubes of the variety having parallel external contact prongs extending from one end thereof, and wherein some of the prongs are spaced differently in the aforementioned array, than other prongs thereof. Particularly, the invention is concerned with an automatic device for desirably orienting and inserting the tube prongs in sockets of the testing apparatus, and a system for correlating the operation of the inserting device with intermittent movements of the sockets.

One type of electron tube testing apparatus includes an elongated endless conveyor along and on which are mounted a plurality of tube sockets. The conveyor is movable intermittently to dispose contact elements of the sockets successively in engagement with fixed contact members spaced along the conveyor path.

Heretofore, it has been the practice to insert manually into the test sockets, prongs of tubes to be tested. When the tubes to be tested are of the miniature type, the accomplishment of a required rotational orientation of the tube for entrance of the prongs thereof into the test socket, is difficult and time consuming. This is because the prongs are not uniformly spaced from each other, as a consequence of which the tube must be rotated manually to a predetermined critical position to dispose the prongs in register with the socket openings designed to receive them. Since the prongs of a tube are shielded from the operator by the tube envelope during an insertion operation, a manual orientation of the tube may not be so exact initially as to insure the entrance of the prongs into the socket openings. A number of unsuccessful attempts to seat the tube in the socket may result in deformation of the prongs thereof and possible damage to the seal region at which the prongs extend through the tube stem. Where the test sockets are mounted on an intermittently moving conveyor, the problem of a manual insertion of tubes in the sockets becomes aggravated by the fact that the inserting operation must be completed during a relatively short time interval between intermittent movements of the sockets.

In addition, by inserting tubes beneath the conveyor, rather than on top, additional time is available for preheating the tubes and a faster machine speed is attained. But space requirements under these circumstances make manual loading unfeasible.

Accordingly, it is an object of the invention to provide an improved tube testing apparatus.

It is a further aim to provide automatic means for orienting an electron tube so as to dispose prongs thereof in register with openings in a socket, and for inserting the oriented tube prongs in said socket.

Another purpose is to automatically orient an electron tube of the miniature kind so as to place the prongs thereof in axial register with openings in a socket, and mount the tube on the socket.

Another object is to automatically orient a tube to dispose the prongs thereof in axial register with openings in a socket spaced from the tube, and to move the tube to seated relation on the socket without disturbing the aforementioned orientation thereof.

A further purpose is to correlate the operations of an intermittently movable conveyor having test sockets thereon with the operations of a device adapted to automatically orient and seat a tube in one of the aforementioned sockets during a relatively short interval when the conveyor is stationary between intermittent movements.

One embodiment of the invention comprises a tube testing apparatus including an endless conveyor having positioned thereon a plurality of test sockets spaced along the conveyor. Means are provided for intermittently moving the conveyor, to dispose the sockets adajcent to a plurality of contact members for suitable electrical connection to contact elements of the sockets. A tube inserting device is disposed adjacent to and below the lower course of the endless conveyor and includes a plurality of control elements connected to the several operating mechanisms of the device. The means for intermittently moving the conveyor is also connected to the control elements referred to so that the several mechanisms of the inserting device perform their functions in timed relation to the movements of the conveyor.

In the aforementioned embodiment, a plurality of tube testing stations are disposed along the lower course of the conveyor and to one side of the inserting device. The remainder of the conveyor, including the upper course, is reserved for preheat stations. The means for intermittently moving the conveyor serves to move the conveyor in a direction from the location of the inserting device and towards the preheat stations. In this way a substantial preheat period is available without adversely affecting the speed of the conveyor. In fact, this arrangement permits an increase in the speed of the apparatus without adverse effects. This advantage is accomplished as a consequence of the automatic inserting device of the invention, without which it would not be practical to load tubes on the lower course of the conveyor.

Further objects and features of the invention will manifest themselves as the present description proceeds.

In the drawing, to which reference is now made for a more detailed consideration of an embodiment of the invention,

FIG. 1 shows a schematic side elevation of a testing apparatus embodying the invention;

FIG. 2 is a plan view of a tube orienting and inserting device according to the invention;

FIGS. 3, 4 and 5 are sectional views taken along the lines 3—3, 4—4, and 5—5, respectively of FIG. 2;

FIGS. 6 and 7 are enlarged plan views of a portion of the device shown in FIG. 2;

FIG. 8 is a partial side elevational view partly in section of the device shown in FIG. 2;

FIG. 9 is a sectional view of a type of solenoid air valve that may be employed in the device shown in FIG. 2;

FIG. 10 is a view partly in section along the line 10—10 of FIG. 1;

FIG. 11 is a perspective view of the cam and switch system shown in FIG. 10;

FIG. 12 is a schematic circuit diagram which illustrates the relationship between the several switches employed in the apparatus of the invention; and

FIG. 13 is a chart illustrating the relative timing of the several movements of the conveyor and the orienting and inserting devices according to the invention.

A tube testing apparatus according to the invention is shown in FIG. 1. The apparatus shown comprises an endless conveyor 16 suitably entrained on spaced sprocket wheels 18, 20, to provide an upper and a lower course. Mounted on the conveyor are a plurality of spaced test sockets 22 having openings for receiving the prongs of tubes 24 which may be of the miniature kind. Means such as a motor 26 transmits power intermittently through

a Geneva transmission **28** (FIG. 10), a shaft **30** and bevelled gears **32, 34** to a shaft **36** to which the sprocket wheel **20** is fixed. The resultant direction of intermittent rotation of sprocket wheel **20** is clockwise. Adjacent to and below the lower course of conveyor **16** is a tube inserting device **38** to be described. Also adjacent to the lower course of the conveyor and to one side of the inserting device **38**, is a plurality of fixed contact members, not shown, over which contact elements, not shown, of the sockets **22** are adapted to ride, for suitably energizing tube components connected to the tube prongs received in the sockets. A plurality of preheat stations, not shown, may be spaced along the upper course of the conveyor.

The tube insertion device **38** is shown in greater detail in FIGS. 2 to 11. The device includes two endless belts **40, 41** made of a pliant material such as rubber. Each belt is provided with spaced teeth **42** engaging power sprocket wheels **46, 48** which are tied together by engagement between one group of bevelled gears **50, 52**, fixed to shaft **54** and another group of gears **56, 58**, one of which, **56**, is fixed to a shaft **60** connected by a belt **61** (FIG. 5), to a constantly running motor **62** cooled by a fan **64**. A plurality of idling pulleys **66, 67, 68, 70, 72, 74** and **76** suitably entrain the belts **40, 41** to provide parallel spaced courses extending from idling pulleys **68, 70** to idling pulleys **66, 76**. The sprocket wheel **46** is so oriented with respect to sprocket wheel **48**, that in the two courses referred to, the teeth **42** of one course are opposite valleys **78** in the other course for a purpose to be described. The two parallel belt courses engage tubes **24** with sufficient force for causing the tubes to follow the movement of the two courses and to permit harmless slippage between the belts and the tubes when the latter are stopped by means to be described.

This harmless slippage is further aided by a feature of the invention according to which one of the belts, **41** for example, is given added resilience by a resilient mounting of sprocket wheel **48** and idling pulleys **66, 67** and **68** (FIGS. 2 and 5). This resilient mounting is provided by a structure comprising a plate **63** held down on a support **65** by shoulder screws **69**. The support **65** includes a raised edge portion **71** through which threaded pins **73** extend and threadedly engage the plate **63**. Springs **75** embracing the screws **73**, resiliently urge plate **63** and the belt **41** toward the belt **40**. Nuts **77** limit the magnitude of movement of the plate **63** toward belt **40**. This mounting and the natural resiliency of the material of belts **40, 41** combine to provide the aforementioned propelling engagement with tube **24** and harmless slippage between the tube and the belts when tube feed is blocked, in a manner to be described.

While the sprocket wheel **48** and beveled gear **58** are mounted on plate **63** and follow the movements thereof, the magnitude of such movements is not sufficiently great to affect seriously the engagement between gears **52** and **58**. While some mild gear chattering takes place, it has not been found intolerable. The effect of such movements on the phase relationship of belts **40, 41** is insignificant. Indeed, the movements aforementioned have not been found to disturb the engagement of the tube work piece by a tooth **42** of one belt and by a valley **78** between adjacent teeth **42** of the other belt.

While lateral support of the tubes **24** on the conveyor of the orienting and inserting device is provided by belts **40, 41**, vertical support of the tube is contributed by an elongated U-shaped member **83** (FIG. 5) having spaced sidewalls for engaging the lower end of the tubes **24**, with the exhaust tubulations of the tubes received in the space between the two side walls referred to for protection against impacts.

Rotation of shaft **60** in a counter-clockwise direction as shown in FIG. 2, causes the two parallel belt courses aforementioned to move to the left as viewed in FIG. 2.

Tubes **24** may be loaded between belts **40, 41** by means of a funnel **81** shown at the right hand end of the device, as viewed in FIG. 2. Loading of the tubes involves placing them successively in the funnel **81** with their non-pronged ends leading, for free fall on the U-shaped number **83** (FIG. 5). The funnel is dimensioned for relatively snug yet movable receipt of the tubes and has slots through which the teeth **42** of the belts **40** and **41** are free to enter, for propellingly engaging the sides of a tube within the funnel, as shown in dotted lines in FIG. 2. The funnel is also provided with a slot (not shown) facing the channel produced by the belts **40, 41** and having a width permitting travel of a tube therethrough and into the channel referred to. As the tubes **24** are moved to the left (FIG. 2) they engage a switch **79** (FIG. 3) mounted in the path of tube travel. As will be explained later, this engagement affects a circuit controlling subsequent operations on the tube. The leading tube engages a gate **80** (FIGS. 2 and 7) which when closed, stops further movement of the tube. Gate **80** extends to and is directly connected to a piston **82** extending into a pneumatic cylinder **84** (FIGS. 6 and 7). Retraction of the piston into the cylinder will cause the gate **80** to move out of tube blocking position as shown in FIG. 6, and outward extension of the piston will cause the gate to close as shown in FIGS. 2 and 7. For actuating the piston to the two positions referred to, a solenoid valve of the type depicted in FIG. 9 may be used.

When the gate **80** is opened, it is desirable that the next adjacent tube be propelled rapidly into the orienting position. The movement of the belts **40, 41**, is not sufficiently rapid for this purpose. Therefore, according to the invention, supplemental means is utilized to accomplish the desired rapid transit of the tube to a position wherein it is adapted to be oriented. This means may be in the form of an air nozzle **85** connected to the lower end of cylinder **84**, so that when air is fed to this end for retracting gate **80**, it also provides a blast of air against the leading tube **24** to rapidly move it to operative orienting position.

Also connected to the piston **82** by means of a link **86** having a slot **88** engaging pin **90** fixed to the piston, is an assembly comprising a plate **92** pivotally connected at **94** to a fixed appurtenance **96** of the device. Two arms **98, 100**, fixed to plate **92**, define coaxial passageways receiving a rod **102** and constitute bearings for the aforementioned rod. Fixed to rod **102** is a dog **104**. The rod **102** is rotatable in the passageways aforementioned under restraint of a coil spring **106** which urges the dog into parallel relation with respect to plate **92**. The purpose of dog **104** and its pivotal mounting will become clear as the description continues. An arm **108** is fixed to and extends from plate **92** into engagement with a switch **110** which includes a movable contact element **112** urged to distended position by an expansion spring **114** shown in FIG. 7. When the contact element **112** of switch **110** is in its distended position the switch is closed. This shorts a capacitor **173** (FIG. 12) causing a motor to be described, to stop.

The function of switch **110** is to energize a motor **116** (FIG. 7). The motor **116** is a relatively small single phase type, the circuit of which includes the capacitor **173**. When the capacitor **173** is shorted, as by closing switch **110**, the motor stops. Since the motor **116** is relatively small, the windings thereof have sufficient ohmic resistance to withstand the surge produced when the capacitor is shorted. The stoppage produced by shorting the capacitor **173** is more abrupt than that resulting from merely deenergizing the motor by opening its supply circuit. The advantage of this dynamic brake feature will become evident as the description proceeds.

The motor **116** serves to rotate a wheel **118** having a periphery **120** composed of a resilient material such as rubber. This function is performed during the portion of the cycle between the shaded areas of line **214** of FIG. 13. Towards the end of the indexing period (FIG. 13),

the piston 82 is extended from cylinder 84, first causing the gate 80 to become interposed between leading tube 24 which has moved into engagement with the periphery of wheel 118, and the next adjacent tube, as shown in FIG. 7. Since the leading tube in this position is free from engagement by the belts 40, 41, supplemental means are provided for controlling the posture of the tube. This supplemental means provides surfaces extending angularly around the leading tube, and which cooperate with the periphery of wheel 118, in providing desired lateral support for the tube. The supplemental means referred to includes a roller 122 shown in FIG. 8 providing a relatively low friction engagement with the tube, and a body 124 of resilient material fixed to a piston 126 extending from a pneumatic cylinder 128 (FIG. 2) actuated by a valve of the type shown in FIG. 9. This material may be a low friction bearing material such as nylon. In this way, rotation of wheel 118 in a counter-clockwise direction as shown in FIG. 2, will cause the leading tube 24 to rotate in a clockwise direction with the tube prongs riding on the dog 104. This rotation of the leading tube continues until the region thereof between the farthest spaced prongs thereof, are opposite the dog 104. This region provides sufficient space for the dog to move toward the center of the tube in response to the spring 114 (FIG. 7). Such movement of the dog causes a surface 126 thereof extending radially of the tube to abut against a tube prong. When dog 104 moves forward in the region between the furthest spaced tube prongs the switch contact element 112 moves forward closing the switch. This causes the motor 116 to stop and further tube rotation is prevented. In this situation the tube is in a rotationally oriented position wherein the prongs thereof are in axial register with passageways or openings in a socket 22 thereabove, as shown in FIG. 8.

The motor 116 as indicated in the foregoing, includes a dynamic brake feature so that on closing of the switch 110, the motor stops immediately. Therefore according to the invention the thrust of a prong on dog 104 is of relatively small magnitude and insufficient to distort the prong. Also of advantage in this connection is the manner in which the dog is mounted on plate 92, which permits a slight movement of rod 102 longitudinally against the force of spring 106.

After the tube 24 has been rotationally oriented to the position indicated, it is raised upwardly by a tube inserting mechanism, until the prongs of the tube fully enter the openings in socket 22, as shown in phantom in FIG. 8. This mechanism comprises a member 129 adapted to engage the lower end of tube 24 and resiliently mounted on a piston 130 by means of an expansion spring 132. The piston extends into a pneumatic cylinder, not shown, which may be controlled by a valve of the type shown in FIG. 9.

It will be noted in FIG. 8 that the member 129 has walls 136 partly defining a cavity for receiving the lower end of tube 24. The cavity is closed on two sides, and open on the other two sides. The side to the right as viewed in FIG. 8 is in the direction of tube feed by belts 40, 41 and is open to permit a tube to enter the cavity. The near side normal to the aforementioned open side, is also open for a purpose to be described.

In the event a tube should fail to seat properly in a socket, by reason, for example, of a bent prong, the tube will fall back on a lowering of the inserting mechanism. During a succeeding intermittent movement of the conveyor 16, the roller 122 is caused to move out of the paper, as shown in FIG. 8, resulting in an ejection of the tube from the nearer open side of the cavity defined by walls 136. To provide this movement of roller 122, a piston-cylinder assembly 138 is provided (FIGS. 2 and 7) on the piston of which the roller is mounted. The cylinder is controlled by a solenoid valve shown in FIG. 9, so as to extend the piston of the assembly during each intermittent movement of the conveyor 16. In addition to its function of ejection, the roller 122 is also of advantage in that it contributes to reduced friction during rotation of tube 24 by the wheel 118. During the ejecting movement of roller 122 the clamp 124 is open.

It will be noted that as the tube 24 is raised during an inserting operation (FIG. 8) the dog 104 is free to rotate upwardly under the sole restraint of coil spring 106, in response to the force of the rising tube. As the tube is moved out of engagement with the dog 104, on a subsequent intermittent movement of the conveyor 16, the dog is rotated by spring 106 back to its operative position. This position is determined by abutment of the inner edge of the dog with the adjacent edge of plate 92. The inner edge aforementioned is rounded at its upper portion as viewed in FIG. 6 to allow the dog to rotate upwardly. The lower portion of the dog edge is flat thus restraining a downward rotation of the dog.

A circuit diagram of the tube orienting and insertion device of the invention, is shown in FIG. 12, and includes a plurality of switches. A switch 144 is manually operable for connecting the circuit system to a suitable source of electric power, not shown. During closure of this switch, motor 62 (FIG. 2) is energized for moving belts 40, 41 in a continuous tube feeding operation. Five of the switches are cam operated, to wit switches 146, 148, 150, 152 and 154. As shown in FIG. 11, these switches are operated respectively by cams 156, 158, 160, 162 and 164 fixed to a shaft 166 rotated by means to be described in a counterclockwise direction as viewed in FIG. 11. Four of these switches (148, 150, 152, 154, FIG. 12) actuate four solenoid valves of the type shown in FIG. 9, for controlling power transfer to four pneumatic cylinder-piston assemblies of the tube orienting and inserting device described in the foregoing. Thus switch 148 actuates solenoid valve 167 for controlling air flow to cylinder 84 (FIG. 2), which results in successive movements of the gate 80. In series with switch 148 is switch 79 (FIG. 3) which is closed only if tubes are present adjacent to switch 79 and between the belts 40, 41. The presence of tubes between the region of switch 79 and the orienting region is necessary, in order to provide mutual support for the tubes. Switch 150 actuates solenoid valve 168 for energizing the piston 130 (FIG. 8). Switch 152 actuates solenoid 171 for energizing the piston on which the ejecting roller 122 (FIG. 8) is mounted and which extends from cylinder 138 (FIG. 2); and switch 154 actuates solenoid valve 172 for energizing piston 126 extending from cylinder 128, for moving the clamping member 124 to tube clamping position (FIG. 2). Other switches include switch 146 which is connected in parallel with switch 110 for energizing motor 116 which turns the orienting wheel 118. Switch 110 (FIG. 6) is normally closed and is opened by a slight rotational movement of the plate 92 in a clockwise direction as viewed in FIG. 6. A slight counterclockwise movement of plate 92 occurring as the result of the movement of the dog 104 into the space between the farthest spaced prongs, closes the switch. Further movement of plate 92 in a counterclockwise direction is restrained by engagement with a stop 93. Closing of switch 110 short circuits condenser 173 resulting in a stoppage of motor 116 (FIG. 12). This stoppage results from a dynamic braking feature incorporated in the motor. Switches 174 and 176 are in series across the circuit energizing solenoid valve 167 associated with the tube gate 80. Switch 174 is opened when the motor 26 (FIG. 1) is stopped, and switch 176 is opened in response to the defective testing panel (not shown) in the tube insertion portion of the apparatus shown in FIG. 1.

The solenoid valves employed in conjunction with the several pneumatic systems described, each comprises a casing 178 having a cavity within which a rotatable valving member 180 is positioned as shown in FIG. 9. The casing 178 has ports 182 and 184. The casing also has a port 186 communicating with one end of a cylinder 188 (which may be one of the pneumatic cylinders previously

described) and a port **190** communicating with the other end of the cylinder. The valving member is normally in the position shown in FIG. 9, wherein the port **182** is connected to the upper end of the cylinder and the lower end of the cylinder **188** is connected to port **184**. The valve member **180** is adapted to be rotated clockwise by the solenoid **192** when the latter is energized through about 90°, so that the lower end of the cylinder communicates with the port **182** and the upper end communicates with port **184**.

Valves of the type described and shown in FIG. 9 are associated with the several cylinders **84**, **138** and **128** shown in FIG. 2, and with the cylinder associated with piston **130** shown in FIG. 8. In the valve associated with cylinders **84** and **128** port **184** is an outlet port and port **182** is an inlet port. In this situation, the piston **126** carrying the tube clamp **124** and the piston **82** carrying the gate **80** are normally distended and are moved to open and unclamped positions by two solenoids **192** when the switches **148** and **152** are closed by cams **158** and **164** (FIG. 11). In the valves associated with the other cylinders aforementioned port **182** is an outlet port and port **184** is an inlet port, so that the pistons associated with these cylinders are normally in retracted positions and are moved to operative or extended positions when solenoids **192** associated with the last named valves, are energized.

For correlating the operations of the several switches **146**, **148**, **150**, **152** and **154**, with the operation of the conveyor **16**, the cam shaft **166** (FIG. 11) is mechanically connected to the driving means for the conveyor. The driving means for the conveyor includes a shaft **194** (FIGS. 1 and 10) connected to motor **26** and which serves to drive shaft **196** by a worm **198** and gear **200** combination. Shaft **196** in turn is coupled to shaft **30** which drives the conveyor **16**, by a Geneva system including pins **202** engaging a groove **204** in collar **206**. The groove **204** is partly normal to shaft **196** and partly inclined with respect thereto, so that continuous rotation of shaft **196** imparts intermittent movement to shaft **30**. Shaft **196** is also coupled to cam shaft **166** by means of a belt **208** engaging sprockets **210**, **212**, of equal diameters mounted on shafts **196** and **166** respectively. This mechanical connection between conveyor **16** and the cam shaft **166** assures a desired correlation between the operations of the conveyor and the orienting and inserting device before described.

As shown in FIG. 13, the intermittent movement imparted to conveyor **16** by the Geneva **28** is such as to provide a cycle wherein the movement or indexing period extends through about 120° of the cycle. Line **214** of the diagram of FIG. 13 shows a shaded portion representing the portion of the cycle during which the orienting motor **116** is stopped by cam switch **146**, FIG. 12. The non-shaded portion of line **214** represents a period when the orienting motor **116** is free to run if switch **146** is closed and switch **110** FIGS. 2, 6 and 7 is depressed (open). Switch **110** is depressed when cam switch **148** (FIG. 12) is depressed as indicated by the shaded portion of line **216** (FIG. 13). Thus, depression of cam switch **148** causes the piston **82** to retract the gate **80** to which the pin **90** is attached. Plate **92** coupled to pin **90** is, therefore, rotated in a clockwise direction depressing switch **110** and opening it. This causes the motor **116** to rotate. When the gate **80** is closed, motor **116** will continue to turn since plate **92** (FIG. 7) will be held in a position wherein the switch is kept open, by dog **104** riding on the tube pins. When the relatively large space between two of the tube pins is opposite dog **104**, the dog and, therefore, plate **92**, move forward, closing switch **110** thus causing motor **116** to stop. The tube is then in its oriented position. The dog **104** is so shaped and dimensioned that it is incapable of movement through the space between the closer spaced tube prongs to a degree to cause the surface **126** thereof to engage a prong. Therefore, the dog **104** is free to ride on the closer spaced prongs. However, it is capable of movement into the space between the two farther spaced prongs so that its surface **126** engages one of these prongs as shown in FIG. 7, for restraining further rotation of tube **24**. It will be noted that engagement between surface **126** and a tube prong is necessary for stoppage of rotation of the tube by the dog **104**, and that this engagement is possible only when the dog enters the space between the two farther spaced prongs.

om3odfddd Llha'Edts5d5inctl amsd ing cmf cm cmcmcm

The shaded portion of line **216** (FIG. 13) shows the portion of the cycle during which the gate is open to permit a tube to pass to the orienting position. Line **218** shows a shaded portion representing a portion of the cycle during which an oriented tube is inserted into a socket. The shaded portion of line **220** indicates the period during which the ejection roller **122** is moved to ejecting position. And the shaded portion of line **222** indicates the period during which the tube clamp **124** (FIG. 2) is open.

It will be noted from the foregoing that the first action occurring during the cycle depicted in FIG. 13 is an intermittent movement of conveyor **16** and an opening of the tube clamp **124** (line **222**) produced by closing switch **154** (FIG. 11). Next and during such movement, the roller **122** is actuated to ejecting position (line **220**). Thereafter and during the movement referred to, the tube gate is opened (line **216**). At the same time orienting motor **116** is started (line **214**) and continues beyond the closing of gate **80** (line **216**) until the dog **104** enters the wider space between the tube prongs. When the gate **80** is closed, the tube clamp **124** is also closed (lines **216** and **222**). Thereafter, the tube insertion mechanism (member **128**, piston **130**) is actuated (line **218**) and the orienting motor **116** is stopped (line **214**).

In order to provide the aforementioned sequence of operations cams **156**, **158**, **160**, **162**, **164** (FIG. 11), are suitably mounted on shaft **166** with their upper dwell or switch closing portions suitably angularly oriented about shaft **166**. The other switches **79**, **170**, **174** and **176** are automatically operable in response to conditions produced during the operations controlled by the cams referred to.

We claim:

1. A tube testing apparatus comprising an intermittently movable conveyor having a plurality of sockets fixed thereto, a tube orienting and inserting device adjacent to said conveyor, and means connected to said conveyor and device for synchronizing the movements thereof, said tube orienting device comprising motor means for orienting said tube, locating means movable into a locating position with respect to said tube and means responsive to the movement of said locating means into locating position with respect to said tube for stopping said motor and for applying dynamic braking thereto, and means for inserting said oriented tube in one of said sockets during a momentary stoppage of said conveyor.

2. A tube testing apparatus comprising a conveyor having a plurality of sockets mounted thereon, a first power means connected to said conveyor for moving the same intermittently, a tube orienting device comprising motor means for rotating said tube, locating means comprising yieldable stop means movable into stopping and locating position with respect to said tube, said locating means comprising means for causing cessation of operation of said motor responsive to said movement of said locating means into stopping and locating position with respect to said tube, and a tube inserting device having movable members adjacent to said conveyor, a plurality of power transfer elements connected to said first power means and to said members, and means connected to said power transfer elements for correlating the movements of said members with the movement of said conveyor, for inserting a tube in one of said sockets after orientation thereof and during a momentary stoppage of said conveyor between intermittent movements thereof.

3. A tube testing apparatus comprising a conveyor,

tube sockets mounted on said conveyor, a device positioned adjacent to said conveyor and including means to orient tubes and means to insert said oriented tubes into said sockets, said device including a shaft having a plurality of cams mounted thereon and a plurality of switches adjacent to said cams for actuating said device, a mechanical connecting element between said conveyor and said shaft, and power means connected to said element for moving said conveyor intermittently and for rotating said shaft continuously, means responsive to one of said switches to energize said tube orienting means and means responsive to another of said switches to energize said tube insertion means, whereby the movement of said conveyor is correlated to the operations of said cams and switches for automatically and successively mounting said tubes in said sockets.

4. A tube testing apparatus comprising a conveyor having a socket thereon, orienting means adjacent to said conveyor and adapted to orient a tube rotationally to dispose prongs thereof in axial register with openings in said socket, inserting means adjacent to said orienting means and adapted to insert the oriented tube prongs in said socket, means for moving said conveyor to displace said socket from said orienting means, and means operable in synchronism with said orienting means and inserting means and after said displacement of said socket, for traversing the space previously occupied by said tube in said orienting means, for clearing said space of a tube failing of insertion.

5. A tube testing apparatus comprising a conveyor having tube sockets mounted thereon, a tube orienting and inserting device adjacent to said conveyor, first means connected to said conveyor for isolating a tube in an orienting position, second means responsive to one position only of said first means for rotating said tube in said location, said first means including a tube locating member movable into a locating position with respect to said tube, said first means being out of said position when said locating member is in said locating position, and third means connected to said conveyor for inserting the tube in one of said sockets after said locating member has reached said locating position.

6. A tube testing apparatus comprising a conveyor having a plurality of sockets adapted to receive tubes to be tested, a tube orienting and inserting device adjacent to said conveyor and including means to orient tubes to dispose prongs thereof in axial register with openings in said sockets and means to insert said prongs in said openings, a switching system connected to said device and including a plurality of cams, means responsive to one of said cams to energize said orienting means and means responsive to another of said cams to energize said insertion means, a cam shaft to which said cams are fixed and means including a shaft for moving said conveyor intermittently, said last named shaft being mechanically connected to said cam shaft for correlating said operations with the intermittent movements of said conveyor.

7. A tube testing apparatus comprising a socket, means adjacent to said socket for rotationally orienting a tube to dispose the prongs thereof in axial register with openings in said socket, said means comprising a conveyor adapted to carry tubes in a predetermined path, resilient stop means against which the leading tube is adapted to abut, a gate movable across said path and between said leading tube and a tube next adjacent thereto, said gate having a surface adapted to bear against the said next adjacent tube, whereby said leading tube is free from restraint by said next adjacent tube, said stop means being rotatable for rotating said leading tube, a member connected to said gate and extending across an end of said tube for stopping the rotation of said tube when said prongs thereof are in said axial register, and means for moving said tube with said end thereof leading, to said socket for inserting said prongs in said socket openings, said member being pivotally mounted for rotation out of the path of said tube during said last named movement thereof.

8. A tube testing apparatus comprising a conveyor having a plurality of sockets thereon, a device adjacent to said conveyor for orienting a tube to dispose prongs thereof in insertion register with one of said sockets, said device comprising a rotatable wheel, a roller, a clamp, said wheel and roller, and said clamp in closed position, being angularly spaced around said tube and adapted to engage portions of said tube angularly spaced from each other less than 180°, means for rotating said wheel, whereby said tube is rotated, and a locating member movable into engagement with said tube while said tube is rotating for stopping said tube when the prongs thereof are in said insertion register, and insertion mechanism adjacent to said orienting device and adapted to move the stopped tube into seated position with respect to one of said sockets, said clamp being closed during operation of said orienting device, locating member and inserting device, an ejecting mechanism including said roller and adapted to eject said tube from said orienting device if said tube fails to seat in said one of said sockets, and means for operating said ejecting mechanism after said clamp has been opened to provide an avenue for unloading said tube from said orienting device.

9. An article orienting device comprising rotatable means adapted to engage and rotate an article to be oriented, electrical power means connected to said rotatable means for rotating the same, an assembly including a locating member adjacent to said rotatable means, said assembly being movable to move said member to locating position, said member being rotatable with respect to said assembly, a switch connected across said electrical power means and positoned in the terminal portion of the path of movement of said assembly and arranged to be engaged by said assembly during said movement thereof, for disconnecting said electrical power means from said rotatable means for stopping rotation of the latter, and means for moving said article after orientation in a direction to rotate said locating member.

10. An article orienting device comprising a conveyor adapted to convey articles to an orienting location, a gate between said conveyor and location, means for rotating said article at said location, stop means adjacent to said location and movable to stop rotation of said article when said article is in a desired angular orientation, said stop means being movable in an angular path, switch means in said path and adapted to deactivate said means for rotating when said stop means is moved to stopping position, and a linkage system connecting said gate and stop means for first moving said gate to closed position, and thereafter moving said stop means to stopping position.

11. In an article orienting device, a rotatable wheel and a roller having spaced parallel axes and including co-planar transverse portions normal to said axes, and adapted to engage angularly spaced portions of an article to be oriented, a resiliently mounted thrust member having an article engaging surface arranged to provide components of opposition with respect to said wheel and roller, and adapted to urge said article against a periphery of said wheel, and means for withdrawing said member in a direction at an acute angle to the direction between said wheel and said roller, and means for rotating said wheel in such direction as to cause the peripheral portion thereof in engagement with said article to travel towards said roller, whereby frictional restraint to rotation of said article is reduced.

12. An article orienting device comprising a conveyor adapted to continuously urge a plurality of articles successively into a predetermined region, means adjacent to said region and adapted to separate the leading article in said region from the other of said articles, three members disposed in said region and angularly spaced around said leading article less than 180° from each other and

adapted to engage portions of said leading article spaced for supporting said leading article with its axis normal to said plane, means for rotating one of said members on an axis parallel to said first named axis, whereby axial rotation is transmitted to said leading article, and means movable across said region and adapted to stoppingly engage said leading article when the same has been rotated to a predetermined angular position, for stopping said leading article in said position.

13. An article orienting device comprising an elongated conveyor having an end portion, means for moving said conveyor for delivering articles successively to said end portion, a gate movable across the path of travel of said articles for isolating the leading article from the other articles, a rotatable orienting member at said end portion and adapted to engage a side of said leading article, a motor connected to said orienting member, a switch for starting and stopping said motor, an elongated plate pivotally supported at one end thereof, an arm extending from the other end thereof and engaging said switch, a locating member mounted on said arm intermediate the ends thereof, and linkage means connecting said plate and gate for first moving said gate to an open position, and then moving said plate for actuating said switch while said gate is in said open position, whereby said motor is started for rotating said orienting member, and thereafter closing said gate while continuing actuation of said switch, whereby said leading article is rotated, and then moving said locating member into engagement with said leading article for stopping rotation thereof in a predetermined angular orientation of said article.

14. An automatic orienting device comprising an elongated conveyor adapted to convey articles to one end thereof in predetermined axial orientation, and an article orienting mechanism adjacent to said one end and including a power wheel, a roller, said wheel and roller being angularly spaced less than 180° and having axes parallel to the axes of said articles in said predetermined orientation and adapted to engage a first and second angularly spaced surface portions of one of said articles in a predetermined plane, and an extendable member movable in a path parallel to and including said plane and at an acute angle to the direction between the axes of said well and roller for disposing a surface thereof in spaced relation with respect to said wheel and roller, said member being extendable to engage a third surface portion of said one of said articles angularly spaced less than 180° from the said first and second surface portions thereof engaged by said wheel and roller, means for rotating said wheel in its axis while said wheel engages said one of said articles, whereby said one of said articles is rotated, and means adjacent to said wheel and adapted to engage and stop rotation of said one of said articles when the same is in a predetermined position.

15. A tube testing apparatus comprising an orienting means including walls partly defining a cavity adapted to receive a tube to be oriented, said cavity having a first open side, a tube conveyor adapted to move tubes in a direction facing said open side, whereby one of said tubes is adapted to enter said cavity, inserting means engaging one end of said cavity and adapted to move said cavity and a tube therein in a predetermined direction, a socket spaced from said cavity in said direction, said cavity having a second open side, and an ejector member movable across said cavity and towards said second open side for ejecting the tube in said cavity if said tube has failed to become seated on said socket.

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