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MACHINE FOR BENDING ENVELOPES FOR CURVED FLUORESCENT LAMPS

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Fig. 1.

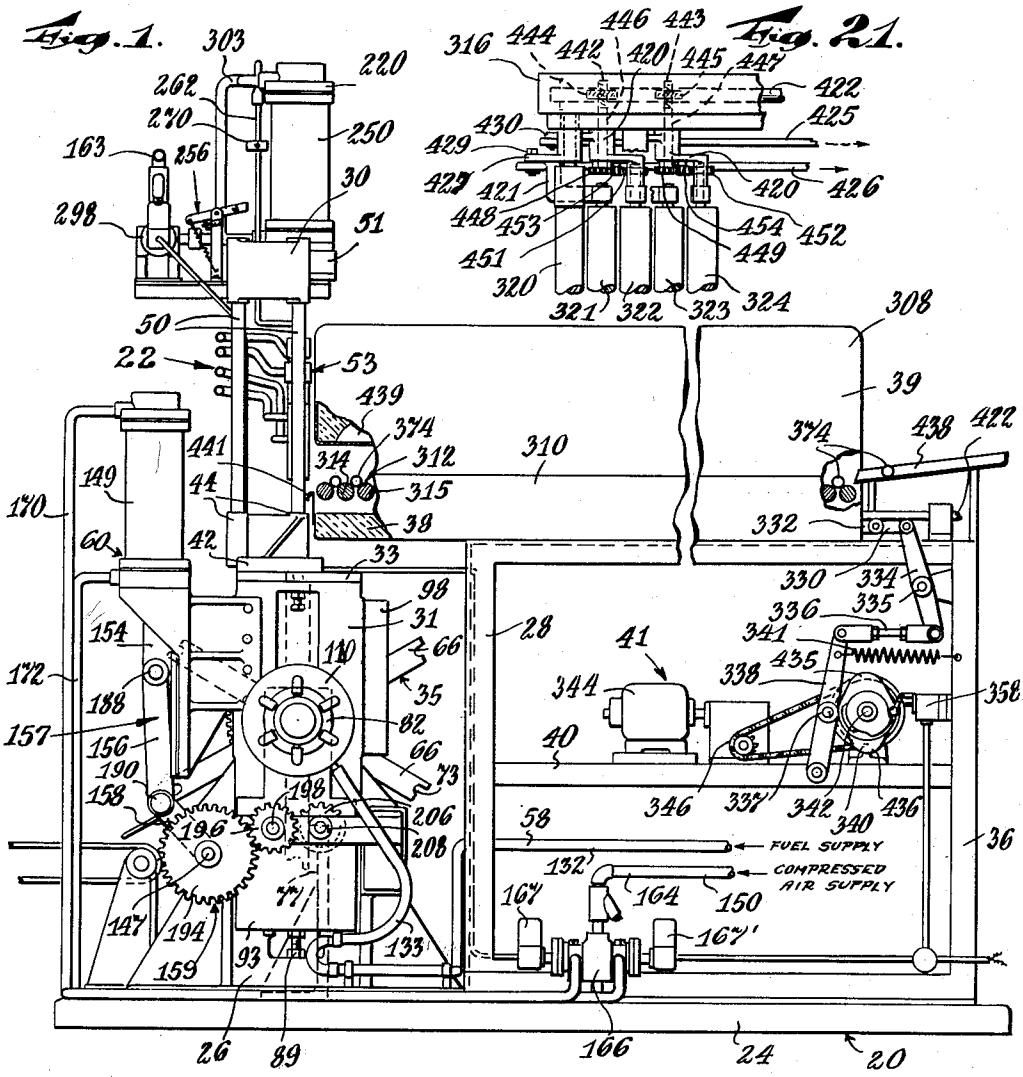
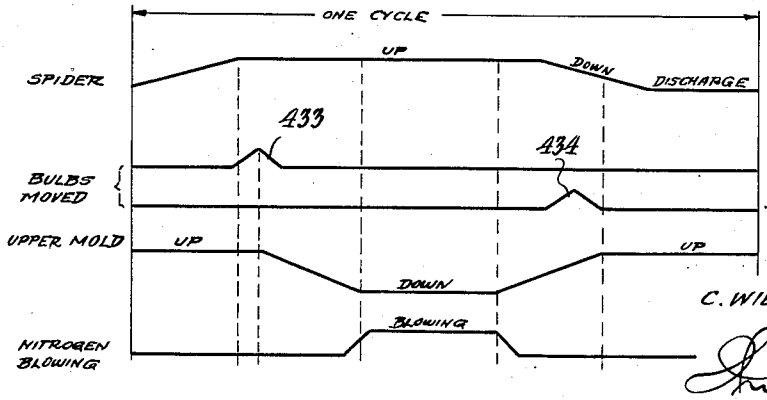


Fig. 2.

Fig. 15.



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Fig. 2.

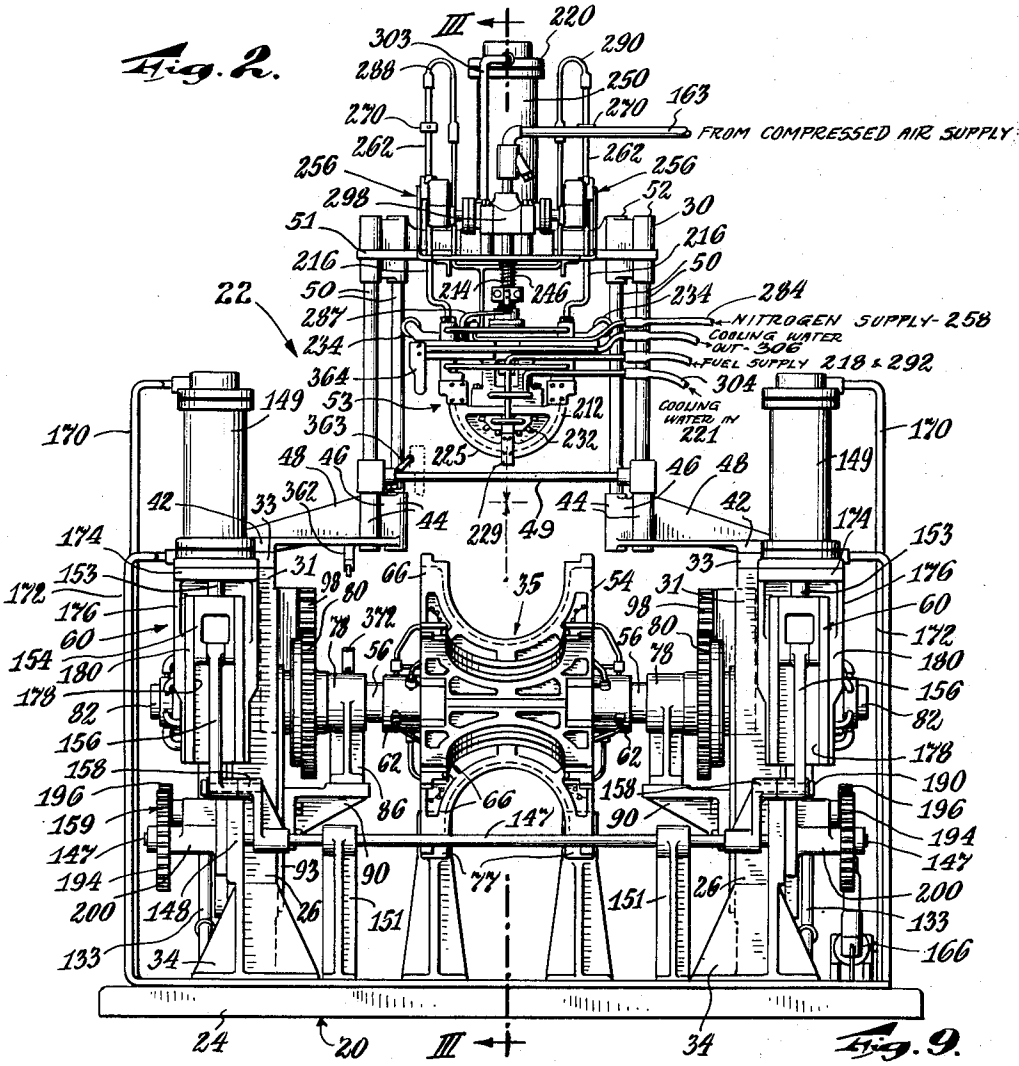


Fig. 9.

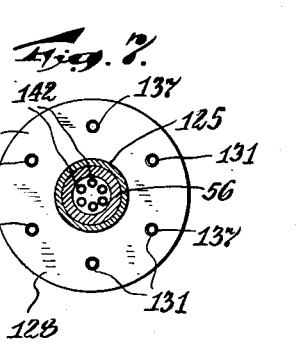


Fig. 7.

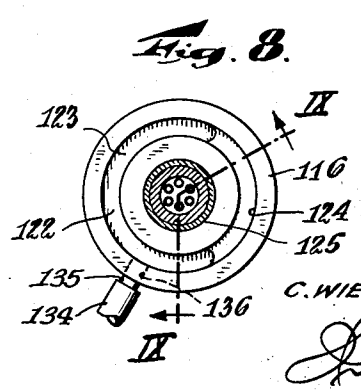
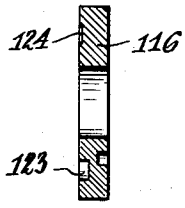


Fig. 8.



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Fig. 3.

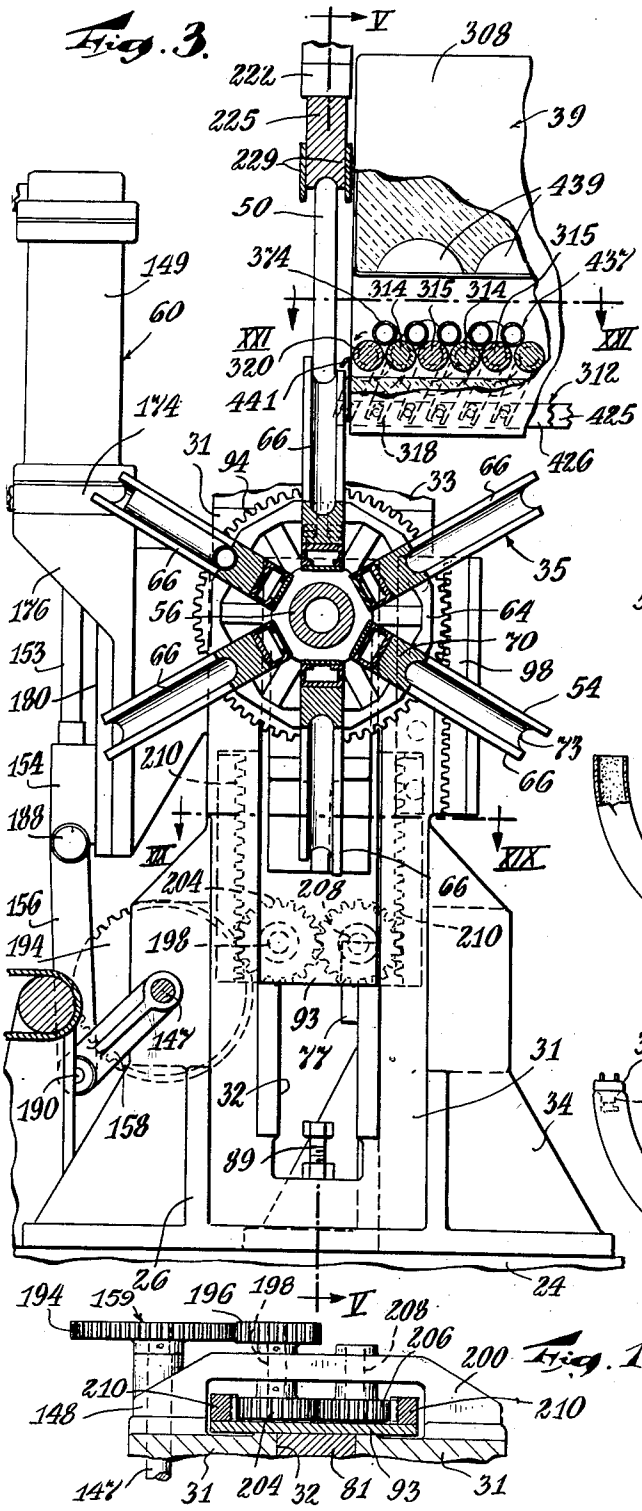


Fig. 4.

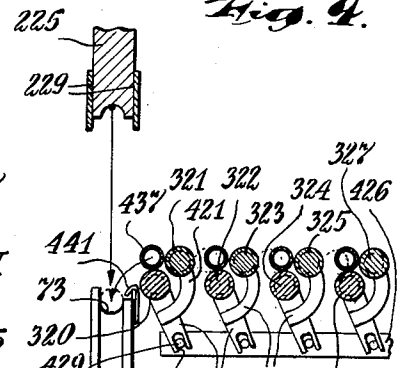


Fig. 20.

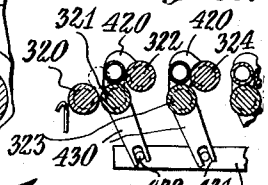


Fig. 17.

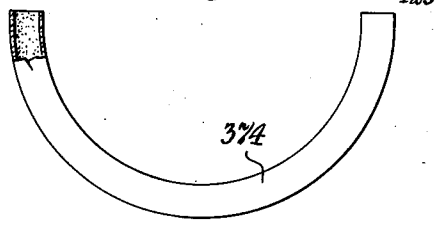


Fig. 18.

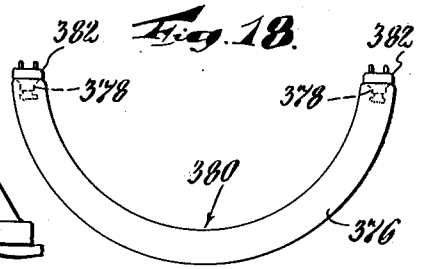


Fig. 19.

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Fig. 6.

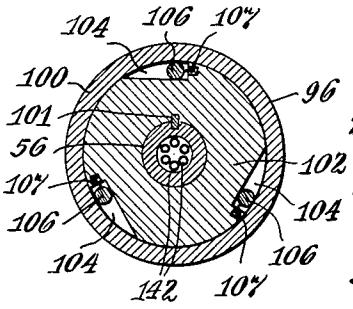


Fig. 5.

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Fig. 10.

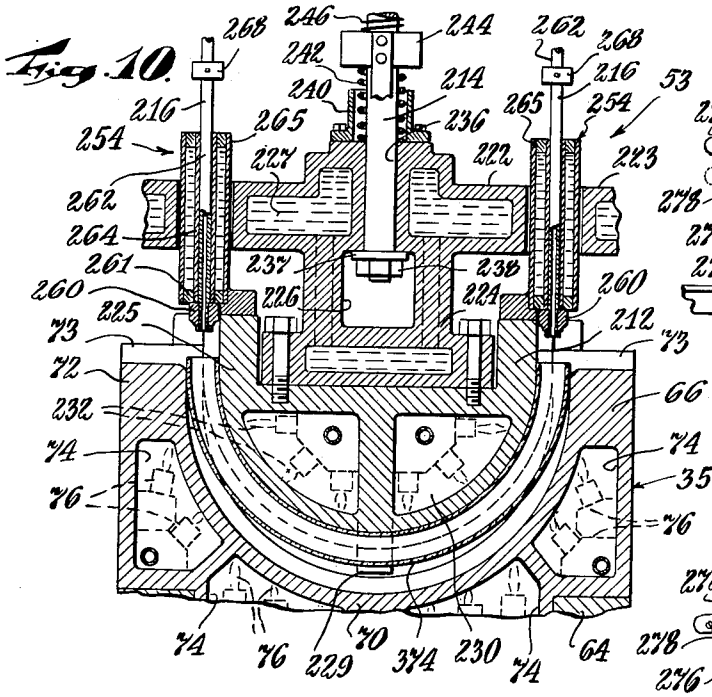


Fig. 11.

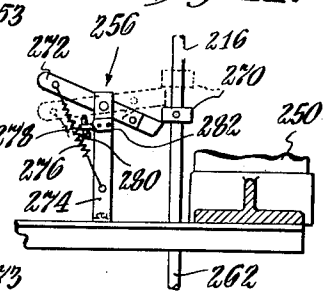


Fig. 13.

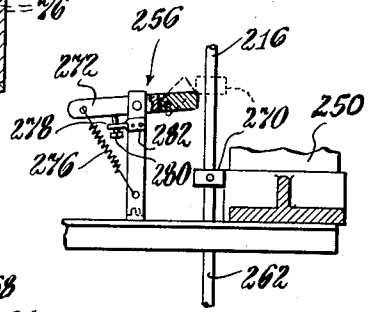


Fig. 12.

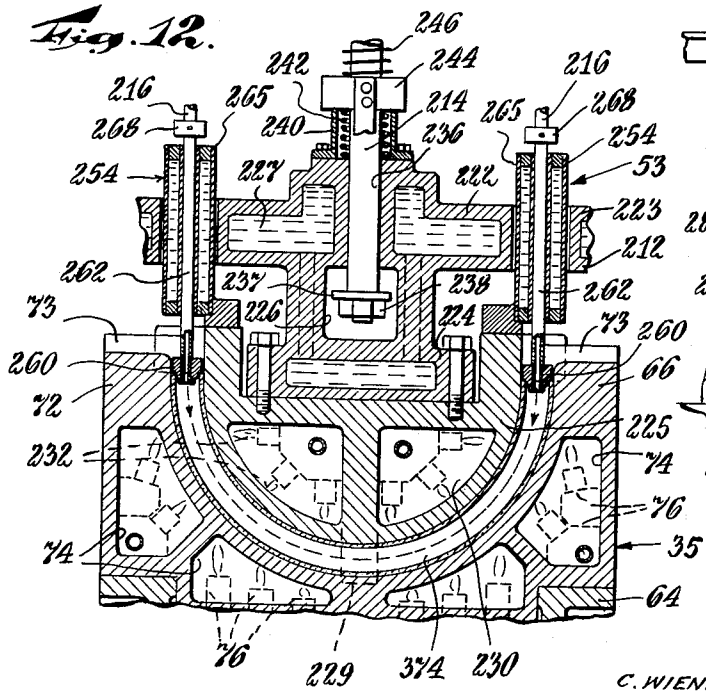
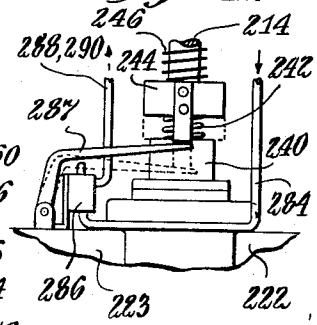


Fig. 14.



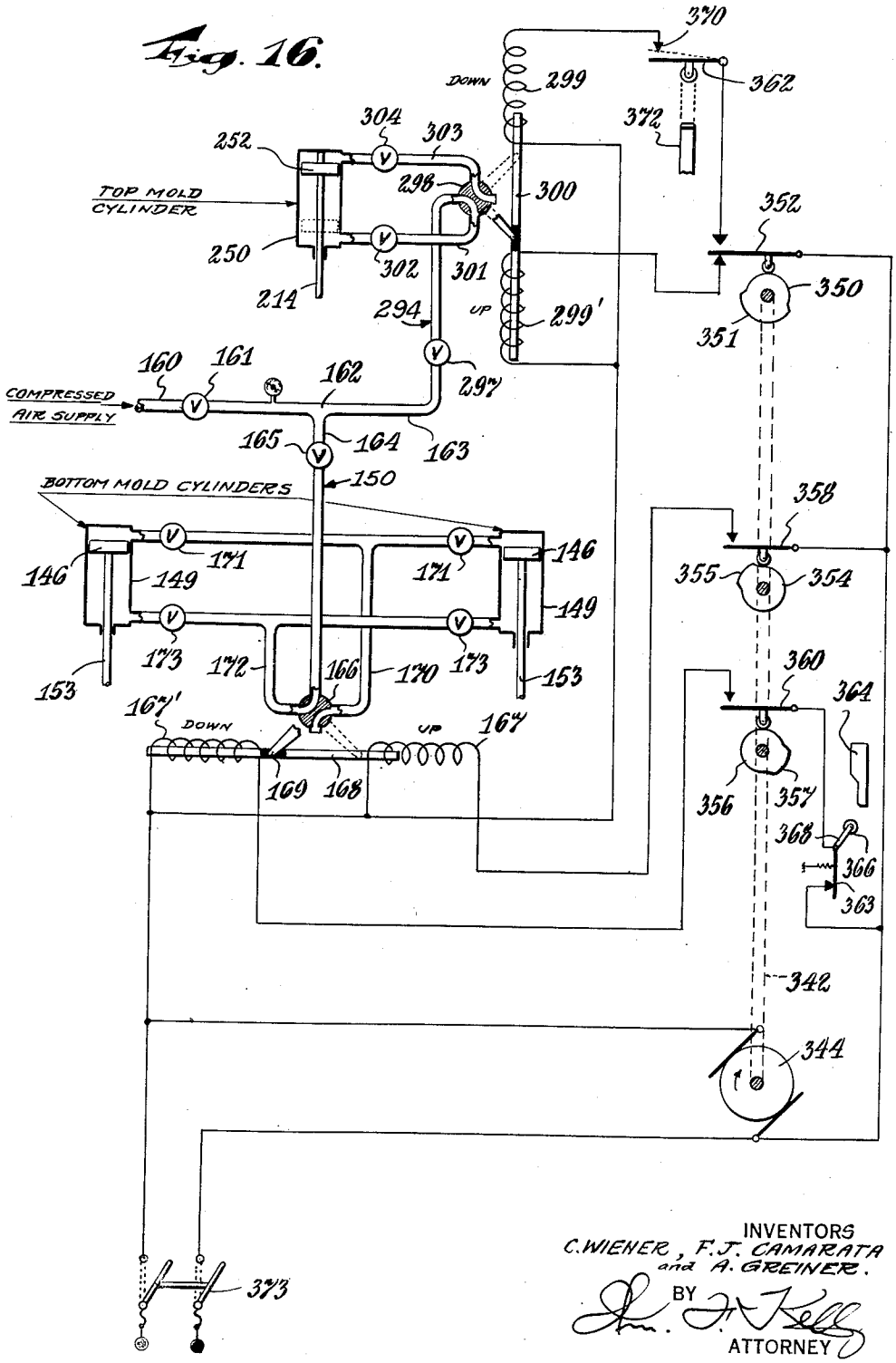
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Fig. 16.



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United States Patent Office

2,696,697

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2,696,697

MACHINE FOR BENDING ENVELOPES FOR CURVED FLUORESCENT LAMPS

Charles Wiener and Frank J. Camarata, Bloomfield, and Arno Greiner, Irvington, N. J., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application June 9, 1951, Serial No. 230,826

8 Claims. (Cl. 49—7)

This invention relates to tube-bending machines and, more particularly, to a machine for lehring and bending the coated tubular envelopes of curved fluorescent lamps.

Fluorescent lamps having their tubular envelopes bent in the form of a half circle are sold by the assignee of the present application under the trade-mark "Circlarc." The short length of the "Circlarc" lamp permits its operation on a small choke as ballast with a manual or glow switch starter. The base pins are desirably located in a plane extending at an angle of 45° to the plane of the lamp, thus allowing the pins of two opposing lamp bases to overlap and reducing the thickness of a two lamp holder to a minimum.

The manufacture of this lamp generally comprises washing and drying the bulb, coating the bulb with a fluorescent mixture or phosphor, drying the coated bulb to remove the volatile solvent or diluent in the coating mixture, baking or lehring the dry, coated bulk to burn out and entirely remove the carbonaceous binder and simultaneously straighten any crooked bulbs, bending the lehred bulb to the "Circlarc" configuration, sealing the mounts into each end of the bulb to form the lamp, exhausting, basing, and testing the lamp.

To reduce production costs, improve quality and increase production, it has been found advantageous, according to our invention, to provide an automatic machine for lehring the tubular coated bulbs and bending the lehred bulb into the "Circlarc" configuration. This machine consists of a lifter-feeder mechanism, a lehring oven, a rotatable slidable turret carrying the lower molding dies, an upper molding die mechanism and an automatic synchronizing mechanism. The lifter-feeder mechanism has two sets of rotating and reciprocating rollers for automatically advancing the bulbs through the lehring oven, which is maintained automatically at the desired lehring temperature.

When a bulb reaches the last roller of the lifter-feeder mechanism, it is automatically dropped into a lower molding die. An upper molding die follows immediately and forms the bulb to the desired shape. During forming a gas such as nitrogen is automatically blown into the bulb to shape the body of the bulb against the walls of the mold. The upper molding die is then retracted and the lehred formed bulb expelled from the lower molding die by the simultaneous rotation and lowering of the turret.

The principal object of our invention, generally considered, is to provide a machine which lehrs tubular phosphor-coated bulbs or envelopes for discharge lamps and automatically forms the lehred coated envelopes into the desired curved configuration.

An additional object is an automatic machine, comprising a lifter-feeder mechanism, a lehring oven, a rotatable, slidable turret having a plurality of lower molding dies, an upper molding die mechanism, and an automatic synchronizing control mechanism, for reducing the cost, increasing the production rate, and improving the quality of the lehring and forming operations in the production of "Circlarc" fluorescent lamps.

Other objects and advantages of the invention relating to the particular arrangement and construction of the various parts will appear to those skilled in the art to which it appertains as the description thereof proceeds, both by direct recitation thereof and by implication from the context.

Referring to the drawings, in which like numerals of reference indicate similar parts throughout the several views:

Fig. 1 is a side elevational view of the lehring and bending machine of our invention in the normal starting position;

Fig. 2 is a front elevational view of the machine of Fig. 1;

Fig. 3 is an axial sectional view of the machine, on the line III—III of Fig. 2 in the direction of the arrows;

Fig. 4 is a fragmentary sectional view of the upper and lower molding die, at the position of Fig. 3, and of the delivery end portions of the lifter-feeder mechanism, showing how lehred bulbs are fed into the lower molding dies;

Fig. 5 is a transverse sectional view of the machine on the line V—V of Fig. 3 in the direction of the arrows;

Fig. 6 is a sectional view of the one-way turret clutch on the line VI—VI of Fig. 5 in the direction of the arrows;

Fig. 7 is a sectional view of the rotatable outer portion of the lower die heating system manifold valve on the line VII—VII of Fig. 5 in the direction of the arrows;

Fig. 8 is a sectional view of the stationary inner portion of the lower die heating system manifold valve on the line VIII—VIII of Fig. 5 in the direction of the arrows;

Fig. 9 is a sectional view on the line IX—IX of Fig. 8 in the direction of the arrows;

Fig. 10 is a sectional view of the upper molding die mechanism and a lower molding die before plugs are dropped into the ends of the lamp envelope to be formed.

Fig. 11 is an elevational view of the plug tripping mechanism for the upper molding die mechanism, before said plugs drop into the ends of the lamp envelope to be formed;

Fig. 12 is a sectional view, similar to Fig. 10, with the plugs in the ends of the formed lamp envelope;

Fig. 13 is an elevational view, similar to Fig. 11, showing the mechanism when the plugs are in the ends of the formed lamp envelope;

Fig. 14 is an elevational view of the valve-tripping mechanism for directing nitrogen into the tube during forming;

Fig. 15 is a timing diagram illustrating the cooperative automatic operation of the component parts of the machine;

Fig. 16 is a schematic diagram showing the wiring and piping of the machine;

Fig. 17 is an elevational view of a lehred and formed "Circlarc" lamp envelope;

Fig. 18 is an elevational view of a completed "Circlarc" lamp;

Fig. 19 is a horizontal sectional view on the line XIX—XIX of Fig. 3, in the direction of the arrows;

Fig. 20 is a fragmentary sectional view corresponding with a portion of Fig. 4, but showing the lifter-feeder mechanism in another position;

Fig. 21 is a fragmentary plan of end portions of the lifter-feeder rollers, on the line XXI—XXI of Fig. 3, in the direction of the arrows.

Referring now to the drawing in detail, and particularly to Figs. 1 and 2, the reference numeral **20** designates the machine frame of one embodiment of our automatic lehring and bending machine **22**. This machine frame comprises a bottom platform **24**, two turret support pedestals **26**, a lehring oven frame **28** (Fig. 1) on said platform, and an upper molding die frame **30** on said pedestals.

Each of said pedestals **26** has essentially a vertical channel portion **31** (Fig. 1) having an axial turret mechanism slot **32** (Fig. 3) cut transversely therethrough substantially the length of pedestal **26**, a top flat flange portion **33** (Fig. 2), and at the bottom a flanged foot portion **34** secured to the platform **24** by suitable nuts and bolts. The pedestals **26** slidably support the rotatable and slidable turret or spider **35**.

The lehring oven frame **28**, an open-sided box-like structure, located rearwardly of pedestals **26**, is constructed of corner angle members **36** (Fig. 1) which support an upper platform **38** for mounting the lehring oven **39** and an intermediate driving mechanism platform **40** for mounting a combination lifter-feeder driving and automatic synchronizing control mechanism **41**. Said members **36** are suitably bolted to the bottom platform **24**.

Bolted in flatwise engagement to the top flanged por-

tion 33 of each pedestal 26 is the bottom support plate 42 (Fig. 2) of upper molding die frame 30, projecting horizontally inwardly from said pedestal 26. This plate 42, a cast metal member, has two suitable hollow vertical sockets or hubs 44 on its inner end, connected by a vertical end plate 46 and supported and reinforced by triangular shaped side members 48.

Threaded into and projecting from sockets 44 are the upper molding die vertical support rods 50 (Fig. 2) which support the upper molding die casting 51 and are inserted into downwardly projecting sockets or hubs 52 on the casting 51. Depending axially from and below casting 51 is the upper molding die mechanism 53. Near the bottom the front rods 50 are reinforced by a horizontal member 49 shown in Fig. 2.

Turret or spider mechanism

The turret mechanism 35 comprises a turret 54 (Figs. 2 and 3) mounted on a horizontal hollow turret shaft 56, a gas heating system 58 (Fig. 1), and a turret driving mechanism 60.

This turret 54 is a hollow cylindrical body having outer projections 62 (Figs. 2 and 5) at each end for bringing out gas line connections, as hereinafter described, from a shaft 56; flanged portions 64 (Figs. 3 and 5), inwardly from projections 62, on which, in the present showing, six lower molding dies 66 are mounted.

Each of the dies 66 is essentially a hollow flat plate, the inner portions 70 (Fig. 5) of which conform to the flanged portions 64 of turret 54. The outer portion 72 of die 66 is recessed into the desired semi-toroidal configuration. The rear edge of each die 66 adjacent the lehring oven 39 is cut off at the open ends as at 73 (Figs. 3 and 5) to facilitate delivery of the lehred bulb to the die 66. As shown particularly in Figs. 10 and 12, suitable symmetrical recesses 74 are cut into the die on both sides between the inner portions 70 and the outer portions 72 for mounting gas burners 76, twenty in the present embodiment, ten on each side, for optimum heating efficiency. When the turret mechanism 35 is at the bottom of its vertical travel, the lower extremities of the bottom die 66 rest on the supports 77 (Fig. 5), suitably bolted to platform 24.

The hollow turret shaft 56 is supported, as shown in Figs. 2 and 5, at each end outwardly from the center of machine 22 by the following adjacent assemblies; namely, an inner support assembly 78, a clutch housing and gear assembly 80, a turret mechanism slide block 81, and an outer valve assembly 82.

The inner support assembly 78 (Fig. 5) comprises bearing 84 and a lower flanged foot portion 86. The bearing 84 is lined with a bushing or sleeve 87 which fits shaft 56 and permits rotation of said shaft therein. The lower flanged portion 86 is bolted to a bracket 90 which is similarly affixed to the inner side of a turret mechanism sliding block retaining plate 93, hereinafter described.

The clutch housing and gear assembly 80 (Figs. 2 and 5) comprise a large vertical drive gear 94 for rotating the turret mechanism 35 and a clutch 96. The gear 94 has a bushing 97 therein similar to bushing 87. Gear 94 engages a rack 98 suitably mounted on the front side of vertical channel portion 31 of pedestal 26.

The clutch 96, as shown in Fig. 6, consists of a housing 100 and a clutch braking plate 102, suitably pinned to shaft 56 at 101, but free to slide within housing 100 in counterclockwise direction. Three clutch recesses 104, shown arranged at approximately 120° intervals, are cut triangular in cross section into the periphery of plate 102. In each recess 104, a clutch roller 106, connected by a spring 107 to the rear radial side wall of the recess, is contained between housing 100 and the bottom of recess 104.

Assuming housing 100 rotates in counterclockwise direction with reference to Fig. 6, rollers 106 are wedged between housing 100 and recesses 104 in plate 102 by springs 107, thus permitting the clutch braking plate 102 and shaft 56 to rotate in a counterclockwise direction. Conversely, during clockwise movement of housing 100, rollers 106 are forced toward the springs 107, thus preventing the clutch braking plate 102 and shaft 56 from turning.

Where shaft 56 passes through a suitable cylindrical hole in the mechanism slide block 81, an appropriate bushing 108 (Fig. 5) similar to bushings 87 and 97 is provided. This block 81 slides in vertical slot 32, of pedestal 26 and is secured therein in slidable engagement by an inner and an outer flat retaining plate 93, one on each side of said block. The outer plates 93 (Figs. 1 and 3) are of inverted T-shaped configuration and bolted to the block 81 at its upper end. Each plate overlaps slot 32, thereby sliding on channel portion 31 of pedestal 26.

The outer valve assembly 82 (Fig. 5) comprises a rotatable outer valve head assembly 110 and a stationary inner valve seat assembly 112, which consists of an inner flanged member 114 pinned to a stationary valve seat 116. Member 114 is secured to the outer turret mechanism sliding block retaining plate 93 by means of threaded connections (not shown). Into complementary cylindrical holes cut into the abutting faces of member 114 and seat 116, is inserted a bushing 118 and a suitable compression spring 120 for maintaining the valve seal. As shown in Figs. 8 and 9, the outer face of seat 116 has an annular gas supply groove 122 cut therein. A portion 123 of this groove is of large rectangular cross section extending about 240° of the periphery (Fig. 8) to supply the required gas for the forming operation of the bulb, the remainder 124 being of reduced rectangular section, for reducing gas flow during the annealing operation hereinafter described.

Between shaft 56 of machine 22 and valve seat assembly 112 (Fig. 5), and extending to the rotatable outer valve head assembly 110 of the valve at the end of shaft 56, is a bushing 125 having a flanged end 126 overlying a valve plate 128, as hereinafter explained.

The rotatable outer valve head assembly 110 of valve assembly 82 has an outer member 127 and the cylindrical valve plate 128 separated by the flange portion 126 of bushing 125. As shown in Fig. 5, plate 128 rotates on the shank of bushing 125, in engagement with its flange 126, and is thereby held in sealed contact with valve seat 116. Six cylindrical holes 131, arranged 60° apart are cut through plate 128, as shown in Fig. 7, so as to be in complementary engagement with the annular gas supply groove 122 in valve seat 116.

Gas heating system

The gas heating system 58 of the turret or spider mechanism 35 is carried, as shown in Fig. 1, from a gas mixer and compressor (not shown) by a suitable line 132 (Fig. 1) having a flexible portion 133 to an inlet connection 134, in the underside of stationary valve seat 116, as shown in Fig. 5. From connection 134, as shown in Fig. 8, the gas runs through a nipple 135 in and projecting from a cylindrical hole 136 in the wall of seat 116. Said hole bends through 90° into the annular gas supply groove 122 in stationary valve seat 116 as shown in Fig. 5. From the annular gas supply groove 122, gas is supplied to ten of the twenty burners 76, in each of the six lower molding dies 66, by one of six similar lines, each of which has the following construction:

The gas flows from groove 122 through a nipple 137 in and projecting from holes 131 (Fig. 2) in the outer valve plate 128, as shown in Fig. 5, through a flexible connection 138 and a nipple 139 connecting with a port 140 in outer member 127 of the rotatable outer valve head assembly 110. This port is connected to a horizontal pipe line 142 within shaft 56. This line which passes through the wall of shaft 56 and the wall of the outer projections 62, connects to a T 143 near its point of emergence. From one side of the T 143, a line 144 feeds into one end of a reservoir 145, within the body of a die 66 for supplying gas to the twelve burners 76, six on each side, in the central recesses 74 of die 66, as shown in Fig. 5. From the other side of T 143, a line 145*a*, runs into the die 66 and supplies with gas by suitable connections (not shown) the four burners 76, two on each side, in the adjacent end recesses 74 of die 66. As shown in Figure 5, the gas is supplied to the remaining ten gas burners 76 by a system, identical to the above described means, and on the other side of the bending machine 22.

The gas seal between the abutting surfaces of rotatable outer valve plate 128 and stationary valve seat 116 is maintained in the following manner. The outer member 127, the flanged end 126 of bushing 125 and outer valve plate 128 are put in compression and the valve surface of plate 128 is compressed against the valve surface of valve seat 116 by the above described members of the gas heating system. In turn, the six compression springs

120 inside the bushings 118 in the complementary holes in the abutting surfaces of the valve seat 116 and the inner flanged member 114 compress the valve surface of valve seat 116 against the valve surface of plate 128, thereby maintaining the gas seal in the outer valve assembly 82.

Turret drive mechanism

The turret drive mechanism 60 is operated by compressed air and consists of two pistons 146 (Fig. 16) operating in cylinders 149, connected to a drive shaft 147 (Fig. 2) running transversely along the front of machine 22, and through suitable bearings 148 attached to pedestals 26.

The drive shaft 147 is further supported by two brackets 151 which are located between the pillars 26 and have their bases bolted to bottom platform 24. Each cylinder 149 is supplied from a compressed air line system 150 (Fig. 16). Each piston 146 is connected by a rod 153 to a cross head 154 (Fig. 1) which drives a crank 158 on shaft 147 by means of a connecting rod 156, and with a gear train 159 forms a drive system 157.

The compressed air line system 150 for the turret driving mechanism 35 introduces the compressed air through line 160 and a valve 161, as shown in Fig. 16, to a T connection 162. A line 163 carries the air on one side of the T 162 to the upper molding die mechanism, as hereinafter described. Another line 164 leads from the other side of T 162 through a regulating valve 165 to a two-way valve 166 operated by solenoids 167 and 167′, the armature 168 of which is pinned to the operating handle of valve 166 at 169. On the outlet side of valve 166, a line 170 carries the air through a regulating valve 171 to the top of air cylinders 149 for motivating the upward motion of the turret mechanism 35. Another line 172 on the other outlet side of said valve 166 leads through regulating valve 173 to the bottom of a cylinder 150 for effecting the downward motion of the turret mechanism 35.

Each main air cylinder 149 is mounted on a horizontal top flange 174, shown in Fig. 3, of a support bracket 176 of generally right triangular cross section, which in turn is bolted to the channel portion 31 of pedestal 26 near its top. This bracket 176 depends vertically below cylinder 150 and has a slot 178, shown in Fig. 2, cut into and running the length of its front face 180.

The cylinder 149 has a piston 146 with a rod 153 (Fig. 16) connected to a cross-head 154 (Fig. 2). This cross-head 154 rides in slot 178 and the connecting rod 156 is pivotally connected thereto at 188. The lower end of rod 156, in turn, is pivotally connected at 190 (Fig. 1) to crank 158 which is fixed to drive shaft 147.

On each end of drive shaft 147 is secured a gear 194, as shown in Figs. 2, 3 and 19. In turn, each gear 194 engages a driven gear 196 on a horizontal shaft 198 (Fig. 19) which runs in a bearing of an end bracket 200 attached to the side wall of foot portion 34 of pedestal 26 (Fig. 2). A gear 204, preferably identical with gear 196, is fixed on shaft 198 between bracket 200 and the side wall of foot member 24.

A gear 206, similar to gears 204 and 196, fastened on an idler shaft 208 meshes with gear 204. To complete the gear train 159 for raising and lowering turret mechanism 35, two vertical racks 210 (Fig. 3), one of which engages gear 204 and the other gear 206, are located within bracket 200 and bolted to the lower portion of the outer turret mechanism sliding block retaining plate 93.

Operation of turret or spider mechanism

According to our invention, at the start of the bending cycle the turret mechanism 35 rests in its lowermost position on adjustable stops 89 and supports 77 (Fig. 2). When operation of the automatic synchronizing control mechanism 41 of the machine 22, as hereinafter described, effects actuation of solenoid 167, the valve 166 (Fig. 16) admits compressed air to line 170 and opens line 172 to the atmosphere, thereby forcing each of the pistons 146 downward in their cylinders 149. As shown in Fig. 1, the downward motion of piston slide block 154, in the slot 178 of bracket 176, and the connecting rod 156, rotates counterclockwise the crank 158 and drive gear 194 on shaft 147. In turn, driven gear 196 and gear 204 rotate clockwise. The clockwise rotation of gear 204 and the counterclockwise rotation of gear 206 on the racks 210, affixed to slidable retaining plates 93, raises the turret mechanism 35. During the upward motion of mechanism 35, the clutches 96 permit each gear 94 on shaft 56 to rotate on rack 98 clockwise with respect to Fig. 1, without turning shaft 56.

During the downward movement of the turret 54, the two way valve 166 operated by solenoid 167′, opens line 170 to the atmosphere and admits compressed air to line 172, as shown in Fig. 16. The upward motion of piston 146 moves the gear train 159 in the opposite direction, thereby causing the racks 210 to move downward on gears 204 and 206, and the drive gears 94 to rotate counterclockwise, as shown in Fig. 1 on rack 98. Clutches 96 lock gears 94 to shaft 56. The shaft 56, turret 54, and of course the lower molding dies 66 rotate exactly 60° counterclockwise during the calculated downward travel of mechanism 35. During the rotation of mechanism 35, the gas supply to burners 76 of the uppermost die 66 is reduced by means of the rotation of the uppermost hole 131 in outer valve plate 128 from engagement with large cross-section 123 of gas supply groove 122 in stationary valve seat 116, to engagement with reduced cross-section 124 of said groove, thereby reducing the temperature of said uppermost die 66 and annealing the lehred formed envelope in said die before discharge at the end of the next rotation cycle.

Upper molding die mechanism

The upper molding die mechanism 53, as shown in Figs. 2, 5, 10 and 12, comprises an upper molding die assembly 212, suspended from casting 51 on vertical rod 214 (Fig. 2), a nitrogen blowing system 216, a gas heating system 218, an upper molding die driving mechanism 220 and a water cooling system 221.

The upper molding die assembly 212 consists of a generally T shaped casting 222 (Fig. 5), desirably of the same thickness as lower dies 66 of the turret 54, having an upper horizontal portion 223 axially aligned with a vertical foot portion 224, to which is bolted an upper molding die 225.

As shown in Figs. 10 and 12, an axial clearance aperture 226 is cut for shaft 214 in the vertical foot portion 224. In the body of the horizontal portion 223 above aperture 226 and in the body of the foot portion 224 below slot 226, there are provided a series of mutually interconnected cooling chambers 227.

The bulb-receiving cavity of this molding die 225 is of semi-toroidal shape and is dimensioned to engage complementarily any one of the six lower molding dies 66 with a formed and lehred bulb or envelope 374 of the desired circular cross-section therebetween, as shown in Fig. 17.

A guide plate 229 depends on each side of the lower end of die 225 to insure proper aligned engagement of the upper molding die 225 and any of the lower molding dies 66, as shown in Fig. 3.

Into each side of the body of molding die 225 are cut two symmetrical recesses 230 (Figs. 10 and 12), similar to inner recesses 74 of lower die 66. In each of these recesses 230 are provided, in this embodiment three burners 232 for heating the mold.

Pivoted at each corner of the upper surface of the horizontal portion 223 of casting 222 is a guide roller 234 (Fig. 5) which rolls up and down on the adjacent forward upper molding die support rod 50.

The vertical shaft 214 slides within an axial hole 236 (Figs. 10 and 12) extending through the horizontal portion 223 of casting 222, to the aperture 226 therein. The lower end of shaft 214 is threaded and secured within the aperture 226 by a washer 237 and nut 238. On shaft 214 and bolted to the upper surface of portion 223 is a compression spring guide 240 of diameter suitable to house the lower end of a compression spring 242. The upper end of spring 242 engages an adjustable stop or collar 244 which is fastened to shaft 214.

Above stop 244 and on shaft 214, as shown in Fig. 2, is a larger compression spring 246 which has its upper end in contact with the lower surface of casting 51. Shaft 214 passes axially through casting 51, in slidable contact therein, and thence into an air cylinder 250 which is mounted on casting 51 in axial alignment with shaft 214. Within air cylinder 250 is provided a piston 252 (Fig. 16) which is affixed to the upper end of shaft 214.

Nitrogen blowing system

The system 216 for blowing nitrogen into each end

of the bulb during the forming operation by the upper die **225** and a lower die **66** comprises mechanism for each end of said bulb. Each system comprises a plug mechanism **254**, a plug tripping mechanism **256**, and a nitrogen supply system **253**.

Each plug mechanism **254**, as shown in Figs. 10 and 12, comprises a plug **260** on the end of a vertical hollow shaft **262** which is slidable through an outer and upper lip **261** of upper molding die **225**, a bushing **264** in upper horizontal portion **223** of casting **222**. An adjustable stop **268** (Fig. 10) between portion **223** and casting **51**, and an adjustable stop **270** (Fig. 2) above casting **51** are provided on said shaft. Plug **260**, suitably of rubber-like material, has a tapered lower end to fit the circular ends of the envelopes being formed. Each bushing **264** is in a housing **265** which projects above and below the upper horizontal portion **223**, and is secured at its lower end to the upper lip **261** of die **225**, as by welding. Each adjustable stop **268**, is secured to its shaft **262** a predetermined distance above housing **265** to limit the downward travel of plug mechanism **254**. Each stop **270** is fixed on its shaft **262** a distance above casting **51** predetermined by the positioning of the plug-tripping mechanism **256** mounted on spider **51**.

The plug tripping mechanism **256**, as shown in Figs. 11 and 13, consists of a trip arm **272** pivoted on a vertical rod **274**, a tension spring **276** for securing one end of arm **272** to the rod **274** and an adjustable trip arm positioning device **278**. The length of arm **272** is designed so that its unsecured inner end is engaged by stop **270**, but not by shaft **262**, during its required movement. The trip arm positioning device **278** consists of a bolt **280** screwed through a threaded portion of a collar **282** on rod **274**. The upper end of bolt **280** limits counter-clockwise motion of the arm **272**.

The nitrogen supply system **258**, as shown in Fig. 2, consists of an inlet line **284** from a nitrogen supply, (not shown) a trip valve **286** mounted on the upper horizontal portion **223** of casting **222**, adjacent the stop **244** on the lower end of shaft **214**, as shown in Fig. 14; and a connecting line **288** and **290** from valve **286** to each of the hollow shafts **262** of the plug mechanism **254**. This valve **286** has a horizontal valve release arm **287** which is engaged by stop **244**, thus admitting nitrogen as hereinafter explained.

Gas-heating system

The gas-heating system **218** for upper molding die mechanism **53** is generally similar to the gas heating system **58** for the lower molding dies **66**. It comprises an inlet gas line **292**, as shown in Fig. 2, from a mixer and compressor (not shown), which runs into the body of upper molding die **225** and feeds, by connecting lines (not shown) therein, burners **232** located in recesses **230** therein.

Upper molding die driving mechanism

The upper molding die driving mechanism **220** is operated like turret drive mechanism **60** by compressed air and consists of the above-mentioned air cylinder **250** having its piston **252** affixed to shaft **214** and a compressed air line system **294**, as shown schematically in Fig. 16.

From T connection **162**, system **294** has a line **163** running through a regulating valve **297** to a two-way valve **298**, similar to valve **166**, of the turret mechanism compressed air line system. This valve **298** is operated by a solenoid **299**, and **299'** having an armature **300** connected to the operating handle of said valve. A line **301** connects one outlet side of the valve **298** through a regulating valve **302** to the bottom of air cylinder **250**. The other outlet side of valve **298** is connected by a similar line **303** through a similar valve **304** to the top of air cylinder **250**.

A water cooling system **221**, as shown in Fig. 2, cools the upper molding die mechanism **53** and consists of an inlet line **304** entering the casting **222** and running through the wall thereat to the cooling chamber **227** below clearance aperture **226**. Water outlet line **306** leaves the casting **222** and runs to the drain.

Operation of upper molding die mechanism

When the operation of the automatic synchronizing control mechanism **41** of the machine **22**, as hereinafter described, actuates solenoid **299**, valve **298** (Fig. 16) admits compressed air into line **303** and opens line **301** to the atmosphere. Air then flows into the top of cylinder **250**, thereby forcing the shaft **214** and upper die mechanism down into contact with the work and a lower molding die **66**. During the downward travel, stop **270** (Fig. 2) on each hollow shaft **262** of plug mechanism **254** is arrested by trip arm **272** (Figs. 11 and 13) of plug tripping mechanism **256** until the upper molding die **225** forms the lehred envelope into the curved configuration, and particularly forms the open end portions of said envelope into upright position to receive the plugs **260**, as shown in Fig. 10.

In this position, plugs **260** are resting against outer lips **261** of die **225**. When die **225** travels the remaining short distance, as shown in Fig. 12, into lower die **66**, stop **270** is pulled downwardly past and freed from trip arm **272**, thus permitting plugs **260** to drop into the open ends of the envelope being formed therebetween. Simultaneously, collar **244** strikes the horizontal valve release arm **287** of valve **286** (Fig. 14), thus opening said valve and releasing nitrogen under pressure somewhat higher than atmosphere through hollow shaft **262**, for the purpose of shaping the envelope to the exact configuration of the combined die.

When valve **298** of system **294** opens line **303** (Fig. 16) to the air and admits compressed air into line **301** and thence the bottom of cylinder **250**, piston **252** and the upper molding die mechanism **53** is raised.

Lehring oven and associated mechanism

The lehring oven **39** on upper platform **38** of frame **28**, as shown in Fig. 3, consists of an oven body **308**, insulating side members **310** and two cooperating lifter-feeder mechanisms **312** on opposite sides of the oven **39**. This oven body is of the usual box-like structure having insulated walls, and incoming gas fuel line connected to a series of radiant burners **439** in the underside of said oven. The body **308** is mounted a suitable distance above the platform **38** (Fig. 1) and the lifter-feeder mechanism **312** on said platform to permit the operation of said mechanism **312**, as hereinafter explained. Side members **310** are extensions of the sides of oven body **308** to retain uniform heating and minimize draft effects. A thermocouple depending below the bottom of oven body **308** and a coordinated automatic gas flow control system (not shown) maintain constant temperature in the lehring oven.

The lifter-feeder mechanism **312**, as shown in Figs. 1, 3, 4, 20 and 21, comprises a first set of rollers **314** and a second set of rollers **315** (Fig. 3), a roller-rotating mechanism **316** (Fig. 21), and a roller lifting and lowering mechanism **318** (Fig. 3). The individual rollers, as shown in Figs. 4, 20 and 21, are designated from left to right as shown in said first two figures by numerals **320** to **327**, inclusive. The first roller **320** is rotatable about a fixed axis, counterclockwise as viewed in Figs. 4 and 20. The near ends of the rollers **321**, **323**, **325**, etc., as viewed in Fig. 4, are pivotally supported from above by overhanging operating arms, corresponding with those designated **420** in Fig. 21, while the opposite ends of said rollers are correspondingly supported by underhanging operating arms, corresponding with that designated **421** in Fig. 21.

This means that, while both ends of the roller **320** are mounted about fixed pivots, all of the other rollers are mounted on shafts which are swingable to alternately raise the two sets of rollers **314** and **315** from the normal position illustrated in Fig. 3. The operations are thus, first to one position, such as illustrated in Fig. 4, and then to another position, such as illustrated in Fig. 20.

This alternate raising and lowering is effected by two drive bars, like those designated **425** and **426** (Fig. 21), at each end of the two sets of rollers. Only two of these bars are illustrated in Fig. 21, but the other two bars correspond, one of these others being shown in Fig. 1 and designated **332**. In other words, the roller **321** is carried at its far end, as viewed in Figs. 4 and 20, by an underhanging operating arm **421** and at its near end by an overhanging operating arm, like that designated **420** in Fig. 21. The next roller **322** is carried by its far end by the overhanging operating arm **420**, and at its near end by an underhanging operating arm, like that designated **421** in Fig. 21. The succeeding rollers are alternatively mounted; that is, the rollers **323**, **325** etc. are

mounted like the roller **321**, while the rollers **324**, **326**, etc., are mounted like the roller **322**.

The underhanging operating arms have depending cranks with their ends bifurcated, as indicated at **428** (Fig. 4), to receive studs or bolts **429** on the drive bar **426**, while the overhanging operating arms **420** have cranks **430** (Fig. 20) with their ends bifurcated, as indicated at **431**, to receive corresponding studs or bolts **432** on the drive bar **425**. This means that each of the rollers of the first set, that is, those comprising numbers **321**, **323**, **325**, etc., are operated by a pair of bars, one of which is designated **426** and acts on cranks **427** from underhanging operating arms, while the other **332** is similar thereto but engages cranks depending from overhanging operating arms, like those designated **420**.

Both of the drive bars **32** and its companion **426** at the near ends of the first set of rollers **314** and at their rearward extremities respectively, are pivotally connected, as shown in Fig. 1, to levers **334** by means of intermediate links **330**. Said levers are pivotally mounted, as indicated at **335**, and their other or lower ends pivotally connected to adjustable connecting rods **336**. The other extremities of the rods **336** are pivotally secured to cam drive levers **338**, pivotally mounted at their opposite or lower ends on the platform **40**. These levers **338** carry rollers **337** which are held in operative engagement with cams **340** by means of springs **341**. These cams are mounted on a timing shaft **342** of the lifter-feeder driving and control mechanism **41**. The shaft **342** is operated by a motor **344** as by means of a sprocket wheel, chain, and gear box system **346**.

It will be understood that the drive bars **332** and **426**, acting through one overhanging and one underhanging operating arm at opposite ends of each roller of one set **314** reciprocate in unison with one another, while those namely **425** and its companion not shown, acting through one underhanging and one overhanging operating arm at opposite ends of each roller of the other set **315** reciprocate in unison with one another, but at times intermediate the operation of the other drive bars.

This operation is illustrated, diagrammatically, in Fig. 15, where the peak **433** represents raising of the first set of rollers **314**, while the peak **434** represents raising of the second set of rollers **315**, by corresponding simultaneous reciprocation of the corresponding drive bars. This alternate operation of the sets of rollers is effected by the positioning of the cams on the shaft **342**, the peak **435** on the cams operating one set of rollers being set 180° from the peak **436** on the cams for operating the other set of rollers, so that glass tubing **437** on the rollers, as shown in Figs. 1, 3, 4 and 20, after being received from a guide **438** leading from a supply hopper (not shown) are advanced step by step through the oven by the alternate raising and lowering of the sets of rollers where they are heated to the desired softening temperature, as by means of radiant heater units **439**, until they pass over the final roller **320** and are guided into the uppermost die of the spider **54** over guard member **441**.

During all this bulb transfer operation by the rollers through the oven, said rollers are turned by the shaft **422** (Figs. 1 and 21), driven in any desired manner, and connecting with the respective rollers of the second set **315** by means of gears **442**, **443**, etc. (Fig. 21), on said shaft **422**, respectively meshing with gears **444** and **445**, etc. mounted on shafts **446**, **447**, etc., carrying on their inner ends gears **448**, **449**, etc., driving gears **450**, **451**, etc., respectively mounted on the shafts of rollers **322**, **324**, etc., through idlers **452**, **453**, etc.

The rollers of the first set **314** are rotated in a corresponding manner through a shaft (not shown) corresponding with that designated **422** and driven in a similar manner through gears and shafts corresponding with those designated **442** to **453**, inclusive, at the near ends of the rollers, as viewed in Figs. 3, 4 and 20. The roller **320** is driven directly from a gear on the shaft corresponding with the shaft **422**, but not shown, meshing with a gear on the other end of its shaft, but not shown.

It will, therefore, be seen that the rollers will not only alternately raise and lower to advance the tubing while being lehred in the oven, but they are simultaneously rotated so that the tubing is correspondingly rotated and uniformly heated around its periphery.

Automatic synchronized control system of machine

The automatic synchronized operation of the lehring bending machine **22** is shown schematically in Fig. 16 and explained by reference to the timing diagram of Fig. 15.

Also on timing shaft **342** (Fig. 1) of lifter-feeder mechanism **312**, and synchronized with lifter-feeder cams **340**, are an upper molding die mechanism cam **350** in roller engagement with a normally closed microswitch **352**, an "up" lower molding die cam **354**, and a "down" lower molding die cam **356** (all shown in Fig. 16) in similar roller engagement, respectively, with normally open microswitches **358** and **360**.

Cam **354** is so secured to shaft **342** that at the start of the bending cycle its raised portion **355**, extending about 60° of its circumference, for closing the switch **358** and the "up" circuit of turret mechanism **53**, is ready to engage the roller of switch **358**.

Cam **350** is secured to shaft **342** so that its raised portion **351** extending about 120° of its periphery for closing the "down" circuit of upper die mechanism **53** by means of switch **352**, engages the roller of switch **352** immediately after switch **358** is again open. Switch **352** is normally closed in the "up" circuit of mechanism **53**.

Cam **356**, having a raised portion **357** extending about 60° in this showing, of its periphery for closing switch **360**, is secured to shaft **342** so as to engage the roller of switch **360** about 90° of ¼ of one revolution after switch **352** is again opened, in order to prevent rotation of turret mechanism **35** before the retraction of upper molding die mechanism **53**.

To prevent self inflicted machine destruction, a normally open safety microswitch **362** (Fig. 2) is provided in series with microswitch **352** in the upper molding die mechanism "down" solenoid circuit. For a similar reason normally closed safety microswitch **363** (Fig. 2) is provided in series with the microswitch **360** in the "down" solenoid circuit of the turret mechanism.

Switch **363**, as shown in Fig. 2, has a vertically depending arm **364** for opening said switch affixed to the outer edge of the horizontal portion **223** of casting **222** of the upper molding die mechanism just below one of the guide rollers **234**. The lower portion of said arm **364** is suitably tapered inwardly to properly engage roller **366** on a spring-tensioned contact arm **368** of switch **363**. This contact arm **368** is pivotally mounted on the lower extremity of guide rod **50**, just above horizontal reinforcing member **49**.

The switch **362** (Fig. 2) is secured to the underside of bottom support plate **42**. The switch operating arm **372** is suitably mounted on the upper surface of the inner support assembly **78** of turret mechanism **35**. A main switch **373** (Fig. 16) is provided for starting motor **344**.

Synchronized automatic operation of machine

As motor **344** starts to rotate shaft **342**, cam **354** closes switch **358** and actuates the "up" circuit of solenoid **167**, as shown in Fig. 16. Armature **168** of solenoid **167** operates valve **166**, thus opening line **172** to the atmosphere and admitting compressed air into line **170**, thereby moving turret mechanism **35** upward and closing switch **362** (Fig. 2).

Simultaneously, as shown in Fig. 15, through the synchronized action of lifter-feeder mechanism cam **340** on shaft **342**, said mechanism **312** delivers a lehred bulb **374** into the upright lower molding die **66** immediately below the fixed roller **320**.

As the roller of switch **358** completes its contact with raised portion **355** of cam **354**, the roller of switch **352** engages the raised portion **351** of cam **350**, thereby closing switch **352** to the "down" circuit of mechanism **53** and activating the "down" circuit of solenoid **299** of the upper molding die mechanism **53**. This closes circuit to solenoid **299** to cause armature **300** to operate valve **298**, thus opening line **301** to the atmosphere and admitting compressed air through line **303** to cylinder **250**. Upper molding die mechanism **53** moves downward onto the bulb **374**, now held in the upright one of the lower molding dies **66**, opening the switch **363** and forming the bulb **374** into the desired curved configuration **376**, as shown in Fig. 17.

When the roller of switch **352** leaves raised portion **351** of cam **350**, switch **352** opens the "down" circuit of solenoid **299** and closes the "up" circuit of the solenoid **299'**. The upper molding die mechanism **53** slides upward, and about midway through the retraction cycle of mechanism **53**, as shown in Fig. 15, safety switch **363**, in series with

switch **360**, closes and the roller of switch **360** contacts the raised portion **357** of cam **356**, thus closing the "down" circuit of solenoid **168** and causing the simultaneous 60° forward rotation and downward travel of turret mechanism **35**.

Simultaneous with the rotation of turret mechanism **35**, a bulb **376** formed on the preceding cycle is discharged automatically from its lower molding die **66**.

After the discharge of the lehred formed bulb **376** from machine **22**, a mount **378** is sealed in each end of the bulb **376** and the lamp **380** thus formed is exhausted, based with suitable bases **382**, and tested to provide the finished product, shown in Fig. 18.

Although preferred embodiments of our invention have been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

We claim:

1. An automatic synchronizing control mechanism for a machine for lehring and bending fluorescent lamp envelopes, said automatic synchronizing control mechanism comprising a timing shaft rotatable by a motor and a sprocket chain system, an upper molding die mechanism cam on said shaft in contact with a roller of a normally closed microswitch in series with a normally open safety microswitch both in the "down" circuit of the upper molding die mechanism; an upper circuit lower molding die cam in contact with a normally open microswitch in the "up" circuit of the turret mechanism; and a "down" circuit lower molding die cam in contact with the roller of a normally open microswitch in electrical series with a normally closed safety microswitch in the "down" circuit of the turret mechanism.

2. An automatic synchronized machine for lehring and bending phosphor-coated envelopes comprising a machine frame, a lehring oven on said machine frame, a lifter-feeder mechanism on said machine frame in said oven for continuously rotating and advancing said envelopes through said oven, a rotatable and slidable turret mechanism on said machine frame adjacent the delivery end of said lifter-feeder mechanism and having a plurality of lower molding dies, a vertically reciprocable upper molding die mechanism on said machine frame above said turret mechanism for engagement with said dies and said envelopes therebetween, and an automatic synchronizing control mechanism for synchronizing the automatic operation of said lifter feeder mechanism, turret mechanism and upper molding die mechanism.

3. An automatic synchronized machine for lehring and bending phosphor-coated envelopes comprising a machine frame, a lehring oven on said machine frame, a lifter-feeder mechanism on said machine frame in said oven for continuously rotating and advancing said envelopes through said oven, a rotatable and slidable turret mechanism on said machine frame adjacent the delivery end of said lifter feeder mechanism and having a plurality of lower molding dies, a vertically reciprocable upper molding die mechanism on said machine frame above said turret mechanism for engagement with said dies and said envelopes therebetween, and an automatic synchronizing control mechanism on said machine frame for synchronizing the automatic operation of said lifter-feeder mechanism, turret mechanism and upper molding die mechanism, said machine frame comprising a bottom platform, turret support pedestals upstanding from said platform, a lehring oven frame on said platform, and an upper molding die frame on said pedestals.

4. An automatic synchronized machine for lehring and bending phosphor-coated envelopes comprising a machine frame, a lehring oven on said machine frame, a lifter-feeder mechanism on said machine frame in said oven for continuously rotating and advancing said envelopes through said oven, a rotatable and slidable turret mechanism on said machine frame adjacent the delivery end of said lifter-feeder mechanism and having a plurality of lower molding dies, a vertically reciprocable upper molding die mechanism on said machine frame above said turret mechanism for engagement with said dies and said envelopes therebetween, and an automatic synchronizing control mechanism for synchronizing the automatic operation of said lifter-feeder mechanism, turret mechanism and upper molding die mechanism, said lifter-feeder mechanism comprising a first set of rotatable liftable rollers and a second set of rotatable liftable rollers connected to a roller rotating mechanism and a roller lifting mechanism.

5. An automatic synchronized machine for lehring and bending phosphor-coated envelopes comprising a machine frame, a lehring oven on said machine frame, a lifter-feeder mechanism on said machine frame in said oven for continuously rotating and advancing said envelopes through said oven, a rotatable and slidable turret mechanism on said machine frame adjacent the delivery end of said lifter-feeder mechanism, a vertically reciprocable upper molding die mechanism on said machine frame above said turret mechanism for engagement with said dies and said envelopes therebetween, and an automatic synchronizing control mechanism for synchronizing the automatic operation of said lifter-feeder mechanism, turret mechanism and upper molding die mechanism, said turret mechanism comprising a turret having a plurality of lower molding dies projecting therefrom and mounted on a horizontal hollow turret shaft, a gas heating system within and on said turret and a turret driving mechanism.

6. An automatic synchronized machine for lehring and bending phosphor-coated envelopes comprising a machine frame, a lehring oven on said machine frame, a lifter-feeder mechanism on said machine frame in said oven for continuously rotating and advancing said envelopes through said oven, a rotatable and slidable turret mechanism on said machine frame adjacent the delivery end of said lifter-feeder mechanism, a vertically reciprocable upper molding die mechanism on said machine frame above said turret mechanism for engagement with said dies and said envelopes therebetween, and an automatic synchronizing control mechanism for synchronizing the automatic operation of said lifter-feeder mechanism, turret mechanism and upper molding die mechanism, said upper molding die mechanism comprising an upper molding die assembly mounted from said machine frame on a vertical rod, a nitrogen blowing system, a gas heating system and a water cooling system on said upper molding die assembly and an upper molding die driving mechanism.

7. An automatic synchronized machine for lehring and bending phosphor-coated envelopes comprising a machine frame, a lehring oven on said machine frame, a lifter-feeder mechanism on said machine frame in said oven for continuously rotating and advancing said envelopes through said oven, a rotatable and slidable turret mechanism on said machine frame adjacent the delivery end of said lifter-feeder mechanism, a vertically reciprocable upper molding die mechanism on said machine frame above said turret mechanism for engagement with said dies and said envelopes therebetween, and an automatic synchronizing control mechanism for synchronizing the automatic operation of said lifter-feeder mechanism, turret mechanism and upper molding die mechanism, said automatic synchronizing control mechanism comprising a timing shaft rotatable by a motor and a sprocket chain system, and on said shaft an upper molding die mechanism cam in contact with a roller of a normally closed microswitch in series with a normally open safety microswitch, both in the "up" circuit of the upper molding die mechanism; an "up" circuit lower molding die cam in contact with a normally open microswitch in the "up" circuit of the turret mechanism; and a "down" circuit lower molding die cam in contact with the roller of a normally open microswitch in electrical series with a normally closed safety microswitch in the "down" circuit of the turret mechanism.

8. In an automatic synchronized machine for bending fluorescent lamp envelopes and having a machine frame, an upper molding die mechanism comprising an upper molding die assembly mounted from said machine frame on a vertical shaft, a gas blowing system, a heating system, and a water-cooling system on said upper molding die assembly, and an upper molding die driving mechanism.

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