July 15, 1941. V. H. VAN SANT 2,249,098

EXHAUST MACHINE

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FIG. 1

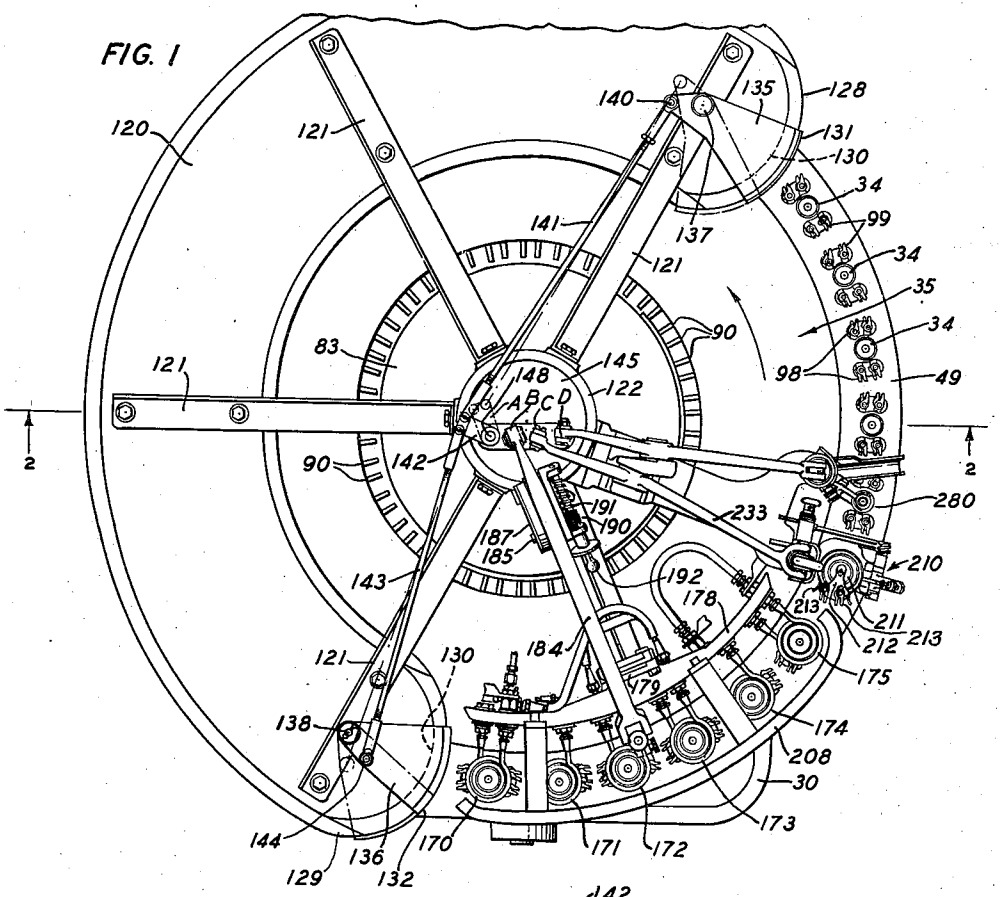
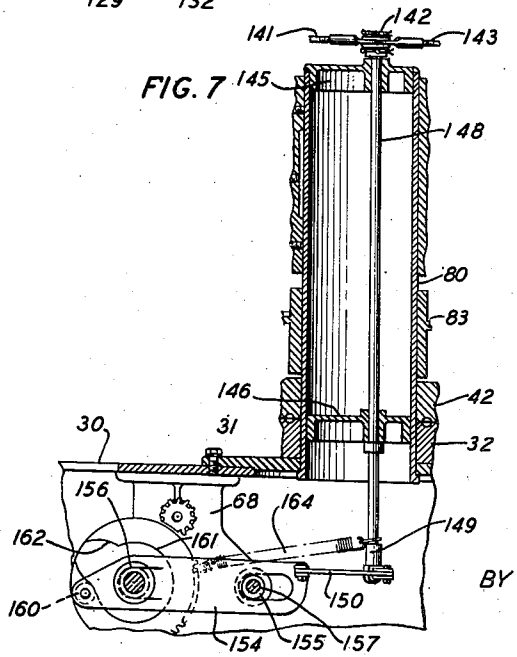


FIG. 7



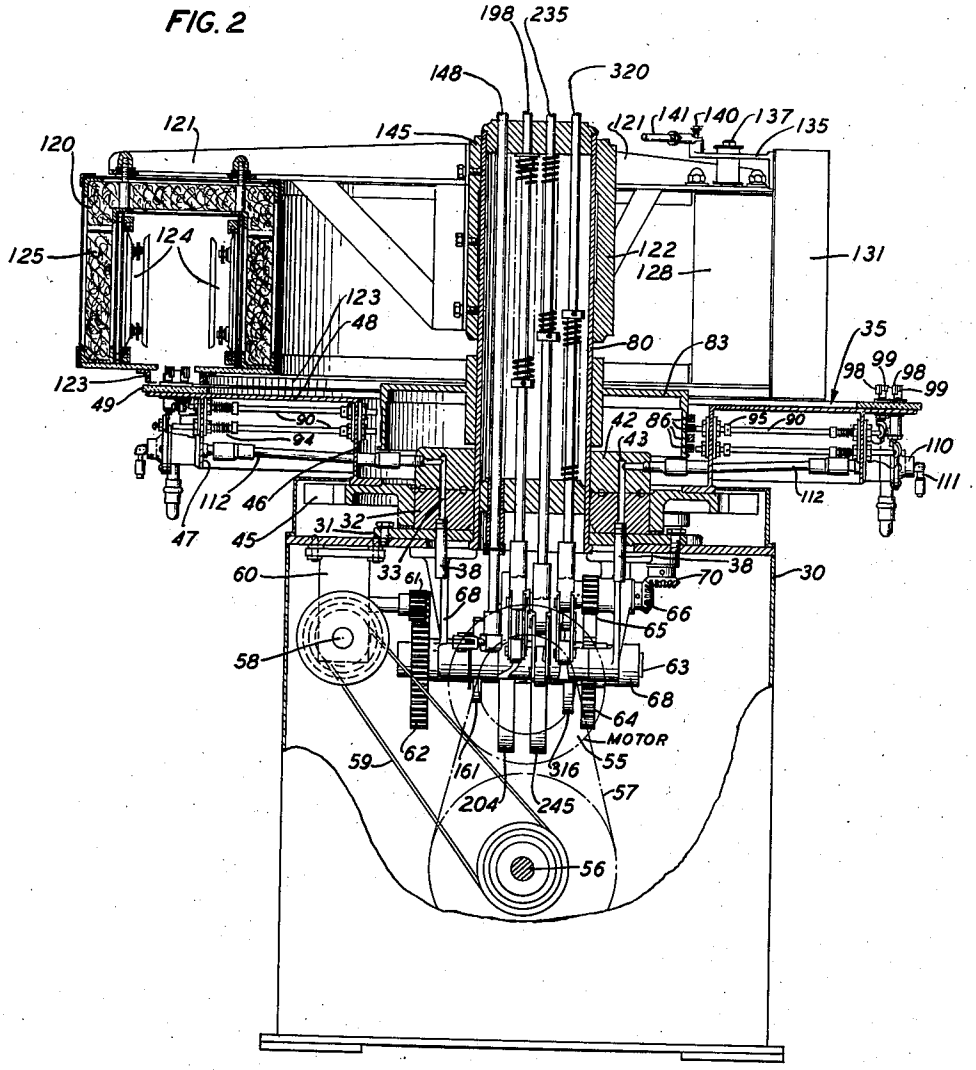
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EXHAUST MACHINE

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FIG. 2



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EXHAUST MACHINE

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FIG. 3

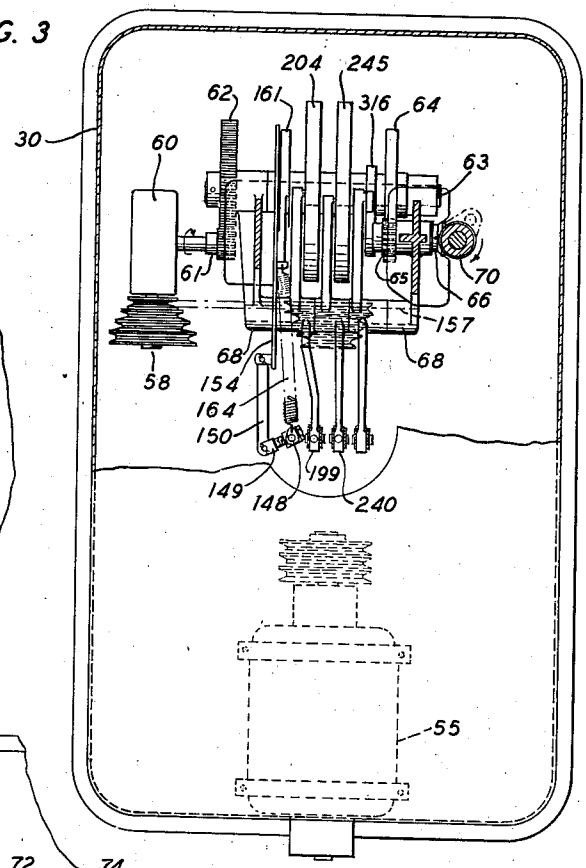


FIG. 5

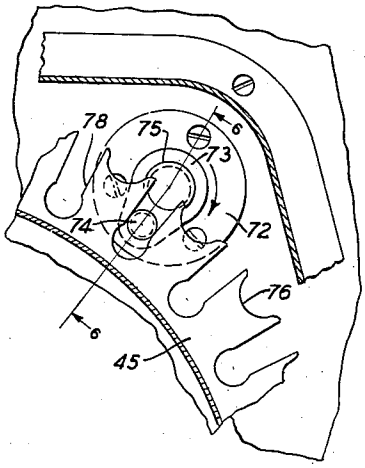


FIG. 4

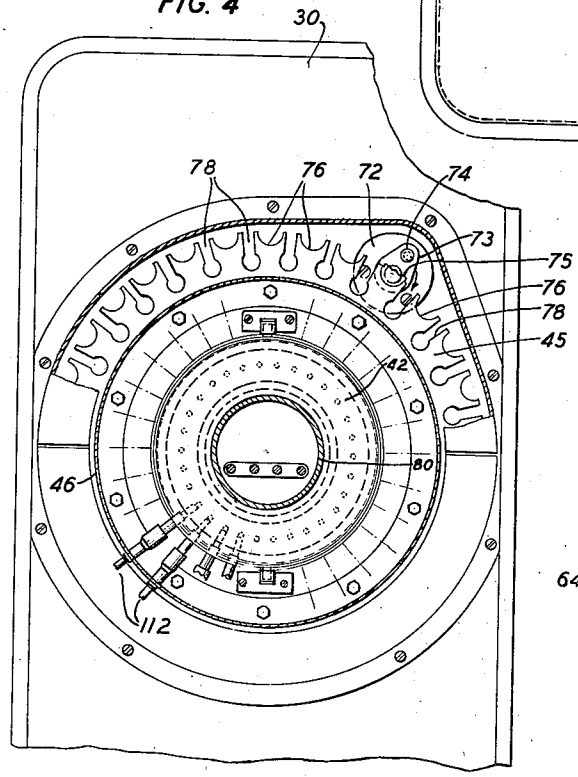
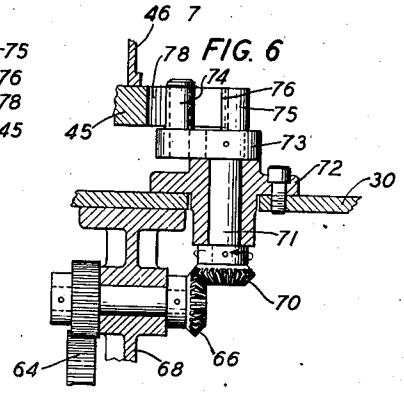


FIG. 6



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EXHAUST MACHINE

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FIG. 9

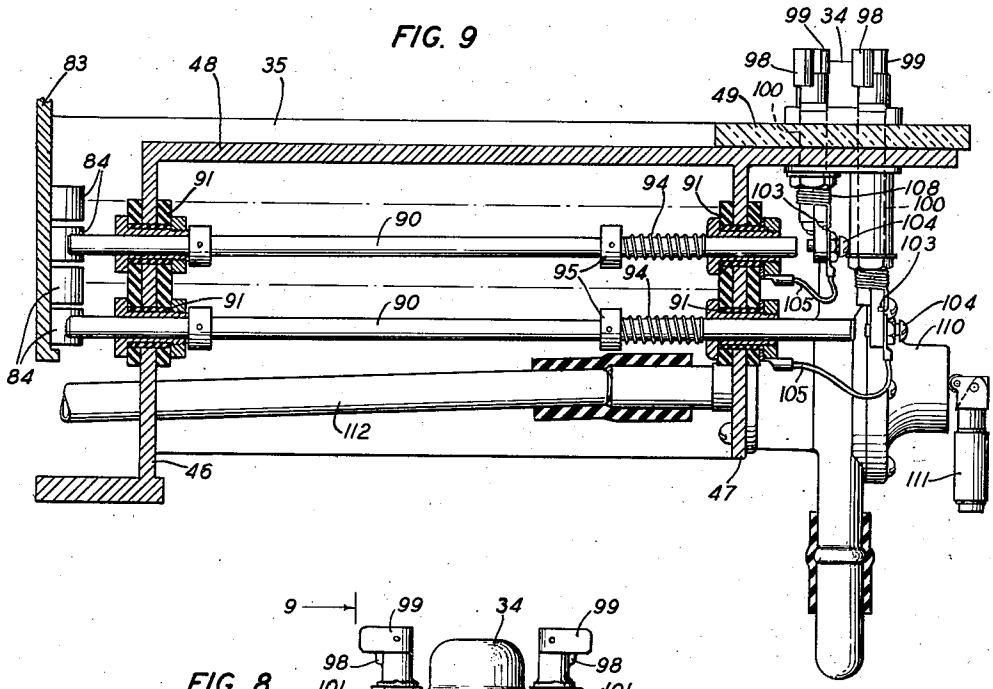
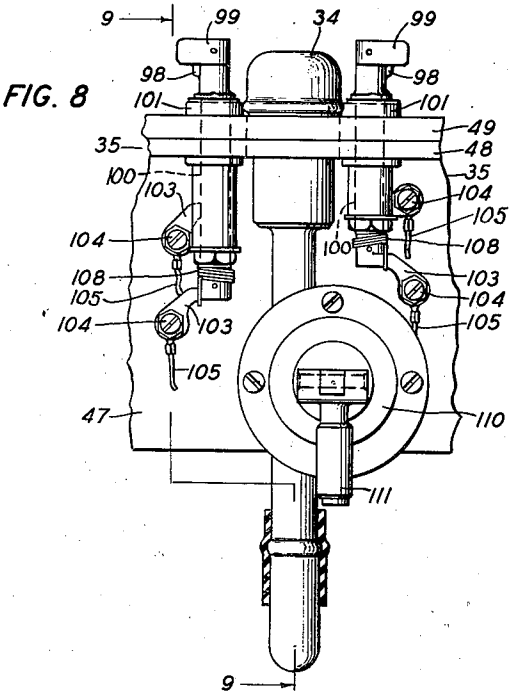


FIG. 8



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EXHAUST MACHINE

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FIG. 10

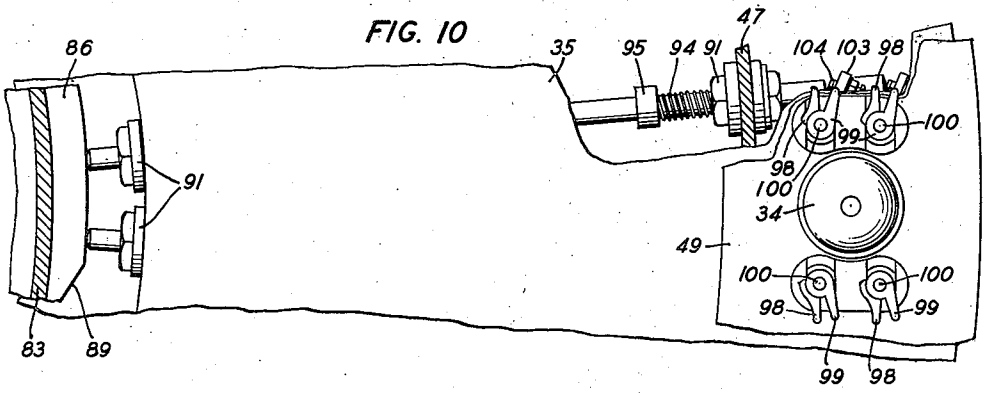


FIG. 11

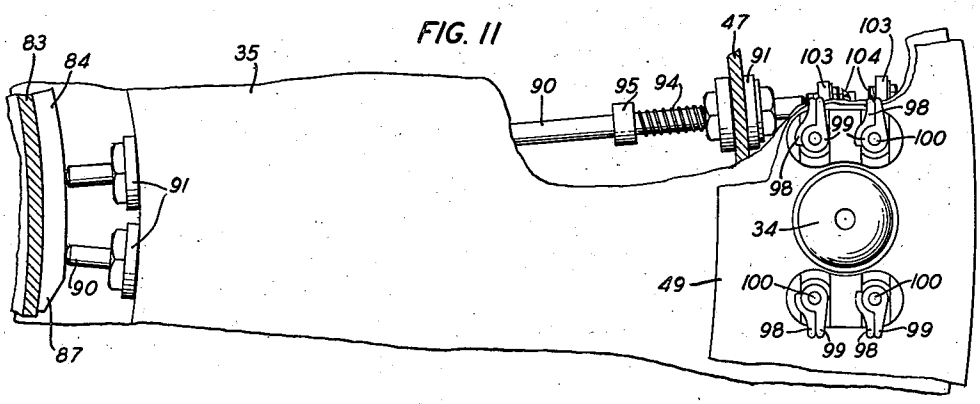
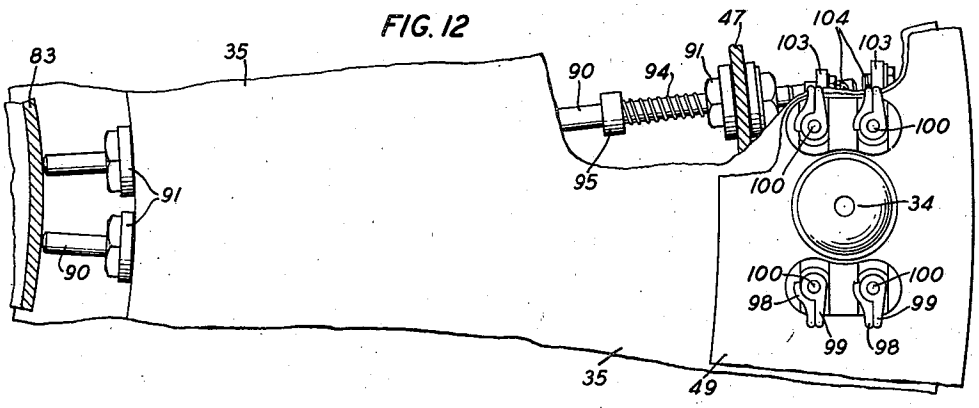


FIG. 12



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FIG. 13

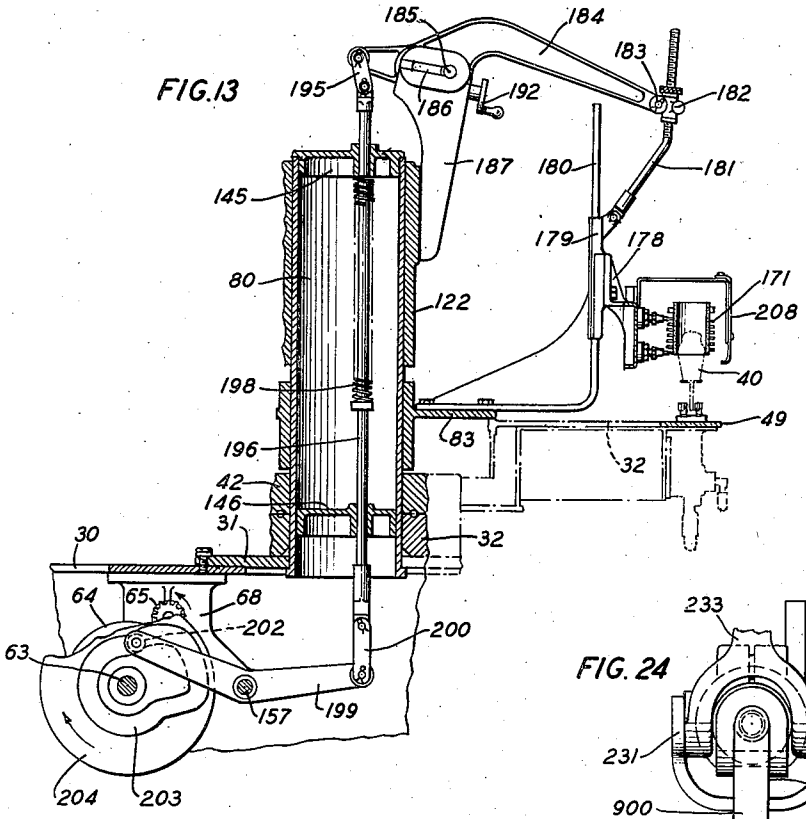


FIG. 24

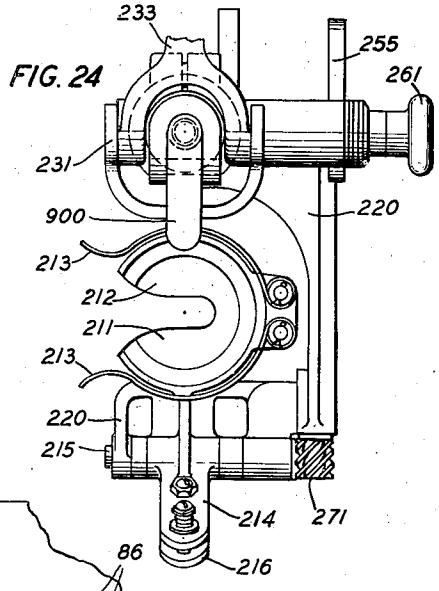
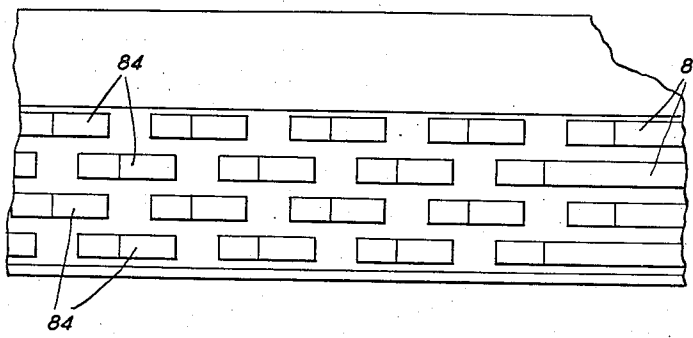


FIG. 25



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EXHAUST MACHINE

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FIG. 14

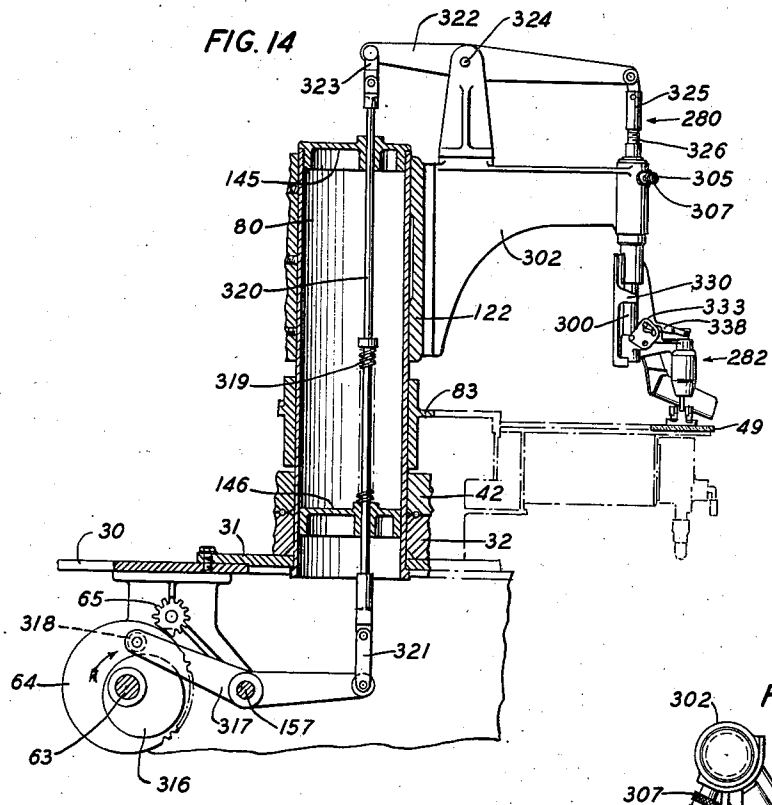


FIG. 18

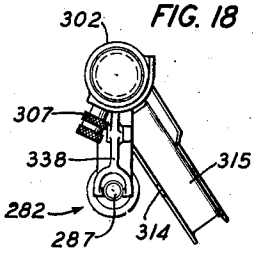


FIG. 15

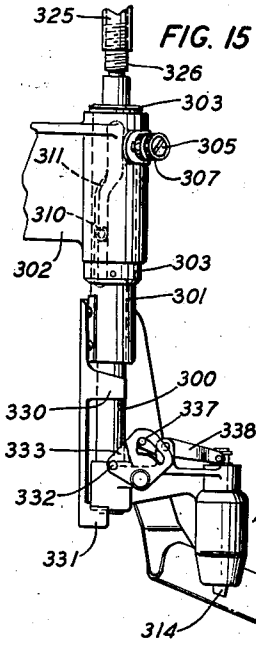


FIG. 16

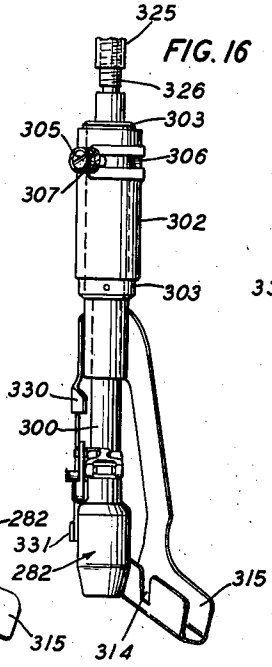
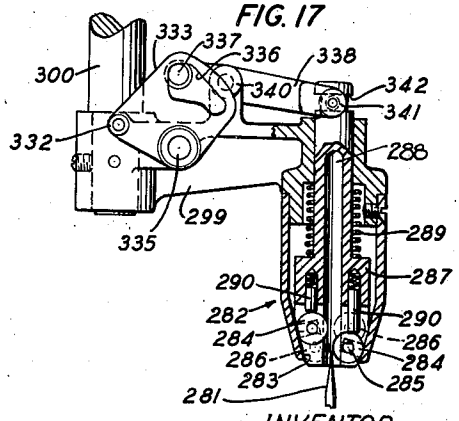


FIG. 17



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EXHAUST MACHINE

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FIG. 19

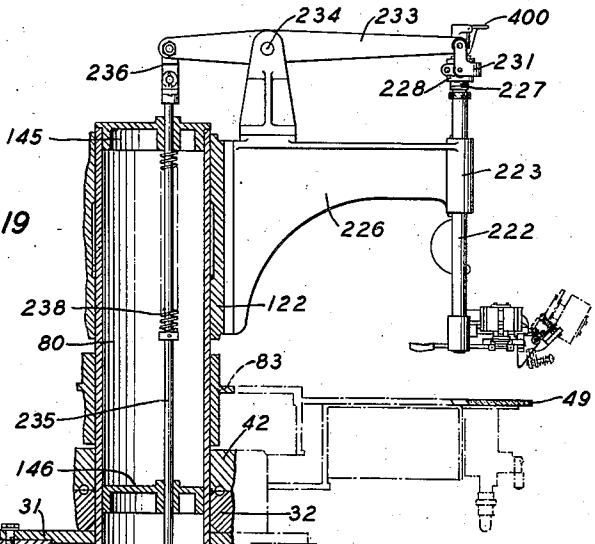


FIG. 20

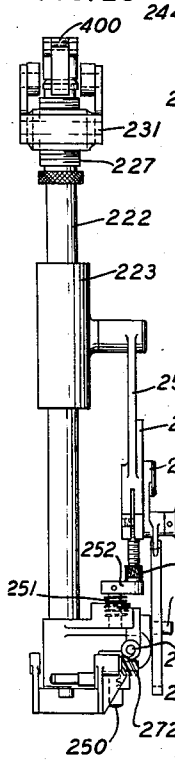


FIG. 21

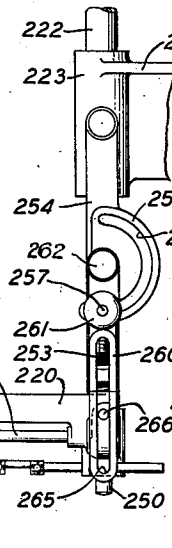


FIG. 22

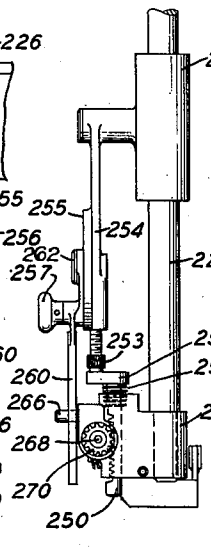
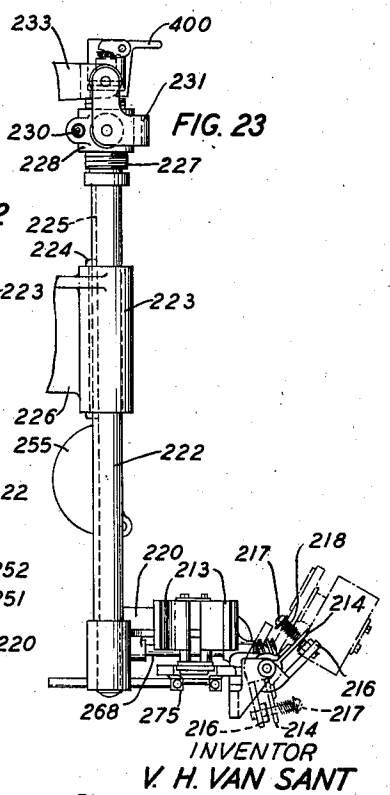


FIG. 23



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Patented July 15, 1941 2,249,098

UNITED STATES PATENT OFFICE

2,249,098

EXHAUST MACHINE

Victor H. Van Sant, Westfield, N. J., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

Application August 10, 1939, Serial No. 289,385

23 Claims. (Cl. 250—27.5)

This invention relates to exhaust machines, and more particularly to machines for exhausting and sealing off vacuum tubes.

An object of the invention is to provide an efficient automatic exhaust machine for vacuum tubes.

With this and other objects in view, the invention comprises an exhaust machine having a table supporting exhaust sockets for tubulations of vacuum tubes to be exhausted and gripping contacts for the lead wires of the vacuum tubes, the table being indexed to move the tubes from loading position through an oven, where the tubes are evacuated while being heated, after which the tubes are moved through positions where they are subjected to high frequency coils, to free remaining gases in the tube and to flash a getter in each tube for completing evacuation, sealed off, removed from the table and deposited in a chute, and the remaining tubulations pulled from the exhaust sockets and ejected. A stationary distributor, about which the table travels, controls the opening and closing of the gripping contacts and the closing of electrical circuits therethrough while control means for operating doors of the oven, the movement of the high frequency coils, the sealing off unit, and the tubulation puller extend through a hollow member coaxial with the distributor.

Other objects and advantages will be apparent from the following detailed description when taken in conjunction with the accompanying drawings, wherein

Fig. 1 is a top plan view of the exhaust machine;

Fig. 2 is a vertical sectional view taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary horizontal sectional view illustrating the driving mechanism and the cams for actuating various units;

Fig. 4 is a horizontal sectional view illustrating the indexing means for the table;

Fig. 5 is an enlarged fragmentary detailed view of a portion of this means;

Fig. 6 is a fragmentary vertical sectional view taken along the line 6—6 of Fig. 5;

Fig. 7 is a fragmentary vertical sectional view illustrating the oven door operating mechanism;

Fig. 8 is a fragmentary front elevational view of a portion of the table illustrating one exhaust socket and one set of gripping contacts;

Fig. 9 is a fragmentary sectional view taken along the line 9—9 of Fig. 8;

Fig. 10 is a fragmentary top plan view of a portion of the table illustrating the gripping contacts in open position;

Fig. 11 is a similar fragmentary top plan view of the table showing the gripping contacts in closed position and included in electrical circuits;

Fig. 12 is a similar fragmentary top plan view of the table illustrating the gripping contacts in closed position when not included in electrical circuits;

Fig. 13 is a fragmentary sectional view illustrating the mechanism for moving the high frequency coils toward and away from the tubes;

Fig. 14 is a fragmentary sectional view of the tube puller;

Fig. 15 is a fragmentary side elevational view of the tube puller;

Fig. 16 is a front elevational view of that shown in Fig. 15;

Fig. 17 is an enlarged fragmentary sectional view of the gripping chuck of the tube puller adjacent the associated parts;

Fig. 18 is a top plan view of the structure shown in Fig. 16;

Fig. 19 is a fragmentary vertical sectional view of the machine illustrating the sealing off mechanism;

Figs. 20, 21, 22 and 23 are fragmentary detailed views taken at various angles of the sealing off unit;

Fig. 24 is a top plan view of the tube supporting and ejecting portion of the sealing off unit, and

Fig. 25 is a schematic view illustrating the distributor.

Referring now to the drawings, particularly Figs. 1 and 2, it will be noted that the exhaust machine has a housing 30 for the drive mechanism, the top portion of the housing being apertured adjacent its center for the passing of various actuating elements therethrough. Upon the housing 30 adjacent the aperture therein is mounted a base plate 31 upon which is fixedly mounted a stationary fluid controlling element 32 having a plurality of equally spaced passageways 33 equal in number to the number of exhaust sockets 34 on a table 35. Certain of the passageways 33 are connected through pipes 38 to vacuum pumps (not shown) for evacuating the tubes, illustrated at 40 (Fig. 13). A movable fluid controlling element 42 is disposed upon the stationary element 32 and has passageways 43 positioned to communicate with the passageways 33 of the stationary element at each of the rest positions of the table 35. The stationary ele-

ment 32 as well as the base plate 31 serve as bearings for a Geneva gear 45 (see Figs. 2, 4, 5 and 6) upon which is mounted the table 35 having the cross sectional contour as illustrated in Fig. 2. In this figure the table is shown as having an inner annular portion 46 with an annular flange resting in a horizontal plane upon the Geneva gear and secured thereto, and an outer annular portion 47, the annular portions 46 and 47 being connected with a horizontal annular portion 48 extending outwardly beyond the vertical annular portion 47 to support an insulating ring 49 and a plurality of exhaust sockets 34 and gripping contacts which will hereinafter be described.

The driving means for the table may be followed from a drive motor 55 shown in Figs. 2 and 3 and traced to the Geneva gear, by viewing Figs. 2 to 6 inclusive. The motor 55 is operatively connected to a shaft 56 through a belt 57 and pulleys schematically shown in Fig. 2. From the shaft 56 the driving means is traced to a shaft 58 through a belt 59, connected to these shafts by suitable pulleys, the shaft 58 being connected through a chain of gears, housed at 60, to a pinion 61.

Referring now to Figs. 2 and 3, it will be noted that the pinion 61 drives a gear 62 which, in turn, drives a cam shaft 63 upon which is fixedly mounted a gear 64. The gear 64 drives a pinion 65 which is mounted upon one end of a shaft, the latter having fixed to the other end thereof a bevelled gear 66. It will be noted that the shaft 63 as well as the shaft supporting the pinion 61 and bevelled gear 66 are journalled in bearings supported by suitable brackets 68 mounted in the housing 30. The housing 60 for the chain of gears is also mounted in the housing 30.

Referring now to the bevelled gear 66, attention is directed to Figs. 2, 3 and 6, which illustrate the interengagement of this bevelled gear with a bevelled gear 70 which is fixed to a shaft 71 journalled in a bearing 72, extending through the upper portion of the housing and secured thereto. The upper end of the shaft 71 has a member 73 fixed thereto for supporting a Geneva pin or roller 74 eccentrically with respect to the axis of the shaft 71, for causing movement of the gear 45, and a locking element 75 conditioned to enter recesses 76 positioned between pin receiving slots 78 in the gear to lock the gear against movement between each intermittent movement caused by the pin 74.

Attention is again directed to Fig. 2, where there is illustrated a tubular member 80 disposed concentric with the axis of the table 35 and the fluid controlling elements 32 and 42 and extending through central apertures of these elements as well as a central aperture in the base plate 31. The tubular member 80 is fixed to the base plate in any suitable manner and serves as a bearing for the movable element 42.

The tubular member 80 also rigidly supports a distributor 83, as illustrated in Fig. 2. The outer wall of the distributor 83 supports four rows of suitably spaced terminals 84 at the positions where it is desirable to include electrical elements of the vacuum tubes in electrical circuits at the various stations during their cycle of travel with the table. The terminals 84 are illustrated in Figs. 9 and 11 and the manner in which they include the elements of the vacuum tubes in the circuit. Cams 86, shown in Fig. 10, are also mounted upon the distributor 83 to cause mechanism to be actuated to control the gripping contacts. The approaching ends of the terminals 84 are bevelled, at 87, and the approaching ends of the cams 86 are bevelled, at 89, so that the inner ends of push rods 90 may readily ride thereupon.

As illustrated in Figs. 2, 9, 10, 11 and 12, the push rods 90 extend through and are movable in insulated bushings 91 mounted in the vertical annular portions 46 and 47 of the table 35. The push rods are normally urged inwardly toward the distributor 83 by concentrically mounted springs 94 but are limited in their movement by annular stop members 95 mounted thereon.

In the present embodiment of the invention there are four push rods 90 at each location on the table 35, there being one push rod for each set of gripping contacts shown in Figs. 8 to 12 inclusive. Each set of gripping contacts is composed of a stationary contact 98 rigidly mounted upon the insulating member 49 of the table 35 and insulated from the latter. A movable contact 99 of each set of gripping contacts is fixedly mounted upon the upper end of a shaft or pin 100 which is suitably journalled in a bearing 101 extending through the insulating member 49 and the portion 48 of the table 35 and insulated from the latter. An arm 103 fixed to the shaft 100 carries a terminal 104 at its outer end which is electrically connected to a flexible conductor 105. The sets of gripping contacts are substantially identical in construction and in conformity with the structure just described, yet, by viewing Figs. 8 and 9, it will be noted that the lengths of the shafts 100 and particularly the positions of the terminals 104 supported by the arms 103 of each set vary in staggered relation so as to allow for the positioning of the push rods 90, as illustrated in Figs. 9 to 12 inclusive. The arm 103 of each set of gripping contacts is provided with a helical spring 108 to normally urge the movable contact 99 toward the stationary contact 98 to firmly grip a lead wire of a vacuum tube when disposed therebetween. In Fig. 9 it will be noted that the conductors 105 are connected electrically to the bushings 91 supported by the vertical annular portion 47 of the table, thus electrically connecting the individual gripping contacts to their respective push rod 90.

The exhaust sockets 34 are of suitable type, for example, a type having apertured flexible tubulation receiving members housed in metallic casings, with their apertures communicating with valves 110 controlled by cam levers 111, illustrated in Figs. 2, 8 and 9. The valves 110 are shown in open position, with their levers 111 extending downwardly, positioned to be moved into a horizontal or closed position by suitable means should the vacuum tube associated therewith be defective. Each valve 110 is connected by means of a suitable pipe line 112 to its respective passageway 43 in the fluid controlling element 42. Through this means each tube, unless it has a leak therein, is disposed in communication with a vacuum pump (not shown) at desired stations during the indexing of the table.

A stationary oven 120, arcuate in general contour and of the cross sectional structure illustrated in Fig. 2, is supported by a plurality of brackets 121 rigidly mounted upon an annular member 122 fixed to the tubular member 80. The lower portion of the oven is open to allow the movement of the vacuum tubes, supported by the exhaust sockets on the table, therethrough but is closed to the atmosphere by stationary arcuate members 123 mounted upon the lower portion of the oven and having their lower surfaces positioned closely adjacent to the insulating member

49 to allow movement of the table relative to the member, yet eliminate as completely as possible loss of heat from the oven. The oven is heated by any suitable means, such as by electrical elements 124, and is suitably insulated as at 125. By viewing Fig. 1, it will be noted that the entrance end 128 and the exit end 129 of the oven are arcuate in general contour, each of these ends being provided with openings 130 which are sufficiently large for the passage of the exhaust sockets with the vacuum tubes therein, and the gripping contacts therethrough.

Door operating mechanism

Doors 131 and 132 are provided for the ends 128 and 129, respectively, of the oven and conform thereto. These doors are so positioned and operated that they will be moved simultaneously into open position to allow the tubes to simultaneously enter the entrance end and leave the exit end of the oven. As illustrated in Figs. 1 and 2, the doors 131 and 132 extend more than the full height of the oven and have supporting brackets 135 and 136, respectively, pivotally supported at 137 and 138, respectively, on the adjacent brackets 121. The supporting bracket 135 has a portion which extends rearwardly from its pivot 137 to pivotally support, at 140, the outer end of a connecting rod 141, the inner end of which is pivotally supported by an arm 142. The supporting bracket 136 of the door 132 has one end of a connecting rod 143 pivotally connected at 144 thereto, between the pivot 138 and the door 132, the other end of the connecting rod being pivotally connected to the arm 142 as shown in Fig. 1.

By viewing Figs. 1, 2 and 7 it will be noted that bearing brackets 145 and 146 are positioned in the tubular member 80, the former being disposed in the upper portion of the tubular member while the latter is disposed near the lower portion thereof. A vertical shaft 148 extends through bearings in the brackets 145 and 146 and has the upper portion thereof rigidly secured to the arm 142 while the lower portion of the shaft has an arm 149 rigidly mounted thereupon, that is, secured against rotation relative to the shaft 148 other than for adjustment with respect thereto. By viewing Fig. 3, it will be observed that the arm 149 has one end in the form of a yoke for pivotally supporting one end of a link 150, while the other end is threaded for adjustment to vary the distance of its pivotal connection with the link 150 relative to the shaft 148. This is the means for varying the distance in which the doors 131 and 132 are moved relative to their respective openings 130. In other words, if the link 150 is given a definite movement by a mechanism soon to be described, variations in the distance between the pivotal connection of the link with the arm 149 and the axis of the shaft 148 will vary the distance the shaft 148 will rotate, thus varying the distance of movement of the doors relative to their openings.

As illustrated in Figs. 3 and 7, the link 150 is pivotally connected to a cam element 154 supported by and guided in its movement by guide members 155 and 156 receivable in elongate apertures in the cam element 154 to thus support and allow longitudinal movement of the cam element along a definite path. The guide member 155 is disposed upon a rod 157 supported by the brackets 68 while the guide member 156 is disposed upon the shaft 63. The end of the element 154 opposite the link 150 supports a cam roller 160 positioned to engage a cam 161 fixedly mounted upon the shaft 63 and having a high portion 162 positioned to cause movement of the element 154 to open the oven doors and after a predetermined interval of time to allow closing of the doors by a spring 164 connected to the element 154 to move the element in the opposite direction from that in which the element is moved by the cam.

High frequency coils

During the travel of the vacuum tubes with the table they are subjected to high frequency coils 170, 171, 172, 173, 174 and 175 in successive stages. The high frequency coils are suitably mounted upon a reciprocable support 178 and are included in desired circuits which are opened and closed at predetermined intervals during the indexing of the table. It is necessary that the coils be raised and lowered to allow for the indexing of the table. This is brought about through mechanism illustrated in Figs. 1, 2 and 13. It will be noted that the support 178 has guideways in a member 179 fixed to the support and conditioned to ride vertically on a track 180 extending laterally and mounted upon the distributor 83, as illustrated in Fig. 13. A projection on the member 179 provides means for pivotal connection thereof with a connecting rod 181, the latter being threaded at its upper end for adjustable connection with a nut 182. The nut 182 supports a pivot 183 connecting it to the outer end of a lever 184 mounted upon an adjustable pivot 185. The pivot 185 has reduced end portions movably disposed in slots 186 of a bracket 187, the latter being rigidly mounted upon the annular member 122. As illustrated in Fig. 1, one end of the pivot 185 has a worm gear 190 mounted thereupon which interengages a worm 191 journalled in bearings in the bracket 187 and conditioned to be rotated through a hand wheel 192. With this mechanism, adjustment of the worm will cause movement of the pivot 185 relative to the ends of the lever 184 varying the effective movement of the lever to vary the positions of the high frequency coils with respect to the tubes. This is an important feature in that it is essential in locating the effective heat of the coils at definite positions relative to the parts thereof to be affected thereby.

The inner end of the lever 184 is pivotally connected to links 195 which connect the lever to a connecting rod 196, the latter extending downwardly through journals in the journal brackets 145 and 146. The connecting rod 196 is normally urged downwardly by a compression spring 198 and is connected at its lower end to a cam lever 199 through links 200. The cam lever 199 is pivotally mounted on the rod 157 and has a cam roller 202 mounted upon the opposite end thereof and positioned to ride in a cam groove 203 of a cam 204. The cam 204 is fixedly mounted on the cam shaft 63 and is driven through the power means previously described. During the intermittent reciprocable movement of the high frequency coils, they are constantly guarded by an element 208, this element being of the general contour illustrated in Figs. 1 and 13 and secured to the support 178.

Sealing off unit

After the tubes under test have passed the stations where they are subjected to the high frequency coils, they arrive at the station where they enter a sealing off unit indicated generally at 210. This unit is illustrated more in detail in Figs. 19 to 23, inclusive. As will be noted in

Fig. 1, a tube support 211 is notched at 212 to receive the tubulation of the exhaust tube, being moved into that position, and has retaining springs 213 mounted thereon positioned to straddle the tube. The support 211 is of sufficient size for the tube to rest upon when the time is present for sealing off and ejecting the tube. An arm 214 extending outwardly from the support 211 pivotally mounts the support on a shaft 215 and extends outwardly at an angle from the shaft as illustrated in Fig. 23, where it is resiliently connected to an arm 216, the latter being fixed to the shaft. The resilient connection of the arms 214 and 216 consists of an adjustable screw 217 carried by the arm 216 and extending freely through an aperture in the arm 214 where it supports a compression spring 218 positioned between the head of the screw and the arm 214 to cause movement of the arm 214 when the arm 216 is moved. The shaft 215 is rotatably carried by a bracket 220 which extends around the back or the right side (Fig. 24) of the support 211 where it is mounted upon a reciprocable rod 222. The rod 222 is slidable vertically in a bearing 223 supporting a key 224 positioned in a keyway 225 of the rod 222 to permit longitudinal movement of the rod relative thereto yet prevent rotation of the rod. The bearing 223 is carried by a bracket 226 mounted upon the annular member 122. Upon the upper portion of the rod 222 is disposed a threaded member 227, receiving an adjusting nut 228 conditioned for adjustment of the rod to vary the position of the support 211 relative to the vacuum tubes. The nut 228 supports a lock screw 230 at a portion where the nut is split to make possible a locking of the nut in any desired adjusted position. A yoke 231 pivotally supported by the nut 228 is connected to the outer fork-like end of a lever 233, the latter being pivotally supported at 234 and connected at its inner end to an actuating rod 235 by links 236. The rod 235 in a similar manner to the rod 196 is reciprocable in bearings in the brackets 145 and 146 and is normally urged downwardly by a compression spring 238. The lower end of the rod 235 is connected to one end of a cam lever 240 through links 241. The cam lever is pivotally supported by the rod 157 and supports, at its other end, a cam roller 243 positioned to ride in a cam groove 244 of a cam 245, the latter being mounted upon the shaft 63.

Through the actuation of the cam 245 the rod 222 is moved upwardly to a predetermined position allowed to remain in that position for a limited time, after which its upper movement is continued to cause rotation of the shaft 215 to move the support 211 arcuately about the shaft to move the tube in that position away from the table and deposit the tube in a chute (not shown) to direct it to a receptacle or other suitable means to receive the tubes. The means for rotating the shaft 215 consists of a rack 250, mounted for vertical movement in the bracket 220 and supported by a compression spring 251 which is disposed concentric therewith, the lower end of the spring resting in a recess in the bracket while the upper end of the spring abuts an arm 252. An adjustable stop 253 carried by an element 254 is positioned for engagement with the arm 252 during vertical movement of the rod 222. The upper end of the element 254 is rotatably supported upon the stationary bracket 223 and has a semi-circular portion 255 adjacent its lower end including an arcuate groove 256 for receiving a threaded member 257. The threaded member 257 is movable in the arcuate groove yet is provided with a tongue interengaging the groove for the locking of a guide member 260 in operative or inoperative positions through the aid of a nut 261. The guide member 260 is pivotally supported at 262 on the element 254 at a position coaxial with the groove 256 to permit swinging of the element arcuately about its pivot through the aid of the nut 261 and the threaded element 257, the latter extending through the guide member. That portion of the guide member beneath the threaded member 257 has an elongate aperture 265 to receive a pin 266 carried by the bracket 220.

Referring now to the rack 250, it will be noted, by viewing Fig. 22, that a shaft 268 has a pinion 270 mounted thereon for interengagement with the teeth of the rack and to cause rotation of the shaft when moved with the bracket 214 relative to the rack, due to engagement with the stop 253 during vertical movement of the rod 222. In Figs. 20 and 21 the shaft 268 is shown as supporting a worm 271 intermeshing with a worm gear 272 mounted upon the shaft 215. Therefore, relative movement of the rack 250 and bracket 214 during vertical movement of the rod 222 will cause rotation of the shaft 268 through its engagement with the pinion 270 to rotate the worm 271 and, in turn, rotate the worm gear 272 and the shaft 215 to cause rotary movement of the arms 214 and 216 to move the support 211 from the solid line position shown in Fig. 23 to the dotted line position.

A gas burner 275 having jets positioned upon both sides of the tubulation is supported by the bracket 220, as illustrated in Figs. 21 and 23, for movement with the rod 222. The burner 275 is connected to a fuel supply (not shown) in any suitable manner.

Tubulation puller

After the tubes have been completed and ejected at the sealing off position, there remains a portion of the tubulation in the exhaust socket. The tubulation puller indicated generally at 280 (Fig. 1) is illustrated in detail in Figs. 14 to 18 inclusive. The portion of the tubulation indicated at 281 remaining in the exhaust socket after passing the sealing off position, is closed at its upper end and tapers upwardly almost to a point. This is a result of heating the glass at the sealing off position to a melting point and stretching the tubulation until it breaks at that portion. The tubulation puller, therefore, consists of a chuck 282 containing means to grip the tubulation 281 and remove the latter from the socket, moving the tubulation to a position in general alignment with a discharge chute and eject it into the chute. The chuck 282 consists mainly of an outer casing having truncated cone-shaped inner wall 283 upon which spring pressed rollers 284 may ride into and out of engagement with the tubulation 281. The rollers 284 carry shafts 285 at their centers which are positioned in tapered slots 286 in an inner member 287. The member 287 is centrally apertured at 288 for receiving the tube 281. The inner member 287 is also grooved to freely receive the rollers 284 and allow rotation thereof. When the inner member 287 is moved downwardly through the force of a spring 289, the rollers 284 are caused to ride upon the inner surface 283 to move into intimate engagement with the tubulation 281 and

to apply sufficient gripping force to the tubulation for the ejection thereof. When the inner member 287 is moved upwardly, spring pressed plungers 290 are free to move the rollers outwardly and downwardly in their tapered slots to free the rollers of the tubulation 281. The plungers 290 also serve to hold the rollers against rotation when they are in gripping engagement with the tubulation.

The chuck 282 is supported by a bracket 299 which is mounted rigidly upon the lower end of a reciprocable rod 300. The rod 300 extends vertically through a tubular cam 301, the latter being rotatably supported by a bracket 302 as illustrated in Figs. 15 and 16 yet held against vertical movement by collars 303. The cam 301 is not rotated during the operation of the machine but may be rotated from an operative position shown in the drawings to a position in which the chuck 282 is out of registration with the sockets 34. This is made possible through a threaded pin 305 carried by the cam 301 and positioned in an elongate aperture 306 in the bracket 302. When the pin 305 is in the position shown in Figs. 15 and 16 the tubulation puller unit is in operative position, but by moving the pin 305 to the other end of the aperture 306 to rotate the cam 301 the same distance the unit will be moved out of registration with the sockets 34. A nut 307 threadedly disposed upon the pin 305 is conditioned to lock the cam in either operative or inoperative position.

A cam roller 310 carried by the rod 300 is positioned to ride in a cam groove 311 of the cam 301 during vertical movement of the rod to cause movement of the chuck 282 from a position in alignment with a socket 34 to move the tubulation 281, after it has been moved free of the socket, through a slot 314 in a chute 315, and in general alignment with the chute.

The means for imparting reciprocatory movement to the rod 300 consists of a cam 316 mounted upon the cam shaft 63 and conditioned to cause actuation of a cam lever 317 through its engagement with a cam roller 318 supported by the adjacent end of the lever. The cam lever 317 is pivoted on the rod 157 and is operatively connected, at its other end, to an actuating rod 320 through links 321. The rod 320 is mounted for vertical movement in bearings in the brackets 145 and 146 and is normally urged upwardly to hold the cam roller 318 in engagement with the cam 316 through the aid of a spring 319. The upper end of the actuating rod 320 is operatively connected to one end of a rocking lever 322 through links 323, the lever being pivotally supported, at 324, and having a nut 325 pivotally supported at the other end thereof. The nut 325 is conditioned to receive a threaded portion 326 of the upper end of the rod 300 so as to allow rotary movement of the rod through the effect of the cam groove 311 on the roller 310 to swing the chuck 282 from its tubulation receiving position to its tubulation ejecting position.

The chute 315 in the present embodiment is formed of sheet metal and is fixed to the cam or any other suitable support 301. Stop members 330 and 331 are also supported by the cam 301 and positioned to engage a roller 332 of a cam 333 to cause movement thereof in opposite directions to move the inner member 287 against the force of spring 289 into open position and to assist the spring in moving the member 287 into closed position. It will be noted, by viewing Figs. 16 and 17, that the cam 333 is pivoted, at 335, upon the bracket 299 and has a cam groove 336 of the contour illustrated, to engage a roller 337 to cause movement thereof relative to the pivot 335 to cause actuation of a cam lever 338 upon which the roller 337 is mounted. The cam lever 338 is pivotally supported, at 340, upon the bracket 299 and has an outer forked end with pins 341 providing a yoke connection with a grooved upper end 342 of the inner member 287 extending through and beyond the bracket 299.

Operation

When the machine is in condition for operation, that is, when sufficient time has been allowed for the oven 120 to be heated to the desired temperature, the motor 55 may be energized through the closing of an electrical circuit thereto, thus starting the table 35 indexing. Rather than attempt to describe all the actions that take place in the machine at each interval of operation it is believed that by following one vacuum tube through the machine the operation of the machine will be more clearly understood.

The table 35 is advanced intermittently in the direction of the arrow (Fig. 1). Therefore, the first two positions beyond the tubulation puller 280 will be termed the loading positions at which positions the operator inserts the tubulations of the vacuum tubes in the exhausting sockets 34. At these positions the gripping contact 99 of each set is in open position, that is, spaced from its stationary contact 98. After inserting the tubulation of the tube in the exhausting socket the four lead wires of the tube are positioned between their respective gripping contacts 98 and 99. The operator thus has two positions in which to insert the tubulation of the tube and position the lead wires of the tube with respect to the gripping contacts. At the third position the tube is brought into communication with a vacuum line traced through the exhaust socket 34, in which it is disposed, through the associated valve 110, through the associated tube 112, passageways 43 and 33 communicating therewith, and through the associated pipe 38 to a vacuum pump (not shown). At the next position, that is, the first position in front of the oven, the vacuum line to the tube is closed and the tube is subjected to a leak detector (not shown), and if a leak should be present in the tube suitable means (not shown) is provided for moving the lever 111 of the valve 110 outwardly in a horizontal position to close the valve, thus cutting off the tube from further communication with subsequent exhaust lines.

For the purpose of illustration, however, let it be assumed that no leak is present in the tube and the valve 110 remains open. As soon as the table 35 is moved to move the tube under test into the oven, the push rods 90 (Figs. 2 and 10) move free of the cams 86, allowing the springs 94 mounted thereon to move the push rods free of the arms 103, or rather the terminals 104 carried by these arms, thus allowing the springs 108 to move their respective contacts 99 to cause gripping of the lead wires of the tube.

The oven doors 131 and 132 are moved in synchronism with the table due to the fact that both receive their power from the same means; that is, the shaft 63 driving the gear 62, causing intermittent movement of the table through the Geneva mechanism, also drives the cam 161 which causes operation of the oven doors at definite intervals. The rotation of the cam 161 will cause the high portion 162 to ride beneath

the roller 160, causing movement to the left (Fig. 7) of the cam element 154, guided in its movement by the members 155 and 156 against the tension of the spring 164 to rotate the shaft 148 a predetermined distance clockwise, viewing Fig. 1, through the connection of the links 150. The rotation of the shaft 148 will move the arm 142 from the solid line position (Fig. 1) to the dotted line position, moving the connecting rods 141 and 143 sufficient distance to move the doors 131 and 132 beyond the openings 130 in the ends of the oven. The action of the oven doors with the table is such that the oven is open only that length of time necessary for the passing of the tube through the opening 130, after which the roller 160 (Fig. 7) has passed beyond the high portion 162 of the cam, allowing the spring 164 to return the element 154 to the position at the right and rotate the shaft, through the links 150, counterclockwise to cause the arm 142 to move the rods 141 and 143 to return the doors to their closed positions.

The tube then becomes heated to a desired temperature to vaporize all moisture in the tube and the tube is again brought into communication with exhausting means through its valve 110 and the passageways brought into communication therewith at each rest period of the table to exhaust the tube. During this interval of movement of the tube through the oven, the electrical elements therein are included in desired electrical circuits which include the cam like terminals 84 (Figs. 11 and 25) and the terminals 104 (Figs. 8 and 9). At positions where it is desired to include the electrical elements of the tube in electrical circuits the cam like terminals 84 electrically engage the push rods 90 and cause movement thereof a sufficient distance to engage the terminals 104 to complete the circuits. It is evident, by viewing Fig. 9, that the circuits are completed upon the engagement of the push rods 90 with the terminals 84, due to the fact that the push rods, through the conductors 105, are at all times electrically connected to the terminals 104. The aforementioned circuits including the terminals 84 and 104 are not shown, for the reason that different types of circuits are employed, the important factor lying in the means for closing the circuits through the elements of the tube during the various intervals of operation.

Although the tube, during the intermittent movement through the oven, that is during each rest period of the table is in communication with an exhausting means in an attempt to completely exhaust the tube, quantities of gases cohering to the metal portions or metallic elements within the tube will remain therein. In order to drive out the occluded gas the tube is now subjected to the high frequency coils 170 to 175 inclusive in successive stages after the tube leaves the oven 120. As stated in the foregoing description of the operation of the oven doors, these doors are moved into open position to allow one tube to enter the oven while another tube moves out of the oven, the doors closing immediately thereafter. During the next five positions the tube is heated inductively by the high frequency coils 170 to 174 inclusive which, together with the coil 175, are moved vertically to free the tube during its intermittent movement from one position to another. This movement is brought about through the mechanism shown in Figs. 1 and 13. In Fig. 13 the position of the cam 204 is about to complete the lowering of the coils to position the first coil 170 about the tube. The coil remains in this position to begin the inductive heating of the electrical elements in the tube to raise the temperature thereof to the vaporization point of the gases that are desired to be volatilized. Due to the fact that the interval of time in which the tube remains at rest is too short in which to so heat the electrical elements of the tube, the inductive heating of such parts, through the high frequency coils, is thus repeated at several positions. Just prior to the moving of the table to move the tube to the next position the cam 204 causes movement of the cam lever 199 about its pivot to move the connecting rod 196 downwardly, rocking the lever 184 about its pivot 185, thus causing movement of the connecting rod 181 upwardly, moving the guideway 179 on the guide 180, and moving the support 178 with the high frequency coils 170 to 175 inclusive upwardly. The table is then advanced to the next position, at which time the cam 204 is moved to reverse the movement of the parts connecting it with the support 178 to lower the coils, at this time placing the coil 171 around the tube. This operation is repeated until the tube arrives at the position of the coil 175. The coil 175 is larger than the other coils and positioned to extend lower around the tubes, the purpose of which is to apply heat at a new portion of the tube in which portion a getter is located. The tube is in communication with the exhausting means at each position adjacent the high frequency coils to remove the occluded gases as they are vaporized. Should any gases remain when the tube reaches the position adjacent the coil 175 the flashing of the getter through the heat caused by the coil 175 will remove such remaining gases.

Just prior to the tube leaving the oven the push rods 90 (Fig. 10) advance to a position where they ride upon the cams 86 and are thus moved by the cams to open the gripping contacts to release the lead wires of the tube. The gripping contacts are thus held open by the cams and push rods to a position adjacent the entrance of the furnace.

After the tube leaves the positions of the high frequency coils it enters the sealing off unit 210. In other words, the support 211 is located, as illustrated in Figs. 1 and 24, so that during the indexing of the table the tubulation of the tube will enter the slot 212, the tube passing between the retaining springs 213 and the lower portion of the tube being positioned a slight distance above the support. The tubulation of the tube is then positioned between the burners 215, where it is subjected to a heat sufficient to soften the glass thereof. During this time the tube is under vacuum, causing the portion of the tubulation subjected to the heat of the burner to collapse. After a definite interval of time sufficient to heat and to collapse the tubulation at the point of application of the heat, the cam 245 is moved to rock the cam lever 240 (Fig. 19) about its pivot to move the actuating rod 235 downwardly, rocking the lever 233 about its pivot 234, causing upward movement of the reciprocating rod 222. During the first interval of movement of the rod 222 the support 211 will be moved into engagement with the tube, causing the tube to rest thereupon and held against falling therefrom by the springs 213. Further movement of the rod 222 will cause the support 211 to move the tube a sufficient distance to cause breaking of the tubulation at the collapsed portion. Both severed portions of the tubulation, that remaining

on the tube and that remaining in the exhaust socket, will be stretched to points when broken. The tube is now freed from the table and further movement of the rod 222 upwardly will move the arm 252 of the rack 250 in engagement with the stop 253, causing rotation of the shaft 268 as the pinion 270 is caused to travel on the rack during continued upward movement of the bracket 220 with the rod 222. Rotation of the shaft 268 (Figs. 21, 22 and 23) will cause rotation of the shaft 215 through the worm 271 and the worm gear 272. The shaft 215 is thus rotated through a portion of a revolution clockwise (Fig. 23) to move the arm 216 fixed thereto from the solid line position shown in this figure to the dotted line position. A similar movement is imparted to the arm 214 through the screw 217 and the spring 218 to move the support 211 with the tube temporarily held in place by the retaining springs 213 from the solid line position to the dotted line position, thus transferring the tube from the table to a chute (not shown) to direct the tube to a suitable container.

Further actuation of the cam 245 will cause downward movement of the rod 222 to its normal position and during the movement of the rod downwardly the spring 251 (Fig. 22) will be rendered effective to hold the rack 250 against movement during downward movement of the bracket 220, thus causing rotation of the shaft 268 in a reverse direction and, through the worm 271 and the worm gear 272, causing reverse rotation of the shaft 215 to return the support 211 to its normal position in time to receive the next tube. The table 35 has started its indexing movement in sufficient time to move the tubulation remaining in the socket free of the support 211 and the burner 275 prior to the lowering of these elements into position to receive the next tube.

At certain times it is desirable to move the sealing off means into an inoperative position, for example, when operation of the machine has just begun, and prior to the time in which the first tube has arrived at the sealing off position. A latch 400, spring pressed to normally connect the rod 222 with the threaded element 227, may be released to allow relative movement of these parts. When such has been accomplished the nut 261 may be loosened and by moving the link 260 through an arc guided by the aperture 256 about the pivot 262 the bracket 220 with the associated parts may be lifted, through the aid of the pin 266, into a position away from the table 35. Movement of the nut 261 to cause gripping engagement of the nut with the portion 255 through the association of the threaded member 257 will lock the parts in the raised position.

The next operation takes place at the next position after the sealing off of the tubulation and the ejecting of the tube, and is the removal of the remaining tubulation from the exhaust socket. This is accomplished by the tubulation puller 280 illustrated in Fig. 1 and Figs. 14 to 18 inclusive. As stated in the foregoing description, the remaining tubulation 281 (Fig. 17) is stretched to a point while being broken at the previous position. A sufficient portion of this tubulation extends above the exhaust socket for the passing of the chuck 282 into gripping engagement therewith. Movement of the chuck 282 may be followed from the cam 316 through the rocking of the lever 317, the upward movement of the rod 320 causing rocking movement of the lever 322 about its pivot to move the nut 325 with the rod 300 downwardly to move the chuck downwardly over the tubulation 281. As the chuck is lowered over the tubulation the gripping rollers 284 are allowed to move against the tension applied to the spring pressed pins to avoid breaking of the tubulation, yet sufficient pressure is applied to the tubulation through the rollers to grip the tubulation and cause removal thereof from the exhaust socket when the chuck 282 is moved upwardly. Cam 316 causes a reversal of the movement of the parts operatively connecting it to the chuck, to cause the chuck to be moved upwardly, moving the tubulation free of the socket 34. During the upward movement of the chuck with the tubulation the rod 300 is moved axially of the cam 301, causing the roller 310 to ride in the cam groove 311 and at the position of the bend in the cam groove the rod 300 is rotated through an arc sufficient to move the chuck to move the tubulation carried thereby through the slot 314 and in direct alignment with the chute 315. At this time the roller 332 is positioned to engage the stop 330, causing movement of the cam 333 about its pivot 335 during continued movement of the rod 300, moving the cam groove 336 relative to roller 337 and causing rocking movement of the lever 338 about its pivot 340. This movement of the lever 338 will cause upward movement of the inner member 287 against the force of the spring 289, moving the rollers 284 upwardly on the tapered or truncated cone shaped wall 283, allowing the spring pressed plungers 290 to move the rollers along their tapered slots free of the tubulation 281 and allowing it to drop into the chute, from where it passes into a receptacle (not shown).

The operation of one cycle of the machine has been completed, setting forth that which takes place at the different positions of rest throughout one intermittent revolution of the table. It should be understood, however, that throughout the thirty positions on the table various operations are carried on in sequence through the operation of various units such as the oven doors, the high frequency coil moving means, the sealing off unit, and the tubulation puller, all of which are operated in synchronism with the table moving means. Furthermore, the control means and its various units are centralized, receiving their power from a central portion of the machine, thus removing mechanisms from the exterior of the machine which might interfere with the operator, in operating the machine, and become hazardous. Furthermore, the cams for operating the gripping contacts as well as the terminals for including the push rods in electrical circuits to include the electrical elements of the tubes are mounted upon a stationary distributing member within the machine and about which the table travels, this mechanism utilizing the push rods 90 both for the circuit closing means and the gripping contact actuating means.

The embodiments of the invention herein disclosed are illustrative only and may be widely modified and departed from in many ways without departing from the spirit and scope of the invention as pointed out in and limited only by the appended claims.

What is claimed is:

1. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted,

an oven with a stationary opening at each end positioned for the movement of the tubes therethrough, doors for the said openings, and means operable in synchronism with the table to intermittently move the doors toward and away from the openings.

2. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, a stationary oven with an opening at each end positioned for the movement of the tubes therethrough, doors for the said openings, and operating means extending through the plane of the table adjacent the axis thereof to move the doors into open and closed positions relative to the oven.

3. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, a stationary oven with an opening at each end positioned for the movement of the tubes therethrough, doors for the said openings, operating means extending through the plane of the table adjacent the axis thereof to move the doors into open and closed positions relative to the oven, and means to vary the operating means to vary the positions of the doors relative to the oven.

4. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of various types of tubes to be exhausted having metallic electrical elements therein, means to inductively heat the tubes between movements of the table, means to move the heating means into and out of heating positions, and means to vary the moving means to vary the distance the heating means is moved relative to the electrical elements in the tubes.

5. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of various types of tubes to be exhausted having metallic electrical elements therein, means to inductively heat the tubes between movements of the table, means to move the heating means into and out of heating positions, and means to vary the moving means to vary the relative position of the heat of the heating means and the tubes.

6. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, sets of normally closed gripping contacts for holding lead wires of electrical elements of the tubes disposed adjacent the exhaust sockets, a reciprocable member electrically connected to each set of gripping contacts, means positioned to electrically include the members and, through the members, the contacts in electrical circuits, and means to reciprocate the members to open the contacts.

7. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, sets of normally closed gripping contacts for holding lead wires of electrical elements of the tubes disposed adjacent the exhaust sockets, a reciprocable member electrically connected to each set of gripping contacts, terminals positioned to engage the members to electrically include the members and, through the members, the contacts in electrical circuits, and means to reciprocate the members to open the contacts.

8. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, sets of normally closed gripping contacts for holding lead wires of electrical elements of the tubes disposed adjacent the exhaust sockets, a reciprocable member electrically connected to each set of gripping contacts, a distributor disposed concentric with the axis and having means positioned to electrically include the members and, through the members, the contacts in electrical circuits, and means to reciprocate the members to open the contacts.

9. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, sets of normally closed gripping contacts for holding lead wires of electrical elements of the tubes disposed adjacent the exhaust sockets, a reciprocable member electrically connected to each set of gripping contacts, and a distributor disposed concentric with the axis and having cams and terminals thereon, the cams positioned to cause movement of the reciprocable members to open the contacts and the terminals positioned to engage the members to electrically include the members and, through the members, the contacts in electrical circuits.

10. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, a heating unit to inductively heat the tubes between movements of the table, a guide for the unit, an oscillating arm to move the unit into and out of heating positions relative to the tubes, and a fulcrum support for the arm variable relative to the arm to vary the heating positions of the heating unit.

11. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, a unit operable to act on the tube, a member to reciprocably move the unit in an operative position to act on the tubes singly, and manually operated means to move the member to move the unit out of the operative position.

12. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, a sealing off unit, a member to reciprocably move the unit in an operative position for sealing off the tubes singly, and manually operated means to move the member to move the unit out of the operative position and into an inoperative position and lock the unit in the last mentioned position.

13. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, a sealing off unit, a member to reciprocably move the unit in an operative position for sealing off the tubes singly, and an element held against movement by the unit when the latter is in its operative position but movable to move the unit out of its operative position.

14. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, a sealing off unit, a member to reciprocably move the unit in an operative position for sealing off the tubes singly, an element held against movement by the unit when the latter is in its operative position but movable to move the unit out of its operative position, and means including an abutting member carried by the element to cause arcuate movement of the unit during reciprocable movement thereof to eject the tubes therefrom.

15. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, a sealing off unit, a member to reciprocably move the unit in an operative position for sealing off the tubes singly, an element held against movement by the unit when the latter is in its operative position but movable to move the unit out of its operative position, and means including an abutting member carried by the element to cause arcuate movement of the unit during reciprocable movement thereof to eject the tubes therefrom, the abutting member being variable to vary the time of the arcuate movement of the unit during its reciprocable movement.

16. In an exhaust machine, a stationary vertical hollow support, a table mounted for intermittent movement about the support, exhaust sockets disposed at spaced positions adjacent the periphery of the table for receiving tubulations of tubes to be exhausted, a sealing off unit to singly seal off the tubulations, sever the tubes therefrom and eject the tubes, a unit for removing the remaining tubulations singly from the sockets, and separate actuating means extending through the hollow support to actuate each unit.

17. In an exhaust machine, a stationary vertical hollow support, a table mounted for intermittent movement about the support, exhaust sockets disposed at spaced positions adjacent the periphery of the table for receiving tubulations of tubes to be exhausted, a sealing off unit to singly seal off the tubulations, sever the tubes therefrom and eject the tubes, a unit for removing the remaining tubulations singly from the sockets, a rotatable cam shaft, operating cams for each unit mounted on the shaft, and separate actuating means extending through the hollow support to operatively connect the units with their respective cams.

18. In an exhaust machine, a stationary vertical hollow support, a table mounted for intermittent movement about the support, exhaust sockets disposed at spaced positions adjacent the periphery of the table for receiving tubulations of tubes to be exhausted, an oven positioned for the passing of the tubes therethrough during movement of the table and having an entrance end and an exit end, doors for the ends of the oven, a sealing off unit to singly seal off the tubulations, sever the tubes therefrom and eject the tubes, a unit for removing the remaining tubulations singly from the sockets, operating cams for each unit and the oven doors mounted on the shaft, and separate actuating means extending through the hollow support to operatively connect the units and the doors with their respective cams.

19. In an exhaust machine, a stationary vertical hollow support, a table mounted for intermittent movement about the support, exhaust sockets disposed at spaced positions adjacent the periphery of the table for receiving tubulations of tubes to be exhausted, a plurality of units to respectively act on the tubes and tubulations, and separate actuating means extending through the hollow support to actuate each unit.

20. In an exhaust machine, a stationary vertical hollow support, a table mounted for intermittent movement about the support, exhaust sockets disposed at spaced positions adjacent the periphery of the table for receiving tubulations of tubes to be exhausted, a plurality of units to respectively heat, seal off the tubes from the tubulations and remove the tubulations, a rotatable cam shaft, operating cams for each unit mounted on the shaft, and separate actuating means extending through the hollow support to respectively connect the units with their respective cams.

21. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, a sealing off unit, a reciprocable member supporting the unit, an actuating arm to reciprocate the member to move the unit into and out of an operative position for sealing off the tubes singly, variable means to connect the actuating arm and the reciprocable member to vary the relative position of the sealing off unit with the tube when in the operative position, and manually operated means to move the member to move the unit out of the operative position.

22. In an exhaust machine, a table movable intermittently about an axis, exhaust sockets disposed at spaced positions about the table for receiving tubulations of tubes to be exhausted, means to exhaust the tubes, means to seal off the tubes and separate them from the tubulations, a unit to remove the tubulations singly from the sockets, a chute to receive the removed tubulations, a reciprocable member to support the unit, means to reciprocate the member, a cam to cause arcuate movement of the unit during reciprocable movement thereof to move the tubulation from its socket to the chute, and means to move the cam to render the unit ineffective to move the tubulations.

23. In an exhaust machine, a stationary vertical hollow support, a table mounted for intermittent movement about the support, exhaust sockets disposed at spaced positions adjacent the periphery of the table to receive tubulations of tubes to be exhausted, a drive shaft, means operatively connected to the drive shaft to move the table, an oven to heat the tubes, doors for the ends of the oven to close the oven after movement of the table to move a tube into and another tube out of the oven, a unit to inductively heat the tubes, a unit to singly seal off the tubes and sever the tubes from the tubulations, a unit to remove the tubulations, separate actuating means for the doors and the units extending through the hollow support, and cams for the actuating means mounted on the drive shaft.

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