Nov. 20, 1951 J. W. FULTON ET AL 2,575,756

EXHAUST MACHINE

Filed Oct. 21, 1949 4 Sheets-Sheet 1

Fig. 1.

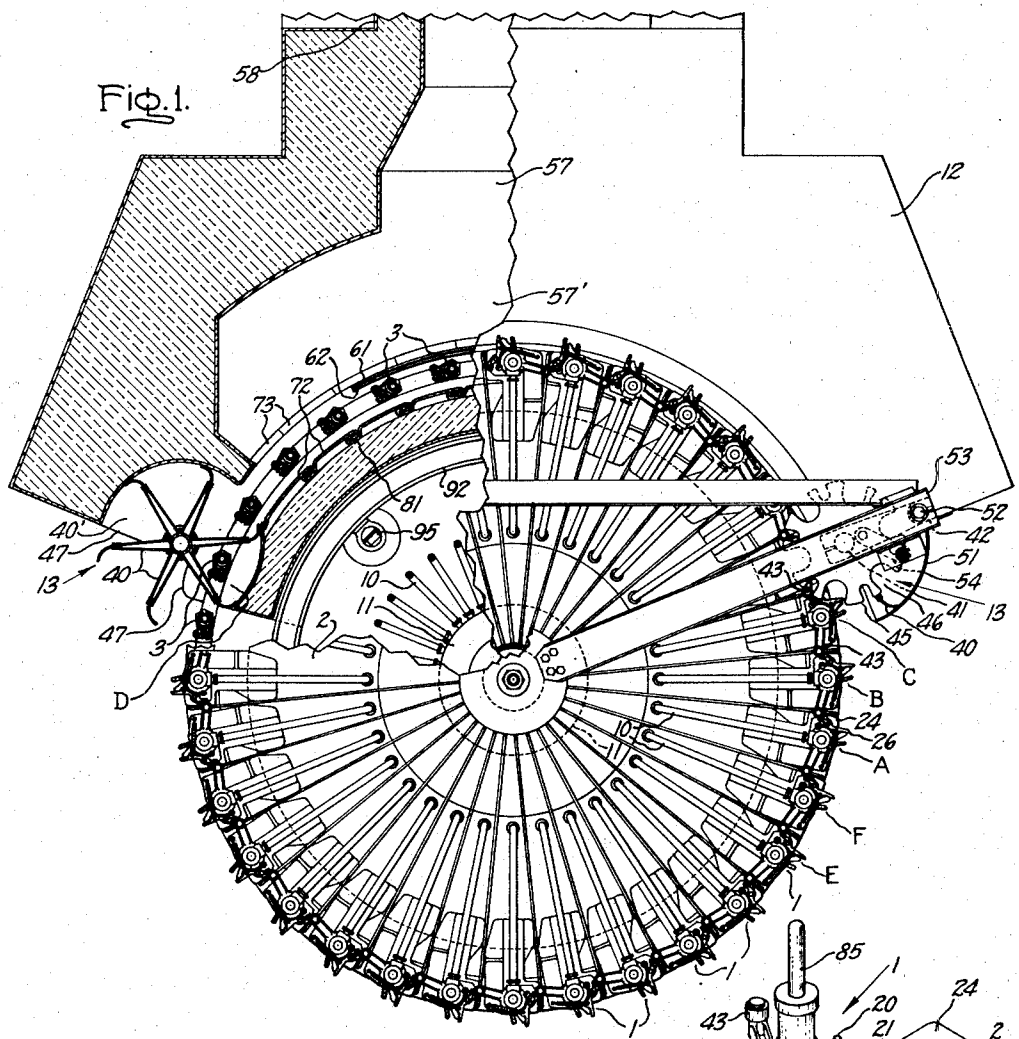


Fig. 2.

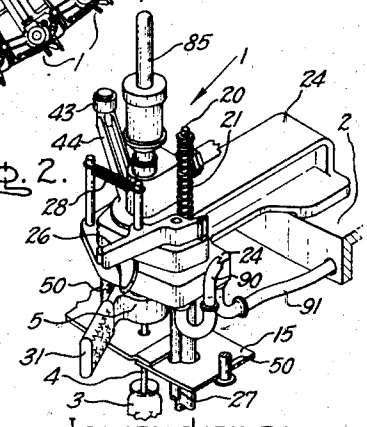
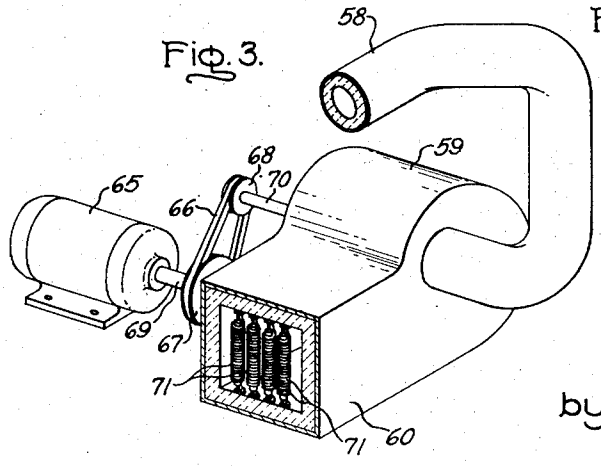


Fig. 3.



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EXHAUST MACHINE

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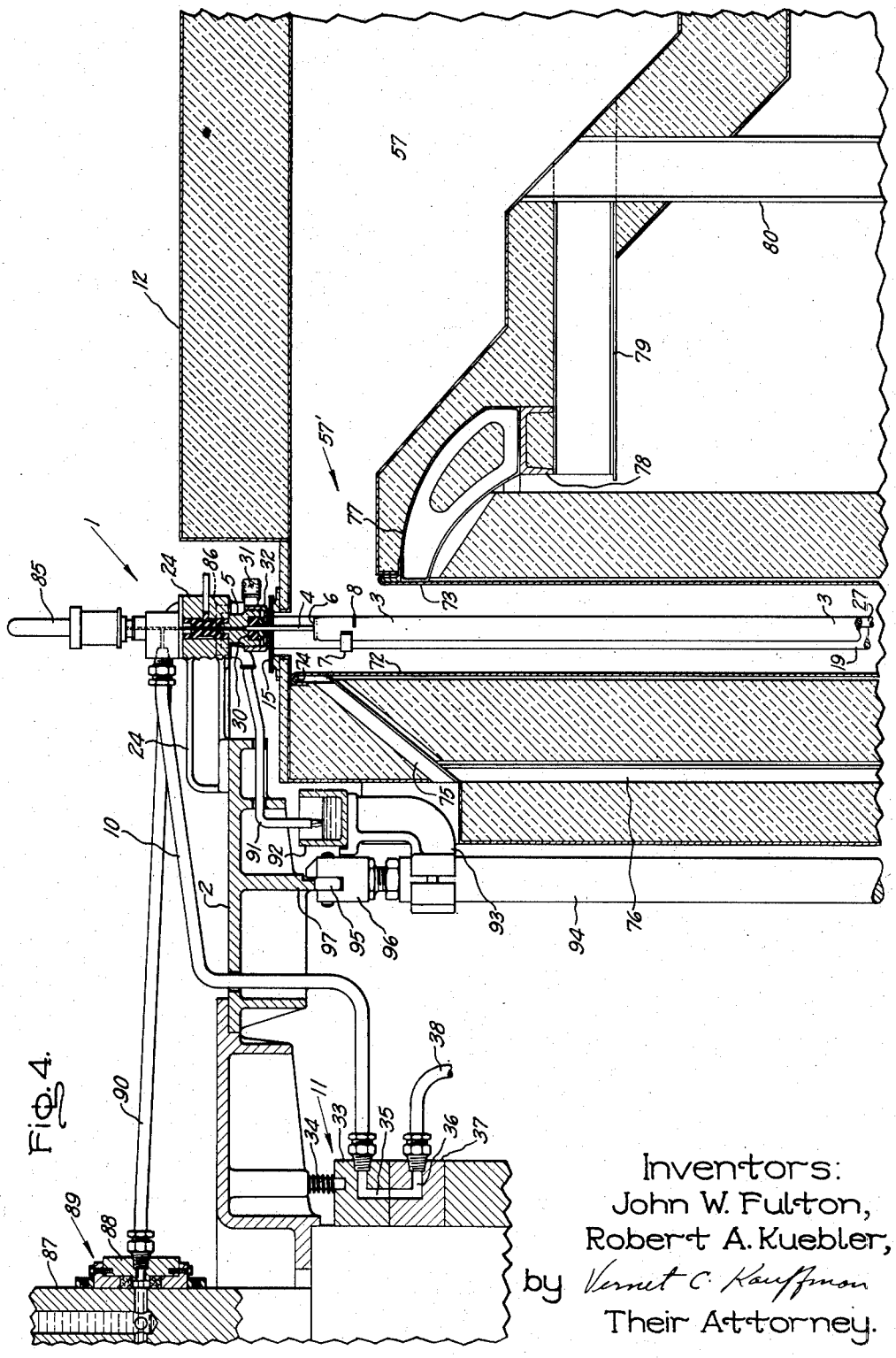

Fig. 4.

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EXHAUST MACHINE

Filed Oct. 21, 1949 4 Sheets-Sheet 3

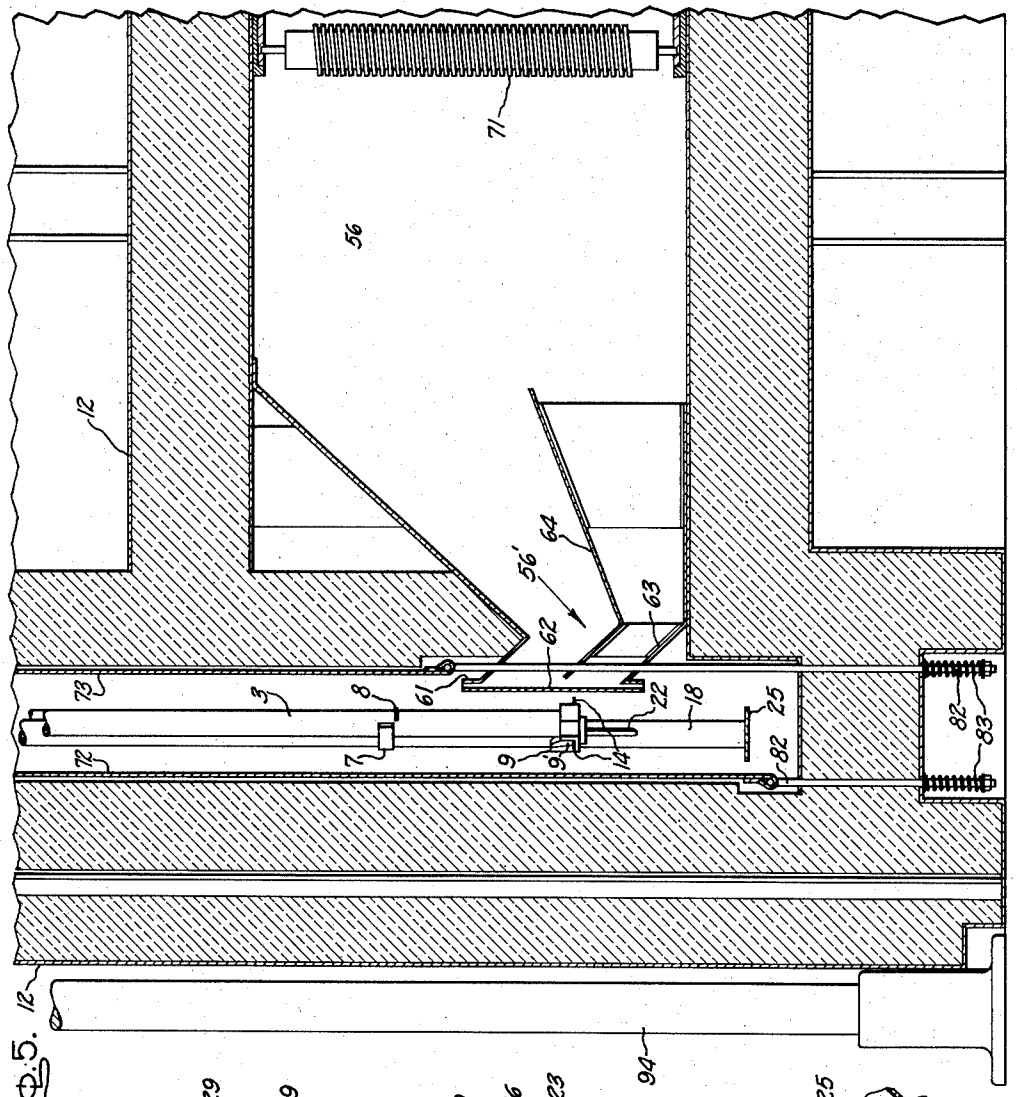

Fig. 5.

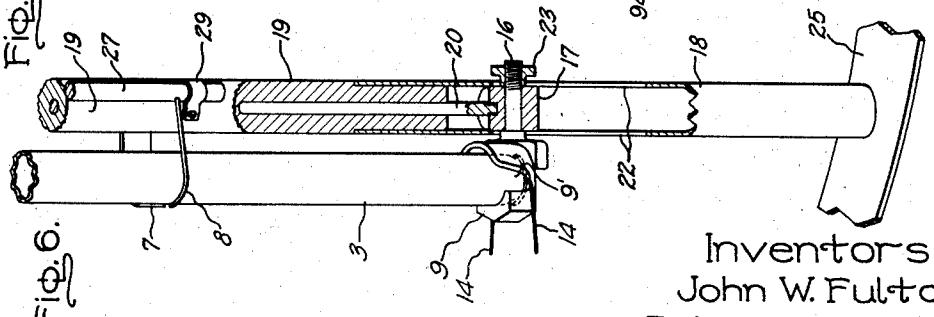

Fig. 6.

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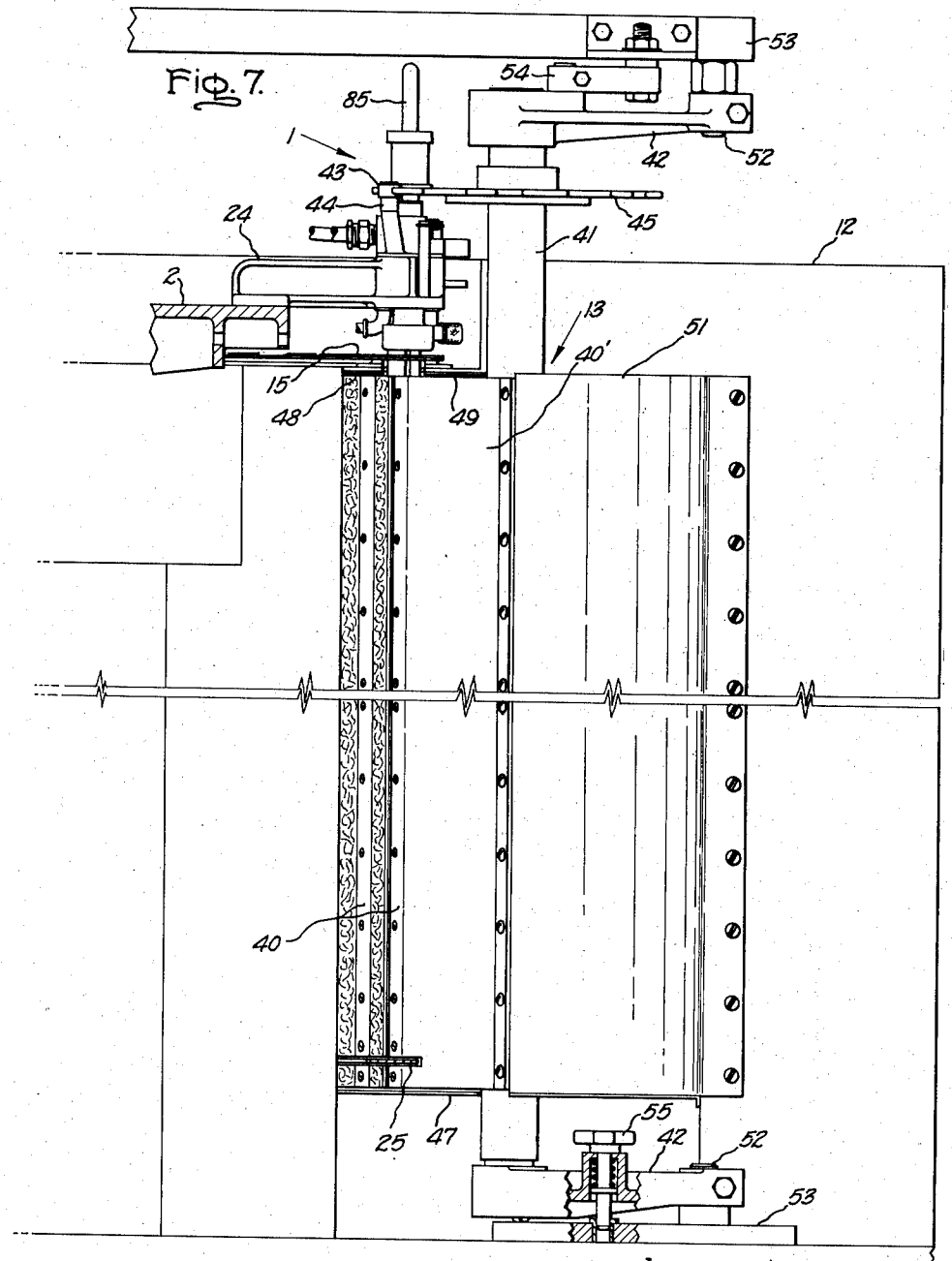
EXHAUST MACHINE

Filed Oct. 21, 1949 4 Sheets-Sheet 4

Fig. 7.



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Patented Nov. 20, 1951

2,575,756

UNITED STATES PATENT OFFICE

2,575,756

EXHAUST MACHINE

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Application October 21, 1949, Serial No. 122,688

16 Claims. (Cl. 316—31)

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Our invention relates to machines for exhausting lamps, discharge tubes and similar electrical devices comprising an enclosing envelope. More particularly, our invention relates to the multiple-station type of machine for exhausting the envelope of such electrical devices automatically and at a high rate of speed.

Machines for exhausting incandescent and fluorescent lamps as well as other electric devices having an enclosing envelope provide for the heating of said devices to assist in the removal of contamination on the interior surfaces and occluded in the envelope and other parts thereof. In certain instances, the heating function of the exhaust machine also effects treatment of a coating on the envelope. An instance of this kind is where the heat has the function of eliminating a binder used to secure the fluorescent powder to the envelope.

One object of our invention is to provide an exhaust machine having means to heat an electric device of the class described which means is particularly adapted to accurately control the temperature of all portions of the electrical device and capable of rapidly raising and maintaining a relatively elevated temperature therein. A machine attaining this object has means remote from the electrical devices for heating air under controlled conditions and other means for blowing a flood of said heated air over the electrical devices. No variation in temperature can occur in the various parts of the devices in this manner of heating and a very rapid rise in the temperature of the device is readily produced. Such a machine permits the use of critical manufacturing schedules of greater effectiveness than usual commercial procedures and accordingly allows the manufacture of improved electrical devices. This machine is also advantageous in that it eliminates the need for larger and more costly apparatus.

Another object of our invention is to provide exhausting and heating apparatus well adapted to treat fluorescent lamps comprised of envelopes of extended length and concentrations of mass in the form of electrode assemblies at opposite ends. Such lamps are often eight feet in length and therefore are difficult to heat rapidly to a desired temperature without excessively heating certain portions. Still further difficulty is encountered in treating fluorescent lamps in that it is only practical to hold said lamps in a vertical position in exhausting apparatus thereby necessitating the use of an oven of considerable vertical extent which normally gives rise to strong

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natural convection currents. To overcome the above difficulties, an oven is provided in the exhaust machine for holding the fluorescent lamps during treatment and an electric heating unit and blower used to circulate heated air through the oven with sufficient rapidity to equalize the temperature in all parts of said oven and the lamp. This method or mode of heating requires that the oven and cooperating elements of the exhaust machine be provided with means to restrict any appreciable loss of heated air; and in that connection, movable doors are provided to block the opening through which the lamps pass into or out of the oven. According to a feature of the invention, the oven doors, which are required at opposite ends of the oven, are preferably in the form of a plurality of blades extending radially from vertical shafts and are partially contained within pockets within the oven in such a manner that the rotation of the shafts causes certain blades to block the openings to the oven while the lamps are carried into or out of said oven in the space between the blades.

According to a still further feature of the invention the electrical device is supported by means extending through an opening in the top of the heat chamber of the oven, which chamber has walls made of sheet metal strips suspended from the top adjacent said opening. This construction allows the thermal expansion of said walls to be absorbed in means at the bottom of the strips and in loose lock seams between strips and is of still further advantage in that it maintains the relative relation of the top of the oven and the lamp holders. This latter condition contributes to the proper association of shields on each lamp holder with the top surface of the oven so that said shields effectively block the passage of air from the opening therein. In accordance with previous practice, the lack of space between the inner part of the oven and the exhaust machine had made it necessary to use very little insulation on the oven. By removing the heating elements from the oven chamber, in accordance with the present invention, it became feasible to apply a comparatively thick wall of insulation to all parts of the oven. This has resulted in a very substantial reduction in the amount of electrical power required, and also provides considerably more comfortable working conditions for the operators.

Still further features and advantages of our invention will appear from the following de-

tailed description of a species thereof and from the drawing.

In the drawing, Fig. 1 is a plan view of a species of exhaust machine comprising our invention, with an overlying portion of one quarter section thereof including the oven removed to show the course of movement of the discharge lamps being treated and the construction of the oven; Fig. 2 is a perspective view of one of the heads on the carrier or turret; Fig. 3 is a perspective view of the air heating and circulating means associated with the oven; Fig. 4 is a vertical section through the upper portion of the half section of the apparatus including the oven and shows in particular the means of supporting and exhausting the lamp through the head, the relationship of the head to the oven, and the upper air circulation passage; Fig. 5 is a vertical section, corresponding to Fig. 4, of the lower portion of the apparatus and shows in particular the lower air circulation passage of the oven and a portion of the air heating means; Fig. 6 is a perspective view with a portion broken therefrom, of the lower portion of the lamp holding means of a head of the apparatus and of the lamp in position therein; and Fig. 7 is an elevation of the entrance end of the oven, and of a head in the course of passing between the partitions of the door of said oven.

The apparatus disclosed in the drawings is constructed and arranged so as to hold a single relatively long (8 foot) fluorescent type discharge lamp in each of a plurality of work heads 1 mounted about the periphery of the carrier or turret 2 and so as to effect the heating thereof automatically during the movement of said heads 1 around the apparatus under the influence of the turret 2. The lamps 3 (Figs. 2 and 4) are suspended in vertical position directly below the main portion of the heads 1 which overhang the periphery of the turret 2 in very much the same manner as in the apparatus disclosed in United States Patent 2,247,513, Marshaus, dated July 1, 1941, and which patent is assigned to the assignee of the present invention. In the course of the operation of the apparatus, the lamps pass through a series of manufacturing steps corresponding to that performed by the patent apparatus. The manufacturing steps include the exhausting and gas filling treatments effected through the main portion of the head 1 directly associated with the turret 2 and to which the upper end of the lamp 3 is connected, and other treatments effected by apparatus located directly below said head portion and along the course of movement of the main portion of the lamp 3.

The first step in the cycle of operations of the present apparatus occurs when the lamp 3 is inserted either mechanically or manually into the heads 1 then located at station A or B. At such times, the lamp 3 is manipulated so that the exhaust tube 4 at the upper end thereof is carried upward into the opening at the center of the exhaust chuck 5 of the head 1 and so that the long tubular envelope 6 is placed between various pairs of jaws 7 and 8 of a downwardly extending holder of the head 1. The insertion operation also includes resting the lower end of the envelope 6 in the cup 9 (Figs. 5 and 6) on the lower portion of the holder of the head 1. The exhaust chuck 5 is the means of connecting the lamp 3 to a conduit 10 leading to a rotary valve 11 located about the axis of rotation of the turret 2, which valve 11 is adapted to effect the exhausting and filling operations of the apparatus in accordance with the rotation of the turret 2 and the location of the head 1 thereabout. The rotary valve 11 and the other directly associated means having to do with the exhausting and filling of the lamp 3 are constructed in accordance with the Marshaus patent hereinbefore referred to, and in general effect changes in these operations in the manner of the patented apparatus. The lamp 3 is advanced from station A to station B and further along the course of movement to each of the 32 work stations by successive indexing movements of the turret 2 under influence of driving means (not shown).

Successive movements of the head 1 advance the lamp 3 to work station C and then through a group of thirteen work stations occupied by an oven 12 which is constructed so as to receive the entire lamp 3 and the depending portion of the head 1 located below the exhaust chuck 5. The oven 12 is equipped with rotatable doors 13 at the entrance and exit ends thereof to prevent the loss of air and to avoid drafts within the oven 12 which could disturb the heat balance thereof. While enclosed within the oven 12, the lamp 3 is heated uniformly from end to end by a flood of heated air forced upward therethrough. Subsequent indexing movements of the work head 1 carry the lamp 3 completely through the oven 12 and then through another group of work stations where the lamp 3 is treated by means directly associated with the work head 1 and other means (not shown) not relevant to this invention. Finally the lamp 3 arrives at station E where it is sealed off and then passes to station F where it is removed from the apparatus. The operations occurring at this latter group of work stations correspond to those occurring in the machine disclosed in the Marshaus patent hereinbefore referred to, and are performed by means not shown in complete detail in the present application. Full details of the operation of the disclosed apparatus, with particular reference to the portions thereof relating to the present invention, appear in the following detailed description.

The insertion of the lamp 3 into the apparatus, the first step in the operation thereof, consists in resting the completely sealed end of said lamp 3 in the cup 9 (Figs. 5 and 6) located on the lower portion of a holder extending downward from the head 1, the operation being performed in such a manner that the leading-in wires 14—14 projecting from that end of the lamp 3 fall into opposed notches 9' in the rim thereof. The lamp 3 is then pushed downward against the yielding resistance of the cup 9 until the exhaust tube 4 (Fig. 4) at the upper end thereof is below the level of the shield 15, whereupon it is moved back under said shield 15 to alignment with the exhaust chuck 5 and moved up into proper engagement therewith. The upward pressure produced by the cup 9 is sufficient to support the lamp 3 and is effected through the attachment of the bolt 16 (Fig. 6) extending from cup 9 to a piston 17 within the tubular lower portion 18 of the post 19 of the holder of the head 1. The piston 17, in turn, is supported by a rod 20 extending upward through the full length of the post 19 and the parts of the head 1 to a nut (Fig. 2) bearing upon the spring 21 surrounding the upper end thereof and seating on said head 1. Slots 22 in opposite sides of the lower tubular portion 18 of the post 19 allow free vertical motion of the bolt 16 so that downward pressure upon the cup 9 which compresses the spring 21 will lower said cup 9.

A nut 23 upon the end of the bolt 16 permits the cup 9 to be detached from the piston 17 and easily replaced with another of different size if desired. The posts 19 of the holder of each head 1 of the apparatus are attached to a lateral portion of the main body 24 of the exhaust chuck 5 and are joined at their lower ends by a circular band 25 of metal extending completely around the apparatus, which band 25 keeps the lower ends of said posts 19 in proper alignment.

At the time the upper end of the lamp 3 is moved under the shield 15 and into alignment with the exhaust chuck 5, the jaws 7 and 8 of the holder therefore are caused to separate sufficiently to permit the lamp envelope 6 to pass therebetween. This operation is effected by manual pressure against the hand lever 26 located adjacent the exhaust chuck 5 so that the vertical shaft 27 on which it is mounted, and the jaws 8 below at various positions along its length, are turned sufficiently to allow the lamp 3 to be pressed against the stationary jaws 7. The release of pressure against the hand lever 26 permits the contraction force of the spring 28 extending between posts in said lever 26 and the body 24 of the exhaust chuck 5 to turn shaft 27 and carry the jaws 8 against the envelope 6 with sufficient pressure to clamp it against the stationary jaws 7 of the holder. Inasmuch as jaws 7 are fastened directly to post 19, the lamp 3 becomes properly aligned with the head 1 when pressed thereagainst. The jaws 8 maintain their relative position in the apparatus since the upper end of the vertical shaft 27 to which they are attached is journalled in the body 24 of the exhaust chuck 5 and is clamped to the side of post 19 at various points along its length by the metal straps 29 (Fig. 6). Insertion of the lamp 3 is completed by a manually produced upward movement of the lamp 3 which threads the end of the exhaust tube 4 through the opening in shield 15 and into the opening in the expansible packing ring 30 of the exhaust chuck 5 and by manipulation of the hand lever 31 extending from the compression cap 32 of the exhaust chuck 5 so as to screw said cap 32 onto the body 24 thereof and squeeze the packing ring 30 sufficiently to seal the exhaust tube 4 in said chuck 5.

The lamp 3 is advanced to work station C from work station B by the index of the head 1 and in so doing is introduced to the first operation of the apparatus having to do with the exhaustion and filling thereof. This operation is effected by the rotation of the upper half 33 of the rotary valve 11, which is joined to the turret 2 by the stud 34, to a position where the passage 35, connected by the conduit 10 and the chuck 5 to said lamp 3, is over a passage corresponding to that shown at 36 in the lower stationary half 37 of the rotary valve 11. The pipe 38 connects passage 36 to the main source (not shown) of vacuum. The exhausting operation continues throughout the entire period the lamp 3 remains at station C and is only interrupted when the periodic index of the turret 2 moves the head 1 and the upper half 33 of the rotary valve 11 to a succeeding position.

The indexing movement carrying the head 1 from station C continues the exhausting and gas-filling operations by again making a suitable connection to the head 1 through the rotary valve 11 and initiates the first step in the introduction of the lamp 3 in the oven 12 by causing said lamp 3 to be carried between two of the partitions or blades 40 of the rotatable door 13 at the entrance

end thereof. The index also effects a partial rotation of the door 13 (Figs. 1 and 7) whereby the blade 40 thereof closing the opening to the oven 12 is moved further into the pocket 40' of said oven 12 holding said door 13, and a second blade passes into position behind the lamp 3 and blocks said entrance. The lamp 3 then has a position corresponding to the lamp 3 shown at station D (Fig. 1) on the opposite side of the turret. The oven door 13 comprises a plurality of blades 40 of the same height as the entrance opening and the pocket 40' in the oven 13, which blades 40 radiate from a central shaft 41 journalled at top and bottom in corresponding arms 42 (Figs. 1 and 7). The door 13 is turned by the engagement of fixed rollers 43, located between the heads 1 on arms 44 extending from the body portions 24 of the exhaust chucks 5, with the notches in the periphery of the wheel 45 at the upper end of the shaft 41. Other notches 46 in the periphery of the wheel 45 provide clearance for the exhaust chucks 5.

The oven door 13 reduces the loss of heat from the entrance to a minimum and in that connection functions in cooperation with a metal shield 47 covering all of the bottom end of the oven pocket 40' except a clearance slot for shaft 41 and shields 48 and 49 covering the top end of the pocket 40' to a point parallel to the end wall of the oven 12 in blocking movement of air therefrom. The shield 47 is positioned so as to be wiped by the bottom edges of the several blades 40 of the door 13 engaging the walls of the oven 12 and therefore is in position to prevent the escape of heat downward between said blades 40. The shields 48 and 49, on the other hand, are positioned so as to be wiped by the top edges of the blades 40 of the door 13 and close off the upward passages between the particular blades 40 adjacent the oven 12 except for a passageway provided to accommodate the posts 19 and shafts 27 of the heads 1. The arcuate shield 15, which rests on the head of a stud 40 extending from the bottom of the body 24 of each exhaust chuck 5, closes the space between shields 48 and 49. Inasmuch as all portions of the door 13 of the oven 12 become heated during operation and radiate heat in the direction of the operator opposite loading stations A and B, a removable curved shield 51 is mounted around that portion thereof adjacent said stations A and B in a position to intercept said heat. The oven door 13 also provides a means of entering the interior of the oven 12 in that the arms 42 engaging the central shaft 41 thereof are pivoted upon bolts 52 held by portions of the frame 53 of the apparatus and can be swung outward away from the entrance to said oven 12 after the strap 54 and pin 55 respectively are loosened from their attachment to another portion of said frame 53.

The succeeding index of the head 1 carries the lamp 3 further into the oven 12 and away from between the blades 40 of the oven door 13, and positions said lamp 3 at the first of a series of stations within the heat chamber of the oven 12. Ten succeeding stations are located within the oven chamber, which is defined by two relatively closely spaced heavily insulated vertical walls of said oven 12, and in each of said stations the lamp 3 is correspondingly subjected to the heat of a flood of air circulated upward therebetween. All heat contained within the oven chamber is supplied by the influx of heated air into the lower portion of said chamber from a large plenum chamber 56 located to one side thereof and is heat

generated outside of the walls of said oven 12 in air recirculated after being withdrawn through a corresponding plenum chamber 57 at the top thereof. The air passes between the plenum chambers 56 and 57 and the oven chamber through connecting passages 56' and 57' extending substantially the full length of said chamber and is circulated by a system including the round pipe 58 (Fig. 3), blower 59 and heater 60. The walls of all portions of the circulating means are insulated in the manner of the oven 12 and restrict the loss of heat to a minimum so that the desired temperature in al parts of the oven 12 can be maintained by the flow of air produced by the blower 59 without difficulty and in an efficient manner. Heating means of the type disclosed provides accurate control of the temperature in the lowest and most extended portions of the oven 12 since said air is circulated between the extremities of the oven 12 and avoids as much as possible inward leakage of cool air, vertical variations effected by convection currents and shielding effects, etc. of portions of the apparatus. The rapid circulation of heated air also promotes very rapid transference of heat to the lamp 3 thereby lessening the period of treatment required and by the accurate maintainance of temperature permits more desirable but more critical heat treatments to be used.

The circulating means associated with the oven 12 provides for drawing air from the top of the full lineal extent of the vertical heat chamber forming the lamp-holding chamber of the oven 12 and withdraws the air through the laterally directed passageway 57' which extends as near as practical to the entrance and exit ends of said heat chamber. The exhausted air traveling out through passage 57' and plenum 57 is gradually drawn into the circular flow pattern of the connected pipe 58 which conducts it to the inlet opening of the centrifugal type blower 59. The heated air, which conditions the heat chamber and consequently the lamp 3, enters the bottom of said chamber from the passage 56' which extends the full lineal extent thereof in the manner of passage 57' and represents the forced flow of air discharged by the blower 59 and conducted through the heater 60 and plenum 56 to the passage 56'. Baffles 61, 62, and 63 (Figs. 1 and 5) are provided at the center of the discharge end of the passage 56' directly opposite the outlet of the heater 60 to impede the flow of air sufficiently to promote the desired flow from the opposite extremes of said discharge end and to effect a controlled direction of flow of air into the heat chamber of the oven 12. The baffle 62 blocks the direct flow of air from the lower end of the lamp 3, whereas the baffles 61 and 63 in cooperation with baffle 62 cause the air discharged into the heat chamber to flow upward and downward respectively along the outer wall of the oven 12. The flow of air is also proportioned between the upper and lower portions of the heat chamber by the fixed baffle 64 midway in the outlet end of the passage 56'.

The lamps 3 contained within the oven 12 are always exposed to the circulation of heated air in that the blower 59, which is driven by the electric motor 65, is continuously operated. The electric motor 65 drives the fan (not shown) of the blower 59 through the belt 66 and the pulleys 67 and 68 on the motor and fan shafts 69 and 70 respectively and at such a rate as to move the air around the lamps 3 in the major part of the heat chamber at a velocity of some 300 feet per minute. This rapid rate of circulation enables lamps 8 feet in length to be quickly raised to the temperature of treatment which in the present instance is in the order of 550° C. Accurate maintenance of this treatment temperature is also accomplished by the circulation of the heated medium as the electric resistance elements 71, which necessarily operate at a higher temperature than the surrounding air, are remote from the lamp 3 and the only heat transferred thereto is that of the circulating air which is subject to accurate control. The temperature of the heat treatment is automatically maintained by electric means (not shown) controlled by thermocouples (not shown) at various positions within the oven 12 and capable of being preset over a wide range to the temperature desired.

Expansion and contraction of the highly heated inside portions of the oven 12 is provided for by having the longer sections of the walls of the heat chamber formed from overlapping strips 72 and 73 of vertically arranged sheet metal fastened at the top to cool and therefore relatively fixed support members of the oven 12 and by keeping said strips taut by a downward pull on the lower ends thereof. The strips 72 forming the wall of the heat chamber adjacent the center of the machine hang from a rod 74 supported by structural members 75 and 76 extending through a relatively cool portion of the oven 12 to the base of the machine, whereas, the strips 73 forming the opposite side of the heat chamber hang from the edge of a plurality of brackets 77 mounted on a cross structural member 78 in turn supported by beams 79 and 80. Loose lock seams 81 (Fig. 1) are provided between adjacent strips 72 and 73 to allow said strips to expand laterally and still maintain a substantially leakproof construction. The lower end of each of the strips 72 and 73 is pulled taut by a rod 82 extending downward through the bottom of the oven 12 where a spring 83 located between a nut on the end thereof and the bottom of the oven 12 exerts a constant pull thereon. The above type of oven construction fixes the top portion of the oven 12 within relatively close limits during all conditions of heat and thereby assures a substantially fixed relation between the parts of the heads 1 and the adjacent portion of said oven 12. As shown in Fig. 4, the lamp holder of the head 1 and the exhaust tube 4 of the lamp 3 are accommodated in an opening in the top of the oven 12 along their course of movement, which opening is blocked off by the shield 15 carried by each head 1. The height of the oven 12 is such that the shields 15 ride up onto the top surface thereof when the head 1 passes into operative relation to said oven 12 and remain in contact with said surface during the entire interval said relation continues. Since each shield 15 is separate from the others, independent vertical movement of each can occur and positive engagement between each shield 15 and the top of the oven 12 is assured under any normal variation in relation between said head 1 and the oven 12.

The exhausting and gas-filling operations performed by the apparatus during the location of the lamp 3 at the work stations occupied by the oven 12 are under the control of the valve 11 as in the usual exhaust apparatus and in accordance with usual practice may include exhausting, flushing and filling operations in any desired combination. In the instance shown,

connections are made through the rotary valve 11 to the exhaust chucks 5 of the heads 1 at each of the above stations which provide for the exhausting of the lamp 3 by a source (not shown) of rough vacuum. No other operations are performed upon the lamp 3 until it passes out of the oven 12 through the rotary door 13 opposite station D.

In the course of the movement of the lamp 3 through the various work stations between station D and stations E and F, the unloading stations, the head 1 advances said lamp 3 into proper operating arrangement with other means not herein disclosed but corresponding to that shown in the Marshaus Patent 2,247,513, which provides for certain other treatments to said lamp 3 and finally the tipping off of the exhaust tube 4. The exhausting and filling operations occurring during the above course of movement are also completed in a manner corresponding to that disclosed in the said Marshaus patent under the control of the rotary valve 11 and, correspondingly, a controlled quantity of mercury is discharged into the lamp 3 through the exhaust chuck 5 by operation of the dispenser or doser 85 which is a unit of the head 1 directly above said exhaust chuck 5.

In the present instance, the heads 1 are each separately cooled by the flow of water passing through the short passage 86 in the body 24 of the exhaust chuck 5. The cooling water flows from a source provided by the stationary pipe 87 located on the axis of rotation of the turret 2 and passes through lateral openings therein to an opening behind the rotatable ring 88 of the stuffing box 89 and thence through openings in said ring 88 and the pipe 90 to one end of the passage 86 in the head 1. The water is drained from the opposite end of the passage 86 through pipe 91 to the stationary open trough 92 which extends completely around the apparatus under the turret 2 and which is provided with a suitable drain pipe. Support for the trough 92 is provided in brackets 93 located at spaced intervals about the apparatus and engaging the upstanding posts 94 of the frame of the apparatus. The posts 94 also add further support and stiffness to the turret 2 by furnishing, through the medium of the roller 95 in the yoke 96 on the upper end thereof, a rest upon which the lower edge of the rib 97 in the turret 2 seats throughout the course of rotation thereof.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An exhaust machine for electric lamps or similar devices comprising a head for holding and making a gastight connection to a lamp, a carrier for supporting the head and advancing it to each of a plurality of stations, means connected to the head for effecting evacuation of the lamp at certain of said stations, an oven mounted adjacent the path of movement of said head and including a chamber for receiving the lamp, and air circulating means connecting opposite extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the said chamber.

2. An exhaust machine for elongated electric lamps or similar devices comprising a head for holding a lamp in a vertical position and making a gastight connection thereto, a carrier for supporting the head and advancing it to each of a plurality of stations, means connected to the head for effecting evacuation of the lamp at certain of said stations, an oven mounted adjacent the path of movement of said head and including an elongated chamber for receiving the lamp, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air upward through the said chamber.

3. An exhaust machine for electric lamps or similar devices comprising a head for holding and making a gastight connection to a lamp, a carrier for supporting the head and advancing it to each of a plurality of stations, means connected to the head for effecting evacuation of the lamp at certain of said stations, an oven mounted adjacent the path of movement of said head including a chamber open at the top and terminating in openings in the ends thereof for receiving the lamp, movable doors at the opposite ends of the oven closing off the openings therein, means for actuating the doors to permit the lamp to pass to and from the oven, a shield mounted on the head and engaging the upper surface of the oven for closing the top opening therein, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air upward through the chamber thereof.

4. An exhaust machine for electric lamps or similar devices comprising a head for holding and making a gastight connection to a lamp, a carrier for supporting the head and advancing it to each of a plurality of stations, means connected to the head for effecting evacuation of the lamp at certain of said stations, an oven mounted adjacent the path of movement of said head including a chamber open at the top and terminating in openings in the ends thereof for receiving the lamp, doors rotatable about a vertical axis at the opposite ends of the oven having blades radiating from said axis and arranged to wipe opposite walls of the openings therein, means engaged by the head during movement thereof to and from operative relation to the oven for rotating the doors to cause the blades thereof to pass successively to opposite sides of the lamp held by the head and to positions to close said openings, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air upward through the chamber thereof.

5. An exhaust machine for electric lamps or similar devices comprising a head for holding and making a gastight connection to a lamp, a carrier for supporting the head and advancing it to each of a plurality of stations, means connected to the head for effecting evacuation of the lamp at certain of said stations, an oven mounted adjacent the path of movement of said head including semi-circular pockets in the ends thereof and a chamber open at the top and terminating in said pockets for receiving the lamp, rotatable doors mounted on a vertical axis within the pockets of the oven having blades radiating from said axis and arranged to wipe the walls of said pockets, means engaged by the head during movement thereof to and from operative relation to the oven for rotating the doors to cause the blades thereof to pass successively to opposite sides of the lamp held by said head and to positions in the pockets to close the openings therein, and air circulating means connecting the

upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air upward through the chamber thereof.

6. An exhaust machine for electric lamps or similar devices comprising a head for holding and making a gastight connection to a lamp, a carrier for supporting the head and advancing it to each of a plurality of stations, means connected to the head for effecting evacuation of the lamp at certain of said stations, an oven mounted adjacent the path of movement of said head including semi-circular pockets in the ends thereof and a chamber open at the top and terminating in said pockets for receiving the lamp, rotatable doors mounted on a vertical axis within the pockets of the oven having blades radiating from said axis and arranged to wipe the walls of said pockets, a notched disc connected to one end of each door and engaged by a portion of the head during movement thereof for rotating said doors to cause the blades thereof to pass successively to opposite sides of the lamp held by the head and to positions within pockets to close the openings therein, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air upward through the chamber thereof.

7. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including a chamber for receiving the lamp terminating in openings in the ends thereof and including lateral passages at the top and bottom of the chamber extending substantially the full length thereof for circulating heated air therethrough, a deflector located within the oven at the juncture of one lateral passage and the chamber for redirecting and restricting the inflow of air from said passage to said chamber, movable doors at opposite ends of the oven for closing off the openings therein, and air circulating means connecting the passages in the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the chamber.

8. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including a chamber for receiving the lamp terminating in openings in the ends thereof and including lateral passages at the top and bottom of the chamber extending substantially the full length thereof for circulating heated air therethrough, deflectors located within the oven opposite the end of one lateral passage for blocking the direct flow of air therefrom to the chamber and redirecting said flow along the walls thereof, movable doors at opposite ends of the oven for closing off the openings therein, and air circulating means connecting the passages in the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the chamber.

9. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including semi-circular pockets in the ends thereof, a chamber terminating in said pockets for receiving the lamp and lateral passages at the top and bottom extremities of the chamber extending substantially the full length thereof, rotatable doors located within pockets of the oven having blades radiating from the axis of rotation and arranged to wipe the walls of said pockets, means to rotate the doors to cause the blades thereof to pass successively to opposite sides of the lamps entering and leaving the chamber of the oven and to positions within the pockets to close off the chamber, deflectors located within the oven opposite the end of the lower lateral passage for blocking the direct flow of air therefrom to the chamber and proportioning said flow along the walls thereof, and air circulating means connected to the lateral passages in the oven and forming a closed circuit therebetween comprising a blower and air heating means effecting a rapid circulation of heated air from the bottom to the top of the chamber in said oven.

10. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including a chamber for receiving the lamp terminating in openings in the ends thereof and formed from relatively narrow overlapping parallel strips of material, movable doors at opposite ends of the oven for closing off the openings therein, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the chamber thereof.

11. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including a chamber for receiving the lamp terminating in openings in the ends thereof and formed from relatively narrow overlapping parallel strips of material, and including fixed support means for one end of the strips and means for exerting a constant pull onto the other end of said strips to absorb longitudinal expansion therein, movable doors at opposite ends of the oven for closing the openings therein, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the chamber thereof.

12. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including a chamber terminating in openings in the ends thereof for allowing the lamp to enter and leave said chamber and having an opening extending between said first-mentioned openings in the ends for permitting constant engagement with the lamp in said chamber, support means for the oven extending externally thereof to portions on opposite sides of the last-mentioned opening, movable doors at opposite ends of the oven for closing off the first-mentioned openings therein, and air circulating means connecting the upper and lower extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the chamber thereof.

13. In an exhaust machine for electric lamps or similar devices, heating means comprising an oven including a chamber terminating in openings in the ends thereof for allowing the lamp to enter and leave said chamber, and having an opening extending between said first-mentioned openings in the ends for permitting constant engagement with the lamp in said chamber, said chamber being formed from relatively narrow overlapping parallel strips of material, fixed support means for the ends of the strips adjacent the last-mentioned opening in the chamber of the oven extending externally of said oven, means for exerting a constant pull onto the other end of said strips to absorb longitudinal expansion therein, movable doors at opposite ends of the oven for closing the openings therein, and air circulating means connecting the upper and lower

extremities of the oven in a closed circuit comprising a blower and air heating means for directing a flow of heated air through the chamber thereof.

14. An exhaust machine for electric lamps or similar devices comprising an oven including an insulated chamber, a carrier including means to support lamps and carry them along a path of travel through said oven, means including exhaust heads on said carrier for connecting the lamps to a source of vacuum, a heating unit, a blower, and means connecting said heating unit and blower with said oven chamber in a closed circuit to recirculate heated air therethrough.

15. An exhaust machine for electric lamps or similar devices comprising an oven including an insulated chamber having walls made of relatively narrow vertical strips of sheet metal attached to each other by loose lock seams to permit expansion thereof without warping, a carrier including means to support lamps and carry them along a path of travel through said oven, means including exhaust heads on said carrier for connecting the lamps to a source of vacuum, a heating unit, a blower, and means connecting said heating unit and blower with said oven chamber in a closed circuit to recirculate heated air therethrough.

16. An exhaust machine for electric lamps or

similar devices comprising an oven including an insulated chamber having walls made of relatively narrow vertical strips of sheet metal attached to each other by loose lock seams to permit expansion thereof without warping and also including fixed support means for the upper ends of said strips and spring means attached to the lower ends of said strips to keep them taut, a carrier including means to support lamps and carry them along a path of travel through said oven, means including exhaust heads on said carrier for connecting the lamps to a source of vacuum, a heating unit, a blower, and means connecting said heating unit and blower with said oven chamber in a closed circuit to recirculate air therethrough.

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