April 22, 1958 P. J. GARDNER 2,831,267

DRYING APPARATUS

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FIG. 2

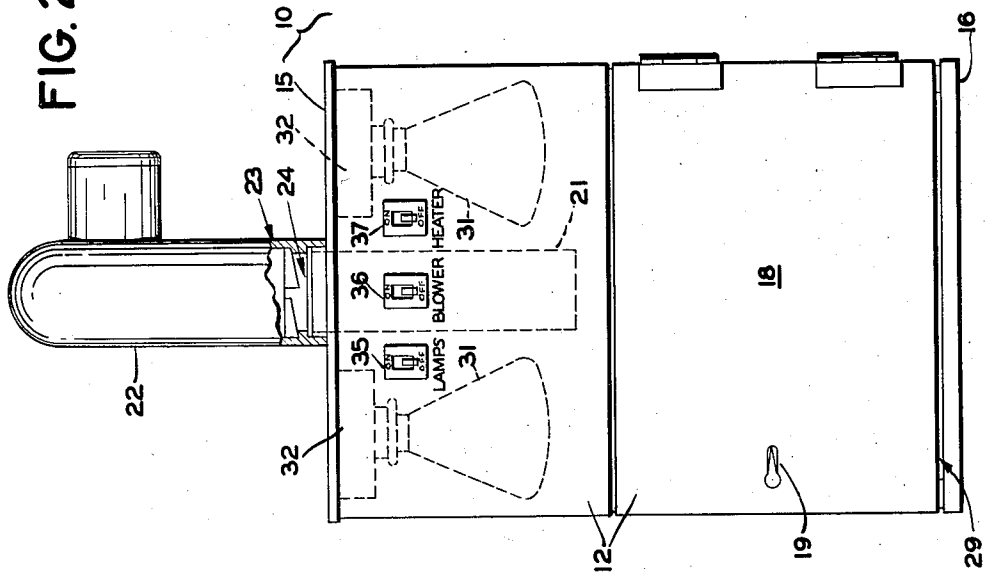
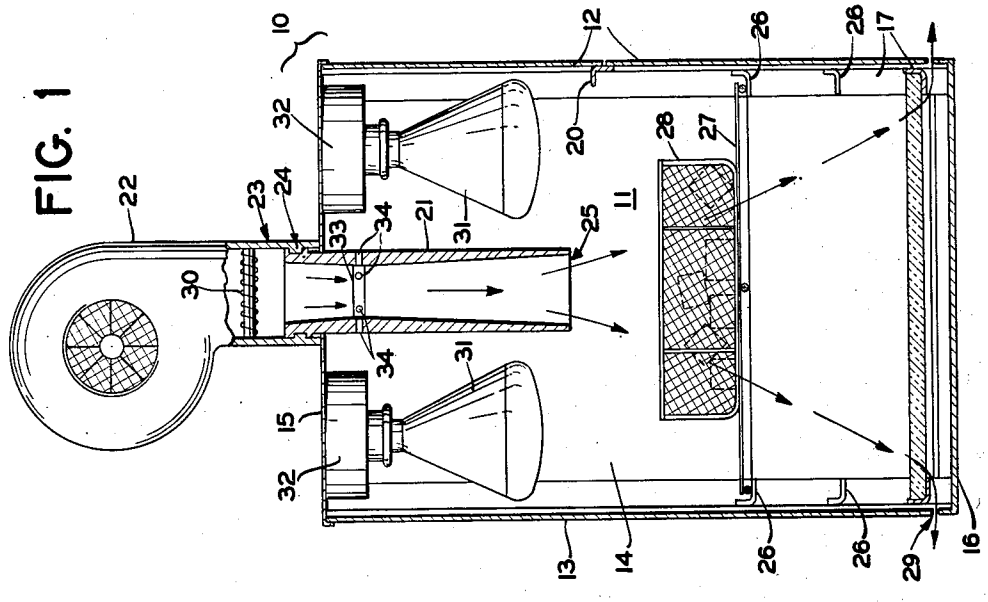


FIG. 1



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FIG. 5

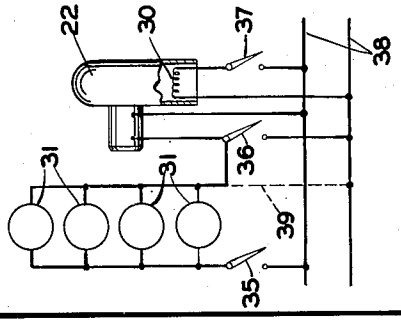


FIG. 4

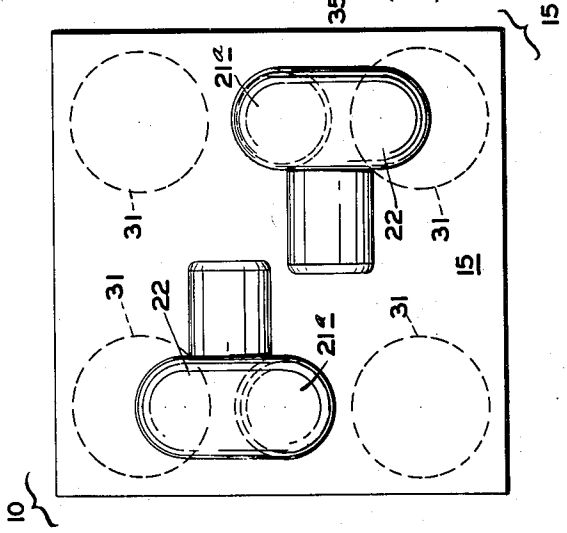
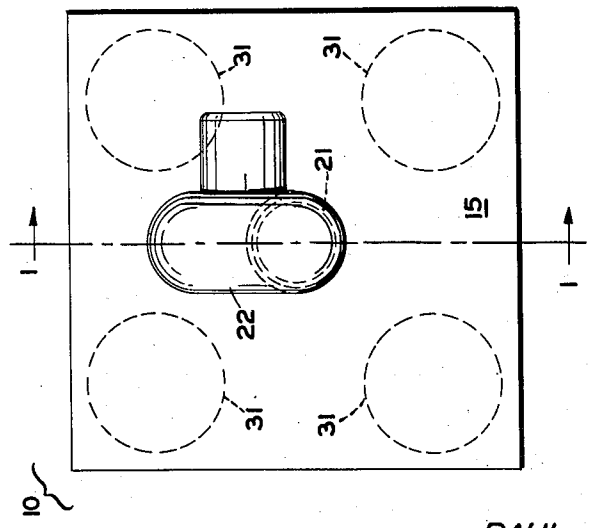


FIG. 3



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FIG. 7

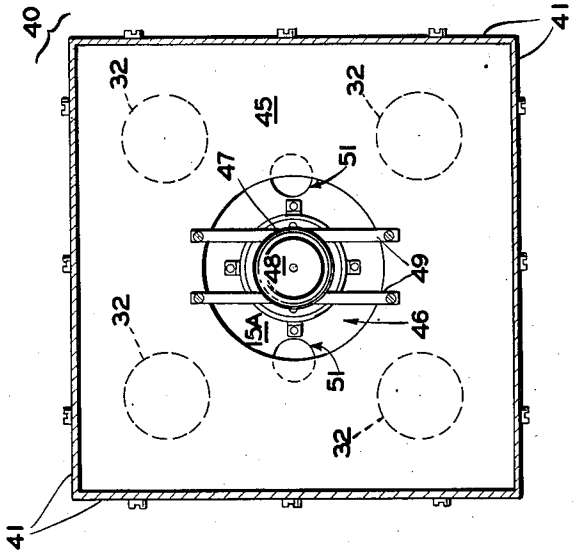
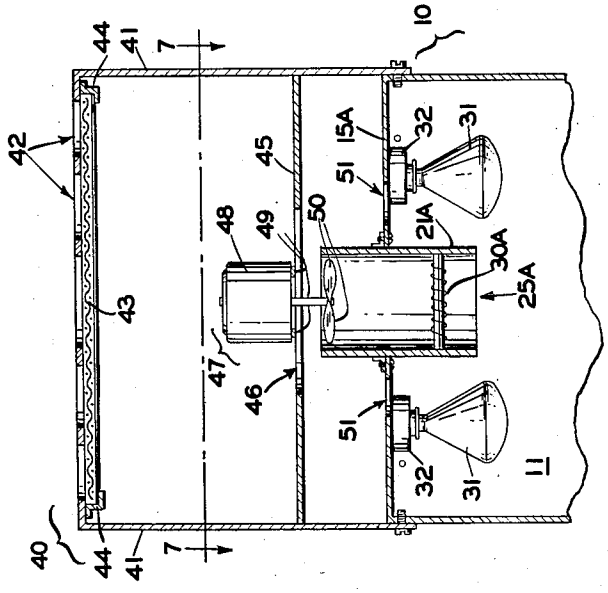


FIG. 6



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United States Patent Office 2,831,267 Patented Apr. 22, 1958

2,831,267

DRYING APPARATUS

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Application December 29, 1954, Serial No. 478,313

5 Claims. (Cl. 34—60)

This invention relates to drying apparatus, and is especially directed to a drier of the type which combines the action of radiant heat with that of an air current.

In production operations requiring the drying of articles, it is important to carry out the drying step as rapidly as is consistent with adequate and efficient drying, since a shorter drying time means greater production per machine and lower costs. This is especially important in drying articles such as machine parts after cleaning or other liquid treatment, since the shape of such parts often increases the difficulty of removing all of the liquid from recesses and interstices. It has been found that with prior types of driers this operation has been comparatively lengthy and correspondingly expensive.

Rapid drying is also important where the retention of liquid on the article surface may have objectionable effects, such as staining or other discoloration or the formation of surface films, which make it desirable to remove the liquid as promptly as is practical.

An object of the invention is to provide a drier that will substantially reduce the time required for efficient drying of articles, and particularly of apparatus parts and the like having irregular contours.

Another object is to combine radiant heat with an air current in a novel manner that increases the efficiency of the drying apparatus.

A further object is to provied an improved air drier in which higher air velocity in the drying zone is obtainable; and a related object is to arrange the drier so that the high speed air flow is uniformly distributed through said drying zone.

An object is to provide an arrangement for returning air in the drying chamber but outside of the drying zone, and especially air that is heated, to the supply of drying air directed to such zone. A related object is to provide an ancillary current of cooling air around a radiant heat source.

A further purpose is to provide a drier that is efficient, compact, readily constructed and operated, and which utilizes standard units.

The foregoing and other objects and advantages of the invention will appear more fully from consideration of the detailed description which follows, together with the accompanying drawings wherein two embodiments of the invention are illustrated. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description and are not to be construed as defining the limits of the invention.

In the drawings:

Fig. 1 is a vertical central section on line 1—1 of Fig. 3, with part of the blower broken away, illustrating one embodiment of the invention;

Fig. 2 is a front elevation of said embodiment with part of the blower broken away;

Fig. 3 is a plan view thereof;

Fig. 4 is a similar plan view of a modified embodiment;

Fig. 5 is a wiring diagram;

Fig. 6 is a vertical central section through another modified form, the lower portion being broken away; and

Fig. 7 is a horizontal section on line 7—7 of Fig. 6.

The drier includes a housing 10 enclosing a drying chamber 11. In the form illustrated, the housing is rectangular and includes a front wall 12, side walls 13, rear wall 14, top 15 and bottom 16, all formed of sheet metal marginally connected and mounted on an angle iron frame 17 to form a closed chamber. The lower portion of the front wall 12 is formed by a hinged door 18 having a latch 19, the joint between the upper part of front wall 12 and door 18 being closed by frame angle 20.

A stream of drying air is supplied through the housing top 15 by means of a tube 21 extending downwardly into chamber 11, arranged for connection to a source of air under pressure. This is conveniently provided by a centrifugal blower 22 having a discharge pipe 23 fitting over and attached to the upper end of tube 21, as by bayonet joint 24.

Housing 10 is provided with a suitable support for articles to be dried, located below the outlet 25 of tube 21. As illustrated, this comprises angle supports 26 mounted on frame 17, and racks 27 removably carried by said supports, on which articles to be dried are placed. Such articles may conveniently be arranged in an open mesh basket 28 located below the tube outlet 25. The region in which articles on racks 27 will be located constitutes a drying zone.

An arrangement is provided for assuring the uniform distribution of the air flow over racks 27 in the drying zone, this arrangement including an outlet located below said racks and formed by a relatively narrow slot arrangement extending circumferentially through the walls of the housing 10 adjacent to the bottom. In the form illustrated, the air outlet slot 29 extends through said walls entirely around the housing immediately above the bottom, a portion of the slot being located below door 18 as shown in Fig. 2. With this arrangement the air from tube outlet 25 travels downwardly and outwardly with uniform outward spread to slot 29, as indicated. A filter or air diffuser 52 of fibrous material offering a minimum of air resistance may be mounted on the chamber walls just above the slot 29, extending entirely across the chamber.

An arrangement for heating the air passing through tube 21 is advantageously provided, and may conveniently include an electrical heating element 30 mounted in the discharge pipe 23 of blower 22.

Means for directing radiant heat against the articles mounted on racks 27 is provided in the upper part of chamber 11. In the form illustrated, said means includes a plurality of electrical heat radiating lamps 31 of conventional form, including internal reflectors, detachably mounted in standard receptacles 32 fixed to the housing top 15 and symmetrically arranged around tube 21 in corner portions of chamber 11. The lamps 31 are advantageously located and oriented in proper positions to apply radiant heat with relative uniformity over the entire surface of racks 27. The tube outlet 25 is advantageously located no higher than the lower ends of lamps 31, and preferably somewhat below said ends as shown, so that the air discharged from outlet 25 will not impinge on said lamps. The walls 12, 13 and 14 may be coated with aluminum paint or otherwise surfaced to reflect heat waves into the drying zone.

With this arrangement the air trapped in the upper part of chamber 11 around lamps 31 is relatively quiescent, and tends to become substantially hot due to its location at the top of the chamber and close to said lamps. An arrangement is provided for feeding such air from

the top of chamber **11** into tube **21**, thereby avoiding the accumulation of heated air, cooling the upper part of said chamber which normally contains or is adjacent to electrical wiring and parts that might be affected by excessive heat, and utilizing the heat in said air to assist the drying operation.

For this purpose the inner face of tube **21** converges slightly from both ends to a thickened zone **33** located adjacent to the upper end of the chamber **11** and forming a venturi throat. Air passages **34** extend from said throat outwardly through tube **21** into communication with the upper part of chamber **28**. The suction effect of the air flow through throat **33** will draw air inwardly into said stream in tube **21** through passages **34**, which are circumferentially distributed to produce even withdrawal of the air from the upper part of chamber **11**.

With this arrangement an exceptionally large volume of air at relatively high velocity can be passed around and through the articles to be dried, which are located in the direct path of the expanding air stream. Heat is uniformly applied, not only from the heated air itself but also from the lamp radiation, which is immediately effective when the apparatus is turned on. The radiant heating arrangement is moreover efficient because its heat is concentrated in the area where it is required. Further, this heating system is advantageous compared to air heating arrangements, since it can be placed in and out of operation immediately merely by operating a suitable switch **35** (Fig. 2) which controls the lamps **31**, instead of waiting for the air to be heated. A separate switch **36** for the blower **22**, and a switch **37** for the blower air heater **30**, permit flexible operation of the system, which can dry with cold air, heated air, or radiant heat alone or in combination with either type of air, by manipulating said switches, a suitable circuit across power line **38** is shown in Fig. 5 and independent operation as described may be obtained by using the alternative circuit indicated by dotted line **39**. In general, however, the full line circuit is preferred, with the lamp circuit connected at one side to the blower circuit beyond switch **36**, so that the heat lamps **31** cannot be turned on unless the blower is operating.

The requisite air velocity in the drying zone is obtained by providing the necessary input velocity through tube **21**, by proportioning the total area of outlet slot **29** to establish the appropriate output velocity, and by arranging housing **10** to close chamber **11** except at tube **21** and slot **29**. In a practical embodiment of the invention an input velocity of 2,000 feet per minute and an output velocity of 450 feet per minute were maintained, producing an air velocity throughout the drying zone very much higher than was found to be practicable with previous dryers. The arrangement provided an air flow of fifty cubic feet per minute. This exceptionally high velocity and volume of air not only dries articles much more rapidly and efficiently, but also makes it possible to dry readily articles that are intricate in contour, which were difficult or impossible to dry in previous driers, the high velocity of the air reaching and removing moisture from remote recesses which could not be penetrated by air streams at lower velocities.

The arrangement also facilitates the use of more than one air source if desired, a modification using two blowers and air supply tubes being illustrated in Fig. 4. In this arrangement the tubes **21***a* are located symmetrically at opposite sides between pairs of heat lamps **31**. In this way a greater volume of air at high velocity, and the distribution of air at such velocity over a wider area, can be obtained. However, it will be evident that the construction is such that it is not restricted to the use of only two air supply units, or to the use of only four heat lamps.

In the embodiment illustrated in Figs. 6 and 7, another arrangement for recirculating the heated air, and

a filter for the incoming air, are provided. In this arrangement a top casing **40** having continuous side walls **41** fixed to and extending upwardly from housing **10**, has a top opening **42**, and carries an air filter extending across said opening, the form illustrated including a flat electrostatic filter **43** covering the entire opening and supported on rails **44**. A baffle plate **45** extending across casing **40** has a central air supply opening **46** concentric with air supply tube **21A** mounted on housing top **15A**.

An electric fan **47** has a motor **48** mounted on support bars **49** fixed to baffle plate **45** and extending across opening **46**, with the fan blades **50** spaced from the motor and located in the upper end of air supply tube **21A**. Heater **30A** is mounted in tube **21A** below fan blades **50**. As illustrated, tube **21A** may extend above top **15A**, and the air outlet **25A** at its lower end may be higher than the lower ends of heat lamps **31**; but while these features have advantages, they are not intended to be restrictive.

Housing top **15A** is provided with openings **51** spaced around tube **21A**, arranged to provide adequate upward flow of air from the upper part of housing **10** to prevent accumulation of hot air in that region, the fan-created suction at the top of tube **21A** serving to maintain the requisite air flow through openings **51**. While two openings **51**, underlying the edge of baffle opening **46** and evenly spaced between opposite pairs of lamps **31**, are disclosed, the desired result may be obtained with other arrangements. The lower part of this embodiment is the same as that shown in Figs. 1 and 2.

In the operation of this embodiment the air is drawn through filter **43**, so that not even fine particles of airborne dirt will reach the articles being dried, and is directed to the inlet of air supply tube **21A** by baffle plate **45** and opening **46** therein. After heating by heater **30A** if desired, the air travels downwardly and outwardly from outlet **25A** as already described, and air in the space around heat lamps **31**, which is out of the main air current, is drawn upwardly through openings **51** to the main air stream as already described.

While a different arrangement of the air supply tube, a different air feedback system, a different type of fan and an added top casing and filter have been shown in combination in Figs. 6 and 7, it will be evident that each of these features may be incorporated in the embodiment shown in Figs. 1 to 4 with or without any of the other features; and all of these features are shown together in Figs. 6 and 7 to avoid a needless multiplicity of drawings and correspondingly lengthy description.

Although but one embodiment of the invention and two modifications have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention, as the same will now be understood by those skilled in the art. In particular, various types of article supports may be substituted in or used with a drier embodying the invention; and while a compact and effective blower and air heating arrangement have been shown, and this arrangement has special advantages in the form illustrated, other types of air supplying and heating apparatus may be substituted therefor.

I claim:

1. Drying apparatus, comprising a housing forming a drying chamber having a drying zone and including a wall, an air supply tube centrally mounted in said wall and extending into the chamber toward said zone, and a plurality of mountings for directional heat lamps on said wall arranged symmetrically around the air tube and directed toward said zone, said housing including an air outlet at the opposite side of the zone extending around said drying chamber.

2. Drying apparatus, comprising a housing forming a drying chamber and including a top, a bottom, and

side walls, an air supply tube extending through the center of the top into the chamber, a plurality of directional heat lamp sockets mounted on the inner face of the top in symmetrical relationship to the supply tube, the lower end of said tube extending to the lower ends of said lamps when in said sockets, a narrow horizontal air outlet passage extending through the side walls around substantially the entire circumference of the chamber, said chamber being substantially closed during operation except for said air inlet tube and outlet passage, and means for supporting articles to be dried in the chamber in a direct line between said tube and passage.

3. Drying apparatus, comprising a housing forming a drying chamber having a drying zone and having a wall opposite said zone, an air supply tube centrally mounted in said wall and extending into the chamber and directed toward said zone, the inner face of said tube having a zone of reduced cross section forming a venturi throat, an air passage extending from said throat laterally through the tube to the chamber, arranged to draw air from the space surrounding said tube and adjacent said wall into an air stream in the tube and a discharge passage for the air stream opposite said tube on the other side of said zone.

4. Drying apparatus, comprising a housing forming a drying chamber having a drying zone and an upper wall, a heater in the chamber adjacent said wall, an air supply tube centrally mounted in said wall and extending downwardly therefrom with its discharge end directed toward said zone, the inner face of said tube having a zone of reduced cross section forming a venturi throat, and an air passage extending from said throat laterally through the tube into the upper part of the chamber, arranged to draw a heated air from the latter part of the chamber around said tube into an air stream in the tube and a discharge passage for the air stream opposite said tube on the other side of said zone.

5. Drying apparatus comprising a housing including a top and substantially continuous side walls forming a laterally closed drying chamber, a tubular inlet for drying air under pressure extending downwardly from the top into the chamber and spaced throughout from the side walls, means for maintaining a current of drying air at substantial velocity diverging outwardly and downwardly from said opening for drying articles located in a drying station in said current, comprising vertically narrow circumferentially extending air outlet means laterally offset from said inlet at opposite sides thereof and located below said station, and radiant heating elements located symmetrically between said tubular inlet and the side walls and directed downward toward said air current and station.

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