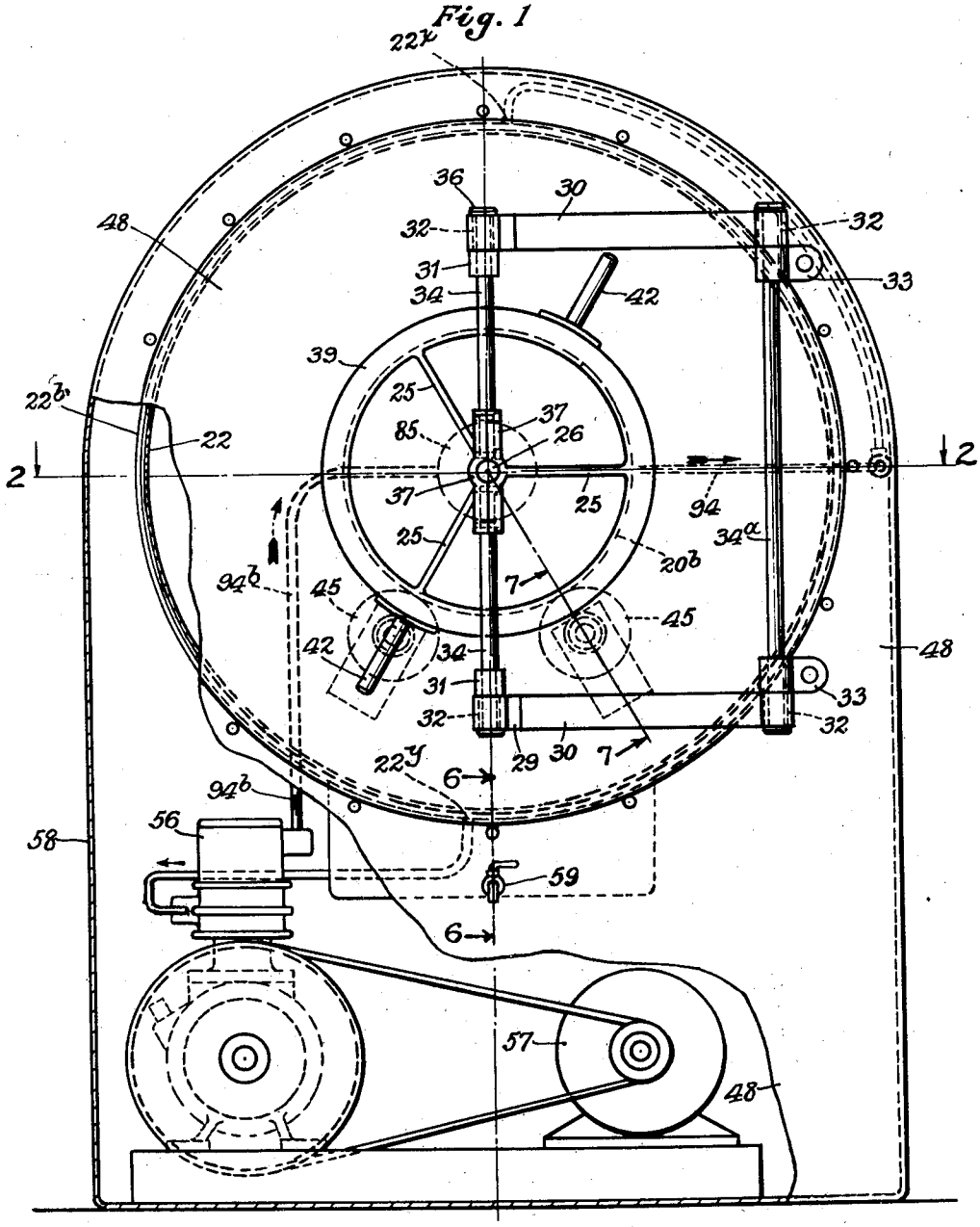
Jan. 24, 1950 W. L. MORRISON 2,495,535

DRIER

Filed Feb. 16, 1946 6 Sheets-Sheet 1

Fig. 1



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DRIER

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Fig. 2

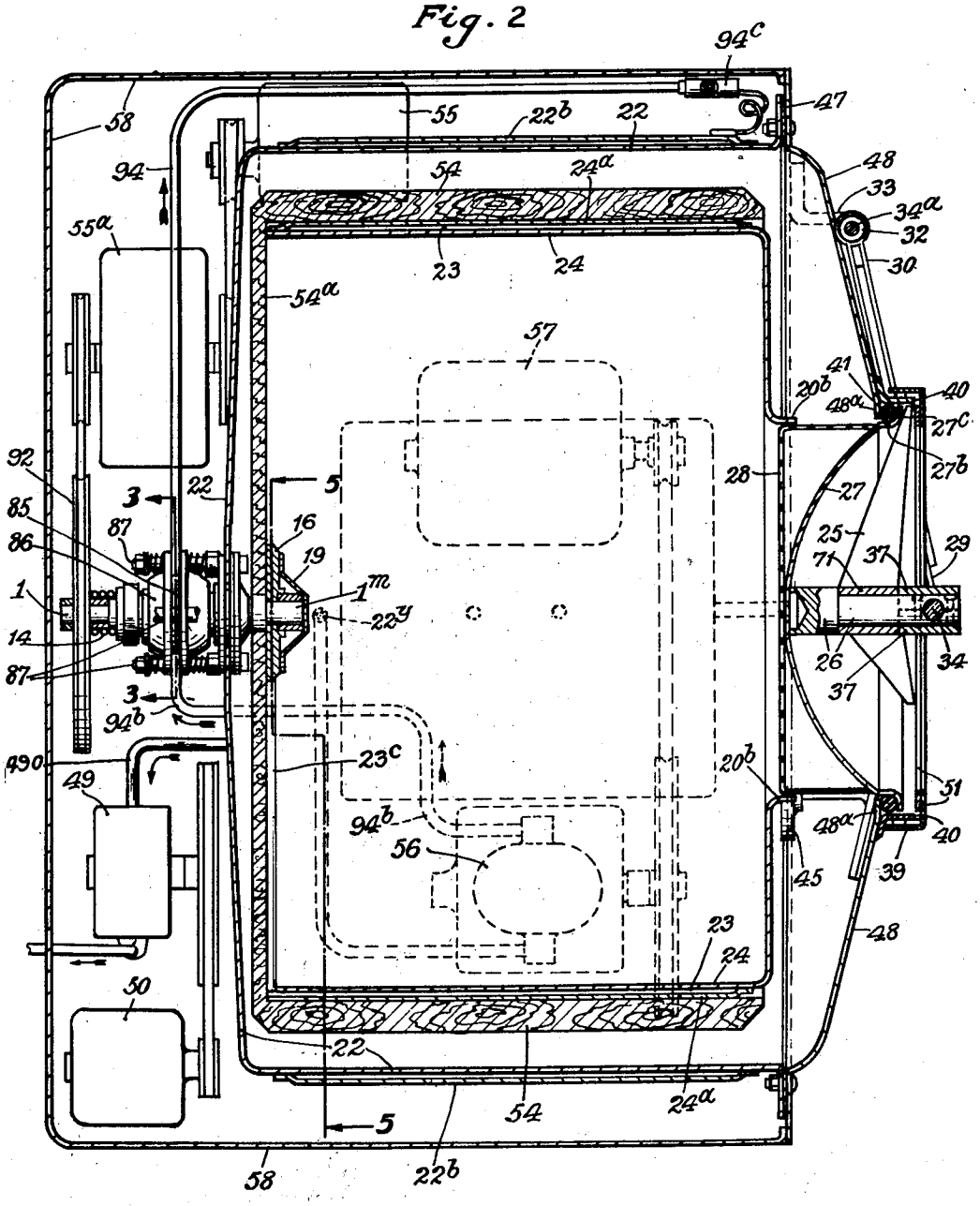

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Fig. 4.

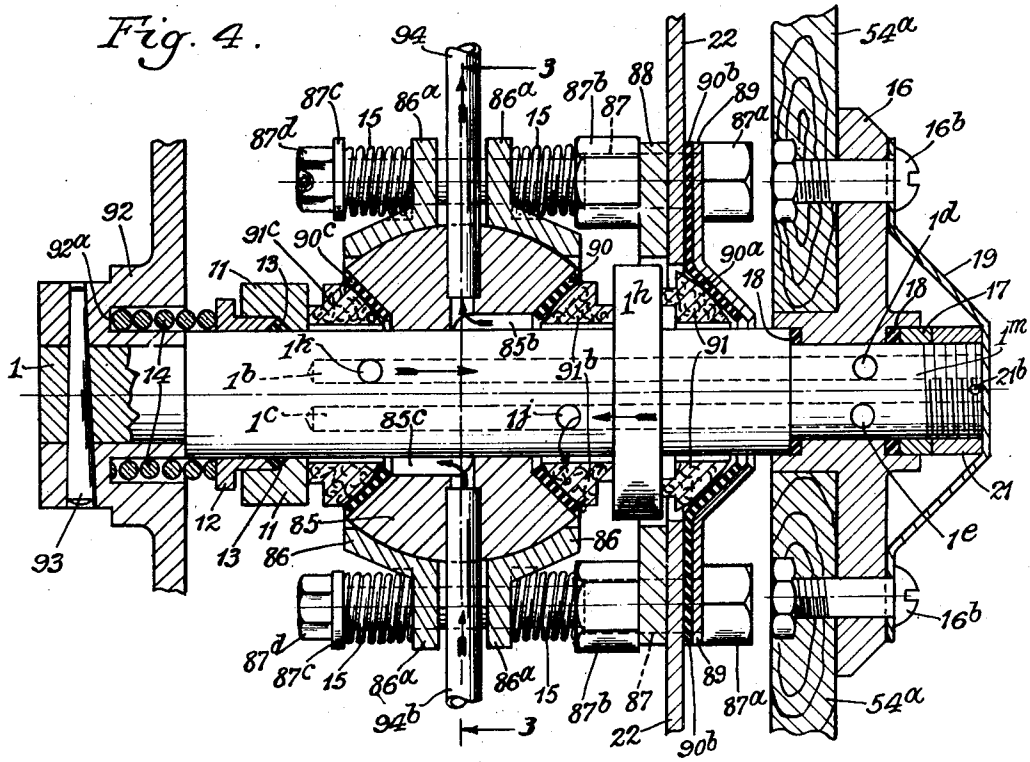

Fig. 3.

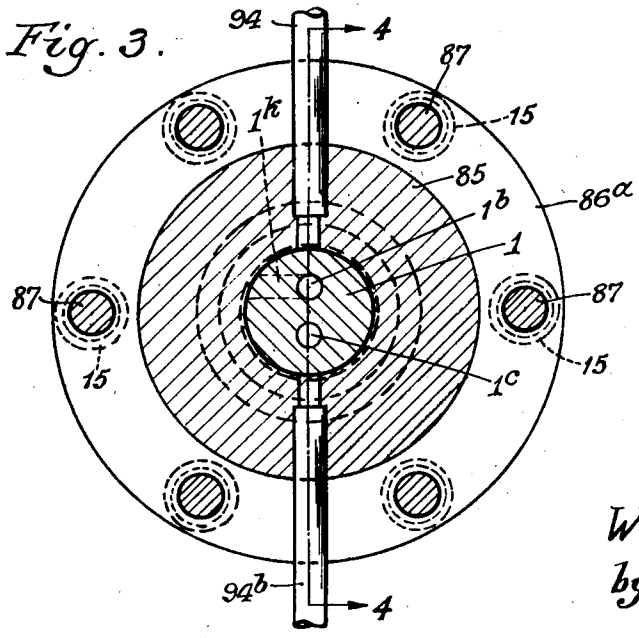

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Fig. 5.

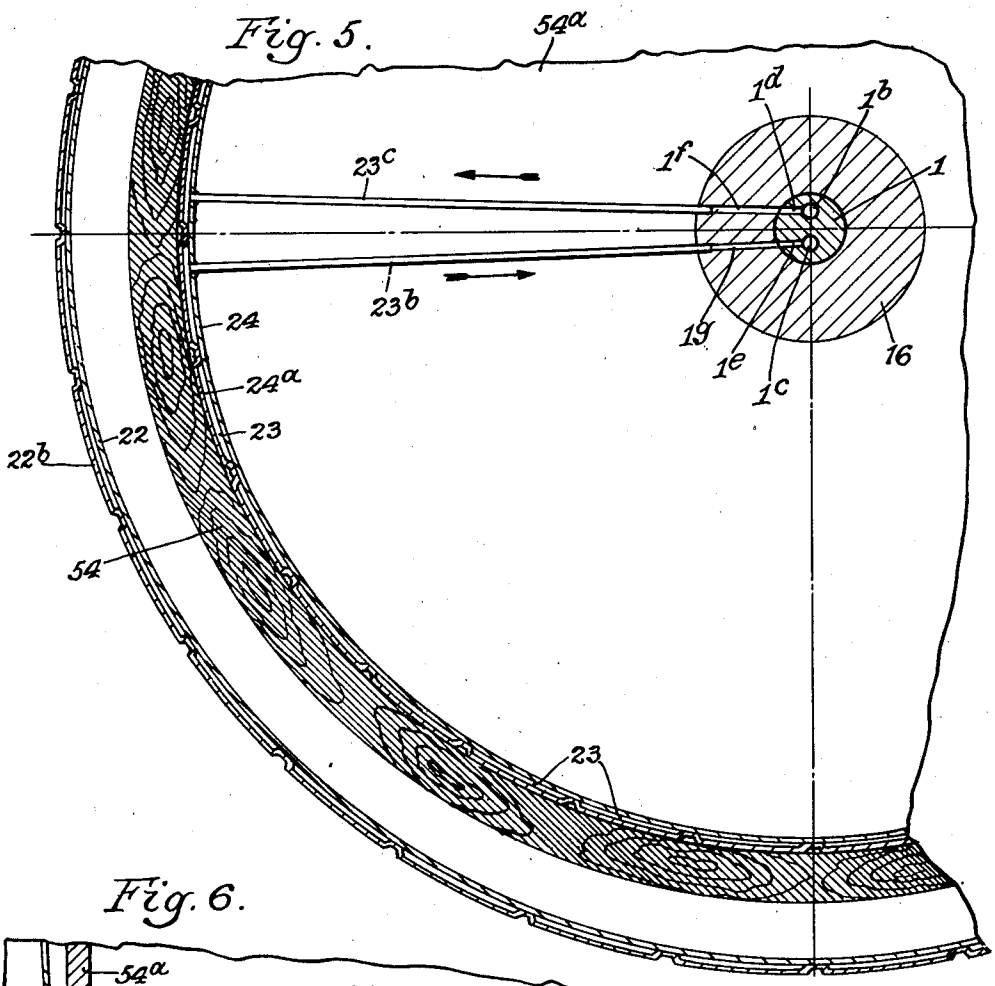
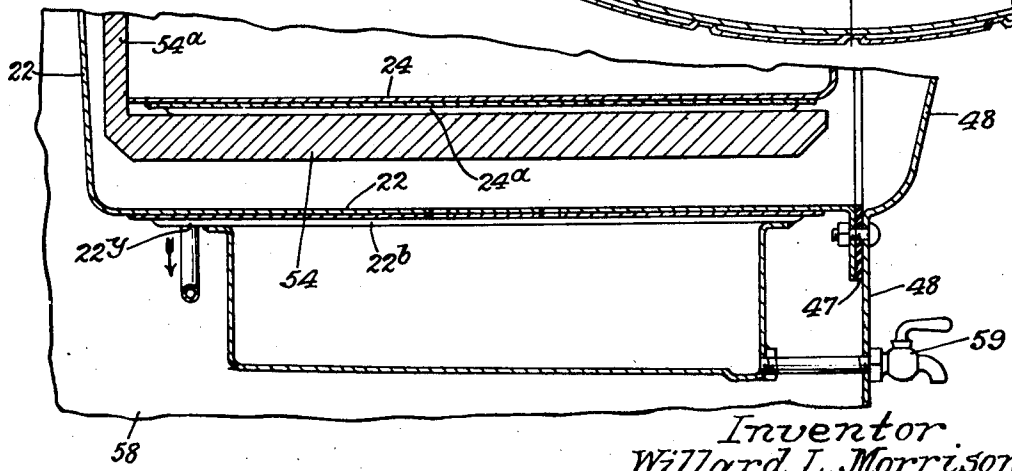


Fig. 6.



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DRIER

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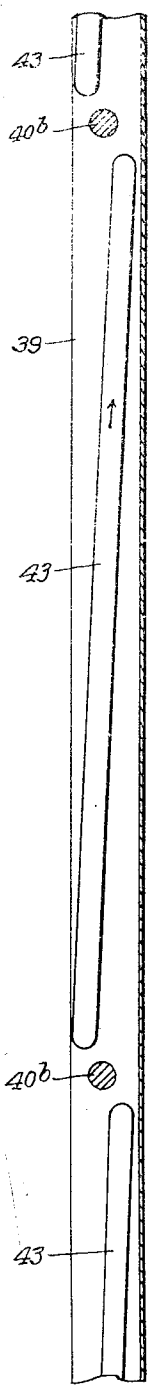

Fig. 8.

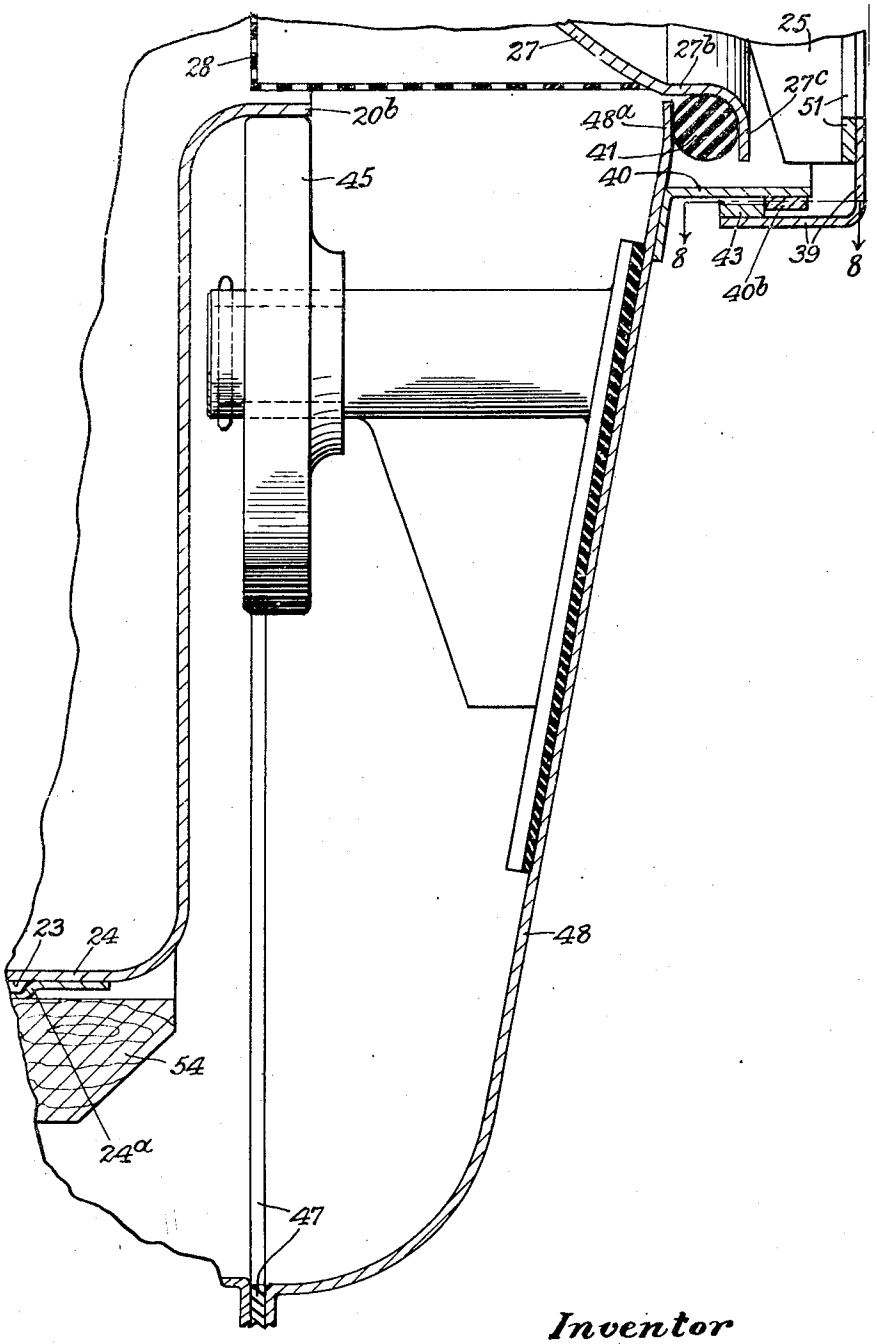

Fig. 7.

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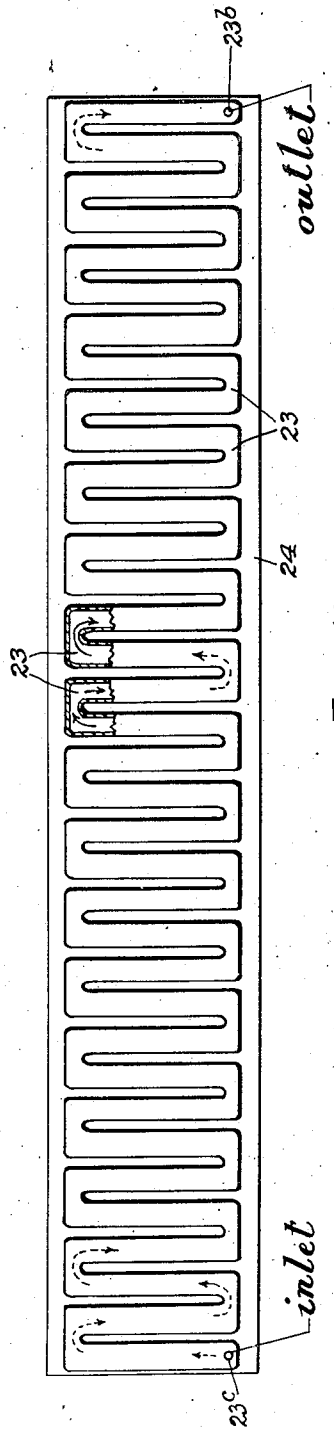

Fig. 10.

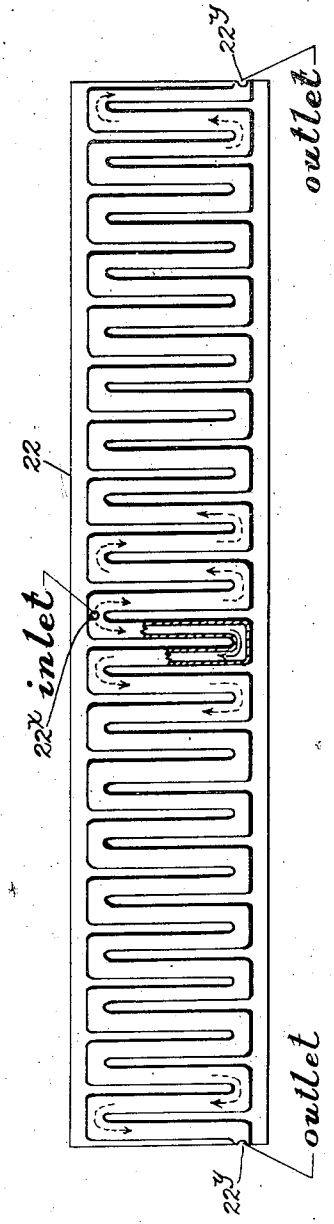

Fig. 9.

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DRIER

Willard L. Morrison, Lake Forest, Ill.

Application February 16, 1946, Serial No. 648,179

6 Claims. (Cl. 34—76)

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My invention relates to a drier, and particularly, to a clothes drier. One purpose is to provide a drier in which the articles to be dried are tumbled in a drying zone in which they are subjected to an elevated pressure.

Another purpose is to provide a drier in which the condenser and evaporator of the type of system often used in refrigeration is employed.

Another purpose is to reduce the amount of electrical energy which is necessary to produce drying in a given length of time.

Another purpose is to prevent an undue increase in the humidity of the air within the room in which the drying is being effected.

Another purpose is to decrease the wear in the fabric being dried, which ordinarily results from tumbling fabrics against screens or other surfaces.

Another purpose is to effect complete drying at a temperature which will be perfectly safe for delicate fabrics.

Another purpose is to provide an electrically operated drying assembly which does not necessitate special house wiring.

Other purposes will appear from time to time in the course of the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

Figure 1 is a front view with parts broken away and parts illustrated in skeleton relationship;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figures 2 and 4;

Figure 4 is a section on the line 4—4 of Figure 3, on an enlarged scale;

Figure 5 is a section on the line 5—5 of Figure 2;

Figure 6 is a sectional detail on the line 6—6 of Figure 1;

Figure 7 is an enlarged section on the line 7—7 of Figure 1;

Figure 8 is a development along the line 8—8 of Figure 7;

Figure 9 is a development of the cylindrical evaporator employed; and

Figure 10 is a development of the cylindrical condenser employed.

Like parts are indicated by like symbols throughout the specification and drawings.

Referring to the drawings I illustrate a generally cylindrical tumbling barrel 54 having a

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side or end 54*a*. The cylindrical portion of the barrel and its end 54*a* may advantageously be formed of wood, but any suitable material having a relatively low thermal conductivity may be employed. I illustrate the barrel or tumbler as mounted upon the shaft 1 at one end, and as supported at the other end by a plurality of rollers 45 which engage the neck 20*b* which may be secured to or be integrally formed with a suitable cylindrical metallic lining 24, which, as will later appear is or includes the condenser of a mechanical refrigeration system. Any suitable outside enclosure may be provided for the tumbler or barrel 54. I illustrate for example the stationary hollow walled closing member 22 which may be provided with any suitable lid or end closure 48 with a gasket 47. As will be clear from Figure 2 the circumferential cylindrical wall of the member 22 has associated therewith a second circumferential cylindrical wall 22*b*, the two walls being sealed together at their ends to provide an evaporator space in which a volatile refrigerant may be evaporated. Thus I employ concentric and relatively rotatable cylindrical condenser and evaporator elements, the condenser element assisting in lining the tumbling space within the tumbling element or drum 54, the evaporator being fixed in position about, and spaced outwardly from the drum which it surrounds. The condenser wall 24 is shown as having an outer wall component 24*a*, the space between the two walls as at 23 serving as a condenser coil. As will be clear from Figures 9 and 10 the inner and outer walls of the evaporator, shown in Figure 9 and the condenser shown in Figure 10, are so related as to define a tortuous path and so as to form a coil through which the refrigerant may flow, during condensation in the condenser, and during evaporation in the evaporator. The lid member 48 is secured not only to the above described evaporator structure, but to an outer housing 58, which surrounds the entire drier structure and which includes or serves as a supporting base which may rest on the floor or any other suitable surface and which houses the below described mechanisms.

The member 48 is shown as outwardly slightly conic, and as surrounding an access aperture located in line with the axis of the shaft 1 and the drum 54. During the drying operation this access opening is tightly closed. I illustrate for example a lid 27 shown as generally spherical but as terminating in a short cylindrical portion 27*b* and an outwardly flared flange 27*c*. A seal-

ing ring 41, which is shown as of circular cross section, is mounted about the cylindrical section 27b. It is preferably of relatively soft and resilient material such as rubber or a rubber substitute, and is fitted tightly about the cylindrical portion 27b and against the flange 27c.

The sealing ring 41 also bears against a plane face 48a on the inner circumference of the lid member 48. Thus when air is evacuated from the space within the cover 48 the atmospheric pressure against the lid 27 forces the cover 27 axially toward the drum and compresses the sealing ring 41 tightly between the flange member 27c and the inner portion 48a of the enclosing lid or cover 48. In order that the sealing ring 41 may initially be held with sufficient tightness so that the amount of air leaking in may be less than the volume which is being removed, I provide a horizontally projecting ring 40 which is rigidly fastened to the lid or cover 48, and surrounds the sealing ring 41. Attached to the ring 40 are a plurality of outwardly projecting pins 40b, as shown for example in Figures 7 and 8. These are adapted to engage in camming relationship with three helical strip members 43, which are fastened to a ring 39 of annular section. The ring 39, which is illustrated for example in Figures 7 and 8 is supported by a ring 51 carried upon spokes 25, the spokes being integral with a spider hub 71 rotatably supported upon a stub shaft or axle 26 which in turn is mounted on the removable closure 27. Handles 42 are mounted on the ring 39, whereby the ring 39, the ring 51 and the entire spider assembly may be rotated in order to obtain a camming locking action between the pins 40b and the helical projections or strips 43. This camming action causes a movement of the entire lid assembly including the closure 27, along the axis of the drum, and powerfully urges the flange 27c against the sealing ring 41, hermetically closing the central opening of the cover or front wall member 48.

Mounted at the end of the stud 26 is a separable clamp 37 which receives two vertical rods 34 mounted on gate members or radius bars 30. The assembly thus provided is pivotally supported by the brackets 33 which are fixed on the front lid or member 48, and which receive the pivot shaft 34a. Bearing bushings 32 are provided, for continuous lubrication. Stop sleeves 31 are provided to maintain proper vertical adjustment of the part. The collar 36 is effective to maintain the support of a portion of the weight of the lid assembly upon the upper gate member or radius bar 30.

It will be understood that means below described are employed to exhaust air from the space within the cylinder 22 and the front member 48.

The shaft 1, upon which the drum or tumbling member 54 is supported, is secured by a plate or disc 16 which is fastened to the inner face of the wall 54a by any suitable securing means. An outer cover plate 19 is provided to surround the end of the shaft 1 and to protect the fabric being tumbled from whatever securing means are employed. As shown in Figure 4, I illustrate screws 16b which are of such size and shape as not to damage the articles being tumbled.

With reference to Figures 3 and 4 the shaft 1 is provided with two longitudinally extending canals 1b and 1c, these canals having drilled connections or apertures 1d and 1e at the end of the shaft engaged by the plate 16. These communicate with similarly drilled holes 1f and 1g in the plate 16, as shown in Figure 5 to provide inlet and outlet for the refrigerant which is to be condensed within the space 23 of the condenser 24, 24a.

The flanged plate 16 is held, by any suitable means, against rotation in relation to the shaft 1; the clearance between the member 16 and the shaft 1 is sufficiently small so that there is only a minute leakage of refrigerant passing through the above connections. It is of vital consequence that there be no leakage of refrigerant to the evacuated chamber surrounded by the evaporator 22 and the lid or cover 48. I therefore provide resilient packing rings 18, as shown in Figure 4, which surround any suitable shaft portion 1m, of reduced diameter. The seal is maintained by the sliding ring 17 on the portion 1m, which is locked in position by the castelated nut 21 threaded on the extension 1m, tightly screwed into position, and held for example by a cotter pin 21b.

The shaft 1 also carries an enlarged double faced shoulder member 1h which is preferably integral with the shaft 1, is of hard material, and has its opposite faces perpendicular to the axis of the shaft 1. These faces are plane and smooth, to a limit of the order of three millionths of an inch. Engaging with the opposite faces of the member 1h are sealing rings 91 and 91b, of any suitable long wearing self-lubricating and non-porous material. The opposite sides of the sealing rings have a surface which constitutes the truncated segment of a sphere, as will be clear from Figure 4. One segmental surface bears against a soft ring 90 which is supported in a conical socket or aperture in the member 85. The other is opposed to a similar soft ring 90a which is provided with an outward extension 90b abutting against the inner face of the evaporator end wall 22. It will be understood that said end wall 22 is suitably apertured. The seal portion 90b is held against the opposed part of the wall 22 by any suitable conic socket plate 89. The parts are locked together by screws 87 which pass also through a reinforcing ring 88 and are provided with heads 87a and nuts 87b. Since it is desired to have a rigid mounting, six of the screws 87 may be employed, and the reinforcing ring 88 is of substantial diameter and thickness. The supporting bearing member 85 has opposite conical sockets one of which receives the soft ring 90 and the other the corresponding and opposite soft ring 90c, opposed to the sealing ring 91c. The sealing ring 91c has an outer bearing face opposed to the thrust member 11 which is in the form of a ring having a highly finished plane surface perpendicular to the axis of the shaft 1. The ring is axially thrust toward the above described sealing assembly by a packing ring 12 provided with a packing 13. The packing ring 12 is thrust into position against the packing by the pressure of the coil spring 14, one end of which presses against the packing ring 12 and the other against a groove 92a in the driving wheel 92. The wheel 92 is rigidly secured to the shaft 1, for example by the taper pin 93. The member 85 is also supported on the screws 87 by ears or flanges 86a on the sockets 86. The center of the radius of the circumferential surface of the bearing member is maintained strictly on the axis of the shaft 1, but a limited angular movement of the member 85 and the shaft 1 is permitted. The socket members 86, which support the member 85, are held in position by means of positioning springs 15 which are compressed between the nuts 87b and the washers 87c held by the castelated nuts 87d on the screws 87. This spring restraint permits limited axial movement of the

sockets and bearing upon the screws 87 while providing a firm support for the bearing member 85.

The bearing member 85 is provided with internal grooves 85b and 85c connected respectively to the ducts or tubes 94 and 94b, which form part of the duct system for the below described refrigeration unit. As shown in Figure 4 the groove 85b connects to the interior of the sealing ring 91b, and therethrough to the aperture 1j. This aperture is drilled to the passage 1c and communicates thereby through the shaft aperture 1e and flange aperture 1g and the condenser duct 23b to the condenser space or coil 23.

The groove 85c is connected to the inside of the sealing ring 91c and thereby with the aperture 1k to the channel 1b. Thus is provided a connection to the aperture 1f in the flanged member 16 which communicates with the condenser duct 23c and therethrough to the condenser space or coil 23, thus providing an inlet tube and an outlet from the condenser, the flow being in the direction of the arrows as shown in Figure 4.

The sealing ring 91c has a ring face which is in contact with the highly finished face of the plane ring 11, the plane ring being finished and smoothed to the order of three millionths of an inch.

Any temporary or permanent deformation of the soft rings 90, 90a and 90c will be accompanied by the longitudinal movement of the various elements between the double faced shoulder 1h and the wheel 92, the expansion of the spring 14 being effective as a takeup means. At the same time the parts will be properly and tightly positioned in relation to the end wall 22 by the springs 15. However rotary motion of the shaft 1 is permitted, but with a closure so tight that a partial vacuum may be obtained in the interior of the tumbling chamber.

It will be understood that the chamber formed within the evaporator 22 and its end wall and the front 48 and its closure constitutes a completely enclosed chamber from which air may be evacuated. I provide for example a vacuum pump 49 driven by a motor 50.

The tumbling barrel 54 may be rotated through the wheel 92, by any suitable drive, from the motor 55 through a speed reducing means 55a. Both motors, together with the pump 49, and the drives involved, are housed within the outer housing 58.

Permanently secured to the lid 27 is a perforated closure 28, adapted to retain in the barrel or tumbler 54 the material being tumbled therein, while permitting a free flow of vapor from within the chamber.

Stated generally, I provide a tumbling area within the condenser 22, in which the articles to be dried are positioned while still wet. They are therein subjected to or maintained in a rarified atmosphere by the operation of the vacuum pump 49, connected to the interior of the housing by the suction pipe 490, effective to reduce the pressure of the space involved to less than the atmospheric pressure. The goods being tumbled are subjected to the tumbling action caused by the rotation of the drum 54 by the motor 55. However the drum is lined by the condenser of a refrigeration system which includes the motor compressor unit 56.

Evaporation of the refrigerant takes place, in response to the operation of the motor compresser unit 56 operated by the motor 57. Evaporation of the refrigerant begins within the annular

space 22b thereby chilling the cylindrical evaporator 22. The heat of evaporation is carried by the vapor issuing from the evaporator chamber, to the compressor 56, where it is compressed. The compressed gas is conducted along the tube 94b, to the bearing member 85, to the groove 85c, through ducts 1k, 1b, 1d, 1f and 23c, into the space 23 in the lining or condenser member 24. The heated gas there comes in contact with the circumferential condenser wall 24 traveling in a tortuous passage completely around the wall or liner 24, and returning by means of the tube or duct 23b, the ducts 1g, 1e, 1c and 1j to the groove 85b and the duct 94. Then it passes by means of the groove 85b and the duct 94 to the expansion valve 94c, where the pressure is reduced and the liquid is returned for evaporation to the interior of the cylindrical evaporator member 22. The nature of the tortuous passage through the evaporator 22 is illustrated in Figure 9, where the liquid refrigerant admitted to the central top inlet passage 22x flows in opposite directions about the cylindrical evaporator to escape from the opposite bottom outlet aperture 22y, one half of which is shown at each end of Figure 9. The passage of the refrigerant through the condenser is similarly illustrated in Figure 10, from the inlet passage 23c to the outlet passage 23b. Thus it passes almost completely around the cylindrical condenser structure.

By means of this procedure, the heat required to bring the moisture in the clothes to the temperature of vaporization and the heat of vaporization are supplied by the metallic lining.

The vapors and their contained heat are then drawn by the vacuum pump through the perforated closure 28 and brought into contact with the cylindrical evaporator 22 which reduces the temperature to a point below the dew point of the vapor. The moisture thereupon condenses upon the evaporator 22 and is accumulated at the bottom of the chamber formed by the evaporator 22, until the drying has been completed. The moisture, in condensing upon the surface of the evaporator 22, yields the latent heat of evaporation, which is absorbed by or transferred to the evaporator to cause the evaporation of the refrigerant within the interior evaporator space 22b. This heat is carried by the vapor of the refrigerant to the compressor 56. The identical heat, to which has been added the heat of compression from the compressor, is again led through the sealing members above described, to the condenser 23 and the metallic condenser lining 24, where the process is accumulatively repeated until the sensible moisture has been removed from the enclosure or surrounded space. Thereafter the dried clothes are removed by opening the lid 27, and the condensed moisture is released from the bottom of the chamber enclosed by the evaporator 22, by means of any suitable valved outlet 59.

I wish to emphasize that by relying upon the heat of the condenser to dry the article that is to be dried, and by relying upon the colder temperature of an evaporator to precipitate or congeal the moisture, I am able to dry clothes at substantially low temperatures which may, for example, under a sufficiently high vacuum be substantially below freezing. My invention, therefore, permits drying of delicate fabrics, such as rayon, at temperatures far below those at which such fabrics become spoiled. It is known, for example, that articles of rayon are likely to be ruined when subjected to the high temperatures of the clothes dryers of the type which take out the moisture by

means of a heating element or by the flow of heated air. To a somewhat less degree woolen fabrics are also subject to deterioration or shrinkage, when subject to heating during drying. Employing my method and apparatus I can remove moisture from fabrics at relatively low temperatures, even in some cases below freezing, and the moisture in suspension can be precipitated as frost upon the evaporator, and later removed.

While it is true that the temperature of a condenser of a refrigerator under atmospheric conditions cannot be reduced below that of the surrounding atmosphere, nevertheless, by the use of a sufficiently high vacuum I am enabled to reduce the temperature of the material below the freezing point. Even though heat is supplied for vaporization or sublimation, the important thing is that by bringing the vacuum down I may lower the temperature of the air and contents inside the housing 23 so that it will pick up water from the clothes by sublimation, and that moisture will be condensed on the evaporator, provided the temperature of the evaporator is, as it must be, below the temperature of the condenser 23.

I claim:

1. In a drier, an outer housing including a circumferential, generally cylindrical wall, a closed end wall, and an opposite end wall having a generally axial access opening, a refrigerant evaporator included in said cylindrical wall, a closure for said access aperture, means for closing it in substantially air-tight relation to said outer housing, an inner rotatable drier housing mounted for rotation within said outer housing about a generally horizontal axis generally concentric with the axis of the cylindrical wall of the outer housing, and means for rotating it, an access opening in said drier housing, co-axial with the access opening of the outer housing, said rotatable drier housing having a generally cylindrical circumferential wall in which a refrigerant condenser is included, an air pervious closure for the access opening of an inner housing, means for rotating the inner housing, and for thereby tumbling the articles undergoing drying while they are being heated by the refrigerant condenser, means for cycling a volatile refrigerant through said evaporator and condenser, and for thereby maintaining a relatively high temperature at said condenser and a relatively low temperature at said evaporator, means for withdrawing condensed moisture from the space within said outer housing but exterior to said inner housing.

2. The structure of claim 1 characterized by and including means for maintaining the air within said inner and outer housings at subatmospheric pressure.

3. In a drier, a tumbling element for articles to be dried, and means for rotating it about a predetermined axis, said tumbling element including the condenser of a refrigerating system, an outer housing in which said tumbling element is housed, an evaporator for said refrigerating system, surrounding but out of contact with the tumbling element, and in heat exchange relationship with air in said outer housing which receives moisture from the articles being dried in said tumbling element, and means for cycling volatile refrigerant through said evaporator and condenser, and for causing evaporation in said evaporator, and condensation in said condenser.

4. In a drier, a tumbling element for the articles to be dried, and means for actuating it, said tumbling element including the condenser of a refrigerating system, an evaporator for said refrigerating system, surrounding but out of contact with the tumbling element, and in heat exchange relationship with air which receives moisture from the articles being dried in said tumbling element, and means for cycling a volatile refrigerant through said evaporator and condenser, and for causing evaporation in said evaporator, and condensation in said condenser.

5. In a clothes drier, a cylindrical inner housing having a wall adapted to receive clothing, an outer housing enclosing, spaced from, and generally conforming to, the contour of the inner housing, a removable closure for the outer housing, an end wall of the cylindrical housing being ported in communication with the outer housing, a refrigerant system including a condenser in the wall of the inner housing and an evaporator in the wall of the outer housing, the wall of the inner housing being insulated from the air space between it and the outer housing.

6. In a clothes drier, a cylindrical inner housing having a wall adapted to receive clothing, an outer housing enclosing, spaced from, and generally conforming to, the contour of the inner housing, a removable closure for the outer housing, an end wall of the cylindrical housing being ported in communication with the outer housing, a refrigerant system including a condenser in the wall of the inner housing and an evaporator in the wall of the outer housing, the wall of the inner housing being insulated from the air space between it and the outer housing, a vacuum pump, a connection between it and the interior of the outer housing at a point far removed from the port joining the inner and outer housings, and means for withdrawing condensed liquid from the outer housing.

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