

March 30, 1926.

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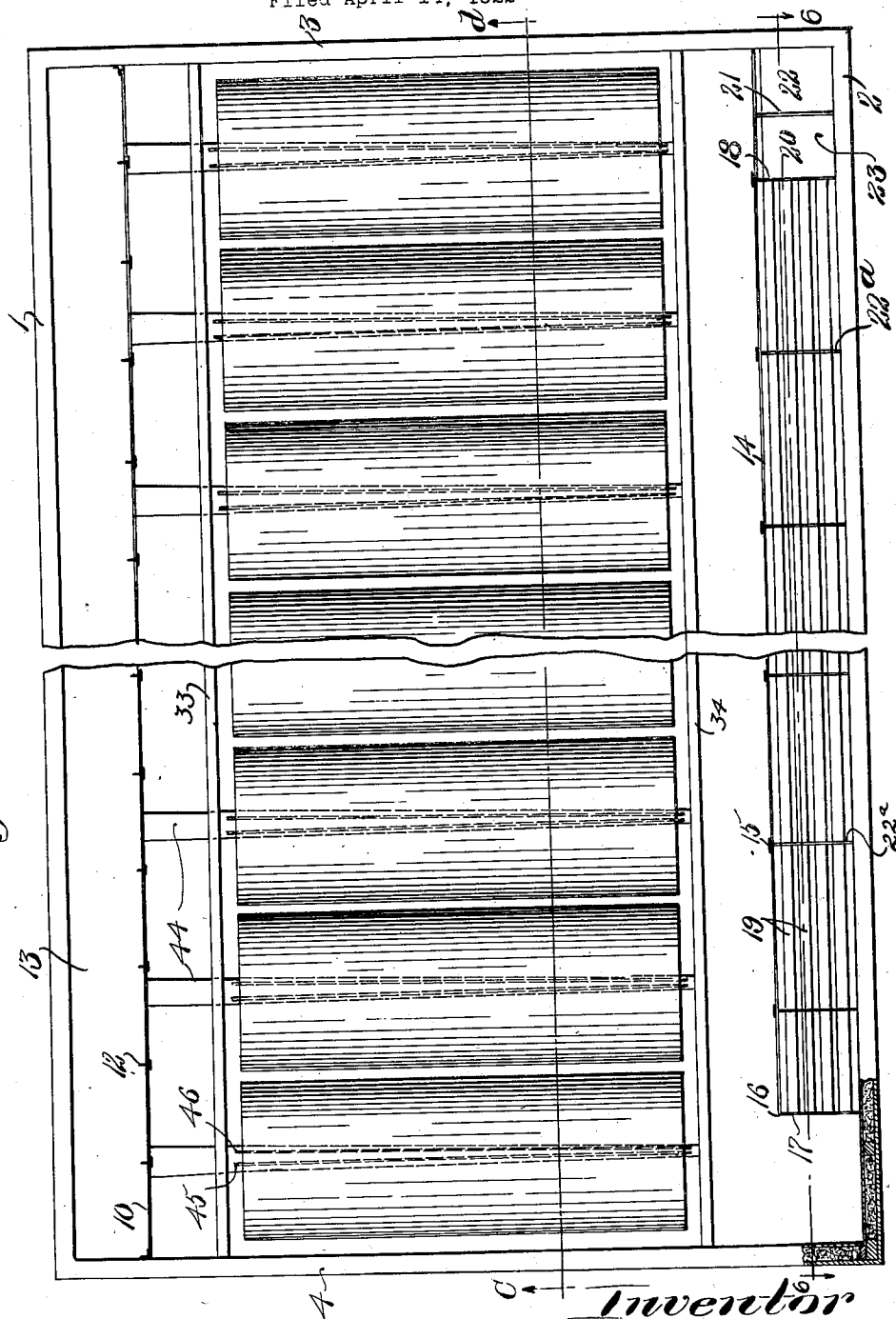
J. H. WALSH

PROCESS OF AND APPARATUS FOR DRYING FABRIC WEBS

Filed April 14, 1922

4 Sheets-Sheet 1

Fig. 1



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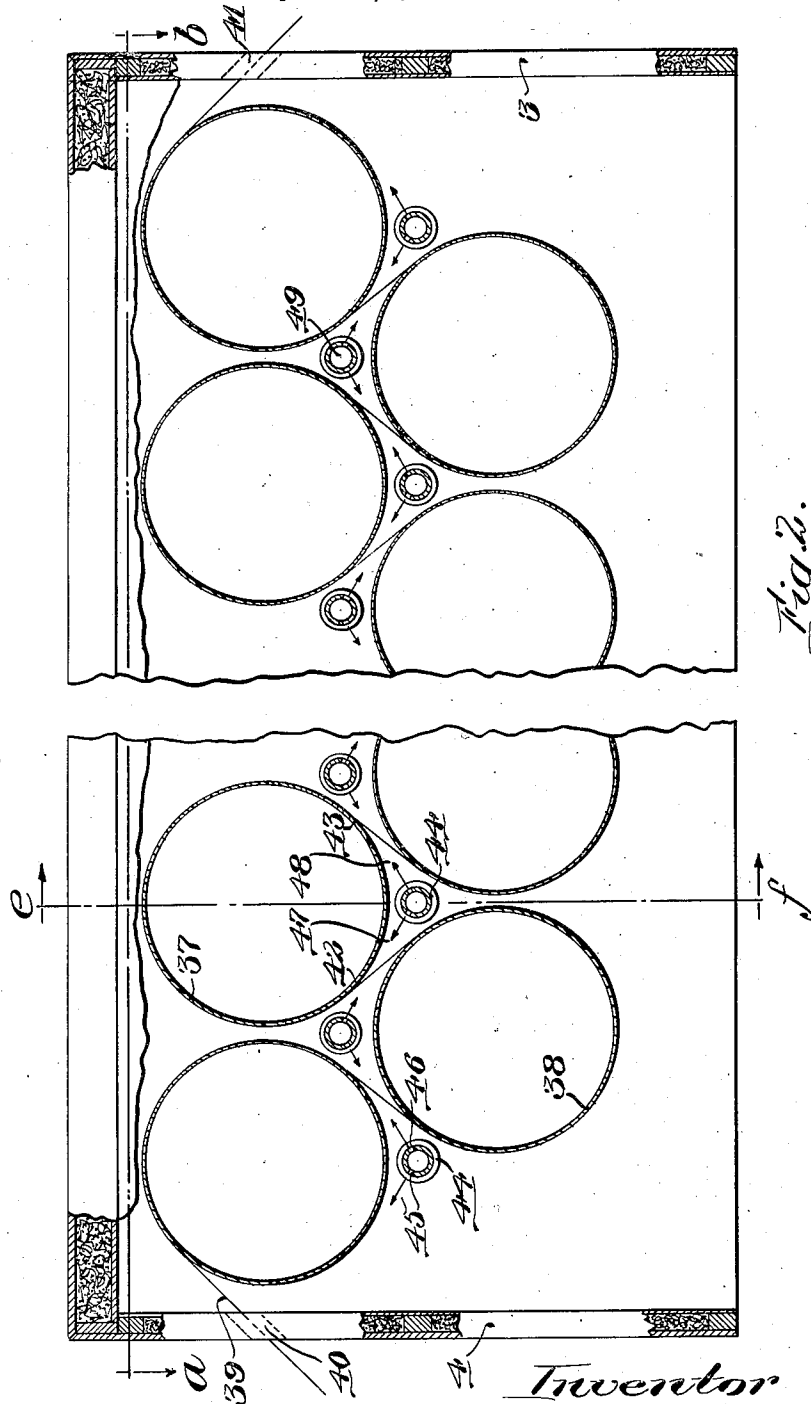
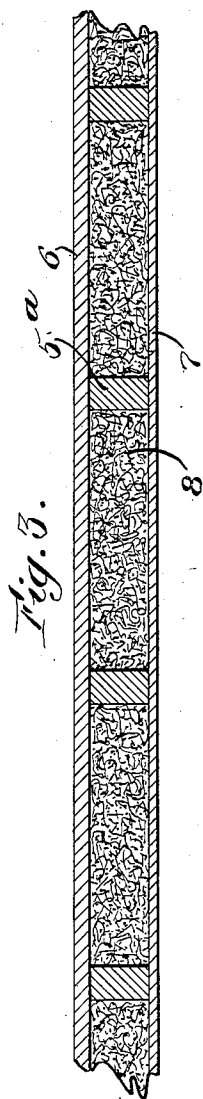
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4 Sheets-Sheet 2



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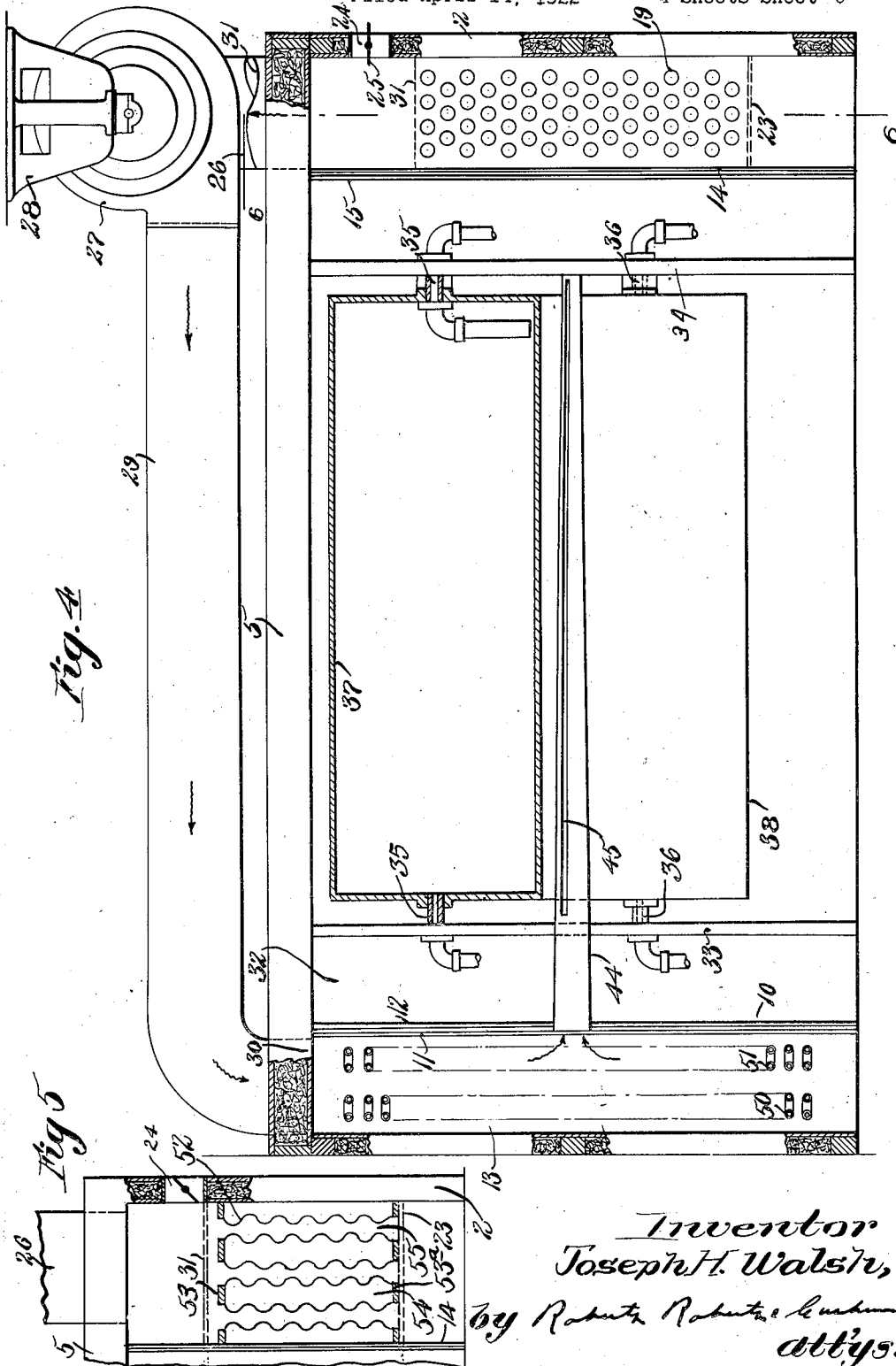
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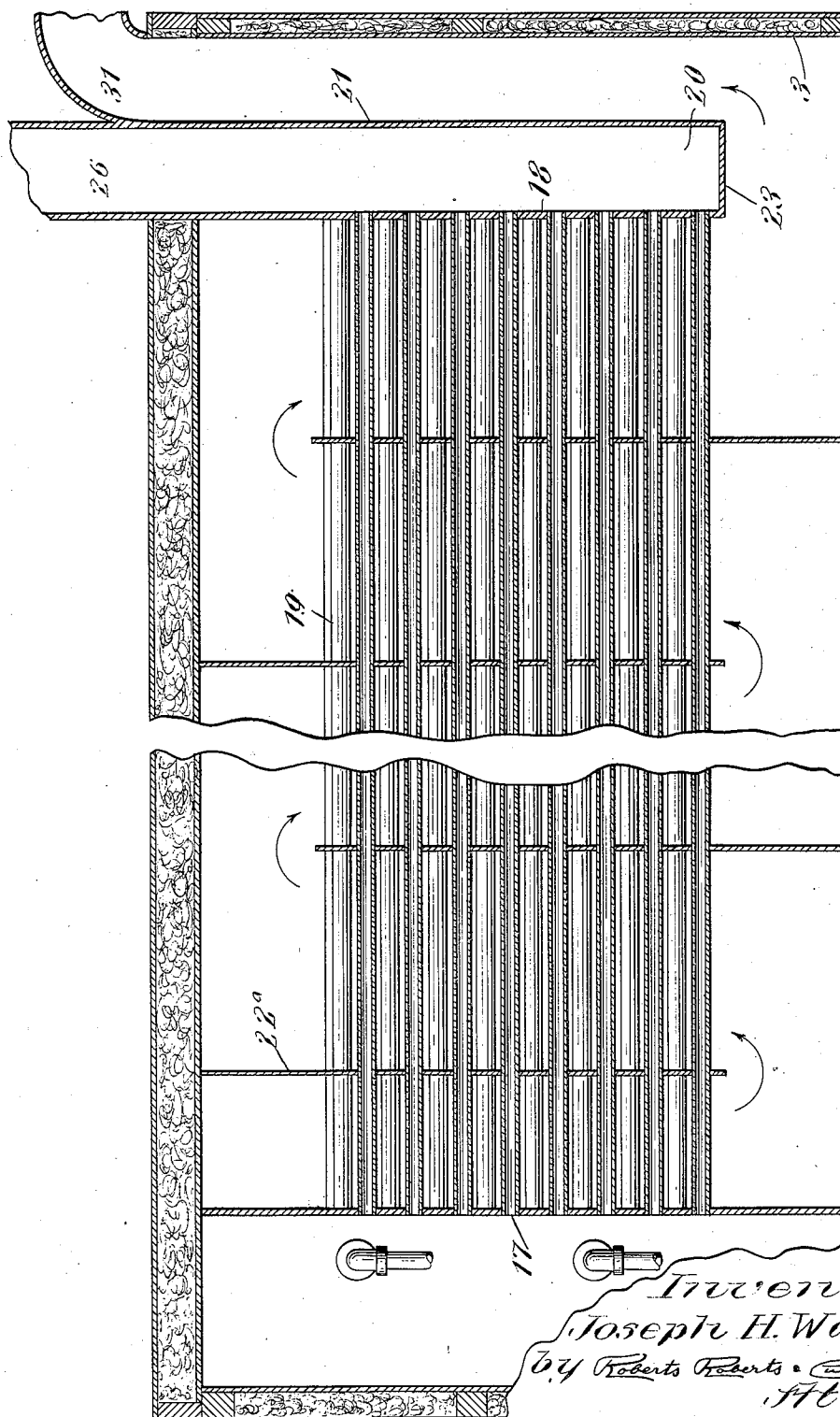


Fig. 6

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UNITED STATES PATENT OFFICE.

JOSEPH H. WALSH, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO JOHNS-MANVILLE, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

PROCESS OF AND APPARATUS FOR DRYING FABRIC WEBS.

Application filed April 14, 1922. Serial No. 552,723.

To all whom it may concern:

Be it known that I, JOSEPH H. WALSH, a citizen of the United States of America, and resident of Boston, in the county of Suffolk and State of Massachusetts, have invented new and useful Improvements in Processes of and Apparatus for Drying Fabric Webs, of which the following is a specification.

This invention concerns the art of drying, and relates more particularly to improvements in a process of drying material in the form of a continuous strand or web and to an apparatus for use in carrying such process into effect in which the web of material to be dried is caused to travel through a tortuous path alternately passing over and under hollow cylinders or "cans" which are maintained at a relatively high temperature, and by contact with which the material is dried. As a usual practice the cylinders or "cans" are heated to a high temperature by steam admitted to their interiors and this temperature is necessary to the complete expulsion of the moisture from the material as the latter passes through the apparatus. Damage from too great heating in such driers is frequent, and particularly noticeable in the case of textile fabrics, such as woollens, the fibers of which may be disarranged locally by the sudden generation of steam from the moisture contained therein. Goods so treated are regarded in the trade as inferior to air-dried materials, and thus, even though in other respects carefully and skillfully fabricated, such goods are unable to compete in the open market with those which have been air-dried. The drying of material by the above method is moreover extremely uneconomical of heat for several reasons, among which may be noted the fact that for the thorough drying of the material in the limited time available the temperature of the heating drums or cans must be kept relatively high, necessitating the employment of a very considerable quantity of steam. Furthermore, the moisture expelled from the material tends to cling more or less to the surface, where it is readily reabsorbed, while at the same time such expelled moisture increases the humidity of the drying chamber so that the difficulty of further evaporation is greatly increased. Another and important loss in economy results from the fact that the latent heat of the moist air of the drying room is usually entirely

wasted by exhausting it directly into the outer atmosphere, while fresh air, having a relatively low temperature and consequently a great heat absorbing capacity, is drawn in to take its place. In many establishments, as for example those devoted to the manufacture of paper, the total quantity of heat thus consumed in the drying room is truly enormous and may constitute a very substantial part of the total heat consumption of the plant.

Objects of the present invention are accordingly to provide an improvement in that method of drying material in continuous web or strand form wherein the temperature of the material is raised by direct contact with a heated surface, together with apparatus suitable for carrying such process into effect, of such a character as to permit of the rapid drying of the material at a temperature so low as to avoid scorching or other appreciable damage, and to effect a substantial economy in the quantity of heat consumed in the process.

This object may well be attained by maintaining the heating drums or cans at a much lower temperature than that commonly employed, and preferably substantially below the boiling point of the liquid with which the material to be dried is moistened, while supplementing the drying action of the drums by jets or blasts of air directed against the material and preferably into the included angles between the drums and the web of material approaching or leaving same. Preferably the air so directed into proximity to the material is given a preliminary treatment whereby its relative humidity is decreased, as for example by actually removing some of the moisture therefrom, or by heating it, or both, such treated air, in passing in contact with the material, serving to remove moisture therefrom by direct absorption and at the same time serving mechanically to carry away moisture expelled from the material on contact with the heated drums. In this manner the relative humidity or vapor pressure in the drying room is prevented from rising to a substantial degree so that vaporization takes place at a lower temperature than usual, thus permitting the heat of the cans or drums to be correspondingly diminished without substantially increasing the duration of the drying process. In some cases the heating

of the drums, (or of the preliminary or first drums) by steam may be entirely dispensed with, as the incoming air jets, if sufficiently heated, serve to raise the temperature of the web on the metallic drums to the desired point. If desired, the air jets may have a temperature substantially greater than that permissible in the drums without occasioning damage to the goods, as the heat of the air jet is quickly dissipated and the movement of the fabric is such that the latter does not remain in contact with the heated jet long enough to sustain any appreciable damage.

Preferably, and as conducive to economy in operation, the air delivered from the jets or nozzles of the apparatus is pre-heated in part at least by causing it to pass in heat transferring relationship to the warm, moisture-laden air discharged from the drying chamber.

The accompanying drawings illustrate by way of example an apparatus suitable for use in attaining the above objects, and in said drawings,—

Fig. 1 is a horizontal section on the line *a—b* of Fig. 2, certain parts being broken away;

Fig. 2 is an elevation partly in vertical section on line *C—d* of Fig. 1;

Fig. 3 is a fragmentary horizontal section to enlarged scale through the side wall of the housing in which the apparatus is enclosed;

Fig. 4 is a transverse vertical section on a line such as *e—f* of Fig. 2;

Fig. 5 is a cross section, illustrating a modified form of economizer construction; and

Fig. 6 is a vertical section substantially on the line *6—6* of Figs. 1 and 4.

The drying apparatus preferably includes a housing or enclosure comprising the side walls 1, 2, the end walls 3, 4 and the top wall 5. While in accordance with the broader aspects of the invention these walls may be formed of any desired material, and in any known manner, it is preferred to employ heat-insulating material. As illustrated, for example in Fig. 3, the stud members 5^a serve to support an outer sheathing 6 of wood or other suitable material and an inner sheathing 7 of "asbestos wood" or the like. If desired, the space between the outer and inner sheathings may be filled with heat-insulating material 8, such for example as asbestos fibre, or sheets of air-cell asbestos. Preferably also the top wall 5 is somewhat thicker than the side and end walls although this is not essential. Within the housing or enclosure, and spaced from one of the side walls, as for example the wall 1, is a vertical partition 10, preferably comprising a sheet of asbestos wood 11 (Fig. 4) supported upon vertically disposed angle irons 12,

and serving to set off a plenum chamber 13. Spaced from the opposite wall of the housing is a similar partition 14 carried upon angle irons 15, this partition, however, stopping short of the length of the housing at the point 16, Fig. 1. A transverse partition 17 serves to close the space between the wall 14 and the side wall 2 of the housing. A similar transverse partition 18 is arranged parallel to the partition 17 at a desired distance from the other end wall 3, of the housing, the several partitions 14, 17 and 18 defining an economizer chamber. The partitions 17 and 18 are provided throughout their central portions with a plurality of aligned openings within which are fitted the opposite ends of parallel open-ended economizer tubes 19. These tubes are preferably of relatively thin metal or other suitable material having high heat-conducting capacity. The tubes 19 at one end open into the interior of the housing through the partition 17, while at the other end such tubes open into a vertical flue 20, which extends between the partition 18 and a second partition 21 arranged parallel thereto. The partition 21 also serves to define a second vertical flue 22 between such partition and the end wall 3 of the housing. The last-named flue extends from the bottom to the top of the housing; while the flue 20 is closed at its lower end by a plate 23, Fig. 4, lying in a plane immediately below the lowermost of the tubes 19. It will thus be apparent that the flue 20 communicates with the interior of the housing only by means of the tubes 19, while the flue 22, which extends substantially to the floor of the housing, communicates freely with the space surrounding the tubes 19. If desired, a series of transverse baffle plates 22^a may be provided which compel the entering air to move downwardly to the bottom of the stack of tubes before it can move laterally toward the flue 22. At the upper portion of the wall 2 there are provided one or more openings 24 leading into the space above the tubes 19, and such openings may be controlled by means of damper members 25 or in other desired manner.

The upper end of the flue 22 is connected, as by means of a pipe 26 to the intake side of an exhaust fan 27 mounted upon a bracket 28 or other suitable support. The delivery end of the fan 27 is connected with a pipe 29 which communicates at the point 30 with the upper end of the plenum chamber 13. From the upper end of the flue 20 a pipe 31 may extend to any desired point, as, for example, the outside atmosphere, although in accordance with the present invention it is preferred to extend such pipe to some point where warmed and moistened air may be found useful. If the drying apparatus herein described is employed in a textile mill for drying the finished material,

the pipe 31 may lead to the weave room for delivering warmed and moistened air thereto.

The space between the partitions 10 and 14 constitutes a main drying chamber 32 of the housing, within which a pair of parallel vertical frames 33 and 34 are arranged. These frames are of any suitable construction to support the trunnions 35, 36 of upper and lower series of the drying drums or cans 37, 38. The trunnions 35, 36 are preferably hollow to permit the introduction and exhaust of steam or other heating fluid into and from the interiors of the hollow drums or cylinders in a manner well known in the art. The drums, or "cans" as they are commonly known in the art, of the upper series are preferably disposed vertically above the spaces between drums of the lower series and in such manner that the web 39 of material, which for example may be paper, textile fabric, or the like, which is to be dried and which may enter the housing through an opening such as 40 in the wall 4, is caused to travel alternately over and under drums of the upper and lower series respectively until it emerges from the housing through the opening 41. The preferred arrangement of the drums and web, as herein disclosed, is such that the web contacts with the outer peripheral surfaces thereof throughout arcs of more than a semi-circumference, the points of tangency of the web in approaching the drum and in leaving the drum as shown being substantially 90° apart, such points being indicated, for example, at 42, 43 respectively, and it will be noted that while one surface of the web contacts with the drums of the upper series, the other surface is brought into contact with the surface of the drums of the lower series, so that extensive contact with the hot surfaces and efficient drying action is secured. Within the spaces beneath the drums 37 and in parallel with the axes of the respective drums of the upper series are arranged nozzle tubes 44. These nozzle tubes are preferably tapered from one end to the other, the larger ends thereof being secured within openings in the partition 10, such larger ends being open while the smaller ends thereof are closed. These tubes are each furnished with a pair of nozzle slots 45, 46 respectively, such slots being preferably slightly tapered toward the small end of the tubes and being so disposed angularly of the tube as to direct the air discharged therefrom into the included angles 47, 48 respectively between the drum surface and the approaching and leaving portions of the web. Similar nozzle tubes 49 may be disposed in the space immediately above the drums 38, as indicated in Fig. 2. Within the plenum chamber 13 there are arranged one or more stacks of heating pipes or coils 50, 51, respectively,

such coils being supplied with steam or any heating medium from other suitable sources.

The operation of the device is substantially as follows, it being understood that the web 39 enters through an opening 40, passes over and under the respective rolls or drums, and out through an opening 41, such web being caused to move by means of exteriorly disposed driving rolls, not shown, or by rotating the drums by power, as may be found desirable. The drums may be heated by admitting steam to their interiors through their hollow trunnions, but preferably the temperature of such drums will be maintained somewhat lower than is usual in similar apparatus and below the boiling point of the liquid with which the material to be dried is moistened. The fan 27 being set in motion draws air upwardly from the flue 22 and discharges it through the pipe 29 into the plenum chamber 13. Such air in passing over the coils 50, 51 is raised in temperature to the desired degree and then passes out through the tubes 44 and is discharged through the slots 45, 46 into the spaces beneath the drums 37 and above the drums 38, if desired. It will be evident from the position of the discharging nozzles, that the warmed air contacts directly with the web at those points where such web approaches and leaves the drums, while at the same time the warmed air is brought into contact with the surfaces of the drums themselves. The surface of the drum is thus freed from any moisture which it may carry in moving away from the web, as at the point 43, while at the same time the surface of the web to which a certain amount of vapor may cling, due to the action of the heated drum immediately preceding; is swept free of such vapor by action of the air current issuing from the nozzle opening. The drying action of the drums is thus facilitated by the employment of the warmed air blast at the point indicated, and furthermore, such blast may be heated to a high temperature, if desired, so that the air of such blast possesses a relatively high capacity for the absorption of moisture enabling it to abstract moisture from the web very rapidly. By reason of the movement of the web and the rapid movement of the air from the jet, there is little if any danger of damage to the fabric by overheating the same such as frequently occurs when it is attempted to employ drums heated to a similar temperature. The warm air escaping from the nozzles and after contacting with the surface of the web and drum passes downwardly between the lower rolls or endwise through the frame members 33, 34 and into the main body of the drying chamber 32. As the fan continues to force air into the drying chamber, this warm and moisture-laden air, which passes out from between

the rolls, tends to escape through the tubes 19 of the economizer device hereinbefore described. Such air passes lengthwise through the tubes, warming them, and then escapes up through the flue 20 and passes on through the pipe 31 to any desired point of use. As the fan 27 draws air up through pipe 26 through the flue 22 fresh air is caused to flow inwardly through openings 24 and downwardly between the pipes 19 toward the lower end of the flue 22 where it is permitted to enter the same. In passing over the pipes 19 such fresh air is warmed to a very considerable degree, the outgoing air passing through the pipes 19 parting with a portion of its heat, so that a very substantial economy of heat is secured. The operation thus continues as the web is drawn through the apparatus, the additional heat necessary for bringing the air jets to the desired temperature being furnished by the coils 50 and 51, as above described. In some cases it may be found that such coils are unnecessary providing the cylinders 37, 38 are maintained at a sufficiently high temperature. In certain instances, however, it may be found desirable to dispense with the heating of the cylinders by the admission of heated fluid to the interiors thereof, and to depend upon the heat of the air jets for imparting the desired temperature to such cylinders. In such case the coils 50, 51 are obviously necessary, and the temperature of the air, prior to its discharge from the jets may be raised thereby to a relatively high degree, it being noted that the cylinders tend to conduct away the heat of the jet very rapidly and to impart such heat to the web which lies in contact therewith throughout a very substantial portion of the length thereof, while at the same time the flow of air from the jets serves to carry away moisture directly from the adjacent portion of the web. Although a preferred form of the invention has been described hereinabove, it is to be understood that such invention in its broader aspects might be embodied in different forms of apparatus and that modifications in the shapes and arrangements of parts, as well as the dimensions thereof and the materials employed may well be made without departing from the spirit of the invention.

Under some circumstances and particularly where corrosive fumes arise from the material in drying it may be desirable to construct the economizer device in a manner somewhat different from that above described. As shown in Fig. 5 for example, in place of the tubes previously referred to the economizer device comprises a series of thin vertical partitions 52 arranged within the economizer chamber and extending longitudinally thereof. Such partitions are preferably of corrugated material and if desired

may be of sheet asbestos, enameled metal or some other substance which is resistant to the corrosive effects of acids or other chemical substances which may be carried by the vapor evolved in the drying process. These partitions are connected in pairs by upper and lower members 53, 53^a respectively, whereby longitudinal passages 54 are formed, such passages being open at their ends where the partitions 52 are secured to the edges of slots formed in the partitions 17, 18 previously described. The passages 54 alternate with vertical flues 55 closed at their opposite ends by the partitions 17, 18 respectively but open at the top and bottom. The passages 54 correspond to the tubes 19 of the previously described economizer device while the flues 55 correspond to the spaces between the tubes of the aforesaid device. The flues 55 communicate at their lower ends with the space leading to the flue 22 while at their upper ends they communicate with the space into which the air inlet duct 24 opens. The ends of the passages 54 communicate respectively with the flue 20 and with the drying chamber. By the employment of the corrugated partitions a very large conductive surface is provided for the transfer of heat so that it is possible to employ a material having a relatively low conductivity and at the same time permitting the manufacture of such partitions from corrugated sheet material by a stamping or similar process.

What I claim is:

1. That process of drying webs of textile fabric which comprises passing such a web through a heat insulated housing and during its passage alternately subjecting the web to the drying action of a blast of heated gaseous fluid of substantially uniform intensity transversely of the web and to that of a heated solid with which the web is caused directly to contact.

2. That process of drying material in the form of a continuous web which comprises passing such web alternately over and under rotary drums arranged in series in a heat insulated housing, drawing air from the space adjacent to said drums heating fresh air, and directing a blast of such heated air into the included angle between the surface of one of said drums and the approaching web.

3. A drying apparatus comprising a housing having a plurality of spaced, heat conducting surfaces therein constructed and arranged for successive engagement by the material to be dried, means for delivering heated air at points intermediate certain, at least, of said surfaces to absorb moisture from the material, means causing moisture laden air to flow from the housing, and heat exchange means for conserving a portion of the heat contained in such moisture laden air for further use.

4. A drying apparatus comprising a housing having heat insulating walls, a plurality of drying cylinders in said housing, air delivery nozzles interposed between certain of said cylinders, means for withdrawing
5 air from said housing, and means whereby heat from said outgoing air is imparted to air on its way to the nozzles.

5. Drying apparatus comprising a series
10 of heated drying drums, means for delivering blasts of air at points adjacent to certain of said drums, means for preheating such air blasts by transference of heat thereto from the hot, moist air arising from
15 said drums, and independent means for further increasing the heat of said blasts.

6. A drying apparatus comprising a housing for the reception of surface contact drying means, a passage at one side of said
20 housing, nozzles communicating with said passage and disposed adjacent to said surface drying means, an economizer device, and means for inducing a current of fresh air to flow in one direction through said
25 economizer device and into said passage for delivery from the nozzles while causing air from adjacent to said drying means to flow in the opposite direction through the economizer device.

7. A drying apparatus comprising a housing, a vertical partition at one side of said housing defining a plenum chamber, a series of nozzles within said housing and communicating with the plenum chamber, an
35 economizer device at the opposite side of the housing, said economizer device comprising a casing having a plurality of thin metallic walls defining passages extending longitudinally thereof, a flue for the ingress
40 of fresh air into the space between said passages, and an exhaust fan for drawing air from said space and delivering it to the plenum chamber whereby warm air from the housing is displaced and forced to flow
45 through the economizer device.

8. A drying apparatus comprising a housing having heat insulated walls, continuously moving heated surfaces within said housing for drying material by contact there-
50 with, means for withdrawing air from the housing and for inducing the entry of fresh air into the housing, such fresh air passing in heat transferring relationship to such withdrawn air, and a conduit leading from the housing for conducting away the with-
55 drawn and partly cooled air.

9. A drying apparatus comprising a housing having a plenum chamber, a drying chamber and a regenerator chamber, heated
60 drying drums within the drying chamber, air delivering nozzles interspersed among said drums and communicating with said plenum chamber, heating coils within said latter chamber, and means for inducing a
65 flow of fresh air through the regenerator

chamber, the plenum chamber and the delivery nozzles while causing the discharge of warm and moist air from the drying chamber and through the regenerator chamber.

10. A drying apparatus comprising a
70 housing having walls of heat insulating material, drying drums therein, a regenerator device having a plurality of substantially parallel flow passages and means for inducing a flow of fresh air through certain of said passages and into the housing at a point adjacent to said drums, said means thereby serving to force air from within the housing to pass outwardly through pas-
sages of the regenerator intervening between said certain passages.

11. A drying apparatus comprising a housing having a drying drum therein, means for guiding a moving web of material into contact therewith, and a nozzle tube having elongated air delivery slots positioned adjacent to that portion of the drum at which the material passes out of contact therewith, and substantially parallel to the axis of the drum, said tube being con-
90 structed and arranged to deliver blasts of warm air against the material on its passage to and its passage away from said drum.

12. An apparatus of the class described comprising a housing of heat insulating
95 material, means for supporting fabric therein, means for directing a current of heated air into contact with the fabric so supported, and an economizer device comprising a series of parallel passages separated
100 by thin corrugated partitions, and through alternate passages of which air is caused to travel in opposite directions in entering and leaving said housing.

13. In combination with a drying appa-
105 ratus, an elongate compartment having a plurality of substantially parallel, vertical partitions of sheet material defining a series of narrow passages between them, an inlet for fresh air communicating with alternate pas-
110 sages of said series, a discharge duct communicating with the opposite ends of said passages, and inlet and outlet passages communicating with the opposite ends respec-
115 tively of the other set of passages.

14. In combination a drying apparatus, an economizer device comprising sheets of corrugated material disposed in substan-
120 tially parallel relation, said sheets being connected in pairs at their longitudinal edges whereby to provide passages opening alternately at the ends of the device and at the top and bottom thereof.

15. In combination in a fabric treating
125 apparatus, a housing provided with a compartment therein having walls of heat insulating material, an economizer device in said compartment comprising a series of thin corrugated partitions defining a plu-
rality of substantially parallel, narrow pas-

sages, an air inlet communicating with alternate passages of said series at one end thereof, a chamber having heating means therein and communicating with the opposite ends of said passages, a fan for inducing the flow of air through said passages and heating chamber into said housing, and a passage leading from said housing to the other passages of said series, the parts be-

ing so constructed and arranged that air flowing into said housing moves through the passages of the economizer in a direction substantially transverse to the flow of outgoing air in the adjacent passages.

Signed by me at Boston, Massachusetts, this twenty-eighth day of January, 1922.

JOSEPH H. WALSH