Oct. 7, 1924. 1,510,615

J. H. WALSH

PROCESS OF AND APPARATUS FOR DRYING COMMINUTED OR SHEET MATERIAL

Filed April 14, 1922 4 Sheets-Sheet 1

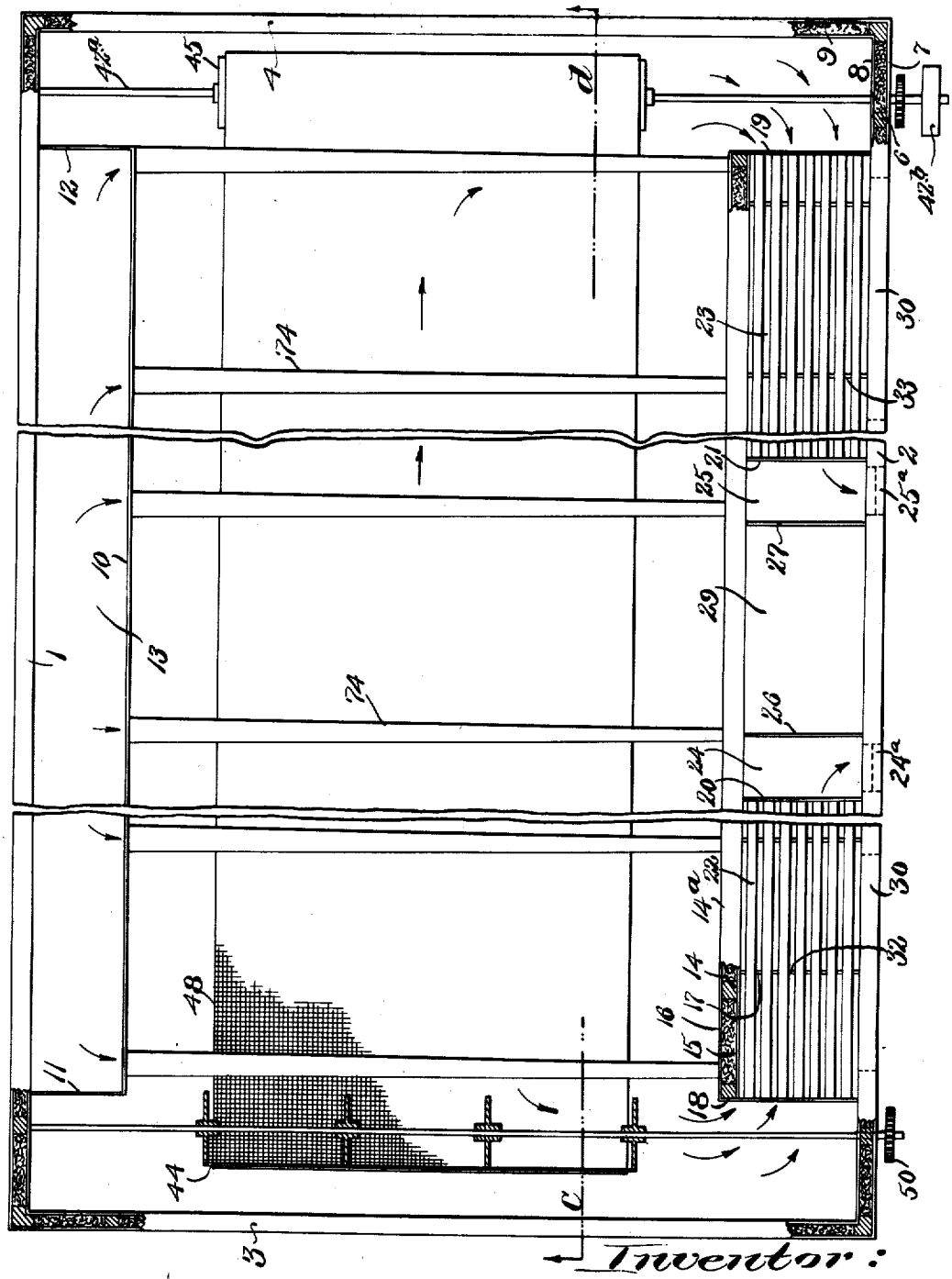


Fig. 1.

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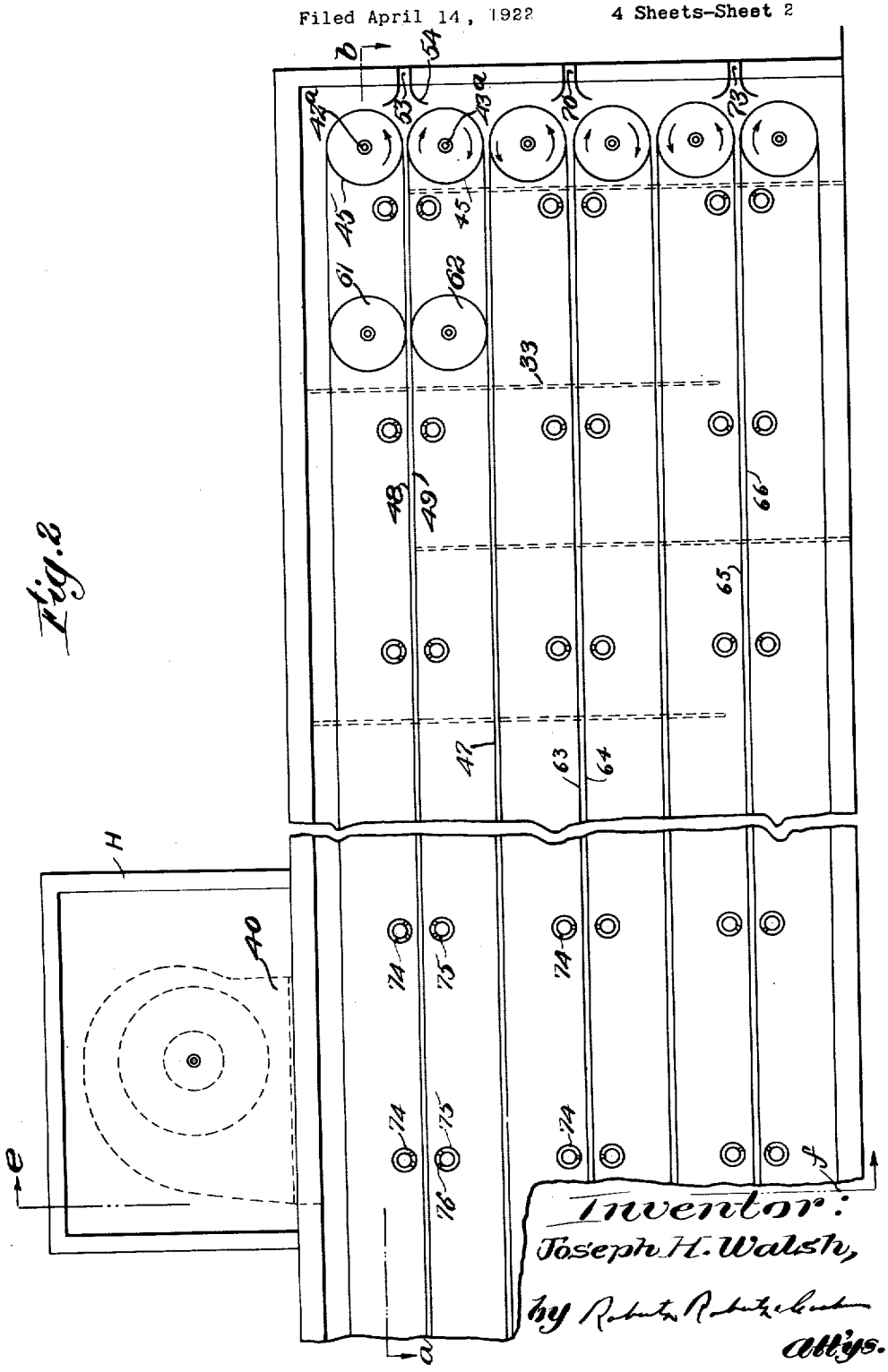


Fig. 2

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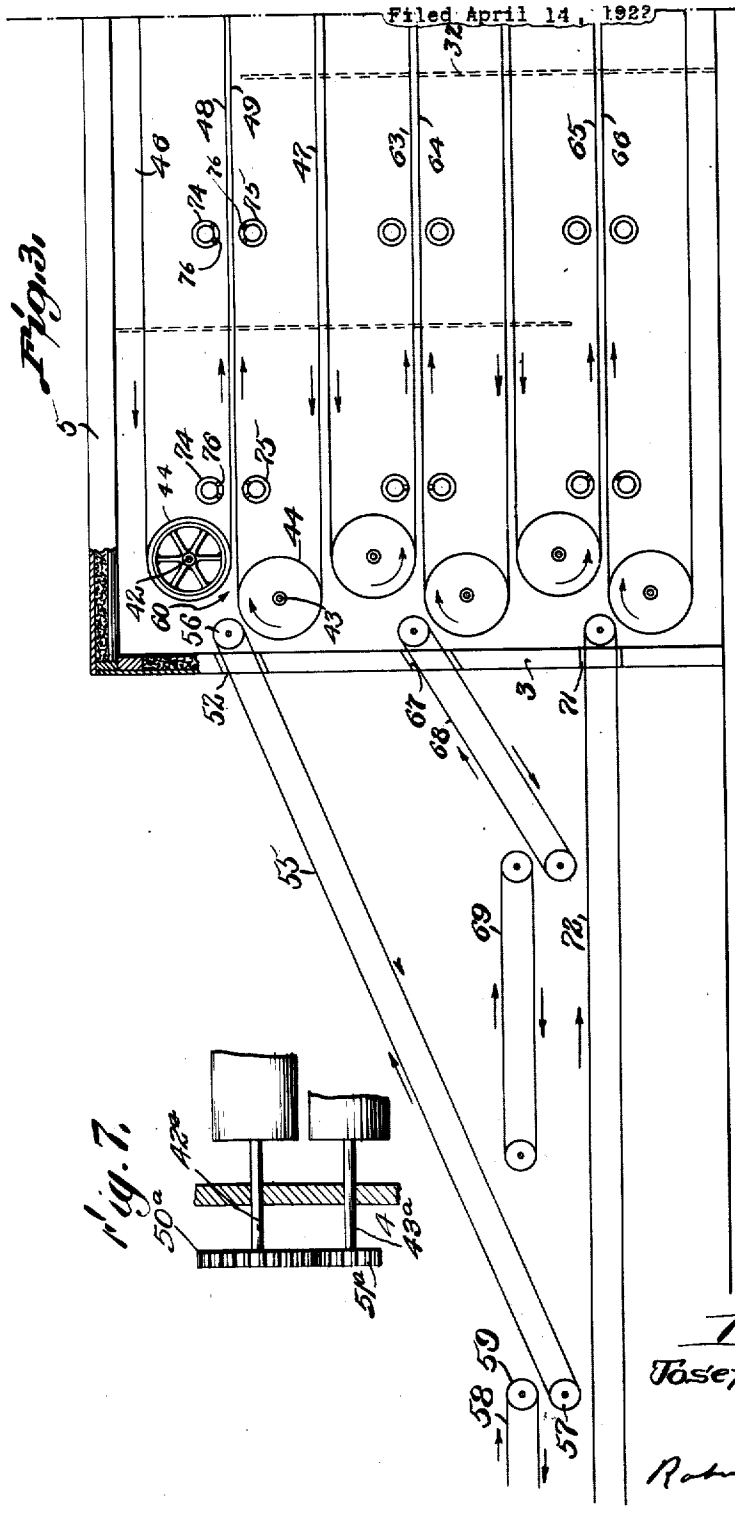


Fig. 3.

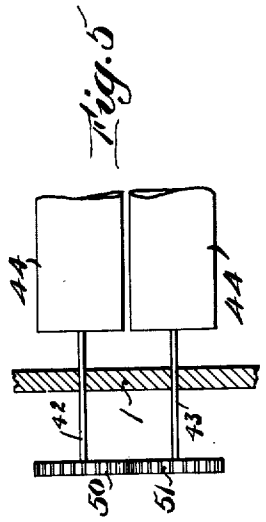


Fig. 5.

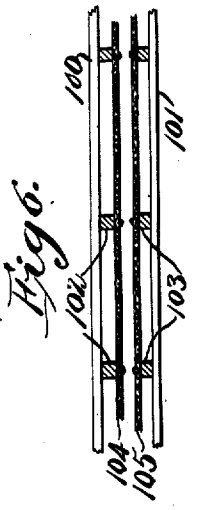


Fig. 6.

Fig. 7.

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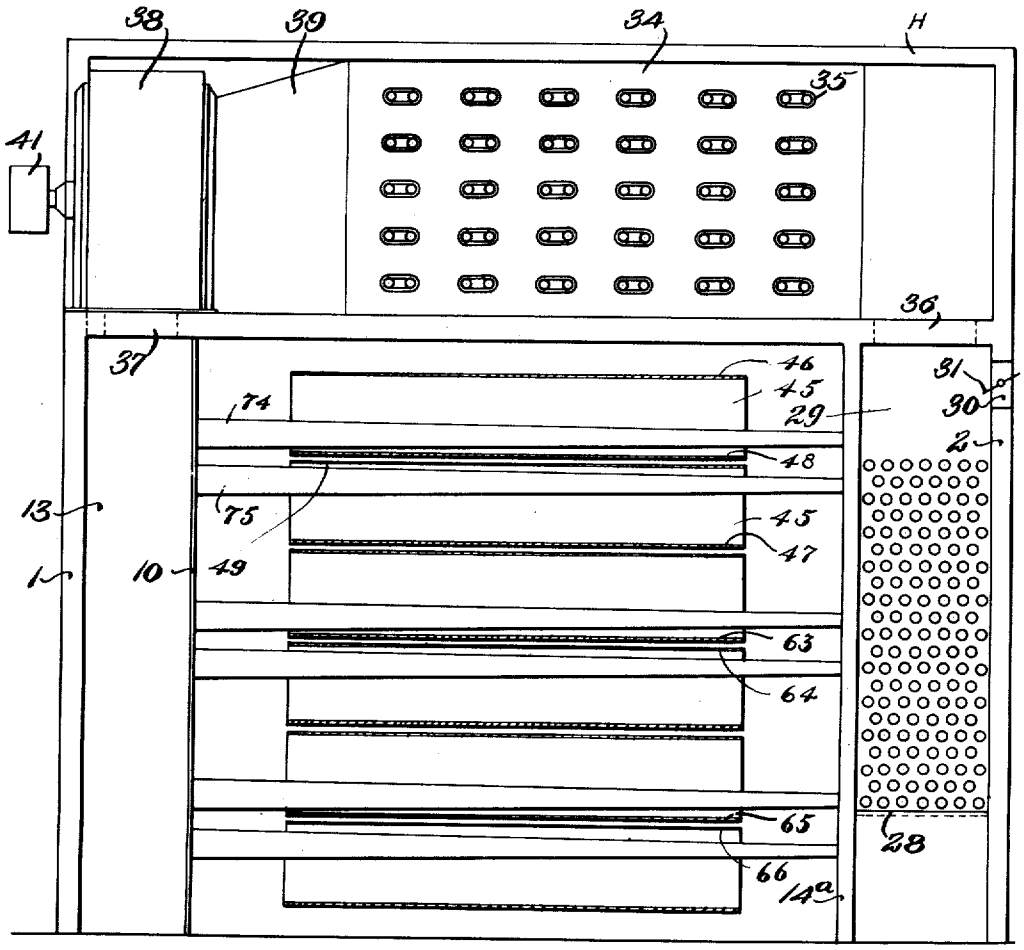
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PROCESS OF AND APPARATUS FOR DRYING COMMINUTED OR SHEET MATERIAL

Filed April 14, 1922 4 Sheets-Sheet 4

Fig. 4.



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Patented Oct. 7, 1924. 1,510,615

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 COMMINUTED OR SHEET MATERIAL.

Application filed April 14, 1922. Serial No. 552,724.

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 Imrovements in Processes of and Apparatus for Drying Comminuted or Sheet Material, of which the following is a specification.

This invention concerns a method of and apparatus for use in the drying of material and relates more particularly to a method and apparatus suitable for the rapid and economical drying of material arranged in a relatively thin layer, whether in sheet or comminuted form.

In the manufacture of leather board for example, the sheets of material in their wet state are enormously swollen by contained water and the rapid and economical removal of this water presents a problem of great difficulty. Commonly the sheets of wet material are spread for drying upon frames in the open air, but this method requires a large amount of space and necessitates great care in order to obtain uniform results under the varying conditions, both of temperature and humidity, existing in the outside atmosphere, while the shrinkage in drying often results in warping and curling of the product to such an extent as materially to decrease its value. With this method of drying, limitations of available drying space as well as weather conditions may determine the output of the plant and thus drying by artificial heat has been resorted to. When however, it has been attempted to dry such material by the use of heat, the difficulty of preventing warping and curling of the material has been greatly accentuated, while in the attempt to speed up the operation an injuriously high temperature has been frequently employed which not only damages the material but also consumes a large amount of heat. In the drying of comminuted or loose bulk material, further trouble is often experienced by reason of the difficulty of preventing such material from scattering or blowing away under the action of the air currents employed, as well as that of securing a uniform exposure of all portions of such material to the action of the drying medium.

A principal object of the present invention is accordingly to provide a method of and apparatus useful in the drying of material in thin sheets or layers, which will be adapted for material containing a relatively large amount of water or other fluid, and be of such a character as to permit of the rapid and uniform drying of such material without scattering or permitting a warp or twist to be set in the material, fabric or sheet being dried; and so devised as to permit drying large quantities of the material in a relatively small space without subjecting it to an injuriously high temperature, and to secure economy in the use of heat.

One embodiment of means suitable for carrying the invention into effect is illustrated by way of example in the accompanying drawings, in which—

Fig. 1 is a horizontal section of the apparatus, certain parts being broken away, on the plane indicated by the line *a—b* of Fig. 2, certain parts being shown in plan;

Fig. 2 is a longitudinal vertical section taken on a line such as *c—d* of Fig. 1 and showing one end of the apparatus, certain intermediate portions thereof being broken away;

Fig. 3 is a view similar to Fig. 2, but showing the opposite end of the apparatus;

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

Fig. 5 is a detail cross section illustrating certain drive connections; and

Fig. 6 is a fragmentary vertical section showing a modification, and

Fig. 7 is a view similar to Fig. 6 showing means for driving adjacent conveyors at different speeds.

The apparatus herein disclosed comprises a housing consisting of the side walls 1, 2, and the end walls 3, 4, such housing being provided with a top or roof 5. Preferably the sides and top of the housing are of heat insulating construction and may consist or studs or joists 6 serving to support an outer sheathing 7 of any suitable material and an inner sheathing 8 of heat insulating material. The sheathing 8 may be of "asbestos

wood" or any equivalent material, and interposed between the inner and outer sheathings there is placed a heat insulating filling 9 which may consist of asbestos fibre or air-cell asbestos board. The housing thus formed serves in an economical manner to prevent the escape of heat from within.

Extending longitudinally at one side of the housing, and spaced from the side wall 1 is a vertical partition 10 of desired length, the ends of the space included between the wall 1 and partition 10 being defined by the transverse partition members 11, 12. The space 13 thus provided serves as a plenum chamber mentioned below.

At a suitable point in the housing, and preferably at the side opposite the plenum chamber, there is arranged a second vertical partition 14^a which extends throughout a substantial portion of the length but stops short of each end of the housing. This partition 14^a is preferably constructed of heat insulating material and may comprise stud members 14, inner and outer sheathings 15, 16, of asbestos wood or the like, and a filling 17 of asbestos in any desired form. The space between the partition 14^a and the wall 2 of the housing serves for the accommodation of a pair of economizer devices, such space being closed at its opposite ends by the transverse partitions 18, 19, respectively. A second pair of partitions 20, 21 extend transversely across the space between the wall 14^a and the wall 2, and between the partitions 18, 20 and 19, 21 respectively extend series of substantially parallel open ended tubes 22, 23, such tubes being seated at their opposite ends in suitable openings in the corresponding partitions, and opening at their remote extremities into the opposite end portions of the housing. The adjacent ends of the tubes 22 and 23 open into vertical flues or ducts 24, 25, respectively, the adjacent walls of such ducts being formed by transverse vertical partitions 26, 27. The lower ends of the ducts 24, 25, respectively, are closed by plates 28 (Fig. 4) which lie immediately below the plane of the lower set of tubes 22, 23 respectively. The space between the partitions 26, 27 and the walls 14^a and 2 constitutes a duct 29 which communicates at its lower end with the space immediately below the tubes of each of the economizer devices. In the wall 2 above the upper side of the economizer tubes elongated openings 30 are formed, such openings being controlled by dampers 31 or in any other suitable manner. These openings communicate with the spaces surrounding the tubes of the respective economizer devices and permit the passage of fresh air inwardly and over the exterior surfaces of such tubes, such air passing downwardly and into the lower end of the duct 29. If desired baffle plates such as 32, 33 may be provided, such baffle plates extending transversely across the spaces surrounding the economizer pipes and serving to cause the incoming fresh air repeatedly to move transversely of the tubes 23. The wall 2 of the housing may also be provided with openings at 24^a, 25^a respectively, communicating with the flues 24, 25 whereby air passing up through such flues is permitted to escape to the outside atmosphere. It is evident that, if desired, pipes may be connected to the exterior of the housing for conveying air escaping through the openings 24^a, 25^a to any desired point.

At a point substantially central of the length of the housing, a secondary housing H, Figs. 2 and 4, is arranged on top of member 5 to provide a heating chamber 34 in which may be arranged heating coils 35 supplied with steam or other heating medium from any source. The heating chamber communicates by means of an opening 36 with the upper end of the duct 29, and at its opposite end opens at 37 into the upper part of the plenum chamber 13. Within the heating chamber 34, and preferably at one side thereof, is arranged a fan 38 having an intake hood at 39 and a discharge hood 40 aligning with the opening 37. This fan may be driven by a belt and pulley 41 or in any other desired manner.

At the opposite ends of the housing are arranged pairs of transverse shafts 42, 42^a; 43, 43^a respectively, such shafts being suitably journalled in the side walls of the housing. These shafts carry drums such as 44, 45 respectively, serving for the support of endless belt conveyers 46, 47. The conveyer 46 is arranged directly above conveyer 47, and in such manner that the lower run 48 of the conveyer 46 extends substantially parallel to the upper run 49 of the conveyer 47, such runs being spaced apart a distance substantially equal to the thickness of the layer or sheet of material to be dried. These belt conveyers are of a width to extend throughout a substantial portion of the space between the plenum chamber 13 and the economizers, and serve to convey the material to be dried from one end of the housing to the other. The conveyers are so actuated that the adjacent runs 48, 49 thereof move in the same direction and for this purpose the shafts 42, 43 may be extended through the side wall 1 of the housing and may have intermeshing gear wheels 50, 51 fixed thereupon. If it be desired that the runs 48, 49 of the conveyers move at the same speed the gears 50, 51 will be of the same size, but if it be desired to move one of such runs at a speed relatively greater than that of the other, such wheels may be of different diameters. Suitable means for securing this difference in speed is illustrated in Fig. 7, wherein the shafts 42^a and 43^a, corresponding to the shafts 42 and 43 of

Fig. 5, are connected by gears 50^a and 51^a of different diameter. Any suitable means may be employed for actuating the gear wheels 50, 51 or the shafts upon which they are mounted; for instance, a pulley 42^b for a drive belt may be employed on the upper shaft, such as 42, of each pair of drums at the delivery end of the apparatus.

A receiving opening 52 is formed in the end wall 3 of the housing substantially in the plane of the space between the runs 48, 49 of the belt conveyer, and at the opposite end of the housing a delivery opening 53 may be provided, such opening being arranged substantially in alignment with the space between the runs 48 and 49 of the belts and being furnished if desired with flaring guide members 54 serving to direct the material as it is delivered from the conveyers into the opening 53.

As illustrated in Fig. 3 suitable feed means may be associated with the opening 52, such feed means preferably consisting of a belt conveyer 55 extending upwardly through the opening 52, and being trained about a guide roll 56 within the housing. This conveyer may be inclined upwardly from a guide roll 57 arranged at a relatively low level, and if desired, may receive its material from a second and horizontally arranged belt conveyer 58 trained about a guide roll 59 above the roll 57. With this arrangement it is evident that material carried upwardly upon the conveyer 55 will be discharged in the direction indicated by the arrow 60 into the space between the runs 48, 49 of the belt conveyers 46, 47 and will be carried thereby to the opposite end of the housing where the material will be discharged through the opening 53. If desired, intermediate guide drums or rollers such as 61, 62 may be arranged at any suitable interval in the length of the housing, such rolls serving to maintain the parallelism of the runs 48, 49 of the conveyers throughout their lengths. As such runs of the conveyers are spaced apart a distance substantially equal to the thickness of the layer of material to be dried, it is evident that the material will be held substantially flat during its passage through the housing and will be prevented in a positive manner from curling or warping under the treatment which it receives during such passage.

Immediately below the pair of belt conveyers 46, 47 there may be arranged as many other pairs of similar belt conveyers as desired, such conveyers being provided with adjacent runs 63, 64, 65, 66, etc., respectively, which operate in a manner similar to those described for the conveyer belts 46 and 47. In the plane of the space between the runs 63, 64 of the intermediate conveyers, a receiving opening 67 is formed in the end wall 3 of the housing, such receiving opening having associated therewith a feed belt 68 receiving its material from a horizontal belt 69 and at the opposite end of the housing a discharge opening 70 is provided. A receiving opening 71 is also provided for feeding material to the runs 65, 66 of the lowermost belt conveyers, the material being fed to such opening by the belt 72, and being discharged from the housing through an opening 73 at the opposite end.

The belt conveyers are preferably formed of foraminous material such as heavy wire-mesh fabric, but if desired, for some purposes, may be other foraminous or absorbent material such as a textile fabric having a more or less open mesh. Arranged above the run 48 of the upper belt conveyer is a series of spaced nozzle tubes 74 communicating with chamber 13; while below the run 49 of the belt conveyer 47 a similar series of spaced nozzle tubes 75 is arranged. These nozzle tubes are of tapering form, the larger ends being secured in openings in the partition 10, while the smaller ends of such tubes are secured in the partition 14^a, the smaller ends being closed. These tubes are provided with longitudinally extending delivery openings such as 76, and as shown in Fig. 3 two such elongated openings or slits are provided in each of the tubes. These openings are so arranged that air supplied to the tubes is discharged against the interior surfaces of the runs 48, 49 respectively, of the upper pair of belt conveyers. The slits or discharge openings 76 are so arranged as to secure a uniform discharge of air from side to side of the belt. The nozzle tubes 74 extend transversely across the width of the belt conveyers and the discharge openings therein are of a sufficient length to provide a blast of air covering the entire width of the material supported upon the belt conveyers. Similar series of nozzle tubes are provided for each pair of belt conveyers as indicated in Figs. 2 and 3.

Any number of slits 76 may be employed in each tube, as may be found desirable for the required effect; as shown in Figs. 1 and 2, the number of such openings and the direction of discharge of air may be varied as desired in accordance with the effect desired, so that a blast is blown at such angles and such points in the travel of the conveyers as required by the work to be done.

In the arrangement shown in Fig. 6 provision is made for positively holding the conveyer belts in closely parallel relation throughout their operative movement. In this arrangement a pair of rails 100, 101, are arranged in parallel spaced relation, such rails serving to guide series of bars such as 102, 103. These bars in turn serve to support the conveyer belts 104, 105 to which bars such belts are securely connected. With this arrangement the movement

of the belts causes the bars to slide along the surfaces of the rails, such bars in turn serving to prevent separation of the conveyer belts. The material contained therebetween is thus positively prevented from warping or curling during the drying process.

In operation, the material is fed by the conveyers 55, 68 and 72 inwardly through the end wall 3 of the housing and is deposited within the spaces between the adjacent runs of the several pairs of belt conveyers. The movement of the belts causes the material to travel toward the other end of the housing and during such movement the material is held in a substantially flat or plane condition by its interposition between the parallel runs of the belt. During operation the fan 38 discharges air from the heating chamber 34 into the plenum chamber 13. This air, which may be highly heated, passes through the nozzle tubes 74, 75 and out through the discharge slits 76 against the interior surfaces of the belts, whose foraminous or porous texture permits the heated air to pass into contact with the opposite surfaces of the confined stream, charge or sheet of the material to be dried. The belt conveyers are themselves kept hot by these blasts, their heat being transmitted by conduction to the material held by them. When the conveyer belts are of absorbent material, moisture is abstracted from the material by their capillary action, which is evaporated constantly. Highly efficient and uniform drying is thus obtained, while the material is prevented from warping or twisting during drying. By the superposition of several pairs of conveyers, as shown, a very large quantity of material can be dried on a given floor space and in a given period of time without duplicating the insulation and heat-economizing devices. The air discharged from the nozzles after absorbing moisture from the material flows outwardly from between the belt conveyers, being discharged from the opposite ends of the housing through the economizer tubes 22, 23 into the educt flues 24, 25 respectively. As such air passes out through said tubes a great part of its heat is taken up by the fresh air entering the openings 30, which passes down over such tubes and into the lower end of the intake flue 29. From this flue the air passes up into the heating chamber 34 where its temperature is further raised to the desired amount. By the employment of these heat-interchange economizers, it is possible to recover in the incoming air much of the useful heat which would otherwise be discharged from the housing with the moist air, and substantial economy in heat is thus attained. Economy in operation is aided by so arranging the economizers as described so as to permit the discharge of air from opposite ends of the housing, which insures rapid removal of the moisture-laden air, and preventing any substantial increase in vapor pressure in the housing such as might serve to delay the drying of the material. The single fan employed operates advantageously in respect to both its induct and educt effort, so that economy in power consumed is also effected.

While the apparatus selected for illustration is particularly adapted for drying sheet material such as leather board, it is also useful without change for drying comminuted materials of various kinds. When so employed it may be found preferable to drive the upper and lower runs of the conveyer belt at different speeds to turn over the particles of the material during their movement from one end of the housing to the other, to insure uniform thorough and rapid drying. While a preferred form of apparatus has been illustrated herein as suitable for carrying the invention into effect, it is to be understood that various changes and modifications in the shapes and dimensions of parts as well as the relative arrangement of the same may be made without departing from the spirit of the invention.

What I claim is:

1. That process of drying material which comprises interposing such material between surfaces of a pair of substantially parallel supports of absorbent character, and subjecting the remote surfaces of said supports to the action of blasts of heated air of substantially uniform intensity from edge to edge of the supports.

2. That process of drying material which comprises interposing a layer of such material between runs of a pair of pervious belt conveyors, moving said runs in the same direction to cause such material to move in a predetermined path, and directing blasts of heated air of substantially uniform intensity transversely of the width of the conveyors to impinge upon surfaces of said runs of the belt conveyors at intervals during the movement of the material therewith.

3. That process of drying comminuted material which comprises interposing a layer of such material between runs of a pair of belt conveyors, moving said runs at relatively different speeds but in the same direction whereby to move said material bodily in a given direction while imparting turning movements to individual parts of the material, and directing blasts of heated air against the runs of the belt conveyors whereby to impart heat thereto.

4. Apparatus of the class described comprising means for supporting and confining a layer of material to be dried, and air of substantially uniform intensity transversely of the supporting means, delivery nozzles

arranged to direct blasts of air simultaneously against opposite surfaces of such material.

5. Drying apparatus for drying material in relatively thin layers comprising a flexible support of foraminous material upon which the material to be dried is carried, and air nozzles arranged upon both sides of said supporting element for directing air against opposite faces of the layer of material carried thereby, the nozzles having delivery orifices substantially coextensive with the width of the support and constructed and arranged to deliver blasts of substantially uniform intensity from end to end of the orifices.

6. Apparatus for drying material comprising a housing of heat insulating material, means for supporting and confining a thin layer of material to be dried, and means for directing blasts of air with substantially uniform velocity throughout the entire width of such layer of material and against both sides thereof.

7. Apparatus of the class described comprising a housing, a foraminous belt conveyor therein, a pair of elongated nozzles arranged at opposite sides respectively of the supporting run of said belt conveyor and having discharge openings extending across the entire width of said run, and means for delivering heated air to said nozzles.

8. A drying apparatus comprising a housing having arranged therein an elongated supporting element of foraminous material, means for moving said element in the direction of its length whereby to cause material resting thereupon to travel from one side of the housing to the other, and a series of air delivery nozzles arranged upon each side of said element for delivering blasts of warm air against opposite surfaces of the material to be dried as the latter moves through the housing.

9. Apparatus for drying material in thin layers which comprises a heat insulated chamber, means for simultaneously moving a plurality of superposed layers of the material in the same direction through said chamber, and means for directing blasts of warm air against opposite sides of each of said layers while so moving.

10. An apparatus for drying material in thin layers comprising a pair of belt conveyors having runs thereof arranged in substantially parallel relation and spaced apart a distance substantially equal to the thickness of the layer of material to be dried, means for holding the said runs against warping of the material, and means for moving such runs in the same direction.

11. An apparatus for drying comminuted material in thin layers, comprising a pair of opposed belt members spaced apart a distance substantially equal to the thickness of such layer of material, means for moving such belt members in the same direction but at relatively different speeds, and means for directing currents of warm air against surfaces of said belt members.

12. A drying apparatus comprising a heat insulated housing having vertically spaced receiving and delivering openings in its opposite side walls, conveyor devices within said housing extending between the respective receiving and delivering openings, air blast nozzles arranged above and below each of said conveyor devices whereby to deliver air against the upper and lower surfaces of material carried thereby, and means associated with the receiving openings for feeding material therethrough to the respective conveyors.

13. Drying apparatus of the class described comprising a heat insulated housing having a plurality of vertically spaced conveyors arranged therein, such conveyors being constructed and arranged to move material from one end of said housing to the other in a substantially horizontal direction, means for directing currents of warm air against opposite surfaces of the material during its travel with such conveyors, means for evacuating from the housing spent air and means for maintaining said currents of warm air.

14. In an air drying apparatus a housing having therein a conveyor belt of pervious material, air discharge nozzles arranged on either side of said belt, means for supplying air to said nozzles, and means whereby such air, prior to its discharge from said nozzles, is brought into heat transferring relationship to warm air flowing from the housing.

15. A drying apparatus comprising a heat insulated housing having a longitudinally extending plenum chamber at one side thereof, a pair of longitudinally extending and spaced economizer devices at the opposite side of said housing, means within said housing for moving material to be dried longitudinally thereof, nozzles communicating with said plenum chamber and disposed upon opposite sides of said material moving means, and a fan disposed substantially centrally of said housing and constructed and arranged to induce a flow of fresh air inwardly through said economizers and into the plenum chamber thereby forcing the warm and moist air from the opposite ends of the housing outwardly and through the respective economizers, such air passing in directions opposite to that of the incoming air.

16. Drying apparatus comprising a housing having a plurality of economizers there-

in, air heating means, and a single fan device for causing air to flow through the respective economizers and into contact with said heating means.

17. Drying apparatus comprising an elongated, heat insulated housing, a plurality of economizers receiving warm and moisture laden air from spaced portions of said housing, a heating chamber above said housing, and a fan associated with said heating chamber and constructed to induce the flow of fresh air through the several economizers in heat transferring relationship to the outgoing warm air, and to cause such fresh air to pass into said heating chamber and into contact with the material at a plurality of different places.

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

JOSEPH H. WALSH.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,510,615, granted October 7, 1924, upon the application of Joseph H. Walsh, of Boston, Massachusetts, for an improvement in "Processes of and Apparatus for Drying Comminuted or Sheet Material," an error appears in the printed specification requiring correction as follows: Page 4, lines 126 to 128, claim 4, strike out the words "of substantially uniform intensity transversely of the supporting means" and insert the same to follow after the word "air" in line 1, page 5, of same claim; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of November, A. D. 1924.

[SEAL.]

KARL FENNING,
Acting Commissioner of Patents.