Oct. 9, 1962 E. A. TIMSON ET AL 3,057,610

APPARATUS FOR DRYING WEBS OF PAPER OR THE LIKE

Filed Jan. 21, 1960 3 Sheets-Sheet 1

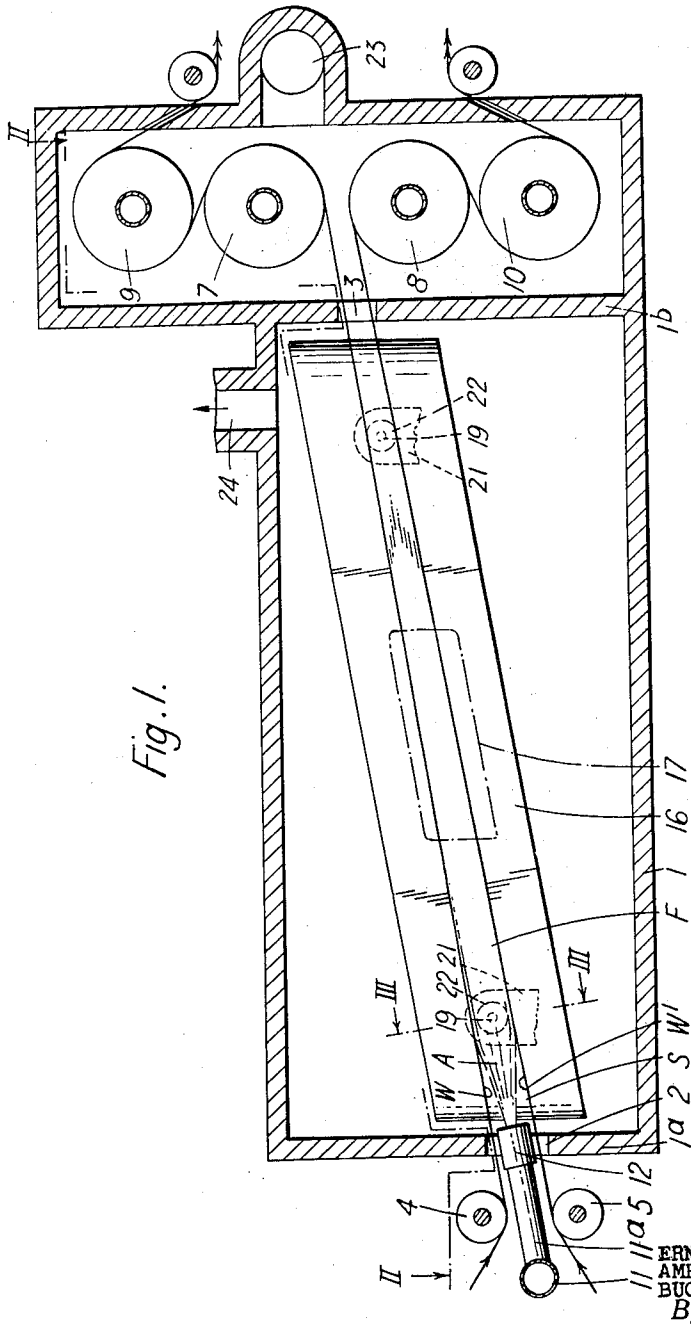


Fig. 1.

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Filed Jan. 21, 1960 3 Sheets-Sheet 2

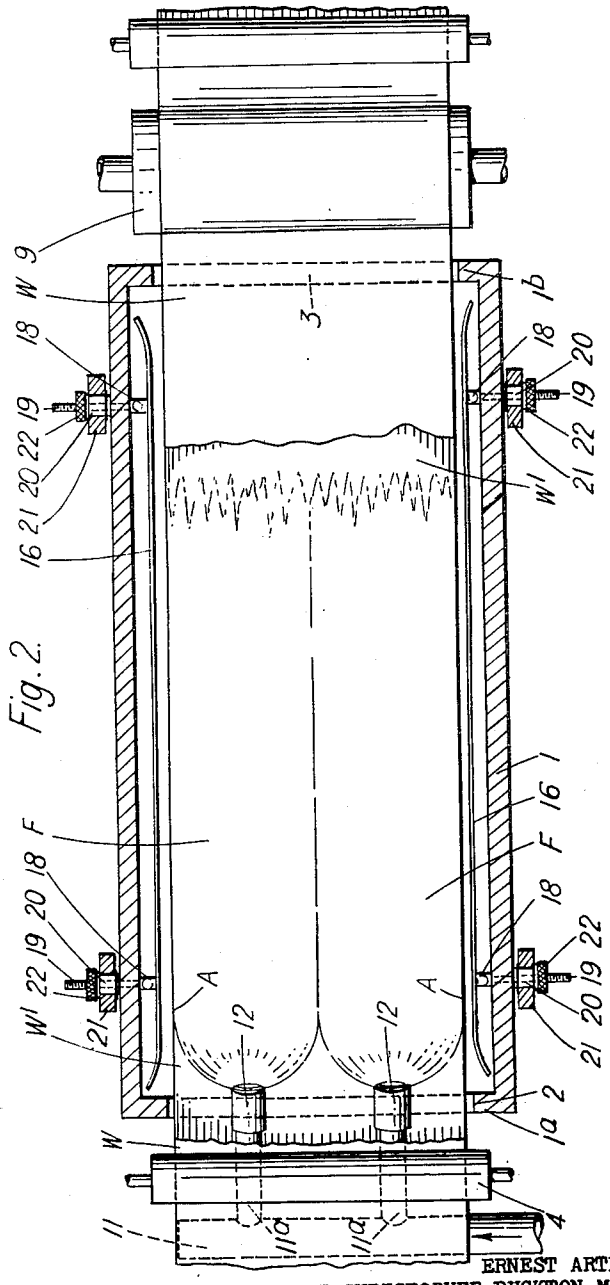


Fig. 2.

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Fig. 3.

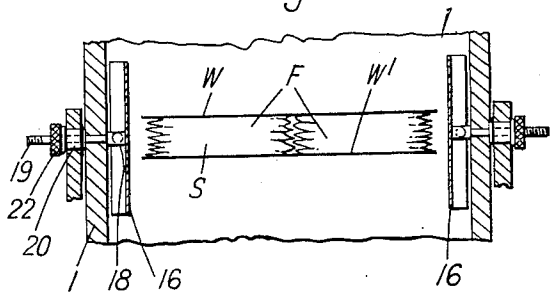


Fig. 4.

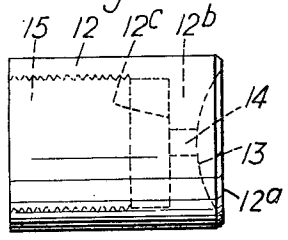
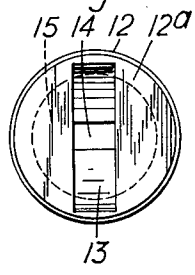


Fig. 5.



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APPARATUS FOR DRYING WEBS OF PAPER OR THE LIKE

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Filed Jan. 21, 1960, Ser. No. 3,784

2 Claims. (Cl. 263—3)

This invention appertains to apparatus for drying travelling webs of relatively thin and flexible material such as paper, cloth, film, foil or the like after such webs have been operated upon by, or treated in, a process involving the deposition of moisture or certain materials upon, or the application of inks, stains, dyes or other liquids to, surfaces of the webs.

Although there is no limitation in this respect, it is primarily the intention to embody the invention in an apparatus of the class suitable for drying travelling webs of paper after they have passed through a printing machine and been printed upon with a volatile ink or like medium, the purpose of the drying process in this instance being to expedite evaporation of the solvent in the medium. Such an apparatus is also suitable for the drying of films by, for instance, penetration, polymerization, oxidation and other drying processes all of which are accelerated by heat. The fusion of powders distributed on webs, as in electronographic methods of printing, is another process capable of being carried out by an apparatus of the class concerned.

The invention, moreover, has reference exclusively to such a web-drying apparatus of a previously proposed form comprising a defined drying zone, e.g. the interior of a drying chamber, means adapted so to support and guide two travelling webs through the said zone that the webs have runs with a space between them, and means arranged to supply between the said spaced runs heat which plays on the opposed surfaces of, and is trapped between the webs.

The support and guide means in an apparatus of this form are customarily constituted by adjustable guide rollers, and may advantageously be so disposed as to be adapted to guide through the drying zone two webs having straight runs which extend a comparatively short distance only apart with a clear space between them. These runs may either extend parallel or substantially so to one another or they may converge. For instance, the webs may be made to run closer together towards their exit from a drying chamber where their distance apart is governed by adjustment of exit rollers. The latter may be in the nature of water-cooled cylinders whose function is to cool down the webs and printing on them to below the "sticky" temperature of the dried ink which even when dry is often thermoplastic. Also the paper suffers if it is kept at 300° F. for a longer time.

Preferably, in such an apparatus, burner means, communicating with a supply of combustible fluid fuel are so arranged as to be adapted, when lighted, to direct a jet or jets of naked flame between the said two runs of the travelling webs.

Advantageously such burners may each be of the form disclosed in the specification of co-pending application Serial No. 3,883, filed January 21, 1960, and designed to produce, by admixture therein of combustible fluid fuel, e.g. coal gas, with air at atmospheric pressure, an only moderately hot, in contradistinction to a high temperature, flame which issues lazily from the burner suchwise as to be carried along, and to flow together, with the travelling material to be dried. The form of each of the burners may additionally be such as to produce a flame

of known fan shape akin to that of a bat's wing, i.e. a laterally spread, flat flame which is very wide in relation to its thickness.

In the prior application Serial No. 3,883 aforesaid are disclosed the advantages of using large volume low temperature flames which are ipso facto of considerable persistance. In this regard such a flame, when formed below a travelling web of paper freshly printed on both sides, may efficiently transfer its heat so that the whole web is uniformly warmed to a temperature of 300° F. or over in times that are available for webs travelling at speeds up to and in excess of 1000 ft. per minute. This temperature is that at which the special inks used for this drying process will dry in the times allowed but at which, in this time, the paper does not suffer. A lower temperature is sufficient for some recent inks. We have found that the use of bat's wing burners results in the whole length of paper web in a drying chamber carrying flame below it for a distance of 4 to 7 ft., being effectively dried. It will be appreciated that a persistent lazy flame pressing upwards against a web has exceptionally good opportunities of delivering a large proportion of its heat to the paper since it soon displaces the dead air film invariably carried along by such a web, and by virtue of the comparatively low relative velocity between the flame and the web the flame can make continuous intimate contact with the underside of the web as long as any flame persists. This arrangement results in the use of less gas for a given amount of drying, than previous known methods of achieving the object in view in a convenient short length of web run. This desirable result will be referred to as high efficiency.

Now in certain printing machines it is customary to run on parallel courses two webs both of which need drying. In other cases the same web needs drying twice. This latter necessity arises when one side of the web has to be printed and dried before the other. Such commonly occurs on web fed letterpress rotary perfecting presses.

Thus, in carrying out the principles embodied in a web drying apparatus of the previously proposed form, a lazy or slack flame issuing from a burner as disclosed in co-pending application Serial No. 3,883 may be formed between the two webs and every effort made to dispense with a duplicate flame below the lower web for the sake of efficiency. The aim in such a case should be to fill the space between the two webs entirely with lazy flame or flames since any departure from this condition results in poorer heating of the bottom web and it is generally necessary that both webs should be heated substantially the same amount.

In most cases it is possible to arrange gas burners of the form disclosed in application Serial No. 793,591, filed February 16, 1959, between two spaced webs at the beginning of their travel but in those cases where the webs require to be closer together (because only a small flame is required which would not fill a wider space of sufficient depth to accommodate the burners without contact) the burners may be mounted in advance and clear of the adjustable guide rollers over and below which the webs run before travelling on their spaced courses. The flat lazy flame or flames in this case is or are directed at the entrance into the space between the webs and is or are drawn in between the webs to fill the space between them. It may be mentioned here that in such a case the said guide rollers need not necessarily be water cooled because they are, in fact, cooled by the continuous feed of cold paper over them through which paper the flame heat has no time to penetrate.

Because each lazy flame is consumed during its travel along with and between the webs it will diminish in

volume as it travels and the webs are therefore preferably made to converge as previously mentioned herein so that the space between them is throughout its longitudinal dimension completely filled with flame, while such flame persists at all.

Obviously the spent products of combustion from the now dead flame or flames will issue from the gap between the exit water cooled cylinders and provision for exhaust has to be made to take these products away to atmosphere; also the similar products which escape laterally from between the webs travelling through the drying chamber have, of course to be exhausted.

One great advantage of "two web apparatus" is that the webs can travel at any inclination without altering the efficiency.

It has been found that at the commencement of the flame travel between the webs there is a substantial reduction of pressure at the spaces between the edges of the webs. This is due possibly to a kind of injector effect, or to an initial shrinkage of the flame on first meeting the said webs. Approximately half way along the travel between the webs the pressure is atmospheric, and at the remote end, pressure is positive and the flame has a tendency to be expelled sideways from the space between the webs. The negative pressure at the edges of the webs at the start of the run is very undesirable as cold air becomes sucked in and not only is the flame diluted with this unnecessary cold air but it is also prevented from fanning out to these edges.

At the end of the run, the flame spilling out sideways is not quite so serious and some control can be exerted by readjusting the distance apart of the water cooled cylinders.

The general object of the present invention is to provide, in a web-drying apparatus of the previously proposed form herein described, an improvement designed to ensure that a maximum amount of the available heat is confined in the space between the runs of the two travelling webs, thereby increasing the efficiency of the apparatus.

Thus, a particular aim of this improvement is to ensure that, in a web-drying apparatus equipped with gas burners, the space between the two travelling webs shall be full of flame and that the upper and lower webs shall be dried equally. A further aim is to prevent waste of flame, and to extend to the limit the travel of the flame before the latter finally dies from exhaustion.

According to this invention, there are provided at opposite sides of the drying zone in a web-drying apparatus of the form herein referred to, members which extend at least partially alongside the paths of the spaced runs of the two travelling webs, in the region of the heat-supplying means, and serve to enclose wholly or in part the space between the webs.

Conveniently, these members may be in the form of relatively thin but rigid plates constituting side walls arranged to complete the enclosure of at least a portion or portions of the space between the relevant runs of the travelling webs. That is to say, such plates serve at least in part to cover and close what would otherwise be the open sides of the said space.

The idea is that the said side members (hereinafter for convenience referred to as "side plates") shall be set as close as is reasonably practicable to the longitudinal edges of the travelling webs, so that they can effectively retain the heat available within the confined space between the webs and so prevent such heat from escaping laterally during the last part of the flame travel through open sides of this space, or the ingress of cold air at the beginning of the flame travel.

In order that the invention may be more clearly understood and readily carried into practical effect, a specific arrangement of the improved web dryer will now be described with reference to the accompanying purely diagrammatic drawings, wherein:

FIGURE 1 is a longitudinal sectional view of the dryer showing gas burner flames directed into the space between the travelling webs of paper, and also one of the flame-confining side plates,

FIGURE 2 is a sectional plan view of the same taken on the line **11—11** of FIGURE 1 showing both of the side plates and means for adjusting these plates laterally in relation to the longitudinal edges of the travelling webs,

FIGURE 3 is a detail cross-sectional view taken on the line **111—111** of FIGURE 1, and

FIGURES 4 and 5 are side elevational and front views respectively of one of the gas burners employed.

Referring to FIGURES 1 and 2 it will be seen that the web dryer comprises a horizontally disposed box-like drying chamber **1** the interior of which constitutes a drying zone. The entrance into the end **1***a* of this chamber is in the form of a rectangular aperture indicated at **2**. Similarly, the exit from the opposite end **1***b* of the said chamber is in the form of a further rectangular aperture **3**. In the particular arrangement shown, the exit aperture **3** is at a higher level than the entrance aperture **2** although both apertures may, if desired, be at the same level. Adjacent to the entrance aperture **2**—on the outside of the chamber **1**—is a pair of web guiding rollers **4** and **5**. These rollers are disposed one above the other with a space between them, and they may be relatively adjustable heightwise to vary the depth of the said space. One web W of paper travels beneath the uper entrance rollers **4** and longitudinally right through the chamber **1**, whilst a second web W′ travels over the lower entrance roller **5** and similarly through the chamber, the two webs passing through the exit aperture **3** and respectively beneath and over a pair of superimposed exit rollers in the form of water-cooled cylinders **7** and **8**. Associated with the cylinders **7** and **8** are further water-cooled cylinders **9** and **10** for the guidance of the two webs. The distance apart of the two webs W and W′ at the exit aperture **3** may, if desired, also be varied by adjustment of the cylinders **7** and **8**. In any event, the pair of guide rollers **4** and **5** and the water-cooled cylinders **7** and **8** are so disposed as to guide through the drying chamber two straight runs of the webs W and W′ which extend a short distance only apart with a clear space S between them.

These runs may either extend parallel or substantially so to one another or they may, as shown in FIGURE 1, converge. That is to say, in the example illustrated, the webs W and W′ are made to run closer together towards their exit from the drying chamber **1**. Moreover, by virtue of the fact that the aperture **3** is higher than the aperture **2**, the two webs are upwardly inclined and travel uphill, although this is by no means essential.

There is provided, immediately in advance of the pair of entrance rollers **4** and **5**, a transversely extending gas pipe or manifold **11** which extends at right angles to the longitudinal edges of the travelling webs of paper. The pipe or manifold **11** is connected to a supply of any suitable inflammable mixture, e.g. coal gas and air, and is furnished with two (or it may be more) suitably spaced gas burners such as **12** each in the form of a hollow jet such as that illustrated in detail in FIGURES 4 and 5. Each such burner, which is fabricated throughout in metal and is connected on to the end of a branch **11***a* of the gas pipe or manifold **11**, has milled in the outer surfaces **12***a* (FIGURES 4 and 5) of the comparatively thick mainly closed end **12***b* thereof a diametral concave recess **13**. In the bottom of this recess, centrally between its ends, is a small rectangular outlet aperture **14** communicating with the hollow interior **15** of the cylindrical burner **12**, this aperture **14** being produced by forming in the inner surface **12***c* of the aforementioned mainly closed end a diametral channel extending at right angles to the milled concave recess **13** (see FIGURE 5). By virtue of the formation described a marked degree of aeration is obtained by turbulence. Each of the burners **12** produces a wide thin flame of fan or bat's wing shape acquiring any

deficiency of air for complete combustion by free turbulence. Such wide, thin flames are depicted at F in FIGURES 1 and 2, and since the hollow burner jets extending from the common pipe or manifold **11** extend beyond the entrance rollers **4** and **5** into the entrance aperture **2**, these flames are directed into the space S between the webs W and W'.

Each of the burners **12** is, moreover, of such a form as to be adapted to produce by admixture therein of gas with air at atmospheric pressure, an only moderately hot, in contradistinction to a high temperature, flame which issues lazily from the burner suchwise as to be carried along, and to flow together and in contact with the travelling material to be dried.

By "an only moderately hot" flame is meant one of the average order of from 900° C. to 1400° C., depending on the zone considered, in contradistinction to an intensely hot flame of anything up to 2,200° C. In this regard it has to be borne in mind that a "lazy" flame comprises zones of various temperatures.

The longitudinal flow of the flames F in the direction of movement of, and hence in company with, the travelling webs is comparatively sluggish since there is no forced draught and blast of air through the burners directing the flames straight at the material. In other words, the flames issuing from the burners spread longitudinally as well as transversely with respect to the path of travel of the spaced webs W and W'. The travelling webs are accordingly contacted by gentle flames which have a comparatively large area in contact with the webs.

If desired, the entrance aperture **2** may be made adjustable in width so that the edges thereof can be set close to the webs of paper for the purpose of disturbing and breaking the film of air which would otherwise be carried along with the webs into the drying chamber **1**. The disturbance of these films of air facilitates the web drying operation. The parallel edges of an adjustable entrance aperture may be constituted by edges of manually adjustable plates (not shown).

In accordance with the characteristic feature of the present invention, there are provided, at opposite sides of the drying zone, relatively thin and rigid side plates or shields **16** which extend alongside the paths of the spaced runs of the two travelling webs W and W' and serve to enclose the space S between the latter (see FIGURE 3). In the particular example illustrated, the side plates **16**, adjusted as closely as conveniently possible to the edges of the web at least at the beginning of the run, are of great value in preventing the ingress at the location A of cold air and the presence of the plates **16** in this vicinity results in the flame spreading to the full width of the webs W and W' surprisingly quickly.

The side plates may, if desired, and as shown in FIGURES 1 and 2, extend continuously alongside the full lengths of the paths of the spaced runs of the two travelling webs, although in practice it may be found convenient to leave a gap or aperture of a foot or so in the central region of each plate corresponding with that part of the travel of the webs where there is little or no tendency for the flame to contract inwards, or to spill out laterally, as this would provide a place where the character and behaviour of the flame could be usefully observed. One such gap or aperture is indicated in chain lines at **17** in FIGURE 1.

The secondary air necessary for satisfactory combustion is amply introduced, even with very close fitting side plates **16** at the beginning of the run, and control to prevent excess is provided by stopping off, as required, the air that flows in between the adjustable entry rollers **4** and **5**.

It is only by adoption of the modifications just described, that the hereinbefore mentioned particular aims of the invention can be realized. But the conditions necessary to obtain quite acceptable results commercially are very far from being as exacting and critical as they might appear to do from this description, and in practice the remarkable result is easily obtained that the efficiency of the "two web apparatus" utilising low temperature, lazy flames is twice that of an apparatus drying a single web with similar flame, and even the last mentioned apparatus produces a very much better result than any previously achieved.

Although the side plates **16** are preferably of sheet metal, suitably reinforced and stiffened as may be necessary or desirable, such members may alternatively be of any suitable tough and rigid non-metallic fireproof material. If necessary or desirable, the side plates may be cooled either by a water or an air cooling system or by conduction.

In accordance with a feature of the invention the side plates **16** may advantageously be relatively adjustable laterally suchwise as to enable them to be set to a nicety in relation to the longitudinal edges of the spaced webs W and W', and to be adjusted to suit webs of different widths, according to requirements.

In the illustrated araringement, the spaced webs run uphill (although they may run horizontally or vertically) and the side plates **16** are disposed in vertical planes at opposite sides of the webs (see FIGURE 5). The outer sides of the plates are provided with pairs of lugs of forked pieces **18** between which are secured the inner ends of laterally directed non-rotatable screws **19** which extend outwardly through the side walls of the drying chamber **1** and also through nuts **20** mounted for rotation in frame members **21** forming part of a framework of the drying chamber. The nuts **20** are furnished with milled knobs **22**. Thus, by turning these knobs, the screws **19** can be moved axially in one direction or the other to adjust the side plates **16** towards and away from the edges of the webs.

The side plates may be either individually adjustable, as shown, or adjustable in respectively opposite directions in common.

In any event, the side plates may be of a width substantally exceeding the depth of the space S between the travelling webs W and W'.

It is preferred that both webs travel in the same direction—away from the burners **12**. The web run for a letterpress perfecting rotary printing press cannot, however, conveniently be arranged so that the webs both run in the same direction because the web then "winds itself up" and cannot be drawn out simply to the folder and delivery, except sideways by means of a turner bar, unless the delivery or reel stand is enveloped by the web run. This is undesirable as the web run is then wastefully extended. Fortunately, in connection with such a machine the heat required to dry the second printing can be appreciably less than that required for the first printing and, this being so, it is considered that the second printing run can be made the lower web through the drier, and travel the opposite way to the first run, i.e. towards the burners. This system does not result in as high an efficiency as when both webs travel in the same direction but is nevertheless thought to be practical when circumstances dictate its desirability.

Referring again to FIGURE 1, provision may advantageously be made as at **23** and **24**, for the exhaust of the spent products of combustion from the dead flames and which escape laterally from between the travelling webs.

We claim:

1. Apparatus for drying two substantially parallel webs of paper-like material comprising a drying chamber having opposed entrance and exit apertures, web feeding means, heat generating means, and two parallel plates disposed in said drying chamber and having adjustment means, said web feeding means comprising two spaced apart rollers adjacent to and exterior of said drying chamber at said entrance aperture and two spaced apart rollers adjacent to and exterior of said drying chamber

at said exit aperture, all of said rollers having substantially parallel axes, said heat generating means comprising at least one gas burner having an axial outlet adapted to generate a lazy flame, said burner being exterior of said drying chamber and between said spaced apart rollers adjacent to said entrance aperture with said axial burner outlet in alignment with both of said apertures, and said parallel plates being supported in said drying chamber by said adjustment means so that the planes in which said plates lie are perpendicular to the axes of said rollers and adjustable by said adjustment means in the direction parallel to the axes of said rollers.

2. Apparatus as claimed in claim 1 wherein said adjustment means comprises threaded projections secured to said parallel plates and nuts rotatably mounted on said drying chamber and screwed onto said projections.

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