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PROCESS AND APPARATUS FOR DRYING SHEET MATERIAL

Filed June 7, 1952

2 Sheets-Sheet 1

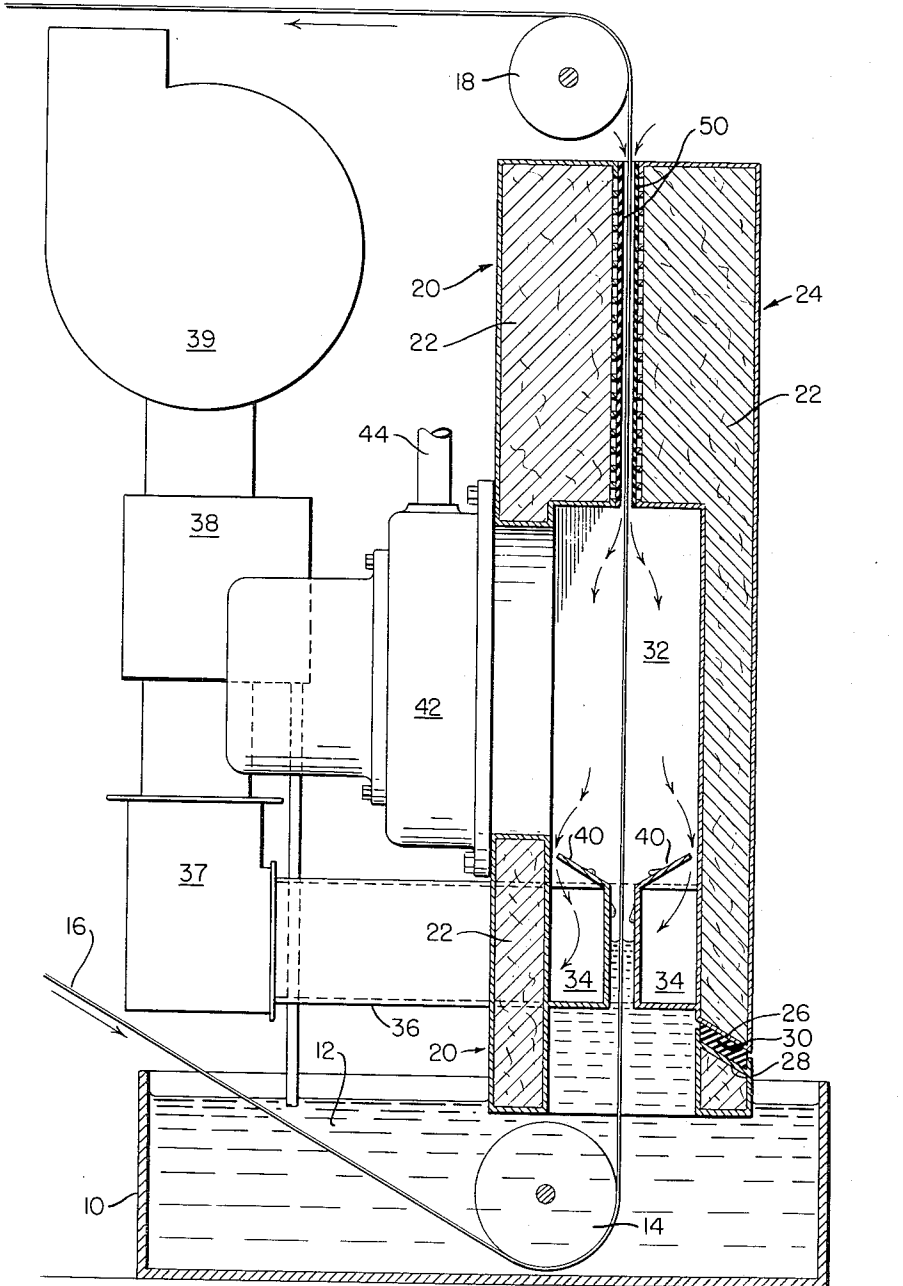


Fig. 1

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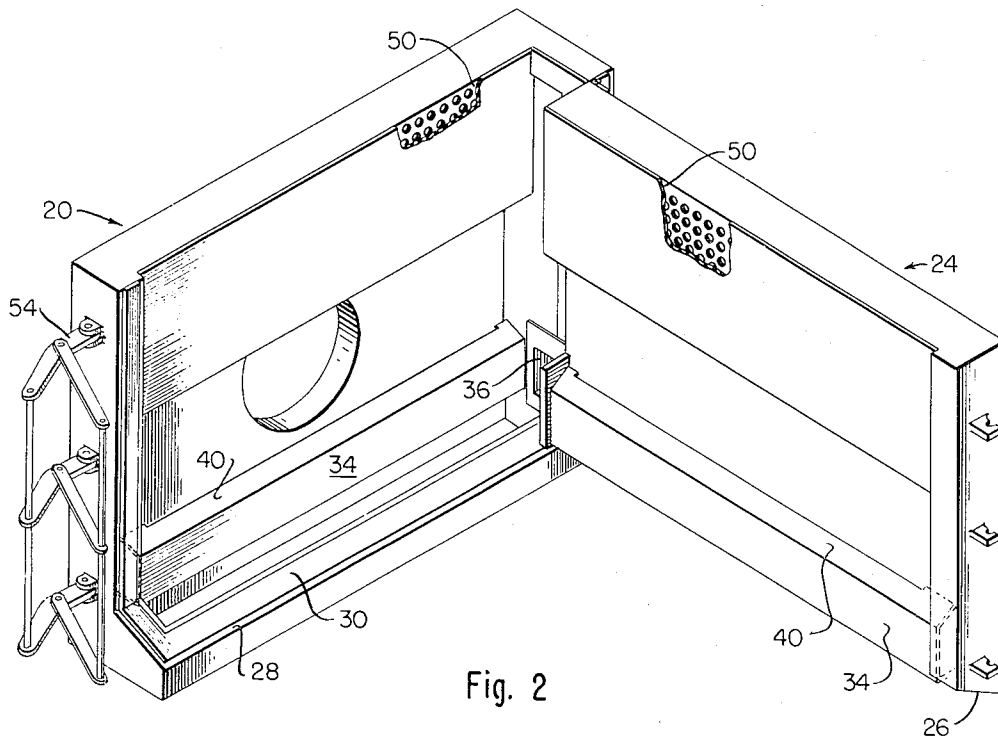


Fig. 2

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2,740,202

PROCESS AND APPARATUS FOR DRYING SHEET MATERIAL

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7 Claims. (Cl. 34-18)

This invention relates to the art of drying the surfaces of web sheet material such as waxed paper and comprises a novel process for removing droplets of liquid from the continuously moving surfaces of such materials, together with novel and useful apparatus by means of which the new process may advantageously be carried out.

Although the invention is applicable to the removal of liquid from any web or sheet material having a relatively smooth non-absorbent surface, the process and apparatus will be disclosed herein in connection with an embodiment, now in successful practice, for removing water droplets from wax paper.

In the manufacture of wax paper it is customary to pass a web or sheet of paper through a hot bath of a liquid wax and then through a quench bath of cold water. It is then desirable to reel the wax paper in large rolls so that it may be shipped to a customer, but before the final reeling can be accomplished it is necessary to remove the water from the waxed surface of the paper. In the past various types of drying apparatus have been resorted to, generally employed in conjunction with wipers and water suction tubes disposed to rest upon the surfaces of wax paper and remove excess moisture. It has been found, however, that the wipers and suction tubes quite frequently act to mar the surface of the paper and that in any case the speed at which water can be effectively removed from the paper is the limiting factor upon the speed with which the waxing, quenching and reeling operations may be carried out. The problem is particularly acute with respect to papers impregnated with modified waxes, that is to say waxes incorporating additives such as polyethylene which gives a higher gloss, a harder finish, and a better seal than regular wax such as paraffin. For example, one manufacturer has found that 650 feet per minute was the practical limit for operations on paper coated with regular wax, whereas with modified wax the maximum speed was 330 feet per minute. Inasmuch as modified wax is displacing regular wax to an increasing extent, it has become extremely desirable to increase the speed of operations with such high gloss waxes.

I have discovered that by running the quenched sheet through an enclosure through which an air stream is forced that I can successfully shake off the water droplets into the air stream by means of sound waves directed to impinge transversely against the moving sheet, the result being that the sheet is vibrated in the manner of a membrane, and the water droplets are disengaged from the moving sheet due to the fact that their surface tension forces are not sufficient to hold them on the dynamically accelerated sheet, the acceleration of which is in response to the pressure of the sound waves.

The primary object of my invention is to improve the efficiency with which liquid may be removed from smooth surfaced sheet material.

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Another object of the invention is to increase the rate of production of materials such as wax paper.

An important feature of the invention resides in vibrating a moving sheet with sound wave energy and simultaneously passing an air stream along the sheet, into which the liquid can be entrained as it leaves the sheet.

Another feature of the invention comprises an insulated enclosure mounted with its lower end beneath the level of liquid in an underlying tank, having a sound wave generator mounted at one side of the enclosure, and provided with ducts by means of which a continuous stream of air is passed through the enclosure.

An important advantage resulting from the use of the invention is that liquid is removed from the surface of the sheet without a rise in temperature or any touching of the sheet with wipers or equivalent instrumentalities.

These and other objects and features of the invention will be more readily understood and appreciated from the following detailed description of a preferred embodiment thereof selected for purposes of illustration and shown in the accompanying drawings in which:

Fig. 1 is a view in side elevation showing apparatus constructed in accordance with the invention, and

Fig. 2 is a view in perspective showing the enclosure in open position.

It is believed that the process of the invention will more easily be comprehended in connection with a description of preferred apparatus by means of which the process may conveniently be practised.

As shown in Fig. 1 the apparatus of the invention is organized about a rectangular tank 10 containing a body of water 12 which serves as a quench bath for paper upon which hot wax has been previously applied by conventional means (not shown). Within the tank 10 there is mounted for rotation a long roller 14 beneath which passes the web or sheet 16 of waxed paper, moving in the direction of the arrow and, as previously stated, having been coated with hot wax. Mounted several feet above the roller 14 and parallel thereto is a second roller 18, both rollers being connected to suitable driving means (not shown). The liquid removing apparatus is disposed between the rollers 14 and 18.

There is provided an upright rectangular stationary sheet metal housing 20 disposed with its lower end beneath the level of water 12 in the tank 10 and provided internally with thick blocks of sound insulating material such as glass fibers, rock wool, or the like. Complementing the housing 20 is a movable door or housing 24 likewise provided internally with insulating material 22 and hinged at one of its vertical sides to the stationary housing 20. The housing 24 terminates at its lower end in an inclined edge 26 cooperating with a ledge 28 formed on the housing 20, there being a heavy rubber gasket 30 interposed between the lower edge of the housing 24 and the ledge 28. When the housings 20 and 24 are in the closed position illustrated in Fig. 1 there is left between them a narrow central passage extending through the upper half of the conjoint housings and leading from an enlarged rectangular chamber 32 formed in the lower half of the housings the latter terminating at its lower end in the liquid of the tank 10.

Adjacent the bottom of the chamber 32 is an air duct 34 leading through an exhaust pipe 36, an exhaust muffler 37, and water eliminator 38 to an exhaust blower 39. The duct 34 is open at its upper end but surmounted by a pair of inclined baffle plates 40 serving to catch spray and deflect it so that it can drip into the tank 10. Above the baffle plates 40 and secured in the side of the housing 20 is a siren 42 served by an air inlet duct 44. While the design of the siren

forms no part of this invention, it must be capable of delivering sound waves at frequencies from 1,000 to 3,000 cycles per second at intensities in excess of 158 decibels. One siren which has been found satisfactory is known as the U-4 manufactured by Ultrasonic Corporation of Cambridge, Massachusetts.

I have found that air may be passed through the housing at the approximate rate of 1,000 to 1,500 cubic feet per minute, the U-4 siren ordinarily delivering in the neighborhood of 200 cubic feet per minute. Although the dimensions of the apparatus are not regarded as critical, I have satisfactorily employed housings 55" high, 78" wide and 16" in transverse cross section. These dimensions are given because those skilled in the art will readily recognize that there is some correlation between the optimum frequency and the dimensions of the enclosure. For the embodiment herein described we have discovered in practice that a frequency of approximately 2,000 cycles per second is optimum. If the optimum frequency is departed from significantly, it will be observed that the maximum speed at which the paper can be satisfactorily processed will be less than that which is obtainable at the optimum frequency.

The optimum frequency depends upon the dimensions of the enclosure, the thickness of the sheet, and possibly on other considerations not now apparent to us. I am convinced, however, that for all practical purposes the optimum frequency lies between 1,000 and 3,000 cycles. If the frequency is too low, the dynamic acceleration of the sheet is too small to result in separating the droplets from the sheet. If the frequency is too high, the sheet will not move through an amplitude sufficiently great to achieve the desired results. Within these limits, however, the optimum frequency may be determined in a matter of minutes.

I have also discovered that satisfactory operation cannot be carried out if the intensity of the sound waves within the enclosure and impinging on the web is appreciably below 158 decibels, and I state that as a definite lower limit.

I deem it important that the air stream through the enclosure pass in a direction counter to that of the moving sheet 16, since in this manner moisture entrained in the air stream is more quickly and efficiently removed from the neighborhood of the sheet.

It is important to note that a siren operating at, say, 2,000 cycles per second at an intensity of greater than 158 decibels is extremely unpleasant to hear. Consequently it is of vital importance that the apparatus be carefully insulated. To this end I provide the insulating blocks 22 within the housing and also obtain a water seal at the bottom of the enclosure. It will be found in practice that the suction developed within the enclosure will be sufficient to raise the level of the liquid within the enclosure appreciably above the normal level in the tank 10. Thus the liquid itself is utilized as a sound barrier. Sound waves striking the surface of the body of liquid are reflected almost entirely, only about 1% of the sonic energy being transmitted to the liquid.

For similar reasons the passage extending above the chamber 32 is made as narrow as possible and lined on each side with soft rubber mats 50 which communicate with the insulating mats or blocks 22 through foraminous walls of the housings 20 and 24.

For ease in threading the sheet through the unit, it is made in two sections hinged together at one edge, as shown in Fig. 2, and provided with a toggle type latch 54 by means of which the housings are locked firmly together before the apparatus is placed in operation. Hence the door 24 cannot accidentally open to release a blast of high intensity sound into the room.

It will be readily appreciated that other forms of housing, other forms of ducts, and other sound generators may be employed. For example, with simple modifications it would be entirely practical to utilize equipment

of the type disclosed in United States Letters Patent No. 2,562,545 to Gogolick et al. As I see it, the operating limits are the frequencies and intensity described above together with appropriate air ducts and exhaust system.

Operation of my novel process and apparatus has shown highly satisfactory results. For example, paper coated with regular wax may be treated at the rate of 1,000 feet per minute to produce wax paper from which the water has been completely removed, and there would appear to be no reason why this speed could not be still further increased were it not for other limiting factors not associated with the problem of removing liquid. With modified wax the limit of speed in my process has likewise not been determined, although satisfactory operations have been carried out at better than 600 feet per minute, an increase of approximately 100%. It is not only important to take account of the increase in production rate made possible by my invention, but also of the fact that the final product is of improved quality by reason of the fact that the surface of the material is at no time touched by any instrumentalities. The surface therefore has a high and uniform gloss deemed highly desirable in the packaging of products for retail consumption.

From what has been said it will be evident that my novel process is particularly useful for removing liquid from material having a smooth, polished, or glossy surface. Where the surface is interrupted, as for example in textiles, the drying would not be as effective because the liquid has in such cases permeated the material and cannot therefore be so readily shaken out of it. However, liquid appearing on a smooth glossy surface is ordinarily found in droplet form and therefore is responsive to my treatment.

Having thus described and illustrated my novel process and apparatus, what I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of removing from a web liquid which is superficially adherent to the surface thereof, which method comprises causing the web to travel longitudinally between surfaces closely opposing its faces to define a restricted passageway, supporting the web at spaced points to provide within said passageway an extended portion capable of membrane-like vibration, impinging sound waves in the range of from 1,000 to 3,000 C. P. S. on the so extended portion to impart thereto vibrations transverse to its plane and effect detachment of liquid droplets therefrom and carrying away the detached droplets by a current of air directed through said passageway over the surface of said portion substantially parallel to its plane.

2. The process set forth in claim 1 wherein the intensity of the sound waves is greater than 158 db.

3. The process of removing liquid from the surface of a smooth sheet, comprising passing the sheet through an enclosure, passing an air stream into the enclosure, about the sheet, and out of the enclosure, and directing sound waves at a frequency of from 1000 to 3000 C. P. S. against both faces of the sheet within the enclosure, whereby liquid droplets are shaken from the sheet and entrained in the air stream.

4. The process of removing liquid from the surface of a smooth sheet, comprising passing the sheet through an enclosure, passing an air stream into the enclosure, about the sheet, and out of the enclosure, and directing sound waves at a frequency of from 1000 to 3000 C. P. S. at a minimum intensity of approximately 158 db against the sheet within the enclosure, whereby liquid droplets are shaken from the sheet and entrained in the air stream.

5. The process of drying waxed paper, comprising passing the sheet through an enclosure, passing an air stream into the enclosure, about the sheet, and out of the enclosure, and directing sound waves at a frequency of from 1000 to 3000 C. P. S. against the sheet within

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the enclosure, whereby liquid droplets are shaken from the sheet and entrained in the air stream.

6. The process of drying waxed paper, comprising passing the sheet through an enclosure, passing an air stream into the enclosure, about the sheet, and out of the enclosure, and directing sound waves at a frequency of from 1000 to 3000 C. P. S. at a minimum intensity of approximately 158 db against the sheet within the enclosure, whereby liquid droplets are shaken from the sheet and entrained in the air stream.

7. Apparatus for removing liquid from a smooth sheet, comprising a pair of insulated panels disposed in close proximity and in upright position, said panels being recessed to provide a centrally located chamber, a tank containing liquid disposed beneath said panels in such position that the level of the liquid is above the lower ends of the panels, a sound generator disposed to discharge sound waves into said enclosure, means for passing a sheet continuously between said panels and through

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said chamber, and blower and duct means for forcing a stream of air between the panels and through the chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,385,042	Decker -----	July 19, 1921
1,722,797	Jessup -----	July 30, 1929
2,097,601	Potdevin -----	Nov. 2, 1937
2,351,549	Schwartz -----	June 13, 1944
2,542,064	Tilden -----	Feb. 20, 1951
2,562,545	Gogolick et al. -----	July 31, 1951
2,576,297	Horsley et al. -----	Nov. 27, 1951
2,645,031	Edwards -----	July 14, 1953

OTHER REFERENCES

Ultrasonics has wide industrial applications, Product Engineering, November 1949, pages 153 and 154.