

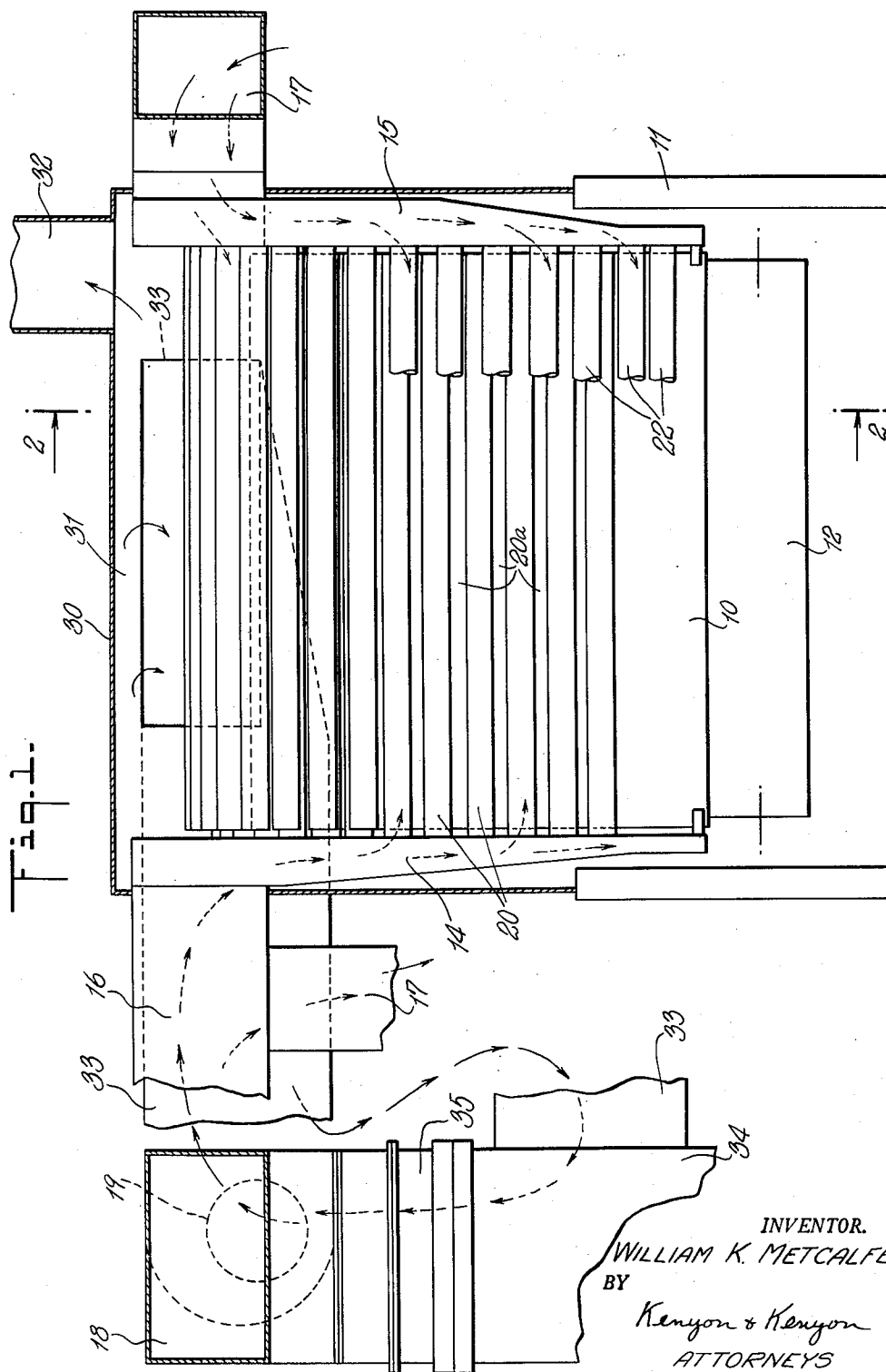
Dec. 23, 1952

W. K. METCALFE
PAPERMAKING MACHINE

2,622,343

Filed Feb. 9, 1950

4 Sheets-Sheet 1



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Filed Feb. 9, 1950

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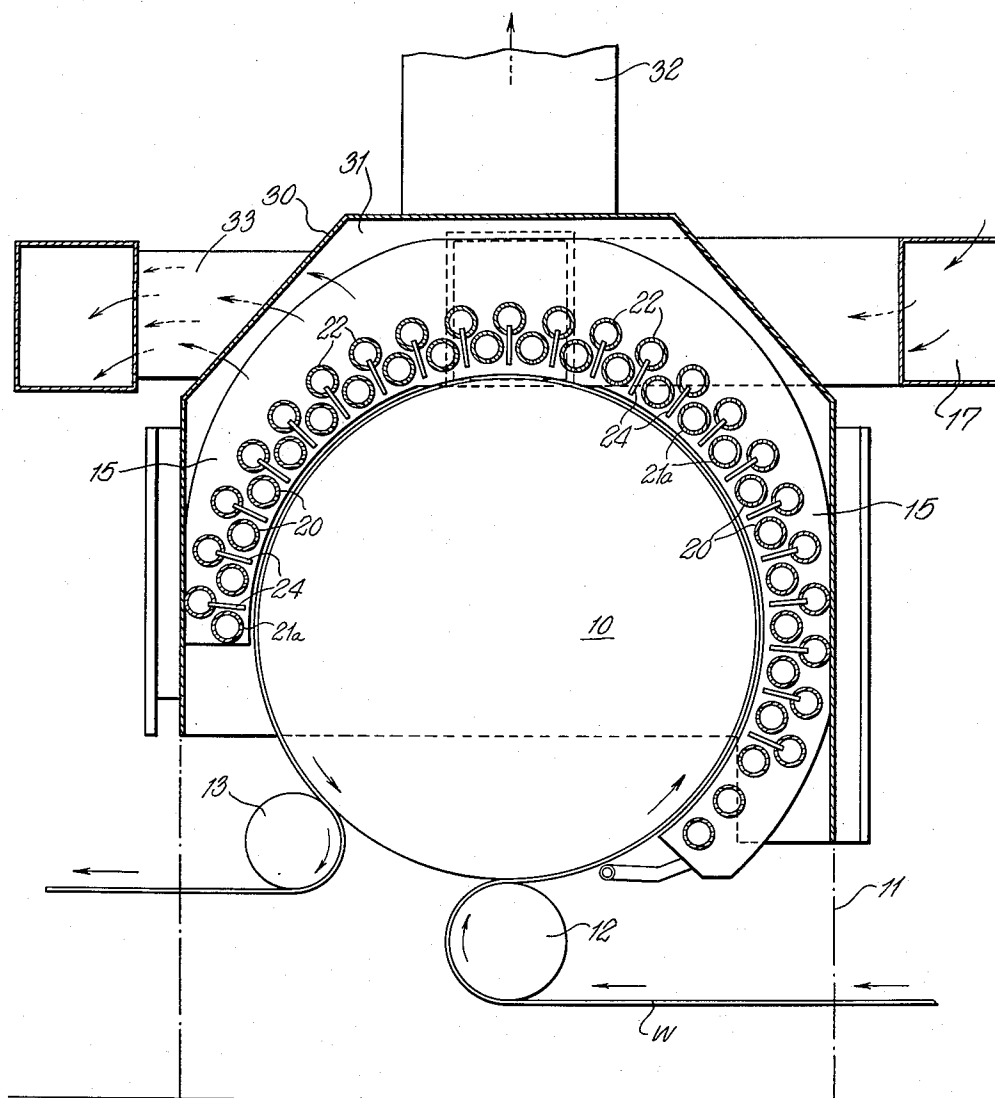


Fig. 2.

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4 Sheets-Sheet 3

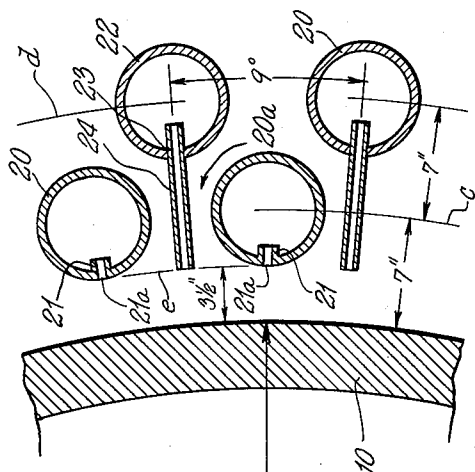


Fig. 3-

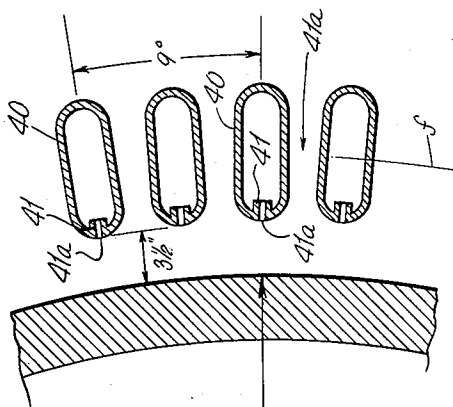


Fig. 4-



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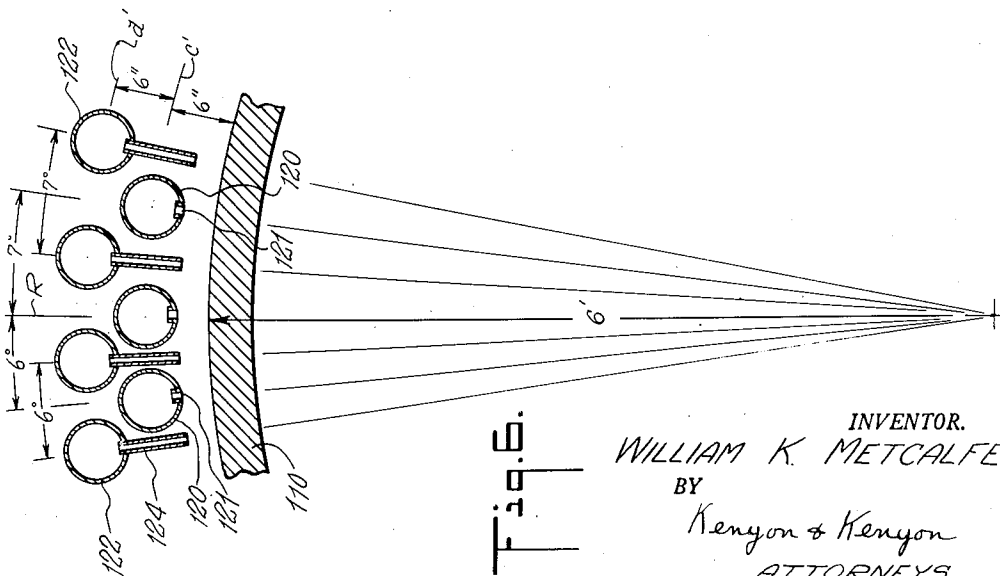
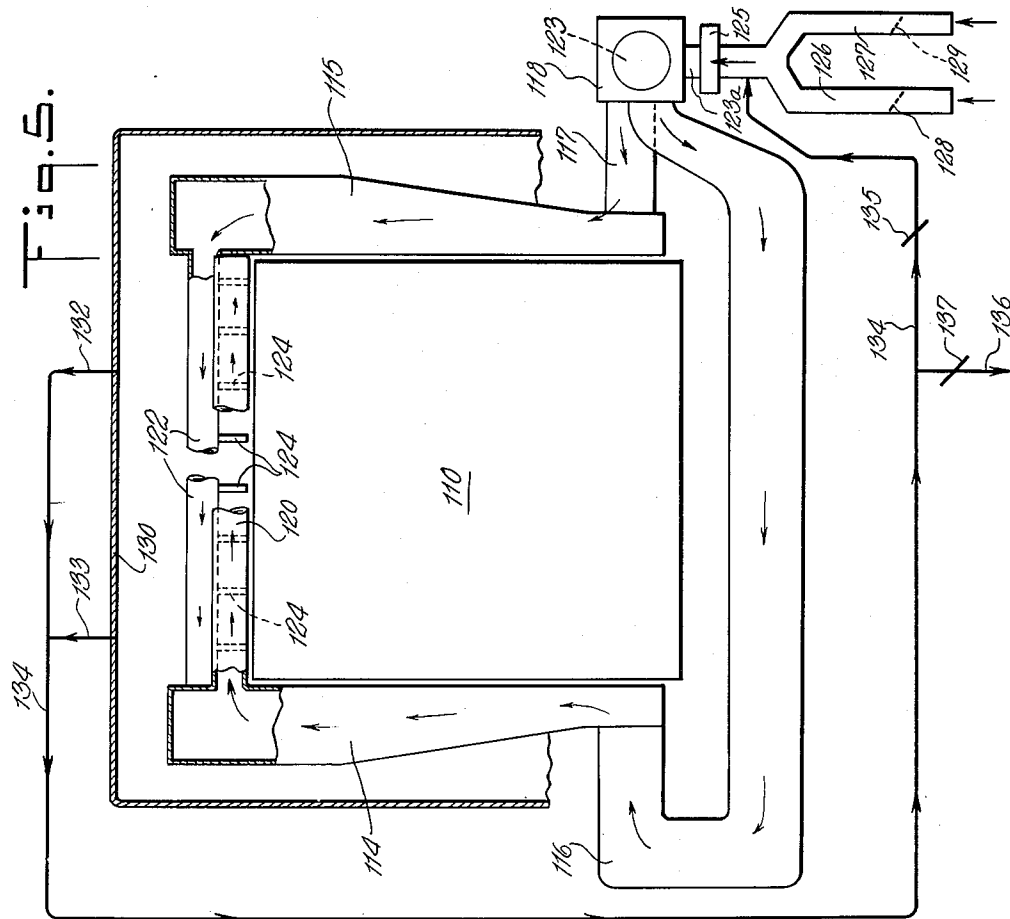
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PAPERMAKING MACHINE

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Application February 9, 1950, Serial No. 143,190

8 Claims. (Cl. 34-122)

1

This invention refers to paper making machines of the single large cylinder or "Yankee" type, frequently known as M. G. Machines, in which the moist paper is pressed against a large diameter heated drum or cylinder for drying and glazing purposes.

In conventional arrangements up to the present time, a single row of round cross-section pipes arranged around the periphery of the drum of the "Yankee" dryer which varies from 8 to 12 feet in diameter and spaced apart just sufficiently to allow for the expended air to find its way between adjacent nozzles has been employed. This arrangement results in blasts of air from the nipples of the nozzle pipes hitting the paper sheets on the drum at spaces from 9 inches to 11 inches apart.

The paper industry has found it advantageous to utilize more air in the drying process to speed it up and, moreover, that impingement of air at smaller increment spacing than that presently available is highly desirable and advantageous. In fact, if air flow can be substantially doubled and if the increment spacing substantially halved, the desirable features and advantages demanded by the industry will result.

Principal features and objects of this invention, therefore, are to provide structure of a practicable nature that will meet the current industrial demand of substantially doubled air flow, and substantially halved increment spacing between air blasts over that of present available arrangements.

In providing the increased air flow, it has been found that the larger quantities of air necessary, require an arrangement whereby part of the impinging air normally flowing to exhaust is reutilized by recirculation, being mixed with the make-up air prior to introduction thereof into the heaters and passage thereof to the air pipes and their nozzles or nipples. Thereby it is possible to handle about twice the quantity of air as formerly used, the division being about 1/2 make-up air and 1/2 recirculated air in the circulating system.

Further objects and features of the invention, therefore, are the provision of an air system including an arrangement for recirculation of part of the exhaust air so as to provide the necessary air for the enlarged air flow needed over that in conventional air circulating systems now commonly employed.

Further objects and features of the invention are the provision of arrangements that can be readily incorporated in existing structures without material modification of the latter.

2

Other objects and novel features of the invention will become apparent from the specification and accompanying drawings wherein:

Fig. 1 is an end elevation, partially in section, of a machine of the type described, embodying the invention;

Fig. 2 is a transverse section taken along the line 2-2 of Fig. 1;

Fig. 3 is an enlarged fragmentary section of details of the structural features of the invention;

Fig. 4 is a similar enlarged fragmentary section of details of a modified form of the invention;

Fig. 5 is an end elevation, partially in section, of a modified structure embodying the invention; and

Fig. 6 is a transverse, fragmentary section on an enlarged scale of details of structural feature of the modification of Fig. 5.

Referring to the drawing and first to Figs. 1-3 inclusive thereof, the machine comprises the usual drum or cylinder 10 mounted for rotation in the frame 11, and provided with the usual feed-on or pressure roll 12 and a stripper 13 for the paper W. Semi-annular headers 14 and 15 are mounted on frame 11 and positioned adjacent opposite sides of the cylinder or drum 10. The headers 14 and 15 are connected respectively by supply ducts 16 and 17 to the outlet 18 of an air fan or blower 19 which in turn may be supported on a platform provided on the frame 11 or elsewhere. This fan or blower has a large capacity. Each header 14 and 15 extends around at least one-half of the cylinder or drum 10 and diminishes progressively in cross-section away from the fan. A set of pipes 20 of substantially circular cross-section is connected either to the header 14, or to both headers 14 and 15. These pipes 20 extend parallel with the longitudinal axis of the cylinder or drum 10 and are equally spaced apart to provide air escape spaces 20a over the drum surface. For example, in an embodiment wherein the drum or cylinder 10 has a 5-foot radius for its outside diameter, the axes of the pipes 20 all lie in a pitch circle c (Fig. 3) of approximately 5'7" radius and are spaced apart approximately an arc of 9° or approximately 11". The outside diameter of each pipe is approximately 7", so that the least distance between the pipe surfaces and the adjacent outside surface of drum or cylinder 10 is at least 3 1/2". The least space 20a available between adjoining surfaces of the pipes 20 is approximately 4". These dimensions are merely exemplary and may be altered as desired. In the embodiment shown, twenty-five pipes 20

are utilized extending over an arc of approximately 216° of the pitch circle. The arcuate extent may be varied as desired as may the number of pipes. These pipes 20 are supported at one end by the header 14 to which they are connected and at their other ends in any appropriate manner, for example, by soldering to a wall of header 15. The pipes 20 each have a plurality of depressed nozzles 21 whose outlet orifices 21a are directed toward the surface of drum 10 or have a narrow slot or perforation extending the full width of the paper W passing over the drum or cylinder 10.

A second set of pipes 22 is provided, each pipe 22 being connected at one end to and supported from the header 15 and communicating therewith. These pipes 22 also extend parallel with the longitudinal axis of the cylinder or drum 10 and their axes are equally spaced apart over the drum surface and lie in a pitch circle *d* of approximately $6\frac{1}{2}$ " in radius. There are twenty-two pipes 22 in the embodiment shown. Any desirable number may be used. The axes of these pipes 22 are centralized relative to the axes of pipes 20 so that the approximate spacing between any axis of a pipe 20 and an axis of a directly adjacent pipe 22 is approximately 9". In other words, the axis of each pipe 22 lies at the apex of an isosceles triangle whose base is defined by the two axes of the two next adjacent pipes 20 and the legs of each isosceles triangle are approximately 9" in length while its base is approximately 11" in length this latter being the distance between axes of any two adjacent pipes 20.

Outlet holes 23 corresponding in number to the orifices 21a are provided in each pipe 22. An outlet nozzle 24 is connected or positioned in each hole 23. These nozzles 24 extend radially of pipes 22 between the spaces 20a between adjacent pairs of pipes 20 and are centralized relative to said spaces 20a. The nozzles 24 are all of the same length and their outer ends 24 all terminate in a pitch circle *e* which is common with the pitch circle common with the outlet orifices 21a of the nozzles 21 of pipes 20 closest to the outer surface of drum or cylinder 10. In the embodiment shown, forty-eight nozzles 24 are mounted on each pipe 22, their axes being equally spaced apart a distance of approximately $2\frac{3}{4}$ " and each being approximately 1" in diameter. Fewer or more nozzles 24 may be used. Thus, the blasts of air from the outlet orifices 21a of nozzles 21 of pipes 20 and from the outlet ends of nozzles 24 are all directed against the paper W on drum or cylinder 10 from a like distance which, in the embodiment shown, is approximately $3\frac{1}{2}$ " from the surface of said drum or cylinder 10. The other ends of the pipes 22 are supported suitably from the header 14 on the side of drum or cylinder 10 as by soldering or the like.

A hood 30 encloses all the pipes 20 and 22 and that portion of the cylinder or drum 10 over which the sets of pipes 20 and 22 lie. This hood is spaced apart from the drum surface and pipes 20 and 22 to provide collecting space 31 for exhaust or spent air blown against the paper W from pipes 20 and 22. An exhaust duct 32 is provided in the hood 30, and in communication with the space 31.

It is material to provide a larger capacity blower or fan 18 to blow or feed air to the two sets of pipes 20 and 22 to provide substantially twice the air over that of conventional equipment. The hood 30 has a recirculating air duct 33 connected to and communicating with the space 31. This duct 33 is connected directly to the make-

up air duct 34 that supplies the fan 19, and in advance of the heater 35, so that the air supplied to the two sets of pipes 20 and 22 from fan 18 via ducts 16 and 17 and headers 14 and 15 consists of a mixture of make-up air drawn in from the surrounding air through duct 34 and recirculated air withdrawn from space 31 via duct 33. Preferably this duct 33 is connected to the duct 34 in advance of the usual heater 35 so that the mixture of make-up air and recirculated air reaching the fan 19 will be thoroughly heated. It is, if desirable, possible to utilize a separate fan in the exhaust duct 33 and supply recirculating air from that duct through a heater to feed one of the two ducts 16 or 17, in which event only the other of these two ducts will receive make-up air from fan 19.

Operation

Assuming operating conditions, the arrangement described operates as follows: Air from ducts 34 and 33 consisting of make-up air and exhaust air passes through heater 35 wherein it is thoroughly heated, and is blown from fan 19 through outlet 18 into ducts 16 and 17 passing therefrom to headers 14 and 15 which distributes it respectively to the two sets of pipes 20 and 22, whence via orifices or openings 21a and outlet ends of nozzles 24, it is directed against the paper W on the drum or cylinder 10 at a distance of approximately $3\frac{1}{2}$ " from the drum surface and with an arcuate spacing of approximately $4\frac{1}{2}^\circ$ between air jets delivered respectively by the outlets or orifices 21a and nozzles 24 of any adjacent pair of pipes 20 and 22. The arcuate spacing between such jets is approximately one-half the arcuate spacing (9°) between jets which would be provided from orifices 21a if only a single set of pipes 20 were employed. It would vary, of course, if different arcuate spacing were used. Moreover, since the total number of pipes 20 and 22 is approximately double the number of pipes 20, substantially twice the amount of drying air is delivered to the paper on the cylinder or drum 10. The combination of halved spacing between jets and substantially doubled quantity of air available greatly speeds up the effective action of the air on the paper and meets current industrial demands.

The spacing between individual pipes 20 of the first set of pipes remains substantially that of systems extant and the location and arrangement of the individual pipes 22 of the second set of pipes together with the introduction of the nozzles 24 does not materially reduce the exhaust space available between pipes 20 or materially impede flow of exhaust air to space 31 of hood 30 and its exhaust duct 32. By computation, on the basis of the dimensions given, it can be shown that introduction of the second set of pipes 22 reduces the exhaust space only about 1.8% which does not materially impede satisfactory operation. In other words, about 98.2% of exhaust space area remains available.

The exhaust air in the hood space 31 exhausts in part through duct 32 and the remaining part is drawn via recirculation duct 33 for mixture with make-up air in duct 34 in advance of heater 35. The provision of this recirculating arrangement for exhaust air provides the required amount of air for the two sets of pipes 20 and 22 with an appropriate capacity fan, about one-half of the air circulated being fresh or make-up air and the balance exhaust air.

Modification

In order to simplify the system described above and to eliminate the necessity for a double-row arrangement of pipes 20 and 22 as illustrated in Figs. 1-3 inclusive while securing all the benefits and advantages of that system and the increased airflow, the modification of Fig. 4 is provided. In that system, the circular cross-section pipes 20 and 22 are replaced by an equal number of pipes 40 of substantially oval cross-section and whose major cross-sectional axes extend radially toward the axis of the drum or cylinder 10. The minor cross-sectional axis of these pipes 40 is made small enough so that three such pipes 40 may be positioned in an arc of 9° as shown in Fig. 4 allowing sufficient space between adjacent pipes 40 for the escape of spent or exhaust air. All of these pipes 40 have outlet nozzles 41 with openings or orifices 41a identical in kind and purpose with nozzles 21 and orifices 21a of pipes 20. In the embodiment shown in Fig. 4, there would be forty-seven pipes 40 arranged over an arc of substantially 216° of the pitch circle *f* of the cross-sectional centers of the elliptical pipes. The airflow capacities of the pipes 40 is substantially equal to the airflow capacities of pipes 20. Preferably the minor outside cross-sectional axis of each pipe 40 is approximately 2" so that the narrowest spacing between adjoining surfaces of a pair of pipes 41 is approximately 3½". This provides adequate venting space 40a for exhaust air into the hood space 31. All of the pipes 40 are conveniently supplied with air from one header, like header 14, with which each pipe communicates. In the alternative but less preferable arrangement, alternate pipes 40 are supplied with air by a header like header 14 with which they communicate and the remaining pipes 40 are supplied with air by a header like header 15 with which they communicate or all pipes may be supplied from each header. A hood, like hood 30, is employed and it has a recirculating air duct identical with duct 33 of hood 30 so that part of the exhaust air is recirculated and mixed with make-up air for the fan in the same way as in the system of Figs. 1-3 for identical purposes. The use of flattened cross-section pipes 40 thus enables the insertion of substantially double the number of pipes like pipes 20 in the same arcuate area about the cylinder without the necessity for the double-row arrangement of Figs. 1-3 and without the necessity of providing the extension nozzles like nozzles 34 of pipes 21. In the modifications of Figure 4 and Figures 1-3, the distance between the innermost and outermost portions of the pipe surfaces in a direction radial to the drum or cylinder is greater than the width of a pipe in a direction circumferentially of the drum or cylinder; and the spacing between the pipes is less than the said radial distance. The outlets of all of the pipes are arranged at substantially the same distance from the drum or cylinder. The arrangement of Fig. 4 operates like and fulfills all the objects of Figs. 1-3 inclusive and provides all the advantages of the latter-named figures while at the same time reducing the number of parts required, thereby providing a cheaper device that is simpler to install. Where two headers like 14 and 15 are used for alternate of the pipes 40, the header that does not supply the alternate pipes is utilized as a support for the non-header communicating pipes, these ends being either soldered to a wall of the header or otherwise suitably secured thereto. Where only a single header like header 14

is used to supply all pipes 40 with air, the non-header communicating ends of the pipes 40 are supported in any conventional manner from a support (not shown) at the non-header side of the cylinder or drum 10. Operation of this modification is substantially identical with that of Figs. 1 to 3 inclusive and need not be further described.

In the embodiment shown, in Figs. 1 and 2, specific dimensions, e. g., distances apart between pipes 20 and relative locations of pipes 22, have been described together with a certain angular dispersion of the pipes over the drum. Also, spacing between all pipes 20 has been described as uniform and specific numbers of pipes have been given. Successful operation, however, is not dependent upon the dimensions, angular dispersion, or number of pipes described. A modified construction is illustrated in Figs. 5 and 6, wherein different numbers of pipes, spacing, angular dispersion and other dimensional factors are utilized as well as other modified structure.

In these figures, thirty-six pipes 120 corresponding to pipes 20 are utilized and twenty-seven pipes 122 are utilized. Fewer or larger numbers may be used. Twenty-two of the pipes 120 are uniformly distributed or dispersed over an arc of approximately 132° to the left of the vertical line R and their central axes spaced apart from each other 6°, the remaining fourteen of the pipes 120 are uniformly dispersed or distributed over an arc of approximately 98° to the right of the vertical line R and their central axes spaced apart 7° from each other. Nineteen of the pipes 122 to the left of the line R are uniformly dispersed over an arc of approximately 102° with their central axes 6° apart, while the remaining eight of the pipes 122 to the right of the line R are uniformly dispersed over an arc of approximately 49° with their central axes 7° apart from each other. Fewer or larger numbers of pipes on each side of line R may be used. Preferably the concentration of pipes at the left of line R is greater than at the right because this is the region where the larger amount of moisture and vapor will be eliminated from the paper. The central axes of pipes 122 are offset relative to those of pipes 120 so that each central axes of each pipe 122 constitutes an apex of an isosceles triangle whose base is defined by the central axes of the two pipes 120 directly adjacent thereto.

The outside radius of drum 110 is approximately 6". The radius of the pitch circle *c'* of the central axes of pipes 120 is approximately 6'6" and the radius of the pitch circle *d'* of the central axes of pipes 122 is approximately 7". Each of pipes 120 and 122 has approximately an outside diameter of 6". Each nipple 124 of each pipe 122 which corresponds with nipple 24 of pipe 22 is a ¾" pipe and each nozzle or nipple 121 corresponding with the nozzles or nipples 21 of pipe 20 is also ¾" in diameter. The diametrical distance between the terminal or outlet ends of nipples 121 and 124 and the outer surface of drum 110 is approximately 3". These dimensions all may be varied.

Pipes 120 are supplied with air from header 114 corresponding to header 14 and pipes 122 are supplied with air from header 115 corresponding to header 15. In the alternative, all pipes 120 and 122 may be supplied with air from both the headers 114 and 115. Header 114, in the embodiment shown, is connected to a supply duct 116 while header 115 is connected to a supply duct 117. The two ducts 116, 117 are

connected to a distributor duct 118 containing a divider to receive air supply from the outlet of a fan 123 whose inlet in turn is connected to a duct 123a containing a heater 125. The duct 123a communicates with a pair of inlet ducts 126, 127 containing respective dampers 128, 129 for drawing make-up air into the system. Exhaust ducts 132, 133 from the hood 130 connect with a common duct 134 which is connected to the duct 123a in advance of heater 125 and subsequent to the connection of duct 123a with make-up air ducts 126, 127. A control damper 135 is provided in duct 134. An exhaust outlet duct 136 controlled by damper 137 is also provided for eliminating excess exhaust air from the circulating system.

Operation of the arrangement of this modification is substantially that described for Figs. 1 and 2. Herein, however, because the spacings of pipes to the left of line R is closer than that to the right of line R, and more pipes are concentrated to the left of line R, more of the air from pipes 120 and 122 is distributed over the surface of drum 110 to the left of line R in the region where the largest amount of moisture and vapor are being liberated from the sheet of paper being dried on drum 110. With the dimensions given, the minimum spacing between adjacent surfaces of pairs of pipes is approximately 2" as contrasted with a minimum spacing of approximately 4" between adjacent surfaces of pairs of pipes 20. In operation, the various dampers 128, 129 and 137 are preferably adjusted so that the air circulating in the duct system to the pipes 120 and 122 consists approximately of $\frac{1}{2}$ make-up air and $\frac{1}{2}$ recirculated exhaust air. These proportions, however, can be varied to suit different conditions encountered in practice by appropriate adjustment of the dampers. In addition, if desired, a separate fan could be installed in the exhaust duct 134, or elsewhere, for supplying the exhaust air to the duct 123a, if the capacity of fan 123 were not large enough to maintain necessary circulation. In such event, the fan 123 would act to supply the make-up air to the system while the added fan would feed necessary exhaust air to duct 123a in advance of heater 125 for mixing with make-up air coming from ducts 126 and 127.

While preferred embodiments of the invention have been described, variations in structural detail are possible within the scope of the claims. There is no intention, therefore, to the exact details shown and described.

What is claimed is:

1. A paper making machine having a large diameter cylinder or drum over which paper is fed for drying, comprising an air fan or blower of large capacity having an inlet duct and an outlet, a multiplicity of pipes extending over a considerable portion of the cylinder or drum where evaporation takes place, conduit means connecting the outlet of the fan with said pipes, said pipes having outlets to direct air against said paper over local areas so as to rid the paper of moisture and vapor and to come in actual contact with the paper, and having spaces between adjacent pairs of pipes of sufficient width to allow free escape of the air between the spaces, said pipes being arranged in two substantially concentrically arranged sets, the pipes of both sets having outlets arranged at substantially the same level, a hood surrounding said cylinder or drum and said pipes and defining an exhaust air chamber therewith, said hood having an ex-

haust outlet, and an air recirculating outlet, and a duct connecting the air recirculating outlet to the inlet duct of said fan whereby a portion of the exhaust air from said chamber is recirculated and intermixed with make-up air entering the inlet duct of fan.

2. A paper making machine according to claim 1, in which the outlets of one set of pipes include nozzles extending between adjacent pairs of pipes of the other set of pipes, said nozzles having outlets terminating at substantially the level of the outlets of the said other set of pipes.

3. A paper making machine according to claim 1, wherein the spacing between adjacent pipes of each set is substantially uniform.

4. A paper making machine according to claim 1, wherein the spacing between adjacent pipes of each set is different in different local areas.

5. A paper making machine according to claim 1, wherein the spacing between adjacent pipes of each set is different in different local areas being closest in the local areas where the largest amount of moisture and vapor is being liberated from the paper, and wherein more pipes of each set are concentrated in the last-named local areas.

6. A paper making machine having a large diameter cylinder or drum over which paper is fed for drying, comprising an air fan or blower of large capacity having an inlet duct and air outlet, a header connected to the outlet and located at one side of said drum, a second header also connected to the outlet and located at the opposite side of said drum, a set of pipes extending laterally from the first-named header over a considerable portion of the cylinder or drum where evaporation takes place and communicating with said first-named header, said pipes being close to the paper and having openings to direct air against the paper over local areas so as to rid the paper of moisture and vapor and to come in actual contact with the paper, and having spaces between adjacent pairs of sufficient width to allow free escape of the air through the spaces, a second set of pipes extending laterally from the second-named header substantially over said same portion of said drum and communicating with said second header, said second set of pipes being spaced from the first set of pipes with each pipe of the second set centralized relative to a space between adjacent pairs of pipes of the first set so that its axis is located at the apex of an isosceles triangle whose base is defined by the axes of a said adjacent pair of pipes of the first set, nozzles projecting from each of the pipes of the second set between the space between each of adjacent pairs of pipes of the first set of pipes for directing air toward said paper at substantially the same distance from the cylinder or drum as that of the openings in the first set of pipes, a hood surrounding said cylinder or drum and both sets of pipes and defining an exhaust air chamber therewith, said hood having an exhaust outlet and an air recirculating outlet, and a duct connecting the air recirculating outlet to the inlet duct of said fan whereby a portion of the exhaust air in said chamber is recirculated and intermixed with make-up air entering the inlet duct of said fan.

7. A paper making machine according to claim 6 including a heater in said inlet duct to said fan, and wherein the duct from the air recirculating outlet of said hood is connected to the inlet duct

of said fan in advance of said heater whereby the recirculated air and make-up air are mixed and heated before entering the fan.

8. A paper making machine having a large diameter cylinder or drum over which paper is fed for drying, said machine comprising an air fan or blower of large capacity having an inlet duct and air outlet, a multiplicity of pipes extending over a considerable portion of the cylinder or drum where evaporation takes place, said pipes being in two substantially concentrically arranged spaced sets, conduit means connecting the outlet of the fan with said pipes, said pipes having outlets to direct air against the paper over local areas so as to rid the paper of moisture and vapor, the spaces between adjacent pairs of pipes being of sufficient width to allow free escape of air through said spaces, and the outlets of all of the pipes being arranged at substantially the same distance from the cylinder or

drum, and a hood surrounding said cylinder or drum and said pipes and defining an exhaust air chamber therewith.

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