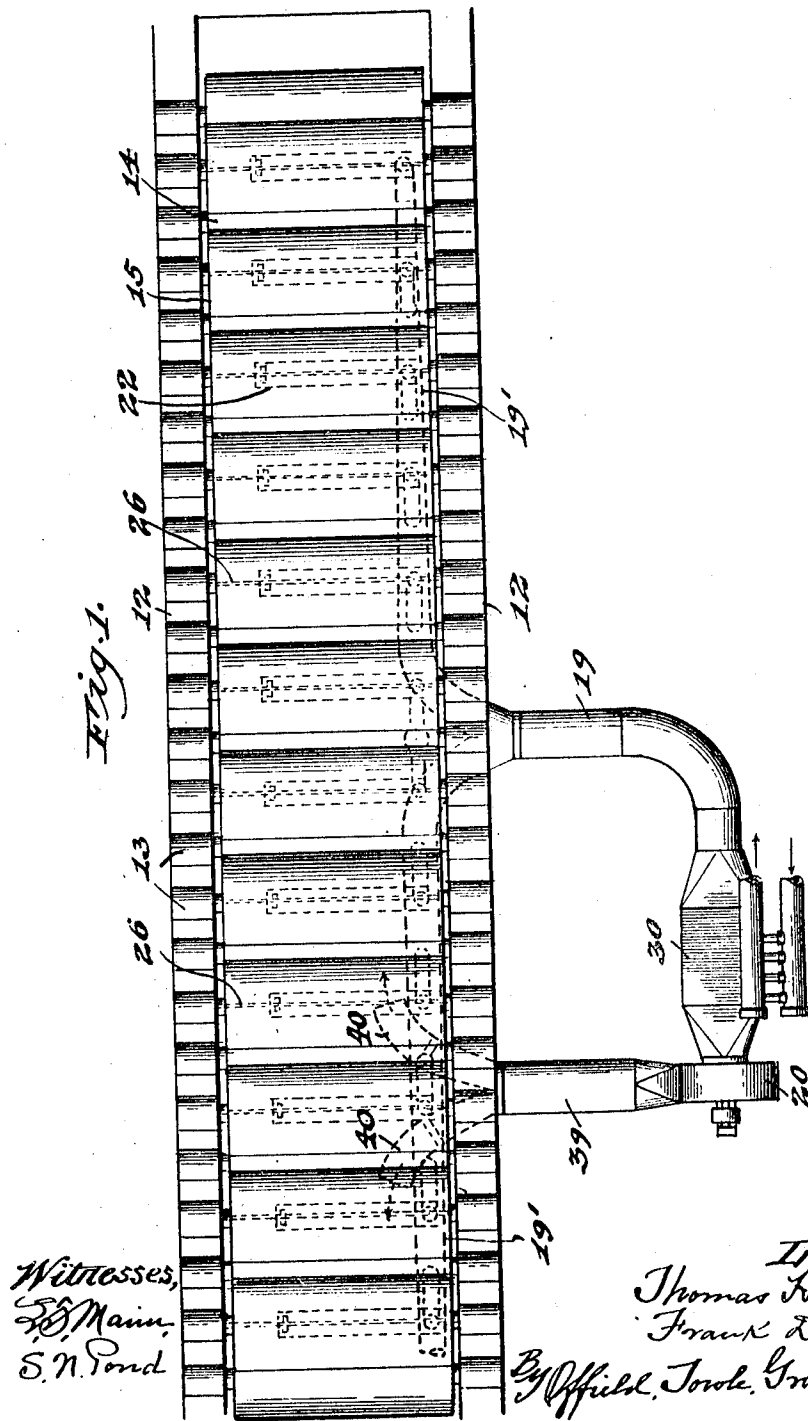


T. H. BELCHER & F. D. WILSON.
 PAPER MAKING MACHINE AND METHOD OF DRYING PAPER.
 APPLICATION FILED SEPT. 7, 1909.

1,035,678.

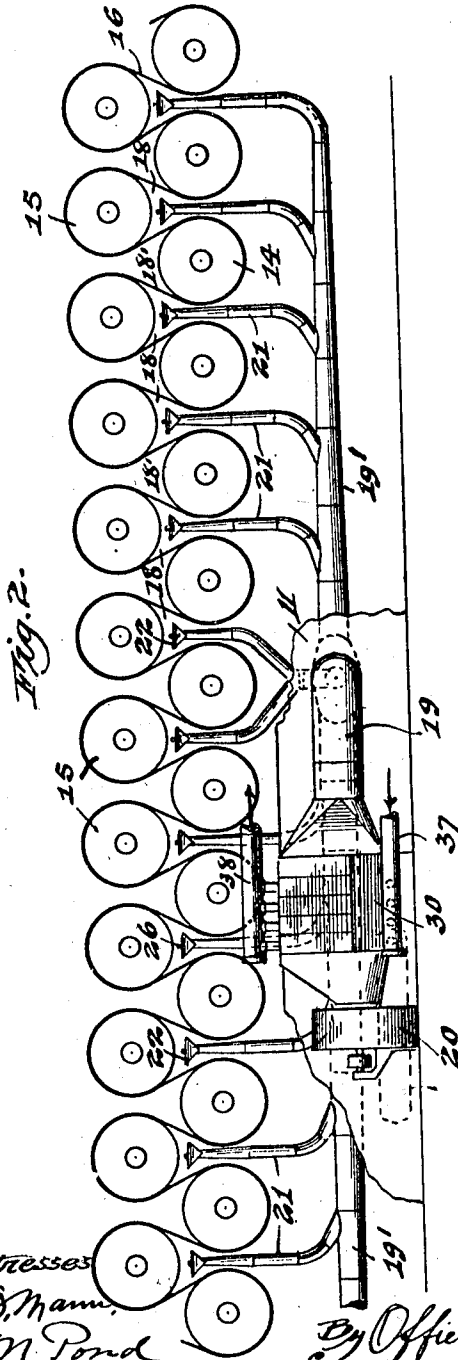
Patented Aug. 13, 1912.
 4 SHEETS—SHEET 1.



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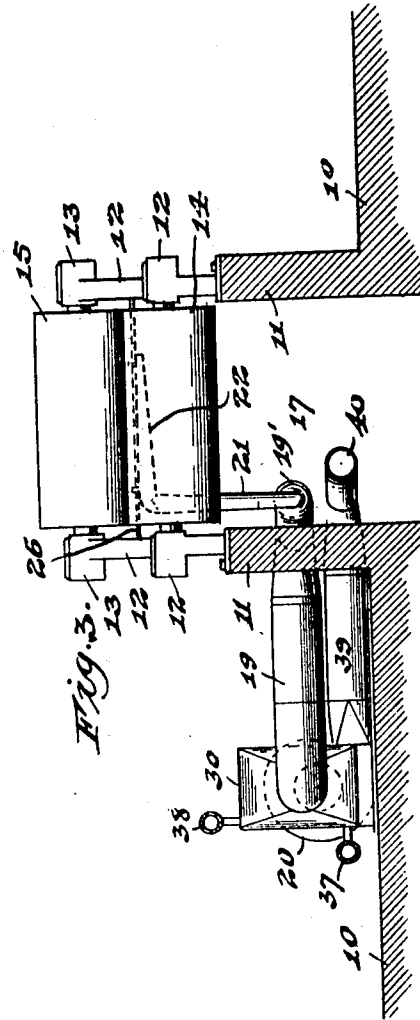
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 4 SHEETS-SHEET 2.

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Witnesses
 J. D. Mann,
 S. N. Pond

By *Offield, Towle, Granger & Offield*
 Attys

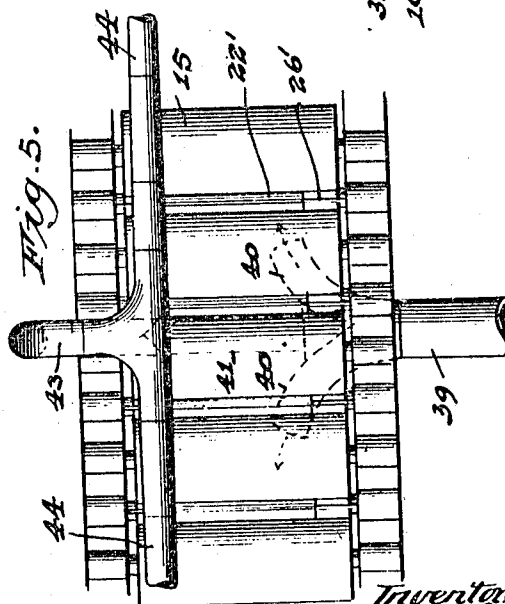
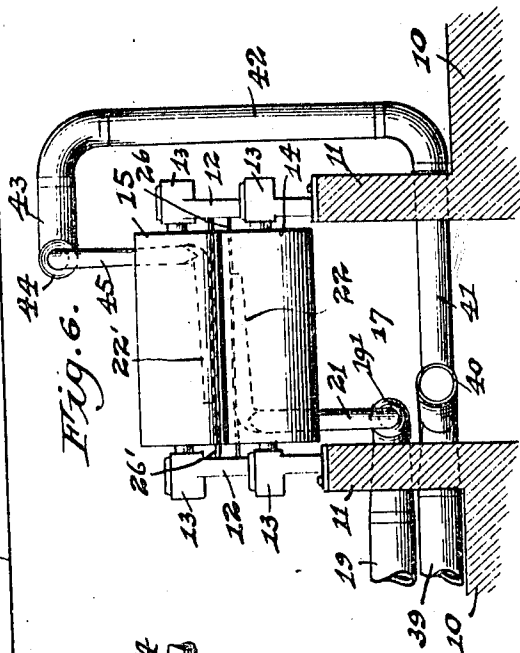
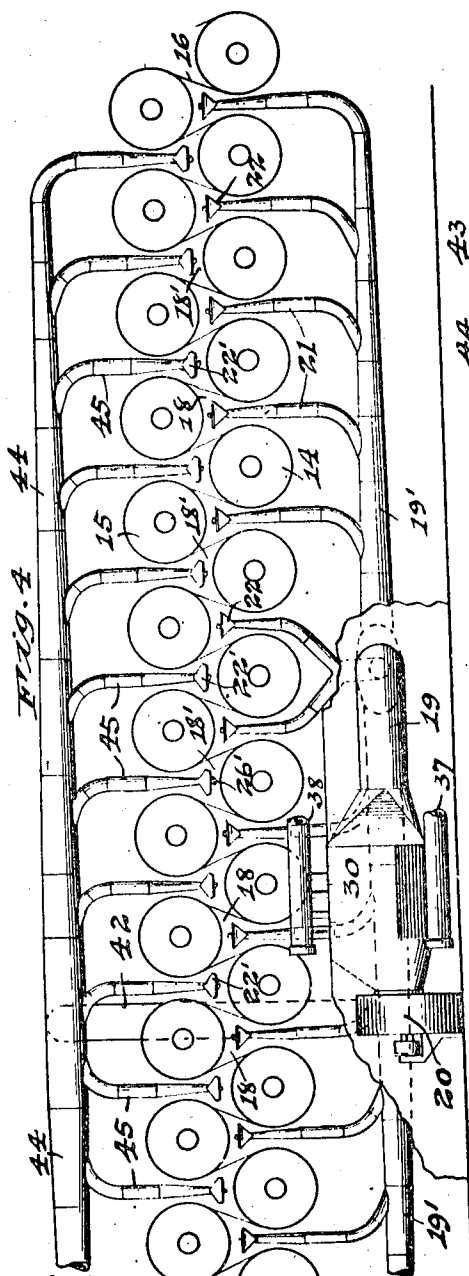


Inventors,
 Thomas H. Belcher,
 Frank D. Wilson,
 By *Offield, Towle, Granger & Offield*
 Attys

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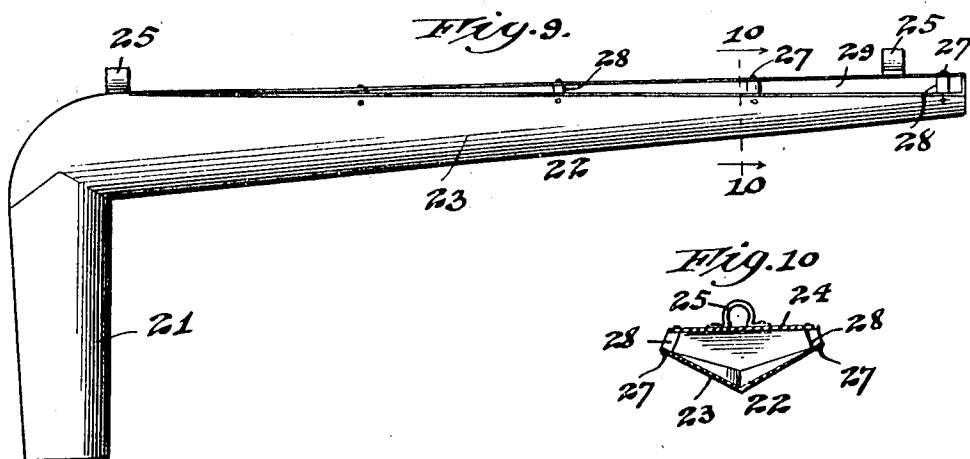
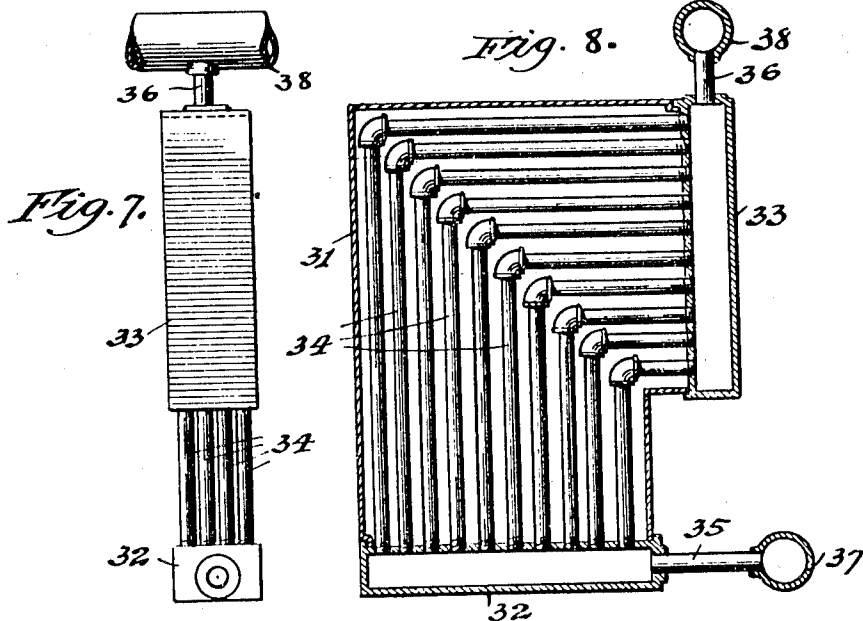
Inventors,
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 By Offield, Towle, Gross & Offield, Attys.

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4 SHEETS-SHEET 4.



Witnesses,
 S. B. Mann,
 S. N. Pond

Inventors,
 Thomas H. Belcher,
 Frank D. Wilson,
 By Offield, Towle, Green & Offield,
 Attys.

UNITED STATES PATENT OFFICE.

THOMAS H. BELCHER, OF CHICAGO, AND FRANK D. WILSON, OF OAK PARK, ILLINOIS;
SAID BELCHER ASSIGNOR TO SAID WILSON.

PAPER-MAKING MACHINE AND METHOD OF DRYING PAPER.

1,035,678.

Specification of Letters Patent.

Patented Aug. 13, 1912.

Application filed September 7, 1909. Serial No. 516,567.

To all whom it may concern:

Be it known that we, THOMAS H. BELCHER and FRANK D. WILSON, both citizens of the United States, and residents, respectively, of Chicago and Oak Park, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Paper-Making Machines and Methods of Drying Paper, of which the following is a specification.

This invention relates to the general art of paper-making, and has reference more particularly to improvements in the manner and means of effecting the drying of the paper web in a cylinder machine between the squeezing rolls and the receiving reel or calendering rolls where the latter are employed.

As is well known, it has heretofore been necessary, in this type of machine, to pass the damp web over and in contact with drying rolls, which are ordinarily heated internally by steam, in order to drive out the moisture and present the paper to the receiving reel in a perfectly dry condition; and to insure the complete expulsion of the moisture a long series of such heated rolls, between and over which the paper web travels comparatively slowly, has been necessary. These drying rolls are usually arranged in two or more rows or series, one above the other, and in staggered or alternating relation, with the paper web traveling in a zig-zag course back and forth between the rolls of the series. The heating of the damp web in this manner through direct contact with the hot drying rolls causes the web to give off large volumes of steam and vapor; and by reason of the fact that the arrangement of the cylinders is such as to form, with the web passing thereover, a series of pocket-like spaces which are constantly filled with such steam and vapor, the drying of the web is considerably impeded by the presence of the moisture therein contained which finds no adequate means of escape and is largely re-absorbed into the web. This is especially true of those pockets which are closed at their upper ends by the cylinders. Of course, the alternate pockets, which are open at their upper ends, are less subject to this undesirable condition, since they afford a somewhat freer means of escape for the steam and hot moist air gener-

ated therein; but nevertheless they hinder to a considerable extent the free escape of the moisture from the vicinity of the upper surface of the web and to that extent impede the drying action. Heretofore it has been the practice in some cases to dispose of the cloud of steam rising from the apparatus by means of a hood overhanging the entire series of rolls and provided with a suction-creating device, but this has been chiefly for the purpose of preventing the room from becoming filled with the steam, and does not prevent to any appreciable extent the re-absorption of the steam and moisture by the web, especially as regards the lower series of pockets, which are closed at their upper ends. This condition is productive of another serious fault in machines of this character. Owing to the fact that the marginal portions of the web, by reason of their more exposed position, re-absorb less of this partially confined steam and vapor, such marginal portions dry out more rapidly than the intermediate portion of the web, thus putting such marginal portions under greater tension, which frequently results in the breaking of the web, causing great delay and inconvenience.

The purpose of the present invention is to cure these evils in machines of this type; and the principle upon which the invention proceeds involves the removal of the steam and vapor collecting in these pockets by positive means located in the pockets themselves.

In the most practical form of the invention which we have devised, the removal of the moisture from the lower pockets, or those presenting closed upper ends, is through the agency of suction, while the moisture collecting in the upper pockets is removed through the agency of a blast of dry air directed against the portions or sections of the web forming the side walls of the pocket. This dry air blast may be supplied from any suitable source, but preferably it is the hot suction draft drawn from the lower pockets with the moisture removed therefrom by a condenser or any other suitable air-drying device. To prevent the breaking in two of the web from the cause above referred to, the removal of the steam and vapor is so effected as to cause the intermediate portion of the web to dry out

at least evenly with the marginal portions, and preferably slightly more rapidly, since a slightly greater contraction of and tension in the intermediate portion does not create any danger of breakage and positively insures against breakage at the margins.

To facilitate a clear understanding of our invention and its mode of application and operation, we present herewith drawings, which show that portion of the paper-making machine which effects the drying of the paper web between the squeezing rolls and the receiving reel or calendering rolls, having applied thereto an apparatus capable of satisfactorily effectuating the purposes of the invention and representing one practical mechanical embodiment thereof.

In these drawings—Figure 1 is a top plan view, showing our improvements applied to the removal of steam and vapor from, and the introduction of dry air to, the lower surface of the web only. Fig. 2 is a side elevation of the apparatus as shown in Fig. 1, with the supporting frame and journals of the cylinders on the side nearest the observer removed for the sake of greater clearness. Fig. 3 is an end elevation as viewed from the right of Fig. 2, in cross-section through the floor and side walls of the usual underlying pit. Fig. 4 is a side elevational view similar to Fig. 2, showing the application of moisture-removing means to the upper surface of the web. Fig. 5 is a fragmentary top plan view of Fig. 4. Fig. 6 is an end elevation as viewed from the right of Fig. 4, in cross-section through the floor and side walls of the underlying pit. Figs. 7 and 8 are details in elevation at right angles to each other of a practical form of condenser which may be used for drying the air. Fig. 9 is a side elevation, on an enlarged scale, of a form of suction-head employed in the lower series of pockets, which, inverted, may also be employed to deliver the blast of dry air into the upper series of pockets; and Fig. 10 is a cross-sectional detail on the line 10—10 of Fig. 9.

Referring to the drawings, and describing first parts which represent common practice in machines of this character, 10 designates the floor and 11 a pair of walls supporting skeleton frames 12 which carry the journals 13 of two horizontal rows of hollow steam-heated cylinders or drums 14 and 15, the cylinders 15 being arranged above and in staggered or alternating relation to the cylinders 14. 16 designates the paper web which passes into the field of action of the drying cylinders at one end of the group from the usual squeezing rolls, the web traveling back and forth between the drums or cylinders of the upper and lower series in the manner clearly shown in Figs. 2 and 4. 17 designates what is commonly called the pit, being the space beneath the cylinders

and between the supporting walls 11. As is well known, a large number of these cylinders are at present required to effect a thorough drying of the paper web, this number increasing with the speed at which the web is caused to travel therethrough, so that, in order to increase the capacity of a machine by a speedier operation thereof, it has been necessary to increase the number of drying cylinders employed, and, conversely, any decrease in the number of cylinders employed is at the expense of its speed of operation and consequently of its capacity. The passage of the damp web over these heated cylinders is accompanied, of course, by the expulsion of a large amount of steam and vapor which thoroughly saturates the air in the vicinity of the web; and the presence of the lower and upper pocket-like spaces 18 and 18' which are formed between each cylinder and the sections of the web lying between the same and the two cylinders of the opposite series on either side thereof hinders to a considerable extent the free escape of the steam and moisture-laden air, with the result that a considerable portion of the moisture driven off by the heat of the cylinders is re-absorbed into the web. This condition is especially aggravated in the case of the lower series of pockets 18 which are closed at their upper ends by the upper cylinders 15, since the natural tendency of the steam and hot moist air is to rise. As above pointed out, this condition of affairs also produces uneven drying of different transverse portions of the web, since the marginal portions of the latter, being in the region of the open ends of the pockets, dry more rapidly than the intermediate portion, with the result that they contract and break under the tensional strain produced by such construction.

Considering now those features in which our present improvements reside, whereby we chiefly rid the machine of the evils referred to, and referring first to the apparatus shown in Figs. 1 to 3 and 7 to 10, inclusive, 19' designates each of a pair of main suction pipes which extend lengthwise of the pit 17 adjacent to one of the walls 11 thereof, beneath the drying cylinders, these suction pipes 19', in the arrangement shown, forming a junction with a laterally extending suction-pipe 19 that leads to the suction side of any suitable air-forcing device, such as a centrifugal fan blower indicated at 20. Extending upwardly from the main suction-pipes 19' between adjacent cylinders 14 of the lower row are branch suction pipes 21, each of which communicates at its upper end with the adjacent end of what we term, as applied to the lower series of pockets, a suction-head, designated as an entirety by 22; this latter being shown in detail in Figs. 9

and 10. This suction-head may, within the purview of the invention, comprise any device capable of effecting the abstraction under suction of practically all the steam and vapor-laden air collecting within the pockets 18; but one simple and practical form of such device which we have formed by test to operate satisfactorily is that herein shown, and comprises a generally trough-like structure 23 tapered or narrowed in the vertical direction toward its free end and provided with a top wall 24 carrying on its upper side eyes 25 by which the head is suspended and supported from a rod 26 extending between the supporting side-frames of the cylinders. The edges of the top 24 are connected to and spaced from the upper edges of the trough-shaped body 23 by bolts or rivets 27 and interposed spacing sleeves 28, thereby producing on either side of the suction-head longitudinal intake openings or slots 29 that are preferably tapered and of increasing width toward the free end of the head remote from the suction-pipe 21. The purpose of the described formation of suction opening or openings is to neutralize the stronger suction action occurring at the inner portion of the head by a greater area of such opening at the more remote points of the suction-head, so that the suction draft will be substantially uniform throughout the entire length of the head. This effect can, of course, be produced by other forms and arrangements of suction ports or openings in the head embodying the same principle.

It will be seen by reference to Fig. 1 that the suction heads are not quite co-extensive longitudinally with the drying cylinders, but underlie the intermediate portions of the latter, stopping short of both ends of the cylinders. While the exact length of the head as related to the cylinder is immaterial, it is preferably made shorter and arranged substantially as shown, for the reason that it is desirable to slightly retard the drying effect at the margins of the web as compared with the intermediate portion to avoid the danger of breaking referred to.

Our invention further contemplates the return and utilization in a dry condition and as a positive drying agent of the moist air thus drawn off from the lower pocket spaces; for which purpose we pass this air through a suitable drying device. The device herein shown consists of a condenser of that general type employing a plurality of pipes or coils through which cold water is caused to circulate and over which the moist air is drawn. Such a condenser is indicated as an entirety in Figs. 1, 2 and 3 at 30, and is shown as interposed in the suction-pipe 19 on the suction side of the blower 20, although it may be located on either side of the latter. One practical form

of such condenser which may be employed is shown in detail in Figs. 7 and 8, and comprises an outer casing 31 made up in part by a plurality of intake and delivery headers 32 and 33, respectively, each connected by a plurality of bent pipes 34, said headers being connected by short pipe sections 35 and 36 with main water supply and delivery pipes 37 and 38, respectively. No novelty is claimed, however, for the particular condenser shown and described, and any other forms or types of air driers may be employed. The air thus dried is returned to the vicinity of either or both surfaces of the web in the form of a positive drying blast or draft. Where the return is solely to the under surface of the web, as shown in Figs. 1, 2 and 3, it is effected by means of a delivery pipe 39 having a branched delivery end, such as 40, located within the pit, whence the dried air may circulate freely beneath the lower row of cylinders and rise into the pockets 18 to replace the steam and moisture-laden air drawn therefrom.

We have found in practice that the drying of the air and the return of the same in this manner gives more satisfactory results than where the moist air drawn off is replaced by air induced through the open vertical sides of the pockets, because such latter action tends to unduly accelerate the drying of the marginal portions of the web. This dried air may also be wholly or partially used to assist the drying action on the upper surface of the web; and in Figs. 4, 5 and 6 of the drawings we have represented a somewhat more complete or elaborate form of the invention, wherein this is done. Referring to these views, 41 (Fig. 6) designates a central branch extension of the dry air delivery pipe 39 that extends across the pit and through the opposite side wall thereof, continuing thence upwardly by a vertical section 42, and thence inwardly by a short horizontal section 43, the inner end of the latter communicating with oppositely extending main delivery pipes 44 (Fig. 4), depending from which latter are a series of branch delivery pipes 45 leading down into one end of the upper series of pockets 18', the lower ends of said branch pipes communicating freely with heads 22' similar in all respects to the suction-heads 22 above described, in inverted position, said heads being supported on cross-rods 26' between the side frames 12. By this apparatus the dry air blast is divided, part of it passing into the pit through the branches 40 and a part passing upwardly through the pipes described and being delivered directly into the pockets 18' lying between the cylinders of the upper row, thus forcing dry air where heretofore there has been but very little circulation and giving an additional air-drying

effect and causing a rapid discharge of the steam and vapor from between and above the drying cylinders.

While the dry air supplied to the vicinity of the web as above described is most conveniently and preferably the dehydrated current drawn off by the suction fan, yet, so far as this feature of the invention is concerned, the dry air blast may be partially or entirely supplied from an independent source within the purview of the invention.

Among the chief advantages possessed by the invention may be mentioned, first, the fact that, at a given speed, a less number of drying cylinders is required, or, with the same number of drying cylinders, the web can be run through more rapidly, and consequently the capacity of the machine increased; second, by effecting the drying of the intermediate portion of the web uniformly with or slightly in advance of the drying of the marginal portions, the delay and annoyance caused by the breaking of the web are obviated; and, third, the described expediting of the drying action very considerably reduces the power required to drive the cylinders, with the consequent gain in economy of cost of operation. We have also found that our improvements produce a paper that is tougher and of a somewhat better grade than when made from the same stock and dried on the same machine not having our improvements.

While we have described our invention in connection with a paper-making machine and contemplate that such will be its principal application, yet it is manifest that our improvements are equally applicable to advantage in analogous machines for drying webs or sheets of other material, such, for instance, as felt; and by the term "web" as used herein, we mean not merely paper stock, but webs or sheets of any material which in their course of manufacture are dried by being passed over heated cylinders or analogous devices.

It will be obvious to those skilled in the art that the specific apparatus herein disclosed for effectuating the purposes of the invention may be very considerably varied in respect to details without involving any departure from the principle of the invention or sacrificing any of the advantages secured thereby. Hence, we do not limit the invention to the particular apparatus shown and described, except to the extent clearly indicated in specific claims.

We claim:

1. In a machine of the character described, the combination with a series of drying cylinders over which the web is passed, of a corresponding series of suction-heads disposed beneath and longitudinally of said cylinders, a main suction-pipe connected with each of said heads, an air drier in com-

munication with said pipe, an air-moving device connected to said pipe, and a pipe connected with the delivery end of said air-moving device and serving to direct the dried air into the vicinity of the surface of said web, substantially as described.

2. In a machine of the character described, the combination with a series of drying cylinders over which the web is passed, of a corresponding series of suction-heads disposed beneath and longitudinally of said cylinders, each of said suction-heads comprising a hollow member formed with a tapered longitudinal slot substantially coextensive longitudinally therewith, substantially as described.

3. In a machine of the character described, the combination with a series of drying cylinders over which the web is passed, of a corresponding series of suction-heads disposed beneath and longitudinally of said cylinders, each of said suction-heads comprising a hollow trough-like member formed with a pair of longitudinal tapered slots located at the upper edges thereof and substantially coextensive longitudinally therewith, substantially as described.

4. In a paper-drying machine, the combination with upper and lower series of drying cylinders between and around which the paper web is adapted to travel, thereby forming a series of pockets above said lower cylinders and between adjacent upper cylinders, of a corresponding series of blast distributing heads located in and extending transversely of said upper pockets, and means for supplying a current of dry air to said heads, substantially as described.

5. In a machine of the character described, the combination with a series of drying cylinders beneath which the web is passed, of a corresponding series of blast-distributing heads disposed above and longitudinally of said cylinders and formed with lateral openings on either side thereof substantially coextensive with the length thereof, and means for supplying a current of dry air to said heads, substantially as described.

6. In a machine of the character described, the combination with upper and lower series of drying cylinders between and around which the web is adapted to travel, thereby forming alternate lower and upper pockets beneath the upper and above the lower series of cylinders, respectively, of a series of suction-heads located in said lower pockets, a suction pipe communicating therewith, an air-drying device in circuit with said suction pipe, an air-moving device communicating on its suction side with said suction pipe, a series of blast-distributing heads located in said upper series of pockets, and supply pipes therefor connected to the delivery side of said air-moving device, substantially as described.

7. The herein described process of expediting the drying action of paper-drying machines of the heated cylinder type, which consists in abstracting by suction the steam and vapor directly given off from one side of the paper stock during the passage through the machine, and simultaneously subjecting the opposite side of said paper stock to currents of dry air, substantially
10 as described.

In testimony that we claim the foregoing as our invention we have hereunto subscribed our names in the presence of two witnesses.

THOMAS H. BELCHER.
FRANK D. WILSON.

Witnesses:

SAMUEL N. POND,
MATTIE B. BLISS.