

No. 690,629.

Patented Jan. 7, 1902.

W. M. BARBER.  
PAPER DRYING MACHINE.

(Application filed Oct. 22, 1900.)

(No Model.)

4 Sheets—Sheet I.

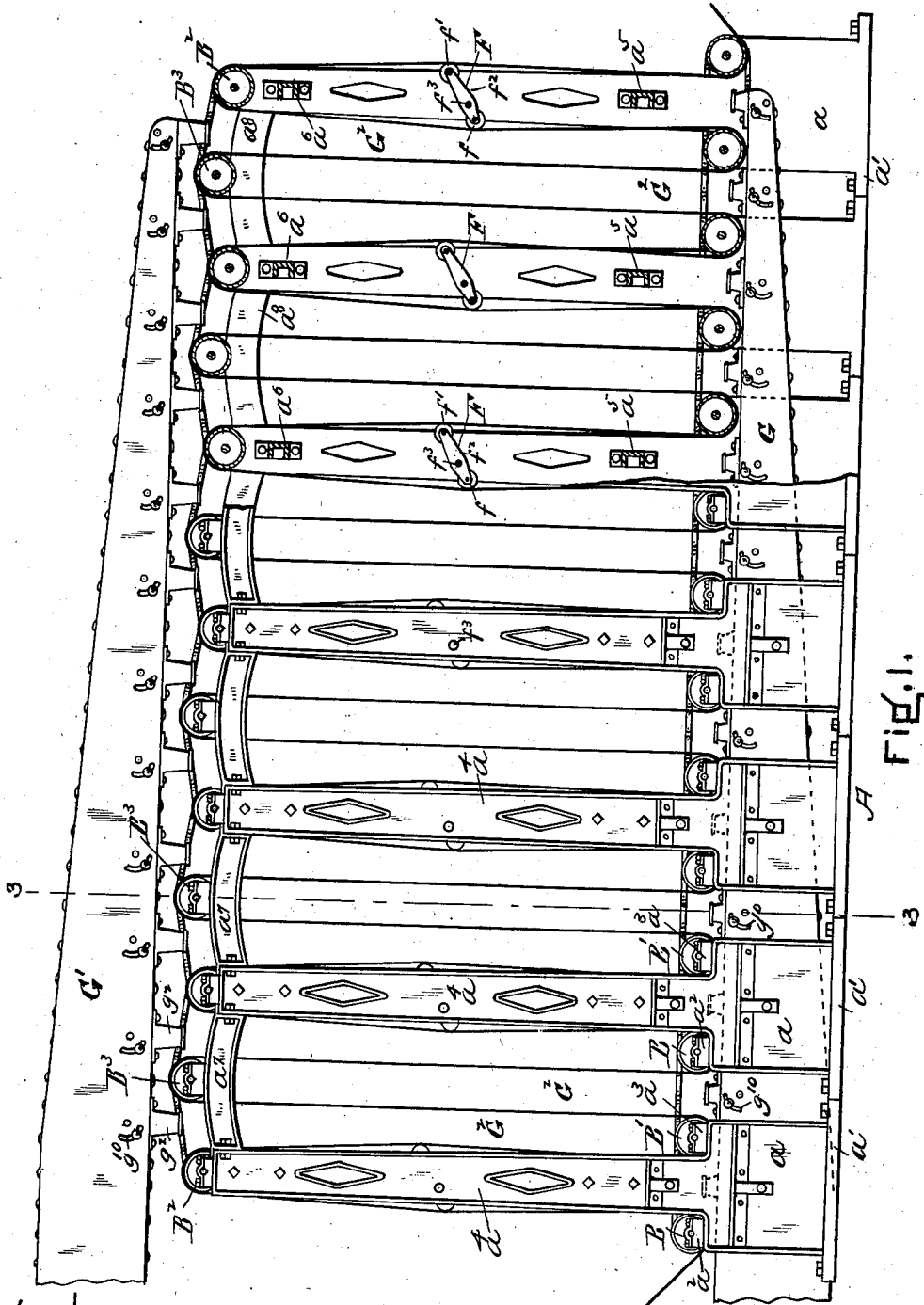


FIG. 1.

WITNESSES  
*John Dolan*  
*Aul S. S. S. S.*

INVENTOR  
*William M. Barber*  
*by his atty Charles Raymond*

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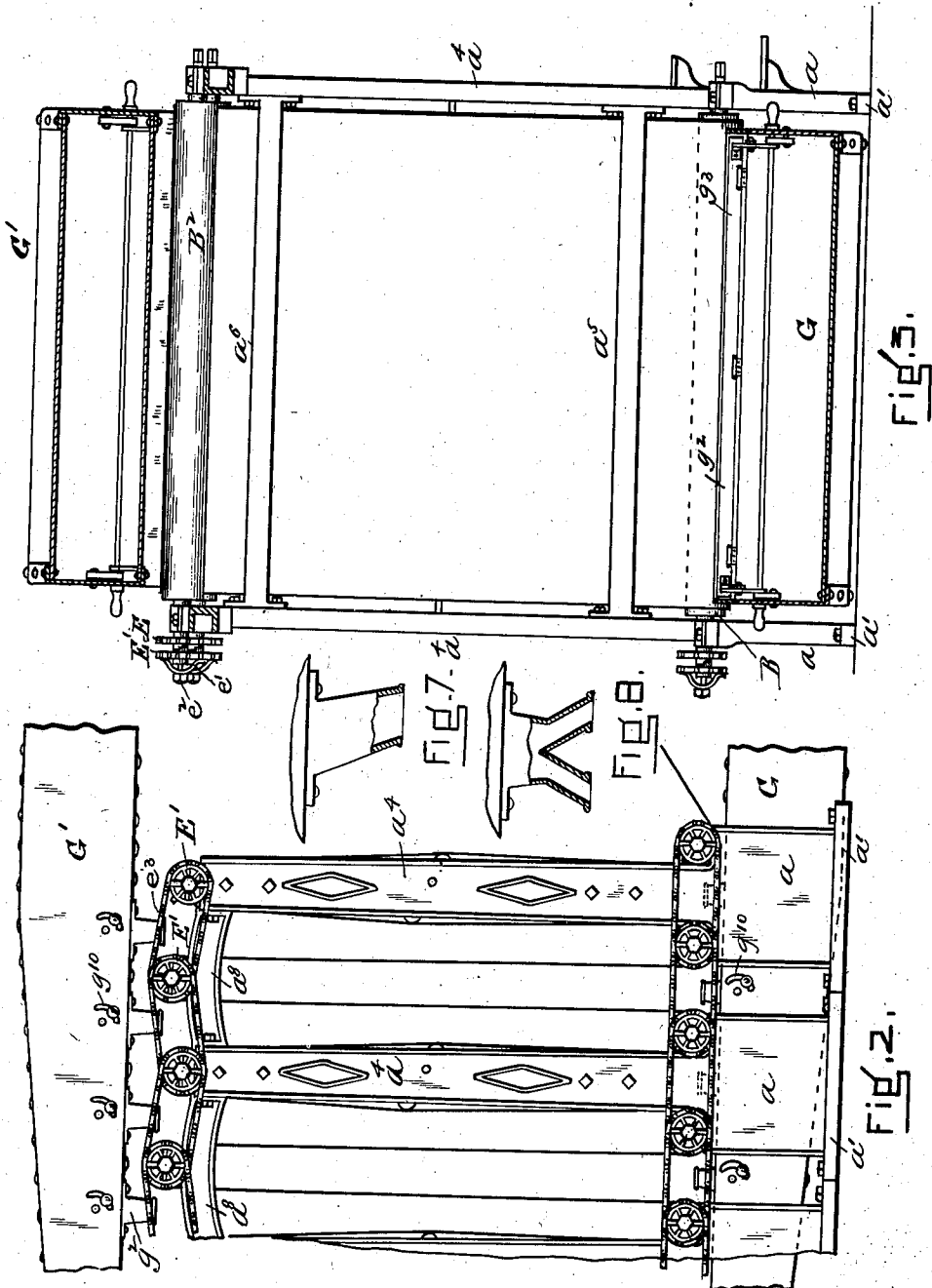
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4 Sheets—Sheet 2.



WITNESSES  
*J. M. Dolan*  
*Saul Seppastian*

INVENTOR  
*William M. Barber*  
by his attys  
*Clark & Raymond*

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4 Sheets—Sheet 3.

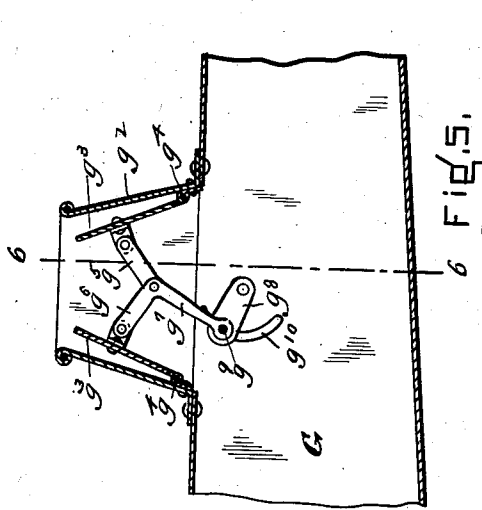


Fig. 5.

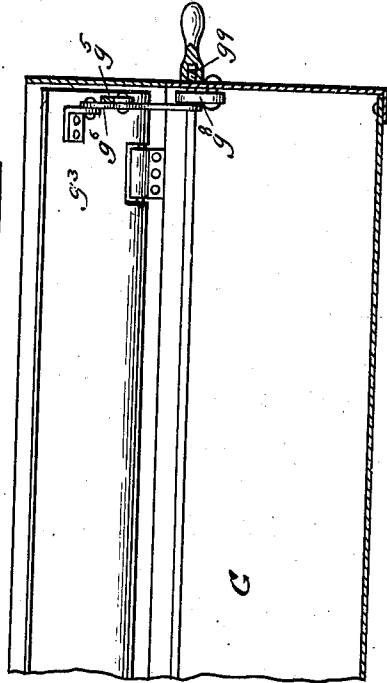


Fig. 6.

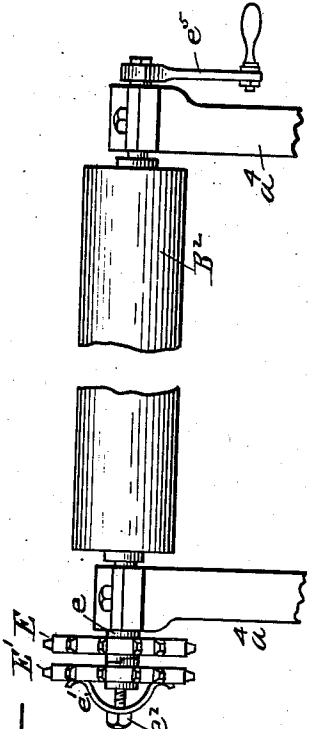
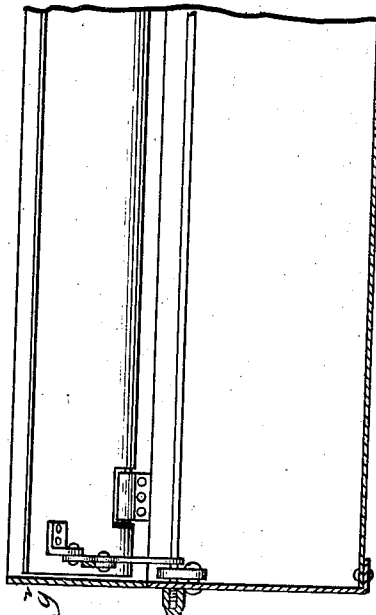


Fig. 4.

WITNESSES  
*J. M. Dolan*  
*Saul S. Siefert*

INVENTOR  
*William M. Barber*  
by *attys*  
*Clark & Raymond*

No. 690,629.

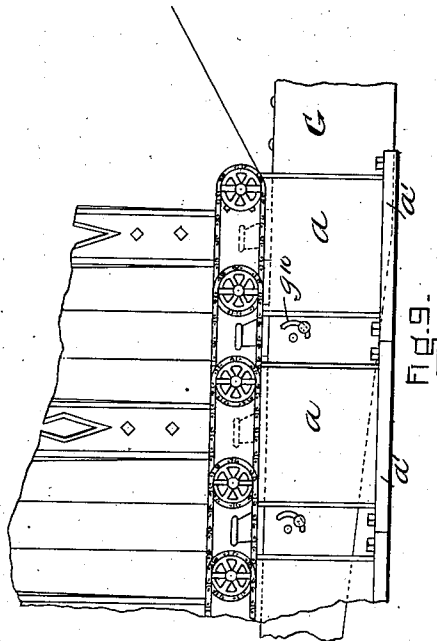
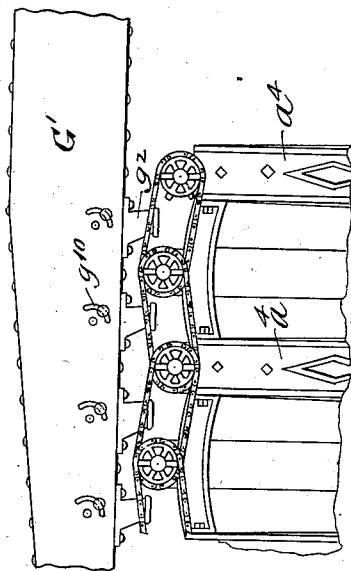
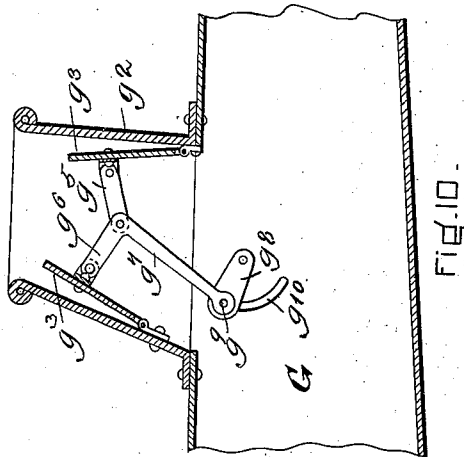
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(Application filed Oct. 22, 1900.)

(No Model.)

4 Sheets—Sheet 4.



WITNESSES:

*J. E. R. Hayes.*  
*Saul Seppenstein*

INVENTOR:

*Wm. M. Barber*  
*by his atty.*  
*Clark & Raymond*

# UNITED STATES PATENT OFFICE.

WILLIAM M. BARBER, OF SOMERVILLE, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO THE SMITH AND ANTHONY COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

## PAPER-DRYING MACHINE.

SPECIFICATION forming part of Letters Patent No. 690,629, dated January 7, 1902.

Application filed October 22, 1900. Serial No. 33,946. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM M. BARBER, a citizen of the United States, residing at Somerville, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Paper-Drying Machines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

The invention relates to an apparatus or means for drying paper in the continuous web as it passes through the paper-making machine to the calender-rolls or to the winding-roll. It is adapted to be used either with or without the calendaring devices and upon either side of them.

It consists in a grid or arrangement of rolls in two horizontal lines separated from each other perpendicularly at any desired distance and preferably arranged a little more than the diameter of a roll apart and with the upper rolls in line with the spaces between the lower rolls. These rolls are driven continuously by a friction driving mechanism, and the web leads up and down under a lower roll and over an upper roll in vertical folds or lengths practically parallel with each other and separated from each other by about the diameter of a roll. The rolls with the web of paper thus passing through them are combined with means for forcing against each vertical surface of the paper between the two lines of rolls blasts or currents of drying-air delivered in reverse directions from between the rolls, the first blast or current being forced upward from between the first two lower rolls and the second blast of air being forced downward from between the first two upper rolls, and so on, and the travelling web of paper separating the blasts or currents, so that the same web, excepting the outermost sections, will while continuously running receive on one surface a blast or current of air that is moving upward and upon its opposing surface a blast or current of air that is moving downward, and this treatment of the continuously-running web of paper is capable of indefinite extension, whereby the web in its

passage from the paper-making machine may be subjected to as many blasts or currents of air as may be necessary for properly drying the same. It will be understood that the paper as it travels over the rolls and is subjected to these drying blasts or currents may also be subjected to any desired tension between the rolls, whereby it may be more readily susceptible to the action of the drying-currents.

The air used for the drying blast or current I prefer to cleanse and dry, and there is employed in connection with the apparatus suitable air cleansing and drying means, as well as exhaust and forcing fans; but I do not consider it is necessary to illustrate these means, and therefore have not shown them in the drawings.

It is desirable in drying paper that the temperature and humidity of the air employed should be known factors, and hence my apparatus will work very effectively where the air supplied for drying is taken from the room in which the drier is located and passed through cleansing and drying appliances and again forced into the room and against the paper by means of the apparatus hereinafter described. This, however, does not have any bearing upon my present invention except as it relates to the most economical way of operating it.

I will now describe the invention in connection with the drawings, wherein—

Figure 1 is a view in front elevation of my improved machine. Fig. 2 is a view in rear elevation of a portion of the same. Fig. 3 is a view in vertical section upon the dotted line 3 3 of Fig. 1. Fig. 4 is a detail view, enlarged, in side elevation, of one of the upper rolls and the sprocket-wheels and turning device thereon. Fig. 5 is a detail view, in vertical section, of a portion of the air-duct, one of its delivery-nozzles, and means for varying the size of said nozzle. Fig. 6 is a view in vertical section upon the dotted line 6 6 of Fig. 5 and in elevation of parts back of said line. Figs. 7 and 8 are forms of air-nozzle to which reference is hereinafter made. Fig. 9 is a detail showing in rear elevation a por-

tion of my improved machine having nozzles of the character shown in Fig. 7, Fig. 10 being a detail of such a nozzle to which an adjustable mouth is applied.

5 In the drawings, A represents the frame of the machine. It is constructed in a manner to permit of indefinite longitudinal extension and is therefore of a sectional character, each section *a* consisting of two sides, each of which  
10 has a base *a'*, which rests upon a floor or support and is bolted to it, bearings *a<sup>2</sup> a<sup>3</sup>* for the pillow-blocks or other means for providing journals for the ends of the shafts of the rolls B B', and a central standard *a<sup>4</sup>*, having a pillow-block or other bearing at its upper end  
15 for one end of the shaft of the roll B<sup>2</sup>. The two sides *a<sup>1</sup>* are connected together by cross-ties *a<sup>5</sup> a<sup>6</sup>*, (see Fig. 3,) and each section is attached to the neighboring sections on each  
20 side of it by the side arches *a<sup>7</sup>* and *a<sup>8</sup>*, the said arches being detachably fastened to the tops of the standards and providing supports for the rolls B<sup>2</sup>. As many of these sections *a* may be arranged in line as may be desired. In the  
25 drawings I have represented in Fig. 1 seven of these sections supporting fourteen under or lower rolls which are upon the same horizontal plane and thirteen upper rolls, seven of which are supported by the standards *a<sup>4</sup>*  
30 and six by the intermediate arches.

The web C of paper passes from the paper-making machine or from the calender-rolls under the roll B, then up over the roll B<sup>2</sup>, then downward under the roll B', upward  
35 again over the roll B<sup>3</sup>, and so on through the machine, making as many turns and forming twice as many vertical parallel lengths as there are upper rolls, the web leaving the rear roll B of the rear section and passing to  
40 the paper-winding roll. The paper thus forms in its vertical passage about the two series of rolls a series of vertical compartments D, open at each end and the side walls of which are formed by the moving web of  
45 paper, one side of which is moving downward while the other side is moving upward. All the rolls are rotated by a rotating mechanism which permits the slip of the driving mechanism in relation to the rolls or the rolls  
50 in relation to it, and this mechanism comprises two sprocket-wheels E E' upon an extension *e* of each roll-shaft. These sprocket-wheels are coupled together to be turned together; but they are secured to the shaft by means which permit their slip upon the shaft  
55 or the slip of the shaft in respect to them, being held to the shaft by friction of any suitable kind. I have represented as one form of this frictional connection the bow-spring  
60 *e'*, the rounded ends of which bear against the outer side of the sprocket-wheel E' and which is fastened to the end of the shaft by a screw *e<sup>2</sup>*, which also adjusts its tension. The slip takes place between the side of said  
65 sprocket-wheel and ends of said spring. The outer sprocket-wheels and inner sprocket-wheels are alternately connected by the

sprocket-chains *e<sup>3</sup> e<sup>4</sup>*, the outer wheels being connected by the chain *e<sup>3</sup>* and the inner wheels by the chain *e<sup>4</sup>* on both the upper and  
70 lower rolls. Power is delivered to the end rolls by any desired means and from these rolls delivered to the other rolls by the sprocket-chain. Each roll has the end of its shaft opposite that carrying the sprocket-  
75 wheels squared to receive a handle *e<sup>5</sup>*, by means of which the roll may be turned in respect to the sprocket-wheels to take up or vary the tension upon the web. Each pair of standards also supports a tension-equaliz-  
80 ing device F, comprising the rolls *f f'* and the arms *f<sup>2</sup>*, in the ends of which the rolls have bearings. These arms *f<sup>2</sup>* are pivoted at *f<sup>3</sup>* respectively to the standards and nearer  
85 one roll than the other in order that one roll may overbalance the other and tend to keep the arms in a horizontal position and the rolls separated sufficiently to bear against the web of paper in its upward and downward course  
90 (see Fig. 1) and slightly bulge or move it outward from a direct perpendicular line, thereby acting as an automatic equalizer and take-up.

It will be understood that the paper as it dries gradually contracts or shrinks, and that there must be provision between the upper  
95 and lower rolls for permitting this contraction or shrinkage while the paper is running, and that by throwing the paper somewhat out of line by a device which is operated by the paper provision for the shortening of this web  
100 in its passage is obtained, for as the paper dries its length between the rolls is reduced by moving the equalizing or tension rolls inward, while, upon the other hand, when the paper is slack the tension or equalizing rolls  
105 preserve a proper tension upon the paper by automatically moving it outward from a direct course sufficient to take up the slack.

There are arranged below and above the rolls the air-ducts G G'. These ducts are con-  
110 nected with air-supplying passages by which air is forced by a forcing fan or device into the ducts. The area of the ducts gradually decreases, and each is provided with a series of discharge outlets or nozzles *g<sup>2</sup>*, which are  
115 arranged to deliver a blast or current of air between each pair of rolls and into the open end of each compartment G<sup>2</sup> formed by the web, as aforesaid, so that there is simultaneously delivered throughout the apparatus  
120 upon each side of the web a large number of drying blasts or currents, which alternately move in opposite directions first up and then down and each of which simultaneously acts  
125 against a surface of the web which is moving upward and a surface which is moving downward. The size of each air outlet or nozzle is adjustable to vary the volume of air discharged, and I have represented as one means for obtaining such adjustment the dampers  
130 or valves *g<sup>3</sup>* within the nozzle or outlet pivoted at their lower ends *g<sup>4</sup>*, connected together by the links *g<sup>5</sup> g<sup>6</sup>* in the nature of a toggle and opened and closed by means of a

link  $g^7$  and rock-shaft  $g^8$ , the link or rock-shaft having a stud  $g^9$  extending through a slot  $g^{10}$  in the side of the duct, the outer end of which acts as a handle by means of which the dampers or valves may be moved toward or from each other and which stud also has a clamping device for clamping it to the side of the duct with the dampers or valves in any desired position to increase or decrease the size of the air-outlet.

The operation of the device and its advantages have been described in connection with the description of the nature of the invention and of the construction of the device. I would say that I do not confine myself to the specific devices herein described for carrying the invention into effect, but may use in lieu thereof the mechanical equivalents of the same.

In Fig. 7 I have shown the nozzle or aperture through which the air drying-blast is fed against the paper web as arranged angularly to cause the blast to first strike against the web on one side and to be then deflected by the web against the surface of that part of the web upon the other side. With a single nozzle the number of times of the impact of the blast back and forth will vary with the inclination of the nozzle. With the divided nozzle (represented in Fig. 8) two blasts are simultaneously deflected against opposing web-surfaces and then simultaneously deflected toward portions of both web-surfaces beyond. In Fig. 10 is shown a nozzle like that of Fig. 7—that is, one arranged angularly, but provided with an adjustable outlet in all respects like that shown in Fig. 5. This method of directing the drying-blast against the paper web is, I consider, a superior one because it causes all the air in large volume to be forced against the paper and is therefore used in taking up the moisture and therefore becomes more thoroughly saturated and therefore more effective in its passage past the web.

It is evident that the air outlets or nozzles shown in Figs. 7 and 8 may advantageously be provided with means for adjusting their opening or openings to vary the volume of air discharged, such mechanism being preferably identical with that shown in Fig. 5. As it seemed unnecessary to show this adjusting mechanism a second time in the drawings, it is omitted from Figs. 7 and 8.

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States—

1. In a device for drying paper in the continuous web as it leaves the paper-making machine, a grid comprising two lines of rolls of comparatively small diameter, about which the web of paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end, said line of rolls being a substantial distance apart, whereby the web of paper forming the walls

of said narrow spaces will be vertical and of considerable length, and means for directing dry-air currents or blasts into said air spaces or compartments from their open ends whereby both sides of said web will be simultaneously dried by said air-currents, as and for the purposes set forth.

2. In a device for drying paper a grid comprising two lines of rolls about which the web of paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end and means for directing dry-air currents or blasts into said spaces or compartments from their open ends and automatic tension-equalizers between the two lines of rolls.

3. In a device for drying paper in the continuous web, a grid comprising two lines of rolls about which the web of paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end, and means for directing air currents or blasts into said spaces or compartments from their open ends, in combination with means for rotating said rolls, said means consisting of a power-shaft and frictional devices connecting each roll with said power-shaft, and means for adjusting the amount of friction between each frictional device and its roll, whereby the speed of rotation of the various rolls of said grid may be adjusted to conform to the shrinkage of the web being dried thereon, as set forth.

4. In a device for drying paper in the continuous web as it leaves the paper-making machine, a grid comprising two lines of rolls about which the web of paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end, frictional devices for rotating said rolls, automatic tension-equalizers between the two lines of rolls and means for directing dry-air currents or blasts into said spaces or compartments from their open ends.

5. In a device for drying paper in the continuous web as it leaves the paper-making machine, a grid comprising two lines of rolls about which the web of paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end, frictional devices for rotating said rolls, additional devices for rotating said rolls independently of said frictional devices and means for directing dry-air currents or blasts into said spaces or compartments from their open ends, as and for the purposes set forth.

6. In a device for drying paper in a continuous web, a series of pairs of independent vertical supports, each pair carrying at its upper and lower end, rolls of the character described, in combination with intermediate supports each carrying a roll arranged as described with reference to the rolls on said vertical supports whereby said rolls will form a grid extensible in length about which a web of paper may pass in a manner to form nar-

row spaces or compartments open at two sides and at one end, as and for the purposes described.

7. In a device for drying paper in the continuous web as it leaves the paper-making machine, a series of pairs of independent vertical supports, each pair carrying rolls of the kind described at its top and bottom, whereby said rolls will form a grid extensible in length about which a web of paper may pass in a manner to form narrow spaces or compartments open at two sides and at one end, the walls forming said compartments being composed of said web of paper, and means for directing dry-air currents or blasts into said air spaces or compartments and simultaneously upon both sides of the same portion of said web, as and for the purposes set forth.

8. As a means for drying paper in a continuous web, a grid comprising two lines of rolls, a web of paper passing around said rolls in a manner to form narrow spaces or compartments, two sides of which are formed by said web, the two ends of which are open, one of the other sides of said compartments being formed of one of said rolls, and means for directing dry-air currents or blasts simultaneously into the open end of each compartment, whereby each portion of the web will be dried by currents passing into the open ends of said compartments simultaneously.

9. As a means for drying paper in a continuous web, paper-stretching rolls or devices over which the web is caused to travel and by which the web is held under tension, frictional devices by means of which said rolls are caused to rotate and means for simultaneously directing dry-air currents or blasts against both surfaces of said traveling web of paper while under tension, whereby the paper will be dried and allowed to shrink during its travel, as and for the purposes set forth.

10. In a device for drying paper in the continuous web, a grid comprising two lines of

rolls about which the paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end, and two air-ducts, one located above the upper line of rolls and the other below the lower line of rolls, each air-duct gradually decreasing in area from one end to the other, the large ends of the air-ducts being respectively above and below the same end of said grid and each air-duct being provided with an opening in line with the end openings of said compartments, as and for the purposes set forth.

11. In a device for drying paper in the continuous web a grid consisting of two lines of rolls about which the web of paper passes in a manner to form narrow spaces or compartments which are open at two sides and at one end, means for directing air currents or blasts into said spaces or compartments from their open ends consisting of nozzles connected with a source of air-supply and devices for varying or adjusting the size of the outlet of said nozzles.

12. In a paper-drying machine the combination of the stand, the rolls supported thereby and the automatic tension-equalizer comprising the arms  $f^2$  pivoted to the stands as described and bearing at their outer ends the tension-rolls  $f, f'$ .

13. In a paper-drying machine, in combination with a continuously-traveling web arranged to travel on parallel or substantially parallel lines, means for deflecting a drying-blast angularly against said web whereby it is caused first to strike one of the surfaces of said web and then to be deflected by it so as to strike the surface of the web diagonally opposite where it first strikes.

WILLIAM M. BARBER.

Witnesses:

F. F. RAYMOND, 2d,  
J. M. DOLAN.