

Nov. 18, 1924.

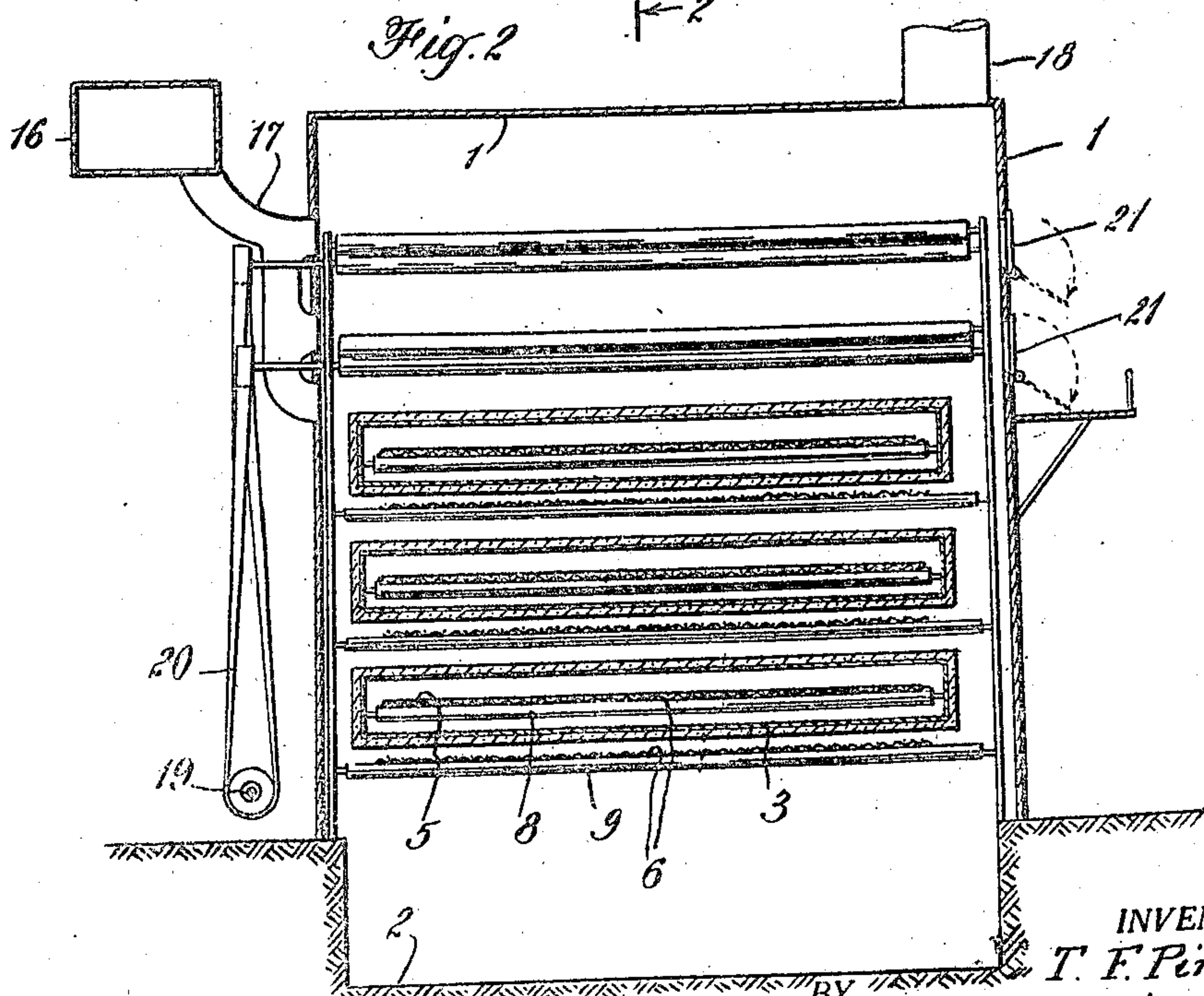
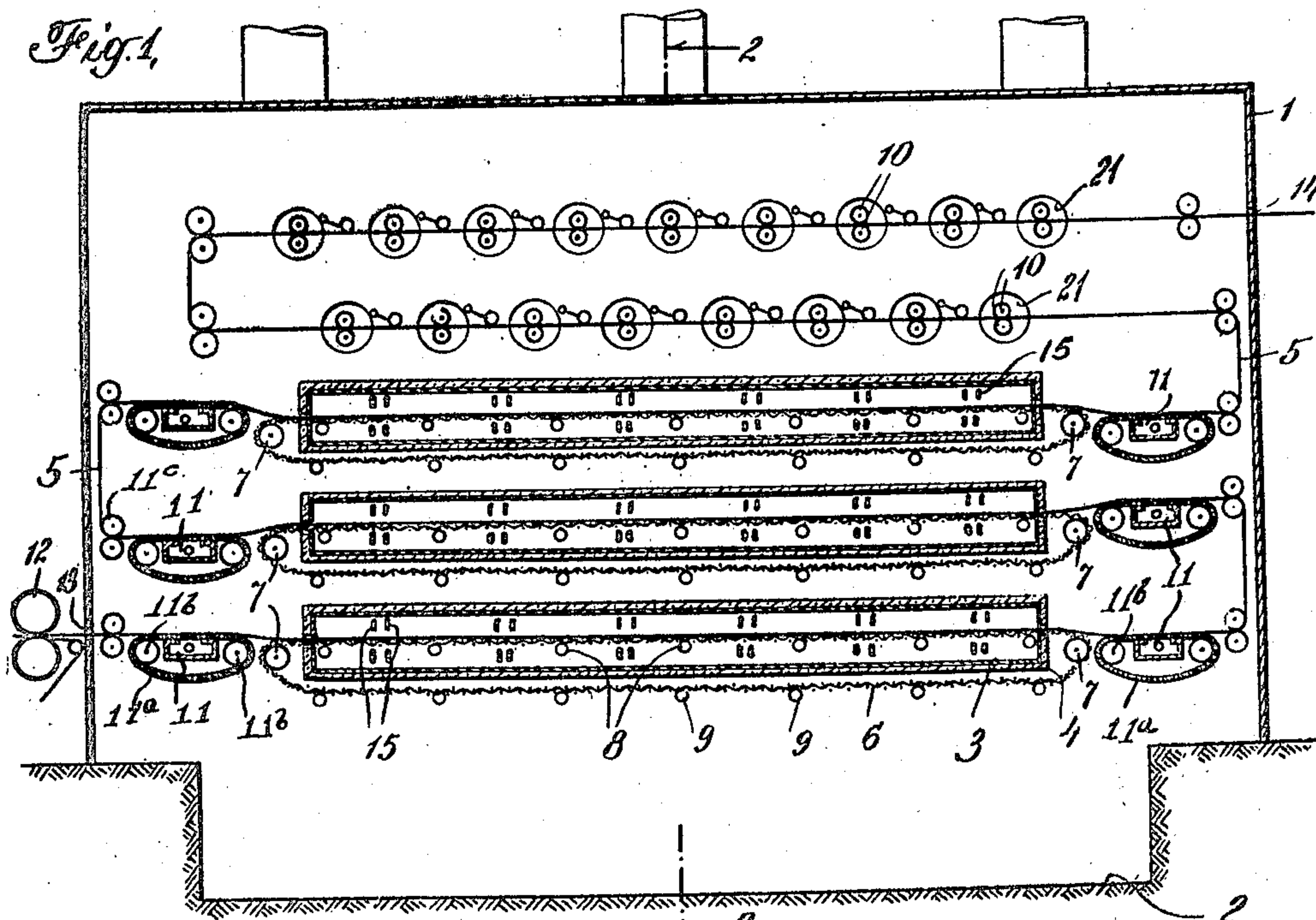
1,515,614

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METHOD AND MACHINE FOR DRYING PAPER

Filed Feb. 2, 1922

2 Sheets-Sheet 1



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Fig. 3,

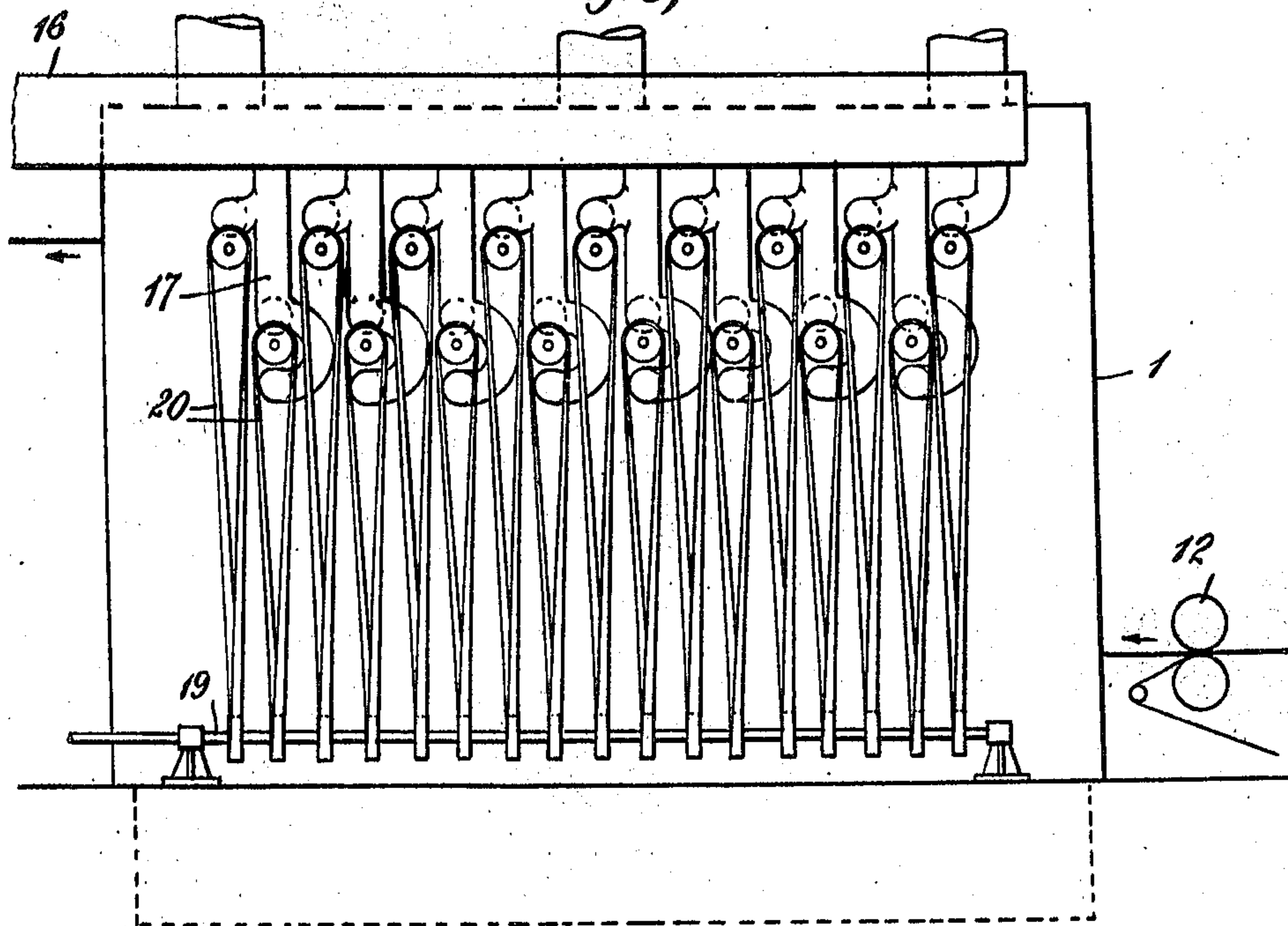
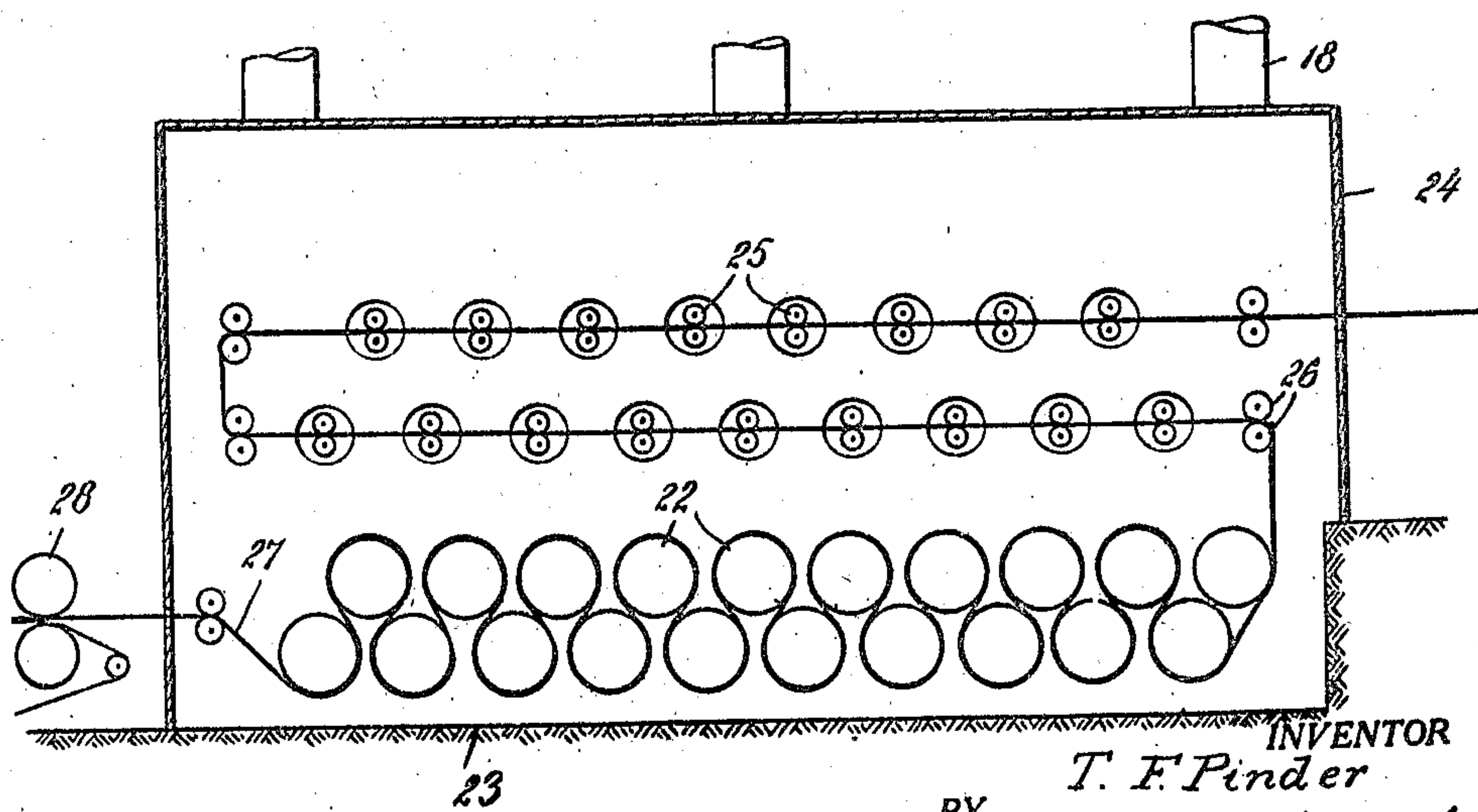


Fig. 4.



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UNITED STATES PATENT OFFICE.

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METHOD AND MACHINE FOR DRYING PAPER.

Application filed February 2, 1922. Serial No. 533,687.

To all whom it may concern:

Be it known that I, THOMAS F. PINDER, a citizen of the United States, residing at Ardmore, in the county of Montgomery, State of Pennsylvania, have invented certain new and useful Improvements in Methods and Machines for Drying Paper; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention is an improvement in methods and machines for drying paper, and relates particularly to methods and machines for drying the heavier grades of paper. In present methods of paper making, evaporation is relied upon to remove the excess moisture. Obviously such moisture cannot be removed except at the surface of the paper web and it must travel to the surface by way of the pores of the web. In some grades of paper, namely those which are relatively thick, such for instance, as paper board, the web is composed of a plurality of layers, and the pulp fibers of each layer are interlaced and intermeshed with each other. The fibers of adjacent layers are not, however, so intimately interlaced and intermeshed. In making such paper, successive layers of pulp, more or less compact, are superposed, and the fibers of the several layers are in effect distinct from those of adjacent layers, merely lying alongside such fibers, without being interlaced or intermeshed therewith. In paper so made, the fibrous structure of the web is not of a homogeneous character throughout the thickness of the web. The continuity of the pores, that is of the cellular structure of the web, is interrupted between the layers, and the travel of the moisture to the faces of the web is checked and hindered at the abutting faces of the adjacent layers. Hence, a large amount of heat is necessary to dry the paper, and the finished product is not so uniform in texture and moisture content as is desired. Compression of the web to express the moisture can be carried only to a certain degree, and only a relatively small amount of moisture can be expressed at any one operation. As soon as the pressure is relaxed, the web because of its natural resiliency expands, and a large amount of the expressed moisture is reabsorbed.

In the present invention, I provide a method of drying, wherein compression and evaporation are alternated, the paper web being subjected to recurring compressions, whereby to express only such quantity of moisture as may be quickly and completely evaporated before any considerable quantity thereof is reabsorbed, and before the web is again compressed. I subject the paper web, to what is, in effect, a kneading operation, thereby to work the moisture from the center of the paper toward the surfaces where it may be easily evaporated, and I so treat the web prior to compression, that the contained moisture is of a temperature such that when expressed it will quickly evaporate, and may be expeditiously removed without the necessity for reheating, and with the avoidance of surface drying of the paper web.

In the drawings;

Figure 1 is a longitudinal vertical section showing diagrammatically one embodiment of the invention.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 is a rear elevation of the embodiment of the invention shown in Figs. 1 and 2.

Figure 4 is a view similar to Figure 1, showing another embodiment of the invention.

In the embodiment of the invention shown in Figures 1 and 2, I provide a casing 1 of sheet metal, of considerable thickness, and preferably of a size to enclose the pit 2 in which the usual construction of dryer is arranged. Within this casing, which is closed at its top, but open at its bottom, I arrange a series of dryer units 3, three in the present instance, each in the form of a casing rectangular in cross-section. The units are supported one above the other, in spaced relation, and each has openings 4 at its ends through which the paper web indicated at 5, may pass, to traverse the casing. An endless belt or apron 6 is so mounted with respect to the casing, that the upper run thereof will pass through the casing, the lower run being below the casing. The endless apron is supported at its ends by rollers 7, and intermediate its ends by series of rollers 8 and 9 arranged within the casing, and below the casing, respectively. The rollers 8 support the upper run of the apron,

and the rollers 9 support the lower run, and the belt is preferably of foraminous material, as for instance, wire mesh. Above the units 3, I arrange a plurality of pairs of press rolls 10, the said rolls in the present instance being arranged in two series, and in such manner that when the paper web is passed between the members of the pairs of either series, it will be held parallel with the upper runs of the endless aprons. In the present instance two series of compression rolls 10 are provided, so that the paper web is supported in five horizontal runs, three of which pass through the casings, and two above the casings. A suction box 11 is arranged at each end of each casing 3. Each of the said boxes is of usual construction, having a slot in its top extending transversely of the direction of travel of the web, and having suitable exhaust mechanism connected with the box. The paper 5 enters the casing 1 by way of an opening 13 from the press rollers 12 of the paper making machine. An endless belt 11^a of perforate material is mounted in such manner that its upper run passes over the slot in the suction box, in the direction of travel of the paper, the belt being supported by rollers 11^b, and being driven by any suitable mechanism connected with one of the said rollers. Preferably the belt is geared to travel a little faster than the movement of the paper. After leaving the last casing, the paper passes between compression rollers 10 of the lower series, eventually leaving the casing 1 through an opening 14. Suitable heating means is arranged within each of the casings 3, the said means being indicated at 15, and the heating means is arranged above and below the web, so that it will simultaneously heat both faces of the same. The temperature in the casings is in the neighborhood of 600° F., and in its passage through the successive casings, the web is thoroughly heated, but in a saturated atmosphere, thus bringing the contained moisture to the temperature of evaporation, while at the same time preventing surface drying of the web. Because of the obstructed capillary movement of the moisture in thick webs there is great liability to surface drying. After the web leaves the last casing 3, it is subjected to the action of dry heated air, which is circulated in close proximity to the faces of the web, and while it is so subjected to the action of the warm dry air, it is compressed at frequent intervals to express a quantity of moisture such as may be readily evaporated before the web is again compressed. Thus the moisture is removed by alternate compression and evaporation. Means is provided, for circulating dry heated air through the entire casing 1, the said means comprising an inlet header 16, having branches 17 communicating with the casing

1 at the level of the series of pairs of rolls 10. The moisture laden air is withdrawn from the casing through outlet pipes 18, which are preferably arranged at the top of the casing 1, and at the opposite side from the header 16. The circulation of air is transverse to the web, and the branch pipes 17 are so arranged that the circulation will be about the same at both faces of the web. The rolls 10 are driven from a line shaft, indicated at 19, through belts 20. These belts connect pulleys on the line shaft, with pulleys on the rolls. Each pair of rolls is driven independently of the other from the line shaft, and there is sufficient slip in the belt to prevent puckering or wrinkling of the web between the pairs of rolls. Doors 21 are provided in the rear wall of the casing 1, for permitting access to the web above the dryer units, and these doors are preferably spring held in closed position. The air which is circulated through the casing 1 need not be highly heated, a temperature of approximately 140° being sufficient. The operation of the device is as follows:—

The paper passing from the press rolls enters the casing 1, and passes in succession through the dryer casings 3. Gradually the temperature is elevated to a high degree, but in an atmosphere saturated with moisture, so that there is but slight evaporation. As the web leaves the casing of the last dryer, and as it passes from casing to casing, it is subjected to the action of the dry air circulating through the casing 1, and this air is in the best possible condition to absorb moisture.

In Figure 4, an embodiment of the invention is shown wherein the heating is done on the usual dryer indicated at 22 and composed of a plurality of drying cylinders. These cylinders are arranged in the usual pit 23 and the casing 24, which corresponds to the casing 1, is mounted over the pit. Within the casing 24 a plurality of series of pairs of compression rolls 25 is arranged, in a similar manner to the arrangement of Figure 1, and between the series the web is guided by press rolls 26. The casing 24 is similar in all respects to the casing 1, having the circulation pipes for circulating dry heated air over the paper.

In the operation of this embodiment, the paper web 27 passes from the press rollers 28 of the paper making machine, through the dryer 22, where the web is heated in a saturated atmosphere. The atmosphere at the drying cylinders 22 is always saturated with moisture, because of the evaporation from the paper on the cylinders. From the dryer, the paper passes between the pairs of compression rolls, where it is subjected to recurring compression in the presence of dry heated air, circulating in close proximity to the web. It will be evident from the de-

scription, that the paper web is subjected to what is, in effect, a kneading operation, the web being alternately compressed and relaxed, thereby to work the moisture toward the surfaces of the paper. As rapidly as the moisture reaches the surface it is evaporated, and the kneading operation eventually eliminates all of the excess moisture. The process comprises essentially, first raising the temperature of the web and its contained moisture to a relatively high degree, in a saturated atmosphere and afterwards subjecting the heated web to an active circulation of dry heated air, while kneading the paper to work the moisture to the surfaces, where it may be readily taken up by the warm dry air.

It will be noticed that when, in the present method, the paper web is subjected to compression, such compression is equal on both faces, and there is no bending of the paper such as would tend to separate the fibers and weaken the web. In the usual processes, whatever compression is exerted, is on one face of the web, and while such face is under contraction. The other face which is not compressed is, under expansion, and this alternate expansion and contraction continues throughout the drying operation. Such alternate expansion and contraction creates internal stresses, which are extremely detrimental to the ultimate strength of the paper. Such stresses are not set up until the paper is almost dry, in the present method and there is no bending of the paper, other than is necessary to change the direction of its travel, when the paper has reached a condition of dryness such that such stresses will be set up.

The compression squeeze rollers 10 are just sufficiently heavy to gently massage and knead the web, squeezing and working the moisture from the center to the surfaces, to insure equal drying throughout the entire web, without crushing the fibers on the two surfaces. The provision of the suction boxes and the tension rollers maintains the paper at all times free from strain due to shrinkage, the paper being held just sufficiently taut to prevent wrinkles. It will be noticed that the top of the belts 11^a are arranged at a lower level than the plane of the paper run, so that the paper moves downward onto the belts of the suction boxes. The guide rollers 11^c arranged outside of the suction boxes constrain the paper to move in this manner, and prevent release of the web from the suction boxes. A gentle action is exerted on the web by the suction boxes tending to move it in the direction of its travel, but there is no tension strain as would be the case were the web nipped by rollers. It will be obvious that instead of a plurality of independent casings, the web might be run through a single casing, in

a plurality of runs, all of the heating in the saturated atmosphere in such case being done in one casing.

I claim:

1. The method of drying paper and the like, which comprises heating the paper to a high temperature in a saturated atmosphere to prevent surface drying, and afterwards removing the moisture from the paper by currents of dry heated air at a lower temperature.

2. The method of drying paper and the like, which comprises heating the paper to a high temperature in a saturated atmosphere to prevent surface drying, and afterwards removing the moisture by currents of dry heated air, and subjecting the paper to recurring compression during the circulation of the air.

3. The method of drying paper and the like, which comprises heating the paper to a high temperature in a saturated atmosphere, removing the paper from the atmosphere and then circulating dry heated air in proximity to the faces of the paper, while subjecting the paper to recurring compression.

4. The method of drying paper and the like, which comprises heating the paper to a high temperature in a saturated atmosphere, and afterwards subjecting the paper to successive compressions sufficient to express moisture therefrom at a relatively low temperature and with active circulation of the heating medium.

5. The method of drying paper and the like, which comprises heating the paper to a high temperature by means of a heating medium with restricted circulation and afterwards subjecting the paper to successive compressions at a relatively low temperature and with active circulation of the heating medium.

6. Apparatus for drying paper and the like, which comprises means for heating the paper to a relatively high temperature in a saturated atmosphere, and means for afterwards subjecting the paper to recurring compression in a dry atmosphere.

7. Apparatus for drying paper and the like, comprising means for heating the paper to a relatively high temperature in a saturated atmosphere, means for afterwards circulating air over the surfaces of the paper, and means for subjecting the paper to recurring compression to work the moisture toward the surface.

8. Apparatus for drying paper and the like, comprising means for heating the paper to a relatively high temperature, means for restricting the circulation of air while the paper is being so heated to provide a saturated atmosphere, means for afterwards subjecting the paper to recurring compressions thereby to work the

moisture to the surface, and means for circulating dry air over the paper while it is being compressed.

9. Apparatus for drying paper and the like, comprising a closed casing through which the paper is passed, means for heating the casing, and a plurality of series of pairs of press rolls outside the casing through which the paper is passed, to subject the paper to recurring compression.

10. Apparatus for drying paper and the like, comprising a closed casing through which the paper is passed, means for heating the casing, a plurality of series of pairs of press rolls outside the casing through which the paper is passed, to subject the paper to recurring compression, and means

for circulating dry heated air over the paper while it is being compressed.

11. A method of drying paper, which comprises heating the paper to raise the temperature of the contained moisture well above the boiling point, and afterwards drying the paper in air having a lower regulated temperature.

12. A method of drying paper, which comprises heating the paper in a saturated atmosphere to a temperature well above the boiling point of water, and afterwards drying the paper in air having a lower temperature.

In testimony whereof I affix my signature.

THOMAS F. PINDER.