Feb. 27, 1934. F. C. LADD 1,949,125

APPARATUS FOR DRYING PAPER

Filed April 4, 1931 2 Sheets-Sheet 1

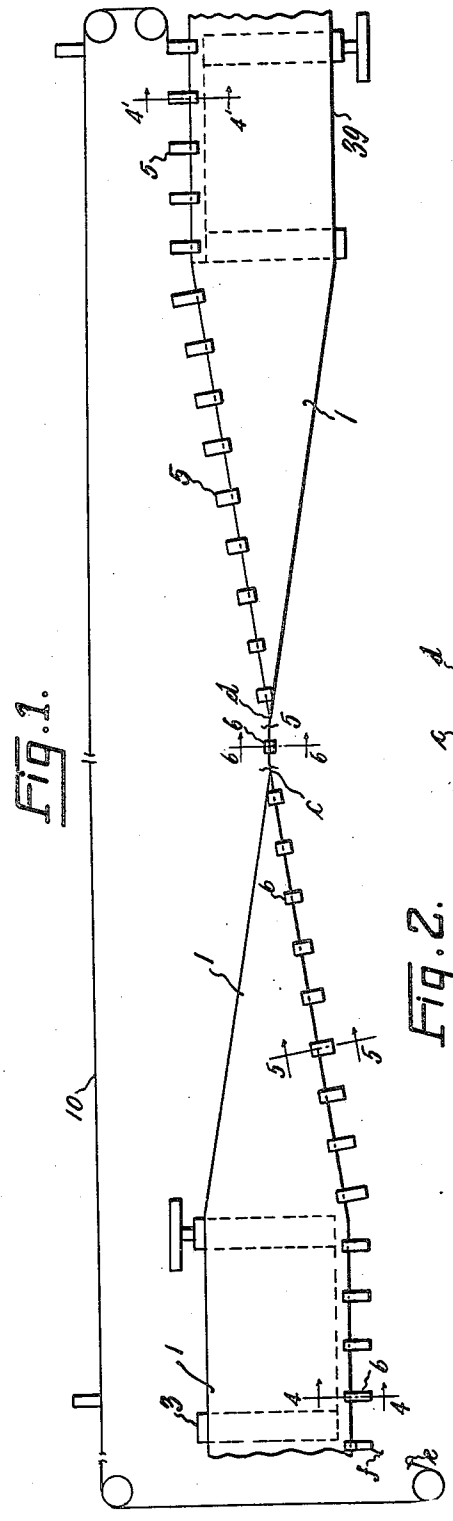


Fig. 1.

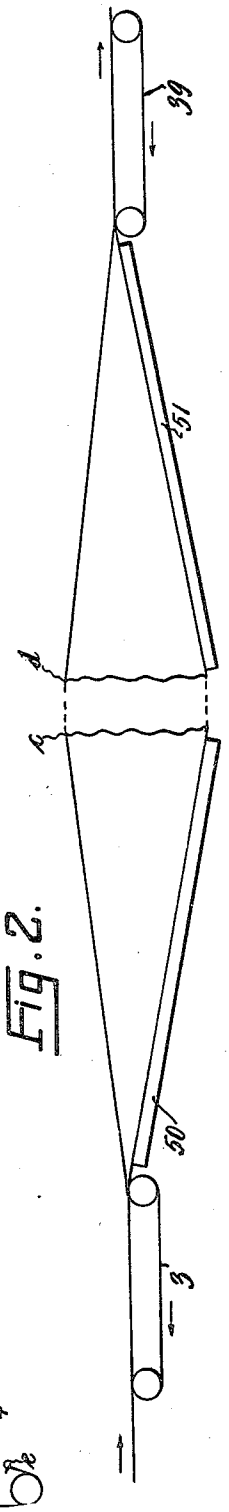


Fig. 2.

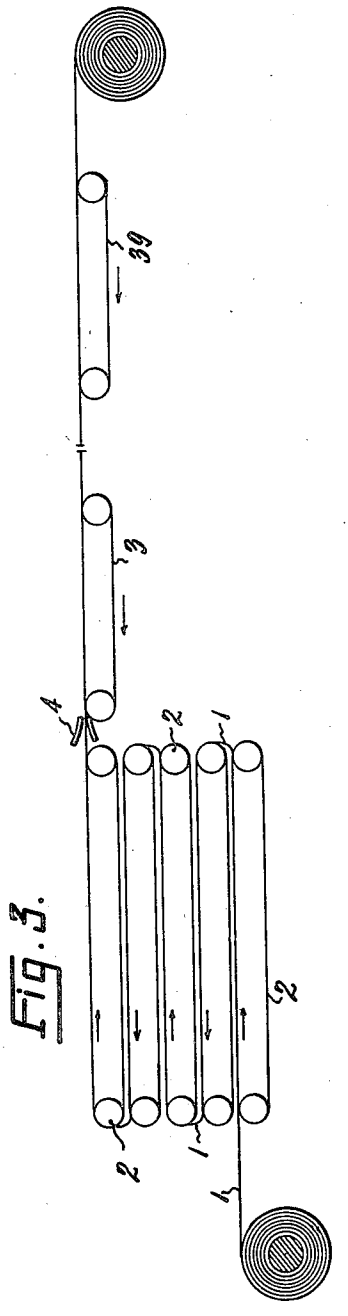


Fig. 3.

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Fig. 4.

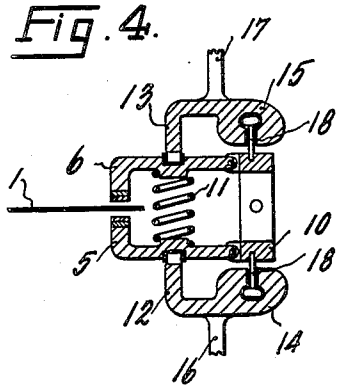


Fig. 5.

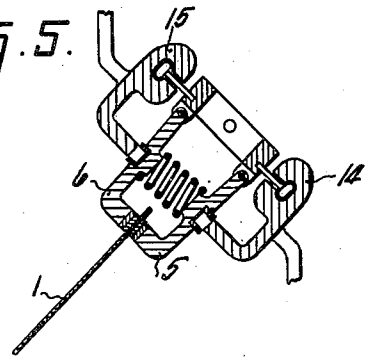


Fig. 7.

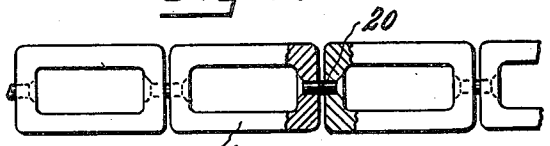


Fig. 6.

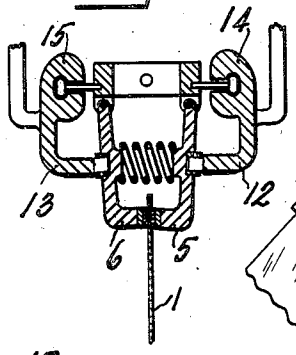


Fig. 9.

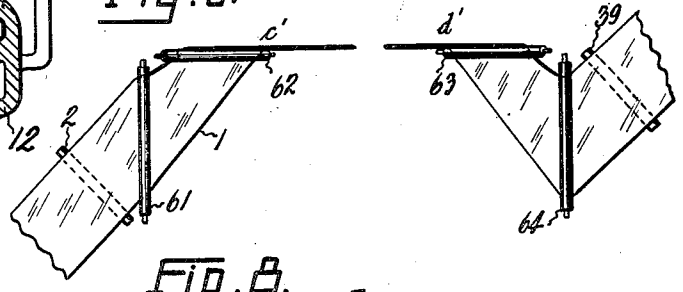
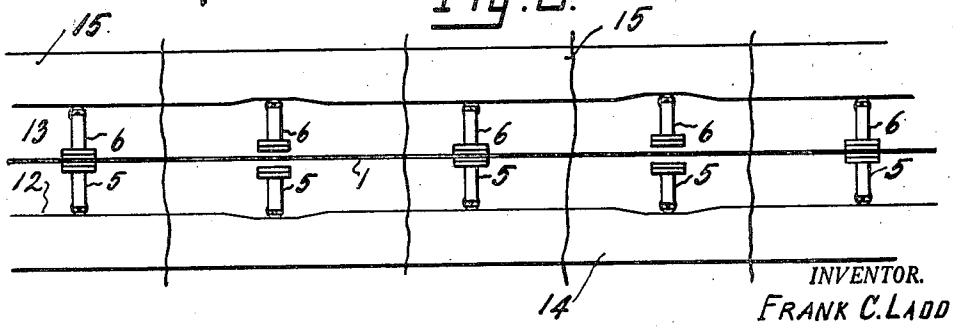


Fig. 8.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR DRYING PAPER

Frank C. Ladd, Turners Falls, Mass.

Application April 4, 1931. Serial No. 527,704

7 Claims. (Cl. 34—48)

This invention relates to paper manufacture and particularly to the drying of the paper as a final manufacturing operation. The invention is an improvement on the loft drying method in paper manufacture and includes an apparatus for carrying on the new method.

It has long been recognized that the old and expensive loft drying method in paper manufacture has definite advantages. The method results in a better quality of paper than where faster and less expensive methods are used. I believe that the reason can be found in the fact that, when loft dried, the paper fibers are permitted to shrink slowly and are free to set themselves in the sheet without the strain due to quick shrinkage in the rapid drying methods which are carried on at higher temperatures than in loft drying.

As commonly carried on, loft drying consists in hanging a number of sheets on a pole and hanging a great many of these poles in a drying room (the loft) for slow drying. Some of the disadvantages in the method, aside from the expense of handling the paper and poles, are that the poles leave pole marks and the paper is somewhat distorted by irregular hanging in sheets as the fibers are shrinking and setting to their final form and relation.

According to my invention, I avoid much of the expense and all the disadvantages of the irregular hanging of the paper while drying, and I retain all the advantages of the loft drying method. Among the advantages in both the loft drying and in my method I desire to emphasize the idea of slow drying at a low enough temperature to give the paper the best quality. The advantages of my method over the old loft drying method are in the way I support the paper to keep it free from distorting strains while drying and in handling it through the drying method to save expense. There are other detailed advantages in the method and apparatus which will appear in the following description and claims.

Referring to the drawings,

Fig. 1 is a diagrammatic view indicating two spaced horizontal conveyers for a paper sheet and the path of an endless chain conveyer apparatus which carries the sheet also indicated through the space between the horizontal conveyers and so that the sheet first turns to a vertical hanging position and then back to the horizontal position between the spaced conveyers;

Fig. 2 is a diagrammatic side view of the spaced conveyers and paper travel as shown in Fig. 1, also indicating a fall board and a riser board adjacent the spaced conveyers to support the paper sheet as it turns from and to vertical position;

Fig. 3 is a diagrammatic view of the two end portions of the drying apparatus arranged in line but not indicating the middle portion or endless chain conveyer for carrying the sheet between the end portions;

Fig. 4 is a vertical sectional view of one of the grippers, mounted on one of the endless conveyer chain links with the gripper guides and supports in position to permit open position for the gripper. This section is taken through a gripper, for example, when it is following the paper sheet supported on the conveyer belt ready to take hold of the edge or after it has released the edge of the sheet, as for example at position 4—4 or 4'—4' of Fig. 1;

Figs. 5 and 6 are views like Fig. 4 but with the position of the grippers respectively on lines 5—5 and 6—6 (Fig. 1) of their chain travel but with the grippers closed;

Fig. 7 is a plan view of a chain section indicating one type that will permit the twisting of the grippers carried thereby in the chain conveyer apparatus from horizontal to vertical position and back again;

Fig. 8 is a diagrammatic view with parts removed, indicating spaced portions of the gripper guides (viewed from below, see Fig. 6) arranged along the travel of the conveyer chain so as to permit the grippers as indicated to successively release the paper and relieve the strain of the sheet between grippers due to shrinkage in drying; and

Fig. 9 is a diagrammatic view of a modified way of turning the paper sheet between the end portions of a drying apparatus such as shown in Fig. 3.

With the apparatus shown, or by hand, I can carry on my method as follows: I first feed a continuous sheet of paper 1, with the plane of the paper in a horizontal position, back and forth through a series of belt conveyers 2 which support the sheet. This preliminary drying is done in a room suitable for drying, such as a loft drying room. The paper starts in that damp condition, just as if it were to be cut in sheets, hung on poles, and loft dried. It is a fact that by feeding the continuous sheet 1 over the belt conveyers 2 first, I can get a preliminary drying without elevating the temperature to such a degree that a large part of the total shrinkage (due to drying) is accomplished. This shrinkage can be easily compensated for by running progressive conveyers of the series 2 at less and less speed. The amount of shrinkage for, say fifty feet of conveyer travel would be several linear inches. All that the conveyers 2 need do is to support the paper as it is fed to the beginning of the series and carry it forward to the end or transfer conveyer 3 in unwrinkled condition with the speeds of the several conveyers 2 arranged to compensate for the rather large shrink-

age in such travel. The preliminary drying conveyers 2 arrange the paper sheet 1 in partially dried condition so that it may be thus delivered to a transfer conveyer 3 and gripped along one edge along the travel of conveyer 3, and the sheet turned when it is so gripped so that it hangs vertically.

I prefer to give the paper sheet a preliminary drying on the conveyer means that supports it in horizontal position. But my method is broad enough in some aspects to dispense with such preliminary step. For example, with or without the preliminary drying I have conceived the step of gripping a strip of paper adjacent one edge at spaced points, letting the paper strip hang vertically and unwrinkled as it travels through the drying room and is dried and winding up after it is dried, all in a continuous operation, with a sheet of indefinite length or a continuously fed sheet. The paper will shrink as it is dried and while it is hanging vertically. Such shrinkage will cause a strain along the line of the carrying edge between the carrying points that are gripped. To relieve this strain I conceived the step of successively and momentarily releasing the points where the sheet is gripped, and taking a new grip at a point slightly offset from the point where the sheet was previously gripped. This plan of releasing the hanging sheet while drying is a special feature added to my method in its broadest aspect.

To illustrate, assume that a workman started with the forward end of a damp paper sheet as it unwound from a roll at one end of a drying room, walked toward the other end and held the edge by hand at two positions. Close behind the first workman another takes a hold of the sheet at the edge, and so on. The sheet could be thus carried through the drying room by a single file of workmen carrying the sheet so that it hangs vertically and unwrinkled. If they all walked at a uniform speed and held their original grips on the paper there would be no provision for shrinkage. To provide for shrinkage I conceived the idea of the grips being successively released and new grips taken so the paper sheet can adjust itself, the shrinking strains can be relieved and still the grips can be applied and carried forwardly to carry the paper all through the drying path.

Paper that is advantageously loft dried is ordinarily of a kind that will take marks from what it rests on while being dried. I conceived the idea that while the paper is taking its permanent drying set condition it is best to have it hanging vertically where both sides are exposed to the same drying conditions and with its edges held by grips that can be temporarily released to release the shrinkage strains. The paper is rather heavy and its vertically hung position for drying gives it an advantageous dried condition. But probably one of the most important features of my method is in the idea of drying steps that lend themselves to handling the paper efficiently from damp to dry condition in a continuous sheet and yet permit the slow loft drying conditions to surround the vertically hanging paper while going through the method.

In drying machines, apparatus, and methods heretofore proposed for handling continuous webs of paper in the drying operation I have found that the paper does not dry out with as good quality as the old loft dried method (hanging in the loft on sticks) will give the same paper. My method and apparatus are conceived for the purpose of duplicating all the good conditions of loft drying (by actually drying slowly under the same drying conditions and avoiding high temperatures) and yet handling the paper to avoid loft marks and save expense.

From the foregoing description concerning the method, one can see that the steps in the method could be carried out by hand if workmen walked a continuous strip of paper to be dried through the loft from a damp roll as it was unwound to a dried roll where it was wound up. To give the desired loft dying conditions we only need to have the workmen take enough time and operate in a loft drying room so that the paper will be given the same slow drying exposure in such a room as would accomplish drying. Of course the apparatus shown in the accompanying drawings is designed to carry out the method more efficiently than the workmen could do. With this method in mind the reasons for the apparatus and some of its detailed structure will be better understood.

Referring to the skeleton views in Figs. 1, 2, 3, and 8, one skilled in the art will readily understand the general structural arrangement as follows. The roll *a* of damp paper, of any usual mill width, is unwound as sheet 1. I prefer to drive the roll *a* by any of the known means, so that it will deliver the sheet 1 at a uniform rate to the lower belt of the series 2. At the end of such belt the sheet 1 is turned up to travel backwardly while supported on the belt conveyer next above. In this manner the sheet travels back and forth through the series of belt conveyers 2. These belts in the series 2 are driven at different speeds so that as the sheet 1 shrinks the shrinkage is compensated for by a slightly slower speed of each successive belt in the series. It is only sufficient to arrange the conveyer driving mechanism so that the shrinkage (which is considerable) will not tighten up the sheet around the belt pulleys but permit a loose travel of the sheet in horizontal festooned manner as indicated. During this travel it will be appreciated that the drying sheet is laid out horizontally and flat, supported first on one side and then on the other as the sheet advances, which makes a good preliminary drying condition.

At the end of the upper belt in the series, the sheet is caused to pass to the transfer belt 3. The latter belt has one edge offset inwardly so that it is narrower along one edge than the sheet of paper. Thus the paper while supported for its whole width on the belts 2, is supported less than its whole width on conveyer 3. Along one edge of belt 3 the paper overlaps and extends out in a free margin.

At this free margin the grippers (Fig. 4) are fed into position to take hold of the sheet. The chain 10, the guide tracks 14 and 15, the cam tracks 12 and 13 (shown in Figs. 4, 5, 6) are arranged in the travel path indicated in Fig. 1. Suitable guide and driving pulleys move the chain 10. Pairs of gripper fingers 5 and 6 are pivoted to some of the chain links so that an endless series of spaced gripper devices are carried by the chain. A spring 11 tends to hold the fingers 5 and 6 apart. But at suitable parts of the chain path the cam paths 12 and 13 hold said fingers together to grip the paper sheet 1. The chain 10 is made so that it can twist as well as bend. Tracks 14 and 15 are engaged by pins 18 (Fig. 4) to guide the chain and cause the chain blocks with gripper fingers 5 and 6 to twist from horizontal to vertical positions and back again at appropriate parts of the chain travel. For exam-

ple, the tracks 14 and 15 supported by hangers 16 and 17 (from the ceiling or any suitable frame) are in position in Fig. 4 for the grippers to close on the sheet 1 at the free margin of the paper along conveyer 3. This is the position on line 4—4 of Fig. 1.

From this position to position of line 5—5 in Fig. 1 the tracks 14 and 15 are gradually twisted to their position shown in Fig. 5. From such position at line 5—5, Fig. 1, to the position of "c", said tracks are gradually twisted to their position shown in Fig. 6. As the grippers 5 and 6 travel with the conveyer chain adjacent the conveyer 3 and in the horizontal position of Fig. 4 the cam tracks 12 and 13 with roller bearing contact force the gripper fingers together with the sheet 1 between them. To make harmless contact with the sheet I prefer to have the gripper fingers faced with soft material such as sponge rubber.

As the sheet 1 feeds off the end of conveyer 3 it is held at spaced edge portions by the gripper devices. I provide for gradually turning the sheet 1 from horizontal to vertical position after it leaves conveyer 3. This turning movement is carried on between the end of conveyer 3 and point "c". The tracks 14 and 15 are gradually twisted and, as shown in Fig. 2, the travel path is slanted upwardly (about half the width of the paper sheet 1) until point "c" is reached. During this turning the far edge of the sheet is gradually turned downwardly as the supported end is lifted upwardly. This action or path of the paper is clearly indicated in Fig. 2. As each gripper device reaches point "c" it has turned to the position shown in Fig. 6. And it keeps such vertical hanging position between points "c" and "d". While the sheet is being turned it is important not to have it wrinkled or strained. To help avoid any such action I prefer to supply a fall board, indicated at 50 (Fig. 2) and the surface of this board is preferably curved transversely so as to follow the natural curvature of the paper sheet as it twists from horizontal to vertical position. Such a board serves as a support against which the paper slides gently as it twists and the board is a guide to keep the paper smooth and avoid strains where the paper sheet is heavy.

Between points "c" and "d", Figs. 1 and 2, the paper sheet 1 travels while hung in vertical position by the spaced gripper devices 5 and 6. In this position the sheet is exposed on both sides and is dried out to its final condition as in loft drying. It is this final drying step that is, I believe, most important with respect to the final quality of the paper. As the paper stock sets during the final drying stage, the drying temperature and all other drying conditions are far more important than in the preliminary drying such as takes place on conveyers 2. I have provided for the vertical travel of the paper sheet from "c" to "d" so that the final drying step can be carried on under conditions of slow drying, at a temperature such as would be suitable for loft dried paper, and so that the paper will not be unduly strained. This vertical travel of the sheet 1 from "c" to "d" is a very long travel which the drawings cannot show. For example, it may be long enough to go from one end to the other of a very long mill room in which the end portions of my apparatus occupy an insignificant part. Instead of being a straight travel it may be a back and forth conveyer travel. My plan includes the idea of making the vertical travel of the sheet long enough and slow enough, for example, that if a single sheet of paper were going to be loft dried according to the old regular method, it would be in the loft dried room for its proper length of time if it were hung on a gripper device of my conveyer and carried the length of the vertical travel. This time of course varies with the paper to be dried and other conditions, but those skilled in the art will appreciate that particular feature of my invention that I want to emphasize—namely, that the vertical travel of the sheet in my apparatus is planned to give the results of loft dried paper in a better manner as to paper support and paper handling, but otherwise as if the paper were loft dried.

During the long slow vertical travel of the sheet 1 between points "c" and "d" the paper is shrinking. To avoid shrinking strains I have provided the means indicated in Fig. 8. At frequent intervals I provide the cam tracks 12 and 13 in the vertical travel path of sheet 1, with portions to successively release and again apply gripper fingers 5 and 6. Thus as the paper shrinks and tends to set up a strain between the gripper devices along the supported edge, such devices are successively released and reapplied by the cam tracks 12 and 13. When reapplied the paper sheet 1 has moved slightly (due to the released shrinking strain) and each gripper device takes hold at a slightly offset position.

When the sheet reaches point "d" it is dried. As indicated in Fig. 1, the grippers beyond "d" cross over and carry the sheet down to a horizontal position and lay it on wind-up conveyer 39. This cross over results in turning the sheet completely over in its travel from one end of the apparatus to the other. As it is desired to turn the sheet 1 from horizontal to vertical and back to horizontal travel, it is a help to turn the sheet completely, as this tends to hold the vertical position of the sheet naturally at the cross over portion and relieves strain.

It will be clear from Figs. 1 and 2 that the travel of the sheet from point "d" up the rising board 51 with the grippers to the horizontal position for laying the sheet on conveyer 39 is the reverse action to that already described at the feed end of the apparatus. There is a free margin of the paper overlying conveyer 39 for the grippers to be released, and they are released by the reverse action to that which causes them to grip the paper on conveyer 3. The grippers then return on their back conveyer travel (indicated in Fig. 1) to again fasten on the continuous sheet or another sheet and repeat the cycle. In the return of the grippers on the conveyer it is desirable, as shown, to turn them completely over as they approach conveyer 3, and this can be done between points "e" and "f" of Fig. 1 by suitably twisting the guide tracks. The dried sheet is wound off of conveyer 39 to roll "b" by any usual wind-up means.

In Fig. 9 I have illustrated diagrammatically a modified means for turning the paper sheet from horizontal to vertical and back again. If the paper is fed off conveyer 2 under the angularly disposed guide roll 61 (the bearing supports and frames are all omitted for clearness) and over the second angularly disposed guide roll 62 at one end of the apparatus and over corresponding guide rolls 63 and 64 to conveyor 39 at the other end of the apparatus, as indicated, a vertical travel between points c' and d' is provided. In this arrangement roll 61 is horizontally arranged at a 45° angle to the line of travel; guide

roll 62 is slanted with its axis at a 45° angle to a horizontal plane and at a 90° angle to the axis of roll 61. Rolls 63 and 64 are similarly arranged. This arrangement of turning a paper sheet is common in printing presses and the like. Used in my apparatus it has the advantage of avoiding the twisting and turning of the conveyer tracks, cam tracks and grippers to accommodate the desired horizontal and vertical position of the paper sheet. In the modification of Fig. 9 a simpler endless conveyer such as is shown in cross section in Fig. 6 could be mounted above the sheet travel from points *c'* to *d'* and the grippers 5 and 6 could grasp and release the paper all along such travel as indicated in Fig. 8, and without the necessity of twisting the grippers about from horizontal to vertical and even completely around as in the case of the form indicated in the other figures.

The reason I have shown a more complicated form of apparatus than that indicated in Fig. 9 is because there is some advantage in handling heavy and wide sheets of paper with a more gradual and gentler means of turning the wet sheet about than that shown in Fig. 9. It is obvious that I can readily combine the two ways of turning the sheet in the same apparatus. In such a case I would prefer to turn the wet sheet to vertical position as described in connection with Fig. 1 and turn the dry sheet at the delivery end, as described in connection with Fig. 9. In this kind of an arrangement cam tracks 12 and 13 would release the grippers from sheet 1 at point "*d*" in Fig. 1, and turning guide rolls 63 and 64 would turn it to horizontal for wind-up conveyer 39 and roll "*b*".

The conveyer chain 10 with grippers 5 and 6 will travel so slowly that no fine machine work is necessary on the apparatus. I have not attempted to show all the guide pulleys and driving means that will be necessary in such a long and heavy mechanism. Those skilled in conveyer mechanism can readily supply those ordinary things.

Having described my invention what I claim is:

1. Apparatus for progressively and continuously drying a paper sheet comprising in combination, a conveyer to carry the sheet horizontally, a second conveyer to carry the sheet vertically, and a third conveyer to again carry the sheet horizontally, said conveyers being arranged in series, means forming part of the second conveyer to take hold of the sheet along one edge while it is on the first conveyer and support it in vertical hanging position as it falls off the first conveyer to be carried by the second conveyer, said second conveyer having a long enough path to carry the sheet in vertical hanging position until it dries, said third conveyer being arranged to receive the sheet when dry and as the second conveyer releases it.

2. In apparatus for drying paper comprising in combination conveyer means to carry the paper horizontally with one edge exposed for gripping means to take hold at said edge, means to turn the paper gradually from horizontal to vertical position, gripping means to fasten on said edge while the paper is in horizontal position and support the paper when it is turned to vertical position, an endless conveyer to carry said gripping means, means to turn the paper from its vertical to a horizontal position, devices to operate said gripping means to fasten on the paper and to release the paper respectively before it turns to vertical position and after it turns back to horizontal position, said conveyer with the gripping means being arranged to carry the paper vertically until it is dried.

3. In a paper drying apparatus the combination of a conveyer, a series of grippers mounted in spaced relation on the conveyer, said grippers being adapted to support a sheet of paper in vertically hanging position with its top edge directed along the line of the conveyer travel to travel with the conveyer for the drying operation, and means to intermittently release successive pairs of said grippers so that the paper may shrink without excessive strain between the grippers as the conveyer carries the sheet through a drying path.

4. An automatic apparatus for handling a continuous web of paper for drying it comprising in combination a drying room, a conveyer operable in a closed path to carry the paper through the drying room, said conveyer having a series of spaced grippers to support the paper from spaced portions along one edge and permit the web to hang with both sides in otherwise free and fully exposed vertical position with its top edge directed along the line of the conveyer travel while traveling through the drying room, means to feed one edge of the web into position for said grippers to take hold successively, a gripper operating device to cause the grippers to thus take hold, a second gripper operating device to cause the grippers to let go of the paper when it is dry and means to take and support the dried web when the grippers release it.

5. An apparatus for drying paper comprising a drying room suitable for drying paper under the loft-dried method, an endless conveyer having a long path in said drying room, said conveyer having releasable means to hold a continuous web of paper along one edge and with such edge directed along the line of the conveyer travel so that it hangs vertically and well exposed for drying as it travels in said room, and means to operate a part of said releasable means to compensate for shrinkage during the drying of the paper.

6. An apparatus for drying paper comprising a drying room suitable for drying paper under the loft-dried method, an endless conveyer having a long path in said drying room, said conveyer having releasable means to hold a continuous web of paper along one edge and with such edge directed along the line of the conveyer travel so that it hangs vertically and with both sides well exposed for drying as it travels in said room, and automatic mechanism to place a portion of the continuous web for support by said conveyer and other mechanism to release the web from such conveyer after it has traveled thereon a sufficient distance in said room to be dried.

7. An apparatus for drying paper comprising a drying room suitable for drying paper under the loft-dried method, an endless conveyer having a long path in said drying room, said conveyer having releasable means to hold a continuous web of paper solely along one edge so that it hangs vertically and with both sides well exposed and out of contact with all parts of the apparatus except said edge holding means for drying as it travels in said room, and mechanism associated with said conveyer to operate the releasable means as the paper shrinks in the drying operation

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