

Nov. 16, 1971

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3,620,110

BROKE CLEARING APPARATUS

Filed July 23, 1970

3 Sheets-Sheet 1

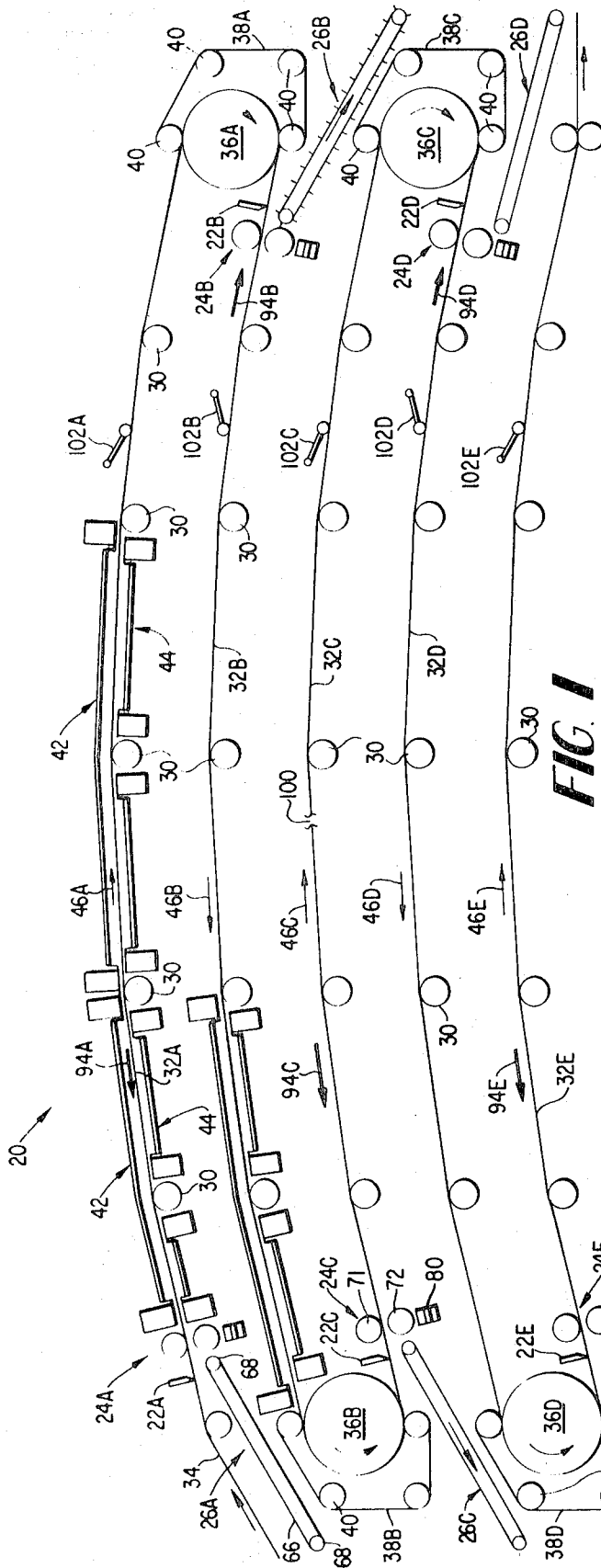


FIG. 1

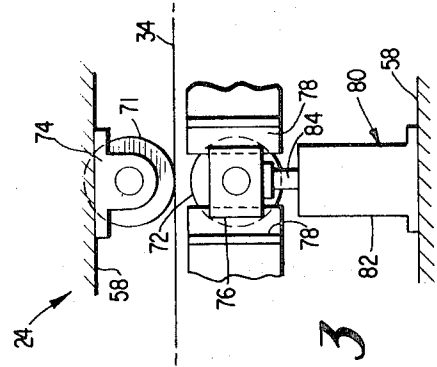


FIG. 3

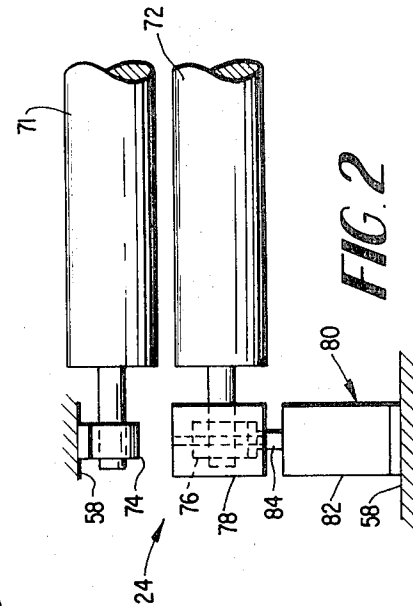


FIG. 2

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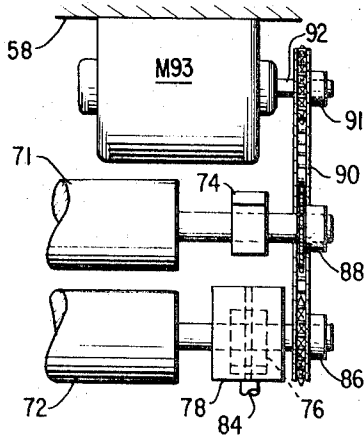
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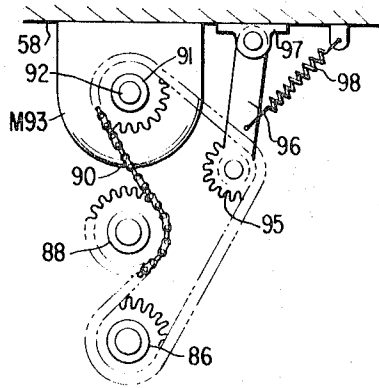
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3 Sheets-Sheet 2

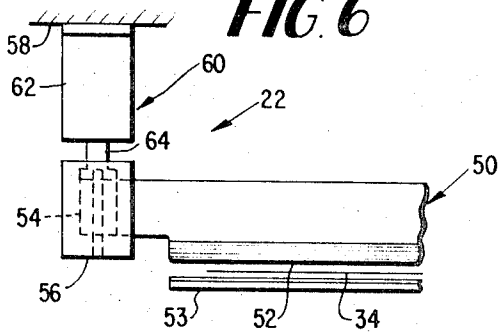
**FIG. 4**



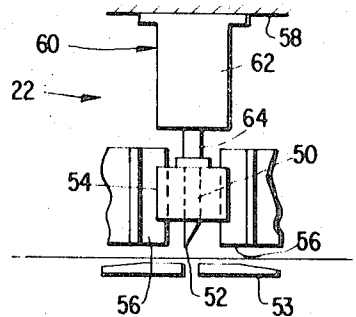
**FIG. 5**



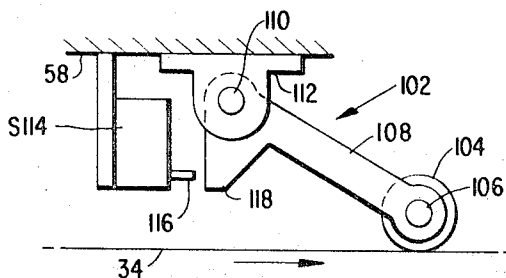
**FIG. 6**



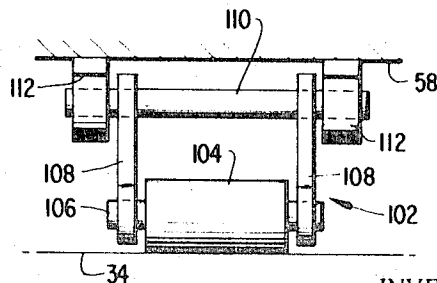
**FIG. 7**



**FIG. 8**



**FIG. 9**



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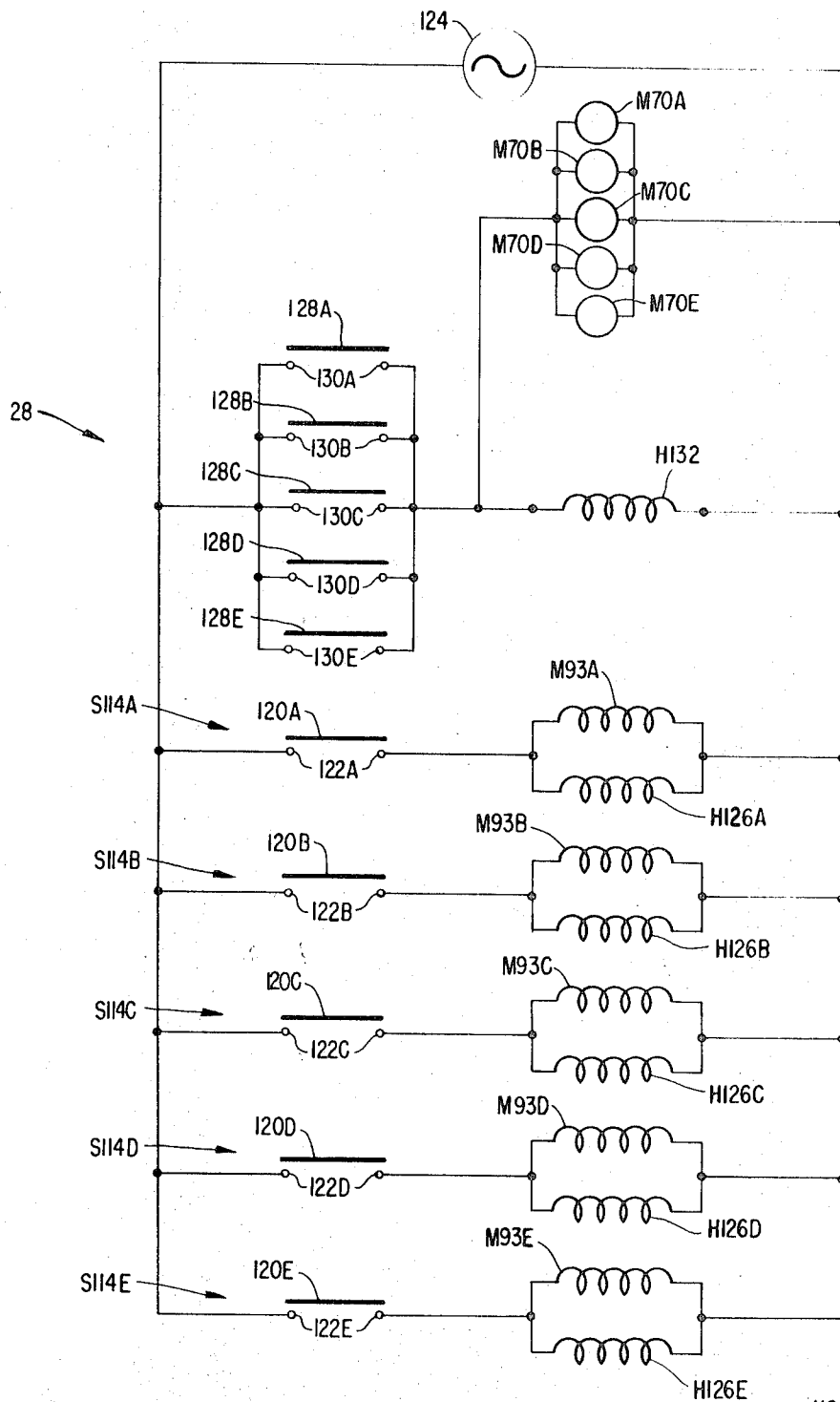
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BROKE CLEARING APPARATUS

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3 Sheets-Sheet 3



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**BROKE CLEARING APPARATUS**  
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Int. Cl. B26d 5/20

U.S. Cl. 83—66

13 Claims

## ABSTRACT OF THE DISCLOSURE

Apparatus for clearing broke from machines for drying web type materials which includes a broke conveyor, a cutter for severing the web when a break occurs, and reversing rolls for conducting the severed portion of the web to the broke conveyor.

This invention relates to novel, improved apparatus for drying material in web form and, more particularly, to web drying apparatus equipped with a system for automatically clearing broke from the apparatus if the web breaks.

Cellulosic products such as paper, fiberboard, and the like are conventionally made in the form of a continuous wet web by Fourdrinier, Rotoformer and other machines. The web is then dried by passing it around a series of heated, cast iron drums or cylinders against which it is held by endless felts. In a modern installation, the dryer section may have from 40 to 75 of these drums, which may be as much as six feet in diameter and 388 inches (over 32 feet) long. The speed of the web through the dryer section may be as high as 3000 feet per minute.

Paper and other products shrink in a lengthwise or longitudinal direction as they dry. However, because of the large frictional forces between the drying cylinders and the web and between the web and the felts, the web cannot slip relative to the drums as it shrinks. This increases the tension on the web.

To relieve this tension, the typical dryer is divided into three sections with the drums in each successive section being rotated at a slightly lower speed to accommodate shrinkage of the web. However, this arrangement is unsatisfactory at best since there is no accommodation for shrinkage of the web between successive drums in each section. Also, because of the speed differential, there is an abrupt change of tension on the web as it passes from one dryer section to the next. As a result, the web is frequently subjected to a tension exceeding its breaking strength in the conventional type of dryer; and the web breaks.

When a break occurs, the product being dried piles up inside the dryer until the feed of the material to the dryer is stopped. In a modern, high speed machine this may amount to as much as 1000 feet of material, which is commonly referred to in the industry as "broke."

Removal of broke from a modern, high speed machine is a time-consuming task because of the large quantity of material involved; and the loss of production during the downtime can consequently become extremely costly. Also, as the broke piles up in the dryer, it can cause extensive damage to internal components.

In my previously issued Patents Nos. 3,228,114<sup>1</sup> and 3,263,340<sup>2</sup>, I disclosed novel horizontal drying machines in which the web of material being dried traverses a series

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of superimposed, generally horizontal runs as it passes through the machines. Radiant heat or preferably a combination of radiant heat and impinging air are employed to evolve moisture and/or other volatiles from the web as it travels through the dryer.

In these novel drying machines, the tension on the web is the same throughout each run. And the speed of the web through succeeding runs can be individually regulated to compensate for web shrinkage and thereby keep the web tension below the breaking strength of the web. Thus, web breakage due to inadequate compensation for web shrinkage and abrupt changes in web tension are virtually eliminated in my novel horizontal dryers.

Nevertheless, web breakage can occur, even in these machines. Such breaks are typically attributable to irregularities in the web as formed or introduced into it as it passes through the press section commonly employed between the web forming machine and the drying machine to mechanically remove water or other liquids from the web before it enters the dryer. Because of the high speed which these machines are capable of obtaining, web breakage and broke accumulation still poses a serious problem.

I have now invented a novel system for automatically clearing the broke from drying machines of the type just described when a break occurs. My novel broke removal system includes a plurality of cutters which are automatically actuated to sever the web in each of the dryer runs when a break occurs. In those runs of the dryer except for the run in which the break occurs, the severed portions of the web continue through the run, around a direction changing and web driving roll and onto broke conveyors disposed at the feed ends of the runs. These conveyors discharge the severed web portions from the drying machine.

In the dryer run in which the break occurs, web reversing rollers are moved into driving engagement with the web as it is severed. These rollers reverse the direction of movement of the portion of the web between the point of severance and the break and feed it onto the broke conveyor at the feed end of the run in which the break occurs.

Novel tension responsive sensors detect breaks in the web being dried to initiate the sequence of events just described.

Perhaps the most important advantage of the present invention is that the broke clearing or removal sequence is automatically initiated immediately upon the occurrence of a break and completed in a very short period of time thereafter. Accordingly, downtime is drastically reduced when a break occurs to the time required to rethread the web through the dryer.

Another important advantage of the present invention is that it affords an appreciable reduction in manpower. As pointed out in U.S. Pat. No. 3,096,233 issued July 2, 1963, it is common to station human observers at those locations where breaks are most likely to occur in drying machines. The present invention eliminates the need for human observers since breaks are detected and the broke removal sequence initiated automatically.

Still another object advantage of the instant invention is that broke is prevented from accumulating in the drying machine and damaging internal components of the machine.

From the foregoing it will be apparent that one primary object of the present invention is the provision of novel improved machines for drying web type materials.

<sup>1</sup> Issued Jan. 11, 1966, for Multiple Run Drier.

<sup>2</sup> Issued Aug. 2, 1966, for Multiple Run Drier Improvements.

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A related and important object of the invention resides in the provision of novel apparatus for removing broke from drying machines when breakage occurs in a web being dried.

Another important and related object of the invention is the provision of a novel apparatus for reducing the down time required to remove broke from drying machines when a break occurs.

Yet another related and important object of the invention is the provision of a novel broke removal system in which web breakage is automatically detected and the broke clearing sequence automatically initiated.

Other important objects of the invention reside in the provision of novel broke removal apparatus which eliminates the need for employing human observers to detect web breakage and which prevent broke from accumulating in and damaging the drying machine when a break occurs.

Other important objects, further novel features, and additional advantages of the present invention will become apparent from the appended claims and as the ensuing detailed description and discussion proceeds in conjunction with the accompanying drawing, in which:

FIG. 1 is a generally diagrammatic side view of a horizontal, multiple run drying machine equipped with a broke removal system constructed in accord with the principles of the present invention;

FIG. 2 is a partial side view of a web reversing roll arrangement employed in the broke removal system, showing the manner in which the rolls are mounted;

FIG. 3 is an end view of the arrangement for mounting the web reversing rolls;

FIG. 4 is a partial side view showing the drive arrangement for the web reversing rolls;

FIG. 5 is an end view of the drive arrangement for the web reversing rolls;

FIG. 6 is a partial side view of a web severing cutter employed in the broke removal system;

FIG. 7 is an end view of the cutter;

FIG. 8 is a side view of a web breakage detector employed in the broke removal system;

FIG. 9 is an end view of the web breakage detector; and

FIG. 10 is an electrical schematic for the broke removal system.

Referring now to the drawing, FIG. 1 depicts a multiple run, horizontal type drying machine or dryer 20 equipped with a broke removal system constructed in accord with the principles of the present invention. The major components of the broke removal system are web cutters 22A-22E, web reversing roll assemblies 24A-24E, broke conveyors 26A-26E, and a control system identified generally by reference character 28 in FIG. 10.

Dryers of the type illustrated in FIG. 1 are disclosed in detail in my previously issued Pat. Nos. 3,228,114 and 3,263,340. Accordingly, dryer 20 will not be described in detail herein. Briefly speaking, however, this dryer includes a plurality of support rolls 30 arranged in superimposed, spaced apart levels to provide generally horizontal drying runs 32A-32E. As shown in FIG. 1, support rolls 30 are substantially equidistantly spaced along each run; and adjacent rolls along each run are vertically displaced to form a slight chordal arch in the web 34 being dried to eliminate high speed flutter.

Also incorporated in drying machine 20 are a plurality of rotatably mounted direction changing rolls 36A-36D. Direction changing rolls 36 are located at the ends of drying apparatus 20 between each pair of adjacent runs 32 with the rolls between successive runs alternated at the left-hand and right-hand ends of the drying machine. For example, direction changing roll 36A is located at the right-hand end of drying apparatus 20 between drying runs 32A and 32B; and direction changing roll 36B is located at the left-hand end of the machine between drying runs 32B and 32C.

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Drive rolls 36 can be rotated by any suitable drive system such as, for example, the system described in Pat. 3,228,114 to move web 34 through the machine along successive drying runs 32.

As shown in FIG. 1, felts 38A-38D are trained around idler rolls 40 and each of the direction rolls 36. These felts press web 34 against the direction changing rolls 36, thereby increasing the driving force of the rolls without increasing the tension in the web. Also, felts 38 keep the web from pulling away from the direction changing rolls under the influence of centrifugal force as the direction in which the sheet is moving changes.

As web 34 travels along successive drying runs 32, moisture and/or other volatiles are removed from it, preferably by a combination of radiant heat and impinging air or other gaseous fluid. The radiant heat and impinging air may be supplied by radiant heat-fluid impingement units 42 and 44 disposed respectively above and below the path of web 34 through each of the drying runs 32 (only part of these units are shown in FIG. 1 for the sake of clarity). Because the details of these units are not critical in the practice of the present invention and because such units are described in detail in my previously issued Pats. Nos. 3,403,454 and 3,403,456, they will not be described herein.

In operation, the wet web 34 of cellulosic or other material travels from the forming machine to the feed end of the uppermost drying run 32A and proceeds through the latter in the direction shown by arrow 46A in FIG. 1 to the discharge end of the run. There the direction of movement is reversed by direction changing roll 36A, which causes the web to move through drying run 32B as shown by arrow 46B in FIG. 1. Web 34 proceeds in this zig-zag fashion through the remaining three runs of drying machine 20 as shown by arrows 46C-46E and is discharged from machine 20 at the discharge end of lowermost drying run 32E.

As discussed above and in my previously issued Pats. Nos. 3,228,114 and 3,263,340, drying machines of the type identified by reference character 20 in FIG. 1 are extremely large and the web being dried moves through them at an extremely high speed—up to three thousand feet per minute. Accordingly, if web 34 breaks, a large quantity of broke will accumulate in the drying machine unless immediate action is taken to keep additional materials from being fed to the machine and to clear or remove the material in it. The second of these functions is performed by the novel broke clearing system of the present invention referred to above.

Referring now to FIGS. 1, 6, and 7, one of the web cutters 22A-22E of the broke removal system is located at the feed end of each of the drying runs 32A-32E. Each of these cutters includes a knife 50 having a cutting edge 52 of sufficient length to span web 34 and a back-up plate 53. Fixed to the ends of knife 50 are H-shaped supports 54, which are guided for movement toward and away from the web in each run by vertically extending slides 56. These slides are fixed in any convenient fashion to the framework of drying machine 20 which is identified generally by reference character 58 in the drawing.

Movement of supports or guides 54 and accordingly knife 50 toward and away from the path of web 34 through drying machine 20 is effected by pneumatic motors 60, which are operatively connected to the knife supporting guides 54. More specifically, the cylinders 62 of motors 60 are fixed to drying machine framework 58. Extending from cylinders 62 are piston rods 64, which are fixed to guides 54.

Cylinders 60 are of the double-acting type. Accordingly, when operating fluid is admitted to the upper ends of the cylinders 62 of a particular web cutter 22, piston rods 64 move downwardly, carrying with them guides 54 and knife 50 to sever web 34. Conversely, when operating fluid is admitted to the lower ends of the cylinders,

piston rods 64 move upwardly, retracting knife 50 to the position shown in FIGS. 6 and 7.

Referring now to FIG. 1, broke conveyors 26A-26E are shown only diagrammatically as they are of a conventional type and as their details are not part of the present invention. As illustrated, these conveyors may consist of an endless belt 66 trained around rollers 68, either or both of which may be driven by a motor M70 (see FIG. 10) through an appropriate drive arrangement (not shown). The broke conveyors are supported in any suitable fashion from the framework 58 of drying machine 20.

Turning now to FIGS. 1-3, the web reversing roll assemblies 24A-24E are located at the feed ends of the drying runs adjacent web cutters 22A-22E. Each of the assemblies 24 includes a fixed roller 71 above the path of web 34 through the drying run and a moveable roller 72 below this path. Both rollers are arranged at right angles to the path of web 34 and are of sufficient length to span the web.

The fixed roller 71 of each assembly is supported in tangent relationship to web 34 by bearings 74, which are fixed to drying machine framework 58. The lower roller 72 is rotatively journaled in bearings 76 which are guided for movement toward and away from web 34 by slides 78 fixed to machine framework 58.

Lower roller 72 is moved toward and away from web 34 by pneumatic motors 80, the cylinders 82 of which are fixed to the drying machine framework 58. The pistons 84 of the motors support and are fixed to roller supporting bearings 76.

Motors 80 are also of the double acting type. Accordingly, when air or other operating fluid is admitted to the bottom of cylinders 82, piston rods 84 are extended, moving roller 72 upwardly to produce driving engagement between roller 72 and web 34 and between web 34 and fixed roller 71. Conversely, when the operating fluid is admitted to the upper ends of cylinders 82, piston rods 84 move downwardly, retracting the movable roller 72 to the position shown in FIGS. 2 and 3.

To effect movement of web 34 by a roller assembly 24, the fixed and movable rollers 71 and 72 in each assembly are rotated by the drive arrangement shown in FIGS. 4 and 5. More specifically, sprockets 86 and 88 are fixed to the ends of rollers 72 and 71, respectively, at one end of the assembly. A roller chain 90 is trained around these sprockets and a sprocket 91 fixed to the output shaft 92 of a motor M93 supported from drying machine framework 58. Accordingly, when the motor M93 of a roller assembly 24 is energized, the rollers 71 and 72 are rotated to move web 34 in the run in which the energized assembly is located in the direction opposite to which it normally moves; i.e., in the direction indicated by the appropriate arrow 94A-94E in FIG. 1.

The drive arrangement also includes a sprocket 95 fixed to a pivot arm 96, which is supported from the machine framework by a bracket 97 and a spring 98 connected between the pivot arm and the framework. This sprocket keeps chain 90 tight as roller 72 is moved upwardly toward roller 71.

Referring now to FIG. 1, if a break occurs in the portion of web 34 moving through run 32C, for example, all of the web cutters 22A-22E, all of the broke conveyors 26A-26E, and web reversing roll assembly 24C will be activated.

Web cutters 22A-22E accordingly sever web 34 in each of the five drying runs 32A-32E. The severed section of the web ahead of cutter 22A drops onto broke conveyor 26A and is discharged from the drying machine. The section of the web between cutters 22A and 22B drops onto broke conveyor 26B and is discharged from the drying machine. Similarly, the section of the web between cutter 22B and cutter 22C falls onto and is discharged from the drying machine by broke conveyor 26C.

Due to the actuation of web reversing roll assembly 24C, the roller 72 of the assembly is moved upwardly to provide driving engagement between it and the web and between the web and fixed roller 71; and motor M93 is actuated to rotate the rollers. Accordingly, the rollers feed that portion of the web between cutter 22C and the break (indicated by reference character 100 in FIG. 1) onto broke conveyor 26C to discharge that portion of the web from the drying machine.

The portion of web 34 between break 100 and cutter 22D is discharged from drying machine 20 by broke conveyor 26D, and the portion between the latter cutter and cutter 22E is discharged from the machine by broke conveyor 26E. The remaining section of the web (that extending from cutter 22E to the discharge end of run 32E) is discharged from the machine in normal fashion.

As will be apparent from the foregoing, the material in drying machine 20 is severed into a number of sections when a break occurs in web 34; and these are simultaneously removed from the drying machine to clear the latter of all broke. Accordingly, the machine may be cleared very quickly, significantly reducing the downtime required to remove the broke from the machine.

The sequence of events just described is initiated by a detector 102A-102E, one of which is located in each drying run 32A-32E, and is controlled through the circuitry 28 of FIG. 10.

Referring now to FIGS. 1, 8, and 9, each of the detectors 102 includes a web engaging roller 104 supported on a shaft 106 which is rotatively journaled in the lower ends of detector arms 108. Arms 108 are pivotable about a shaft 110 supported in bearings 112, which are fixed in any convenient fashion to drying machine framework 58.

Also fixed to drying machine framework 58 adjacent one of the detector arms 108 is a limit switch S114 having an actuator 116 extending into juxtaposition with a depending projection 118 on the actuator arm.

As long as there is continuity in the web 34 in the drying run 32 in which a particular detector 102 is located, roller 104 maintains detector arm projection 118 in spaced relationship to switch actuator 116 as shown in FIG. 8. However, if a break occurs, the roller drops down under the influence of gravity, and projection 118 pivots clockwise as shown in FIG. 8, depressing actuator 116.

Referring now to FIGS. 1 and 10, and still assuming that a break occurs in drying run 32C, the actuator 116 of the limit switch S114C is depressed, moving the contactor 120C of switch S114C into engagement with normally open contacts 122C. This completes a circuit from power source 124 through the solenoid H126 of a valve (not shown), which controls the flow of fluid to the cylinders 82 of pneumatic motors 80 in web reversing assembly 24C. As a result, the roller 72 of the assembly is moved upwardly, as discussed above, to produce driving contact between it and web 34 and between the web and fixed roller 71.

At the same time, a parallel circuit is completed through the winding of the motor M93C of the web reversing roll assembly to rotate rollers 71 and 72 and thereby feed the section of web 34 between cutter 22C and break 100 onto broke conveyor 26C.

Referring still to FIG. 10, each of the limit switches S114 will typically have a second contactor 128 mechanically connected to its contactor 120. Accordingly, when the actuator 116 of switch S114C is depressed, the contactor 128 completes a circuit between normally open limit switch contacts 130 at the same time that the circuit described above is completed. This energizes the solenoid H132 of a valve (not shown) which controls the flow of operating fluid to the motors 60 of the five web cutters 22A-22E. Knives 50 accordingly move downwardly, severing web 34 in each of the five drying runs 32A-32E in the manner discussed above. Completion of

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the circuit across contacts 130 also connects motors M70A-M70E across power source 124 to initiate operation of broke conveyors 26A-26E.

After the broke is cleared from machine 20, the detector is reset to the illustrated position, opening switch contacts 122 and 130 to stop the operation of broke conveyors 26A-26E and the motor M93C of web reversing roll assembly 24C and deactivate solenoids H126 and H132. The valves controlled by these solenoids will typically be two-way valves. Accordingly, when solenoids H126 and H132 are de-energized, operating fluid will be admitted to the lower ends of the fluid cylinders in all five web cutters 22A-22E and to the upper ends of the fluid cylinders 82 in web reversing roll assembly 24C. This returns knives 50 of web cutters 22A-22E and the movable roller 72 of web reversing roll assembly 24C to their normal, inactive positions.

While the principles of the present invention have been developed in relation to multiple run, horizontal drying machines, it is to be understood that they are also applicable to broke clearing apparatus for other types of drying machines. Accordingly, to the extent that such applications of the invention are not expressly excluded from the appended claims, they are fully intended to be covered therein.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. In multiple run drying apparatus for continuous webs of material: means forming a plurality of web drying runs; means for moving a web of material to be dried seriatim through said runs; and means for clearing broke from said runs if a break occurs in said web as it is moving through the apparatus, said broke clearing means including means for concurrently severing the web in all of said drying runs; means for conveying the severed portions of said web from said runs; and means for reversing the direction of movement of that portion of the web between the feed end of the run in which the break occurs and the break to thereby keep said portion of said web from being moved into and accumulating in the one of said runs in which the break occurs.

2. The apparatus of claim 1, wherein the means for forming the web drying runs comprises a plurality of support rolls arranged in rows to form a plurality of superimposed web drying runs and wherein the means for conveying the severed portions of the web from the runs comprises a broke conveyor at the end of each of said runs, whereby the means for reversing the direction of movement of the aforesaid portion of the web conducts said web portion to the broke conveyor at the feed end of the run in which the break occurs.

3. In multiple run drying apparatus for continuous webs of material: support rolls arranged in rows to form a plurality of superimposed web drying runs; means for moving a web of material to be dried seriatim through said runs; and means for clearing broke from said runs if a break occurs in said web as it is moving through the apparatus which includes means for concurrently severing the web in all of said drying runs; a broke conveyor at the feed end of each of said runs for conveying the severed portions of said web from said runs; and means for reversing the direction of movement of that portion of the web between the feed end of the run in which the break occurs and the break to thereby conduct said web portion to the broke conveyor at the feed end of said run.

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4. The apparatus of claim 3, together with means for detecting a break in the web being dried and generating a signal when a break occurs and means actuable by a signal generated by the break detecting means to initiate the operation of the web severing means, the broke conveyors, and the web reversing means

5. The apparatus of claim 3, wherein there is a direction reversing means as aforesaid at the feed end of each of said drying runs.

6. The apparatus of claim 3, wherein said direction reversing means comprises a fixed rotatable roller on one side of the path of the web through the run; a movable rotatable roller on the opposite side of the path of the material through the run; means for moving said movable roller toward said fixed roller when a break occurs to thereby grip the web between the movable and fixed rollers; and drive means for rotating the movable and fixed rollers.

7. The apparatus of claim 3, wherein there is a web severing means for each of said runs and wherein each of said web severing means comprises a knife spanning the path of the web through the run; means mounting said knife for movement toward the path of the web; and means for moving said knife toward said web path to sever the web when a break occurs.

8. The apparatus of claim 3, wherein the means for moving the web through the drying runs comprises a drive roll at the end of each drying run for moving the web being dried through the drying apparatus and for transferring the web from that run to the succeeding run for movement in the opposite direction therealong and wherein there is a broke conveyor associated with each such drive roll, the feed end of the conveyor being located beneath the drive roll.

9. In drying apparatus for continuous webs of material, means providing a drying run; means for moving a web of material to be dried through said run; and means for clearing broke from said run if the web breaks comprising means for severing the web at the feed end of the run, a broke conveyor at the feed end of said run, and means actuable when the web breaks to reverse the direction of movement of the severed portion of the web and conduct said web portion to said broke conveyor for discharge from said drying apparatus.

10. The apparatus of claim 9, together with means for detecting a break in the web being dried and generating a signal when a break occurs and means actuable by the signal generated by the break detecting means to initiate the operation of the web severing means, the broke conveyor, and the web reversing means.

11. The apparatus of claim 10, wherein the break detecting and signal generating means comprises a switch having an actuator; a member mounted for pivotal movement above and adjacent the path of the web through the run, a portion of said member being adjacent and thereby engageable with the switch actuator; and a rotatable web contacting element carried by said pivotally mounted member whereby, if the web breaks, said rotatable element will drop under the influence of gravity and engage the pivotally mounted member with the switch actuator to thereby actuate said switch.

12. The apparatus of claim 9, wherein the means for reversing the direction of movement of the severed portion of the web located at the feed end of the drying run comprises a fixed rotatable roller on one side of the web through the run; a movable rotatable roller on the opposite side of the path of the material through the run; means for moving said movable roller toward said fixed roller when a break occurs to thereby grip the web between the movable and fixed rollers; and drive means for rotating the movable and fixed rollers.

13. The apparatus of claim 9, wherein the web severing means comprises a knife spanning the path of the web through the run; means mounting said knife for movement toward the path of the web; and means for

moving said knife toward said web path to sever the web  
when a break occurs.

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FRANK T. YOST, Primary Examiner

U.S. Cl. X.R.

34—43; 83—367, 370; 162—255; 226—11