May 7, 1974 J. J. STANSBREY 3,809,606

METHOD AND APPARATUS FOR REPAIRING A DIAGONAL BREAK IN A PAPER WEB

Filed July 13, 1972

FIG. 1

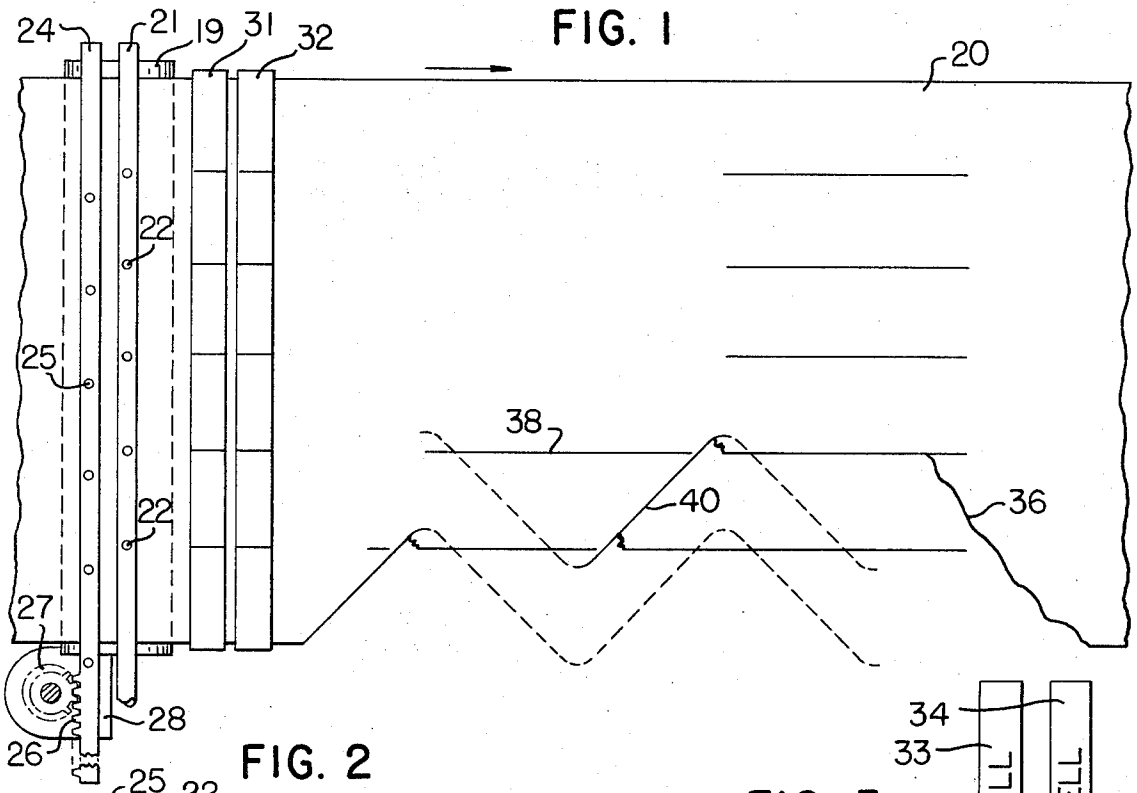


FIG. 2

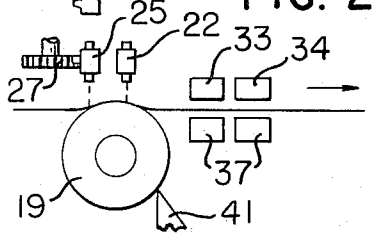


FIG. 3

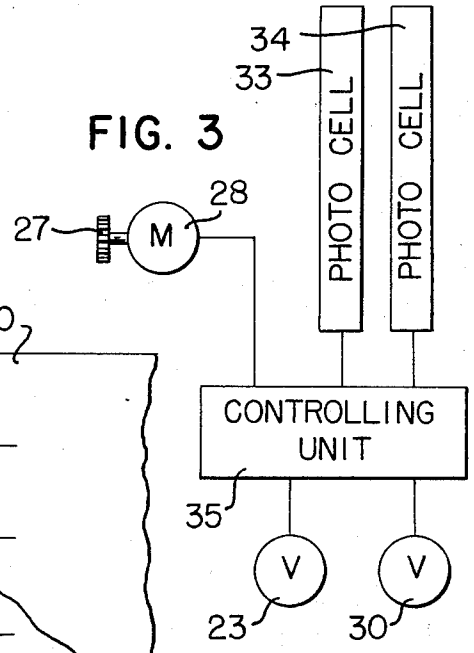
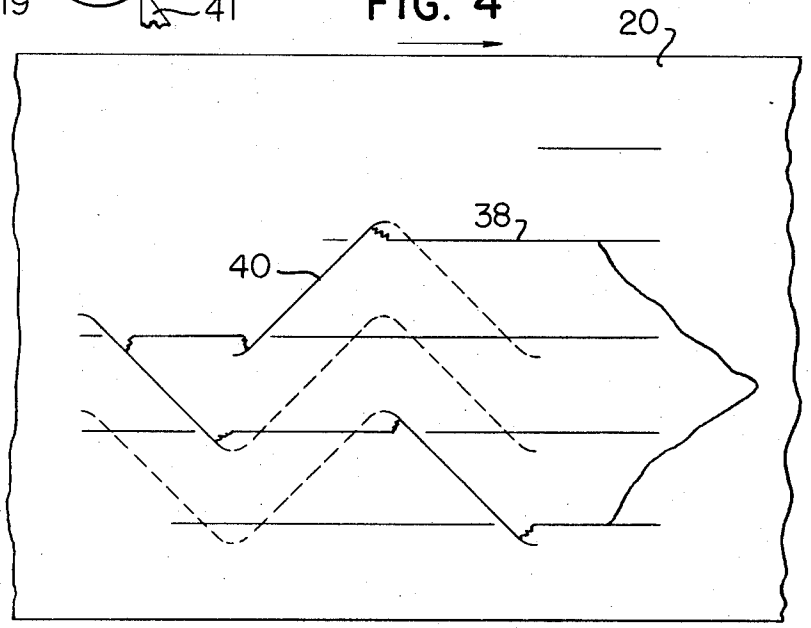


FIG. 4



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METHOD AND APPARATUS FOR REPAIRING A DIAGONAL BREAK IN A PAPER WEB

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U.S. Cl. 162—194 5 Claims

ABSTRACT OF THE DISCLOSURE

A mechanism for automatically repairing breaks in a web of paper is disclosed in addition to a method for repairing such breaks. Included in the mechanism is a plurality of banks of sensing devices for determining the location of the break, a control unit for receiving information from the sensing devices and a plurality of banks of water jets selectively operated by the control unit to provide a plurality of longitudinal and diagonal slits in the web of paper for confining and eliminating the tear portion of the web, the longitudinal slits being interrupted when intersecting the diagonal slits.

BACKGROUND OF THE INVENTION

In the process of making paper, the most common type of machine used is the Fourdrinier machine in which the paper web is formed on a moving screen known as a Fourdrinier wire, from which the web, in wet form, is transported, unsupported through a series of press rolls. It is during this movement between the press rolls that the web is most likely to break due to the weakness of the web. The web used in the present example is 225 inches wide and is traveling at the speed of 2400 ft./minute. When a break occurs, the tear will quickly spread across the web thereby interrupting the production of the paper. This interruption, during which time repairs to the web are made, constitutes loss of production and increased time costs. In order to reduce this problem to a minimum, several methods have been proposed. In U.S. Pats. No. 1,662,200 and No. 1,725,108 fixed water jets mounted adjacent each edge of the web will, upon the discovery of a break, operate to cut longitudinal slits in the web which will intercept and stop the further movement of the break. A second movable water jet is manually moved across the web during subsequent movement of the web, thereby cutting out the torn area of the web but providing a narrow strip which is continuous adjacent the break allowing the web to continue its operation. In U.S. Pat. No. 1,838,603, there is provided a water jet nozzle located in the middle of the web and which is operated automatically upon the sensing of a break in the web to be moved transversely in either direction to stop the break. In each of these patents, the amount of web that is lost utilizing these inventions is still high which increases the cost of operations due to the loss of paper and the time to clean up the torn portion from the machine. Additionally each of the mechanisms disclosed will fail to stop a tear which starts in the middle of the web. It is therefore an object of this invention to provide a mechanism for repairing a break in a paper web which is automatic in operation and eliminates any interruption of the paper making process. Another object of this invention is to provide a mechanism which will repair a break in a paper web which starts from either edge or anywhere in the middle of the web. A further object of this invention is to provide a mechanism which will repair a break in a paper web in a minimum amount of time and will eliminate as much paper waste as possible.

SUMMARY OF THE INVENTION

These and other objects of the invention are accomplished by locating over a paper web a plurality of fixed water jets extending across the width of the web, a plurality of movable water jets positioned adjacent the fixed water jets and means for sensing a rupture in any area of the web for controlling the operation of individual fixed and movable water jets to repair the break in the web. The operation of the fixed water jets produce longitudinal slits in the web while operation of the movable jets produce diagonal slits in the web in a direction perpendicular to the direction of the break. Each diagonal slit intersects an adjacent longitudinal slit wherein the operation of the fixed water jets is interrupted at the intersection to provide lateral and longitudinal support between the web portions adjacent the slits.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial top plan view of the paper repair mechanism showing the mechanism for actuating the movable water jets and the repair pattern of the fixed and movable jets when a tear occurs at the edge of the web of paper.

FIG. 2 is a partial side view of the paper repair mechanism showing in schematic form the water jets and the photo-electric cells.

FIG. 3 is a schematic representation of the control circuit for controlling the actuating motor and the valves in the water jets.

FIG. 4 is a top plan view of the repair pattern of the fixed and movable jets when a tear occurs at the middle of the paper web.

DESCRIPTION OF A COMPLETE EMBODIMENT

Referring to FIG. 1, there is shown the apparatus for repairing the break in a paper web **20** which is transported over a press roll **19**. The apparatus includes a fixed conduit **21** which supports a number of water jets **22** depending from the conduit and positioned above the web **20**. Each of the water jets **22** includes a solenoid operated control valve **23** (FIG. 3) for controlling a supply of water under pressure to each of the jets **22**. The water supplied to each of the jets **22** is by means of pipes (not shown) located within the conduit **21**. Since the mechanical construction of the jets **22**, the valve **23** and the piping for the water supply is of standard construction and forms no part of the present invention, it is therefore unnecessary to show or describe the details thereof. Reference should be made to the previously cited U.S. Pats. Nos. 1,662,200; 1,725,108 and 1,838,603 for examples of structures that may be used.

Mounted adjacent to the upstream of the conduit support member **21** is a second conduit **24** suporting a plurality of water jets **25**. Both the conduit **24** and the water jets **25** are of the same construction as that of conduit **21** and water jets **22**. Each of the water jets **25** is controlled by a control valve **30** (FIG. 3) similar to that of valves **23**. The conduit support member **24** is slidably mounted for movement in a direction transverse to the movement of the web **20**. One end of the conduit constitutes a rack portion **26** (FIG. 1) which engages a pion gear **27** driven by a motor **28**. The motor **28** is of the reversible type and will oscillate the conduit **24** through a predetermined distance in a manner that will be described more fully hereinafter.

As shown in FIG. 2, the conduit support members **21**, **24** are positioned adjacent a roll **19** over which the paper web **20** moves. The roll **19** is schematically represented in FIG. 2. Positioned downstream of the conduits **21**, **24** are a pair of members **31**, **32**, each of which supports a bank of photo-electric cells **33**, **34** (FIG. 2), respectively.

As shown schematically in FIG. 3, the photo-electric cells **33, 34** are connected to a control unit **35** of any suitable type which is connected to the valves **23, 30** and the motor **28.** The control unit **35** may be of any type in which control signals are generated in response to receiving signals from the photo-cells or any other type of sensing means. Examples would include process controllers or other type of electronic devices which may be programmed to operate the valves **23, 30** in accordance to the results desired. Each of the photo-electric cells **33** controls a corresponding valve **23** to one of the water jets **22** while the photo-electric cells **34** control the valves **30** located in the water jets **25.** While two sets of photocells are shown in the present example, it is obvious that one set of photocells may be used with each photocell producing signals which control the operation of both control valves **23, 30.**

Referring now to FIG. 1, there is shown a schematic representation of the operation of the water jets when a tear occurs at the edge of the paper web. The tear **36** will develop normally in a diagonal direction against the movement of the web **20.** As the flap of the paper drops down, it will tend to curl toward the middle of the web thereby exposing a light source **37** (FIG. 2) which actuates the associated photo-electric cells **33, 34.** While the photo-electric cell arrangement of FIGS. 1 and 2 is utilized for the detecting means, it is obvious that other detecting means such as pneumatic sensing means can be used. As shown in U.S. Pat. No. 2,451,816, the method of reflecting light off the web from a light source to a photo-electric cell is another example of a detecting system that may be used. The type of detecting system used is therefore not critical to the practice of this invention.

The detection of a tear in a web by any of the photocells **33** will result in the sending of signals to the control unit **35.** Depending on the programming of the control unit **35,** all the water jets **22** or those jets in the area of the tear will be turned on through the operation of the valves **23** by the control unit. Operation of the jets **22** will slit the paper web into a plurality of longitudinal strips. As disclosed in the previously-cited patents, Nos. 1,662,200; 1,725,108 and 1,838,603, the longitudinal slits **38** (FIG. 1) will intercept and stop the tear in the web. The control unit **35,** in addition to the operation of the jets **22,** will also operate the motor **28** resulting in the oscillation of the conduit **24** in a transverse direction with respect to the paper web **20.** The tear in the web will also be sensed by the photocells **34** in the same manner as was sensed by the photocells **33.** Signals will be sent to the control unit **35** by the photocells **34,** upon sensing a break in the web, allowing the control unit to operate the appropriate valves **30** resulting in the turning on of the corresponding water jets **25.**

As shown in FIG. 1, each of the jets **25** is off-set with respect to a corresponding jet **22.** Upon the transverse movement of the conduit **24** by the motor **28,** the jets **25** will produce diagonal slits **40** which move across the longitudinal slits **38** produced by the jets **22.** The control unit **35** is programmed to control the operation of the valves **23** so that the water is shut off from the jets **22** as they cross the slits **40** made by the jets **25.** Depending from what edge the tear originates, the photocells **34** will supply the control unit **35** with sufficient information such that the jets **25** will be sequentially operated during the movement of the conduit **24** to make diagonal slits **40** which will be generally perpendicular to the direction of movement of the tear. Normally those jets **25** positioned adjacent the tears, as determined by the signals from the photocells **34,** will be operated to confine the area of the tears to a minimum.

As shown in FIG. 1, the jets **25,** under the control of the photocells **34,** will trace a zig-zag pattern with relation to the longitudinal slits **38** with the jets turned on only during the movement of the conduit in one direction. By interrupting the jets **22** as they intercept the path of the jets **25,** a continuous connection will be made between adjacent strips formed by the slits **38** and between the area of the paper web adjacent the diagonal slits **40.** Thus, the diagonal slits **40** function to limit the amount of paper that is lost by the tearing of the web and also to provide a continuity between the tear area and the rest of the web which allows the web to continue its movement without stopping. The tear portion of the paper web will normally tear off between the longitudinal slit **38** and its closest diagonal slit **40** due to the weight of the paper. If this tear portion does not drop off, it will move over the roll **19** where it will adhere to the roll **19** and be cut off by a knife **41** (FIG. 2) positioned adjacent the roll **19.** The tag end of the paper will now be supported, after the tear portion has been cut off, by the adjacent web area sufficiently so as to continue its movement through the remainder of the processing operation.

Once the tear portion has been removed, the photocells will sense the condition of the paper web and signal the control unit **35** accordingly, wherein the jets **22, 25** will be turned off.

While many of the tears that occur in the web start from the edge of the web, there are occasions where the tear will start approximately in the center of the web. Under this condition, the tear can proceed upstream in any direction. FIG. 4 shows this condition. The tear will be intercepted by a pair of the longitudinal slits **38.** The control unit **35** will operate the jets **25** to produce a series of diagonal slits **40** which are perpendicular to the direction of tear. The tear portion will normally break off between the diagonal slit **40** and an adjacent longitudinal slit **38** due to the weight of the paper as described previously.

It is obvious from the above construction that the jets **22, 25** can be selectively operated by the control unit **35** as a result of signals generated by the photocells so that after a tear has been detected and confined by the slits in the manner described above, those jets which are not needed can be turned off. Depending on the amount of control over the jets that is desired, additional banks of photocells can be positioned downstream of the photocells **33, 34** to selectively operate the jets so that only those jets in the immediate vicinity of the tear will be actuated. Although this description is directed towards repairing breaks in the "wet end" of the web, it is obvious that this method and apparatus can be utilized to repair breaks in the "dry end" of the web using a cutting means, for example, a laser beam, which will cut slits in the dry web in the same manner as the water jets cut slits in the wet web. It will thus be seen that this construction allows for the repairing of a break in any part of the web without interrupting the production of the web.

What is claimed is:

1. A mechanism for repairing a diagonal break in the web of paper moving at a high rate of speed including

(a) a first set of sensing members positioned transverse to and adjacent the web for sensing the location of a diagonal break in the web, said sensing members generating signals upon sensing a break in the web;

(b) a second set of sensing members positioned parallel to said first set of sensing members and adjacent the web for sensing the direction of travel of a diagonal break in the web, said second set of sensing members generating signals upon sensing the direction of travel of a diagonal break in the web;

(c) control means operatively connected to said first and second set of sensing members, said control means generating first control signals in response to receiving signals from said first set of sensing members and generating second control signals in response to receiving signals from said second set of sensing members;

(d) a plurality of stationary cutting members operatively connected to said control means and positioned adjacent said web each cutting a plurality of aligned spaced apart longitudinal slits in the web in

response to the generation of said first control signals;

(e) a support member positioned adjacent said web and mounted for movement in a direction transverse to the movement of the web;

(f) drive means engaging said support member for oscillating said support member a distance greater than the width of two adjacent horizontal slits in response to said first control signals;

(g) and a plurality of second cutting members operatively connected to said control means and mounted on said support member, each of said second members cutting a diagonal slit in the web in response to the generation of said second control signals upon the oscillatory movement of said support member, each diagonal slit intersecting adjacent line of longitudinal slits in the space between the longitudinal slits whereby a portion of the web formed by a diagonal break and the adjacent longitudinal and diagonal slits will be removed without stopping the movement of the web.

2. The mechanism of claim 1 in which

(a) said support means includes a rack portion;

(b) and said drive means includes a gear member engaging said rack portion;

(c) and a reversible operating drive motor engaging said gear member and operated in response to said first control signal to rotate said gear member whereby said support member is oscillated through a predetermined distance in a direction transverse to the movement of the web.

3. The mechanism of claim 2 in which each of said second cutting members is positioned downstream and off-set to a corresponding first cutting member whereby movement of said second cutting member by said drive motor will cut a plurality of diagonal slits, each of which intersect the space between the adjacent longitudinal slits cut by the corresponding first cutting member.

4. A mechanism for removing a portion of a moving paper web formed by a diagonal break including

(a) a plurality of first photo-electric cells disposed adjacent to and extending across the web for generating signals upon sensing the location of a break in the web;

(b) a plurality of second photo-electric cells disposed adjacent to and extending across the web downstream from and parallel to said first photo-electric cells, said second photo-electric cells generating a plurality of signals representing the direction of travel of the diagonal break;

(c) control means operatively connected to said first and second photo-electric cells, said control means generating first control signals in response to receiving signals from said first photo-electric cells and generating second control signals in response to receiving signals from said second photo-electric cells;

(d) a plurality of first equally spaced stationary water jets disposed adjacent to and extending across the web, each of said water jets operatively connected to said control means to cut a plurality of aligned spaced apart longitudinal slits in the web in response to said first control means;

(e) a slidably mounted conduit support member positioned adjacent the web and downstream of said first water jets, said support member mounted for movement in a direction transverse to the movement of the web;

(f) actuating means engaging said support member and oscillating the support member in a direction transverse to the movement of the web in response to said first control signals;

(g) and a plurality of second equally spaced water jets mounted on said support member, each of said second water jets positioned normally on said support member adjacent the longitudinal slits cut by a corresponding first water jet and, in response to said second control signals, said jet cuts a diagonal slit in the moving web which intersects the adjacent longitudinal slits in the space between the longitudinal slits whereby the web portion formed by the break and adjacent the longitudinal and diagonal slits will be removed from the web without stopping the web.

5. A method for repairing a diagonal tear in a web of paper moving at a high rate of speed comprising the steps of

(a) sensing the location of the tear in the web;

(b) generating first control signals in response to the sensing of the location;

(c) sensing the direction of movement of the tear in the web;

(d) generating second control signals in response to the sensing of the direction of the tear;

(e) cutting a pluarilty of rows of aligned interspaced longitudinal slits in the web in response to said first control signals;

(f) and cutting a plurality of diagonal slits in the web in a direction generally perpendicular to the direction of the tear in response to said second control signals, said diagonal slits extending through a pair of adjacent rows of and between aligned longitudinal slits.

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U.S. Cl. X.R.

162—255, 286