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WEB BREAK SENSING MONITOR FOR PAPER MACHINES

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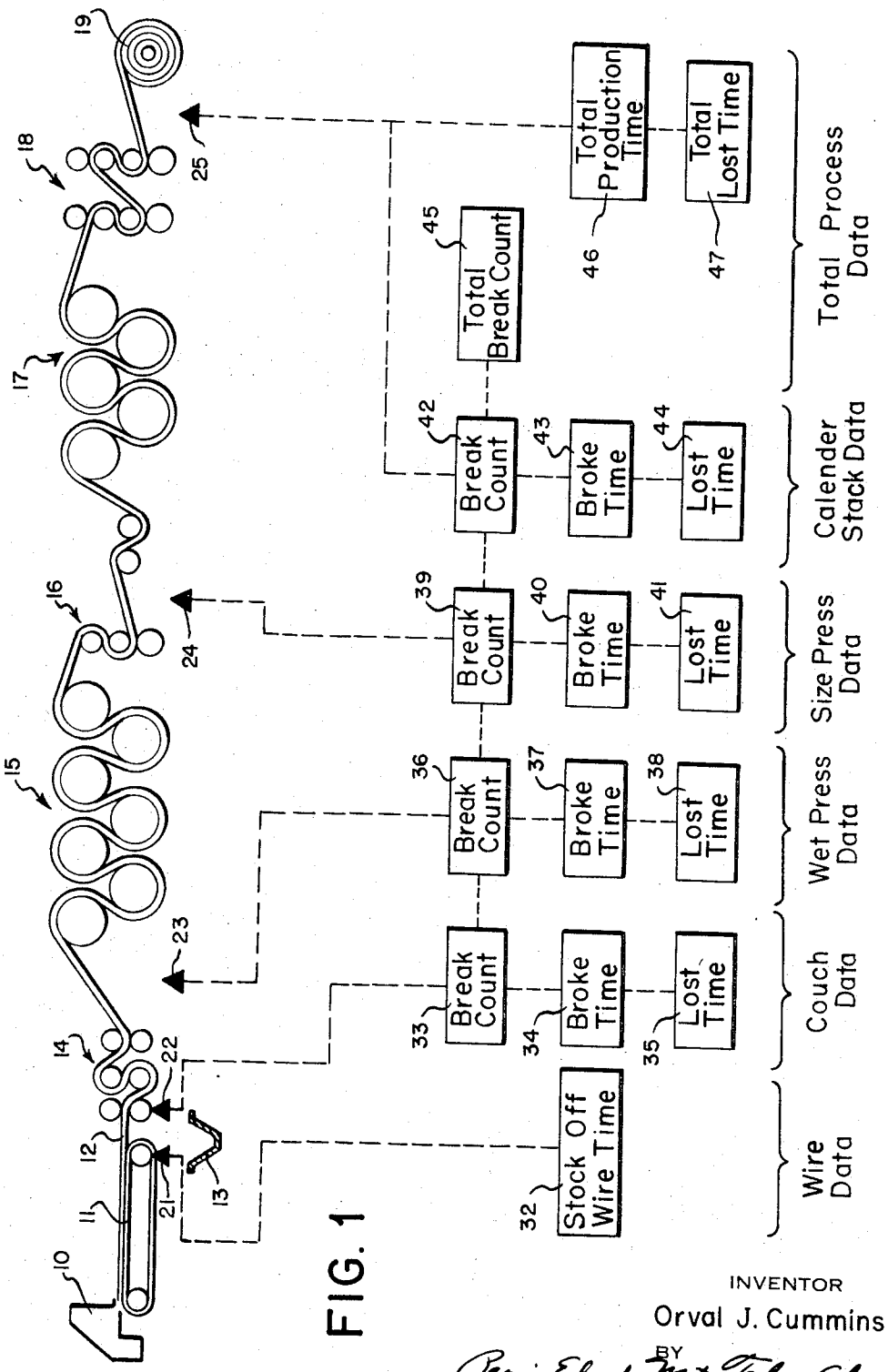

FIG. 1

INVENTOR
Orval J. Cummins
BY
Pearne Edmonds Morton Taylor & Adams
ATTORNEYS

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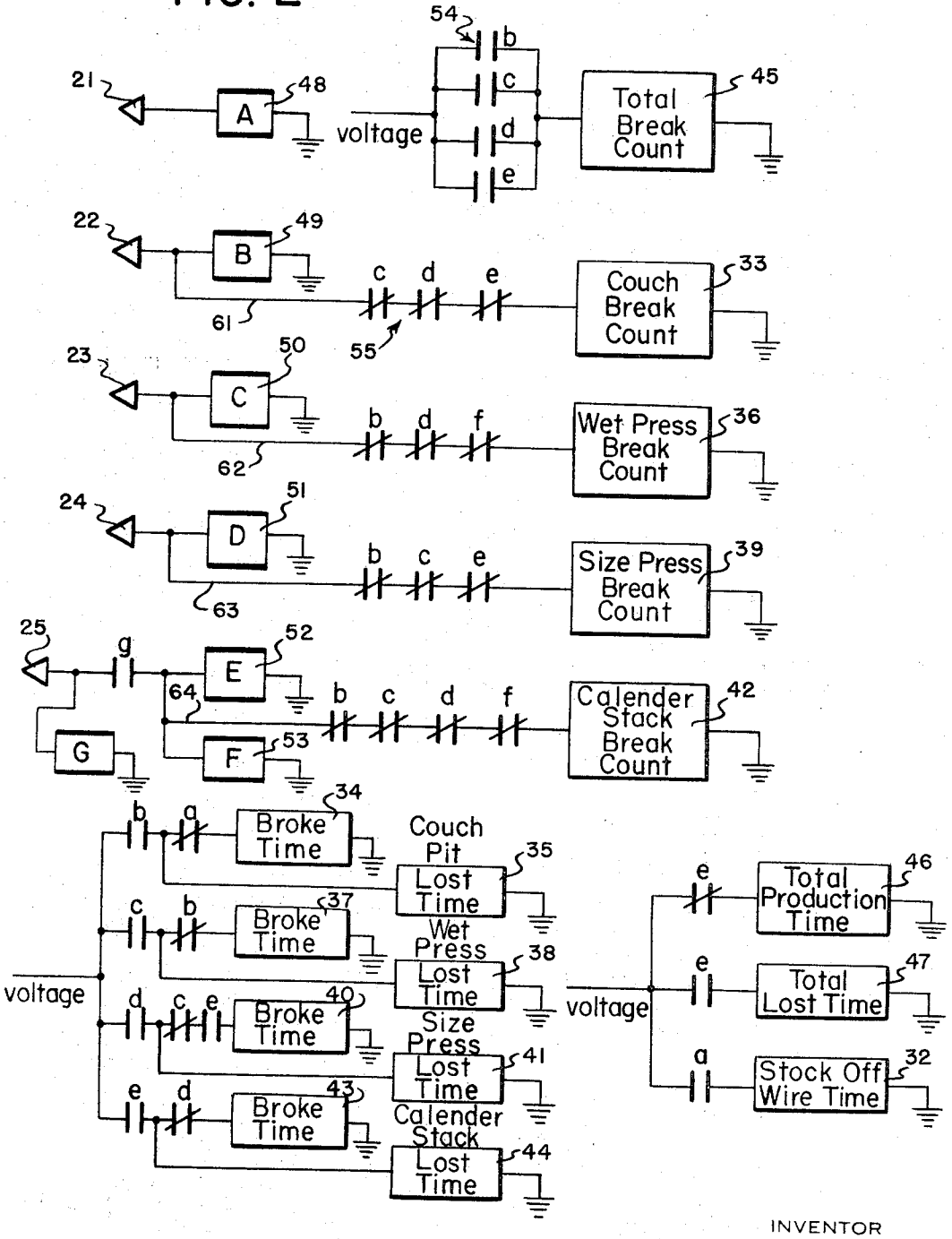
FIG. 2



INVENTOR
Orval J. Cummins
BY
Dennis Edwards Martin Taylor & Adam
ATTORNEYS

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WEB BREAK SENSING MONITOR FOR PAPER MACHINES

Orval J. Cummins, Chautauqua, Ohio, assignor to Oxford Paper Company, New York, N.Y., a corporation of Maine

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This invention relates to monitoring apparatus for a paper making machine, and particularly to apparatus for indicating the occurrence, location and duration of breaks in a paper web.

A paper making machine involves the formation of a continuous web of paper pulp upon a wire screen and the pressing, drying, sizing, calendering, etc. of the paper web in successive processing stages. Throughout the manufacturing process the paper web is subject to tearing and other discontinuities known generally as "breaks." The occurrence of a paper web break indicates a malfunction which requires correction before production can proceed. For effective quality control, machine maintenance and production record keeping it is desirable to record the occurrence and duration of paper web breaks and the portion of the machine in which each break occurs. Previously it has been necessary to obtain and record this data manually. Upon the occurrence of a paper web break, one of the operating personnel notes the break and where it has occurred, and manually records this information along with the total down time attributable to the break. Since the primary duty of the operating personnel at this time is to quickly correct the operation to regain a continuous paper web, their record keeping function suffers and the resulting data are frequently incomplete, inaccurate or unreliable.

The present invention provides apparatus for monitoring a paper making machine in which a paper web passes through successive processing stages. The apparatus uses a plurality of sensors for detecting breaks in the paper web, located at respective stations spaced along the path of travel of the web, and the actuation of the sensors is arranged to control the accumulation of the information concerning web breaks. In the preferred embodiment described in detail hereafter, several types of indications are obtained. One type is the number of breaks occurring at each station, and provision is made so that breaks occurring at a given station are counted only at that station and not at succeeding stations. A second type is the total broke time at each station due to breaks thereat, and similar provision is made so that the time accumulated at a given station is due only to breaks first occurring thereat. A third type is a continuous record of lost time at each station regardless of the cause. Further, overall totals of production time, lost time, number of breaks, etc. are obtained.

These and further features and advantages of the invention will be more readily understood from the following description of a specific embodiment thereof.

In the drawings:

FIG. 1 illustrates schematically a paper making machine and the monitoring apparatus of the invention; and

FIG. 2 is a schematic circuit diagram illustrating relay connections for actuating the various indicators of FIG. 1.

In the paper making machine shown in FIG. 1, paper pulp stock is distributed from a hopper **10** onto a moving Foudrinier wire screen **11** where a paper web **12** is formed. The paper web proceeds to move from the wire screen **11** over a couch pit **13**, through a wet press **14**, a first dryer **15**, a size press **16**, a secondary dryer **17**, a calender stack **18** and finally onto a reel **19**. In this specific embodiment sensors are located at five stations along the path of travel of the paper web. Each of these sensors is

capable of detecting the presence or absence of the paper web at the sensor station.

A first sensor **21** is located at the end of the Foudrinier wire screen. This sensor in the preferred embodiment is a vacuum-operated switch which responds to variations in couch vacuum, and hence indicates whether or not there is paper stock on screen **11**. A second sensor **22** is located at the wet press **14** to detect breaks in the web thereat. This also may be a vacuum-operated switch. The third sensor **23** is positioned between the web press **14** and first dryer **15** to detect wet end breaks. The fourth sensor **24** is between the size press **16** and secondary dryer **17**, preferably out of reach of coating splatter during normal operation of the size press and hosing down during a clean-up period. The fifth sensor **25** is between the calender stack **18** and reel **19**. These three latter sensors may be conventional photocell units capable of detecting a break in the paper web as it moves past them. Each of the sensors is capable of energizing an electric relay as hereinafter described.

It will be understood that the paper making machine shown in FIG. 1 is illustrative only, and that the number and location of the sensors may be selected in view of the particular apparatus to be monitored, and the amount of information it is desired to collect. The type of sensor employed at each location may be selected in view of the operating conditions thereat to provide a reliable response.

Associated with the five sensors are a group of indicators as shown in FIG. 1. The first sensor **21** has associated with it an electrical accumulating timer **32** for indicating the accumulated time during which paper stock is not on the screen **11**. This time is identified as "Stock Off Wire Time." The timer is resettable and of conventional design, as are all the other data indicators of the monitor.

Associated with the second sensor **22** are an electrical counter **33**, an accumulating timer **34**, and a moving chart recorder **35**. Counter **33** records the number of paper web breaks first detected by sensor **22**. This data is known as "Couch Break Count" since the web breaks counted are attributable to the couch portion of the process. Timer **34** accumulates the time during which web breaks are first detected by sensor **22**, called "Couch Broke Time." Chart recorder **35** records the time of day and duration of all paper web breaks detected by sensor **22** whether first detected at that station or not. This record is called "Couch Lost Time."

Similar data recording devices are associated with the other three sensors. Thus, associated with sensor **23** are a counter **36**, a timer **37** and chart recorder **38** indicating "Wet Press Break Count," "Wet Press Broke Time" and "Wet Press Lost Time," respectively. Counter **39**, timer **40** and chart recorder **41** are associated with sensor **24** and give corresponding Size Press data. Counter **42**, timer **43** and chart recorder **44** are associated with sensor **25** and give corresponding Calender Stack data.

Additional units are provided to give overall data. Counter **45** is employed to record the total number of breaks occurring in the process. Two further timers **46**, **47** are associated with the last sensor **25**. Timer **46** indicates the accumulated time during which the paper web passes onto the reel **19**, which is the "Total Production Time." Timer **47** accumulates the time during which paper web breaks are detected by **25**. Since during this time no web passes on to the reel **19**, it is called the "Total Lost Time."

FIG. 2 shows the circuitry of the monitoring system in more detail. Each of the five sensors **21–25**, on detecting absence of paper stock on screen **11**, or a subsequent web break, actuates a corresponding electromagnetic relay **48–52**. For convenience these relays are also designated by capital letters A–E, respectively. The last sensor **25** actuates relay E through a time delay relay G,

and also actuates a time delay relay F, for purposes to be described. Each of the relays A–G controls switch contacts which are designated by the lower case letter corresponding to the letter designation of the relay controlling them. Thus, switch contacts **54**, also designated *b*, are a normally open set of contacts controlled by relay B. These contacts remain open when sensor **22** does not detect a web break, but close when **22** detects a break and actuates relay B. Contacts **55**, also designated *c*, are a normally closed set of contacts controlled by relay C. They open when sensor **23** detects a web break.

Considering first the actuation of the four break counters, the counters **33**, **36**, **39** and **42** are assumed to be of the type which count upon application of an electrical signal thereto, but will not count again until the signal is first removed. As will be observed, the couch break counter **33** is actuated by a signal from sensor **22** passing through line **61** and the normally closed contacts of relays C, D and E. Thus if a break occurs ahead of the wet press **14**, the count will be incremented. As the web ahead of the break passes by succeeding sensors, normally closed contacts *c*, *d* and *e* in line **61** will open in succession. Therefore counter **33** cannot be actuated again until the fault has been repaired and a continuous web again extends from the wet press **14** to the roll **19**.

Wet Press Break counter **36** is actuated by a signal from sensor **23** through line **62** containing the normally closed contacts of relays B, D and F. If a break occurs between the wet press **14** and first dryer **15**, the count will be incremented. However, if the break occurred ahead of the wet press, relay B will have been actuated, thus breaking the circuit in line **62** before sensor **23** delivers a signal thereto, and counter **36** will not be actuated Once actuated, the subsequent opening of contacts *d* and *f* in line **62** will inhibit another actuation until a continuous web extends to roll **19**.

Size Press Break counter **39** is similarly actuated by a signal from sensor **24** through line **63** containing normally closed contacts of relays B, C and E. If the break first occurred at a previous station, relay B and/or C will have ben actuated to break the circuit of line **63** and inhibit actuation of counter **39**, so no count will be registered. After counting, the opening of contacts *e* will inhibit further counting until a continuous web extends to roll **19**.

Calender Stack Break counter **42** is actuated by a signal from sensor **25**. Here provision is made to prevent counting a break during reel change-over. During normal production, when one reel **19** has been filled, it is removed and the paper web fed to another reel. Although the change-over normally takes only a few seconds, during this interval the web is necessarily broken and may flop around until the change-over is complete. Thus sensor **25** will be actuated during the change-over, and may be actuated several times due to web flutter.

Time delay relay G is employed to introduce a time delay sufficient to allow reel change-over before contacts *g* are closed, say, five seconds. Thus the sensor **25** cannot apply a signal to line **64** until after this delay, and normal change-overs will not be counted. A break due to malfunctioning will last longer than the delay interval and hence will be counted. Instead of relay G, a photocell unit incorporating a time delay could be used for sensor **25**.

Line **64** contains normally closed contacts *b*, *c* and *d* which inhibit a count if the break first occurred at a previous station. The line also contains contacts *f* of relay F, which is a time delay relay providing a short delay, say one second, sufficient to allow the counter **42** to be actuated before contacts *f* open. The contacts remain open until a continuous web again extends to reel **19**.

It will be noted that each of lines **61–64** contains in series the contacts of all the relays actuated by preceding sensors with which counters are associated. Thus only the station where a break first occurs is charged with a break count. The lines also contain in series the contacts of relays actuated by all subsequent sensors to inhibit further counting until a continuous web to the reel has again been established. For the latter purpose, instead of using contacts of all subsequent relays, in some instances it may suffice to use only the contacts of the last subsequent relay to inhibit further counting. However, the arrangement shown is advantageous in order to insure that there will be no counts due to web breaking during a rethreading interval, to shorten the intervals during which the counters are held energized, and to facilitate cleaning the photocell light sources during wash up periods without disturbing any of the counts.

In line **62**, contacts of relay E could be used in place of those of relay F if a sufficient number of sets of contacts are available.

The Total Break counter **45** is incremented by closure of normally open contacts of any one of relays B, C, D, E. However, there will be only one count per break since closure of the contacts of one relay will establish the energizing circuit for the counter, and closure of the contacts of subsequently actuated relays will establish additional parallel energizing circuits which will prevent a further count increment until all the relays are deenergized, corresponding to a continuous web being fed to the reel.

Couch Broke timer **34** is energized whenever relay B is actuated and relay A is not. This condition corresponds to the situation where a break is detected by sensor **22** but sensor **21** indicates there is paper stock on the screen **11**. By analogous connections, timers **37**, **40** or **43** are energized when a break is first detected by sensors **23**, **24** or **25**, respectively. Their energization continues while the break continues to be detected by the sensor first detecting it. It will be understood that if a break occurs at one station and actuates the corresponding relay, say B, subsequent relays C, D and E will be actuated in succession as the portion of the web ahead of the break passes by the subsequent sensors. Thus subsequent timers **37**, **40** and **43** will not be energized until the fault has been repaired and a continuous web starts passing by the stations in succession. As each relay deenergizes, the timer at the next station will be energized for a brief period until the web reaches it. Due to the speed of travel of the web, the time accumulated in this manner will be small compared to the time accumulated for actual breaks first occurring at a given station. To reduce the error, normally open contacts of relay E may be placed in series, as shown by contacts *e* for timer **40**.

Chart recorders **35**, **38**, **41** and **44** are energized during the detection of paper web breaks by sensors **22–25**, respectively, by closure of the respective relay contacts *b–e*.

Stock Off Wire timer **32** accumulate the time during which relay A is actuated, or in other words the time during which sensor **21** indicates there is no paper stock on screen **11**. Total Production timer **46** accumulates the total time during which relay E is not actuated, wherein no web breaks are detected by sensor **25**. Total Lost timer **47** accumulates the time during which relay E is actuated, corresponding to the detection of web breaks by sensor **25** and the absence of a continuous web passing to the reel.

The overall operation will be explained by starting with a shut-down period and applying power to the monitoring apparatus. Initially all sensors **21–25** will be actuated and the corresponding relays A–F will be actuated. The energizing lines **61–64** for break counters **33**, **36**, **39** and **42** will be open due to the open relay contacts in series therewith, and the counters may be reset to zero or their initial count noted. Total Break counter **45** will be energized, and it may be reset to zero or its count noted. The energizing circuits for Broke Time accumulators **34**, **37**, **40** and **43** will be open due to the open relay contacts in series therewith, and they also may be set to zero or their

initial accumulated times noted. Lost time chart recorders **35, 38, 41** and **44** will start recording down time at the four stations. Total Production timer **46** will be inactive, and Total Lost and Stock Off Wire timers **47, 32** will start operating. They may be reset to zero or their initial times noted.

After paper stock is placed on screen **11** and operation begins, sensor **21** and its relay A will deenergize, and Stock Off Wire timer **32** will stop accumulating time. As the paper web reaches the detecting stations in succession, the sensors **22–25** and corresponding relays will deenergize in succession and the corresponding Lost Time chart recorders **35, 38, 41, 44** will stop recording down time and change to running time positions. Broke Time accumulators **34, 37** will operate in succession for brief intervals determined by the time of travel of the web from one station to the next. Actuation of Broke Time accumulator **40** will be inhibited by the open contacts *e*, and accumulator **43** will operate momentarily as the web passes from sensor **24** to **25**. As the web passes the last sensor **25** and onto reel **19**, the deenergizing of relays E and F starts Total Production timer **46**, cuts off Total Lost timer **47**, and completes the closing of the relay contacts in break counter energizing lines **61–64**.

The monitor is now ready to indicate breaks in the paper web. When a break occurs, other than that accompanying a reel change-over, the sensor first to detect it will increment the corresponding break counter **33, 36, 39, 42** and its corresponding relay will energize the corresponding Broke Time accumulator **34, 37, 40, 43** and increment Total Break counter **45**. The actuation of the relay will inhibit the incrementing of counters and actuation of accumulating timers corresponding to succeeding sensors as the portion of the web ahead of the break passes thereby, as previously described. However, chart recorders **35, 38, 41** and **44** will start recording down time as each sensor is actuated. When the last sensor **25** detects a break lasting longer than normal reel change-over, Total Production timer **46** stops and Total Lost timer **47** starts.

When the faulty operation of the machine has been corrected and a continuous web starts toward reel **19**, the previously actuated sensors successively return to their normal conditions and the Broke Time accumulators and chart recorders which have been energized are de-energized. When the web reaches the reel, the de-energizing of relays E and F re-establish the energizing lines **61–64**, ready for counting the next break. Also, Total Lost timer **47** stops and Total Production timer **46** resumes.

If a break is detected by the last sensor **25** which is due to normal reel change-over, no break will be indicated since the time delay introduced by relay G will prevent the sensor from being effective during the change-over period.

In practice, indicator lights are used to indicate actuation of the relays, recorders, etc., but these have been omitted in the drawing for simplicity.

It will be understood that various types of indicators other than those specifically described may be used if desired, and that fewer or more indicators or types of indicators may be employed depending on the type and amount of data it is desired to accumulate. Also, various changes may be made in the detailed circuitry within the spirit and scope of the invention.

I claim:

1. Apparatus for monitoring the operation of a paper making machine wherein a paper web passes through successive processing stages which comprises

(a) a plurality of sensors located at respective stations spaced along the path of travel of the paper web for detecting breaks in the web thereat,

(b) a plurality of timers associated with said sensors, repectively, for accumulating the total time of breaks at the respective stations,

(c) and circuit means responsive to said sensors for actuating respective timers upon the detection of breaks thereby,

(d) said circuit means including means responsive to the actuation of a preceding sensor for inhibiting the actuation of the timer corresponding to a succeeding sensor along said path of travel, while said succeeding sensor remains in break detection condition.

2. Apparatus for monitoring the operation of a paper making machine wherein a paper web passes through successive processing stages which comprises

(a) a plurality of sensors located at respective stations spaced along the path of travel of the paper web for detecting breaks in the web thereat,

(b) a plurality of indicators associated with said sensors respectively,

(c) and circuit means responsive to said sensors for actuating respective indicators upon the detection of breaks thereby,

(d) said circuit means including means responsive to the actuation of a preceding sensor for inhibiting the actuation of the indicator corresponding to a succeeding sensor along said path of travel while said succeeding sensor remains in break detection condition and including means responsive to the actuation of a succeeding sensor for inhibiting the actuation of the indicator corresponding to a preceding sensor.

3. Apparatus in accordance with claim **2** in which said circuit means includes means responsive to the actuation of each sensor for inhibiting the actuation of the indicators corresponding to all succeeding sensors along said path of travel, and means responsive to the actuation of the last sensor along said path of travel for inhibiting the actuation of the indicators corresponding to preceding sensors during the actuation of said last sensor.

4. Apparatus in accordance with claim **3** in which said indicators are counters for counting the number of breaks at the respective stations.

5. Apparatus in accordance with claim **2** in which said paper web passes through said successive processing stages to a reel, the last of said sensors is positioned to detect breaks between the last processing stage and said reel, and said indicators are counters for counting the number of breaks at the respective stations, and including means responsive to the actuation of said last sensor for inhibiting the actuation of the counters corresponding to the preceding sensors during the actuation of the last sensor.

6. Apparatus for monitoring the operation of a paper making machine wherein a paper web passes through successive processing stages which comprises

(a) a plurality of sensors located at respective stations spaced along the path of travel of the paper web for detecting breaks in the web thereat,

(b) a plurality of timers associated with said sensors, respectively, for accumulating the total time of breaks at the respective stations,

(c) a plurality of electrical relays actuable by respective sensors upon the detection of breaks thereby and having a plurality of switch contacts,

(d) and a plurality of electrical circuits responsive to the actuation of respective sensors upon the detection of breaks thereby for actuating respective timers,

(e) said electrical circuits which correspond to succeeding sensors along said path of travel including switch contacts of relays corresponding to preceding sensors for inhibiting the actuation of the timer corresponding to a succeeding sensor when a preceding sensor has detected a web break, while said

succeeding sensor remains in break detection condition.

7. Apparatus for monitoring the operation of a paper making machine wherein a paper web passes through successive processing stages which comprises

(a) a plurality of sensors located at respective stations spaced along the path of travel of the paper web for detecting breaks in the web thereat,

(b) a plurality of counters associated with said sensors, respectively, for counting the number of breaks at the respective stations,

(c) a plurality of electrical relays actuable by respective sensors upon the detection of breaks thereby and having a plurality of switch contacts,

(d) and a plurality of electrical circuits responsive to the actuation of respective sensors upon the detection of breaks thereby for actuating respective counters,

(e) each of said electrical circuits including switch contacts of each relay actuated by a preceding sensor for inhibiting the actuation of the counters corresponding to succeeding sensors when a preceding sensor has detected a web break while said succeeding sensors remain in break detection condition,

(f) and each of said circuits actuated by a preceding sensor including switch contacts of at least the relay actuated by the last sensor for inhibiting further counting of breaks at preceding stations until no break is detected at the last station.

8. Apparatus in accordance with claim 7 in which said paper web passes through said successive processing stages to a reel, and said last sensor is positioned to detect breaks between the last processing stage and said reel.

9. Apparatus in accordance wih claim 7 including a plurality of timers for accumulating total broke time at respective stations, and an energizing circuit for each timer including contacts of the relays actuated by the corresponding and next preceding sensors for energizing the timer upon detection of a break at the respective station with no break detected at the next preceding station.

10. Apparatus in accordance with claim 9 including a counter for accumulating the total number of breaks at all said stations, and an energizing circuit for said counter including switch contacts of said relays in parallel.

11. Apparatus in accordance with claim 10 including a pair of timers for accumulating total production and total lost time, respective energizing circuits for said timers including respective contacts of the relay actuated by the last sensor along the path of travel of the paper

web, said contacts being connected to energize one timer during the detection of breaks and the other timer during the absence of breaks.

12. Apparatus for monitoring the operation of a paper making machine wherein a paper web passes through successive processing stages to a reel, the paper web being broken at intervals and fed to different reels during reel change-over periods, which comprises

(a) a plurality of sensors located at respective stations spaced along the path of travel of the paper web for detecting breaks in the web thereat,

(b) the last of said sensors being positioned to detect breaks between the last processing stage and the reel in use,

(c) a plurality of indicators associated with said sensors respectively,

(d) circuit means responsive to said sensors for actuating respective indicators upon the detection of breaks thereby,

(e) said circuit means including means responsive to the actuation of a preceding sensor for inhibiting the actuation of the indicator corresponding to a succeeding sensor along said path of travel,

(f) and means for introducing a delay between the detection of a break by said last sensor and the actuation of the respective indicator to prevent indication of breaks during normal reel change-over periods.

13. Apparatus in accordance with claim 9 for monitoring a paper making machine in which the paper web is fed from the last processing stage to a reel and the web is broken at intervals and fed to different reels during reel change-over periods, the last of said sensors being positioned to detect breaks between the last processing stage and the reel in use, said apparatus including means for introducing a delay between the detection of a break by said last sensor and the actuation of the respective counter and accumulating timer to prevent actuation thereof during normal reel change-over periods.

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S. LEON BASHORE, *Primary Examiner.*