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Crain et al.

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[54] **ENDLESS BELT PAPER TRANSPORTING AND PROCESSING APPARATUS**

[72] Inventors: **N. Robert Crain,** Huntington Beach; **William W. Crain,** Santa Ana; **Gary L. Pollitt,** Fountain Valley; **Donald E. Rea,** Santa Ana, all of Calif.

[73] Assignee: **Documentor Sciences Corporation,** Santa Ana, Calif.

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[52] **U.S. Cl.**.....**197/127 R,** 197/130, 197/137

[51] **Int. Cl.**.....**B41j 13/00**

[58] **Field of Search**.....197/127, DIG. 9, 128, 130, 197/137

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Primary Examiner—Ernest T. Wright, Jr.
Attorney—Spensley, Horn & Lubitz

[57] **ABSTRACT**

A processing input and output apparatus wherein a paper member bearing input data is transported along a path from the input of the apparatus to the output thereof by cooperating endless belts supported on crowned rollers and driven frictionally by a drive wheel in a sprocketless assembly. During the movement through the apparatus, the paper is sensed, read and printed upon.

5 Claims, 5 Drawing Figures

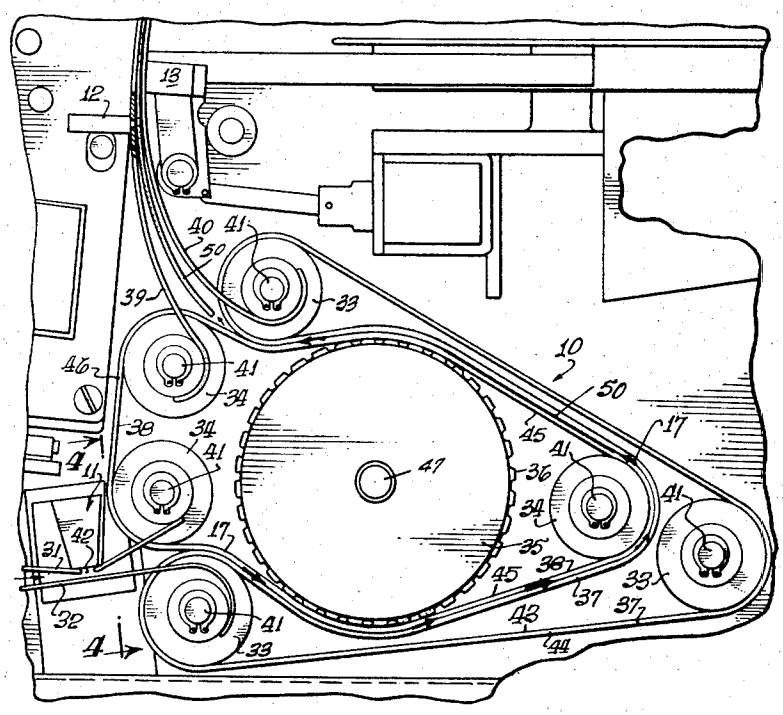

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FIG. 1.

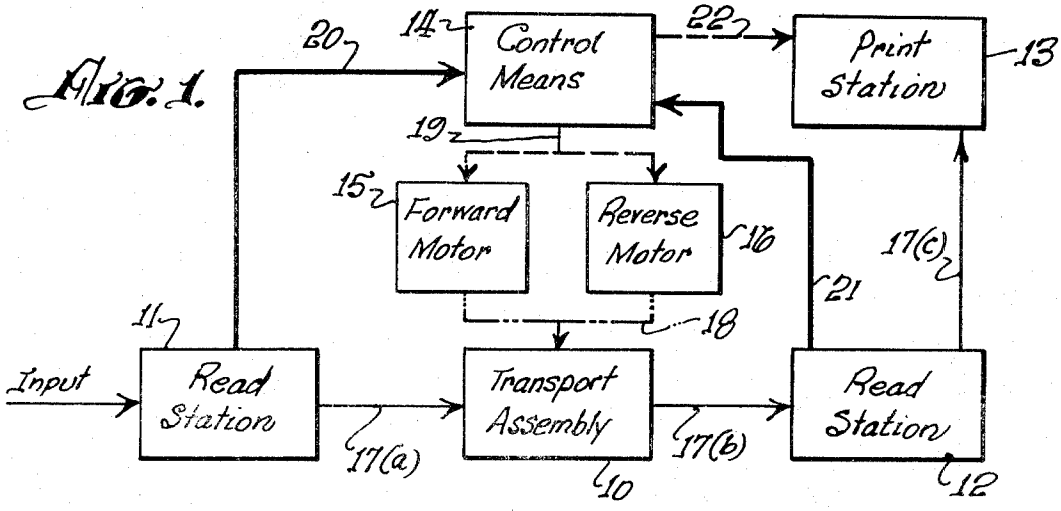
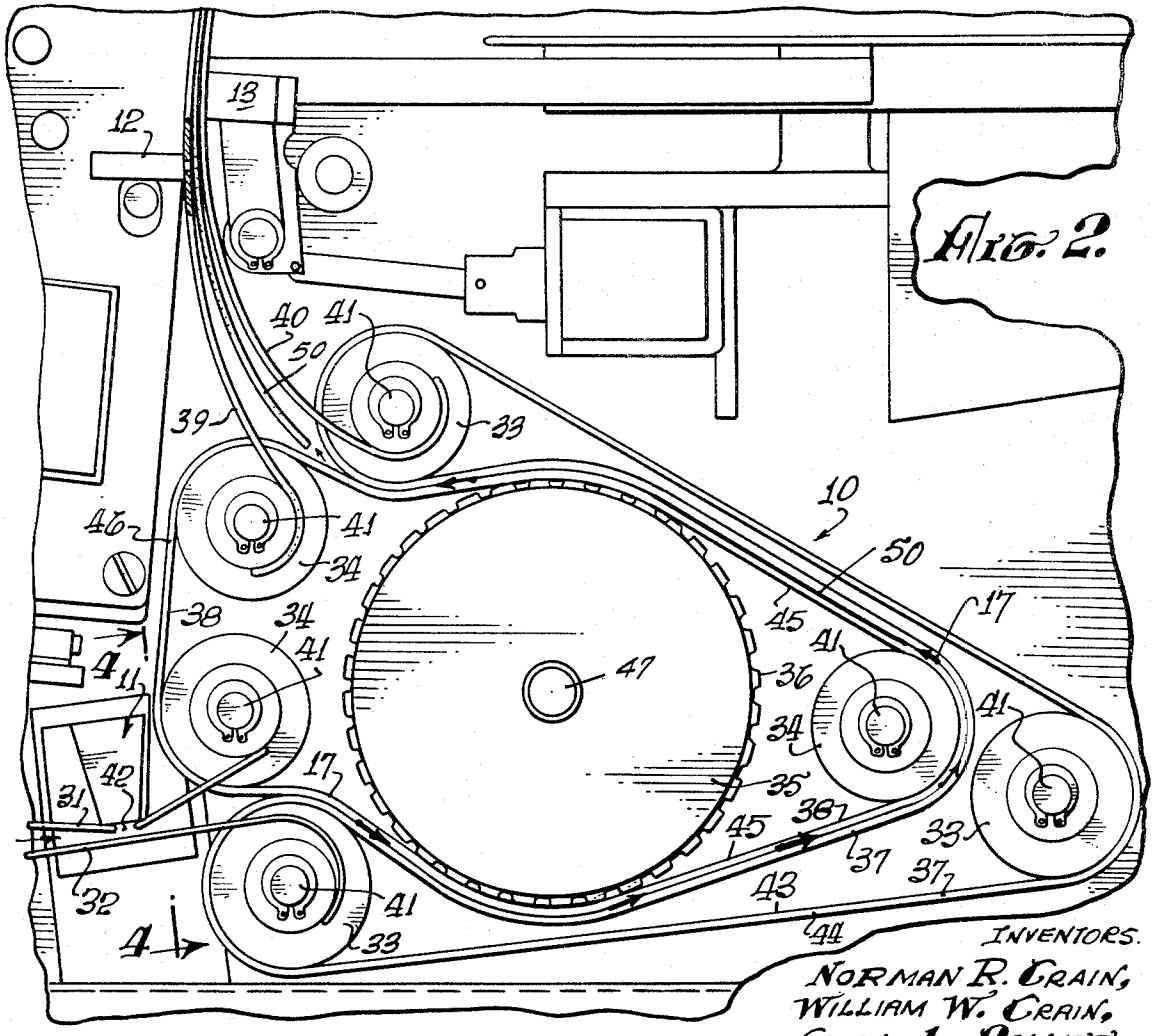


FIG. 2.



INVENTORS.
NORMAN R. CRAIN,
WILLIAM W. CRAIN,
GARY L. POLLITT,
DONALD E. REA,

BY THEIR ATTORNEYS
Spensley & Horn

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FIG. 3.

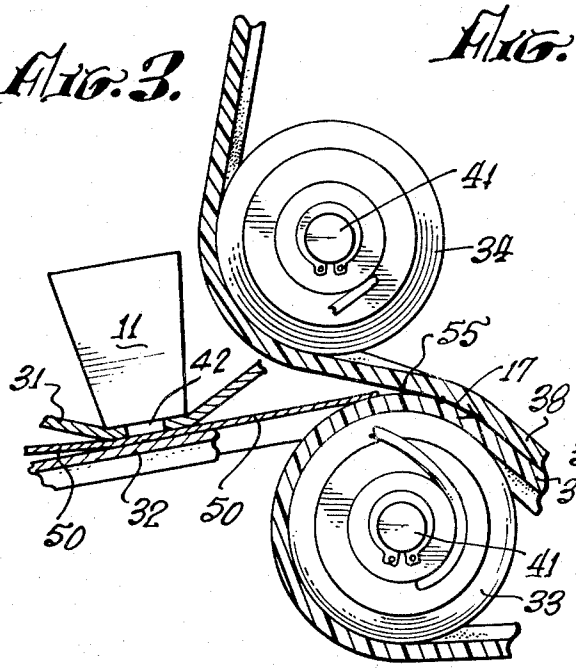


FIG. 4.

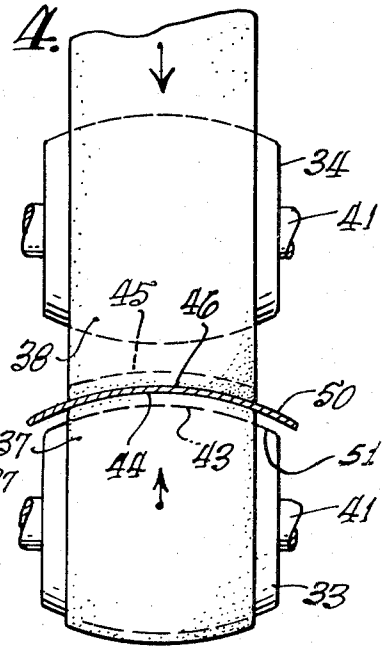
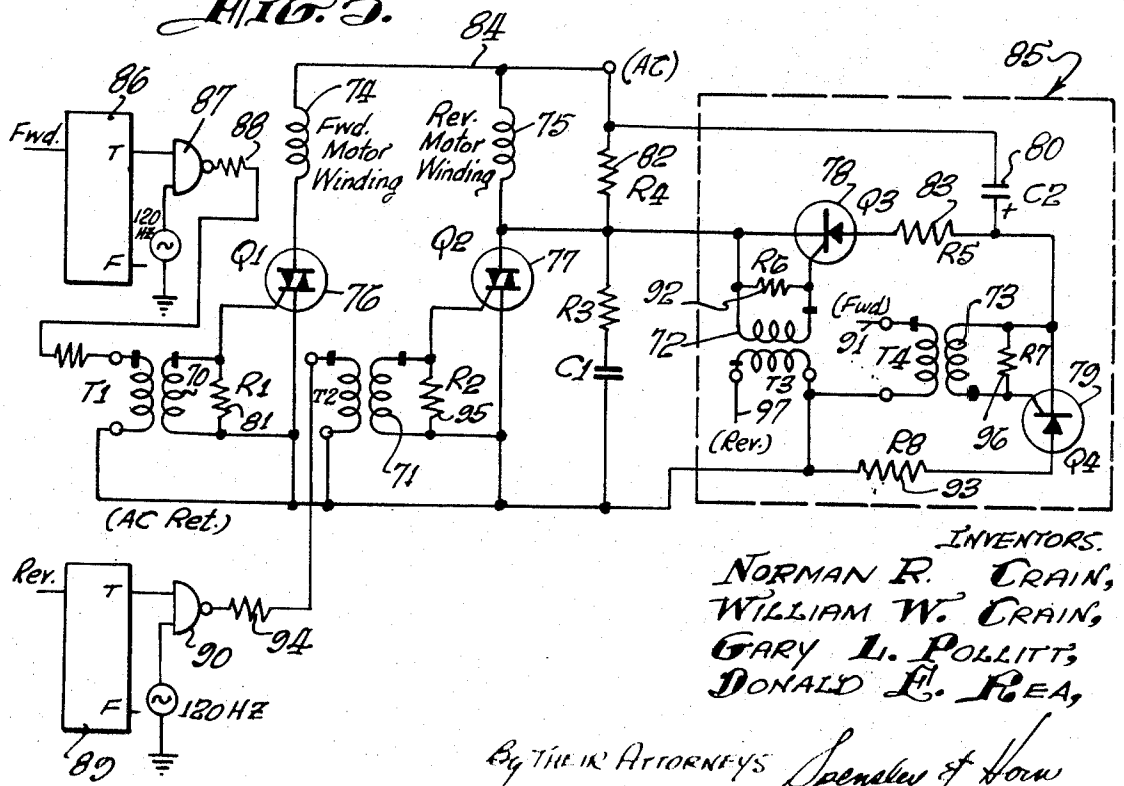


FIG. 5.



INVENTORS.
NORMAN R. CRAIN,
WILLIAM W. CRAIN,
GARY L. POLLITT,
DONALD E. REA,

By THEIR ATTORNEYS Spensley & Horn

ENDLESS BELT PAPER TRANSPORTING AND PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention apparatus relates generally to the field of paper handling devices, and more specifically to the class of devices providing in-line reading and printing capabilities.

2. Prior Art

With the increased use of data handling devices in an ever expanding segment of the economy, the need for an improved data handling apparatus is evident. The art has progressed from purely manual operations to extensive procedures carried out by digital computer systems.

The devices disclosed by the prior art have left several problems unresolved. In order to accurately position a paper or card member for printing thereon, the devices disclosed by the prior art have typically used sprockets or a combination of a capstan and roller alone to position the paper or card member. The problem inherent in the use of sprockets is the need for a special paper or card member. The member that is to be printed upon must have sprocket holes, therefore this would limit the effective uses to which such a device could be put. In addition, when employing sprocket holes in a paper member, the holes may not provide an accurate and sound driving member for the sprocket. The use of a capstan-roller combination alone fails to solve the positioning problem because of a lack of accuracy in positioning the paper or card structure.

SUMMARY OF THE INVENTION

The present invention apparatus solves the problems left unresolved by the prior art by using a sprocketless transport assembly. In addition, combining the sprocketless transport assembly with in-line read and print stations provide a particularly effective low-cost processing input-output apparatus. The present invention apparatus can accurately position the paper medium through the use of two motors cooperatively coupled to the transport assembly. The two motors and control means enable the apparatus to quickly start and stop the paper member which contributes to the accurate positioning thereof.

A first read station establishes the presence of a paper member and initiates the operation of a transport assembly. The transport assembly is operated from a central drive wheel. The shaft of the drive wheel is coupled to the pair of motors, one of the motors being adapted for the forward movement of the drive wheel and the other motor being adapted for the reverse movement thereof. Two groups of rollers are positioned around the drive wheel, each group cooperatively engaging one of two endless rubber belts. The groups of rollers are arranged to enable the inside surface of one of the rubber belts to contact the peripheral surface of the drive wheel. The outside surface of the second endless rubber belt cooperatively engages the outside surface of the first rubber belt. The engagement of the two endless rubber belts establishes a continuous transport path for the paper or card member from the first read station to the area preceding the print station.

Since the paper member is to be the subject of a subsequent print operation, the member must be accurately positioned under the printing mechanism. This requirement arises where the paper member has preprinted locations for subsequentially added data. The present invention apparatus utilizes a second read station in conjunction with control means for the pair of motors. One of the motors drives the transport assembly in a forward direction, the second motor driving the transport assembly in a reverse direction. The two motors are both cooperatively coupled to the drive shaft of the drive wheel. This combination enables quick and precise positioning of the selected portions of the paper member at the printing station.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objectives and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawing in which a presently preferred embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description only, and is not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a schematic diagram in block form setting forth the control and data path of the present invention.

FIG. **2** is a side elevation view of one embodiment of the present invention illustrating the paper form transport, read station and printer of FIG. **1**.

FIG. **3** is an enlarged elevation view of the input read station and the roller-belt input to the transport assembly of FIG. **2**.

FIG. **4** is an enlarged view of the roller-belt assembly shown in FIG. **2** taken along line **4—4** with a paper member inserted in said embodiment.

FIG. **5** is a schematic diagram of an electrical circuit for the operation of the forward and reverse motors and coupled drive wheel of FIG. **2**.

DESCRIPTION OF A PRESENTLY PREFERRED EMBODIMENT

An understanding of the operation of certain aspects of one form of a paper handling apparatus can be obtained from the block diagram shown in FIG. **1**. A paper or card member to be processed will be input at the read station **11** and carried by transport assembly **10** along the transport path **17***a*, **17***b* and **17***c* passing through second read station **12** and finally emerging at print station **13**. The forward motor **15** and reverse motor **16** are cooperatively coupled to transport assembly **10** via the coupling **18**. The motors **15** and **16** provide for forward and reverse movement respectively along the transport path **17***a* and **17***b* as well as for electronic breaking when a member to be processed is in the transport path **17***c*. The forward and reverse motors **15** and **16** are conventional motors, but are preferably electric motors. The control means **14** accepts data from the read stations **11** and **12** on the data lines **20** and **21** respectively, and after evaluating the data, issues control instructions to the motors **15** and **16** and the print station **13** via control lines **19** and **22** respectively.

Referring now to FIG. 2, an elevation view of an embodiment of the present invention paper handling apparatus is shown therein. The present invention paper handling apparatus is shown to have four subassemblies, i.e., first read station 11, second read station 12, print station 13 and the transport assembly generally designated by reference numeral 10. The read station 11 is located in advance of the input to transport assembly 10, read station 11 being for detection of the structure to be processed. The structure being processed is preferably an ordinary paper member 50 but it can be constructed of conventional known materials which can be printed upon or otherwise inscribed to represent information, such as thin cardboard. A typical paper member 50 will have specified areas for printing thereon, but it will be obvious to one with skill in the art that the printing area need not be specified by the paper member 50 itself.

Read station 11 can be a conventional data reading device for detecting and/or reading data, but it is preferably an optical reader adapted for the detection and/or reading of marked data. The paper guides 31 and 32 set the upper and lower movement of the paper member 50 thereby guiding the paper member 50 to the input station of the transport assembly 10. An orifice 42 is provided through the upper paper guide 31 to permit the optical reader 11 to view the paper member 50.

The transport assembly 10 provides a path 17 for the paper member 50 extending from optical read station 11 to the area formed by the paper guides 39 and 40. The transport path 17 is defined by the area provided by the interface of the two belt structures to be described in detail hereinbelow.

The transport assembly 10 comprises two groups of rollers 33 and 34, each revolving on a stationary shaft 41. The preferable profile of the roller 33 or 34 will be a conventional crown, but it could have any profile which will insure proper movement of the belt 37 or 38 across the periphery of the rollers 33 and 34 respectively. The driving force of the transport assembly 10 is derived from the drive wheel 35. The drive wheel 35 is cooperatively coupled to the forward motor 15 and reverse motor 16 via a conventional shaft 47 secured to the drive wheel 35. The group of crowned rollers 34 are in cooperative engagement with the endless belt 38 and the group of crowned rollers 33 are in cooperative engagement with the endless belt 37. The endless belts 37 and 38 are each fabricated of known material, e.g., rubber, capable of forming a highly frictional interface when placed against one another.

The crowned rollers 33 and 34 are oriented so as to form a transport path 17 for the paper member 50 from read station 11 to the print station 13. When belt 38 is mounted on crowned rollers 34, the inside surface 45 of belt 38 will contact the surface of rollers 34 as well as the peripheral surface 36 of driving wheel 35. The configuration of the belt 38 formed by rollers 34 may be generally referred to as a male belt configuration. The peripheral surface 36 of the drive wheel 35 is preferably a surface which can frictionally engage the rubber belt 38, but the surface 36 could utilize other conventional contacting means. When belt 37 is mounted upon the rollers 33, the inside surface 43 of the belt 37 will contact only the rollers 33. The outside surface 44 of the belt 37 engages the outside surface 46 of the belt 38 forming the transport path 17 for the paper member 50. The configuration of the belt 37 around the rollers 33 may be generally referred to as a female belt configuration. The term female belt configuration is understood to refer to the visual appearance of belt 37 as it appears in the side elevation view of FIG. 2. This view is to be contrasted with the profile of the interface between belts 37 and 38 as shown in FIG. 4 which is described below. The female belt configuration has a concave portion which intimately receives and contacts the male belt configuration over a substantial portion of the surface of the male belt 38 forming transport path 17.

In operation, when the drive wheel 35 is rotating in a counter-clockwise direction, the engagement of the outer surfaces 44 and 46 of belts 37 and 38 respectively will move the paper member 50 from the area of the first read station 11 to the flanges of the paper guides 39 and 40. The entire length of the transport path 17 is enclosed between the frictionally interfaced surfaces 44 and 46 of the belts 37 and 38 respectively without any portion thereof permitting longitudinal or lateral slippage of the paper member 50. Therefore, the orientation of the rollers 33 and 34 and corresponding belts 37 and 38 preclude the need for sprockets to transport the paper member 50 through the present invention apparatus. When the drive wheel 35 is driven in a clockwise direction, the paper member 50 which is rejected for any reason can be transported back to the input read station 11.

The paper guides 39 and 40 will direct the paper member 50 from the transport path 17 to the print station 13 as illustrated in FIG. 2 where paper member 50 is shown moved to a position ready for removal from the present invention transporting and processing apparatus. To insure proper positioning of the paper member 50, a second read station 12 immediately precedes print station 13, the special relationship between read station 12 and print station 13 being dependent upon the stopping time of the electronic braking circuit which will be described in detail below. The read station 12 is preferably an optical reader capable of optically detecting the presence of the paper member 50 and reading data and position reference marks therefrom, but it can be any conventional data detection device. The detection of position reference marks of the paper member 50 (not shown) by read station 12 will initiate electronic breaking of the forward driving motor 15, a subject which will be discussed hereinbelow. As an alternative to the use of read station 12, the distance between the read station 11 and the print station 13 and the speed of the transport assembly 10 could be used as the basis for initiating operation of electronic braking.

The final subassembly of the present invention paper handling apparatus is the print station 13. The print station 13 is preferably one which utilizes a rotating type wheel and impact printer, but it can be any conventional printing device. A control means 14 utilizes the data detected at read station 11, and after the paper member 50 is accurately positioned, the control means 14 employs this data to control the printing upon the paper member 50 in any predetermined position thereon. The combination of the data detected at read station 12 and the action taken by the control means 14

will provide the registration necessary to move the paper member **50** past the print station **13**, printing the requisite data in the required manner.

The manner in which the paper member **50** is inserted into the present invention apparatus can be best seen from FIG. **3**. The paper member **50** is inserted between paper guides **31** and **32**. The read station **11** detects the leading edge of the paper member **50** initiating activation of the transport assembly **10**. The forward motor **15** will rotate the drive wheel **35** in a counter-clockwise direction. The leading edge of the paper member **50** is engaged by the primary interface **55** of the converging belts **37** and **38** and drawn into the transport assembly **10** by the frictional engagement of the belts **37** and **38**. As an alternative embodiment of the present invention, several of the present invention paper handling apparatus can be connected in a mode whereby the paper member **50** in each apparatus is processed in a sequential manner by a single control means **14** in one of said apparatus whereby said control means **14** is shared. In such an embodiment, the leading edge of the paper member **50** will be adapted to initiate a signal via the read station **11** to start the forward motor **15**, but initiation would be delayed by a central, shared control means **14**. In this manner, the transport assembly **10** of each connected apparatus will be enabled by respective read station **11**, but motion of the paper member **50** at the respective primary interface **55** will be delayed until the time requirements of the control means **14** have been met.

The manner in which the paper member **50** can be transported through the present invention apparatus without the need of sprockets can be best seen by reference to FIG. **4**. FIG. **4** illustrates a front view of the crowned rollers **33** and **34** and the input into the transport assembly **10**. FIG. **4** also illustrates a typical paper member **50** engaged by the outside surfaces **44** and **46** of the endless rubber belts **37** and **38** and being transported into the transport path **17**. The crowned rollers **33** and **34** are adapted to provide a means whereby the belts **37** and **38** will move over the crowned rollers **33** and **34** without any substantial shifts of the belts **37** and **38**. The crown or curvature **51** of the rollers **33** and **34** provide the necessary adaptation. The profile of rollers **33** and **34** is preferably the convex crown showed in FIG. **4**, but it can be any profile which will prevent lateral slippage of the belts **37** and **38**. The rollers **33** and **34** can be made of conventional materials, the specific material used not being part of the present invention.

The belts **37** and **38** as shown in FIG. **4** are being moved to provide forward movement of the paper member **50** along the transport path **17**. As a point on the belt **38** proceeds over the roller **34**, outside surface **46** of the belt **38** will frictionally engage the outside surface **44** of belt **37**. When the paper member **50** is inserted, the belt **37** and paper member **50** will conform to the curvature of the crowned roller **33**. The paper member **50** will be firmly secured between outside surfaces **44** and **46** of the belts **37** and **38** by the frictional engagement thereof. Referring again to FIG. **2**, the non-slipping frictional contact of the belts **37** and **38** is substantially maintained from the input location shown in FIG. **3** to the input of the paper guides **39** and **40**, the distance of contact corresponding to the transport path **17**. The principal which permits the paper member **50** to be accurately positioned at the print station **13** can be best understood by reference to FIG. **5** wherein an electrical circuit used for electronic breaking of the forward motor **15** is illustrated therein. The basic objective of the electrical circuit shown herein is to initiate the operation of the reverse motor **16** upon the occurance of the signal to stop the paper member **50**, and thereby quickly stop the forward motion of the paper member **50**. The electrical circuit shown in FIG. **5** is one embodiment of the present invention and an effective means to carry out the stated objectives.

As stated above, the forward motor **15** and reverse motor **16** are cooperatively coupled to the drive wheel **35** each providing rotational force to the drive wheel **35** at the proper time. Referring now to FIG. **5**, the forward motor winding **74** and reverse motor winding **75** are electrically connected to one side of the alternating current (A.C.) line **84**. The second electrical connection to the motor windings **74** and **75** are driven by bidirectional triode thyristors **76** and **77** respectively, the thyristors **76** and **77** hereinafter referred to by the conventional term used in the art, i.e., triac. In addition, the reverse motor winding **75** is driven by the electronic breaking circuit generally designated by the reference numeral **85**. When the read station **11** indicates that the paper member **50** is to be moved in a forward direction, the flip-flop **86** will initiate operation of the forward motor **15**, the forward motor **15** applying the proper rotational motion to the drive wheel **35**. It will be obvious to one skilled in the art that the flip-flop **86** could be replaced with other conventional binary mode devices. The "true" output of the flip-flop **86** supplies the enabling signal to gate **87**, the designation "true" being used in the conventional manner employed for binary logic. Through the limiting resistor **88**, an alternating 120Hz signal is supplied to the isolation transformer **70** with the output of the secondary winding thereof being applied across the load resistor **81** and the triac **76**. Isolation transformer **70** as shown in FIG. **5** uses the conventional electrical symbol **T1**. Isolation transformers **71**, **72** and **73** to be described hereinbelow are also shown in FIG. **5** using the conventional electrical symbols **T2**, **T3** and **T4** respectively. All isolation transformers **70**, **71**, **72** and **73** are conventional alternating current transforming components well known to those persons having skill in the art. Since the triac **76** will turn off each time its input signal passes through a zero (**0**) crossing, the gating signal enables the triggering of the triac **76** each half cycle and therefore maintains an A.C. signal across the forward motor winding **74**.

When a paper member **50** is rejected for any reason thereby requiring a motor reversal to return the paper member **50** to the input station, flip-flop **89** will initate the operation of the reverse motor winding **75** via the triac **77**. Energizing reverse motor winding **75** will initiate rotational motion of reverse motor **16**, the rotational motion being transferred to the drive wheel **35**. As in the case with the operation of the forward motor **15**, the gate **90** will supply an alternating 120Hz signal to the isolation transformer **71** through the limiting resistor **94**. The input signal appearing on the secondary winding of the transformer **71** is applied across the load resistor **95** and the triac **77**. The triac **77** will apply the

A.C. signal across the reverse motor winding **75**. Setting fliplflop **89** to the "true" state also resets flip-flop **86** thereby deactivating forward motor winding **74** when reverse motor winding **75** is activated.

The ability to stop the movement of the paper member **50** and thereby accurately positioning same for printing purposes is provided by the electronic braking circuit **85**. When read station **12** detects the presence of position reference marks on paper member **50**, control means **14** will turn flip-flop **86** off and turn a braking signal on thereby initiating application of a braking voltage to the reverse motor winding **75**, an event which will result in faster stopping than would occur by the mere triggering of the triac **77** after the stopping of forward motor **15**. The rapid stop time is obtained by superimposing the action of the initiated reverse motor **16** upon the energized forward motor **15**. In operation, while the forward motor **15** is operating, a forward gating signal is applied to input **91** of the isolation transformer **73**, the secondary winding of the transformer **73** applying an alternating current signal across the load resistor **96** and the gate-cathode combination of the silicon controlled rectifier (SCR) **79**. The SCR **79** will conduct electrical current, limited only by the resistor **93**. The conduction of current through SCR **79** will charge capacitor **80** to approximately the peak A.C. line voltage, the charging of capacitor **80** being limited only by the internal resistance of SCR **79** and resistor **93**. When the reverse motor winding **75** is to be energized for the purpose of providing rapid stopping of the transport assembly **10**, an alternating current signal derived from the output of the flip-flop **89** or any other proper logical braking indicator is applied to the isolation transformer **72** at input **97**, the output signal of the secondary winding of the transformer **72** being applied across load resistor **92** and the gate-cathode combination of SCR **78**. At the time the braking indicator is turned on, the forward motor **15** is still providing forward rotational motion to the drive wheel **35**. The initiation of the reverse signal is to energize reverse motor winding **75** and thereby superimpose the reverse rotation of the reverse motor **16** upon the decaying forward rotation of the forward motor **15**. The firing of SCR **78** will provide a current conducting path through SCR **78** thereby applying the voltage stored in the capacitor **80** across the reverse motor winding **75** and the load resistor **82**, discharging the capacitor **80** through the resistors **82** and **83**. Applying the peak line voltage stored in capacitor **80** across the reverse motor winding **75** will institute rapid activation of reverse motor **16** thereby rapidly degrading the forward motion of the forward motor **15** and ultimately stopping the rotation of the drive wheel **35**. The charge stored in capacitor **80** produces a voltage which is greater than the output of triac **77**. The braking voltage derived from capacitor **80** will typically exceed the power rating of motor winding **75**, but since it is applied only for a short period of time dependent on the time constant of the circuit, no damage will result to motor winding **75**. The operation of the electronic braking circuit **85** will typically stop a paper member **50** moving at a speed of 10 inches per second in approximately 50 milliseconds.

Representative values for the components of the electrical circuit illustrated in FIG. **5** are shown below:

Component	Value
R1, R2, R5, R6, R7	100 ohms
R3, R8	4.3 ohms
R4	6,200 ohms
C1	.068 microfarads
C2	100 microfarads
Q1	MAC3-4
Q2	MAC3-6
Q3, Q4	2N4443

Although electronic braking circuit **85** is the preferred means to enable accurate positioning of paper member **50**, a conventional stopping motor or an electromagnetic braking circuit could be effectively utilized.

The sprocketless transport assembly **10** operating in conjunction with the read stations **11** and **12** and print station **13** provides a highly efficient, low cost paper handling apparatus. A paper member **50** requiring data processing, can be input to the present invention apparatus, processed according to predetermined criteria and positioned accurately for requisite printing thereon. The use of the male and female belt configurations insure that paper member **50** will be transported through the present invention apparatus without significant slippage either in a lateral or longitudinal direction. As a result, a paper member **50** will be processed and accurately positioned for printing thereon if the latter step is required.

We claim:

1. An apparatus for transporting and processing data bearing paper sheets comprising:

a. a paper sheet transport including first and second groups of crowned rollers, a drive wheel having a peripheral frictional engagement surface, first and second endless sprocketless belts, each having an inside and outside surface thereof, the inside surface of said first belt cooperatively engaging said first group of crowned rollers and the peripheral surface of said drive wheel, the inside surface of said second belt cooperatively engaging said second group of crowned rollers, portions of the outside surfaces of said first and second belts being in frictional engagement whereby an input end and output end of said engaged belt portions are formed;

b. first and second optical detectors substantially adjacent the input end and output end respectively of the portions of said first and second belts in frictional engagement with one another;

c. a printer substantially adjacent to said second optical detector and opposite from said engaged belt portions whereby said paper sheet is printed upon after being output from the output end of said engaged belt portions and detected at said second optical detector; and

d. first and second motors coupled to said drive wheel, said first and second motors being alternately operated to rotate said drive wheel in a forward and reverse direction respectively.

2. An apparatus as defined in claim **1** including a motor control circuit comprising:

a. first and second binary switching means for registering forward and reverse motor rotation respectively;

b. a pair of thyristors each having an input and output terminal and a gate terminal, each of said gate terminals being coupled to one of said binary

switching means and each of said output terminals being connected to a respective one of said first and second motors; and

c. means for connecting said second binary switching means and said second motor coincident with forward rotation whereby the forward rotation of said drive wheel is rapidly halted.

3. An apparatus as in claim **1** wherein said first and second endless sprocketless belts are rubber sprocketless belts.

4. An apparatus for transporting and processing a data bearing paper form comprising:

a. first and second optical readers;

b. a paper form transport comprising:

i. a first and second group of crowned rollers;

ii. a drive wheel having a peripheral frictional engagement surface;

iii. first and second endless sprocketless belts each having an inside and outside surface thereof, the inside surface of said first belt being symmetrically disposed upon and cooperatively engaging said first group of crowned rollers and the peripheral surface of said drive wheel, the inside surface of said second belt being symmetrically disposed upon and cooperatively engaging said second group of crowned rollers, a portion of said outside surfaces of said first and second belts being in frictional engagement for a distance substantially extending from said first optical reader to said second optical reader;

iv. first and second motors cooperatively coupled to said drive wheel, alternately operated to rotate said drive wheel in a forward or reverse direction to move the paper form from said first optical reader to said second optical reader and from said second optical reader to said first optical reader respectively;

c. a printer disposed substantially adjacent said second optical reader whereby said paper form is printed upon after detection thereof; and

d. control means for positioning the paper form at said printer, said control means coupled to said first and second optical readers, said transport and said printer.

5. An apparatus as defined in claim **4** wherein said control means comprises means for superimposing the rotation of said first and second motors whereby the forward motion of said drive wheel is rapidly halted.

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