

[54] **INFORMATION RECORDING ON ELONGATE CARRIERS WITH CARRIER PRESENCE AND/OR POSITION DETERMINATION**

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[51] Int. Cl. **G11b 15/16**

[58] Field of Search **179/100.2 R, 100.2 S; 242/188, 189, 190, 195, 75.51**

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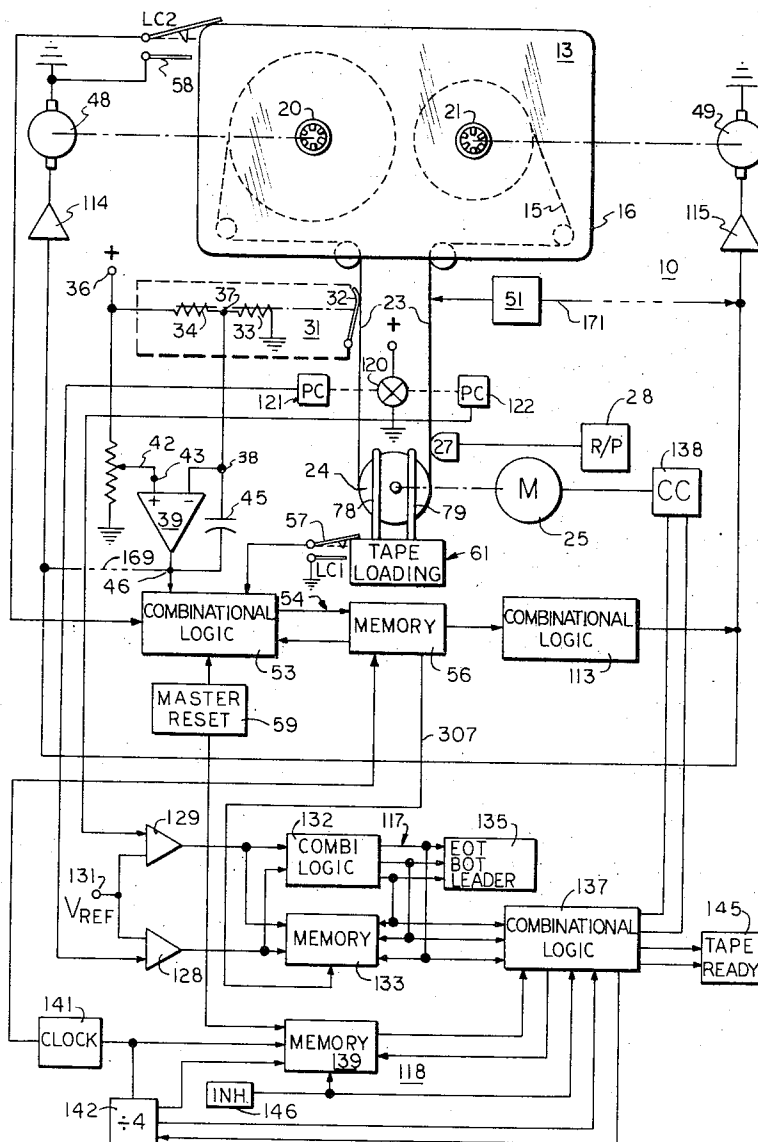
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Assistant Examiner—Robert S. Tupper
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[57] **ABSTRACT**

Tensioning forces are applied to an elongate information carrier prior to the performance of a predetermined function relative to the carrier. The application of tensioning forces is timed and performance of the predetermined function is only initiated if a tensioning of the elongate information carrier occurs within a predetermined time. A determination of the carrier position preparatory to the performance of a desired function may be effected by sensing whether the beginning, and end, or another portion of the carrier is located at a function performing station. In response to this determination the information carrier is operated until its beginning is located at the station.

31 Claims, 12 Drawing Figures



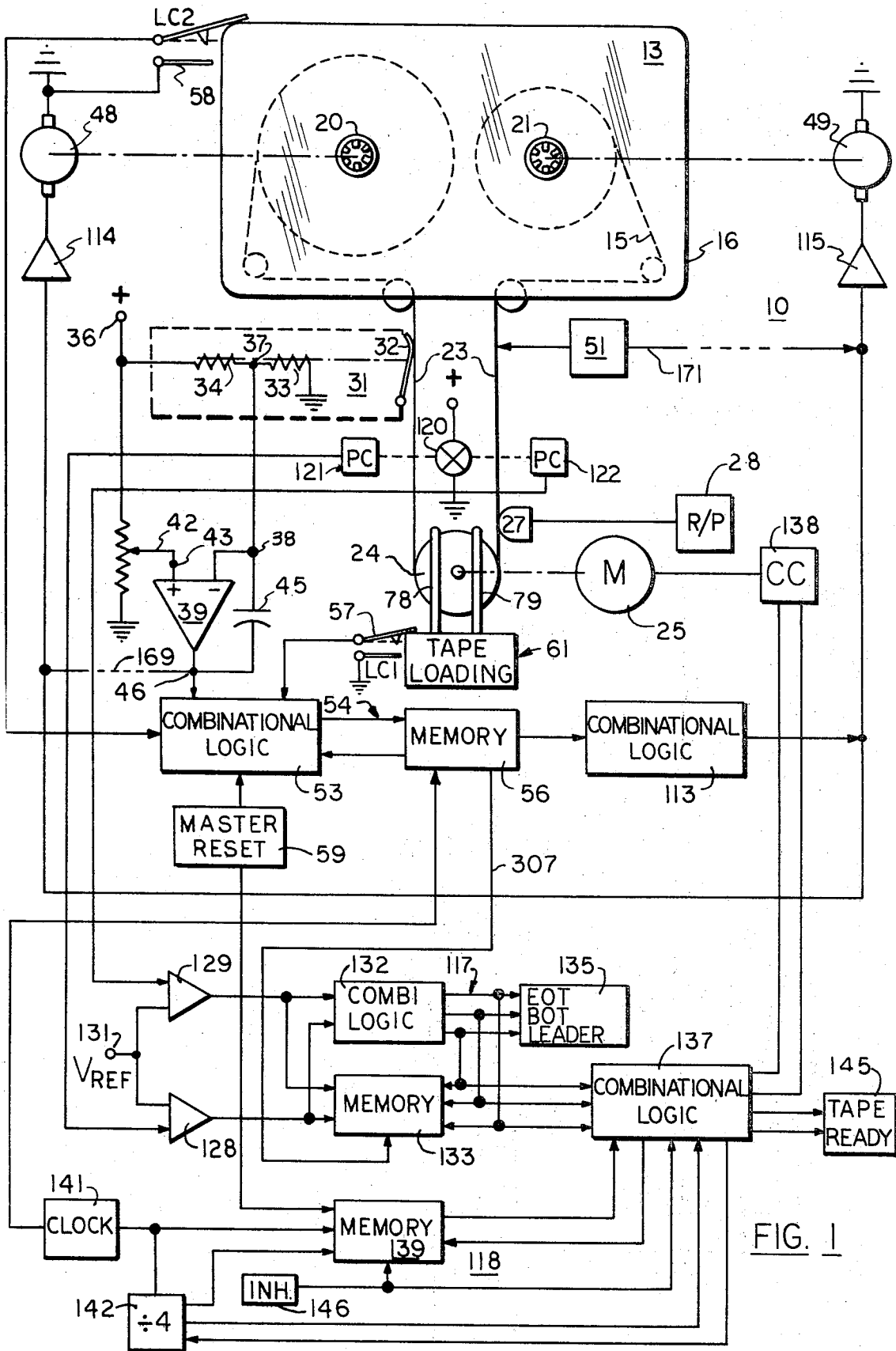


FIG. 1

FIG. 3

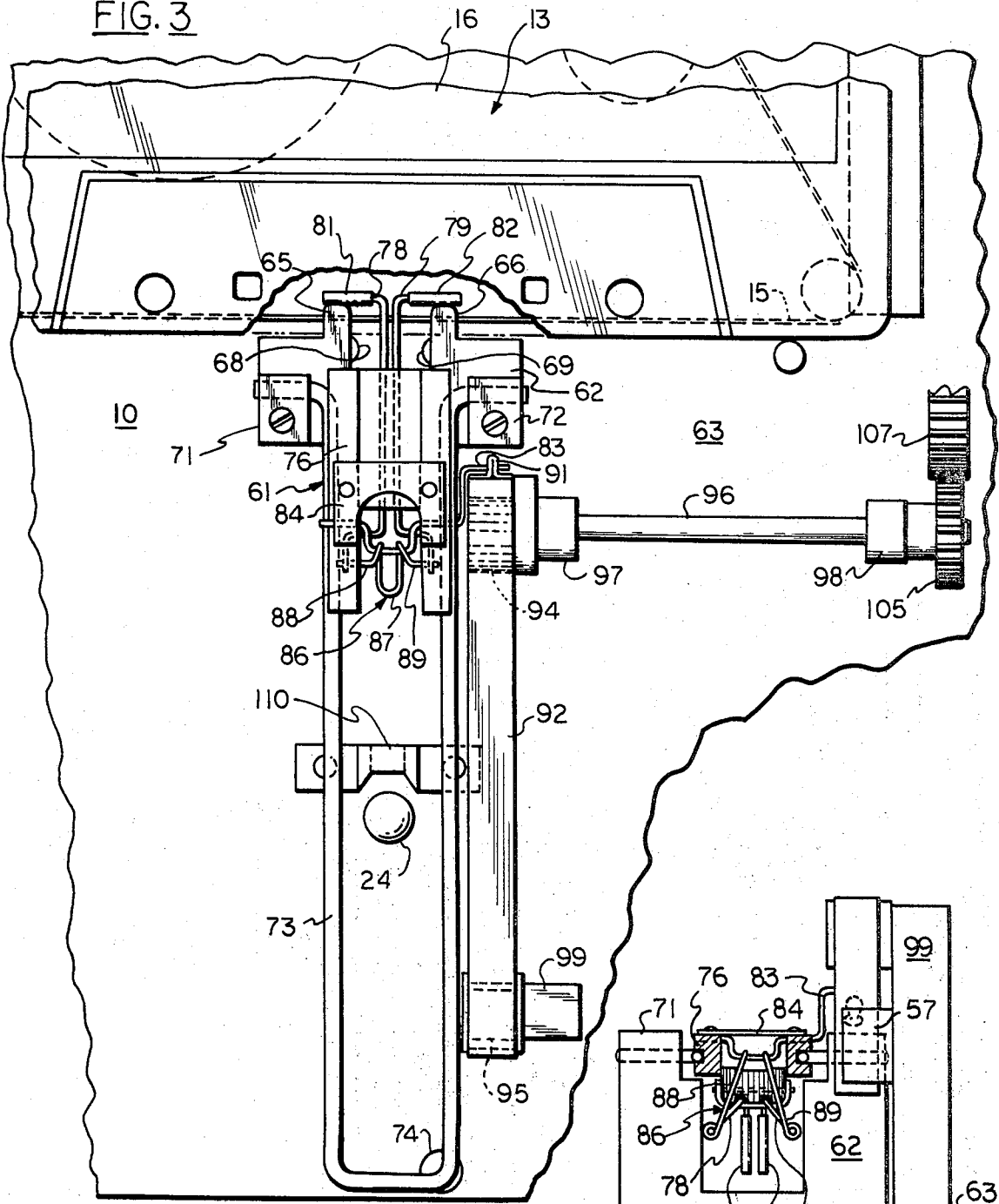


FIG. 4

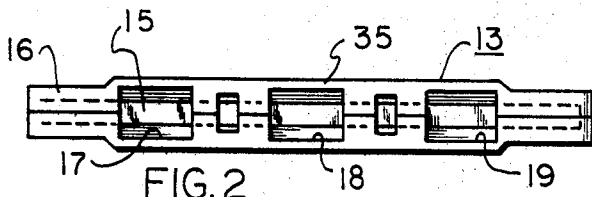
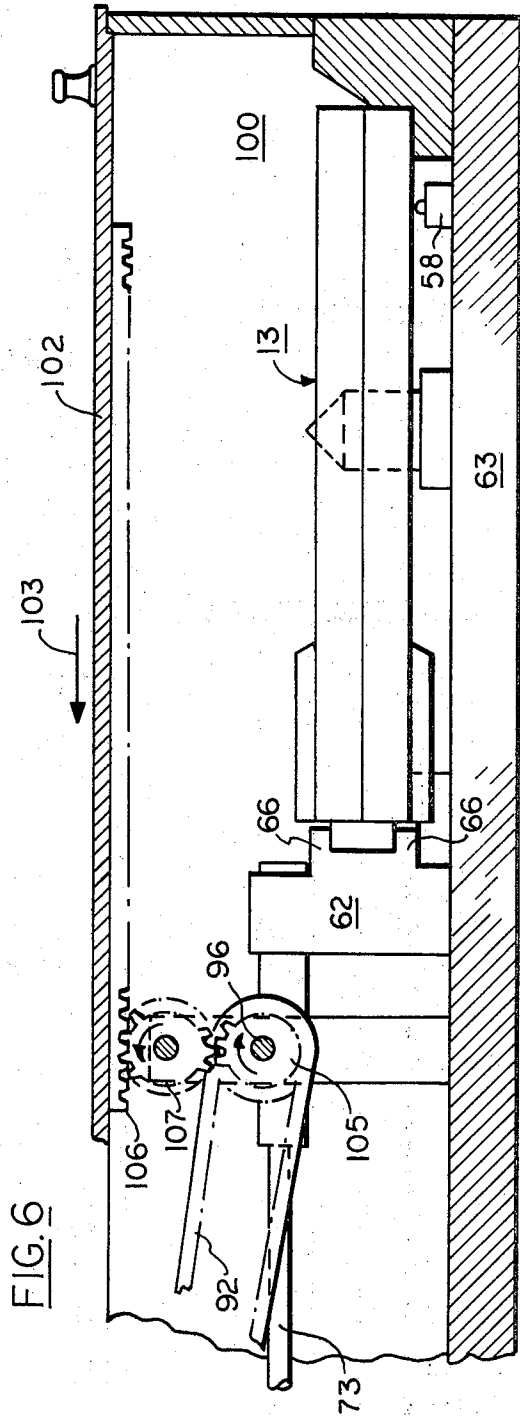
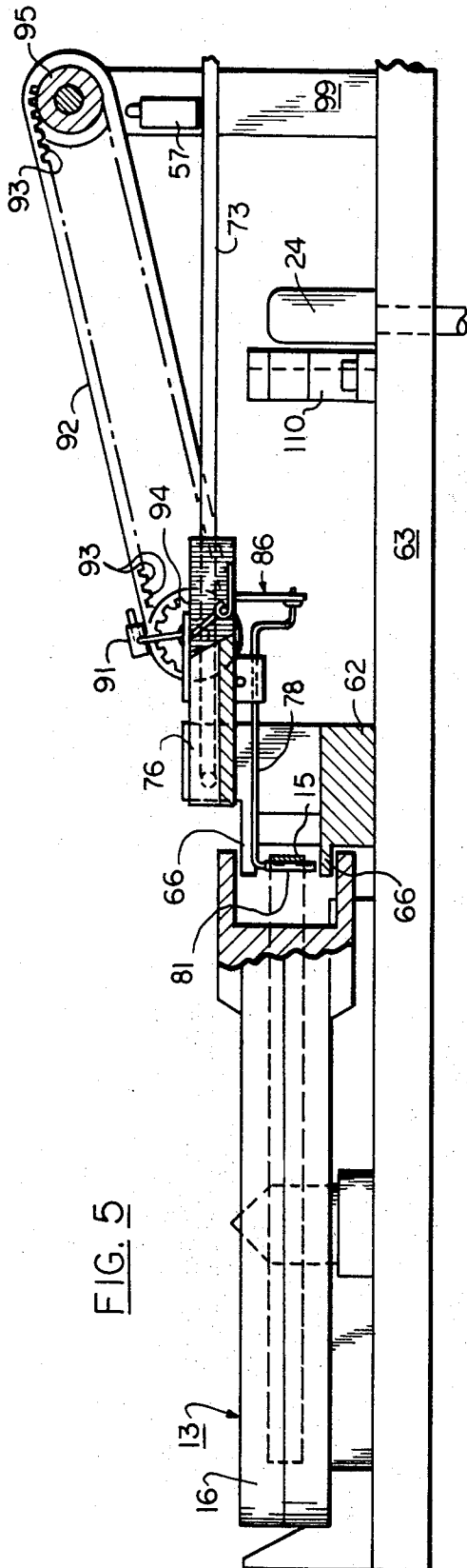


FIG. 2



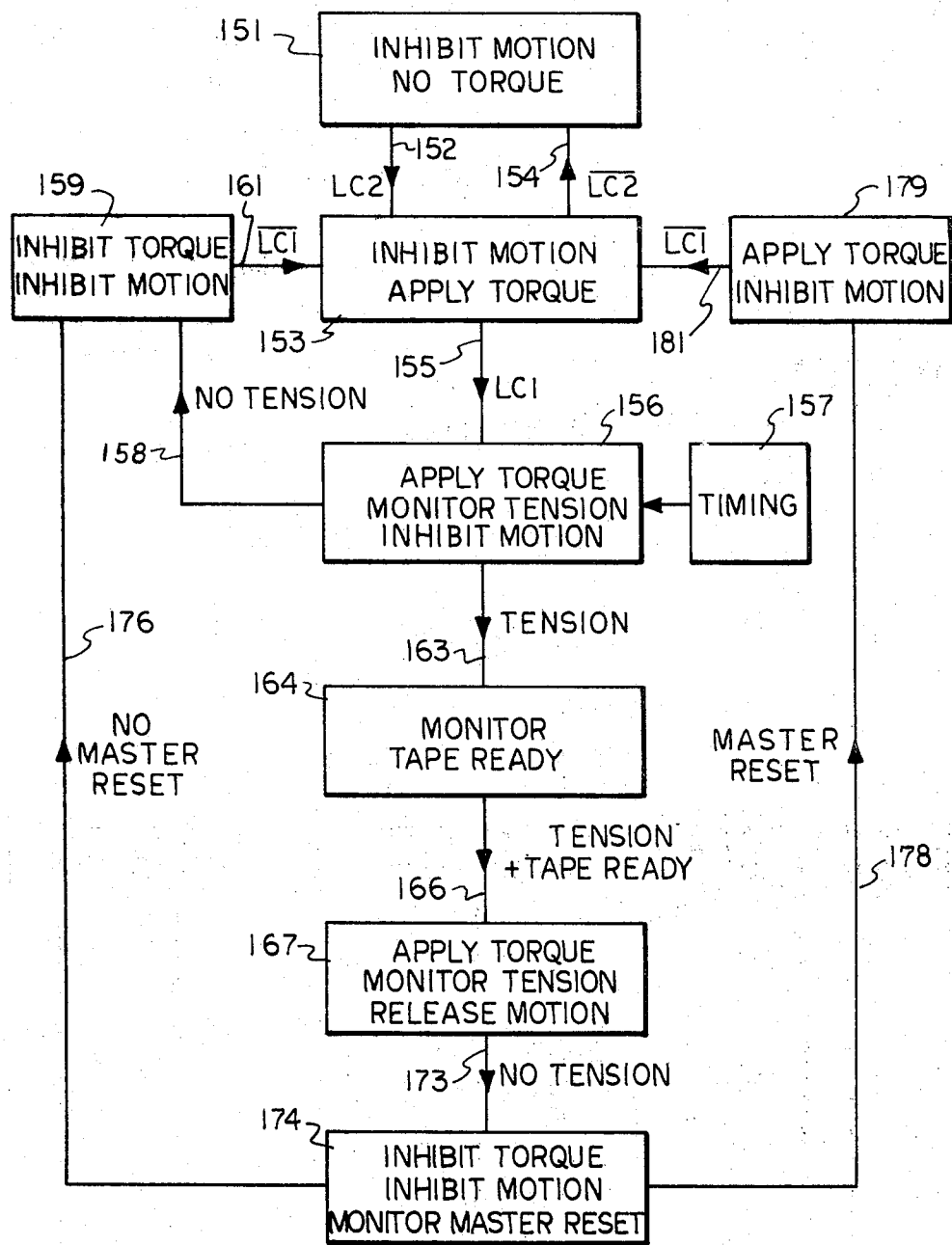
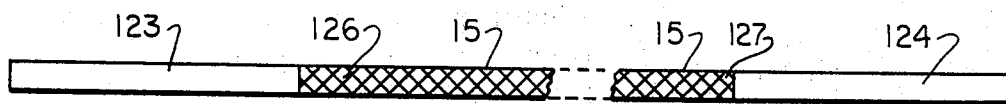
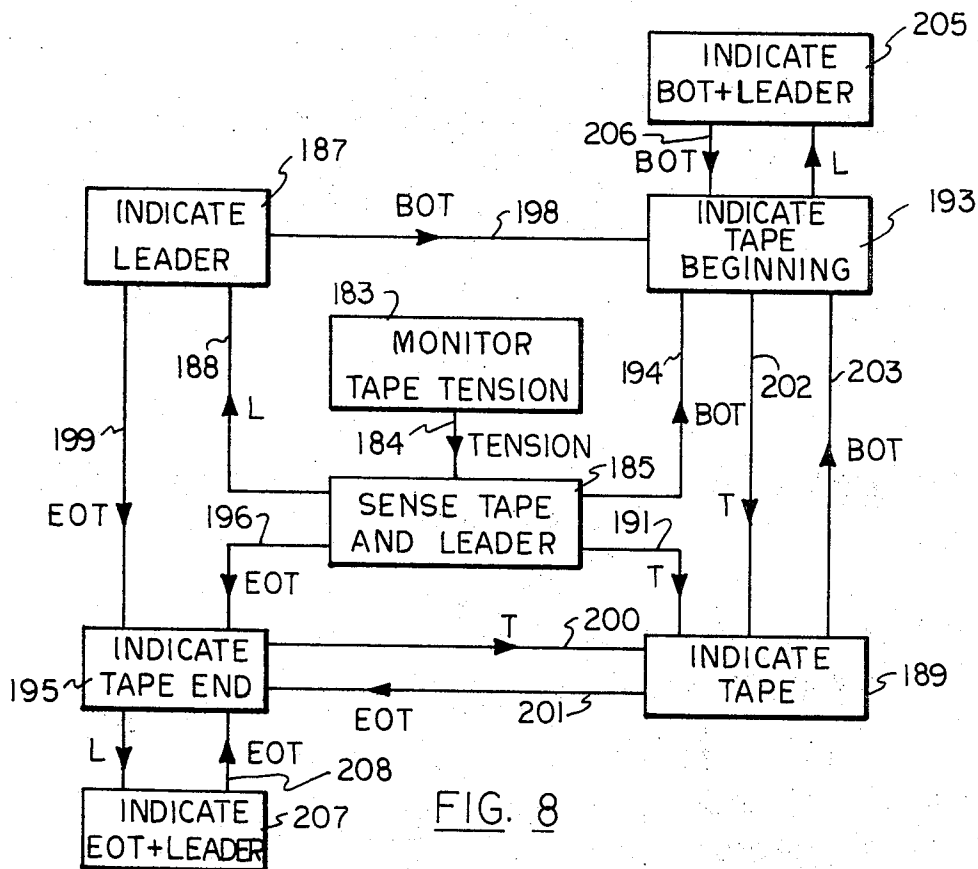
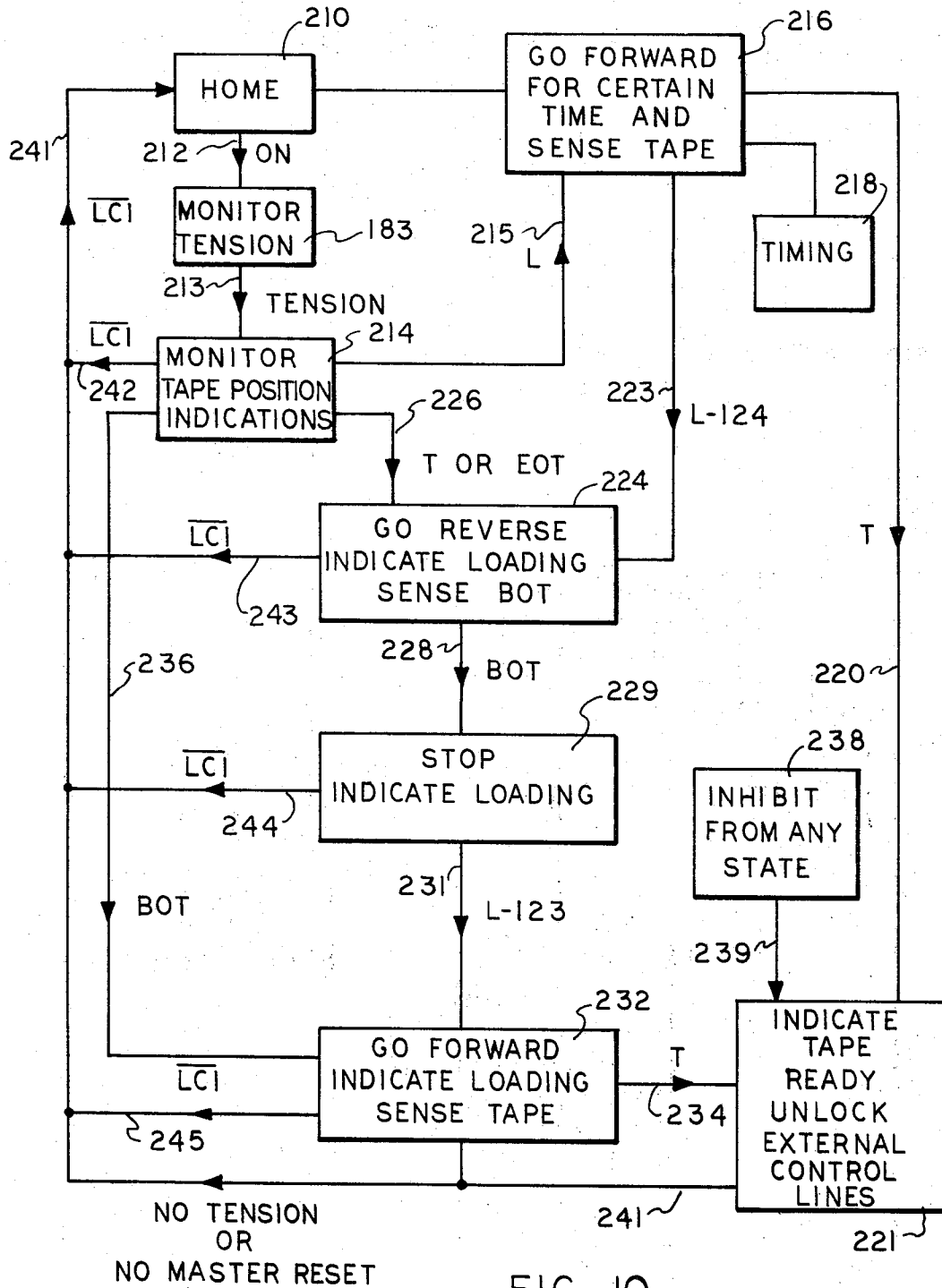
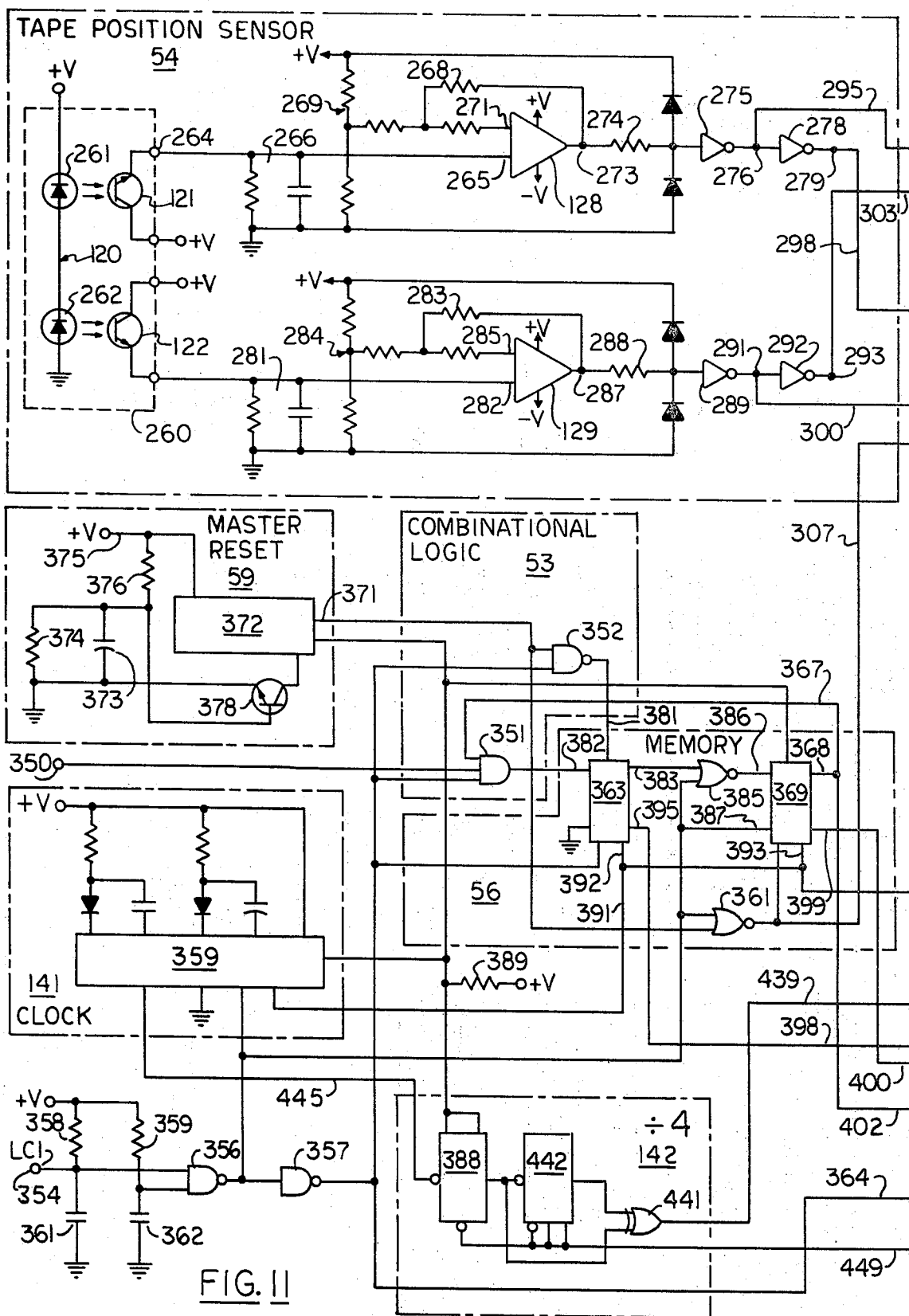
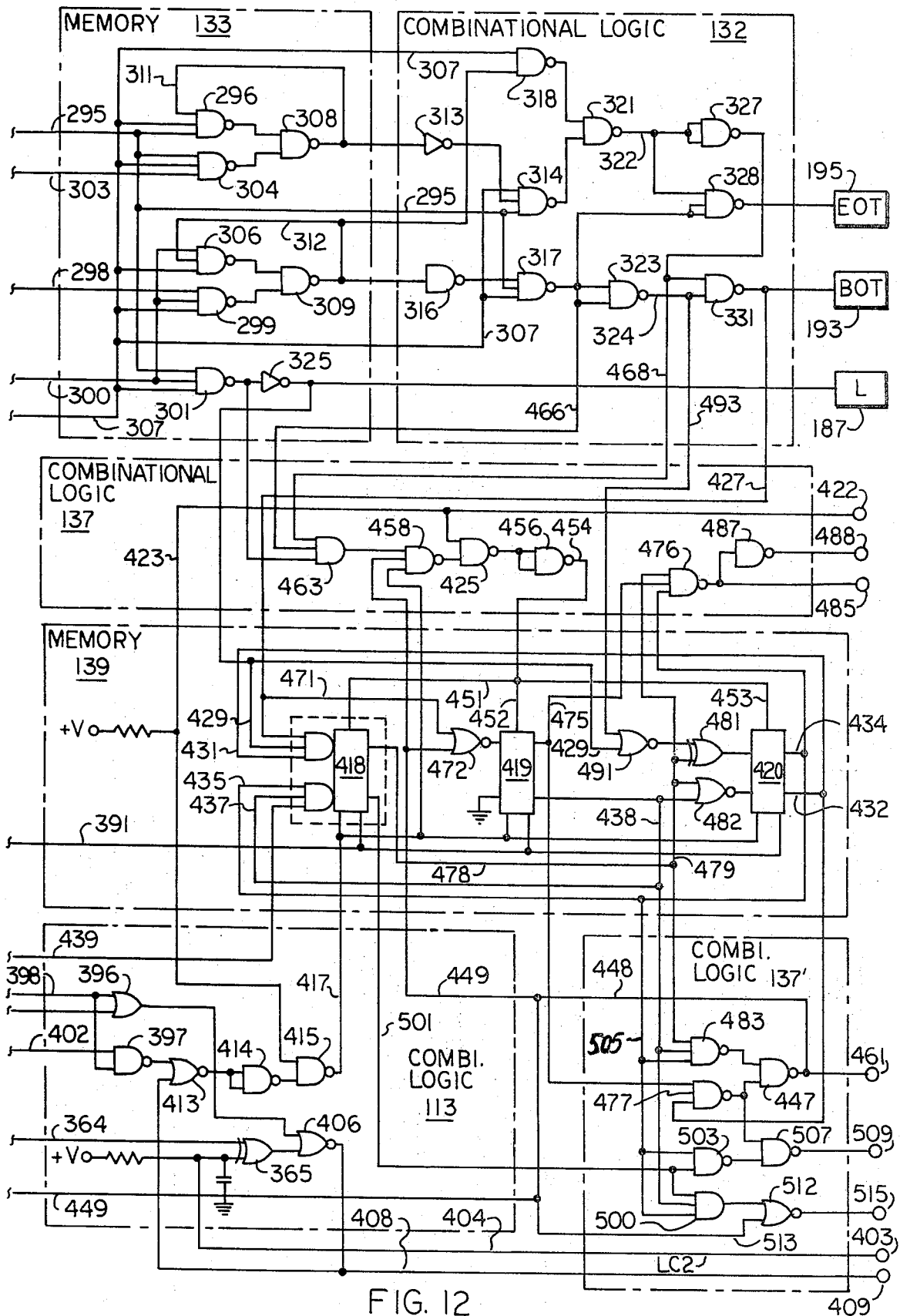


FIG. 7









INFORMATION RECORDING ON ELONGATE CARRIERS WITH CARRIER PRESENCE AND/OR POSITION DETERMINATION

CROSS-REFERENCE TO RELATED APPLICATIONS

The present patent application is related in subject matter to the following patent applications which are assigned to the same assignee as the subject patent application and which are herewith incorporated by reference herein:

U.S. Pat. application S.N. 89,995, filed Nov. 16, 1970 by Joseph J. Neff; and

U.S. Pat. application S.N. 134,172, filed Apr. 15, 1971 by Peter A. Howes and Eugene A. Cooper.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The subject invention relates to the field of information recording and, more particularly, to the handling of elongate information carriers, such as magnetic or other recording tapes or films, in conjunction with information transducing operations.

2. Description of the Prior Art

Elongate information carriers are sometimes subject to rupture. In a similar vein, equipment employed for placing an elongate information carrier in position at a function performing station will sometimes malfunction. In either case commencement of the function performing operation in the absence of the elongate information carrier will lead to further malfunction, especially if automated carrier handling equipment is employed.

A similar problem arises with automated carrier handling equipment from the difficulty of determining what part of the information carrier is initially located at a function performing station. For instance, it is difficult for existing carrier sensing equipment to determine whether the beginning, the end, or another part of the information carrier is present at a given location. Errors in the sensing of the carrier position lead to further malfunction.

SUMMARY OF THE INVENTION

It is an object of this invention to overcome the above mentioned disadvantages.

It is also an object of this invention to provide methods and apparatus for reliably performing predetermined functions relative to an elongate information carrier.

It is also an object of this invention to provide methods and apparatus for performing a predetermined function relative to an elongate information carrier only in the absence of breaks in the carrier.

It is also an object of this invention to provide methods and apparatus for performing a function relative to an elongate information carrier only in the absence of malfunctions in the placement of the information carrier at a function performing station.

It is also an object of this invention to provide methods and apparatus for sensing the position of an elongate information carrier relative to a predetermined location.

It is a related object of this invention to provide methods and apparatus for sensing the loading position of an elongate information carrier.

It is also an object of this invention to place an elongate information carrier in a predetermined position preparatory to the performance of a desired function.

From one aspect thereof, the subject invention resides in a method of performing a function relative to an elongate information carrier having a first end connected to a first rotary carrier winding and storage device and having a second end connected to a second rotary carrier winding and storage device. The invention according to this aspect resides more specifically in the improvement comprising in combination the steps of providing drive means for rotating the first and second rotary carrier winding and storage devices, providing means for sensing tension of the information carrier between the first and second carrier winding and storage devices, providing means for timing the tension sensing for a predetermined period of time, energizing the drive means to tension the information carrier between the first and second carrier winding and storage devices, sensing the tension of the information carrier with the tension sensing means, timing the tension sensing of the information carrier with the timing means to determine whether the drive means tension the information carrier within the predetermined period of time, and performing said function relative to the information carrier in response to a determination that the drive means have tensioned the information carrier within the predetermined period of time.

In accordance with a preferred embodiment of the subject invention, the above mentioned improvement include in combination the step of repeating the energization of the drive means to tension the information carrier between the first and second carrier winding and storage devices, repeating the sensing of the tension of the information carrier with the tension sensing means, repeating the timing of the tension sensing of the information carrier with the timing means to determine whether the drive means tension the information carrier within the predetermined period of time while the energization of the drive means is repeated, and de-energizing the drive means if the drive means fail to tension the information carrier within the predetermined period of time.

In this manner it is possible to prevent malfunction of the equipment in case of information carrier breakage or rupture or, for instance, in case of loss of the information carrier by carrier loading equipment.

The expression "elongate information carrier" as herein employed is intended to be broad enough to cover magnetic recording tape, photographic film, and other elongate tapes or carriers for recording or storing information.

From another aspect thereof, the invention resides in a method of performing a function relative to an elongate information carrier having an elongate information recording medium, a first leader connected to a beginning of the information recording medium and connected to a first rotary carrier winding and storage device, and a second leader connected to an end of the information recording medium and connected to a second rotary carrier winding and storage device. The invention according to this aspect resides, more specifically, in the improvement comprising in combination the steps of providing a pair of spaced sensing devices for sensing the first and second leaders and the information recording medium, effecting a carrier position sensing function with the first and second sensors, this

carrier position sensing function including the step of determining whether the information recording medium is present at both of the spaced sensors, rewinding the information recording medium onto the second rotary device in response to a determination that the information recording medium is present at both of the spaced sensors, rendering said sensors sensitive to said beginning of the information recording medium, continuing said rewinding of the information recording medium until said sensors sense the arrival of said beginning of the information recording medium at said sensors, placing the beginning of the elongate information recording medium at the first leader into a predetermined position, and initiating a predetermined information conveying function relative to the information recording medium.

According to another aspect thereof, this invention resides in apparatus for performing a function relative to an elongate information carrier having a first end connected to a first rotary carrier winding and storage device and having a second end connected to a second rotary carrier winding and storage device. The invention according to this aspect resides in the improvement comprising, in combination, means for rotating the first and second rotary carrier winding and storage devices, means connected to the rotary devices for tensioning the elongate information carrier, means operatively associated with the elongate information carrier for sensing tension of the elongate information carrier, means for timing the tension sensing for a predetermined period of time, means operatively associated with the tension sensing means and the timing means for determining whether the tensioning means have tensioned the information carrier within the predetermined period of time, means for performing a predetermined function relative to the information carrier, and means for activating the function performing means only after a determination that the tensioning means have tensioned the information carrier within the predetermined period of time.

In accordance with the preferred embodiment of this invention, the latter improvement includes means for deactivating the mentioned means for rotating the first and second rotary devices in response to a determination that the tensioning means have failed to tension the information carrier within the predetermined period of time.

In accordance with another aspect thereof, this invention resides in apparatus for performing a function relative to an elongate information carrier having a first leader, a second leader, and an elongate information recording medium between the first and second leaders. The invention according to this aspect more specifically resides in the improvement comprising, in combination, means for sensing the position of the information carrier including a pair of spaced sensing devices for sensing the first and second leaders and the recording medium, means for determining whether the information recording medium is present at both of the spaced sensing devices, means for determining whether either of the first and second leaders is present at both of the spaced sensing devices, means for determining whether the first leader is present at one of the sensing devices and the recording medium is present at the other of the sensing devices, and means for determining whether the recording medium is present at the one sensing device and the second leader is present at the

other sensing device, and means operatively associated with the sensing means for readying the recording medium for a function performing operation, the latter readying means including means for rewinding the recording medium onto the second rotary device in response to a determination that the recording medium is present at both of the spaced sensing devices, and for rewinding the second leader and the recording medium onto the second rotary device in response to a determination that the second leader is present at the other sensing device and that the recording medium is present at the one sensing device, means for driving the recording medium in a forward direction in response to a determination that either of the first and second leaders is present at both of the first and second sensing devices, and means connected to the driving means for timing the driving in the forward direction for a period of time sufficient to rewind the first leader onto the first rotary device in each case in which the leader present at both spaced sensors is the first leader.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention and its objects will become more readily apparent from the following detailed description of preferred embodiments of the invention, illustrated by way of example in the accompanying drawings, in which:

FIG. 1 is a diagram of an information recording and playback apparatus in accordance with a preferred embodiment of the subject invention;

FIG. 2 is a front view of a tape cassette used in the apparatus of FIG. 1;

FIG. 3 is a top view of a tape loading mechanism that may be used in the apparatus of FIG. 1;

FIG. 4 is a rear view of a part of the tape loading mechanism of FIG. 3;

FIG. 5 is a side view of the apparatus of FIG. 3;

FIG. 6 is a side view of a modification of the apparatus of FIGS. 3 to 5;

FIG. 7 is a functional block diagram of part of the apparatus of FIG. 1;

FIG. 8 is a block diagram of another part of the apparatus of FIG. 1;

FIG. 9 is a foreshortened view of an information carrier that may be used in the apparatus of FIG. 1;

FIG. 10 is a functional block diagram of another part of the apparatus of FIG. 1;

FIGS. 11 and 12, when placed uprightly side-by-side, are a circuit diagram of parts of the apparatus of FIG. 1.

Like reference numerals in the drawings designate like or functionally equivalent parts.

DESCRIPTION OF PREFERRED EMBODIMENTS

The tape recorder 10 shown in FIG. 1 typically operates with magnetic tape cassettes 13 of standard design.

The tape cassette 13 has a magnetic recording tape 15 located initially in a casing 16. As seen in FIG. 2, the tape 15 passes from side to side past a number of windows 17, 18 and 19 which are provided in peripheral portions of the casing 16. The tape cassette 13 further includes a first rotary tape winding and storage device 20 to which one end of the tape 15 is connected, and a second rotary tape winding and storage device 21 to which the other end of the tape 15 is connected. The tape may be wound on either of the devices 20 and 21 by rotating the particular device.

In the preferred embodiment illustrated in FIG. 1, a loop 23 of the tape 15 extends out of the window 18 and around a tape advance capstan 24 which is rotatably mounted at a distance from the cassette 13. Accordingly, when the capstan 24 is rotated by its drive 25, the recording tape 15 is advanced out of the cassette 13 and subsequently back into the cassette.

During its travel outside of the cassette 13, the recording tape 15 moves past a magnetic recording and playback head 27 which is connected to conventional recording and playback equipment 28 which may, for instance, include conventional recording and playback amplifiers and means for generating or receiving a signal to be recorded, as well as means for reproducing or storing a played-back signal. These, as well as other conventional means, are illustrated by the block 28 since they do not form part of the subject invention. It is also understood that conventional means (not shown) may be provided for erasing recorded information from the tape 15.

For the purpose of operational convenience and superior performance, no nip or pinch roller has been associated with a capstan 24 in the illustrated embodiment. Accordingly, the capstan 24 drives the tape 15 by virtue of the friction of the tape 23 relative to the capstan 24. In accordance with the invention disclosed in the above mentioned Howes and Cooper patent application, closed-loop servo systems may be employed to avoid objectionable slippage of the recording tape 15 relative to the capstan 24 by equalizing the tape tensions in both legs of the tape loop 23. Preferred embodiments of the Howes and Cooper invention include servo systems in which there is a tension sensor for each leg of the tape loop 23 and in which each tension sensor controls the operation of a corresponding reel motor.

A suitable kind of tension sensor is shown at 31 in FIG. 1. The tension sensor 31 has a resilient feeler 32 engaging the tape 15 to sense the tension thereof in one leg of the tape loop 23. The feeler 32 acts on a pair of resistive strain gage elements 33 and 34 which have identical temperature characteristics, but which are mutually opposed in terms of their response to strain variations imposed by the feeler 32. The strain gage elements 33 and 34 are connected between an electric current supply terminal 36 and ground, and have a sensor tap 37 connected to the inverting input 38 of an operational amplifier 39.

The operational amplifier 39 may be of a conventional type, such as, by way of example, the type 741 of Fairchild or the type MC1,439 by Motorola. A potentiometer 41 is connected between the current supply terminal 36 and ground, and has a wiper arm 42 connected to the non-inverting input 43 of the operational amplifier 39 to present to the operational amplifier a signal indicative of a desired tape tension.

The signal provided by the tension sensor 31 operates on the amplifier 39 as a negative feedback signal which tends to reduce the output signal provided by the operational amplifier 39 in response to a given setting of the variable potentiometer 41. An integrating capacitor 45 is connected in the feedback path of the operational amplifier 39 for operational stability.

In accordance with the above mentioned Howes and Cooper patent application, the tape tension signal appearing at the output 46 of the operational amplifier 39 may be employed to control the operation of a reel

motor 48 during the operation of the tape recorder so that the tape tension in the left-hand leg (as seen in FIG. 1) of the tape loop 23 is closely maintained at the desired value set by the potentiometer 41. A replica of the tension sensor 31 and operational amplifier 39 may be associated with the right-hand leg (as seen in FIG. 1) of the tape loop 23 to provide a tape tension signal for controlling a reel motor 49 so as to maintain the tape tension in the right-hand leg closely at a set value. A block 51 indicates such replicated tension sensing equipment. It is to be understood at this juncture that the described tension sensing servo loops do not form part of the subject invention and are thus not herein illustrated in greater detail than necessary to explain tension sensing equipment employed in the practice of the subject invention.

The tape tension signal provided by the operational amplifier 39 is applied to the combinational logic of a tension sensor monitoring system 54. The function of the combinational logic is to receive inputs from different sources and pass these inputs on to a memory device 56.

One input source of the combinational logic 53 is the operational amplifier 39 which, as mentioned above, provides at its output 46 a signal indicative of the tension of the tape 15 in the tape loop 23. Another input source of the combinational logic 53 is a switch 57 which has been labeled "LC1" to indicate its function as a loading switch. Another input source of the combinational logic is a switch 58 which has been labeled "LC2" to indicate its function as a loading switch. Yet another input source of the combinational logic 53 is a master reset 59 which provides an "on" signal upon the appearance or reappearance of electric power after a power failure or interruption.

The load switch 57 is normally closed as long as no complete tape loading operation has been effected. Completion of a tape loading operation opens the switch 57. Similarly, the load switch 58 is closed as long as no tape cassette 13 has been inserted into the recording apparatus. Insertion of a tape cassette 13 into the recording apparatus opens the load switch 58.

For a fuller appreciation of the operation of the preferred embodiment illustrated in FIG. 1, the following brief digression into a consideration of FIGS. 3 to 6 may be helpful at this juncture.

According to FIG. 3, the tape recording and playback apparatus 10 includes equipment 61 for extracting tape 15 from the cassette 13 and for placing the extracted tape in the form of a loop onto the tape drive capstan 24. The tape extracting equipment 61 includes a block 62 attached to a base plate 63 of the tape recorder 10. The block 62 has projecting tape guide members 65 and 66. These guide members project into the casing window 18 when the cassette 13 is located in its place in the recorder. The projecting tape guide members restrain the recording tape 15 against movement lateral to the direction of tape advance. The block 62 also mounts a pair of rotatable or stationary rollers 68 and 69 which serve to guide the recording tape 15 as it is being pulled out of the window 18, as well as after it has been so pulled out.

The block 62 also has a pair of pivots 71 and 72 for a substantially U-shaped track 73. A stop 74 is provided on the base plate 63 to provide for a confinement of the downward movement of the free end of the track 73.

A carriage 76 is mounted on the track 73 for sliding movement therealong. The carriage 76 carries a pair of fingers 78 and 79 which have finger portions 81 and 82. These finger portions are formed of end portions of the wires which provide the fingers 78 and 79 and of sleeves of a conventional wear-resistant flexible material.

A bent piece of wire forms a finger actuator 83 which is pivotally mounted on the carriage 76 with the aid of a metal plate 84. The finger actuator 83 is connected by a wire spring 86 to the fingers 78 and 79.

The wire spring 86 has a bight portion 87 and a pair of legs 88 and 89. The leg 88 is connected to the finger 78, and the leg 89 is connected to the finger 79.

The illustrated wire spring 86 and arrangement of the fingers 78 and 79 and finger actuator 83 impart a bistable character to the actuation of the fingers 78 and 79. Accordingly, the finger portions 81 and 82 have a first position in which they extend substantially in parallel to an edge of the recording tape 15, as well as a second position in which they extend substantially at right angles to a recording tape edge (see FIG. 5). The spring wire legs 88 and 89 are designed for lateral flexing, and the spring bight portion 87 is designed for torsional loading thereby providing for the above mentioned bistable actuation of the fingers between their positions.

A bracket 91 connects the finger actuator to an endless flexible belt 92. This endless belt has teeth 93 at the inside thereof (see FIG. 5). The teeth 93 mesh with a pair of gear pulleys 94 and 95. The pulley 94 is mounted adjacent the block 62 in the vicinity of the cassette window 18 by a shaft 96 which extends through a pair of bearing blocks 97 and 98. The pulley 95 is rotatably mounted on a block 99 at a location which is beyond the capstan 24 as seen from the cassette window 18. The block 99 is higher than the block 97 so that the endless belt 92 ascends at an inclined angle as seen from the cassette window 18. The angle of inclination is such that the finger portions 81 and 82 with the extracted length of recording tape will clear the capstan 24 as the carriage 76 moves along the tracks 73 in a direction away from the cassette window 18.

The operation of the tape extracting equipment will now be considered. To this end it is assumed that the tape recorder has a well 100 for receiving a tape cassette 13 (see FIG. 6). The well 100 may be closed by a cover 102 which is slidable in the direction of the arrow 103 to open the well 100, and which is slidable in a direction opposite to the direction of the arrow 103 for a closure of the well 100 by the cover 102.

Preparatory to the insertion of a cassette 13 into the well 100, the cover 102 is opened. This rotates a gear 105 in a clockwise direction as seen in FIG. 6 by the action of a rack 106 connected to the cover 102 and a gear 107 in meshing relationship with the rack 106 and the gear 105. The gear 105 is located on the shaft 96 to drive the pulley 94. In this manner the endless belt 92 is advanced so that the bracket 91 and finger actuator 83 place the finger portions 81 and 82 in the horizontal position illustrated in FIG. 3 preparatory to the insertion of a cassette into the well 100.

The cassette 13 is then inserted into the well whereby the upper edge of the tape 15 slides past and below the finger portions 81 and 82. The cover 102 is thereupon closed which imparts a counter-clockwise rotation on the shaft 96 as seen in FIG. 6. This provides for such

an advancement of the endless belt 92 that the bracket 91 is moved from the position shown in FIG. 3 to the advanced position shown in FIG. 5. As a result, the finger actuator 83 is rotated by 90°. This pushes the wire spring 86 downwardly whereby the finger portions 81 and 82 are rotated to their alternative vertical position illustrated in FIG. 5.

In this alternative position, the finger portions 81 and 82 extend at right angles to the edges of the recording tape 15 and are located behind the recording tape as seen from the front opening of the cassette window 18. Accordingly, further advancement of the belt 92 through continued closing of the cover 102 causes a length of recording tape 23 to be pulled out of the cassette through the window 18 by the finger members 81 and 82.

Due to the above mentioned inclination of the endless belt 92, the finger portions 81 and 82 and the pulled-out tape length clear the capstan 24. The fingers and finger portions are thus capable of forming the pulled-out recording tape length into the substantially U-shaped loop 23.

The objective of the extracting equipment now is to place the bight portion of the U-shaped loop 23 about part of the periphery of the capstan 24. To this end, the advancement of the endless belt 92 is continued by continuing the closing motion of the cover 102. The bracket 91 on the belt is thereby advanced about the upper pulley 95. In this manner, the finger portions 81 and 82 move laterally past the capstan 24 in the direction of a retention member 110. To better illustrate the resulting position of the finger portions 81 and 82, the capstan 24 and the recording tape 15 have not been shown in FIG. 4. It should, however, be understood that the finger portions 81 and 82 move past the capstan 24 into a cavity of the retention member 110. In consequence, the recording tape 15 is placed about part of the periphery of the capstan 24 so as to be in driving engagement with the capstan over an angle of some 180°. The tape 15 is then in the position shown in FIG. 1.

The tape extracting equipment and the tape extracting method shown in FIGS. 3 to 6 are more fully disclosed, and are claimed, in the above mentioned Neff patent application.

The load switch 57 is also shown as a normally closed microswitch in FIG. 5. The microswitch 57 is attached to the post 99 and is closed by the bracket 91 when the finger elements 81 and 82 have moved past the capstan 24 and into the member 110. The load switch 58 of FIG. 1 is also shown as a microswitch in FIG. 6. The microswitch is opened by the cassette 13 upon the completed insertion of the cassette into the well 100.

In principle, movement of the tape extraction fingers in the described manner past the capstan 24 does not necessarily mean that any tape has in fact been placed in driving engagement with the tape advance capstan. For instance, it would in principle be possible to attempt commencement of the tape recording operation without the placement of any tape cassette into the recorder. To avoid this from occurring, the switch 58 is provided. Correct insertion of a cassette 13 into the well 100 will open the switch 58 and will provide the combinational logic 53 with a signal indicating presence of a tape cassette in the recorder. In terms of logic connotation the symbol LC2 may be employed to indicate presence of the tape cassette 13 in the tape re-

corder well 100, while the symbol $\overline{LC2}$ may be employed to signify that no cassette is present in the well or that a cassette is to be inserted into the well.

In a similar vein, actuation of the switch 57 provides the combinational logic 53 with a signal indicating a completion of a tape extracting operation. In logical terms, actuation of the switch 57 by the tape extracting or loading mechanism 61 may be signified by the symbol $\overline{LC1}$, while the symbol $\overline{LC1}$ may be used to indicate that the tape extracting operation either has not been completed or initiated, or that a tape extracting operation is to be initiated.

Before the equipment connected to the combinational logic 53 can make a decision as to the next step to be effected, there has to be certainty that a tape is actually in operating position located about the capstan 24 as shown in FIG. 1. For instance, the tape will not be an operating position if the extracting equipment has lost the tape during the extracting process or if a break in the tape has occurred. To ascertain the desired presence of a recording tape, the above mentioned tension sensor 31 with operational amplifier 39 is employed for tension sensing purposes. Preparatory to a tape extracting operation, the reel motors 48 and 49 are energized by the combinational logic 113 and by way of servo amplifiers 114 and 115 to rotate the tape winding devices 20 and 21 in opposite senses so as to tension the recording tape 15. The tape extracting equipment 61 is then employed to extract a loop 23 of the recording tape. Tensioning of the recording tape in the manner just described will retain the bight portion of the extracted loop on the finger elements 81 and 82 until the same has been placed about the capstan 24.

Tensioning of the tape in the manner just described will also cause the tension sensor 31 and operational amplifier 39 to provide a tape tension signal at the amplifier output 46 as soon as the tape has been loaded about the capstan and is in the position shown in FIG. 1. This tape tension signal is in the instant case employed to signify that no tape break has occurred and that the tape has been correctly loaded onto the capstan 24. A memory device 56 is provided to permit the execution of various functions in response to the presence of the tape loop 23, as well as in response to an absence thereof. These functions are more fully described below in connection with FIG. 7.

A further aspect of this invention provides tape position sensing equipment to be presently described. It should, however, be understood that the preferred embodiment of the invention so far described, with the tension sensing equipment, can be employed by itself if no automated tape position sensing or positioning is necessary or desired.

Tape position sensing equipment 117 and tape positioning equipment 118 in accordance with a preferred embodiment of a further aspect of this invention are, however, shown in FIG. 1. The tape position sensing equipment includes a light source 120 and a pair of photocells 121 and 122. Only one light source has been shown but each photocell may be provided with its own light source if desired.

As seen in FIG. 9, the recording tape 15 has a first leader 123 attached to one end thereof and a second leader 124 attached to the other end thereof. The recording tape 15 is opaque, while the leaders 123 and 124 are clear in accordance with conventional practice. The length of conventional leaders is typically

such that portions of one and the same leader are located at both photocells 121 and 122 at the end of a tape winding operation. By way of example, the length of each leader may be about 17 inches.

Accordingly, both photocells are illuminated if there is no tape on the capstan 24, or if either of the leaders 123 and 124 is present at both photocells. On the other hand, both photocells are obscured if the recording tape 15 is present in the tape loop 23 at both photocells. Conversely, one of the photocells is illuminated and the other photocell is obscured if the beginning of the recording tape is present at the bight portion of the loop 23, and the one photocell is obscured and the other photocell is illuminated if the end of the tape is present at that bight portion. Whether a tape end is considered the beginning or the end of the tape is, of course, a matter of reference. In the instant case, the tape end 126 at the leader 123 is considered the beginning and the tape end 127 at the leader 124 is considered the end of the tape. The leader 123 is further considered attached to the tape winding device 20, and the leader 124 is considered attached to the tape winding device 21.

The photocells 121 and 122 are, respectively, connected to amplifiers 128 and 129. These amplifiers are connected to a reference voltage terminal 131 and provide an output only in response to an input exceeding the reference potential. The output signals of the amplifiers 128 and 129 are applied to a combinational logic 132 and to a memory device 133. The memory device 133 responds to a "tape tension achieved" signal received from the memory 56 via a line 307, and enables a determination whether a sensed tape end is the beginning of the tape or the end of the tape. The combinational logic 132 serves the purpose of receiving and appropriately conveying signals provided by the amplifiers 128 and 129 and by the memory device 133. Further circuits 135 indicate the presence of the end of tape (hereinafter EOT), the presence of the beginning of tape (hereinafter BOT), and the presence of a leader 123 and 124 (hereinafter sometimes designated by the letter L) at the sensors.

A further combinational logic 137 receives the outputs of the combinational logic 132 and energizes a capstan control 138 for an advance of the recording tape forward and/or backward until the tape beginning has been positioned at the recording or playback head 27. The combinational logic 137 and capstan control 138 are aided in their task by a memory device 139. Operation of the memory 139 is timed by a clock 141. At the completion of a tape positioning operation, a further circuit device 145 indicates that the tape is ready for a recording or playback operation (or for any other function to which the apparatus may be adapted within the scope of the subject invention).

A further circuit 146 provides an inhibit signal when a manual control of the tape positioning function is desired.

A practical example of the sensing and control equipment shown in FIG. 1 will be provided in the further course of this disclosure. Before considering those circuit diagrams, we will review the functional block diagrams of FIGS. 7, 8 and 10.

As indicated in the block 151 in FIG. 7, motion of the capstan 24 is initially inhibited and no torque is initially provided by the reel motors 48 and 49. As indicated at the line 152 and in the block 153 torque is applied to

the reel motors 48 and 49 so as to tension the tape 15 in the cassette 13 upon closure of the switch 58. This corresponds to the above mentioned statement that the tape is tensioned preparatory to a tape loading operation to retain the tape on the extracting equipment during the tape loading process. If the cassette should be removed from the recorder prior to an extracting operation, the reel motors 48 and 49 will be automatically deactivated as indicated by the line 154.

As indicated at the line 155 and in the block 156 application of torque by the reel motors 48 and 49 to tension the tape is continued beyond the completion of a tape loading operation. As explained above, this serves the purpose of ascertaining that the recording tape has actually been loaded on the capstan 24.

As further indicated in the block 156, the tension of the extracted tape is then monitored. This, as mentioned above, is effected with the aid of the tension sensor 31 and operational amplifier 39 shown in FIG. 1. As indicated by the block 157, the tension monitoring operation is timed to ascertain whether tape tension appears within the time it takes with a given system to establish and to tension the tape loop 23 shown in FIG. 1. As indicated by a line 158 and in a block 159 a failure to achieve tape loop tension within the given time will cause the control to inhibit further torque in addition to an inhibition of capstan motion. As further indicated by a line 161 a renewed tape loading operation may be initiated in response to a "no tension" signal. In this manner, loading of the tape on the capstan 24 will be repeated if the tape should have been lost by the extraction equipment in a loading operation. The functions indicated by the blocks 156 and 157 will then be repeated upon completion of a tape loading operation.

As indicated by a line 163 and in a block 164 achievement of tape tension within the predetermined period of time will cause the apparatus to determine whether the recording tape is ready for the desired operation (e.g., recording, playback, etc.). The function represented by the block 164 may be dispensed with if it is not important at which location the particular tape function is commenced, or if the tape is always re-wound preparatory to a tape loading operation, so that the extracted tape loop is always the beginning of the tape. If, on the other hand, a tape positioning operation is desired, then the function or equipment represented by the block 164 may be employed to monitor the tape positioning functions or equipment illustrated in FIG. 10 and more fully disclosed below.

As indicated by a line 166 and in a block 167 capstan motion is released in response to a signal indicating a "tape ready" condition in addition to the existence of tape tension in the loop 23. Release of the capstan motion permits energization of the capstan motor 25 by the capstan control 138 to rotate the capstan 24 for the purpose of advancing the recording tape 15. As indicated in the block 167 the application of torque to the tape winding devices 20 and 21 by the reel motors 48 and 49 is continued at that stage to ascertain that advanced tape is properly wound onto the particular reel. As also indicated in the block 167 the tape tension is continued to be monitored to safeguard against undetected tape breakage. As mentioned above, this phase of the tape monitoring process is more fully disclosed in the aforesaid Howes and Cooper patent application.

Briefly, that monitoring operation establishes a closed-loop servo through the tension sensor 31, opera-

tional amplifier 39, a path illustrated by a partially broken line 169, the servo amplifier 114, the reel motor 48, the tape winding device 20 and the length of tape between the device 20 and the tension feeler 32. This servo loop ascertains that the tape tension is maintained at the value set by the potentiometer 41.

As mentioned above, tape tension in the other leg of the loop 23 may be monitored by equipment 51 which includes a tension sensor similar to the sensor 31 and an operational amplifier similar to the amplifier 39. A closed-loop servo is established from the equipment 51 by way of a path indicated by a partially broken line 171, through the servo amplifier 115, by way of the reel motor 49, by way of the tape winding device 21 and along the length of tape between the reel 21 and the sensor 51 to ascertain that the tape tension in the particular leg of the loop 23 is maintained at a set value. As further disclosed in the above mentioned Howes and Cooper patent application, switchable resistive devices (not shown) actuated by the tape extracting equipment 61 may be employed to change the tension upon completion of each tape loading operation so that each of the tape tensioning operations before accomplished tape loading as well as during tape advance can conveniently be tailored to the needs of the particular operation.

It will now be recognized that the functions listed in the block 167 and FIG. 7 refer to the normal running state of the tape recording or playback equipment. During the persistence of such normal state, information may be recorded on or played back from the tape 15 with the head 27 and equipment 28.

As indicated by a line 173 and in a block 174 in FIG. 7, the provision of torque by the reel motors 48 and 49 and the movement of the capstan 24 are inhibited in response to a signal that the sensor 31 has lost the tape tension in the loop 23. Such loss of tape tension can occur when the recording tape 15 ruptures or when the electric power supply is interrupted. As further indicated in the block 174 a master reset is monitored to determine whether electric power reappears. The master reset typically is a device which provides a signal upon occurrence of electric supply power.

As indicated by the line 176, both the applications of torque and the motion of the capstan are inhibited (see block 159) if no master reset signal occurs following a loss of tension. On the other hand, as indicated by a line 178 and in a block 179, the reel motors 48 and 49 apply torque for tensioning the recording tape 15 if a master reset signal indicates the reappearance of electric power. As further indicated by the line 181 the tape extracting equipment 61 then must go through a tape loading operation to re-initiate the loading sequence and reset the logic.

The above mentioned functions concerning the blocks 156, 159 and 164 are then repeated until the tape recorder is in the normal running state represented by the block 167.

A tape position sensing system that may be employed in conjunction with the system of FIG. 7 or that may be used independently thereof will now be described with the aid of FIG. 8.

The system of FIG. 8 has a block 183 which monitors the tension of the tape in the loop 23 shown in FIG. 1. By way of example, the block 183 may monitor the tension represented at the line 163 of FIG. 7. As explained above, that tension occurs when the tape has been cor-

rectly loaded on the capstan 24. As indicated in FIG. 8 by a line 184 achievement of tape tension is employed to activate a tape and leader sensing operation represented by the block 185. This sensing operation may be effected by the photocells 121 and 122 with amplifiers 128 and 129 shown in FIG. 1.

If both photocells 121 and 122 sense either of the leaders 123 and 124, an apparatus 187 for indicating the sensing of either leader is actuated by way of a line 188.

If both of the photocells 121 and 122 sense the recording tape 15, a circuit 189 for indicating such sensing of tape by both photocells is activated via a line 191.

The tape beginning is indicated by a circuit 193 energized via a line 194 when the photocell 121 senses a leader (in this case the leader 123) while the photocell 122 senses the recording tape 15. Conversely, a circuit 195 indicating the end of the tape is energized via a line 196 when the photocell 122 senses a leader (in this case the leader 124) while the photocell 121 senses a recording tape 15.

As illustrated by a line 198, sensing of the beginning of tape 126 (see FIG. 9) after indication of a leader energizes the beginning of tape indicator 193. Conversely, the end of tape indicator 195 is energized via a line 199 upon sensing of the end of tape after indication of a leader. The tape indicator 189 is energized via a lead 200 if both photocells sense the recording tape 15 after indication of the tape end 127. Conversely, the end of tape indicator 195 is energized via a line 201 if the tape end 127 is sensed by the photocells after indication of a sensing of the recording tape by both photocells.

The tape indicator 189 is also energized via a line 202 if both photocells sense the recording tape after a beginning of tape indication. Conversely, the beginning of tape indicator 193 is energized via a line 203 if the photocells sense the beginning of tape after an indication that the tape has been sensed by both photocells.

A beginning of tape and leader indication is provided by a component 205 when a leader is sensed by the photocells after a beginning of tape indication. Conversely, the component 193 indicates the tape beginning if the beginning of tape is then sensed by the photocells as indicated by the line 206.

Similarly, a component 207 provides an end of tape and leader indication if the leader 124 is sensed by the photocells after an end of tape indication. Conversely, the end of tape indicator 195 is energized if the photocells then sense the end of tape as indicated by a line 208.

A practical application of the tape position sensor of FIG. 8 will now be disclosed with the aid of FIG. 10.

The block 210 in FIG. 10 represents the normal "off" state (home state) of the apparatus shown in FIG. 1. In response to an on signal conveyed by a line 212 the above mentioned tension monitor 183 determines whether tension has been achieved in the tape loop 23 after a tape loading operation. A signal that tension has been achieved is conveyed by a line 213 to a component 214 for monitoring the tape position indications shown in FIG. 8.

A line 215 conveys a signal to a control circuit 216 in response to an indication by the component 187 of FIG. 8 that both photocells have sensed a leader (which sensed leader may either be the leader 123 or the

leader 124 shown in FIG. 9). In response to such an input signal received through the line 215 the control circuit 216, acting through the capstan control 138, causes the recording tape to go forward (i.e. from the winding device 21 to the winding device 20) for a certain period of time. A timing device 218 connected to the control circuit 216 permits the latter tape advance operation to extend over a period of time which is sufficient for a winding of the leader 123 on the winding device 20 when the leader sensed by the photocells at that juncture is the leader 123.

In other words, since a leader sensed by both photocells could either be the first leader 123 or the second leader 124, it is necessary to take some action to determine which leader has been sensed at a particular time. To this effect, the control 216 and the timing device 218 cooperate in advancing the tape for such a period of time that the recording tape 15 will appear at both photocells after the timed tape advance if the sensed leader was the first leader 123. On the other hand, if the sensed leader was the leader 124, then the recording tape 15 will not appear at the photocells after the timed tape advance represented by the block 216 and 218.

As indicated by the line 220 and the block 221, an indication that the recording tape is ready for a performance of the desired function (recording, playback, etc.) is provided if both photocells sense the tape 15 after the timed advance provided by the controls 216 and 218. This phase of the operation of the system shown in FIG. 10 presents a considerable simplification over a possible alternative in which a beginning of tape sensing operation is effected at the particular junction. This simplification is possible since the execution of the timed tape advance after a sensing of either leader provides certainty that the tape sensed upon expiration of the timed advance must be the tape beginning 126.

Conversely, and as indicated at a line 223 in FIG. 10, a leader which is sensed by the photocells upon expiration of the timed tape advance must be the second leader 124, since the first leader would have been wound on the device 20 during the timed tape advance if the sensed leader had been the first leader 123.

As indicated by the line 223 and in the block 224 the recording tape is advanced in the reverse direction in response to the determination that a sensed leader is the second leader 124. In this manner, the second leader 124 and the recording tape 15 are wound onto the winding device 21. The tape rewinding block 224 is also energized for the same purpose if a signal conveyed by a line 226 indicates that the tape position monitor 214 has ascertained that the tape indicator 189 in FIG. 8 is indicating a sensing of the recording tape by both photocells. Similarly, the tape rewinding block 224 is energized via the lead 226 if the tape position monitor 214 has ascertained that the component 195 in FIG. 8 indicates the sensing of the tape end by the photocells.

During the tape rewinding operation the block 224 causes the photocells 121 and 122 to be sensitive to the tape beginning 126. As soon as the arrival of the tape beginning at the photocells 121 and 122 is sensed, a signal is conveyed by a line 228 to a component 229 which operates through the capstan control 138 to stop further tape advance.

In a typical practical application, the tape advance will coast to a stop so that the leader 123 is present at

both photocells 121 and 122 by the time the tape advance has actually stopped. Accordingly, a line 231 provides a signal causing a component 232 to act on the capstan control 138 in FIG. 1 for advancing the recording tape forwardly for a moment so as to make sure that the recording tape beginning 126 is at the recording or playback device 27 before a line 234 conveys a signal to the component 221 to indicate that the tape 15 is ready for the execution of a desired function (recording, playback, etc.).

With reference to the component 229, the photocells 121 and 122 may be employed to sense the leader 123 before the "go forward" signal is conveyed by the line 231 to the component 232. In practical applications this sensing step may, however, be dispensed with since the beginning of tape sensing step signified by the line 228 is generally a sufficient indication that a leader next occurring at the photocells will be the leader 123 and will in fact occur after the tape advance has coasted to a stop.

A somewhat simplified procedure is initiated if the tape position monitor component 214 ascertains from the component 193 shown in FIG. 8 that the tape beginning is located between the photocells 121 and 122 shown in FIG. 1 after a successful tape loading and tensioning operation. In that case, the component 232 is energized via a line 236 to place the tape beginning 126 at the recording or playback head 27. If the photocells 121 and 122 then both indicate the presence of tape, the component 221 is energized via the line 234 to indicate that the tape is ready for an execution of the desired function (recording, playback, etc.).

To apprise the operator that the tape is not running away during the above mentioned tape rewinding, stopping, and advancing operations, each of the blocks 224, 229 and 232 includes a component which indicates tape loading in any desired manner, such as by a visual indication to the operator. This loading signal is turned off upon indication of the "tape ready" condition by the component 221.

The "tape ready" indication provided by the component 221, may, for instance, be a visual indication to the operator who thereupon may initiate a desired function. As shown in the component 221 external control lines are unlocked at the time of a "tape ready" indication so that the control of interface motion control lines is automatically released to the operator.

A component 238 is provided in the system of FIG. 10 to permit the operator to force a "tape ready" condition at any stage of the loading operation. The inhibit component 238 energizes the tape ready component 221 directly via a line 239 thereby bypassing the tape positioning operation otherwise effected by the components 214 through 232.

However, the tape break and power monitor functions cannot in the illustrated preferred embodiment be inhibited by the component 238. A line 241 connects the "tape ready" component 221 with the homing component 210 whereby the apparatus will be switched to the off condition if the tape tension disappears because of a tape break or any other reason or if no master reset occurs after a power failure. As indicated by the lines 242, 243, 244 and 245, the homing component 210 is also actuated if tape tension is lost during any of the operations indicated by the blocks 214, 224, 229 and 232. In case of tape breakage the reel motors 48 and 49 and the ready signal are stopped, necessitating a reload of

the recording tape. In the case of a momentary power failure a similar "not ready" condition exists except that the reel motors are turned on again so that reloading or unloading is possible.

A circuit diagram in accordance with a preferred embodiment of the invention of the control of the apparatus shown in FIG. 1 will now be described with the aid of FIGS. 11 and 12.

According to FIG. 11, the photocells 121 and 122 and the light source 120 are part of an optical sensor component 260. The light source 120 in this case has an individual light-emitting diode 261 for the photocell 121 and a separate light-emitting diode 262 for the photocell 122. The diodes 261 and 262 may be infrared-radiation emitting diodes, since the expression "light" as herein employed is not intended to be limited to visible light only. The magnetic recording tape 15 and the clear leaders 123 and 124 are not shown in FIG. 11 as it is understood that these run along paths between each diode and its corresponding photocell. In FIG. 11, the photocells comprise phototransistors.

The output terminal 264 of the photocell 121 is connected to the inverting input 265 of the operational amplifier 128 by way of a noise suppression filter 266. A feedback circuit 268 and a voltage divider 269 are connected to the non-inverting input 271 of the operational amplifier 128. In this manner, the operational amplifier 128 is caused to operate as a Schmitt trigger which only operates upon the illumination of the photocell 121 reaching a certain level. The output 273 of the operational amplifier 128 is connected by a resistor 274 to an inverter 275. The output 276 of the inverter 275 provides a signal in response to an illumination of the photocell 121. An inverter 278 is connected to the output 276 of the inverter 275. The output 279 of the inverter 278 provides a signal as long as the photocell 121 is not illuminated.

The photocell 122 is connected by way of a noise suppression filter 281 to the inverting input 282 of the operational amplifier 129. A feedback circuit 283 and a voltage divider 284 are connected to the non-inverting input 285 of the operational amplifier 129. In this manner, the operational amplifier 129 is also caused to act as a Schmitt trigger requiring a certain level of illumination of the photocell 122.

The output 287 of the operational amplifier 129 is connected by way of a resistor 288 to an inverter 289. The inverter provides a signal at its output 291 in response to an illumination of the photocell 122. An inverter 292 is connected to the inverter output 291 and provides a signal at its output 293 as long as the photocell 122 is not illuminated.

Circuit diagrams of the memory 133 and the combinational logic 132 of the tape position sensing system 117 (see FIG. 1) are shown in FIG. 12. A lead 195 connects the inverter output 276 in FIG. 11 to an input of a NAND element 296 of the memory 133. A lead 298 connects the inverter output 279 in FIG. 11 to an input of a NAND element 299 in the memory of FIG. 12.

Similarly, a lead 300 connects the inverter output 291 in FIG. 11 to an input of a NAND element 301 in the memory 133. A lead 303 connects the inverter output 293 in FIG. 11 to an input of a NAND element 304 in the memory 133 of FIG. 12.

Inputs of the NAND elements 304 and 301 are also connected to the lead 295 as shown in FIG. 12. An input of the NAND element 299 and an input of a fur-

ther NAND element 306 of the memory 133 are also connected to the lead 300 as shown in FIG. 12. Further inputs of the NAND elements 296, 299, 301, 304 and 306 are connected to a lead 307 which is energized by the memory 56 upon a successful tape loading and tensioning operation (see also FIG. 1).

The memory device 133 further includes two NAND elements 308 and 309. The outputs of the NAND elements 296 and 304 are connected to the inputs of the NAND element 308. The outputs of the NAND elements 299 and 306 are connected to the inputs of the NAND element 309.

A lead 311 connects the output of the NAND element 308 to an input of the NAND element 296, and a lead 312 connects the output of the NAND element 309 to an input of the NAND element 306. The feedback leads 311 and 312 enable the memory 113 to store information about the sensing operation of the photocells 121 and 122 so as to permit the tape position sensing system to distinguish between beginning of tape and end of tape.

The output of the NAND element 308 is also connected by way of an inverter 313 to an input of a NAND element 314 in the combinational logic 132. Similarly, the output of the NAND element 309 is connected by way of a NAND element 316 to an input of a NAND element 317 in the combinational logic 132. A further NAND element 318 of the combinational logic 132 has one of its inputs connected to the tension signaling line 307 and another input connected to the output of the NAND element 309.

Further inputs of the NAND element 314 and 317 are connected to the tension signaling line 307, and yet further inputs of the NAND elements 314 and 317 are connected to the tape position signaling line 295.

A further NAND element 321 in the combinational logic 132 has its inputs connected to the outputs of the NAND elements 314 and 318 in order to provide at its output 322 a signal indicating sensing by the photocells 121 and 122 of either end of tape or leader, or end of tape and leader.

Similarly, a NAND element 323 in the combinational logic 132 has both of its inputs connected to the output of the NAND element 317 in order to provide at its outputs 324 a signal indicating the sensing by the photocells 121 and 122 of either beginning of tape or leader, or beginning of tape and leader.

It will be noted at this juncture that the NAND element 321 performs the function indicated for the component 207 in FIG. 8, and that the NAND element 323 performs the function indicated for the component 205 in FIG. 8. The function of the component 187 in FIG. 8 is performed in FIG. 12 by the NAND element 301 which, in conjunction with an inverter 325 provides a signal indicating the sensing of either of the leaders 123 and 124 by the photocells 121 and 122.

Two further NAND elements 327 and 328 in the combinational logic 132 have inputs connected to the output 322 of the NAND element 321. The NAND element 328 also has inputs connected to the outputs of the NAND element 317 in order to provide a signal indicating the sensing of end of tape in the manner of the component 195 in FIG. 8.

Similarly, a further NAND element 331 in the combinational logic 132 has one input connected to the output of the NAND element 327 and another input connected to the output 324 of the NAND element 323 in

order to provide a signal indicating the sensing of the beginning of tape in the manner of the component 193 in FIG. 8. It will also be noted that the outputs 279 and 293 of the inverters 278 and 292 of the tape position sensor provide signals indicating that both photocells are obscured by tape. In this respect, the inverters 278 and 292 perform the function of the component 189 of FIG. 8.

A preferred embodiment of the tape tension sensing system 54 will now be described with the aid of FIGS. 11 and 12.

According to FIG. 11, the tape tension sensing signal provided by the sensor 31 and operational amplifier 39 (see FIG. 1) is applied through a terminal 350 to an input of an AND element 351. The AND element 351 and a NAND element 352 form the combinational logic 53 indicated in FIG. 1.

The tape loading switch 56 shown in FIG. 1 is connected by way of a terminal 354 and a lead 355 to an input of a NAND element 356. This input, as well as another input, of the NAND element 356 are electrically biased through a pair of resistors 358 and 359 and are provided with noise filter capacitors 361 and 362. The output of the NAND element 356 is connected to an input of a NAND element 357, to a triggering input of an astable multivibrator 359 which constitutes the clock 141, and to an input of a NOR element 361 in the memory 56.

The output of the NOR element 357, on the other hand, is connected to an input of the AND element 351 and to an input of the NAND element 352 in the combinational logic 53, and to a clearing input of a J-K flip-flop 363 in the memory 56. The output of the NAND element 357 is also connected by a lead 364 to an input of an EXCLUSIVE OR element 365 in the combinational logic 113 shown in FIG. 12.

The third input of the AND element 351 is connected by a lead 367 to the Q-output 368 of a J-K flip-flop 369 in the memory 56. The second input of the NAND element 352 in the combinational logic 53 is connected to an output 371 of a one-shot multivibrator 372 in the master reset 59. The master reset 59 has a capacitor 373 with a parallel-connected resistor 374. The capacitor 373 is charged from an electric power supply line 375 by way of a resistor 376 upon the appearance or reappearance of electric power after an off condition or a power failure. The charged capacitor turns on a transistor 378 which triggers the one-shot multivibrator 372. The output 371 of the multivibrator 372 provides a master reset signal for the NAND element 352 in the combinational logic 53 and for the NOR element 361 in the memory 56.

The output of the NAND element 352 in the combinational logic 53 is connected to the presetting input 381 of the J-K flip-flop 363 in the memory 56. The output of the AND element 351 is connected to the J-input 382 of the J-K flip-flop 363. The Q-output 383 is connected to an input of a NOR element 385 which, in turn, is connected to the J-input 386 of the J-K flip-flop 369 in the memory 56.

The output of the NAND element 356 is not only connected to a triggering input of the multivibrator 359 in the clock 141, but is also connected to inputs of the NOR elements 361 and 385 and to the K-input 387 of the J-K flip-flop 369 of the memory 56. The multivibrators 359 and 372 and the J-K flip-flop 369, as well as the J and K-inputs of a J-K flip-flop 388 in the fre-

quency converter 142 are energized from the power supply through a resistor 389.

The multivibrator 359 in the clock 141 provides clock pulses through a line 391. The line 391 is connected to clock pulse inputs 392 and 393 of the J-K flip-flops 363 and 369. The memory 56 is thus clocked to provide at the line 307 a signal indicating that loading of the tape loop 23 about the capstan 24 and tensioning of that tape loop has been achieved within a predetermined period of time. The lead 307 applies the tape tension signal to the memory 133 of the tape position sensing system as described above.

The $\bar{Q}$ -output 395 of the J-K flip-flop 363 is connected to an input of an EXCLUSIVE OR element 396 and to an input of a NAND element 397 of the combinational logic 113 shown in FIG. 12, by way of a line 398 extending from FIG. 11 to FIG. 12.

The $\bar{Q}$ -output 399 of the J-K flip-flop 369 is connected by a line 400 to another input of the EXCLUSIVE OR element 396 of FIG. 12. Similarly, the Q -output 368 of the J-K flip-flop 369 is connected by a line 402 to another input of the NAND element 397 in FIG. 12.

In the system of FIG. 1 the cassette loading switch 58 is shown connected to the combinational logic 53. By way of slight modification, this cassette loading switch is connected in FIG. 12 to an input of the EXCLUSIVE OR element 365 by way of a terminal 403 and a line 404. As previously mentioned, the other input of the EXCLUSIVE OR element 365 is connected by way of the line 364 to the output of the NAND element 357 in the tape loading circuit shown in FIG. 11.

The output of the EXCLUSIVE OR element 365 is connected to an input of a NOR element 406 whose other input is connected to the previously mentioned EXCLUSIVE OR element 396 in the same combinational logic 113. In this manner, the output of the NOR element 406 is able to control the servo amplifiers 114 and 115 of the reel motors 48 and 49 (see FIG. 1) by way of a lead 408 and a terminal 409. A tensioning of the tape will thus be provided for the purpose of tape loading when the switch 58 indicates a positioning of the cassette in the cassette well 100 shown in FIG. 6.

The output of the NOR element 406 is also connected by a lead 412 to an input of a NOR element 413 in the combinational logic 113. The other input of the NOR element 413 is connected to the output of the previously described NAND element 397. Inputs of a NAND element 414 are connected to the output of the NOR element 413. An input of a further NAND element 415 is connected to the output of the NAND element 414. A line 417 is connected to the output of the NAND element 415 to apply a clearing signal to clearing inputs of J-K flip-flops 418, 419 and 420 until loading and tensioning of the tape loop 23 has been achieved. The J-K flip-flops 418, 419 and 420 are part of the memory 139 shown in FIGS. 1 and 12.

The inhibit function shown at 146 in FIG. 1 and at 238 in FIG. 10 is controlled through a terminal 422 and a lead 423 connected to a further input of the NAND element 415 in the combinational logic 113 and connected to an input of a NAND element 425 in the combinational logic 137.

The J-input element of the J-K flip-flop 418 in the motion control memory 139 is energized through a lead 427 when the combinational logic 132 indicates the sensing of the beginning of tape by the photocells 121

and 122. This J-input element is also energized by way of leads 428 and 429 when the combinational logic 132 indicates the sensing of a leader by the photocells 121 and 122. Finally, this J-input element is energized through a lead 431 from the $\bar{Q}$ -output 432 of the J-K flip-flop 420.

The K-input element of the J-K flip-flop 418 is energized from the Q -output 434 of the J-K flip-flop 420 via a lead 435. Leads 437 and 438 energize this K-input element from the $\bar{Q}$ -output of the J-K flip-flop 419. This K-input element is also energized through a lead 439. The lead 439 is connected to the output of an EXCLUSIVE OR element 441 which has its inputs energized from the Q -output of the J-K flip-flop 388 and from the $\bar{Q}$ -output of a J-K flip-flop 442.

The Q -output of the flip-flop 388 is also connected to a clock pulse input of the flip-flop 442. A lead 445 connects the output of the multivibrator or clock 359 to a clock input of the flip-flop 388. The flip-flops 388 and 442 and the EXCLUSIVE OR element 441 cooperate in timing the forward motion of the recording tape in response to the sensing of a leader by the photocells 121 and 122 so that the first leader 123 will be wound on the winding device 20 if the sensed leader was in fact the first leader. Clearing inputs of the flip-flops 388 and 442, as well as the J and K-inputs of the flip-flop 442 are also energized from the output of a NAND element 447 in the combinational logic 137' by way of leads 448 and 449. The combinational logic 137' is in fact part of the logic 137 (see FIGS. 1 and 12) but has in FIG. 12 been shown separated from the proper of that combinational logic.

The flip-flops 418, 419 and 420 are preset by way of leads 451, 452 and 453 from the output 454 of a NAND element 456, both of whose inputs are connected to the output of the previously mentioned NAND element 425. The input of the NAND element 425 not so far described is connected to the output of a NAND element 458 which has one of its inputs connected by the above mentioned leads 449 and 448 to the output of the NAND element 447 in the combinational logic 137'. By way of background, the output of the NAND element 447 controls the forward and reverse operations of the capstan drive 25 (see FIG. 1) by way of a terminal 461.

Another input terminal of the NAND element 458 is connected by the lead 417 to the clearing output of the NAND element 415. Yet another input of the NAND element 454 is connected to an output of an AND element 463.

The AND element 463 has one of its inputs connected to the output of the NAND element 301 in the memory 113 by a lead 465, and has another of its inputs connected to the output of the NAND element 317 in the combinational logic 132 via a lead 466. A lead 468 connects yet another input of the NAND element 463 to the output of the NAND element 327 in the combinational logic 132.

The output of the NAND element 331 in the combinational logic 132 is also connected by the lead 427 and by a lead 471 to an input of a NOR element 472 in the motion control memory 139. Another input of the NOR element 472 is connected to the previously mentioned lead 449.

The output of the NOR element 472 is connected to the Q -output of the flip-flop 419. The K-input of the flip-flop 419 is grounded. The Q -output of the flip-flop

419 is connected by a lead 475 to an input of a NAND element 476 in the combinational logic 137 and to an input of a NAND element 477 in the combinational logic 137'. The Q-output 434 of the flip-flop 420 is connected to another input of the NAND element 476. Leads 478 and 479 moreover connect the Q-output of the flip-flop 418 to the input of the NAND element 476 and to inputs of an EXCLUSIVE OR element 481, a NOR element 482, and a NAND element 483. The output of the NAND element 476 provides a negative-going "tape ready" signal at a terminal 485. This may be used as an indication to the operator or to a control that the recording tape is not ready for recording or playback. An input of a further NAND element 487 is connected to the output of the NAND element 476. The output of the NAND element 487 provides at a terminal 488 an indication that the recording tape is ready for recording and playback. In this sense, the NOR element 487 provides the function of the component 221 in FIG. 10. An input of a NOT element 491 is connected by the above mentioned leads 428 and 429 to the output of the inverter 325 which provides a signal indicating the sensing of a leader. Another input of the NOR element 491 is connected by a lead 493 to the output of the above mentioned NAND element 323 which provides an indication upon the sensing of a leader or beginning of tape. The output of the NOR element 491 is applied to an input of the above mentioned EXCLUSIVE OR element 481 whose output energizes the J-input of the flip-flop 420. The Q-output of the flip-flop 419 is connected to an input of the NOR element 482 whose output energizes the K-input of the flip-flop 420.

In this manner, the above mentioned "tape ready" and negative-going "tape ready" indications are provided at the terminals 488 and 485 to apprise the operator of the condition of the recording tape.

The Q-output of the flip-flop 419 is also connected via the lead 438 to an input of an AND element 500. A lead 501 connects the Q-output of the flip-flop 418 to another input of the AND element 500 and to one input of a NAND element 503. The remaining inputs of the AND element 500 and of the NAND element 503 are connected via a lead 505 to the Q-output 434 of the flip-flop 420. The output of the NAND element 503 is connected to an input of a NAND element 507 whose other input is connected to the output of the NAND element 477 in the same combinational logic 137'. The output of the NAND element 507 provides at a terminal 509 the tape loading indication mentioned in the blocks 224, 229 and 232 of FIG. 10. This loading indication may be visually observable to apprise the operator that the tape is not running away during a tape rewind operation in the course of the tape positioning function.

The output of the AND element 500 is connected to an input of a NOR element 512 whose other input is connected via a lead 513 and a lead 448 to the output of the NAND element 447 in the same combinational logic 137'. The output of the NOR element 512 provides at a terminal 515 a stop/go signal with which the tape advance can be stopped after a sensing of the beginning of tape (see block 229 in FIG. 10) and can be advanced forward (see block 232 in FIG. 10) in order to position the tape beginning 126 appropriately at the recording or playback head 27 shown in FIG. 1. The capstan control 138 of FIG. 1 may consist of standard

components which alternatively energize the capstan drive 25 for tape forward and tape reverse motion in response to the signal provided at the terminal 416 in FIG. 12, and which deenergize and briefly energize the capstan drive 25 for stopping of the tape and for a brief tape forward motion in response to signals at the terminal 515.

The recording and playback operations themselves may proceed in the manner disclosed in the above mentioned Howes and Cooper patent application.

Modifications and variations within the spirit and scope of the subject invention will become apparent or suggest themselves to those skilled in the art on the basis of the subject disclosure.

I claim:

1. In a method of performing a function relative to an elongate information carrier having a first end connected to a first rotary carrier winding and storage device and having a second end connected to a second rotary carrier winding and storage device, the improvement comprising in combination the steps of:

- providing drive means for rotating said first and second rotary carrier winding and storage devices;
- providing means for sensing tension of said information carrier between said first and second carrier winding and storage devices;
- providing means for timing said tension sensing for a predetermined period of time;
- energizing said drive means to tension said information carrier between said first and second carrier winding and storage devices;
- sensing the tension of said information carrier with said tension sensing means;
- timing the tension sensing of said information carrier with said timing means to determine whether said drive means tension said information carrier within said predetermined period of time; and
- performing said function relative to said information carrier in response to a determination that said drive means have tensioned said information carrier within said predetermined period of time.

2. A method as claimed in claim 1, including in combination the steps of:

- repeating said energizing of said drive means to tension the information carrier between the first and second carrier winding and storage devices;
- repeating said sensing of the tension of the information carrier with said tension sensing means;
- repeating said timing of the tension sensing of the information carrier with said timing means to determine whether said drive means tension the information carrier within said predetermined period of time while the energizing of said drive means is repeated; and

deenergizing said drive means if said drive means fail to tension the information carrier within said predetermined period of time.

3. A method as claimed in claim 1, wherein:

the performance of said function includes the step of advancing said information carrier in response to a determination that said drive means have tensioned said information carrier within said predetermined period of time.

4. A method as claimed in claim 1, including in combination the steps of:

- providing said elongate information carrier with a first leader at said first end, a second leader at said

second end, and an elongate information recording medium between said first and second leaders; effecting a carrier position sensing function in response to a determination that said drive means have tensioned said information carrier within said predetermined period of time, said carrier position sensing function including the step of determining whether said information recording medium is present in a predetermined region; and rewinding said elongate information recording medium onto one of said rotary devices in response to a determination that said information recording medium is present in said predetermined region when said carrier position sensing function is effected.

5. A method as claimed in claim 4, wherein: said elongate information recording medium is rewound onto said secondary rotary device until said first leader is present in said predetermined region; said first leader is thereupon rewound onto said first rotary device until the beginning of said elongate information recording medium is present in said predetermined region; said elongate information carrier is stopped when the beginning of said elongate information recording medium is present in said predetermined region; and a predetermined information conveying function is thereupon initiated relative to said information recording medium.

6. A method as claimed in claim 4, wherein: said carrier position sensing function also includes the step of determining whether said second leader is present in said predetermined region; and said second leader and said elongate information recording medium are rewound onto said second rotary device in response to a determination that said second leader is present in said predetermined region.

7. A method as claimed in claim 6, wherein: said elongate information recording medium is rewound onto said second rotary device until said first leader is present in said predetermined region; said first leader is thereupon rewound onto said first rotary device until the beginning of said elongate information recording medium is present in said predetermined region; said elongate information carrier is stopped when the beginning of said elongate information recording medium is present in said predetermined region; and a predetermined information conveying function is thereupon initiated relative to said information recording medium.

8. A method as claimed in claim 1, including in combination the steps of: providing said elongate information carrier with a first leader at said first end, a second leader at said second end and an elongate information recording medium between said first and second leaders; effecting a carrier position sensing function in response to a determination that said drive means have tensioned said carrier within said predetermined period of time, said carrier position sensing function including the step of determining whether said first leader is present in a predetermined region;

rewinding said first leader onto said first rotary device until the beginning of said elongate recording medium is present in said predetermined region; stopping said elongate information carrier when the beginning of said elongate information recording medium is present in said predetermined region; and initiating a predetermined information conveying function relative to said information recording medium.

9. A method as claimed in claim 8, wherein: said carrier position sensing function also includes the step of determining whether said second leader is present in said predetermined region; and said second leader and said elongate information recording medium are rewound onto said second rotary device in response to a determination that said second leader is present in said predetermined region.

10. A method as claimed in claim 9, wherein: said elongate information recording medium is rewound onto said second rotary device until said first leader is present in said predetermined region; said first leader is thereupon rewound onto said first rotary device until the beginning of said elongate information recording medium is present in said predetermined region; said elongate information carrier is stopped when the beginning of said elongate information recording medium is present in said predetermined region; and a predetermined information conveying function is thereupon initiated relative to said information recording medium.

11. A method as claimed in claim 1, including in combination the steps of: providing said elongate information carrier with a first leader at said first end, a second leader at said second end and an elongate information recording medium between said first and second leaders; effecting a carrier position sensing function in response to a determination that said drive means have tensioned said information carrier within said predetermined period of time, said carrier position sensing function including the step of determining whether said second leader is present in a predetermined region; rewinding said second leader and said elongate information recording medium onto said second rotary device in response to a determination that the second leader is present in said predetermined region.

12. A method as claimed in claim 11, wherein: said elongate information recording medium is rewound onto said second rotary device until said first leader is present in said predetermined region; said first leader is thereupon rewound onto said first rotary device until the beginning of said elongate information recording medium is present in said predetermined region; said elongate information carrier is stopped when the beginning of said elongate information recording medium is present in said predetermined region; and a predetermined information conveying function is thereupon initiated relative to said information recording medium.

13. A method as claimed in claim 1, including in combination the steps of:

- providing said elongate information carrier with a first leader at said first end, a second leader at said second end and an elongate information recording medium between said first and second leaders; 5
- providing a pair of spaced sensing devices for sensing said first and second leaders and said recording medium;
- effecting a carrier position sensing function in response to a determination that said drive means have tensioned said information carrier within said predetermined period of time, said carrier position sensing function including the step of determining whether said information recording medium is present at both of said spaced sensors; 10
- rewinding said information recording medium onto said second rotary device in response to a determination that said information recording medium is present at both of said spaced sensors; 20
- placing the beginning of said elongate information recording medium at said first leader into a predetermined position; and
- initiating a predetermined information conveying function relative to said information recording medium. 25

14. A method as claimed in claim 13, wherein:

said carrier position sensing function includes the step of determining whether said second leader is at one of said sensors and said information carrier is at the other of said sensors;

said information recording medium is rewound onto said second rotary device in response to a determination that said second leader is at one of said sensors and said information carrier is at the other of said sensors; 35

the beginning of said elongate information recording medium at said first leader is thereupon placed into a predetermined position; and 40

a predetermined information conveying function is thereupon initiated relative to said information recording medium.

15. A method as claimed in claim 14, wherein:

said carrier position sensing function includes the step of determining whether said first leader is present at said other sensor and said information carrier is present at said one sensor; 45

said first leader is rewound onto said first rotary device in response to a determination that said first leader is present at said other sensor and said information carrier is present at said one sensor; and 50

a predetermined information conveying function is thereupon initiated relative to said information recording medium. 55

16. A method as claimed in claim 15, wherein:

said carrier position sensing function includes the step of determining whether either of said first and second leaders is present at both of said spaced sensors; 60

said information carrier is driven in a forward direction in response to a determination that either of said first and second leaders is present at both of said spaced sensors;

said driving of the information carrier in a forward direction is contained for a period of time sufficient to rewind said first leader onto said rotary device 65

in each case in which the leader present at both spaced sensors is the first leader;

a second carrier position sensing function is thereupon effected to determine whether said information recording medium is present at both of said spaced sensors; and

a predetermined information conveying function relative to said information recording medium is initiated in response to a determination during said second sensing function that said information recording medium is present at both of said spaced sensors.

17. A method as claimed in claim 16, wherein:

said second carrier position sensing function includes the step of determining whether the second leader is present at both of said spaced sensors upon expiration of said period of time;

said second leader and said information recording medium are rewound onto said second rotary device in response to the last-mentioned determination;

the beginning of the elongate information recording medium at said first leader is placed into a predetermined position; and

a predetermined information conveying function is initiated relative to said information recording medium.

18. In a method of performing a function relative to an elongate information carrier having an elongate information recording medium, a first leader connected to a beginning of said information recording medium and connected to a first rotary carrier winding and storage device, and a second leader connected to an end of said information recording medium and connected to a second rotary carrier winding and storage device, the improvement comprising in combination the steps of: 35

providing a pair of spaced sensing devices for sensing said first and second leaders and said information recording medium;

effecting a carrier position sensing function with said first and second sensors, said carrier position sensing function including the step of determining whether said information recording medium is present at both of said spaced sensors; 40

rewinding said information recording medium onto said secondary rotary device in response to a determination that said information recording medium is present at both of said spaced sensors; 45

rendering said sensors sensitive to said beginning of the information recording medium;

continuing said rewinding of the information recording medium until said sensors sense the arrival of said beginning of the information recording medium at said sensors; 50

placing the beginning of said elongate information recording medium at said first leader into a predetermined position; and

initiating a predetermined information conveying function relative to said information recording medium. 55

19. A method as claimed in claim 18, wherein:

said carrier position sensing function includes the step of determining whether said second leader is at one of said sensors and said information carrier is at the other of said sensors;

said information recording medium is rewound onto said second rotary device in response to a determi-

nation that said second leader is at one of said sensors and said information carrier is at the other of said sensors;

the beginning of said elongate information recording medium at said first leader is thereupon placed into a predetermined position; and

a predetermined information conveying function is thereupon initiated relative to said information recording medium.

20. A method as claimed in claim 19, wherein:
said carrier position sensing function includes the step of determining whether said first leader is present at said other sensor and said information carrier is present at said one sensor;
said first leader is rewound onto said first rotary device in response to a determination that said first leader is present at said other sensor and said information carrier is present at said one sensor; and
a predetermined information conveying function is thereupon initiated relative to said information recording medium.

21. A method as claimed in claim 18, wherein:
said carrier position sensing function includes the step of determining whether either of said first and second leaders is present at both of said spaced sensors;
said information carrier is driven in a forward direction in response to a determination that either of said first and second leaders is present at both of said spaced sensors;
said driving of the information carrier in a forward direction is continued for a period of time sufficient to rewind said first leader onto said first rotary device in each case in which the leader present at both spaced sensors is the first leader;
a second carrier position sensing function is thereupon effected to determine whether said information recording medium is present at both of said spaced sensors; and
a predetermined information conveying function relative to said information recording medium is initiated in response to a determination during said second sensing function that said information recording medium is present at both of said spaced sensors.

22. A method as claimed in claim 21, wherein:
said second carrier position sensing function includes the step of determining whether the second leader is present at both of said spaced sensors upon expiration of said period of time;
said second leader and said information recording medium are rewound onto said second rotary device in response to the last-mentioned determination;
the beginning of the elongate information recording medium at said first leader is placed into a predetermined position; and
a predetermined information conveying function is initiated relative to said information recording medium.

23. In apparatus for performing a function relative to an elongate information carrier having a first end connected to a first rotary carrier winding and storage device and having a second end connected to a second rotary carrier winding and storage device, the improvement comprising in combination:

means for rotating said first and second rotary carrier winding and storage devices;

means connected to said rotary devices for tensioning said elongate information carrier;

means operatively associated with said elongate information carrier for sensing tension of said elongate information carrier;

means for timing said tension sensing for a predetermined period of time;

means operatively associated with said tension sensing means and said timing means for determining whether said tensioning means have tensioned said information carrier within said predetermined period of time;

means for performing a predetermined function relative to said information carrier; and

means for activating said function performing means only after a determination that said tension means have tensioned said information carrier within said predetermined period of time.

24. An apparatus as claimed in claim 23, including:
means for deactivating said means for rotating said first and second rotary devices in response to a determination that said tensioning means have failed to tension said information carrier within said predetermined period of time.

25. An apparatus as claimed in claim 23, for performing a function relative to an elongate information carrier having a first leader at a first end, a second leader at a second end, and an elongate information recording medium between said first and second leaders, said apparatus including:

means for sensing the position of said information carrier in response to a determination that said tensioning means have tensioned said information carrier within said predetermined period of time, said position sensing means including means for determining whether said first leader is present in a predetermined region, means for determining whether said recording medium is present in said predetermined region, and means for determining whether said second leader is present in said predetermined region;

means for rewinding said first leader onto said first rotary device in response to a determination that said first leader is present in said predetermined region; and

mean for rewinding said second leader and said recording medium onto said second rotary device in response to a determination that said second leader is present in said predetermined region, and for rewinding said recording medium onto said second rotary device in response to a determination that said recording medium is present in said predetermined region.

26. an apparatus as claimed in claim 23, for performing a function relative to an elongate information carrier having a first leader, a second leader, and an elongate information recording medium between said first and second leaders, said apparatus including:

means for sensing the position of said information carrier in response to a determination that said tensioning means have tensioned said information carrier within said predetermined period of time, said position sensing means including a pair of spaced sensing devices for sensing said first and second leaders and said recording medium, means for de-

termining whether said information recording medium is present at both of said spaced sensing devices, means for determining whether either of said first and second leaders is present at both of said spaced sensing devices, means for determining whether said first leader is present at one of said sensing devices and said recording medium is present at the other of said sensing devices, and means for determining whether said recording medium is present at said one sensing device and said second leader is present at the other sensing device; and means operatively associated with said sensing means for readying said recording medium for a function performing operation, said readying means including means for rewinding said recording medium onto said second rotary device in response to a determination that said recording medium is present at both of said spaced sensing devices, and for rewinding said second leaders and said recording medium onto said second rotary device in response to a determination that said second leader is present at said other sensing device, and that said recording medium is present at said one sensing devices, means for driving said recording medium in a forward direction in response to a determination that either of said first and second leaders is present at both of said first and second sensing devices, and means connected to said driving means for timing said driving in said forward direction for a period of time sufficient to rewind said first leader onto said first rotary device in each case in which the leader present at both spaced sensors is the first leader.

27. An apparatus as claimed in claim 26, wherein: said position sensing means include means for effecting a second carrier position sensing function, said means for effecting said second carrier position sensing function include means for determining whether said second leader remains at both of said first and second sensing devices throughout said period of time, and means for determining whether said recording medium arrives at both of said spaced sensors during said period of time; said readying means include means for rewinding said second leader and said recording medium onto said second rotary device in response to a determination that said second leader remains at both of said first and second sensing devices throughout said period of time; and said apparatus include means for initiating a predetermined information conveying function relative to said recording medium in response to a determination that said recording medium has arrived at both of said spaced sensors during said period of time.

28. An apparatus as claimed in claim 27, wherein: said readying means include means for advancing said recording medium in said forward direction in response to a determination that said first leader is present at said one sensing device and said receiving recording medium is present at said other sensing device.

29. In apparatus for performing a function relative to an elongate information carrier having a first leader, a second leader, and an elongate information recording medium between said first and second leaders, the improvement comprising in combination:

means for sensing the position of said information carrier including a pair of spaced sensing devices for sensing and first and second leaders and said recording medium, means for determining whether said information recording medium is present at both of said spaced sensing devices, means for determining whether either of said first and second leaders is present at both of said spaced sensing devices, means for determining whether said first leader is present at one of said sensing devices and said recording medium is present at the other of said sensing devices, and means for determining whether said recording medium is present at said one sensing device and said second leader is present at the other sensing device; and

means operatively associated with said sensing means for readying said recording medium for a function performing operation, said readying means including means for rewinding said recording medium onto said second rotary device in response to a determination that said recording medium is present at both of said spaced sensing devices, and for rewinding said second leader and said recording medium onto said second rotary device in response to a determination that said second leader is present at said other sensing device and that said recording medium is present at said one sensing device, means for driving said recording medium in a forward direction in response to a determination that either of said first and second leaders is present at both of said first and second sensing devices, and means connected to said driving means for timing said driving in said forward direction for a period of time sufficient to rewind said first leader onto said first rotary device in each case in which the leader present at both spaced sensors is the first leader.

30. An apparatus as claimed in claim 29, wherein: said position sensing means include means for effecting a second carrier position sensing function, said means for effecting said second carrier position sensing function include means for determining whether said second leader remains at both of said first and second sensing devices throughout said period of time, and means for determining whether said recording medium arrives at both of said spaced sensors during said period of time;

said readying means include means for rewinding said second leader and said recording medium onto said second rotary device in response to a determination that said second leader remains at both of said first and second sensing devices throughout said period of time; and

said apparatus include means for initiating a predetermined information conveying function relative to said recording medium in response to a determination that said recording medium has arrived at both of said spaced sensors during said period of time.

31. An apparatus as claimed in claim 29, wherein: said readying means include means for advancing said recording medium in said forward direction in response to a determination that said first leader is present at said one sensing device and said recording medium is present at said other sensing device.

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**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,769,470 Dated October 30, 1973

Inventor(s) Brian K. Curtis

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 31, "include" should be --includes--. Column 5, line 44, "gate" should be --gage--, and line 51, "MC1,439" should be --MC1439--. Column 7, line 2, "carrige" should be --carriage--, and line 23, "lexing" should be --flexing--. Column 9, line 18, "an" should be --in--. Column 12, line 44, "applications" should be --application--. Column 13, line 57, "on" should be --"on"--. Column 16, line 56, "195" should be --295--. Column 17, line 38, "138" should be --318--. Column 23, line 6, "periof" should be --period--, and line 18, "secondary" should be --second--. Column 25, line 66, "contained" should be --continued--. Column 26, line 30, "reocrding" should be --recording--, and line 51, "reocrd-" should be --record--. Column 28, line 18, "tension" should be --tensioning--, and line 56, "an" should be --An--. Column 29, line 60, delete "receiv-", and line 61, delete "ing". Column 30, line 3, "and", first occurrence, should be --said--.

Signed and sealed this 10th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents