May 20, 1952 W. C. ANDERSON 2,596,973

TEXTILE CONTROL

Filed July 13, 1948 2 SHEETS—SHEET 1

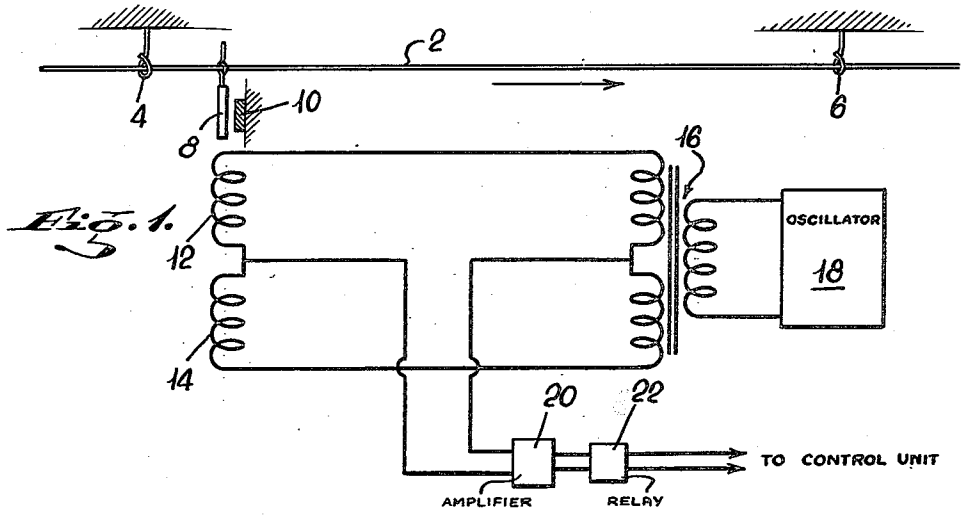


Fig. 1.

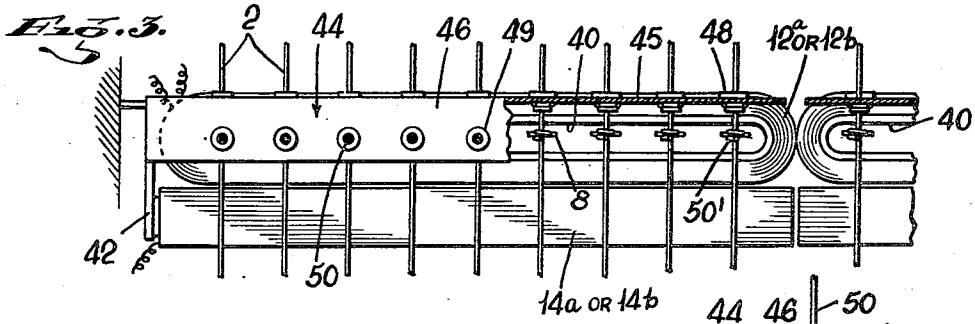


Fig. 3.

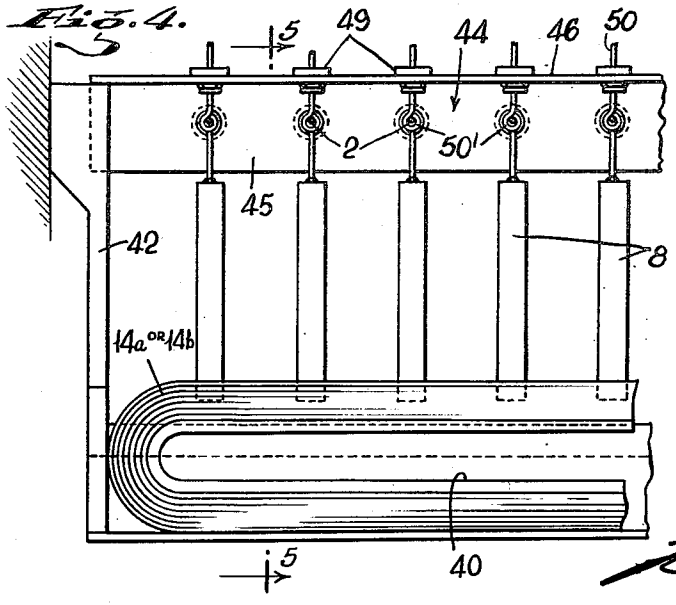


Fig. 4.

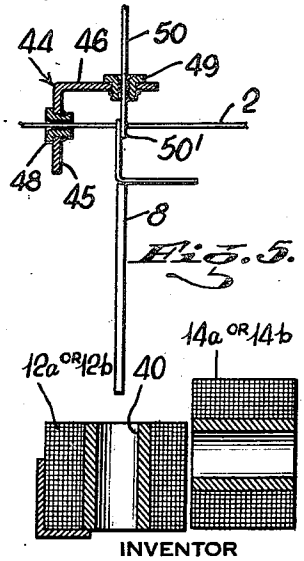


Fig. 5.

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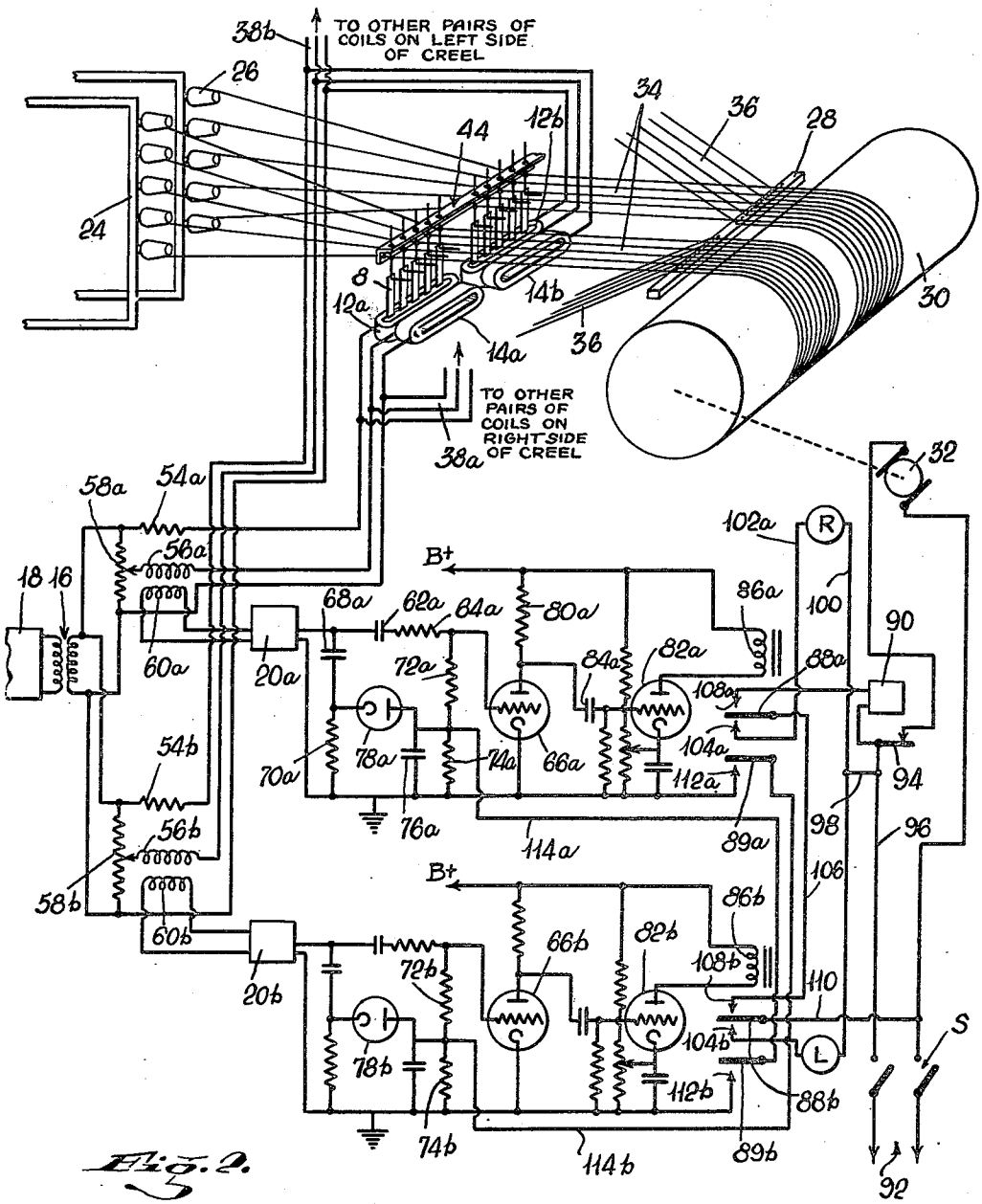


Fig. 2.

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2,596,973

TEXTILE CONTROL

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12 Claims. (Cl. 28—51)

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The present invention relates to the control of textile machinery, and more particularly to methods and means for detecting yarn breakage, or reduction in yarn tension, in arrays of yarn ends or threads moving under tension, as for example the warp ends of a warper or of a loom.

There are various devices, called stop motions, now in use on warpers which operate upon breakage of a warp end to stop the motor driving the take-up beam or otherwise to arrest the travel of the warp. In most of the devices now in commercial use, each end of yarn, destined to form the warp of a fabric, passes through an eye of a drop wire and supports the wire out of contact with a metal bar below it. When the end breaks, the resulting slackening of tension therein permits the drop wire to make contact with the bar, making an electrical connection with a bar holding the drop wires and closing a control circuit for arresting rotation of the take-up beam.

A very common cause of faulty operation in such prior art devices is the fact that the electrical contact arrangement is open and is thus exposed to dirt and lint and to the corrosive effect of moisture, any or all of which may prevent proper contact of the drop wire with the bar below it and may thus inhibit the flow of sufficient current in the control circuit. When relatively high voltages are used at the contacts, there is danger of shock to the operator. Also with high voltages dust particles, and fly, accumulate by electro-static attraction.

Another disadvantage in prior art practice is the lack of any indication to the operator as to which end has broken. There are normally several hundred ends gathered in the warper, and it is impossible for the operator standing in a position behind the beam to determine which of these ends has broken. A skilled operator can very often sight the broken end on a single trip down the length of one side of the creel, but this can be done only when he has the good fortune to chance upon the side which has the broken end; if he picks the wrong side, he must retrace his steps, go around the warper and start all the way up the length of the other side. It will be apparent that a great deal of time is thus wasted, during most of which time the warper could be in operation if indication of the position of the broken end were provided.

The use of a circuit including an indicator light for this purpose and actuated by the drop wire contact has been suggested, and such circuits may be set up for each end, for each of a number of banks of ends, or for each side of the

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creel. The difficulty in such an arrangement would be that the operator would have to keep his eyes fixed on the indicator panel at all times to determine which light went on first. The stopping of the beam immediately thereafter causes laxity or slackness in every end, and all the drop wires promptly fall, which would complete all the light circuits.

An object of the invention is to provide a method of detecting yarn breakage which does not utilize circuit closing elements carried by the yarn and hence may be practised with apparatus not subject to failure when exposed to lint, dirt, moisture or the like.

A further object of the invention is to provide a stop motion for warpers which is sensitive and reliable in operation and which is free from hazard of shock to the operator.

The invention also has in contemplation the provision of an improved stop motion unit for use in a warping operation wherein an indicator system promptly designates the location of a broken end.

The present invention further provides an improved circuit for a stop motion device in association with a warper, which circuit includes means for limiting designation of a broken end to only one of a plurality of positions.

Other objects and advantages of this invention will be apparent from the following description, taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a circuit diagram explanatory of the invention;

Fig. 2 is a schematic perspective view of a stop motion device for use in association with a warper and includes a diagram of the electrical circuit employed;

Fig. 3 is a fragmentary top plan view, partly broken away, and on an enlarged scale, of a pair of coils forming part of the stop motion device of Fig. 2 and showing the orientation of the coils with respect to the yarn ends in a warper;

Fig. 4 is a front elevation of the parts shown in Fig. 3; and

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4.

The new method of detecting yarn or thread breakage differs radically from methods heretofore in use. Instead of relying upon closure of an electrical circuit to detect breakage, such indication is obtained by detection of change in magnetic induction when a yarn carried element of relatively high magnetic permeability is introduced into a magnetic field. In the novel

apparatus provided for practising the method of the invention, a small element of relatively high magnetic permeability is suspended from an end of yarn traveling under tension and a coil carrying alternating current creates an alternating magnetic field in the vicinity of the element so that, when the end breaks, the reduction in tension therein permits the element to enter the field and to change the flux linked with the coil. The change in inductance of the coil is detected and used for creation of a control current for signalizing yarn breakage, preferably by arresting the travel of the yarn, as hereinafter described. Thus the invention completely obviates the use of contact closing drop wires with their attendant susceptibility to failure from accumulation of lint and their inherent hazard of shock to the operator when high voltages are employed.

In Fig. 1, to which reference may now be had, there is diagrammatically illustrated a circuit arrangement suitable for use in practicing the invention. For simplicity, the system of Fig. 1 is shown as arranged for detection of breakage of a single end of yarn. It will be understood that the yarn, indicated at 2, is being advanced under tension in the direction of the arrow by any suitable means (not shown). The yarn passes through suitable guide means, indicated at 4 and 6, which determine its path of travel. An element 8 of relatively high permeability is freely suspended from the yarn 2 at one point of its travel. Any suitable means, such, for example, as hereinafter described in connection with Figs. 3 to 5, can be provided for preventing travel of the element with the yarn. In Fig. 1 such means are diagrammatically indicated as comprising a fixed stop 10.

A pair of matched inductance coils, 12 and 14, are connected in series across the secondary winding of a transformer 16, the primary winding of which is supplied with alternating current by an oscillator 18. Coil 12 is so positioned with respect to the element 8 that the element will be introduced into the core of the coil when the tension in the yarn is reduced, as by breakage. An amplifier 20 is connected across the midpoint of the secondary of the transformer 16 and the junction of the coils 12 and 14. With the above described arrangement and with substantial initial balance of the circuit, a relatively large signal will be applied to the amplifier when the balance of the circuit is upset by the introduction of element 8 into core 12. This signal, after amplification, is applied to a relay 22. Relay 22 may control a signal device, such as an indicating lamp or may control the circuit of the yarn advancing means or may perform both of these functions as desired and as well known in the art.

Although the detecting circuit of Fig. 1 has been described with reference to the detection of breakage of a single end of yarn, the principle of the system is equally applicable to detection of breakage of any one or more of an array of yarn ends. A plurality of pairs of series-connected matched coils can be provided, one pair for each end, with all detecting coils connected in parallel and all matching coils connected in parallel, or a single large balancing coil can be provided for balancing a plurality of parallel-connected detecting coils. Preferably, however, the detecting coil is so dimensioned as to accommodate in its core a plurality of elements 8, and a matching coil is provided for each detecting coil and positioned adjacent thereto so as to be subject to the same conditions of temperature and humidity. Such preferred arrangement is embodied in the warper stop motion device illustrated in Figs. 2 to 5, to which reference may now be had.

In Fig. 2, a textile warper is indicated diagrammatically as comprising a creel 24, carrying cones of yarn 26, a comb 28, a warp beam 30 and drive motor 32 for the warp beam. Rotation of the warp beam 30 by the motor 32 draws the ends from the cones 26 through the comb 28 and winds them upon the warp beam. In the drawing, the array 34 of yarn ends represent those ends drawn from cones on the right and left side of but part only of the creel. Similar arrays of yarn ends from higher and lower banks of the creel will be drawn through the comb 28 to the warp beam. Parts of such other arrays are indicated at 36. In the embodiment of the invention illustrated in Fig. 2 a pair of of coils 12*a* and 14*a*, corresponding to coils 12 and 14 of the circuit of Fig. 1, is associated with those ends of array 34 coming from cones on the right side of the creel and another such pair of coils, indicated at 12*b* and 14*b*, is associated with the ends of array 34 coming from cones on the left side of the creel. Coil 12*a* is connected in parallel with other detecting coils (not shown) for other ends from the right side of the creel and coil 14*a* is connected in parallel with balancing coils (not shown) associated with such other detecting coils, as indicated by the legend applied at lines 38*a*. Similarly the coils 12*b* and 14*b* are respectively connected in parallel with other detecting and balancing coils (not shown) for the left side of the creel as indicated by the legend applied to lines 38*b*. Each detecting and balancing coil, as shown best in Figs. 3 to 5, is composed of a plurality of turns of wire wound on a long shallow hollow core 40 of Bakelite or the like. The coils of each pair are mounted in a framework 42, which is suitably supported at its ends from any fixed part of the system. The upper part of each frame 42 comprises a strip 44 of right angle stock having a vertical wall section 45 and an upper horizontal wall section 46. The wall section 45 is provided with a plurality of eyelets 48 for passage of the ends therethrough and the upper section 46 is provided with a like number of eyelets 49 through each of which extends a wire 50. Each wire 50 has a looped yarn guide eye 50' by means of which the wire is supported on the yarn. A metal strip 8 of ferromagnetic material, such as iron or an alloy thereof, is welded or otherwise secured to each wire 50 below the loop 50' therein. Each wire 50 beyond the part at which the strip is secured, is bent at right angles to prevent the strip from falling through the core of the detecting coil when the associated end of yarn is slacked and to provide a means for lifting the strip during threading of the warper. The detecting coil is so mounted in the framework 42 as to have its core positioned beneath the strips 8. The balancing coil is mounted alongside the detecting coil so as to be subject to like conditions of temperature and humidity, but is positioned so as to be uninfluenced by dropping of an element 8 as a result of yarn breakage.

The coils 12*a* and 14*a* are connected in series with a resistor 54*a* across the secondary winding of the transformer 16, the primary of which is supplied with alternating current from the oscillator 18. The junction of the coils 12*a* and 14*a*

is connected through a winding 56a with an adjustable tap on a resistor 58a also connected across the secondary winding of the transformer. An amplifier 20a is inductively coupled through a winding 60a with the winding 56a so as to have a signal applied thereto upon unbalance of the circuit including the coils 12a and 14a. Amplifier 20a can be directly connected to a relay for control of the circuit of motor 32 but preferably the circuit now to be described is employed in order to provide a "fail safe" arrangement and also to provide an interlock for giving an indication, as between the two sides of the warper, of the location of yarn breakage.

As shown in Fig. 2, the ungrounded output terminal of amplifier 20a is connected through a capacity 62a and resistor 64a with the control grid of a triode 66a and is also connected to ground through a series-connected capacity 68a and resistor 70a. The control grid of tube 66a is connected to ground through a pair of series-connected resistors 72a and 74a, of which resistor 74a is substantially larger and is bridged by a capacity 76a. A rectifier 78a has its anode connected to the junction of resistors 72a and 74a and its cathode connected to the ungrounded end of resistor 70a. The anode of triode 66a is connected through a resistor 80a to a suitable source of positive potential, indicated as B+. This anode is also connected to the control grid of a second triode 82a through a condenser 84a. The cathode of the triode 82a is operated at positive potential, as indicated, and the anode circuit of this tube includes the winding of a control relay 86a having two armatures 88a and 89a associated therewtih. Thus, with an initial slight unbalance of the circuit including coils 12a and 14a, a signal amplified by triode 66a and sufficient to maintain triode 82a energized is obtained but, when a relatively large signal is transmitted by the amplifier, corresponding to introduction of one of the strips 8 into the core of coil 12a or into the core of one of the detecting coils in parallel therewith, the rectifier 78a drives the grid of triode 66a sufficiently negative to block that tube. Triode 82a passes current so long as triode 66a is not blocked, and hence relay 86a is energized except when a strip 8 is introduced into the core of coil 12a.

As the channel associated with coils 12b and 14b is shown as identical with that just described, and as the elements thereof are identified with like reference numerals, except that the subscript b is attached thereto, no additional description thereof is necessary.

Control relay 86a and the corresponding control relay 86b of the circuit associated with coils 12b and 14b jointly control, over their armatures 88a and 88b and associated front contacts, the circuit of a holding relay 90 for the circuit of motor 32. When both relays 86a and 86b are energized, and a manually operable switch, indicated at S, is closed, relay 90 is energized from a suitable source of energy (not shown) connected to terminals 92. When energized, relay 90 holds the circuit of motor 32 closed over an armature 94 and front contact associated therewith. Deenergization of either relay 86a or 86b opens the circuit of the holding relay which relay, in turn, opens the circuit of motor 32 to arrest rotation of the warp beam 30.

In order that an indication may be given as to the location of the yarn break initiating deenergization of the motor 32, a pair of signal devices, indicated at R and L, are provided. The

circuit of device R may be traced as follows: from one terminal 92, through leads 96, 98 and 100 to the indicator R, lead 102a to a back contact 104a associated with armature 88a, armature 89a, lead 106, front contact 108b associated with armature 88b of relay 86b, armature 88b and lead 110 back to the other terminal 92. The circuit of indicator L includes a back contact 104b associated with armature 88b, armature 88b and lead 110. Thus, when both relays 86a and 86b are energized, the circuits of both indicators are open. When relay 86a is deenergized as the result of breakage of a yarn end on the right side of the creel, the circuit of indicator R is closed at back contact 104a. Similarly, deenergization of relay 86b causes closure of the circuit of indicator L. When the warp beam 30 ceases to rotate, all ends are slacked and consequently, with the circuit so far described, both relays 86a and 86b would be eventually deenergized each time an end breaks and the circuit of indicator R would open at contact 108b. In order to avoid this eventuality, circuit means are provided for maintaining either control relay energized upon deenergization of the other. For this purpose a back contact 112a associated with armature 89a is grounded, and armature 89a is connected by a lead 114b to the junction of resistors 72b and 74b. Similarly back contact 112b associated with armature 89b is grounded and that armature of relay 86b is connected by a lead 114a with the junction of resistors 72a and 74a. Thus, when relay 86a is deenergized, the bias voltage is removed from the control grid of tube 66b and consequently that triode remains energized irrespective of the application of a signal from amplifier 20b. Triode 82b and relay 86b thus remain energized and signal R is energized to indicate the division of the creel in which yarn breakage has occurred. When yarn breakage occurs in the left side of the creel, relay 86b is deenergized, signal L is energized and relay 86a is maintained energized by removal of the bias applied to the control grid of tube 66a.

The operation of the system of Fig. 2 will be apparent from the description already given. As the control relays 86a and 86b and the holding relay 90 are normally energized, any failure of the circuit will result in stoppage of the warp beam. Thus there is no danger of false "safe" indications. The unbalance voltage sufficient to maintain the control relays energized can be readily adjusted by adjustment of the position of the taps on resistors 58a and 58b of the balance circuits and by adjustment of other circuit elements, for example resistors 54a and 54b, as will be apparent to those skilled in the art. By the provision of the indicators with their interlocking control, positive indication of the location of yarn breakage is given.

As the cores of detecting coils 12a and 12b are open ended, lint or dust cannot accumulate therein. Moreover, as no electrical, or even physical, contact of parts in the neighborhood of the yarn is required for detection of breakage, the system is not subject to the defects inherent in prior art systems. The elements can be light in weight and small in size and can be of a variety of materials. Satisfactory operation has been obtained when the elements were of an alloy of iron and nickel and had a thickness of .014 inch, a width of .375 inch and a length of 2.25 inches. With suitably dimensioned detecting and balancing coils, a relatively large signal can be obtained with the circuit of Fig. 2 when a yarn suspended

element enters the core of a detecting coil. For example, in one specific construction, the detecting coils had an inductance of 25 millihenrys each, were made of 315 turns of #28 wire and had a major core dimension of about 20 inches so as to accommodate 30 drop elements. With such construction a ratio of signal voltage to unbalance voltage of 30 to 1 at the input to the amplifier was obtained, when the oscillator frequency was 5 kilocycles.

The invention has now been described with particular reference to a specific embodiment thereof. Obviously, the broad principle of the invention, the detection of yarn breakage or yarn laxity of one or of a plurality of ends by detection of change of magnetic induction in a medium, can be practised with devices and with circuits other than those specificaly illustrated and described and various changes can be made in the particular stop motion device of the drawings without departing from the spirit of the invention or from the scope of the appended claims. The coil, the current through which creates the alternating magnetic field, and the inductance of which changes upon introduction into its core of a yarn carried element, need not necessarily be an element of a bridge network, as changes in inductance of the coil can be detected without recourse to balancing networks. Balancing networks are preferred, however, because of the relatively high sensitivity obtained therewith. Various other balancing circuits, as heretofore suggested, can be employed in lieu of the specific circuit illustrated. At present the plurality of matching pairs of adjacent coils is deemed to be preferred because, with such arrangement, localized changes in temperature or humidity do not affect the balance of the circuit. An alternative arrangement and one which halves the number of coils required for any given number of ends of yarn is one in which both coils of each pair are positioned to serve as detecting coils so that introduction of an element into the core of either coil of a pair upsets the balance of the circuit associated therewith. This is a satisfactory arrangement as the likelihood of simultaneous introduction of elements into both coils of a pair is relatively remote. Although the "fail safe" type of circuit shown in Fig. 2 is preferred, obviously the system can be arranged to energize, rather than to deenergize, controlling relays. In the specific system illustrated in Fig. 2, but two indicating channels have been shown. Additional channels with interlocking indicators can be provided, if indications of yarn breakage at more than two sections of the creel are desired. Other modifications within the scope of the invention will be apparent to those skilled in the art.

The stop motion device of the invention has been described with particular reference to a textile warper, but obviously the principle thereof can be employed in a stop motion device for any machine in which one or a plurality of yarn ends are advanced under tension. For example, the invention can be used in twisters and spoolers, or in looms.

In the appended claims the term "yarn" is intended to include any textile filamentary material, whether twisted or untwisted and whether composed of continuous filaments or of staple fibers.

The following is claimed:

1. In a textile machine having means for moving a plurality of ends of yarn under tension, a stop motion device for the yarn advancing means comprising in combination means for creating an alternating magnetic field beneath a portion of the normal path of the ends, a plurality of elements of magnetic permeability greater than air, one suspended from each yarn end above the field so as to be introduced therein upon reduction in tension of a supporting end, and circuit means responsive to the introduction of an element into the field for stopping said yarn advancing means, said circuit means including a part the effective impedance of which is altered when an element is introduced into the field.

2. In a textile machine having means for advancing a plurality of yarn ends under tension, a stop motion device for the yarn advancing means comprising in combination a circuit including at least one air core coil carrying alternating current and positioned beneath a portion of the path of travel of at least some of the ends, a plurality of elements of relatively high magnetic permeability suspended from the yarn ends, each element being suspended from a different end and at least one of said elements being suspended above said coil so as to be introduced into the core thereof upon reduction of tension in the supporting end and means responsive to a change in the inductance of the coil occasioned by introduction of an element into the core for stopping the yarn advancing means.

3. The stop motion device according to claim 2 wherein said circuit is a bridge network having said coil in one branch thereof and being normally substantially in balance, said last mentioned means being responsive to substantial unbalance of the network occasioned by change in the permeability of the core of said coil.

4. The stop motion device according to claim 2 wherein a plurality of said elements are suspended above said coil whereby said last mentioned means operates to stop the yarn advancing means when the tension in any one of the ends supporting said elements is reduced.

5. In a textile machine having means for advancing a plurality of ends of yarn under tension, a stop motion device for the yarn advancing means comprising in combination a plurality of inductors positioned adjacent the path of travel of the ends, a plurality of elements each associated with a different end and adapted, upon reduction in tension of the associated end, to be introduced into the core of an adjacent inductor and means responsive to a change in the permeability of the core of any of the inductors for stopping said yarn advancing means.

6. The combination according to claim 5 including at least two indicating devices, circuit means for causing operation of one of said devices when the permeability of the core of any inductor in one group of inductors changes and for causing operation of the other of said devices when the permeability of the core of any of the inductors in another group of inductors changes and interlocking means effective when one of said devices operates to prevent operation of the other of said devices.

7. In a textile machine having means for advancing a plurality of ends of yarn under tension, the combination comprising a source of electrical oscillations, a pair of substantially matching coils, a circuit connecting said coils in series across said source, a second circuit so coupled to said first circuit as to detect unbalance in the effective impedance of said coils, a plurality of elements of relatively high permeability

suspended from a group of yarn ends, means for supporting one of said coils beneath said elements with the core of the coil positioned for introduction therein of an element when its supporting yarn end is slacked, and relay means controlled by said detecting circuit for stopping said yarn advancing means upon a predetermined unbalance of the effective impedance of said coils corresponding to that resulting from introduction of one of said elements in the core of the coil positioned thereunder.

8. The combination according to claim 7 including another pair of substantially matching coils, a circuit connecting said coils in series across said source, a second detecting circuit so coupled to said last mentioned circuit as to detect unbalance in the effective impedance of said last mentioned pair of coils, a plurality of other elements of relatively high permeability suspended from a second group of yarn ends, means for supporting one of said last mentioned coils beneath said last mentioned elements with the core of the coil positioned for introduction therein of an element when its supporting yarn end is slacked, second relay means controlled by said last mentioned detecting circuit for stopping said yarn advancing means upon a predetermined unbalance of the effective impedance of said last mentioned pair of coils, a pair of indicators each operatively connected to a different one of said relays and selectively responsive to the operation of its associated relay, and interlocking means interconnecting said relays and detecting circuits to prevent operation of one of said relays after the other has operated as a result of yarn break, whereby said advancing means is automatically stopped whenever one of the ends breaks and whereby the group in which it is included is automatically indicated by one of said indicators.

9. A stop motion for a textile warping machine having a warp beam, the rotation of which advances a plurality of ends of yarn under tension, comprising yarn supported elements of relatively high magnetic permeability, an air core coil adjacent the moving ends with its core positioned for introduction therein of at least one of said elements upon reduction of tension of its supporting yarn end, means for energizing said coil with alternating current, a normally energized electronic device having a control electrode, circuit means connected to said electrode and responsive to the inductance of said coil for causing deenergization of said device upon a predetermined increase in the inductance of said coil corresponding to the introduction of one of said elements into the core thereof, and means controlled by said device and operative upon deenergization of said device for stopping rotation of the warp beam.

10. The stop motion according to claim 9 including a second coil adjacent the moving ends of yarn with its core positioned for introduction therein of at least one other of said elements upon reduction of tension of its supporting yarn end, means for energizing said second coil with alternating current, a second normally energized electronic device having a control electrode, a second circuit means connected to the control electrode of said second electronic device and responsive to the inductance of said second coil for causing deenergization of said second device upon a predetermined increase in the inductance of said second coil corresponding to the introduction of one of said elements into the core thereof, and means controlled by said second device and operative upon deenergization of said second device for stopping rotation of the warp beam.

11. The stop motion according to claim 10 including a pair of interlocking circuits, each connected to the control electrode of one device and controlled by the other device, for preventing deenergization of one device after deenergization of the other device and a separate signal associated with each device for indicating deenergization of the associated device whereby when a yarn end breaks causing an element to enter the core of one of said coils, one of said electronic devices is deenergized, the rotation of the warp beam is stopped and the appropriate signal indicates into which coil an element has been introduced as a result of yarn breakage.

12. The combination with a textile machine having means for advancing textile material, of a source of electrical oscillations, a pair of substantially matching coils, a circuit connecting said coils in series across said source, a second circuit so coupled to said first circuit as to detect unbalance in the effective impedance of said coils, means for supporting at least one of said coils adjacent textile material being advanced by said advancing means, and relay means controlled by said detecting circuit for stopping said material advancing means when an abrupt change in a characteristic of the material passing said last mentioned coil produces a predetermined unbalance of the effective impedance of said coils.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,032,176	Kovalsky	Feb. 25, 1936
2,116,586	Stoller	May 10, 1938
2,390,799	Lisenmeyer	Dec. 11, 1945
2,405,218	Lambach	Aug. 6, 1946