May 23, 1972 S. STANTON ET AL 3,664,564

ELECTRONICALLY CONTROLLED STITCHING MACHINE

Filed Sept. 16, 1970 3 Sheets-Sheet 1

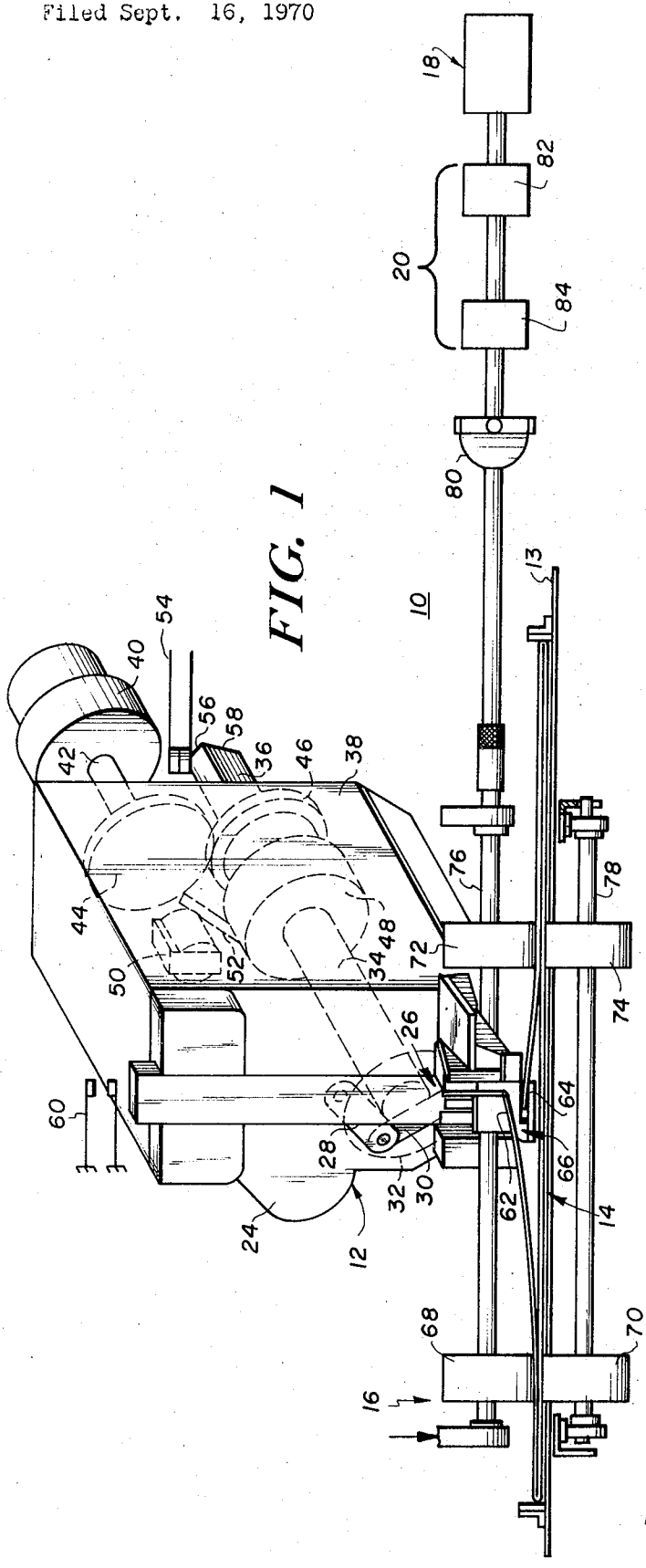

FIG. 1

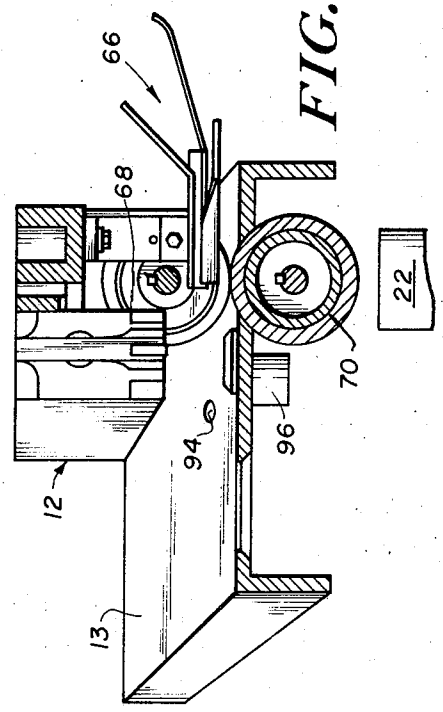

FIG. 2

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ELECTRONICALLY CONTROLLED STITCHING MACHINE

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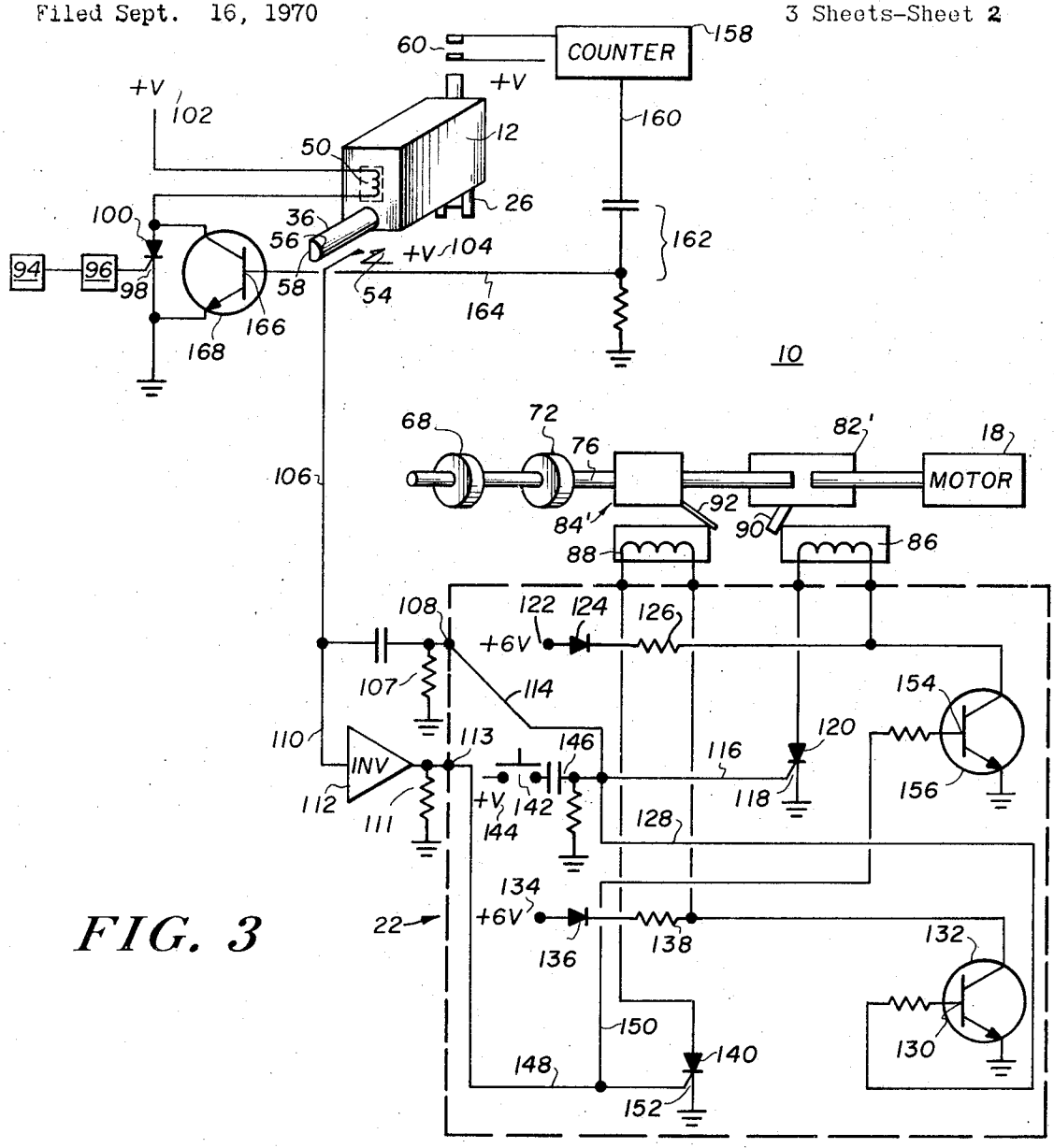

FIG. 3

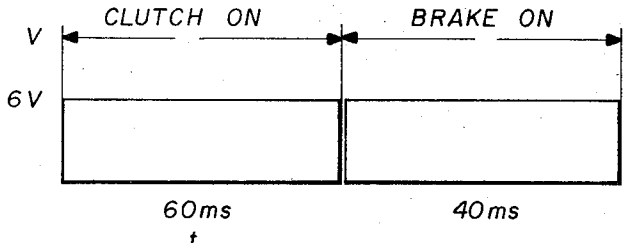

FIG. 4

ELECTRONICALLY CONTROLLED STITCHING MACHINE

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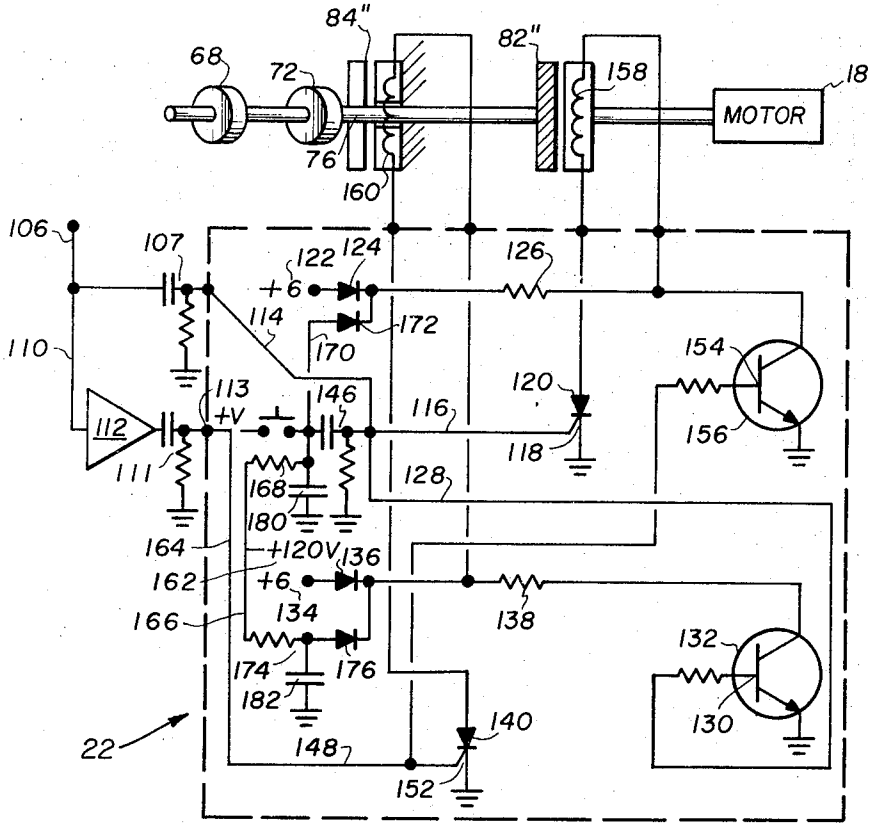

FIG. 5

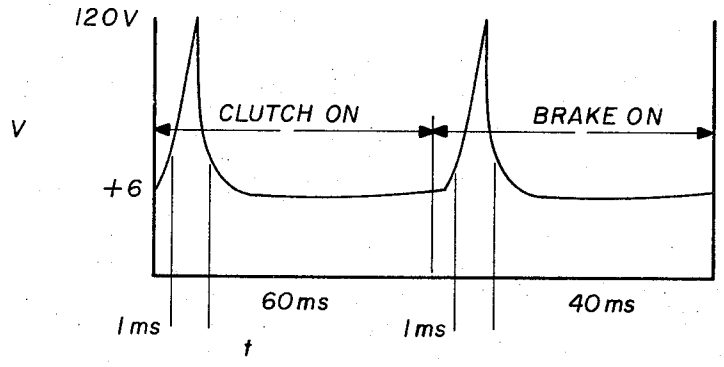

FIG. 6

United States Patent Office 3,664,564 Patented May 23, 1972

3,664,564

ELECTRONICALLY CONTROLLED STITCHING MACHINE

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Filed Sept. 16, 1970, Ser. No. 72,764
Int. Cl. B27f 7/06
U.S. Cl. 227—100 18 Claims

ABSTRACT OF THE DISCLOSURE

A stitching machine is disclosed which includes first means in the form of a stitching head for applying stitches to a work piece passing thereby; second means preferably in the form of cooperating pull rollers for conveying the work piece past the stitching head; a motor selectively connectable to the pull rollers for the operation thereof; interconnection means in the form of a clutch-brake combination responsive to preselected operating signals for selectively connecting and disconnecting the motor to the pull rollers to thereby effectuate incremental indexing of the work piece past the stitching head; and electronic control means for generating the preselected operating signals necessary to effectuate the incremental advance of the work piece through the machine. In a preferred embodiment, the electronic control means is responsive to the operation of the stitching head and includes circuitry designed to produce an extremely rapid energization and de-energization of the clutch brake combination defining the aforementioned interconnection means whereby extremely accurate high-speed stitching is made possible.

BACKGROUND OF THE INVENTION

This invention relates to box stitching machinery or apparatus, and more particularly to such box stitching machinery which operates on the principle of incremental advancement of the work piece therethrough.

In the art of box stitching, it has been known for many years to construct a box stitching machine comprising a stitching head for applying wire stitches to the overlapping portions of a box blank passing therebeneath, and conveying means for incrementally advancing the box blank passed the stitching head. Conventionally, such conveying means has taken the form of cooperating pull rollers which sandwich the box blank therebetween and advance same through the machine in response to the driving rotation thereof.

In the control of such machinery, at start up it is necessary to have the pull rolls operating at a continuous high rate of speed to initially convey the box blank from the input side of the machine (and normally from the operator's manual control of the box blank) toward the stitching station defined by the stitching head. When the box blank has reached a preselected position with respect to the stitching head, appropriate sensing means (in the form of a mechanical sensing finger or a photocell arrangement) detects the leading edge of the box blank to energize a timer which after timed out, generates a command signal to start the operation of the stitching head which then begins to apply the first stitch to the box blank now positioned therebeneath.

Simultaneously, a signal must be generated to stop the aforementioned pull rollers such that the box blank will be stationary beneath the head when the first stitch is applied thereto. After the completion of the first stitch, and after the stitch driving means associated with the head has been lifted from the box blank, another signal must be generated to start the pull rollers moving again

to advance the blank a preselected distance whereupon the pull rollers must again be stopped to halt the movement of the box blank to await the application of the next stitch being applied by the now continuously operating stitching head. This cycle of stop and start movement of the box blank, and the application of a stitch at the stop or dwell period of the box blank motion, continues until a preselected number of stitches have been applied. At that point, the stitching head must be de-energized, and the pull rolls retuned to their earlier mode of continuous operation to rapidly eject the box blank out the rear of the stitching machine.

In the prior art stitching machines over which the instant invention is intended to be an improvement, all of the above control signals are generated by purely mechanical means. For example, prior art apparatus of the type in question employ cams, cam followers, mechanical gear trains, etc., to generate, synchronize, and coordinate the various operations discussed above. Typical of this type of operation is the box stitching apparatus disclosed for example in U.S. Patent 2,785,403. It will be appreciated however, that in addition to being relatively complex and expensive to manufacture, such mechanically controlled mechanisms are extremely slow. In fact, the slow stitching speed which necessarily results from this type of mechanical operation is one of the prime reasons that box stitching apparatus of this type incorporating wire stitching heads are not readily accepted in the box forming industry.

Specifically, when given a choice, box manufacturers would rather employ tape dispensing and/or gluing machinery to fabricate cardboard boxes. This is so since such machinery can be operated in a continuous mode (that is the tape or glue being applied to the moving box blank) as compared to the incremental advancement (stop and start motion) utilized in wire stitching apparatus. However, for boxes designed for extremely heavy contents, tape and/or glue is not a sufficient joining means, and the fabricators must turn to wire stitches to provide the necessary strength.

However, and for the reasons discussed above, such wire stitching machines operate at such a slow rate of speed that fabricators have been faced with a choice involving the best of two evils: either they can refrain from manufacturing wire joined cartons (and lose the potential business income derived therefrom), or they incur great operating expenses by either shutting down, slowing down, or losing time on their high speed tape and/or glue production lines in favor of manufacturing the wire joined boxes on the much slower wire stitching apparatus. This problem becomes especially severe in situations for example where the customer desired a wire stitched carton (for strength), but also requires tape and/or glue on the box seam, for example, to make it impervious to water. In that situation, the boxes which have been taped and/or glued on the main high-speed production line must be slowed down to receive the wire stitches or physically removed from the production line to another location where the wire stitching apparatus is employed.

Equally as important, if not more so, is the problems relating to poor stitching accuracy which results from the above described mechanically controlled box stitching apparatus. Specifically, it is one of the basic requirements of box stitching apparatus that the stitches be applied at precisely desired locations (for example with respect to the leading and trailing folds which define the intermediate body portion of the planar box blank). Similarly, it is essential that the spacing between adjacent stitches be maintained uniform throughout a given stitching sequence. However, with box stitching apparatus employing me-

chanical means to synchronize and control the operation thereof, extended usage over long periods of time necessarily results in mechanical wear, looseness or "play," etc., all of which has the unstoppable effect of completely destroying the close tolerances which are essential in the industry.

SUMMARY OF THE INVENTION

In contradistinction to the prior art, the instant invention provides wire stitching apparatus broadly similar to the above described wire stitching apparatus but which employs high speed electronics to control, synchronize and assure the necessary cooperation of the various components thereof.

More specifically, wire stitching machinery constructed in accordance with the teachings of the instant invention broadly includes a stitching head for applying fastening means (in the form of wire stitches) to a work piece (the box blank) passing thereby; second means (preferably in the form of pull rollers) for conveying the work piece past the stitching head; motive means (in the form of an electric motor) selectively connectable to the pull rollers for the operation thereof; interconnection means (in the form of a clutch and brake) responsive to preselected operating signals for selectively connecting and disconnecting the electric motor to the pull rollers to thereby control the incremental stop and start operation thereof; and electronic control means for generating the preselected operating signals necessary to properly control and synchronize the clutch and brake defining the aforementioned interconnection means. Preferably the electronic control means is responsive to the operation of the stitching head but, it is within the purview of this invention that both the stitching head and the electronic control means could be operated by and synchronized by a central programmer.

In the broad application of the instant invention, the aforementioned clutch and brake may be of conventional construction operating on mechanical principles and energized upon the application of electrical signals to operating solenoids the movement of whose armatures is indirectly used to engage and disengage the mechanical clutch and brake. In this context, the electronic control means of the instant invention and its relationship to the operation of the stiching head will guarantee the quick and highly accurate generation of the operating signals utilized to energize the respective operating solenoids. In this manner, the stitching machine will be significantly faster than its equivalent counterpart in the prior art and, equally as important, significantly more accurate.

In various preferred embodiments of the instant invention, the inventor has chosen to employ what may be conveniently classified as purely electrical clutches and brakes in the sense that an electrical signal applied thereto is directly utilized to bring about the engagement of the respective device. For example, typical of this type of clutch or brake is a device which includes a coil located directly in one of the two confronting pieces which define the clutch or brake. When an electrical signal is applied to such coil, a magnetic path is established through both halves of the clutch or brake to physically draw the movable portion thereof into engagement with the nonmovable portion thereof. With such purely electrical devices, however, the physical mass of the movable half dictates the utilization of an extremely high voltage to bring about the initial engagement of the confronting parts. Once engaged however, with the moving mass requiring no further lateral movement, a much smaller voltage can be used to maintain the clutch or brake engagement.

In accordance with a further aspect of the invention, the electronic control means thereof includes means to generate an extremely high voltage spike during an initial portion of the preselected period during which the clutch or brake is to remain engaged, and means for applying the lesser required operating voltage to the clutch or brake for the remaining portion of the preselected period of time during which the clutch or brake is to remain engaged. In this manner the spike insures the rapid engagement of the clutch and brake of the interconnection means, thereby increasing the speed of operation of the machine and simultaneously guaranteeing the accuracy of the interstitch spacing required.

Accordingly, it is an object of the instant invention to provide a stitching machine comprising first means for applying fastening means to a work piece passing thereby; second means for conveying said work piece passed said first means; motive means selectively connectable to said second means for the operation thereof; interconnection means responsive to preselected operating signals for selectively connecting and disconnecting said motive means and said second means; and control means for generating said preselected operating signals.

Another object of the instant invention is to provide such a stitching machine which controls, synchronizes and assures the cooperating of the various components thereof by means of high speed electronics.

Yet another object of the instant invention is to provide such a stitching machine which is materially faster and more accurate than the stitching machines available in the prior art.

These as well as other objects of the instant invention will be had by referring to the following description and drawings in which:

FIG. 1 is a somewhat schematic pictorial illustration of a wire stitching machine constructed in accordance with the teachings of the instant invention;

FIG. 2 is a side view, partly in section, of a portion of the wire stitching machine illustrated in FIG. 1;

FIG. 3 is a schematic circuit diagram of the control means of the instant invention illustrating the manner in which it cooperates with the stitching head and conveying system thereof;

FIG. 4 is a graph illustrating the cycle of operation of the clutch and brake schematically illustrated in FIG. 3;

FIG. 5 is a schematic circuit diagram illustrating the manner in which an alternative embodiment of the electronic control means of the instant invention cooperates with an alternative embodiment of a clutch and brake which can be employed therein; and

FIG. 6 is a graph illustrating the cycle of operation of the clutch and brake illustrated in FIG. 5.

Turning to the figures wherein like numerals are used to designate like elements, there is shown the wire stitching machine **10** of the instant invention. Broadly speaking, and as will be described in greater detail, the machine **10** includes first means **12** for applying fastening means to a work piece **14** incrementally passing therebeneath on a work table **13**. Second means broadly designated **16** are provided for conveying the work piece **14** passed the first means **12**. Motive means **18** are provided, and as will be described, are selectively connectable to the second means **16** for the driving operation thereof. Interconnection means **20** are responsive to preselected operating signals to selectively connect and disconnect the motive means **18** to the second means **16**. Finally control means **22** (FIG. 2) are provided for generating the necessary operating signals for the interconnection means **20**. Preferably the control means **22** is responsive to the operation of the first means **12**, but it is within the purview of the invention that both the control means **22** and the first means **12** could be operated by and synchronized by a central programmer (not shown).

In the wire stitching machine of the instant invention, the first means **12** takes the form of a wire stitching head which, when energized, applies wire stitches to the work piece **14** passing therebeneath. In the system of the instant invention, the wire stitching head **12** may be any conventional, well known stitching head available in the industry, but most preferably, takes the form of

the wire stitching head disclosed and claimed in U.S. patent application Ser. No. 37,190, filed May 14, 1970, in the name of Lauri C. Barland entitled "Stitching Head Apparatus" and assigned to the assignee of the present invention.

In order to understand the manner in which the stitching head **12** functions within the overall stitching machine **10** of the instant invention, and to point out the manner in which any other stitching head might be modified to function in the machine **10** of the instant invention, it is initially worthwhile perhaps to outline the operation of the stitching head **12** which in the drawings, takes the form of the head disclosed in the aforementioned application Ser. No. 37,190.

The stitching head **12** includes on a front face **24** thereof vertically reciprocating stitch forming and driving means broadly designated **26**. As explained in greater detail in the aforementioned application, the stitch forming and driving means **26** is vertically reciprocally driven, when the stitching head is operating, by a pair of links **28** and **30** pivotally secured to a driving cam **32**. As explained in the Barland application, when the driving cam **32** is rotated, a stitch is fed, cut, formed and driven into the work piece positioned beneath the head, with the forming and driving means **26** actually coming into contact with the work piece for a small portion of the overall stitch forming and driving cycle.

The cam **32** is secured on one end of a shaft **34** the rear end **36** of which passes out the rear of the frame **38** of the head **12**. Motion is imparted to the shaft **34** by a continuously running electric motor **40** the output shaft **42** of which is applied to a gear train **44**, **46**, and a clutch **48** selectively energizable to interconnect the continuously rotating gear **46** to the shaft **34**. As explained in the Barland application, the clutch **48** may be engaged or disengaged by the selective energization of a clutch coil **50** which when energized moves a lever **52** to engage the clutch and thereby impart rotary motion to the shaft **34** and the driving cam **32**.

Positioned adjacent the rear end **36** of the shaft **34** of the head **12** is a pair of normally open contacts **54** which are maintained closed whenever the normal uninterrupted circumference or periphery **56** of the end of the shaft **36** is in engagement and maintained thereagainst. However, the rear end of the shaft **34** also includes a flat cordal segment **58** which when confronting the contacts **54** will allow the contacts to revert to their normally open condition for purposes to be described below.

It should be pointed out, that the size of the cordal flat **58** and its location with respect to the contacts **54** are chosen such that during the stitching operation, it is only when the stitch forming and driving means **26** is actually driving the stitch into the work piece **14** that the cordal segment **58** confronts the contacts **54**. At all other times during the stitching cycle, that is, when the stitch forming and driving means **26** is experiencing up and down motion (but not actually driving the stitch), the uninterrupted peripheral surface **56** of the shaft **34** confronts and maintains the contacts **54** in their closed condition. As will be explained below, it is the opening and closing of these contacts **54** which synchronize the operation of the stitching head **12** with the stop and start motion of the second means **16** which conveys the work piece past the stitching head **12**.

A second pair of contacts **60** are provided in close proximity to the path of motion of the stitch forming and driving means **26**. Each time the stitch forming and driving means **26** rises to complete the application of a stitch, the contacts **60** are closed, and as will be explained below, a counter is advanced to accumulate the number of stitches being applied in any given stitching sequence. It will be appreciated that the contacts **60** are shown schematically in FIGS. 1 and 3. Any type of contacts may be used including a magnetic reed switch operable by a magnetic member secured to and movable with the vane of the stitching head. After a preset number of stitches have been applied, the clutch coil **50** will be de-energized, to disengage the clutch; the stitching operation will cease; and the control system **22** will generate appropriate signals to cause the second means **16** to revert from its stop and start operation to its continuous mode of operation to eject the work piece **14** from the stitching machine **10**.

Thus it will be appreciated from the brief description presented above, that to function in the stitching machine **10** of the instant invention, the stitching head **12** employed must really include only three basic components. There must be some means (such as the clutch coil **50**) to begin and stop its operation; there must be some operating means (such as the contacts **54** cooperating with the shaft end **36**) to generate signals indicative of the portion of the overall stitching cycle that the stitch forming and driving means is driving a stitch into the work piece **14**; and third means (such as contacts **60**) for generating a count of the number of stitches driven in a particular sequence. Thus it will be appreciated that these three basic operating characteristics could be derived from an appropriately modified conventional stitching head available in the industry, and it was on this basis that such comment was made earlier in the description.

Returning to the overall stitching operation, the work piece **14** is, in the system of the instant invention, a cardboard box blank which has been appropriately folded to include overlapping side edges **62** and **64** which are to be joined by the wire stitches applied by the stitching head **12**. In this connection, a conventional guide shoe **66** is provided with oppositely directed receiving pockets to properly align the overlapping edges **62** and **64** as they enter the machine **10**.

The second means **16** for conveying the work piece **14** past the stitching head **12** comprises cooperating pairs of pull rollers **68**, **70**, **72** and **74** fixedly secured on shafts **76** and **78**. In the disclosed embodiment, shaft **78** is an idler shaft while shaft **76** is driven through universal coupling **80** and the motive means **18** upon the selective energization and de-energization of the interconnection means **20** to be described below. It will be appreciated that when the motive means **18** is connected to the shaft **76** by way of the interconnection means **20**; the driving rollers **68** and **72** in conjunction with the rollers **70** and **74** will advance the work piece **14** through the machine **10** and under the stitching head **12**.

The motive means **18** preferably takes the form of a continuously operating electric motor the speed of which can be preset by the machine operator. As will be apparent below, the speed chosen for the motor **18** determines the spacing between stitches.

The interconnection means **20** takes the form of a clutch **82** and a brake **84**. As briefly mentioned above, in various embodiments of the instant invention the clutch **82** and brake **84** may be of the electro-mechanical type (in the sense that they depend upon the electrical energization of a coil to generate mechanical motion used in turn to engage and disengage a purely mechanical clutch); or the clutch **82** and brake **84** may comprise what has been designated a purely electrical device in the sense that the flux path established by the energizing coil thereof is directly utilized to engage the clutch or brake respectively.

Finally, the control means **22** shown in detail in FIGS. 3 and 5 are utilized to perform the following operations. Initially, when the stitching machine **10** is first turned on, the electric motor such as **40** associated with the stitching head and the electric motor **18** of the motive means are running. At this point, the control means **22** must generate an operating signal which guarantees that the clutch **82** is "on" and the brake **84** is "off," such that the motor **18** is connected to the drive shaft **76**. In this manner, the pull rollers **68** and **72** are continuously

running at a high rate of speed awaiting the reception of the first work piece **14**. The operator then places the first work piece **14** in its proper relationship with respect to the guide shoe **66** and pushes it into the grasp of the pull rollers. Thus the work piece will be taken over from the operator and rapidly advanced toward the stitching head **12**.

Subsequently, when, in a manner to be further described, the work piece reaches a predetermined location with respect to the stitching head, and the stitching head initiates a stitch forming and driving operation; the control means is utilized to quickly generate an operating signal which energizes the brake **84** and de-energizes the clutch **82** thereby quickly stopping the work piece for that brief period of time necessary for the work piece to receive the stitch from the stitching head. Immediately thereafter, when the stitch forming and driving means of the stitching head **12** has been withdrawn from the work piece, the control means must quickly generate another operating signal to turn on the clutch **82** and de-energize the brake **84** to thereby start the pull rollers and the work piece moving again.

In the short interval of time that the work piece is advancing, the stitching head has completed a full cycle and is ready to deposit the next stitch into the work piece. Thus the control means **22** must again rapidly apply an operating signal to energize the brake **84** and de-energize the clutch **82** to make sure that the work piece is again at rest and at a dwell period when the next stitch is applied by the stitching head **12**. This sequence continues until a preselected number of stitches (dependent upon the size of the work piece) has been driven at which time the stitching head is de-energized, and the control means must be capable of maintaining an operating signal on the clutch to revert the pull rolls to their continuous mode of motion and thereby eject the work piece out of the rear of the machine.

From the above description, it can be appreciated why the control means utilized to synchronize the operation of the stitching machine of the instant invention must be extremely quick acting and reliable. To emphasize this point, it should be appreciated that in stitching machines of the type under consideration, it is desirable that the stitching head be capable of applying more than 600 stitches per minute to the work piece incrementally advancing therebeneath. Quite clearly then, the importance of the synchronizing control means cannot be over estimated. It should be equally as clear, that the mechanical controls prevalent in the prior art simply cannot function accurately at the high rates of speed involved.

Turning to FIG. 3, there is illustrated in detail, one embodiment of the control means **22** and the manner in which it cooperates in an overall wire stitching machine **10** of the instant invention. In this embodiment of the invention, the clutch **82'** and the brake **84'** are of the electro-mechanical type in the sense that energization of their respective operating coils **86** and **88** are utilized to displace an armature **90** and **92** respectively which in turn engages or disengages the clutch **82'** or brake **84'** constructed of and operating upon conventional mechanical principals. In this connection, it might be pointed out that the clutch **82'** is schematically illustrated in FIG. 3 for the reason that any available mechanical clutch suitable for the operating characteristics desired may be employed. For example, one might employ the type of clutch described in detail in the aforementioned application Ser. No. 37,190, but in a broader sense any convenient clutching mechanism can be employed. Similarly, the brake **84'** is schematically shown to suggest that any convenient braking apparatus available in the industry can be employed. For example, the brake **84'** could comprise an oppositely operated clutch arranged to halt the rotation of one of the shafts thereto upon proper energization, and permit free rotation thereof upon its de-energization. Of course, any other equivalent braking apparatus can be interchangeably employed as well.

As noted previously, when the stitching machine **10** is turned on, pull rollers **68** and **72** are rotating continuously to rapidly advance the work piece **14** toward the stitching head **12**. As seen in FIG. 2 and schematically illustrated in FIG. 3, a photoelectric sensing means **94** is positioned in the work table **13** and functions to sense the leading edge of the box blank or work piece **14** as it advances through the stitching machine. When the photocell detects the presence of the leading edge, it energizes a conventional timer **96** which is set to time out upon the expiration of a predetermined amount of time corresponding to the length of the front flaps of the carton to be constructed from the box blank being stitched by the machine. When the timer **96** is timed out (and the actual overlapping edges **62** and **64** of the work piece **14** are now properly under the stitching head **12**), it generates a signal applied to the gate **98** of a semiconductor controlled rectifier **100** which is thereby turned on to complete a circuit comprising voltage source **102**, clutch coil **50** of the stitching head **12**, the SCR **100**, and to ground. Once clutch coil **50** is energized, the stitching head **12** begins the above described stitching cycle.

It should be appreciated, that before the stitching head **12** begins its cycle, the stitch forming and driving means **26** thereof was quite naturally in its upper non-stitching position. Accordingly, the periphery **56** of the shaft end **36** maintains the contacts **54** in their closed condition thereby applying a signal from a voltage source **104** through the contacts **54**, through the line **106**, to a capacitor-resistor network **107** to apply a pulse to a "turn on clutch-turn off brake" input terminal **108** of the control means **22**. Also, it should be pointed out that a parallel line **110** including a conventional inverting circuit **112** necessarily establishes no signal on the "turn on brake-turn off clutch" input terminal **113** of the control means **22**.

The pulse applied to the terminal **108** traveled by line **114** and **116** to the gate **118** of a semiconductor controlled rectifier **120** which was thereby turned on to complete a circuit from a six volt source **122** through diode **124**, limiting resistor **126**, clutch coil **86**, and semiconductor controller rectifier **120** to ground. Once the SCR **120** was turned on by the application of the pulse to the gate **118** thereof, it continues to fire such that the clutch coil **86** is constantly energized to attract the armature **90** which in turn engages the clutch **82** and thereby interconnects the motor **18** and the pull roll drive shaft **76**. Thus it will be appreciated that even before the stitching head **12** begins its stitching cycle, and before the SCR **100** was ever ignited, the control means **22** had generated the necessary operating signals to have the pull rolls **68** and **72** operating in a continuous mode.

It should also be mentioned at this point, that when the pulse was developed by the capacitor-resistor network **107** to apply a signal to lines **114** and **116**, the same signal was simultaneously applied to the line **128** to apply a momentary turn-on signal to the base **130** of transistor **132**. As will be explained below, when transistor **132** is momentarily turned on, it will instantaneously establish a circuit from a six volt source **134** through diode **136**, through a limiting resistor **138**, and through the low impedance transistor **132** to ground. The making of this circuit, necessarily interrupts a circuit which might be made from the six volt source **134**, the diode **136**, the resistor **138**, the brake coil **88**, a semiconductor controlled rectifier **140** to be discussed below and ground; thereby guaranteeing the extinguishment of the SCR **140** in the event that it was inadvertently or accidentally conducting. In effect, the net result of the pulse having been applied to the "turn-on clutch turn-off brake" terminal **108** is that the clutch coil **86** remains energized and the possibility that the brake coil **88** could be energized is eliminated.

Before returning to the operation of the stitching head, it will be appreciated that a push button **142** is interposed

between a voltage source **144** and a capacitor-resistor network **146** for manually applying a pulse to the line **116** and **128** at start up.

Returning now to the stitching operation, let it be assumed that the clutch coil **50** has been energized as described previously; the stitching head **12** is operating; and the stitch forming and driving means **26** is about to apply a stitch to the work piece **14** now passing beneath the stitching head **12**. At that time, and as noted previously, the cordal flat **58** of the shaft end **36** will confront the contacts **54** and allow them to revert to their normally open condition thereby effectively providing a "not" signal on the line **106**. This "not" signal, when inverted at **112** and applied to the capacitor resistive network **111**, ends up producing a pulse on lines **148** and **150** to thereby apply a "turn on" signal to the gate **152** of the SCR **140** and a "turn on" signal to the base **154** of transistor **156**.

When the SCR **140** is turned on, a circuit is completed from the voltage source **134**, through the diode **136**, through the resistor **138**, the brake coil **88**, and the SCR **140** to ground. Thus the brake coil **88** has been energized to draw the armature **92** theretoward which in effect turns on the brake **84'** to stop the drive shaft **76** and halt the movement of the work piece **14** during the reception of the stitch now being applied by the stitching head **12**. Simultaneously, with transistor **156** momentarily turned on, the circuit including the clutch coil **86** and the SCR **120** has been diverted such that the SCR **120** is extinguished; the clutch coil de-energized; and the clutch **82'** disengaged.

As described previously, once the stitch is applied and the stitch forming and driving means **26** lifted; the peripheral portion **56** of the shaft end **36** will again close the contacts **54** to initiate the generation of the signals which will turn on the SCR **120** (to initiate clutch engagement) and momentarily energize transistor **132** to extinguish SCR **140** and thereby initiate the disconnection of the brake **84'**. Hence the work piece will begin advancing again to await the next "brake on clutch off" operating signals generated by the control means **22** in response to the operation of the stitching head **12**. FIG. 4 shows a typical cycle of operation in which the clutch is on for approximately 60 milliseconds and the brake is on for approximately 40 milliseconds, the six volt level having been dictated by the voltage sources **122** and **134**.

When the preset number of stitches have been sensed by contacts **60** and accumulated by a counter **159**; a signal is applied on the line **160** which the capacitor-resistive network **162** converts to a pulse appearing on a line **164** which is applied to the base **166** of a transistor **168** which turns on to thereby momentarily "make" a low impedance bypass circuit around the SCR **100** which is thereby extinguished. Thus coil **50** is de-energized and the stitching head **12** ceases operation. It should be pointed out that when the stitching head **12** ceases, the stitch forming and driving means **26** will be lifted from the work piece **14** whereby the contacts **54** will have been closed by the shaft end **36** to generate the necessary pulses for the control means **22** to generate the necessary "turn on clutch and turn off brake" operating signals whereby the pull rolls will revert to their continuous mode of operation and rapidly eject the work piece out of the rear of the machine **10**.

Turning to FIG. 5, there is illustrated an alternative embodiment of the control means **22** and the manner in which it cooperates with an alternative type of clutch and brake designated **82''** and **84''** respectively. In this embodiment, the clutch and brake **82''** and **84''** are of the type previously designated "purely electrical" in the sense that energization of their respective coils **158** and **160** is used to directly establish a flux path through the respective parts of the clutch and brake which draws the laterally moving part thereof into engagement with the stationary part thereof. Such clutches and brakes as illustrated at **82''** and **84''** in FIG. 5 are conventional and may be purchased on the open market. The distinguishing characteristic thereof is that upon the energization of the respective operating coil thereof, a relatively heavy mass thereof is physically drawn into clutching or braking engagement with the stationary portion thereof. Hence, and as described previously, in the operation of these "electrical" clutches and brakes, a high voltage surge is initially required to bring about quick engagement while a lesser voltage can be used to maintain the engagement once so established.

The control means **22** of FIG. 5 is provided with circuit means for effectuating this type of operation during an initial portion of the period of time that the clutch **82''** or brake **84''** is energized during a given cycle of operation. Control means **22** of FIG. 5 includes every one of the elements shown and described in FIG. 3, and corresponding numerals appear in FIG. 5 accordingly. However, the control means of FIG. 5 also includes a 120 volt source **162** which is applied by lines **164** and **166** to two branch circuits. Specifically line **164** is applied to an RC network **168**, a line **170**, and a diode **172** in parallel with the forementioned diode **124**. In like manner the line **166** from the 120 volt source **162** is applied to an RC circuit **174**, and a diode **176** in parallel with the aforementioned diode **136**.

In operation, the 120 volt source charges the capacitors **180** and **182** to approximately 120 volts. Thus, when, as described previously, a pulse is applied to the lines **114**, **116** and to the gate **118** to turn on the SCR **120**; the capacitor **180** will rapidly discharge (the duration depending on the time constant established by the RC network **168**) across diode **172**, through the operating coil **158** of the electrical clutch **82''** and through the SCR **120** to ground. Thus, for an initial portion of the "clutch on" period, there will be an extremely high voltage spike approaching 120 volts through the operating coil **158** which will generate the necessary high flux to initially move the movable half of the clutch toward the stationary half thereof. After that high spike subsides to a voltage less than 6 volt source **122**, the six volt source **122** will continue to apply the lower magnitude clutch holding signal through the coil **158** the SCR **120** and to ground.

In like manner when a "brake on" signal has been applied to the line **148** and gate **152** to turn on the SCR **140**; the capacitor **182** will be initially discharged across the diode **176**, the brake operating coil **160** and on to ground through the SCR **140**. Once the initial high voltage spikes subsides, the six volt source **134** will continue to apply a brake energizing signal of lower magnitude across the diode **136**, to the operating coil **160**, the SCR **140**, and on to ground. Again, these electrical signals correspond to the fact that for the electrical brake **84''** employed, it is first necessary to generate a high voltage spike to rapidly engage the brake, but thereafter, a lesser voltage can be employed to maintain the brake in engagement.

FIG. 6 shows the voltage level which appears across the clutch coil **158** and brake coil **160** respectively during the incremental clutch and brake operation of the stitching machine of the instant invention over a 100 millisecond cycle. Thus, during the first sixty millisecond period when the clutch is to be energized, the RC network **168** is chosen such that the time constant produces the 120 volt spike for approximately 1 millisecond, with the six voltage source maintained on the clutch on for the remaining period. Similarly with the brake, the time constant of the RC network **174** is chosen to generate the 120 volt spike for approximately 1 millisecond with the six bolt source **134** maintaining the brake on for the remaining of the period.

It should be pointed out, that the control means **22** of FIG. 5 is essentially a modified version of the electronic circuitry provided by the Warner Electric Clutch and Brake Company of Beloit, Wis. for the operation

of an "electrical" clutch and brake assembly manufactured by this company. The inventor hereof has taken this company's basic control system **22** and the brake and clutch assembly **82"** and **84"** operated thereby, modified them, and applied them to the incremental advancement of pull rollers of a wire stitching machine operating in conjunction with and dependent upon the stitching cycle of a stitching head associated therewith. In like manner, the control means **22** of FIG. 3 is a modified version of the control means produced by the Warner Electric Clutch and Brake Company of Beloit, Wis.; but, here again, the inventor hereof has modified and combined same in the control of the pull rollers of the wire stitching machine dependent upon and cooperating with the stitching head thereof.

Although this invention has been described with respect to its preferred embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art, and it is preferred therefore, that the scope of the invention be limited, not by the specific disclosure herein, only by the appended claims.

What is claimed is:

1. A stitching machine comprising:

first means for applying fastening means to a workpiece passing thereby;

second means for conveying said work piece past said first means;

motive means selectively connectable to said second means for the operation thereof;

interconnection means responsive to preselected operating signals for selectively connecting and disconnecting said motive means and said second means; and

control means responsive to operation of said first means for generating said preselected operating signals.

2. The stitching machine of claim **1** wherein said interconnection means includes clutch means for connecting said motive means and said second means; and said control means includes clutch-on circuit means for applying an operating signal to said clutch means for a first preselected period of time.

3. The stitching machine of claim **2** and further including control signal generating means responsive to operation of said first means for generating, a first control signal for said first preselected period of time; and said control means includes enabling circuit means responsive to said first control signal for enabling said clutch-on circuit means.

4. The stitching machine of claim **2** wherein said interconnecting means further includes braking means for positively halting the motion of said second means, and wherein said control means includes brake-on circuit means for applying an operating signal to said braking means for a second preselected period of time which occurs after said first preselected period of time.

5. The stitching machine of claim **4** and further including control signal generating means responsive to operation of said first means for generating a first control signal for said first preselected period of time and a second control signal for said second preselected period of time after the occurrence of said first preselected period of time; and said control means includes first enabling-disabling circuit means responsive to said first control signal for enabling said clutch-on circuit means and disabling said brake-on circuit means.

6. The stitching machine of claim **5** wherein said control means further includes second enabling-disabling circuit means responsive to said second control signal for enabling said brake-on circuit means and disabling said clutch-on circuit means.

7. The stitching machine of claim **2** wherein said clutch-on circuit means includes first circuit means for applying an operating signal of a first predetermined magnitude to said clutch means for an initial portion of said first preselected period of time and second circuit means for applying an operating signal of a second predetermined magnitude less than said first preselected magnitude to said clutch means for the remaining portion of said first preselected period of time.

8. The stitching machine of claim **7** wherein said interconnecting means further includes braking means for positively halting the motion of said second means, and wherein said control means includes brake-on circuit means for applying an operating signal to said braking means for a second preselected period of time which occurs after said first preselected period of time; and

wherein said brake-on circuit means includes third circuit means for applying an operating signal of a third predetermined magnitude to said braking means for an initial portion of said second preselected period of time and fourth circuit means for applying an operating signal of a fourth predetermined magnitude less than said third predetermined magnitude to said braking means for the remaining portion of said second preselected period of time.

9. The stitching machine of claim **8** wherein said first and third predetermined magnitudes are equal, and said second and fourth predetermined magnitudes are equal.

10. The stitching machine of claim **8** and further including control signal generating means responsive to operation of said first means for generating a first control signal for said first preselected period of time and a second control signal for said second preselected period of time after the occurrence of said first preselected period of time;

said control means includes first enabling-disabling circuit means responsive to said first control signal for enabling said clutch-on circuit means and disabling said brake-on circuit means; and

wherein said control means further includes second enabling-disabling circuit means responsive to said second control signal for enabling said brake-on circuit means and disabling said clutch-on circuit means.

11. The stitching machine of claim **5** wherein said first means is a stitching head having stitch driving means for driving a stitch into said work piece during a portion of a stitching cycle; said stitching head having operating means for causing said control signal generating means to generate said second control signal when said stitch is being driven into said work piece and for causing said control signal generating means to generate said first control signal at all other times during said stitching cycle; whereby said clutch means will be engaged to advance said work piece whenever said stitching head is not driving a stitch, and said brake means will be engaged to halt said work piece whenever said stitching head is driving a stitch.

12. The stitching machine of claim **11** wherein said control signal generating means includes a voltage source, a turn-on clutch line, an operating turn-on brake line in parallel with said turn on clutch line and normally open contact means in series with the parallel network of said turn-on clutch line and said inverting turn-on brake line for generating said first control signal on said turn-on clutch line when said contacts are closed and for generating said second control signal on said inverting turn-on brake line when said contacts are open.

13. The stitching machine of claim **12** wherein operating means of said stitching head maintains said contact means open when said stitch is being driven into said work piece and closed at all other times in said stitching cycle.

14. The stitching machine of claim **13** wherein said stitching head includes a shaft rotating in synchronism with the operation of said stitch driving means, said shaft having a flat position thereon of predetermined size relative to the remaining circumference of said shaft to correspond to the portion of said stitching cycle when said stitch is being driven in said work piece; said normally

open contact means being in preselected location with respect to said shaft to be closed by said remaining portion of said circumference thereof and allowed to revert to its normally open condition by virtue of said flat confronting contact means.

15. The stitching machine of claim **11** wherein said stitching head includes motor means, clutching means selectively operable to interconnect said motor means and said stitch driving means, and stitcher head starting means for energizing said clutching means.

16. The stitching machine of claim **15** and further including counter means responsive to operation of said stitching head for accumulating a preselected number of stitches; and stitcher head stopping means responsive to said counter accumulating said preselected number of stitches for de-energizing said clutching means.

17. The stitching machine of claim **16** wherein said control means further includes start-up means for initially enabling said first enabling-disabling circuit means; whereby when said start up means is operated, said clutch means will be energized; said brake means will be de-energized; and said second means will continuously convey said work piece toward said stitching head.

18. The stitching machine of claim **17** wherein said stitcher head starting means includes work piece sensing means responsive to said work piece reaching a predetermined position with respect to said stitching head for generating a start-timer control signal; timing means responsive to said start-timer control signal for generating a braking means enabling signal at a preselected time after reception of said start-time control signal; and braking means enabling circuitry responsive to said braking means enabling signal for energizing said braking means.

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U.S. Cl. X.R.

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