Dec. 9, 1969 SHIGEKI HAYASHI ET AL 3,482,538

APPARATUS FOR STOPPING A NEEDLE-BAR AT ANY PREDETERMINED LEVEL OF A SEWING MACHINE

Filed June 12, 1967 6 Sheets-Sheet 1

Fig. 1

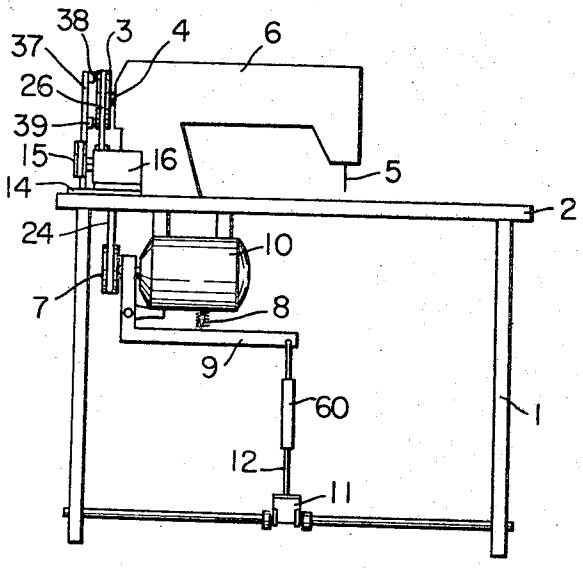
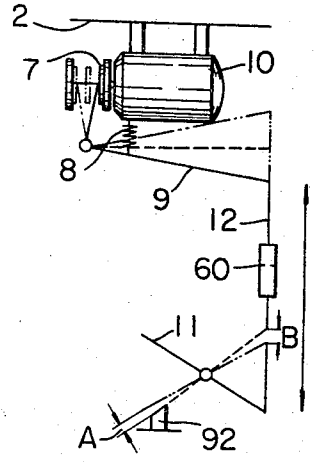


Fig. 9



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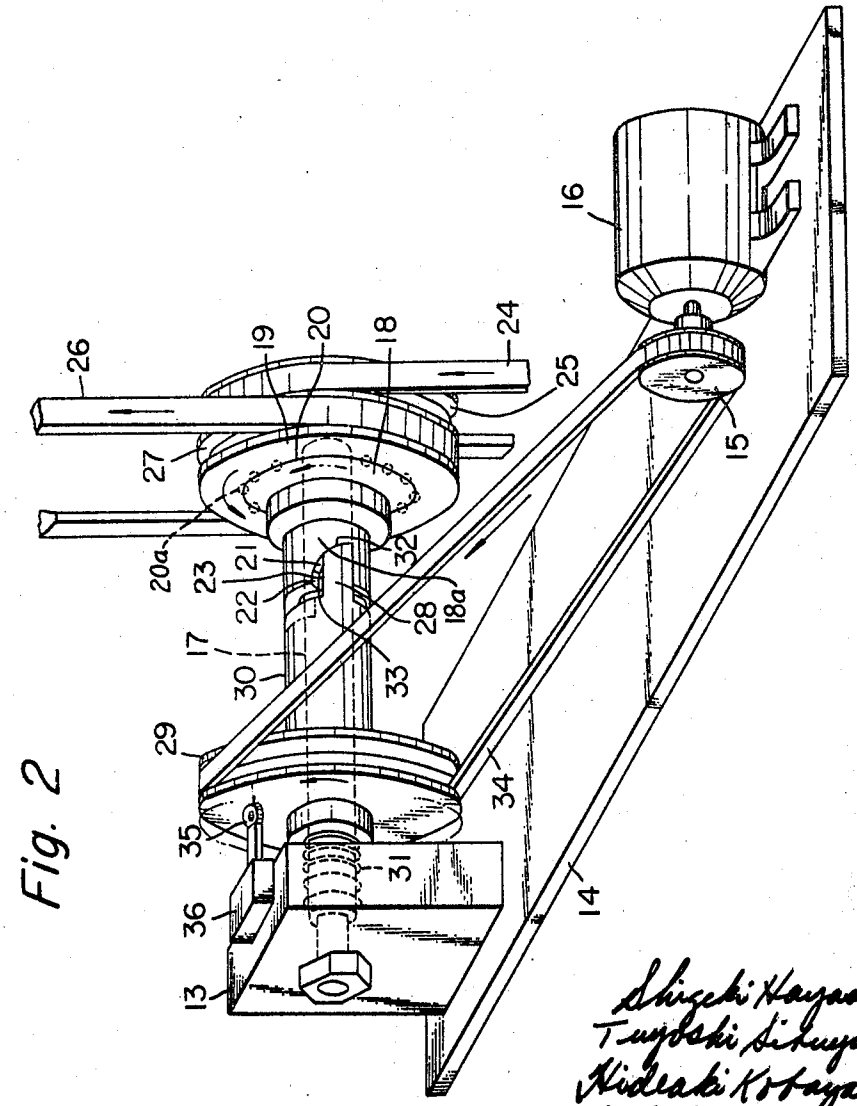


Fig. 2

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APPARATUS FOR STOPPING A NEEDLE-BAR AT ANY PREDETERMINED LEVEL OF A SEWING MACHINE
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Fig. 3

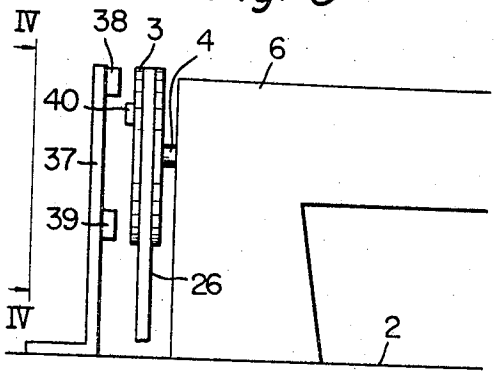


Fig. 4

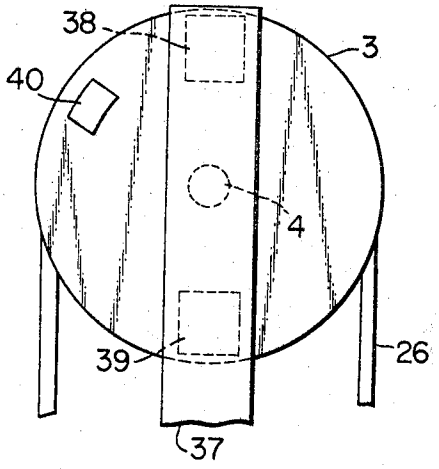
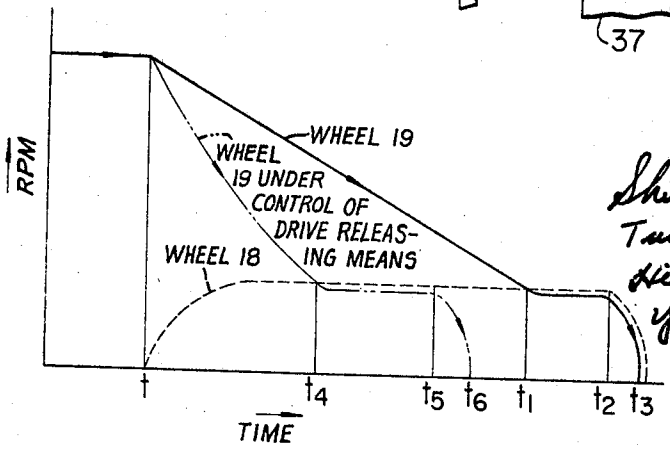


Fig. 6

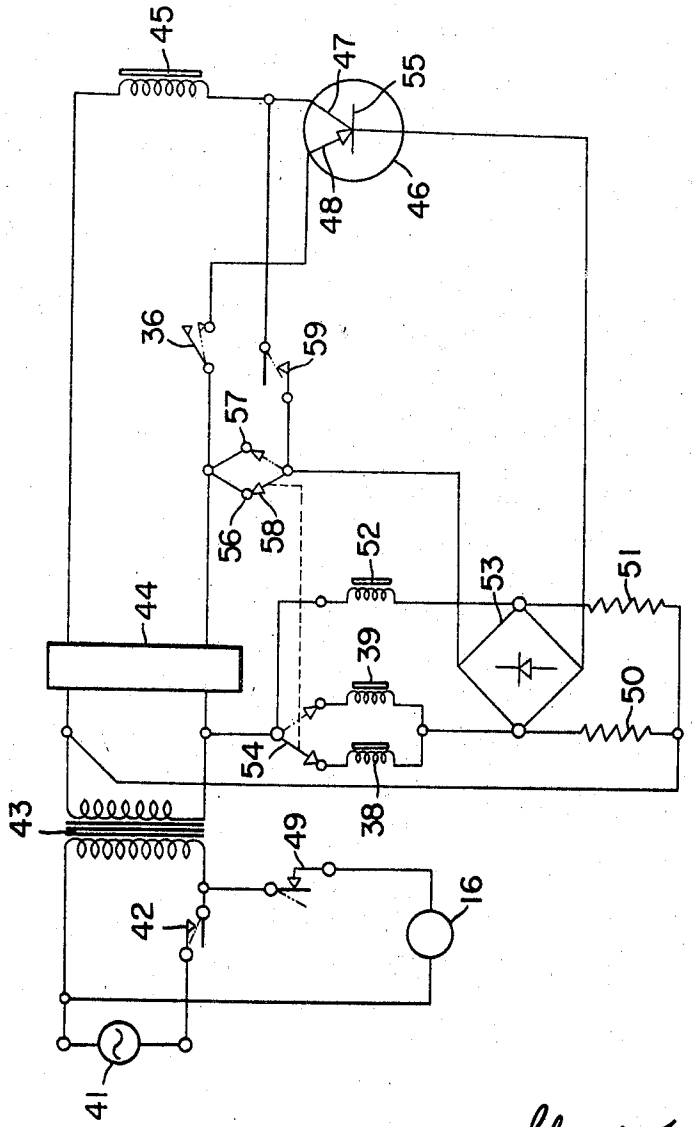


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Fig. 5



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Fig. 7

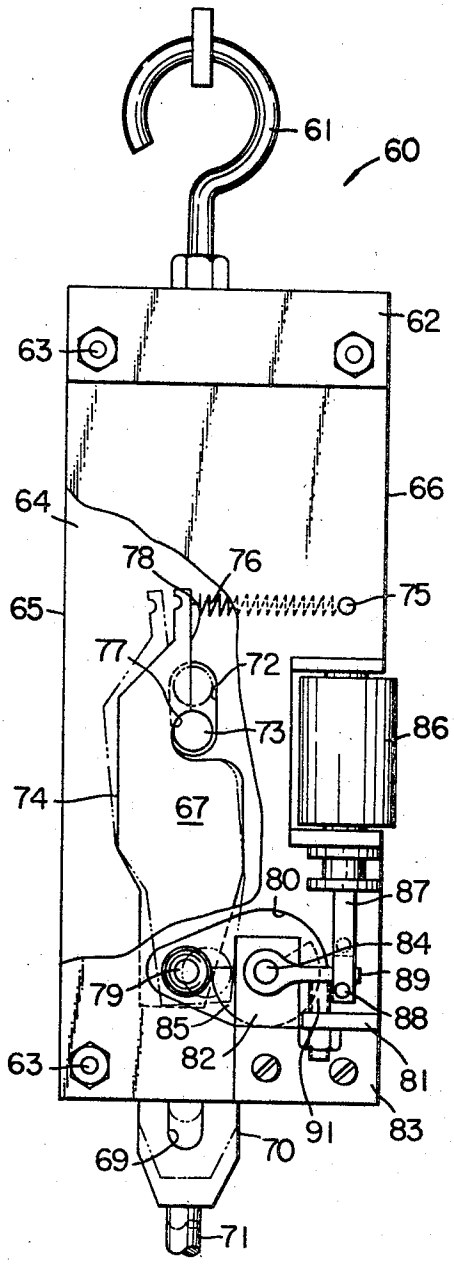
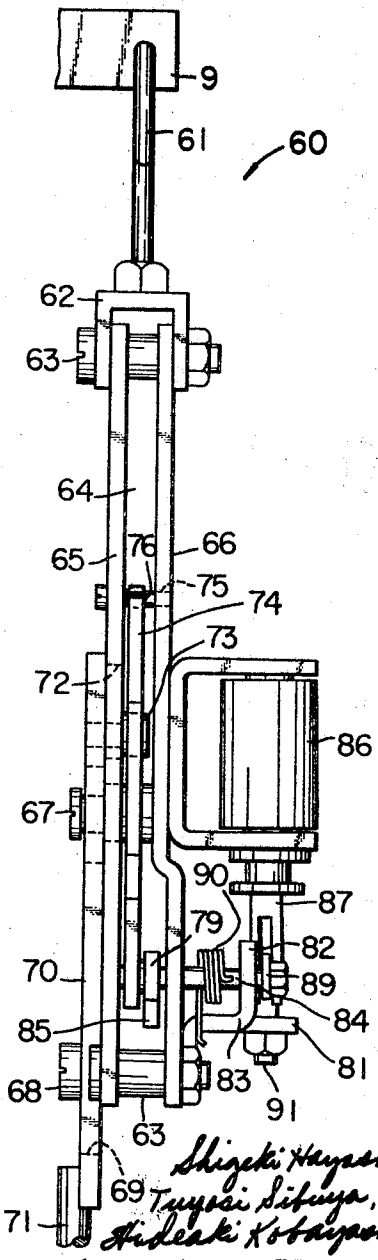


Fig. 8



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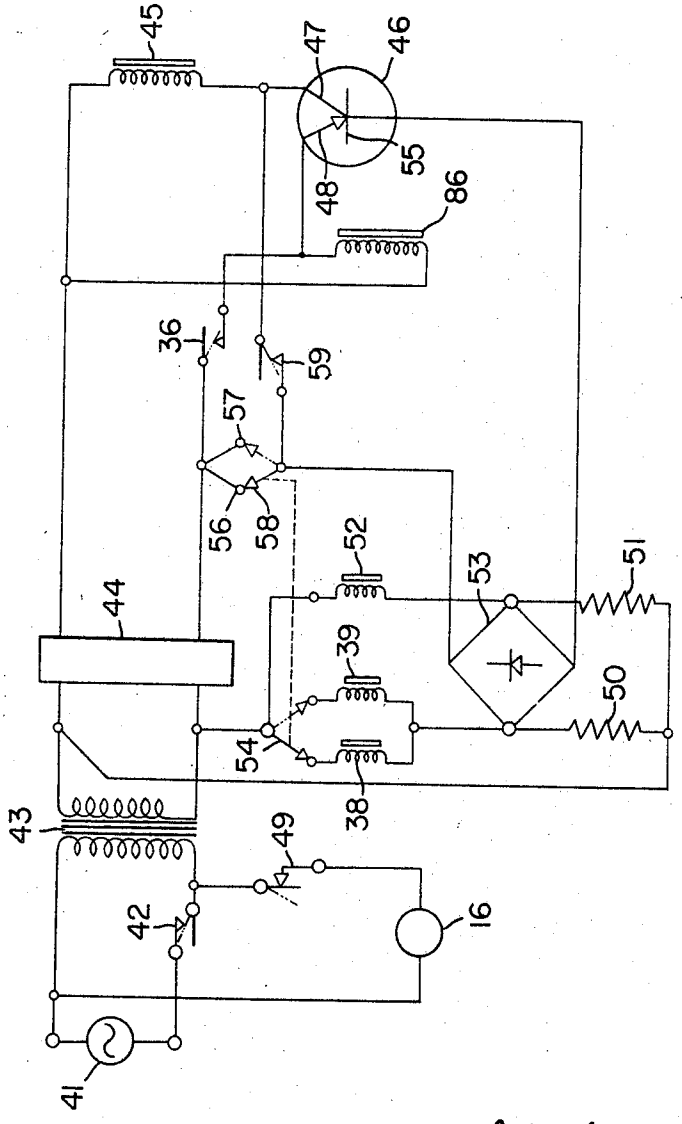
BY Wenderoth, Lind and Ponack, Attorneys

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APPARATUS FOR STOPPING A NEEDLE-BAR AT ANY PREDETERMINED LEVEL OF A SEWING MACHINE

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Fig. 10



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3,482,538

APPARATUS FOR STOPPING A NEEDLE-BAR AT ANY PREDETERMINED LEVEL OF A SEWING MACHINE

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U.S. Cl. 112—219 5 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to an apparatus for stopping a needle-bar at any predetermined level of a sewing machine, the latter having a needle-bar, a prime mover or clutch motor, an auxiliary motor with a pulley for driving the machine at a slow speed, a one-way clutch having concentric internal and external wheels which rotate integrally in only one direction, a bridge circuit, a rotatable magnetic piece and an electromagnet. The magnetic piece breaks the balance of the bridge circuit causing electric current to flow through a relay to stop the machine so as to dispose the needle-bar at any present level. The electromagnet is energized by properly actuating the footpedal for disconnecting the power transmission of the prime mover to slow the machine quickly.

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for use with a sewing machine for stopping a needle-bar at any predetermined level, and more particularly, is directed to an apparatus for quickly stopping a needle-bar at any predetermined level in addition to the prior art apparatus for stopping a needle-bar at any present level.

Heretofore, needle-bars in conventional sewing machines have been stopped at a given or desired level by manually rotating the flywheel when the thread is to be cut after the sewing operation or when initially threading the needle. This manual adjusting rotation of the flywheel for stopping the needle at the desired level has been a bothersome and complicated operation for the operator, sometimes resulting in dangerous and incorrect operation.

SUMMARY OF THE INVENTION

This invention eliminates the aforementioned disadvantages of the conventional sewing machine, and provides a novel and improved apparatus for stopping a needle-bar at any predetermined level of a sewing machine, and further provides a novel and improved quick stopping mechanism for a high speed sewing machine.

One object of this invention is to provide an apparatus for stopping a needle-bar at any predetermined level in a sewing machine.

Another object of this invention is to provide an apparatus for stopping a needle-bar at the top or bottom dead center positions in a sewing machine.

A still further object of this invention is to provide an apparatus for quickly reducing the high speed rotation of a sewing machine so as to shorten the stopping time.

It is an advantage of this invention that the sewing machine is capable of automatically and positively stopping a needle-bar at any predetermined level during operation.

Yet another advantage of this invention resides in the ability of the sewing machine to automatically reduce the high speed machine rotation so as to shorten the stopping time.

According to one aspect of the present invention, there is provided an apparatus for stopping a needle-bar at any

predetermined level in a sewing machine having a needle-bar, a prime mover of clutch motor, an auxaliary motor with a pulley for driving the machine at a slow speed, and a oneway clutch consisting of concentric internal and external wheels which are relatively rotatable and which also rotate integrally in only one direction. A bridge circuit is provided including two resistors, a standard coil and one or more coils of a plurality of coils, and a rectifier, and when a magnetic piece closely approaches the one or more coils, the balance of the bridge circuit alters the flow of electric current through a relay to stop the auxiliary motor, thereby stopping the needle-bar at a preset level. The arrangement can be such as to stop the needle-bar at a plurality of intermediate levels. More specifically, two coils are oppositely disposed relative to a rotating part of the apparatus carrying the magnetic piece to correspondingly stop the needle-bar at a top and at a bottom dead center position. The said clutch is constructed so that when the rotative speed of the internal wheel is faster than that of the concentric external wheel, the latter is driven by said internal wheel.

According to another aspect of the present invention, there is provided, in addition to the apparatus previously described, a drive releasing mechanism including an electromagnet for retarding high speed rotation of the machine, whereby the high speed thereof is quickly reduced when it is desired to stop the sewing machine. The overall length of the mechanism is adapted to be shortened when the mechanism operates, thereby aiding in quickly reducing the high speed of the machine. When the rotating speeds of the concentric external and internal wheels of the clutch coincide, the electromagnet is adapted to operate to stop the transmission of the prime mover.

In accordance with the present invention, the sewing machine is preferably operated via the external wheel of the one-way clutch, said wheel acting as an intermediate pulley and being rotated by the prime mover or clutch motor. Furthermore, there is connected with the internal wheel a pulley which is rotated by the auxiliary motor for a slow rotating drive, which pulley begins to rotate when the treadle is pressed by the foot in order to stop the sewing machine. When the speed of the wheels of the one-way clutch, consisting of the external wheel of the intermediate pulley and the concentrically disposed internal wheel driven by the auxiliary motor, coincide, the sewing machine is driven by the auxiliary motor and at the same time a switch is operated so as to complete a circuit. A magnetic piece secured at a predetermined position on the flywheel approaches the coil of the bridge circuit and the impedance of the coil is changed, and an electric current produced by the unbalancing of the bridge circiut by altering the impedance by changing the inductance of the coil causes electric current to flow through the relay to open an electric circuit to stop the slowly operating auxiliary motor, thereby stopping the needle-bar of the machine at a predetermined level.

In the operation of the drive releasing mechanism, which operates in association with the apparatus for stopping the needle-bar of a sewing machine rotating at high speed within a short time and at a predetermined level, when the treadle is pressed by the heel of the foot, the transmission is disengaged from the prime mover and if the rotation of both the internal and external concentric wheels of the one-way clutch coincide at the same time the electromagnet is operated, then the drive is removed automatically through the pulley from the prime mover or clutch motor by pressing the drive releasing mechanism provided between the treadle and the clutch lever of the clutch motor by said heel of the foot, and thereafter the sewing machine is driven by only the auxiliary motor so that the high speed rotation normally associated with the

inertia of the sewing machine is quickly slowed down to shorten the stopping time.

The invention will be described in detail in connection with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic overall view of the sewing machine;

FIG. 2 is a perspective view of an embodiment of this invention showing an auxiliary motor and clutch mechanism;

FIG. 3 is a rear elevation view of a detecting portion of the apparatus for stopping a needle-bar at any predetermined level of a sewing machine;

FIG. 4 is an enlarged elevational view taken from the direction of line IV–IV' in FIG. 3;

FIG. 5 is a schematic electrical circuit diagram of the apparatus for stopping a needle-bar at any predetermined level of a sewing machine;

FIG. 6 is a graph showing the relationship between the time and number of revolutions per unit of time during stopping of the prime mover of clutch motor and the starting of the auxiliary motor;

FIG. 7 is a side view partially broken away of the means according to this invention for quickly stopping the needle-bar while the sewing machine is rotating at high speed, showing the drive releasing mechanism for the prime mover;

FIG. 8 is a left side view of the means of FIG. 7;

FIG. 9 is a schematic view showing the relationship between the treadle and the drive releasing mechanism; and

FIG. 10 is a schematic electric circuit diagram of the apparatus for stopping a needle-bar at any predetermined level by means of the drive releasing mechanism of a sewing machine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Although specific forms of the invention have been selected for illustration in the drawings, and the following description is drawn in specific terms for the purpose of describing those forms of the invention, this description is not intended to limit the scope of the invention, which is defined in the claims.

Referring now to the drawings, and particularly to FIGS. 1–6, which show one embodiment of means for stopping the needle-bar at any predetermined preset level for various purposes, they will hereinafter be described.

In FIG. 1, the sewing machine includes a support means having legs **1**, a table top **2** supported by the legs **1**, a flywheel **3**, an upper shaft **4**, a needle-bar **5** vertically movable and operable by the upper shaft **4** by rotation of the flywheel **3**, said shaft extending through a body **6** on the table **2**, all of which is generally well known to those skilled in the art. Further, a drive pulley **7** is disposed on the output shaft of a prime mover or clutch motor **10** secured underneath the table **2**, and is operable by means of a bell-crank type clutch lever **9** disposed with one arm operatively associated with said pulley **7** and having the other arm of the lever remote from the pulley adapted to be pulled upwards by a spring **8** connected between the lever and motor **10**. A treadle **11**, provided under the table **2**, is pivotally connected to the free end of the other clutch lever arm **9** through a connecting rod **12**.

Referring now to FIG. 2, the apparatus comprises a bearing block **13**, a base **14** on which the bearing block **13** is mounted, a pulley **15** on the shaft of an auxiliary motor **16** which is mounted on the base **14**. A shaft **17** is mounted in and projects from the bearing block **13**, and concentrically superposed wheels comprising an internal wheel **18** and an external wheel **19** are mounted at the free end of the shaft **17** and constitute in part a conventional overrunning clutch **20**. The internal and external wheels of the clutch are disposed relative to one another to rotate integrally in only one direction at a time by utilizing a free wheel mechanism including conventional rollers or balls **20***a* interposed in pockets or the like between said wheels. The clutch structure further includes an axially projecting sleeve transmission member **18***a* projecting from the hub portion of internal wheel **18** in a coaxial manner with and around the free end of shaft **17**, while a longer sleeve member **30** projects toward said sleeve member **18***a* from the hub of a driven pulley **29**, which is also rotatably mounted on shaft **17**. The sleeves have interengaging means for transmitting power therebetween, including a recess **23** having an inclined inner end portion **21** on the sleeve member **18***a*. The recess **23** is open at the left end, as viewed in FIG. 2, and the inclination is axially shorter than the depth of the recess, there being a linear portion **22** extending parallel to the axis of the shaft **17** from the outer end of the inclined portion **21** and extending to the outer end of the recess. A belt **24** transmits the rotation of the pulley **7** of the clutch motor **10** engaging in a first groove **25** in the periphery of the external wheel **19**, while a belt **26** transmits the rotation of said external wheel **19** to the flywheel **3** mounted in the body **6** engaging in a second groove **27** in the periphery of said external wheel **19**.

A projecting cam-like portion **28** on sleeve **30** cooperatively intermeshes with the recess **23** provided in the sleeve portion of the internal wheel **18**. Pulley **29** is mounted on sleeve **30** between the bearing block **13** and the recess **23**, and a spring **31** is provided around the shaft **17** between the right end of the bearing block **13** and the left end of the sleeve **30** to constantly urge the sleeve **30** to the right, as shown in the drawing. The projecting portion **28** is narrower in width than the aforesaid recess **23**, and has parallel axially extending sides **33** and a sloping portion **32** on the end complementary to the inclined portion **21** of the inner end of recess **23**. An engaging side **33** of the projecting portion **28** is parallel to the linear portion **22** of the recess **23** so as to engage in the recess **23** responsive to urging of the spring **31** with the sloping portion **32** projecting into the deepest portion of the recess **23**. A drive belt **34** drivably interconnects the pulley **15** of the motor **16** with said pulley **29**. A switch **36** is provided on the bearing block **13**, and a contact member **35** positioned adjacent the left side of the pulley **29** is adapted to close said switch when the peripheral speeds of the external and internal wheels **19** and **18** of the one-way clutch **20** coincide.

As shown in FIGS. 3 and 4, the sewing machine further includes an upright support **37** mounted on the table **2** outwardly of the flywheel **3**. Two coils **38** and **39** are secured to the support on opposite sides of and equally spaced from the centerline of the upper shaft **4** and on the side of the support **37** facing the flywheel **3**. A magnetic piece **40** is secured to the outside face of the flywheel **3**, the latter of which is spaced sufficiently from support **37** so that there is clearance between the magnetic piece **40** as it rotates with the flywheel **3**, and the coils **38** and **39**. Furthermore, magnetic piece **40** is positioned so that the needle-bar **5** is disposed generally at the top or bottom dead center when the position of the magnetic piece **40** coincides alternately with the oppositely disposed fixed coils **38** and **39**.

Referring now to FIG. 5, the illustrated circuit comprises an electric power source **41**, a switch **42** operable so that it closes when the treadle **11** is released by the foot in order to stop the sewing machine and opens when the treadle **11** is pressed by the foot. Further included in the circuit is a transformer **43** to the primary of which the power source **41** is connected through the switch **42**. A rectifier **44** is connected across the secondary windings of transformer **43**, and in series with the rectifier is a relay **45** and a transistor **46** having a collector **47** to which one side of the rectifier **44** is connected through a switch **36** and a base **55** which will hereinafter be described. A

switch 49 and an auxiliary motor 16 are connected across the power source 41 in parallel with the primary winding of the transformer 43 and between the switch 42 and the primary winding. The circuit further includes a bridge circuit including resistors 50 and 51, standard coil 52, and parallel coils 38 and 39, and a rectifier 53 disposed in the center thereof. When the relationship between the impedances of the standard coil 52, and coil 38 or 39 and the resistance of the resistors 50 and 51 becomes such that the resistance of the resistor 50 times the impedance of the coil 52 is equal to the resistance of the resistor 51 times the impedance of the coil 38 or 39, then the electric current between the ends of the rectifier 52 becomes zero. A positioning switch 54 is utilized for switching or selecting either the coil 38 or coil 39, which are mounted on support 37, as described above with respect to FIG. 3. One lead of the rectifier 53 is connected to the base 55 of the transistor 46, while the other lead of the rectifier 53 is connected to switch contact arm 58 which can be switched to either of switch terminals 56 and 57 connected between rectifier 44 and switch 36. A switch 59 is connected between the contact arm 58, and a point in the line between the relay 45 and the collector 47 of the transistor 46, said switches 49 and 59 being conversely operated to be open or closed by the operation of the relay 45. When the relay 45 is not energized, the switch 49 closes and the switch 59 opens, whereas when the relay 45 is energized, the switch 49 opens and the switch 59 closes.

In operation, when the stopping level of the needle 5 of the sewing machine is determined, or when it is determined that the positioning switch 54 is to be operated to selectively stop the needle-bar 5 at the uppermost dead center point, the circuit elements are in the positions shown by full lines in FIG. 5, the bridge circuit comprising the coil 38, resistors 50 and 51 and the standard coil 52, and the contact arm 58 being positioned so as to contact to the terminal 56. The foot treadle 11 is pressed, which by means of the connecting rod 12 and clutch lever 9 causes rotation of the pulley 7 of the clutch motor 10, and by means of the drive belt 24 and the external wheel 19 of the one-way clutch 20 drives the adjacent belt 26, to thereby rotate the flywheel 3 to commence vertical movement of the needle-bar 5 within body 6 to start sewing. However, since switch 42 is open, the electric current does not flow through the circuit shown in FIG. 5, the auxiliary motor 16 does not rotate, and the internal wheel 18, shown in FIG. 2, is stopped so that the external wheel 19 of the one-way clutch 20 rotates in the direction as shown by the arrow.

When the treadle 11 is released so as to stop the operation of the sewing machine, the clutch motor 10 is de-energized and rotation thereof ceases, while at the same time the switch 42, in the circuit shown in FIG. 5, closes to initiate rotation of the auxiliary motor 16. Current also flows through the transformer 43 from the electric power source 41. Even though the operator's foot is released from the treadle 11, in as much as the rotary speed of the sewing machine decreases gradually due to the inertia of the various rotary components thereof, the external wheel 19 of the one-way clutch 30 still continues to rotate, and the sleeve 30 attached to the pulley 29 also rotates, being driven by the auxiliary motor 16. The sloping or cam-like portion 32 of projection 28 is pressed by means of the spring 31 into the deepest portion of the recess 23 of the sleeve portion carried by the internal wheel 18. The internal wheel 18 rotates at a different speed and in the same direction as the external wheel 19 by the rotation of the sleeve 30.

Referring now to FIG. 6, which shows the relationship between time and the number of revolutions per unit of time of the prime mover or clutch motor 10 and the auxiliary motor 16 upon stopping of the motor 10, the relationship of the change of revolutions per unit of time between the external wheel 19 rotating due to inertia and that of the internal wheel 18 driven by the auxiliary motor 16 is shown, the full line curve representing the revolutions of the external wheel 19 and the dotted line curve representing those of the internal wheel 19.

If, at the point of time designated t on the abscissa of the graph in FIG. 6, the foot treadle 11 is released to thereby energize the auxiliary motor 16, the speed of the external wheel 19 gradually becomes slower, and that of the internal wheel 18 rises at first, but immediately thereafter becomes a constant slow speed. During the time interval t to t_1 the speed of the external wheel 19 is faster than that of the internal wheel 18, whereby the external and internal wheels 19 and 18, respectively, rotate separately in the same direction and at different speeds.

Commencing at point 5, when the switch 42 closes, the electric current simultaneously flows through the bridge circuit so that the magnetic piece 40 of the flywheel 3 approaches the coil 38 to change the inductance thereof, and also to change the impedance thereof, thus altering the balance between the resistor 51 and the respective coils 52 and 38 in the bridge circuit to effect flow of electric current between the ends of the rectifier 53. But there is no current flowing through the emitter 48 of the transistor 46, because the switch 36 is open, the sleeve 30 and pulley wheel 29 being urged to the right by spring 31. Accordingly, the transistor 46 does not operate, and consequently the relay 45 and switches 49 and 59 do not operate.

At the point of time t_1, the rotational speeds of the internal and external wheels 18 and 19 become the same, and thereafter the respective speeds thereof are in a converse relationship. That is to say, the internal wheel 18 rotates faster than the external wheel 19, and the external wheel 19 is then driven by the internal wheel 18 so that the projecting portion 28 of the sleeve member 30 moves to the left against the spring 31, whereby contact 35 is contacted by pulley 29 to close the switch 36. That is, when the rotational speed of the internal wheel 18 becomes greater than that of the external wheel 19, due to the character of the one-way clutch 20, said wheels 18 and 19 commence to rotate integrally in the direction shown by the arrow in the drawing, whereby a large torque is applied to the one-way clutch 20. Because the sleeve member 30 is unable to resist the large torque, it is driven by the motor 16 to rotate in a counterclockwise direction a distance corresponding to the difference of the width between the projecting portion 28 and the recess 23, thus permitting the side 33 of projecting portion 28 and linear portion 22 of the recess to come into engagement. The sewing machine commences to rotate at a slower speed through the internal and external wheels 18 and 19, respectively, being driven by the auxiliary motor 16, and the sloping portion 32 of the projecting portion 28 moves along the inclined portion 21 of the recess 23, and the sleeve member 30 and pulley 29 compress spring 31, and accordingly move to the left on the shaft 17, as shown by the dot-dash lines in FIG. 2. This movement pushes the contact 35 of the switch 36 to the left to close said switch 36.

When the switch 36 closes, the electric current flows through the emitter 48 of the transistor 46. In this state, when the magnetic piece 40 of the flywheel 3 approaches the coil 38, its inductance changes and the impedance is altered so that the balance between the resistance of the resistor 51 and the respective coils 38 and 52 alters the flow of electric current between the ends of the rectifier 53. Since switch 36 is closed, the current flows through the base 55 of the transistor 46 so that the voltage from rectifier 44 is amplified by the transistor 46 and the relay 45 is energized. The switch 59 is closed by relay 45, and at the same time the switch 49 of the auxiliary motor 16 is opened. Consequently, since the auxiliary motor 16 stops generally with the magnetic piece 40 on the flywheel 3 coincident with the coil 38, the needle-bar 5 stops at the uppermost dead center point or level.

In FIG. 6, t_2 is the time at which switch 49 opens, and

t_3 is the time at which the sewing machine stops operating. The time interval between t_2 and t_3 is very short, because the speed of the auxiliary motor **16** is relatively slow, and therefore has less inertia.

Referring now to FIG. 5, the positions of the respective switches at the stopping of the sewing machine is shown by the dot-dash line. Electric current flowing through the rectifier **53** in the bridge circuit due to the change of the inductance of the coil **38** is transient, so that when the transistor **46** operates the relay **45**, the switches **49** and **59** are held in the positions indicated by the dot-dash lines in the drawing. Since the current from the rectifier **44** flows through the terminal **56**, switch contact **58** and switch **59** to the relay **45**, the relay **45** continues to operate to keep the switches **49** and **59** in the positions shown by the dot-dash lines.

In order to stop the needle-bar **5** at the bottom dead point or level, the positioning switch **54** is switched from the coil **38** so as to contact the coil **39**, and switch contact **58** is simultaneously switched from the terminal **56** to contact the terminal **57**. Thus the complete circuit operating the relay **45** is opened to render said relay **45** inoperative so that the switches **49** and **59** are switched to the positions shown by the full lines to enable the auxiliary motor to commence rotation of the sewing machine. The bridge circuit is formed by the coil **39**, standard coil **52**, and resistors **50** and **51** when the switch contact **58** is switched to the terminal **57** from the terminal **56**, so that when the magnetic piece **40** on the flywheel **3** approaches the coil **39** it alters the inductance of the coil **39**, and thereby changes the balance between the resistance of the resistor **51** times the impedance of the coil **52**, and that of the resistance of the resistor **51** times the impedance of the coil **39**, to cause the current to flow between the ends of the rectifier **53**. This causes the mechanism to operate, as described hereinbefore, at the time the positions of the coil **39** and the magnetic piece **40** of the flywheel **3** coincide approximately, whereby the needle-bar **5** stops at the bottom dead center point.

Summarizing, in order to stop the needle-bar **5** at the bottom dead center point, the positioning switch **54** is positioned as shown by the dotted line in the drawing, while in order to selectively stop the needle-bar **5** at the top dead center point, the positioning switch **54** need only be switched from the position shown by the dotted line to that shown by the full line in the drawing. Further, by providing a plurality of appropriately positioned coils such as **38**, **39**, etc., and by selecting any one of these coils, the needle-bar **5** can be stopped at any intermediate level or point between the top and bottom positions.

FIGS. 7–10 show another part of the embodiment of the present invention relating to a drive releasing mechanism for automatically stopping the needle-bar at any predetermined preset level very quickly by decreasing the inertia due to the high speed rotation to shorten the stopping time.

In FIGS. 7 and 8, the drive releasing mechanism generally designated **60** is engaged between the connecting rod **12** and the treadle **11** for connecting the treadle and clutch lever **9** (FIG. 1). It comprises a hook **61** at the upper end attachable to one end of the clutch lever **9**, a support **26** which, in cross-section, has the shape of an inverted rectangular U and which is secured to the lower portion of the hook, a plurality of pins **63** extending through the support **62**, and two parallel plates **65** and **66** spaced apart at **64** and secured to the support by said pins **63**. Further, pins **63** at the lower ends of the plate hold the plates spaced apart at the lower end thereof. A shaft **67** is secured approximately through the center of the plates **65** and **66**, and a shaft **68** is mounted at the lower portion of the plate **65**. A sliding plate **70** has an elongated slot **69** therein to accommodate shafts **67** and **68** and is vertically slidable up and down. A connecting rod **71** is attached to the lower end of plate **70** and is connected at the lower end to the treadle **11**. A vertically elongated slot **72** is provided at the upper portion of the plate **65**, and a pin **73** extends through the slot **72** and projects between the plates **65** and **66**. A rotatable plate **74** in the space **64** between the plates **65** and **66** is rotatable on the shaft **67**. Further, an anchor pin **75** is secured to the plate **65**, and a spring **76** is provided between the upper portion of the rotatable plate **74** and said pin **75** so that said spring **76** normally biases the rotatable plate **74** clockwise in FIG. 7 around the shaft **67** as the center. A recess or slot **77** is provided in one side of the rotatable plate **74** and has a smaller depth on the upper side than the side toward the shaft **67**. Said plate **74** has a linear edge **78** extended upwardly from the slot **77**. A roller **79** is rotatably mounted at the lower end of the rotatable plate **74** adjacent plate **66**, and a hole **80** is provided adjacent the roller **79** in the lower portion of the plate **66**. The mechanism **60** further comprises a horizontally projection portion **81** comprised of a support bracket **83** provided at the right lower portion of the plates, said bracket also having a vertical portion **82** projecting upwardly opposite the upper portion of the hole **80** and parallel with the plate **66**. A shaft **84** is supported in the parallel vertical portion **82** and is rotatable in the plate **65** and projects through hole **80** opposite said parallel vertical portion **82**, and a generally semicircular securing plate **85** is mounted on shaft **84** and disposed in the space **64** between the plates **65** and **66**, in a manner whereby the outer periphery of the securing plate **85** slidingly contacts or is spaced slightly from the outer periphery of the roller **79** when the pin **73** is in the deepest portion of the recess **77** in the rotatable plate **74**. Additionally, an electromagnet **86** is mounted on the right center surface of the plate **66**, and includes a plunger **87** of an electromagnet **86**, a pin **88** in the lower end of the plunger **87**, an operating plate or arm **89** having one end pivotally secured to the vertical portion **82** of the bracket **83** by means of the shaft **84**, with the non-pivoted end of plate **89** contacting or supported on the pin **88**. A spring **90** encircles and is attached to the shaft **84** and is attached to the support bracket **83** so that the shaft **84** is always rotatably urged in a clockwise direction in FIG. 7 to press said end of the operating plate **89** against the pin **88**. An adjustable abutment or stop **91** is provided on the horizontal arm **81** of bracket **83** so as to restrict or limit the downward movement of the operating plate **89**.

When the electromagnet **86** is not energized, the peripheries of the roller **79** and securing plate **85** are in contact with each other, as shown by the full lines in FIG. 7, while, when the electromagnet **86** is energized, the arm **89** is rotated to rotate plate **85** so that the roller **79** and securing plate **85** are no longer in contact, as shown in dotted lines in FIG. 7.

As shown in FIG. 10, in the electric circuit, the electromagnet **86** is connected across the rectifier **44** between the switch **36** and the emitter **48** of the transistor **46**, and between the rectifier **44** and relay **45**. When the switch **36** closes, the electromagnet **86** is energized.

In the operation of the drive releasing mechanism **60**, starting with the parts in the positions as shown by the full lines in FIG. 7, when the connecting rod **71** is pulled down, the pin **73** on the sliding plate **70** contacts the lower end of the hole **72** in the plate **65** so that the overall drive releasing mechanism **60**, including the upper end of the hook **61**, is pulled downward. Conversely, if the connecting rod **71** is pushed upwardly, the pin **73** on the sliding plate **70** moves upwardly in the hole **72** so as to push against the slot **77** to rotate the rotatable plate **74** on the shaft **67** as the center. However, since the roller **79** on the lower end of the rotatable plate **74** contacts or abuts the outer periphery of the securing plate **85**, its rotation is prevented and the drive releasing mechanism **60** is merely pushed upwardly. When being pushed upwardly, as shown by the full lines in FIG. 7, if the electromagnet **86** is operated, the plunger **87** is pulled upwardly by the pin **88** so that the shaft **84** is rotated

counterclockwise by the operating arm **89**, thereby rotating the securing plate **85** so as to separate the roller **79**. Consequently, the rotatable plate **74** is rotated counterclockwise on the shaft **67**. Thus the sliding plate **70** rises, as shown by the dotted line in the drawing (FIG. 7), whereby the rotatable plate **74** is moved to the left against the action of the spring **76** by means of the upward force of the sliding plate **70** and the pin **73** against the recess **77**. If the operation of the electromagnet **86** stops so that the connecting rod **71** is pulled downwardly, conversely to the above condition, the sliding plate **70** is lowered together with the pin **73**, the plate **74** is rotated clockwise on the shaft **67**, and the securing plate **82** and operating plate **89** rotate clockwise under the action of the spring **90** of the shaft **84**, so that the respective portions return to the original positions, as shown in full lines in FIG. 7.

Referring now to FIG. 9, the effect of the variable length of the connecting rod **71** will be explained. When the drive releasing mechanism **60** is engaged with the connecting rod **12**, as shown by the full lines in FIG. 7, in order to stop the sewing machine when it is operating, the foot treadle **11** is pressed by the heel of the foot so that the clutch lever **9** is pushed upwardly with enough force to compress the spring **8** of the clutch lever **9** to the position shown by the dot-dash line, so as to apply a brake (not shown), and thus the space designated A between the treadle **11** and its limit stop **92** is decreased. When the space A becomes zero, the distance that the connecting rod **71** is raised from the full line to the dotted line position (such that the whole length of the drive releasing mechanism **60** is shortened) is longer than the length designated B so that the leading end of the treadle **11** is raised from its dotted line position to that shown by the dash lines.

From the above construction and description, it is apparent that, when the treadle **11** is pressed by the toe-end of the foot, the drive releasing apparatus **60** operates to pull the clutch lever **9** down against the force of spring **8**, as shown by the full lines in FIG. 9, so as to initially start the sewing machine. When the treadle **11** is pressed by the heel of the foot so as to stop the sewing machine and to activate the rotary transmission of the clutch motor **10**, since the peripheries of the roller **79** on the plate **74** and that of the securing plate **85** of the drive releasing mechanism **60** contact each other, the clutch lever **9** is pushed upwardly to the full line position in FIG. 7, but represented by the dot-dash line in FIG. 9. Accordingly, the rotary inertia of the sewing machine is restrained by application of the brake. By depressing the heel of the treadle **11**, the switch **42**, in FIG. 10, simultaneously closes to pass the electric current through the transformer **43** for the auxiliary motor **16** to commence rotation. By so doing, the rotative inertia of the sewing machine is quickly decreased so that its rotation corresponds to the one-way clutch **20** driven by said auxiliary motor **16**. At that time, the switch **36**, shown in FIG. 10, also closes. The balance of the operation is the same as that of the previous embodiment, and need not be further described.

When the switch **36** closes, the electromagnet **86** (FIG. 10) operates so that the plunger **87**, shown in full line in FIG. 7, rotates the securing plate **85** by raising the pin **88** and rotating the operating plate **89** and pivot shaft **84**, whereby said plate **74** is rotated counterclockwise on the shaft **67** by the effect of the pin **73** against the recess **77**. Responsive to the upward force on the connecting rod **71**, the sliding plate **70** and connecting rod **71** move relatively upwardly, as shown in FIG. 7 by the dot-dash line.

In as much as the overall length of the drive releasing mechanism **60** is shortened by the raising of the connecting rod **71**, as previously described, so that the treadle **11** is moved downwardly from the position as shown by the dot-dash line in FIG. 9 to the dotted line position in engagement with the stop **92**, the total amount the drive releasing mechanism **60** is shortened is greater than the distance B the leading end of the treadle is raised, and the clutch lever **9** is lowered to the position shown in the dashed line, and the brake is automatically released.

Since the various operations from the time when the coincident switch **36** closes to when the sewing machine stops at the predetermined level of the needle-bar **5** are similar to that previously described in connection with FIGS. 1–6, it will not be further described.

Referring again to FIG. 6, there is shown the relationship of the time lag between that caused by the rotative inertia of the external wheel **19** and that caused by the auxiliary motor **16** of the internal wheel **18**. Also illustrated by the dot-dash line is the rotative change of the peripheral speed of the one-way clutch **20** comprised of the external and internal wheels **19** and **18**, respectively, with respect to when, at the time designated *t*, the force on the treadle **11** is released and pressed by the heel side of the foot so as to restrain rotary inertia commenced by the toe operation of the treadle; at time t_4 the switch **36** closes; at the time designated t_5 the switch of the auxiliary motor **16** opens so as to stop the rotation of the auxiliary motor **16**, and at the time t_6 the needle-bar **5** of the sewing machine stops at the predetermined preset level.

Thus, in accordance with the present invention, with the drive releasing mechanism of the sewing machine, in addition to the ability to stop a needle-bar automatically at any predetermined level of a sewing machine, when the heel of the treadle is pressed so that the rotary transmission of the prime mover or clutch motor is removed or transferred to the intermediate pulley to restrain the rotary inertia, if the rotations of both the internal and external wheels comprising the one-way clutch coincide, an electromagnet can be operated by one switch, and thereafter the sewing machine will be driven by only the auxiliary motor so that the high speed rotation of the sewing machine can be quickly slowed down to shorten the stopping time. Consequently, the high speed rotation of the machine may be automatically reduced so as to shorten the stopping time in addition to the previous capability of stopping a needle-bar automatically at any predetermined level.

What is claimed is:

1. An apparatus for stopping the needle bar of a sewing machine in a predetermined position comprising a flywheel on said sewing machine, prime mover means for periodically driving said sewing machine, a pulley means coupled between the prime mover means and the sewing machine, a one-way overrunning clutch operatively associated with said pulley means, an auxiliary slow speed motor, means coupling said auxiliary motor to said pulley through said one-way clutch for periodically driving said pulley means at a slow speed in the same direction as said prime mover means, the auxiliary motor engaging said clutch and driving the pulley means when the speed of the pulley upon disengagement of the prime mover falls below the speed of the coupling means driven by the auxiliary motor, at least one impedance coil positioned adjacent the periphery of the flywheel of the sewing machine, a magnet mounted on the flywheel of the sewing machine so that it moves past said coil for changing the impedance of said coil, and an auxiliary motor control circuit including a bridge circuit having said coil as an element thereof, circuit energizing switching means coupled in said circuit for energizing said bridge circuit and operatively associated with said coupling means and being closed thereby when said clutch means is engaged for driving the pulley means from said auxiliary motor, auxiliary motor deenergizing switch means for deenergizing said auxiliary motor, and switch actuating means coupled between said bridge circuit and said motor deenergizing switch means for actuating said motor deenergizing switch means when the current flow in said bridge

circuit is changed as said magnet is positioned adjacent said coil.

2. An apparatus as claimed in claim 1 in which there are a plurality of coils at spaced intervals around the axis of said flywheel corresponding to various levels of the needle-bar, said coils being connected in parallel to said bridge circuit, and coil switching means in said bridge circuit for connecting only one coil at a time in said bridge circuit.

3. An apparatus as claimed in claim 1 in which there are two coils on diametrally opposite sides of the axis of the flywheel and corresponding the topmost and bottommost positions of the needle-bar, said coils being connected in parallel to said bridge circuit, and coil switching means in said bridge circuit for connecting only one coil at a time in said bridge circuit.

4. An apparatus as claimed in claim 1 in which said pulley means comprises a pulley having one groove for a belt drive adapted to be coupled to the prime mover and a second groove adjacent thereto for a belt drive adapted to be coupled to the sewing machine, and said clutch means comprises an inner wheel freely rotatable within said pulley in one direction of relative rotation between said wheel and said pulley and engaged with said pulley when the relative rotation between said wheel and said pulley is in the opposite direction.

5. An apparatus as claimed in claim 1 further comprising brake means for braking the prime mover, a lever coupled to said brake means for actuating said brake means when said lever is pivoted to one extremity of its pivotal movement, said lever being spring loaded in a brake releasing direction, treadle means pivotal from a drive position to a brake actuating position, and a releasing mechanism coupled between said lever and said treadle, said releasing mechanism including a shortenable linking means, and an electromagnet coupled to said linking means for actuating the linking means for shortening it, said electromagnet being coupled to said circuit energizing switching means for being energized when said circuit energizing switching means energizes said bridge circuit, whereby when said auxiliary motor starts to drive said sewing machine, said linking means is shortened for allowing the lever to be moved out of the braking position and releasing the brake means.

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