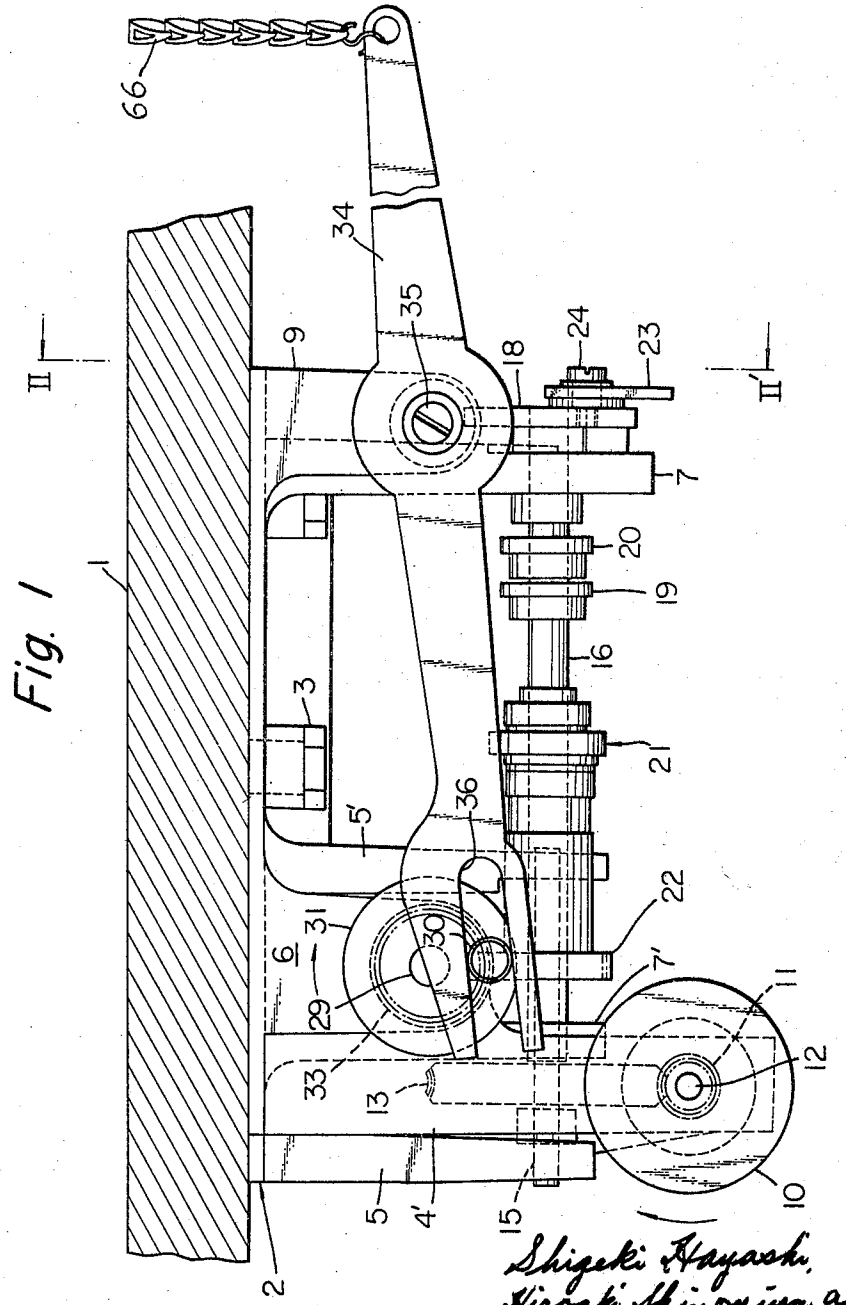
Dec. 9, 1969 SHIGEKI HAYASHI ET AL 3,482,535

CYCLIC SEWING MACHINE

Filed June 12, 1967 8 Sheets-Sheet 1

Fig. 1



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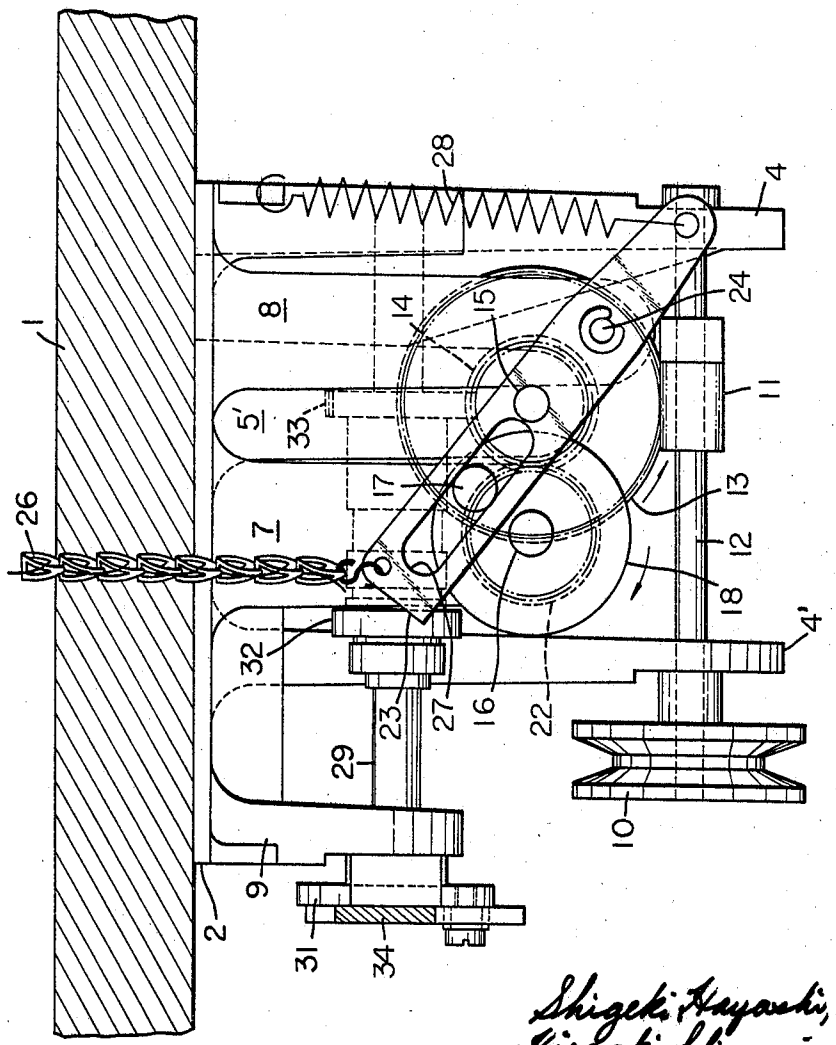
BY Wenderoth, Lind and Ponack, Attorneys

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CYCLIC SEWING MACHINE

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Fig. 2



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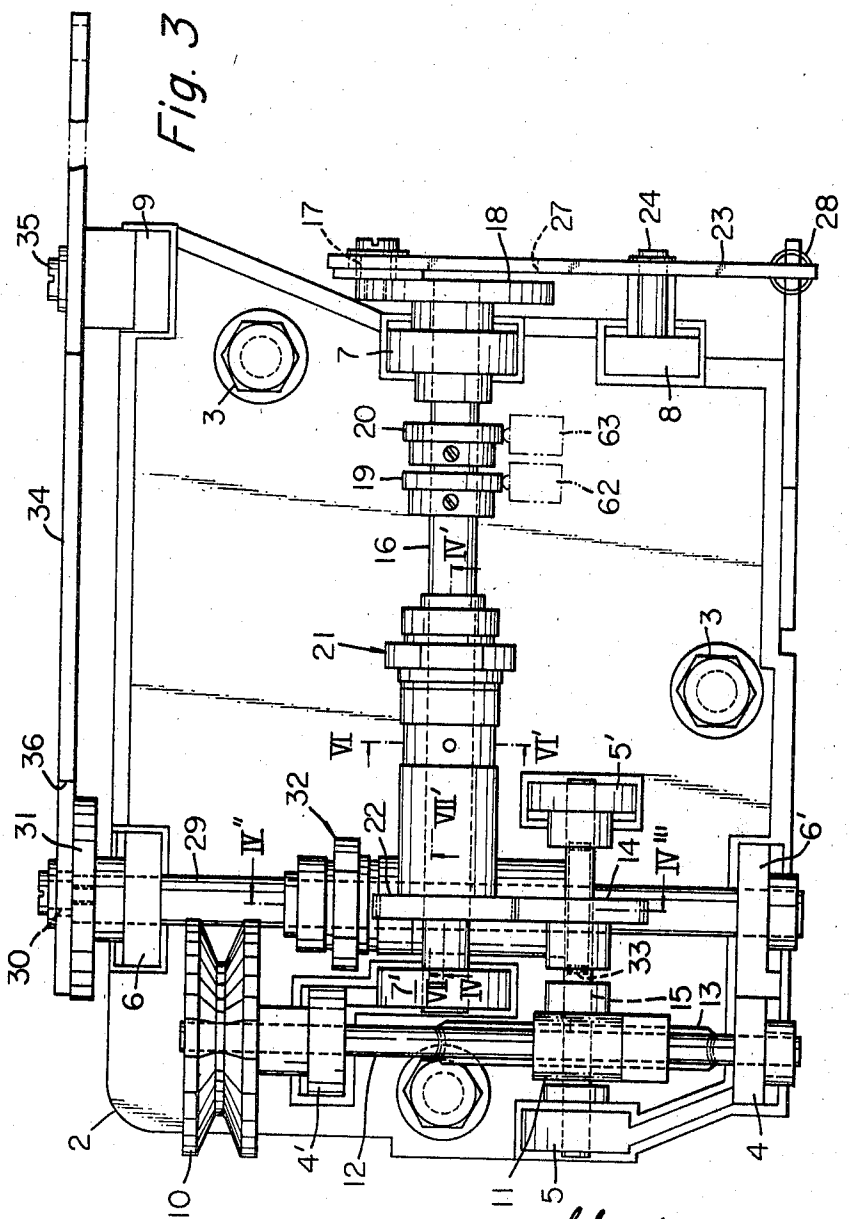
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CYCLIC SEWING MACHINE

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Fig. 3



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Fig. 4

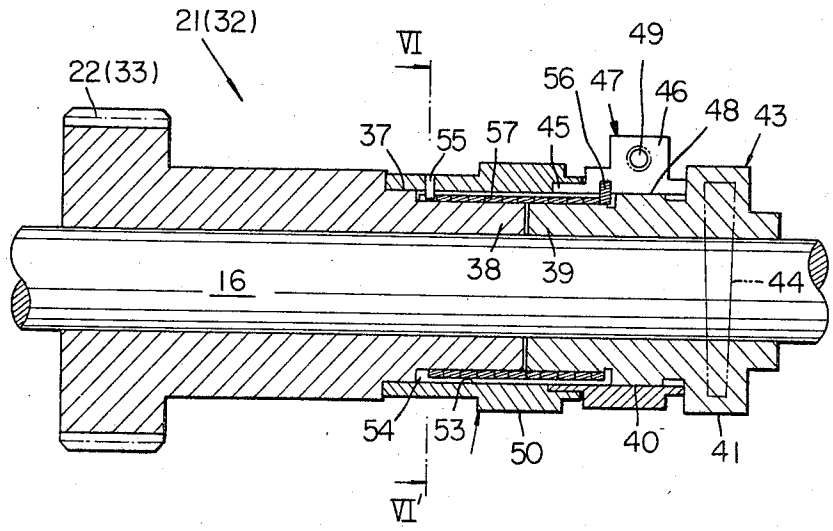
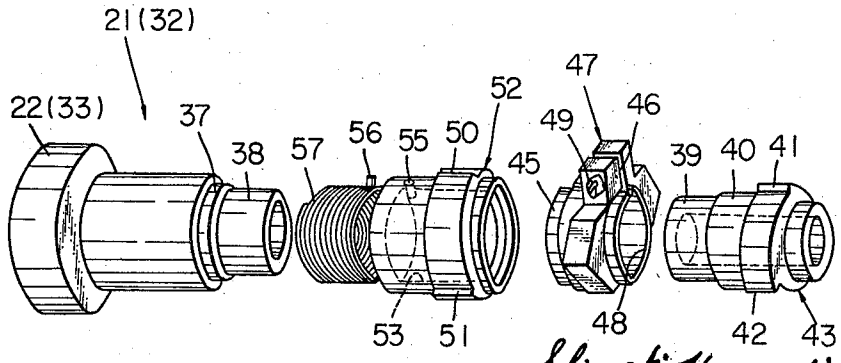


Fig. 5



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CYCLIC SEWING MACHINE

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Fig. 6

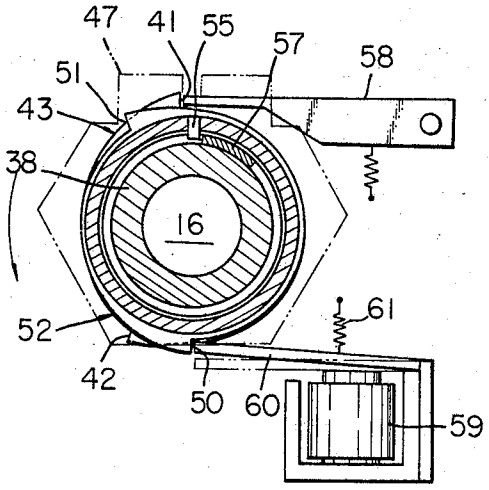
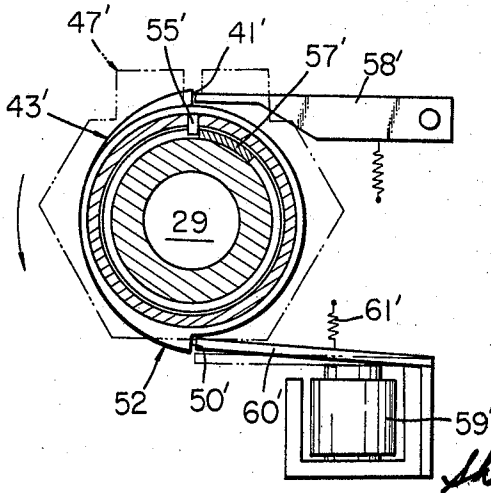


Fig. 7



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CYCLIC SEWING MACHINE

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Fig. 8

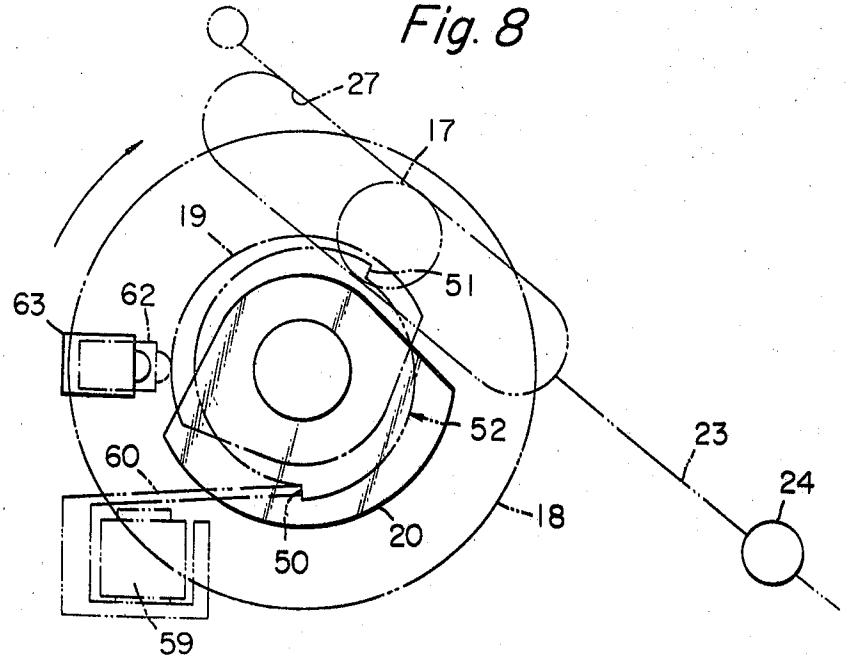
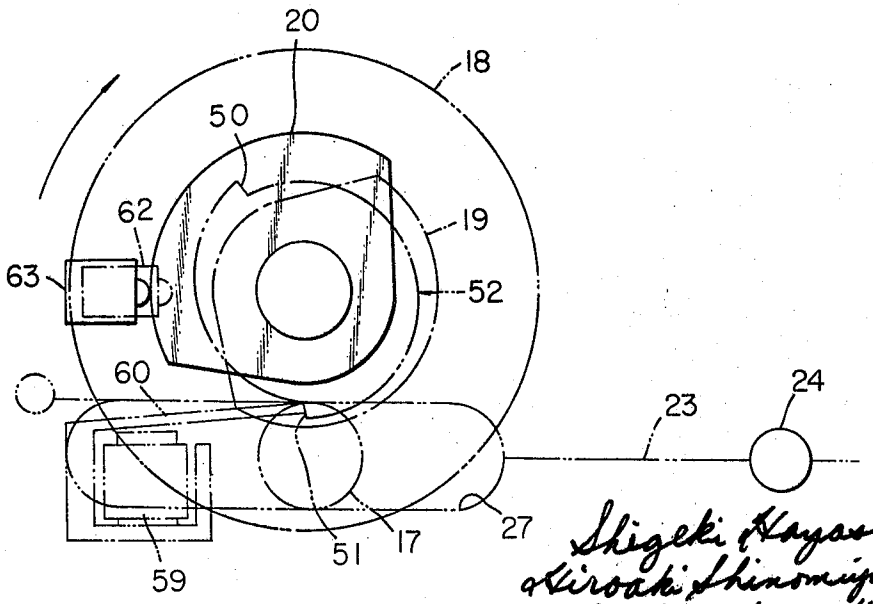


Fig. 9



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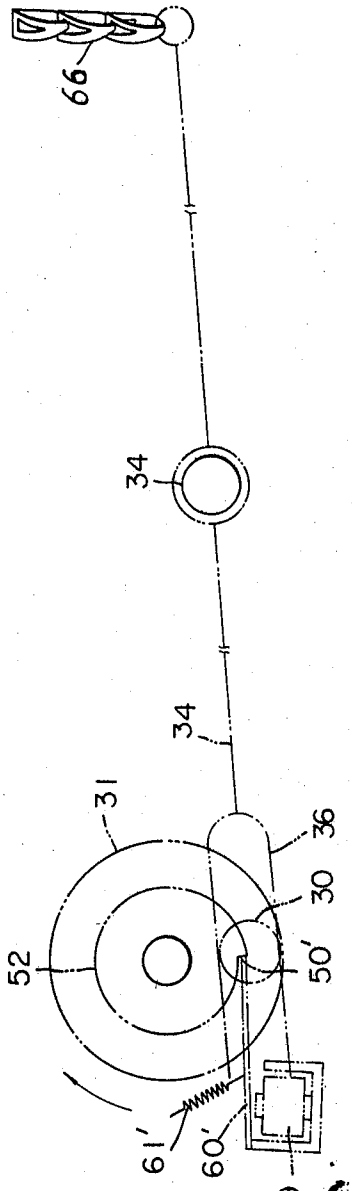
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CYCLIC SEWING MACHINE

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Fig. 10



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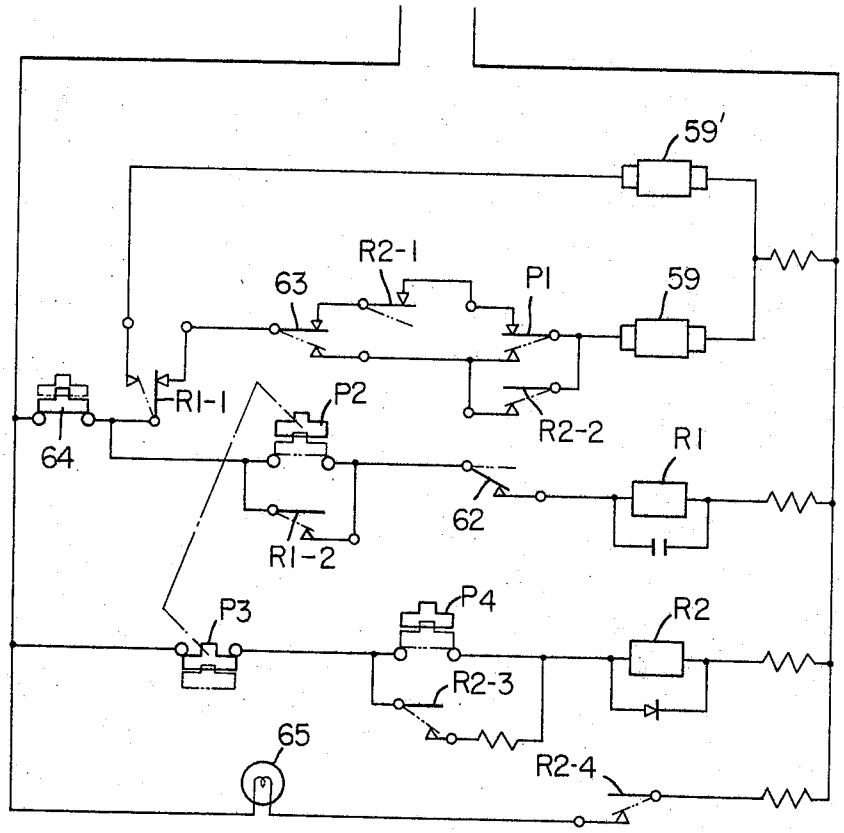
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CYCLIC SEWING MACHINE

Filed June 12, 1967 8 Sheets-Sheet 8

Fig. 11



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Patented Dec. 9, 1969

3,482,535

CYCLIC SEWING MACHINE

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Filed June 12, 1967, Ser. No. 645,415
Int. Cl. D05b 3/00; F16d 21/00
U.S. Cl. 112—67 5 Claims

ABSTRACT OF THE DISCLOSURE

A cyclic sewing machine in which the machine actuating and shut-off mechanism and the presser foot control mechanism are so arranged that after the presser foot has been lowered to its predetermined operative position for holding down the material to be sewn, the machine is actuated and after a desired seam has been formed the machine automatically stops and then the presser foot is raised to the initial inoperative position and in response to the upward movement of the presser foot the thread cut-off blade is actuated to cut the thread off.

BACKGROUND OF THE INVENTION

In a conventional cyclic sewing machine, generally two separate manually operated pedals are provided and one of the pedals is adapted to actuate a mechanism which in turn actuates the machine and raises the needle to a predetermined upper inoperative position to set the same in said position (the mechanism will be referred to as "shut-off" mechanism herein) while the other pedal is adapted to actuate a mechanism which in turn moves the presser foot upwardly and downwardly independently of the shut-off mechanism. The operation of the shut-off mechanism and the presser foot control mechanism should be repeated each time a cycle of the sewing operation is performed for each seam to be formed in the material to be sewn and accordingly, when it is desired or necessary to form a number of seams in the material successively, the operator has to respect operation of both the mechanisms the corresponding number of times requiring considerable labor and the operator becomes fatigued quickly resulting in a lowered operation efficiency. Furthermore, the operation of the shut-off mechanism and presser foot control mechanism in a predetermined timed relation requires skilled operators. In addition, after a cycle of the sewing operation, when the needle is not set in the predetermined upper inoperative position due to trouble in the shut-off mechanism and remains in position in the material or stops halfway between the predetermined upper and lower limits of its movement, if the operator raises the presser foot carelessly, the thread cut-off blade, which is adapted to operate in response to the upward movement of the presser foot, may strike against and break or damage the needle.

Another conventional cyclic sewing machine includes manually operated switches, relays operated by some of the switches, further switches actuated by the relays, switches for actuating and stopping the machine, two magnets operative in response to the closing and opening of all the switches and relays, two shafts adapted to intermittently rotate in response to the energizing and deenergizing of the magnets and in which the two shafts are rotated in such a timed relation that one of the shafts first lowers the presser foot to an intermediate position between the predetermined upper and lower limits of its movement and then after the machine has been precisely positioned relative to the material to be sewn, further lowers the pressure foot to the predetermined lower limit or material holding-down position, whereupon the machine is actuated. After a cycle of operation has been completed the machine is stopped and at the same time the presser foot is returned to the predetermined upper limit position. However, in such a conventional cyclic sewing machine, in order to ascertain whether or not the pressure foot is in a correct position with respect to a portion of the material where a seam is formed the presser foot has to be temporarily suspended midway between the predetermined upper and lower limits of its movement above the portion of the material and accordingly, it is not easy to precisely align the presser foot with the portion of the material. If the presser foot is directly lowered to the lower limit or material holding-down position in order to align the presser foot with the portion of the material, since the machine is adapted to be actuated as soon as the presser foot has been lowered to the material holding position, it is difficult to align the presser foot with the portion of the material. Since the switches are so arranged that they raise the presser foot to the predetermined upper limit as soon as a seam has been formed in the material portion, if the thread breaks during the time the seam is being formed, the particular cycle of operation will finish without forming a complete seam and the presser foot is raised to the upper limit position. In this case the material will be dislocated and accordingly, a complete seam or a length of continuously stitched seam cannot be obtained.

SUMMARY OF THE INVENTION

The present invention relates to a novel cyclic sewing machine suitable for forming button holes and like operations, and more particularly to the control mechanism for such a sewing machine whereby the machine actuating and shut-off mechanism and the presser foot control mechanism are operated in such a timed relation that after the presser foot has been positively lowered to a correct position on the material where a seam is to be formed during a cycle of operation by the sewing machine, the needle is actuated to perform the cycle of operation, and after a predetermined number of stitches for forming a seam have been made in the material the needle and accordingly, the machine automatically stops its operation whereupon the presser foot is raised to its predetermined upper inoperative or ready-for-operation position and in response to the upward movement of the presser foot the thread cut-off blade is actuated to cut the thread off.

The present invention improves the above-mentioned conventional cyclic sewing machine by eliminating the disadvantages inherent in this type of sewing machine. According to the present invention, crank mechanisms are respectively provided on two shafts which are adapted to intermittently rotate through spring clutches in response to the energizing and deenergizing of magnetic devices. The crank mechanisms are respectively connected to the machine shut-off mechanism and the presser foot control mechanism, said magnetic devices being adapted to be energized and deenergized in response to the closing and opening of pedal-actuated switches, as well as switches operative in response to the rotational movement of the shaft associated with said presser foot control mechanism and switches or relays associated with said machine shut-off mechanism, whereby the presser foot can be moved between the lowered operative position and the upper raised ready-for-operation position. When tripped, the shut-off mechanism can actuate the machine to perform a cycle of operation. The presser foot is adapted to be held in said raised ready-for-operation position when the sewing machine needle is held in a predetermined raised inoperative position above the material to be sewn after a cycle of operation by the machine.

One object of the present invention is to provide a novel sewing machine which can effectively eliminate

the defects inherent in the prior art cyclic sewing machines as described above.

Another object of the present invention is to provide a novel cyclic sewing machine in which when manually operated, the foot pedal operates switches associated with the shut-off mechanism and the presser foot control mechanism whereby the presser foot is lowered to its predetermined material holding-down position and immediately after the presser foot has been lowered to the holding-down-position the machine is actuated.

A further object of the present invention is to provide a novel sewing machine in which the presser foot can be easily and precisely aligned with a portion of the material where a seam is to be formed.

A still further object of the present invention is to provide a novel cyclic sewing machine which does not require skilled personnel for operating the machine.

The above and other objects and advantages of the present invention will be more readily apparent to those skilled in the art from the following description when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a preferred form of a control mechanism for a cyclic sewing machine according to the present invention with portion broken away and the machine table thereof shown in section;

FIG. 2 is an end elevational view as seen substantially in the direction of II—II of FIG. 1;

FIG. 3 is a bottom plan view of said control mechanism for a cyclic sewing machine shown in FIG. 1;

FIG. 4 is a fragmentary cross-sectional view taken substantially along the line VI–IV′ or IV″–IV‴ of FIG. 3 showing the spring clutch mechanism associated with the presser foot drive shaft or the needle actuating shaft;

FIG. 5 is an exploded perspective view of the spring clutch mechanism shown in FIG. 4;

FIG. 6 is a fragmentary cross-sectional view taken substantially along the line VI–VI′ of FIG. 3;

FIG. 7 is a fragmentary cross-sectional view taken substantially along the line VII–VII′ of FIG. 3;

FIGS. 8 and 9 are schematic views illustrating the relationship between the presser foot support and drive shaft and the associated spring clutch mechanism and showing them in different operative positions, respectively;

FIG. 10 is a schematic view illustrating the relationship between the needle actuating shaft and the associated spring clutch mechanism; and

FIG. 11 is a circuit diagram of the control mechanism of said cyclic sewing machine.

The control mechanism of the present invention is particularly adapted to be used with a cyclic sewing machine of the type disclosed in U.S. Patent 2,721,526 to Ivanko, to which reference is made for details of the sewing machine per se.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the accompanying drawings and more particularly to FIGS. 1 through 3 thereof in which a preferred embodiment of the present invention is illustrated, the control mechanism body **2** for the novel cyclic sewing machine is secured by means of set screws **3** to the underside of the machine table **1** on which the sewing machine (not shown) is mounted in the known manner. The control mechanism body **2** includes four pairs of bearings **4** and **4′**, **5** and **5′**, **6** and **6′** and **7** and **7′**, the two bearings in each pair being laterally spaced from each other. The control mechanism body **2** further includes individual bearings **8** and **9**.

The first pair of bearings **4** and **4′** rotatably support a prime mover shaft **12** at the opposite ends of the shaft and the shaft has a pulley **10** secured at one extreme end thereof adjacent to the bearing **4′**. A worm **11** is fixedly mounted on the prime mover shaft **12** at a point between the opposite ends of the shaft. The pulley **10** is adapted to transmit continuous rotational movement from a suitable conventional prime mover (not shown) through a conventional transmission means such as an endless belt (not shown) to the shaft **12**.

The second pair of bearings **5** and **5′** rotatably support intermediate shaft **15** at the opposite ends thereof and the axis of the intermediate shaft **15** lies above and intersects at right angles with the axis of the prime mover shaft **12**. The intermediate shaft **15** has a worm gear **13** and a screw gear **14** at spaced intervals therealong and secured thereto between the opposite ends of the shaft and the worm gear **13** meshes with the worm **11** on the prime mover shaft **12**.

The fourth pair of bearings **7** and **7′** rotatably support a presser foot drive shaft **16** at the opposite ends of the shaft and the presser foot drive shaft extends in the same plane and parallel to the intermediate shaft **15**. The presser foot drive shaft **16** has a crank **18** secured to one extreme end thereof adjacent to the bearing **7**, the crank **18** being provided with a outwardly projecting crank pin **17**, and laterally spaced switch cams **19** and **20** are secured to the shaft **16** between the opposite ends thereof. The presser foot drive shaft **16** further has a spring clutch mechanism **21** secured thereto at a position laterally spaced from the switch cam **19**. The construction and operation of the clutch mechanism will be described in detail hereinafter. A helical gear **22** is mounted on the presser foot drive shaft **16** for free rotational movement thereon. The helical gear **22** constitutes part of the spring clutch mechanism **21** and meshes with the screw gear **14** on the intermediate shaft **15**.

The individual bearing **8** supports a presser foot drive plate **23** in such a manner that the plate can pivot about a pivot pin **24**. The drive plate **23** is provided with an elongated slot **27** into which the crank pin **17** on the crank **18** associated with the shaft **16** extends and the crank pin **17** is slidable along the walls of the slot. As shown in FIG. 2, the lower end of a chain **26** is attached to the left end of the presser foot drive plate **23**, the upper end of the chain **26** being connected to the presser foot operating mechanism (not shown) of the sewing machine. Chain **26** corresponds to chain **17** in said Patent 2,721,526. The lower end of a spring **28** is anchored to the right end of the presser bar drive plate **23** (FIG. 2), the upper end of the spring **28** being suitably anchored to the control mechanism body **2**. The strength of the spring **28** is sufficient to counterbalance the force of the spring (not shown) of the presser foot mechanism for holding down material to be sewn by the sewing machine. When the crank pin **17** is in the raised position as shown in FIG. 2, the presser foot (not shown) is in its predetermined lowered operative or material holding-down position and when the crank pin **17** is in the lowered position, the presser foot is in its predetermined raised inoperative or ready-for-operation position.

The third pair of bearings **6** and **6′** rotatably support a needle actuating shaft **29** the axis of which extends above and parallel to the axis of the prime mover shaft **12** and lies above and intersects at right angles with the axis of the intermediate and presser foot shafts **15** and **16**, respectively. The needle actuating shaft **29** has a crank **31** secured to one extreme end thereof adjacent to the bearing **6**, the crank **31** being provided with an outwardly extending crank pin **30**, and a second spring clutch mechanism **32** is fixedly mounted on the needle actuating shaft **29** between the opposite ends thereof. A screw gear **33** which meshes with the screw gear **14** on the intermediate shaft **15** is mounted on the needle actuating shaft **29** for rotational movement thereon. The screw gear **33** constitutes part of the associated clutch mechanism **32**.

The other individual bearing **9** pivotally supports a needle actuating plate **34** substantially in the center thereof by means of a stepped screw **35** which serves as the

fulcrum of the plate. The needle actuating plate **34** is bifurcated at one end as shown at reference numeral **36** (FIG. 1) into which bifurcation the crank pin **30** on the crank **31** associated with the shaft **29** extends for slidable movement between the prongs of the bifurcated end. The other end of the needle actuating plate **34** has the lower end of a chain **66**, which is similar to the chain **26** of the presser foot drive plate **23**, secured thereto and the upper end of the chain **66** is connected to the shut-off mechanism (not shown) of the sewing machine. Chain **66** corresponds to chain **64** in said Patent 2,721,526. When the crank pin **30** is moved to the upper position as a result of rotational movement of the crank **31** on which the pin is mounted, the needle and accordingly, the sewing machine is actuated for a cycle of sewing operation.

The above-mentioned spring clutch mechanisms **21** and **32** mounted on the presser foot drive shaft **16** and needle actuating shaft **29**, respectively, are substantially identical with each other in construction except for one portion thereof, and accordingly, the construction and operation of only the spring clutch mechanism **21** will be described in detail with reference to FIGS. 4, 5 and 6 and the portion of the other spring clutch mechanism **32** different from the corresponding portion of the spring clutch mechanism **21** will be described with reference to FIG. 7.

Referring now to FIGS. 4, 5 and 6, the helical gear **22** freely rotatably mounted on the presser foot drive shaft **16** constitutes part of the spring clutch mechanism **21**. The helical gear **22** is provided at one end thereof with successively smaller diameter portions **37** and **38** so as to have a stepped configuration and an abutment member **43** having the same inner diameter as that of the gear **22** is fixedly mounted on the shaft **16** by means of a transverse pin **44**.

The abutment member **43** is also provided at the end adjacent to the stepped end of the gear **22** with successively smaller diameter portions **39** and **40** having the same inner and outer diameters as the reduced diameter portions **38** and **37**, respectively, so as to form a member with a stepped configuration. The abutment member **43** has two integral pawls **41** and **42** at two angularly spaced points on the periphery thereof and the pawls are directed in diametrically opposite directions to each other.

A split adjusting member **47** having an annular inner portion **48** is releasably mounted on the reduced diameter portion **40** by means of the inner portion **48** which has the same inner diameter as the outer diameter of the reduced diameter portion **40** of the abutment member **43**. The adjusting member is further provided with a reduced diameter portion or boss **45** and opening **46** which is radially aligned with the axis of the member. A screw **49** extends transversely of the opening **46** so as to adjustably secure the adjusting member **47** against the reduced diameter portion **40** of the abutment member **43**.

A clutch member **52** is loosely mounted around the reduced diameter portion **37** of the helical gear **22** and the reduced diameter portion **45** of the adjusting member **47** and has two angularly spaced pawls **50** and **51** on its periphery. The orientation of the pawls **50** and **51** is diametrically opposite to that of the pawls **41** and **42** on the abutment member **43** and these pawls **50** and **51** also direct in diametrically opposite directions to each other. However, the angular displacement between the pawls **50** and **51** is the same as that between the pawls **41** and **42**. The clutch member **52** has an axial bore **53** whose inner diameter is larger than the outer diameter of the adjacent reduced diameter portions **38** and **39** of the helical gear **22** and abutment member **43** and accordingly, the axial bore **53** and the reduced diameter portions **38** and **39** define an annular space **54** therebetween. The inner periphery of the axial bore **53** is provided with a pin **55** which extends radialy toward the axis of the annular space **54**.

A spring **57** in the form of a coiled flat spring steel strip is loosely disposed in the annular space **54** with one end **56** thereof bent radially and outwardly into and anchored in the opening **46** of the adjusting member **47** and the free end of the spring is adapted to abut against the pin **55** of the clutch member **52**.

As shown in FIG. 6, the spring clutch mechanism **21** is adapted to cooperate with a detent piece **58** which is pivoted to the frame (not shown) of the clutch mechanism in a known manner and the detent piece is adapted to abut against either one of the two pawls **41** and **42** on the abutment member **43** so that the abutment member is allowed to intermittently rotate in the direction of the arrow or counterclockwise direction, but is prevented from rotating in the clock-wise direction as seen in FIG. 6.

The spring clutch mechanism **21** is further adapted to cooperate with a magnetic device **59** which has an armature **60** adapted to engage either one of the pawls **50** and **51** on the clutch member **52**. The magnetic device is so designed that when the device in its deenergized position its armature **60** is caused to engage one of the pawls **50** and **51** so as to prevent the clutch member **52** from rotating in the direction of the arrow as seen in FIG. 6, but when the device is in its energized position its armature **60** is caused to disengage from the engaged pawl **50** so as to allow the clutch to rotate in the direction of the arrow. The armature **60** of the magnetic device **59** is normally urged against either one of the pawls **50** and **51** on the clutch member **52** by means of a spring **61** having a strength less than the attractive force of the device **59** and the other end of the spring is suitably anchored to a conventional anchoring means (not shown).

As mentioned above, the spring clutch mechanism **32** is substantially the same as the first spring clutch mechanism **21** except that the abutment member **43** is provided provided with only one pawl which is shown at reference **41** in FIG. 7, instead of two pawls as in the case of the clutch mechanism **21** and the clutch member **52** is also provided withonly one pawl which is shown at reference numeral **50'** instead of two pawls as in the case of the clutch mechanism **21**. The orientation of the abutment member pawl **41'** is the same as that of the corresponding pawl **41** on the abutment member **43** while the orientation of the pawl **50'** is also the same as that of the corresponding pawl **50** on the clutch member **52**. The other parts and arrangement of the second spring clutch mechanism **32** are identical with those of the spring clutch mechanism **21** and the corresponding parts of the second spring clutch mechanism are indicated with the same reference numerals with primes added thereto in FIG. 7.

The positions and orientations of the pawls on the abutment member **43** and clutch member **52** for the presser foot drive shaft **16** are as shown in FIG. 6, and when the pawl **50** on the clutch member **52** is in engagement with the armature **60** of the magnetic device **59**, the pawl **41** on the abutment member **43** is also in engagement with the detent piece **58** and under these conditions the position of the crank pin **17** on the crank **18** associated with the presser foot drive shaft **16** is as shown with the circular broken line in FIG. 8 in which the presser foot (not shown) is in its predetermined lowered operative position for holding down the material to be sewn by the sewing machine (not shown).

When the pawl **51** on the clutch member **52** is in engagement with the armature **60**, the pawl **42** on the abutment member **43** is also in engagement with the detent piece **58** and under these conditions the position of the crank pin **17** on the crank **18** is as shown with the circular broken line in FIG. 9 in which the presser foot is in its predetermined upper inoperative position or ready-for-operation position.

The positions and orientations of the pawls on the abutment member **43'** and clutch member **52'** associated with the needle actuating shaft **29** are as shown in FIG. 7, and when the sole pawl **50'** on the clutch member **52'** is in engagement with the armature **60'** of the magnetic device **59'**, the sole pawl **41'** on the abutment member **43'**

is also in engagement with the detent piece **58'**, and under these conditions, the position of the crank pin **30** on the crank **31** associated with the needle actuating shaft **29** is as shown with the circular broken line in FIG. 10 in which the shut-off mechanism is not yet tripped, but thereafter when the crank **31** and accordingly, the crank pin **30** is moved to the predetermined raised position as the shaft **29** rotates, the shut-off mechanism is tripped to permit the needle and accordingly, the sewing machine to begin operation.

As shown in FIG. 3, switches **62** and **63** are provided so as to cooperate with and to be actuated by the switch cams **19** and **20**, respectively and the cams are adapted to alternately actuate the respectively associated switches as the presser foot drive shaft rotates. The relationship between the switch cams **19**, **20** and the associated switches is so designed that when the presser foot (not shown) is in its predetermined lowered operative position for holding down the material to be sewn and the presser foot drive shaft **16** and associated parts are as shown in FIG. 8, the cam **19** closes the associated switch **62** while the cam **20** opens the associated switch **63**. On the other hand, when the presser foot is in its predetermined raised inoperative or ready-for-operation position and the presser foot drive shaft **16** and associated parts are as shown in FIG. 9, the cam **19** opens the associated switch **62** while the cam **20** closes the switch **63**.

FIG. 11 shows the electric circuit for the control mechanism of the novel cyclic sewing machine and in this circuit, a switch **64** is provided which is associated with the shut-off mechanism, such as described in said Patent 2,721,526, which is adapted to actuate the sewing machine when the shut-off mechanism is tripped and to hold the needle in its predetermined raised inoperative position when the shut-off mechanism is actuated.

The switch **64** is so designed that when the needle is positively held in its predetermined inoperative raised position, the switch is closed, but as soon as the sewing machine is actuated for sewing operation, the switch **64** is opened and maintained in its open state during the sewing operation of the machine. Switch **64** can be actuated by arm **38** shown in said Patent 2,721,526 to be closed when the arm **38** is the position of FIG. 3 of the patent and the sewing machine is running, and open when the arm **38** is in the FIG. 5 position of the patent, and the sewing machine is stopped.

The switches **62** and **63** are alternately closed and opened by the respective cams **19** and **20** on the presser foot drive shaft **16**, in the manner as mentioned above.

The magnetic device **59** is associated with the spring clutch mechanism **21** on the presser foot drive shaft **16** as shown in FIG. 6 and the other magnetic device **59'** is associated with the spring clutch mechanism **32** on the needle actuating shaft **29** as shown in FIG. 7.

Switches P1, P2 and P3 are provided in the circuit and adapted to be closed and opened by manipulation of the manual foot pedal of the sewing machine. The switches P2 and P3 are so mechanically interlocked that when one of the two switches is closed or opened the other switch is opened or closed, respectively, and the switches P1 and P2 are also interlocked in the same manner as in the case of the switches P2 and P3. The switches P1, P2 and P3 may be sequentially manipulated in the order mentioned, for example by fully depressing the foot pedal, or only the switch P1 may be manipulated independently of the other two switches, for example by partially depressing the foot pedal.

Relays R1 and R2 are also provided in the circuit and when these relays are energized or deenergized a plurality of switches R1–1 and R1–2 and R2–1, R2–2, R2–3 and R2–4, respectively, are closed or opened accordingly.

When the relays T1 and R2 are deenergized the switches assume the positions shown in the solid lines, respectively, in FIG. 11 and when the two relays R1 and R2 are energized their associated switches assume the positions shown with the broken lines in the same figure.

Reference numeral **65** designates a conventional lamp which is lighted up or out by a switch P4. The switch P4 is closed only when the automatic thread breakage detection device (not shown) has detected a thread breakage and the closed switch P4 lights up the lamp **65** to indicate to the operator the necessity for interrupting the operation of the sewing machine.

The solid line position of the various switches in the circuit of FIG. 11 show the conditions in which the sewing machine is not operated, the presser foot is lowered to its predetermined operative position for holding down the material to be sewn, the switches P1 and P2 are not actuated by the foot pedal and no current is flowing through the circuit.

In operation, when the prime mover (not shown) is energized, continuous rotational movement is transmitted from the mover through the conventional transmission means (not shown) to the pulley **10** to rotate the pulley is the direction of the arrow in FIG. 1 and the rotation of the pulley **10** in turn continuously rotates the prime mover shaft **12** on which the pulley is fixedly mounted in the same direction.

As the shaft **12** rotates the worm **11** fixedly mounted on the shaft is rotated and the worm in turn rotates the intermediate shaft **15** and the screw gear **14** on the shaft by virtue of meshing engagement between the worm **11** and screw gear **14** fixedly mounted on the intermediate shaft in the counter-clockwise direction as seen in FIG. 2. In this case, the helical gear **22** meshing with the screw gear **14** and constituting part of the spring clutch mechanism **21** rotates about the presser foot drive shaft **16** and the screw gear **33** meshing with the gear **14** and constituting part of the spring clutch mechanism **32** also rotates about the needle actuating shaft **29**.

The rotational direction of the helical gear **22** is counterclockwise as seen in FIG. 6 and the reduced diameter portion **38** integral with the gear also rotates in the same direction as the gear **22**, but when the magnetic device **59** is not energized its armature **60** abuts against the pawl **50** or **51** on the clutch member **52** and the free end of the spring **57** abuts against the inwardly projecting pin **55** so that the spring can be prevented from following the rotating helical gear **22**, and accordingly, the helical gear **22** is allowed to rotate about the shaft **16** independently of the clutch member **52** and abutment member **43**.

When the magnetic device **59** is energized to magnectically attract the armature **60** so as to disengage the pawl from the associated pawl on the clutch member **52**, the clutch member will be permitted to rotate in the counterclockwise direction as seen in FIG. 6 and as a result, the pin **55** releases the free end of the spring **57**. In this case, due to frictional contact between the reduced diameter portion **38** of the continuously rotating helical gear **22** and the inner periphery of the spring **57** the spring is caused to be firmly wound on the outer periphery of the helical gear **22** and of the reduced diameter portion **39** of the abutment member **43** (see FIG. 4) so as to be firmly engaged with the reduced diameter portions. Accordingly, the rotational movement of the helical gear **22** causes rotation of the presser foot drive shaft **16** which is secured to the abutment member **43** by means of the pin **44**.

On the other hand, when the magnetic device **59** is deenergized the armature **60** thereof is urged toward the associated pawl on the clutch member **52** to resume its engagement with the clutch member **52** by the force of the spring **61** having the lower end thereof secured to the armature whereupon the pin **55** is held in the predetermined position so as to be engaged by the free end of the spring **57** whereby the spring **57** is prevented from following the rotating helical gear **22**. Therefore, the helical gear **22** and the abutment member **43** which are now connected to each other by the spring **57** will be separated

from each other whereby the presser foot drive shaft **16** ceases to rotate and the helical gear **22** resumes independent rotational movement about the now stationary shaft **16**,

As mentioned above, the spring clutch mechanism **32** on the needle actuating shaft **29** (FIG. 7) has the substantially same construction as that of the corresponding mechanism **22** on the presser foot drive shaft **16** and the operation of the mechanism **32** is substantially the same as that of the first mechanism **21**.

To describe the operation of the spring clutch mechanism **32** briefly, when the associated magnetic device **59'** is in its deenergized position and its armature **60'** is in engagement with the sole pawl **50'** on the clutch member **52'** as shown in FIG. 7, the helical gear **33** is allowed to rotate about the needle actuating shaft **29**. On the other hand, when the magnetic device **59'** is energized and the associated armature **60'** is disengaged from the associated pawl **50'** on the clutch member overcoming the force of the spring **61'** secured to the armature, the helical gear **33** and the actuating shaft **29** will be caused to rotate in unison in the counter-clockwise direction as seen in FIG. 7.

After a cycle of operation has been completed, the magnetic device **59'** is again deenergized and its armature **60'** is urged to engage the pawl **50'** on the clutch member **52'** by the force of the spring **61'** whereupon the spring clutch mechanism **32** is tripped to cause the actuating shaft **29** to cease its rotation and to allow the helical gear **33** to rotate freely about the shaft **29** again.

As the presser foot drive shaft **16** rotates in the clockwise direction as seen in FIG. 2, the crank **18** fixedly mounted on the shaft **16** and having the crank pin **17** thereon rotates in the same direction. In this case, the movement of the crank pin **17** between its predetermined upper and lower limits controls the movement between the upper inoperative position and lower operative position of the presser foot (not shown) by means of the drive plate **23** and chain **26** secured thereto.

As the needle actuating shaft **29** rotates in the clockwise direction as seen in FIG. 1, the crank **31** fixedly mounted on the shaft **29** and having the crank pin **30** thereon rotates in the same direction. In this case, the movement of the crank pin **30** between its predetermined upper and lower limits controls the movement of the needle (not shown) between the upper inoperative position and lower operative position by means of the actuating plate **34** and chain **66** secured thereto.

To describe the manner in which the novel cyclic sewing machine is actually operated for a sewing operation, when the needle actuating shaft **29** and the crank pin **30** are in the positions as shown in FIG. 1, the cyclic sewing machine is in its inoperative condition in which the presser foot drive shaft **16** and the crank pin **17** assume the positions as shown in FIG. 2 with the presser foot lowered on the material to be sewn and holding down the same against the machine table. Under this condition, the sole pawl **50'** on the clutch member **52'** associated with the needle actuating shaft **29** is engaged by the armature **60'** of the magnetic device **59'** which is in the deenergized state as shown in FIGS. 7 and 10. Also under this condition, the positions of the switch cams **19**, **20** and the clutch pawls **50** and **51** associated with the presser foot drive shaft **12** are as shown in FIGS. 6 and 8 in which the switch cam **19** closes the associated switch **62** while the switch cam **20** opens the associated switch **63** and the pawl **50** is engaged by the armature **60** of the magnetic device **59** which is now in the deenergized state. The positions of the various switches in the electric circuit under this condition are indicated with the solid lnes.

When current is caused to flow through the electric circuit of FIG. 11, the current flows through the switch **64**, the relay switch **R1–1**, the switch **63**, the relay switch **R2–1** and the switch **P1** to energize the magnetic device **59** whereby the armature **60** associated with the magnetic device is disengaged from the pawl **50** on the clutch member **52** whereupon the spring clutch mechanism **21** is operated to rotate the associated presser foot drive shaft **16** in the clock-wise direction as seen in FIG. 2.

The shaft **16** continues to rotate about 150° until the switch cam **19** on the shaft opens the switch **62** and the switch cam **20** closes the switch **63** to the position indicated with the broken line in the circuit of FIG. 11 whereupon the circuit to the magnetic device **59** is broken off to deenergize the device and to armature **60** engages the pawl **51** on the clutch member **52**, and then the shaft **16** ceases to rotate. According, when the shaft **16** has completed its 150° rotation the crank pin **17** has moved from the position of FIG. 8 to that of FIG. 9 and the presser foot has been raised from the lower operative position to the upper inoperative or ready-for-operation position. Under this condition, the switches **62** and **63** have been moved to the positions indicated with the broken lines in FIG. 11.

With the presser foot held in the raised position as mentioned just above, the material to be sewn is placed on the machine table below the presser foot and thereafter the switch **P1** is depressed to the broken line position to close the switch whereupon current flows through the switch **64**, the relay switch **R1–1**, the switch **63** (now in the broken line position) and the switch **P1** to energize the magnetic device **59**.

The energized magnetic device **59** magnetically attracts its armature **60** to disengage the armature from the now engaged pawl **51** on the clutch member **52** whereupon the spring clutch mechanism **21** is operated to rotate the presser foot drive shaft **16** in the clock-wise direction as seen in FIG. 2. The shaft **16** continues to rotate about 210° until the switch cam **19** closes the switch **62** while the switch cam **20** opens the switch **63** to the solid line position of FIG. 11 whereupon the circuit to the magnetic device **59** is broken off to deenergize the device and to urge the associated armature **60** to engage the pawl **50** on the clutch device **52** and then the shaft ceases to rotate.

The rotation of the presser foot drive shaft **16** through 210° as mentioned above moves the crank pin **17** from the position of FIG. 9 to that of FIG. 8 and lowers the presser foot from the upper inoperative or ready-for-operation position to the lower operative or material holding down position by means of the presser foot drive plate **23** and the chain **26** secured thereto.

In this case, if it has been found that the material is not disposed in a proper sewing position on the machine table, the switch **P1**, which is now in the broken line position, is moved to the solid line position and current is allowed to flow through the magnetic device **59** to energize the device. The energized magnetic device operates in the same manner as mentioned above and the crank pin **17** is moved from the position of FIG. 8 to that of FIG. 9 whereby the presser foot is raised to the upper inoperative position and held there and the position of the material is adjusted to a proper sewing position while the presser foot is held in the raised position. With the presser foot held in this upper inoperative position, the switch **63** is closed or in the broken line position of FIG. 11, the switch **62** is in open or in the broken line position of FIG. 11 and the switch **P1** is in the solid line position of FIG. 11.

After the material to be sewn has been positioned in the proper sewing position on the machine table below the presser foot, the switch **P1** is again depressed down to the broken line position whereupon the magnetic device **59** is energized in the manner as described above and the crank pin **17** is moved from the position of FIG. 9 to that of FIG. 8 so as to lower the presser foot to the lower operative position for holding down the material and at the same time the switch **62** is closed to the solid line position and the switch **63** is opened to the solid line position of FIG. 11, respectively.

Thus, it will be understand that when the material to be sewn is not in the proper sewing position the presser foot can be raised to the upper inoperative position and the position of the material can be adjusted with the presser foot held in the raised inoperative position.

After the position of the material has been adjusted, the switch P1 which has been depressed to the broken line position of FIG. 11 is further depressed so as to move the associated switches P2 and P3 to the broken line positions of FIG. 11 whereupon current is caused to flow through the switches 64, P2 and 62 (now in the solid line position) to energize the relay R1. The energized relay R1 moves the switches R1–1 and R1–2 to the broken line positions of FIG. 11. When the switch R1–1 is moved to the broken line position current is caused to flow through the switches 64 and R1–1 (now in the broken line position) to energize the magnetic device 59′ whereby the armature 60′ of the device 59′ is disengaged from the pawl 50′ on the clutch 52′ whereupon the spring clutch mechanism 32 is operated to cause the needle actuating shaft 29 to rotate in the clockwise direction as seen in FIG. 1.

When the crank pin 30 on the crank 31 associated with the shaft 29 is moved to the predetermined upper limit of its stroke as the shaft 29 rotates in the above direction, the crank pin 30 trips the shut-off mechanism (not shown) by means of the needle actuating plate 34 and chain 66 attached thereto so as to actuate the needle and accordingly, the sewing machine sewing operation with the shut-off mechanism held in its tripped position. The control mechanism of the invention thus initiates the sewing machine operation, and further drive is carried out by the sewing machine itself. Simultaneously, the switch 64 is opened to the broken line position of FIG. 11 to break off the circuit to the relay R1 to deenergize the relay and move the switches R1–1 and R1–2 to the solid line positions thereby to break off the circuit to the magnetic device 59′ to deenergize the device. Accordingly, the magnetic device 59′ is deenergized before the needle actuating shaft 29 has completed a complete rotation of 360° and the armature 60′ of the magnetic device 59′ is moved to the upper position and engages again the pawl 50′ on the clutch member 52′ which has just completed a complete rotation. Thereby the crank pin 30 and the needle actuating plate 34 stop in the positions as shown in FIGS. 1 and 10, respectively.

The reason for which the switch R1–2 is closed in the broken line position is that the closed switch R1–2 completes a self-holding circuit for the relay R1 which prevents any trouble which may occur if the switch P2 was depressed for a very short period of time. That is, if by the actuation of the relay R1 the switch R1–1 is moved to the broken line position and the switch P2 is opened before the magnetic device 59′ is energized, without the holding circuit the relay R1 would be deenergized and return the switch R1–1 to the initial solid line position so that the magnetic device 59′ would not be energized.

After the operator has confirmed that the presser foot has been sufficiently lowered to the material holding-down position and the sewing machine has been set in operation, he releases the switches P1 and P2 (P3) by releasing the foot pedal which has been previously depressed. Under this condition, since the presser foot is now in its lowered operative position (FIG. 8), the switches 62 and 63 are then in the solid line positions of FIG. 11. And since the sewing machine has been set in operation, the switch 64 is in the broken line position (open), the released switches P1 and P2 (P3) are in the solid line positions, and the switches R1–1 and R1–2 are in the solid line position with the relay R1 held in the inoperative position.

Thus, after the cyclic sewing machine has completed a cycle of operation by forming a predetermined number of stitches on the material to be sewn and the needle has been raised to the predetermined upper inoperative position and set there by the actuation of the shut-off mechanism, the switch 64 is closed to the solid line position whereupon current is caused to flow through the switches 64, R1–1, 63, R2–1 and P1 to energize the magnetic device 59 whereby the presser foot is caused to automatically rise to the predetermined upper inoperative position.

In other words, the energized magnetic device 59 magnetically attracts the armature 60 to disengage the same from one of the pawls 50 and 51 of the clutch member 52 whereupon the spring clutch mechanism 21 is operated to rotate the presser foot drive shaft 16 in the clockwise direction as seen in FIG. 2. The presser foot drive shaft 16 continues to rotate about 150° until the switch cam 19 opens the switch 62 while the switch cam 20 closes the switch 63 to the broken line position in FIG. 1 to break off the circuit to the magnetic device 59 to deenergize the device. The armature 60 associated with device 59 is caused to engage the other pawl on the clutch member, and then the shaft ceases to rotate. Thus, as the shaft 16 rotates about 150° as mentioned above, the crank pin 17 moves from the position of FIG. 8 to that of FIG. 9 while raising the presser foot from the lower operative position to predetermined the upper inoperative position by means of the drive plate 23 and chain 26 secured thereto and at the same time the switches 62 and 63 are moved to the broken line positions of FIG. 11.

As mentioned above, when it is desired or necessary to adjust the position of the material to be sewn so as to dispose a portion or portions of the material where a predetermined number of stitches are to be formed in a proper position relative to the presser foot, the switch P1 is operated to raise the presser foot to the upper inoperative position and the position of the material is adjusted with the presser foot held in the raised position, and after the material has been properly positioned, the switch P2 (P3) is closed to actuate the sewing machine. After it has been confirmed that the sewing machine has been set in motion, the switches P1 and P2 (P3) are returned to the initial positions.

If the thread breaks during the operation of the sewing machine, the switch P4 associated with the thread breaking detection device (not shown) is automatically energized to close to the dotted line position of FIG. 11 and current is caused to flow through the switches P3 and P4 to energize the relay R2 and the energized relay R2 in turn moves the switches R2–1, R2–2, R2–3, and R2–4 to the closed positions in FIG. 11.

The switch R2–1 is adapted to break the circuit to the magnetic device 59 so as not to energize the device even if the switch 64 is closed after a cycle of operation by the sewing machine. The switch R2–3 is adapted to cause the relay R2 to self-hold and the switch R2–4 is adapted to light up the lamp 65 so that the operator will be given a visual warning of such breakage of the thread.

The function of the switch R2–1 will now be described. Since the switch R2–1 is opened before a cycle of the sewing operation is completed and the magnetic device 59 is not energized even if the switch 64 is closed after the cycle of the sewing operation, the presser foot can not rise to the upper inoperative position after the cycle of operation and remains in the lower operative or material holding-down position and the sewing machine ceases operation with the presser foot held in the lower position.

Under this condition, since the sewing machine is not in its normal operation position, the positions of the various switches of the electric circuit of FIG. 11 will be such that the switch 64 is in the solid line position, the switches 62 and 63 are in the solid line positions because the presser foot is held in the lowered position, the switches R2–1, R2–2, R2–3 and R2–4 are in the broken line positions because their relay R2 is energized, the switches P1 and P2 (P3) are in the solid line positions because the manual pedal has been released.

If the sewing machine is manually turned back to the same position in which the thread broke and then the

broken ends of the thread are tied together, thereafter the switch P4 will be opened to the solid line position. But the relay R2 is self-holding by means of the switch R2–3, and the relay maintains its energized condition. Thereafter, when the switch P1 is depressed the switch assumes the position indicated with the broken line, but since the switch 63 is in the solid line position, the magnetic device 59 is not energized and the presser foot is held in the lowered operative position.

Furthermore, when the switch P2 (P3) is depressed to the broken line position, then the switch P2 energizes the relay R1 to move the switch R1–1 to the broken line position whereby the magnetic device 59′ is energized to actuate the sewing machine in the manner mentioned above and the switch P3 breaks off the circuit to the relay R2 to deenergize the relay and accordingly, the switches R2–1, R2–2, R2–3 and R2–4 are moved to the solid line positions. The switch R2–3 releases the relay R2 from its function of self-holding and the switch R2–4 opens to deenergize the lamp 65 and subsequently the switches P1 and P2 (P3) are opened by release of the foot pedal after the sewing machine has resume its operation to move the switches to the solid line positions. Accordingly, the sewing machine can resume sewing operation from the point on the material where the thread broke down and when the machine has completed this particular cycle of sewing operation which was once interrupted due to thread breakage. The needle is then raised to the predetermined inoperative position and held there whereupon the switch 64 is closed to energize the magnetic device 59 so as to raise the presser foot to the predetermined upper inoperative or ready-for-operation position in the manner as mentioned above.

When the sewing machine is left inoperative for a fairly long period of time such as the period from the time at which one day's work on the sewing machine has ended to the time at which the next day's work starts, since the presser foot is left in its raised position for such a long time, the spring which is adapted to urge the presser foot against the material to be sewn for holding the material down is left in its extended state for the long time. The spring can easily become fatigued and there is the possibility that the holding-down force of the presser foot may fluctuate.

In order to eliminate such a difficulty, the following electric circuit is established. That is, when a cycle of the sewing operation has been completed, since the sewing machine still stands in the predetermined inoperative position and the presser foot is held in the upper inoperative position (FIG. 9) a circuit is so established such that only the switches 62 and 63 associated with the presser foot drive shaft 16 (in the material holding-down position) among the various switches shown in FIG. 11, are in the broken line positions and all the other switches are in the solid line positions.

With the electric circuit established in this way, when the switch P4, which is responsive to the automatic thread breakage detection device, is closed to the broken line position, current is caused to flow through the switches P3 and P4 to energize the relay R2 so as to move the switches R2–1, R2–2, R2–3 and R2–4 which are associated with the relay R2 to the broken line positions. Thereupon the switch R2–1 interrupts the circuit to the magnetic device 59, the switch R2–3 causes the relay R2 to self-hold and the switch R2–4 lights the lamp 65 up. And when the switch R2–2 is moved to the broken line position, simultaneously current is allowed to flow through the switches 64, R1–1 and 63 (in broken line position) to energize the magnetic device 59 so as to attract the associated armature 60 to separate the same from the pawl 51 on the clutch member 62. Thereupon spring clutch mechanism 21 is operated to rotate the presser foot drive shaft 16 in the clock-wise direction as seen in FIG. 2.

The drive shaft 16 continues to rotate about 210° until the switch cam 19 closes the switch 62, the switch cam 20 opens the switch 63 to the solid line position in FIG. 11, the magnetic device 59 is deenergized because both the circuits thereto are interrupted and the armature 60 engages the other pawl 50 on the clutch member 52, and then the shaft 16 ceases to rotate. As the presser foot drive shaft 16 rotates in the manner as described just above, the crank pin 17 on the crank 18 associated with the shaft 16 moves from the position of FIG. 9 to that of FIG. 8 and lowers the presser foot from the upper inoperative or ready-for-operation position to the lower operative or material holding-down position and hold in the lowered position by means of the presser foot drive plate 23 and chain 26 secured thereto.

As is clear from the foregoing description, in the novel cyclic sewing machine, when the various switches are manipulated by pressing the only one pedal down, both the sewing machine shut-off mechanism (which normally holds the needle in the predetermined upper inoperative position and when tripped, actuates the needle and accordingly, the sewing machine) and the presser foot control mechanism are simultaneously actuated. As compared with the conventional cyclic sewing machine, in which the shut-off mechanism and presser foot control mechanism must be separately operated, requiring complicated operation procedures and highly trained operators, the novel cyclic sewing machine can be operated with great ease and simple procedures and reduce fatigue of the operator whereby operation efficiency can be greatly enhanced.

Furthermore, if desired or necessary, only the presser foot can be moved upwardly and downwardly while the other machine parts are kept inoperative, and accordingly, the position of the needle can be precisely aligned with the material to be sewn by suitably adjusting the position of the needle relative to that of the material.

In addition, if any thread breakage occurs during a cycle of operation, after a cycle of the sewing operation has been completed forming an imperfect seam line on the material, the presser foot can be effectively prevented from being raised to the upper inoperative position, and accordingly, the next cycle of sewing operation can resume at the very point on the material where the thread breakage occurred.

Furthermore, the novel cyclic sewing machine is so designed that when the thread cutting blade is operated in response to the upward movement of the presser foot and the switch 64 associated with the shut-off mechanism is closed so as to raise the presser foot only when the needle has been set in the predetermined upper inoperative position, when the shut-off mechanism gets out of order and the needle fails to rise to the predetermined upper position, the thread cut-off blade also fails to operate, and accordingly, the presser foot and the thread cut-off blade will not intersect each other and breakage and/or damage which will be otherwise inevitable will be prevented.

While one preferred embodiment of the invention has been shown for purpose of disclosure, other embodiments of the invention as well as modifications to the disclosed embodiment thereof which do not depart from the spirit and scope of the invention may occur to those skilled in the art.

What is claimed is:

1. In a cyclic sewing machine of the type having a shut-off mechanism operable to initiate the operation of the sewing machine and to stop the sewing machine with the needle held in its predetermined raised position after a cycle of operation of the sewing machine has been completed, a first pull chain for actuating said shut-off mechanism to start the sewing machine, a presser foot movable between its lowered material clamping position and its raised ready-for-operation position and a second pull chain for actuating said presser foot; a control mechanism comprising a support, a starting shaft rotatably mounted on said support and having a first crank on one end thereof, a starting lever pivotally mounted on

said support and having one end connected with said first pull chain and the other end coupled with said first crank, a first spring clutch on said starting shaft, a first electromagnet operatively associated with said first clutch to cause said starting shaft to rotate through only one revolution each time said first electromagnet is actuated to cause said starting lever to pull said first pull chain to start the sewing machine, a presser foot drive shaft rotatably mounted on said support and having a second crank secured to one end thereof, an actuation lever pivotally mounted on said support and having one end connected with said second pull chain and the other end coupled with said second crank, a second spring clutch on said presser foot drive shaft, a second electromagnet operatively associated with said second clutch to cause the presser foot drive shaft to rotate intermittently and to stop at two positions during each revolution for moving said actuation lever to pull and release said second pull chain to cause said presser foot to rise and lower between its raised position and its lowered position, and a control circuit connected to said electromagnets and having manually actuated switch means and shut-off mechanism actuated switch means there-in for energizing said electromagnets for raising and lowering of said pressing foot and for starting operation of said sewing machine by tripping said shut-off mechanism.

2. A control mechanism as claimed in claim 1 in which the manually actuated switch means of said control circuit comprises a first switch in series with said second electromagnet for selectively energizing said second electromagnet for selectively operating said presser foot, and a second switch in parallel with said first switch and a relay in series with said second switch, said first electromagnet being in parallel with said second electromagnet and said control circuit having a relay switch in series with said electromagnets for energizing them alternately, said relay switch being switched by said relay, whereby when said second switch is actuated, said first electromagnet is energized to trip said shut-off mechanism for starting said sewing machine.

3. A control mechanism as claimed in claim 2 in which said shut-off mechanism actuated switch means comprises a further switch in series with said first and second electromagnets and said second switch for deenergizing said circuit when said shut-off means has been tripped for operating said sewing machine through a cycle of operation.

4. A control mechanism as claimed in claim 2 in which said first and second switches are mechanically linked for sequential operation in the named order.

5. A control mechanism as claimed in claim 2 further comprising a thread breakage responsive switch, said sewing machine having a thread breakage detecting means with which said responsive switch is coupled, a thread breakage responsive relay in series with said thread breakage responsive switch, and relay switches actuated by said thread breakage responsive relay connected in said circuit with said second electromagnet, said relay switches breaking said circuit including said second electromagnet when the thread breaks for preventing energization of said electromagnet and rise of the presser foot.

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