

[54] SEWING MACHINE ELECTRICAL DRIVE
DEVICE

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[57] ABSTRACT

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[58] Field of Search 112/219 A, 219 B,
112/219 R, 67, 87, 220

A sewing machine drive device in which a current interrupter comprising conducting rings, part of whose peripheries are insulated, and brushes, each being in contact with the periphery of the corresponding ring, is employed to make it possible to stop a sewing machine needle accurately in a desired position.

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3 Claims, 8 Drawing Figures

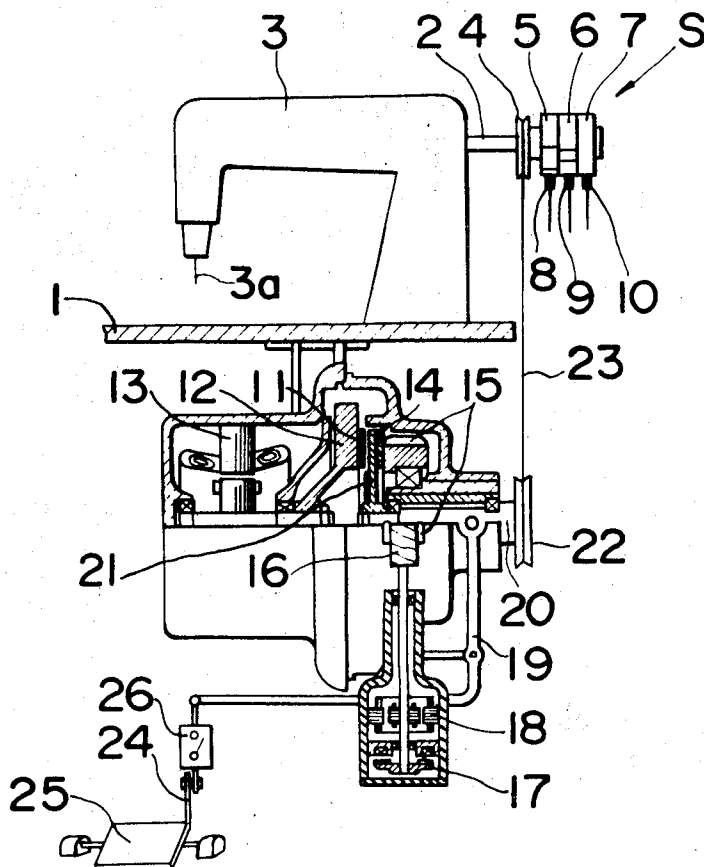


FIG. 1

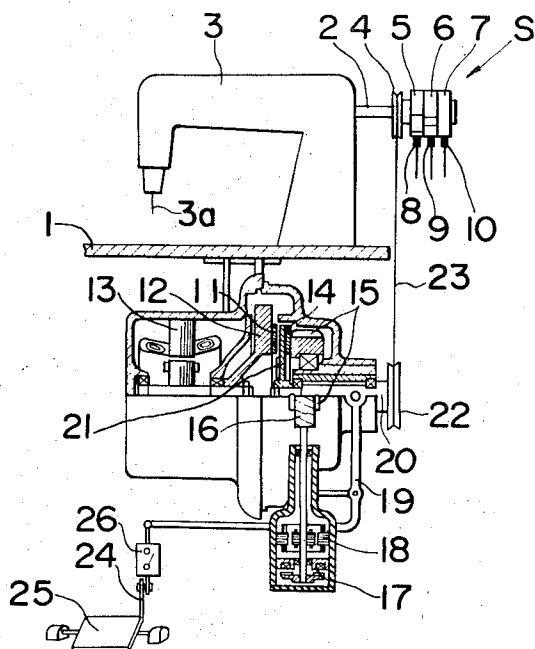


FIG. 2

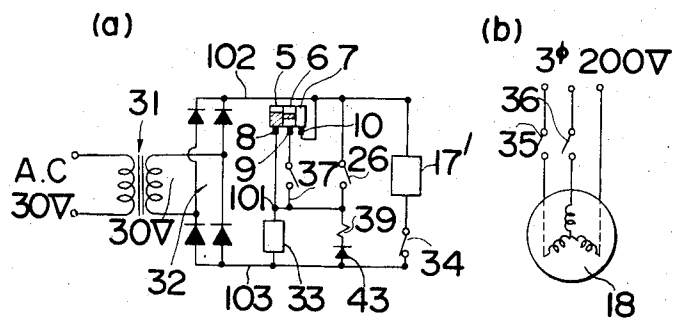


FIG. 3

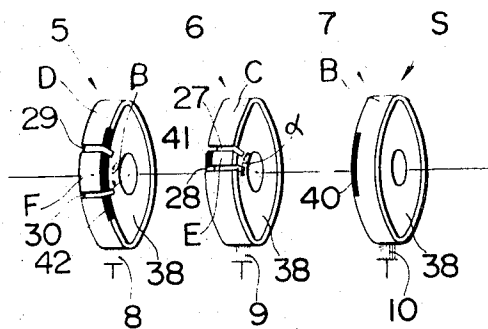
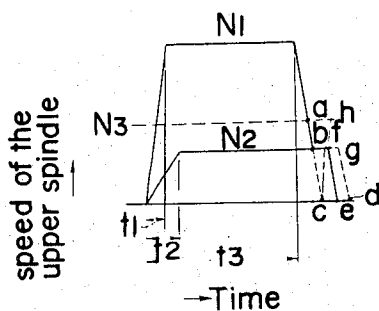
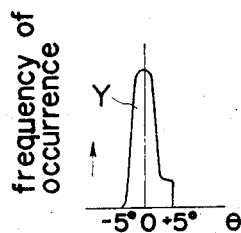


FIG. 5

FIG. 4



angle of the stopped position of the upper spindle

FIG. 6

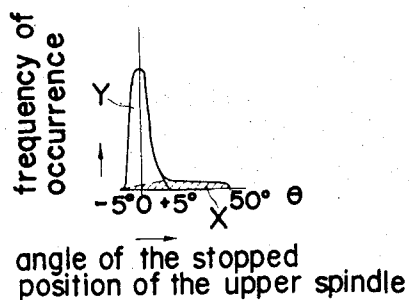
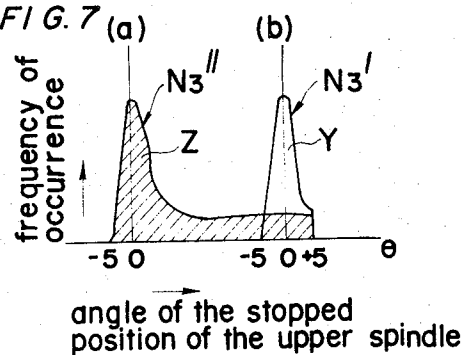


FIG. 7



SEWING MACHINE ELECTRICAL DRIVE DEVICE

The present invention relates to sewing machines, and more particularly to a drive device for improvement of sewing machine functions which is provided with a control unit whereby a sewing machine needle can be stopped in a predetermined position.

The sewing machine drive device of this kind usually comprises a main and an auxiliary drive section, and provides means such an arrangement including a clutch, relay and the like whereby, when the sewing machine is stopped from the normal driving of the main drive section the sewing machine upper spindle for driving the sewing machine needle is disengaged from the main drive section and coupled to the auxiliary drive section and rotated until the needle reaches the predetermined stopping position. A sewing machine being an object of frequent use, it is, of course, desirable that in such machine relays, and other parts be long-lasting, as well as it being possible to stop the needle in a predetermined position. There are known drive devices to provide the above-described function, but such conventional devices suffer from the disadvantages that, especially when a machine is being operated at high speed, however careful an operator is, when he or she wishes to stop the needle momentarily in a predetermined position, there is practically always difference between the desired position and the position where the needle actually stops (for example, up to 50°, calculating on the basis of angular displacement of the machine upper spindle), or that, if it is attempted to improve the stopping precision, chattering of relays results and the effective life of connecting parts is considerably lessened or low-speed rotation has to be kept at a constant speed.

To overcome the disadvantages inherent in conventional devices, it is accordingly an object of the present invention to make it possible to stop a sewing machine upper spindle in a predetermined position, for example, with a precision of within about 10 angular degrees.

It is a further object of this invention to make it possible to maintain the above-mentioned precision in stopping a sewing machine upper spindle regardless of the speed of low-speed operation of the sewing machine, i.e., the speed when the machine is driven by the auxiliary drive section.

It is a further object to provide the above-described facilities while at the same time ensuring outstandingly long service of the relays used in the control unit.

According to one preferred embodiment of the present invention, a sewing machine electrical drive device is shown as generally comprising a main drive unit, a secondary drive unit that operates at reduced speed, a brake unit that controls the secondary drive unit, a clutch assembly for selective engagement with the main or secondary drive unit to drive a sewing machine upper spindle, a switch that is closed when said clutch assembly is engaged with the main drive unit and open when the clutch assembly is disengaged from the main drive unit and engaged with the secondary drive unit, a relay possessing a holding contact and contacts which control the above-mentioned brake unit, and a current interrupter fixedly mounted on the sewing machine upper spindle and comprising conducting rings, part of whose peripheries are non-conducting and into two of which grooves are cut at the respective non-conducting peripheries the length of the arc lying between the

grooves in one ring being greater than that between the grooves in the other, and brushes which contact the said conducting rings, wherein the said relay is brought into connection with an electrical power source through the action of the said switch and through the said brushes in contact with said conducting rings and a series circuit in connection with the above-mentioned holding contact.

In the arrangement of a sewing machine drive device as hereinbefore described, a current interrupter comprising conducting rings, part of whose peripheries are insulated, and brushes, each being in contact with the periphery of the corresponding ring, makes it possible to stop a sewing machine needle accurately in a desired position. Since it is ensured that the sewing machine upper spindle is always stopped from the reduced speed of the secondary drive unit by the relay controlled by the current interrupter of three rings contacted each other in a line at their peripheries part of which are non-conducting, a first ring of which contacts a brush in connection with the power source, a second ring of which contacts a brush in connection with the relay through the holding contact, and a third ring of which contacts a brush in connection with the relay.

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with one preferred form of embodiment thereof shown in the accompanying drawings, in which;

FIG. 1 is a schematic front view of the sewing machine associated with an electrical drive device embodying the present invention, portions of which are broken away for the purpose of illustration of various component parts disposed therein,

FIG. 2, (a) and (b), is a control circuit diagram employed in the drive device of FIG. 1,

FIG. 3 is an exploded schematic perspective view, on an enlarged scale, of the association among essential parts of the drive device of FIG. 1,

FIG. 4 is a time chart illustrating operative stages of the drive device of the present invention,

FIG. 5 is an explanatory graph illustrating stopping point distribution of the sewing machine spindle driven by the drive device of the present invention,

FIG. 6 is a similar view to FIG. 5 but using a conventional drive device, and

FIG. 7 is a similar view to FIG. 6 but using another conventional drive device.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by the like reference numerals throughout the several views of the accompanying drawings. It is further to be noted that, for the sake of brevity, the description of the present invention will be hereinafter made in comparison with the conventional drive device used in a sewing machine.

Referring first to FIGS. 1 to 3, a sewing machine table 1 is supporting thereon a sewing machine head-stock 3 provided with an upper spindle 2 on which is mounted a pulley 4 and a current interrupter S comprising three rings 5, 6 and 7 each being in sliding contact with the corresponding fixed brushes 8, 9 and 10, which detects the angular position of the upper spindle 2 in connection with the stopping position of a sewing machine needle 3a. The sewing machine drive unit associated with a treadle 25 is mounted below the sewing machine table 1 by conventional means such as a bolt

and the like and comprises a main motor 13 which provides direct drive to a fly-wheel 12, on which is fixedly mounted a clutch plate 11 for high-speed operation, a secondary motor 18, whose shaft is in connection at one end with a direct current electromagnetic brake unit 17 and at the other end with a worm 16, which always engages a worm gear 15 mounted on a clutch plate 14 for low-speed operation, and a clutch including the pair of clutch plates 11, 14 and a rotatory disc 21, which, through connection with a clutch shaft 20 on which is mounted a motor pulley 22, and cooperative action of a lever 19, is selectively shifting in the direction of the clutch shaft 20 to engage with the high-speed clutch plate 11 or the low-speed clutch plate 14. The sewing machine upper spindle 2 is driven by a belt 23 around the motor pulley 22 of the clutch shaft 20 so that, when the rotatory disc 21 is in frictional engagement with the high-speed clutch plate 11, the upper spindle 2 is driven fast, and when it engages the low-speed clutch 14, the upper spindle 2 is driven by the secondary motor 18 acting through the worm 16 and the worm gear 15 and is slowed to low-speed operation. The lever 19 is operated to shift it in the direction of the clutch shaft 20 by means of the treadle 25 as well known in the prior art, to which it is connected by a rod 24 and through a switch 26 of conventional construction, which is always opened and is closed upon the treadle 25 being pressed down, whereupon the lever 19 causes the rotatory disc 21 to engage the high-speed clutch plate 11.

The current interrupter S fixedly provided on the upper spindle 2 comprises a metal ring 7, part of whose periphery faced to the next metal ring 6 is insulated by an insulator 40, around a central insulator portion 38 to be mounted on the upper spindle 2, the metal ring 6, part of whose periphery faced to the next metal ring 5 is similarly insulated by an insulator 41, around a central insulator portion 38 to be mounted on the upper spindle 2 and into which a pair of grooves 27, 28 are cut at both ends of the insulator 41 at an angle α with respect to one another to form an insulation portion E, and the metal ring 5, part of whose periphery faced to the last metal ring 6 is also insulated by an insulator 42, around the central insulator portion 38 to be mounted on the upper spindle 2 and into which a pair of grooves 29, 30 are cut at both sides of the insulator 42 at an angle β with respect to one another to form an insulation portion F, it being essential that the metal ring 5 be provided with the insulation portion F of the angle β corresponding to the amount of ranges in which position the sewing machine spindle can be stopped and, for example, being 10 angular degrees greater than the angle α of the metal ring 6 so that the insulation portion F is extended a small amount of itself beyond the both ends of the insulation portion E when the set of metal rings 5, 6, 7 are fixedly mounted in a line on the upper spindle 2 and pressure engaged to one another as shown in FIG. 1. In this arrangement of the current interrupter S, the conduction portions B, C, D, of the three metal rings provide a path for current as a unit, but the insulation portions E and F of the two metal rings 5, 6 being completely isolated electrically, no current flow is possible, of course, between E and F, nor between E and B, C, D, or F and B, C, D. In other words, the brush 10 does not conducted to the other brushes 8, 9 when they are simultaneously in contact with the respective insulators E, F of the metal rings 6,

5 within the range of angle α , but does conducted to the one brush 9 when the brush 9 is not in contact with the insulator E of the metal ring 6 while the brush 9 is not contact with the insulator F of the metal ring 5 within the range of angle $(\beta - \alpha)$, and dose conducted to the other brushes 8, 9 when they are simultaneously in contact with the respective metal rings 6, 5 excluding the insulation portions thereof within the range of angle $(360^\circ - \beta)$.

Below follows a description of the device of the present invention with reference to FIGS. 1 to 4. The control electric circuit of the sewing machine drive device mentioned hereinbefore is D.C. operated by conventional means, the necessary D.C. voltage being obtained from rectified main motor 13 alternating current taken through an isolation transformer 31 and a rectifier 32, whose construction is that of a conventional full-wave bridge rectifier. In the circuit there is provided a relay 33 having a holding contact 37 and make-or-break contacts 34, 35, 36, in which a pair of contacts 35, 36 form a supply circuit to the secondary motor 18 as shown in FIG. 2 while the contact 37 is in connection with the brush 9 of the metal ring 6 and the contact 34 is in connection with a direct current electromagnetic brake coil 17'. Upon excitation of the relay 33, the magnetic field in the direct current electromagnetic brake coil 17' demagnetizes, and the contacts 35, 36 close the supply circuit to the secondary motor 18, which causes rotation of the worm 16, and hence of the low-speed clutch plate 14. Conversely, upon demagnetization of the magnetic field of the relay 33, the supply circuit to the secondary motor 18 is cut, the direct current electromagnetic brake coil 17' is energized, and the secondary motor 18, and hence the low-speed clutch plate 14, is stopped. The metal ring 7 is in permanent connection with the positive side of the rectifier 32 through the brush 10, and voltage impressed on the portion B of the metal ring 7 is likewise impressed on the portions C, D of the metal rings 6, 5 respectively, from where voltage taken out through the brush 9 being impressed on a circuit point 101 of the relay 33 through the holding contact 37, and that taken out through the brush 8 being impressed on the circuit point 101 directly. A resistor 39 and a diode 43 form a series circuit connected in parallel to the relay 33 and connected in series to the switch 26, which series circuit can also be suitably composed of a capacitor and resistor, varistor, or any other similar surge absorption circuit.

The sewing machine is started by depression of the treadle 25 by the operator, whereupon, through the action of the lever 19, the rotary disc 21 is brought into frictional engagement with the high-speed clutch plate 11 being rotated by the main motor 13 which is driven by a main switch (not shown in figure) as well known in conventional method, and the switch 26 is closed at the same time. As the switch 26 is closed, voltage from the rectifier 32 is applied to the relay 33 through lines 102 of the switch 26 and 103 of the relay 33, and the relay 33 is excited so that the direct current electromagnetic brake coil 17' is demagnetized and the contacts 35, 36 close the supply circuit to the secondary motor 18, which therefore becomes operative. At the same time, the voltage built-up in the relay 33 closed the holding contact 37, so that even if the switch 26 is turned off by restoration of the treadle 25 to the original position both circuits one of which including the

line 102, brush 10, metal ring 7, metal ring 6, brush 9, holding contact 37, circuit point 101 and relay 33, and the other of which including the line 102, brush 10, metal ring 7, metal ring 6, metal ring 5, brush 8, circuit point 101 and relay 33 are maintained automatically held to close of themselves. When the treadle 25 returns to its original position, the rotatory disc 21 is released from engagement with the high-speed clutch plate 11 and the switch 26 is opened. Although the magnetic field of the relay 33 is demagnetized upon opening of the above mentioned circuits by the complete contact between the insulator 41 of the metal ring 6 and the brush 8, demagnetization of the magnetic field in the relay 33 is not, however, immediate, but is delayed due to the reasons that during high-speed operation of the sewing machine by closing the holding contact 37 in parallel with the switch 26 duration of contact between the insulation portion E of the metal ring 6 and the brush 9 is extremely brief because of the high-speed rotation of the metal ring 6 and of the small angle α of the insulator 41 mounted on the metal ring 6, the response of the relay 33 is generally poor, and the series circuit 39, 43 of surge absorption is in connection with the relay 33. Hence, the relay 33 is enabled to be self-closing until the sewing machine upper spindle 2 reaches a certain rotatory speed N_3 which depends on the demagnetization time of the relay 33 and the size of the angle α enclosed by the insulation portion E of the metal ring 6. When the rotatory speed of the upper spindle 2 is less than a certain speed N_3 and the contact time between the brush 9 and the insulation portion E of the metal ring 6 is enough for demagnetizing the magnetic field of the relay 33 so that the relay 33 can no longer maintain excitation for a sufficient length of time and its magnetic field collapses completely, whereupon the contact 37 is opened, contacts 35, 36 are opened, thus cutting supply of current to the secondary motor 18, the contact 34 is closed, thus voltage is applied to the direct current electromagnetic brake coil 17', and the secondary motor 18 is stopped, thus stopping the low-speed clutch plate 14 and the rotatory disc 21 with which it is engaged, and hence the upper spindle 2. Accordingly, the sewing machine needle is stopped within a predetermined position in accordance with the stopped position of the upper spindle 2 because the upper spindle 2 is stopped in such a manner that the metal ring 5 mounted on the upper spindle 2 is stopped in contact with the brush 8 at its insulation portion F within the range of angle β after rotation speed of the upper spindle 2 is exactly lowered to the certain speed N_3 by arrangement of the metal ring 6, brush 9 and holding contact 37 as mentioned hereinafter with reference to FIGS. 4 to 7.

In FIG. 4 shown relation between the speed of the sewing machine upper spindle 2 and the time of operation, at the time t_1 from starting of the sewing machine by depression of the treadle 25 the main motor 13 is reached to the full speed to rotate the upper spindle 2 through the clutch plate 11 and the rotatory disc 21, and the secondary motor 18 is reached to the full speed at the time t_2 from the simultaneous closing of the switch 26. In connection of the high speed N_1 rotation of the upper spindle 2 driven by the main motor 13, if the treadle 25 is returned to its original position at the time t_3 the rotatory disc 21 is disengaged from the high-speed clutch plate 11 and engages the low-speed clutch plate 14 by the lever 19 and the upper spindle 2 falls

rapidly from the high-speed N_1 to the low-speed N_2 of the secondary motor 18. During this fall in speed of the upper spindle 2, if the brush 9 is brought into contact with the insulation portion E of the metal ring 6 in the interval a to b shown in FIG. 4 between the middle-speed N_3 and the low-speed N_2 which can be obtained the enough time for opening the relay 33, the upper spindle 2 goes beyond the low-speed rotation of the secondary motor 18 and is stopped at the point c shown in FIG. 4. However, the stopped position of the upper spindle 2 at point c often lies within the hatched portion X of FIG. 6 beyond the predetermined area Y defined as an angular range deviated the same amounts in the negative and positive direction with respect to the desired stop position of the sewing machine needle, since the speed for opening the relay 33 in the condition of contacting the brush 9 with the insulation portion E of the metal ring 6 is relatively high and varies at random, for example, if the speed as it opened the relay 33 is near to the middle-speed N_3 , the stopped position of the upper spindle 2 is far from the predetermined area. FIGS. 5 to 7 respectively show curves of the angular deviations with respect to the stopped position of the upper spindle 2, each in which an abscissa expresses the frequency of occurrence in connection with the stopped position of the upper spindle 2 and an ordinate defines the positive or negative angle with respect to a standard point of the upper spindle 2, the spindle of FIG. 5 being employed three metal rings 5 to 7 with the holding contact 37 in accordance with the present invention while the other spindles of FIGS. 6 and 7 are employed two metal rings 5 and 7, or 6 and 7 and are sometimes stopped beyond the predetermined area relating to the desired stop position of the sewing machine needle. It is to be noted that the middle speed N_3 which settles the upper limit for closing the relay 33 is necessary to set a speed much higher than the low-speed N_2 of the secondary motor 18 since if the middle-speed is equal or near to the low-speed there occurs to make it impossible to operate the secondary motor by the relay 33 which is maintained to keep its closing without reliability in some cases. In addition, the brush 9 is in contact with the insulation portion E of the metal ring 6 in the interval b to f of FIG. 4 in low-speed N_2 of the secondary motor 18, the upper spindle 2 is stopped at point e in FIG. 4 of which the angular deviation lies within the predetermined area of the central distribution curve of FIG. 6, since the speed of demagnetizing in the relay 33 is always even. However, when the upper spindle 2 has two metal rings 6 and 7 with the holding contact 37 of the relay 33 except for the metal ring 5, the stopped position of the upper spindle 2 does not ensure to put into the predetermined area as shown in FIG. 6, so that the present invention is provided a sewing machine electrical drive device in which the upper spindle has three metal rings 5, 6 and 7 including the metal ring 5 in contact with the brush 8 connected directly with the relay 33 so as to eliminate the disadvantages of FIG. 6, i.e., the hatched, tailing portion of the distribution curve in FIG. 6.

In the present invention, the assurance for stopping the upper spindle 2 within the predetermined area as shown in FIG. 5 is achieved by providing an arrangement of three metal rings 5, 6 and 7 whereby the brush 8 being always kept in contact with the metal ring 5 and in connection with the relay 33 is removed from the insulation portion F of the metal ring 5 when the stopping

point of the upper spindle 2 falls within the hatched, tailing portion shown in FIG. 6 beyond the predetermined area. By this arrangement, when the brush 8 comes into contact with the connection portion D of the metal ring 5 beyond its insulation portion F corresponding to the insulation portion E of the next metal ring 6 the relay 33 is again energized through the three metal rings 5, 6 and 7 and the secondary motor 18 started, under which conditions the upper spindle 2 is again driven to rotate at the low-speed N_2 by the secondary motor 18 as following the dotted line c to h of FIG. 4 and, when the brush 8 is again brought into contact with the insulation portion F of the metal ring 5 at point g in FIG. 4 and the secondary motor 18 is stopped by opening the relay 33, is stopped within the predetermined area at point d in FIG. 4. Accordingly, with this arrangement it is ensured that the stopping point of the upper spindle 2 always lies within the predetermined area Y of the central distribution curve of FIG. 5 since it can eliminate the disadvantages of the FIG. 6 by the provision of the metal ring 5 having the insulation portion F of which distance is more wider than that of the corresponding insulation portion E of the metal ring 6 and the brush 8 being in contact with the metal ring 5 and in connection with the relay 33. Thus, by suitable positioning of the upper spindle 2, a sewing machine drive unit of extremely high precision is obtained. Moreover, there are known conventional devices which do not possess the metal ring 6 and the holding contact 37, but with the other rings 5 and 7 there is no guarantee that the stopping point of the upper spindle 2 lies within the predetermined area of the distribution curve of FIG. 5, but rather the distribution is always as shown in FIG. 7 and varies in accordance with the middle speed N_3 depending upon the characteristic of the relay 33. When the middle-speed N_3 is larger than the low speed N_2 enough to step the spindle 2, there is a strong tendency for producing chattering of the relay 33, which considerably impairs the length of the service-life of the relay 33, and the upper spindle 2 is often stopped beyond the predetermined area as shown with an area Z in FIG. 7, while, when the middle-speed N_3 is small sufficient to eliminate the chattering of the relay 33, the upper spindle is stopped within an area Y in FIG. 7. In other words, the former is one case in which condition the low-speed N_2 is much smaller than the middle-speed N_3 while the latter is the other case in which condition the middle-speed N_2 is large than that of the former and near to the middle-speed N_3 . This is because that the sewing machine is generally driven either at high-speed (about 6,000 r.p.m.) or at low-speed (about 3,000 r.p.m.) by the operators' election and, accordingly, the low-speed N_2 lies on either high-speed or low-speed. The area Z of FIG. 7 shows the frequency of occurrence when the sewing machine is driven at low-speed, and the area Y of FIG. 7 shows the frequency of occurrence when the sewing machine is driven at high-speed. Thus, as clearly understood from the above-mentioned, the conventional sewing machine drive devices have disadvantages such as that a relay often produces the chattering to cause to shorten the life of itself, and the stop position of the sewing machine varies at a large area of the frequency of occurrence in accordance with the changing of the rotation speed of the sewing machine. On the contrary the present invention offers a control drive device of the sewing machine whose precision is greatly im-

proved compared with conventional devices, and which eliminates relay chattering, thus improving relay service-life, and in which, moreover, precision does not depend on the speed of operation of a sewing machine, the device of the present invention thus being of great practical advantage in sewing machine operation.

Although the present invention has been fully described with reference to the accompanying drawings in connection with the preferred embodiment thereof, various changes and modifications are apparent to those skilled in the art. Therefore, the present invention is not to be limited thereby and such change and modifications should be construed as included within the scope of the present invention unless otherwise they depart therefrom.

What is claimed is:

1. A sewing machine electrical drive device comprising a main drive unit, a secondary drive unit that operates at reduced speed, a brake unit that controls the secondary drive unit, a clutch assembly for selective engagement with the main or secondary drive unit to drive a sewing machine upper spindle, a switch that is closed when said clutch assembly is engaged with the main drive unit and open when the clutch assembly is disengaged from the main drive unit and engaged with the secondary drive unit, a relay possessing a holding contact and contacts which control the above-mentioned brake unit, and a current interrupter fixedly mounted on the sewing machine upper spindle and comprising conducting rings, part of whose peripheries are non-conducting and into two of which grooves are cut at the respective non-conducting peripheries the length of the arc lying between the grooves in one ring being greater than that between the grooves in the other, and brushes which contact the said conducting rings, wherein the said relay is brought into connection with an electrical power source through the action of the said switch and through the said brushes in contact with said conducting rings and a series circuit in connection with the above-mentioned holding contact.

2. A sewing machine electrical drive as claimed in claim 1, wherein the said current interrupter comprised a first metallic ring part of whose periphery is insulated by an insulator material around a central portion composed of an insulator material, a second metallic ring part of whose periphery is insulated by an insulator material around a central portion composed of an insulator material, said grooves being cut at the insulation portion at a distance from one another into the central portion, and a third metallic ring part of whose periphery is insulated by an insulator material around a central portion composed of an insulator material, said grooves being cut at the insulation portion at a distance from one another into the control portion, the distance of the third ring being greater than the distance of the second ring, the said three metallic rings being brought together by pressure engagement in which configuration the portions between grooves of the said two rings form insulated portions, the first ring contacting with a brush connected to the power source, the second ring contacting with a brush connected to the relay through the holding contact, and the third ring contacting with a brush connected to the relay.

3. A sewing machine electrical drive device as claimed in claim 1, wherein the said relay contacts function to actuate the said secondary motor upon energization of the said relay and to actuate the said brake unit upon de-energization of the relay.

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