Jan. 5, 1960 M. SCHWAB 2,920,221

SEWING MACHINE DRIVE SYSTEM

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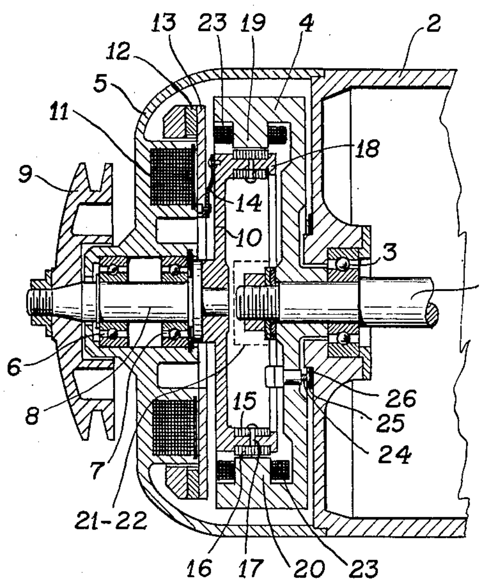


Fig. 1.

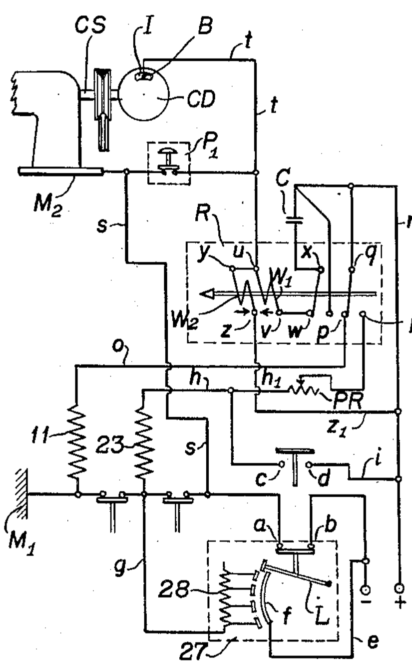


Fig. 2.

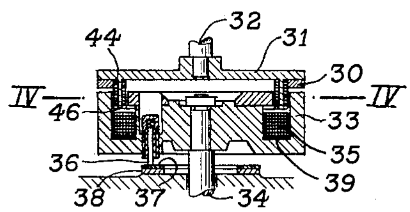


Fig. 3.

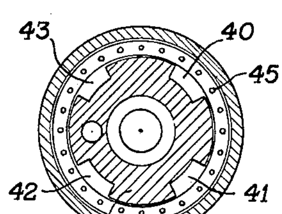


Fig. 4.

INVENTOR.
Max Schwab
BY Eric E. Franke
ATTORNEY

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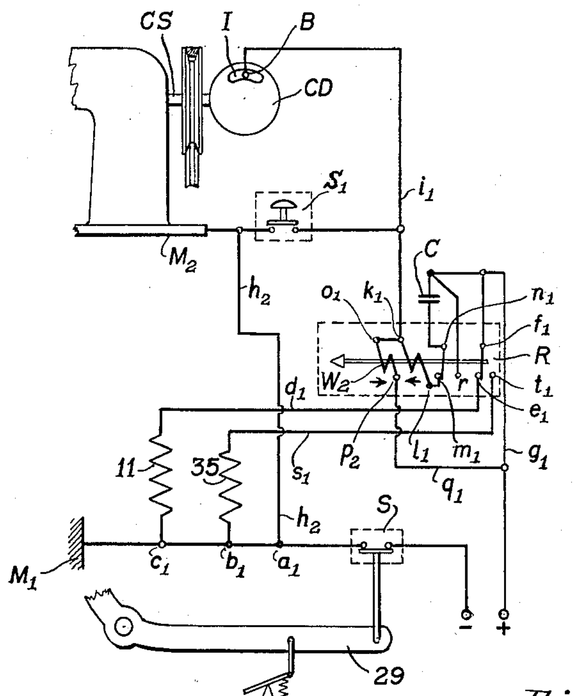


Fig. 5.

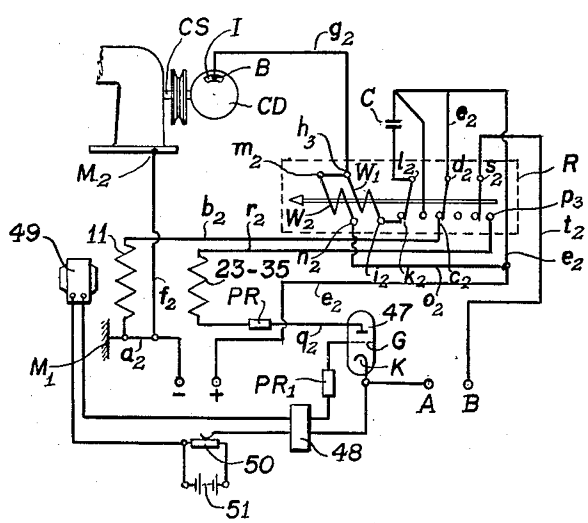


Fig. 6.

INVENTOR.

Max Schwab

BY Eric E. Franke

ATTORNEY

United States Patent Office

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## SEWING MACHINE DRIVE SYSTEM

Max Schwab, Schwetzingen, Germany; Olga Brunhilde Schwab, sole heir of said Max Schwab, deceased

Application October 1, 1954, Serial No. 459,817

7 Claims. (Cl. 310—96)

The present invention relates to an electric drive system for sewing machines, designed to enable the operator to stop the sewing machine with the needle bar in a pre-elected position.

Prior electric drives for sewing machines comprise, for example, a motor coupling that can be disengaged at will. The coupling includes a continuously rotating shaft carrying a driving coupling member, a non-rotatable brake member, a driven coupling member and connecting means for actuating the sewing machine. This arrangement does not solve the problem of stopping the sewing machine at will with the needle bar in a pre-elected position, for example in the highest dead point position. Various constructions have been suggested for this purpose. Some of them include rather complicated, purely mechanical speed reducing means. Others comprise a slow auxiliary drive of contsant speed, such as an auxiliary motor or a subsidiary drive branched off from the main drive and including a magnetic clutch which, after cut-off of the main drive, continues to rotate the sewing machine at slow speed until an interrupter, rotated by the sewing machine, stops the latter in the desired dead position. Since the driving coupling member in such devices is actuated by the auxiliary drive, the speed reduction results from the drag exerted by the sewing machine and from the slow rotation of the auxiliary drive. Obviously, when using either an auxiliary motor or a subsidiary drive taken off the main drive, new gears or other driving elements must be brought from a standstill to full rotational speed, only to have their momentum destroyed immediately thereafter, in order to bring the sewing machine to the required stop.

It is an object of the present invention to provide a solution of the problem of stopping a sewing machine with the needle bar in a pre-elected dead position by less complicated means of faster response, and to eliminate the necessity of an auxiliary motor or subsidiary drive branched off from the main drive.

It is another object of the invention to provide an electric drive for the described purpose which is characterized by far less inertia and greater simplicity than hitherto known constructions.

It is a still further object not only to simplify the entire driving mechanism by eliminating any auxiliary motor or other complicated means for transmitting mechanical power, but to provide a device that is dependable in operation, more compact and lower in cost.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, and any additional objects and advantages thereof will best be understood from the following description of several preferred embodiments of the device when read in conjunction with the accompanying drawings, in which:

Figure 1 is a sectional view of a clutch according to the present invention;

Fig. 2 is a circuit diagram;



Fig. 3 is a sectional view of the clutch members of an embodiment combining a mechanical and an electro-magnetic clutch.

Fig. 4 is a cross-sectional view along the lines 4—4 of Fig. 3;

Fig. 5 is a diagrammatic view of a circuit designed for use in conjunction with the clutching device shown in Figs. 3 and 4; and

Fig. 6 is a schematic illustration of an embodiment including an electronic tube for regulating the current intensity passing through the field winding of an electro-magnetic clutch.

The object of this invention is attained by transmitting power from a driving clutch member to a driven clutch member and, therefrom, to the sewing machine, by electro-magnetic rather than by mechanical means. However, it is also possible, according to this invention, to transmit the torque momentum for the regular operation of the sewing machine by mechanical means and to transmit electro-magnetically only the torque required for running the sewing machine at reduced speed until the sewing needle reaches a pre-determined dead position.

The herein claimed device, comprising a magnetic brake and an electro-magnetic clutch, is designed to initiate, upon passing an excitation current through a so-called primary winding of the electro-magnetic clutch, a slipping movement of the driven clutch member and, because of the ensuing eddy currents, an appreciably increased slipping tendency on the part of the driven clutch member while, at the same time, the previously active brake is disengaged. However, immediately upon the sewing machine reaching a predetermined angular position, the circuit including the magnet winding of the brake is again closed in order to restore the brake action.

As a result of this arrangement, the speed of the driven clutch member is reduced to the required low terminal speed without the insertion of speed reducing gears or auxiliary drives. If, thereafter, the driven clutch member has atttained a certain rotary position at which the needle of the sewing machine is at the, say, highest point, the voltage supply to the electro-magnetic clutch is interrupted while the afore-mentioned braking action is instantaneously brought to pass. This is accomplished by means of a circuit including a timing device, such as a relay of the delayed closing type that, in order to assure an instantaneous braking action, produces a momentary release when the circuit is opened by contact means rotating in synchronism with the sewing machine. According to the invention, the desired action is possible because, at full speed of the sewing machine, the insulating insert of the contact device merely exerts a chopping effect upon the control current which does not cause any response on the part of the relay. The purpose of the delayed closing of the relay is, therefore, to prevent rotation of the driven clutch member by the power source during a first braking action while, upon reaching the desired dead position of the needle, the circuit including the magnetic clutch is instantaneously opened in order not to counteract the ensuing action of the brake.

A still better arrangement includes a timing relay device comprising two oppositely wound coils and a condenser inserted into the circuit of one of the coils. The storing of electric energy by the condenser prevents the flux of current to the one coil for a period equal to the pick-up delay so that the action of the other coil, the pick-up coil of the relay, is not impeded.

Moreover, according to the present invention it is not only possible to transmit by electro-magnetic means the power for the terminal rotational movement of the sewing machine, but also the regular operating power, i.e. the torque of the electric motor; in such a manner that the speed of the rotation can be controlled or regulated by an adjustable resistor. The terminal rotational motion can be also regulated by inserting, say, a potentiometer into the circuit ahead of the field winding of the electro-magnetic clutch. Thus, the magnitude of the torque to be transmitted cannot only be adjusted at will, but the length of the angular path required for stopping the sewing machine in a pre-elected position can be also regulated.

In order to be effective, the clutching device must be built on the principle of an induction motor. The trigger momentum, resulting from an overload must cause an automatic disengagement of the clutch. For this purpose, the secondary clutch member can be a metal disk or, preferably, be built on the principle of a short-circuited armature. As a result of movements of the two clutch members relative to each other, induction currents are produced which, together with the rotating field of the salient pole armature, develop torques that act upon the primary and secondary member, i.e. on the two clutch members, so that the faster rotating driving clutch member carries the driven clutch member along. It does not matter which of the two clutch members is the driving clutch member.

Desirably, the armature is equipped with cage bars or is given the design of a squirrel cage type of pronounced current crowding with high, narrow bars.

While the aforedescribed conditions afford the requirements of a sewing machine demanding high starting torque, according to the present invention, the terminal speed of the sewing machine can be kept constant independently of the torque by inserting an electronic tube into the control circuit. In this case, a small tachometer-dynamo, coupled to the driven shaft, produces a voltage which, depending upon the speed of rotation, is opposed to the firing voltage applied to the electronic tube. The relatively slow rotational speed attained by the slipping clutch member can be adjusted by means of a potentiometer inserted ahead of the grid of the electronic tube.

Having reference now to the drawings, Fig. 1 illustrates a continuously rotating input shaft **1** of an electric motor **2** as the power source. The shaft is held by bearings **3** and has the driving clutch member **4** mounted at the free end thereof, a clutch housing **5**, fastened to the front of the motor housing, concentrically with the motor shaft **1**, encloses the bearings **6** and **7** as well as the take-off or driven shaft **8**, held by said bearings. A sheave **9** for driving the sewing machine is mounted at the free end of the driven shaft **8**, outside the housing **5**. Also keyed to the driven shaft **8**, at the other extremity thereof, is the driven clutch member **10**. Mounted at the inside of the front wall of the clutch housing **5** is the control coil **11** as stationary part of a magnetic brake. A friction layer **12** is fastened, preferably adjustable, to the frame of the control coil **11** so that the magnet disk **13** representing the movable part of the brake being keyed to the take-off shaft **8**, enters into contact with the friction layer **12** upon excitation of the coil **11**. A membrane **14** connects the magnetic disk **13** to the driven clutch member **10**. The driven clutch member **10** represents, in effect, a short-circuited armature ring, which clutch member **10** comprises a short circuit ring **18** connected by the active conductor bars to the support disc of the driven clutch member **10** to form a squirrel cage winding therewith. The bars are cast or could be replaced by rivets in the pierced openings in the laminations **15**. The driving clutch member **4** has a corresponding number of poles **19, 20, 21, 22**. The number of poles can however be larger or smaller. Each of the poles is equipped with one or several excitation coils of the field winding **23**. Current to the field winding **23** which continuously rotates with the driven clutch member **4** is supplied by means of a brush **24**, contacting a slide ring **25** that is mounted, say, on the front cover of the motor housing **2**, with an insulating ring **26** therebetween.



Fig. 2 illustrates the arrangement of an operating circuit for the embodiment shown in Fig. 1. The field winding **23** of the driving clutch member **4** shown in Fig. 1, as well as the control coil **11** of the magnetic brake are schematically represented. **27** is a control which may be adapted as a foot or manual control to start the sewing machine and to regulate the operating speed by appropriate movements of the lever L. Depression of the lever L opens the contacts *a—b* and closes the contacts *c—d* which causes a current flow from the negative terminal (—) of a D.C. voltage source, through conductor *e*, slide *f* and one of the contact points of resistor **28**, conductor *g*, field winding **23**, conductor *h*, contacts *c—d* and conductor *i* to the positive terminal (+) of the D.C. source. The excitation voltage depends upon the position of the lever L. Since the field winding **23** rotates with the continuously turning input shaft **1** (Fig. 1), voltages are induced in the conductor bars and current flows through the short-circuiting rings **18**, with the result that a given amount of slip occurs in the rotation of the driven clutch member **10**, depending upon the degree of excitation. Thus, the speed of the driven clutch member **10** can either be gradually increased, or the highest speed can be immediately attained by completely depressing the lever L. Under the described conditions, the excitation coil **11** of the magnetic brake is without current, because the circuit is interrupted at the open contacts *k—l* and *m—n*. If now the operating drive is disengaged by releasing or returning the lever L into the illustrated or original position, the branch circuit, including the resistor **28** and the contacts *c—d*, is opened, while the branch circuit, including contacts *a—b*, *k—l* and *m—n*, is closed. Consequently, current flows from the negative terminal (—) through the last named branch circuit to $M_1$, through control coil **11** of the magnetic brake, conductor *o* to contact *p* of a relay R and from there to contact *q* and through conductor *r* to the positive terminal (+) of the D.C. source. Passing current through control coil **11** activates the magnetic brake which, through its action, destroys the kinetic energy of the rotating parts of the sewing machine and the driven clutch member **10**. At the same time, current flows from the negative terminal (—) through the circuit branch including contacts *a—b*, conductor *s* mass, $M_2$ and needle bar control shaft CS of the sewing machine, through contact disk CD, brush B, conductor *t* and point *u*. However, the current flow is interrupted when, as a result of the rotary motion of the needle bar control shaft, the insulating insert I of the contact disk CD passes underneath the brush B. The angular position of the insulating insert with respect to the brush corresponds with the momentary reciprocating position of the needle bar of the sewing machine.

From point *u*, one part of the current flows through relay coil $W_1$, points *v*, *w* and *x* to condenser C and from there through conductor *r* to the positive terminal (+), while another part of the current flows through point *y*, relay coil $W_2$, point *z* and conductor $z_1$ to the positive terminal (+). The coils $W_1$ and $W_2$ are wired in opposite sense, so that their effect is cancelled out until the condenser C is fully charged and then blocks the flow of current through coil $W_1$. During this interval, the pick-up coil $W_2$ prevails and actuates the relay; with the result that the brake circuit is interrupted at point *p*, while the branch circuit of the field winding **23** of the driving clutch member **4** is closed at point $p_1$. Thus, relay R and condenser C together constitute a timing device. Current flows from the negative terminal (—) through contacts *a—b*, *m—n*, field winding **23**, conductors *h*, $h_1$, a slide-wire rheostat PR, points $p_1$, *q* and conductor *r* to the positive terminal (+). The degree of excitation of the field winding **23** depends upon the resistance of rheostat PR so that, under the influence of the field winding 23, the driven clutch member is rotated, but with a high slip momentum and, consequently, at reduced rotational speed, until the needle of the sewing machine assumes the desired stopping point upon the insulating insert I of the contact disk CD reaching the position illustrated in Fig. 2, at which the circuit is interrupted by the instantaneous action of relay R, causing at point $p_1$ a break in the current flow through field winding 23 and, at point $p$, a closing of the branch circuit of the magnetic brake, resulting in an instantaneous excitation of control coil 11 and a dead stop of the driven clutch member 10 and of the sewing machine connected therewith.

By providing a push-button switch $P_1$, inserted into the circuit, as illustrated, the herein disclosed arrangement permits a sewing operation at greatly reduced speed upon depressing the switch.

Figs. 3 to 5 illustrate an embodiment wherein the clutch is engaged and disengaged by means of a lever 29. Upon operating this lever, the friction layer 30 of the driven clutch member 31, mounted on the take-off shaft 32, shown only in part, is placed into engagement with the driving clutch member 33.

The driving clutch member is keyed to a continuously rotating motor shaft 34. A field winding 35, comprising a part of the driving clutch member, is applied with voltage by means of a brush 36 and a slide ring 37 mounted on the insulating plate 38. The field winding is held by a magnet pole 39, provided with cut-outs 40, 41, 42 and 43. Obviously, another number of poles will be equally appropriate. The pole plate is coaxially rotatable within the driven clutch member 31, preferably designed as a squirrel cage armature 44. Here too, armature rods 45 are provided which are short-circuited by means of the disk 31 and the short-circuit ring 46, respectively.

In the absence of engaging pressure upon the clutch lever 29, the latter assumes the position illustrated in Fig. 5 and the friction layer 30 remains out of contact with the driving clutch member 33. Under these conditions, current flows from the negative terminal (—) of a D.C. source through switch S, points $a_1$, $b_1$ and $c_1$ to mass $M_1$ and control coil 11 of a brake magnet such as shown in Fig. 1, and from there through conducter $d_1$ and points $e_1$, $f_1$ of an electro-magnetic relay R and, finally, through conductor $g_1$ to the positive terminal (+). Consequently, the brake is actuated and the kinetic energy of the rotating clutch member that is not in engagement with the power source is destroyed. At the same time, current flows from the negative terminal (—) through switch S, point $a_1$, conductor $h_2$, mass $M_2$ and needle bar control shaft CS of the sewing machine, contact disk CD, brush B, conductor $i_1$ to point $k_1$ of a relay R. Obviously, the current flow will be interrupted when, as a result of the rotary motion of the contact disk, the insulating insert of the contact disk passes into juxtaposition with the brush B. From point $k_1$, current flows through relay coil $W_1$, points $l_1$, $m_1$ and $n_1$ to condenser C and from there through conductor $g_1$ to the positive terminal (+). Simultaneously, current flows from point $k_1$ through point $c_1$ to relay coil $W_2$, and from there through point $p_2$ and conductor $q_1$ to the positive terminal (+). The relay coils $W_1$ and $W_2$ are wired in opposite sense so that their effect is cancelled out until the condenser C is fully charged and blocks the flow of current through coil $W_1$, which permits coil $W_2$ to trip the relay; with the result that the brake circuit is opened at point $e_1$ and the field winding 35 of the driving clutch member is energized by current flowing from the negative terminal (—) through switch S, points $a_1$, $b_1$, field winding 35, conductor $s_1$, points $t_1$, $f_1$ and conductor $g_1$ to the positive terminal (+).

The energized field winding 35 produces an induction current in armature rods 45 so that the driven clutch member 31 is rotated, but at reduced speed, depending upon the degree of excitation of the field winding and the amount of slip resulting therefrom. The sewing machine is turned over in this manner until the brush B passes over the insulating insert I of the contact disk CD, at which time the electromagnetic relay R instantaneously opens the circuit at point $t_1$ so that the field winding 35 is inactivated, while the circuit is closed at point $e_1$ and the control coil 11 is re-energized which causes an immediate braking action resulting in a complete stop of the needle bar of the sewing machine in the desired dead position. By means of a switch $S_1$, the contact disk CD may be eliminated to permit stitch-by-stitch sewing.

Fig. 6 illustrates an electronically controlled device. With the clutch disengaged, current flows from the negative terminal (−) of a D.C. source through conductor $a_2$ to mass $M_1$ and through the control coil 11 of the magnetic brake, conductor $b_2$, points $c_2$, $d_2$ of an electro-magnetic relay R, conductor $e_2$ to the positive terminal (+). As a result, the brake is activated and destroys the kinetic energy of the still rotating clutch and sewing machine. At the same time, current flows from the negative terminal (−) through conductor $f_2$ to mass $M_2$ and needle bar control shaft CS of the sewing machine, contact disk CD, brush B, conductor $g_2$ to point $h_3$ of the relay R, provided, however, that the current flow is not interrupted by the insulating insert I of the contact disk. From point $h_3$, current flows through point $m_2$, relay coil $W_2$, point $n_2$, conductors $o_2$, $e_2$ to the positive terminal (−). The relay coil $W_1$ is wired oppositely to the relay coil $W_2$, so that the effect of the two coils is cancelled out until the condenser C is charged and pick-up coil $W_2$ is able to actuate the relay into closing the circuit at point $p_3$. Plate current flows from the line terminal A through the electronic tube 47, conductor $q_2$, series resistor PR, field winding 23/35 (Fig. 1 or 3, respectively), conductor $r_2$, points $p_3$, $s_2$ and conductor $t_2$ to line terminal B. In this manner, the voltage of excitation current flowing through field winding 23/35 of the driving clutch member can be adjusted by ignition voltage, applied between control grid G and cathode K of the electronic tube 47. The ignition voltage is obtained in the usual manner from a control amplifier 48. The input voltage of the control amplifier represents the difference between the voltages of a tachometer dynamo 49, actuated by the take-off shaft 8/32 (Fig. 1 or 3, respectively) and a potentiometer 50, fed by a storage battery 51. The arrangement provides, furthermore, an adjustment resistor $PR_1$ between amplifier 48 and control grid G.

Under the influence of the field winding 23/35, the driven clutch member 10/23 and the sewing machine are rotated at reduced speed until the needle bar reaches the desired position, at which time the insulation insert I turns into contact with brush B. At this point, the relay R opens instantaneously the circuit including the field winding 23/35 at point $p_3$ and closes, at point $c_2$, again the circuit including the control coil of the brake magnet 11. The tachometer-dynamo 49 prevents too high a terminal speed, because of the increase in opposing voltage delivered upon an increase in the rate of rotation of the take-off shaft 8/32.

While I have disclosed several embodiments of the present invention, it is to be understood that the embodiments are given by example only and not in a limiting sense, the scope of the present invention being determined by the objects and the claims.

I claim:

1. A system for driving a reciprocally acting device comprising a rotating control shaft and stopping said control shaft at a predetermined rotary position, said system comprising, a first electric contact device connected with said control shaft to be actuated in positional dependence upon said control shaft, a power input shaft continuously driven when the drive system is in operative condition,

a power take-off shaft and transmission means connecting said take-off shaft with said control shaft for driving said control shaft, a variable slip clutch having an electric clutch control winding and having a driving clutch member mounted on said input shaft and a driven clutch member mounted on said take-off shaft, a brake having a fixed part including a brake control coil and a movable part, said movable part being connected with said driven clutch member for stopping said take-off shaft under control by said coil, current supply means, a clutch control circuit connecting said current supply means with said clutch control winding and including a control rheostat for varying the slip of said clutch, said rheostat having a control member displacable between device stopping and full speed positions, a second electric contact member connected with said rheostat control member and being in active conditions only when said control member is in said stopping position, a time relay delay device having delayed pickup and momentary drop-off characteristic, said relay device having relay control means connected to said current supply means through said two contact members so as to pick up with delay only when said rheostat control member, previously displaced, is returned to said stopping position and said control shaft is simultaneously in a given position, a brake control circuit connecting said brake control coil with said current supply means through said second contact member and through said relay device when said relay device is in dropped-off condition whereby said brake is temporarily actuated to decelerate said driven clutch member during the interval of time from the return of said rheostat control member to stopping position to the delayed pick-up operation of said relay device and is thereafter again actuated to stop the device when the relay drops off.

2. A drive system according to claim 1, comprising a second clutch control circuit connecting said clutch winding to said current supply means through said relay device only when said relay device is in dropped-off condition, said second control circuit including a current-limiting resistor for causing said clutch to continue driving said take-off shaft at reduced speed until said relay device drops off to actuate said brake.

3. A drive system according to claim 2, said two clutch members having respective magnetizable bodies and forming together an induction motor system, said winding being disposed on said driving member and said driven member forming a short-circuited rotor, whereby electric energy on the take-off side of said clutch is consumed by electro-dynamic braking within said clutch during said interval.

4. In a drive system according to claim 1, said relay device comprising an electro-magnetic relay and said relay control means comprising a pick-up coil in said relay, and said first contact device forming an interrupter having a single break gap and being series connected with said pick-up coil, whereby the current supplied to said pick-up coil is chopped by said first contact device and thus remains insufficient to operate said relay as long as the speed of said control shaft is excessive.

5. In a drive system according to claim 4, said electromagnetic relay having another coil opposingly related to said pick-up coil, a direct current circuit energized from said current supply means and including said other coil, and a condenser in said direct current circuit in series with said other coil, whereby said pick-up coil becomes effective only after charging of said condenser.

6. A system for driving a reciprocally acting device comprising a rotating control shaft and stopping said control shaft at a predetermined rotary position, said system comprising a power input shaft continuously driven when the drive system is in operative condition, a power take-off shaft drivingly connected with said control shaft, a controllable slip clutch having a driving member mounted on said input shaft and a driven member mounted on said take-off shaft, said driving clutch member and said driven clutch member forming together a dynamo-electric system and having a field winding disposed on said driving clutch member to induce, when excited, electric current in said driven clutch member for thereby entraining said driven clutch member, a controllable brake having a stationary part and a movable part and having electric actuating means for selectively placing said parts into and out of braking engagement with each other, said movable part being connected with said driven clutch member for acting on said driven clutch member when said brake is in operation, an electric control circuit connected with said field winding and having adjustable current control means for supplying controllable excitation to said field winding to thereby vary the slip of said clutch, said control means so as to stop said take-off shaft when said control means to operate said brake in dependence upon said control means so as to stop said take-off shaft when said control means is adjusted for maximum slip of said clutch, a speed regulator of variable resistance connected in said control circuit, and a speed responsive current source connected with said control shaft to provide a voltage proportional to the speed of the driven device, and means connecting said source with said regulator for controlling said resistance to maintain the speed of the driven device at a constant value in accordance with the adjustment of said current control means.

7. In a drive system according to claim 6, said regulator device comprising an electronic tube having a plate circuit in series with said control circuit and having a grid circuit which forms part of said connecting means between said source and said regulating device.

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