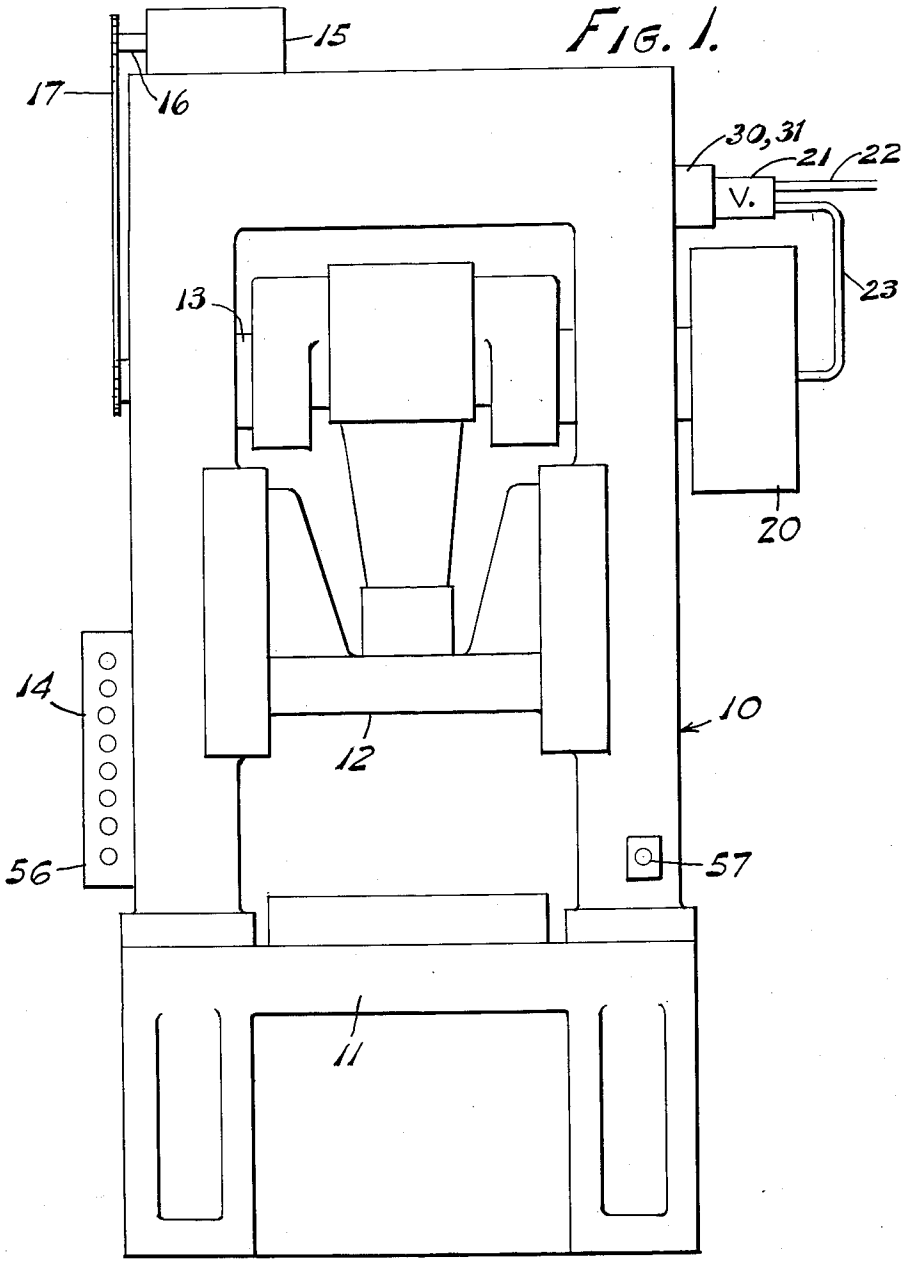
Feb. 6, 1962 E. A. MUNSCHAUER, JR 3,019,878

POWER PRESS CONTROL MEANS

Filed April 14, 1959 2 Sheets-Sheet 1

FIG. 1.



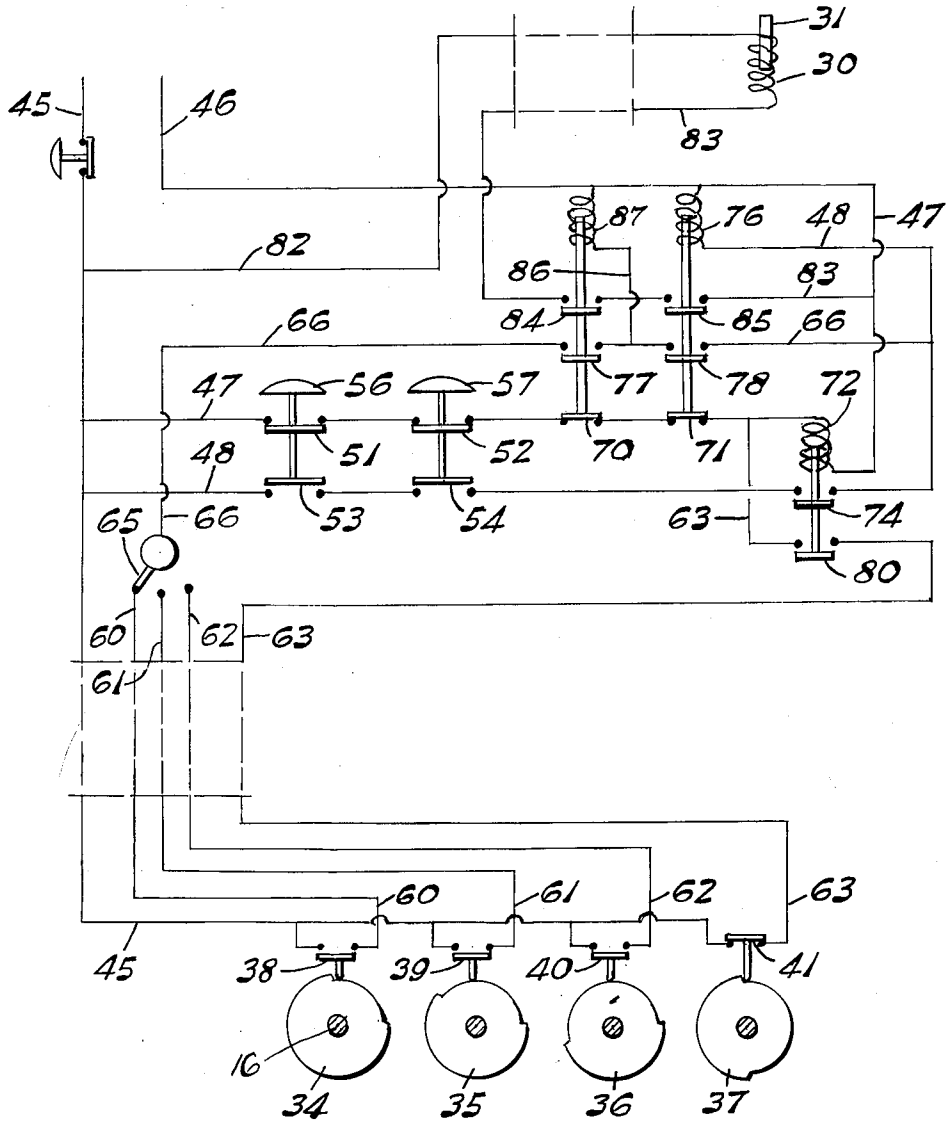
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POWER PRESS CONTROL MEANS

Filed April 14, 1959 2 Sheets-Sheet 2

FIG. 2.



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United States Patent Office 3,019,878 Patented Feb. 6, 1962

3,019,878

POWER PRESS CONTROL MEANS

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Filed Apr. 14, 1959, Ser. No. 806,319
9 Claims. (Cl. 192—144)

This invention relates to control means for power presses, press brakes, power shears and analogous machines.

The machine control means of the present invention relates particularly to electrical control circuits and a control arrangement particularly adapted for producing manually initiated single complete strokes or cycles of a machine. More particularly, the present invention provides means for effectively controlling single stroke machine operation with means for simply and selectively compensating for certain varying conditions which are incident to operating a machine of this general character at varying speeds.

It is common to provide so-called two-hand operating electrical push buttons which are spaced apart so that an operator must have his two hands on the push buttons at the time that a cycle of operation of a machine is initiated. The control circuit thus initiated may actuate a solenoid valve for operating a fluid pressure controlled clutch, a clutch and brake, or a combined clutch-brake mechanism. Various types of clutches may be so controlled, such as positive jaw clutches or friction clutches. In the alternative, the eletrical impulse may be employed in other ways for controlling machine starting and stopping.

In control circuits of this general type it is imperative that the operator must keep his two hands on the push buttons during the first portion of the cycle of operation to prevent his hands from being in an unsafe position or place. However, it is generally considered safe for the operator to remove his hands from the push buttons after the machine has gone through the first part of its cycle, say from 90 degrees to 120 degrees of the cycle, since at normal speeds of operation it would be impossible for the operator to move his hands from the push buttons into the dies before the dies are completely closed if his hands are on the push buttons for that portion of the first part of the stroke.

Furthermore, it is desirable that the operator be free to remove his hands from the push buttons when it is safe to do so, so that he may prepare to remove a piece from the die, feed the next workpiece to the press, or perform other similar operations. For these reasons the control circuitry usually includes means for completing the stroke automatically after the cycle has proceeded through a safe period as described above.

Still further, conventional power press control circuits generally include a non-repeat arrangement which insures stoppage of the press at the end of a complete cycle even though the push buttons be held down. It is thus necessary for an operator to remove both hands from the push buttons before a succeeding cycle can be initiated by re-depressing the buttons. This is commonly referred to as a non-tie-down feature which prevents taping one or both of the buttons down to attempt to produce unauthorized continuous non-cyclic or one-hand operation.

From the foregoing it will be seen that the end of a cycle of operation is determined automatically and a common means for such determination is a cam member which controls a limit switch and moves in unison with the crankshaft of a power press, press brake, power squaring shear or the like. The end of a cycle of operation may be effected by opening or closing of a limit switch which sets up conditions for clutch disengagement

or for clutch disengagement and brake engagement. In any event, there is an unavoidable time lag between the moment of switch actuation and the ultimate stopping of the machine parts which is known in the art as "drift." This drift in a given machine is fairly constant in angular magnitude for a given machine speed but is considerably greater at higher speed operation than at low speed operation, and accordingly provision for adjustment of one kind or another must be made if a machine is subject to variations in speed of operation.

In machine control arrangements of this general class in the prior art it is general to design the limit switch control cam or cams for a given speed of operation. It is, therefore, necessary to effect a major rearrangement if the speed of operation of the machine is to be changed, either by substituting a redesigned limit switch cam, or by providing multiple plate cams which may be physically adjusted to vary their lift periods to provide for varying points of switch opening or closure, or both.

Means have been proposed to regulate the drive between a power press crankshaft and limit switch mechanism for controlling power press operation, as in Bitler Patent No. 2,635,727, for instance. However, since these limit switches are usually mounted in the general vicinity of the crankshaft of the press they are high in the air and require a ladder to make the necessary adjustment. The arrangement of the present invention provides ready selection of a proper limit switch combination from the usual control panel of the press.

The present invention provides means whereby a simple selector switch located at and operable from the usual control panel of such machine varies the time of clutch disengagement to occur at varying times before the end of a machine cycle to properly compensate for the drift of the parts from the instant of operation of the switch which institutes clutch disengagement or other machine-stopping operation to the time when the parts reach their desired position of rest.

In the form of the invention illustrated and described herein a plurality of such clutch stop limit switches are provided for selective inclusion in the machine control circuit by operation of the aforesaid selector switch. Each of the clutch stop limit switches is under the control of a cam proportioned to operate the switch at predetermined points in the machine cycle and the several cams are mounted upon a single shaft which is connected to rotate in unison with the crankshaft or main drive shaft of the machine.

The multiple cam unit with the limit switches that are controlled and operated directly by such cams will preferably be disposed upon the machine at a position where they may be conveniently driven from the drive transmission means of the machine, with suitable electrical conductors extending therefrom to the machine control panel for cooperation with the control circuits and components of the machine. Preferably, in power press and similar use, the cams will be directly driven from the crankshaft of the press at a one to one ratio.

A further prior art proposal for adjusting the making and breaking of power press control circuits is shown in Bitler Patent No. 2,520,709. In all of these prior art adjustments it is not only necessary to reach a remotely controlled limit switch unit by the use of a ladder or the like, but adjustment is generally effected by trial and error and this is obviously very awkward and time-consuming, particularly where the type of adjustment necessitates opening the limit switch enclosure and readjusting cams, commutators and the like by trial and error.

In the selector switch of the present invention the point at which the selection is made is conveniently located in the control panel which is directly in front of

the operator and adjustment is effected by the mere flick of a switch to go from one range of operation to another.

A single specific embodiment of the principles of the present invention is illustrated in the accompanying drawings and described in detail in the following specification. However, it is to be understood that the principles of the invention are not limited to the precise form shown by way of example and that the spirit and scope of the invention are limited only as defined in the appended claims.

In the drawings:

FIG. 1 is a somewhat diagrammatic front elevational view of a representative power press with the rotating cam limit switch unit and the control panel thereof illustrated in their respective positions; and

FIG. 2 is a wiring diagram of the control circuit arrangement of the present invention.

Referring to FIG. 1, a power press **10** having the usual die-receiving bed **11** and reciprocable slide or ram **12** is provided with a conventional crankshaft **13** for reciprocating the slide **12** and is further provided with a control panel **14** within convenient reach of the operator for starting and stopping the press and effecting other control functions. The numeral **15** designates a rotating cam limit switch of a type which is available commercially and which includes a series of cams on a common shaft, each controlling the opening and closing of a limit switch included in the rotating cam limit switch unit. In the present instance, the operating shaft of this unit is designated **16** and is connected to the crankshaft **13** of the press by a chain and sprocket connection **17** for rotation in unison with the crankshaft **13**.

Referring particularly to the wiring diagram, the numeral **30** designates a winding which controls an armature **31** which operates a valve or other control means for the clutch and brake units of the power press and, as indicated in the diagram, these components may be located conveniently with respect to the clutch and brake unit or units or at any other convenient point remote from the remaining electrical control components. As indicated in the preamble, the winding **30** may control the machine starting and stopping function in other ways and clutch control and clutch and brake control are referred to herein as familiar means to this end.

In FIG. 1 the numeral **20** indicates a conventional clutch-brake unit mounted on crankshaft **13**. A solenoid valve **21** controlled by electromagnet **30**, **31** controls an operating air supply conduit **22** which leads to the clutch-brake unit by way of a conduit **23**. In the wiring diagram a series of four cams **34**, **35**, **36** and **37** are shown, it being understood that these cams rotate synchronously and will generally be mounted upon a common shaft of a unit known familiarly in this art as a rotating cam limit switch, the shaft being rotated in unison with and at a one to one ratio with respect to the crankshaft of the power press. The limit switches controlled by the cams **34** through **37** comprise, respectively, normally open limit switches **38**, **39** and **40** and a normally closed limit switch **41**. The three limit switches **38**, **39** and **40** are clutch stop limit switches and are used selectively in the alternative as will later appear. The fourth limit switch **41** is an anti-repeat limit switch and its function in the control cycle will likewise presently appear. It will be noted that the four cams **34** through **37** and the limit switches **38** through **41** controlled thereby are a part of the unit **15** shown in FIG. 1 and are generally remotely located with respect to the other control means, which latter will now be described.

A pair of supply conductors **45** and **46** energize the control circuits and thus ultimately the winding **30** which directly controls the clutch or the clutch and brake of the power press. Conductors **47** and **48** lead from one side of the power supply and include spaced pairs of switches **51**, **52**, **53** and **54**. The switches **51** and **52** of conductor **47** are normally closed and the switches **53** and **54** of conductor **58** are normally open. The switches **51** and **53** are controlled by a common push button **56** and the switches **52** and **54** are controlled by a common push button **57**. The push buttons **56** and **57** are spaced to require two-hand operation thereof as is well known in this art.

One side of each of the limit switches **38**, **39**, **40** and **41** is energized directly from supply conductor **45** and the other side of each of these limit switches leads back to the control portion of the circuit by means of conductors designated respectively **60**, **61**, **62** and **63**. A selector switch at the control panel of the press is designated **65** and selectively connects any of the conductors **60**, **61** and **62** to a conductor **66** to render any of the three limit switches **38**, **39** and **40** effective in controlling the terminal point of energization of winding **30** in a manner and for a purpose which will presently appear.

Conductor **47**, in addition to the normally closed, push-button-opened switches **51** and **52**, contains normally closed switches **70** and **71** and a solenoid winding **72** and thence leads back to the opposite conductor **46** of the power supply. Conductor **48**, in addition to the normally open, push-button-closed switches **53** and **54**, includes a normally open switch **74** which is closed when winding **72** is energized, and conductor **48** also includes a winding **76** which controls certain switches in a manner which will presently be described, whereupon conductor **48** returns to the opposite conductor **46** of the power supply.

The conductor **66** which leads from the selector switch **65** and is thus controlled by one or another of the switches **38**, **39** and **40**, includes a pair of normally open switches **77** and **78** and thence connects with conductor **48** to lead back to supply conductor **46**, also by way of the solenoid winding **76**. The conductor **63** which leads from and is controlled by the anti-repeat limit switch **74** includes a normally open switch **80**, which is likewise closed by energization of winding **72** of conductor **47**, and thence leads to conductor **47** at a point between switch **71** thereof and winding **72** thereof.

The circuit which directly energizes the clutch and brake control solenoid winding **30** when the proper conditions exist in the control circuit comprises a conductor **82** from supply conductor **45** and a return conductor **83** which includes a pair of normally open switches **84** and **85** and then returns to the opposite supply conductor **46**, in the present instance jointly with the return portion of conductor **47**. A further switch control solenoid winding **87** connects with conductor **66** between the switches **77** and **78** thereof by way of a conductor **86** and has its opposite side connected to the return portion of conductor **47** as illustrated in the wiring diagram.

In the wiring diagram the several cams **34** through **37** are illustrated in the positions which they assume at top dead center of the crankshaft of the press, that is, their positions when the crankshaft is at rest between operating cycles.

It will be noted that the cams **34**, **35** and **36** are similar excepting that the end of the rise portion of each of these cams occurs at a different point. In cam **34** the rise ends a relatively short distance before top dead center, possibly ten degrees. In cam **35** the end of this rise portion occurs some 50 degrees before top dead center, whereas in cam **36** the end of the rise occurs approximately 100 degrees before top dead center.

Thus the three cams are respectively contoured to initiate clutch disengagement and brake operation at points spaced variously from the end of the desired stroke of the machine to allow for the varying degrees of drift in slow, medium and high speed operation. The following operation of the control structure and circuits will be discussed by way of example in connection with the slow speed cam **34** and the limit switch **38** controlled thereby, it being noted that selector switch **65** is in a position wherein limit switch **38** is included in the control structure

whereas limit switches 39 and 40 are temporarily eliminated from the control circuits.

It may be noted that the control circuit illustrated in the wiring diagram shows only that portion of a machine control circuit which is effective and operative to produce single stroke cycles of a machine, with automatic termination of the cycles arranged and provided for, as will appear later herein. In an actual complete control circuit arrangement there will be additional circuit means provided for so-called jogging or inching of the press and also for continuous non-cyclic operation. These latter two modes of operation are employed in the alternative with the single stroke operation which is here under consideration and need not be further considered in this disclosure.

It will be noted that energization of the clutch and brake control solenoid winding 30 is ultimately, finally and directly determined by closure of the two switches 84 and 85, the circuit for winding 30 being from supply conductor 45 through conductor 82, winding 30, conductor 83 which includes switches 84 and 85 in series, and thence back to the opposite supply conductor 46 by way of the return portion of conductor 47. Since both switches 84 and 85 must be closed to energize and maintain energization of clutch and brake solenoid winding 30, the windings 87 and 76 which operate to close the switches 84 and 85 must be energized to maintain the operating cycle by way of winding 30.

In an ordinary cycle of operation an operator depresses the manual push buttons 56 and 57 by two-hand operation, thus opening switches 51 and 52 of conductor 47 and closing the switches 53 and 54 of conductor 48.

At this beginning point in the cycle of operation, winding 72 is maintained energized, despite the opening of switches 51 and 52, by a holding circuit, and switches 74 and 80 are therefore held closed. The holding circuit is from conductor 45 through the normally closed anti-repeat limit switch 41, conductor 63, switch 80 and thence through winding 72 and the return portion of conductor 47 back to the opposite supply conductor 46.

The closure of switches 53 and 54 establishes a circuit through winding 76 which opens switch 71 and closes switches 78 and 85 and closure of the switch 78 establishes a circuit through winding 87 by way of conductor 48 through the now closed switches 53, 54 and 74, and thence through a portion of conductor 48, conductor 66, switch 78 and conductor 86. With the energization of the windings 76 and 87 in this manner the clutch and brake operating winding 30 is maintained energized but it will be noted that release of either of the buttons 56 or 57 during this beginning portion of a cycle will break the circuit of winding 76 through conductor 48, thus opening switch 85, to deenergize winding 30.

After a press has proceeded through a certain portion of the cycle the dies thereof advance toward a closed position a sufficient degree so that an operator can no longer get his hands therein and thus the two-hand push button control may be released after the press has operated through a predetermined portion of the cycle, say, for instance, 90 degrees as in the presently illustrated instance.

Accordingly, at the 90-degree point in the operation, cam 34 (or either of cams 35 or 36 if the selector switch happens to be set appropriately) closes switch 38 so that the clutch control winding 30 will be maintained energized until a predetermined end point in the cycle, despite release of the push buttons 56 and 57 and consequent opening of switches 53 and 54. This end point of energization of the winding 30, as indicated above, is determined by allowing an un-energized period at the end of the cycle sufficient to allow for the time lag in clutch release and/or brake operation, known in the art as "drift."

This holding circuit which becomes established by operation of cam 34 (in the illustrated position of the selector switch) is by way of conductor 45, limit switch 38, conductor 60, selector switch 65, conductor 66 including the two closed switches 77 and 78, and thence by way of the return portion of conductor 48, through winding 76 to the other supply conductor 46.

At the time when limit switch 38 takes over in the above fashion, winding 87 is also energized by the circuit comprising conductor 45, limit switch 38, conductor 60, selector switch 65, conductor 66, switch 77 and conductor 86 through the winding 87 and thence to the opposite supply conductor 46.

With as much of the operation as has thus far been described, the buttons 56 and 57 could be held depressed to continue energization of the winding 30 beyond the rise of the cam 34 to effect continuous running of the machine, which cannot be permitted. It would thus be possible for an operator to tape the two buttons down and achieve continuous running against regulations and safety precautions, or he could tape one button down and employ a one-hand operation which is likewise hazardous.

To prevent this is the function of cam 37 and an anti-repeat relay arrangement which is under the control of switch 41. When the press has effected approximately 180 degrees of its cycle of operation, the rise portion of cam 37 opens switch 41 which has been serving to maintain energization of the anti-repeat winding 72. Upon such deenergization switches 74 and 80 assume their normally open positions and winding 72 cannot again be energized excepting by return of both of the buttons 56 and 57 to their released positions wherein they close switches 51 and 52 and to effect such reenergization of winding 72 these buttons must remain in their released position beyond the end of the period of energization of the winding 30 as determined by the end of the rise of the cam 34 (in the illustrative instance). At the end of the rise of cam 34 the windings 76 and 85 become deenergized as previously described and normally closed switches 70 and 71 thus close to complete the reenergization of winding 72 and render possible the subsequent institution of a new cycle of operation by a further joint depression of the buttons 56 and 57.

I claim:

1. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for maintaining such energization after a predetermined initial period, a normally open switch in said first circuit means and manual push button means for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for including one or another of said plurality of switches in said second circuit means, a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches at a predetermined point in the machine cycle and open the same before the end of a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds, and anti-repeat means comprising a cam rotatable with the aforesaid cams and a switch opened and closed thereby during each machine cycle to open said first circuit means and prevent reclosure thereof until the push button means is released and reclosed at the end of a cycle of operation.

2. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for maintaining such energization after a predetermined initial period of energization instituted by said first circuit means, normally open switch means in said first circuit means and manual push button means for closing the same to initiate a machine cycle, a plurality of

parallel switches in said second circuit means and a selector switch for including one or another of said plurality of switches in said second circuit means a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches at a predetermined point in the machine cycle and open the same before the end of a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds, and anti-repeat means comprising a cam rotatable with the aforesaid cams and a switch opened and closed thereby during each machine cycle to open said first circuit means and prevent re-closure thereof until the push button means is released and reclosed at the end of a cycle of operation.

3. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for maintaining such energization after a predetermined initial period, a normally open switch in said first circuit means and manual push button means for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for including one or another of said plurality of switches in said second circuit means, and a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches at a predetermined point in the machine cycle and open the same before the end of a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds.

4. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for maintaining such energization after a predetermined initial period, a pair of normally open switches in said first circuit means and a pair of spaced manual push button means for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for alternatively including one or another of said plurality of switches in said second circuit means, a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches at a predetermined point in the machine cycle and open the same before the end of a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds, and anti-repeat means comprising a cam rotatable with the aforesaid cams and a switch opened and closed thereby during each machine cycle to open said first circuit means and prevent reclosure thereof until the push button means is released and reclosed at the end of a cycle of operation.

5. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for maintaining such energization after a predetermined initial period, a pair of normally open switches in said first circuit means and a pair of spaced manual push button means for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for alternatively including one or another of said plurality of switches in said second circuit means, a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches at a predetermined point in the machine cycle and open the same before the end of a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds.

6. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for maintaining such energization after a predetermined initial period of energization instituted by said first circuit means, normally open switch means in said first circuit means and manual push button means for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for including one or another of said plurality of switches in said second circuit means, and a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches at a predetermined point in the machine cycle and open the same before the end of a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds.

7. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for alternatively energizing said operating circuit, a pair of normally open switches in series in said first circuit means and a pair of spaced manual push buttons for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for including one or another of said plurality of switches in said second circuit means, a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches and open the same during a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds.

8. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for alternatively energizing said operating circuit, normally open switch means in said first circuit means and manual push button means for closing the same to initiate a machine cycle, a plurality of parallel switches in said second circuit means, a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches and open the same during a cycle of machine operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds and a selector switch for including one or another of said plurality of switches in said second circuit means.

9. In a control system for machines, electromagnetic means for starting and stopping the same, an operating circuit for the electromagnetic means, a first circuit means for energizing said operating circuit and a second circuit means for alternatively energizing said operating circuit, normally open switch means in said first circuit means and a manual push button means for closing the same to intiate a machine cycle, a plurality of parallel switches in said second circuit means and a selector switch for including one or another of said plurality of switches in said second circuit means, a plurality of synchronously rotating cams driven from said machine, each of said cams being adapted to close one of said plurality of switches and open the same during a cycle of machine

operation, the switch opening points of said cams being variously spaced from the end of a machine cycle to compensate for varying degrees of drift of the machine at various operating speeds, and anti-repeat means comprising a cam rotatable with the aforesaid cams and a switch opened and closed thereby during each machine cycle to open said first circuit means and prevent re-closure thereof until the push button means is released and reclosed at the end of a cycle of operation.

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