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CAM-ACTUATED SPEED CONTROL FOR CYCLICALLY OPERATED MACHINES

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Fig 1

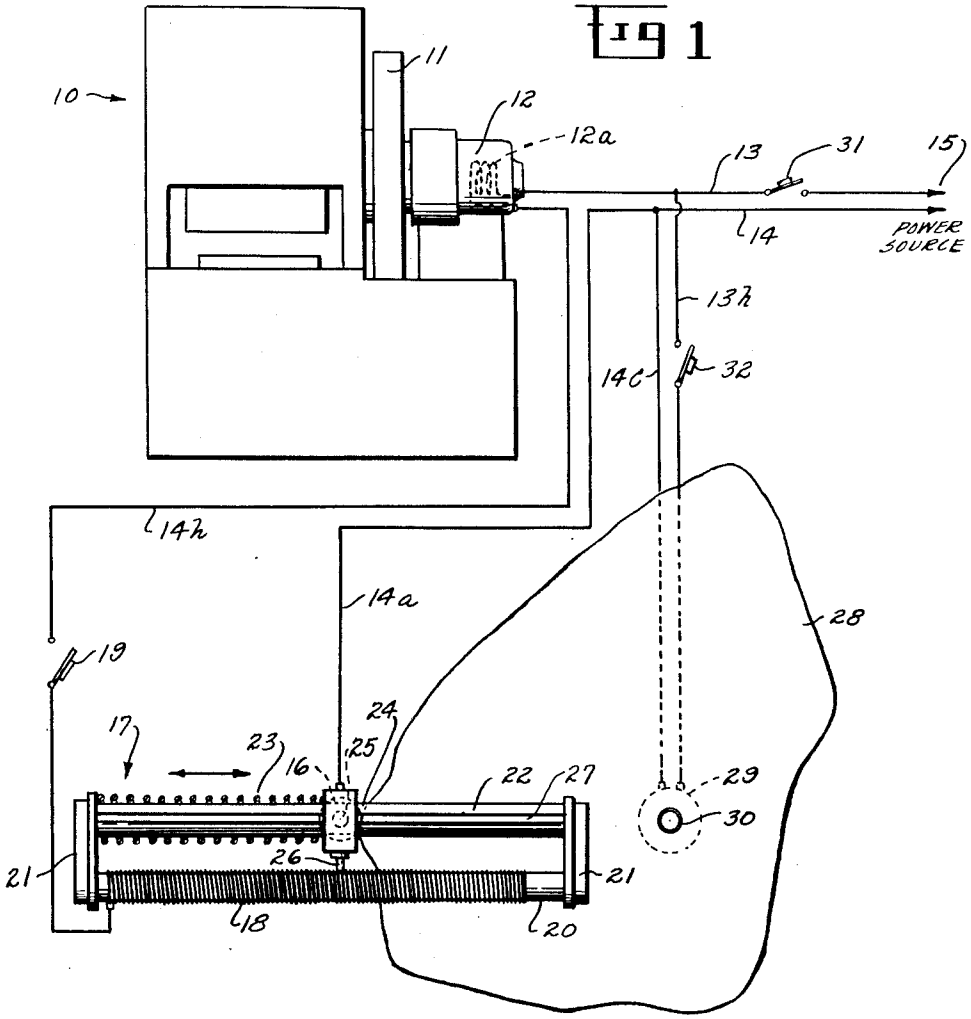
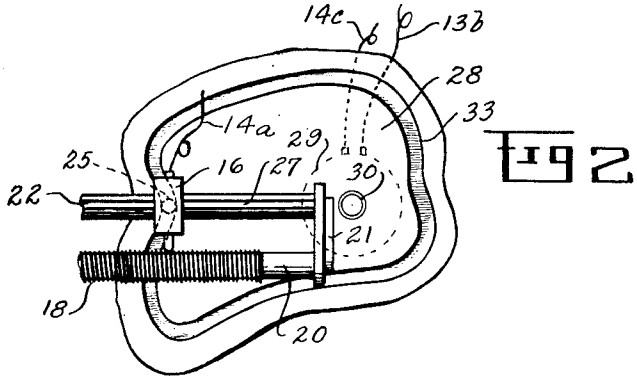


Fig 2



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CAM-ACTUATED SPEED CONTROL FOR CYCLICALLY OPERATED MACHINES

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9 Claims. (Cl. 318—164)

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The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

This invention relates to a cam-actuated speed control for cyclically operating machines such as punch presses, draw presses, metal cutting-, forming-, or drilling-machines or machine tools in general which go through a large number of repeat cycles. This classification includes lathes, planers, molding machines, extruding machines and the like.

In such machines, production time is important and this invention offers a means of speeding-up the operation of the machine when that part of the cycle is being performed during which speed is permissible and desirable, and of slowing down the operation when time must be given for metal to flow, tools to cut, plastics to harden or other similar operations which can not be conveniently shortened without sacrificing the quality of the product. By the use of my control, the cycle need not be paced at the speed of the slow part of the operation as has heretofore been the case, but may be speeded up in those parts of the cycle where a higher speed will not hurt the quality of the article being manufactured.

Briefly stated, my device includes a substantially flat cam, the edge contours of which are exactly formed to control the speed of a given operation, a motor for driving the cam at the constant slow speed, a potentiometer of the slide-wire type, the slider of which is under control of the cam, a motor driving the cyclic machine which is to be controlled and a circuit for this motor which includes the potentiometer just described. In hydraulic machines, a motor which drives the machine will be coupled or geared to a pump which supplies the hydraulic fluid under high pressure. The action of the controller on the machine will approximate the change of pace of a skillful human operator who slows down when a delicate step demanding the highest degree of care is to be performed, but who speeds up when noncritical steps are to be carried out.

Referring to the accompanying drawing, Fig. 1 shows, schematically my control attached to a draw or punch press of a motor driven type.

Fig. 2 is an elevation showing a modified cam drive for the potentiometer slider in which the return spring of the potentiometer as shown in Fig. 1, is eliminated.

In Fig. 1, 10 is a punch or draw press of the kind having a large actuating gear 11 which is driven by an electric motor 12. The motor is

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fed current through the conductors 13 and 14 of a power circuit deriving current from a power source 15. Conductor 14 is connected as to one end 14*a* with a slider 16 of a potentiometer 17, the impedance or resistance winding of which is indicated at 18. Conductor 14*b* is connected through a switch 19 to one end of the impedance or resistance winding 18. The impedance or resistance winding is wound over a preferably non-metallic or insulated bar 20 which is affixed by yokes 21 to a similar bar 22 upon which the slider 16 may operate. Between one yoke 21 and the slider 16 there is a heavy coil spring 23 which is normally pressing the slider 16 to the right and which has sufficient stored energy to bring it into contact with the right hand yoke 21 when there is no other force tending to compress the spring 22 to the left. Behind slider 16 there is a non-conductive small wheel 24 which is able to revolve freely on a stub shaft 25 which projects rearwardly from the slider 16 at right angles to the bar 22. Projecting downwardly there is a spring-pressed conductive button 26 which is adapted to make electrical contact with the winding 18 and to connect conductor 14*a* with the winding 18 by conventional means (not shown). The bar 22 may be square to prevent rotation of a slider about the bar or it may have a key and keyway 27 extending along its length to accomplish the same purpose.

The electrical properties of the winding 18 are such that when the slider 16 is in abutment with the left hand yoke 21, there is substantially no impedance or resistance of the winding 18 in the circuit defined by conductors 14*a*, winding 18 and conductor 14*b*; on the other hand when the slider 16 is in contact with the right hand yoke 21, the button 26 is not in contact with the winding 18 at all, so that the impedance or resistance of the circuit just mentioned is infinite. The conductors 13, 14, 14*a* and 14*b* supply current to the armature winding 12*a*. The element 12*a* is intended to have a broader co-notation than an armature winding. It designates an element within the motor which is capable of causing a change in the speed of the motor in accordance with the amount of current flowing through the said element 12*a*. This element may be a field winding or an armature winding. The armature winding is under the control of the potentiometer 17 and the position of the slider 16 on the potentiometer is under joint control of the coil spring 23 and of a cam 28, the edges of which make rolling contact with the wheel 24 at the rear of the slider 16. The cam 28 is driven slowly by a motor 29 which is supplied with current from leads 14*c* and 13*b*. The cam 28 is

affixed to the shaft 30 of motor 29 by conventional means, so that it will rotate with the shaft 30 without slippage. The motor 29 may be a synchronous motor adapted to keep proportional step at a reduced speed with the press-driving motor 12. A switch 31 is provided in the main conductor 13 and a switch 32 is provided in the secondary conductor 13b. Switches 13, 32 and 31 may be ganged together by mechanical means if desired, so that they may open and close simultaneously.

The cam 28 is made preferably of thick plywood, the edges of which are smoothed. Its contours are such that the perimeter is traversed once over the wheel 24 for one rotation of the motor 29. Therefore one rotation of the motor 29 and the cam 28 represents one cycle of the press or other machine 10. The shortest distance between the shaft 30 and the edge of the cam represents the slowest speed which can be applied to motor 12. At that speed, there will be the greatest amount of resistance due to the presence of winding 18 in the motor supply circuit 14a and 14b. This is because the potentiometer slider 16 will be forced continually against the edge of the cam 28 by the spring 23. A maximum of resistance is thus introduced into the motor supply circuit as great as the contour of the cam 28 will permit, until the slider button 26 is forced entirely off the winding 18 and optionally according to cam contour, onto the bar 28. When the cam is in the position during which the greatest speed of the press is desired, the distance between the edge of the cam and the motor shaft 30 will be at its maximum. When the slider 16 is at the extreme left side of the potentiometer, the speed of the press should be the maximum recommended by the manufacturer thereof; when the slider is at the extreme right hand position on the potentiometer 17, the press should have no speed, i. e. it may be at rest. Complete stoppage of the press between cycles is optional through control of cam contour.

Referring to Fig. 2, a modified form of cam 28 is shown, which form enables the coil spring 23 to be dispensed with. In this form, there is a groove 33 cut into the face of the cam 28 just wide enough to accommodate the diameter of the stub shaft 25 of the slider 16. The position of the slider is therefore governed by the curvatures of the groove 33 which do not necessarily have to parallel the outer edges of the cam 28. Several grooves 33 of varying curvature may therefore be cut into a single plywood cam providing that the grooves do not cross each other. The motor 12 might be the motor supplying energy to a power feed either lengthwise or crosswise on a lathe apron. It might also be the motor which traverses the table of a milling machine against the cutters thereof either lengthwise or crosswise. In the case of a hydraulically driven machine, the motor 12 could be the motor which drives the main pump or an auxiliary feed pump, for example the pump which drives the lengthwise or cross wise table feed on a hydraulically driven milling machine. In the case of feed motors, unless these have reversing limit switches, the table or equivalent must be returned to its starting position manually or under manual control. It is to be seen therefore that a control of general applicability is provided which is not limited to any particular kind of machine except as already stated, and which can with equal facility be applied to a mechanical or a hydraulic electrically driven machine.

Although in the foregoing description the invention has been described as applied to a direct current motor in which the speed thereof is controlled by controlling a current in the armature circuit, it will be understood that the invention can as well be applied to a direct current motor in which the speed thereof is controlled by controlling the field current. In such case, the cam member 28 will be constructed to have dimension opposite to that described above. That is to say, that where a cam controlling the armature circuit would insert more resistance to produce a desired speed change, a cam controlling the field circuit would decrease the impedance to produce the same change in speed and vice versa.

A carbon disc pile-type resistor is the equivalent of a potentiometer in this invention, since, like the slide-wire potentiometer, the more it is pressed by the cam, the less resistance it will have and the higher the speed of the drive motor will be.

I claim as my invention:

1. In combination with a motor drivable machine of the kind which is adapted to go through many substantially identical cycles of operation whereby at the end of a cycle to produce a complete or incomplete article of manufacture, a motor, an energizing circuit therefor including an impedance, adjusting means for varying the electrical value of said impedance, a cam for operating said adjusting means, and means for causing rotation of said cam and operation of said adjusting means, driving means for said rotation-causing means, said driving means and said motor being both driven from said energizing circuit and timed to complete one revolution of said cam in substantially the same length of time that it takes the machine to complete its cycle, the two operations proceeding simultaneously.

2. In combination with an electric motor driven machine of the kind which is adapted to go through many substantially identical cycles of operation whereby at the end of a cycle to produce a complete or incomplete article of manufacture, a drive motor having an armature winding, a source of power, means for energizing said drive motor from said power source, said means including a conductive circuit, a resistance in said circuit, an electric timing motor, a cam mounted thereon for rotation whereby the contour of which cam is representative of the proper speeds to be pursued seriatim by the machine during its cycle, and means in contact with said cam for varying said resistance in the drive motor circuit to vary the speed of said motor and said machine in response to the rotational movement of said cam, the rotational movement of said timing motor and cam having a value proportional to the speed of said drive motor.

3. In combination with an electric motor driven machine of the kind which is adapted to go through many substantially identical cycles of operation whereby at the end of a cycle to produce a complete or incomplete article of manufacture, a drive motor having an armature winding, a source of power, a conductive circuit between said source of power and said armature winding, a potentiometer in said circuit, an electric timing motor, a cam mounted thereon for rotation, the contour of which cam when so mounted being representative of the proper speeds to be pursued seriatim by the machine during its cycle, and means in contact with said cam for varying the resistance in the drive motor

circuit to vary the speed of said motor and said machine in response to the rotational movement of said cam, the rotational movement of said timing motor and cam having a value proportional to the speed of said drive motor.

4. In combination with an electric motor driven machine of the kind which is adapted to go through many substantially identical cycles of operation whereby to produce a complete or incomplete article of manufacture, a drive motor having an armature winding, a source of power for said motor, a conductive circuit between said source of power and said armature winding, a potentiometer of the slide wire type in said circuit, the armature winding of said motor being in series with said potentiometer, an electric timing motor driven from said circuit, a cam mounted on the drive shaft of said timing motor to rotate therewith, the contour of which cam, when so mounted being representative of the proper speeds to be pursued by the machine during one cycle thereof, said potentiometer having an electrically conductive slider carrying a terminal of one arm of said circuit, means for spring-pressing said slider into continuous contact with said cam.

5. In combination with an electric motor driven machine of the kind which is adapted to go through many substantially identical cycles to produce a complete or incomplete article of manufacture, a first electric motor having an armature circuit, a source of power, a conductive circuit between said source of power and the armature winding of said motor, a potentiometer of the linearly extended type including two parallel bars, resistance wire wound on one of said bars in series with said field windings, a pickoff traversible on the other bar to contact said resistance wire throughout a range thereof, a timing motor, the speed of which is proportional to, but slower than that of the first motor and cam means carried by said timing motor, the contour of which cam means when so carried, is instantly representative of the desired speed to be followed by said first motor of said machine controlling said pickoff to increase the impedance to the current supplied to the armature windings of the first motor whereby to decrease the speed of said first motor, and return means in contact with said pickoff influencing said pickoff to follow the contours of said cam means to govern the speed of at least a portion of the machine throughout its cycle.

6. In combination with a draw press of the kind actuated by a large gear, the drive motor cooperating with said gear, said drive motor having an armature winding, a source of power, a conductive circuit between said source of power and said winding, a variable resistance in said circuit, the armature winding for said motor being included in said circuit, an electric timing motor, a cam mounted thereon for rotation therewith, the contour of which cam when so mounted being representative of the proper speeds to be pursued seriatim by the press during its cycle, and means on said resistance in contact with said cam for varying the impedance in the motor drive circuit to vary the speed of the drive motor and the press in response to the rotational movement of said cam, the rotational movement of the timing motor and the cam having a value proportional to the speed of said drive motor.

7. In combination with an electric motor driven draw press of the kind which is actuated through a large gear, a drive motor operatively connected to said gear, said drive motor having an armature winding, a source of power, a conductive circuit between said source of power and said winding, a potentiometer in one arm of said circuit, an electric timing motor, a cam mounted thereon for rotation therewith, the contour of which cam when so mounted being respresentative of the proper speeds to be pursued seriatim by the press during its cycle and means on said potentiometer in contact with said cam for varying the resistance in the drive motor circuit to vary the speed of said motor in said machine and response to the rotational movement of said cam, the rotational movement of said timing motor and cam having a value proportional to each speed of said drive motor.

8. In combination with an electric motor press of the kind which is actuated through a large gear, a drive motor having an armature winding, a source of power, a conductive circuit between said source of power and said winding, a potentiometer of the slide wire type in one arm of said circuit, the armature winding of said motor being in series with said potentiometer, an electric timing motor driven from said circuit, a cam mounted on the drive shaft of said timing motor to rotate therewith, the contour of which cam when so mounted being representative of the proper speeds to be pursued by the press during one cycle thereof, said potentiometer having an electrically conductive slider carrying a terminal of one arm of said circuit, and means for spring pressing said slider into continuous contact with said cam.

9. In combination with a metal working press, an electric drive motor in operative relation to said press, said motor having an armature winding, a source of power for said motor, a conductive circuit between said source of power and said winding, a potentiometer of the linearly extended type including two parallel bars, resistance wire wound on one of said bars in series with said armature winding, a pickoff traversable on the other bar to contact said resistance wire throughout a range thereof, a timing motor, the speed of which is proportional to, but slower than that of the drive motor and cam means carried by said timing motor, the contour of which cam means when so mounted being instantly representative of the desired speed to be followed by said drive motor of said press, said cam means controlling said pickoff to increase the resistance to the current supplied to the armature winding of the drive motor whereby to decrease the speed of said drive motor and return means in contact with said pickoff influencing said pickoff to follow the contours of said cam means to vary the speed of at least a portion of the press throughout its cycle.

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