SAFETY CONTROL SYSTEM FOR HYDRAULICALLY OPERATED MACHINES

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ABSTRACT OF THE DISCLOSURE

A system for controlling operation of a plurality of machine parts exemplified by a set of hydraulic valves connected to control the operation of the respective machine parts and actuated by a set of cams mounted on a common camshaft. The camshaft is mounted on a slidable frame adapted in one position to cause the cams to actuate the respective valves, in a second position to cause the cams to release the valves which are then returned to starting position by springs, and in a third position to bring manually controlled members into alignment with the valves to permit manual adjustment thereof. A master control is provided for positioning said frame and for interrupting the supply of hydraulic fluid to said valves. The camshaft is driven by an electric motor, having in its control circuit a plurality of switches, actuated in accordance with the movement of the control elements and connected to prevent each controlled part from being actuated until the preceding controlled part has reached a predetermined point in its cycle.

This invention relates to a safety control mechanism for power operated machines having a plurality of interlocked, sequentially operated parts, and more particularly to a mechanism for simultaneously interrupting the operation of the controlled parts and restoring them to their start positions.

An object is to provide a mechanism of the above type which is capable of instantly stopping a power operated machine and either leaving the machine parts in their positions, at the time of interruption, or restoring the parts to their initial positions.

A further object is to provide means for converting the operation of the control means from automatic to manual and for restoring them to automatic operation as desired.

Another object is to provide, in mechanism of the above type, means for restarting the operation either with the parts in their interrupted position or in their initial positions. Another object is to provide a control system of the above type wherein each controlled part reaches a predetermined point in its cycle of operation prior to the start of the operating cycle of the succeeding part.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

The said control elements may constitute electrical relays or fluid operated valves, or other equivalent mechanisms. In the embodiment shown by way of example, a bank of control valves are arranged to be operated by a cam carried camshaft in a predetermined sequence. The camshaft is mounted on a sliding frame which can be shifted in response to a manual control from an automatic position wherein the valves are actuated by the cams to a stop position wherein all of the cams are removed from contact with the valve followers so that all of the valves can be returned to their initial positions. In the case of a press, for example, the platen would be not only stopped but restored to its initial position.

The camshaft may complete its cycle and be brought to rest in its start position so that, when the camshaft is again shifted to bring the cams into engagement with the cam followers, a new cycle of operation is commenced.

In a third position of the sliding frame, a set of manual control pins is brought into registration with the various cam followers so that the valves can be individually controlled as desired. A master control member is provided to shut off the hydraulic pressure to all of the valves so as to interrupt the operation of the various controlled parts of the machine without restoring them to their start positions.

The valves are connected to control the operation of the hydraulic cylinders having switches connected to prevent a cylinder from being actuated until the previous cylinder has reached a predetermined point in its cycle of operation.

The nature of the invention will be better understood from the following description, taken in connection with the accompanying drawings in which a preferred embodiment has been shown for purposes of illustration.

In the drawing:

FIG. 1 is a side elevation of a control mechanism embodying the invention; and

FIG. 2 is a transverse section taken on the line 2—2 of FIG. 1; and

FIG. 3 is a partial section, similar to FIG. 2, illustrating a further embodiment of the invention.

Referring to the drawing more in detail, the invention is shown as embodied in a control mechanism for a set of hydraulic valves adapted to control the sequence of operation of a set of parts of a hydraulically operated machine such as a press. More specifically, the mechanism includes a frame having a horizontal base portion 10 and a pair of vertical track members 11 having tracks 12 formed in their inner surfaces. The frame carries a bracket 13 on which is mounted a set of hydraulic control valves 14, each of which includes a slide spool 15 actuated by a stem 16 having at its end a cam follower 17. Each valve 14 is biased to an advanced or starting position by a spring 18.

Hydraulic fluid is supplied to the valves 14 through a header 20 mounted above the valves and supplied by a line 21 through a manual master stop valve 22 by means of which the supply of fluid pressure to all of the valves can be interrupted for bringing the movement of the controlled parts to rest.

Each of the spool valves 14 is connected by a fluid line 46 to a cylinder 47 carrying a piston 48 which is spring pressed by a spring 53 to its retracted position but is advanced in response to fluid pressure in the line 46 when the spool valve is actuated to supply fluid under pressure to the cylinder 47 and is retracted by the spring 53 when the cylinder is connected to exhaust by the spool valve.

A rectangular slide frame 30 is mounted to slide vertically in the tracks 12. This slide frame 30 is connected to be actuated by a piston rod 31 and a piston 32 sliding in a cylinder 33 carried by the base member 10 and controlled by a line 34 carrying hydraulic fluid and having a manual control valve 35 by which the movement of the slide frame 30 is controlled.

The frame 30 carries a horizontal camshaft 40 and a driving motor 41 which may be an electric motor having a control switch 42 which may be set for causing continuous operation of the motor or for causing the motor to turn the camshaft through a single revolution and then bring the camshaft to rest until reactivated.

The camshaft 40 carries a series of cams 45 which, when the slide frame 30 is in position for automatic operation, register with the cam followers 17 for actuating the various control valves 14 in a sequence which depends
upon the setting of the cams. When the valves 14 are retracted by their actuating cams 45, the controlled machine parts are connected to be set in motion and the parts are returned to their starting positions when the valves 14 are restored to their initial positions by the biasing springs 18.

A set of manual control members 50 are mounted on a bracket 51 carried by the frame 30 below the camshaft 40. The members 50 are threaded into the bracket 51 and cam control knobs 52 by which they can be individually adjusted. When the frame 30 is raised from its lower or intermediate position as shown in Fig. 1 to its upper or manual control position, the camshaft 40 is shifted out of alignment with the cam followers 17 and the manual control members 50 are brought into registration therewith so that each control valve 14 can be individually and manually adjusted as desired. The manual control members 50 are displaced from the camshaft 40 to a sufficient distance so that the slide frame 30 can be brought into an intermediate or stop position in which both the cams 45 and the manual members 50 are out of registration with the cam followers 17 and the various valves 14 are restored to their advanced positions by their biasing springs 18. The manual control valve 35 is adapted to set the frame 30 in a selected one of its three positions.

One of the cams 45 may be connected to actuate the switch 42 for stopping the motor when the camshaft 40 has completed its cycle, and when the camshaft has shifted out of its automatic operating position. In this way, the cams are restored to starting position after the automatic operation of the controlled element has been interrupted and all the individual parts have been restored to their respective starting position.

Each piston 48 is connected to a piston rod 54 by which a certain part of the controlled machine is actuated. The piston rod 54 carries an arm 55 which is positioned to engage and close a switch 56 when the piston 48 is fully retracted and to engage and close a switch 57 when the piston 48 is fully advanced. In other positions of the piston both switches are open. The switches 56 and 57 of each cylinder 47 are connected in parallel as by lines 58 and the pairs of switches 56 and 57 are connected in series in the supply circuit of motor 41 as by lines 59.

At the start of the operating cycle it is assumed that all of the pistons 48 are in retracted position and all of the switches 56 are closed. The motor 41 is energized and starts to turn the camshaft 40. When the first cam 45 engages its cam follower 17 and actuates the spool valve 14 fluid under pressure is supplied to the cylinder 47 controlled thereby and the piston 48 of that cylinder starts to advance, thereby opening its contact 56 and interrupting the drive of the motor 41. The camshaft 40 thus stops and remains in its first position until the first piston 48 reaches its fully advanced position at which time its switch 56 is closed to again complete the motor circuit. The drive continues until the next cam actuates its follower to repeat the above operation.

In this system each control stroke is completed before the next control operation is started and the cam-shaft advances step-by-step until the cycle of operation of the machine is completed.

This system is suitable for use with various types of automatic machines such as, for example, presses or the like wherein each stroke must be completed before the next operation is started. Such a system automatically compensates for any deviation in any of the sequential operations from a predetermined timed sequence.

In normal operation the valve 35 is set to shift the slide frame 30 to its lower or manual control operating position, the valve 22 is set to supply operating fluid to the control valves 14 and the motor control switch 42 is set in the on position either for continuous automatic operation of the motor or for operation through a single cycle as desired. The cams 45 then engage and retract the cam followers 17 in sequence to effect normal operation of the controlled machine.

If it should be desired to stop the machine, while leaving the parts in their advanced positions, the master valve 22 is closed to interrupt the supply of hydraulic fluid to the header 20 and to the various valves 14. The valve 22 may be interconnected to the switch 42 to stop the motor immediately so that the parts resume their normal operation when the valve 22 is again opened and the motor 41 restarted.

Upon stopping a machine such as a press, it is usually desirable not only to bring the parts to rest but to restore them to their starting positions. That is, the platen of the press is first stopped and then retracted. For this purpose the manual valve 35 is actuated to shift the slide frame 30 to its intermediate or stop position. The cams 45 are raised out of registration with the cam followers 17 so that all of the valves 14 are free to be restored to their initial positions by the biasing springs 18. The manual valve 35 may be interconnected with the motor switch 42 to set the switch for stopping the motor 41 at the end of its cycle so that the cams 45 complete their cycle and are brought to rest in their starting positions. Thus, by the actuation of a single manual valve, the operator can immediately stop and reset the machine for its next cycle. When it is desired to restart the cycle, the manual valve 35 is reset at automatic for shifting the slide from to the automatic control position.

If, after stopping the machine, it is desirable to adjust certain of the parts manually, the manual control valve 35 is set to manual and supplies fluid pressure to shift the slide frame 30 to its upper or manual position wherein the pins 50 are brought into registration with the cam followers 17. The knobs 52 may then be set individually for actuating a selected valve 14 and its corresponding machine part.

In the embodiment of Fig. 3 the camshaft 40 is shown as shown on a bracket 11 secured to the frame 11. The frame 30a carries a bar 65 in which a set of pins 66 are mounted for axial sliding movement in holes 68. The pins 66 are interposed between the cam 45 on the camshaft 40 and the cam followers 17 of the valves 14. Each pin 66 carries a cam follower 67 adapted to engage and be actuated by the cam 45 for causing the pin to slide axially in the bar 65 and to thereby engage and actuate the cam follower 17 on the valve stem 16.

The frame 30a is mounted to slide in the channel 11 as in the case of the frame 30 of FIGS. 1 and 2 between an operating position wherein the pins 66 interconnect the cams 45 and the cam followers 17 of the valves 14, and release position wherein the pins 66 are brought out of alignment with the cams 45. When in this release position the valves 14 are released from the control of the cams 45 and are spring returned to their initial positions as above described.

It is to be understood that the various control members and actuating valves are the same as shown in FIGS. 1 and 2 and that only so much of the apparatus has been shown in Fig. 3 as is necessary for an understanding of the invention. The various parts shown in FIG. 3 have been given the same reference numbers as in FIGS. 1 and 2 for convenience and the description thereof will not be repeated.

What is claimed is:

1. A system for controlling the operation of a plurality of sequentially operated machine parts, comprising a set of control members operable between starting and advanced positions connected to actuate the respective parts, a cam shaft carrying a set of cams adapted to engage the respective control members, means driving said camshaft for causing said cams to advance said control members in a predetermined sequence, a moveable frame carrying said camshaft, means for shifting said frame for disengaging said cams from said control members, and return means for restoring said control mem-
bers to their respective starting positions when so released from said cams, said means for shifting said frame comprising a hydraulic cylinder connected to shift said frame and a manual control valve connected to actuate said cylinder between an automatic position wherein the cams engage the cam followers and a stop position wherein the cams are out of engagement with said cam followers.

2. A system for controlling the operation of a plurality of sequentially operated machine parts, comprising a set of control members operable between starting and advanced positions connected to actuate the respective parts, a set of cams adapted to advance the respective control members, means driving said cams for causing said cams to advance said control members in a predetermined sequence, means for disengaging said cams from said control members and return means for restoring said control members to their respective starting positions when released from said cams, and a set of controlled members connected to be actuated by said control members, and means to prevent the cams from continuing their rotation until each controlled member has reached a predetermined point in its operating cycle.

3. A system as set forth in claim 2 including means to interrupt the rotation of said cams during a portion of the operating cycle of each controlled member.

4. A system as set forth in claim 2 including a motor connected to rotate said cams, a control circuit for said motor, and switch means actuated by at least one of said controlled members at predetermined points in its operating cycle, said switch means being connected to interrupt the motor circuit during a predetermined portion of the operating cycle of said controlled member.

5. A system as set forth in claim 1 in which a set of manual valve adjusting elements is mounted on said frame in alignment with said cams but spaced therefrom and adapted to register with and actuate said valves when brought into alignment therewith, and said manual control valve is connected to shift said frame into a third position for such manual operation of said valves.

6. A system as set forth in claim 1 in which said control members comprise hydraulic valves having cam followers actuated by said cams, and fluid for actuating said valves is supplied through a header having a supply line including a master valve adapted to interrupt the supply of fluid pressure to all of said control valves for stopping the operation of the controlled parts of said machine.

7. Apparatus for controlling the operation of various parts of a hydraulically operated machine, comprising a set of hydraulic cylinders having pistons connected to actuate said parts, hydraulic control means including a set of cams connected to control the operation of said pistons in sequence, means including a motor connected to drive said cams, a control circuit for said motor including switch members associated with the respective cylinders and connected in series in said circuit and adapted to actuate said motor when all of said switch members are closed, and means associated with each of said pistons to close its corresponding switch member only when said piston is in a predetermined advanced position or in a predetermined retracted position, whereby said cams are advanced by said motor to actuate each successive piston only after the preceding piston has reached a predetermined point in its stroke.

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