Dec. 19, 1939. K. C. MONROE 2,184,052

HYDRAULIC BROACHING MACHINE AND WORK SUPPORT THEREFOR

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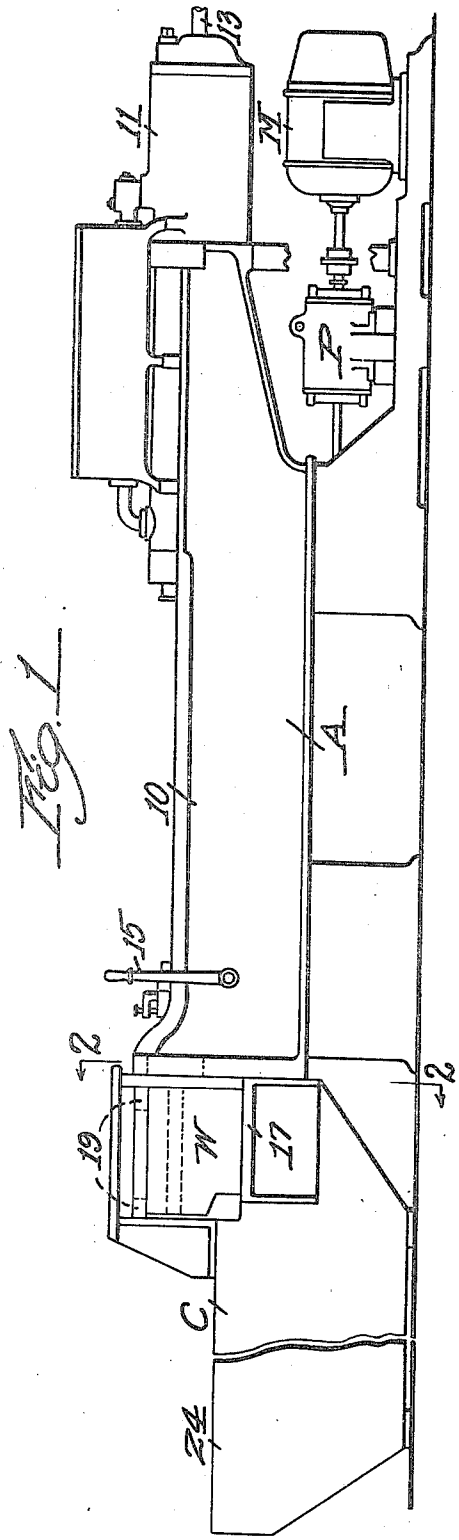

Fig. 1

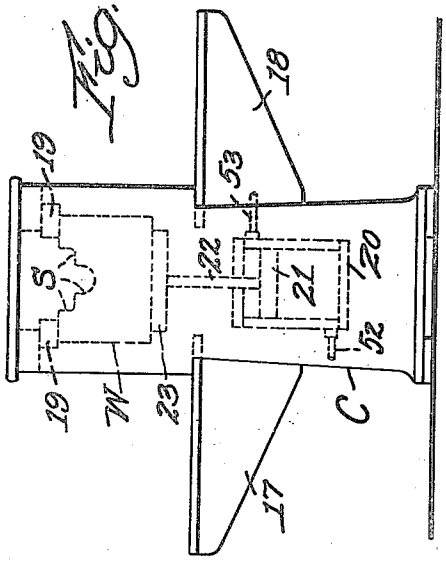

Fig. 2

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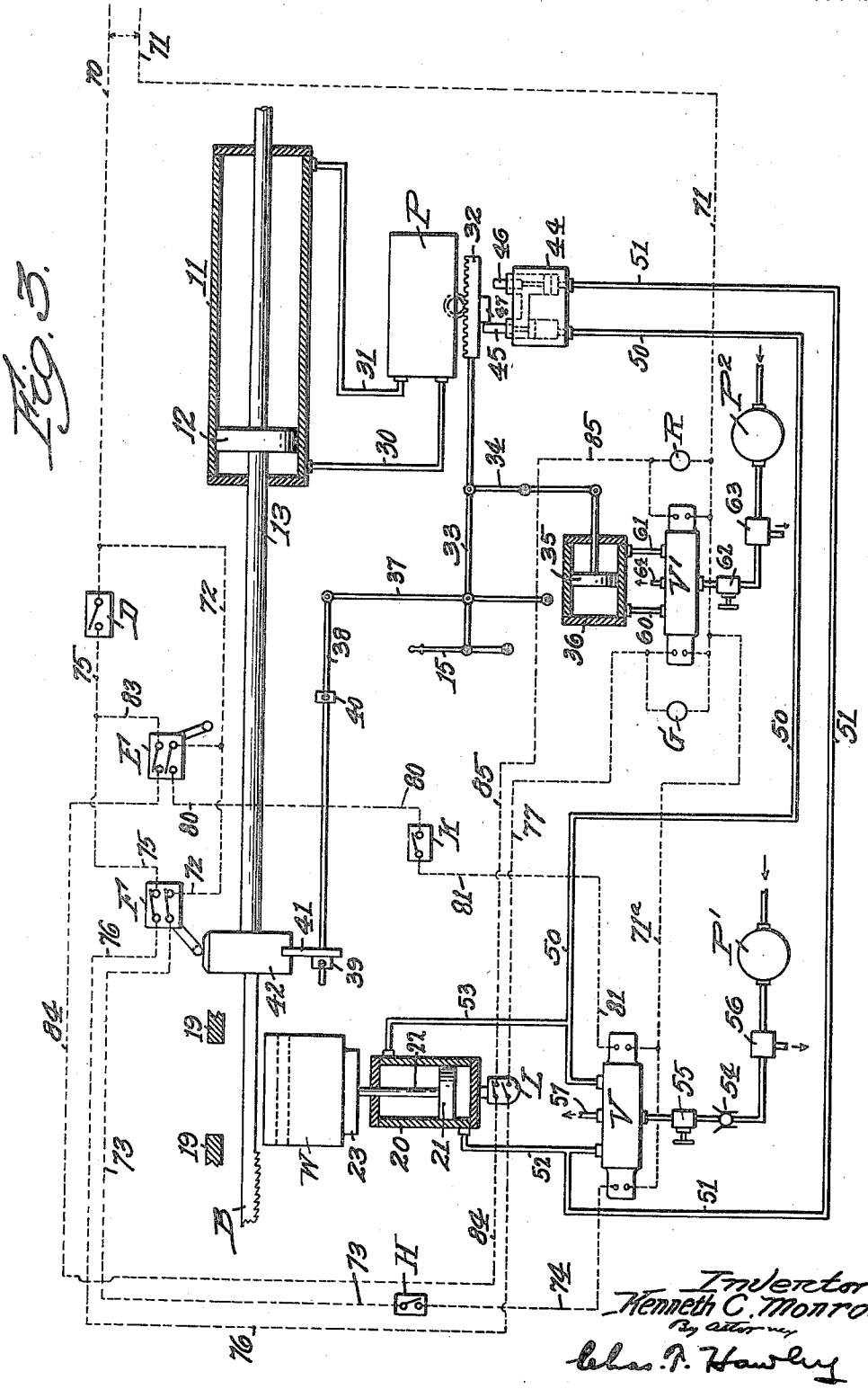
Fig. 3.



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HYDRAULIC BROACHING MACHINE AND WORK SUPPORT THEREFOR

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Fig. 4.

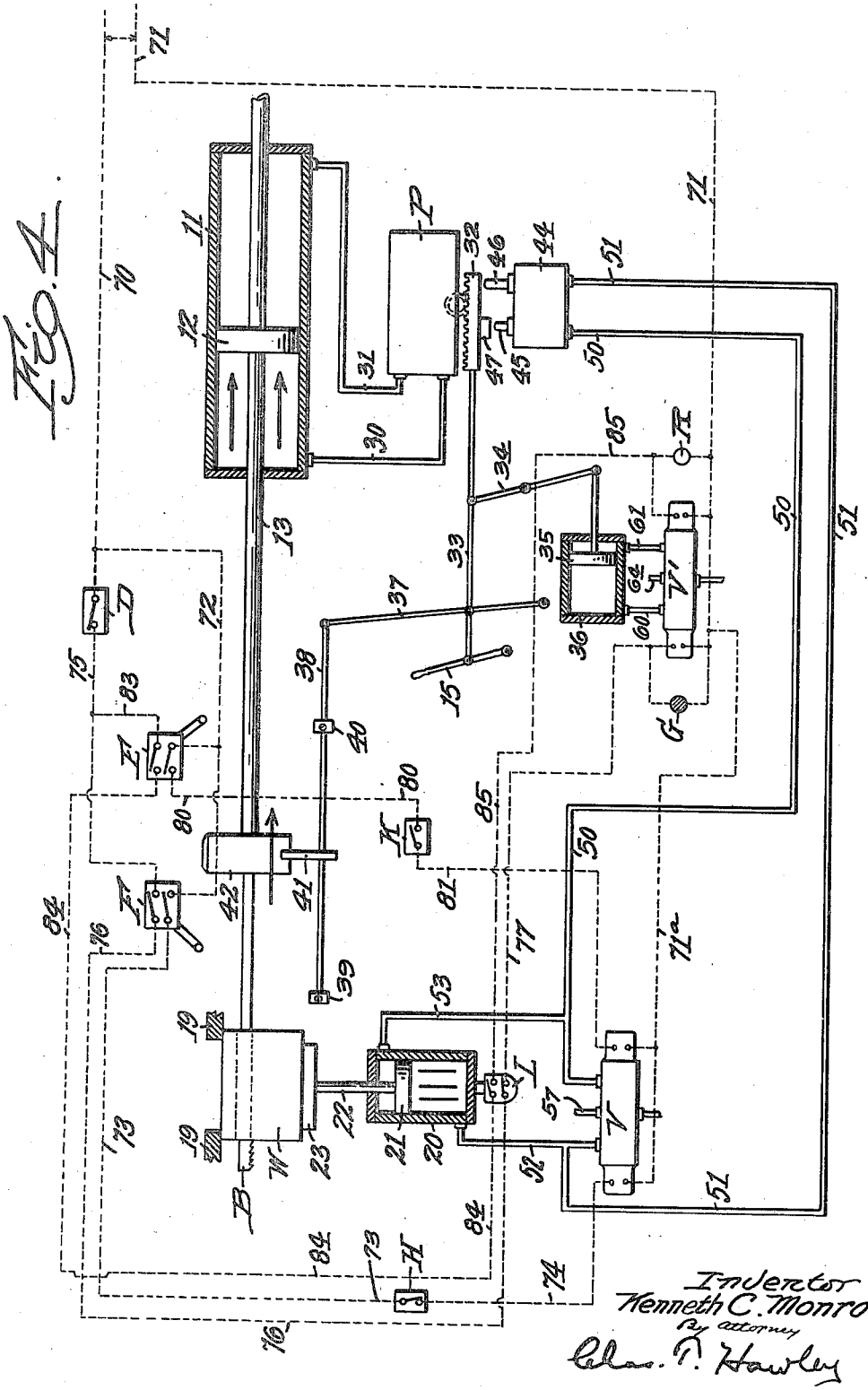

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Fig. 5.

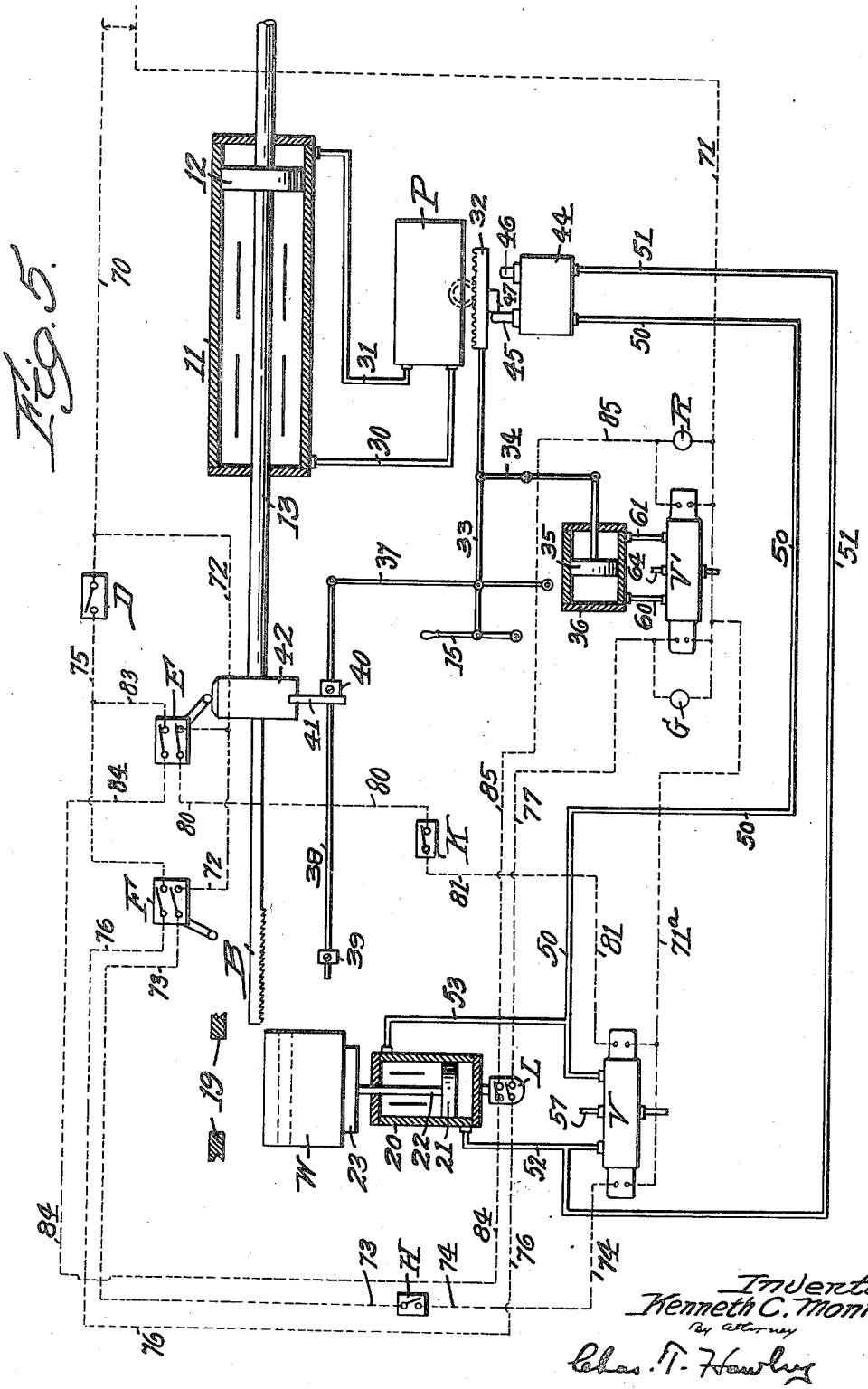

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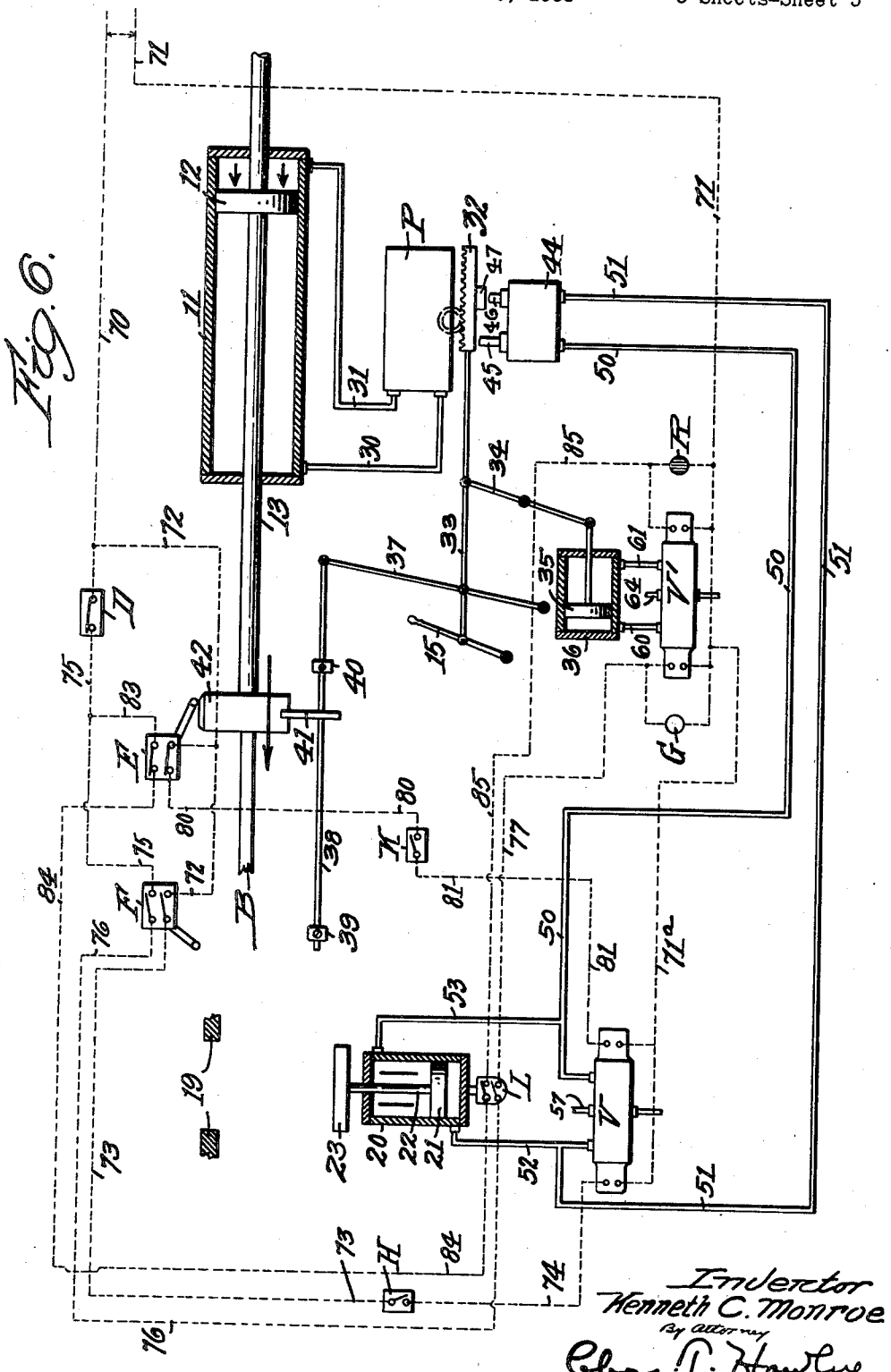
Fig. 6.



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Patented Dec. 19, 1939 2,184,052

UNITED STATES PATENT OFFICE

2,184,052

HYDRAULIC BROACHING MACHINE AND WORK SUPPORT THEREFOR

Kenneth C. Monroe, Hudson, Mass., assignor to The Lapointe Machine Tool Company, Hudson, Mass., a corporation of Maine

Application March 5, 1938, Serial No. 194,191

2 Claims. (Cl. 90—33)

This invention relates to hydraulic broaching machines and to means for supporting and holding a piece of work in such a machine. My invention is shown herein as applied to a horizontal type of surface broaching machine, but in certain aspects the invention is capable of more general application.

It is the general object of my invention to provide power-actuated control devices in such a machine, together with electric interlocks so designed and correlated to said control devices that an improper sequence of operative steps in the use of said machine is rendered impossible.

In particular, I provide control devices and electric interlocks so constructed that a broaching stroke cannot be started until the work is positively clamped in broaching position, and that a return stroke of the broach cannot begin until the work has been unclamped and removed from broaching position. It is also impossible to unclamp the work while the main ram and broaching head are in motion.

I also provide means which requires the main reversible-discharge pump to be shifted out of neutral position in a predetermined direction only, which direction is determined by the position of the operating parts.

My invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of the invention is shown in the drawings, in which:

Fig. 1 is a side elevation of a horizontal surface broaching machine embodying my invention;

Fig. 2 is an end elevation of the work support, taken substantially along the line 2—2 in Fig. 1; and

Figs. 3, 4, 5 and 6 are diagrammatic views showing the hydraulic connections and electric interlocks in the positions which they assume at successive points in the cycle of broaching operations.

Referring to Figs. 1 and 2, I have shown a horizontal broaching machine A and an associated work support C, said machine and work support being longitudinally aligned and rigidly secured together and being particularly adapted for surface broaching.

The broaching machine A comprises a base 10 supporting a main cylinder 11 in which a piston or ram 12 (Fig. 3) and a piston rod 13 are slidable. For purposes of illustration, the piston rod 13 is indicated as extending through both ends of the cylinder 11, thereby simplifying the drawing by providing equal displacement at each side of the piston 12. This arrangement, however, forms no part of my invention, and in actual commercial use the double end piston rod would probably be replaced by a single end rod, with suitable means to take care of the unequal displacement, such means being shown for instance in the prior patent to West, No. 1,685,760.

The machine A is provided with a main pump P which is preferably of the variable-delivery, reversible-discharge type, also shown in a prior patent to West, No. 1,722,832. A motor M is provided to continuously rotate the pump P but the discharge of the pump may be varied from zero to full-discharge in either direction by means of a hand lever 15 or by hydraulic control devices to be described.

The work support C is provided with loading and discharge side platforms 17 and 18, and with a fixed overhead structure providing abutments 19 against which the work W may be clamped.

The work support also comprises a hydraulic cylinder 20 and piston 21 connected by a piston rod 22 to a vertically movable work-supporting member 23. If oil under pressure is admitted below the piston 21, the work W will be raised and clamped against the abutments 19 and will be rigidly held in this position during the broaching operation and as long as the pressure in the lower end of the cylinder 20 is maintained. The work W is indicated herein as an engine block in which the surfaces S are to be finished in the broaching operation.

The longitudinally extended portion 24 of the work support C provides a slide or runway for the member to which the inverted surface broach is secured.

Fig. 3 is a diagrammatic view of the various hydraulic and electric features of my improved broaching machine, with the parts shown in loading position.

The pump P is connected by pipes 30 and 31 to the two ends of the main cylinder 11. The direction and rate of discharge is controlled by a rack bar 32 connected by a rod 33 to the hand lever 15.

The rod 33 is also connected by a lever 34 to a piston 35 in a pump-control cylinder 36, and by a lever 37 to a knock-off rod 38. The rod 38 is provided with collars 39 and 40 which may be adjustably positioned on the rod 38 for engagement by a knock-off arm 41 on the puller head 42 which is mounted at the end of the piston rod 13 and to which the broach B is secured.

A locking device 44 is provided for the pump-shifting rack bar 32 and comprises plungers 45 and 46 alternately movable into position for engagement by a block 47 on the rack bar 32. The plungers are operated by pistons slidable in cylinders which are cross-connected so that if pressure is applied to raise one piston and plunger, the other piston and plunger will be depressed.

The locking device 44 is connected by branch pipes 50 and 51 to pipes 52 and 53 by which a

solenoid-operated valve V is connected to the opposite ends of the work-clamping cylinder 20 previously described. Oil under pressure is supplied to the valve V from an auxiliary pump P' through a check valve 54 and needle valve 55, and the excess discharge of the pump P' is exhausted through a relief valve 56. Oil discharged from the cylinder 20 through the valve V passes to storage through an exhaust pipe 57.

The pump-control cylinder 36 is connected by pipes 60 and 61 to a solenoid-operated valve V' which is similarly provided with an auxiliary pump P^2, needle valve 62, relief valve 63 and exhaust pipe 64.

The valves V and V' are each provided with solenoid coils in each end by which the valve may be drawn or shifted in either direction. The valve V remains in shifted position until a reverse pressure is applied but the valve V' returns to mid or neutral position as soon as circuit is broken.

The parts above described constitute the essential hydraulic and mechanical elements of my improved broaching machine and its associated work support.

The electrical interlock for my improved machine comprises line wires 70 and 71 to which current is supplied from any suitable source of power. The line 71 is connected to one side of each of the two solenoid coils in each of two shunt circuits which control signal lights G and R.

Six switches D, E, F, H, K and L are utilized in my electric interlock. The switches D, H and K are hand-operated switches, designed to be momentarily closed by the operator at different points in the sequence of operations. The switch L is a double switch associated with the work-clamping cylinder 20 in such manner that an upper part of the switch will be closed when the work is unclamped and lowered, and a lower part of the switch will be opened under the same conditions. When the work is raised and clamped, the connections are reversed and the upper part will be open while the lower part is closed.

The switches E and F are also double switches, each controlling two circuits, and each of these four circuits includes one of the solenoid coils in the valves V and V'. Both parts of the switch F are closed when the pull head 42 is in its extreme left-hand position and ready to begin the working stroke, as shown in Fig. 3. Both parts of the switch E are closed when the puller head 42 is in extreme right-hand position and ready to start the idle or return stroke, as indicated in Fig. 5. All circuits through both switches E and F are open when the puller head 42 is in any intermediate position, during either the working or the return stroke of the head, as indicated in Fig. 4.

The normal position of the hydraulic control devices and electric interlock, with the machine in idle or loading position, is as shown in Fig. 3, with the pump P in mid or neutral position, the piston 21 in lowered position in the work-clamping cylinder 20, the double switch E open, the double switch F closed, the hand switches D, H and K open, the upper part of the switch L closed, and the lower part open.

The sequence of steps by which a broaching operation is performed will now be described. Assuming that a new piece of work W has been placed on the work-supporting member 23, the operator closes the hand switch H, thus completing a circuit from the line wire 70 through a branch wire 72, the lower part of the switch F, a wire 73, the switch H, and a wire 74 to the left-hand solenoid of the valve V, and back through a branch wire 71a to the line wire 71.

This causes the valve V to be shifted to the left, supplying pressure through the pipe 52 to the lower end of the cylinder 20 and raising the work W against the fixed abutments 19. When pressure is thus applied through the pipe 52 to the lower end of the cylinder 20, similar pressure is applied through the branch pipe 51 to reverse the positions of the locking plungers 45 and 46 and to move said plungers to the positions shown in Fig. 4. The application of pressure to the lower end of the cylinder 20 also reverses the connections through the switch L, as indicated in Fig. 4, and closes the lower part of said switch L.

If the hand switch D is then closed, the line wire 70 is connected through the wire 75, switch F, wire 76, switch L and wire 77 to the left-hand solenoid of the valve V' and thence to the line wire 71. The signal G is also lighted. These connections are as shown in Fig. 4, except that the switch F is still closed.

The valve V' then shifts to the left and supplies pressure through the pipe 60 to the left-hand end of the pump-control cylinder 36, causing the piston 35 to shift the pump P to the position shown in Fig. 4, in which position the pump discharges oil into the left-hand end of the main cylinder 11. This causes the piston or main ram 12, puller head 42 and broach B to move to the right in a working stroke.

As soon as this working stroke begins, the switch F opens, thus breaking the previously closed solenoid circuits through the left-hand ends of the valves V and V', even if the hand switches H and D are held closed, which however does not ordinarily occur. The signal G goes out as the circuit of the solenoid in the valve V' is broken.

The valve V remains in its left-hand position, thus maintaining pressure on the pipe 52, but the valve V' returns automatically to mid or neutral position, with both ends of the cylinder 36 connected to the exhaust. This exhaust connection is essential, as otherwise the mechanical knock-off could not operate.

As the working stroke of the puller head 42 to the right is completed, as shown in Fig. 5, the puller head 42 closes both parts of the double switch E, and the arm 41 engages the collar 40 on the knock-off rod 38 and shifts the pump P back to the mid or neutral position shown in Fig. 3 but with the locking plungers 45 and 46 still in the reverse position shown in Fig. 4. It is thus impossible to shift the pump beyond mid-position, either automatically or manually, so that no return movement of the ram 12, puller head 42 and broach B can be started.

The operator then closes the hand switch K (Fig. 5) completing a circuit from the line wire 70 through the wire 72, switch E, wire 80, switch K and wire 81 to the right-hand solenoid in the valve V and thence through the branch wire 71a to the line wire 71. This causes the valve V to shift to the right, admitting pressure through the pipe 53 to the upper end of the cylinder 20 and causing the work-supporting member 23 and work W to move downward out of the path of the broach B. At the same time the connections through the switch L are reversed, the upper part of the switch now being closed and the lower part open. Admission of pressure to

the pipe 53 also admits pressure to the branch pipe 59, returning the locking plungers 45 and 46 to their original positions, as shown in Fig. 3.

If the operator now closes the hand switch D a second time, as indicated in Fig. 6, a circuit will be completed from the line wire 70 through the switch D, wire 75, branch wire 83, the upper part of switch E, wire 84, upper part of switch L and wire 85 to the right-hand solenoid in the valve V' and thence to the line wire 71.

This lights the signal R and causes the valve V' to shift to the right, admitting pressure through the pipe 61 to the right-hand end of the pump control cylinder 36 and causing the piston 35 to shift the pump to the position shown in Fig. 6, thus discharging oil into the right-hand end of the main cylinder 11 and acting on the piston 12 to move the puller head 42 and broach B to the left in a return stroke.

As soon as this return movement begins, the double switch E opens, breaking the circuits through the two right-hand solenoids in the valves V and V', even if the switches D and K have not been released. When these circuits are broken, the valve V continues to maintain pressure in the pipe 53 and branch pipe 59, but the valve V' shifts to mid or neutral position, in which both pipes 60 and 61 are connected to the exhaust pipe 64.

As the return stroke is completed, the arm 41 engages the collar 39 on the knock-off rod 38 and returns the pump and associated parts to the mid or neutral position shown in Fig. 3. Also as the return stroke is completed, the double switch F is closed, thus putting the parts in such position that a new cycle of operations may be initiated by closing the switch H as previously described.

It will thus appear that my improved broaching machine and work support are so controlled and interlocked that no improper sequence of operations can take place. More specifically, the broaching stroke cannot be started until the work is elevated and clamped in working position, which reverses the connections to the switch L. The work cannot be unclamped until the working stroke is completed and the switch E is closed. It is then necessary to unclamp the work by closing the switch K in order to return the switch L to its initial position and also to reverse the locking plungers 45 and 46, otherwise the pump cannot be shifted to reverse position for a return stroke.

It should be particularly noted that no circuit in the machine can be completed unless the puller head 42 is in one or the other of its extreme positions, as every circuit must be completed through the switch E or the switch F, both of which are open when the puller head is in any intermediate position.

The pilot or signal lights G and R are provided for the convenience and protection of the operator, the light G signifying that the working stroke is about to commence and the light R signifying that the return stroke is about to commence.

While I have described the machine as semi-automatic and requiring the cooperation of the operator in manually closing the switches D, H and K at different points in the working cycle, one or more of these switches may be permanently closed, thus rendering the machine more fully automatic. For instance, if the switch D is permanently closed, the clamping of the work and the performance of the broaching stroke will follow automatically when the switch H is closed. Similarly, the unclamping of the work and the performance of the return stroke will follow automatically when the switch K is closed. If the switches D and K are both permanently closed, the entire sequence of operations of clamping, broaching, unclamping and return will be performed automatically when the switch H is closed.

While more fully automatic operation may thus easily be attained, it is found in most cases that the semi-automatic operation first described is more satisfactory, as the machine is more directly under control of the operator. The outstanding advantage of my improved machine, however operated, lies in the fact that all operative steps must follow in proper sequence and that no operation can take place in such manner that injury to the machine, the tools or the work can occur.

In a machine of this type, the broach is commonly not removed from the machine at any time, and it is accordingly very desirable that return movement of the broach be rendered impossible until the finished work has been lowered out of operative position.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what I claim is:

1. A hydraulic surface-broaching machine comprising a broaching head, a stationary abutment, a device to support a piece of work, means to raise and lower said work-supporting device and work and to firmly press and hold the work in raised broaching position against said stationary abutment, thereby simultaneously clamping and positioning said work, means to actuate said broaching head, and interlocking mechanism operable with said several means to prevent a working stroke of said broaching head until the means for actuating the work-supporting device has raised and clamped the work in abutment-engaging position, and operable thereafter to prevent return movement of said broaching head until said means for actuating said work-supporting device has lowered the work from abutment-engaging position.

2. A hydraulic surface-broaching machine comprising a broaching head, a stationary abutment, a device to support a piece of work, means to raise and lower said work-supporting device and work and to firmly press and hold the work in raised broaching position against said stationary abutment, thereby simultaneously clamping and positioning said work, a constant-delivery pump to actuate said raising and lowering means, a reversible pump to actuate said broaching head, a control valve for shifting said reversible pump, which valve automatically returns to neutral position when released, a mechanical knock-off effective to shift said reversible pump to neutral position after said control valve is released and has returned to neutral position, and means to prevent movement of said reversible pump to return said broaching head to initial position until the means for actuating the work-supporting device has lowered the work from abutment-engaging position.

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