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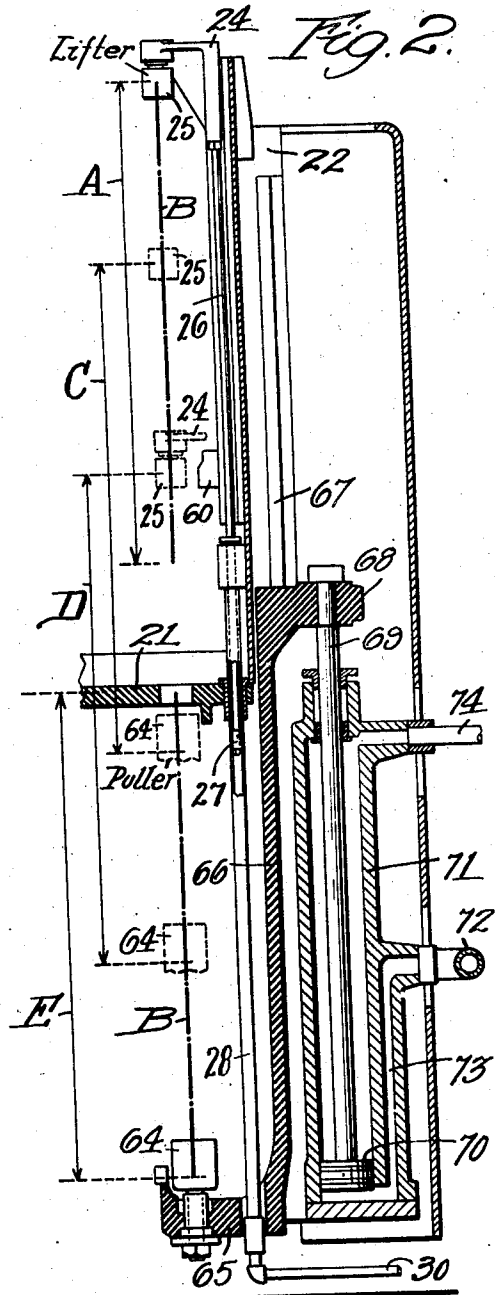
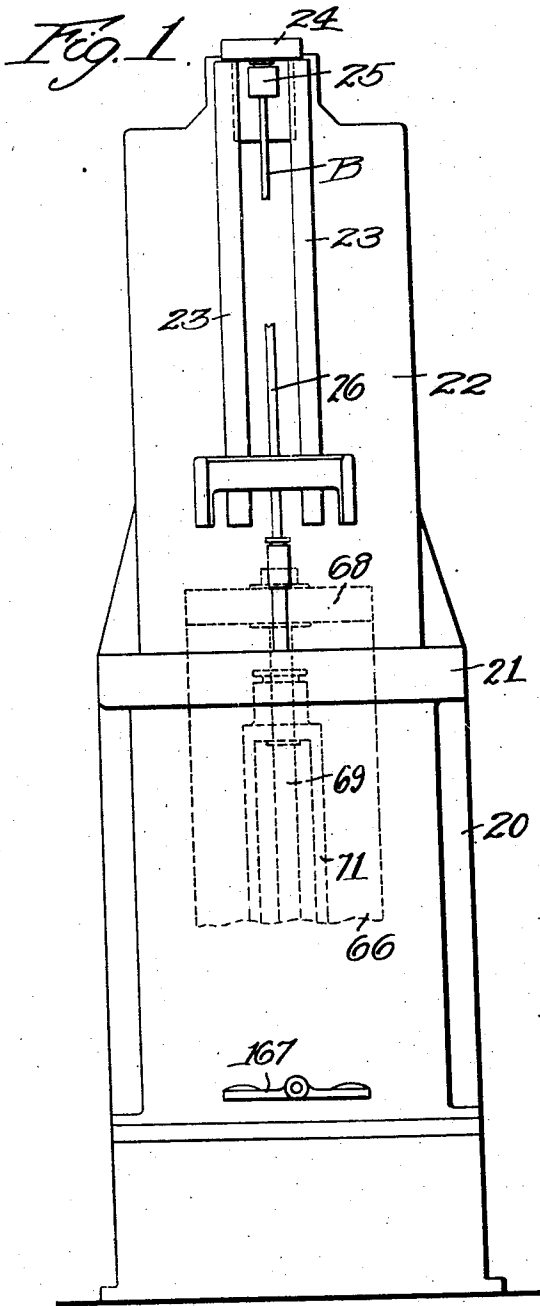
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2,135,157

VERTICAL HYDRAULIC BROACHING MACHINE

Filed Feb. 15, 1937

6 Sheets-Sheet 1



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Nov. 1, 1938.

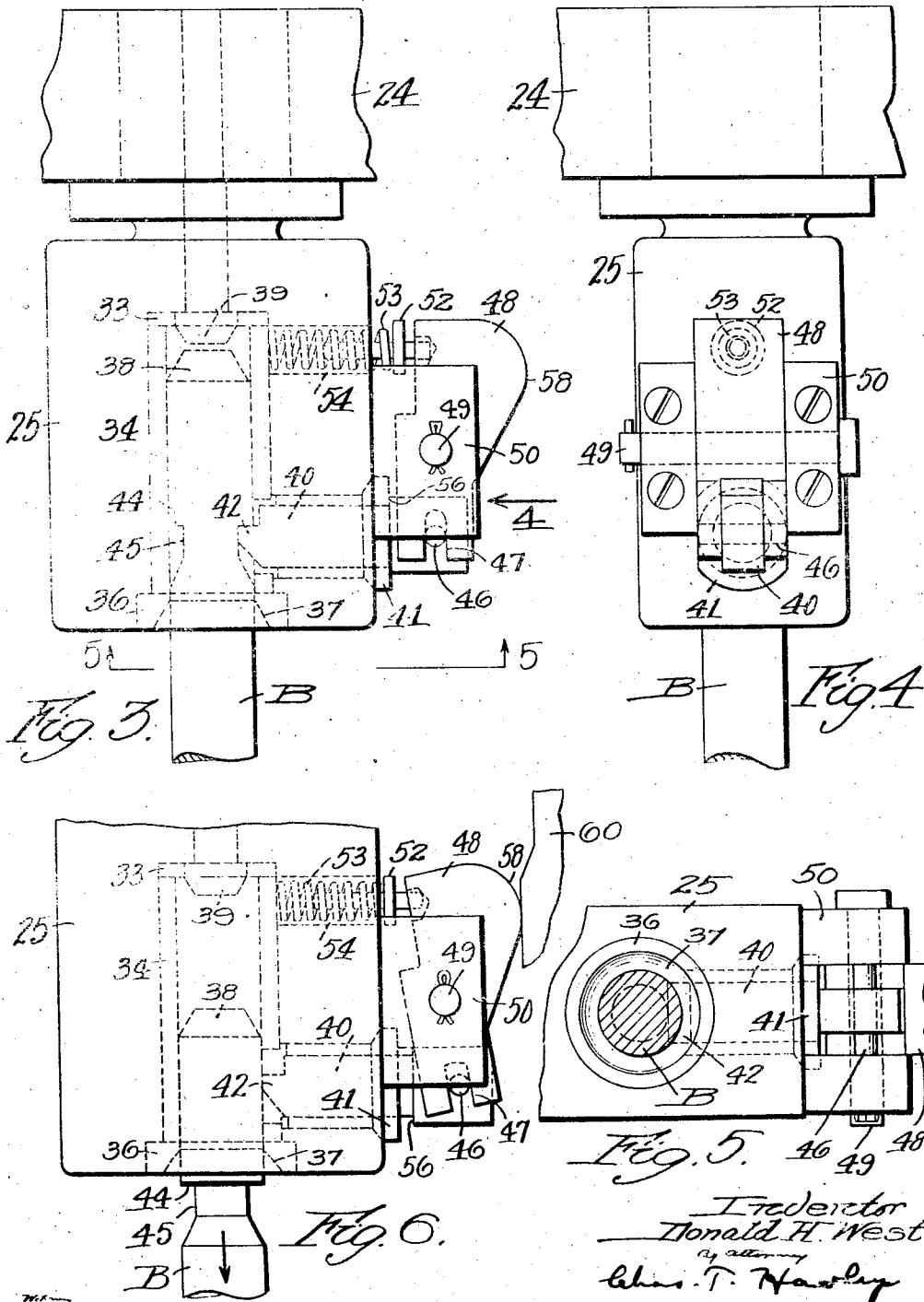
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VERTICAL HYDRAULIC BROACHING MACHINE

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6 Sheets-Sheet 2



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VERTICAL HYDRAULIC BROACHING MACHINE

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6 Sheets-Sheet 3

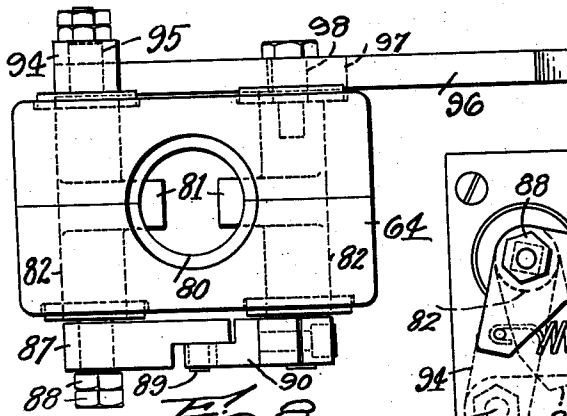


Fig. 8.

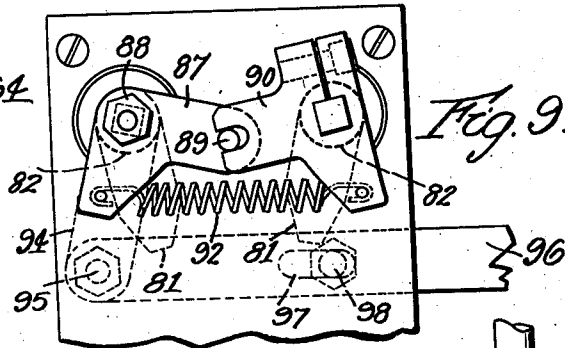


Fig. 9.

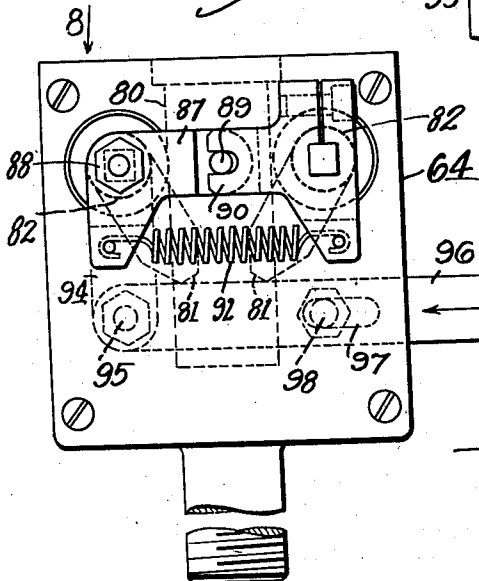


Fig. 7.

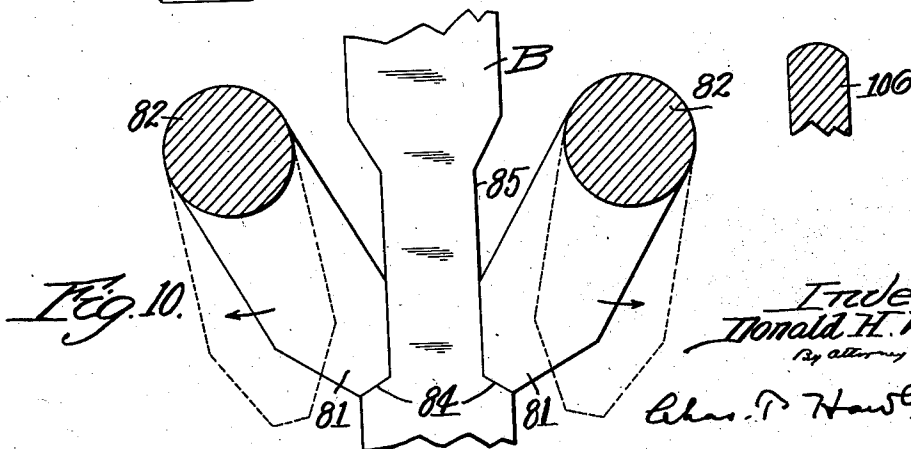
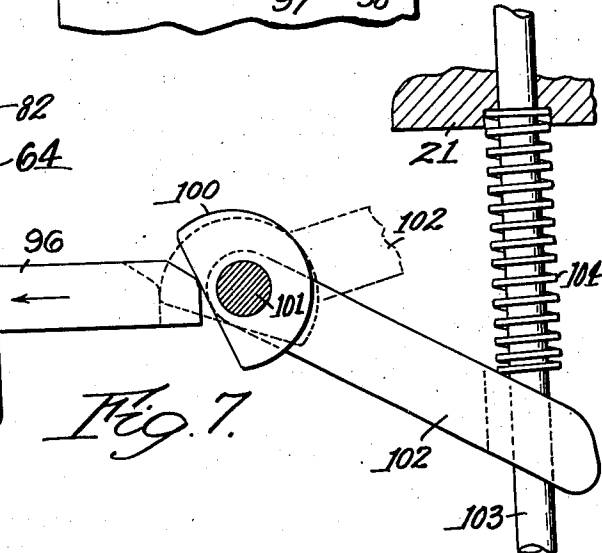


Fig. 10.

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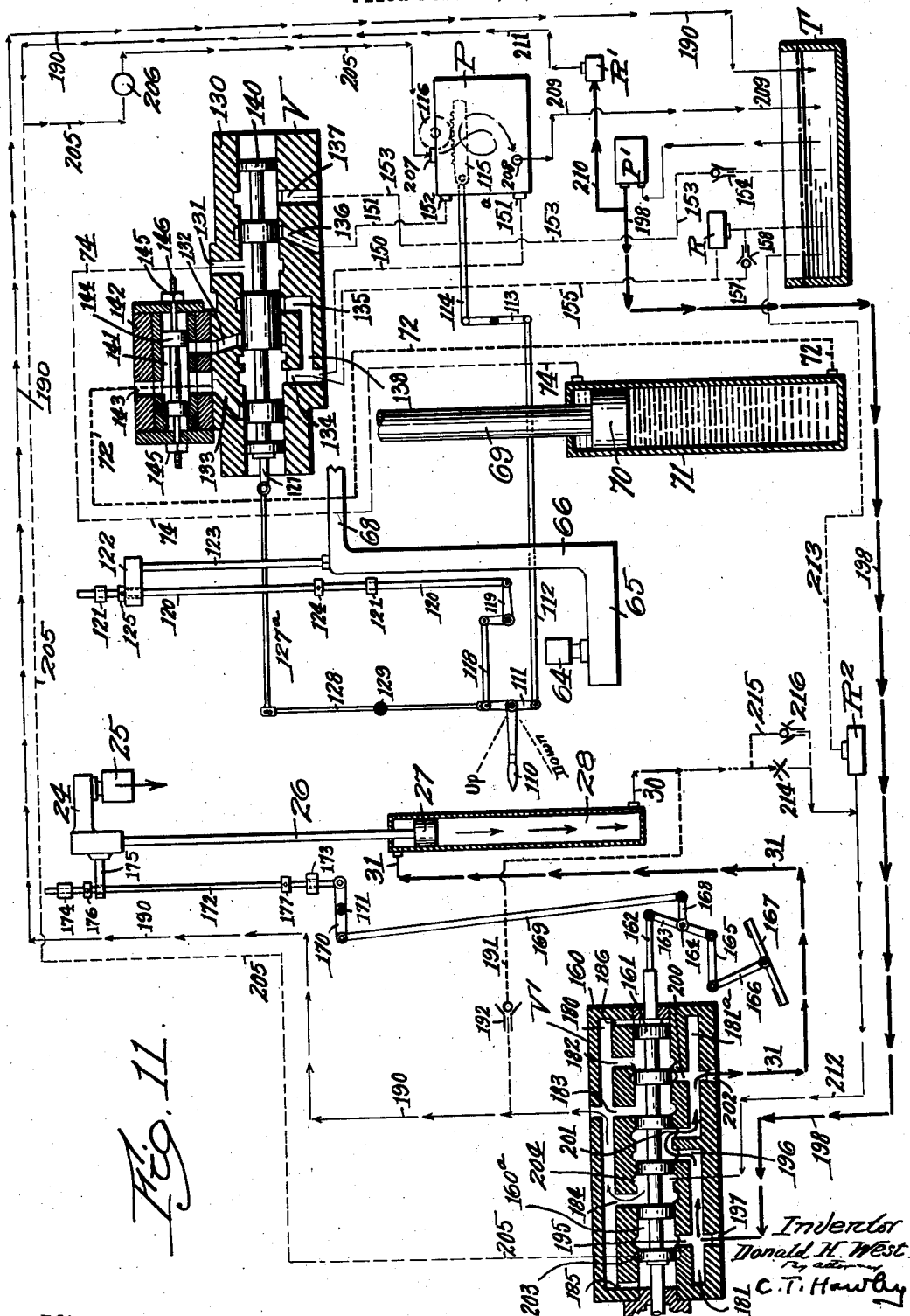
D. H. WEST

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VERTICAL HYDRAULIC BROACHING MACHINE

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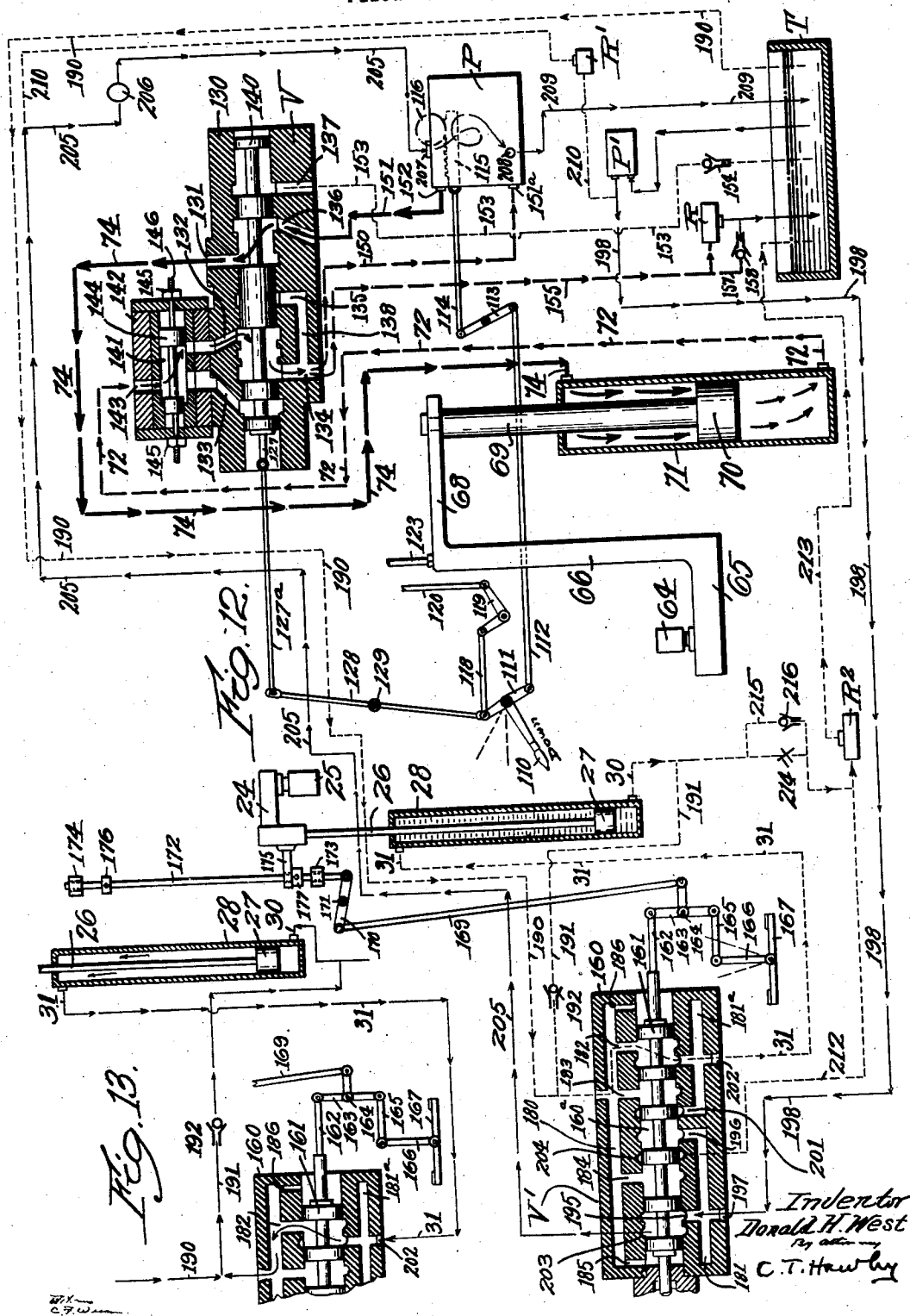
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VERTICAL HYDRAULIC BROACHING MACHINE

Filed Feb. 15, 1937

6 Sheets-Sheet 5



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VERTICAL HYDRAULIC BROACHING MACHINE

Filed Feb. 15, 1937

6 Sheets-Sheet 6

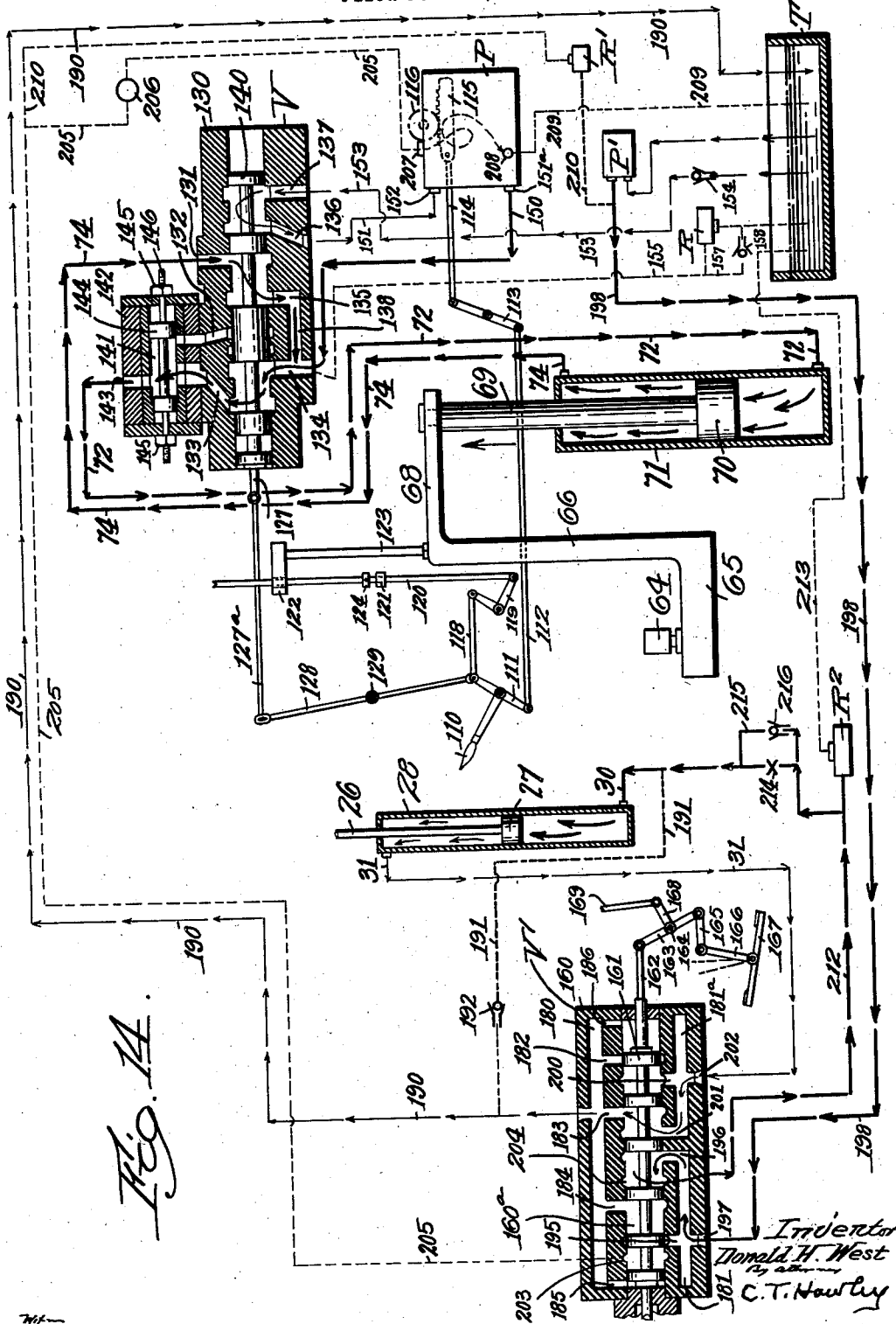


Fig. 11.

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UNITED STATES PATENT OFFICE

2,135,157

VERTICAL HYDRAULIC BROACHING MACHINE

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Application February 15, 1937, Serial No. 125,871

3 Claims. (Cl. 90—33)

This invention relates to broaching machines and particularly to hydraulically operated vertical broaching machines.

Vertical broaching machines of the pull-down type have been heretofore devised, in which the broach is drawn downward through the work by a pulling device which grips the lower end of the broach. It is the general object of my invention to improve the construction and operation of a pull-down broaching machine in such manner that it will be more reliable in operation and more satisfactory in use.

To the attainment of this general object, I provide improved gripping members for the pulling device, together with means for automatically releasing said gripping members. I also provide power-actuated means for lifting the broach and returning it to its initial raised position above the work, all under the direct control of the operator. In the preferred form, the latter means is also operable to thereafter lower the broach for engagement with the pulling device at the beginning of a succeeding work cycle.

A further object of my invention is to provide such a combination of work-pulling and work-lifting devices that all manual manipulation of the broach during a complete broaching cycle is eliminated.

I also provide new and improved hydraulic mechanism by which the various movements and operations of my improved broaching machine may be effected and controlled.

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 my invention is shown in the drawings, in which

Fig. 1 is a front elevation of my improved broaching machine;

Fig. 2 is a sectional side elevation of the machine;

Fig. 3 is an enlarged side elevation of the lifter head;

Fig. 4 is a rear elevation thereof, looking in the direction of the arrow 4 in Fig. 3;

Fig. 5 is a sectional bottom view, taken along the line 5—5 of Fig. 3;

Fig. 6 is a view similar to Fig. 3 but showing the parts in released position;

Fig. 7 is an enlarged side elevation of the broach-pulling head;

Fig. 8 is a plan view thereof, looking in the direction of the arrow 8 in Fig. 7;

Fig. 9 is a partial side view similar to Fig. 7 but showing the parts in released position;

Fig. 10 is an enlarged sectional side elevation of certain parts of the pulling head; and

Figs. 11 to 14 are diagrammatic views illustrating the hydraulic connections and the operation of my improved broaching machine.

Referring to Figs. 1 and 2, I have shown a vertical hydraulic broaching machine comprising a frame 20 having a bed or platen 21 on which the work is supported during the broaching operation. The frame 20 also has an upwardly extending portion 22 provided with guideways 23 for a sliding block or bracket 24 from which a lifter head 25 is supported. A piston rod 26 is attached at its upper end to the block or bracket 24 and is provided with a piston 27 at its lower end, which is slidable in a vertical cylinder 28.

A pipe 30 is connected to the lower end of the cylinder 28 and a similar pipe 31 (Fig. 11) is connected to the upper end of the cylinder.

Lifter head

The upper or lifter head 25 of my improved broaching machine is shown in detail in Figs. 3 to 6 and comprises a casing having a recess 33 open at its lower end and provided with a lining sleeve 34 adapted to slidably receive the upper end of the broach B. A disc or washer 36 is secured in the enlarged lower end portion of the recess 33 and has a tapered opening 37 to co-operate with the tapered upper end 38 of the broach B as the end of the broach is presented to and entered in the lifter head 25. A plug 39 is mounted in the lifter head 25 and projects into the upper end of the recess 33 to limit inward movement of the broach in the sleeve 34.

A latch 40 is slidably mounted in a horizontal guideway or bushing 41 fixed in the rear portion of the head 25. A projection 42 on the latch 40 is adapted to engage a shoulder 44 forming the upper end wall of an annular recess 45, formed in the upper end portion of the broach B.

The latch 40 has a cross-pin 46 located in slots 47 in the forked lower end of a rocker arm 48 pivoted on a stud 49 in a rearward projection 50 of the head 25. A spring plunger 52 engages the upper end of the rocker arm 48 and is forced outward by a coil spring 53 seated in an opening 54 in the rear portion of the lifter head 25. The latch 40 is normally maintained yieldingly in the position shown in Fig. 3, inward movement of the latch being limited by a

shoulder 56 (Fig. 3) on the latch which engages the outer end of the bushing 41.

The rocker arm 48 has a cam portion 58 which is engaged by a fixed cam 60 (Fig. 6) as the broach B approaches its lower limit of travel. The latch 40 is thereby withdrawn, thus releasing the broach so that it may be drawn downward sufficiently to cause the upper end of the broach to clear the work and permit removal thereof. As soon as the lifter head 25 is thereafter raised above the cam 60, the latch 40 resumes its normal position and will snap under the shoulder 44 of the broach when the broach is again presented thereto.

15

Puller head

The lower or puller head 64 (Fig. 2) of my improved broaching machine is mounted in the offset lower end 65 of an elongated slide 66, movable in fixed vertical guideways 67 on the frame 20 and on its upward extension 22. At its upper end, the slide 66 has another offset portion 68 to which is secured the upper end of a piston rod 69.

A piston 70 (Fig. 2) on the rod 69 is slidable in a fixed vertical cylinder 71 having a pipe 72 connected through a passage 73 to the lower end of the cylinder and having a pipe 74 connected to the upper end of the cylinder. The elongated offset slide 66 is used for the purpose of economizing vertical space, as it permits the cylinder 71 to be mounted behind the slide 66 rather than below the pulling head 64.

The construction of the pulling head 64 is shown in detail in Figs. 7 to 10 inclusive. The pulling head comprises a casing having a recess 80 open at its upper end and adapted to slidably receive the lower end of the broach B.

A pair of broach-gripping dogs 81 are formed on studs 82 rotatably mounted in bearings in the pulling head 64, which head is formed in separable parts to permit insertion of the dogs and studs. The dogs 81 swing freely in recesses within the head 64 and when the dogs are in the operative position shown in full lines in Fig. 10, the lower ends of the dogs engage an inclined annular shoulder 84 forming the lower end wall of an annular recess 85 in the lower end portion of the broach B. When the dogs 81 are moved to the dotted line position in Fig. 10, the broach is released.

An arm 87 is secured by nuts 88 on the squared outer end of one stud 82 and the arm 87 is provided with a pin 89 projecting into a slotted arm 90, clamped to the squared outer end of the second stud 82. The arms 87 and 90 cooperate to move the dogs 81 simultaneously toward or away from each other.

A tension spring 92 connects the depending lower ends of the arms 87 and 90 and normally maintains the dogs 81 yielding in operative or broach-gripping position.

An arm 94 is secured to a stud 82 at the opposite end from the arm 87, and the lower end of the arm 94 is connected by a stud 95 (Fig. 7) to a release member 96 which is slotted at 97 to receive a stud 98 on which it is slidably supported.

A cam 100 (Fig. 7) is mounted on a rock shaft 101 which is supported in bearings on the slide 66 and which is movable vertically with the puller head 64. A cam lever 102 projects rearward from the shaft 101 and is forked to embrace a rod 103 on which a spring 104 is mounted.

The upper end of the spring is seated in the under side of the fixed platen 21.

A fixed stop 106 (Fig. 7) is positioned for engagement by the lever 102 as the puller head reaches its lower limit of travel. Such engagement moves the cam 100 from the full line to the dotted line position in Fig. 7 and moves the release member 96 to the left to the position shown in Fig. 9, thus separating the dogs 81 and releasing the broach.

As the puller head 64 thereafter moves upward and approaches its upper limit of travel, the arm 102 engages the spring 104 and the cam 100 is returned to the full-line position of Fig. 7, whereupon the dogs 81 resume operative positions.

General operation

The cooperating action of the lifter and puller heads in my improved pull-down broaching machine is briefly as follows:—

At the beginning of a work cycle, the broach B is held in the lifter head 25 only and occupies the raised position indicated by the line marked A in Fig. 2. The lifter head is then lowered by the action of the piston 27 in the cylinder 28 and moves the broach to the position indicated by the line C, at which point the lower end of the broach enters and is gripped in the puller head 64. The broach is then moved downward by the puller head to the position indicated by the line D, during which downward movement the greater part of the broaching operation is performed. During this movement the broach is engaged and guided by both the puller head 64 and the lifter head 25.

The lifter head then releases the broach by engagement of the rocker arm 48 with the cam 60, but the puller head 64 continues its downward pulling action until the broach B has been drawn entirely through the work to the position indicated by the line E, at which point the dogs 81 release the broach by engagement of the lever 102 with the stop 106 (Fig. 7) as previously described.

The travel of the puller head 64 is then reversed, moving the broach upward until it again engages and is latched in the lifter head 25, which head is, thereafter moved upward at a faster rate to its initial raised position, the puller head at the same time completing its upward travel.

During the upward travel of the puller head, the dogs 81 are held inoperative by the cam 100 until the broach has been drawn out of the puller head by the faster-moving lifter head. Engagement of the lever 102 with the spring 104 then moves the cam 100 to release the dogs 81, which then return to holding position and yieldingly receive the end of the broach when it is thereafter lowered and inserted therein.

Hydraulic operating and control mechanism

The operating and control mechanism of my improved machine is shown diagrammatically in Figs. 11 to 14. Referring to Fig. 11, I have indicated certain parts of the mechanism previously described, including the cylinder 28 for operating the lifter head 25 and the cylinder 71 for operating the slide 66 and puller head 64.

The operating fluid for the main cylinder 71 is provided by a reversible variable delivery pump P which may be of the commercial type shown in my prior Patent #1,722,832, issued July 30, 1929.

A handle 110 (Fig. 11) is connected to a pivotally mounted rock arm or lever 111, the lower end of which is connected through a link 112, 7

ver 113 and link 114 to a slidable rack bar 115 engaging a gear 116 which corresponds to the gear 54 in my prior patent.

Vertical swinging movement of the handle 110 causes the rack bar 115 to be moved to the right or left in Fig. 11, thus effecting angular movement of the gear 116 through which the rate and direction of discharge of the pump P is controlled. For further details of the pump and its reversing mechanism, reference is made to my prior patent.

The upper portion of the rock arm or lever 111 is connected through a link 118 and bell crank 119 to a rod 120 vertically slidable in guides or bearings 121 mounted on the upwardly extending frame portion 22. A knock-off arm 122 is mounted on a post 123 secured to the elongated slide 66 and movable vertically therewith.

The block 122 has a vertical opening to receive the rod 120 and is freely slidable relative thereto. The rod 120 is provided with collars 124 and 125 positioned for engagement by the block 122 as the slide 66 approaches the ends of its working and return strokes respectively. When so engaged, the rod 120 and associated parts will be moved to bring the parts to the neutral or inoperative position shown in Fig. 11, in which position the pump P will also be in neutral position and will not discharge in either direction.

A control valve mechanism V is provided between the pump P and the main cylinder 71 and the valve rod 127 thereof is connected by a link 127^a to a lever 128 pivoted at 129 and having its lower arm connected by a pin and slot with the upper arm of the lever 111 previously described. Through these connections the piston valve member will be moved axially whenever the handle 110 and lever 111 are moved to vary or reverse the discharge of the pump P.

The valve V comprises a casing 130 having a cylindrical central opening and having a series of ports 131, 132, 133, 134, 135, 136 and 137. The port 135 is cross connected by a passage 138 to the port 134. The piston valve member 140 comprises a plurality of separate cylindrical portions spaced apart by connecting portions of reduced diameter.

The port 131 is connected to the pipe 74 leading to the upper end of the main cylinder 71. The ports 132 and 133 are connected to a chamber 141 in a back pressure device 142, which device is provided with a port 143 which is connected by the pipe 72 to the lower end of the main cylinder 71.

An axial movable piston valve member 144 is slidable in the opening 141 and may be adjusted axially by nuts 145 threaded on the valve rod 146. The piston valve member 144 is commonly so adjusted as to partially close the port 132 at its upper end as shown in the drawings and for a purpose to be described.

The port 134 is connected by a pipe 150 to one discharge port 151^a of the pump P, and the port 136 is connected by a pipe 151 to the other discharge port 152 of the pump P. The ports 151^a and 152 of the pump P may each function either as a discharge port or an intake port, depending upon the position of the handle 110, rack bar 115 and the parts controlled thereby.

The port 137 of the valve mechanism V is connected by a pipe 153 to the supply or storage tank T through a check valve 154 opening away from the tank. The port 134 is connected by a second pipe 155 through a relief valve R to the tank T. A by-pass 157 is provided around the

relief valve R, which by-pass has a check valve 158, also opening away from the tank T.

An auxiliary pump P' is provided to supply the operating fluid for the lifter cylinder 28, this pump being preferably of the constant delivery type and of substantially smaller capacity than the main pump P.

Additional control valve mechanism V' is provided for the pump P' and lifter cylinder 28. The valve mechanism V' comprises a casing 160 having a central cylindrical opening 160^a in which a piston valve 161 is slidable. The valve 161 comprises a plurality of separate piston elements spaced apart by connecting portions of reduced diameter, and the piston valve is provided with a valve rod 162 connected to the upper end of a lever 163 pivoted at 164 and having its lower end connected by a link 165 to an arm 166 projecting upward from a pivoted foot lever or pedal 167.

An additional arm 168 is secured to the lever 163 and is connected by a link 169 to a lever 170 pivoted at 171 and having connected thereto the lower end of a rod 172, vertically slidable in fixed bearings 173 and 174 on the upwardly extending portion 22 of the frame 20.

An arm 175 projects laterally from the block or bracket 24 by which the lifter head 25 is supported. The arm 175 has a vertical opening therein to loosely receive the rod 172, and the rod 172 is provided with collars 176 and 177 positioned for engagement by the arm 175 at its upper and lower limits of travel respectively.

When thus engaged, the piston valve member 161 will be moved to the neutral position shown in Figs. 12 and 13.

The casing member 160 of the control valve mechanism V' is provided with an upper longitudinal passage 180 and with lower longitudinal passages 181 and 181^a. A plurality of ports 182, 183 and 184 connect the upper passage 180 to the central opening 160^a, and additional end ports 185 and 186 are provided to equalize the pressure at the ends of the piston valve 161.

The upper longitudinal passage 180 is connected by a pipe 190 to the tank T and the pipe 190 is connected by a branch pipe 191 to the pipe 30 which is connected to the lower end of the cylinder 28. A check valve 192 is provided in the pipe 191 and opens toward the pipe 30 and cylinder 28.

The lower passage 181 is provided with ports 195 and 196 communicating with the central opening 160^a, and with an external port 197 connected by a pipe 198 to the discharge side of the pump P'.

The lower passage 181^a is provided with ports 200 and 201 communicating with the central opening 160^a, and with an external port 202 connected by the pipe 31 to the upper end of the cylinder 28.

The central opening 160^a of the valve mechanism V' is also provided with annular ports 203 and 204. The port 203 is connected by a pipe 205 through a filter 206 to an upper inlet 207 of the cooling space in the casing of the main pump P. An outlet 208 from the cooling space is connected by a pipe 209 to the storage tank T. The passage of oil through the casing of the pump P is utilized to cool and lubricate the bearings and working parts of the pump P.

A pipe 210 branches off of the discharge pipe 198 of the auxiliary pump P' and is connected through a relief valve R' and pipe 211 to the pipe 205 above the filter 206.

The annular port 204 in the valve mechanism V' is connected by a pipe 212 to a relief valve R², 75

which in turn is connected by a pipe 213 to the storage tank T. The discharge pipe 30 of the lifter cylinder 28 is connected through a needle valve 214 to the pipe 212, and a by-pass 215 is provided around the needle valve 214, which by-pass has a check valve 216 opening toward the cylinder 28.

Having described the detail construction of the hydraulic operating and control mechanism, I will now describe the operation of the machine with respect thereto, it being noted that in Figs. 11 to 14 the heavy arrows indicate flow of oil under operating pressure, the light arrows indicate flow of oil to exhaust or under relatively light pressure, and the broken lines indicate parts of the apparatus in which no flow is taking place.

In Fig. 11, the parts are shown at the beginning of the working stroke, with the slide 66 and puller head 64 in up position, and with the lifter head 25 just beginning its downward stroke. In order to start this stroke, the foot pedal 167 has been shifted from the neutral position shown in Fig. 13 to the down stroke position shown in Fig. 11, thereby shifting the piston valve 161 to the right.

In this position, the valve mechanism V' connects the auxiliary pump P' through the pipe 198, passages 181 and 181^a and pipe 31 to the upper end of the lifter cylinder 28, thus forcing downward the lifter head 25 and the broach B suspended therefrom.

The lower end of the cylinder 28 is connected through the pipe 30, needle valve 214, pipe 212, upper passage 180 and pipe 190 to the tank T. The rate of downward movement of the lifter head 25 is controlled by the setting of the needle valve 214.

The handle 110 is in neutral or mid-position and the oil in the lower part of the main cylinder 71 cannot flow out through the pipe 72, as both parts 132 and 133 connected therewith are closed by the piston valve 140 of the valve mechanism V. Consequently the slide 66 and puller head 64 cannot move downward so long as the handle 110 is in neutral position.

Any surplus oil discharged by the auxiliary pump P' passes through the branch pipe 210, relief valve R', pipe 211, pipe 205, filter 206 and main pump casing to the pipe 209 and thus back to the tank T. The relief valve R' regulates the operating pressure in the upper end of the lifter cylinder 28.

As soon as the lower end of the broach has passed through the work and the supporting platen and has been brought into holding engagement with the puller head 64, the operator moves the handle 110 to the down or operative position shown in Fig. 12. This causes the piston valve 140 to move to the right in the valve mechanism V and simultaneously adjusts the pump P to discharge through the pipe 151, which is connected through the valve mechanism V and pipe 74 to the upper end of the main cylinder 71, thus moving the slide 66 and puller head 64 downward on the working stroke.

Oil from the lower end of the cylinder 71 is conducted through the pipe 72 to the cylindrical opening 141 in the back pressure device 142 and thence through the valve mechanism V to the pipes 150 and 155. A part of the oil is returned through the pipe 150 to the pump P to replace the oil delivered therefrom to the upper part of the cylinder 71, and the surplus oil from the lower end of the cylinder 71 is discharged through the pipe 155 and relief valve R to the tank T.

The relief valve R counteracts gravity and prevents the main valve from moving downward too rapidly before the cutting teeth on the broach engage the work. The piston valve 144 in the back pressure device 142 throttles the exhaust from the main cylinder and prevents pulsation of the slide 66 and puller head 64, due to intermittent load on the broach as cutting teeth enter or leave the work.

The lifter head 25 follows the broach B downward, with the hydraulic connections to the lifter cylinder 28 remaining as in Fig. 11, until the cam 60 unlocks the broach near the lower end of the working stroke, at which point the lower collar 177 is engaged by the knock-off arm 175, whereupon the piston valve 161 in the valve mechanism V' is returned to neutral position, as shown in Fig. 12.

In this position of the valve, the auxiliary pump P' discharges through the pipe 198 and ports in the valve mechanism V' to the return pipe 205, and thence through the filter 206 and the casing of the pump P to the pipe 209 and tank T.

The piston 27 in the lifter cylinder 28 is therefore prevented from moving downward when the valve mechanism V' is in neutral, as oil from the bottom of the cylinder cannot escape through the pipe 191 by reason of the check valve 192 and cannot escape through the needle valve 214 except by overcoming the relief valve R'. Consequently the lifter head 25 remains at a fixed elevation during the further downward travel of the broach B.

Downward motion of the main piston 70, slide 66 and broach B continues until the knock-off arm 122 engages the lower collar 124 and returns the handle 110 to neutral position, at the same time setting the valve mechanism V at neutral and also the main pump P.

After removing the work which has just been broached, the operator then moves the handle 110 to the up position shown in Fig. 14, shifting the piston valve 140 to the left and starting the main piston 70 and slide 66 on their return upward stroke. At this time the lower end of the broach is seated in the puller head 64 but the dogs 81 are withdrawn, so that the broach is not locked therein.

With the handle 110 in the up position, the pump P is set to discharge through the pipe 150, valve mechanism V and back pressure device 142 to the pipe 72 which is connected to the lower end of the main cylinder 71, thus forcing the piston 70 upward. Oil forced out of the upper part of the cylinder 71 is discharged through the pipe 74 to the valve mechanism V where it is recirculated with the oil entering through the pipe 150 and is returned to the lower part of the cylinder 71, thus increasing the speed of the piston 70 on its idle or return upward stroke.

When the lifter head 25 is engaged by the upper end of the broach, the lifter head and piston 27 are pushed freely upward, during which operation oil circulates as shown in Fig. 13 from the upper end of the cylinder 28 through the pipe 31, valve mechanism V', pipe 190, branch pipe 191 and pipe 30 to the lower end of the cylinder 28, with additional oil drawn in through the pipe 190 from the tank T.

After the lifter head has been raised above the cam 60, so that the broach B is again latched in the lifter head, the foot pedal 167 is shifted to the position shown in Fig. 14, thus moving the piston valve 161 to the left and connecting the pump P'

through the pipe 198, passage 181, port 196, annular port 204, pipe 212, check valve 216, by-pass 215 and pipe 30 to the lower end of the cylinder 28. At the same time, the upper end of the cylinder 28 is connected through the pipe 31, valve mechanism V' and pipe 190 to the tank T.

Under these conditions, the lifter head is moved at greater speed than the puller head, thus drawing the broach out of the puller head before the dogs 81 are allowed to return to operative position at the upper end of the puller head stroke.

When the lifter head 26 approaches its upward limit of movement, the knock-off arm 175 engages the upper collar 176 and moves the piston valve 161 in the valve mechanism V' to neutral position, as shown in Fig. 12, in which position the lifter head is locked from free downward movement as previously described.

When the puller head approaches its upper limit of movement, the knock-off arm 122 engages the upper collar 125 and returns the handle 110 to neutral position, with similar movement of the piston valve 140 in the valve mechanism V and of the control mechanism of the pump P.

The cycle of operations is thus completed and all parts are restored to initial position.

I have thus provided an unusually efficient and reliable pull-down broaching machine of the semi-automatic hydraulic type. Attention is particularly called to the closed construction of the puller head 64, which prevents entrance of chips or dirt, during the broaching operation, as all operating parts are entirely enclosed within the puller head casing.

Attention is also called to the design and proportions of the dogs 81, which so engage the broach that an increased pull on the broach merely locks the broach more securely in the

puller head. No external clamping device whatever is required.

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. In a pull-down broaching machine, a puller head, a pair of broach-holding dogs in said head, a rotatable cam means to render said dogs inoperative at the end of the working down stroke of said broach, said cam having an enlarged concentric portion to hold said dogs inoperative until the return up stroke is substantially completed, and automatic means to turn said cam alternately in opposite directions at the end of the working and return strokes.

2. In a broaching machine, a broach actuating head, hydraulic actuating mechanism for said head, a reversible discharge pump for said hydraulic mechanism, a control valve for said hydraulic mechanism, and a control device operative to move said valve and to simultaneously control the amount and direction of discharge of said pump, whereby both said valve and said pump will be in neutral position at the same time.

3. In a pull-down broaching machine, a lifter head, a piston connected thereto, a cylinder for said piston, a separate pump for said lifter cylinder, means to provide free flow to said cylinder and restricted discharge from said cylinder during a lifting stroke and to provide separately restricted flow from said cylinder during a return stroke of said lifter head, a manually controlled valve for said lifter cylinder, and a relief device for said pump and cylinder providing escape of oil from said cylinder during a working stroke of said machine if said manually controlled valve is shifted to neutral position.

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