Oct. 9, 1928. 1,687,369

F. J. LAPOINTE

HYDRAULIC BROACHING MACHINE

Filed Dec. 18, 1925 4 Sheets-Sheet 1

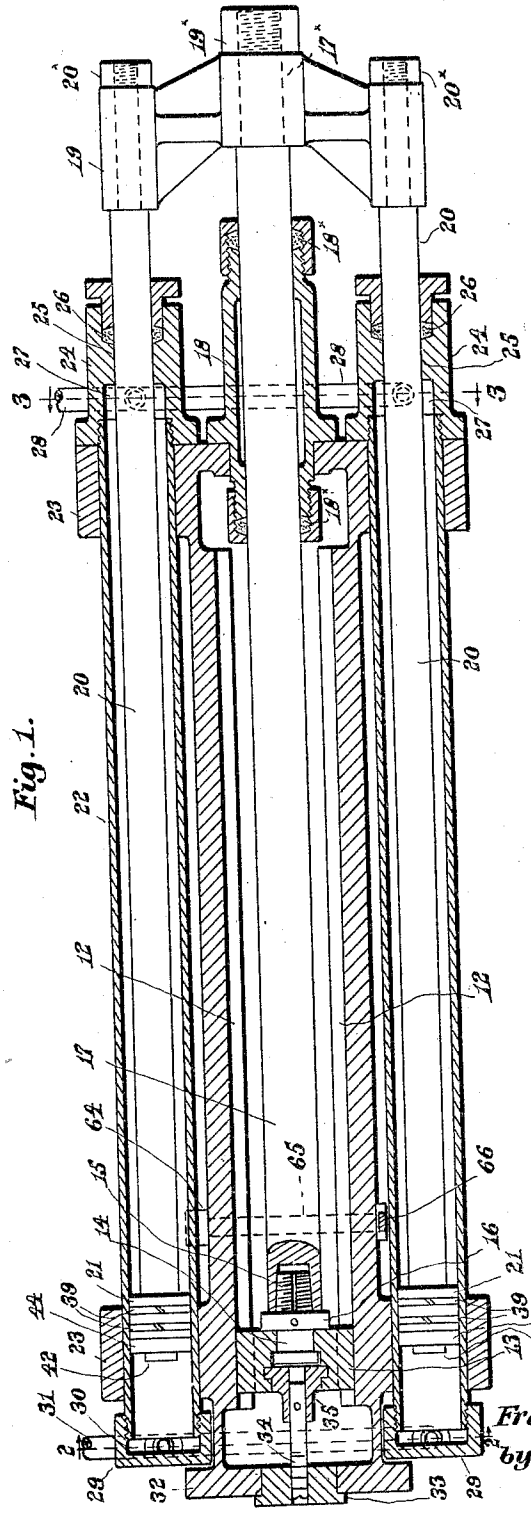


Fig. 1.

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Fig. 2.

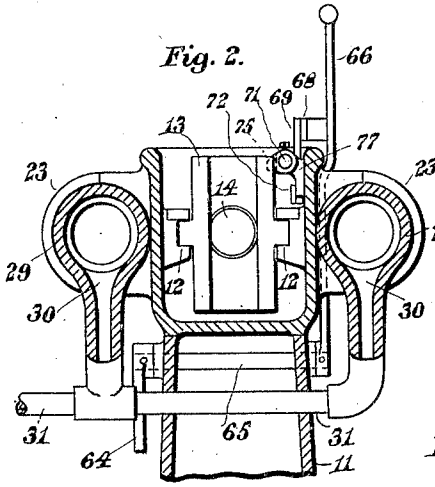


Fig. 3.

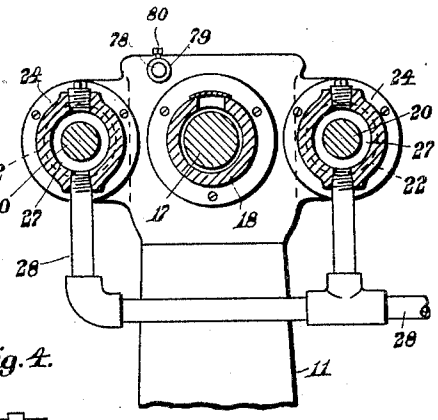


Fig. 4.

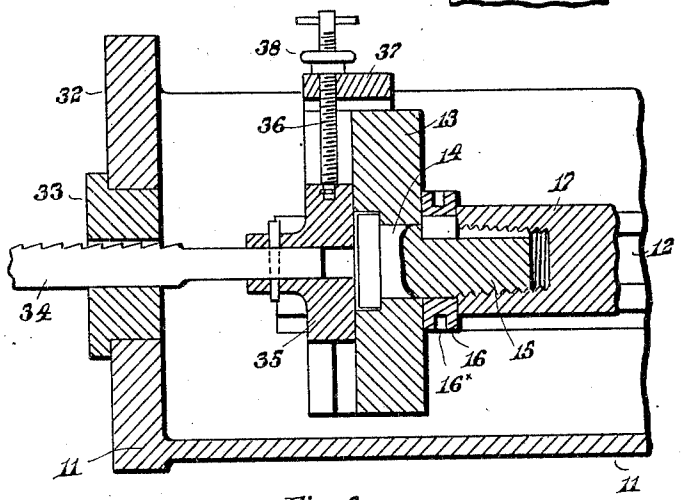
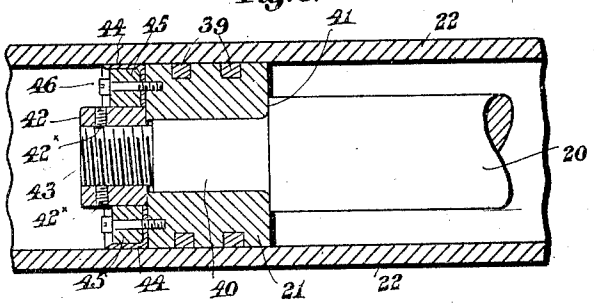


Fig. 5.



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Fig. 6.

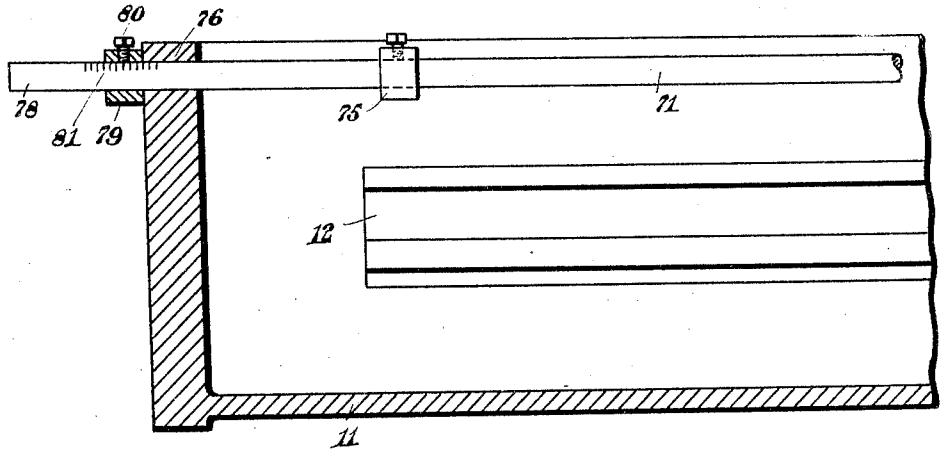
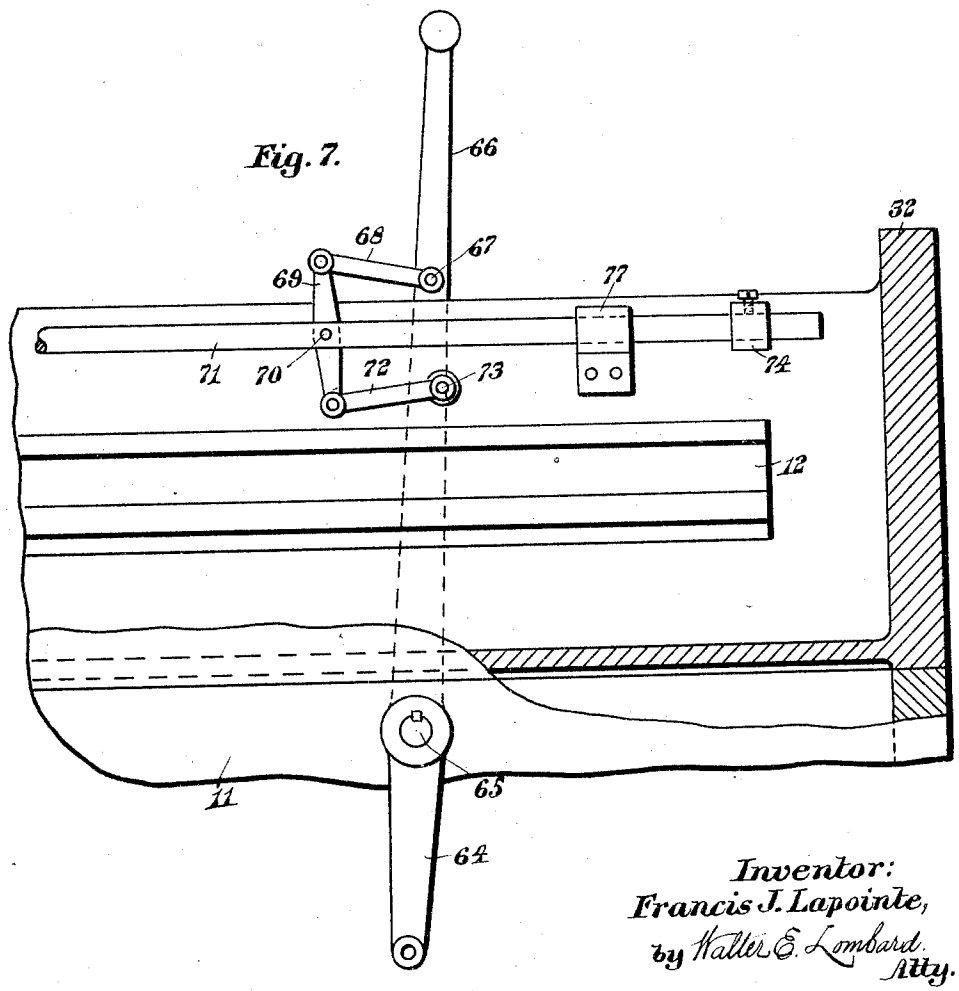


Fig. 7.



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HYDRAULIC BROACHING MACHINE

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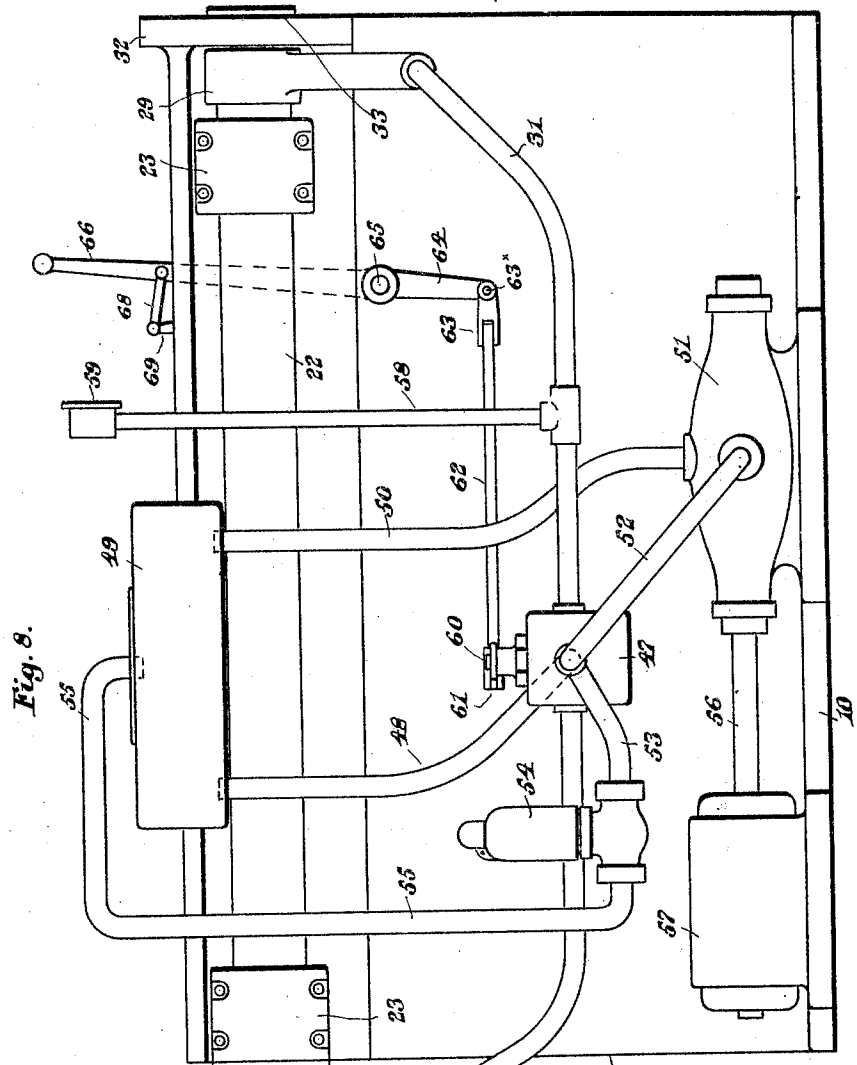


Fig. 8.

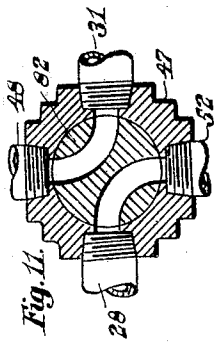


Fig. 11.

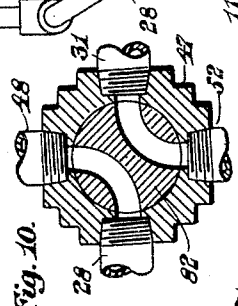


Fig. 10.

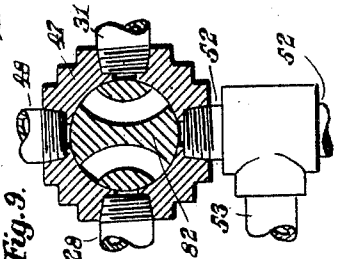


Fig. 9.

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Patented Oct. 9, 1928. 1,687,369

UNITED STATES PATENT OFFICE.

FRANCIS J. LAPOINTE, OF ANN ARBOR, MICHIGAN.

HYDRAULIC BROACHING MACHINE.

Application filed December 18, 1925. Serial No 76,309.

This invention relates to broaching machines and particularly to that class of machines in which the broach pulling ram is actuated by hydraulic pressure and has for its object the production of a machine of this character in which two cylinders are used in which reciprocate pistons connected directly to the pulling ram whereby a balanced pull is obtained.

Another object of the invention is to provide means whereby the liquid entering the high pressure end of said cylinders will act directly against the entire surface of one end of the pistons during the pulling movement of the ram while the liquid admitted to the low pressure end of the cylinders will be exerted against a very small surface on the opposite end of said pistons during the return movement of the ram.

These objects are attained by the mechanism illustrated in the accompanying drawing.

For the purpose of illustrating the invention, one preferred form thereof is illustrated in the drawings, this form having been found to give satisfactory and reliable results, although it is to be understood that the various instrumentalities of which the invention consists can be variously arranged and organized, and the invention is not limited to the precise arrangement and organization of these instrumentalities as herein shown and described except as required by the scope of the appended claims.

Of the drawings:

Figure 1 represents a horizontal section of a portion of a broaching machine having applied thereto a hydraulic system for actuating the broach and embodying the principles of the present invention.

Figure 2 represents a transverse vertical section of same on line 2, 2 on Fig. 1.

Figure 3 reperesents a transverse vertical section of the same on line 3, 3 on Fig. 1.

Figure 4 represents a longitudinal vertical section of the same showing the means for connecting the broach to the pulling ram.

Figure 5 represents a section of a portion of one of the cylinders and the piston member reciprocable therein.

Figure 6 represents a longitudinal vertical section of one end of the frame showing one end of the shifting rod adapted to reciprocate relatively to the frame.

Figure 7 represents a similar section of the opposite end of the frame and showing the shifting rod and the means for actuating it.

Figure 8 represents a schematic view showing the various instrumentalities used in the improved hydraulic system for actuating the broach, and

Figures 9, 10 and 11 represent diagrammatic sections of the controlling valves as shown in different positions to be hereinafter described.

Similar characters indicate like parts throughout the several figures of the drawings.

In the drawings 10, is a supporting base having super-imposed thereon a framework 11, the upper end of which has formed therein oppositely disposed guideways 12 in which a carriage 13 is adapted to reciprocate.

The carriage 13 has extending therethrough a headed member 14, the outer end 15 of which is threaded and has keyed thereto an annular member 16 having sockets 16^{x} therein adapted to receive a spanner wrench by which said headed member 14 may be rotated about its axis.

The threaded end 15 extends into a threaded socket in the pulling ram 17, the opposite end of which extends through a guide 18 having stuffing boxes 18^{x} at the opposite ends thereof.

The guide 18 is chambered out and the chamber therein is adapted to be filled with lubricant which lubricates the pulling ram 17 as it reciprocates therein.

The outer end of the pulling ram 17 has a reduced portion 17^{x} on which is secured a cross member 19 by a nut 19^{x}, each outer end of the member 19 having extending therethrough and secured thereto the reduced end of a piston rod 20 by means of a nut 20^{x} while the opposite end of the rod 20 has a piston 21 mounted thereon. Each of these pistons is adapted to be reciprocated in a cylinder 22.

These cylinders 22 are disposed in recesses upon opposite sides of the framework 11 and are clamped in position therein by the caps 23 secured to the outer faces of the framework 11.

Adjacent the cross member 19 and surrounding each piston rod 20 is a housing 24 having a bearing 25 for the piston rod and provided with a stuffing box 26. This housing 24 also has a chamber 27 therein com-

municating with one end of a cylinder 22. From this chamber 27 extends a pipe 28.

The opposite end of each cylinder 22 has threaded thereto a cap 29 having a chamber 30 therein communicating with the interior of the cylinder 22. From this chamber 30 extends a pipe 31.

One end of the framework 11 has a bearing plate 32 in which is mounted a work support 33 of usual construction and through which the broach 34 extends.

The broach 34 is keyed to a member 35 slidable vertically in the carriage 13. The upper end of the member 35 has revolubly mounted therein the lower end of an adjusting screw 36 threaded to a cross plate 37 secured to the carriage 13. By turning this screw 36 the member 35 may be raised and lowered to adjust the position of the broach 34.

When the broach is in adjusted position the clamping nut 38 is screwed down on to the plate 37 and retains the member 35 in any desired position.

Each piston 21 has a plurality of peripheral piston rings 39. Each piston 21 surrounds the reduced end 40 of the piston rod 21 and is forced against the shoulder 41 on said piston rod 21 by means of the nut 42 threaded to the screw portion 43 of said piston rod. The nut 42 is prevented from turning when in adjusted position by means of the set screws $42^{\times}$.

Positioned against the outer end of each piston ring is a cup-shaped leather packing 44 in which is disposed an annular member 45 through which extends a plurality of screws 46, the inner ends of which are threaded to the piston 21 as indicated in Fig. 5 of the drawings.

The outer edge of the cup-shaped packing member 44 extends beyond the outer face of the ring 45 so that when pressure is applied to the piston 21 said projecting ends will be forced against the wall of the cylinder and assist in preventing all leakage past the piston.

The rings 39 also assist in preventing this leakage.

The pipe 31 communicates with the chamber 30 of both of the caps 29 as indicated in Fig. 2 of the drawings.

The pipe 28 likewise communicates with the chambers 27 in both housings 24 as indicated in Fig. 3.

The pipes 28 and 31 communicate with the casing of a four way valve 47 on opposite sides thereof. From another side of the casing 47 extends a pipe 48 to one end of an oil reservoir 49. From the opposite end of the reservoir 49 a pipe 50 extends downwardly to a pump 51 having a delivery pipe 52 extending therefrom to the valve casing 47. The delivery end of this pipe 52 is oppositely disposed to the end of the pipe 48.

A branch pipe 53 extends from the pipe 52 to a safety valve 54 and from this safety valve 54 extends an overflow pipe 55, the upper end of which extends into the top of the reservoir 49.

The pump 51 is operated by a revoluble shaft 56 rotated by a motor 57, said motor and pump being of any well known construction.

As the motor 57, pump 51, safety valve 54, four way valve 47, are all of usual construction it is deemed unnecessary to illustrate them in detail.

Extending upwardly from the pipe 31 is a branch pipe 58 having a gauge 59 at its upper end which indicates to the operator the pressure of the oil within the pipe 31.

The plug of the four way valve has upwardly extending spindle 60 to which is secured a lever 61, to the outer end of which is pivotally secured one end of a rod 62, the opposite end of which is pivotally connected to one end of a link 63, the opposite end of which is connected by a pivot $63^{\times}$ to the lower end of a lever 64 secured to an oscillating shaft 65 mounted in bearings in the framework 11, this shaft 65 at its opposite end having an upwardly extending arm 66 by the movement of which the valve 47 may be operated to admit oil from the pump 51 through the delivery pipe 52 to either the pipe 28 or the pipe 31.

To the arm 66 is pivotally connected at 67 one end of a link 68, the opposite end of which has a pivotal connection with one end of the lever 69 adapted to oscillate about a stud 70 extending outwardly from the shifting rod 71. The opposite end of the lever 69 is pivotally connected to one end of another link 72, the opposite end of which is pivotally mounted upon a stud 73 fixedly secured to and projecting from the framework 11 and about which stud said link 72 may oscillate.

The lever 69 being connected midway of its length to the shifting rod 71 and also connected at its outer ends to links 68, 72, the opposite end of one of which is pivotally connected to the lever 66 while the other is adapted to swing about a fixed point on the framework, a means is provided whereby a short movement may be imparted to the shifting rod 71 by a much longer movement of the arm 66.

This shifting rod 71 has adjustably mounted thereon the stop collars 74 and 75 which are usual in all broaching machines where it is desired to stop the carriage at the end of its movement in either direction.

The shifting rod 71 reciprocrates in a bearing 76 in one end of the framework 11 and in a bearing formed in a bracket 77 secured to the framework 11 near its opposite end.

The projecting end 78 of the shifting rod

71 has an adjustable collar 79 thereon adapted to be secured in adjusted position by the set screw 80. This collar may be set in any desired position by having one wall thereof registering with a predetermined mark on the scale 81 formed on the shifting rod 71.

By adjusting this collar 79 in this manner it is obvious that the movement of the shifting rod toward the opposite ends of the framework 11 will be stopped in different positions corresponding to the adjustment of the collar 79 on the shifting rod 71.

When the carriage 13 in its movement in either direction strikes one of the stop members 74, 75 it will move it and the shifting rod 71 to which said members 74, 75 are secured a distance sufficient to return the arm 66 to its normal vertical position, at which time the valve 47 will be in such position as to prevent the delivery of oil to either of the pipes 28, 31, and consequently there will be no further movement of the carriage until the arm 66 is again moved from its vertical position.

As shown in the drawings the carriage 13 is in position to draw the broach 34 through the work and the arm 66 has been moved sufficiently to partially open the valve 47 to the pipe 31 allowing oil to pass through said pipe to the high pressure end of the cylinders 22 and force the pistons 21 and with them the pulling ram 17 toward the outer end of the machine.

If the collar 79 had been set nearer the end 78 of the shifting rod prior to this movement, it is obvious that the arm 66 could have been moved through a greater arc and the valve 47 would have been opened to a greater extent, thereby permitting a greater pressure of oil to be admitted to the cylinders 22.

In other words, during the operation of cutting by the broach, a predetermined amount of oil at any desired pressure may be admitted to the high pressure end of the cylinders by simply adjusting the collar 79 on the end 78 in accordance with the markings of scale 81.

This is of great consequence for in order to obtain satisfactory results when cutting into different metals different speeds must be employed, one metal requiring a different speed of cutting than is required by other metals.

When the machine is at rest the valve plug 82 is in the position shown in Fig. 9 and all oil from the pump 51 will pass through the pipes 52, 53, valve 54, pipe 55 to the reservoir 49 and return to the pump through the pipe 50.

When the plug 82 is in the position indicated in Fig. 10 the oil will pass from the pump 51 into the pipes 52 and 31 and move the pistons 21 toward the outer end of the machine, the oil in the cylinders 22 in advance of the pistons 21 passing outwardly from said pistons through the pipe 28 to and through the valve 47 and then through the pipe 48 to reservoir 49.

When the plug 82 is in the position indicated in Fig. 11 the oil will pass through the valve 47 to pipe 28 to the low pressure end of the cylinders 22 and force the pistons 21 to their original positions, the oil in advance of the pistons passing outwardly from the cylinders 22 into the pipe 31, through the valve 47 to pipe 48 and then to the reservoir 49.

In the operation of the machine, the actuating arm 66 is normally in vertical position and the carriage 13 is at the high pressure end as shown in Fig. 1.

At this time the work to be operated upon may be placed upon the work support 33 with the broach 34 extending therethrough.

When the work has been properly positioned the motor 57 is started and the pump 51 will draw oil from the reservoir 49 through the pipe 50 and force it back into said reservoir through the pipes 52 and 55 creating a complete circulation of the oil, the valve plug 82 at this time being in the position indicated in Fig. 9.

The operator at this time sets the collar 79 for the desired speed to be imparted to the pulling ram 17 and then moves the arm 66 about the axis of the shaft 65 from its vertical position into the position indicated in Fig. 8, this movement being limited by the collar 79 coming into contact with the end face of the framework 11 as shown in Fig. 6.

The valve plug 82 will then be approximately in the position shown in Fig. 10, the exact opening of the valve depending upon the setting of the collar 79.

When the plug 82 is in the position indicated in Fig. 10 oil will be forced by the pump 51 through the pipes 52 and 31 into the cylinders 22 directly behind the pistons 20 therein and cause said pistons to move toward the low pressure end of the machine, this movement of the pistons 20 being transmitted to the pulling ram 17 through the cross member 19.

By having the cylinders 22 on opposite sides of the frame 11, the movement of the pulling ram will be perfectly balanced and there will be no tendency to cramp in the bearings therefor.

Moreover, by thus disposing the cylinders on opposite sides of the frame rather than beyond the end thereof the machine occupies much less space in the shop which, in itself, is a very great advantage.

When the oil is forced against the pistons 20 it will spread the cup-shaped leather

packing members 44 outwardly against the inner wall of the cylinders 22, thereby effectually preventing leakage past these pistons.

The oil in advance of the pistons 21 will be pushed forward thereby and discharged from the opposite ends of the cylinders 22 into the pipe 28 returning it to the reservoir 49 through a passage in the plug 82 and the return pipe 48.

The pistons 21 will continue to move towards the low pressure end of the machine at a predetermined speed until the carriage 13 strikes the stop collar 75 on the shifting rod 71 and moves it the required distance to return the arm 66 to its normal vertical position.

This return movement of the arm 66 will move the plug 82 of valve 47 into the position indicated in Fig. 9 and the oil will then be cut off from the pipe 31 and will be diverted through pipes 53, 55 to the reservoir 49 returning to the pump 51 through pipe 50.

The machine will remain at rest until the operator moves the arm 66 in the opposite direction to its former movement from the vertical, which new movement will cause the plug 82 to assume the position indicated in Fig. 11.

When in this position oil will be admitted to the opposite side of the pistons 20 and return the pulling ram 17 to its original position preparatory to another working stroke of the broach 34, it being understood that when the carriage 13 comes into contact with the stop member 74 and moves it and the shifting rod 71, the arm 66 will be returned to its vertical position and the carriage will come to a standstill.

Should, in the pumping of the oil, an excessive pressure be created a portion of the oil will be diverted into the pipe 53 to the safety valve 54 which may be set for any desired pressure.

It will be noted that the piston rods 20 have a diameter almost as great as the diameter of the pistons 21 so that there is very low pressure against the pistons 21 on the return stroke compared to the high pressure thereon during the working stroke, inasmuch in the latter case the oil acts against the entire end of the piston.

During the working or cutting stroke there is a pressure against the piston of approximately 2200 pounds per square inch, while on the return stroke these pistons are only subjected to a pressure of approximately 175 pounds per square inch.

As a consequence of this high pressure behind the piston 21 during the working stroke, it is evident that provision must be made to prevent any leakage from the high pressure end of the cylinders and this is accomplished by having the pistons 21 disposed upon the end of the piston rods 20 and this end of each cylinder tightly closed by the caps 29 screwed thereon.

On the low pressure side of the pistons 21 the rods 20 may extend through stuffing boxes 26 owing to the fact that there is never any undue pressure on this side of the pistons 21 and the stuffing boxes 26 are sufficient to prevent leakage.

By subjecting the entire end of the pistons 21 to the high pressure during the working stroke the cylinders 22 may be made much smaller than would be possible if the piston rod extended through the high pressure end of the cylinder as in the latter case there would be much lost area due to the presence of the piston rods which must have considerable diameter to be strong enough to accomplish the work required of them.

Moreover, where such piston rods or rams extend through heads at the high pressure end of the cylinders it would be practically impossible to prevent leakage through said heads around the glands provided to prevent such leakage.

By the construction herein shown such leakage is prevented which obviously is a very great advantage.

The gauge 59 will determine the number of pounds per square inch being exerted during the working stroke and will also indicate the gross tonnage under which the machine is operating.

The arm or operating lever 66 operates a valve controlling mechanism which makes it possible to attain a variable speed, from the slowest movement to one as high as 20 feet per minute.

With a machine constructed as herein shown and described there are no undue pressures or claims on the machine itself and consequently its life is greatly prolonged.

It is believed that from the foregoing description the operation and many advantages of the invention will be fully understood without further description.

Having thus described my invention, I claim—

1. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to one end of said ram and slidable on and between said guides; a member secured to and projecting laterally from the other end of said ram; hydraulic means for actuating said ram, said means including a piston enclosed in a cylinder parallel to and alongside said ram, said piston being con-

nected to said projecting member; and means for delivering liquid into said cylinder against the entire surface of one end of said piston during the pulling operation of said ram.

2. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to one end of said ram and slidable on and between said guides; a member secured to and projecting laterally from the other end of said ram; hydraulic means for actuating said ram, said means including a piston enclosed in a cylinder parallel to and alongside said ram, said piston being connected to said projecting member; means for delivering liquid into said cylinder against the entire surface of one end of said piston during the pulling operation of said ram; and means for predetermining the rate of flow of the liquid delivered.

3. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to one end of said ram and slidable on and between said guides; a member secured to and projecting laterally from the other end of said ram; hydraulic means for actuating said ram, said means including a piston enclosed in a cylinder parallel to and alongside said ram, said piston being connected to said projecting member; and means for delivering liquid into said cylinder against the entire surface of one end of said piston during the pulling movement of said ram and against a lesser surface of the other end of the piston during the return movement.

4. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to one end of said ram and slidable on and between said guides; a member secured to and projecting laterally from the other end of said ram; hydraulic means for actuating said ram, said means including a piston enclosed in a cylinder parallel to and alongside said ram, said piston being connected to said projecting member; means for delivering liquid into said cylinder against the entire surface of one end of said piston during the pulling movement of said ram; and means operable by said ram at the end of its pulling movement for shutting off the flow of liquid to the high pressure end of said cylinder.

5. In a broaching machine having oppositely disposed guides with a horizontal bearing at one end thereof, the combination of a reciprocable carriage slidable on and between said guides; a pulling ram detachably connected at one end thereto and reciprocable in said bearing; a member projecting laterally from the other end of said ram; and hydraulic means extending along the opposite sides of said ram and connected to the opposite ends of said projecting member, said hydraulic means being adapted to reciprocate said ram and give a balanced pull thereto during its reciprocatory movement.

6. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; hydraulic means on opposite sides of said ram and adapted to reciprocate said ram, said means including a single valve simultaneously controlling the liquid supply to both hydraulic means; and means in the path of movement of said ram and adapted to be operated thereby at the end of its movement in either direction for actuating said valve and shutting off the supply of liquid.

7. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; hydraulic means supported by said bed on opposite sides of said ram and adapted to reciprocate said ram, said means including a single valve regulating the liquid supply to both hydraulic means; a delivery pipe leading from said valve; a pump for delivering liquid to said delivery pipe; a branch pipe extending from said delivery pipe to the main liquid supply; and means in the path of movement of said ram and adapted to be operated at the end of movement of the ram in either direction for actuating the valve and shutting off the supply of liquid.

8. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the

inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; hydraulic means supported by said bed on opposite sides thereof and adapted to reciprocate said ram; means for delivering liquid under pressure to said hydraulic means; and means for predetermining the quantity of liquid delivered.

9. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides of and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; and means for delivering liquid to said cylinders.

10. In a broaching machine, the combination of a horizontal bed having integral guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing mounted in one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways towards and from said ram bearing; a cross bar secured to the outer end of said ram; and hydraulic means supported by said bed on the opposite sides thereof and parallel with said ram and connected to the outer ends of said cross bar so as to impart reciprocatory movement to said ram.

11. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons in said cylinders; rods extending therefrom connected to the opposite ends of said cross bar; and means for alternately admitting oil under pressure to both of said cylinders upon opposite sides of said pistons.

12. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons in said cylinders; rods extending therefrom connected to opposite ends of said bar; means for alternately admitting oil under pressure to both of said cylinders upon opposite sides of said pistons; and means regulating the amount of oil delivered to said cylinders.

13. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel with said ram; pistons in said cylinders; rods extending therefrom connected to the opposite ends of said bar; and means for delivering oil to either end of both of said cylinders.

14. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and provided with outwardly extending ribs slidable on and between said guideways; a a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel with said ram; pistons in said cylinders; rods extending from one end of said pistons to the opposite ends of said bar; and a pump for delivering oil to either end of both of said cylinders in predetermined quantities.

15. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported at their opposite ends by said bed on opposite sides thereof and parallel with said ram; pistons in said cylinders; rods extending from one end of said pistons to the opposite ends of said bar; and means for delivering oil under pressure to one end of both of said cylinders against the entire end faces of said pistons.

16. In a broaching machine, the combination of a horizontal bed having parallel and

oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel with said ram; pistons in said cylinders; rods extending from one end of said pistons to the opposite ends of said bar; means for delivering oil under pressure to one end of both of said cylinders against the entire end faces of said pistons; and means for varying the quantity of oil delivered.

17. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways toward and from said ram bearing; a cross bar secured to the outer end of said ram; cylinders on opposite sides of said bed parallel with said ram and supported at their ends by said bed; pistons in said cylinders; rods extending from one end of said pistons to the opposite ends of said bar; means for delivering oil under pressure to one end of both of said cylinders against the entire end faces of said pistons; and means for predetermining the quantity of oil delivered.

18. In a broaching machine, the combination of a horizontal bed having parallel and oppositely disposed guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders on opposite sides of said bed and parallel to said ram with the opposite ends thereof supported in projections from the opposite ends of said bed; pistons in said cylinders; rods extending thereform connected to opposite ends of said bar; a pump; a valve, pipes leading from said valve to opposite ends of both of said cylinders and to said pump; a reservoir; a pipe from said valve to said reservoir; a pipe from said reservoir to said pump; and an actuating lever controlling the operation of said valve.

19. In a broaching machine, the combination of a horizontal bed having parallel separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders with their opposite ends supported in projections extending from the opposite sides of said bed and parallel to said ram; pistons in said cylinders; connecting means between the opposite end of the ram and pistons for insuring movement thereof in unison; and means for delivering oil under pressure to one end of both of said cylinders against the entire end faces of said pistons.

20. In a broaching machine, the combination of a horizontal bed having parallel separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end of said guideways and centrally positioned relatively thereto; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons in said cylinders; connecting means between the opposite end of the ram and pistons for insuring movement thereof in unison; means for delivering oil under pressure to one end of both of said cylinders against the entire end faces of said pistons; and means for varying the quantity of oil delivered.

21. In a broaching machine, the combination of a horizontal bed having parallel separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end of said guideways and centrally positioned relatively thereto; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; means for delivering liquid to said cylinders; and means for shutting off the supply of liquid at the end of movement of said ram in either direction.

22. In a broaching machine, the combination of a horizontal bed having parallel separated guideways extending lengthwise thereof and horizontally disposed cylindrical bearing at one end of said guideways and centrally positioned relatively thereto; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a

cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; and means operable by said ram at the end of its movement in either direction for shutting off the flow of oil delivered to said cylinders.

23. In a broaching machine, the combination of a horizontal bed having parallel separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end of said guideways and centrally positioned relatively thereto; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; a valve; a rod slidable in bearings and movable in the reciprocation of said ram; operative connections between said rod and valve; pipes leading therefrom to the opposite ends of both of said cylinders; a pump; a delivery pipe between said valve and pump; and an overflow pipe extending from said delivery pipe.

24. In a broaching machine, the combination of a horizontal bed having parallel separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end of said guideways and centrally positioned relatively thereto; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; means for delivering oil under pressure to one end of both of said cylinders against the entire surface of one end of said pistons, said means including a pump and a delivery pipe therefrom; a supply reservoir; a branch pipe extending from said delivery pipe to said reservoir; a liquid controlling valve; a slidable rod movable endwise by the reciprocation of the ram; and operative connections between said rod and valve.

25. In a broaching machine, the combination of a horizontal bed having separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and provided with oppositely extending members slidable on said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; means for delivering oil under pressure to one end of both of said cylinders against the entire surface of one of said pistons, said means including a pump and a delivery pipe therefrom; a supply reservoir; a branch pipe extending from said delivery pipe to said reservoir; a safety valve communicating with said branch pipe; a liquid controlling valve; an actuating lever for operating said valve; a rod movable endwise by the reciprocation of the ram; and operative connections between said rod and lever.

26. In a broaching machine, the combination of a horizontal bed having separated guideways extending lengthwise thereof and a horizontally disposed cylindrical bearing at one end thereof, said guideways being formed integral with said bed; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a cross bar secured to the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons reciprocable in said cylinders; rods connecting said pistons to said cross bar; a shifting rod adapted to be engaged and moved endwise by said ram at the end of its movement in either direction; means for delivering liquid to said cylinders against the entire surface of said pistons; a valve in said delivering means; and means interposed between said valve and shifting rod whereby the former will be closed whenever the latter is moved by said ram.

27. In a broaching machine, the combination of a horizontal bed having separated guideways extending lengthwise thereof and a horizontally disposed bearing at one end thereof, said guideways being formed integral with said bed; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a laterally extending member on the outer end of said ram; hydraulic means connected to said member for reciprocating said ram; a valve for controlling the direction of movement of said ram; an actuating lever for operating said valve; and means movable by said ram at the end of its movement in either direction for moving said lever and thereby closing said valve.

28. In a broaching machine, the combination of a horizontal bed having separated guideways extending lengthwise thereof and

a horizontally disposed bearing at one end thereof, said guideways being formed integral with said bed; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a laterally extending member on the outer end of said ram; hydraulic means connected to said member for reciprocating said ram a valve for controlling the direction of movement of said ram; a rod movable by said ram at the end of its movement in either direction; an oscillating lever on said rod; an actuating lever, a link connection between one end of said oscillating lever and the actuating lever; a fixed stud and a link connection between the other end of said oscillating lever and the fixed stud.

29. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram extending through and reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a laterally extending member on the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons in said cylinders; rods connecting said pistons to the opposite ends of said laterally extending member; a valve; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe leading from said valve to said reservoir; a pipe from said reservoir to said pump; an actuating lever controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod; and means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram.

30. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a laterally extending member on the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons in said cylinders; rods connecting said pistons to the opposite ends of said laterally extending member; a valve; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe leading from said valve to said reservoir; a pipe from said reservoir to said pump; an actuating lever controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod, said rod having one end projecting through a fixed bearing; a collar adjustable lengthwise of said projecting end; and means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram.

31. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a laterally extending member on the outer end of said ram; cylinders supported by said bed on opposite sides thereof and parallel to said ram; pistons in said cylinders; rods connecting said pistons to the opposite ends of said laterally extending member; a valve; a pump; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe leading from said valve to said reservoir; a pipe from said reservoir to said pump; an actuating lever controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod, said rod having one end projecting through a fixed bearing; a collar adjustable lengthwise of said projecting end; a scale upon said projecting end for predetermining the proper adjustment of the collar thereon; and means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram.

32. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; a laterally extending member on the outer end of said ram; cylinders supported by said bed on opposite sides thereof parallel to said ram; pistons in said cylinders; rods connecting said pistons to the opposite ends of said laterally extending member; a valve;

pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe leading from said valve to said reservoir; a pipe from said reservoir to said pump; an actuating lever controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod; a link; a fixed stud; and means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram, said means consisting of an oscillating lever pivoted to said shifting rod and connected at one end to said actuating lever by said link and connected by a link at its opposite end to said fixed stud.

33. In a broaching machine the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of the ram; a shifting rod adapted to be engaged and moved endwise by said ram at the end of its movement in either direction; hydraulic means on opposite sides of said bed and adapted to move endwise said ram, said means including pistons enclosed in cylinders; means for delivering liquid to both of said cylinders against the entire surface of one end of said pistons; a valve in the delivering means; and means interposed between said valve and rod whereby the former will be closed whenever the latter is moved by said ram.

34. In a broaching machine the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of the ram; hydraulic means supported in projections from the opposite sides of said bed and adapted to reciprocate said ram; a valve coacting with said hydraulic means for controlling the direction of movement of said ram; an actuating lever movable from a vertical position to open said valve; and means movable by said ram at the end of its movement in either direction and operatively connected to the actuating lever to return said lever to its vertical position and thereby close the valve.

35. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted therein at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; hydraulic means for reciprocating said ram supported by said bed on opposite sides thereof; a valve controlling the direction of movement of said ram; an actuating lever for operating said valve; a rod movable endwise by said ram at the end of its movement in either direction; and link mechanism interposed between said rod and lever and adapted in each movement of the lever to impart a less movement to said rod.

36. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted in an end wall thereof; a tool pulling ram extending through and reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; hydraulic means for reciprocating said ram, said means being supported in projections from opposite sides of said bed and including pistons in horizontally disposed cylinders; a pump; a valve; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe from said valve to said reservoir; a pipe from the reservoir to said pump; an actuating lever controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod; and means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram.

37. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing mounted in an end wall thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; hydraulic means for reciprocating said ram, said means being positioned on opposite sides thereof including pistons in cylinders supported by said bed; a pump; a valve; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe from said valve to said reservoir; a pipe from the reservoir to said pump; an actuating lever for controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool

pulling ram at the end of its movement in either direction and move the rod, said rod having one end projecting through a fixed bearing; a collar adjustable lengthwise of said projecting end; and means interposed between the shifting rod and actuating lever, whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram.

38. In a broaching machine, the combination of a horizontal chambered bed having guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; hydraulic means for reciprocating said ram, said means being positioned on opposite sides thereof and including pistons in cylinders supported by said bed; a pump; a valve; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe from said valve to said reservoir; a pipe from the reservoir to said pump; an actuating lever for controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod, said rod having one end projecting through a fixed bearing; a collar adjustable lengthwise of said projecting end; means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram; and a scale upon said projecting end for determining the proper adjustment of the collar mounted thereon.

39. In a broaching machine, the combination of a horizontal chambered bed having separated guideways extending lengthwise of the inner walls thereof and a horizontally disposed bearing at one end thereof; a tool pulling ram reciprocable in said bearing; a tool supporting member detachably secured to the inner end of said ram and slidable on and between said guideways; hydraulic means for reciprocating said ram, said means being supported by said bed on opposite sides thereof and including pistons in horizontally disposed cylinders; a pump; a valve; pipes leading from said valve to the opposite ends of both of said cylinders and to the pump; a reservoir; a pipe from said valve to said reservoir; a pipe from the reservoir to said pump; an actuating lever controlling the operation of said valve; a reciprocating shifting rod having stop collars thereon adapted to be engaged by the tool pulling ram at the end of its movement in either direction and move the rod; two links; a fixed stud; and means interposed between the shifting rod and actuating lever whereby the latter will be moved into a neutral position and close the valve when the rod is moved by said ram, said means consisting of an oscillating lever pivoted to said shifting rod and connected at one end to said actuating lever by one of said links and connected by the other one of said links at its opposite end to said fixed stud.

Signed by me at Ann Arbor, Michigan this 27th day of November, 1925.

FRANCIS J. LAPOINTE.