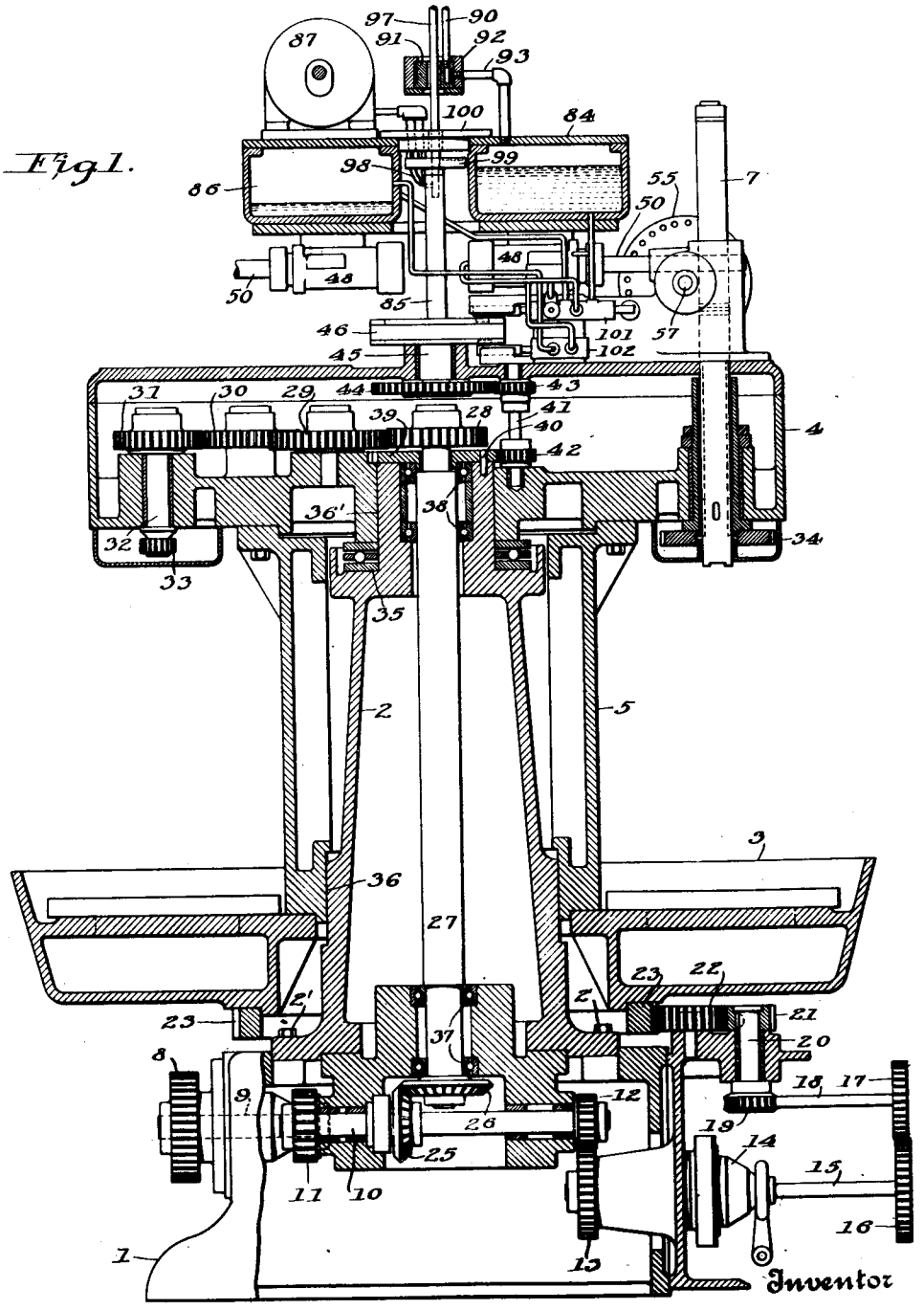
Sept. 8, 1931. A. L. DE LEEUW 1,822,690

CONTINUOUS ROTARY MACHINE

Filed Dec. 7, 1926 6 Sheets-Sheet 1

Fig 1.



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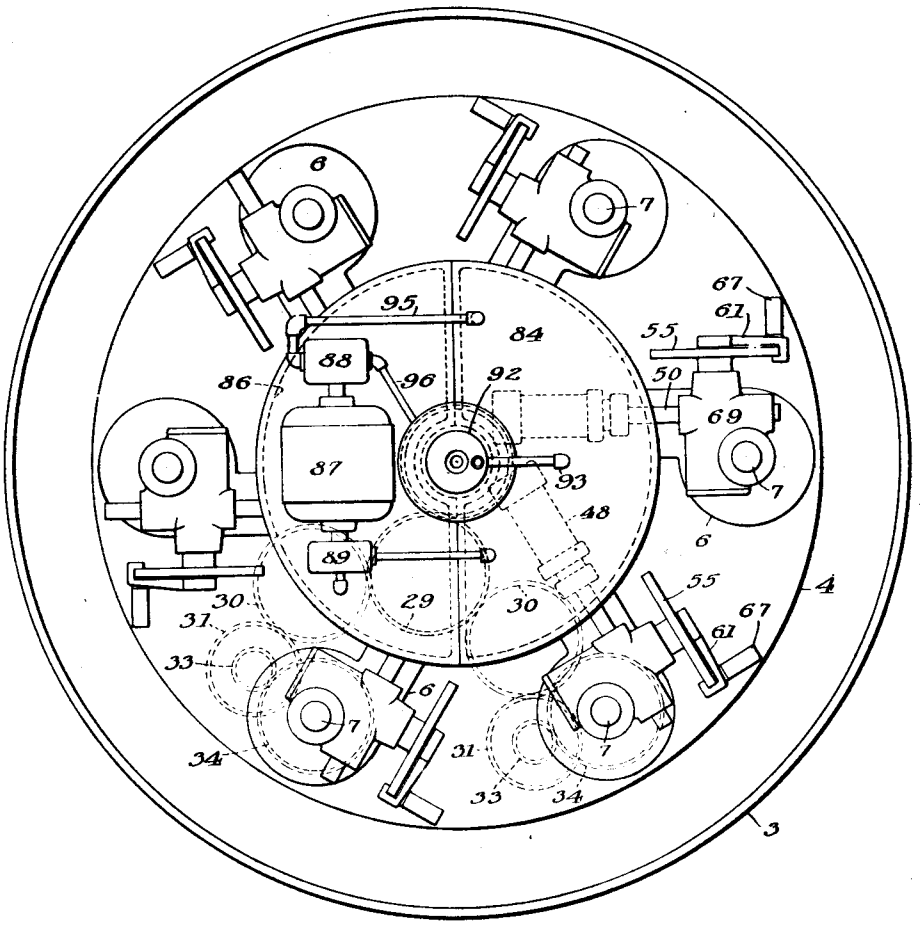

Fig. 2.

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CONTINUOUS ROTARY MACHINE

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Fig. 3.

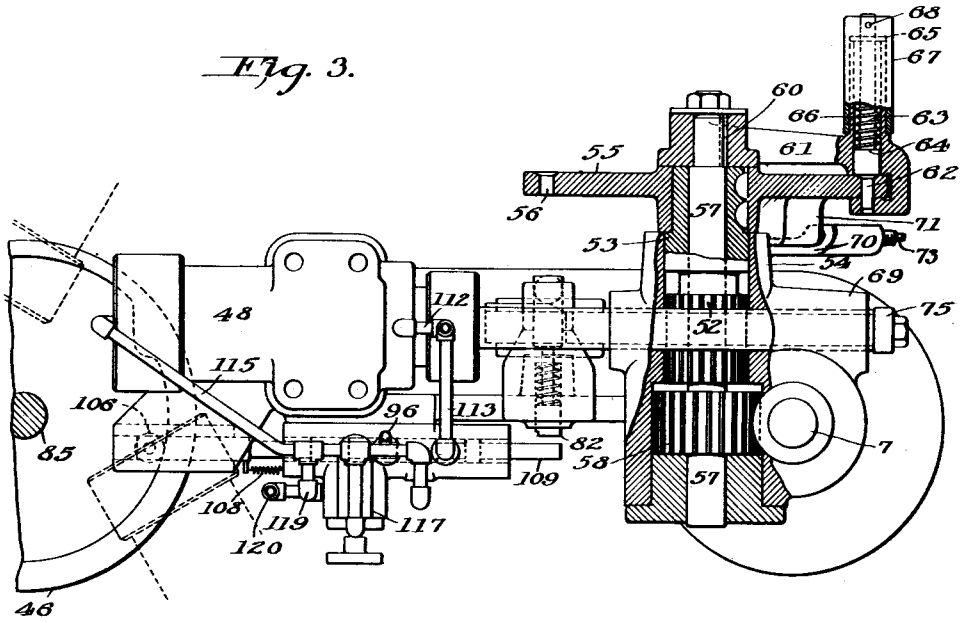
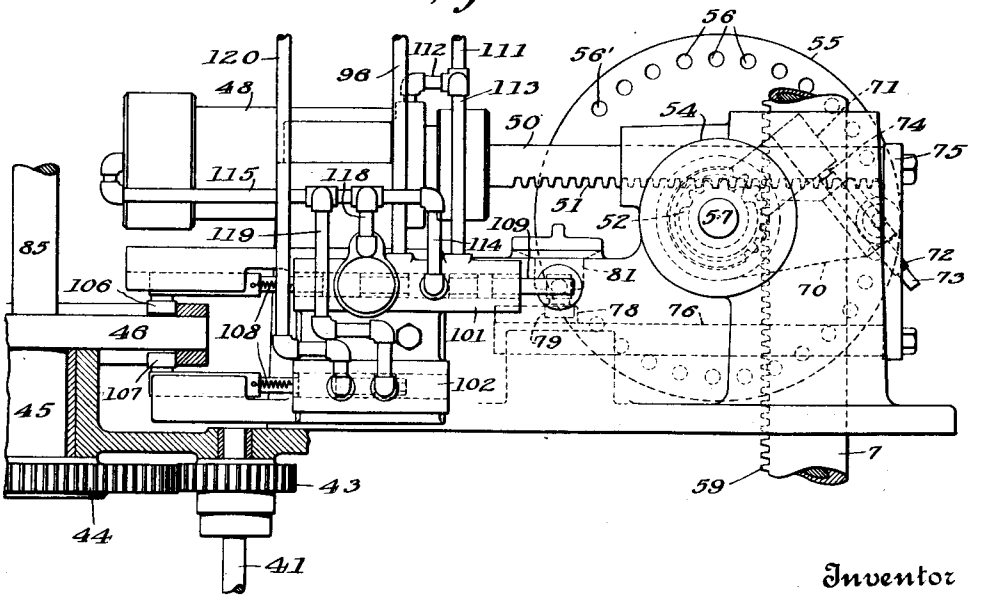


Fig. 4.



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CONTINUOUS ROTARY MACHINE

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Fig. 5.

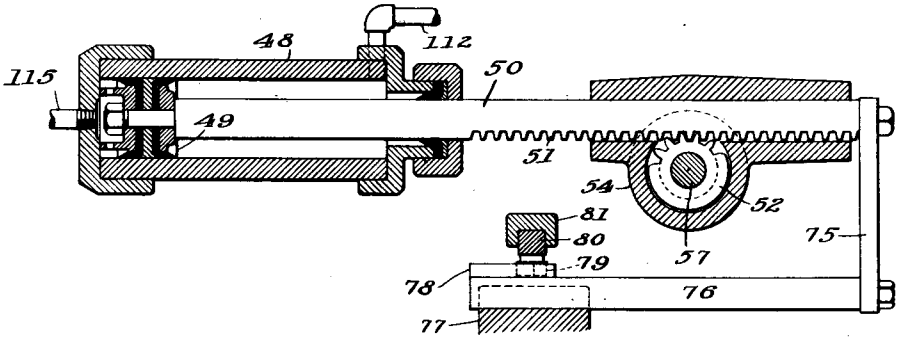
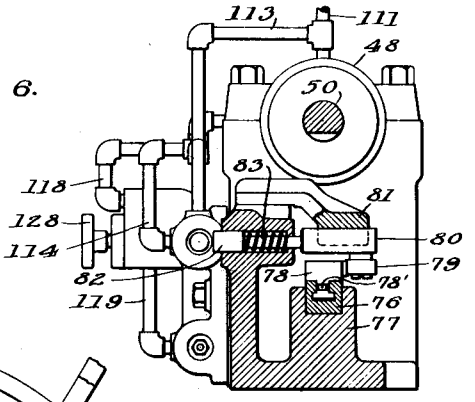


Fig. 6.



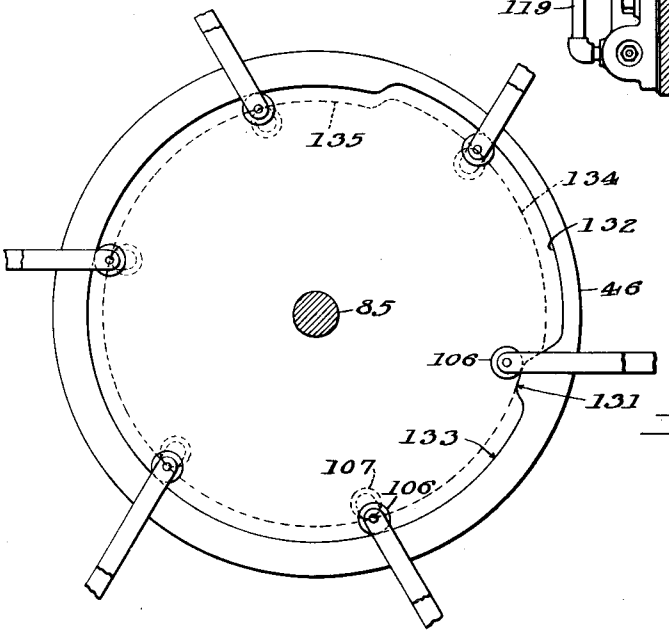


Fig. 7.

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CONTINUOUS ROTARY MACHINE

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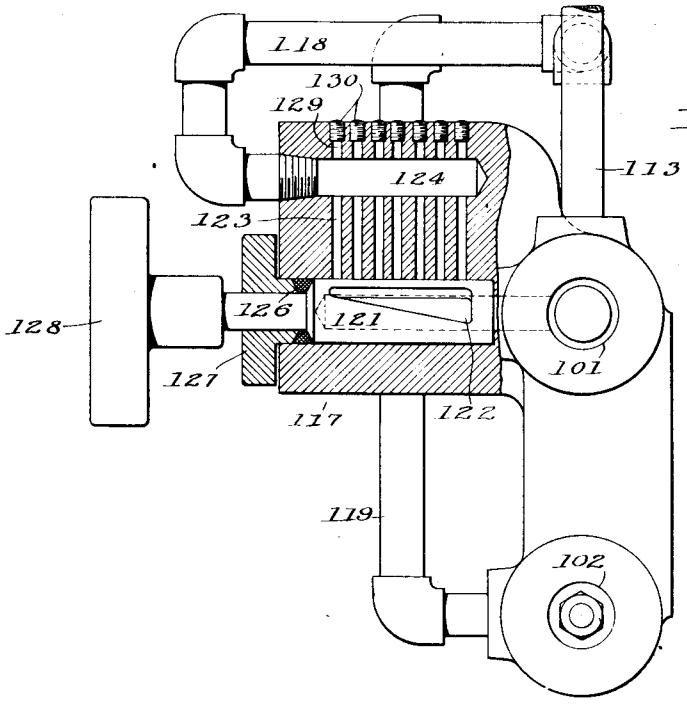

Fig. 9.

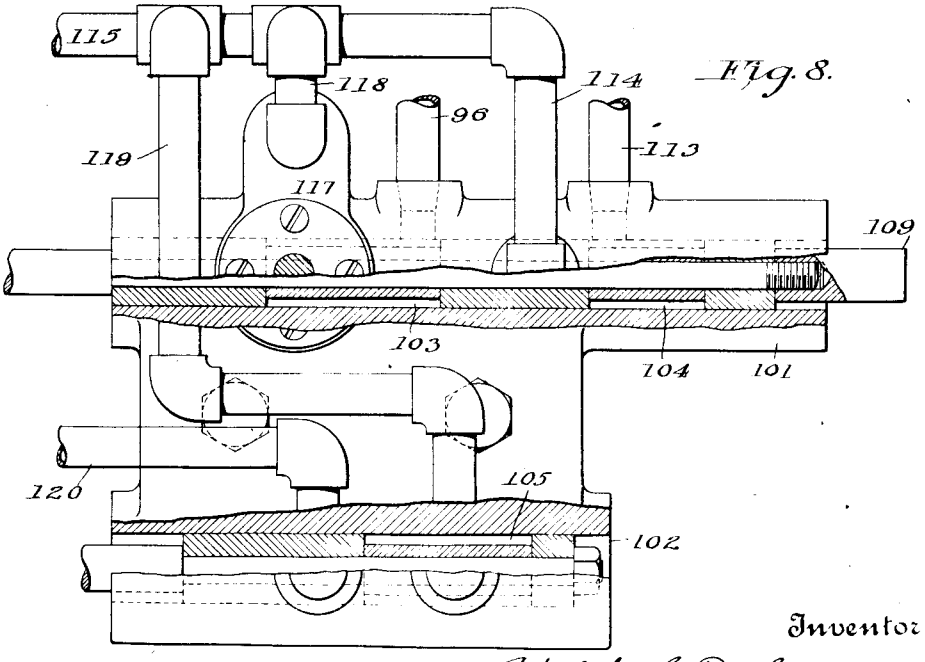

Fig. 8.

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CONTINUOUS ROTARY MACHINE

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Fig 10.

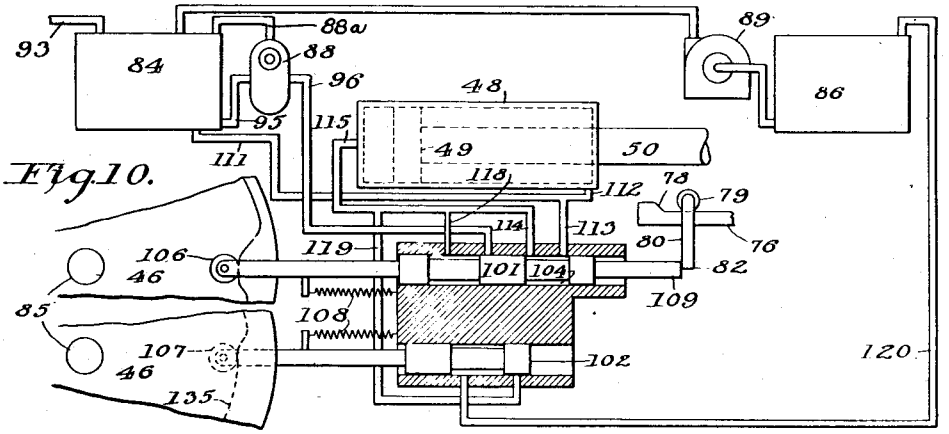


Fig 11.

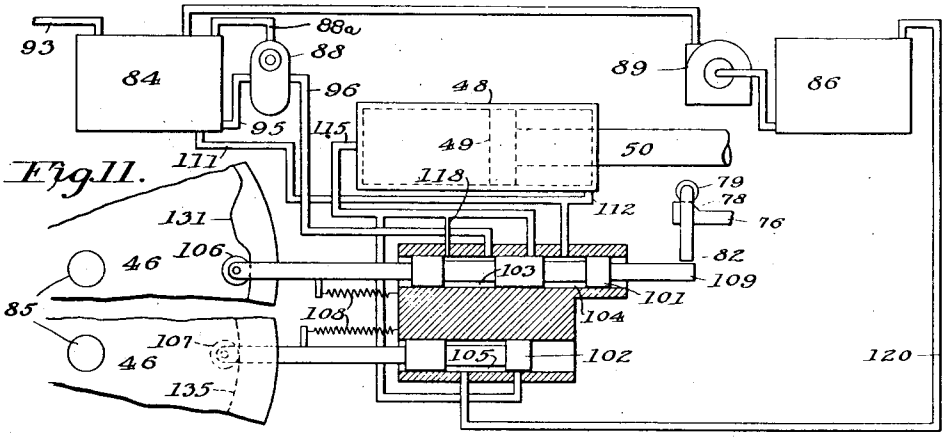
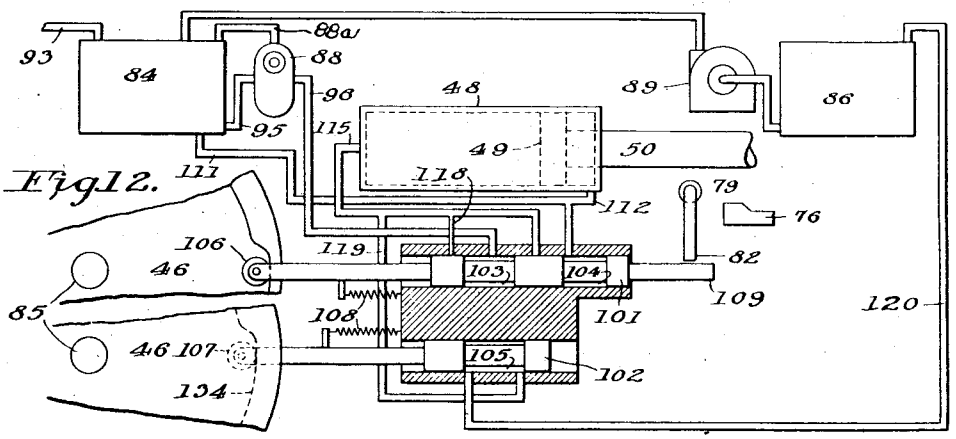


Fig 12.



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UNITED STATES PATENT OFFICE

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CONTINUOUS ROTARY MACHINE

Application filed December 7, 1926. Serial No. 153,177.

This invention relates to the adaptation of fluid pressure means to the operation of various elements in machine tools, and as specifically disclosed herein to a continuous rotary machine. Such a machine usually comprises broadly a large rotary head supported on a vertical column and adapted to rotate continuously but slowly thereon. The head carries with it a plurality of rotatable spindles adapted also to receive a vertical movement relative to the head as it rotates. A work table is designed to rotate with the head and to carry stock thereon so positioned as to be acted on by the respective tool. A series of operations may be automatically performed on each piece of stock in order so that upon a complete rotation of the head and table the machining operation is complete. The rotation is slow and usually does not necessitate stopping of the machine for changing the stock as the spindles revolve consecutively before the workman.

As will appear later many of the novel features disclosed herein and desired to be patented are not limited to the machine tool shown but may be applied to other devices requiring actuation from a source of power.

Many of the advantages of fluid pressure operating means are well known and such means have been variously applied to the translation of drill spindles, lathe head, rotary turrets, and other like machine elements wherein the steady, strong, smooth movement derived from the application of fluid pressure to a movable element aids greatly in obtaining the accuracy and refinement characteristic of a modern machine.

It is often desirable to move an object with varying rates of speed or with greater force to overcome a greater resistance. This is especially true in a machine tool as e. g. for rapid production the working tool should receive a quick traverse forward to engage the work, a slow working stroke and a quick traverse back. Various means have been provided in fluid pressure actuators to accomplish these movements such as a variable displacement pump capable of being controlled to supply fluid at different rates or a constant displacement pump and auxiliary valve regulating means for throttling the flow. Hence in either case the pump must be designed to supply the maximum amount which would be required at any time and making it necessary therefore to have a pump which at lower rates would operate inefficiently.

Another and still greater difficulty results from the fact that the pressure required at certain times varies between wide limits. When the working tool engages the work a very high pressure may be required, but when the only resistance offered is that of friction or the force required to elevate a spindle then a very moderate pressure is sufficient. The former pressure might often be required to be 1,500 lbs. per square inch or even higher in a punch press, for example, while the lower pressure might be 40 lbs. Hence, the pump must be designed to furnish fluid at the highest pressure and also at a sufficient rate to move the tool rapidly during a large part of the time.

The present invention has for some of its objects the provision of a very economical method and means for accomplishing the operation desired and obviating the objections noted above. This is done by providing two sources of fluid one of which is a small capacity high pressure system and the other is a large capacity low pressure system.

The invention also contemplates novel means for controlling these systems and so co-relating them that they may be brought into operation whenever desired. When a low pressure fluid is sufficient the low pressure system is automatically connected up to furnish fluid at either a rapid or slow rate. Likewise the high pressure system is connected in when a greater force is required. In machine tools controls have previously been developed in connection with the fluid pressure operating means for limiting and determining the amount of the various movements and for reversing the direction at suitable points. Such devices often involved latch mechanisms which were subject to wear and inaccuracies. Positive stops have also been provided but with the objection that the range of movement of the tool was often limited thereby leaving an insufficient dis-

tance through which the working tool could be retracted.

The objects of this invention include means for accurately controlling the movements of the working spindle and also positive stop means capable of a very fine adjustment. This is all accomplished without changing the range of movement of the spindle. The accomplishment of these objects is partly due to the unique and simple manner in which applicant has taken a known type of indexing plate having a plurality of holes therein adapted to receive an adjustable handle and combined them with differential fluid piston means to provide a very simple and adjustable actuating means for a tool spindle.

Another object of this invention is the application of fluid pressure means to the actuation of the work spindle of a continuous rotary machine. Such means have been employed in various other machine tools but the unusual advantages obtained from applying them to a continuous rotary machine wherein the actuated parts are being continually revolved about a central column has not been recognized. Applicant has discovered a very practical method of accomplishing this adaptation of fluid pressure operating means. The novel application of the fluid means to the type of machine shown herein includes and has for its objects an arrangement whereby the machine is a complete power plant in itself. The only power applied is an inlet for an elastic fluid and a connection to a source of electric current.

The fluid means includes two pumps for circulating a hydraulic fluid at different pressures. These pumps are driven by an electric motor. Two reservoirs are provided for the liquid and gaseous fluids. All of these parts are mounted on the head in close proximity to the individual fluid motion for actuating the spindles. A simple, complete hydraulic actuating system is thus carried by the rotating head, practically independent of external pumps and such devices.

Another object of this invention resides in the simplified control means for the individual units. Applicant has eliminated a number of cams and links and latches heretofore found necessary by providing one central cam member. This cam member remains stationary. The fluid motors in revolving thereabout have members engaging with the cam for operating the various valve control means of each unit. Each unit receives exactly the same controlling effect and in a consistent and proper order.

A still further object is to be found in the valve means herein provided, and consisting of two valves which are caused to coordinate in a manner especially advantageous in the type of fluid means herein disclosed.

In addition to these valve means a valve is provided for varying the rate of flow of the high pressure liquid. Valves for a similar purpose have been previously designed but have not functioned with the accuracy and ease of the one disclosed herein which consists of a rotatable valve having a tapered opening thereby forming a better balanced valve and one freer from leaks and better adapted to the high pressures used than the ordinary shut-off valves heretofore used.

The objects also include the provision, in conjunction with the head having the various elements thereon which have been outlined of a supporting structure therefor designed to carry the unusual vertical and horizontal loads in a very efficient manner and at the same time provide a rigid supporting structure for the gearing for rotating the table and spindles. The elements are compactly and symmetrically arranged to result in a smooth well balanced machine tool.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawings.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, drawings depicting a preferred typical construction have been annexed as a part of this disclosure and, in such drawings, like characters of reference denote corresponding parts throughout all the views, of which:—

Figure 1 is a vertical view chiefly in section of a continuous rotary machine tool. Fig. 2 is a plan view thereof showing the symmetrical arrangement of the several units thereon. Fig. 3 is a plan view of one of the fluid pressure units adapted to operate the individual spindles. Fig. 4 is an elevation thereof and Fig. 5 is a detail view of the fluid pressure cylinder showing the rack means and other actuating members rigidly connected to the differential piston. Fig. 6 is a view taken from the right of Fig. 5 but with the addition thereto of control means for the admission of fluid to the cylinder. Fig. 7 is a detached view of the cam adapted to control the actuation of the control means. Fig. 8 is a detailed view of the valve control means for one of the units. Fig. 9 is a view of the same means looking from the right in Fig. 8 and showing the means for controlling the rate of flow of the fluid during the working stroke. Fig. 10 is a diagrammatic view of the fluid system with the valves positioned so as to give the tool its rapid forward traverse. Fig. 11 is a similar view but with the valve means positioned to give the slow working stroke and Fig. 12 shows the valves in the position occupied for quick return traverse.

The machine specifically disclosed herein is what may be generally termed a continuous rotary machine tool and the general features of which are a base 1 having rigid therewith

a vertical supporting column 2 held thereon by the bolts 2′ around which rotate the work table 3 and the supporting head 4. The work table and supporting head are rigidly connected to rotate together by means of a cylindrically shaped member 5.

The head 4 is adapted to carry the individual power units 6, each of which actuates a spindle 7 which is also rotatable and adapted to engage the stock which is placed on the work table 3. Six of these units symmetrically arranged on the head are shown but the number may be varied in accordance with the requirements of the work.

The normal operation of such a machine as is herein disclosed consists generally of a rotary motion of the head and work table which is continuous and during which rotation the spindles 7 carrying tools are moved vertically whereby the tools engage the work which is fastened by any suitable means on the table 3. The movements of the spindle are controlled by the mechanism to be described more in detail so that the tool performs its operation on the stock during one complete revolution of the machine.

The means for rotating the members described comprises a gear 8 mounted on a stub shaft 9 and adapted to have power applied thereto from any suitable source. The rotation of shaft 9 is transferred to shaft 10 by suitable gearing 11. Mounted on shaft 10 is the gear 12 for engagement with the gear 13 mounted on a third shaft. At 14 is shown a clutch for selectively connecting the shaft 15 to be rotated thereby. 16 and 17 are change gears for causing the rotation of the shaft 18 and through the worm gearing 19 the vertical stub shaft 20. The gears 16 and 17 constitute the ordinary change gears, that is, provide means for substituting gears of a different ratio whereby the speed of rotation of the head may be varied.

Keyed on the stub shaft 20 is the gear 21 engaging with the gear 22 which in turn engages with the large bull wheel 23 rigidly connected to the rotatable head and table.

The means for rotating the various individual spindles 7 comprises a bevel gear 25 mounted on the shaft 10 to be rotated thereby and meshing with the bevel gear 26 rigidly mounted on the central shaft 27 which has at its upper end the central gear 28 for imparting rotation to the individual spindles. Such rotation is accomplished by the change gearing comprising gears 29, 30 and 31. The gear 31 is mounted on a stub shaft 32 having at its lower end a small gear 33 for engagement with the gear 34 mounted on the spindle 7. The spindle 7 is splined in the gear 34 thereby permitting vertical reciprocation of the spindle without interrupting the rotation thereof by the gearing described. Reference to Fig. 2 shows that the gear 29 simultaneously engages with two gears 30 thus reducing the number of gears required.

Any other type of gearing or means of rotating the spindles 7 may be substituted for that shown.

As shown in Fig. 1 the vertical weight of the rotary members is carried by the thrust bearing 35. The central column 2 also has the large bearing surfaces 36 and 36′ to receive lateral forces and accurately position the heavy rotary structure. Bearings 37 and 38 are provided at the respective ends of the central vertical shaft 27.

Mounted on the central supporting column 2 in a horizontal manner is the stationary gear 39 held against rotation thereon by the pin 40. At 41 is shown a rotary shaft adapted to revolve around the fixed gear 39. The shaft 41 has rigidly mounted thereon gear 42 for engagement with the gear 39 and the gear 43 for engagement with the gear 44. The gears 39 and 44 are of the same size as also are the gears 42 and 43. Hence as the shaft 41 revolves around the gear 39 and receives rotation therefrom the speed of the gear 43 will be such as to maintain the speed of the gear 44 the same as that of 39 or in other words in the arrangement shown, the gear 44 will remain stationary.

The gear 44 is rigidly mounted on a shaft 45 having also mounted thereon the double cam 46 which by the arrangement shown is adapted to remain stationary as the head revolves for a purpose to be later disclosed.

A detailed description of the individual fluid actuating units designed to impart a vertical motion to the respective spindle will now be given. Since these units are all alike it is deemed sufficient to describe only one of these in detail. Referring more particularly to Figs. 3, 4 and 5, the fluid means comprises primarily a cylinder 48 having therein a differential piston 49 adapted to actuate the piston rod 50 having thereon rack teeth 51 for engagement with the rack gear 52 rigid with the shaft 53 mounted for rotation in the housing 54 and adapted to have a bearing therein. Fastened on the outer end of the stub shaft 53 is the index plate 55 having therein a series of holes 56.

Centrally mounted in the sleeve or shaft 53 is the shaft 57 and which has rigid therewith the gear 58 meshed with the rack 59 which is a part of the spindle 7. The outer end of the shaft 57 has fastened thereon by means of the key 60 a manually adjustable lever 61 having at its outer end a latch mechanism for permitting it to be adjusted with relation to the plate 55. Such means comprises a pin 62 adapted to be inserted in any one of the holes 56. The pin is normally urged into engagement with such holes by means of the compression spring 63 adapted at one end to bear against the shoulder 64 on the pin and at the other end against a washer 65 rigidly

connected to the cylindrical member 66. The pin 62 may be manually withdrawn from one of the holes 56 for adjustment of the lever 61 by means of the sleeve 67 adapted to slide over the sleeve 66. The pin 62 is fastened to the sleeve 66 by means of a locking pin 68.

Projecting from the main housing 69 is a bracket 70 adapted to serve as a stop. Rigid with the plate 55 is a projecting lug 71 adapted during the rotation of the plate 55 to engage with the stop 70 to thereby limit the stroke of the piston and likewise the tool spindle. Inserted through the stop 70 is the set screw 72 having the squared end 73 for adjustment of the screw 72 whereby the end 74 on the pin may be accurately positioned to limit the movement of the disk 55. Such means provides a finer adjustment to take care of the distance between the holes 56.

The means for adjusting and limiting the stroke above described constitute one of the important objects of this invention.

By the means described it is apparent that the rotation of the handle 67 relative to the plate 55 will move the spindle 7 without changing the position of the piston in the cylinder or in any way changing the length of the stroke thereof, nor of the working stroke of the spindle 7. Movement of the handle 67 to any one of the various holes 56 merely changes the relative position of the spindle 7 at either end of the stroke of the piston but does not change the range of the movement. Hence if the handle 67 were so moved around to engage with the hole 56′ the height of the spindle 7 in its retracted position would be greater than for the adjustment shown in the drawings but the range of movement of the spindle would be unchanged. A full clearance could therefore be obtained for any kind of an operation and at the same time the spindle will be stopped in any position desired. The only change in the length of this stroke would be that resulting from adjustment of the screw 73. It is desired to point out also the screw means 73 provides a very accurate and positive stop means for limiting the downward stroke of the spindle and is independent from any latch mechanisms or trips and such devices which become worn and inaccurate and unreliable.

Connected to the outer end of the rack 51 is a bracket 75 which in turn is connected to a reciprocatory member 76 having a sliding support in the boss 77 rigid with the base of the unit. The member 76 has supported thereon and rigid therewith a cam 78 adapted to engage with a roller 79 and and which roller is mounted on a slide member 80 mounted for reciprocation in the bracket 81. The cam 78 is adjustable along the member 76 by means of set screw 78′. The bar 80 carries at its outer end a latch 82 adapted to engage with one of the valve stems for a purpose to be later described. The latch 82 is normally held in an outer position by means of the compression spring 83.

The means for supplying fluid pressure to the various cylinders will now be described in detail: Such means as shown in Figs. 1 and 2 are also mounted on the head 4 for rotation therewith. This means comprises primarily a reservoir 84 and a tank 86. The stationary cam 46 hereinbefore referred to has extending from its upper surface a shaft 85 which like cam 46 remains stationary during the revolution of the units. At the upper end of the shaft 85 are shown connections for bringing in electrical current to be described more in detail.

Mounted on the tank 86 is an electric motor 87 adapted to drive the high pressure liquid pump 88 and the low pressure pump 89. The reservoir 84 is adapted to be maintained under a constant pressure by admission thereto of an elastic fluid which is admitted through the pipe 90 to the stationary cylindrical member 91. The cylindrical member 91 has surrounding it a rotary cylinder 92 through which is connected the pipe 93 for leading elastic fluid to the reservoir 84. An annular groove on the exterior of the stationary member 91 provides means for admitting such fluid to the pipe 93. If desired the high pressure pump may be provided with a pressure relief valve of any recognized type discharging through the line 88ª.

The elastic fluid admitted through 90 to the reservoir 84 may be any elastic fluid found convenient but ordinarily would be connected to the compressed air line such as is found in most manufacturing plants. The pressure of the fluid in the reservoir 84 is intended normally to be comparatively low.

The reservoir is connected directly to the end of the cylinder having the smaller piston face therein. Pressure is intermittently applied from the reservoir to the opposite end of the cylinder against the larger face of said piston whereby the piston is forced to the right and returned to the left by the constant pressure acting on the smaller piston face when the pressure is relieved from the left end of the cylinder. Additional means are shown for supplying high pressure fluid to the left end of the cylinder, such means comprising the high pressure pump 88 heretofore mentioned which takes fluid from the reservoir 84 through the pipe 95 and supplies said fluid through the pipe 96 which has branches leading to the various units. The fluid furnished by this pump is of a very much higher pressure than that supplied directly to the units from the reservoir 84 and for the purpose principally of carrying the tool through its working stroke after the tool has been brought into engagement therewith by the low pressure means referred to.

As shown in Fig. 1, the electric current is led to the motor 87 by the following means:

Concentric with the shaft 45 and extending from the upper surface of the cam 46 may be seen the shaft 85 which will be rigid with the cam 46 and remain stationary. At the upper end of the shaft 85 is a conduit 97 for bringing in electrical current which passes therethrough and is led out as shown at 98 to the stationary distributor plate 99. The rotary plate 100 has brushes thereon engaging with the distributor plate 99 and the current is led therethrough into the motor 87.

Referring to Figs. 4, 8 and 9, the valve control means comprises two main valves 101 and 102, the former constituting the admission valve and the latter the exhaust valve. The valve 101 has fixed on its stem three piston members so spaced as to form the annular grooves 103 and 104. The valve member 102 has two piston members thereon thereby forming the annular opening 105. The valve 101 has at its inner end that is to the left end as shown in Fig. 4, for example, a roller 106 pivoted thereon to engage with the cam surface on the upper part of the cam 46. In a similar manner the roller 107 attached to valve 102 engages a cam surface on the lower side of the cam 46. These valves are normally urged to the right against the cam surfaces by means of the tension springs 108. The valve 101 has projecting from its outer or right end a latch member 109 adapted at certain times to be engaged by the slide 82 hereinbefore referred to.

The fluid connections comprise a pipe 111 which leads from the reservoir 84 and by means of the connection 112 is in constant communication with the right end of the cylinder 48 whereby it acts constantly on the smaller piston face therein. This pipe 111 has a branch 113 leading to the valve 101. For certain positions of the valve to be described later, the fluid flows therethrough, through the valve 101, pipe 114, and pipe 115 into the left end of the power cylinder. The pipe 96 leads from the high pressure pump 88. Liquid therefrom flows through the main valve 101 and a control valve 117 to be described more in detail; then through pipe 118 and into the pipe 115 whereby high pressure fluid is furnished to the left end of the cylinder at a certain time depending upon the valve position. Exhaust from the left end of the cylinder takes place through the pipe 119 leading from the pipe 115 into the valve 102 through the annular groove 105 and out the fluid pipe 120 to the tank or sump 86.

As best shown in Fig. 9 the control valve 117 comprises a primarily hollow rotary valve member 121 located therein which has a triangular shaped opening 122 communicating with the hollow center thereof. Through the upper part of the valve casing are shown a series of holes 123 which lead to the chamber 124 then on through the pipe 118 to the pipe 115. The inner end of the valve communicates at certain times with the annular groove 103 whereby high pressure fluid passes through the control valve up to the left end of the fluid motor.

This valve is especially adapted to the high pressure fluids which are often used in a machine of this type. The valve member 121, inasmuch as fluid is led into the center thereof, is practically balanced except for the triangular opening 121. The pressure tends to move the valve to the left as shown in Fig. 9 where it acts against the packing 126 held in place by the adjustable nut 127. Manual adjustment of the valve is provided by means of the handle 128, the rotation of the valve brings the triangular opening into communication with one or more of the series of holes 123 thereby providing a very accurate control. Owing to the balanced feature it is very easy to adjust and is practically free from leaks. The valve is comparatively simple to manufacture, the holes 123 are drilled from the upper part of the valve through the holes 129 which thereafter are closed by means of the screw plugs 130. These screw plugs can be quickly removed for cleaning the valve.

The stationary cam carrying member 46 is shown more in detail in Fig. 7 which is a view looking down thereon. The path of the roller thereon comprises a high cam portion 131 for setting the valve 101 to the position shown in Fig. 10, a cut-in portion 132 and the longer cam surface 133. The under surface of the cam plate 46 is provided with cam surfaces 134 and 135 similar to the cam surfaces 132 and 133 on the upper surface. The cam surfaces on the lower side as well as the corresponding positions of the roller 107 are shown in Figs. 7 and 10 to 12 by dotted lines.

The operation of the fluid pressure actuating means can be more clearly understood by referring to the diagrammatic Figs. 10, 11 and 12 which illustrate the three major positions of the valves. In Fig. 10 the cylinder shown therein with its accompanying valve control means has just been rotated into the position whereby cam surface 131 has moved the valve 101 into the farthest position to the left at which time the latch 82, which has been held back by the projection 109 of the valve 101, is released and jumps out in the path of the projection 109 holding the valve in the position shown in Fig. 10. In this position low pressure fluid flows from the reservoir 84 through the annular groove 104 in the upper valve and through pipes 114 and 115 into the left end of the power cylinder. Owing to the differential surfaces of the piston exposed therein the piston is caused to move rapidly to the right which is the rapid traverse down to bring the tool into engagement with the work. At a proper time the

cam surface 78 connected to move with the piston engages the roller 79 to move the slide 80 releasing the projecting end 109 of the valve 101 whereby the valve is urged by spring 108 to the right. Since the cam 78 is adjustable along the member 76 this operation can take place whenever desired. Cam 131 at this time has moved out of engagement with the roller 106.

The valves are now so positioned that the fluid from the high pressure pump is led through the valve through the annular groove 103 into the left end of the cylinder for moving the piston on its working stroke, the speed of this stroke being controlled by means of the regulating valve 117 positioned in the pipe line 118 as shown in the main figures but for reasons of making the diagrams more simple not shown in the diagrammatic view. As shown in Fig. 11 the connection for leading low pressure fluid to the left end of the cylinder is now closed off by means of the middle piston on the stem of the valve 101.

Fig. 12 illustrates the position for the quick traverse return. In Figs. 10 and 11 as may be seen the valve 102 has occupied a position to the left being held in such a position by the cam surface 135. However as shown in Fig. 12 this valve is now released whereby it is moved to the right permitting communication between the pipe 119 leading from the left end of the power cylinder and the pipe 120 whereby exhaust takes place into the sump 86. The piston is now moving to the left and carrying with it the cam 78 for moving to the position shown in Fig. 10.

As most clearly shown in the diagrammatic views a system has been provided for furnishing a fluid to a power piston at different rates and different pressures during the same stroke. This is one of the most important features of this invention and results in an efficient and economical means of operating a machine element such as heretofore has not been thought possible. The low pressure pump 89 is designed to return the fluid from the sump to the reservoir 84 at a rapid rate but at a relatively low pressure, such pressure being roughly 40 lbs. per square inch. The pump 89 may be any desirable type for furnishing a large volume of fluid such as an ordinary centrifugal pump. The pump 88 must be a pump capable of supplying liquid at a very high pressure. However, the volume of fluid furnished by this pump is exceedingly small as compared with the low pressure pump 89. The high pressure pump as has been shown only furnishes fluid during the working stroke which in normal operation is but a very small portion of the total movement of the piston. Also the working stroke would be relatively slow as compared with the quick traverse forward and quick return traverse. The high pressure pump may be of any known type such as a gear pump designed to furnish high pressures.

As may be evident if it were not for the two systems that is the low and high pressures shown herein a pump or some other means would have to be supplied for furnishing fluid at the maximum pressure as well as the maximum rate. The high pressure fluid would often be 1,000 lbs. per square inch or even higher in certain types of machines. Hence it would be an extremely uneconomical arrangement to employ a pump designed to furnish both the maximum rate and maximum pressure of fluid.

The fluid means disclosed herein is to be understood as not limited to the actuation of the particular device shown but is capable of application to any machine element which it may be desired to move in a manner similar to the spindle or the drill as shown herein.

The advantages and saving which might be accomplished in any single machine are multiplied several times in a machine of the type shown herein. The fluid required to be furnished for a single unit machine would probably be several gallons per minute. Since the major portion of this is furnished at a comparatively low pressure, an enormous saving is accomplished even in the actuation of a single unit, this being multiplied six-fold in the continuous rotary machine shown herein.

The whole fluid system is mounted in a very compact and a substantial manner on the upper part of the head, such comprising a complete hydraulic system practically independent of exterior pumps and power means except for the connection to the air pressure line or other elastic fluid and the lead-in for the electrical current.

The construction of the operating parts of the power devices for translating the spindles is very much simplified. Many latches, and levers for actuating the valves and change gearing and other machine elements heretofore found necessary are eliminated by the provision of the fixed cam plate 46 with which the two valves are engaged to be operated thereby. Since each unit is controlled by the same cam means, each unit must necessarily operate in a manner similar to the rest and the various series of movements take place in proper order and in accurate relation to each other.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefor, such adaptations should

be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims:—

Having thus revealed this invention, I claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:—

1. Fluid pressure means for generating mechanical power comprising piston means having two exposed faces of unequal area; means for continuously applying a fluid at constant low pressure to the piston face having the smaller area; means for intermittently supplying a low pressure fluid to the piston face having the larger area; and other means for supplying a high pressure fluid to the larger piston face.

2. Hydraulic actuating means comprising cylinder and piston means having two exposed piston faces of unequal area; a reservoir having a liquid therein connected to act constantly on the piston face having the smaller area; means for applying a low pressure elastic fluid to act constantly on the liquid in said reservoir; means for admitting liquid from said reservoir to act on said piston face of larger area whereby said piston is caused to move against the pressure on the smaller piston face; a source of high pressure liquid; and means for admitting liquid therefrom to act on said piston face of larger area.

3. Hydraulic actuating means comprising cylinder and piston means; a reservoir; a liquid therein; a source of low pressure elastic fluid connected to act constantly on the liquid in said reservoir; means for rapidly admitting low pressure liquid from said reservoir to actuate said pistons in either direction at a rapid rate; a source of high pressure liquid; means engaged by mechanism movable in timed relation with the movement of the piston means for admitting fluid from said last named source to actuate said piston means for a portion of its stroke; and pump means for delivering the exhaust fluid from said piston means to said reservoir.

4. Hydraulic actuating means comprising a power cylinder; piston means therein; a reservoir connected to said cylinder; a liquid in said reservoir and connections to the cylinder; a source of low pressure elastic fluid connected to act constantly on the liquid in said reservoir; means for rapidly admitting liquid from said reservoir to said piston means whereby said piston means are operated at a rapid rate; a high pressure hydraulic pump connected to said reservoir and to said cylinder; control means engaged by mechanism movable in timed relation with said piston means for admitting liquid to said cylinder from said high pressure pump; and means for adjusting said control means whereby said high pressure liquid may be admitted at any predetermined position of said piston.

5. Hydraulic actuating means comprising cylinder and piston means; a reservoir connected to said cylinder and having an hydraulic fluid therein; means for maintaining said fluid at a constant low pressure; means for admitting fluid therefrom for actuating said piston means; a high pressure hydraulic pump directly connected to said reservoir and to said cylinder for supplying a flow of high pressure fluid to feed said piston means at a higher pressure than said reservoir; a sump; means for exhausting fluid from said cylinder thereto; and means for returning fluid from said sump to said reservoir.

6. Fluid pressure actuating means comprising a cylinder and piston means having two exposed faces of unequal area; a reservoir containing a fluid under low pressure adapted to act constantly on the piston face having the smaller area; means for intermittently admitting fluid from said reservoir to said piston face having the larger area whereby said piston is caused to reciprocate; a high pressure pump and control means therefor connected to supply fluid from said reservoir to act on said larger piston face whereby said piston may be caused to move with greater force; means for exhausting the fluid acting on the piston face of larger area and means for returning said exhaust back to said reservoir.

7. Fluid actuating means comprising a power cylinder; piston means therein; a source of high pressure fluid; a source of low pressure fluid; a valve for separately admitting said fluids to said cylinder; an exhaust valve; a cam disk having cams thereon; means connected to said valves for engagement with said cams; means for causing relative movement between the cams and the engaging members whereby the fluids are admitted and exhausted from said cylinder in a predetermined order.

8. Fluid actuating means comprising a power cylinder; a piston therein; a member adapted to be reciprocated thereby; a source of high pressure fluid; a source of low pressure fluid; valve means for separately admitting said fluids to said cylinder; means for positioning said valve whereby one of said fluids is admitted; latch mechanisms for releasably holding the valve in such position; and means connected to said reciprocatory member for tripping said latch mechanism whereby the other fluid is admitted to said cylinder.

9. Hydraulic actuating means combining a motor; mechanism operated thereby; a source of low pressure hydraulic fluid; a source of high pressure hydraulic fluid; valve means for controlling the admission of said fluids to said motor; impositive means for urging said valve means in one direction; a

continuous cam co-acting with said valve means; means for imparting relative motion between said cam and valve means whereby said valve means is moved thereby in opposition to said impositive means; latch means for holding said valve in a predetermined position wherein one of said fluids is admitted; and means operated in timed relation with said motor for tripping said latch means to permit said valve means to move to a position for admitting the other of said fluids.

10. Hydraulic power means comprising a motor; a source of low pressure hydraulic fluid; a source of high pressure hydraulic fluid; a single valve means for selectively admitting said fluids; a separate exhaust valve means; and means operated by mechanism movable in timed relation with said motor and positively engaged at predetermined points in its travel for operating said admission and exhaust valves.

11. A machine tool combining a hydraulic motor including piston means therein; a source of low pressure hydraulic fluid; a pump for supplying high pressure hydraulic fluid; a control valve; means for operating said valve to admit said low pressure fluid to said motor during a portion of a stroke; means for subsequently admitting during the same uni-directional movement said high pressure fluid, said last named means being adjustable to be positively operative at a preselected point in the movement of said piston; an exhaust valve; and means operated by the movement of said piston to control the operation of said exhaust valve.

12. Hydraulic fluid pressure operating means comprising cylinder and piston means; a high pressure low volume liquid pump for supplying hydraulic fluid thereto; a reservoir containing fluid under relatively low pressure for supplying hydraulic fluid to said piston means; valve means for controlling the admission of said low and high pressure hydraulic fluids respectively and for successive periods during a uni-directional movement of said piston means; means positively engaged by mechanism movable with said piston means to operate said control valve to terminate the admission of said low pressure hydraulic fluid and cause the admission of said high pressure hydraulic fluid; and a low pressure high volume pump for returning fluid from said piston means to said reservoir.

13. A machine tool combining a hydraulic motor having a reciprocatory piston therein; means for supplying to said motor at a rapid rate a hydraulic fluid under a relatively low pressure during a predetermined period; means for supplying to said motor a hydraulic fluid under a higher pressure for a predetermined period, both of said supplying means being operative during a uni-directional movement of said piston; valve means for controlling said respective periods; cam means operative in timed relation with the cycle of said machine tool for governing said valve means; and releasable latch means operative by mechanism movable with said piston for further governing said valve means to initiate the admission of said high pressure fluid in accordance with a predetermined position of said piston.

14. Hydraulic actuating means comprising a power cylinder; piston means therein; a source of low pressure fluid; a pump for supplying a flow of high pressure fluid; valve means for selectively admitting said high and low pressure fluids during a uni-directional movement of said piston means; impositive means for urging said valve means in one direction; cam means operative in timed relation with said machine for moving said valve means against the pressure of said impositive means and for subsequenty releasing the valve means; latch means for releasably holding said valve means; and means movable with said piston means for releasing said valve means.

In witness whereof, I have hereunto subscribed my name.

ADOLPH L. DE LEEUW.