April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 1

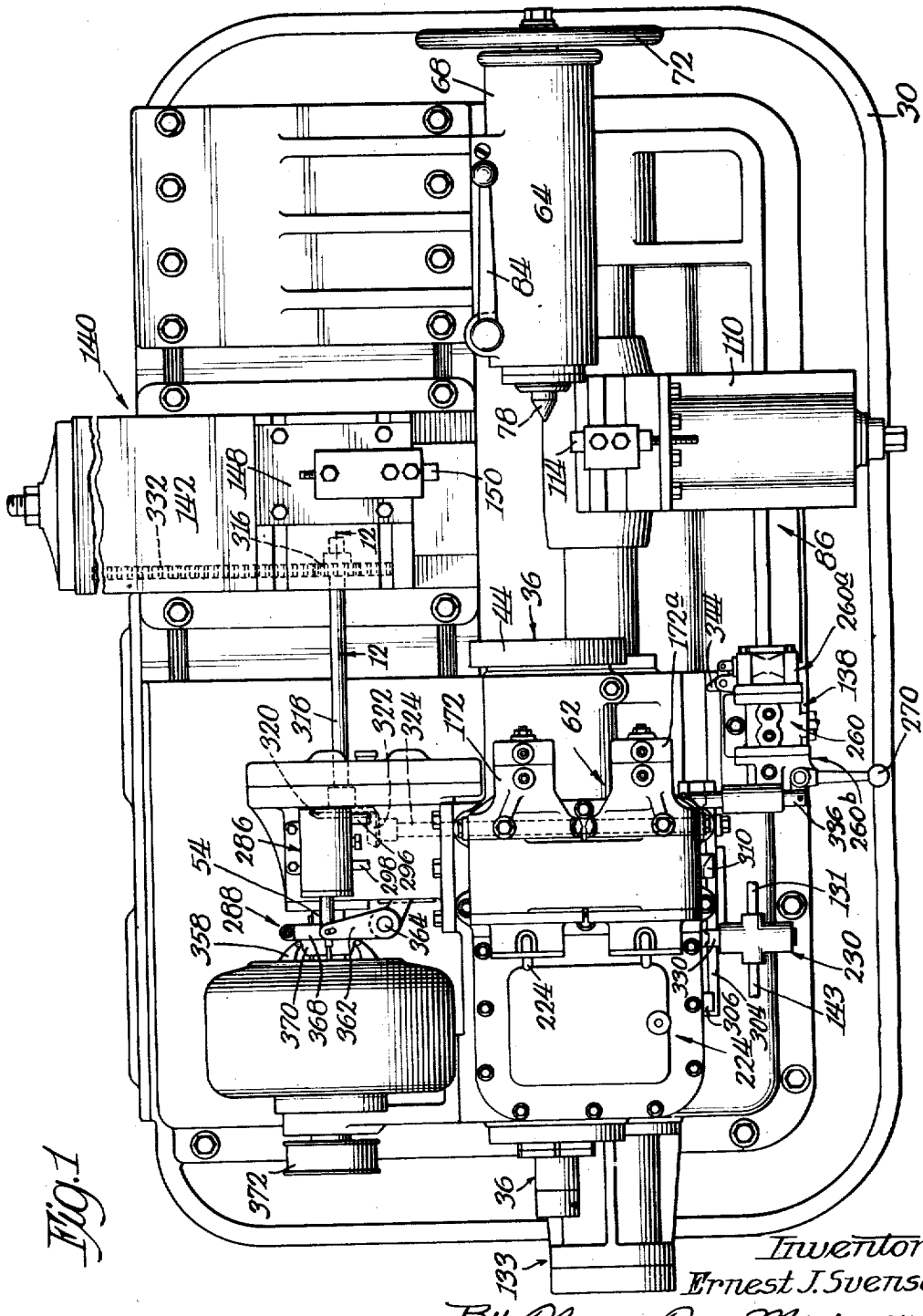


Fig. 1

Inventor
Ernest J. Svenson
By Clisseur, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 2

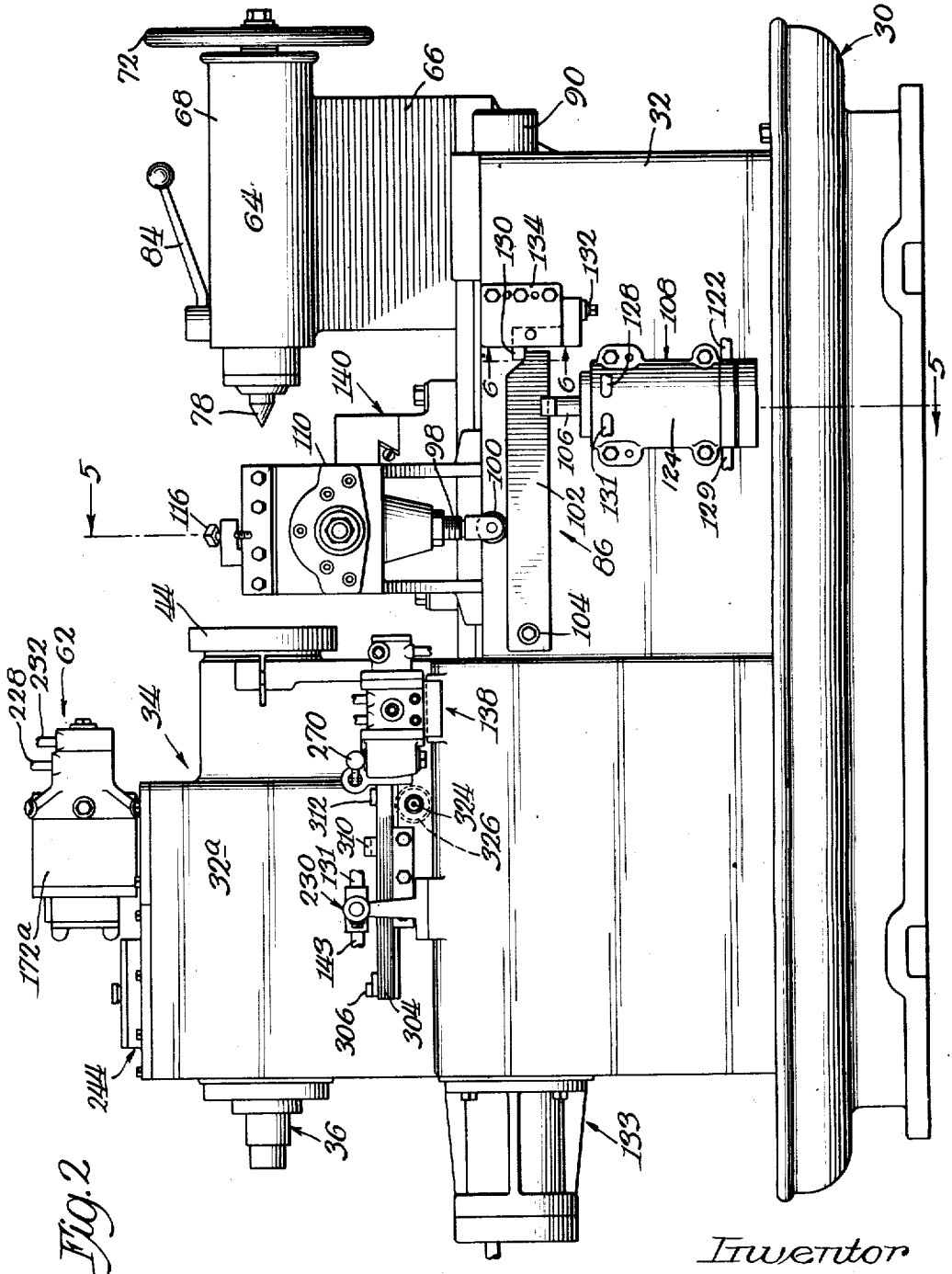


Fig. 2

Inventor
Ernest J. Svenson
By Clarence, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 3

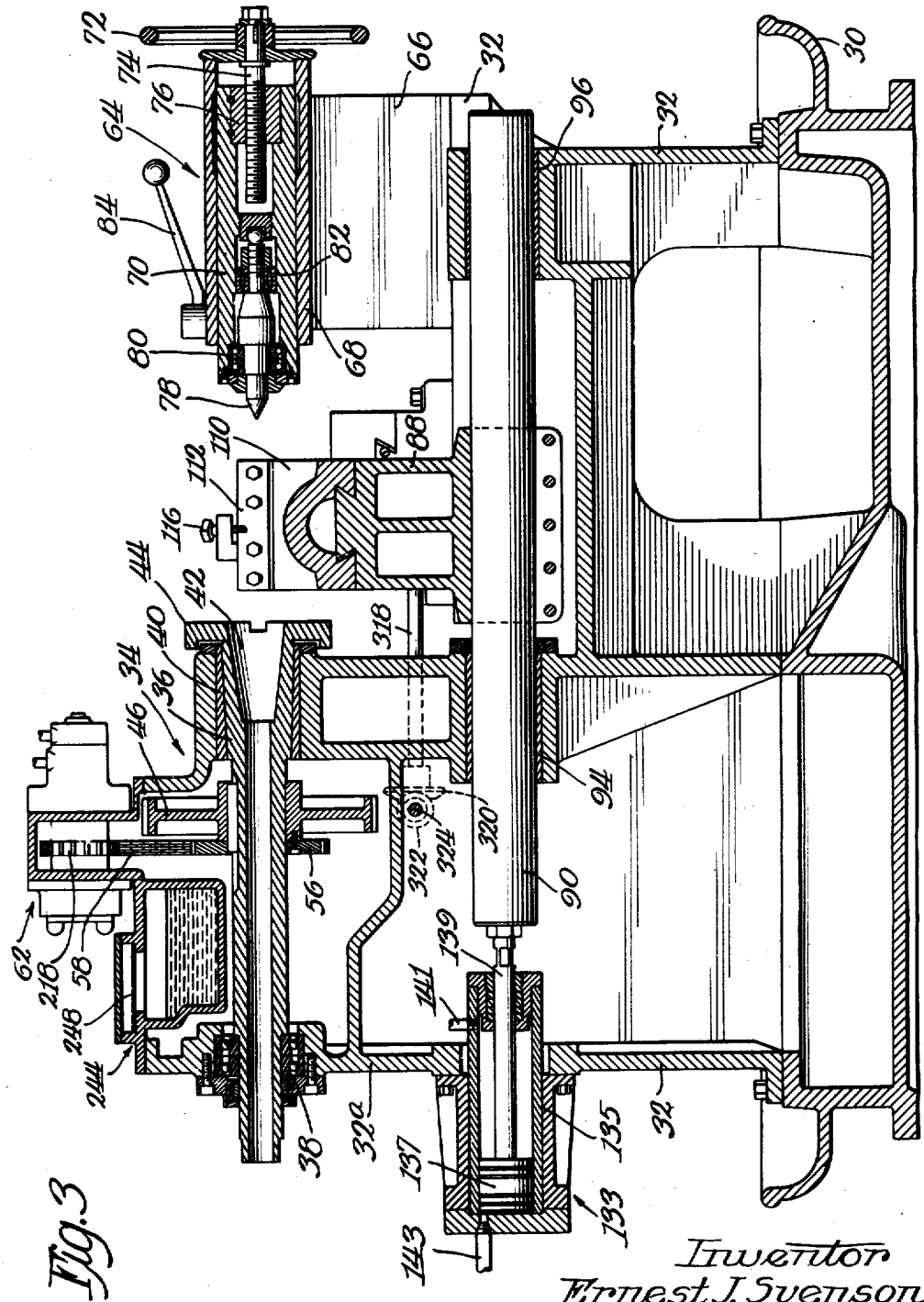


Fig. 3

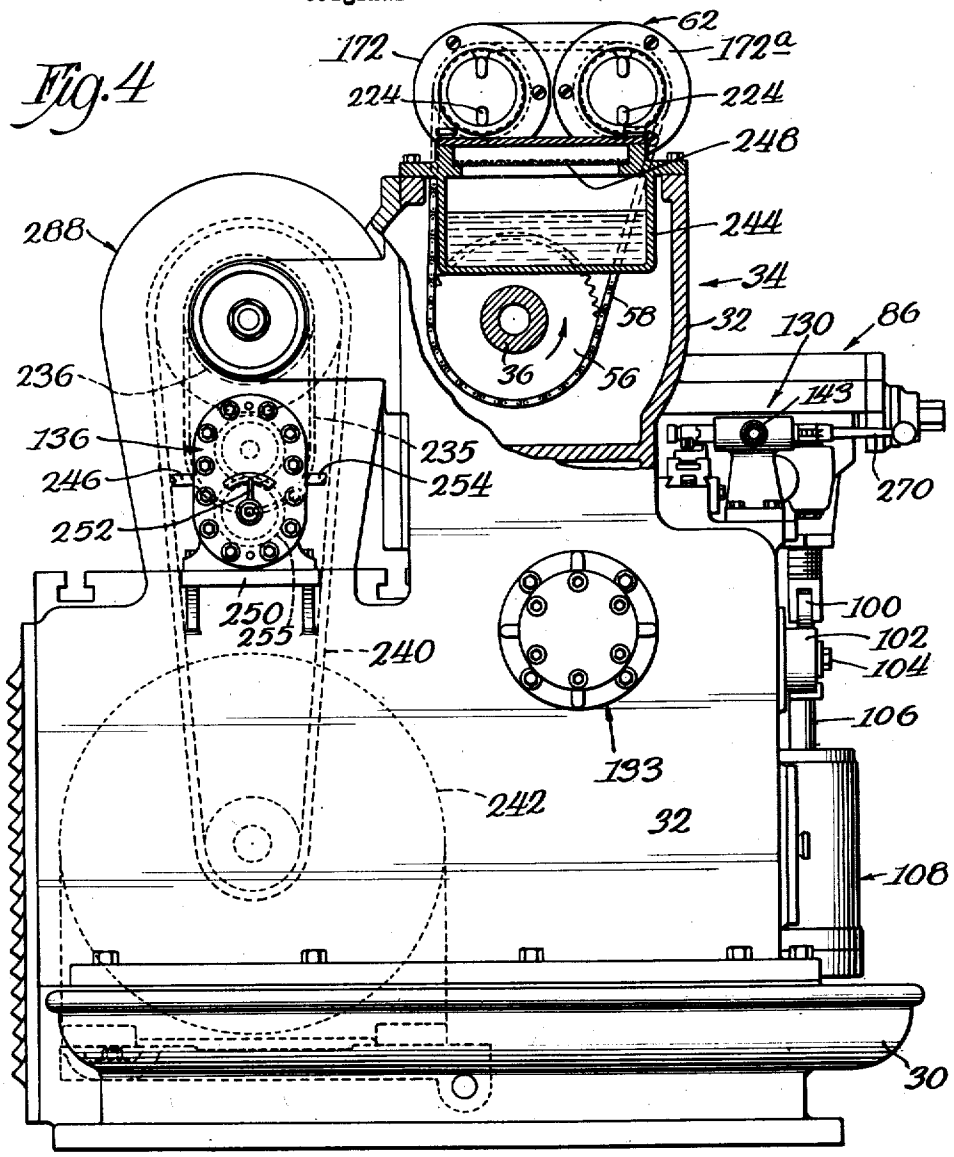
Inventor
Ernest J. Svenson
By Cleaver, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 4

Fig. 4



Inventor:
Ernest J. Svenson
By Cleaves, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 5

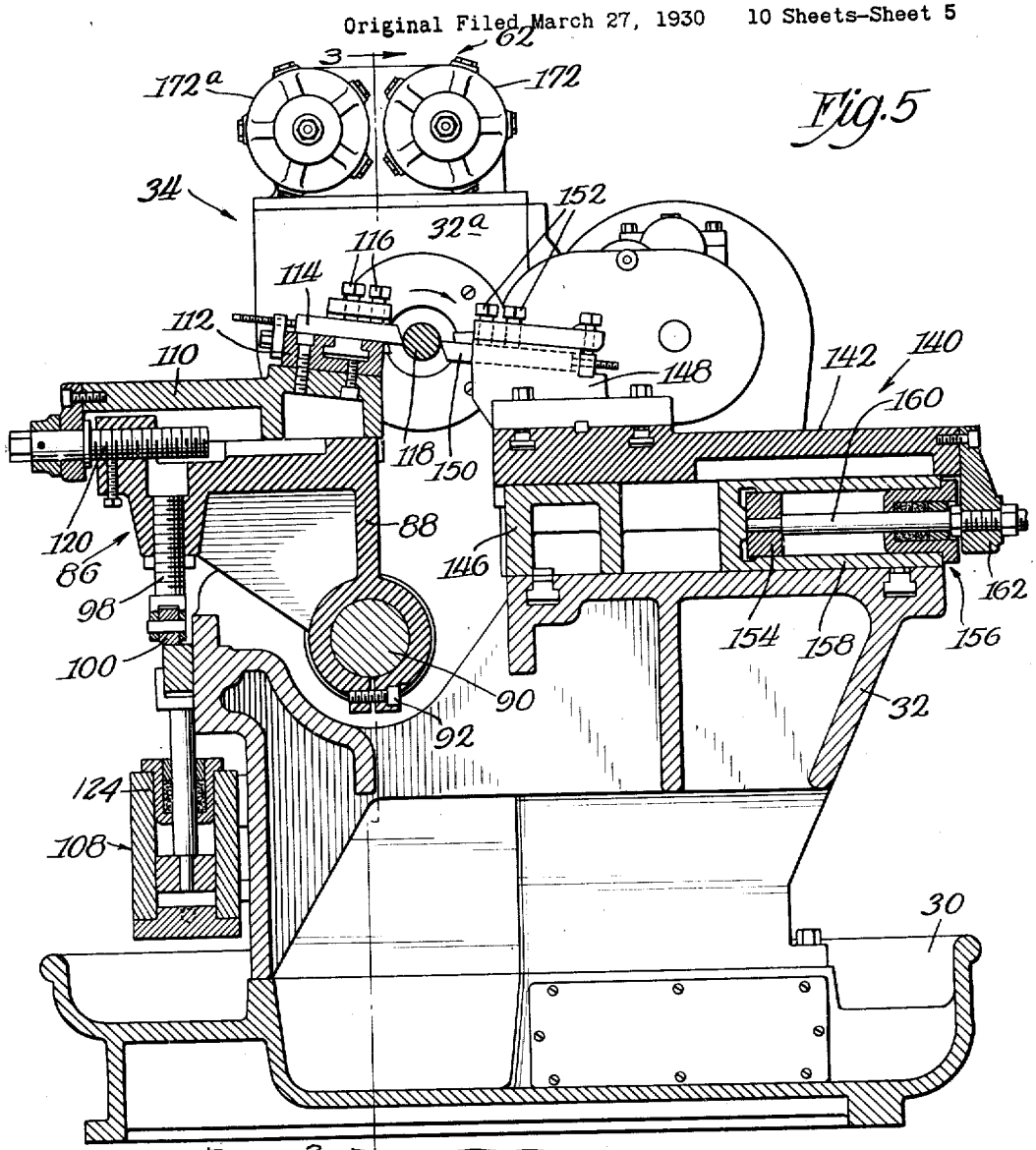


Fig.5

Fig.6

Fig.7

Inventor
Ernest J. Svenson
By Cleaver, Cox & Moore
Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 6

Fig. 8

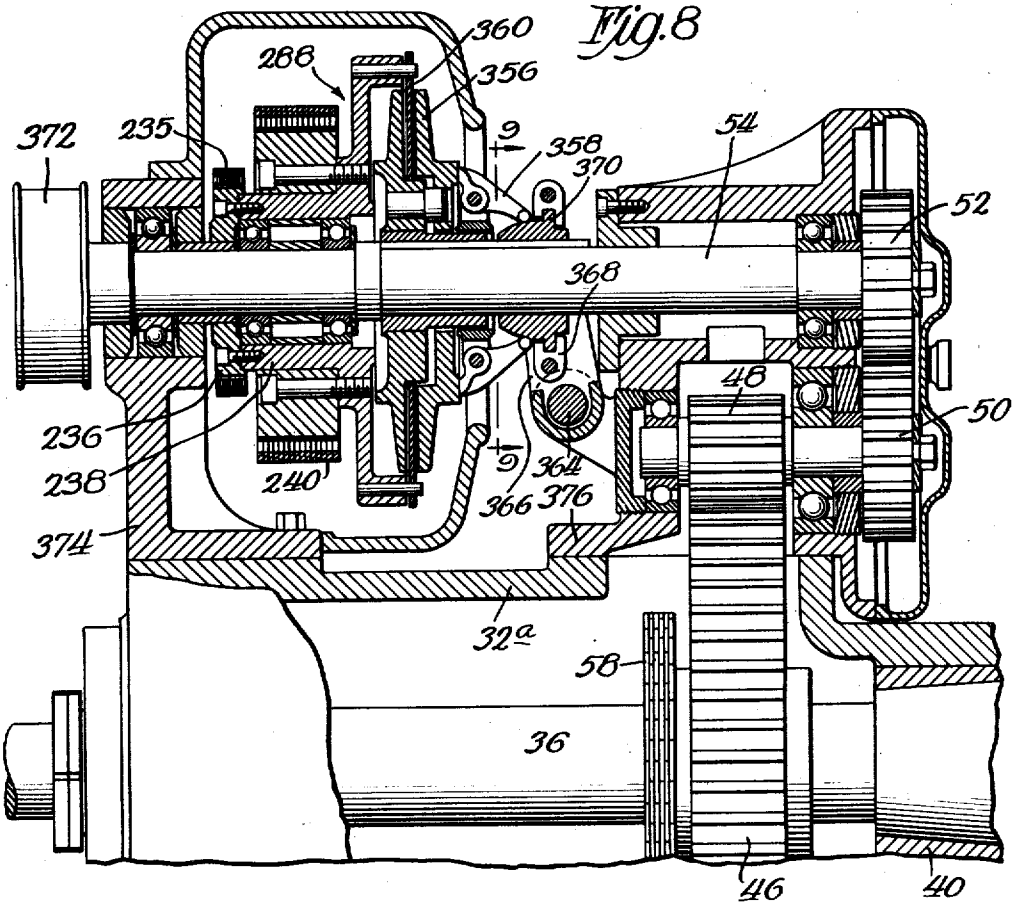


Fig. 9

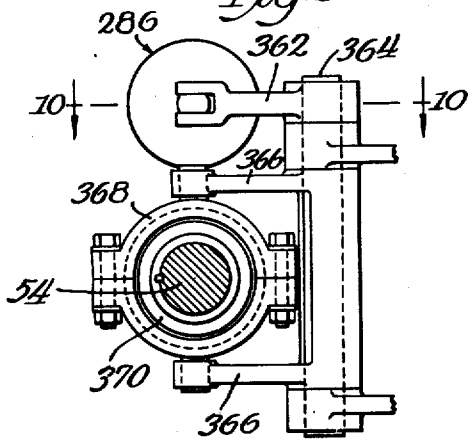
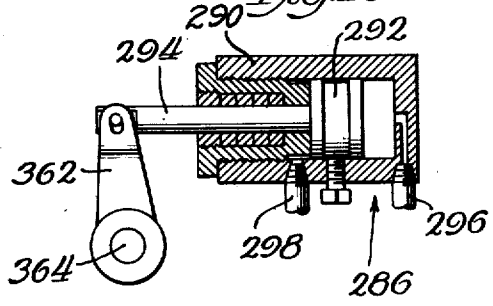


Fig. 10



Inventor
Ernest J. Svenson
By Oliver, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

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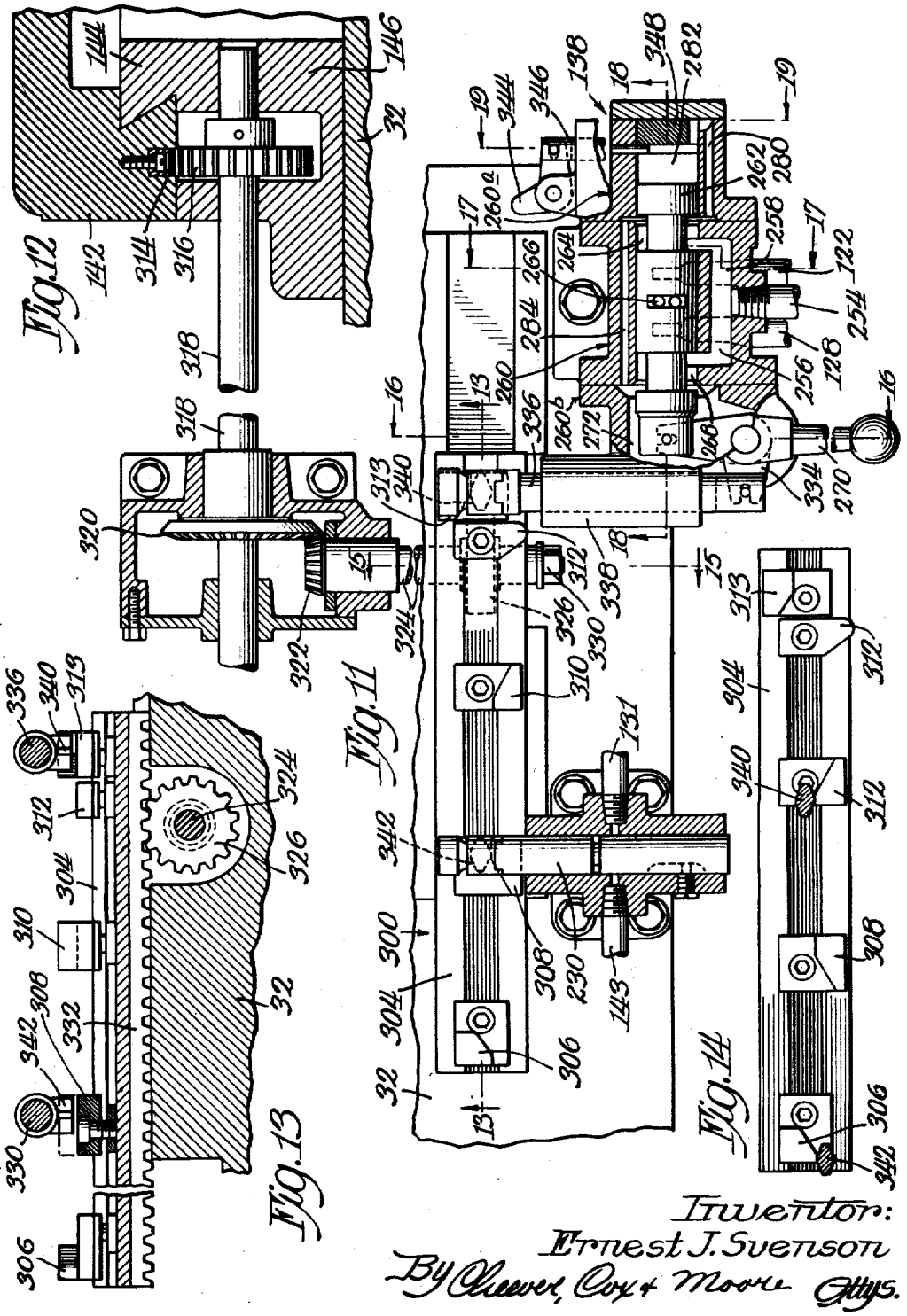
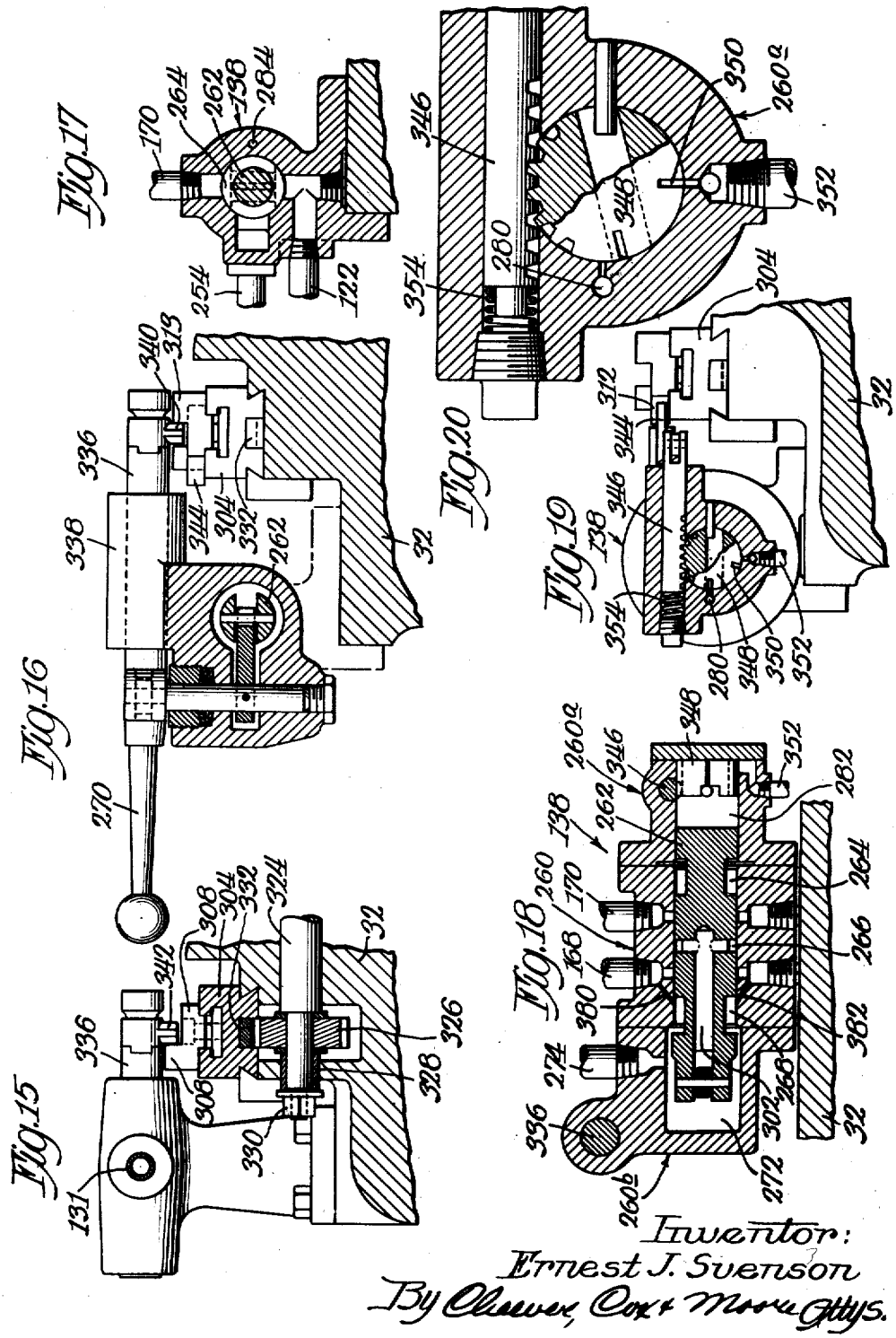


Inventor:
Ernest J. Svenson
By Cleaver, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 8



April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Original Filed March 27, 1930 10 Sheets-Sheet 9

Fig. 21

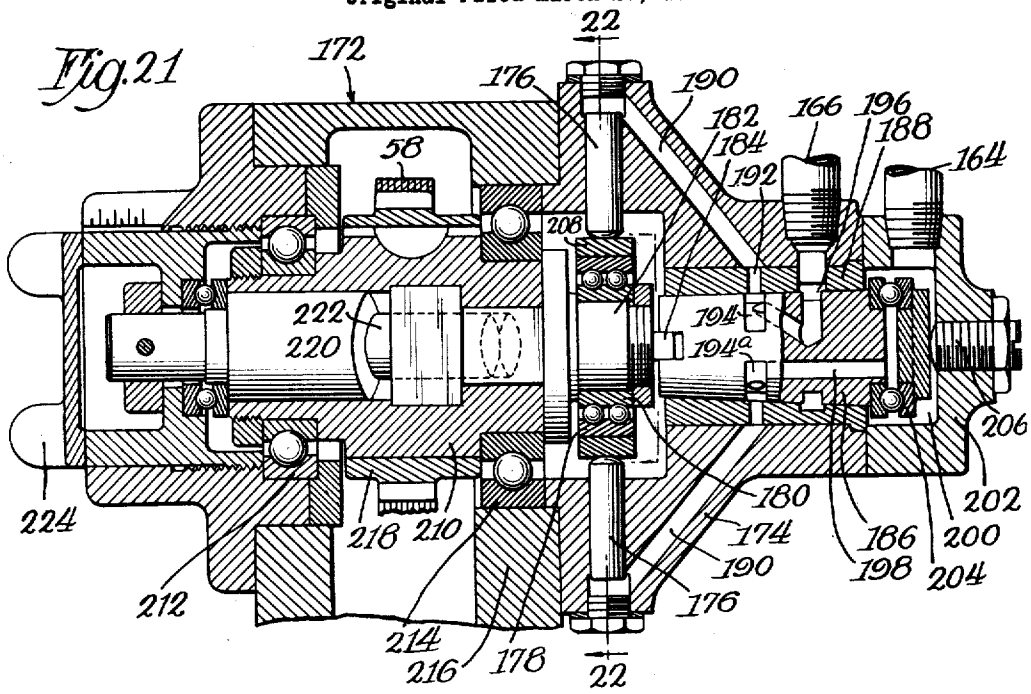


Fig. 22

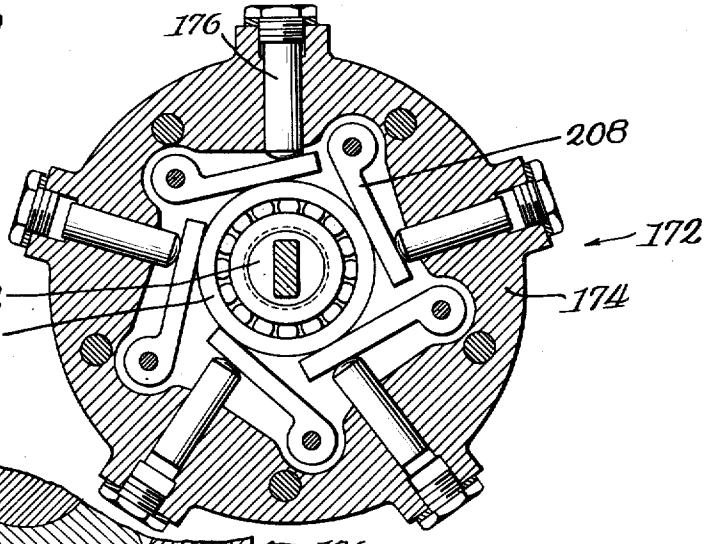
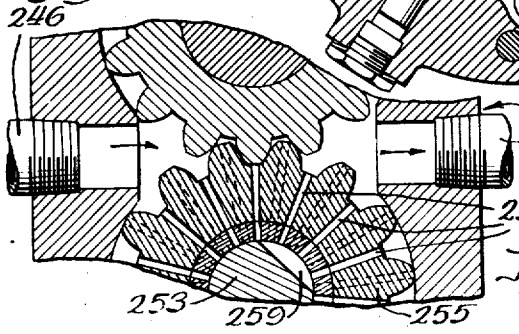


Fig. 26



Inventor:
Ernest J. Svenson
By Cleaver, Cox & Moore Attys.

April 27, 1937. E. J. SVENSON 2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

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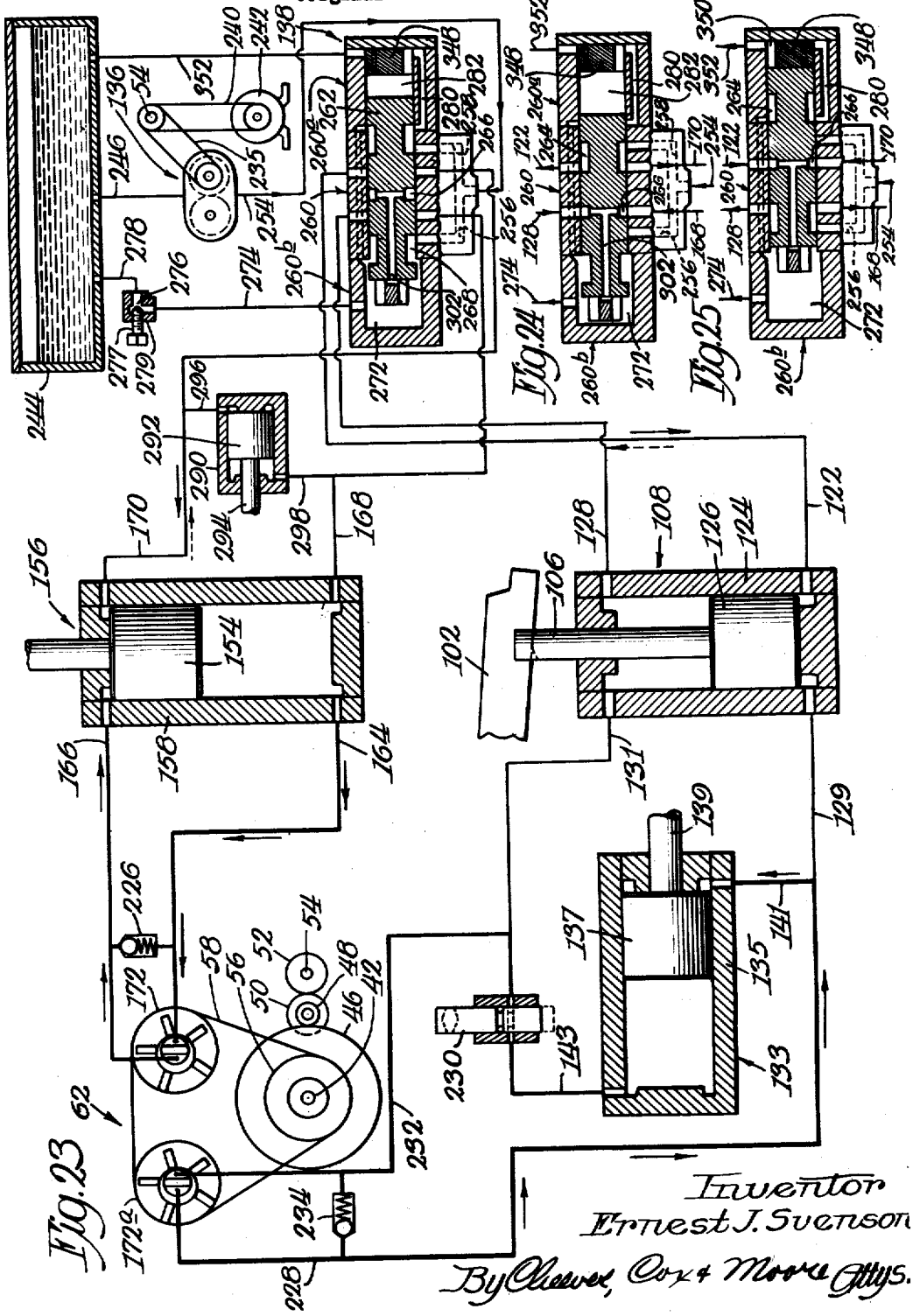

Fig. 23

Fig. 24

Fig. 25

Inventor
Ernest J. Svenson
By Clarence, Cox & Moore Attys.

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UNITED STATES PATENT OFFICE

2,078,695

AUTOMATIC LATHE AND FLUID CIRCUIT

Ernest J. Svenson, Rockford, Ill.

Application March 27, 1930, Serial No. 439,306
Renewed February 3, 1937

219 Claims. (Cl. 82—2)

My invention relates generally to automatically actuated material working apparatus, and particularly to apparatus such as automatic lathes equipped with a fluid or hydraulic system of control.

My present invention relates in a general way to apparatus or machines of the type shown in my co-pending application, Serial No. 391,130, filed September 9, 1929. My present invention, however, contemplates the provision of improved structural features, by means of which cutting operations and the like may be performed upon a work piece in a more expeditious manner. To bring to pass these desirable results, I propose to provide a lathe or metal cutting machine, in which the constituent number of parts is reduced greatly, the structural arrangement is unusually rigid, and the combination of machine elements is exceedingly simple. This simple yet durable structural arrangement will enable my device to be operated with a minimum amount of skill and effort on the part of an attendant, and it is also my purpose to so arrange the cooperating machine elements so as to render the control thereof foolproof.

One of the important objects of my present invention is to provide, in combination with movable machine elements, such as tool carriages and the like, a system of fluid control which is not only exceedingly simple in arrangement and economical to manufacture, but which is also exceedingly efficient and positive in controlling the movement of these machine elements. To this end I propose to provide what I shall hereinafter refer to as a closed, valveless, fluid circuit, in combination with the machine elements, such as tool carriages and the like, which are to be shifted. This novel and practical valveless fluid circuit is not only adapted for use in connection with the control of machine tools, but has a very broad application in various fields wherein it is desirable to hydraulically effect the shifting of parts.

Another object of my invention is to provide hydraulic means, in combination with a machine spindle, whereby a governed amount of movement of tool carriages and the like may be obtained per revolution of said spindle. In other words, I propose to correlate the movement of the spindle with the movement of the tool carriages, and in order to present a practical, workable arrangement, I contemplate directly coupling with the spindle a plunger pump of a new and practical design which is free from fluid leakage or slippage.

Still another object of my present invention is to provide, in combination with elements to be moved, such as machine tool carriages and the like, a fluid system of control having a closed high pressure circuit and an associated low pressure circuit, said high pressure circuit being employed for feeding purposes, and the low pressure circuit for rapid traverse movements.

More specifically, my invention contemplates the provision of the above mentioned associated high and low pressure fluid circuits which are so arranged that each of said circuits is operable independently of the other.

A further object is to eliminate the necessity of employing complicated fluid control valves and the like which have not only been very expensive, but which have also had a decided tendency by reason of fluid leakage, etc., to materially reduce the propelling effectiveness of the fluid pumping mechanism forming a part of the circuit which normally includes such control valves. To remedy this condition I propose to provide a new and improved single control for governing the movement of a plurality of machine tool carriages and the like, which may be conveniently manipulated without disturbing or affecting in any way the propelling effectiveness of the pump included within the feeding circuit.

A still further object of my invention is to provide, in combination with machines as above set forth, a continuously operable low pressure fluid propelling mechanism, such as a gear pump, and a high pressure fluid propelling mechanism, such as a plunger pump, which is directly coupled with the machine spindle, the propelling effectiveness of one of said pumps being totally independent of the propelling effectiveness of the other.

Another object is to overcome the disadvantages and difficulties resulting from the use of clutch and other transmission arrangements which have been employed in connection with machine tools and the like.

These and numerous other objects and advantages will be more apparent from the following detailed description when considered in connection with the accompanying drawings, wherein—

Figure 1 is a plan view of an automatic lathe which is constructed and arranged in accordance with the teachings of my present invention;

Figure 2 is a front elevational view of the device shown in Figure 1;

Figure 3 is a vertical sectional view taken longitudinally of the machine substantially along the line 3—3 of Figure 5;

Figure 4 is an end elevational view as viewed from the left of Figure 2, a portion of the upper structure thereof being broken away to more clearly disclose the position of the upper fluid reservoir;

Figure 5 is a vertical transverse sectional view taken substantially along the line 5—5 of Figure 2;

Figure 6 is an enlarged fragmentary sectional view taken transversely of the guide bar along the line 6—6 of Figure 2;

Figure 7 is a view of the device shown in Figure 6, said view being taken substantially along the line 7—7 of Figure 6;

Figure 8 is an enlarged plan sectional view of the main drive shaft and its associated driving elements;

Figure 9 is a detail sectional view of the clutch control mechanism, said view being taken substantially along the line 9—9 of Figure 8;

Figure 10 is a horizontal sectional view of the clutch control cylinder and piston, said view being taken substantially along the line 10—10 of Figure 9;

Figure 11 is an enlarged plan view of the dog supporting slide, the mechanical mechanism controlled by the rear tool carriage for causing the actuation of said slide, the main control or reversing valve, and the valve for controlling the longitudinal movement of the front carriage, said valves being shown in section in order to disclose more clearly the structural characteristics thereof;

Figure 12 is a vertical sectional view taken transversely of the rear tool carriage substantially along the line 12—12 of Figure 1;

Figure 13 is a fragmentary vertical sectional view of the slide and associated parts, said view being taken along the line 13—13 of Figure 11;

Figure 14 is a plan view of the slide, said slide being shown in its advanced position as distinguished from the neutral position shown in Figure 11;

Figure 15 is a fragmentary transverse vertical sectional view taken substantially along the line 15—15 of Figure 11;

Figure 16 is a similar transverse sectional view taken along the line 16—16 of Figure 11;

Figure 17 is also a transverse sectional view taken along the line 17—17 of Figure 11;

Figure 18 is a central longitudinal sectional view of the reversing valve taken substantially along the line 18—18 of Figure 11;

Figure 19 is a transverse sectional view of the right end of the reversing valve taken along the line 19—19 of Figure 11;

Figure 20 is a sectional view similar to Figure 19, disclosing the relative positions occupied by the valve ports when said valve has been rotated so as to effect the discharge of fluid from one extremity of the valve chamber for reversing purposes;

Figure 21 is a central sectional view of one of the high pressure plunger pumps disclosing the manner in which fluid is received and discharged by said pump;

Figure 22 is a transverse vertical sectional view of said pump taken substantially along the line 22—22 of Figure 21;

Figure 23 is a diagrammatic representation of the fluid circuit for controlling the movement of the tool carriages, the control or reversing valve being shown in its neutral position;

Figure 24 discloses the reversing or control valve when said valve has been shifted to its forward or starting position;

Figure 25 discloses said valve in its reverse position; and

Figure 26 is a fragmentary vertical sectional view of the continuously operable gear pump.

Referring now to the drawings more in detail wherein like numerals have been employed to designate similar parts throughout the various figures, it will be observed that for the purpose of illustrating one practical application of my invention I have shown the same as applied to an automatic lathe. This lathe comprises a suitable base 30 which serves to support a machine frame 32, Figures 1 to 5 inclusive. In order to set forth more clearly the structural arrangement of my improved material working machine or lathe, I shall describe successively various general units which together constitute the machine in its entirety.

Head stock

The head stock is designated generally by the numeral 34, Figures 1 to 5 inclusive, and a casing portion 32a of the head stock forms an integral upwardly extending section of the main frame 32, as clearly shown in Figures 2 and 3. Mounted within the head stock housing 32a is a spindle 36, Figure 3, the reduced or outward extremity of the spindle being mounted within a suitable anti-friction bearing 38, and the inner work supporting extremity of the spindle being mounted within a tapered bearing 40. The spindle is provided with a tapered opening 42 and is also flanged to present a face plate 44. For a more detailed description of the specific arrangement of the spindle bearings, reference is made to my above mentioned co-pending application, Serial No. 391,130. Rotation is imparted to the spindle 36 by means of a main drive gear 46, which is keyed to the spindle and is driven through the agency of a pinion 48, Figure 8, and a pair of change gears 50 and 52. The gear 52 is connected directly to a main drive shaft 54, and the mechanism for controlling the operation of this drive shaft will be described later. Mounted upon the spindle 36 and rotatable with the gear 46 is a roller chain sprocket 56 which is connected by means of a suitable chain 58 to gears of a pair of fluid propelling mechanisms or pumps 62, to be described later.

Tail stock

The tail stock is indicated generally by the numeral 64, Figures 1 to 3 inclusive, and includes an upright frame section 66 which is slidably mounted upon ways provided within the main frame 32. The upper portion of the frame 66 presents a casing 68, and slidably mounted within the casing 66 is a sleeve 70. Longitudinal movement of the sleeve 70 within the casing 68 is controlled by means of a hand wheel 72 which is mounted upon a screw 74 extending within a screw block 76, Figure 3. The opposite extremity of the sleeve 70 supports a center piece 78 which is rotatably mounted within the sleeve by means of suitable anti-friction bearings 80 and 82. The specific structural arrangement of this center piece 78 and mountings therefor form a part of the invention disclosed in my above mentioned co-pending application. A suitable lever 84 is employed to secure the sleeve 70 in its various positions of longitudinal adjustment within the casing 68.

Front carriage

The front carriage of the machine is designated generally by the numeral 86, Figures 2 and 5. This carriage structure includes a tiltable base or frame 88 which is clamped upon a horizontally disposed cylindrical member or bar 90 by means of screws 92. The cylindrical bar 90 is mounted in suitable bearings 94 and 96, Figure 3, disposed on opposite sides of the front carriage frame 88. The bar 90 is capable of longitudinal and rotative movement within said bearings. The frame 88 extends upwardly and forwardly of the bar 90, as clearly shown in Figure 5, the outer or forward portion of the frame being supported by a depending screw 98, the lower extremity of which carries a roller 100. This roller rests upon a guide bar 102 which is pivotally mounted at one end by means of a pin 104, Figure 2, the opposite extremity of said bar resting upon the upper end of a piston rod 106 which forms a part of a fluid actuated mechanism 108. Slidably mounted in guides provided along the upper portion of the frame 88 is a slide 110 which provides a mounting for a tool holder 112. This tool holder 112 carries a suitable metal cutting tool 114, Figure 5, which is secured in position by means of clamping screws 116. The slide 110 is adjustable toward and away from the axis of a supported work piece 118 by means of a screw 120. The upward movement of the guide bar 102 about its pivot 104 serves to swing the front carriage 86 about the axis of the bar 90, and thereby carry the tool 114 into proper cutting relation with respect to the work piece. For a more detailed description of the structural arrangement of the front carriage frame 88 and its associated parts, reference is made to my above mentioned co-pending application.

The upward movement of the piston rod 106 is occasioned in response to the admission of a suitable fluid, such as oil, through a pipe line 122, Figures 2 and 23, which communicates with the chamber of a cylinder 124 mounted on the front side of the machine frame 32. This fluid acts upwardly against a piston 126 at the lower end of the piston rod 106, and fluid from the opposite side of the piston 126 is discharged through a pipe line 128. The upward movement of the bar 102 is interrupted by a stop 130, Figures 2, 6, and 7. The underside of this stop 130 is formed with an inclined surface, which is adapted to be engaged by a complementary inclined surface at the free extremity of the bar 102. The inclination of these surfaces is such as to cause the bar 102 to be urged toward the front surface of the machine frame 32, and thereby prevent said bar from experiencing vibrations during the operation of the machine. The stop 130 is vertically adjustable by means of a screw 132 which is supported by a bracket 134. Thus, the degreee of upward movement of the bar 102 may be determined by adjusting the position of the stop 130 by means of the screw 132. The pipe lines 122 and 128 are connected to a constantly driven fluid propelling mechanism 136, Figures 4 and 23, through the medium of a control valve 138, said fluid propelling mechanism and control valve to be described later in more detail.

Pipe lines 129 and 131 are also connected at opposite extremities of the cylinder 124, and these pipe lines establish communication between the cylinder 124 and a fluid actuated mechanism 133, Figures 3 and 23, which is employed to impart longitudinal movement to the cylinder bar 90. This mechanism 133 includes a cylinder 135 in which a piston 137 is reciprocable, and this piston 137 is connected to one extremity of the cylindrical bar 90 in any suitable manner, such as by means of a piston rod 139. A pipe line 141 is connected to one extremity of the cylinder 135, and a pipe line 143 is connected to the opposite end of said cylinder. The mechanism 133 is operated in timed relation with respect to the operation of the mechanism 108, as will later more fully appear.

It is to be noted that the work piece and spindle rotate in the direction indicated by the arrow in Figures 4 and 5.

Rear carriage

The rear carriage of my apparatus is denoted generally by the numeral 140, Figures 1 and 5. This carriage includes a slide 142 mounted on guides 144, Figure 12, of a guide frame 146. This guide frame 146 is supported by the main machine frame 32, as clearly shown in Figures 5 and 12. Mounted upon the slide 142 is a tool holder 148 which is adapted to carry a cutting tool 150, said tool being secured in position by means of suitable clamping screws 152. Movement of the rear tool holder and slide toward and away from the work piece 118 is occasioned in response to the movement experienced by a piston 154, which forms a part of the fluid actuated means which I have designated generally by the numeral 156, Figures 5 and 23. This mechanism 156 includes a cylinder 158, and the piston 154 which is reciprocable within said cylinder is connected to a piston rod 160. The outer extremity of this piston rod is adjustably connected to a bracket arm 162 depending from and secured to the outer extremity of the slide 142. Pipe lines 164 and 166 shown diagrammatically in Figure 23 connect the opposite extremities of the cylinder 158 with the high pressure pumping mechanism 62, while pipe lines 168 and 170 connect the opposite extremities of said cylinder with the main control valve 138, which is connected with the low pressure pumping mechanism 136. Movement of the piston 154 inwardly causes the tool 150 to be carried into operative association with the work piece for the purpose of making a facing cut across the work as distinguished from the peripheral cutting action of the tool 114. The fluid actuated mechanisms 108, 133, and 156 are operated in timed relation in a manner to be described later.

Fluid supply for feeding purposes

The mechanism which I have previously designated by the numeral 62, includes a pair of plunger pumps 172 and 172*a*, Figures 1, 2, 4, and 21 to 23 inclusive. These plunger pumps are conveniently mounted upon the upper portion of the head stock frame 32*a* immediately above the spindle 36. Each of these pumps 172 and 172*a* includes a stationary cylinder block or housing 174, Figures 21 and 22, in which a plurality of radial pistons or plungers 176 are reciprocably mounted. Movement is imparted to these pistons by a ring 178 which is supported by an antifriction bearing 180 carried by a rotary driving member 182. This rotary driving member 182 is coupled by means of a tongue and groove connection 184 with a tapered or frusto-conical rotary valve 186 which is mounted within a complementary tapered bearing 188. The upper end of each of the chambers, in which the pistons 176 are reciprocable, is connected by means of

a passageway 190 with companion ports 192 provided in the tapered bearing member 188, Figure 21. This rotary valve 186 is provided with peripheral ports 194 and 194a which are adapted to register successively with the radially positioned passageways 190. The peripheral port 194 communicates with an annular port 196 provided in the bearing member 188, while the peripheral port 194a communicates by means of a longitudinal passageway 198 with a chamber 200, which is enclosed by means of a casing 202. A suitable anti-friction thrust bearing 204 is provided to take up end thrust experienced by the rotary valve, and an abutment screw 206 serves to adjustably position the valve within its bearing or seat. The chamber 200 communicates with the pipe line 164, and the annular port or chamber 196 communicates with the pipe line 166.

When the driving ring 178 is positioned coaxially with respect to the rotary valve 186, no movement will be imparted to the pistons 176, but when said ring 178 is eccentrically positioned with respect to the axis of the rotary valve, and the driving member 182 is revolved, said pistons will be reciprocated during each complete revolution of said driving member. Pivoted fingers 208 are interposed between the adjustable driving ring 178 and the pistons 176 so as to eliminate side thrust during the movement of said pistons. Rotation is imparted to the driving member 182, or what might properly be called a coupling driving member, through the agency of a journal or a sleeve 210. This sleeve 210 is supported by anti-friction bearings 212 and 214 within an annular casing 216, said sleeve being keyed to a roller chain sprocket or gear 218. The driving or coupler member 182 is driven by the sleeve 210 and is laterally shiftable within said sleeve through the agency of a longitudinal shiftable member 220. This member 220 is provided with an extension 222 which is angularly disposed with respect to the axis of rotation of the journal or sleeve 210, and by longitudinally shifting the member 220 as by means of the micrometer adjusting ring 224, the driving member and its supported driving ring 178 may be sensitively adjusted.

While I have in a separate application, Serial No. 430,867, filed February 24, 1930, now matured into Patent No. 1,989,117, described and claimed specifically the plunger pump or fluid propelling means shown in Figures 21 and 22, I have also described in some detail the structural arrangement of this pump in the present application in order that the high pressure closed fluid circuit, about to be described, may be understood more readily. This will be appreciated more easily when it is understood that the plunger pump just described is of such a nature as to positively preclude fluid slippage or leakage. Heretofore, in using conventional types of fluid plunger pumps, the leakage or slippage of fluid through the rotary valve fittings, as well as other of the pump fittings, has been so great as to positively prevent the use of such devices in a closed or valveless fluid circuit. The gear 218 is directly connected with the gear 56 on the spindle 36 by means of the roller chain 58 previously referred to. A single roller chain may be employed for propelling both of the plunger pumps 172 and 172a, as clearly shown in Figures 4 and 23.

Rear carriage feeding circuit

From the foregoing it will be apparent that when rotation is imparted to the work supporting spindle 36, the plunger pump 172 will simultaneously be activated. This will result in the displacement of fluid at high pressure by the pistons 76 through the ports in the rotary valve and into the pipe line 166, and this fluid at high pressure will be directed against the rear carriage piston 154. Fluid from the portion of the chamber in front of the piston 154 will be discharged through the pipe line 164 to the intake side of the pump 172, or, in other words, into the chamber 200, Figure 21. This fluid will be directed through the longitudinal passageway 198 in the rotary valve and thence into association with those pistons which are experiencing their inward stroke. That is to say, fluid from the advancing end of the rear carriage piston is employed to charge the pump 172, and fluid under high pressure from the discharge side of the pump is being employed to advance the rear carriage piston. To relieve against the development of excessive pressures within the closed circuit, I provide a suitable pressure relief mechanism 226, as clearly shown in Figure 23.

The fact that I use a fluid propelling mechanism or pump which is free from the usual fluid slippage or by-passing, enables me to employ what may be termed literally a closed or valveless fluid circuit. By employing a closed fluid circuit, in combination with a non-leakable fluid pump which is directly connected with a rotary portion of the machine, such as the work supporting spindle, I am able to obtain a governed amount of movement of a shiftable machine element, such as a tool supporting carriage for each revolution of the spindle. In other words, the movement of the tool carriage is correlated with the rotary movement of the work supporting spindle. This presents a very practical and extremely simple arrangement which has a very broad application in the machine tool industry, as well as in other fields.

Front carriage feeding circuit

The pump 172a is identical in construction and operating characteristics to the pump 172 already described, and is directly connected to the spindle 36 by means of the roller chain 58. A pipe line 228 is connected with the high pressure or discharge side of the pump 172a, Figure 23, and connects with the pipe 141 which, in turn, is connected to one end of the cylinder 135 of the fluid operated mechanism 133. The intake side of the pump 172a is connected with the opposite extremity of the cylinder 135 through the agency of the pipe 143, a cut-off valve 230, and a pipe line 232. When the valve 230 occupies the position shown in Figure 23 communication between the pipe lines 143 and 232 is broken, but when said valve is shifted in a manner later to be described, to a forward position, as indicated by the dot and dash lines in Figure 23, communication is established between the mechanism 133 and the intake side of the pump 172a. Thus it will be apparent that when the valve 230 occupies its open position and rotation is experienced by the spindle 36, the piston 137 and consequently the front tool carriage 86 will be moved to the left, Figures 3 and 23. A conventional pressure relief mechanism 234 is connected between the pipe lines 228 and 232 to relieve against the building up of excessive pressures in the system. It will be seen that the feeding circuit, which includes the mechanism 133 and the pump 172a, is a closed circuit, and that the longitudinal movement of the front carriage is

correlated with the rotative movement of the spindle. That is to say, for each revolution of the spindle, the front tool carriage will be shifted to the left a predetermined distance, Figures 3 and 23.

Low pressure fluid supply

From the description given thus far it will be understood that forward movement of the rear tool carriage **140** will take place when the spindle **36** is rotated. I shall now proceed to describe the parts comprising a fluid circuit which includes the continuously driven low pressure mechanism or pump **136**. This pump **136** is mounted at one end to the rear of the machine, as clearly shown in Figure 4. This pump is driven by a roller chain **235** connected with a sprocket **236** which is mounted upon the main drive shaft **54**, Figure 8, and which is connected to a continuously rotatable clutch member **238**. This clutch member is directly connected through ehe agency of the roller chain **240** to any suitable driving means, such as an electric motor **242**, Figure 4.

This pump **136** may be a gear pump, and I prefer to employ the type of gear pump disclosed in my co-pending application, Serial No. 430,868, filed February 24, 1930, now matured into Patent No. 1,912,737. The intake side of the gear pump **136** is connected with a fluid or oil reservoir **244**, Figures 4 and 23, by means of a suitable pipe line **246**. By having this reservoir **244** positioned above the pump **136**, oil is continuously supplied to the pump under slight pressure, and thus air is prevented from entering the fluid circuit. In order to prevent the introduction of foreign matter within the oil of the reservoir **244**, I provide a strainer or screen **248**, as shown in Figure 4. The pump **136** is mounted upon a bracket **250** and may be shifted on said bracket in order to make adjustments with respect to the roller chain **235**. Variation in displacement of the gear pump **136** may be obtained by merely adjusting the position of a lever **252**. This lever serves to operate a central valve **253**, Figure 26, within the lower gear **255** of the gear pump. This gear **255** is provided with a plurality of radial passages **257** which are adapted to communicate with a valve port **259** to prevent oil from becoming heated. The valve port **259** may also be adjusted so as to vary the fluid displacement, and this arrangement has a very practical application in connection with automatic lathes and machines of like nature. For a more detailed description of this gear pump **136**, reference is made again to my above mentioned co-pending application.

Low pressure control for rear carriage

The discharge side of the gear pump **136** is connected to a pipe **254** which, in turn, has a common connection with branch lines **256** and **258**, as clearly shown in Figure 23. These branch lines are connected to the control or reversing valve **138**. This valve **138**, Figures 15 to 20 inclusive and Figures 23 to 25 inclusive includes a central casing or housing **260**, which is supported on the forward side of the machine frame **32**. The housing **260** is capped at one end by a casing section **260***a*, and at its opposite end by a casing section **260***b*. A cylindrical valve member **262** is longitudinally shiftable within the casing **260** and is provided with a series of valve ports **264**, **266**, and **268**. The valve member **262** may be manually shifted by means of a single control lever **270**, Figures 1, 2, and 11, one extremity of said valve having a pivotal connection with the inner extremity of the control lever or handle **270**. In Figures 11, 18, and 23 the valve member **262** occupies what will be referred to hereinafter as its neutral position. In this position the branch line **256**, Figure 23, communicates with the annular port **268**, and this annular port, as shown in Figure 11, in that instant communicates with a chamber section **272** in the casing section **260***b*. This chamber section **272** is connected by a return pipe line **274**, Fig. 23, an adjustable restricted orifice **276**, and a pipe line **278** with the reservoir **244**. Thus fluid is circulated through the pump **136**, the valve **138**, and the restricted orifice **276**. Fluid from the branch line **258** passes into the annular valve port **264** and from this port is conducted through a longitudinal passageway **280** in the casing **260***a* to a chamber section **282** which is oppositely disposed from the chamber section **272**. A passageway **284** connects the port **264** with the chamber **272**, as clearly shown in Figure 11. In this manner the fluid pressure is balanced at each extremity of the valve member.

By imparting a movement to the control handle or lever **270** to the right, Figure 11, the valve member **262** will be moved to the left so as to occupy the position shown in Figure 24. This position will be referred to hereinafter as the forward position. Fluid is now directed from the branch line **258** through the annular valve port **264** and thence through the pipe line **170** which connects with one extremity of the rear carriage cylinder **158**. In this connection it is to be noted that the pipe line **168** is connected also with the valve **138**. Consider, for example, that the machine spindle **36** is at rest and the valve member **262** is shifted to the forward position shown in Figure 24. Forward movement in response to the pressure of the fluid directed into the cylinder **158** from the pipe line **170** will cause the rear carriage piston **154** to experience a rapid forward movement. This movement will be referred to hereinafter as the rapid traverse movement which is required to bring the rear carriage tool **150** into operative association with the work piece. Attention is directed to a fluid actuated mechanism **286**, Figures 1, 9, 10 and 23, which is operatively connected with a clutch mechanism **288**, Figures 8 and 9, later to be described. This fluid operated mechanism **286** includes a cylinder **290** and a piston **292** reciprocably mounted therein. This piston **292** is connected as by means of a piston rod **294** with means for operating the above mentioned clutch mechanism **288**. One extremity of the cylinder **290** is connected to the pipe line **170** by means of a line **296**, and the opposite extremity of said cylinder is connected to the pipe line **168** by a pipe line **298**. Upon shifting the valve member **262** to its forward position as above set forth, the piston **292** of the mechanism **286** is shifted to the left, Figures 10 and 23, so as to actuate the clutch mechanism **288** and thereby cause the main drive shaft **54** to be rotated. Rotation of this drive shaft obviously causes rotation of the work supporting spindle **36**. In response to the actuation of a mechanically shifted slide mechanism **300**, Figures 11 and 14, later to be described, the valve **262** is returned to its neutral position shown in Figure 23, at a predetermined interval. This predetermined interval is determined by the distance the tool **150** must be moved in order to bring said tool into operative association with the work. In other words, the tool is subjected to a rapid traverse movement by the low pressure fluid so as to bring said tool

quickly into operative relation with the work piece. With the valve 262 shifted to its neutral position, the low pressure fluid circuit including the pipe lines 168 and 170 is rendered functionally inoperative, and the high pressure fluid circuit which includes the plunger pump 172 and the pipe lines 164 and 166 is rendered functionally operative. That is, fluid under high pressure is directed against the rear carriage piston 154 to effect the feeding of the tool 150 across the face of the work piece. Thus it will be apparent that the low and high pressure fluid circuits are operable independently of each other.

When the feeding stroke of the rear carriage piston 154 has been completed, the valve 262 may be shifted manually or automatically to its reverse position shown in Figure 25. When the valve is shifted to this position, fluid from the gear pump 136 is directed through the branch line 256 into the annular valve port 268 and thence through the pipe line 168 in the direction indicated by the dotted arrows, Figure 23. Reversing the direction of flow of the fluid in the pipe line 168 causes the piston 292 within the clutch control mechanism 286 to be shifted to the right, Figure 23, thereby disconnecting the driving motor from the main drive shaft 54, and consequently arresting the rotation of the work supporting spindle 36. The rear carriage piston 154 is rapidly urged in a reverse direction, and fluid from the pipe line 170 is returned to the valve port 266, Figure 25. Fluid from this port 266 is directed through a longitudinal passageway 302 which communicates with the valve chamber 272. Thus the fluid is returned from the chamber section 272 through the pipe line 274, the restricted orifice 276 to the reservoir 244. It should be understood that the adjustable restricted orifice 276 supplants the usual spring operated relief valve, and has been found more practical and efficiently operable than any fluid relief devices which have been in common use heretofore. The size of the orifice 276 is adjusted by means of a suitable valve member 277 which is mounted within a casing 279. The size of the orifice 276 may be adjusted to maintain a predetermined desired low pressure in the circuit for preventing any air from entering the circuit, and I have found that undue heating of the fluid which has been experienced heretofore in using spring valves and the like is eliminated when my simple adjustable orifice arrangement is employed.

When the rear carriage piston 154 reaches the limit of its rearward stroke, the valve 262 may be manually or automatically shifted to its neutral position, and the cycle of operation just described may be repeated. It is to be noted that the spindle 36 is at rest during the rearward movement of the tool 150, thereby permitting an operator to remove the completed work piece and insert another work piece. The time element in operating machines of the type described is an important factor and, as stated above, my invention contemplates reducing to a minimum the time required to set up a work piece in the machine and to complete the cutting operations on said work piece.

Low pressure control for front carriage

Thus far I have described the manner in which a low pressure fluid circuit is employed to impart rapid traverse movement to the rear carriage cutting tool, and I shall endeavor now to describe the manner in which the low pressure fluid is employed to control the front carriage tool 114. As set forth above, the pipe line 128 is connected at one extremity to one end of the cylinder 124, Figures 2 and 23. The opposite extremity of this pipe line 128 is connected to the valve 138. Similarly the pipe line 122 serves to communicate the other end of the cylinder 124 with the valve 138, and it will be seen that these pipe lines 122 and 128 are diametrically positioned with respect to the pipe lines 168 and 170 already described. When the valve member 262 occupies the neutral position shown in Figure 23, the circuit including the pipe lines 122 and 128 is functionally inoperative, but when the valve 262 is moved to its forward position, as shown in Figure 24, low pressure fluid is directed through the pipe line 122 and thus against the lower end of the piston 126. This causes the rapid upward movement of the tiltable guide bar 102 and consequently a rapid swinging of the tool 114 toward the work piece. As stated above, the upward movement of the piston 126 is limited by the engagement of the free end of the guide bar with the adjustable stop 130. At a predetermined interval which is determined by the shifting of a slide mechanism 300, later to be described, the valve 230, Figures 11 and 23, is shifted to the dot and dash position shown in Figure 23, and as described above, the valve member 262 is shifted to its neutral position. Under these conditions a high pressure fluid from the pipe line 228 passes through the pipe line 141 and thence into the cylinder 135 of the fluid actuated mechanism 133. This causes the front carriage cutting tool to be moved across the peripheral surface of the work piece to the left, Figures 3 and 23, at a feeding rate. When the tool 114 reaches the limit of its peripheral cutting stroke, the valve member 262 is shifted manually or automatically to the reverse position, as above described. This causes the spindle 36 to stop rotating, and thus renders the fluid in the front carriage feeding circuit functionally inoperative as a propelling medium. The flow of low pressure fluid in the pipe lines 128, 131, 143, 141, 129, and 122, Figure 23, is reversed, thereby causing a rapid reversal of the piston 137 which actuates the front tool carriage. The front tool carriage is swung downwardly, thereby maintaining the tool 114 out of engagement with the work piece during the reverse movement thereof. When the front carriage reaches its starting position, the valve 230, Figures 11 and 23, is shifted to its closed position, and the valve member 262 is moved to its neutral position.

It should be understood clearly that my invention is by no means limited to the specific arrangement and timing of the tool carriages shown in the accompanying drawings. In the foregoing description I have stated that the front carriage is swung upwardly to bring the tool 114 into proper position with respect to the work piece for making a peripheral cut longitudinally of said work piece. However, this front carriage tool may be employed for actually making a cut during its movement transversely of the work piece, as well as during its movement longitudinally thereof. In other words, a feeding movement may be imparted to the front carriage about its support 20 without departing from the broad scope of my invention. In fact, in certain instances it may be desirable to employ only the swinging or oscillating movement of the front carriage, and the longitudinal movement, if any, of the carriage may be employed for additional purposes not specifically shown in the drawings.

A device constructed in accordance with the teachings of my invention may be employed for making a great variety of cuts in a work piece, and hence it should be understood clearly that the specific arrangement and timing of the cutting tools as described above is representative of only one of a wide range of constructions which might be employed.

Automatic fluid control mechanism

Means for automatically controlling the movement of the valve member **262** and the valve **230** includes the above mentioned slide mechanism **300**, Figures 11 to 14 inclusive. This slide mechanism comprises a horizontal slide **304** which carries a plurality of dogs **306**, **308**, **310**, **312**, and **313**. The movement of the slide **304** is controlled by the rear carriage slide **142**. The bottom of this slide **142** supports a rack bar **314** which drives a gear **316**, and this gear **316** actuates a shaft **318** which carries a bevel gear **320**. This bevel gear **320** meshes with a companion bevel gear **322** carried by a shaft **324**. The outer end of this shaft **324** carries a pinion or gear **326**. This gear or pinion **326** is secured frictionally upon the shaft **324** by means of a suitable collar **328**, Figure 15, and associated clamping nut **330**. The frictional mounting of the gear **326** upon the shaft **324** is such that said gear will rotate with the shaft for driving a rack bar **332** which is carried on the underside of the slide **304**. If the slide **304** meets with resistance beyond a predetermined amount, the gear **326** will not rotate with the shaft **324**, thereby preventing any parts of the slide from being subjected to undue strains and stresses. In Figure 11 I have shown the position occupied by the slide **304** when the machine is at rest and the control valve member **262** occupies the neutral position shown in Figure 23. Consider now that the valve member **262** is moved to its forward position shown in Figure 24 by shifting the control handle **270** to the right, Figure 11. This control handle carries an arm **334** which makes a slotted connection with a slidable shaft **336**. This shaft **336** is mounted within a sleeve or casing **338**, which is formed integral with the casing section **260b**, and the outer end of this shaft **336** detachably supports a depending lug **340**. As the rear tool carriage **142** experiences its forward movement, the slide **304** is moved to the right, Figure 11, and the dog **310** is eventually carried into engagement with the depending lug **340**, thereby causing the shaft **336** to be shifted rearwardly. This causes the valve member **262** to be moved to its neutral position. At a predetermined interval, which is in accordance with the nature of the work piece, the dog **306** is carried into engagement with a depending lug **342** detachably supported at the outer extremity of the valve member **330**. This causes said valve to be moved to its open position so as to effect the longitudinal feeding movement of the front tool carriage. As the slide **304** continues to move to the right, the dog **312** eventually engages a bell crank **344**, and this engagement takes place when the tool carriages have reached the limit of their advancing strokes. The bell crank **344** is connected to one end of a rack bar **346** which traverses the upper portion of the valve mechanism **138**, as clearly shown in Figures 18 to 20 inclusive. This rack bar **346** meshes with teeth formed on the peripheral surface of a rotary balancing member **348**, and the shifting of the bell crank as above described causes the member **348** to be shifted from the position shown in Figures 18 and 19 to the position shown in Figure 20. When this balancing member is shifted to the position shown in Figure 20, pressure of the fluid within the chamber section **282** of the valve **138** is relieved, said fluid passing from the chamber section through a port **350** and thence into a return pipe **352** which connects with the oil reservoir **244**. Relieving the pressure in this chamber **282** causes the valve member **262** to be unbalanced, and thus automatically shifted to the reverse position shown in Figure 25. A spring **354** at one extremity of the rack bar **346** causes said bar to be automatically shifted outwardly when the dog **312** is moved away from the bell crank **344**, thereby automatically reestablishing the closed position of the valve **348**.

At this point it should be understood that automatic means, other than the unbalancing arrangement just described, may be employed for imparting a reversing movement to the valve member **262** without departing from the spirit and scope of my present invention. The mechanism whereby the fluid pressure on said valve member is unbalanced is particularly applicable in instances where a very quick reversal of the valve member is required. However, in other instances it may be advisable to employ a simple mechanical control, which will directly engage the valve member **262** to effect the reversal thereof. Such an arrangement is not shown in the drawings, but my present invention contemplates means other than the specific valve unbalancing arrangement for effecting the automatic shifting of the valve member **262** within its casing or housing **260**.

When it is desirable to manually control the shifting of the valve **262**, it is only necessary to shift the lugs **340** and **342** out of the path followed by the dogs on the slide **304**. This is readily accomplished by merely pulling outwardly on the pins which support these lugs and then imparting a slight rotary movement thereto, so as to shift said lugs out of the path of movement of the dogs on the slide. Obviously this may be accomplished without disturbing the position of the dogs on the slide. Thus, in instances where the operator wishes to have complete manual control of the machine, it is only necessary to quickly shift the normally depending lugs **340** and **342** in the manner described.

Shifting the valve member **262** to its reverse position causes the rear tool carriage to be moved rearwardly and the front tool carriage to be moved toward its starting position. When these tool carriages reach the limit of their movement, a dog **313** on the slide **304** engages the depending lug **340**, and thereby automatically moves the valve member **262** to its neutral position, and the dog **308** closes the valve **330**, Figure 11.

Clutch and driving mechanism

The clutch mechanism **288**, Figure 8, is similar to that disclosed and described in connection with my above mentioned co-pending application and may be of any practical design. The mechanism disclosed includes a clutch member **356** which is axially movable in response to the movement of actuating arms **358**. The movement of the member **356** into engagement with a rotary friction disk **360**, in response to outward movement imparted to the arms **358**, causes power to be applied to the drive shaft **54** from the prime mover or motor **242**. This outward movement of these arms **358** is occasioned in response to the shifting to the left of the piston rod **294**.

This movement of the piston rod **294** causes a horizontally disposed arm **362** connected therewith to rotate a vertical shaft **364** which, in turn, causes arms **366** supporting a yoke **368** to move a member **370**, Figure 8, into engagement with the arms **358**. When the piston rod **294** is moved to the right, Figure 10, the clutch elements are disengaged and the prime mover **242** is disconnected from the drive shaft **54**. The outer end of the drive shaft **54**, Figure 8, carries a pulley **372** which may be connected to a cooling pump (not shown). The specific structural characteristics of the clutch mechanism is a part of my present invention, only as it enters into the general combination, and therefore it should be understood that said invention is not limited in any sense to a particular type of clutch mechanism.

This clutch mechanism **288** and associated driving elements including the main drive shaft **54**, the change gears **50** and **52**, as well as the pinion **48**, is supported by a bracket **374** and a bracket **376**. These brackets are detachably mounted upon the rear side of the head stock casing **32***a*, as clearly shown in Figure 8. By supporting these parts which comprise the transmission in the brackets **374** and **376**, I am able to subassemble the parts before securing the entire unit to the head stock. This arrangement considerably reduces the amount of machining work on the head stock and bed, and also enables said head stock to be secured conveniently and rigidly in position upon the machine base. This is of utmost importance in connection with the design of machines which are to be subjected to heavy duty operating conditions.

Statement of operation

Consider that the dogs on the slide mechanism **300** have been properly positioned on the slide **304**, that is, in accordance with the desired timing of the movements of the rear and front cutting tools. Consider also that the electric motor or prime mover **242** is operating and thus driving the gear pump **136**. A work piece is secured in position between the head stock spindle and the tail stock center piece. After the work has been set up properly, the operator moves the control handle **270** to the right, thereby shifting the control valve **262** to its forward position as shown in Figure 24. This causes low pressure fluid from the gear pump to effect a rapid traverse movement of the rear carriage tool toward the work piece and also causes the front carriage to be swung about its axis so as to bring the tool supported thereby into proper position for making a peripheral cut upon the work piece. The clutch control mechanism **286** is also activated by the low pressure fluid so as to operatively connect the main drive shaft **54** and consequently the spindle **36** with the prime mover. This causes the actuation of the high pressure variable displacement plunger pumps **172** and **172***a*. The dog supporting slide **304** is moved in response to the forward movement of the rear carriage slide, and at a predetermined interval the control valve member **262** is shifted to its neutral position through the action of the dog **310**, and the valve **230** is shifted to its open position through the action of the dog **306**. The plunger pumps **172** and **172***a* are now included within a closed valveless fluid circuit, the displacement of fluid from the pump **172** causing a forward feeding movement of the rear carriage tool across the face of the work piece, and the fluid displaced by the pump **172***a* causing the front carriage tool to be fed longitudinally of the work piece. Upon the completion of the feeding stroke of these cutting tools, the valve member **262** is automatically shifted to its reverse position in response to the engagement of the dog **312** with the bell crank **344**. The engagement of the dog with the bell crank **344** causes the valve member **348** to be rotated sufficiently to effect the release of the fluid from within the chamber section **282**, thereby unbalancing the fluid pressures at the opposite extremities of the valve member **262**. The shifting of the valve member **262** to the reverse position causes a reversal in the direction of flow of fluid in the low pressure circuits, with the result that the clutch control mechanism **286** is operated to disconnect the spindle **36** from the prime mover. The reversal of flow in these circuits also causes a rapid reverse movement of the front and rear tools, and when these tools reach their starting position the dog **313** engages the depending lug **340**, thereby shifting the valve member **262** to its neutral position. The work piece does not rotate as the cutting tools are reversed, and hence the operator may use this period to good advantage in removing the work piece and inserting another. After a subsequent work piece has been set up in the machine a repetition of the cycle just described is obtained by merely shifting the control handle **270** to the right.

As a precaution against the possibility of leakage in the cylinders of the fluid actuated mechanism **108**, **133**, and **156**, which might result from wear or improper adjustment, I employ bleed passages **380** and **382**, Figure 18, in the valve casing **260**. Experimental work has shown that these restricted openings **380** and **382** will serve to replenish any fluid which is lost as a result of the above mentioned improper adjustment. This experimental work disclosed that it is not necessary to employ these restricted openings when the fluid actuated mechanisms are in proper adjustment, but I have found that a $\frac{1}{32}$ inch hole will not injure or cause any difference in action in the closed valveless circuit during the feeding stroke if the load of the piston is of a pulsative nature. The area of one of the cylinders in the average construction is approximately ten square inches, and therefore it will be understood that it is impossible to place any load on the piston which would force the fluid through a $\frac{1}{32}$ inch hole so as to cause a pulsated action. As stated above, these holes **380** and **382** are merely employed in instances where compensation must be made for the adjustment of the cylinders. These holes merely serve as compensating means to prevent the building up of too great a pressure on the advancing side of the piston.

Summary

From the foregoing it will be understood that my invention contemplates the provision of an inexpensive, simple, and durably constructed material working apparatus and a hydraulic or fluid system of control which is not only extremely simple in arrangement, but which is of a very practical design. By employing this system of fluid control, I am able to eliminate the necessity of using the usual complicated and expensive control valves. These conventional control valves are normally connected to both low and high pressure circuits, and hence their structural arrangement is quite complicated. My improved

system of control enables the use of a single, simple, three-position valve which is connected only to a low pressure circuit. In other words, leakage or fluid slippage which has been experienced heretofore in using conventional control valves in high pressure fluid circuits, is completely obviated by my improved arrangement. In my device, the high pressure circuit is operable independently of the low pressure circuit, and no valves of any kind are required in said high pressure circuit. Through the agency of this closed valveless circuit combined with my improved variable displacement plunger pump directly driven from the work supporting spindle, I able to obtain a predetermined feeding movement of an actuator piston per revolution of the work supporting spindle. The tapered valve arrangement combined with the stationary block for supporting the radial pistons, presents a pumping structure which is particularly adaptable for use in closed circuits. This results from the fact that the tapered valve positively prevents leakage toward its smaller end, and any slow leakage of fluid at its larger end is redirected to the intake side of the pump. This is to be distinguished clearly from pumping devices which have been employed heretofore, wherein a high degree of fluid slippage has been experienced along the surfaces of the rotary valves, thereby causing the overheating of the fluid and a material decrease in the propelling efficiency of the pump. In other words, my invention provides, in combination with an actuator piston, a pumping mechanism having valveless ducts extending between said pump and the actuator piston, and the fluid medium confined within said parts being substantially non-compressible, imparts a positive and constant propelling force against the actuator piston. Thus, the high pressure circuit may be termed a primary circuit, and the low pressure circuit may be termed a secondary circuit, said primary circuit being used for feeding purposes, and the secondary circuit for the purpose of rapid traverse. It should be understood that means other than that disclosed in the drawings, may be employed for imparting rapid traverse movements to the tools without departing from the spirit and scope of my present invention. In other words, my present invention contemplates other mechanical arrangements which would serve to impart such movements at predetermined intervals to the tool carriages.

It will be apparent from the foregoing description that my invention contemplates the provision of a hydraulic actuator system for controlling the movement of machine parts and the like in such a manner that uniform movement of the machine part is positively effected in direct accordance with volumetric displacement of fluid to the intake portion of the actuator cylinder irrespective of variations in fluid pressure or load to which the actuator piston may be subjected during its feeding stroke.

To explain this advantage from a more practical view-point, I call attention to the fact that the present invention is particularly adaptable for use with metal cutting machines, such as lathes, milling machines, and the like, wherein the tool or work is frequently subjected to varied degrees of resistance during the cutting operation. For example, in a milling machine equipped with the present hydraulic system of control, the table of the milling machine carries the work and is moved horizontally by the hydraulic actuator past a rotary cutter. If the cutter is rotating in such a direction that the teeth of the cutter exert a force which is in a direction opposite to the direction of movement of the table, then the pressure of the fluid on the trailing side of the piston is greater than the pressure of the fluid on the opposite side. On the other hand, if the cutter is rotating in a direction so that the cutting teeth exert a force in the same direction as the table, then the pressure of the fluid on the advancing side of the actuator piston will be greater. It will be apparent that, unless the hydraulic circuit is arranged in a particular manner to meet these conditions, the table will experience a non-uniform or pulsating action, due to the variations in fluid pressure on the opposite sides of the piston.

In the present invention the plunger pump is connected to the opposite sides of the actuator cylinder in such a manner that a uniform movement of the tool or carriage propelled by the actuator piston is positively effected in direct accordance with the volumetric displacement of fluid to the intake portion of the cylinder irrespective of the resistance encountered by the tool or carriage in its travel. That is to say, even though a milling machine carriage or lathe tool meets with varying degrees of resistance during its travel (resulting from soft spots in the metal, or non-circular form of the part to be turned in the lathe), the volumetric displacement to the intake side of the cylinder continues at a uniform rate, and therefore the piston must likewise travel uniformly in accordance with such displacement.

The plunger pump is connected with the advancing side of the piston in such a manner that fluid confined in front of the advancing side of the piston must be returned at the same rate as the fluid displaced to the intake side of the actuator piston by the plunger pump. By this arrangement the fluid bodies controlled by the action of the plunger pump operate similarly to a lead screw in a lathe wherein no slippage takes place.

Another example in which a variation in fluid pressure occurs on opposite sides of the actuator piston is in a machine, such as a drill press having a vertically disposed drill holder, which must be vertically reciprocated. By employing a vertically reciprocable actuator piston within a cylinder in conventional machines, some auxiliary means must be provided to prevent gravity from acting upon the piston so as to urge it downwardly. In the present invention no auxiliary means need be provided to prevent gravity or other forces from shifting the actuator piston, because when the fluid body is positioned beneath a vertically disposed piston, it is locked in position, and, although it is subjected to greater pressure than the fluid on the opposite side of the piston; no variation nor non-uniformity of piston movement will occur. That is to say, the uniform movement of the piston which drives the machine part is positively effected in direct accordance with the volumetric displacement of the fluid (not pressure) to the intake portion of the cylinder.

The phenomenon just described should also be considered in connection with the variations in fluid pressure on the opposite sides of the actuator piston which result when the tool carriage is suddenly changed from rapid traverse to feed. It will be recalled that during the rapid traverse of the machine part or carriage, fluid

from the large displacement gear pump passes through the main control valve into one end of the actuator cylinder, and fluid from the opposite end of said cylinder passes through said valve and is returned to the reservoir through a restricted orifice which sets up the required degree of back pressure. The instant that the main control valve is shifted from its rapid traverse to its neutral or feeding position, the opposite sides of the feeding circuit are completely sealed from the rapid traverse fluid, and the momentum of the tool carriage will cause a sudden building up of pressure at the advancing side of the actuator piston and a sudden lowering of fluid pressure on the opposite side. This sudden building up of pressure might properly be referred to as a "preloading action". That is to say, the fluid sealed within the forward side of the actuator cylinder experiences a sudden increase in pressure at the instant that the small displacement or feed pump becomes functionally operative. This preloading action serves to positively prevent any stuttering or pulsating effects when the tool begins its cutting operation. Heretofore considerable difficulty has been experienced with conventional hydraulic systems of control when the fluid pressure on the opposite sides of the actuator piston varies. In fact, it has been common practice to employ relief valves to permit the fluid to by-pass when sudden increases in fluid pressure are experienced, and obviously under such conditions no preloading of the fluid can take place, and hence a non-uniform or stuttering action takes place when the shiftable machine part changes from one speed to another. Therefore, it will be apparent that this sudden increase in pressure or preloading action conditions the fluid on the intake side of the small displacement or feed pump in readiness to charge said pump the instant that the main control valve "clips off" the low pressure fluid and renders the closed feeding circuit functionally operable. At this point it should also be understood that various types of prime movers, such as multi-speed motors, may be employed to impart rotation to the machine spindle.

Attention is called to the fact that by employing the secondary low pressure circuit, in combination with the primary or high pressure circuit, I am able to constantly change the fluid in said high pressure circuit. This will be clear when it is understood that each time the secondary circuit functions, fluid from said circuit is taken into one end of the actuator piston cylinder and discharged from the opposite end. This prevents the fluid in the closed primary circuit from deteriorating.

By having the transmission elements carried by brackets which are detachably mounted upon the head stock frame, a very practical transmission unit is presented. This may be readily assembled before mounting upon the machine, and while in operation said unit does not impart any undue strain on the head stock frame. The changeable gears provide a convenient arrangement for varying the spindle speed, and it will be understood that other forms of speed varying devices may be employed which come within the scope of my present invention. The gear pump is conveniently connected to the transmission and is readily accessible for purposes of replacement and the like. By employing a variable displacement gear pump, as shown, the fluid displacement in the low pressure circuit may be varied without varying the speed of the prime mover. By having the oil reservoir placed at a higher level than the gear pump, oil is constantly supplied under slight pressure to said pump, and air is completely eliminated from the circuit. It is to be noted that the prime mover or motor is housed in a ventilated chamber and may be adjusted for taking up wear in the roller chain. The automatic control of the clutch by means of the mechanism included within the low pressure circuit, provides a very simple and positively acting device. It is to be noted also that this control is operated independently of the high pressure fluid circuit. It should be understood that the invention is not limited to the specific arrangement of the disclosed clutch construction, but contemplates the provision of a clutch control which will timingly control the rotary movement of the work supporting spindle.

It will be understood from the foregoing description that the discharge side of the rapid traverse or gear pump 136 is never connected with the intake side of the feed pump during the operative functioning of the feed pump. That is to say, when the actuator 156 moves forwardly in response to the action of the pump 136, fluid discharged from said actuator is subjected to back pressure set up within the restricted orifice 276, and this back pressure exerts itself upon the fluid within the conduit 164 which connects with the intake side of the plunger pump 172. In this manner air is positively precluded from entering the intake side of the feed circuit during the rapid forward advancement of the actuator piston 154. When the actuator piston 154 is moved in a reverse direction, the plunger pump 172 stops, and hence, while the duct or conduit 164 communicates with the fluid discharged by the gear pump 136, no movement of fluid in the duct 164 or 166 takes place, and thus air is positively precluded from entering the feed circuit. During the reverse movement of the actuator piston 154 the fluid discharged thereby is subjected to back pressure set up by the restricted orifice 276, and this pressure exerts itself upon the fluid in the duct 166, thereby preventing any movement of the fluid in said duct. In the above described manner, any air which may be taken in through the action of the gear pump 136 is positively prevented from entering the feed circuit. This is of the utmost importance in preventing the actuator, and consequently the tool driven thereby, from experiencing a pulsating movement. By having this construction, the feed pumps may be placed above the level of the reservoir without the possibility of any fluid flowing out of the feed circuit, and without the possibility of air being introduced within said circuit.

From the foregoing it will be apparent that I provide two independent circuits, namely, a high pressure circuit which is connected to the plunger pump, and a low pressure circuit which is connected to the gear pump. The low pressure circuit is initially placed in operative position by shifting the main valve, and at this interval the high pressure circuit is in an inoperative state. The actuation of the low pressure circuit causes the high pressure circuit to be rendered functionally operative, and the low pressure circuit is then rendered functionally inoperative, thereby allowing the high pressure circuit to impart feeding movement to a tool carriage independently of any other circuit. At a predetermined interval, and in response to the move-

ment of said tool carriage, the low pressure circuit is again rendered functionally operative, and then said low pressure circuit causes the high pressure circuit to be rendered functionally inoperative, whereby said low pressure circuit operates independently of the high pressure circuit to impart a rapid reverse movement to the tool carriage.

Attention is directed to the fact that by employing my improved hydraulic actuator system, I am able to impart a speed to an actuator piston which is constantly proportional to the speed of movement of the prime mover. In other words, if in the present instance the work supporting spindle is considered as a prime mover with respect to the plunger pumps, it will be clear that said plunger pumps will impart a speed to the actuator piston connected therewith which is constantly proportional to the rotative speed of the prime mover or spindle. Fluid from the plunger pumps is dispatched at a uniform rate and there is no slippage of the fluid, hence there is a direct and constant proportion between the linear travel of the actuator piston and the angular or rotary displacement of the driving spindle.

It will also be noted that by employing my invention, I preclude the necessity of employing the conventional coupling of a gear pump to a plunger pump for charging purposes. In my device the plunger pump is employed in combination with a hydraulic actuator in such a manner that the fluid displaced by one of the plunger pump pistons serves to impart movement to the actuator, and the actuator simultaneously causes fluid to be directed to another of the pump pistons so as to urge it inwardly. Thus the actuator piston propelled by the plunger pump directly delivers fluid under charging pressure to the intake side of the plunger pump, and thus supplies the required fluid pressure for forcing the plungers inwardly. In conventional hydraulic actuator systems, gear pumps have been employed which has a capacity greater than the maximum amount of charging fluid which is required. Consequently it has been necessary heretofore to supply sufficient power from the prime mover to actuate a gear pump for continuously directing fluid to the intake side of the plunger pump to take care of leakage, etc. Such an arrangement obviously necessitates the continuous by-passing and consequent heating of the fluid from the gear pump, and this should be clearly distinguished from my improved arrangement, whereby fluid from the advancing side of the actuator piston is conducted back to the intake side of the plunger pump for charging purposes without the necessity of subjecting said fluid to any by-passing. Furthermore, the power required to drive a gear pump for continuously taking care of leakage and charging the plunger pump is eliminated by employing my device. In fact, the power supplied by the prime mover for actuating the plunger pump is sufficient to effect not only the displacement of fluid under high pressure but the delivery of fluid under low pressure to the intake side of the plunger pump.

Obviously, my invention is not limited to the specific lathe construction and fluid system shown in the drawings, but is capable of numerous other variations and modifications without departing from the spirit and scope thereof.

It should be further understood that in the closed circuit, as for example, the circuit including the plunger pump **172**, said plunger pump is rendered functionally inoperative in the event that the movement of the actuator piston **154** or the carriage and tool shifted thereby, are suddenly interrupted, as for example, when the piston engages the forward end of the cylinder **158**. The metal to metal contact thus made between the piston **154** and the end of the cylinder **158** causes the pressure in the pipe line **166** to be increased slightly above normal, and in view of the fact that the flow of fluid in the pipe line **164** ceases, the pump **172** also ceases to be charged. Subsequently the pressure in both sides of the circuit is equalized. By normal pressure I mean the pressure in the circuit just before the sudden stopping of the actuator takes place. To clearly understand what occurs within the plunger pump **172** when the above conditions are presented, reference is again made to Figure 22. It will be seen that the inner extremities of all of the pistons or plungers **176** are subjected to atmospheric pressure, while the outer extremities of these pistons are sealed from the atmosphere. With no fluid being supplied to the charging side of the plunger pump, there will consequently be no movement imparted to the pistons, in response to the movement of the driving ring **178**. In other words, the driving ring **178** will operate within the pump without causing the pistons to build up any pressure within the circuit. The moment that the pressure against the forward extremity of the actuator or its associated parts is released, the pump will automatically be rendered functionally operative. The sudden stopping of the actuator piston, as for example, by means of a metal to metal contact as explained above, should be clearly differentiated from the pressure experienced by the tool in making a cut in the work. The cutting action of the tool does not present a sudden stoppage, and the plunger pump will continue to be charged. It will thus be apparent that I have found it unnecessary in most instances to employ the relief mechanisms **226** and **234**, Figure 23. In other words, if any sudden stopping of the tool is occasioned, the plunger pump is automatically rendered functionally inoperative, thereby preventing the building up of pressure in the system.

By having the generating means or plunger pump generate its own charging fluid and by eliminating actuating and relief valves, numerous advantages over prior art structures are obtained. I am able to completely eliminate any by-passing of the fluid and thus eliminate the development of heat in the fluid. As long as only a resilient or what might be termed a "compressible" resistance occurs, as for example, when a tool makes a cut in the work, a pressure is built up in the fluid which is sufficient to overcome the resistance, but which will not render the mechanism functionally inoperative. It is common practice to employ a by-pass when such resistance is encountered, and such by-passing materially affects the operating efficiency of the device. It will also be noted that in my device, fluid cannot be displaced faster than the movement of the actuator piston will permit. In other words, the displacement is governed by the closed circuit arrangement. In common practice, hydraulic actuators, such as pistons, are connected on both sides with low pressure or back pressure relief valves. My invention positively eliminates the necessity for such constructions. It will also be seen that my improved circuit arrangement positively precludes air from entering the system.

With regard to the arrangement of the pistons 137 and 154 shown in Figure 23, it will be apparent that, due to the presence of the piston rods, in each instance there will be a slightly less volume of fluid introduced on the piston rod side of the cylinder chamber than is discharged from the other side during each movement of said piston. Hence, as the pistons move forwardly and their respective piston rods enter the cylinder chamber, a greater volume of fluid will be displaced on the advancing side of the piston than is taken in on the opposite side of said piston during a given movement of said pistons. The bleed passages or restricted orifices 380 and 382 of the valve 260, Figure 18, provide means for allowing this excess fluid on the advancing side of the pistons to escape. However, my invention also contemplates the provision of piston constructions, in which the volume of fluid taken in on the piston rod side of the pistons during a given movement thereof will equal the volume displaced from the opposite side thereof. In such instances there is no necessity of providing the bleed passages.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a hydraulic actuator system for moving machine parts and the like, a prime mover, an actuator including a cylinder and piston, fluid propelling mechanism connectible with said prime mover having intake and outlet ports, said propelling mechanism being adapted to impart linear speed to the actuator piston, which is constantly proportional to the speed of movement of said prime mover, a closed duct leading from the intake of the propelling mechanism to one side of the actuator piston, and a second closed duct leading from the outlet of the pump to the opposite side of the actuator piston, whereby fluid may be sealed against leakage within said ducts and moved as a unit for effecting the movement of said actuator.

2. In a hydraulic actuator system for moving machine parts and the like, a prime mover, an actuator including a cylinder and piston, a fluid propelling mechanism connectible with said prime mover having intake and outlet ports, said propelling mechanism being adapted to impart linear speed to the actuator piston, which is constantly proportional to the speed of movement of said prime mover, a valveless duct leading from the intake of the propelling mechanism to one side of the actuator piston, and a second valveless duct leading from the outlet port of the pump to the opposite side of the actuator piston, whereby a circuit is presented for retaining a sealed volume of fluid free from leakage, said fluid being movable within the circuit as a unit for effecting the movement of said actuator.

3. In a hydraulic actuator system for moving machine parts and the like, an actuator including a cylinder and piston, a variable displacement fluid propelling mechanism having intake and outlet ports, a sealed duct leading from the intake of the fluid propelling mechanism to one side of the actuator piston, and a second sealed duct leading from the outlet of the fluid propelling mechanism to the opposite side of the actuator piston, whereby fluid may be sealed against leakage within said ducts and moved under pressure for effecting the movement of said actuator.

4. In a hydraulic actuator system for moving machine parts and the like, a prime mover, an actuator including a cylinder and piston, a fluid propelling mechanism connectible with said prime mover having intake and outlet ports, said propelling mechanism being adapted to impart linear speed to the actuator piston, which is constantly proportional to the speed of movement of said prime mover, a sealed duct leading from the intake of the propelling mechanism to one side of the actuator piston, and a second sealed duct leading from the outlet of the pump to the opposite side of the actuator piston, whereby fluid within the circuit which includes the above mentioned parts may be moved as a unit for effecting the movement of said actuator.

5. In a hydraulic actuator system the combination of a fluid operated actuator, piston supporting means, a plurality of pistons reciprocably mounted in said supporting means, a central tapered valve having intake and outlet ports for controlling the delivery of fluid toward and away from said pistons, the tapered construction of said valve being such as to prevent leakage of fluid from the high to the low pressure side of the system along said valve, a duct leading from the outlet port of said valve to one side of the fluid operated actuator, and a duct leading from the other side of said actuator to the intake port of said valve, whereby a closed fluid circuit is presented.

6. In a hydraulic actuator system the combination of a fluid operated actuator, piston supporting means, a plurality of radial pistons reciprocably mounted in said supporting means, a central tapered valve having intake and outlet ports for controlling the delivery of fluid toward and away from said radial pistons, the tapered construction of said valve being such as to prevent leakage of fluid from the high to the low pressure side of the system along said valve, a fluid chamber at the large end of said valve which communicates with the intake port thereof, a duct leading from the outlet port of said valve to one side of the fluid operated actuator, and a duct leading from the other side of said actuator to the intake port of said valve, whereby a closed fluid circuit is presented.

7. In a hydraulic actuator system the combination of a fluid operated actuator, stationary piston supporting means, a plurality of pistons reciprocably mounted in said supporting means, a rotary valve having intake and outlet ports for controlling the delivery of fluid toward and away from said pistons, said valve being tapered to prevent leakage of fluid from the high to the low pressure side of the system along said valve, a duct leading from the outlet port of said valve to one side of the fluid operated actuator, and a duct leading from the other side of said actuator to the intake port of said valve, whereby a closed fluid circuit is presented.

8. In a hydraulic actuator system the combination of a fluid operated actuator, a plunger pump including a plurality of reciprocable pistons, a central rotary valve having intake and outlet ports for directing fluid toward and away from said pistons, a fluid operated actuator, a closed duct leading from the intake port of said rotary valve to one side of the actuator, and a second closed duct leading from the outlet port of the valve to the opposite side of said actuator, said ducts serving to seal the fluid within the system, whereby fluid within the circuit including the above mentioned parts may be moved as a unit for effecting the movement of said actuator.

9. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connectible with opposite sides of the actuator and fluid propelling means connectible with said ducts, and a second fluid circuit for imparting feeding movement to said actuator, whereby the feeding speed is governed in accordance with the delivery of fluid to said actuator, said second circuit including a second fluid propelling mechanism connectible with said actuator, the functioning of said second circuit being independent of the functioning of the first circuit.

10. In a hydraulic actuator system for moving machine tools and the like at different rates of speed, an actuator including a cylinder and piston, a fluid propelling mechanism for moving the actuator piston at a given speed, a duct leading from one side of the propelling mechanism to one side of the piston, a second duct leading from the other side of the propelling mechanism to the other side of the piston, said ducts being sealed, whereby to enable said propelling mechanism to impart a positive action to the actuator, and means for imparting rapid movement to the actuator.

11. In a hydraulic actuator system for moving machine parts and the like, an actuator including a cylinder and piston, fluid propelling mechanism having intake and outlet ports, a sealed duct leading from the intake of the propelling mechanism to one side of the actuator piston, a second sealed duct leading from the outlet of the propelling mechanism to the opposite side of the actuator piston, whereby fluid may be sealed within said ducts and moved as a unit for effecting the movement of said actuator, and means for imparting rapid movement to the actuator.

12. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure fluid circuit connectible with said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connectible with said actuator for imparting a slower feeding movement thereto, each of said circuits being adapted to function independently of the other, and means for selectively controlling the functioning of said circuits.

13. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a second fluid propelling means for imparting uniform feeding speed to said actuator, said first circuit serving to condition said second circuit for propelling purposes with respect to said actuator, and means for rendering said first mentioned circuit functionally inoperative during the functioning of said second circuit, whereby the fluid in said second circuit will impart feeding movement to the actuator independently of said first mentioned circuit.

14. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a fluid propelling means for imparting feeding movement to said actuator, and a valve mechanism connected wholly within the first mentioned circuit for rendering said circuit functionally inoperative during the functioning of said second circuit.

15. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a fluid propelling means for imparting feeding movement to said actuator, means for actuating the propelling mechanism in said second circuit, and means operable in response to the functioning of said first mentioned circuit for controlling the means for actuating the fluid propelling mechanism in said second circuit.

16. In material working apparatus of the class described, a rotary supporting member, fluid propelling mechanism driven in timed relation with said supporting member and having means for preventing slippage of fluid from the high to the low pressure side thereof, said means including valve means within said fluid propelling mechanism, a fluid operated actuator, and ducts connecting said actuator with said fluid propelling mechanism, the fluid propelling mechanism and ducts being so arranged that fluid contained therein may be moved as a unit whereby the movement experienced by said actuator will be directly proportional to the movement of the supporting member.

17. In material working apparatus of the class described, rotary supporting means, a variable displacement plunger pump directly driven from said rotary means, a driving means, and means for connecting and disconnecting the rotary means with respect to said driving means, said plunger pump being operable automatically when rotation is imparted to said rotary supporting means.

18. In material working apparatus of the class described, a rotary supporting means, a fluid propelling mechanism driven in timed relation with said rotary supporting means, a fluid operated actuator, and means connecting said fluid propelling mechanism with said actuator, so as to prevent slippage of fluid from the high to the low pressure side of said propelling mechanism whereby a governed amount of travel at uniform speed is experienced by the actuator for each revolution of the rotary supporting means.

19. In apparatus of the class described, a rotary supporting means, a fluid propelling mechanism driven in timed relation with said supporting means, said fluid propelling mechanism being adapted to impart a speed to said fluid operated actuator which is constantly proportional to the rotary speed of said rotary supporting means, a fluid operated actuator, and closed ducts connecting said fluid propelling mechanism with said actuator, whereby, in response to rotation of the supporting means, the fluid propelling mechanism operates automatically to propel the actuator.

20. An apparatus of the class described, a spindle, a fluid operated actuator, and a fluid propelling mechanism adapted to impart a speed to the fluid operated actuator which is constantly proportional to the speed of movement of said spindle, said propelling mechanism and actuator being included within a closed fluid circuit, said propelling mechanism being operable automatically in response to the rotation of the spindle.

21. In apparatus of the class described, a rotary supporting spindle, fluid pressure generating means driven in timed relation with said spindle, a support, fluid actuated means for moving said support, ducts connecting said fluid actuated means with said fluid pressure generating means, the fluid in said ducts being sealed against leak-

age from the system, whereby a predetermined movement of the second supporting means is experienced in response to each revolution of the supporting spindle, and means for automatically controlling the degree of movement of said support.

22. In apparatus of the class described, a supporting spindle, a fluid operated actuator piston, and a fluid propelling mechanism driven in timed relation with said supporting spindle, said propelling mechanism and actuator piston being included within a closed circuit, the linear movement of the actuator piston being constantly proportional to the degree of movement experienced by said spindle.

23. In material working apparatus of the class described, a supporting spindle, a fluid propelling mechanism driven in timed relation with said supporting spindle, a fluid operated actuator, and means connecting said fluid propelling mechanism with said actuator, in a closed circuit whereby a governed amount of travel is experienced by the actuator for each revolution of the supporting spindle.

24. In apparatus of the class described, a supporting spindle, a fluid propelling mechanism driven in timed relation with said supporting spindle, a fluid operated actuator, and sealed ducts connecting said fluid propelling mechanism with said actuator, whereby, in response to rotation of the supporting spindle, the fluid propelling mechanism operates automatically to propel the actuator.

25. In material working apparatus of the class described, a frame, a spindle rotatably mounted in said frame, a fluid propelling means, means for imparting rotation to said spindle, a fluid operated actuator, said fluid propelling means and actuator being included within a closed circuit, and means for driving said fluid propelling means in timed relation with said spindle, whereby the movement experienced by said actuator will be constantly in direct relation with the rotary movement experienced by the spindle.

26. In material working apparatus of the class described, a frame, a spindle rotatably supported by said frame, a fluid propelling mechanism adapted to impart a speed to a fluid operated actuator which is constantly proportional to the rotative speed of said spindle, a fluid operated actuator connected with said fluid propelling mechanism by means of closed ducts, whereby uniform movement of said actuator is experienced irrespective of variations in fluid pressure in the opposite sides thereof, and means directly connecting the spindle with said fluid propelling mechanism, whereby rotation of the spindle will automatically cause fluid to be propelled by said propelling mechanism.

27. In material working apparatus of the class described, a rotary supporting means, a variable displacement pump driven from the rotary supporting means, a fluid operated actuator connected with said variable displacement pump, an adjustable delivery gear pump connectable with said fluid operated actuator, whereby the displacement of low pressure fluid to said actuator may be adjustably controlled and means for selectively controlling the functioning of said pumps with respect to said actuator.

28. In material working apparatus of the class described, the combination with a rotary supporting member and a fluid operated actuator, a gear pump for supplying low pressure fluid to shift said actuator, and valve means for diverting a portion of the fluid at the discharge side of said gear pump to thereby vary the fluid delivery and consequently the speed of said actuator.

29. In material working apparatus of the class described, the combination with a rotary supporting member and a fluid operated actuator, a gear pump for supplying low pressure fluid to shift said actuator, and means for adjusting the fluid delivery of said gear pump while the relative axial disposition of the gears is maintained to thereby vary the delivery of fluid and consequently the speed of said actuator without affecting the speed of rotation of said gear pump.

30. In material working apparatus of the class described, the combination with a rotary supporting means and a fluid operated actuator, a variable displacement pump for delivering fluid at high pressure to said actuator, a constantly driven gear pump for delivering fluid at low pressure to said actuator, and means for varying the delivery of said gear pump to thereby vary the speed of said actuator while the cooperative relationship of the teeth in the gears remains undisturbed.

31. In material working apparatus of the class described, a frame, a spindle rotatable within said frame, driving means for imparting rotation to said spindle, a fluid operated actuator, a variable displacement pump driven in synchronism with said spindle for delivering fluid at high pressure to said actuator, a constantly driven gear pump connected directly with said driving means for delivering fluid at low pressure to said actuator, and means for diverting a portion of the fluid at the discharge side of the gear pump to thereby vary the fluid delivery to the actuator and consequently the speed of said actuator.

32. In an automatic lathe, a frame, a spindle rotatably supported thereby, a driving means, a clutch mechanism for controlling the delivery of power from said driving means to said spindle, a shiftable carriage, a fluid operated actuator for moving said carriage, a variable displacement pump driven from said spindle for propelling said actuator, means for delivering fluid at low pressure to said actuator, and means controlled by the low pressure fluid for shifting the clutch mechanism.

33. In an automatic lathe of the class described, a frame, a spindle rotatably mounted in said frame, a variable displacement pump driven from said spindle, a shiftable carriage, a fluid operated actuator connected with said pump for shifting said carriage, a driving means, a clutch mechanism for controlling the delivery of power from the driving means to the spindle, a gear pump driven by said driving means for delivering fluid at low pressure to said actuator, and a second fluid operated actuator for controlling the clutch mechanism, said actuator being operatively connectable with said gear pump for propelling purposes independently of said variable displacement pump.

34. In an automatic lathe of the class described, a frame, a spindle rotatably mounted within said frame, a shiftable carriage, an actuator including a cylinder and piston for moving said carriage, a fluid propelling mechanism having intake and outlet ports, closed conducting means leading from the intake of the propelling mechanism to one side of the actuator piston, and closed conducting means leading from the outlet of the pump to the opposite side of the actuator piston, whereby fluid may be sealed within said means

and moved as a unit for effecting the movement of said actuator.

35. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure circuit connectable with said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connected with said actuator for imparting a slower feeding movement thereto, one of said circuits being adapted to function independently of the other, and a second fluid operated actuator connected with said low and high pressure circuits.

36. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure circuit connectable with said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connected with said actuator for imparting a slower feeding movement thereto, one of said circuits being adapted to function independently of the other, a second fluid operated actuator connected with said low and high pressure circuits, and a single valve mechanism for controlling the functioning of said circuits.

37. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure circuit connectable with said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connectable with said actuator for imparting a slower feeding movement thereto, a second fluid operated actuator connectable with said low and high pressure circuits, and a single valve mechanism connected wholly within the low pressure circuit for rendering said circuit functionally inoperative during the functioning of the high pressure circuit.

38. In material working apparatus of the class described, a rotary supporting means, driving means therefor, a fluid propelling mechanism driven in synchronism with said rotary means, a carriage, a fluid operated actuator for relatively shifting said carriage and rotary supporting means, one extremity of said actuator being connected with the intake side of said fluid propelling mechanism, and the opposite extremity of said actuator being connected with the outlet side of said mechanism, a second carriage, a fluid operated actuator for relatively shifting said second carriage and said rotary supporting means, and a second fluid propelling mechanism driven in synchronism with said rotary supporting means, one extremity of said second actuator being connected with the inlet side of said second fluid propelling mechanism, and the opposite extremity of said actuator being connected to the outlet side of said mechanism.

39. In material working apparatus of the class described, a rotary supporting means, driving means therefor, a fluid propelling mechanism driven in synchronism with said rotary means, a carriage, a fluid operated actuator for relatively shifting said carriage and rotary supporting means, one extremity of said actuator being connected with the intake side of said fluid propelling mechanism, and the opposite extremity of said actuator being connected with the outlet side of said mechanism, a second carriage, a fluid operated actuator for relatively shifting said second carriage and said rotary supporting means, a second fluid propelling mechanism driven in synchronism with said rotary supporting means, one extremity of said second actuator being connected with the inlet side of said second fluid propelling mechanism, and the opposite extremity of said actuator being connected to the outlet side of said mechanism, and a third fluid propelling mechanism for imparting rapid traverse to said fluid operated actuators.

40. In material working apparatus of the class described, a rotary supporting means, driving means therefor, a fluid propelling mechanism driven in synchronism with said rotary means, a carriage, a fluid operated actuator for relatively shifting said carriage and rotary supporting means, one extremity of said actuator being connected with the intake side of said fluid propelling mechanism, and the opposite extremity of said actuator being connected with the outlet side of said mechanism, a second carriage, a fluid operated actuator for relatively shifting said second carriage and said rotary supporting means, a second fluid propelling mechanism driven in synchronism with said rotary supporting means, one extremity of said second actuator being connected with the inlet side of said second fluid propelling mechanism, and the opposite extremity of said actuator being connected to the outlet side of said mechanism, a third fluid propelling mechanism for imparting rapid traverse to said fluid operated actuators, and a valve mechanism for controlling the delivery of fluid from said third fluid propelling mechanism.

41. In material working apparatus of the class described, a frame, a spindle rotatably mounted within said frame, a carriage for moving a tool transversely of said spindle, a fluid operated actuator for moving said carriage, a variable displacement pump driven from said spindle for imparting feeding movement to said actuator, a second carriage for moving a tool longitudinally of said spindle, a second fluid operated actuator for shifting said second carriage, a second variable displacement pump driven from said spindle for moving said second actuator, and means for controlling the functioning of said variable displacement pumps.

42. In material working apparatus of the class described, a frame, a spindle rotatably mounted in said frame, a tool carriage shiftable transversely of the spindle, a fluid actuator for moving said carriage, a variable displacement pump driven from the spindle for propelling said actuator, a second oscillatory frame for moving a tool toward and away from the axis of the spindle and for moving said tool longitudinally of said spindle, a fluid actuator for longitudinally shifting said second carriage, a second variable displacement pump driven from said spindle for moving said second actuator, and a third fluid operated actuator for shifting said carriage toward the spindle axis.

43. In material working apparatus of the class described, a frame, a spindle rotatable within said frame, a carriage shiftable transversely of said spindle, a fluid operated actuator for moving said carriage, a propelling mechanism driven from said spindle for delivering fluid to said actuator, a second pivotally mounted carriage capable of moving longitudinally of the spindle, a second fluid operated actuator for longitudinally shifting said second carriage, a second variable displacement pump for delivering fluid to said second actuator, and a third fluid operated actuator for moving said second carriage about its pivotal point.

44. In material working apparatus of the class described, a frame, a spindle rotatably mounted in same frame, a carriage shiftable transversely of the spindle, a fluid actuator for moving

said carriage, a variable displacement pump driven from the spindle for propelling said actuator, a second oscillatory frame for causing relative shifting of said carriage toward and away from the axis of the spindle and for causing relative shifting of said carriage longitudinally of said spindle, a fluid actuator for longitudinally shifting said second carriage, a second variable displacement pump driven from said spindle for moving said second actuator, a third fluid operated actuator for shifting said carriage toward the spindle axis, a third fluid propelling mechanism for delivering fluid under low pressure, and a valve mechanism for controlling the delivery of said low pressure fluid.

45. In material working apparatus of the class described, a frame, a spindle rotatably mounted in said frame, a shiftable carriage, a fluid operated actuator for shifting said carriage, and a fluid propelling mechanism positioned on the upper portion of the apparatus for delivering fluid to said actuator, said propelling mechanism including a pair of detachable units, one of said units being detachable without disturbing the position of the other, and means connecting said spindle with said fluid propelling mechanism.

46. In material working apparatus of the class described, a frame, a spindle rotatably mounted in said frame, a shiftable carriage, a fluid operated actuator for shifting said carriage, a fluid propelling mechanism positioned on the upper portion of the apparatus for delivering fluid to said actuator, means connecting said spindle with said fluid propelling mechanism, a second shiftable carriage, a fluid operated actuator for shifting said carriage, and a second fluid propelling mechanism positioned at the upper portion of the apparatus and driven from said spindle for delivering fluid to said second actuator.

47. In a material working apparatus of the class described, a frame, a horizontally disposed spindle rotatably mounted within said frame, a shiftable carriage, a fluid operated actuator for shifting said carriage, and a fluid propelling mechanism for delivering fluid to said actuator, said mechanism being positioned immediately above said spindle in clear view of an operator during the rotation thereof and driven in timed relation with said spindle.

48. In a material working apparatus of the class described, a frame, a horizontally disposed spindle rotatably mounted within said frame, a shiftable carriage, a fluid operated actuator for shifting said carriage, a variable displacement pump for delivering fluid to said actuator, said pump being positioned above and driven from said spindle, a second shiftable carriage, an actuator for shifting said carriage, and a second variable displacement pump positioned above and driven by said spindle for delivering fluid to said second actuator.

49. In material working apparatus of the class described, a frame, a rotary supporting means, a carriage, a fluid operated actuator for relatively shifting said carriage and said rotary supporting means, a variable displacement pump for delivering fluid to said actuator, a gear pump for delivering fluid at low pressure to said actuator, and a reservoir for retaining a fluid medium, said reservoir being positioned above the level of the gear pump, whereby to effect the delivery of fluid to said gear pump under pressure.

50. In material working apparatus of the class described, a frame, a rotary supporting means, a carriage, a fluid operated actuator for relatively shifting said carriage and said rotary supporting means, a variable displacement pump for delivering fluid to said actuator, a gear pump for delivering fluid at low pressure to said actuator, a reservoir for retaining a fluid medium, said reservoir being positioned above the level of the gear pump, whereby to effect the delivery of fluid to said gear pump under pressure, and a filter extending across the top of said reservoir.

51. In material working apparatus of the class described, a frame, a horizontally disposed spindle rotatably mounted within said frame, a carriage, a fluid operated actuator for relatively shifting said carriage and said spindle, a variable displacement pump for delivering fluid to said actuator, a gear pump for delivering fluid at a lower pressure to said actuator, and a reservoir positioned above said spindle and above the level of the gear pump, whereby to effect the delivery of fluid under pressure to the intake side of said gear pump.

52. In material working apparatus of the class described, a shiftable carriage, a fluid operated actuator for shifting said carriage, a variable displacement pump for delivering fluid for feeding purposes to said actuator, a low pressure circuit including a second pump for propelling fluid in said circuit, and a valve mechanism connected wholly within said low pressure circuit for controlling the direction of flow of fluid in said circuit.

53. In material working apparatus of the class described, a shiftable carriage, a fluid operated actuator for shifting said carriage, a variable displacement pump for delivering fluid for feeding purposes to said actuator and connectable within a closed circuit, a low pressure circuit including a second pump, a valve mechanism including a valve shiftable within a housing, said valve member and housing having a plurality of cooperative ports for controlling the delivery of fluid under low pressure to said actuator, said valve in one shifted position serving to render said closed circuit functionally operative, and means for controlling said valve mechanism.

54. In material working apparatus of the class described, a shiftable carriage, a fluid operated actuator for shifting said carriage, a variable displacement pump for delivering fluid for feeding purposes to said actuator and connectable within a closed circuit, a low pressure circuit including a second pump, a valve mechanism including a valve shiftable within a housing, said valve member and housing having a plurality of cooperative ports for controlling the delivery of fluid under low pressure to said actuator, said valve in one shifted position serving to render said closed circuit functionally operative, and means operable in response to the movement of the carriage for controlling said valve mechanism.

55. In material working apparatus of the class described, a shiftable carriage, a fluid operated actuator for shifting said carriage, fluid propelling mechanism for delivering fluid to said actuator for feeding purposes, a low pressure fluid circuit connected with said actuator, said circuit including a second fluid propelling mechanism, a valve mechanism interposed between said second fluid propelling mechanism and said actuator, said valve mechanism being positioned wholly within said low pressure circuit, and means for unbalancing the fluid pressure within said valve mechanism to effect the shifting thereof, and means for controlling the actuation of the unbalancing means.

56. In a material working apparatus of the

class described, a frame, a shiftable carriage on said frame, a fluid operated actuator for shifting said carriage, a piston supporting means, a plurality of pistons reciprocably mounted within said supporting means, a central valve, a duct leading from the outlet side of the valve to one side of the fluid operated actuator, a second duct leading from the other side of said actuator to the intake side of the valve, rotary driving means for imparting reciprocation to said pistons, and means operable from a point externally of the piston supporting means for laterally adjusting said rotary means to vary the stroke of said pistons.

57. In a material working apparatus of the class described, a frame, a shiftable carriage on said frame, a fluid operated actuator for shifting said carriage, a piston supporting means, a plurality of pistons reciprocably mounted within said supporting means, a central valve, a duct leading from the outlet side of the valve to one side of the fluid operated actuator; a second duct leading from the other side of said actuator to the intake side of the valve, rotary driving means for imparting reciprocation to said pistons, and an adjusting screw operable from a point externally of the piston supporting means for laterally adjusting the rotary driving means to vary the stroke of said pistons.

58. In material working apparatus of the class described, a frame, an oscillatory carriage mounted on said frame, vertically reciprocable means for imparting movement to said oscillatory carriage including a shiftable member, and abutment means adapted to be engaged by said shiftable member, the engaging surfaces of the shiftable member and the abutment being inclined from the horizontal so as to urge said shiftable member laterally upon the engagement thereof with said abutment means.

59. In material working apparatus of the class described, a frame, an oscillatory carriage mounted on said frame, vertically reciprocable means for imparting movement to said oscillatory carriage including a pivotally mounted member having an abutment surface inclined from the horizontal, and abutment means having a complementary inclined surface, whereby said pivotal member will be urged laterally toward the frame upon the engagement of said inclined surfaces.

60. A system of hydraulic control and actuation including a hydraulic actuator, a relatively high pressure pump for imparting uniform feeding speed to said actuator, a second pumping mechanism for imparting rapid traverse to said actuator, and a shiftable control mechanism adapted in one shifted position to cause fluid to be directed from the first mentioned pump for feeding purposes to said actuator independently of said second mentioned pumping mechanism and to maintain the feed pump hydraulically operative.

61. A system of hydraulic control and actuation including a hydraulic actuator, a relatively high pressure pumping mechanism for imparting uniform feeding speed to said actuator, a second pumping mechanism for imparting rapid traverse to said actuator, and a control mechanism for rendering the second pumping mechanism functionally inoperative for propelling purposes with respect to the actuator during the functioning of the first mentioned pumping mechanism and for maintaining said feed pumping mechanism hydraulically operative.

62. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for imparting uniform feeding speed to said actuator, a second fluid propelling means for imparting rapid traverse to said actuator, and hydraulically actuated valve means for rendering the second mentioned propelling means functionally inoperative for propelling purposes with respect to the actuator piston during the operative functioning of the other propelling means.

63. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for delivering fluid under pressure at a substantially uniform rate to one side of the actuator piston, and means for directing fluid from the opposite side of said piston to the intake side of said fluid propelling means, the fluid from the discharge side of said actuator being sufficient to charge the intake side of said fluid propelling means, whereby said actuator experiences constant linear travel in accordance with the uniform delivery of fluid by said fluid propelling means.

64. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a variable displacement plunger pump for delivering fluid under pressure at a substantially uniform rate to one side of the actuator piston, and means for directing fluid from the opposite side of said piston to the intake side of said variable displacement plunger pump, the fluid from the discharge side of said actuator being sufficient to charge the intake side of said plunger pump, whereby said actuator experiences constant linear travel in accordance with the uniform delivery of fluid by said plunger pump.

65. In a hydraulic actuator system for moving machine parts and the like, a prime mover, a hydraulic actuator including a piston within a cylinder, mechanism for delivering fluid under pressure at a substantially uniform rate of displacement to one side of said actuator piston, means connecting said prime mover with said fluid delivering means, and passageways connecting said fluid delivering means with said hydraulic actuator, whereby fluid delivered to the intake side of the actuator and fluid from the discharge side of said actuator will be shifted as confined fluid bodies within said passageways without the presence of air so that the linear speed to which the actuator is subjected will be constantly proportional to the speed of movement of said prime mover.

66. In material working apparatus of the class described, a prime mover, a hydraulic actuator including a piston within a cylinder, fluid propelling mechanism driven in timed relation with said prime mover and adapted to impart a linear speed to the actuator which is constantly in synchronism with the speed of travel of said prime mover, and fluid conducting means free from air connecting said fluid propelling mechanism with said hydraulic actuator.

67. In material working apparatus of the class described, a prime mover, a hydraulic actuator including a piston within a cylinder, fluid propelling mechanism driven in timed relation with said prime mover and adapted to impart a linear speed to the actuator which is constantly proportional to the speed of travel of said prime mover, fluid conducting means free from air connecting said fluid propelling mechanism with

said hydraulic actuator, and means for imparting rapid movement to said actuator.

68. In material working apparatus of the class described, a prime mover, a hydraulic actuator including a piston within a cylinder, fluid propelling mechanism driven in timed relation with said prime mover and adapted to impart a linear speed to the actuator which is constantly proportional to the speed of travel of said prime mover, means connecting said fluid propelling mechanism with said hydraulic actuator, means for imparting rapid movement to said actuator, and means for selectively controlling the operative functioning of the fluid propelling mechanism and the means for imparting rapid movement to the actuator.

69. In a hydraulic actuator system for controlling the movement of and for actuating machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling mechanism for delivering fluid under relatively high pressure into the actuator at a uniform feeding rate to propel the actuator at a feeding rate, a second relatively low pressure fluid propelling mechanism for propelling said actuator at a rapid rate, and shiftable valve means for selectively controlling the delivery of fluid from the low pressure means to the actuator, said valve means serving in one shifted position to render the low pressure propelling mechanism functionally operative for propelling purposes with respect to the actuator and in another shifted position to render said low pressure propelling mechanism functionally inoperative for propelling purposes with respect to said hydraulic actuator, whereby to cause said high pressure propelling mechanism to propel said actuator.

70. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a fluid propelling means for delivering fluid under relatively high pressure into the actuator at a uniform feeding rate for imparting feeding speed to said actuator, a second fluid propelling means for delivering fluid under lower pressure for rapid traverse purposes to said actuator, said propelling means being hydraulically connectable by conduit means with said actuator, and control means for rendering said high pressure propelling means functionally operable for propelling purposes with respect to the actuator independently of the propelling action of the other propelling means and for maintaining said high pressure propelling means hydraulically operative.

71. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a fluid propelling means for delivering fluid under relatively high pressure into the actuator at a uniform feeding rate for imparting feeding speed to said actuator, a second fluid propelling means for delivering fluid under lower pressure for rapid traverse purposes to said actuator, said propelling means being hydraulically connectable by conduit means with said actuator, control means for rendering said high pressure propelling means functionally operable for propelling purposes with respect to the actuator independently of the propelling action of the other propelling means and for maintaining said high pressure propelling means hydraulically operative, and means for timingly controlling the functioning of said control means.

72. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a fluid propelling mechanism for driving said actuator at a uniform feeding rate, a second fluid propelling mechanism for driving said actuator at a rapid rate, a fluid reservoir connected with said second fluid propelling mechanism, and shiftable control means for controlling the operative functioning of said fluid propelling mechanisms with respect to said actuator, said control means being adapted in one shifted position to direct fluid discharged by said second propelling mechanism to the reservoir independently of the fluid discharged by the first mentioned propelling mechanism and for maintaining said feeding propelling mechanism hydraulically operative and in another shifted position serving to deliver fluid discharged by said second propelling mechanism for rapid traverse purposes to said actuator.

73. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a fluid propelling mechanism for driving said actuator at a uniform feeding rate in a given direction, a second fluid propelling mechanism for driving said actuator at a rapid rate in a reverse direction, a fluid reservoir connected with said second fluid propelling mechanism, and shiftable control means for controlling the operative functioning of said fluid propelling mechanisms with respect to said actuator, said control means being adapted in one shifted position to direct fluid discharged by said second propelling mechanism to the reservoir independently of the fluid discharged by the first mentioned propelling mechanism and for maintaining said first mentioned propelling mechanism hydraulically operative and in another shifted position serving to deliver fluid discharged by said second propelling mechanism for rapid traverse purposes in a reverse direction to said actuator.

74. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for imparting feeding movement to said actuator, a second fluid propelling means for imparting rapid traverse to said actuator, a shiftable control valve adapted to occupy one of three positions, namely, a neutral position, a forward position, and a reverse position, and means connecting said valve with said second fluid propelling means, said valve being adapted in its neutral position to effect the circulation of fluid from said second propelling means independently of the fluid discharged by the first mentioned propelling means, the forward shifted position of said valve serving to operatively connect said second mentioned propelling means for rapid traverse purposes with said actuator and the reverse shifted position of said valve serving to direct fluid in a reverse direction for rapid traverse purposes to said actuator.

75. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for imparting feeding movement to said actuator, a second fluid propelling means for imparting rapid traverse to said actuator, a shiftable control valve adapted to occupy one of three positions, namely, a neutral position, a forward position, and a reverse position, means connecting said valve with said second fluid propelling means, said valve being adapted in its neutral position to effect the circulation of fluid from said second propelling means independently

of the fluid discharged by the first mentioned propelling means, the forward shifted position of said valve serving to operatively connect said second mentioned propelling means for rapid traverse purposes with said actuator and the reverse shifted position of said valve serving to direct fluid in a reverse direction for rapid traverse purposes to said actuator, and means for rendering the functioning of the first fluid propelling means functionally inoperative for feeding purposes during the operative functioning of said second fluid propelling means.

76. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a relatively high pressure pumping means for imparting feeding movement to said piston, a relatively low pressure high displacement pumping means for imparting rapid traverse to said piston, and a shiftable control valve, said valve having a pair of ports hydraulically connected with opposite sides of said actuator piston and a port connectible with the discharge side of the low pressure pumping mechanism, said valve being adapted in one shifted position to close the ports connected with the actuator and thereby operatively disconnect the low pressure pumping means with respect to said actuator and in a second shifted position serving to open said ports so as to operatively connect said low pressure pumping means for rapid traverse purposes to said actuator.

77. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a relatively high pressure pumping means for imparting feeding movement to said piston, a relatively low pressure high displacement pumping means for imparting rapid traverse to said piston, and a shiftable control valve, said valve having a pair of ports hydraulically connected with opposite sides of said actuator piston and a port connectible with the discharge side of the low pressure pumping mechanism, said valve being adapted in one shifted position to close the ports connected with the actuator and thereby operatively disconnect the low pressure pumping means with respect to said actuator and in a second shifted position serving to open said ports so as to operatively connect said low pressure pumping means for rapid traverse purposes to said actuator, said high pressure pumping means being functionally operable during the disconnection of said low pressure pumping means to propel the actuator piston at a feeding rate independently of said low pressure pumping means.

78. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a relatively high pressure pumping means for imparting feeding movement to said piston, a relatively low pressure high displacement pumping means for imparting rapid traverse to said piston, a shiftable control valve, said valve having a pair of ports hydraulically connected with opposite sides of said actuator piston and a port connectible with the discharge side of the low pressure pumping mechanism, said valve being adapted in one shifted position to close the ports connected with the actuator and thereby operatively disconnect the low pressure pumping means with respect to said actuator and in a second shifted position serving to open said ports so as to operatively connect said low pressure pumping means for rapid traverse purposes to said actuator, and means for automatically effecting the sudden shifting of said control valve in timed relation with the movement of said actuator.

79. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a relatively high pressure pumping means for propelling the actuator at a feeding rate a second lower pressure pumping means for propelling said actuator piston at a rapid rate, and a valve mechanism interposed between the low pressure pumping means and the actuator for controlling the connection and disconnection thereof, said valve mechanism including a valve member shiftable within a housing, said valve mechanism having ports hydraulically connectible with opposite sides of the actuator piston and a port connectible with the discharge side of said low pressure pumping means, the shiftable valve member of said valve mechanism having a port adapted to selectively communicate with the ports connected with said actuator but otherwise sealed against communication with said actuator, whereby to prevent the introduction of pulsative effects within said actuator during the shifting of said valve member.

80. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, and a plunger pump for imparting movement to said actuator, the plungers of said pump being adapted to discharge fluid under relatively high pressure to one side of said actuator during one portion of their stroke and being adapted to receive fluid for charging purposes during the other portion of their stroke, the discharge side of said actuator serving to force fluid under pressure from said cylinder to the pump plungers for effecting the charging stroke thereof.

81. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump including a plurality of plungers adapted to receive fluid at a given pressure and to discharge said fluid under increased pressure, and ducts connecting the discharge and intake sides of said plunger pump with opposite sides of said actuator, the plungers of said pump serving during their compression stroke to deliver fluid under pressure to one side of said actuator piston, the opposite side of said piston serving to deliver fluid to the intake side of said plunger pump at a pressure which is sufficient to effect the charging stroke of said plungers.

82. In a hydraulic system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a pumping mechanism including a plurality of plungers for receiving fluid under a given pressure and discharging said fluid under increased pressure, valve mechanism for timingly controlling the flow of fluid toward and away from said pistons, and ducts connecting opposite sides of said actuator with the intake and outlet sides of said valve mechanism, said actuator serving during one stroke to force fluid into said valve under a pressure which is sufficient to effect the charging stroke of the pump plungers.

83. In material working apparatus of the class described, a frame, a spindle supported thereby, driving means, clutch mechanism for controlling the delivery of power from said driving means to said spindle, a shiftable carriage, a hydraulic actuator for relatively shifting said carriage and

spindle, a variable displacement pump driven in timed relation with said spindle for propelling said actuator, means for delivering fluid at a relatively low pressure to said actuator for rapid traverse purposes, and fluid operated means for timingly controlling the shifting of said clutch mechanism.

84. In material working apparatus of the class described, a support, a spindle rotatable within said support, a plurality of shiftable machine elements, an actuator coupled with each of said elements, a plurality of transmissions driven in timed relation with said spindle, one of said transmissions being companion with and serving to propel one of said actuators and another of said transmissions being companion with and serving to propel another of said actuators, and means associated with at least one of said transmissions for varying the speed thereof during rotation of said spindle without affecting the speed of the other transmission.

85. In material working apparatus of the class described, a support, a spindle rotatable within said support, a plurality of shiftable machine elements, an actuator coupled with each of said elements, a plurality of transmissions driven in timed relation with said spindle, one of said transmissions being companion with and serving to propel one of said actuators and another of said transmissions being companion with and serving to propel another of said actuators, and means associated with each transmission whereby the speed of either transmission may be varied with respect to the other during the rotation of the spindle.

86. In material working apparatus of the class described, a prime mover, a plurality of shiftable machine elements, actuators for each of said shiftable elements, a plurality of transmissions driven from said prime mover, each of said transmissions being companion to and connected with one of said actuators, and means for adjustably varying the speed of at least one of said transmissions independently of the other transmission during the functioning of said prime mover.

87. In material working apparatus of the class described, a prime mover, a plurality of shiftable machine elements, a hydraulic actuator connected with each of said elements including a piston within a cylinder, a plurality of pumping mechanisms driven in synchronism with said prime mover, each of said pumping mechanisms being companion to and connected with one of said hydraulic actuators, and means associated with one of said pumping mechanisms for varying the displacement thereof independently of the displacement of the other pumping mechanism during the functioning of the prime mover, whereby to effect a variation in the speed of one of said hydraulic actuators with respect to and independently of the other.

88. A hydraulic actuator system comprising a hydraulically operated actuator, a low pressure circuit for imparting rapid traverse to said actuator, a high pressure circuit for imparting slower feeding movement thereto, a valve included within the low pressure circuit for controlling the movement of said actuator, and means controlled in response to the movement of said valve for initiating and arresting the operative functioning of said high pressure circuit.

89. A hydraulic actuator system comprising a hydraulically operated actuator, a low pressure circuit for imparting rapid traverse to said actuator, a high pressure circuit for imparting slower feeding movement thereto, a valve included wholly within the low pressure circuit for controlling the movement of said actuator, and means controlled in response to the movement of said valve for initiating and arresting the operative functioning of said high pressure circuit.

90. In a hydraulic actuator system for controlling the movements of and for actuating machine parts, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, fluid propelling means for delivering fluid at a relatively rapid rate to said cylinder, fluid propelling means for delivering fluid at a slower rate to said cylinder, and shiftable valve means adapted in one position to allow the by-passing of fluid from the first mentioned propelling means and to connect the second fluid propelling means in a closed circuit with said actuator.

91. In a hydraulic actuator system for controlling the movements of and for actuating machine parts, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, fluid propelling means for delivering fluid at a relatively rapid rate to said cylinder, fluid propelling means for delivering fluid at a slower rate to said cylinder, a shiftable valve adapted in one position to allow the by-passing of fluid from the first mentioned propelling means and to connect the second fluid propelling means in a closed circuit with said actuator, and means operable in response to the shifting of said valve for controlling the initiating and arresting of the operative functioning of said second fluid propelling means.

92. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston and cylinder relatively reciprocable with respect to each other, fluid propelling means for delivering fluid to said actuator and connected in a closed circuit therewith, a valve mechanism including a valve member shiftable within a casing, said valve member having a central neutral position for effecting the by-passing of fluid from said fluid propelling mechanism and adapted to be shifted to opposite sides of said neutral position for directing fluid in opposite directions to said actuator, and means for effecting the unbalancing of said valve member to shift the same to one side of said neutral position.

93. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a relatively small delivery pump for imparting uniform feeding speed to said actuator, a relatively large delivery pump for imparting rapid movement to said actuator, a source of fluid supply, and automatically shiftable valve means adapted in one position to effect the by-passing of fluid from said large delivery pump to said source of supply under relatively low pressure during the operative functioning of the small delivery pump and to maintain said small delivery pump hydraulically operative, and in another shifted position to direct fluid from said large delivery pump for propelling said actuator at a rapid rate, said large delivery pump being operable for propelling purposes only during said rapid traverse movement of the actuator.

94. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator

including a piston and cylinder relatively movable with respect to each other, a relatively small delivery pump for imparting feeding movement to said actuator, a relatively large delivery pump for imparting rapid movement to said actuator, a source of fluid supply, and automatically shiftable valve means adapted in one position to effect the by-passing of fluid from said large delivery pump to said source of supply under relatively low pressure during the operative functioning of the small delivery pump, and in another shifted position to direct fluid from said large delivery pump for propelling said actuator at a rapid rate, said large delivery pump being operable for propelling purposes only during said rapid traverse movement of the actuator, said small delivery pump being chargeable from a source which is independent of fluid delivered by said large delivery pump.

95. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a hydraulic feeding circuit, a hydraulic rapid traverse circuit, a constantly driven rapid traverse pump within said latter circuit, a feed pump within said feeding circuit, means for driving said feed pump, and shiftable means operable in accordance with the direction of fluid flow in the rapid traverse circuit for controlling the operative functioning of said feed pump.

96. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a rotary spindle, a feed pump mechanically connected with said spindle, said feed pump being connected with said actuator for propelling same at a feeding rate, means for imparting rapid movement to said actuator, and means for effecting the arresting of the movement of the spindle and consequently the flow of fluid from the feed pump to said actuator during the rapid traverse of said actuator.

97. In material working apparatus, a rotary spindle, a shiftable machine part, a hydraulic actuator for shifting said part including a piston and cylinder relatively movable with respect to each other, a feed pump, driving means for delivering power to said spindle and pump, said pump being adapted to propel the shiftable machine part at a feeding rate, means for imparting a rapid traverse movement to said machine part, and control means for initiating the rapid traverse movement of said machine part and for simultaneously effecting the stopping of the spindle rotation whereby to permit said shiftable machine part to travel in a given direction while said spindle remains stationary.

98. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator, a fluid pump for propelling said actuator, said pump including a plurality of shiftable members for subjecting fluid received by said pump to increased pressure, a control valve in said pump adapted to prevent the slippage of fluid from the high to the low pressure side of said pump, means for adjusting said valve to maintain the proper fit thereof in accordance with the pressure conditions within the system, and means hydraulically connecting said pump with said actuator.

99. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a pump for delivering fluid to said actuator, and fluid conducting means connecting said pump with said actuator, said pump having a plurality of shiftable members for subjecting received fluid to increased pressure, which members are shiftable to an inoperative position when movement of the actuator is interrupted so as to render said pump functionally inoperative for propelling purposes, thereby preventing the building up of an excessive fluid pressure within the system.

100. In a hydraulic actuator system for controlling the movements of machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a pump for delivering fluid to said actuator, and fluid conducting means connecting said pump with said actuator, said pump having a plurality of shiftable plungers for subjecting received fluid to increased pressure, which plungers are shiftable to an inoperative position when movement of the actuator is interrupted so as to render said pump functionally inoperative for propelling purposes, thereby preventing the building up of an excessive fluid pressure within the system.

101. The method of hydraulically propelling a machine part or the like, such as a relatively shiftable piston and cylinder structure connectable with a machine part to be moved, which consists in delivering fluid under pressure from a suitable source such as a pump to the intake side of the actuator as a confined body, directing fluid from the discharge side of said actuator as a confined body to the intake side of the source or pump in such a manner that uniform movement in a given direction will be experienced by the actuator irrespective of variations in fluid pressure acting on opposite sides of said actuator, and maintaining the fluid employed substantially free from air.

102. The method of hydraulically propelling a machine part or the like such as a relatively shiftable piston and cylinder structure connectable with a machine part to be moved, which consists in delivering fluid at a relatively rapid rate from a source of supply, such as a large displacement pump, to said actuator, suddenly cutting off said source of supply and simultaneously introducing fluid at a slower rate from a suitable source of supply, such as a small displacement pump, to said actuator, and employing the sudden increase in fluid pressure resulting from the tendency of the actuator to continue at a rapid rate to preload the advancing side of the actuator and thereby enable the part driven thereby to change from rapid movement to slower movement without experiencing pulsative effects.

103. The method of hydraulically propelling a machine part or the like such as a relatively shiftable piston and cylinder structure connectable with a machine part to be moved, which consists in delivering fluid at a relatively rapid rate from a source of supply, such as a large displacement pump, to said actuator, suddenly cutting off said source of supply and simultaneously introducing fluid at a slower rate from a suitable source of supply, such as a small displacement pump, to said actuator, employing the sudden increase in fluid pressure resulting from

the tendency of the actuator to continue at a rapid rate to preload the advancing side of the actuator and thereby enable the part driven thereby to change from rapid movement to slower movement without experiencing pulsative effects, and maintaining the fluid last delivered within a closed circuit.

104. In a hydraulic actuator system the combination of a fluid operated actuator, piston supporting means, a plurality of pistons reciprocably mounted in said supporting means, valve mechanism for controlling the delivery of fluid toward and away from said pistons, said valve mechanism including means cooperating with a surface to prevent leakage of fluid from the high to the low pressure side of the system along said surface, a duct leading from the outlet of said valve mechanism to one side of the fluid operated actuator, and a duct leading from the intake of said valve mechanism to the other side of said actuator, whereby a closed fluid circuit is presented.

105. In a hydraulic actuator system the combination of a fluid operated actuator, piston supporting means, a plurality of pistons reciprocably mounted in said supporting means, valve mechanism for controlling the delivery of fluid toward and away from said pistons, said valve mechanism including a valve member cooperating with a surface to prevent leakage of fluid from the high to the low pressure side of the system along said surface, means for maintaining said valve member in operative relation with respect to said surface, a duct leading from the outlet of said valve mechanism to one side of the fluid operated actuator, and a duct leading from the intake of said valve mechanism to the other side of said actuator, whereby a closed fluid circuit is presented.

106. In a hydraulic actuator system the combination of a fluid operated actuator, piston supporting means, a plurality of pistons reciprocably mounted in said supporting means, a central tapered valve having inlet and outlet ports for controlling the delivery of fluid toward and away from said pistons, the tapered construction of said valve being such as to prevent leakage of fluid from the high to the low pressure side of the system along the surface thereof, a fluid chamber at one end of said valve which communicates with the intake port thereof, a duct leading from the outlet port of said valve to one side of the fluid operated actuator, and a duct leading from the other side of said actuator to the intake port of said valve, whereby a closed fluid circuit is presented.

107. In material working apparatus of the class described, a frame, a shiftable carriage on said frame, a fluid operated actuator for shifting said carriage, a piston supporting means, a plurality of pistons reciprocably mounted within said supporting means, valve mechanism for controlling the flow of fluid toward and away from said pistons, a duct leading from one side of the valve mechanism to one side of the fluid operated actuator, a second duct leading from the other side of the valve mechanism to the other side of said actuator, rotary driving means for shifting said pistons, and means operable from a point externally of the stationary piston supporting means for laterally adjusting said rotary means to vary the stroke of said pistons.

108. In a material working apparatus of the class described, a frame, a shiftable carriage on said frame, a fluid operated actuator for shifting said carriage, a piston supporting means, a plurality of pistons reciprocably mounted within said supporting means, a central valve, a duct leading from the outlet side of the valve to one side of the fluid operated actuator, a second duct leading from the other side of said actuator to the intake side of the valve, rotary driving means for imparting reciprocation to said pistons, and adjusting means operable from a point externally of the piston supporting means for laterally adjusting the rotary driving means to vary the stroke of said pistons.

109. In material working apparatus of the class described, rotary supporting means, a feed pump adapted to be driven in synchronism with said rotary supporting means, driving means, a machine part to be shifted, a hydraulic actuator connected with said machine part, means establishing hydraulic communication between the feed pump and said actuator, and means for controlling the starting and stopping of the rotary supporting means while maintaining the feed pump hydraulically coupled with said actuator.

110. In material working apparatus of the class described, a supporting spindle, a fluid propelling mechanism driven in timed relation with said supporting spindle, a fluid operated actuator, and means connecting said fluid propelling mechanism with said actuator in a closed circuit, whereby a governed amount of travel is experienced by the actuator for each revolution of the supporting spindle.

111. In material working apparatus of the class described, a frame, a spindle rotatably mounted in said frame, a fluid propelling mechanism adapted to impart a speed to the fluid operated actuator which is constantly proportional to the rotative speed of said spindle, a fluid operated actuator connected with said fluid propelling mechanism by means of ducts presenting a closed circuit, whereby uniform movement of said actuator is experienced irrespective of variations in fluid pressure in the opposite sides thereof, and means directly connecting the spindle with said fluid propelling mechanism, whereby rotation of the spindle will automatically cause fluid to be propelled by said propelling mechanism.

112. In material working apparatus of the class described, a rotary supporting means, a variable displacement pump driven from the rotary supporting means, a fluid operated actuator connected with said variable displacement pump, an adjustable delivery gear pump connected with said fluid operated actuator, whereby the delivery of low pressure fluid to said actuator may be adjustably controlled, means for adjusting the delivery of both pumps without varying the speed of said pumps, and means for selectively controlling the functioning of said pumps with respect to said actuator.

113. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connectable with said ducts, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling means for propelling fluid at a uniform feeding rate and connectable with said actuator, the functioning of said second circuit being independent of the functioning of the first circuit

and the ducts in one circuit controlling the flow of fluid from one of the fluid propelling means to the actuator independently of the flow of fluid from the other fluid propelling means to the actuator.

114. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connected with said ducts, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling means connectable with said actuator, the functioning of said second circuit being independent of the functioning of the first circuit, said second circuit being combined with the actuator so that the fluid therein may be motionless when the first circuit functions to move the actuator in a reverse direction.

115. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connected with said ducts, a second fluid circuit for imparting feeding movement to said actuator, the functioning of said second circuit being independent of the functioning of the first circuit, pump driving mechanism, and control means for enabling the fluid propelling means to circulate fluid at substantially no pressure and to control the stopping of the feeding fluid flow when the actuator is at rest.

116. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connected with said ducts, a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling means and connectable with said actuator, driving means for said second fluid propelling means, a clutch for controlling the delivery of power from said driving means, and control mechanism for enabling the circulation of fluid from the first mentioned fluid propelling means at substantially no pressure and for controlling the functioning of the clutch mechanism to stop the second fluid propelling means when the actuator is at rest.

117. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a fluid propelling means for imparting feeding movement to said actuator, means for actuating the propelling mechanism in said second circuit, and means operable in response to the functioning of one of said circuits for controlling the means for actuating the fluid propelling mechanism in the other circuit.

118. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure circuit connected to said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connected with said actuator for imparting a slower feeding movement thereto, each of said circuits being adapted to function independently of the other, a second fluid operated actuator connectible with said low and high pressure circuits, and a single valve mechanism for controlling the operative functioning of both the high and low pressure circuits.

119. In material working apparatus of the class described, a frame, a spindle rotatably mounted within said frame, a plurality of shiftable machine carriages, a hydraulic actuator for each carriage, a variable displacement pump connected with each actuator, and means associated with each pump and operable from a point externally thereof for controlling fluid displacement, each of said pumps being positioned to enable an operator to have an unobstructed view of the carriages and contemporaneous convenient access to the pump adjusting means, whereby adjustment of the speed of travel of either of said carriages may be controlled irrespective of the distance to be traveled by said carriages.

120. In material working apparatus of the class described, a frame, a spindle rotatably mounted within said frame, a plurality of shiftable machine carriages, a hydraulic actuator for each carriage, a variable displacement pump connected with each actuator, and means associated with each pump and operable from a point externally thereof for controlling fluid displacement during the operative functioning of said pumps, each of said pumps being positioned to enable an operator to have an unobstructed view of the carriages and contemporaneous convenient access to the pump adjusting means, whereby adjustment of the speed of travel of either of said carriages may be controlled irrespective of the distance to be traveled by said carriage.

121. A system of hydraulic control and actuation including a hydraulic actuator, a relatively high pressure pumping mechanism for imparting uniform feeding movement to said actuator, a second pumping mechanism for imparting rapid traverse to said actuator, and a shiftable control mechanism for said pumping mechanisms comprising a member shiftable within a casing adapted in one shifted position to direct fluid from the first mentioned pump for feeding purposes to said actuator independently of said second mentioned pumping mechanism.

122. A system of hydraulic control and actuation including a hydraulic actuator, a relatively high pressure pumping mechanism for imparting uniform feeding movement to said actuator, a second pumping mechanism for imparting rapid traverse to said actuator, and a control mechanism for rendering the second pumping mechanism functionally inoperative for propelling purposes with respect to the actuator during the functioning of the first mentioned pumping mechanism and for maintaining said feeding pumping mechanism hydraulically operative and for rendering the first pumping mechanism functionally inoperative for propelling purposes with respect to the actuator during the operative functioning of the second mentioned mechanism.

123. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connectable with said ducts, a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling means connectible with said actuator, the functioning of said second circuit being independent of the functioning of the first circuit, pump driving mechanism, control

means for enabling the first fluid propelling means to circulate fluid at substantially no pressure and to control the stopping of the other fluid propelling means when the actuator is at rest, and a fluid reservoir for supplying fluid to said first mentioned fluid propelling means, said reservoir being positioned at a point which is above the fluid operated actuator.

124. A system of hydraulic control including a hydraulic actuator, a feed pump for propelling said actuator at a feeding rate, a rapid traverse pump for propelling said actuator at a faster rate, and a shiftable valve mechanism adapted to occupy a neutral position, a forward position, and a reverse position, said valve in its neutral position serving to effect the circulation of the fluid from only one of the pumps and simultaneously conditioning the actuator for receiving fluid from the other pump for propelling purposes.

125. In combination with a rotary supporting spindle and driving mechanism associated therewith, a system of hydraulic control including a hydraulic actuator, a feed pump for imparting feeding movement to said actuator, a rapid traverse pump for imparting rapid movement to said actuator, pump driving means, and a shiftable control mechanism for controlling the stopping of the spindle and for controlling the operative effectiveness of said pumps, said control mechanism in one shifted position causing the stopping of the spindle, the simultaneous stopping of the flow of fluid from the feed pump to the actuator for propelling purposes, and the simultaneous delivery of fluid in a reverse direction to said actuator from said rapid traverse pump.

126. A system of hydraulic control including a hydraulic actuator, a feed pump connectible with said actuator, a rapid traverse pump connectible with said actuator, a shiftable valve mechanism for controlling the delivery of fluid from said rapid traverse pump to said actuator and for rendering said feed pump operable in a closed circuit with respect to said actuator, and means including a restricted orifice to compensate for differences in volumetric capacities on opposite sides of the actuator.

127. A system of hydraulic control including a hydraulic actuator, a feed pump connectible with said actuator, a rapid traverse pump connectible with said actuator, a shiftable valve mechanism for controlling the delivery of fluid from said rapid traverse pump to said actuator and for rendering said feed pump operable in a closed circuit with respect to said actuator, and a restricted passageway furnishing limited communication between the fluid in said closed circuit and the fluid discharged by the rapid traverse pump without disturbing the operative functioning of said closed circuit.

128. In a hydraulic actuator system, a hydraulic actuator for propelling machine parts and the like, a feed pump for driving the actuator at a feeding rate, a rapid traverse pump for driving said actuator at a faster rate, means for setting up back pressure against the fluid discharged from said actuator during the operative functioning of the rapid traverse pump, the intake side of the feed pump being under the influence of said back pressure during the rapid traverse of the actuator in a given direction, whereby to maintain the fluid body at the intake side of the feed pump under pressure to thereby prevent the entrance of air within said body, and control means for governing the timed functioning of said pumps.

129. In a hydraulic actuator system, a hydraulic actuator for propelling machine parts and the like, a feed pump for driving the actuator at a feeding rate, a rapid traverse pump for driving said actuator at a faster rate, means for setting up back pressure against the fluid discharged from said actuator during the operative functioning of the rapid traverse pump, the intake side of the feed pump being under the influence of said back pressure during the rapid traverse of the actuator in a given direction, means communicating with the discharge side of the feed pump whereby, when the actuator is moved in reverse direction through the influence of the rapid traverse pump, said discharge side of the feed pump will be subjected to the influence of said back pressure, and control means for governing the timed functioning of said pumps.

130. In a hydraulic actuator system, a hydraulic actuator for propelling machine parts and the like, a feed pump for driving the actuator at a feeding rate, a rapid traverse pump for driving said actuator at a faster rate, means for setting up back pressure against the fluid discharged from said actuator during the operative functioning of the rapid traverse pump, the intake side of the feed pump being under the influence of said back pressure during the rapid traverse of the actuator in a given direction, whereby to maintain the fluid body at the intake side of the feed pump under pressure, and control means for governing the timed functioning of said pumps and for causing the flow of fluid from the feed pump to the actuator to stop when said actuator is driven in reverse direction by the rapid traverse pump.

131. In metal working apparatus, a reciprocable supporting means, a rotary supporting means, a transmission for delivering power to said rotary supporting means, a shiftable actuator member, a transmission for delivering power to said actuator member connected with said reciprocable supporting means, means positively connecting said transmissions to effect uninterrupted synchronized movement of said transmissions whereby a change in speed of one of said transmissions will correspondingly affect the speed of the other transmission when variation in load is experienced by said shiftable actuator member, a source of power supply common to both transmissions, independent means for imparting rapid traverse to said actuator member without affecting the positive connection between said transmissions, and control means for governing the timed functioning of said transmissions.

132. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connectable with said ducts, valve means adapted to control the starting and direction of flow of fluid within said ducts, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling mechanism connectable with said actuator for delivering fluid under relatively high pressure into said actuator at a uniform feeding rate, the functioning of said second circuit being independent of the functioning of the first circuit.

133. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse

of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connected with said ducts, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling mechanism for delivering fluid at a uniform feeding rate and connectible with said first mentioned ducts whereby said fluid propelling mechanism is adapted to dispatch fluid to said actuator in accordance with the direction of movement thereof established by said rapid traverse circuit, the functioning of said second circuit being independent of the functioning of the first circuit.

134. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connectable with said ducts, valve means for controlling the starting and direction of fluid flow within said ducts and for intermittently rendering the rapid traverse circuit functionally operable during the movement of the actuator in a given direction, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling mechanism connectable with said actuator and adapted to deliver fluid at a uniform feeding rate, the functioning of said second circuit being independent of the functioning of the first circuit.

135. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connectible with said ducts, valve means adapted to control the starting and direction of flow of fluid within said ducts, a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling mechanism connectible with said actuator and adapted to deliver fluid at a uniform feeding rate, the functioning of said second circuit being independent of the functioning of the first circuit, and means for effecting a variation in fluid flow in either of said circuits to thereby control the speed of said actuator.

136. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure fluid circuit connectable with said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connected with said actuator for imparting a slower feeding movement thereto, each of said circuits being adapted to function independently of the other, means within said high pressure fluid circuit for varying the amount of fluid flow to said actuator to thereby control the speed of said actuator, and means for selectively controlling the functioning of said circuits.

137. In a hydraulic actuator system for moving machine parts and the like, a fluid reservoir, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a fluid propelling means for imparting feeding movement to said actuator, and means for rendering said second circuit functionally operable in response to the fluid flow in the first mentioned circuit, whereby to enable the circulation of fluid in the first circuit into said reservoir.

138. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a fluid propelling means for imparting feeding movement to said actuator, and means for rendering said first mentioned circuit functionally inoperative during the functioning of said second circuit, whereby the fluid in said second circuit will impart feeding movement to the actuator independently of said first mentioned circuit, the fluid in the return side of said circuits being maintained under a predetermined pressure.

139. In material working apparatus of the class described, rotary supporting means, variable fluid pressure generating means directly driven from said rotary means, a driving means, and means for connecting and disconnecting the rotary means with respect to said driving means, said variable fluid pressure generating means being operable automatically when rotation is imparted to said rotary supporting means.

140. In material working apparatus of the class described, a rotary supporting means, fluid pressure generating means driven in timed relation with said rotary supporting means, a fluid operated actuator, and means connecting said fluid propelling mechanism with said actuator so as to prevent slippage of fluid from the high to the low pressure side of said fluid pressure generating means, said fluid pressure generating means and actuator being included within a closed fluid circuit, said fluid pressure generating means being operable automatically in response to the rotation of the spindle.

141. In apparatus of the class described, a rotary supporting means, a fluid propelling mechanism driven in timed relation with said supporting means, said fluid propelling mechanism being adapted to impart a speed to said fluid operated actuator which is constantly proportional to the rotary speed of said rotary supporting means, a fluid operated actuator, sealed ducts connecting said fluid propelling mechanism with said actuator whereby, in response to rotation of the supporting means, the fluid propelling mechanism operates automatically to propel the actuator, and means for preventing suction on the intake side of the fluid propelling mechanism.

142. An apparatus of the class described, a spindle, a fluid operated actuator, and a fluid propelling mechanism adapted to impart a speed to the fluid operated actuator which is constantly proportional to the speed of movement of said spindle, said propelling mechanism and actuator being included within a closed fluid circuit in a manner to enable the fluid discharged from said actuator to have a pressure charging effect upon said fluid propelling mechanism, said propelling mechanism being operable automatically in response to the rotation of the spindle.

143. In apparatus of the class described, a rotary supporting spindle, a fluid pressure generating means driven in timed relation with said spindle, a support, fluid actuated means for moving said second support, ducts connecting said fluid actuated means with said fluid pressure generating means, the fluid in said ducts being sealed against leakage from the system whereby a predetermined movement of said second supporting means is experienced in response to each revolution of the supporting spindle, and means for automatically controlling the degree of movement of said second support.

144. In apparatus of the class described, a

rotary supporting spindle, a fluid pressure generating means driven in timed relation with said spindle, a support, fluid actuated means for moving said second support, ducts connecting said fluid actuated means with said fluid pressure generating means, the fluid in said ducts being sealed against leakage from the system whereby a predetermined movement of said second supporting means is experienced in response to each revolution of the supporting spindle, and single control means for causing the stopping of one of said supports and the simultaneous reversal of the other of said supports.

145. In apparatus of the class described, a rotary supporting spindle, a fluid pressure generating means driven in timed relation with said spindle, a tool support, fluid actuated means for moving said tool second support, ducts connecting said fluid actuated means with said fluid pressure generating means, the fluid in said ducts being sealed against leakage from the system whereby a predetermined movement of said second tool supporting means is experienced in response to each revolution of the supporting spindle, and hydraulically actuated single control means for causing the stopping of one of said supports and the simultaneous reversal of the other of said supports.

146. In apparatus of the class described, a main supporting spindle, a hydraulic actuator, a prime mover for driving said spindle, and a fluid propelling mechanism driven in timed relation with said supporting spindle and said prime mover, said propelling mechanism and hydraulic actuator being included within a closed circuit, the linear movement of the actuator being constantly proportional to the degree of movement experienced by said spindle.

147. In material working apparatus of the class described, a supporting spindle, a fluid propelling mechanism driven in timed relation with said supporting spindle, a fluid operated actuator, and means connecting said fluid propelling mechanism with said actuator in a manner to confine fluid bodies on opposite sides of the actuator, whereby said actuator during the movement thereof is subjected to fluid pressure on opposite sides and whereby a governed amount of travel is experienced by the actuator for each revolution of the supporting spindle.

148. In apparatus of the class described, a supporting spindle, a fluid propelling mechanism driven in timed relation with said supporting spindle, a fluid operated actuator, closed ducts connecting said fluid propelling mechanism with said actuator whereby, in response to rotation of the supporting spindle, the fluid propelling mechanism operates automatically to propel the actuator, rapid traverse mechanism for propelling said actuator at a faster speed, and fluid actuated mechanism for governing the rotation of said supporting spindle and for governing the operative functioning of said rapid traverse mechanism.

149. In material working apparatus, a frame, a spindle rotatably supported thereby, a prime mover for rotating said spindle, a shiftable carriage, a hydraulic actuator for relatively shifting said carriage and spindle, a variable displacement pump driven in timed relation with said spindle and prime mover for propelling said actuator, pumping means for delivering fluid at a low pressure to said actuator for rapid traverse purposes, said second pump being operable independently of said first mentioned pump, and means controlled by the low pressure fluid for governing the operative functioning of said prime mover.

150. In an automatic lathe of the class described, a frame, a spindle rotatably mounted in said frame, a variable displacement pump driven from said spindle, a shiftable carriage, a fluid operated actuator connected with said pump for shifting said carriage, said connection including ducts for delivering fluid discharged by the pump to one side of the actuator for propelling purposes and for directing fluid under pressure from the discharge side of the actuator to the intake side of the pump, a driving means, a clutch mechanism for controlling the delivery of power from the driving means to the spindle, a gear pump driven by said driving means for delivering fluid at low pressure to said actuator, and a second fluid operated actuator for controlling the clutch mechanism, said actuator being operatively connectable with said gear pump.

151. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure circuit connected to said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connected with said actuator for imparting a slower feeding movement thereto, each of said circuits being adapted to function independently of the other, a second fluid operated actuator, a single valve mechanism for controlling the functioning of said circuits, and means for varying the rate of fluid flow to said actuators to thereby control the individual speed of each actuator during the feeding movement thereof.

152. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure circuit connectable with said actuator for imparting rapid traverse thereto, a high pressure fluid circuit connectable with said actuator for imparting a slower feeding movement thereto, each of said circuits being adapted to function independently of the other, a second fluid operated actuator connected with said low and high pressure circuits, valve mechanism connected wholly within the low pressure circuit for rendering said circuit functionally inoperative during the functioning of the high pressure circuit, and means for varying the rate of fluid flow to said actuators whereby to govern the speed of said actuators during the feeding movement thereof.

153. In material working apparatus, a rotary supporting means, driving means therefor, fluid pressure generating means driven in timed relation with said rotary supporting means, a carriage, said carriage and rotary supporting means being relatively shiftable in a plurality of directions, a hydraulic actuator for effecting relative movement between the spindle and carriage in a given direction, said actuator being connected on one side thereof with the intake side of said fluid pressure generating means, and the opposite side of said actuator being connected with the outlet side of said fluid pressure generating means, a second hydraulic actuator for imparting relative movement to the spindle and carriage in another direction, said last mentioned actuator being connectible in a closed circuit with said fluid pressure generating means, and means for selectively controlling the operative functioning of said actuators.

154. In material working apparatus, a frame structure, a rotary spindle supported thereby, a supporting carriage, a hydraulic actuator for effecting relative movement between the spindle

and said carriage, a feed pump for imparting feeding movement to said hydraulic actuator, an electric motor for rotating said spindle and for driving said feed pump, a rapid traverse pump for propelling said actuator at a relatively rapid rate, a reservoir for supplying fluid to said rapid traverse pump, valve mechanism for governing the operative functioning of said pumps and the direction of movement of said hydraulic actuator, said valve mechanism being adapted to render the feed pump functionally operable independently of said rapid traverse pump by permitting the circulation of fluid from the reservoir through said rapid traverse pump and thence to said reservoir, and restricted orifice means for directing returned fluid to said reservoir.

155. In material working apparatus of the class described, a shiftable carriage, a fluid operated actuator for shifting said carriage, a high pressure pump for delivering fluid for feeding purposes to said actuator, means for varying the effective flow of fluid to the actuator for propelling purposes and thereby govern the rate of feeding movement of said actuator, a low pressure circuit including a second pump for propelling fluid in said circuit, and a valve mechanism connected wholly within said low pressure circuit for controlling the direction of flow of fluid in said circuit.

156. In material working apparatus of the class described, a shiftable carriage, a fluid operated actuator for shifting said carriage, fluid propelling mechanism for delivering fluid to said actuator for feeding purposes, a low pressure fluid circuit connected with said actuator, said circuit including a second fluid propelling mechanism and power operated shiftable valve mechanism for connecting said second fluid propelling mechanism and said actuator, said valve mechanism being adapted in one shifted position to effect circulation of low pressure fluid and in another shifted position to render said low pressure fluid operable for propelling said actuator at a rapid traverse speed, means for unbalancing the fluid pressure within said valve mechanism to effect the shifting thereof, and means for controlling the actuation of the unbalancing means.

157. A system of hydraulic control and actuation including a hydraulic actuator, a relatively high pressure pumping mechanism for imparting feeding movement to said actuator, the fluid interposed between the discharge side of said actuator and the intake side of said pumping mechanism being maintained at a pressure which is sufficient to insure the operative functioning of said pumping mechanism, a second pumping mechanism for imparting rapid traverse to said actuator, and a shiftable control mechanism adapted in one shifted position to direct fluid from the first mentioned pump for feeding purposes to said actuator independently of said second mentioned pumping mechanism.

158. A system of hydraulic control and actuation including a hydraulic actuator, a relatively high pressure pumping mechanism for imparting feeding movement to said actuator, the fluid interposed between the discharge side of said actuator and the intake side of said pumping mechanism being maintained at a pressure which is sufficient to insure the operative functioning of said pumping mechanism, a second pumping mechanism for imparting rapid traverse to said actuator, and a control mechanism for rendering the second pumping mechanism functionally inoperative for propelling purposes with respect to the actuator during the functioning of the first mentioned pumping mechanism.

159. In a hydraulic actuator system for moving machines parts and the like, a hydraulic actuator including a piston within a cylinder, a high pressure pumping mechanism for imparting feeding movement to said actuator, the fluid interposed between the discharge side of said actuator and the intake side of said pumping mechanism being maintained at a pressure, a second fluid propelling means for imparting rapid traverse to said actuator, and hydraulically actuated valve means for rendering the second mentioned propelling means functionally inoperative for propelling purposes with respect to the actuator piston during the operative functioning of the other propelling means.

160. In material working apparatus of the class described, a prime mover, a hydraulic actuator including a piston within a cylinder, fluid propelling mechanism driven in timed relation with said prime mover and adapted to impart a speed to the actuator which is constantly proportional to the speed of travel of said prime mover, means connecting said fluid propelling mechanism with said hydraulic actuator, means operable in synchronism with said prime mover for imparting rapid movement to said actuator, and means for selectively controlling the operative functioning of the fluid propelling mechanism and the means for imparting movement to the actuator.

161. A hydraulic actuator system comprising a hydraulically operated actuator, a low pressure circuit for imparting rapid traverse to said actuator, a high pressure circuit for imparting slower feeding movement thereto, and control mechanism including valve means within the low pressure circuit having an arrangement of ports for governing the direction of fluid flow to said actuator and adapted, when directing fluid thereto in a given direction to move said actuator at a rapid rate a predetermined distance, to render the feeding circuit operative for propelling purposes and to simultaneously circulate the rapid traverse circuit at substantially no pressure, said valve means being further adapted, when fluid is directed thereby to the actuator in the opposite direction, to render the feeding circuit functionally inoperative and the rapid traverse circuit functionally operative for imparting rapid reverse movement to said actuator.

162. A hydraulic actuator system comprising a hydraulically operated actuator, a low pressure circuit for imparting rapid traverse to said actuator, a high pressure circuit for imparting slower feeding movement thereto, and control mechanism including valve means wholly within the low pressure circuit having an arrangement of ports for governing the direction of fluid flow to said actuator and adapted, when directing fluid thereto in a given direction to move said actuator at a rapid rate a predetermined distance, to render the feeding circuit operative for propelling purposes and to simultaneously circulate the rapid traverse circuit at substantially no pressure, said valve means being further adapted, when fluid is directed thereby to the actuator in the opposite direction, to render the feeding circuit functionally inoperative and the rapid traverse circuit functionally operative for imparting rapid reverse movement to said actuator.

163. In a hydraulic actuator system for controlling the movements of machine parts, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other,

fluid propelling means for delivering fluid at a relatively rapid rate to said cylinder, fluid propelling means for delivering fluid at a slower rate to said cylinder, and automatically shiftable valve mechanism for controlling the timed functioning of the actuator, said valve mechanism being constructed and arranged so that in one position it serves to prevent direct communication between said first mentioned fluid propelling means and said actuator and to simultaneously condition the second mentioned fluid propelling means operable to propel said actuator.

164. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a hydraulic feeding circuit, a hydraulic rapid traverse circuit, a constantly driven rapid traverse pump within said latter circuit, a feed pump within said feeding circuit, means for driving said feed pump, and shiftable means cooperative with the fluid flow in the rapid traverse circuit for controlling the operative functioning of at least one of said pumps.

165. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a rotary spindle, a feed pump mechanically connected with said spindle, said feed pump being connected with said actuator for propelling same at a feeding rate, means for imparting rapid movement to said actuator, and means for effecting the arresting of the movement of the spindle and consequently the flow of fluid from the feed pump to said actuator during the rapid traverse of said actuator, the arresting of the flow of fluid to and from said feed pump serving to render the rapid traverse means functionally operable.

166. In a machine tool, a frame structure, a supporting spindle rotatably mounted therein, rotary spindle driving transmission, supporting means, actuator means for effecting relative movement between said supporting spindle and said supporting means, feeding transmission for said actuator means, a prime mover for driving both transmissions, power operated rapid traverse transmission for causing said actuator means to effect relative movement between said spindle and supporting means to a feeding position and for causing reversal of said actuator means, said feeding transmission and rotary tool driving transmission being driven in synchronism from said prime mover, and means for rendering said rapid traverse transmission functionally ineffective to thereby condition the feeding transmission for operatively propelling said actuator means.

167. In a machine tool, a frame structure, a supporting spindle rotatably mounted therein, rotary spindle driving transmission, supporting means, actuator means for effecting relative movement between said support spindle and said supporting means, feeding transmission for said actuator means, a prime mover for driving both transmissions, power operated rapid traverse transmission for causing said actuator means to effect relative movement between said spindle and supporting means to a feeding position and for causing reversal of said actuator means, said feeding transmission and rotary tool driving transmission being driven in synchronism from said prime mover, and means for rendering said rapid traverse transmission functionally ineffective to thereby condition the feeding transmission for operatively propelling said actuator means, said feeding and rapid traverse transmissions being simultaneously operable in propelling said actuator means during at least a portion of the cycle of movement thereof.

168. The combination with a rotary supporting spindle, supporting means movable relatively thereto and actuator means for effecting said relative movement, of a spindle transmission for governing the rotation of said spindle, feeding transmission for governing the relative movement between said spindle and supporting means, means for synchronously driving said transmissions, rapid traverse transmission for effecting rapid movement between said spindle and supporting means, and control mechanism for rendering said rapid traverse transmission functionally inoperative with respect to said actuator means to thereby condition said feeding and spindle transmissions functionally operative.

169. In a fluid transmission system and control mechanism therefor, a first fluid circuit including fluid pressure generating means therefor, a second fluid circuit including a second fluid pressure generating means adapted to move fluid as a unit in said second circuit, control mechanism including a shiftable plunger within a housing for determining the starting and stopping of fluid flow in said circuits, and means responsive to the flow of fluid in at least one of the circuits for variously and automatically positioning said control mechanism.

170. In a fluid transmission system for machine tools and the like, a first fluid circuit including fluid pressure generating means therefor, control mechanism including a shiftable plunger within a housing for determining the starting and stopping of the fluid flow in said circuit, a second fluid circuit including a second fluid pressure generating means which is adapted to be functionally operative independent of said first fluid pressure generating means, and means for maintaining fluid within said second circuit to provide an abutment for fluid in said first circuit when said second circuit is functionally inoperative.

171. In a fluid transmission system for machine tools and the like, a first fluid power circuit including fluid pressure generating means therefor, driving means for said fluid pressure generating means, control mechanism for said circuit including a shiftable plunger within a housing for determining the starting and stopping of fluid flow in said circuit, a second fluid pressure generating means, driving means for said second fluid pressure generating means independent of the first mentioned driving means, and means automatically actuated by said first circuit for starting and stopping of fluid flow in said second circuit in timed relation with the fluid flow in said second circuit.

172. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, means positively connecting said transmissions to effect uninterrupted synchronized movement of said transmissions, a source of power supply common to both transmissions, independent means for imparting rela-

tive rapid traverse to said actuator member without affecting said positive connection of said transmissions, and control means for governing the timed functioning of said transmissions.

173. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, a source of power supply common to both transmissions, a unitary means for coupling said transmissions for driving purposes with said source of power supply to effect uninterrupted synchronized movement of said transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, and control means for governing the timed functioning of said independent means for imparting relative rapid traverse.

174. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, a source of power supply common to both transmissions, a single clutch means for coupling said transmissions for driving purposes with said source of power supply to effect uninterrupted synchronized movement of said transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, and control means for governing the timed functioning of said clutch means and said independent means for imparting relative rapid traverse.

175. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, a source of power supply common to both transmissions, a single clutch means for coupling said transmissions for driving purposes with said source of power supply to effect uninterrupted synchronized movement of said transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, control means for governing the timed functioning of said clutch means and said independent means for imparting relative rapid traverse, and fluid power means for actuating said clutch means.

176. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, means positively connecting said transmissions to effect uninterrupted synchronized movement of said transmissions when variation in load is experienced by at least one of said supporting means, a source of power supply common to both transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, and control means for governing the timed functioning of said transmissions.

177. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, an adjustable feed transmission for delivering power to said actuator member, means positively connecting said transmissions to effect uninterrupted synchronized movement of said transmissions, a source of power supply common to both transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, and control means for governing the timed functioning of said transmissions.

178. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, means positively connecting said transmissions to effect uninterrupted synchronized movement of said transmissions, speed change gearing for at least one of said transmissions, a source of power supply common to both transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, and control means for governing the timed functioning of said transmissions.

179. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, an adjustable transmission driven by said rotary supporting means, a unitary means for connecting and disconnecting and for starting and stopping the rotation of said rotary supporting means, whereby to effect synchronized starting and arresting of both the adjustable transmission and the relatively movable supporting means, a source of power supply common to both transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting the connection between said transmissions, and control means for governing the timed functioning of said transmissions.

180. In a metal working apparatus, a rotary supporting means, a transmission for delivering power to said supporting means, a second supporting means relatively movable with respect to said rotary supporting means, a shiftable actuator member for causing said relative movement, a feed transmission for delivering power to said actuator member, means positively connecting said transmissions to effect uninterrupted synchronized movement of said transmissions, a source of power supply common to both transmissions, independent means for imparting relative rapid traverse to said actuator member without affecting said positive connection of said transmissions, and an automatic control means actuated in synchronism with the speed of said shiftable actuator member for governing the timed functioning of said transmissions.

181. In a machine tool structure, a rotary supporting spindle, driving means therefor, a reciprocable supporting member, a rapid traverse transmission for said supporting member, a slower feed transmission for propelling said supporting member independently of said rapid traverse transmission, power means for actuating said spindle driving means and said transmissions, shiftable control elements for selectively causing the reciprocable member to be driven by either of said transmissions, one of said control elements being shiftable as an incident to the shifting of another of said control elements, and an initiating member adapted when shifted to a given position to cause one of said control elements to shift in a preselected direction whereby to initiate actuation of another of said control elements.

182. In a machine tool structure, a rotary supporting spindle, driving means therefor, a supporting member movable in forward and reverse directions, a rapid traverse transmission for said supporting member, a slower feed transmission for propelling said supporting member independently of said rapid traverse transmission, power means for actuating said spindle driving means and said transmissions, shiftable control elements for selectively causing the reciprocable member to be driven by either of said transmissions and in either forward or reverse direction, one of said control elements being shiftable as an incident to the shifting of another of said control elements, an initiating member adapted when shifted in a given direction to cause one of said control elements to shift in a predetermined direction whereby to initiate actuation of another of said control elements, and means for shifting said first mentioned control element so as to cause said supporting member to be moved in a reverse direction.

183. In a fluid transmission system for machine tools and the like, a first fluid circuit including fluid pressure generating means therefor, control mechanism including a shiftable plunger within a housing for determining the direction of fluid flow in said circuit and control circuit means for causing said plunger to be shifted to its reverse position, a second fluid circuit including a second fluid pressure generating means which is adapted to be functionally operable independently of said first fluid pressure generating means, and means for initiating the fluid flow in said control circuit as an incident to the flow of fluid in said second circuit, the fluid within said second circuit being secured against effective flowing when said second circuit is functionally inoperative.

184. In a fluid transmission system for machine tools and the like, hydraulic actuator means movable in forward and reverse directions, a first fluid circuit including fluid pressure generating means for propelling said actuator means at a relatively rapid rate, in forward and reverse directions, control mechanism including a shiftable control member for determining the direction of fluid flow in said circuit, secondary control circuit means for causing said control member to be shifted to its reverse position whereby said first fluid circuit will cause said hydraulic actuator means to move in a reverse direction, and a second fluid circuit including a second fluid pressure generating means for propelling said actuator means at a slower speed in the forward direction, said second fluid pressure generating means being adapted to operatively function independently of said first fluid pressure generating means.

185. In a fluid transmission system for machine tools and the like, a first fluid circuit including rapid traverse fluid pressure generating means, a second fluid circuit including slow traverse fluid pressure generating means which is adapted to be functionally operable independently of said rapid traverse fluid pressure generating means and means operable as an incident to the fluid flow in said first fluid circuit to cause said slow traverse fluid pressure generating means to be rendered functionally ineffective.

186. A fluid transmission system for machine tools and the like, a hydraulic actuator member, two sources of fluid supply, means for conducting fluid from said sources to said actuator for propelling purposes, and control means operable for enabling the fluid from both of said sources to simultaneously act upon said actuator member during a predetermined movement of said actuator member and including means operable in response to the shifting of said actuator member by the action of fluid from both of said sources to enable the positive continued movement of said actuator member under the influence of fluid from only one of said sources.

187. In a transmission for machine tools and the like, a rotary supporting spindle, a transmission for said spindle, a supporting member relatively translatable with respect to said spindle, feed transmission for relatively translating said supporting member and spindle, rapid traverse transmission for relatively translating said supporting member and spindle independently of said feed transmission, and means including mechanism for arresting operation of said feed and spindle transmissions, which arresting serves to render said rapid traverse transmission functionally operable independently of said feed transmission.

188. In a transmission for machine tools and the like, a rotary supporting spindle, a transmission for said spindle, a supporting member relatively translatable with respect to said spindle, feed transmission for relatively translating said supporting member and spindle, rapid traverse transmission for relatively translating said supporting member and spindle in forward and reverse directions independently of said feed transmission, and means including mechanism for arresting operation of said feed and spindle transmissions, which arresting serves to render said rapid traverse transmission functionally operable independently of said feed transmission for causing relative reverse movement of said supporting member and spindle.

189. In a fluid transmission system and control mechanism therefor, a first fluid circuit including fluid pressure generating means therefor and restricted orifice means for maintaining a predetermined pressure in said circuit, a second fluid circuit including a second fluid pressure generating means adapted to move fluid as a unit in said second circuit, control mechanism including a shiftable plunger within a housing for determining the starting and stopping of fluid flow in said circuits, and means responsive to the flow of fluid in at least one of the circuits for variously and automatically positioning said control mechanism.

190. In a fluid transmission system and control mechanism therefor, a first fluid circuit including fluid pressure generating means therefor, a second fluid circuit including a second fluid pres-

sure generating means and means for preventing leakage whereby to move fluid as a unit in said second circuit, control mechanism including a shiftable plunger within a housing for determining the starting and stopping of fluid flow in said circuits, and means responsive to the flow of fluid in at least one of the circuits for variously and automatically positioning said control mechanism.

191. In a hydraulic actuator system for moving machine parts and the like, an actuator including a cylinder and piston, fluid pressure generating means having intake and outlet ports, a closed duct leading from the intake of the fluid pressure generating means to one side of the actuator piston, a second closed duct leading from the outlet of the fluid pressure generating means to the opposite side of the actuator piston, whereby fluid may be sealed against leakage within said ducts and moved as a unit for effecting the movement of said actuator, and a second fluid pressure generating means adapted to intermittently shift said actuator and, as an incident to said shifting, cause intermittent replacement of the fluid which is shifted as a unit by said first mentioned pressure generating means.

192. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connected with said ducts, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling mechanism and ducts connecting said mechanism with said actuator, the functioning of said second circuit being independent of the functioning of the first circuit, the fluid under pressure in said first circuit serving to seal the fluid in the second circuit against leakage.

193. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a fluid circuit including rapid traverse fluid generating means for effecting rapid traverse of said actuator, said circuit including ducts connected with opposite sides of the actuator and fluid propelling means connected with said ducts, and a second fluid circuit for imparting feeding movement to said actuator, said second circuit including a fluid propelling mechanism connectible with said actuator, the functioning of said second circuit being independent of the functioning of the first circuit, the fluid in said second circuit being sealed against leakage by the fluid pressure developed by said rapid traverse fluid pressure generating means.

194. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a low pressure fluid circuit connected to said actuator for imparting rapid traverse thereto in opposite directions, a high pressure fluid circuit including adjustable fluid pressure generating means connected with said actuator for imparting slower feeding movement thereto at various rates, each of said circuits being adapted to function independently of the other, and means for selectively controlling the functioning of said circuits.

195. In material working apparatus of the class described, a rotary supporting member, driving means therefor including a prime mover, fluid propelling mechanism driven in timed relation with said supporting member and having means for preventing slippage of fluid from the high to the low pressure side thereof, said means including valve means within said fluid propelling mechanism, hydraulically actuated clutch means for coupling said prime mover with said driving means, a fluid operated actuator, and ducts connecting said actuator with said fluid propelling mechanism, the fluid propelling mechanism and ducts being so arranged that fluid contained therein may be moved as a unit whereby the movement experienced by said actuator will be directly proportional to the movement of the supporting member, and fluid power means to move said actuator at a faster speed and to actuate said clutch means.

196. In material working apparatus of the class described, rotary supporting means, driving means therefor including a prime mover, a variable displacement plunger pump directly driven by said rotary means, hydraulically actuated clutch means for connecting and disconnecting the rotary means with respect to said driving means, said plunger pump being operable automatically when rotation is imparted to said rotary supporting means, and a second pump adapted to furnish fluid pressure to actuate said clutch.

197. An apparatus of the class described including a spindle, a fluid operated actuator, and a fluid propelling mechanism having means provided therein for sealing against leakage whereby to adapt said mechanism to impart a speed to said actuator which is constantly proportional to the speed of movement of said spindle, said propelling mechanism and actuator being included within a closed fluid circuit, said propelling mechanism being operable automatically in response to the rotation of said spindle.

198. In material working apparatus of the class described, a rotary supporting means, driving means therefor, a variable delivery fluid propelling mechanism driven by said rotary means, a shiftable carriage, a fluid operated actuator for moving said carriage, one extremity of said actuator being connected with the intake side of said fluid propelling mechanism, and the opposite extremity of said actuator being connected with the outlet side of said mechanism, a second carriage, a fluid operated actuator for moving said second carriage, a second variable delivery fluid propelling mechanism driven from said rotary supporting means, one extremity of said second actuator being connected with the inlet side of said second fluid propelling mechanism, and the opposite extremity of said actuator being connected to the outlet side of said mechanism, a rapid traverse pump providing the source of rapid traverse fluid for both of said actuators, and means operable in response to pressure of fluid from said rapid traverse pump for causing said variable delivery fluid propelling mechanisms to shift each of said actuators at preselected individual feeding rates.

199. In material working apparatus of the class described, a frame, a rotary supporting means, a shiftable carriage, a fluid operated actuator for shifting said carriage, a variable displacement pump for delivering fluid to said actuator, a gear pump for delivering fluid at low pressure to said actuator, and a reservoir for retaining a fluid medium, said reservoir being positioned above the level of the gear pump and above said fluid operated actuator, whereby to effect the delivery of fluid to said gear pump under pressure.

200. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a

plunger pump including shiftable pressure generating plungers, actuating means for said plungers and means interposed between said actuating means and said plungers for causing the plungers to experience substantially uniform acceleration and deceleration during the compression stroke thereof, whereby to cause the delivery of fluid under pressure at a substantially uniform rate to one side of the actuator piston, and means for directing fluid from the opposite side of said piston to the intake side of said fluid propelling means, the fluid from the discharge side of said actuator being sufficient to charge the intake side of said fluid propelling means, whereby said actuator experiences constant linear travel in accordance with the uniform delivery of fluid by said plunger pump.

201. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump including shiftable pressure generating plungers, actuating means for said plungers and means interposed between said actuating means and said plungers for causing the plungers to experience substantially uniform acceleration and deceleration during the compression stroke thereof, whereby to cause the delivery of fluid under pressure at a substantially uniform rate to one side of the actuator piston, and means for directing fluid from the opposite side of said piston to the intake side of said variable displacement plunger pump, the fluid from the discharge side of said actuator being sufficient to charge the intake side of said plunger pump, whereby said actuator experiences constant linear travel in accordance with the uniform delivery of fluid by said plunger pump.

202. In material working apparatus of the class described, a prime mover, a hydraulic actuator including a piston within a cylinder, a plunger pump driven in timed relation with said prime mover, said plunger pump including shiftable pressure generating plungers, actuating means for said plungers, and means interposed between said actuating means and said plungers for causing the plungers to experience substantially uniform acceleration and deceleration during the compression stroke thereof, whereby to impart a linear speed to the actuator which is constantly in synchronism with the speed of travel of said prime mover, and fluid conducting means free from air connecting said plunger pump with said hydraulic actuator.

203. In material working apparatus of the class described, a prime mover, a hydraulic actuator including a piston within a cylinder, plunger pump driven in timed relation with said prime mover, said plunger pump including shiftable pressure generating plungers, actuating means for said plungers, and means interposed between said actuating means and said plungers for causing the plungers to experience substantially uniform acceleration and deceleration during the compression stroke thereof, whereby to impart a linear speed to the actuator which is constantly proportional to the speed of travel of said prime mover, fluid conducting means free from air connecting said plunger pump with said hydraulic actuator, and means for imparting rapid movement to said actuator.

204. In a hydraulic actuator system for controlling the movement of machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling mechanism for delivering fluid under relatively high pressure to propel the actuator at a feeding rate, a second relatively low pressure fluid propelling mechanism for propelling said actuator piston at a rapid rate, shiftable valve means for selectively controlling the delivery of fluid from the low pressure means to the actuator, said valve means serving in one shifted position to operatively connect the low pressure propelling mechanism with the actuator and in another shifted position to render said propelling mechanism functionally inoperative for propelling purposes with respect to said hydraulic actuator, and restriction means for receiving fluid discharged from said actuator during the rapid traverse movement thereof, whereby, upon the termination of the movement of the actuator at a rapid rate, the high pressure fluid is maintained operative for propelling purposes during the feeding movement of said actuator.

205. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, and a plunger pump including shiftable pressure generating plungers, actuating means for said plungers, and means interposed between said actuating means and said plungers for causing said plungers to experience substantially uniform acceleration and deceleration during the compression stroke thereof, said plungers being adapted to discharge fluid under relatively high pressure to one side of said actuator during one portion of their stroke and to receive fluid for charging purposes during the opposite stroke thereof, the discharge side of said actuator serving to force fluid under pressure from said cylinder to the pump plungers for effecting the charging stroke thereof.

206. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, fluid pressure generating means for delivering fluid at a relatively rapid rate to said cylinder, fluid pressure generating means for delivering fluid at a slower rate to said cylinder, a fluid reservoir, a shiftable valve adapted in one position to allow the by-passing of fluid from said first mentioned fluid pressure generating means into said reservoir and to connect the second fluid pressure generating means in a closed circuit with said actuator, and means for restricting the flow of fluid returned to said reservoir.

207. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a hydraulic feeding circuit, a hydraulic rapid traverse circuit, a constantly driven rapid traverse pump within said latter circuit, a feed pump within said feeding circuit, means for driving said feed pump, shiftable means operable in accordance with the direction of fluid flow in the rapid traverse circuit for controlling the operative functioning of said feed pump, and restriction means within said rapid traverse circuit for presenting the required fluid pressure to actuate said shiftable means.

208. In material working apparatus of the class described, a rotary supporting member, a pump driven in timed relation with said supporting member, a transmission for said rotary supporting member, a fluid operated actuator, ducts connecting said actuator with said pump,

said ducts and pump being so arranged that the movement experienced by the actuator will be directly proportional to the degree of rotation of said rotary supporting member, means for adjusting the displacement of said pump, and pick-off gears for controlling the speed at which said pump is driven by said rotary supporting member.

209. In a hydraulic actuator system, a hydraulic actuator including a piston and cylinder construction, fluid propelling means for delivering fluid at a rapid rate to said cylinder, fluid propelling means for delivering fluid at a slower, uniform feeding rate to said cylinder, and shiftable valve means adapted in one position to allow the by-passing of fluid from the first mentioned propelling means, whereby to render the second fluid propelling means functionally operable for propelling said actuator.

210. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a relatively small delivery pump adapted to deliver fluid at a uniform feeding rate for imparting feeding movement to said actuator, a relatively large delivery pump for imparting rapid movement to said actuator, a source of fluid supply, and shiftable valve means adapted in one position to effect the by-passing of fluid from said large delivery pump to said source of supply under relatively low pressure during the operative functioning of the small delivery pump, and in another shifted position to direct fluid from said large delivery pump for propelling said actuator at a rapid rate, and fluid control means operated by fluid from one of said pumps for controlling the operative effectiveness of the small delivery pump.

211. In a hydraulic actuator system, the combination of a fluid operated actuator, piston supporting means, a plurality of pistons reciprocably mounted in said supporting means adapted to deliver fluid under pressure at a uniform feeding rate, valve mechanism for controlling the delivery of fluid toward and away from said pistons, said valve mechanism including means cooperating with a surface to prevent leakage of fluid from the high to the low pressure side of the system along said surface, a duct leading from the outlet of said valve mechanism to one side of the fluid operated actuator, and a fluid delivery duct connected with the intake of said valve mechanism.

212. In apparatus of the class described, a rotary supporting means, a fluid propelling mechanism for delivering fluid at a uniform feeding rate and driven in timed relation with said supporting means, said fluid propelling mechanism being adapted to impart a speed to said fluid operated actuator which is constantly proportional to the rotary speed of said rotary supporting means, a fluid operated actuator, duct means connecting said fluid propelling mechanism with said actuator whereby, in response to rotation of the supporting means, the fluid propelling mechanism operates automatically to propel the actuator, and means for maintaining a predetermined fluid pressure on the intake side of said fluid propelling mechanism.

213. In material working apparatus, a source of fluid supply, a shiftable carriage, a fluid operated actuator for shifting said carriage, fluid propelling mechanism for delivering fluid to said actuator for imparting a uniform feeding speed thereto, low pressure fluid circuit means connectible with said actuator and including a second fluid propelling mechanism, shiftable valve mechanism positioned wholly within said low pressure circuit means adapted in one shifted position to allow by-passing of the low pressure fluid and in another shifted position to block the return of the low pressure fluid to said source of supply, hydraulically actuated means for shifting said valve mechanism, and means for controlling the actuation of said hydraulically actuated means.

214. In material working apparatus, a source of fluid supply, a shiftable carriage, a fluid operated actuator for shifting said carriage, a high pressure pump for delivering fluid at a uniform rate of flow for feeding purposes to said actuator, means for varying the effective flow of fluid to the actuator for propelling purposes and thereby govern the rate of feeding movement of said actuator, a low pressure circuit including a second pump for propelling fluid in said circuit, and hydraulically shiftable valve mechanism for receiving only low pressure fluid, said valve mechanism adapted in one shifted position to allow the circulation of fluid to said source of supply, and in another shifted position to block said circulation.

215. A system of hydraulic control, including a hydraulic actuator, high pressure pump mechanism for imparting feeding movement to said actuator, means for maintaining the fluid at the discharge side of said actuator under pressure, a second pumping mechanism for imparting rapid traverse to said actuator, shiftable control mechanism adapted in one shifted position to direct fluid from the first mentioned pump for feeding purposes to said actuator, and fluid responsive means for automatically controlling the operative effectiveness of said high pressure pumping mechanism with respect to said actuator.

216. In a hydraulic actuator system for moving machine parts and the like, a fluid operated actuator, a circuit including fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a fluid propelling means for imparting feeding movement to said actuator, and fluid operated valve mechanism wholly within the rapid traverse circuit for rendering said rapid traverse circuit functionally operative for propelling said actuator at a rapid rate.

217. In a hydraulic actuator system for controlling the movements of and for actuating machine parts and the like, a hydraulic actuator including a piston and cylinder relatively movable with respect to each other, a hydraulic feeding circuit, a hydraulic rapid traverse circuit, a constantly driven rapid traverse pump within said latter circuit, a feed pump within said feeding circuit, means for driving said feed pump, and hydraulically shiftable means within the rapid traverse circuit for controlling the operative functioning of said feed pump with respect to said actuator.

218. In a hydraulic actuator system, a hydraulic actuator for propelling machine parts and the like, a feed pump for driving the actuator at a uniform feeding rate, a rapid traverse pump for driving said actuator at a faster rate, means for setting up back pressure against the fluid discharged from said actuator during the operative functioning of the rapid traverse pump, means for maintaining back pressure during the operative functioning of said feed pump whereby to main-

tain the fluid body at the outlet end of said actuator under a predetermined pressure, and control means for governing the timed functioning of said pumps with respect to said actuator.

219. In a hydraulic actuator system for shifting machine parts and the like, a fluid operated actuator, a source of fluid supply, a circuit including a fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a second fluid propelling means for imparting feeding speed to said actuator, said first circuit serving to condition said second circuit for propelling purposes with respect to said actuator, and means for by-passing said first fluid propelling means under a relatively low control pressure to said source of supply during the functioning of said second circuit, whereby the fluid in said second circuit will impart feeding movement to the actuator independently of said first circuit.

ERNEST J. SVENSON.

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Hereby enters this disclaimer to claims 13, 62, 69, 95, 121, 132, 136, 137, 163, 164, 166, 181, 182, 186, 209, 210, 215, and 219.

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tain the fluid body at the outlet end of said actuator under a predetermined pressure, and control means for governing the timed functioning of said pumps with respect to said actuator.

219. In a hydraulic actuator system for shifting machine parts and the like, a fluid operated actuator, a source of fluid supply, a circuit including a fluid propelling means for imparting rapid traverse to said actuator, a second circuit including a second fluid propelling means for imparting feeding speed to said actuator, said first circuit serving to condition said second circuit for propelling purposes with respect to said actuator, and means for by-passing said first fluid propelling means under a relatively low control pressure to said source of supply during the functioning of said second circuit, whereby the fluid in said second circuit will impart feeding movement to the actuator independently of said first circuit.

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