Oct. 4, 1949. K. F. GALLIMORE 2,483,535

RECIPROCATORY DRIVE FOR MACHINE TOOLS

Filed July 31, 1944 2 Sheets-Sheet 1

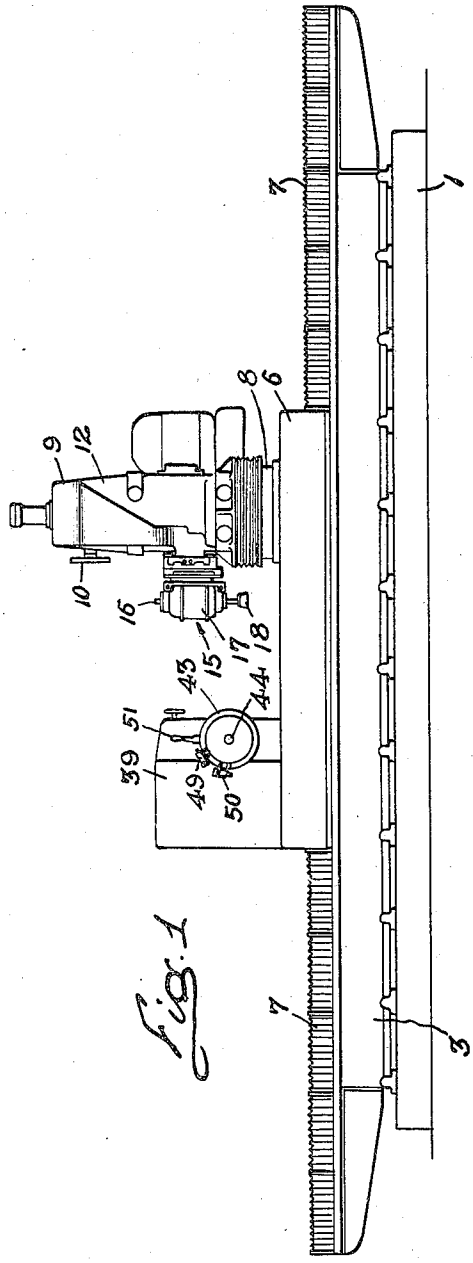


Fig. 1

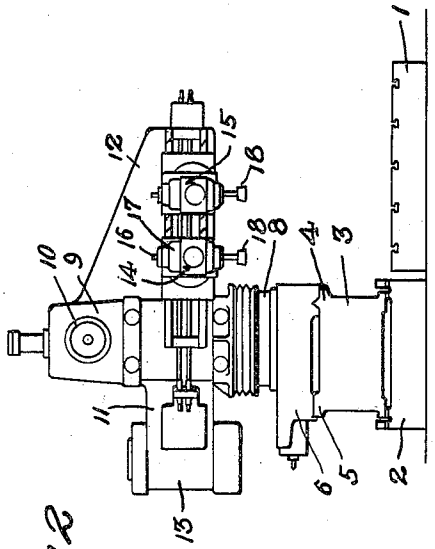


Fig. 2

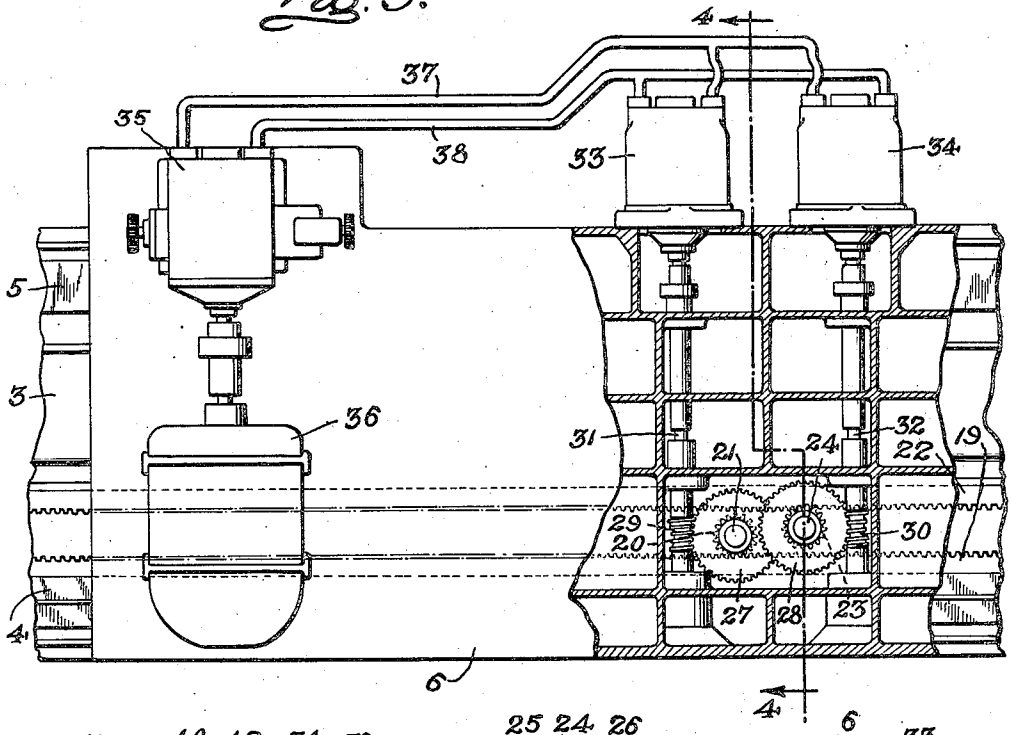
INVENTOR
Keith F. Gallimore
BY
Carlson, Pitzner, Hubbard & Wolfe
ATTORNEYS

Oct. 4, 1949. K. F. GALLIMORE 2,483,535

RECIPROCATORY DRIVE FOR MACHINE TOOLS

Filed July 31, 1944 2 Sheets-Sheet 2

Fig. 3.



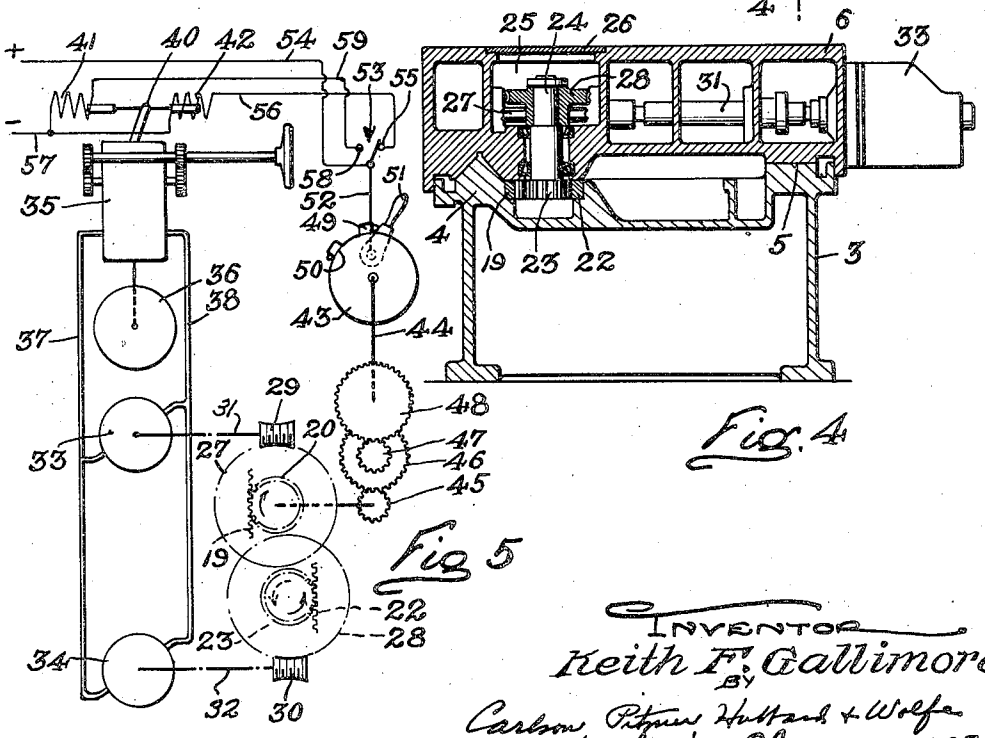


Fig. 4

Fig. 5

INVENTOR
Keith F. Gallimore
BY
Carlson, Pitzner, Hultman & Wolfe
ATTORNEYS

Patented Oct. 4, 1949

2,483,535

UNITED STATES PATENT OFFICE

2,483,535

RECIPROCATORY DRIVE FOR MACHINE TOOLS

Keith F. Gallimore, Fond du Lac, Wis., assignor to Giddings & Lewis Machine Tool Co., Fond du Lac, Wis., a corporation of Wisconsin

Application July 31, 1944, Serial No. 547,481

8 Claims. (Cl. 74—33)

1

The present invention relates generally to improvements in reciprocatory drives for machine tools, and has particular reference to a new and improved drive or transmission especially adapted for traversing heavy machine tool units having a long range of movement.

One of the objects of the invention is to provide a novel reciprocatory drive for a machine tool unit which is adapted to impart a uniform motion, particularly at the points of reversal.

Another object is to provide a new and improved drive which is adapted to impart a balanced force to the machine unit so as to avoid any tendency of the unit to rock crosswise of the guiding means.

A further object is to provide a novel drive of the foregoing character adapted to translate the unit over a long range of movement without requiring a supporting base of a length appreciably greater than that necessary to accommodate the movement.

A general object is to provide a new and improved reciprocatory drive for heavy machine tool units which is simple and inexpensive in construction, which is sturdy and reliable in operation, and which is readily adjustable to vary the rate and range of movement.

Other objects and advantages will become apparent as the description proceeds.

In the accompanying drawings,

Figure 1 is a front elevational view of a machine embodying the features of my invention.

Fig. 2 is an end elevational view of the machine.

Fig. 3 is an enlarged fragmentary plan view of the machine, partially in horizontal section to illustrate the drive.

Fig. 4 is a transverse vertical sectional view taken along line 4—4 of Fig. 3.

Fig. 5 is a diagrammatic representation of the drive and a reversal control therefor.

Referring more particularly to the drawings, the invention is adapted for use generally in various types of machines for traversing heavy machine units adjustably over an extended range of movement. Such machines may be adapted to perform various kinds of metal removing operations, such for example as milling or grinding long surfaces.

The invention is particularly useful for, and hence shown and described as embodied in, a machine for precision grinding hardened steel ways and other surfaces on large machine units, such for example as beds, columns, tables, saddles, rails, etc. Heretofore, machine ways have commonly been finished by slow and tedious hand scraping. The present machine eliminates these hand operations and their attendant difficulties by finish grinding the ways or other surfaces economically and with a high degree of accuracy.

2

The machine constituting the preferred embodiment of the invention comprises an elongated floor plate 1 adapted to support the work to be machined. For example, a machine bed (not shown) having longitudinal way surfaces on the top to be ground may be supported in stationary position on the plate 1. The machine also comprises a stationary base structure having an elongated sub-base 2 positioned alongside the floor plate 1, and an elongated bed 3, preferably of box-type construction, resting on the sub-base and substantially coextensive in length therewith. The bed 3 is formed on the top with suitable spaced parallel longitudinal ways 4 and 5 for slidably supporting a reciprocable saddle 6. In the present instance, the ways 4 and 5 are formed along the marginal edges of the bed 3, one way 4 being a guiding V-way, and the other way 5 being a flat supporting way. Suitable guards 7 in the form of accordion bellows are attached at opposite ends to the ends of the bed 3 and saddle 6, and serves in all positions of the saddle to enclose the top surfaces of the bed to protect the latter against the entry of foreign matter.

Supported on one end of the saddle 6 for movement therewith is a vertical column 8 which preferably is square in transverse construction and formed with vertical guiding means at the four corners. A tool supporting arm structure 9 is mounted on the column 8 for vertical adjustment along the guiding means, and is suitably counterbalanced and adapted to be adjusted manually by operation of a hand wheel 10 and to be clamped in selected position of adjustment. The arm structure 9 is formed with oppositely extending radial overarms 11 and 12 adapted to be supported selectively in operative position over the floor plate 1 for reciprocation with the saddle 6 along the surfaces of the workpiece to be machined. The overarm 11 supports a motorized roughing tool unit or head 13 which may comprise a large end face grinding wheel located on a vertical axis. Mounted on the other overarm 12 in laterally spaced relation and for independent adjustment longitudinally of the arm and also for angular adjustment are two tool units or heads 14 and 15. Each of the units 14 and 15 comprises a vertical grinding spindle 16 driven by a motor 17 and having a grinding wheel 18 on the lower end adapted to finish grind the work surfaces.

The present invention relates primarily to a reversible translatory drive for traversing the saddle 6 on the bed 3, and thereby causing the grinding wheels 18 to traverse the surfaces of the work to be ground. In the preferred form, the drive comprises two parallel longitudinal gear racks 19 and 22 mounted in fixed position in the top of the bed 3, and disposed with their teeth in opposed relation. Two suitable gear pinions 20 and 23 are in mesh respectively with the gear racks 19 and 22, and are fixed on the lower ends of two stub shafts 21 and 24 suitably journaled in the saddle 6. To avoid tooth interference, the pinions 20 and 23 and their shafts 21 and 24 are spaced longitudinally of the saddle 6, and are offset with respect to each other transversely of the saddle. The upper ends of the pinion shafts 21 and 24 extend into a gear chamber 25 formed by the webs in the upper portion of the saddle 6 and closed at the top by a removable access plate 26. Secured respectively to the upper ends of the shafts 21 and 24 within the chamber 25 are two worm gears 27 and 28 in mesh at opposite sides respectively with driving worms 29 and 30. Preferably, the worms 29 and 30 are of the hourglass type and formed to provide extensive engagement with the teeth of the worm gears. To permit a close center distance between the shafts 21 and 24, the worm gears 27 and 28 are disposed in different horizontal planes so as to permit overlapping of their peripheries.

It will be evident that the rack and gear drive for the saddle is simple and compact in construction. By providing the two rack and pinion assemblies, a strong and balanced drive is obtained. It should also be noted that both rack and pinion assemblies are located in closely spaced relation to the guiding V-way 4 with the result that during the normal translation of the saddle 6, and particularly at the points of reversal of movement, any tendency to rock the saddle crosswise is substantially avoided. Preferably, both racks 19 and 22 are mounted in the top of the bed 3 at the inner side of the way 4, but in closely spaced relation thereto. The innermost rack 22 thus is spaced somewhat further than the other rack 19 from the way 4, but due to the compact arrangement permitted by the use of the pinion drive, the racks are located closely together and the unequal spacing in relation to the way does not have any appreciable effect. It is to be understood, however, that the two racks 19 and 22 might be disposed at and along opposite sides of the V-way if an absolutely balanced relationship should be desired.

The drive worms 29 and 30 are, in turn, fixed respectively on two shafts 31 and 32 which extend through the gear chamber 25 transversely of the saddle 6 and which are suitably journaled in bearings supported in the saddle web structure. Provision is made for driving the worms simultaneously in the same direction with a balanced or differential action so that both rack and gear assemblies will act jointly and with equal force to drive the saddle 6. In the present instance, a hydraulic drive is employed, and this drive in its preferred form comprises two rotary hydraulic motors 33 and 34 coupled respectively to the worm shafts 31 and 32. The hydraulic motors may be of any suitable type, such for example as type C-411 made by the Oilgear Company, of Milwaukee, Wisconsin. These motors are of the reversible constant displacement type, and are flange-mounted on the rear wall of the saddle 6, and disposed with their operating shafts in axial

alinement with and directly coupled to the worm shafts 31 and 32.

Any suitable source of fluid under pressure may be provided for supplying fluid reversibly to the motors 33 and 34. In the present instance, the pressure source comprises a rotary pump 35 driven by an electric motor 36, and having discharge and return sides connected in a closed circuit through suitable conduits 37 and 38 in parallel to the intake and exhaust sides of the motors 33 and 34. Both the pump 35 and motor 36 are mounted on the saddle 6 and enclosed in a suitable control housing 39.

The pump 35 may be of the type DX-411 made by the aforesaid Oilgear Company. The details of this pump per se form no part of the present invention and, therefore, are not fully disclosed herein. It is sufficient to state that the pump 35 has a volume control member 40 which is shiftable through a central or neutral position defining zero displacement into opposite limit positions defining respectively preset displacements in opposite directions of delivery. The member 40 is operable under the control of valve means adapted to be actuated by solenoids 41 and 42. Thus, when the solenoid 41 is excited, the pump 35 will be adjusted to deliver fluid through the line 37 to the motors 33 and 34 and receive the return fluid from the motors through the line 38. Consequently, the motors 33 and 34 will operate simultaneously to effect rotation of the pinions 20 and 23, for example in the direction of the full arrows (Fig. 5) to translate the saddle 6 to the right. Upon energization of the solenoid 42, the pump 35 will be reversed to deliver fluid through the line 38 and receive return fluid through the line 37 so as to operate the motors 33 and 34 in the reverse direction, and thereby effect rotation of the pinions 20 and 23, for example in the direction of the dotted arrows to translate the saddle 6 to the left. When both solenoids are deenergized, the pump 35 will be adjusted into position of zero displacement, under which condition the saddle 6 will be idle. It will be understood that the rate of travel of the saddle 6 may be varied by adjustably limiting the operative positions of the pump control member 40 so that any preset pump delivery in either direction may be obtained.

By providing two hydraulic motors 33 and 34 of the reversible rotary type, the use of long columns of fluid tending to result in unevenness of travel is obviated, and the extent of saddle movement in both directions is not restricted by any physical limitations of the motors, but can be varied both as to extent and location, restricted only by the length of the bed 3. If motors of the cylinder and piston type were employed, they would be mounted within and extend longitudinally of the bed, and for a given maximum length of travel would require the bed to be provided with a greatly increased overall length.

The two hydraulic motors 33 and 34, being connected to receive fluid under pressure in parallel from the pump 35, and being connected through like parallel gear reduction drives to the rack and pinion assemblies, serve to exercise a differential action so that the pinions will exert substantially the same thrust against their respective racks 19 and 22 to share and equalize the load, and at the same time any slight irregularities or unevenness that may be present in the gear teeth of the racks and pinions will be compensated for.

Provision is made for effecting automatic re-

versal of the pump 35 to reciprocate the saddle 6 through a predetermined adjustable range. This means comprises a rotary control disk 43 mounted on a shaft 44 projecting from the control housing 39. The shaft 44 is connected for rotation in synchronism with the translation of the saddle 6, and to this end is driven from the worm shaft 31 through a train of reduction gears 45 to 48, as shown in Fig. 5. The speed ratio is such that the control disk 43 will be rotated through slightly less than one revolution, for example 300°, for translation of the saddle 6 through its maximum range of movement.

Adjustably mounted on the control disk 43 are two reversing stops or dogs 49 and 50 adapted for engagement alternately and respectively upon movement of the saddle 6 in opposite directions with a switch operating lever 51. This lever is mounted for swinging movement at the rear of the control disk 43 in the path of the dogs 49 and 50, and has an operating shaft 52 for actuating a limit switch 53 controlling the selective excitation of the valve solenoids 41 and 42.

In operation, at the end of the movement of the saddle 6 in one direction into one predetermined position, the dog 49 will engage the switch lever 51 to initiate swinging movement of the latter into one extreme position, for example as shown in Fig. 5. A suitable over-center device (not shown) is provided for completing the movement of the lever 51 with a snap action. In this position, a circuit is completed for the solenoid 42 from a suitable source of electric current through a line 54, one contact 55 of the switch 53, a line 56, the solenoid 42, and a line 57. Consequently, the pump adjusting member 40 will be actuated through neutral into one adjustable limited or preset position to reverse the delivery of the pump 35 and thereby effect reversal of the saddle 6. Upon movement of the saddle 6 in the opposite direction into another predetermined position, the other dog 50 will engage the switch lever 51 to initiate swinging movement of the latter into its opposite extreme position. The lever 51 thereupon will reverse the switch 53 to deenergize the solenoid 42 and energize the solenoid 41, the circuit being completed from the source through the line 54, the contact 58 of the switch 53, a line 59, the solenoid 41, and the line 57. Consequently, the pump adjusting member 40 will again be shifted through neutral into its opposite adjustable limit position to reverse the delivery of the pump, and thereby the direction of translation of the saddle 6.

With the control as shown, the saddle 6 will continue to reciprocate back and forth and, for each reciprocation, the total head may be manually adjusted downwardly in a feed increment. To stop the reciprocation when the work surface has been ground to the desired depth, or for any other purpose, the operator need merely shift the lever 51 into central and neutral position, thereby opening the switch 53 and permitting the pump adjusting member 40 to adjust the pump for zero displacement. A positive latching device may be provided for securing the lever 51 releasably in stop position.

It will be evident that I have provided a new and improved hydraulically actuated reciprocatory drive which is simple and compact in construction, and which is sturdy and reliable in operation and adapted to impart a balanced double thrust to the machine unit to be reciprocated. By arranging the drive in the immediate proximity of the guiding means for the machine unit, any side thrust against the guiding means is substantially avoided. The hydraulic drive provides an equalizing force adapted to compensate for any minor irregularities in the mechanical gear transmissions so that the machine unit is operated uniformly and smoothly. By employing rotary hydraulic motors, long columns of fluid under pressure with their attendant difficulties are avoided, so that the saddle will be translated and reversed smoothly.

I claim as my invention:

1. A reciprocatory drive for a translatory machine unit slidable on an elongated bed having a longitudinal guideway, said drive comprising, in combination, two closely spaced parallel oppositely facing longitudinal gear racks mounted on said bed adjacent to and alongside said guideway, two vertical shafts journaled in said unit and having drive pinions secured thereto and meshing respectively with said racks, two transverse shafts journaled in and extending crosswise of said unit, worm and worm gear assemblies respectively connecting said transverse shafts to said vertical shafts, two reversible rotary hydraulic motors mounted on said unit and coupled respectively to said shafts, a reversible variable delivery pump mounted on said unit and connected in a closed circuit in parallel with said motors whereby to rotate said motors in the same direction, said worm and worm gear assemblies being operable by said motors to rotate said vertical shafts relatively in opposite directions, and control means movable in synchronism with said unit and operable automatically to reverse the delivery of said pump upon movement of said unit respectively in opposite directions into predetermined positions of reversal.

2. A reciprocatory drive for a translatory machine unit slidable on an elongated bed having a longitudinal guideway, said drive comprising, in combination, two parallel longitudinal gear racks mounted on said bed adjacent to and alongside said guideway, two pinion shafts journaled in said unit and having drive pinions secured thereto and meshing respectively with said racks, two drive shafts journaled in and extending crosswise of said unit, worm and worm gear assemblies respectively connecting said drive shafts to said pinion shafts, two reversible rotary hydraulic motors mounted on said unit and coupled respectively to said shafts, a reversible variable delivery pump connected in parallel to said motors, and control means movable in synchronism with said unit and operable automatically to reverse the delivery of said pump upon movement of said unit respectively in opposite directions into predetermined positions of reversal.

3. A reciprocatory drive for a translatory machine unit slidable on an elongated bed having a longitudinal guideway, said drive comprising, in combination, two parallel longitudinal gear racks mounted on said bed adjacent to and alongside said guideway, two pinion shafts journaled in said unit and having drive pinions secured thereto and meshing respectively with said racks, two reversible rotary hydraulic motors operatively connected respectively to drive said shafts, and means for supplying fluid under pressure reversibly and in parallel to said motors.

4. A reciprocatory drive for a translatory machine unit comprising, in combination with an elongated bed having longitudinal guide means thereon, two spaced parallel oppositely facing longitudinal gear racks mounted on said bed ad-

jacent to and alongside said guide means, two vertical shafts journaled in said unit and having drive pinions secured thereto and meshing respectively with said racks, hydraulic motor means of the rotary type mounted on said unit and operatively connected to drive said shafts reversibly and relatively in opposite directions with a differential action, and means for supplying fluid under pressure reversibly to said motor means.

5. A reciprocatory drive for a translatory machine unit comprising, in combination with an elongated bed having longitudinal guide means thereon for said unit, two parallel longitudinal gear racks mounted on said bed adjacent to and alongside said guide means, two shafts journaled in said unit and having drive pinions secured thereto and meshing respectively with said racks, hydraulic motor means of the rotary type mounted on said unit and operatively connected to drive said shafts reversibly and relatively in opposite directions with a differential action, and means for supplying fluid under pressure reversibly to said motor means.

6. A reciprocatory drive for a translatory machine unit comprising, in combination with an elongated bed having longitudinal guide means for said unit, dual mechanical drive means connected in parallel to translate said unit reversibly along said guide means, two rotary hydraulic motors respectively connected to operate said drive means jointly with a differential balanced action, and a reversible variable delivery pump connected in parallel in a closed circuit with said motors to supply fluid under pressure reversibly to the latter and thereby to effect reciprocation of said unit in opposite directions, and means operable in response to movement of said unit into its opposite end positions to reverse the delivery of said pump.

7. A reciprocatory drive for a translatory machine unit comprising, in combination with an elongated bed having longitudinal guide means for said unit, dual mechanical drive means connected in parallel to translate said unit reversibly along said guide means, rotary hydraulic motor means respectively connected to operate said drive means jointly with a differential balanced action, and a reversible variable delivery pump connected to supply fluid under pressure reversibly to said motor means and thereby effect reciprocation of said unit in opposite directions, and means operable in response to movement of said unit into its opposite end positions to reverse the delivery of said pump.

8. A reciprocatory drive for a translatory machine element slidable on an elongated bed having a longitudinal guide way, said drive comprising, in combination, two closely spaced parallel oppositely facing longitudinal gear racks mounted on said bed adjacent to and alongside said guideway, two vertical shafts journaled in said unit and having drive pinions secured thereto and meshing respectively with said racks, and two drive motors mounted on said unit and operatively coupled respectively to said shafts to rotate said pinions respectively in opposite directions, whereby the side pressures between said racks and said pinions are balanced.

KEITH F. GALLIMORE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,571,323	Cole et al.	Feb. 2, 1926
1,912,060	Beattie et al.	May 30, 1933
1,990,237	Lloyd	Feb. 5, 1935
2,033,406	Vancil et al.	Mar. 10, 1936
2,118,489	Carter	May 24, 1938
2,120,196	Wright	June 7, 1938
2,303,639	Herfurth et al.	Dec. 1, 1942
2,336,911	Zimmermann	Dec. 14, 1943
2,360,671	Haas et al.	Oct. 17, 1944