May 1, 1945. M. A. MATHYS 2,374,764

HYDRAULIC POWER UNIT

Filed Jan. 25, 1943 2 Sheets-Sheet 1

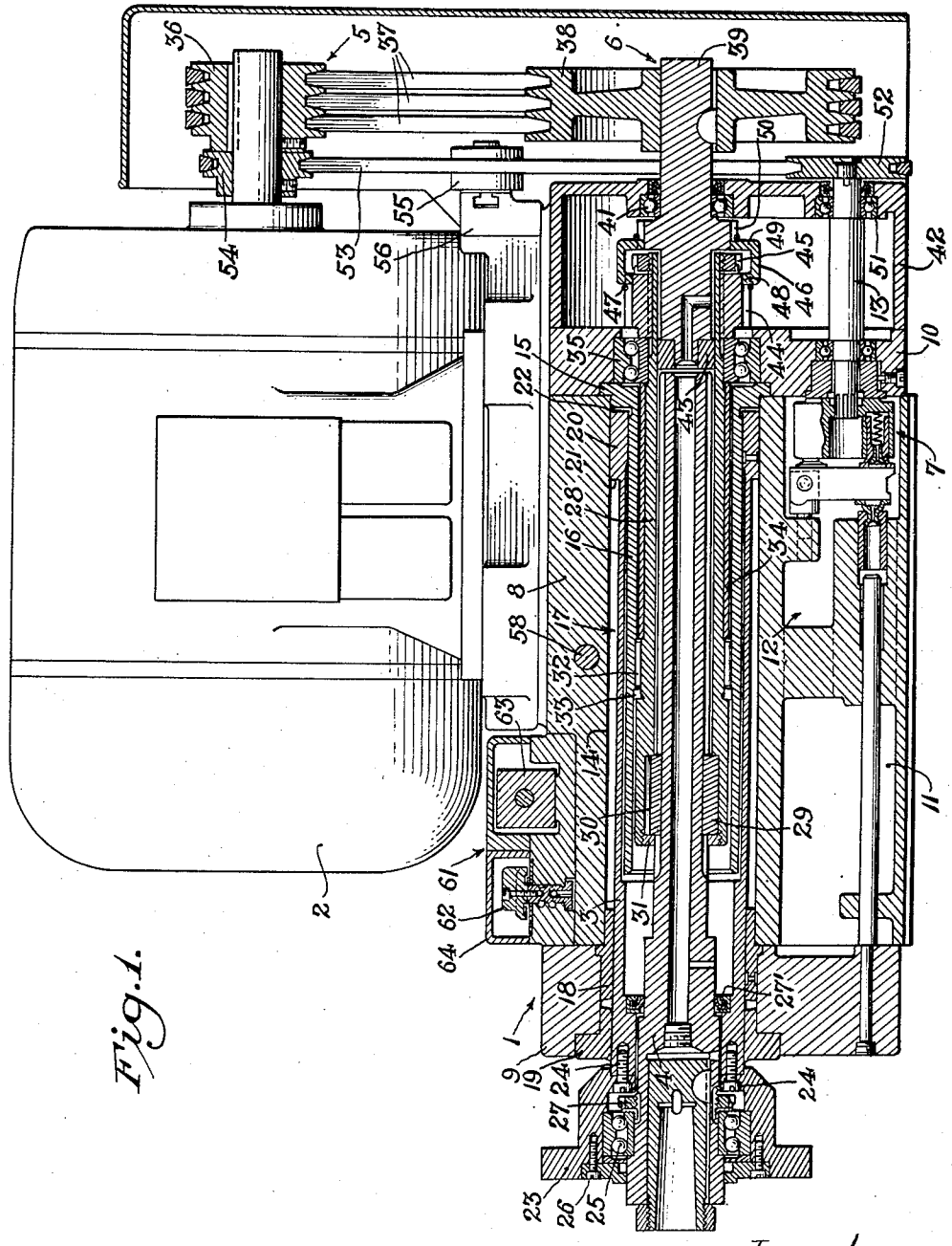


Fig. 1.

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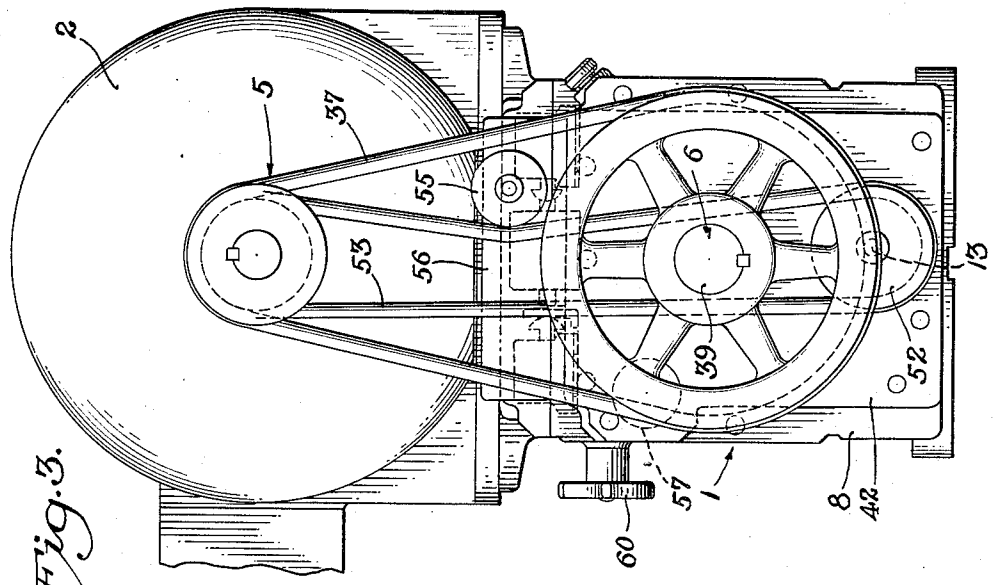


Fig. 3.

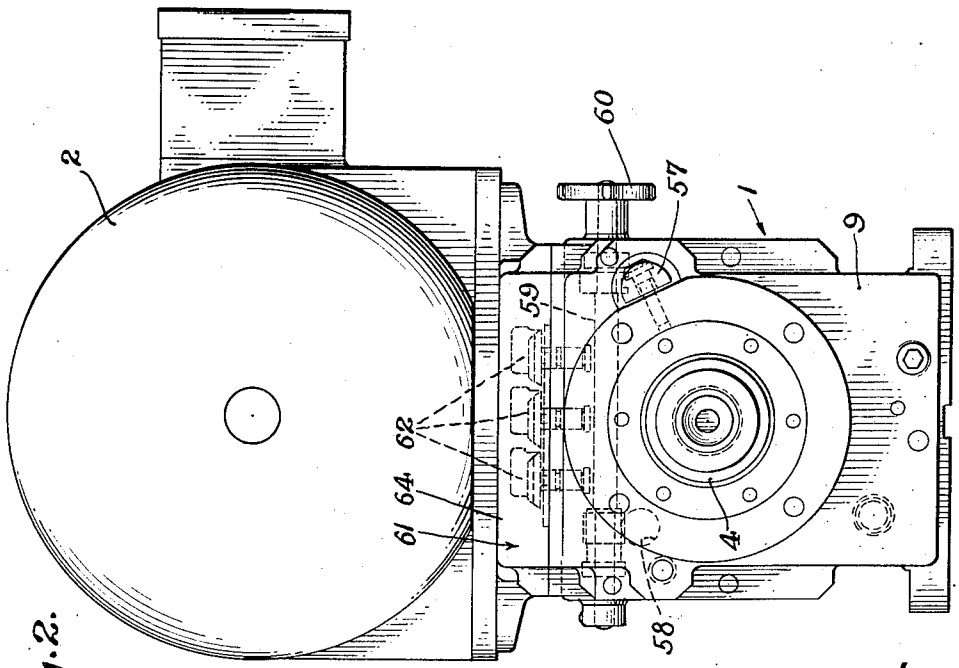


Fig. 2.

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UNITED STATES PATENT OFFICE

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HYDRAULIC POWER UNIT

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14 Claims. (Cl. 74—22)

The present invention pertains to hydraulic power units of the so-called self-contained type and has particular reference to power units in which the spindle is supported in a quill for translation axially relative to a head structure stationarily mounted upon a bed or base.

The general object of the invention is to provide an improved hydraulic power unit of the quill type, which is of simple and rugged construction and which provides for maximum length of spindle stroke for a power unit of given length.

Another object is to provide a combined spindle supporting quill and hydraulic actuator construction which not only lends compactness to the unit but which permits of the application of the translating force axially of the spindle.

A further object is to provide an improved hydraulic actuator for power units of the character indicated, together with a spindle drive mechanism of advantageous character.

The objects of the invention thus generally stated, together with other and ancillary advantages, are obtained by the construction and arrangement shown by way of illustration in the accompanying drawings forming a part hereof, in which:

Figure 1 is a longitudinal sectional view through the improved hydraulic power unit, the view being taken substantially centrally thereof but showing the driving motor in elevation.

Fig. 2 is a front end view of the unit.

Fig. 3 is a rear elevational view.

In the embodiment selected for purposes of illustration, the improved power unit comprises a head structure 1, generally rectangular in character, surmounted by an electric motor 2 having its axis extending in a direction lengthwise of the unit. 3 designates a quill mounted for translation in a front to rear direction in the head structure and rotatably supporting a tool spindle 4. At the rear of the unit is a belt drive mechanism 5 by which power is transmitted to a spindle drive mechanism 6 and also to a piston pump 7 enclosed within the lower portion of the head structure.

The head structure 1 comprises a central body member 8 and front and rear closure plates 9 and 10. In the lower portion of the structure are formed intercommunicating chambers 11 and 12 together constituting an oil reservoir, the pump 7 being contained in the rear chamber 12. The hydraulic system including the pump forms per se no part of the present invention and therefore may be of any suitable or preferred character. As shown, the pump is of the variable delivery swash plate type and has a drive shaft 13 suitably journaled in the rear closure plate 10 in the lower portion of the unit.

The body member 8 of the head structure is provided centrally thereof with a longitudinal bore 14 to form the outer wall of an annular space constituting the piston chamber of the hydraulic actuator for the unit. The rear end of the bore is closed by a rear cylinder cap 15, and rigid with and formed integral with this cap is a tubular member or sleeve 16 which extends forwardly from the cap in inwardly spaced relation to the bore so as to provide an annular piston chamber 17. At the forward end of the bore 14 the piston chamber is closed by a rearward extension 18 of a front cylinder cap 19.

The piston portion of the actuator is formed in the present instance at the rear end of the quill 3 by an integral external enlargement 20. The piston as shown is of the differential type, its forward pressure area 21 being approximately one-half that of its rear pressure area 22 formed by the rear end of the quill. At its forward end, the quill is slidable in the front cylinder cap 19, the annular space formed by the bore 14 and the sleeve 16 being open to receive the quill.

The spindle 4 is operatively connected with the forward end of the quill so as to permit of rotation of the spindle as well as axial feeding movement with the quill. For this purpose, the quill has a flanged head 23 secured to its forward end as by means of cap screws 24; and interposed between the head and the forward end of the spindle is a double row ball bearing 25 held between a cap plate 26 secured to the head and a nut 27 secured to the spindle. A suitable oil seal 27' is preferably interposed between the forward end portion of the quill and the spindle.

The portion of the spindle projecting rearwardly into the head structure is made of a diameter substantially less than the internal diameter of the sleeve 16 to provide an annular space for the reception of a tubular drive shaft 28 surrounding the spindle. The spindle is formed with spline grooves throughout the major portion of its length and carries a correspondingly splined sleeve 29 seated in a recess in the forward end of the tubular drive shaft and held against rotation therein by means of a pin 30. The spline sleeve together with the pin 30 are removably held in position by a collar 31.

Near its forward end the drive shaft 28 is rotatably supported in the stationary sleeve 16 through the medium of a needle bearing 32 having a forward retaining ring 33 and a rear retaining bush-

ing 34. At its rear end the drive shaft is supported in a double row ball bearing 35 mounted in the rear closure plate 10, the drive shaft being extended rearwardly through the closure for this purpose.

The power transmission 5 comprises in the present instance a multiple belt drive mechanism consisting of a pulley 36 on the motor shaft connected by means of belts 37 with a pulley 38 operatively associated with the driving spindle drive mechanism 6. Preferably this mechanism is of a character such as to permit either a direct drive or the introduction of change gears when different spindle speeds are desired. For this purpose the pulley 38 is mounted on a stub shaft 39 disposed axially of the tubular drive shaft 28 at the rear end of the unit and supported through the medium of a ball bearing 41 in the rear wall of an auxiliary housing 42. At its forward end the stub shaft is supported in a bushing 43 in the rear end portion of the shaft 28 and the latter is extended rearwardly from the plate 10 to support a spur gear 44 keyed onto the shaft and secured by means of a nut 45.

A direct driving connection between the stub shaft 39 and the tubular drive shaft 28 is provided in the present instance by means of a coupling member 46 which is in the form of an annulus held in position by means of split rings 47. This member has a forward internal flange 48 provided with teeth adapted to mesh with the gear 44, and a corresponding rearward flange 49 whose teeth engage with a spur gear 50 rigid with the stub shaft 39, thus locking the two shafts together. It will be understood that when it is desired to introduce speed change gears it is only necessary to remove the coupling member 46 and provide suitable additional gears (not shown) for cooperation with the gears 44 and 50.

The shaft 13 of the pump 7 extends rearwardly from the plate 10 through the lower portion of the auxiliary housing 42 for support by a bearing 51 in the rear wall of this housing. At its extreme rear end the pump shaft carries a pulley 52 which is driven by means of a belt 53 from a pulley 54 fast on the motor shaft. Preferably a shiftable belt-tensioning idler 55 is adjustably mounted upon the rear edge of a base plate 56 for the driving motor 2.

As above indicated, fluid under pressure may be delivered by the pump to the actuator to effect the reciprocation of the spindle by any preferred means. Preferably included in such means is a dog bar 57 (Fig. 2) for controlling the operation of a valve 58 and this dog bar is operatively associated with the head structure so as to perform the additional function of holding the quill 3 against rotational movement. 59 designates a transverse valve operating shaft equipped with a hand wheel 60, and 61 is a control panel disposed forwardly of the motor at the top of the head structure and having suitable control devices generally designated 62 and 63 all enclosed by a cover 64.

A feature of primary importance is the construction and arrangement whereby the maximum length of travel of the spindle in proportion to the length of the unit is obtained, and this together with the application of the translating force to the quill axially thereof. In particular this is rendered possible by the provision of a sleeve extending forwardly from the rear cylinder cap 15, to form the inner wall of an annular piston chamber and to provide for the passage of the spindle drive shaft axially of the chamber. Thus the tail portion of the usual piston rod is eliminated and the overall length substantially reduced. At the same time ample bearing support is provided for the forward and rear ends of the combined piston and quill.

I claim as my invention:

1. A hydraulic power unit comprising a head structure providing an annular piston chamber, a quill slidably supported in said head structure and projecting rearwardly into said piston chamber, said quill and chamber cooperating to form a hydraulic actuator, a spindle supported at the forward end of said quill and extending rearwardly concentrically of the quill but in inwardly spaced relation thereto, and a tubular drive shaft disposed peripherally between the spindle and quill and having a splined connection with the spindle.

2. A hydraulic power unit comprising a head structure providing an annular piston chamber, a quill slidably supported in said head structure and projecting rearwardly into said piston chamber, said quill and chamber cooperating to form a hydraulic actuator, a spindle supported at the forward end of said quill and extending rearwardly concentrically of the quill but in inwardly spaced relation thereto, a tubular drive shaft rotatably supported in the rear portion of said head structure and extending forwardly between the spindle and quill, said drive shaft having a splined connection with the spindle, a motor mounted on said structure, and means providing a driving connection between said motor and said tubular drive shaft.

3. A hydraulic power unit comprising, in combination, a head structure having a main body and end plates at opposite ends of the body, said body having a longitudinal bore, end caps mounted in said plates at opposite ends of said bore, one of said end caps having rigid therewith an elongated sleeve concentric with but spaced from said bore to form an annular piston chamber, and a spindle-supporting quill slidable in said forward end cap and projecting rearwardly into said piston chamber, said quill having a radial enlargement at its rear end forming a piston in said chamber.

4. A hydraulic power unit comprising, in combination, a head structure, a quill mounted for axial sliding movement in said head structure, means fixed in said head structure forming an annular piston chamber, a piston in said chamber fixed to said quill, a tool spindle mounted in the quill, and a drive shaft rotatably mounted in said head structure and having a splined connection with said spindle.

5. A hydraulic power unit comprising, in combination, a head structure having a body with a longitudinal bore, an elongated sleeve secured at its rear end to the body but spaced inwardly from said bore to form an annular piston chamber, and a spindle-supporting structure comprising a sleeve slidably mounted at the forward end of the body and projecting rearwardly into said piston chamber and terminating therein, said sleeve cooperating with said piston chamber to form a hydraulic actuator.

6. A hydraulic power unit comprising, in comprising, in combination, a head structure having a body with a longitudinal bore, an elongated sleeve secured at its rear end to the body but spaced inwardly from said bore to form an annular piston chamber, a spindle-supporting

structure comprising a sleeve slidably mounted at the forward end of the body and projecting rearwardly into said piston chamber, said sleeve cooperating with said piston chamber to form a hydraulic actuator, a spindle mounted in said movable sleeve, and a tubular drive shaft encircling said spindle and having a splined connection therewith, said tubular drive shaft being rotatably supported in said stationary sleeve.

7. A power unit comprising, in combination, a head structure, a tool spindle mounted in said head structure, an electric motor mounted on said head structure, a drive shaft for said spindle having a telescopic splined connection therewith, and a power transmission between said motor and said drive shaft comprising a gear element fast on said drive shaft, a stub shaft mounted in rotatable relation to said gear element and operatively connected with said motor, the inner end of said stub shaft extending into and being rotatably supported within said drive shaft, a second gear element on said stub shaft, and a coupling member detachably connecting said two gear elements.

8. A power unit comprising, in combination, a head structure, a tool spindle rotatably mounted in said head structure, a gear element in driving relation to said spindle, a stub shaft axially alined with said gear element and supported in rotative relation thereto, means for driving said stub shaft, a second gear element on the stub shaft, and a coupling member engageable with the teeth of the respective gear elements for locking them together.

9. A power unit comprising, in combination, a head structure having a rear bearing plate, a tool spindle mounted in said head structure, a gear element rotatably supported by said plate and having a driving connection with said tool spindle, said head structure having a rear housing enclosing said gear element, a stub shaft mounted in said housing in axial alinement with said gear element and having a second gear element thereon, and means detachably connecting said two gear elements for rotation in unison.

10. A hydraulic unit comprising, in combination, a cylinder structure formed with a cylinder bore, annular end caps secured to said structure at opposite ends of said bore, one of said caps having a bearing sleeve fitted coaxially within said bore, the other of said caps having a stationary elongated sleeve extending coaxially and in peripherally spaced relation into said bore to define therewith an annular piston chamber, and a tubular quill slidably supported in said bearing sleeve and extending therethrough into said bore and in peripherally spaced relation into said piston chamber, the inner end of said quill terminating within said piston chamber and being formed with an annular piston disposed in sliding engagement with the inner peripheral surface of said bore and the outer peripheral surface of said elongated sleeve.

11. A hydraulic unit comprising, in combination, a cylinder structure formed with a cylinder bore, annular end caps secured to said structure at opposite ends of said bore, one of said caps having a bearing sleeve fitted coaxially within said bore, the other of said caps having a stationary elongated sleeve extending coaxially and in peripherally spaced relation into said bore to define therewith an annular piston chamber, a tubular quill slidably supported in said bearing sleeve and extending therethrough into said bore and in peripherally spaced relation into said piston chamber, the inner end of said quill terminating within said piston chamber and being formed with an annular piston disposed in sliding engagement with the inner peripheral surface of said bore and the outer peripheral surface of said elongated sleeve, a tubular drive shaft journaled against endwise movement externally of said bore and extending coaxially into said elongated sleeve, means for rotatably supporting the inner end of said shaft within said elongated sleeve, a spindle rotatably supported in the outer end of said quill for axial movement therewith and extending in peripherally spaced relation coaxially into said shaft, and a splined rotary drive connection between said spindle and the inner end of said shaft.

12. A hydraulic unit comprising, in combination, a cylinder structure formed with a cylinder bore, annular end caps secured to said structure at opposite ends of said bore, one of said caps having a bearing sleeve fitted coaxially within said bore, the other of said caps having a stationary elongated sleeve extending coaxially and in peripherally spaced relation into said bore to define therewith an annular piston chamber, and a tubular quill slidably supported in said bearing sleeve and extending therethrough into said bore and in peripherally spaced relation into said piston chamber, the inner end of said quill terminating within said piston chamber and being formed with an annular piston disposed in sliding engagement with the inner peripheral surface of said bore and the outer peripheral surface of said elongated sleeve, one end face of said piston having an effective pressure area approximately one-half that of the other end face.

13. A hydraulic unit comprising, in combination, a cylinder structure formed with a cylinder bore, means supported in fixed position within said structure and coacting with the inner peripheral surface of said bore to define an annular piston chamber, a tubular quill slidably supported in said structure and extending in peripherally spaced relation coaxially into said piston chamber, the inner end portion of said quill terminating within said piston chamber, and an annular piston fixed on said inner end portion of said quill and in sliding engagement with said bore and said first mentioned means.

14. A power unit comprising, in combination, a head structure, a drive shaft journaled in said structure in fixed axial position, a spindle supported in said structure for rotation and axial translation and having a telescopic splined connection with said shaft, a stub shaft rotatably journaled in said structure in axial alinement with said drive shaft, a gear removably secured to one end of said drive shaft, a nut for securing said gear in position on said drive shaft, said stub shaft extending through said gear and being supported at one end within said drive shaft, a second gear fixed on said stub shaft intermediate the ends thereof and located outwardly from said nut, and an annular coupling member having internal annular toothed flanges respectively in meshing engagement with said gears to connect said gears for rotation in unison, said coupling member enclosing said nut.

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