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㉔ **Multiple spindle machine tool**

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㉛ Proprietor: **KEARNEY & TRECKER CORPORATION**
11000 Theodore Trecker Way Milwaukee,
Wisconsin 53214 (US)

㉜ Inventor: **Kielma, Ervin, J.**
2536 S. 64th Street
West Allis, Wisconsin 53219 (US)
Schabowski, Albin, J.
3749 S. 19th Street
Milwaukee, Wisconsin 53221 (US)

㉝ Representative: **Baillie, Iain Cameron, et al**
c/o Ladas, Parry, von Gehr, Goldsmith &
Deschamps Blumenstrasse 48
D - 8000 München 2 (DE)

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Multiple spindle machine tool

This invention relates to multiple spindle machine tools which utilize a plurality of interchangeable multiple spindle toolheads.

In the past, such machines had relatively complicated toolhead transfer mechanisms for transferring toolheads from the storage magazine to the toolhead driver and a relatively long time was required to effect this transfer. Transfer of the toolheads from the toolhead driver back to the storage magazine was equally complex and time-consuming.

One such prior art arrangement is shown in French Patent No. 2,091,166 in which a rotary toolhead changer or turret is adapted to receive toolheads from a toolhead magazine. The turret is disposed for rotation about an axis which intersects the axis of movement of the machine tool driver at an angle of 45°. In the French Patent the rotary turret is mounted on the same housing containing the machine tool driver and moves with the machine tool driver and away from the workpiece. As a result, toolheads cannot be transferred to or from the turret when the machine tool is performing a machining function.

The object of this invention is to provide a multiple spindle machine tool which overcomes this problem and which has a toolhead transfer mechanism which is simpler and faster than those heretofore known in the art.

In accordance with the present invention, the rotary toolhead changer is mounted independently of and in an elevated position above the toolhead driver. The toolhead driver has clamping means thereon for clamping thereto a toolhead, the toolhead being released from the toolhead changer for movement toward and away from the worktable upon engagement of said clamping means.

In the drawings:

Figure 1 is a side elevation view of one preferred embodiment of the invention;

Fig. 2 is a plan view of the embodiment shown in Fig. 1;

Figure 3 is an enlarged fragmentary side elevation view of the drive mechanism for the toolhead changer arm shown in Fig. 1;

Fig. 4 is an enlarged fragmentary cross-sectional view taken on the line 4—4 of Fig. 3;

Figure 5 is an enlarged fragmentary end view of one end of the toolhead changer arms taken on the line 5—5 of Fig. 1;

Figure 6 is an end view similar to Fig. 5 but with exterior portions cut away to reveal inner details.

Figure 7 is a fragmentary side view taken on the line 7—7 of Fig. 5;

Figure 8 is a longitudinal sectional view taken on the line 8—8 of Figs. 5 and 6.

Figure 9 is an enlarged fragmentary side elevation view of the toolhead driver and the toolhead clamped thereto;

Figure 10 is a fragmentary end view of the toolhead driver taken on line 10—10 of Fig. 9;

Figure 11 is a fragmentary end view of the toolhead taken on the line 11—11 of Fig. 9;

Figure 12 is an enlarged fragmentary longitudinal sectional view of the drive connection between the toolhead driver and the toolhead;

Figure 13 is an enlarged fragmentary end view, partially cut away, of one toolhead clamp on the toolhead driver;

Figure 14 is an enlarged fragmentary plan view taken on the line 14—14 of Fig. 13;

Figure 15 is an enlarged fragmentary side view taken on the line 15—15 of Fig. 14;

Figure 16 is an enlarged fragmentary side elevation view of the toolhead shifter for shifting the toolheads from the toolhead storage magazine to the toolhead changer arm;

Figure 17 is an enlarged fragmentary cross-sectional view taken on line 17—17 of Fig. 16; and

Figure 18 is an enlarged fragmentary plan view taken on the line 18—18 of Fig. 16.

Referring to Fig. 1, one preferred embodiment of the invention includes a first bed portion 20 upon which a worktable 22 is slidably mounted for movement along a horizontal X axis and is rotatably mounted for rotation about a vertical B axis perpendicular to the X axis. A pallet 24 carrying a workpiece 26 is shown mounted on worktable 22.

A second bed portion 28 has a toolhead driver 30 slidably mounted thereon on ways 32 for movement along a Z axis 34 toward and away from worktable 22. Toolhead driver 30 is selectively driven along ways 32 by a Z axis motor 36 along with the conventional mechanical coupling means (not shown) and the conventional electrical control means (not shown). Toolhead driver 30 contains a drive shaft 38 (Fig. 12) which is rotated by a spindle drive motor 40 (Fig. 1) along with the conventional mechanical coupling means (not shown) and the conventional electrical control means (not shown). Toolhead driver 30 also contains clamp means for locating and clamping multiple spindle toolhead 42 thereto as described in later paragraphs.

Each multiple spindle toolhead 42 has a plurality of spindles 44 which are each equipped to receive a drill or a tap and are all simultaneously rotated by a common drive shaft 46 (Fig. 12) which mates with toolhead drive shaft 38 and is driven thereby. In the operation of this embodiment, multiple spindle toolheads 42 are clamped to toolhead driver 30 and are then moved against workpiece 26 to simultaneously drill or tap a predetermined pattern of holes therein.

In this embodiment of the invention, a toolhead storage magazine 48 (Fig. 1) and

toolhead transfer mechanism 50 are mounted on an elevated frame 52 which is supported above toolhead driver 30 by a single rear post 54 and a pair of front posts 56 (Fig. 2) which are arranged in a triangular pattern with front posts 56 flanking toolhead driver 30. Toolhead transfer mechanism 50 includes a toolhead changer arm 58, which is journaled to frame 52 for rotation about an axis 60, and a toolhead shifter 62, which shifts toolhead 42 from toolhead magazine 48 to the adjacent end of toolhead changer arm 58. The rotary axis 60 of toolhead changer arm 58 is inclined at an angle of 45° to Z axis 34. The diametrically opposed ends 64 and 66 of toolhead changer arm 58 are each inclined at an angle of 45° to the rotary axis 60 thereof as indicated by the corresponding longitudinal toolhead axes 68 and 70. This particular disposition of the axes 60, 68 and 70 permit toolhead changer arm 58 to swing toolheads 42 from a horizontal to a vertical position and vice versa. As toolhead changer arm 58 swings through an 180° arc to interchange the toolheads 42, the toolheads 42 travel in a conical path which has an apex angle of 90°.

The mechanism which rotates toolhead changer arm 58 is shown in Figs. 3 and 4. Toolhead changer arm 58 has a central circular hub 72 which is journaled to frame 52 by bearings 74. A ring gear 76 is rigidly attached to arm 58 around hub 72 and is driven by a pinion 78 on shaft 79 which is journaled to frame 52 by bearings 80 and 82. Shaft 79 is driven by a bevel gear set 84 whose pinion is attached to a shaft 86 which is journaled to frame 52 by bearings 88, 90 and 91. Shaft 86 is driven by a spiroid gear set 92 whose worm is attached to a shaft 94 which is journaled by bearings 96 and 98 to frame 52 and is driven by an electric motor 100 mounted on frame 52.

Motor 100 is energized by conventional control circuitry (not shown) to drive the above-described gear train to cause toolhead changer arm 58 to rotate through a 180° arc and then to stop at the location shown in Figs. 1 and 2 with the toolhead 42 on one end being adjacent to tool storage magazine 48 and the toolhead 42 on the other end being adjacent to toolhead driver 30. When toolhead changer arm 58 is rotated a second time through an 180° arc, the position of the two toolheads 42 is interchanged.

Figs. 5—8 show the clamp on the ends of toolhead changer arm 58 for clamping the toolheads 42 thereto. Each of the toolheads 42 have a pair of tapered rails 102 (Figs. 5 & 6) attached thereto by bolts 103. Each of the rails 102 has an inwardly tapered surface 104 against which a pair of opposed clamp blocks 106 are wedged. Clamp blocks 106 are slidably mounted on two guide rods 107 which serve to carry the weight of toolhead 42. Clamp blocks 106 are connected to opposite ends of a threaded shaft 108 by threaded sockets 110

which are attached to blocks 106 by bolts 112. One end of shaft 108 is threaded in the right hand direction while the other is threaded in the left hand direction so that blocks 106 will be spread apart when shaft 108 is rotated in one direction and will be drawn together when shaft 108 is rotated in the opposite direction.

Shaft 108 is journaled within a bore 114 in the end 66 of tool changer arm 58 by bearings 116 and 118 and has a worm gear 120 rigidly attached to its inner portion. Worm gear 120 meshes with another worm gear 122 (Fig. 8) on shaft 124 which is journaled to arm end 66 through bearings 126 and 128. Shaft 124 extends at right angles to shaft 108 and is driven by a hydraulic motor 130.

Motor 130 is controlled by a conventional electro-hydraulic motor control circuit (not shown) to turn in one direction when it is desired to clamp a toolhead 42 to tool changer arm end 66 and to turn in the other direction when it is desired to unclamp the toolhead 42. Clamping is effected by pressing clamp blocks 106 outwardly against rails 102 and unclamping is effected by moving clamp blocks 106 inwardly away from rails 102 far enough to clear rails 102.

An identical clamping structure is mounted on other end 64 of the toolhead changer arm 58 for clamping a toolhead 42 thereto.

Figs. 9—15 show the locating and clamping of toolhead 42 to toolhead driver 30. Toolhead 42 is supported on toolhead driver 30 by a pair of lugs 132 (Figs. 9 & 10) on the end of toolhead 42 which rest on a pair of matching brackets 134 that project from the front of toolhead driver 30. Toolhead 42 is clamped to toolhead driver 30 by the combination of four clamp assemblies 136 (Fig. 10) on the toolhead driver 30 which rotate lugs 138 into recesses 139 (Fig. 11 & 14) behind rails 140 on toolhead 42 and then press lugs 138 against rails 140. Rails 140 are clamped against blocks 141 that are fastened to clamp assembly 136. Each of the lugs 138 projects at right angles from a rotatable sleeve 142 (Fig. 14) which has a pinion gear 144 thereon which meshes with a rack 146 (Fig. 13). Rack 146 is slidably mounted in clamp assembly 136 and is moved back and forth by a hydraulic cylinder 148 to cause lug 138 to rotate through a 90° arc to engage and disengage rail 140.

After lug 138 is engaged with rail 140 a second portion of the clamp structure is actuated to press lug 138 against rail 140. This second portion of the clamp structure is illustrated in Figs. 14 and 15. Sleeve 142 rotates 90° on camshaft 143 which has a cam slot 150 therein (Fig. 14) which is shaped to interact with a wedge 152 which is slidably mounted in clamp assembly 136 and is moved back and forth by a hydraulic cylinder 154. When wedge 152 is moved in one direction by cylinder 154, it wedges lug 138 against rail 140. One wedge 152 is moved in the other

direction, it releases the pressure on lug 138 and frees it to be disengaged from rail 140.

Each of the clamping assemblies 136 is identical to the above-described clamping assembly 136 and are actuated simultaneously by conventional hydraulic cylinder control circuits (not shown) to simultaneously clamp or unclamp all four corners of toolhead 42.

Two additional clamping assemblies 156 and 158 (Fig. 10) are mounted on the front of toolhead driver 30. Clamping assembly 156 has a hydraulic cylinder 160 and a clamp member 162 which is moved thereby and which interacts with a matching clamp member 164 (Figs. 9 & 11) on toolhead 42. Clamping assembly 158 has a hydraulic cylinder 166 and a clamp member 168 which is moved thereby and which interacts with rail 140.

Fig. 12 shows the driving connection between toolhead 42 and toolhead driver 30. Toolhead 42 has a drive shaft 46 which is journaled therewithin by bearings 170 and projects outwardly therefrom. An alignment flange 172 is rigidly attached to shaft 46 and has alignment notches 174 (Fig. 11) cut therein which engage an alignment pin 176 (Fig. 12) when toolhead 42 is detached from toolhead driver 30. Shaft 46 always stops with a notch 174 aligned with pin 176. Alignment pin 176 is spring loaded outwardly by a spring 178 and is pressed inwardly to release shaft 46 for rotation by a release pin 180 on hub 182 which surrounds drive shaft 38 on toolhead driver 30. Drive shaft 38 makes driving connection with drive shaft 46 via a key 184 on shaft 38 which engages a slot 185 in shaft 46 when toolhead driver 30 is moved by the Z axis drive into contact with toolhead 42. This movement also causes release pin 180 to depress alignment pin 176 and thus to release shaft 46 for rotation. When toolhead driver 30 is moved by the Z axis drive away from toolhead 42, alignment pin 176 moves back into contact with alignment notch 174 and thus locks drive shaft 46 in position.

Figs. 16, 17 and 18 show the details of toolhead shifter 62 which transfers toolheads 42 from toolhead magazine 48 to the adjacent end of toolhead changer arm 58. Referring to Figs. 1 and 17, toolhead 42 is rollably supported on horizontal rails 186 by rollers 188. Horizontal rails 186 are supported by vertical arms 190 having rack gears 192 thereon. Vertical arms 190 are slidably mounted on frame 52 for upward and downward movement and are driven upwardly and downwardly by pinion gears 194 and 196. Pinion gears 194 and 196 are mounted on opposite ends of a shaft 198 which is journaled to frame 52 by bushings 200. Pinion gear 196 extends past rack 192 and engages a rack 202 on a shaft 204 (Fig. 16) which is slidably mounted in frame 52 and is driven by a hydraulic cylinder 206. When shaft 204 is extended by hydraulic cylinder 206, it causes arm 190 to raise, and when shaft 204 is

retracted by hydraulic cylinder 206, it causes arms 190 to lower.

Toolhead 42 is shifted longitudinally along rollers 188 by a pin 208 which engages a socket 210 in the bottom of toolhead 42. Two sockets 210 are provided in the bottom of each toolhead 42 to permit two shifting movements for each toolhead 42. Pin 208 is slidably mounted in a carriage 212 which is rollably mounted on frame 52 by rollers 214. Pin 208 has a rack gear formed therein which engages a pinion gear 216 (Fig. 18) on a shaft 218 journaled to carriage 212. Pinion gear 216 engages a second rack gear 220 on a shaft 222 which is extended and retracted by a hydraulic cylinder 224 to raise and lower pin 208. The entire carriage 212 is moved horizontally by a relatively large hydraulic cylinder 226 which is coupled thereto.

To shift toolhead 42 from the end of toolhead changer arm 58 to toolhead magazine 48, cylinder 226 is first actuated to place pin 208 under the socket 210 nearest toolhead magazine 48. Cylinder 224 is then actuated to raise pin 208 into socket 210. Cylinder 226 is then extended to move carriage 212 toward toolhead magazine 48. The first stroke of cylinder 226 moves toolhead 42 halfway to toolhead magazine 48. Pin 208 is then detached from socket 210 and cylinder 226 is retracted until pin 208 is under socket 210 furthest from toolhead magazine 48. Pin 208 is inserted into socket 210. Cylinder 226 is then extended a second time to move toolhead 42 the rest of the way into the toolhead magazine 48. Pin 208 is then disengaged from socket 210 and cylinder 226 is retracted.

The foregoing process is reversed to shift a toolhead 42 from toolhead magazine 48 to the end of toolhead changer arm 58. The elevator mechanism described previously is used to lower horizontal rails 186 clear of toolhead 42 just previous to a toolhead interchange.

Toolhead magazine 48 contains suitable rollers (not shown) for slidably receiving toolheads 42 along with conventional indexing means for selectively presenting any desired compartment thereof to the loading and unloading position adjacent to toolhead shifter 62.

Although the illustrative embodiments of the invention have been described in considerable detail for the purpose of fully disclosing a practical operative structure incorporating the invention, it is to be understood that the particular apparatus shown and described is intended to be illustrative only and that the various novel features of the invention may be incorporated in other structural forms without departing from the spirit and scope of the invention as defined in the subjoined claims.

Claims

1. A multiple spindle machine tool including

a plurality of multiple spindle toolheads (42); a toolhead magazine (48) for storing said toolheads; a worktable (22); a toolhead driver (30) for driving any selected one of said toolheads, said toolhead driver being mounted for movement along a first axis (34) toward and away from said worktable, a rotary toolhead changer (58) journaled for rotation about a second axis (60) which is inclined at an angle of 45° to said first axis (34), said toolhead changer (58) having portions (64, 66) for receiving toolheads (42), clamping means (106) on said portions (64, 66) for clamping said toolheads thereto, said toolhead changer (58) being adapted to receive toolheads (42) from said toolhead magazine (48), and upon rotation to transfer said toolheads (42) to said toolhead driver (30) and vice versa, characterized by said toolhead changer (58) being mounted independently of and in an elevated position above said toolhead driver (30), said toolhead driver (30) having clamping means (136) for clamping thereto a toolhead (42) in position to be driven by said toolhead driver (30), the toolhead (42) being released from said toolhead changer (58) for movement along said first axis (34) with said toolhead driver (30) upon engagement of said clamping means (136) on said toolhead driver (30).

2. The machine tool according to claim 1, characterized in that said said toolhead changer (58) has two diametrically opposed arms (64, 66) which are each inclined at an angle of 45° to the rotary axis of said toolhead changer (58).

3. The machine tool according to claim 2, characterized in that said clamp means on said toolhead changer (58) are provided on both arms of said toolhead changer (58).

4. The machine tool according to claim 1, 2 or 3, characterized in that said clamp means for clamping said toolhead to said toolhead driver comprises four clamping assemblies (136) each located on a corresponding corner of said toolhead driver (130).

5. The machine tool according to any of claims 2 to 4, characterized by a toolhead shifter (62) positioned between said toolhead magazine (48) and said toolhead changer (58) for shifting said toolheads (42) from said toolhead magazine (48) to said toolhead changer (58) and vice versa.

6. The machine tool according to claim 5, characterized in that said toolhead shifter comprises a pair of horizontal rails (186) mounted in position to receive a toolhead (42) from either said toolhead magazine (48) or said toolhead changer (58), means on said rails for slidably receiving said toolhead, and means for sliding said toolhead back and forth along said rails.

7. The machine tool according to claim 6, characterized by means for raising said rails from its normal position to move the toolhead thereon out of engagement with said clamping means (106) on the toolhead changer arm (64

and 66) and to lower the toolhead thereon into its normal position for engagement with the clamping means (106) on the toolhead changer arm (64 or 66) in that location.

8. The machine tool according to claim 7, characterized in that said means for raising and lowering said rails comprises a pair of vertical arms (190) supporting said rails (186), a rack gear (192) on each of said vertical arms (190), a first shaft (198) journaled transverse to said vertical arms (190) adjacent to said rack gears (192), a pair of pinion gears (194, 196) on said shaft (198), each pinion gear (194, 196) being meshed with a corresponding one of said rack gears (192), a second shaft (204) slidably mounted adjacent to one of said pinion gears (196), a second rack gear (202) on said second shaft (204), said second rack gear (202) being meshed with the adjacent pinion gear (196), and means (206) for moving said second shaft (204) back and forth to raise and lower said rails (186).

9. The machine tool according to claim 6, characterized in that said means for sliding said toolhead (42) back and forth along said rails (186) comprises a carriage (212) slidably mounted between said rails (186) for movement along an axis parallel to said rails, means (208, 216, 218, 220, 222, 224) on said carriage for selectively engaging said toolhead, and means (226) for moving said carriage (212) back and forth along said axis.

10. The machine tool according to claim 9, characterized in that said means for selectively engaging said toolhead comprises a vertical pin (208) slidably mounted on said carriage (212) for upward and downward movement along a vertical axis, and means for actuating said pin in its vertical movement.

Revendications

1. Une machine-outil à broches multiples comprenant plusieurs têtes porte-outils (42) à broches multiples; un magasin (48) à têtes porte-outils pour ranger les têtes porte-outils, une table de travail (22); un dispositif (30) d'entraînement de tête porte-outils pour entraîner l'une quelconque sélectionnée desdites têtes porte-outils, ledit dispositif d'entraînement de tête porte-outils étant monté de façon à pouvoir se déplacer le long d'un premier axe (34) en rapprochement et en éloignement de la table de travail, un changeur de tête porte-outils rotatif (58) monté à rotation autour d'un second axe (60) qui est incliné à un angle de 45° sur le premier axe (34), ledit changeur (58) de tête porte-outils comportant des parties (64, 66) pour recevoir des têtes porte-outils (42), des moyens de serrage (106) disposés sur lesdites parties (64, 66) pour serrer sur elles lesdites têtes porte-outils, ledit changeur (58) de tête porte-outils étant agencé pour recevoir des têtes porte-outils (42) dudit magasin (48) à têtes porte-outils et après

rotation à transférer lesdites têtes porte-outils (42) audit dispositif (30) d'entraînement de tête porte-outils et vice-versa, caractérisé par le fait que ledit changeur (58) de tête porte-outils est monté indépendamment dudit dispositif (30) d'entraînement de tête porte-outils et dans une disposition surélevée au-dessus dudit dispositif, ledit dispositif (30) d'entraînement de tête porte-outils comportant des moyens de serrage (136) pour serrer sur lui une tête porte-outils (42) en position pour être entraînée par ledit dispositif (30) d'entraînement de tête porte-outils, la tête porte-outils (42) étant détachée dudit changeur (58) de tête porte-outils pour pouvoir se déplacer le long dudit premier axe (34) avec ledit dispositif (30) d'entraînement de tête porte-outils à la suite du serrage desdits moyens de serrage (136) prévus sur ledit dispositif (30) d'entraînement de tête porte-outils.

2. La machine-outil selon la revendication 1, caractérisée en ce que ledit changeur (58) de tête porte-outils comporte deux bras (64, 66) diamétralement opposés dont chacun est incliné à un angle de 45° sur l'axe de rotation dudit changeur (58) de tête porte-outils.

3. La machine-outil selon la revendication 2, caractérisée en ce que lesdits moyens de serrage prévus sur ledit changeur (58) de tête porte-outils sont prévus sur les deux bras dudit changeur (58) de tête porte-outils.

4. La machine-outil selon l'une des revendications 1, 2 ou 3, caractérisée en ce que lesdits moyens de serrage pour serrer ladite tête porte-outils sur ledit dispositif d'entraînement de tête porte-outils comportent quatre ensembles de serrage (136) chacun disposé sur un angle correspondant dudit dispositif (130) d'entraînement de tête porte-outils.

5. La machine-outil selon l'une quelconque des revendications 2 à 4, caractérisée par un dispositif (62) de déplacement de tête porte-outils positionné entre ledit magasin (48) à têtes porte-outils et ledit changeur (58) de tête porte-outils pour déplacer lesdites têtes porte-outils (42) à partir dudit magasin (48) à têtes porte-outils jusqu'audit changeur (58) de tête porte-outils et vice-versa.

6. La machine-outil selon la revendication 5, caractérisée en ce que ledit dispositif de déplacement de tête porte-outils comprend une paire de rails horizontaux (186) montés en position pour recevoir une tête porte-outils (42) soit dudit magasin (48) à têtes porte-outils, soit dudit changeur (58) de tête porte-outils, des moyens sur lesdits rails pour recevoir à coulissement ladite tête porte-outils, et des moyens pour faire coulisser ladite tête porte-outils en va-et-vient le long desdits rails.

7. La machine-outil selon la revendication 6, caractérisée par des moyens pour soulever lesdits rails au-dessus de leur position normale pour déplacer la tête porte-outils disposée sur eux hors d'engagement avec lesdits moyens de serrage (106) prévus sur le bras (64 ou 66)

changeur de tête porte-outils et pour abaisser la tête porte-outils disposée sur eux dans sa position normale pour qu'elle s'enclenche avec les moyens de serrage (106) prévus sur le bras (64 ou 66) changeur de tête porte-outils dans cet emplacement.

8. La machine-outil selon la revendication 7, caractérisée en ce que lesdits moyens pour soulever et abaisser lesdits rails comprennent une paire de bras verticaux (190) portant lesdits rails (186), une crémaillère (192) disposée sur chacun desdits bras verticaux (190), un premier arbre (198) monté à rotation transversalement par rapport auxdits bras verticaux (190) au voisinage desdites crémaillères (192), une paire de pignons (194, 196) portés par ledit arbre (198), chaque pignon (194, 196) engrenant avec l'une desdites crémaillères (192) qui lui correspond, un second arbre (204) monté coulissant adjacent à l'une desdits pignons (196), une seconde crémaillère (202) prévue sur ledit second arbre (204), ladite seconde crémaillère (202) engrenant avec le pignon adjacent (196), et des moyens (206) pour déplacer ledit second arbre (204) en va-et-vient pour soulever et abaisser lesdits rails (186).

9. La machine-outil selon la revendication 6, caractérisée en ce que lesdits moyens pour faire coulisser ladite tête porte-outils (42) en va-et-vient le long desdits rails (186) comprennent un chariot (212) monté coulissant entre lesdits rails (186) de façon à pouvoir se déplacer le long d'un axe parallèle auxdits rails, des moyens (208, 216, 218, 220, 222, 224) prévus sur ledit chariot pour accrocher sélectivement ladite tête porte-outils, et des moyens (226) pour déplacer le chariot (212) en va-et-vient le long dudit axe.

10. La machine-outil selon la revendication 9, caractérisée en ce que lesdits moyens pour accrocher sélectivement ladite tête porte-outils comprennent une tige verticale (208) montée coulissante sur ledit chariot (212) de façon à pouvoir se déplacer vers le haut et vers le bas le long d'un axe vertical, et des moyens pour actionner ladite tige dans son mouvement vertical.

Patentansprüche

1. Mehrspindel-Werkzeugmaschine mit einer Mehrzahl von Mehrspindel-Werkzeugköpfen (42), einem Werkzeugkopf-magazin (48) zum Lagern der Werkzeugköpfe, einem Werkstück-tisch (22), einer Werkzeugkopf-Antriebseinrichtung (30) zum Antreiben jedes ausgewählten Werkzeugkopfes, wobei die Werkzeugkopf-Antriebseinrichtung für Bewegung entlang einer ersten Achse (34) in Richtung gegen den Werkstücktisch und von diesem weg angebracht ist, mit einer Drehwechseleinrichtung (58) für die Werkzeugköpfe, die für Drehung um eine zweite Achse (60) gelagert ist, die zu der ersten Achse (34) in einem Winkel von 45° schräg verläuft, wobei die Werkzeugkopf-Wechseleinrichtung (58) Teile (64, 66)

zum Aufnehmen von Werkzeugköpfen (42) und Klemmeinrichtungen (106) an diesen Teilen (64, 66) aufweist, um die Werkzeugköpfe an diese Teile zu klemmen, und wobei die Werkzeugkopf-Wechseleinrichtung (58) Werkzeugköpfe (42) aus dem Werkzeugkopfmagazin (48) aufnehmen kann und bei Drehung die Werkzeugköpfe (42) zu der Werkzeugkopf-Antriebseinrichtung (30) überführt und umgekehrt, dadurch gekennzeichnet, daß die Werkzeugkopf-Wechseleinrichtung (58) unabhängig von der Werkzeugkopf-Antriebseinrichtung (30) und in einer erhöhten Stellung über dieser angeordnet ist, die Werkzeugkopf-Antriebseinrichtung (30) Klemmmittel (136) zum Anklemmen eines Werkzeugkopfes (42) an die Werkzeugkopf-Antriebseinrichtung in einer Stellung aufweist, daß sie von der Werkzeugkopf-Antriebseinrichtung (30) angetrieben werden können, und daß der Werkzeugkopf (42) von der Werkzeugkopf-Wechseleinrichtung (58) freigegeben wird für Bewegung entlang der ersten Achse (34) mit der Werkzeugkopf-Antriebseinrichtung (30) bei Eingriff der Klemmmittel (136) an der Werkzeugkopf-Antriebseinrichtung (30).

2. Werkzeugmaschine nach Anspruch 1, dadurch gekennzeichnet, daß die Werkzeugkopf-Wechseleinrichtung (58) zwei diametral gegenüberliegende Arme (64, 66) aufweist, deren jeder in einem Winkel von 45° zur Drehachse der Werkzeugkopf-Wechseleinrichtung (58) schräg angeordnet ist.

3. Werkzeugmaschine nach Anspruch 2, dadurch gekennzeichnet, daß die Klemmeinrichtungen an der Werkzeugkopf-Wechseleinrichtung (58) an beiden Armen der Werkzeugkopf-Wechseleinrichtung (58) vorgesehen sind.

4. Werkzeugmaschine nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß die Klemmmittel zum Klemmen des Werkzeugkopfes an die Werkzeugkopf-Antriebseinrichtung vier Klemmeinrichtungen (136) aufweisen, deren jede an einer entsprechenden Ecke der Werkzeugkopf-Antriebseinrichtung (130) angeordnet ist.

5. Werkzeugmaschine nach irgendeinem der Ansprüche 2 bis 4, gekennzeichnet durch eine Werkzeugkopf-Schiebeeinrichtung (62), die zwischen dem Werkzeugkopfmagazin (48) und der Werkzeugkopf-Wechseleinrichtung (58) angeordnet ist, um die Werkzeugköpfe (42) aus dem Werkzeugkopfmagazin (48) zu der Werkzeugkopf-Wechseleinrichtung (58) und umgekehrt zu verschieben.

6. Werkzeugmaschine nach Anspruch 5, dadurch gekennzeichnet, daß die Werkzeugkopf-Schiebeeinrichtung ein Paar von waagerechten Schienen (186), die in einer Lage angeordnet sind, daß sie einen Werkzeugkopf (42) ent-

weder aus dem Werkzeugkopfmagazin (48) oder aus der Werkzeugkopf-Wechseleinrichtung (58) aufnehmen, eine Einrichtung an den Schienen zum verschiebbaren Aufnehmen des Werkzeugkopfes, und eine Einrichtung zum Hin- und Herschieben des Werkzeugkopfes entlang der Schienen aufweist.

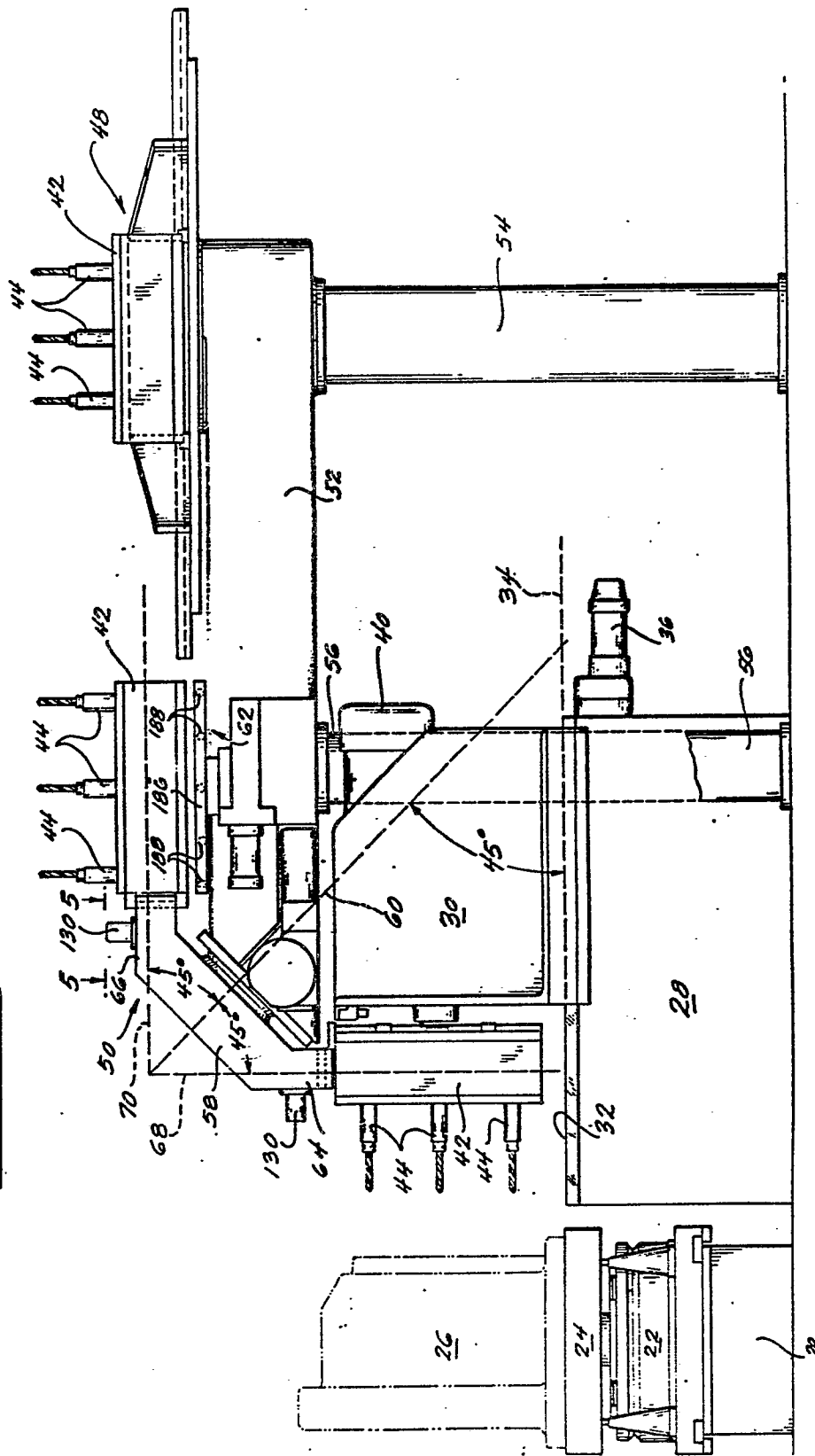
7. Werkzeugmaschine nach Anspruch 6, gekennzeichnet durch eine Einrichtung zum Heben der Schienen aus ihrer normalen Lage zum Bewegen des an ihnen befindlichen Werkzeugkopfes außer Eingriff mit der Klemmeinrichtung (106) an dem Werkzeugkopf-Wechselarm (64 oder 66) und zum Absenken des an ihnen befindlichen Werkzeugkopfes in seine normale Stellung für Eingriff mit der Klemmeinrichtung (106) an dem Werkzeugkopf-Wechselarm (64 oder 66) an dieser Stelle.

8. Werkzeugmaschine nach Anspruch 7, dadurch gekennzeichnet, daß die Einrichtung zum Heben und Absenken der Schienen ein Paar von senkrechten Armen (190), welche die Schienen (186) abstützen, eine Zahnstange (192) an jedem der senkrechten Arme (190) eine erste Welle (198), die den Zahnstangen (192) benachbart quer zu den senkrechten Armen (190) gelagert ist, ein Paar von Antriebszahnradern (194, 196) an der Welle (198), deren jedes mit einer betreffenden Zahnstange (192) kämmt, eine zweite Welle (204), die einem der beiden Antriebszahnradern (196) benachbart verschiebbar angeordnet ist, eine zweite Zahnstange (202) an der zweiten Welle (204), die mit dem benachbarten Antriebszahnrad (196) kämmt, und eine Einrichtung (206) aufweist zum Hin- und Herbewegen der zweiten Welle (204) zum Heben und Absenken der Schienen (186).

9. Werkzeugmaschine nach Anspruch 6, dadurch gekennzeichnet, daß die Einrichtung zum Hin- und Herschieben des Werkzeugkopfes (42) entlang der Schienen (186) einen Wagen (212), der zwischen den Schienen (186) für Bewegung entlang einer Achse parallel zu den Schienen verschiebbar angebracht ist, eine Einrichtung (208, 216, 218, 220, 222, 224) an dem Wagen zum wahlweisen Erfassen des Werkzeugkopfes, und eine Einrichtung (226) aufweist zum Hin- und Herbewegen des Wagens (212) entlang der genannten Achse.

10. Werkzeugmaschine nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung zum wahlweisen Erfassen des Werkzeugkopfes einen senkrechten Stift (208), der an dem Wagen (212) für Aufwärtsbewegung und Abwärtsbewegung entlang einer senkrechten Achse verschiebbar angebracht ist, und eine Einrichtung aufweist zum Betätigen des Stiftes in seiner senkrechten Bewegung.

Fig. 1



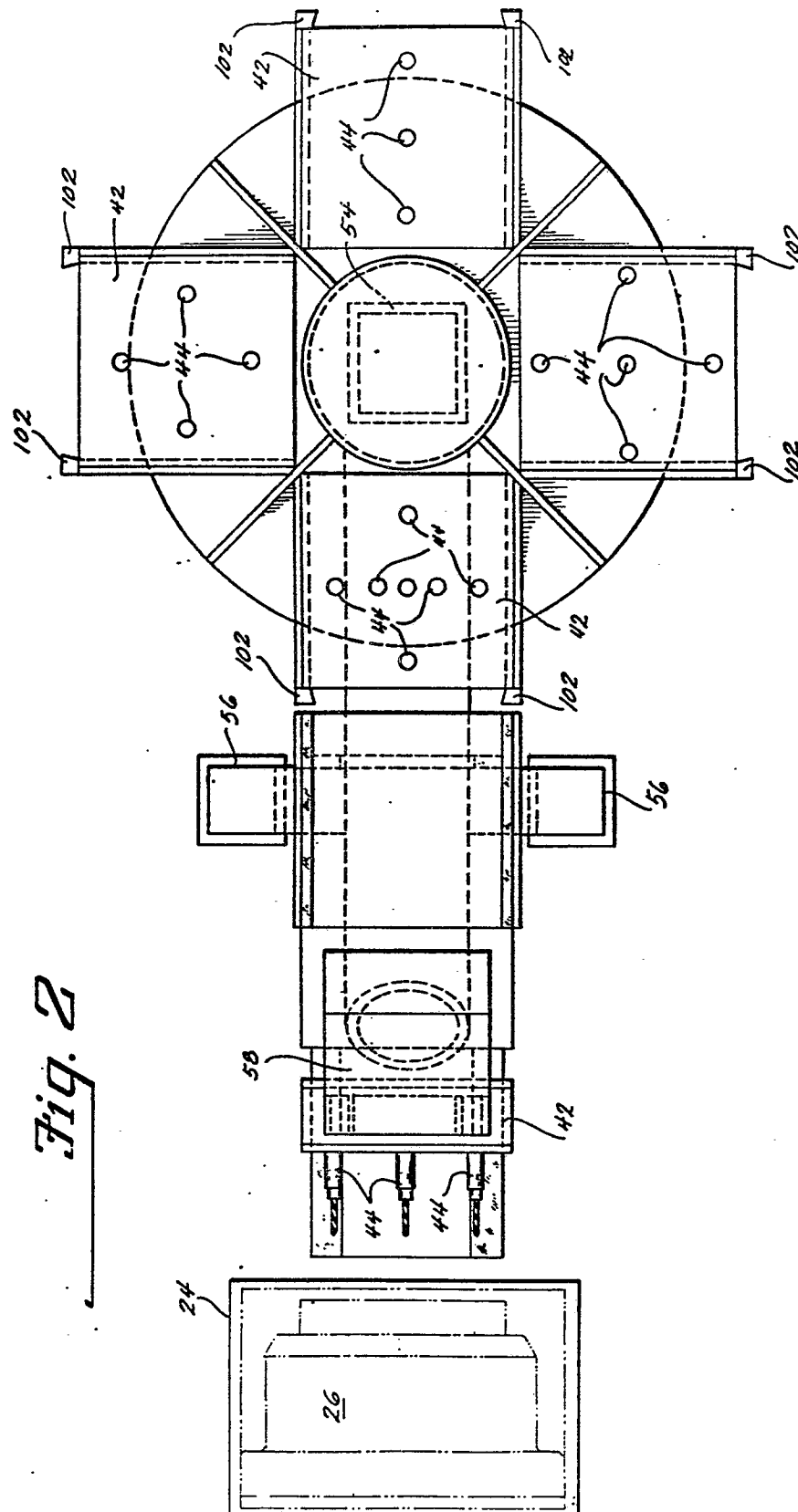


Fig. 2

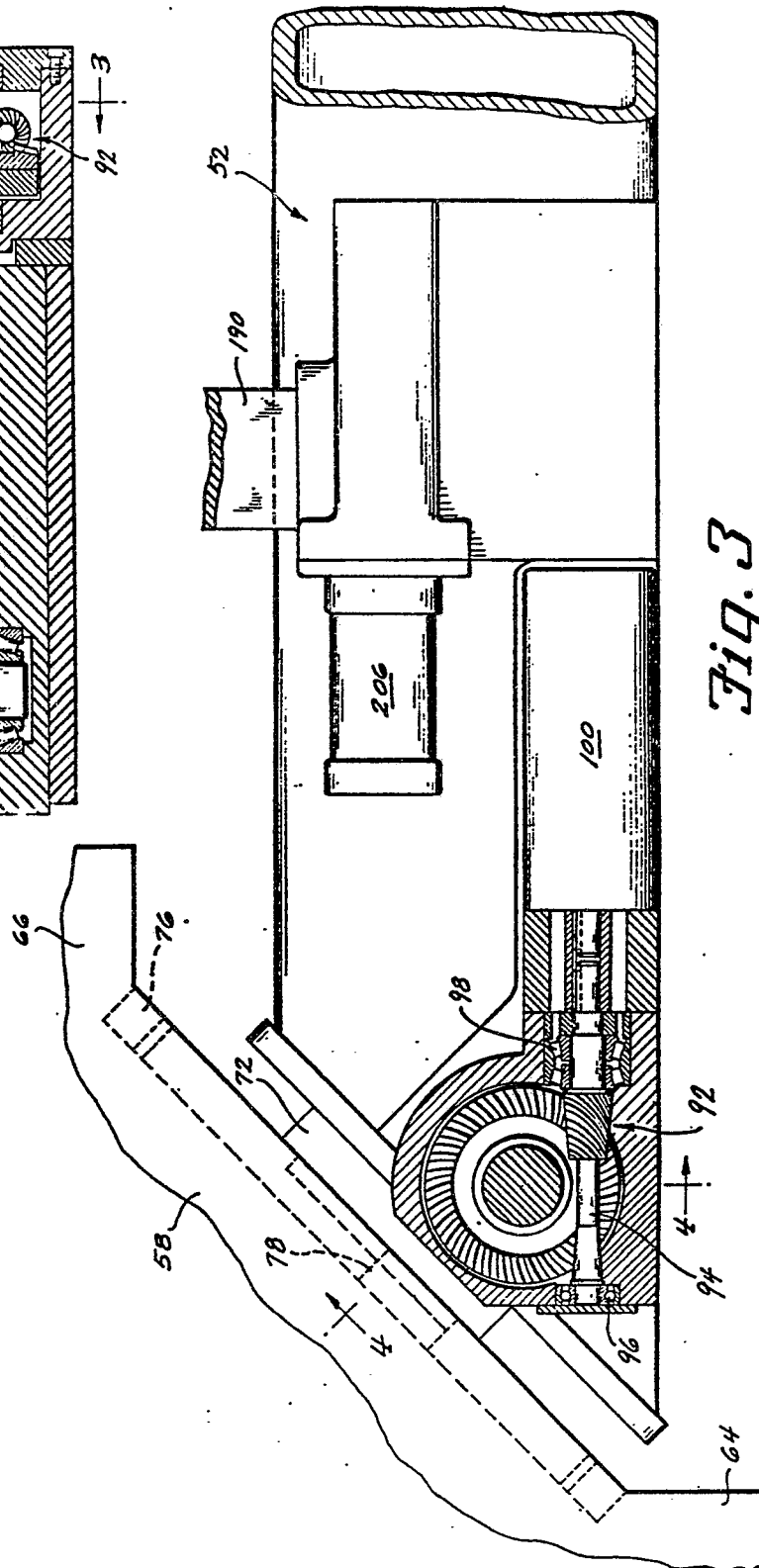
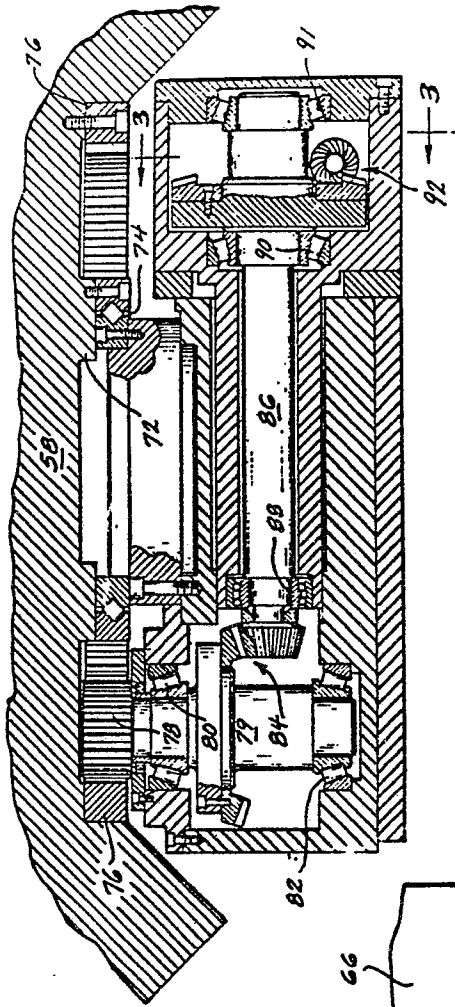


Fig. 6

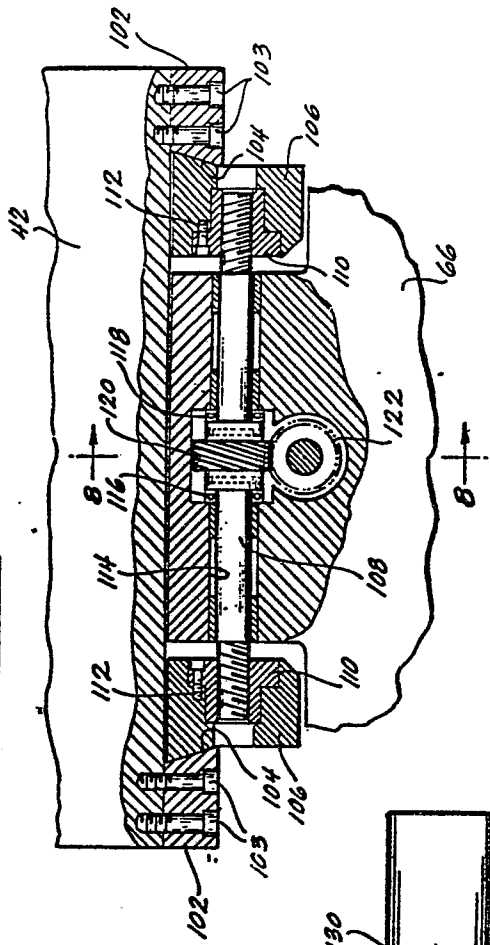


Fig. 5

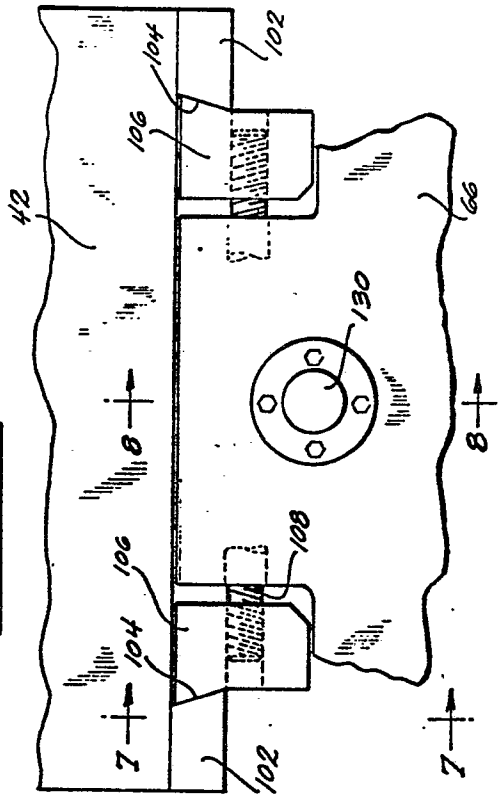


Fig. 8

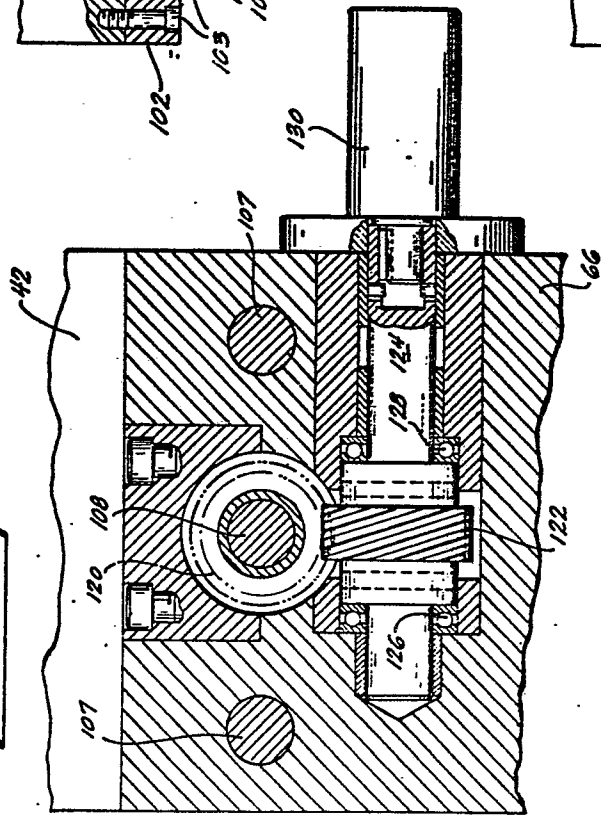


Fig. 7

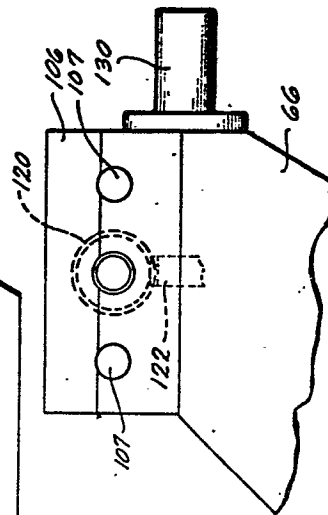


Fig. 9

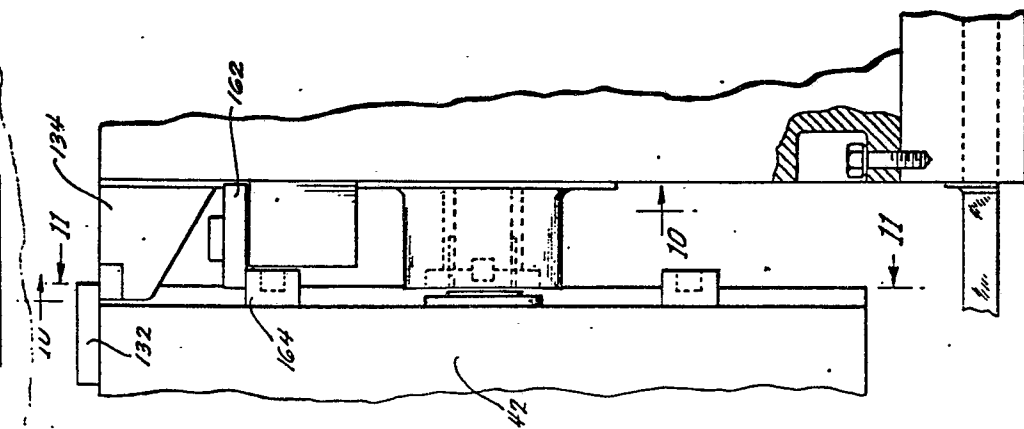


Fig. 10

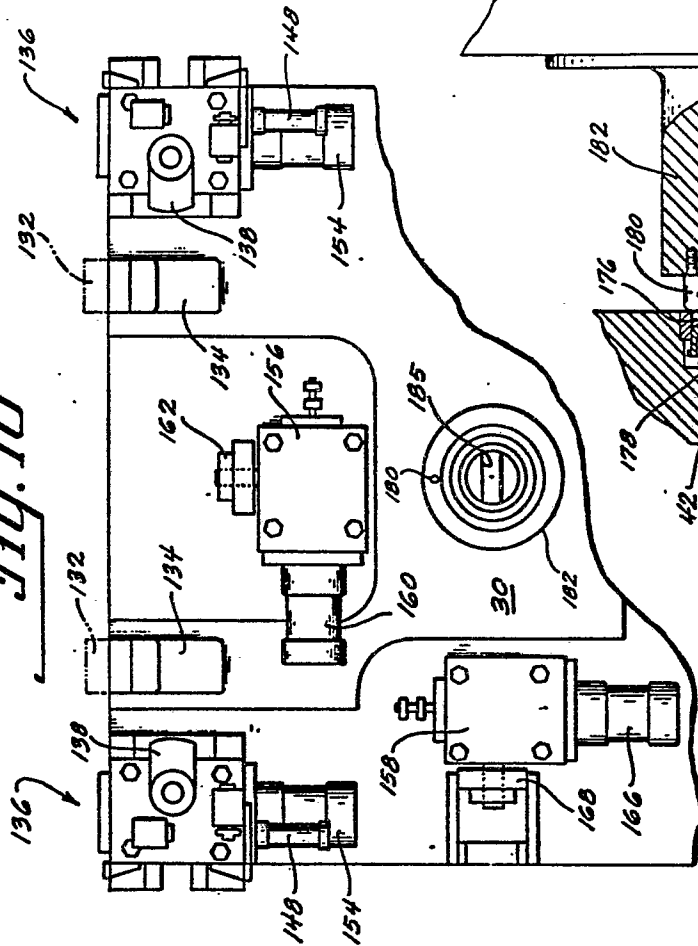
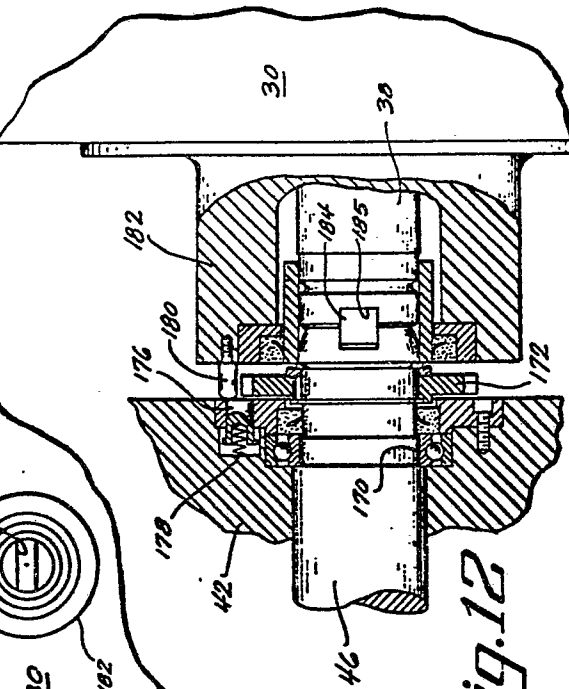


Fig. 12



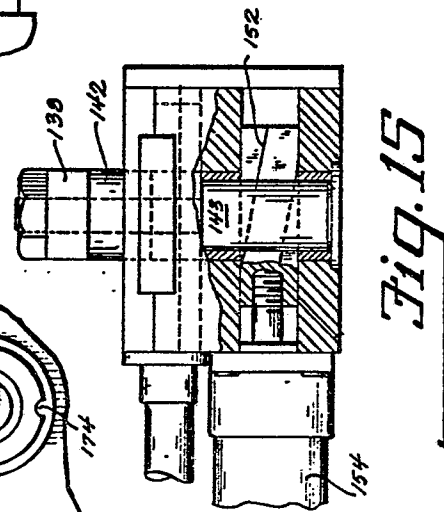
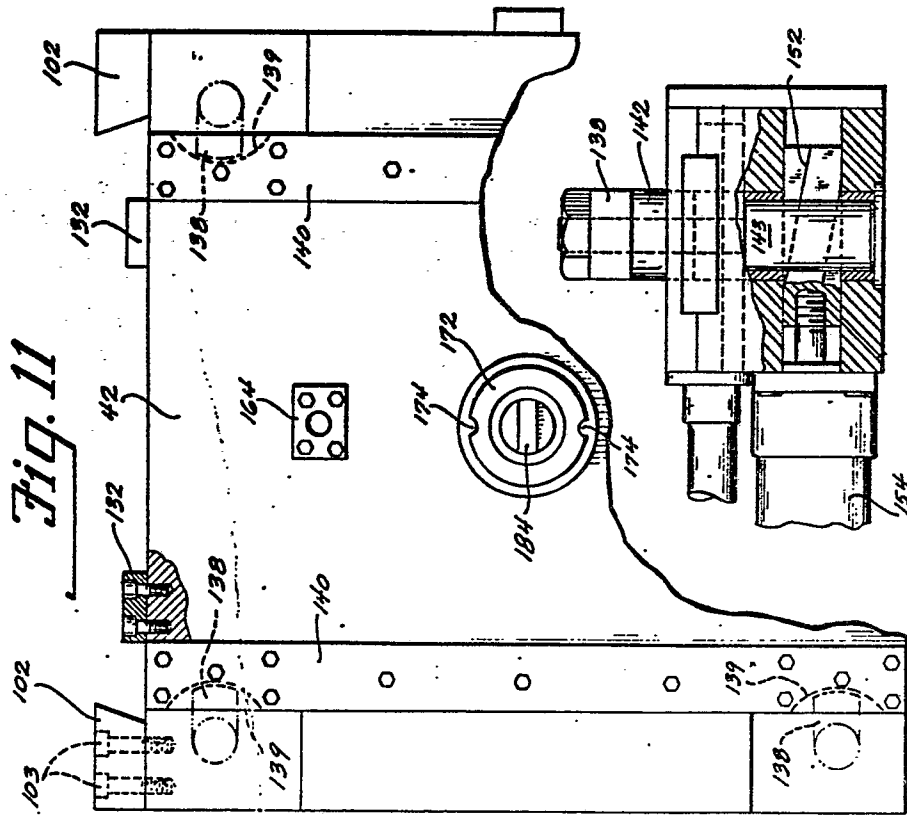
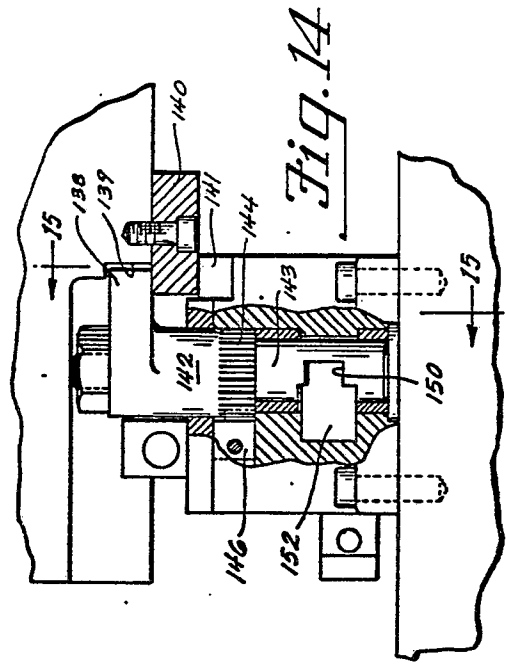
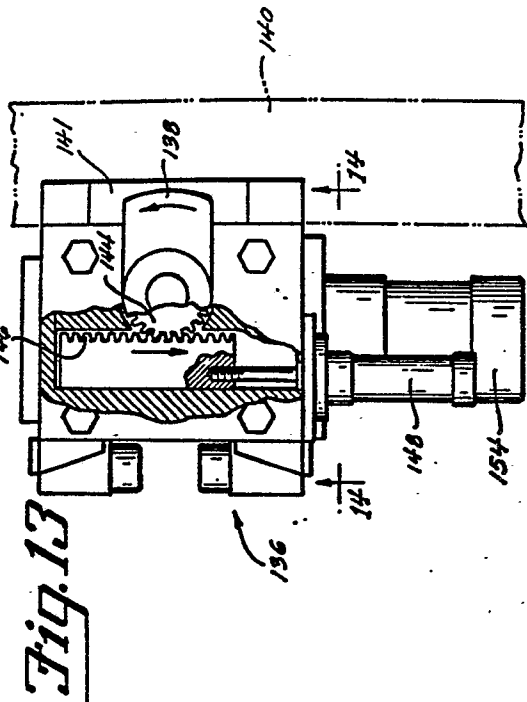


Fig. 16

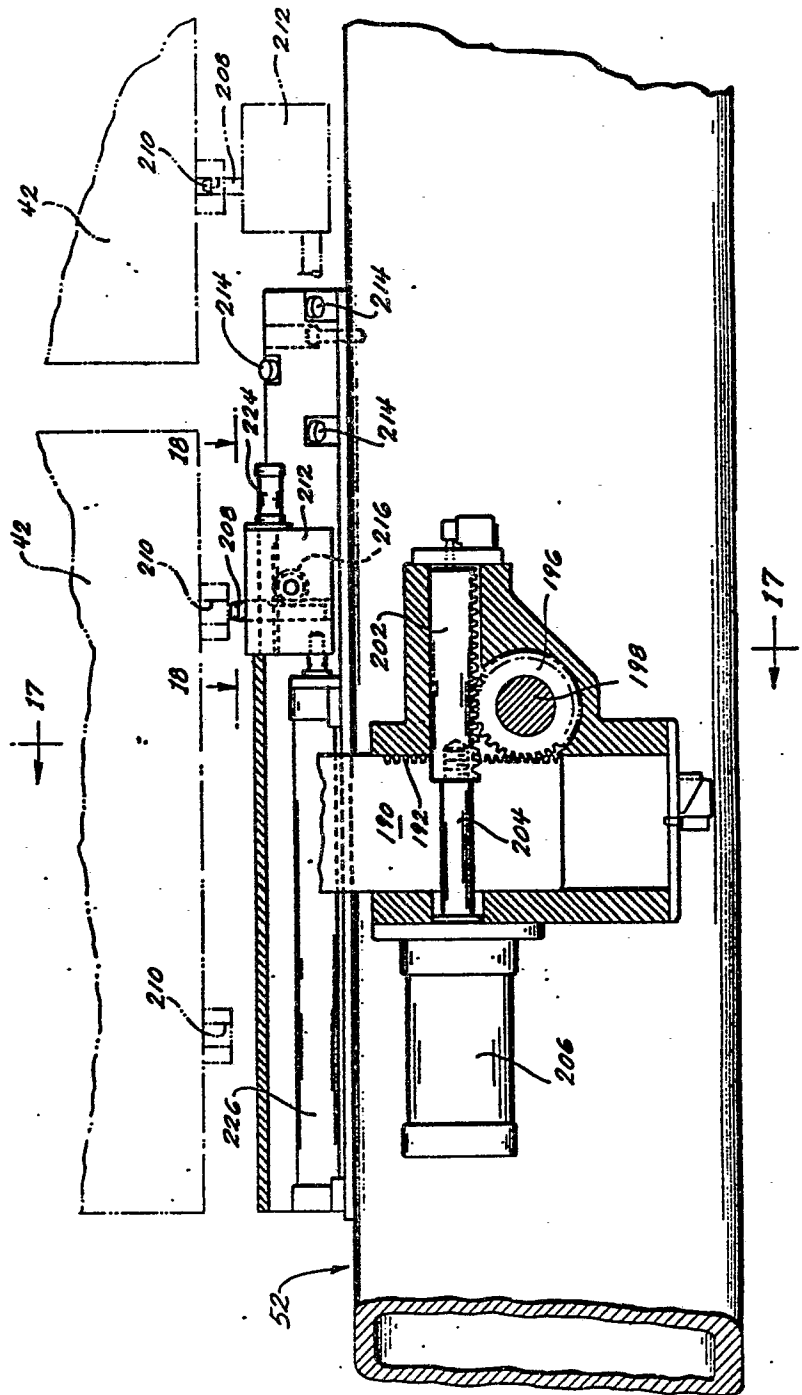


Fig. 17

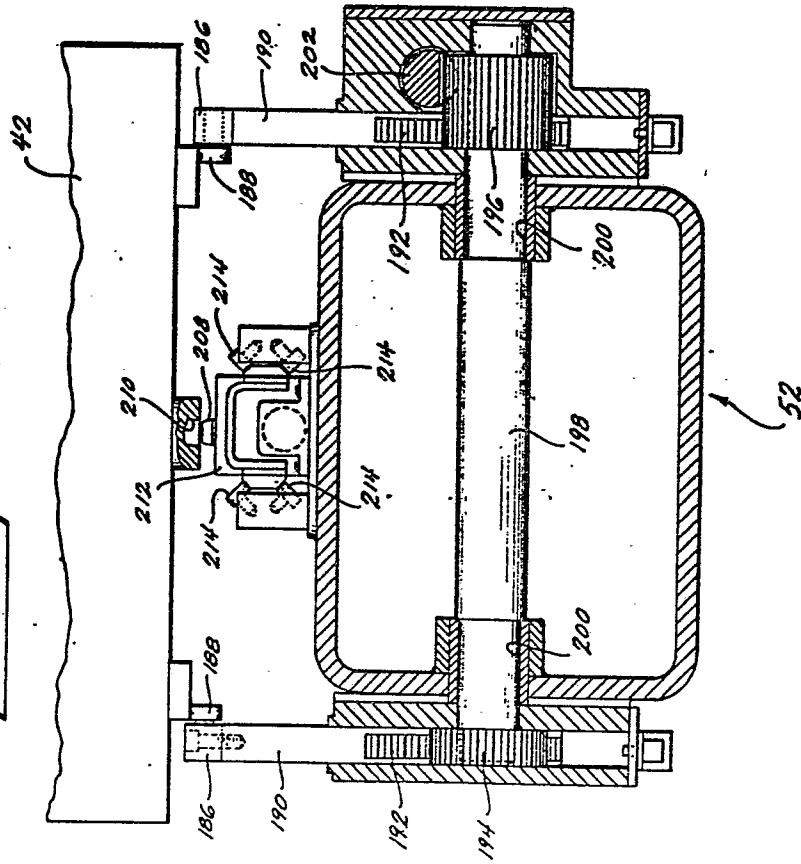


Fig. 18

