United States Patent

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Oak Brook, Ill.

[54] **PORTABLE MACHINE TOOL FOR VERTICAL DRILLING, THREADING AND THE LIKE**
15 Claims, 18 Drawing Figs.

[52] **U.S. Cl.** **408/103,** 29/26, 90/12, 10/128, 51/241
[51] **Int. Cl.** **B23b 45/14**
[50] **Field of Search** ..... 77/13, 2; 51/241 S; 29/26; 90/12; 10/128, 129

[56] **References Cited**

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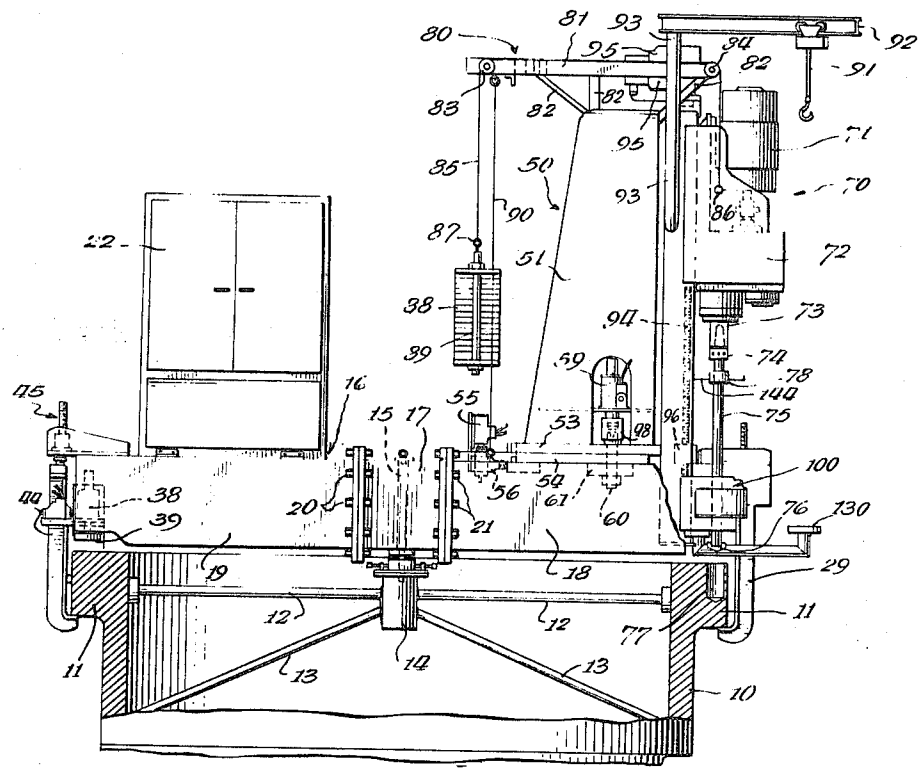
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ABSTRACT: Disclosed is a portable machine tool for drilling, reaming, tapping and chamfering, spot facing and grinding large diameter deep vertical holes in metal with means for removing the heat and chips generated from drilling, reaming or tapping the holes as they are produced. The machine has means for aligning or levelling it relative to the workpiece and for clamping it to the workpiece to prevent lifting or shifting in use.



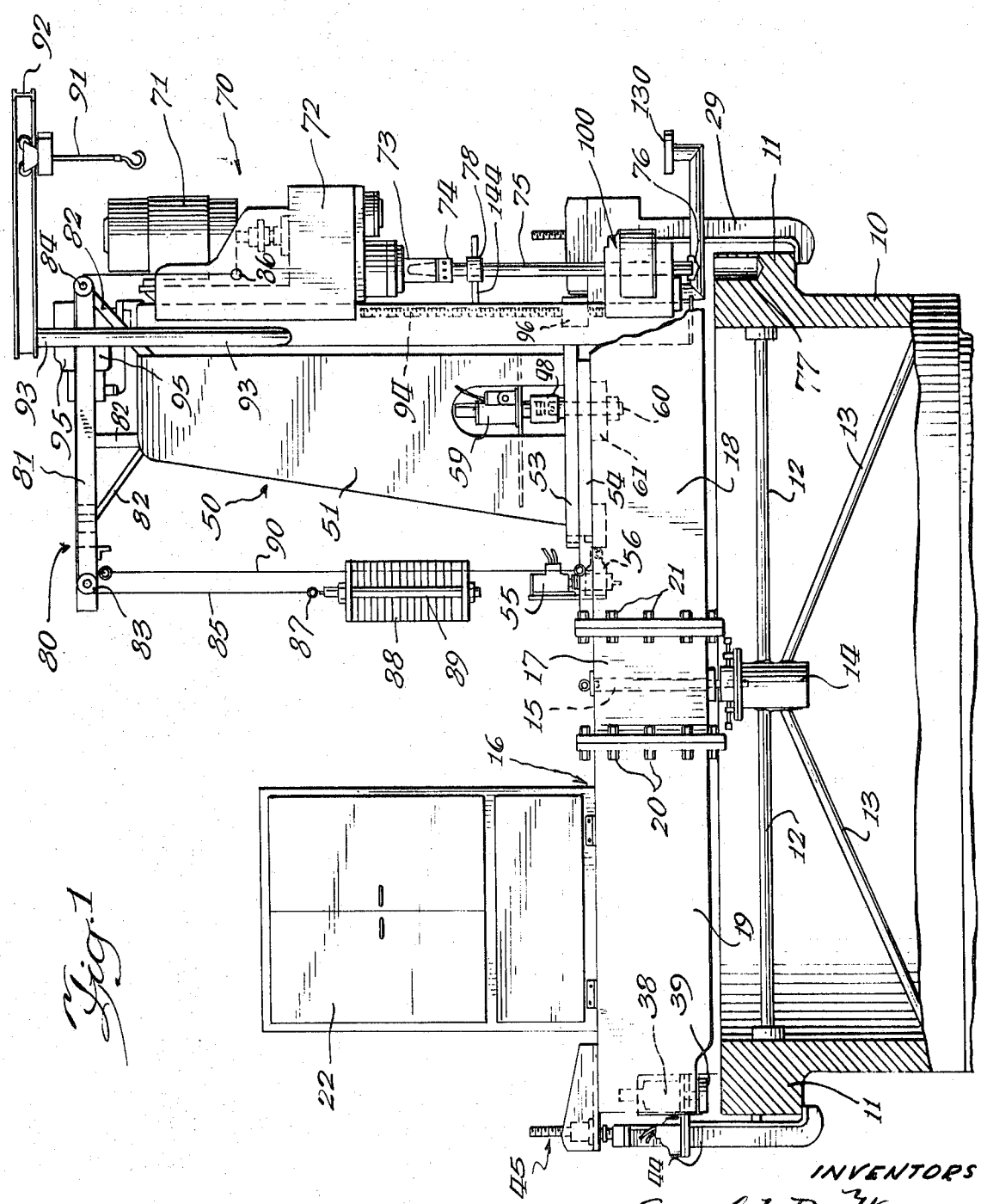
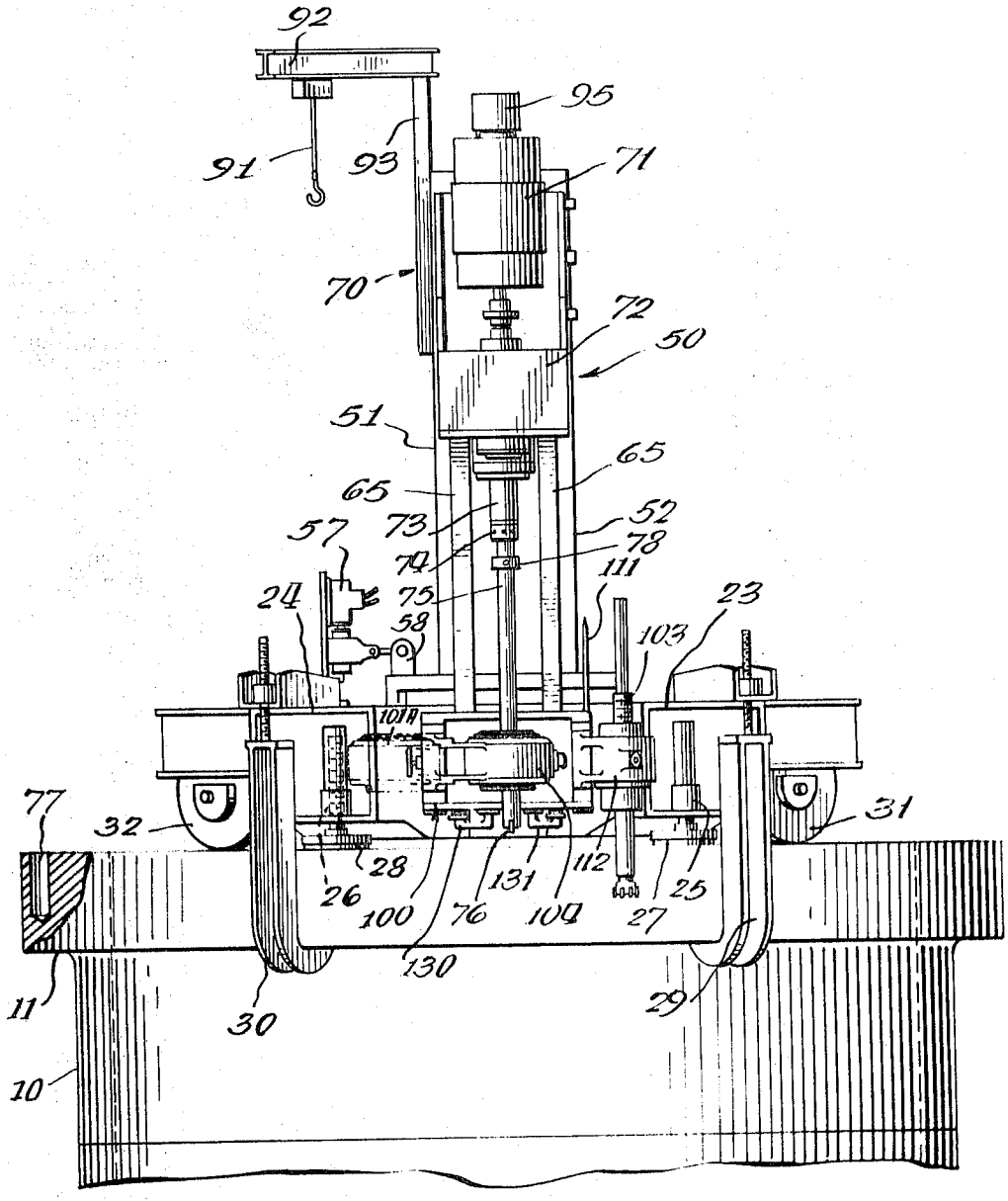


Fig. 1

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Fig. 2



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Fig. 3

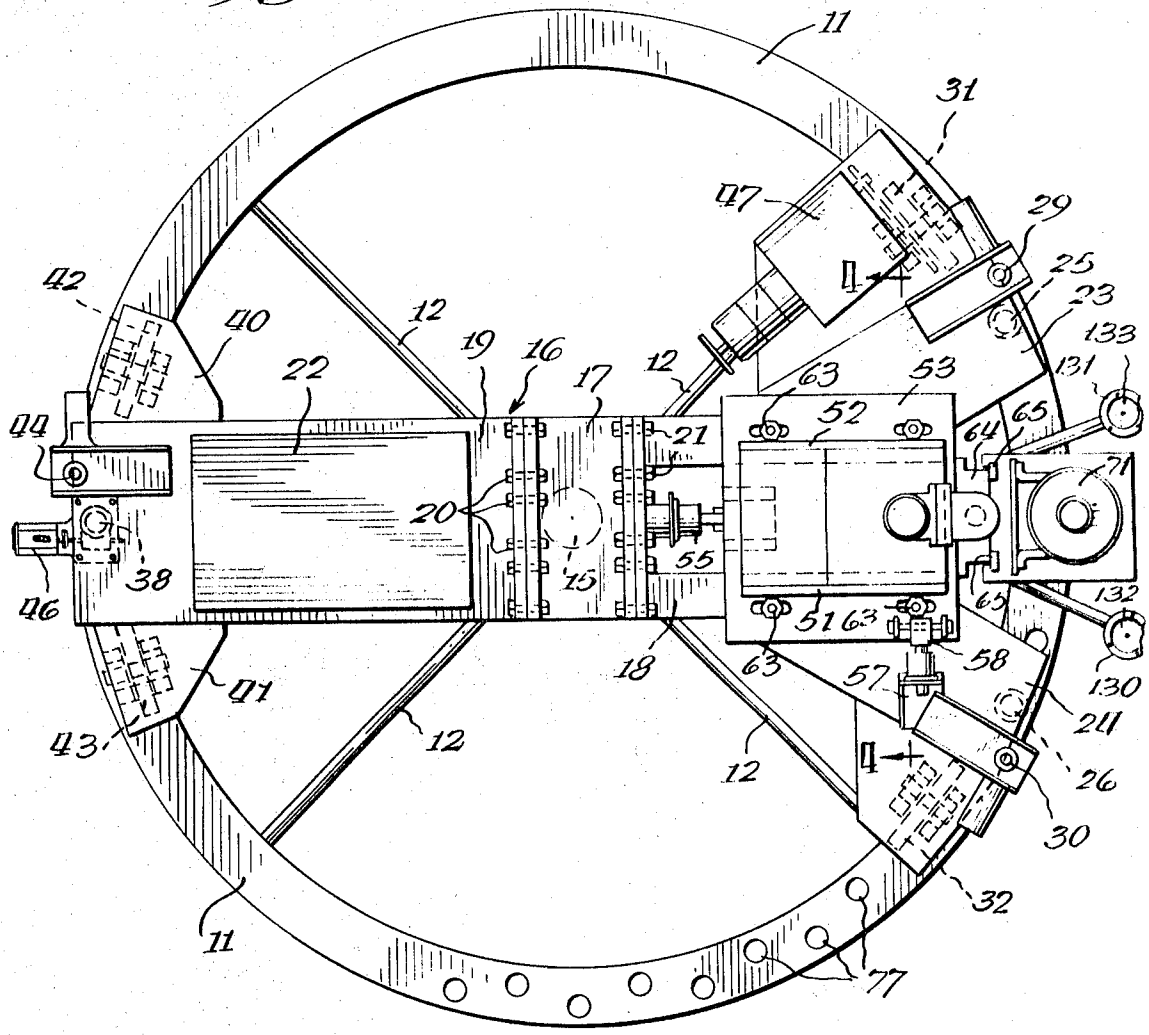
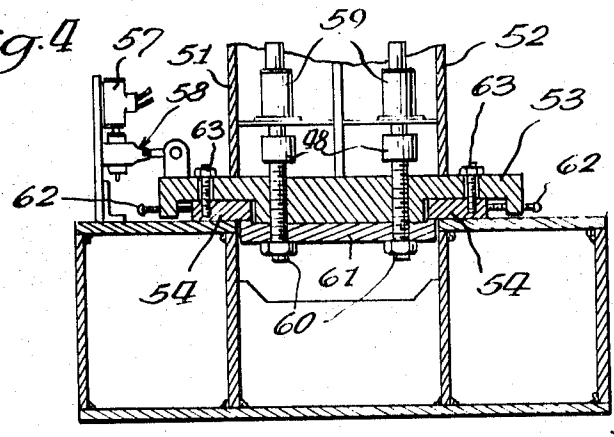


Fig. 4



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Fig. 5

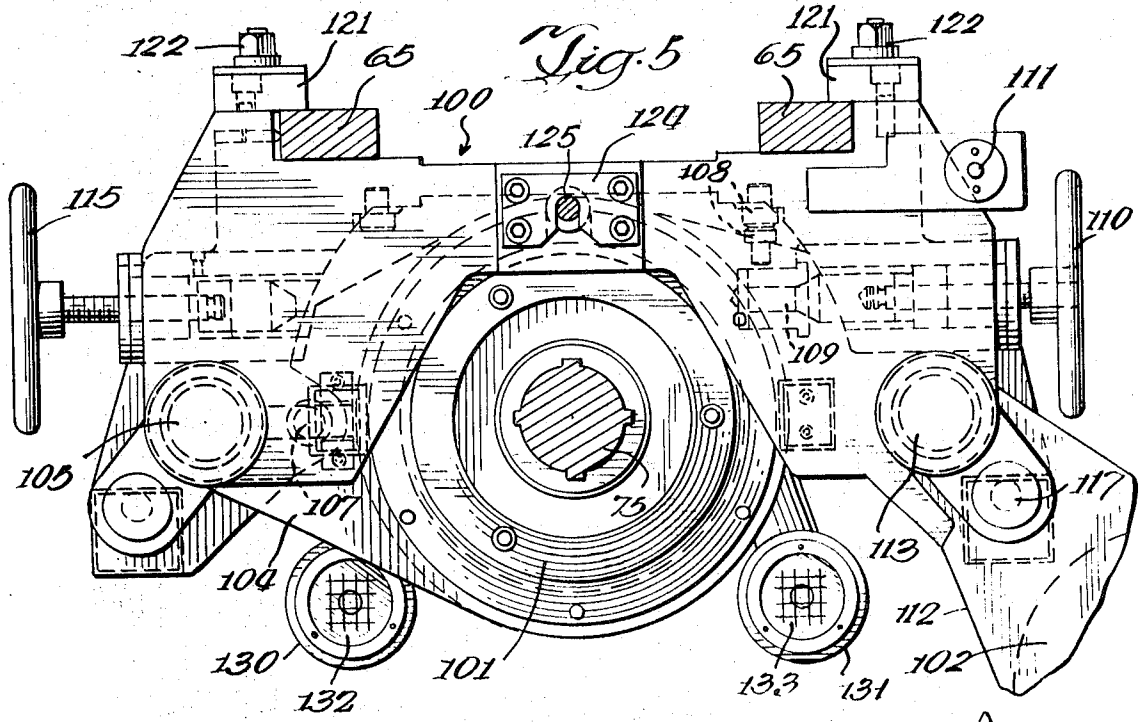
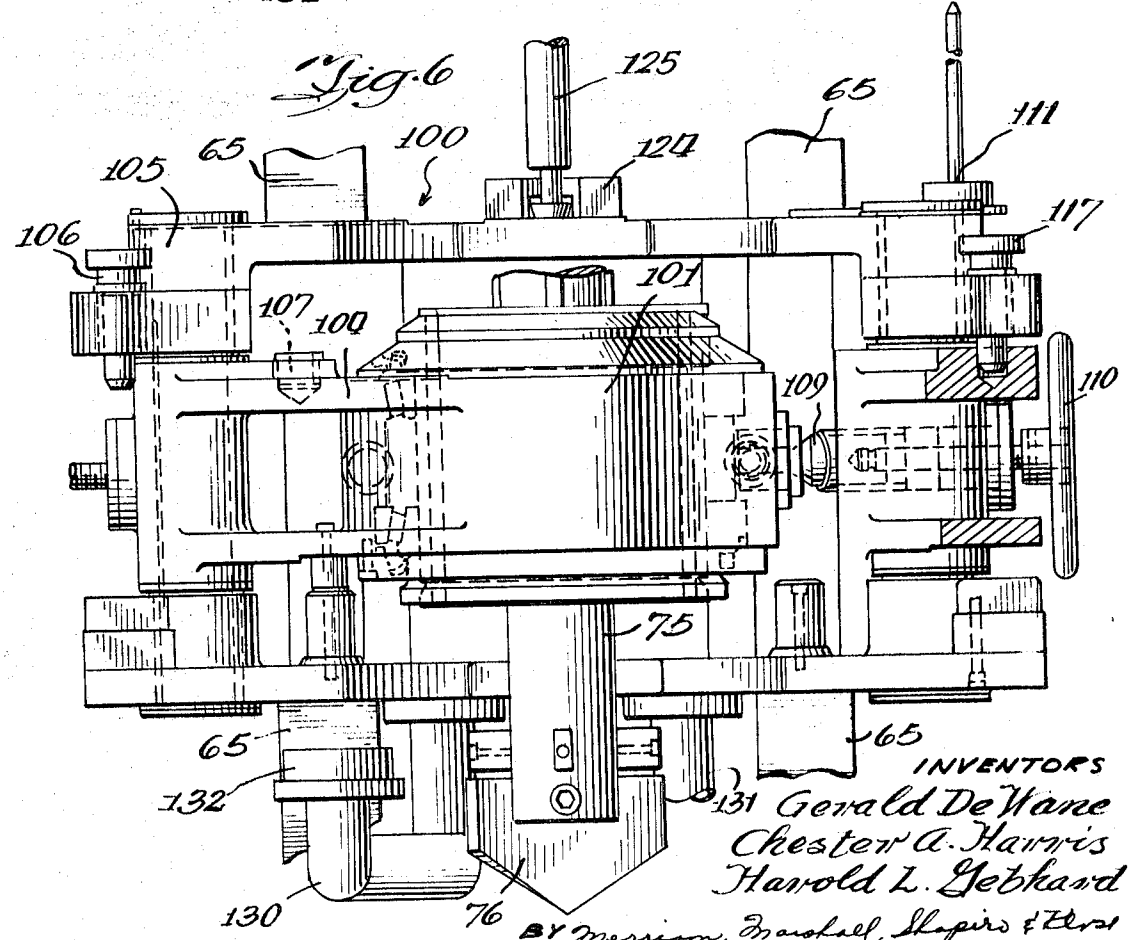


Fig. 6



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Fig. 7

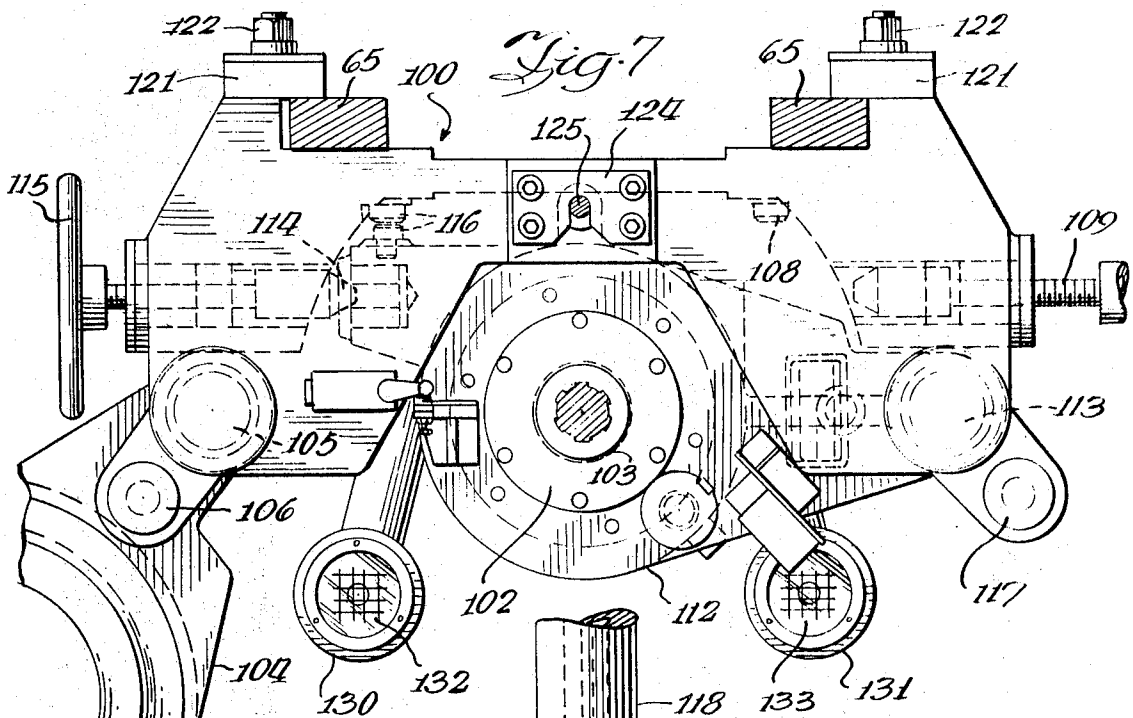
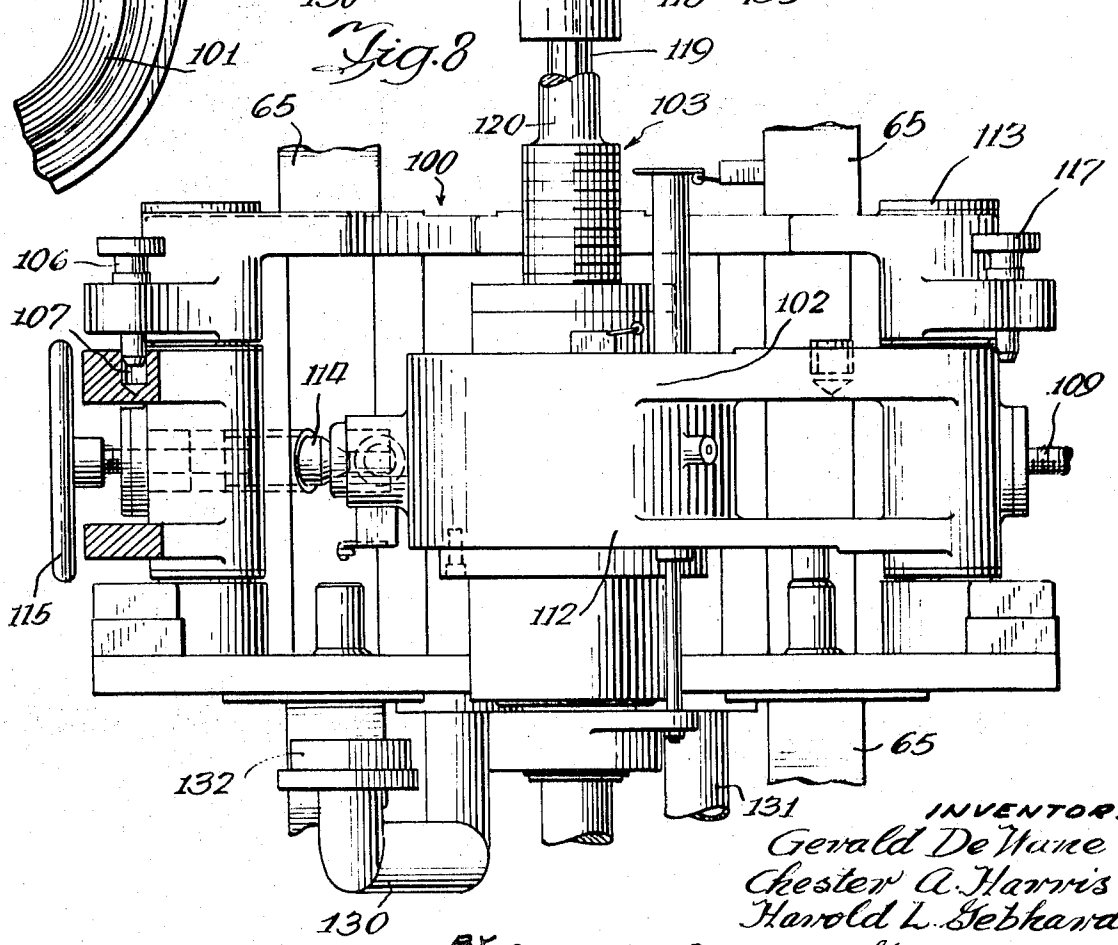
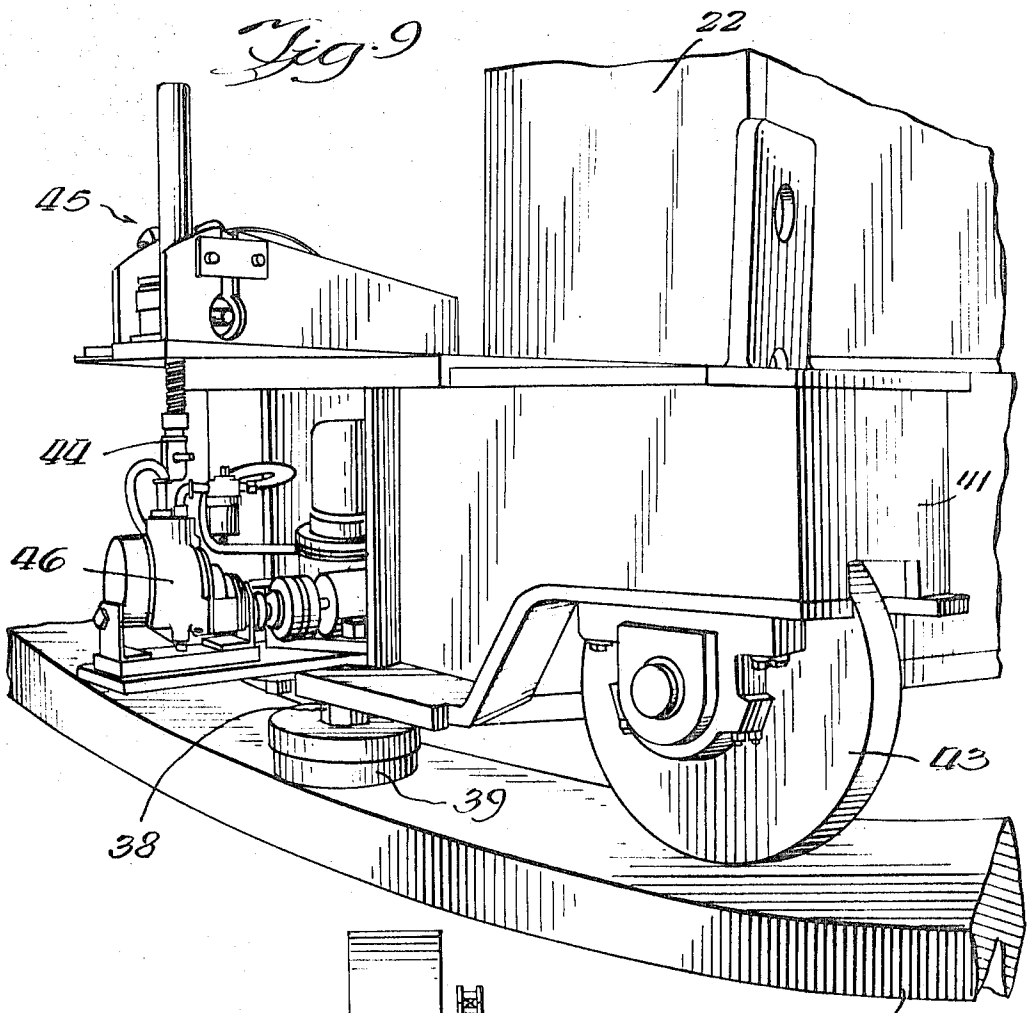


Fig. 8



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Fig. 9



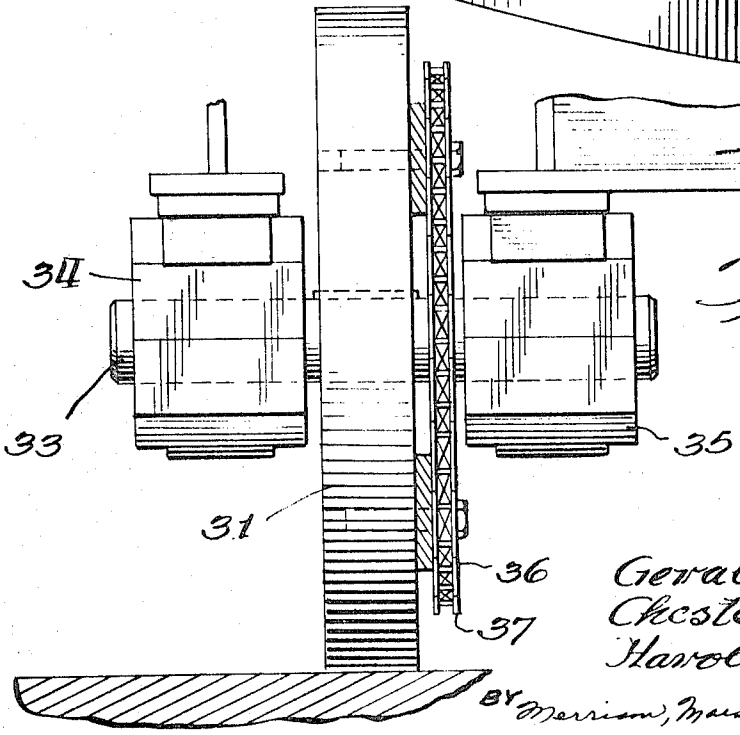
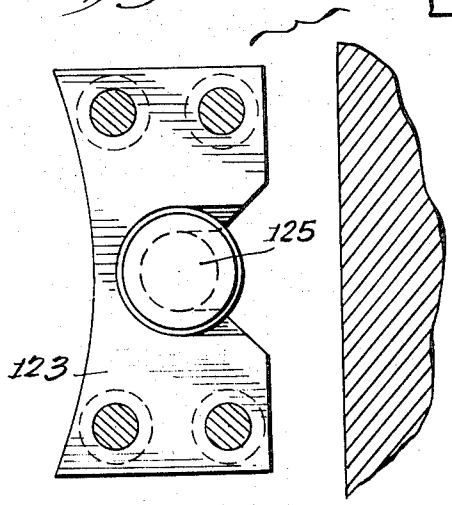


Fig. 10

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Fig. 12



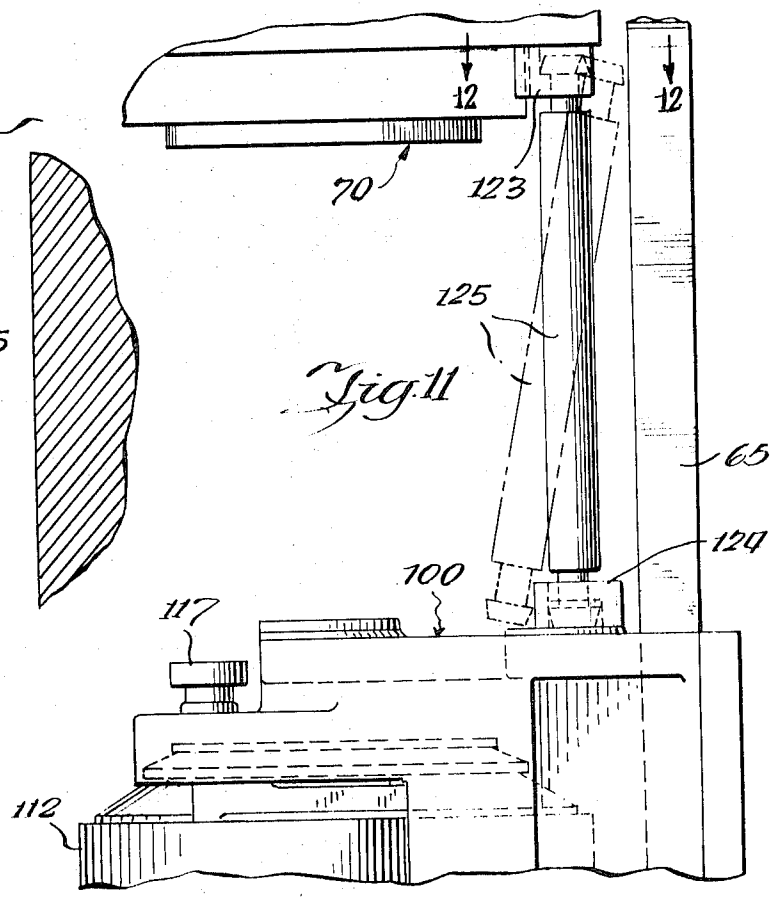
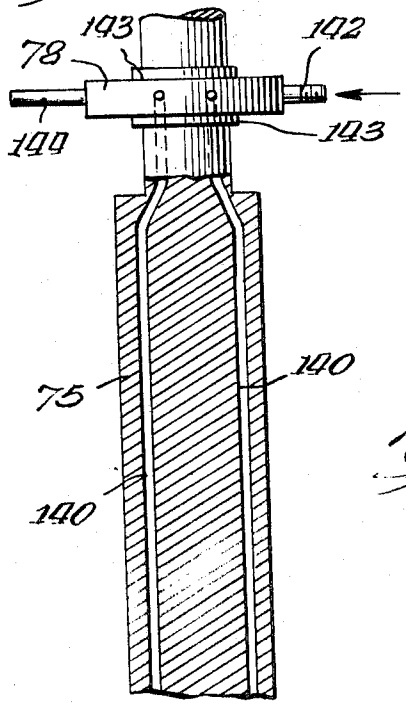


Fig. 11

Fig. 13



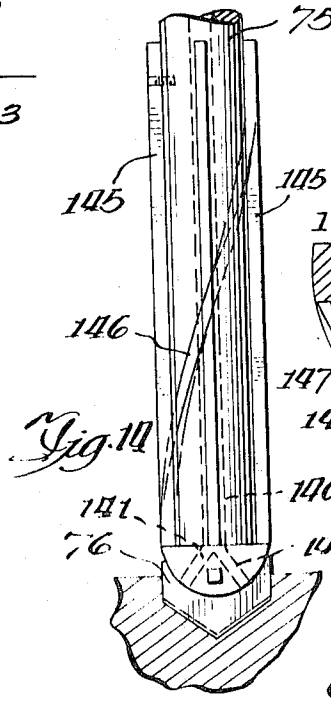


Fig. 14

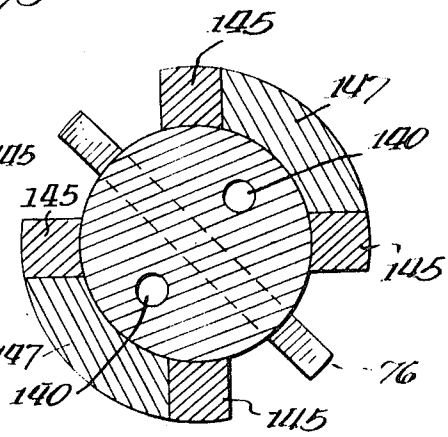


Fig. 15

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Fig. 16

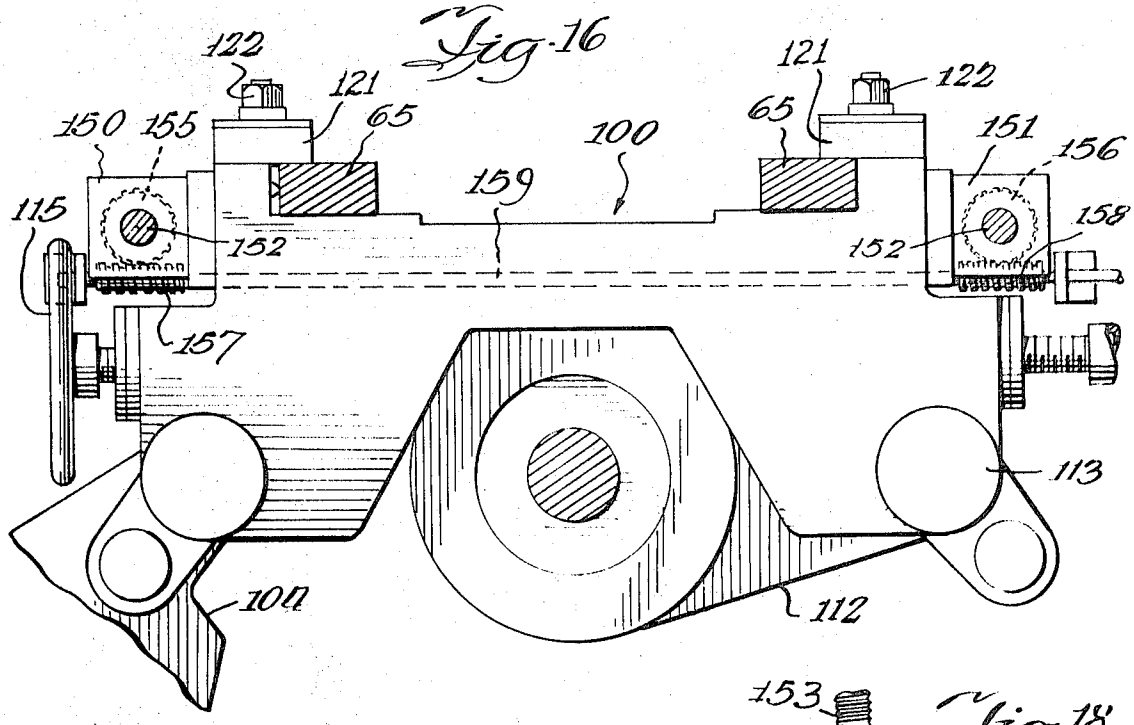


Fig. 18

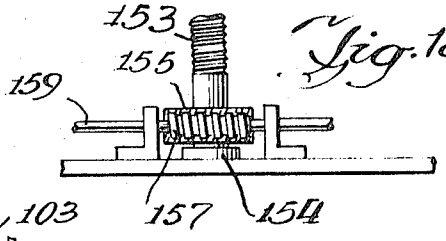


Fig. 17

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PORTABLE MACHINE TOOL FOR VERTICAL DRILLING, THREADING AND THE LIKE

This invention relates to machine tools. More particularly, this invention relates to machines used to drill or gore holes in metal or other materials as well as the use of such machines to tap threads in, to ream, to chamfer, to spot face or perform similar operations in or in the vicinity of holes.

In the production of large size metal structures and containers it is often necessary to fasten or connect together various pieces by means of bolts, studs or other similar fasteners which must fit into, or pass through, large size holes. The drilling, tapping, reaming and the like of large diameter, deep holes in metal such as holes 2 to 10 inches in diameter and 1 to 5 feet deep, is generally effected with the axis of the rotating drill or other tool in the horizontal position. With horizontal drilling the chips produced by the operation can be removed from the hole without too much difficulty. Vertical drilling, however, of large diameter deep holes in the shop or the field has presented a difficult problem particularly where extreme accuracy is required as well as holes of excellent quality free of imperfections. Vertical machining, if possible, would be preferred to horizontal machining in many instances because of the nature of the workpiece and greater ease of observation and operation for the mechanic, whether in the field or in the shop.

Because of the large size and great weight of many pieces of apparatus and equipment needed in present-day systems, it is impractical to fabricate and assemble this equipment in a shop and move it to its final location. While individual pieces or equipment of a structure might be fabricated and rough machined in the shop it becomes necessary to weld all the component parts together in the field. The welding process distorts the assembly and sets up internal stresses which must be relieved by heating. This so-called "stress relief" process tends to scale metal surface and distort flanges and other parts of the assembly. Therefore, final machining such as milling, facing, drilling and tapping must be carried out after the assembly has been completed. The assemblies are usually positioned vertically in their final location, thus requiring vertical machining, often 25 to 80 feet above grade.

In the production of nuclear reactor vessels, such as for use in the generation of electricity, the cover is generally made removable from the reactor vessel body. The cover is generally tightly secured to the nuclear reactor body by a series of large metal studs threaded into a flange around the upper periphery of the reactor body. The metal studs, which are often 5 inches or more in diameter, then project upwardly through a mating flange around the periphery of the reactor cover. The holes through which the metal studs pass in the flange of the cover can be anywhere from 1 to 10 or more feet long. Because of the large number of metal studs required to secure the reactor cover in place it is necessary that the holes be drilled with very great accuracy. Such holes, as well as the holes into which the metal studs are threaded, are best drilled vertically since it would be most difficult to position the nuclear reactor body or the cover in position for horizontal drilling. However, prior to this invention there was no equipment available for drilling large size deep vertical holes in metal with the accuracy required for the engineering standards called for and, in addition, no suitably effective means was available for removing the metal chips produced in the hole during the drilling operation. These deficiencies in previously available machines to achieve the desired goals have been overcome by the subject invention.

According to the present invention there is provided a machine for drilling, reaming, tapping, chamfering or spot facing of large size deep vertical holes in objects and for performing other similar operations in the shop or the field. The machine is portable and can be moved by equipment available in the shop or at a field erection site The machine, however, is of considerable weight and, as illustrated in the subsequent drawings, may weigh as much as 40 tons. This weight is desirable in order to achieve the needed accuracy in direction and condition of the machining.

The machine broadly comprises a rigid frame or carriage, a power head-support vertically positioned on the frame, a vertically movable power head for a tool for drilling, reaming, tapping, grinding, chamfering or spot facing or the like, mounted on vertical slideways on the power head-support, extendable means mounted on the frame for aligning or levelling the machine relative to a workpiece, and clamping means on the frame for securing the machine to the workpiece or other fixed anchor to prevent shifting or lifting of the machine during use. Also advisably mounted on the vertical slideways below the power head-support is a bushing holder for a bushing for stabilizing a drill, tap, reamer, grinding or other tool shaft during use to aid in achieving the sought for high degree of accuracy. The power head-support is advisably slideably mounted on the frame or carriage so that, after the machine has been clamped into position and aligned or levelled, the power head containing the drill, tap or other tool can be slid backward, forward or sideways to effect positioning of the power head for machining at a precise point in the workpiece.

The invention will now be described further in conjunction with the attached drawings, in which:

FIG. 1 is a side elevational view of an embodiment of the machine of this invention;

FIG. 2 is a front elevational view of the machine of FIG. 1;

FIG. 3 is a plan view of the machine of FIGS. 1 and 2;

FIG. 4 is a vertical sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a plan view of the bushing holder used on the machine of FIGS. 1 to 3 with the support arm for the drill shaft support bushing locked in place for use;

FIG. 6 is a front elevational view of the bushing holder arranged as described with reference to FIG. 5;

FIG. 7 is a plan view of the bushing holder showing a bushing support for the thread-cutting tap locked in position;

FIG. 8 is a front elevational view of the bushing holder as arranged in FIG. 7;

FIG. 9 is an isometric view of the back or rear end of the machine and shows one of the two rear wheels, part of the rear clamp and one of the two rear levelling pads;

FIG. 10 is an elevational view of the drive wheel used to rotate the machine about an vertical axis;

FIG. 11 is a partial side elevational view of the machine and shows the rod connecting the bushing holder to the power head in order that vertical movement of the bushing holder can be effected through movement of the power head;

FIG. 12 is a sectional view along the line 12—12 of FIG. 11;

FIG. 13 is an elevational view partially in section of the drill shaft and shows the conduits by which drilling liquid coolant is supplied to the drill and which flushes out with it chips produced in drilling;

FIG. 14 is an elevational view of the drilling shaft with a spade drill bit at the end;

FIG. 15 is a sectional view of the drilling bit of FIG. 14;

FIG. 16 is a plan view, partially in section, of an alternative mechanism for moving the bushing holder;

FIG. 17 is a front elevational view of the mechanism shown in FIG. 16 for moving the bushing holder; and

FIG. 18 is an elevational view of the worm gear arrangement for driving the screws for moving the bushing holder.

So far as is practical, the same or similar elements which appear in different views of the drawings will be identified by the same number. Furthermore, some of the drawings show structural parts which do not appear in other views of the machine, even though they could appear therein, but have been excluded in order that other structural features may be seen more clearly.

The drawings of FIGS. 1 2 and 3 show an embodiment of the machine of this invention mounted on a vessel body 10 having a flange 11 in which it is necessary to drill and tap a series of large deep holes in spaced apart relationship around the periphery of the flange. Rods 12 and 13 are connected at their outer ends to the inside wall of vessel 10 and their inner ends are joined to member 14 which supports pivot pin 15 in-

sertably located therein. Pin 15 provides a pivotable axis about which the machine can rotate in drilling the series of holes in flange 11. The machine, however, does not bear against the centering member 14 since the entire weight of the machine is borne by the reactor vessel flange 11.

The embodiment of the machine shown in FIGS. 1, 2 and 3 has a rigid frame or carriage 16 fabricated of thick steel plate. The frame is elongated as shown more clearly in FIG. 3. This particular embodiment of frame or carriage 16 has a center frame section 17, a forward frame section 18 and a rear frame section 19. Forward frame section 18 and rear frame section 19 are joined to center frame section 17 by means of bolts 20 and 21. To increase the length of frame or carriage 16 the bolts 20 and 21 can be removed and suitable spacers placed therebetween of any length necessary to obtain the desired elongation in the frame. Alternatively, a larger center frame section 17 can be used to increase the length of the carriage 16. In this way the drilling machine can be adapted for use on a wide variety of structures, vessels, tanks and the like and accommodated to the diameter or length thereof. Center frame section 17 is provided with a suitable hole for receiving pin 15. Although frame 16 is shown made of three pieces it can be made of one piece, two pieces or more than three as desired.

Cabinet 22 is provided to house electrical controls for suitable operation of the machine. The electrical circuits for operating the various motors are conventional and form no part of this invention.

Projecting out from each side of front end frame section 18 are branches 23 an 24 as shown in FIGS. 2 and 3. These branches thus form a total frame structure having the general shape of a Y or of a yoke. Frame branches 23 and 24 are open in the area between their extremities and this space comprises the working station for drilling, tapping, reaming, grinding or performing a similar operation on a metal workpiece located in the area therebetween.

Each of the frame branches 23 and 24 support levelling legs 25 and 26 as shown in FIG. 2. The levelling legs are operated by air motors connected to a worm gear which rotates a screw mounted in a stationary screw block or nut to raise and lower the same. The bottom of the legs is provided with levelling pads or discs 27 and 28. In addition, the frame branches 23 and 24 support clamps 29 and 30 with one clamp being on each frame branch. Each clamp is operated by an air motor connected to a worm gear which rotates a screw mounted in a stationary screw block or nut. The hooked end of each clamp, as shown in FIGS. 1 and 2, fits under the flange 11 of the workpiece and thereby restrains the machine against upward lift during all machining operations. Should foundation settlement occur, both the machine and workpiece move together and their physical relationship does not change. In prior machining, the machine and workpiece were secured on separate foundations so that any shifting or settling changed their physical relationship and caused dimensional errors.

Also positioned on the frame branches 23 and 24 are wheels 31 and 32 as shown in FIG. 2 for moving the machine into proper position. Each wheel is mounted in a suitable axle supported by bearings adequate to bear the load. The wheels are positioned to facilitate rotation of the machine around pin 15. Wheel 31 is a power drive wheel for rotating the machine in a circle. As shown in FIG. 10, wheel 31 has axle 33 supported in bearings 34 and 35. Connected to wheel 31 is sprocket 36 which receives power through sprocket chain 37 from variable-speed drive motor 47 (FIGS. 3 and 10).

Mounted on the rear of frame 16 is aligning or levelling leg 38 having a lower pad 39 similar to pads 27 and 28 on the front levelling legs 25 and 26. Aligning or levelling leg 38 is also operated for vertical displacement by an air motor 46 through a worm gear screw and screw block arrangement. Horizontal extensions 40 and 41 extend laterally out from the rear of frame section 19 and support wheels 42 and 43, with one being on each extension. Each wheel is supported in a suitable axle mounted in bearings as shown more clearly in FIG. 9.

The rear of the machine is also provided with clamp 44 which is operated by an air motor through a worm gear, screw and stationary screw block system in order to secure the rear of the machine tightly against the workpiece, or some other anchor structure, to hold the machine against movement during use. The mechanism for releasing and tightening clamp 44 is shown in FIG. 9 as structure 45.

The aligning and levelling legs 25, 26 and 38 not only align and level the machine but also lift the wheels out of contact with the workpiece or other support during operation of the machine. After the machine has been raised in this manner the holddown clamps 29, 30 and 44 are used to secure the machine in place.

Mounted on the front end of frame 16 is power head-support 50 which has sidewalls 51 and 52 of heavy plate steel and front and backwalls of similar metal plate to achieve the rigidity needed for the accurate machining sought for by use of the machine of this invention. Power head-support 50 has a baseplate 53 slidably mounted on bars 54 positioned horizontally on the top surface of the forward section 18 of frame 16.

Forward and rearward movement of power head-support 50 is achieved by means of air motor 55 which connects with mechanism 56 comprising a worm gear, screw and stationary screw block or nut to push or pull the power head-support 50 in the direction desired (FIG. 1). Similarly, air motor 57 is used to obtain lateral or side-way movement of the power head-support 50 by means of linkage and connector 58 (FIG. 2). Once the power head-support 50 has been positioned in the location desired it is locked in place by means of a single throttle for air motors 59 (FIG. 1) which operate worm gear and screw 48 to tighten bolts 60 which force plate 61 against the bottom of bars 54. Bolts 62 and 63 are also used to secure the power head-support 50 in position so that it does not shift during drilling operations.

The forward face of power head-support 50 is substantially vertical and on it is mounted rigid bed 64 which supports precision hand fit vertical slideways 65. Mounted on the vertical slideways is power head 70 comprising variable-speed reversible direct current motor 71 connected by means of suitable gearing to gearbox drive 72 from which power is delivered to spindle 73. The spindle is equipped with a quick-change sleeve nut 74 to effect tool changing in a minimum of time. As shown in FIG. 1 drill shaft 75 is secured by the quick-change nut 74 to spindle 73. At the working end of drill shaft 75 is located spade drill 76. Shown in flange 11 is a hole 77 drilled by spade drill 76.

The drill shaft 75 is provided with a rotary coupling of large capacity by which cooling liquid can be delivered to the inside of the drill shaft at high pressure (250 p.s.i. at 150 g.p.m.) and fed from there down to the exit ports adjacent the spade drill tip 76. The drilling cooling liquid rises in the hole being drilled, tapped or reamed and carries with it the chips formed by the operation thus keeping the bore essentially free of interfering debris.

The weight of power head 70 is counterbalanced by rigging 80 (FIG. 1). A pair of parallel spaced apart channel members 81 (FIG. 1). A pair of parallel spaced apart channel members 81 (only one of which is shown in FIG. 1) are secured by struts 82 to the top of the power head-support 50. A sheave 83 and a sheave 84 are placed at approximately each end of each of the two channel members 81. Two parallel spaced-apart cables 85 pass over the sheaves 83 and 84. One end of the cable is attached at 86 to the power head-support and the other end is attached 87 to the counterbalancing weight unit 88. Counterweight 88 is made up of a series of individual metal plates held together by two bolts 89. The counterweight 88 extends between the spaced apart cables 85. In order to prevent counterweight 88 from swinging, two guide cables or rods 90 are connected in parallel arrangement at the top to channel members 81 and at the bottom to frame 18.

To facilitate lifting heavy tools into position an air operated hoist 91 is supported by channel 92 which is connected in a pivotable manner to post 93 mounted on the top of power head-support 50.

Vertical movement of power head 70, both up and down, is effected by means of screw 94 (FIG. 1) which is power driven by motor 95 positioned at the top of power head-support 50. Two electric clutches between the motor 95 and the screw 94 permits rapid traverse (6 in./sec.) to remove the tool from a hole quickly, or regular machining traverse. The lower end of screw 94 is supported in thrust bearing 96 and is associated there with an electrical mechanical brake to stop the motor from coasting when a stop control is operated. Screw 94 moves the power head 70 to position it and drive it for advancing the drill during operation. Advancement of power head 70 by means of feed screw 94 aids in obtaining very accurate drilling. In conventional methods the power head is normally stationary and advancement of the tool is achieved by progressive extension of a spindle out of the power head unit. This leads to less accurate results since movement of such parts involves clearance tolerances for suitable operation which permit the tool to drift more than desired. Feed screw 94 is locked out and not used during tapping threads since a tap is used with its own built-in feed screw and with the power head held stationary.

Another important feature of this invention comprises the provision of a tool stabilizer in the vicinity of the tool working end. Supported below the power head 70 and mounted on the vertical slideways 65 is bushing holder 100, as shown in FIGS. 1 and 2. The bushing holder 100, as shown in this embodiment of the invention, supports two different bushings, only one of which is in use at any particular time. Thus, bushing 101 is shown in position to stabilize drill shaft 75. It is pivotably mounted so that it can be swung out of the way to position 101A, shown in phantom, when not in use. A second bushing 102 is shown in swung-out position, as shown in FIG. 2, since it is not in position for use. The bushing 102 is shown there holding an automatic collapsible thread tap 103. The thread tap collapses when the proper thread depth is reached. The tap would then be withdrawn with the tap out of contact with the thread on its way out.

FIGS. 5 to 8 show in substantial detail the structural arrangement of bushing holder 100. The bushing holder 100 has two pivotally mounted arms one of which is positioned on the left side for bushing 101 and the other on the right side for bushing 102. Each is essentially a mirror image of the other. As shown in FIGS. 5 and 6, arm 104 is pivotally mounted by pin 105. Pin 105 is vertically positioned so that horizontal rotation of arm 104 can be effected. When bushing arm 104 is swung out, pin 106 fits into hole 107 to hold it securely in out position. FIG. 7 shows arm 104 swung out and locked in position. When in use arm 104 is swung inwardly to the position shown in FIGS. 5 and 6 to position bushing 101 directly below the power head so that the tool will protrude through the bushing from the top. The adjusting bolts 108 serve to limit and govern inward rotation of arm 104. Cone pointed screw 109 is advanced by wheel 110 into a hole positioned in the sidewall of arm 104 to thereby securely lock the arm in position to properly fix the position of the bushing such as used to stabilize the drill shaft.

A safety limit switch 111 is provided to restrict the downward movement of the power head during operation. Since the bushing holder 100 is held securely in fixed position during drilling or tapping it is essential to have a safety limit control to stop downward movement of the power head to avoid damage to the unit.

FIGS. 7 and 8 show the bushing arm 104 swung out in locked nonuse position and with bushing arm 112 rotated by means of pin 113 into position for use to stabilize another tool. Cone-tipped screw 114 is advanced by means of lock wheel 115 into a hole located in arm 112 to lock the arm in position. Adjusting bolts 116 serve to limit the inward swing of bushing arm 112. Pin 117 locks the bushing arm 112 in open position when not in use as shown in FIG. 5.

Bushing arm 112 supports thread tapping bushing 102 which in turn guides the automatic collapsible self-advancing thread-tapping head 103. As shown in FIG. 8, splined bushing 118, which is connected to spindle 73, delivers power to splined shaft 119 which in turn delivers power to thread feed screw 120 to thereby advance the thread cutting tool at a rate and pitch identical to the thread to be cut.

Bushing holder 100 is locked into place by means of plates 121 which contact slideways 65 (FIGS. 5 and 7). Plates 121 are locked into position by means of bolts 122.

Bushing holder 100 is quite heavy and to effect its proper positioning with ease on slideways 65 it is moved by means of positioning rod 125 as shown in FIG. 11. Each end of rod 125 is recessed and fits into a cooperating recess in plates positioned on the power head 70 and on the bushing holder 100. Thus, the grooved lower end of rod 125 fits into a recessed area in plate 124 and the upper grooved end of the rod fits into a recessed area in plate 123 positioned on the power head unit. Rod 125 is only employed to position the bushing holder 100. By positioning the rod in place and operating the feed screw 94, power head 70 is caused to move vertically, either up or down, and by means of rod 125 a similar movement of bushing holder 100 is effected. Once the bushing holder 100 has been secured in place by bolts 122, rod 125 is removed since it is not employed during drilling, tapping or reaming.

Extending from the forward end of frame section 18 are a pair of level support brackets 130 and 131 having flat horizontally positioned upright surfaces at their ends. On the flat surfaces round levels 132 and 133 are placed. One or more levels can be used at a time. Levels are advisably used which can read less than 0.001 inches in one foot. When the power head spindle has been positioned to be 90° to the workpiece surface, which may or may not be at true level, the two levels are adjusted to read true level as a reference. Once set the levels are left as is since they show the true relationship of drill spindle to workpiece. During operation of the machine they are carefully watched since any out of level reading indicates something is out of line.

The vertical drilling and boring of large diameter deep holes is greatly facilitated by novel processes and apparatus provided herewith which effect efficient and reliable removal of chips produced during the operation. It has been found that removal of drilling chips from vertical holes can be effected by continuously feeding a cooling liquid under high velocity and high pressure by means of a conduit to the bottom space of a vertical hole being drilled, bored or the like. The high velocity and high pressure of the cooling liquid provide hydraulic lift and propel the chips out of the top of the vertical hole at a rate faster than they are produced. In the drilling of a 5-inch vertical hole in steel an upward flow of liquid at a rate of 200 ft./min. provides excellent hydraulic lift and prevents chip accumulation in the hole. Usually a flow of at least 150 gallons per minute is advisably employed.

FIGS. 13 to 15 illustrate apparatus useful for supplying liquid to the bottom area of a hole being drilled to effect removal of chips by hydraulic lift. Drill stem or shaft 75 is provided with one or more conduits or holes 140 which extend from the upper portion of the stem to the lower end. As shown in FIG. 14, the holes branch out 141 at the bottom to deliver the liquid ahead of the front or cutting face of the spade drill 76. In this way the chips are subjected to hydraulic lift immediately after being produced. Although the conduit for supplying the liquid is shown in FIGS. 13 to 15 as an integral part of the drill stem or shaft, it is feasible to have a conduit separate from and external of the shaft but supported axial thereof and against the side of the shaft.

Liquid is supplied by pipe 142 to rotary coupling 78 which feeds it to conduits 140. Seals 143 keep the liquid from leaking out between the rotary coupling and the drill shaft. A small arm 144 is provided to maintain rotary coupling 78 in fixed position during drilling. Arm 144 bears against member 51 and provides a stop therefor.

Drill shaft 75 is provided with guides 145 which extend for that length of the shaft to be inserted in a hole during drilling. Although the guides are shown axially positioned in FIGS. 14 and 15, they can be positioned spirally as shown in phantom 146 in FIG. 14. The guides stabilize the drill shaft and prevent it from drifting.

With reference to FIG. 15, two filler pieces 147, such as of wood or aluminum, are positioned between and extend for the length of adjacent guides 145. The filler pieces are of such size and shape as to come into close proximity with the wall of the hole being drilled. The purpose of the filler pieces is to reduce the area through which the liquid can flow propelling the chips upwardly thus maintaining a high velocity of flow.

As the liquid and chips emerge from the hole they are diverted to chip pans where the liquid is recovered, filtered and reused.

The drawings in FIGS. 16 to 18 show an alternative arrangement for effecting vertical movement of bushing holder 100. The structure as shown in these figures permits powered movement of bushing holder 100 without movement of power head 70 using rod 121 as shown in FIG. 11.

As shown in FIGS. 16 to 18, threaded nuts 150 and 151 are placed on opposing vertical sides of bushing holder 100. Vertically positioned screws 152 and 153 are threaded through nuts 150 and 151 respectively. The bottom ends of the screws are supported by bearings 154, mounted on part of frame 16, which stabilize the screws against vertical displacement but which allow the screws to rotate freely. Mounted at the lower end of each of screws 152 and 153 are gears 155 and 156 which mesh with worm gears 157 and 158. Worm gears 157 and 158 are joined by shaft 159 which extends to air motor 160 to effect power movement of the gears and thereby vertical displacement of bushing holder 100.

The machining tool of this invention can be used for machining steel or other metals and in addition finds use in machining inorganic materials such as stone and concrete. It can also be used on polymeric plastic materials.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What we claim is:

1. A machine for driving a rotating tool such as for drilling, reaming, tapping or grinding large size deep vertical holes in objects or performing other such operations which comprises:
- a rigid frame;
- a power head-support vertically positioned on the frame;
- a vertically movable power head, for rotating a tool, mounted on vertical slideways on the power head-support;
- extendable means mounted on the frame for aligning or levelling or raising the machine relative to a workpiece;
- clamping means on the frame for securing the machine to the workpiece or other fixed anchor to prevent shifting during use; and
- said power head-support being slidably mounted on the frame with means to slide the power head-support sideways, forward and backwards and means to lock the power head-support tightly to the frame in fixed position.

2. A machine according to claim 1 in which a vertically slidable bushing holder is supported by the vertical slideways below the power head, and the holder supports a bushing for stabilizing the tool.

3. A machine according to claim 2 in which the bushing holder has two horizontally swingable arms, each of which arms supports a bushing for the tool, said arms being alternately swingable into a station beneath the power head, lock means to securely and accurately hold the bushings alternately in station for use, and means to fix the other arm in standby swung-out position.

4. A machine for drilling, tapping, reaming or grinding large size deep vertical holes in objects or performing other such operations which comprises:
- a rigid frame;
- at least three wheels attached to the frame for effecting rolling movement of the machine;
- at least three extendable leg means attached to the frame for aligning, levelling or raising the machine relative to a workpiece and to lift the wheels out of contact with a workpiece;
- at least three clamping means attached to the frame for securing the machine to a workpiece or other fixed member to prevent shifting of the machine during use;
- a power head-support vertically positioned on the frame;
- means to slidably move the power head-support sideways, forward and backwards on the frame, and means to lock the power head-support tightly to the frame in fixed position;
- a vertically movable power head mounted on vertical slide ways on the power head-support;
- a bushing holder mounted by the vertical slide ways below the power head, said holder supporting a bushing for a tool driven by the power head; and
- power-driven screw means on the power head-support to raise and lower the power head on the slideways.

5. A machine according to claim 4 in which the bushing holder has two horizontally swingable arms, each of which arms supports a bushing such as for a drilling or thread-tapping tool, said arms being alternately swingable into a station beneath the power head, lock means to securely and accurately hold the bushings alternately in station for use, and means to fix the other arm in standby swung-out position.

6. A machine according to claim 2 in which the power head-support and bushing holder have power-driven means to raise and lower them on the slideways.

7. A machine according to claim 4 in which the frame has pivot guide means intermediate its ends for use in rotating the machine in a horizontal circle.

8. A machine according to claim 1 in which the frame has an outwardly projecting horizontal branch on each side of the end containing the power head-support, and said frame branches and back end of the frame each carry wheels for moving the machine and also carry the extendable means for aligning and levelling the machine, said extendable means comprising power operated vertically displaceable aligning and levelling legs.

9. A machine according to claim 1 in which the frame has pivot guide means intermediate its ends for use in rotating the machine in a horizontal circle.

10. A machine according to claim 9 in which the frame has a plurality of wheels positioned for circular movement of the machine and one of said wheels is a power operated drive wheel.

11. A machine according to claim 1 in which the frame is in sections detachably fastened together and the length of the frame is adjustable by a spacer between the sections.

12. A machine according to claim 1 having a surface for holding a level adjacent the area of drilling or tapping so that an operator can readily observe any shifting of the machine in operation.

13. A machine according to claim 2 comprising power-driven screw means for effecting vertical displacement of the bushing holder independent of movement of the power head.

14. A machine according to claim 1 in which the extendable means and the clamping means are operated by power means mounted on the machine.

15. A machine according to claim 2 comprising power-driven dual screw means for effecting vertical displacement of the bushing holder independent of movement of the power head.

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