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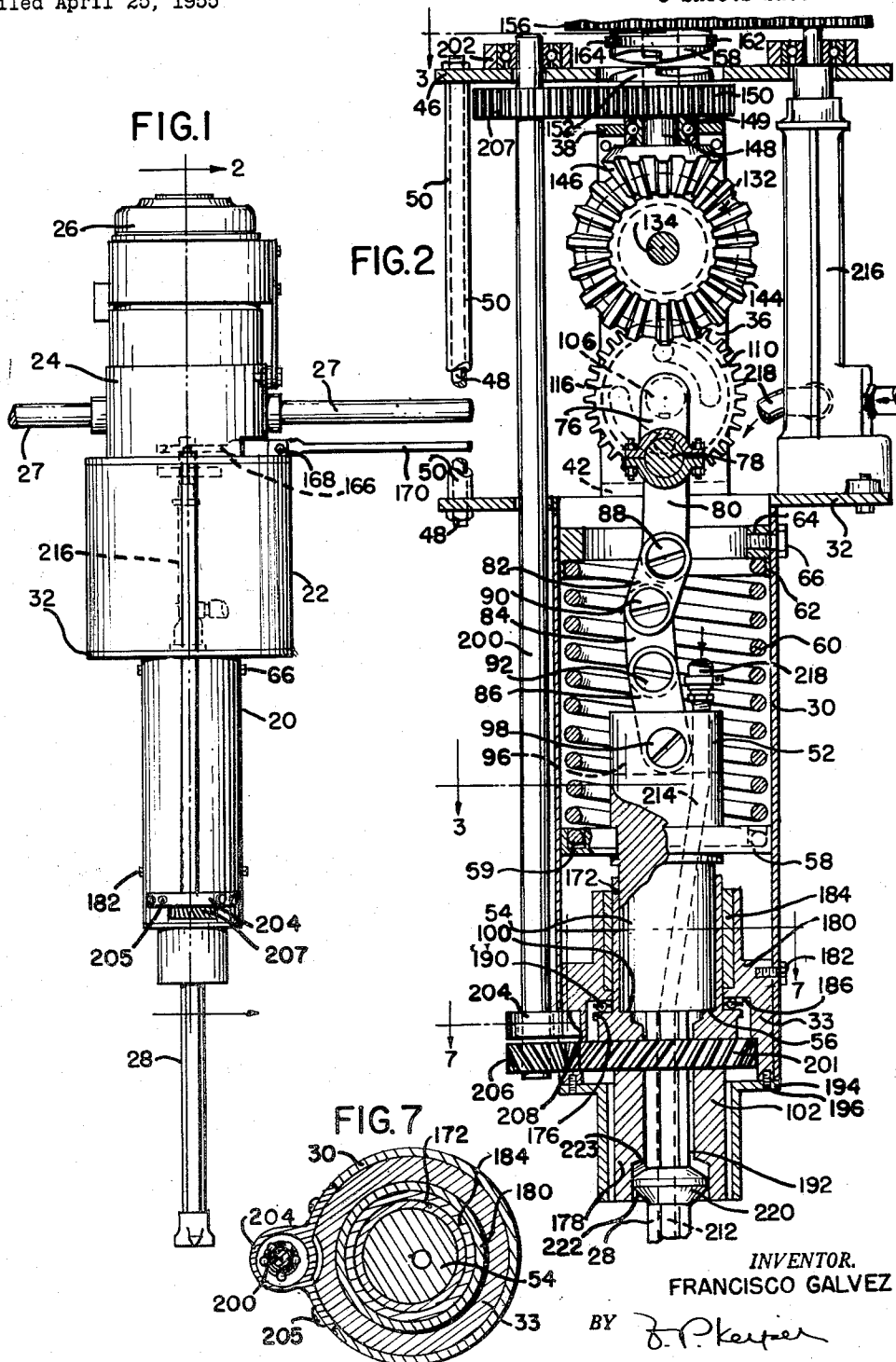
F. GALVEZ

2,772,858

POWER HAMMERS

Filed April 25, 1955

3 Sheets-Sheet 1



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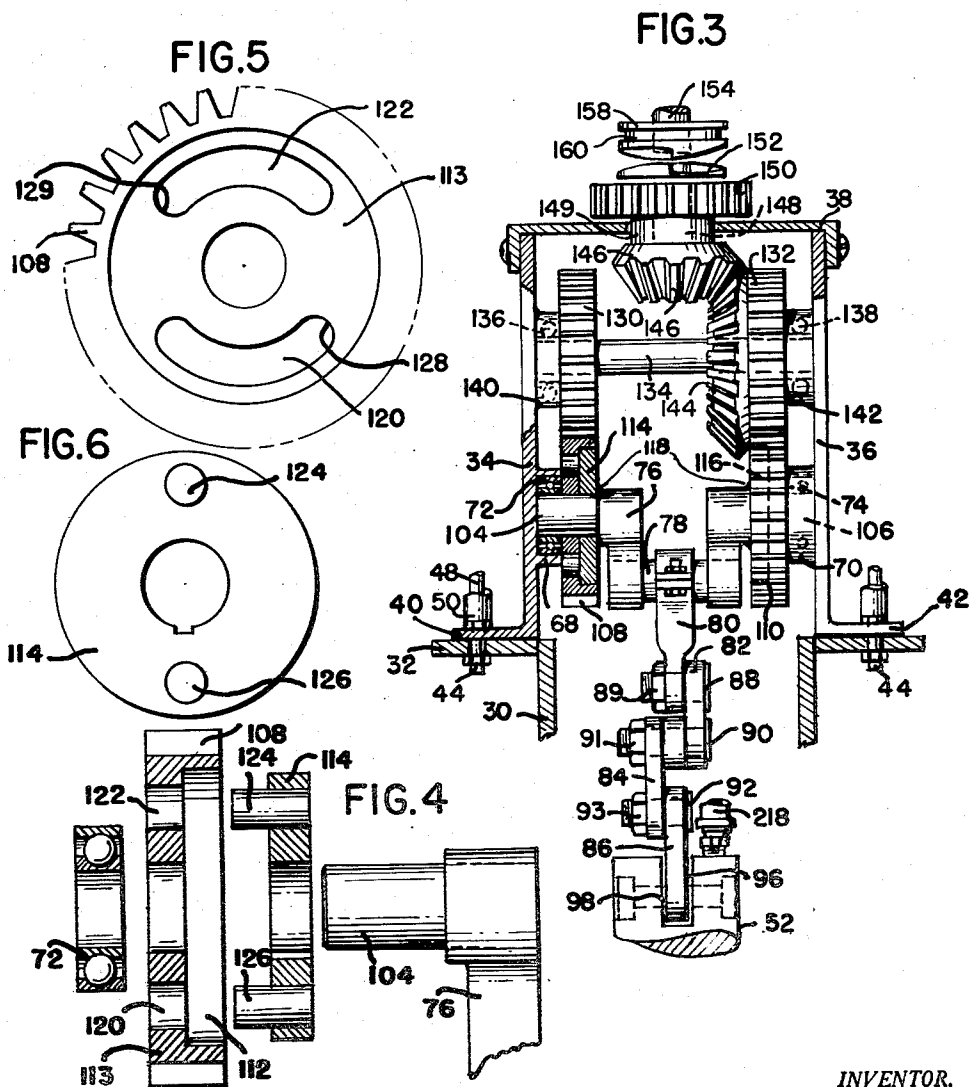
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3 Sheets-Sheet 2



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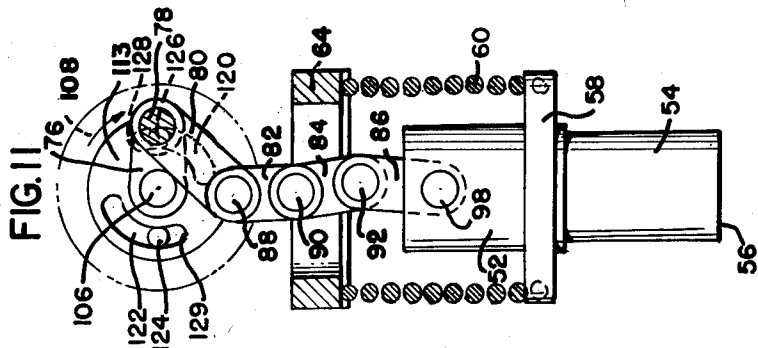
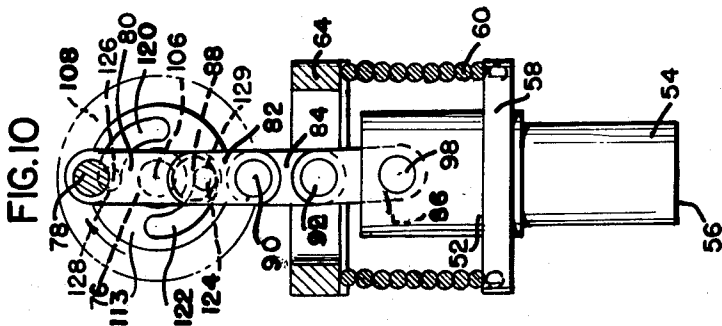
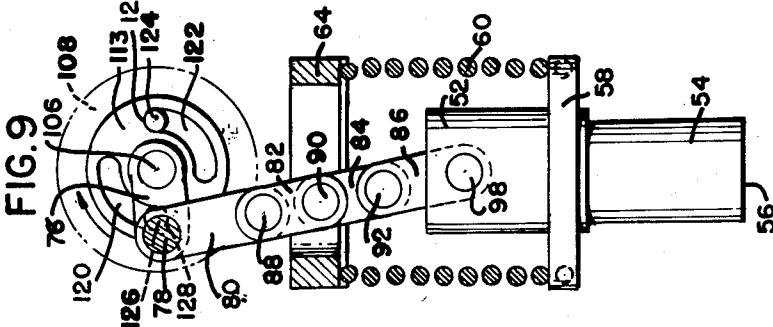
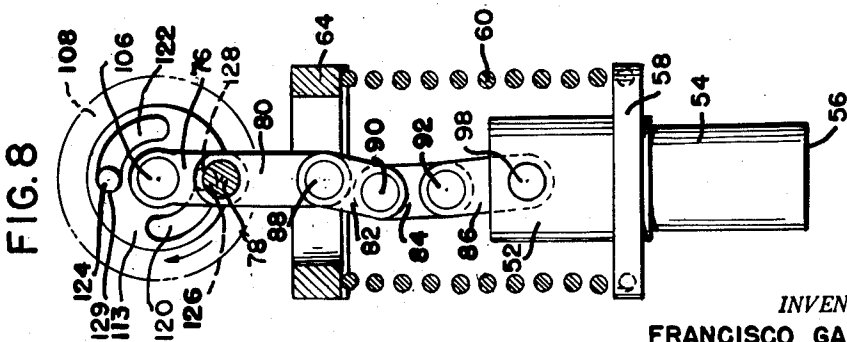
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3 Sheets-Sheet 3



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2,772,858

POWER HAMMERS

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Application April 25, 1955, Serial No. 563,407

10 Claims. (Cl. 255—39)

This invention relates to power hammers, and more particularly to power hammers of the mechanical type employing spring recoil for driving an inertia member.

In power hammers of the type referred to, which are employed for rock drilling and similar uses, it has generally been the practice to employ compressed air for the driving force. Such devices, where use is required remote from the source of compressed air, require extended hose connections which are cumbersome, and result in low efficiency. The present invention is directed to a mechanical hammer in which the driving power in the form of an electric motor or other prime mover may form a part of and provide a direct drive. The invention is further directed to a power hammer having highly efficient hammer driving mechanism operable by minimum power requirements. The invention is directed to a power hammer wherein continuous rotary movement is employed to repeatedly compress a spring, the recoil of which drives the inertia hammer member. The invention is further directed to a mechanical rotary lost motion drive associated with a crank for compressing the spring, which permits the crank to freely accelerate with reference to the prime mover driven driving member, in response to spring recoil, after passing top dead center position. The invention is further directed to a mechanism in which spring compression is effected by the application of continuously available steady power, whereby compression and recoil occurs in rapidly repeating cycles. Further the invention is directed to the use of an articulated connecting rod between the crank and inertial member whereby no force other than tension during the actual compression of the spring is transmittable between the inertia member and the crank. The invention additionally is directed to applying to a mechanical hammer, means for continuously rotating the hammer driven tool, and for continuously supplying water to the tool cutting edges as required.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description, when taken in conjunction with the accompanying drawings. It is expressly understood that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein like reference characters indicate like parts:

Figure 1 is an elevational view of the power hammer; Figure 2 is a sectional view taken substantially on the line 2—2 of Fig. 1;

Figure 3 is a sectional view taken substantially on the line 3—3 of Fig. 2;

Figure 4 is an exploded fragmentary view of the drive members and crank, with parts in section;

Figure 5 is an elevational view of the driving member of Fig. 4;

Figure 6 is an elevational view of the driven member of Fig. 4;

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Figure 7 is a transverse fragmentary sectional view taken substantially on the line 7—7 of Fig. 2; and

Figures 8, 9, 10, and 11, are schematic views of the drive members and hammer-operating linkage at successive phases of a cycle of operation.

Referring to Figure 1, the power hammer is shown as having a tubular guide assembly 20, drive mechanism therefor located thereabove as at 22, a motor mounting sleeve 24, motor 26, and a tool 28 in the form of a rock drill, projecting from the lower end. The motor mounting sleeve is provided with opposed handle bars 27. The guide assembly comprises a tubular member 30, having a flange 32 at its upper end integrally secured thereto, and a guide collar assembly 33 mounted at its lower end.

As shown in Figure 2, there is mounted on the flange 32 a U bearing frame (see also Fig. 3) having uprights 34 and 36, tied together by a cross member 38, the uprights having laterally extending feet 40 and 42 which are secured to the flange 32 by bolts 44. Above the bearing frame is a plate 46 which is secured in spaced relation to the flange 32 by a plurality of bolts such as 48, each extending through a spacer sleeve as at 50, such bolts being located adjacent the marginal edges of the flange 32 and plate 46 at suitable uniform intervals, about six in number being desirable.

Within the guide tube 30 is an inertia member or hammer 52 of generally circular cross-section, the hammer having a slightly reduced cross section lower end 54, terminating in a head end 56. About midway along the length of the member is affixed integral therewith a circular flange 58 of a diameter to slide upon the internal wall of the tubular member 30. The flange is provided adjacent its marginal edge with an annular upwardly facing channel or groove 59, to receive the end of a coil spring 60. The upper end of the coil spring is seated in an annular seat 62, of a ring 64, which ring is bolted to the tubular member by a plurality of radial bolts such as 66 angularly disposed with uniform spacing around the tubular member 30.

The frame members 34 and 36 are provided with aligned and facing bearing cups 68 and 70 in which are positioned ball bearings 72 and 74, which receive the ends of a crankshaft 76, such shaft having a single crank throw 78. The throw 78 of the crankshaft carries a connecting rod 80, having a plurality of links 82, 84 and 86, which provide an articulated connection to the hammer 52. Such links are pivotally connected together and to the connecting rod 80 by heavy pivot bolts 88, 90, and 92, the link 86 lying in the plane of the connecting rod, and the links 82 and 84 lying on opposite sides thereof, the bolt 90 being provided with a spacing collar 94 between the links 82 and 84. The link 86 extends into a transverse slot 96 in the upper end of the hammer 52, and is pivoted on a transverse bolt 98. The threaded portion of each of the bolts 88, 90 and 92 is of reduced diameter to provide a shoulder against which the nuts 89, 91, and 93 are drawn, whereby to provide fixed spacing for the links pivoted on the bolts so as to provide free pivotal movement of the links with respect to one another. The links 82, 84, 86 and the connecting rod 80 are of such a length as to readily buckle in the manner shown in Fig. 2, when the crankshaft is at the low position, and the hammer head is resting on the upper face 100 of the tool receiving collar 102, or in fact at any time when the linkage is not subjected to tension.

The opposite ends 104 and 106 of the crankshaft 76 are provided with gear drive members 108 and 110, each of which is freely rotatable on the respective shaft ends. Such drive members each have circular facing recesses 112, adapted to receive driven disc members such as 114 and 116, which are keyed to the crankshaft and other-

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wise secured rigidly thereto as by welding, as is indicated at 118. The discs nest with slight clearance within the recesses 112 of the driving members 108 and 110. The web 113 of each of the driving members 108 and 110 is provided with arcuate slots as at 120 and 122, which are of about 90° in arcuate length, and the driven discs 114 and 116 are provided with driving pins 124 and 126 which project into said slots and are adapted to seat against the ends 128 and 129 of the slots 120 and 122, so as to be driven by the driving members 108 and 110. The pins are of a diameter to freely travel the arcuate length of the slots, so that the discs may rotate ahead of and accelerate in relation to the driving members 108 and 110.

The gear teeth of the driving members 108 and 110 mesh with the teeth of pinions 130 and 132 fixed to the shaft 134, the ends of which are journaled in ball bearings 136 and 138, received in bearing cups 140 and 142 on the frame uprights 34 and 36. The pinion 132 is provided with an integral bevel gear 144, meshing with a driving bevel gear 146 mounted on a stub shaft 148. The stub shaft is journaled in a ball bearing 149 mounted in the cross member 38. The upper end of the shaft has affixed thereto a gear 150 and a jaw clutch member 152.

The motor 26 has a shaft 154, the lower end of which has affixed thereto a pump drive gear 156, and a jaw clutch member 158, the latter being keyed to but slidable axially of the shaft into and out of engagement with the jaw clutch member 152. The member 158 has a shifting collar groove 160, which is adapted to receive the forked ends 162 and 164 of a shifting lever 166, such lever extending through an aperture in the sleeve 24 and being pivoted on the plate 46 as at 168, and having a manual lever handle projecting laterally from the apparatus as at 170, conveniently located with respect to a handle bar 27.

With the gearing as shown, it will be seen that the driving members or gears 108 and 110 are adapted to be continuously driven at a substantially uniform speed by the motor 26, the speed being reduced by about 1/2 or more by the bevel gears and pinions 130 and 132 and gears 108 and 110, the pitch circle diameters being so chosen as to provide a speed of rotation of the driving members in the order of about 400 revolutions per minute. It will be seen that the crankshaft is adapted to be driven by the pins 124 and 126 in the slots 120 and 122 of the driving members.

With clockwise rotation of the driving members 108 and 110, as seen in Fig. 2, the ends 128 and 129 of the slots will engage the pins 124 and 126 whereby the crankshaft 76 will be rotated from the low point shown, to the top dead center position, the crank acting to take up the slack in the connecting rod 80 and links 82, 84 and 86, as the crank progresses in its rotation to the top dead center position. When the links are placed in tension, the hammer 52 is lifted, compressing the coil spring 60, which spring reaches maximum compression when the crank shaft reaches top dead center.

As soon as the crank shaft is carried beyond top dead center, the compression of the spring 60 causes the crank shaft to accelerate ahead of the driving members 108 and 110, the slots permitting the pins to angularly rotate ahead and accelerate. At the same time, the connecting rod and articulated linkage thereof relieve the crankshaft of any positive connection with the hammer, the linkage being free to buckle, and being incapable of transmitting any force between the crank and hammer other than tension. The slots are of sufficient arcuate length so as to provide complete freedom of the crankshaft during the period of descent of the hammer, it being understood that during such descent, the driving members 108 and 110 are also following along at a relatively steady angular velocity. For this reason the angular length of the slots, to give complete freedom during the acceleration of the hammer on the down stroke, need be about 90° as shown.

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The spring recoil is thus free to accelerate the hammer and deliver a blow to the end of the tool 28.

In Figures 8, 9, 10 and 11, the successive positions of the parts are illustrated at various stages of a single cycle of operation. In Fig. 8, the crank throw is at the bottom and about to be rotated upward by clockwise rotation of the slotted driving members 108 and 110. The links 80, 82, 84 and 86 are shown as buckled. The pins 124 and 126 are shown at the ends 128 and 129 of the slots 120 and 122. The hammer is at its lower end point of travel. In Figure 9, the driving members have rotated about 90° and carried the crank throw about half way to top dead center. The connecting rod and links are shown drawn taut in tension, and the hammer has been partially lifted, partially compressing the spring 60. In Figure 10, the spring has been fully compressed, the crank is at top dead center, and further rotation of the crank carries it beyond dead center, at which point, the compression of the spring is free to recoil and commences to accelerate the hammer downwardly. The crank is free to jump ahead, and the connecting rod linkage is free to buckle and effect a disconnection between the crankshaft and hammer. By the time the driving members have rotated about 60° further as shown in Figure 11, the hammer has delivered its blow. During such period, the crankshaft has been free to float ahead of the movement of the driving members 108 and 110, the disc pins 124 and 126 being positioned at some point towards the forward end of the slots 120 and 122.

Continued rotation of the driving members 108 and 110 results in taking up the slack or lost motion, until the position of the parts again reaches that generally indicated in Figure 8.

The lower end 54 of the hammer is adapted to reciprocate in a guiding sleeve 172, formed as a part of a tool holding collar 102, such collar having a thrust bearing flange 176, and a tool guiding shank portion 178. The sleeve is journaled within a collar 180 secured internally of the tubular member 30, by a series of radial bolts 182 disposed circumferentially with uniform spacing around the tubular member. The collar 180 is provided with a bearing sleeve 184 for the sleeve 172, and an annular downwardly facing shoulder 186. A thrust bearing 190 is interposed between the shoulder 186 and flange 176. The tool holder has an aperture 192 coaxial thereof for receiving a tool 28, such aperture being of hexagonal or polygonal configuration to receive the shank of the tool of complementary cross section. The tool holder is retained in place by the flanged end sleeve 194 secured as by screws 196 to the end of the collar 180.

Affixed to the shank 178 is a helical toothed gear 201, by means of which the tool holder is rotated. Rotation is effected by a shaft 200 extending alongside the assembly, such shaft being provided with a top bearing 202 mounted on the plate 46, and a bottom bearing located in a bearing clamp 204 secured to the collar 180 as by screws 205. The shaft is provided with a pinion 207 meshing with the gear 150 at its upper end, and a pinion 206 meshing with the gear 201 at its lower end. The tubular member 33 is cut away as at 208 for this purpose.

The tool 28 may have a bore 212 extending lengthwise thereof to provide a steady flow of water to the lower cutting end 213 thereof, and the hammer 52 is provided with a bore 214 extending from a laterally disposed position at the upper end to the center of the head end. A pump of the gear type as at 216 is mounted on the flange 32, and a flexible conduit 218 connects the outflow of the pump to the bore 214, such flexible conduit extending into the upper end of the tubular member 30, and within the upper turns of the coil spring 60.

The tool 28 has a shoulder ring 220, which is received in the enlarged shoulder forming bore 222 of the collar 102, the ring being adapted to engage the shoulder 223 at the end of the enlarged bore to serve as a means for

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limiting the tool position within the collar, with its upper end above the face 100 of the tool receiving collar. In practice, the upper end of the tool will be located about ¼" or more above such face to receive the repeated blows of the head end of the hammer.

In practice, a motor of one-half horsepower, three phase or single phase, may be employed to compress the spring for recoil hammer operation, and while an electric motor has been shown, it will be understood that any fractional horsepower prime mover may be mounted on the upper structure to drive the driving members 108 and 110.

It will be appreciated that the articulated connecting rod, in addition to severing all connection between crank and hammer during the recoil of the spring, also serves as a shock dampener when the crank commences to apply tension to the linkage to initiate spring compression, the links upon being drawn taut, tending to cushion the shock. In practice, six or seven complete cycles of operation, or hammer blows, occur each second, and the weight of the apparatus is such as to absorb a substantial amount of the shock to the operator guiding the apparatus by the handles 27.

The clutch members 152 and 162, when uncoupled, stop the rotation of the tool. The pump, however, is continuously driven to supply a flush of water, so that the rock hole being drilled by the tool may be flushed at will, without necessitating the concurrent operation of the hammer.

While the invention has been shown in its direct application and in a single embodiment which has been illustrated and described, it is to be understood that the invention is not limited thereto. As various changes in the construction and arrangement may be made without departing from the spirit of the invention, as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A power hammer comprising a reciprocating inertia member, a frame including a guide way for said member, a coil spring having one end bearing against said inertia member, and the other secured within said guide way, a single throw crank shaft extending transversely of the axis of movement of said member and journaled on said frame beyond the other end of said coil spring and on opposite sides of the axis, an articulated connecting rod connecting the throw of said crank shaft with said inertia member to compress said spring said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, rotatable driving means freely rotatable on said crank shaft, means providing for limited relative angular movement between said driving means and crank shaft whereby said crank shaft may accelerate in reference to said driving means in response to spring recoil, and power means for rotating said driving means at a substantially uniform angular velocity.

2. A power hammer comprising a reciprocating inertia member, a frame including a guide way for said member, a coil spring having one end bearing against said inertia member, and the other secured within said guide way, a single throw crank shaft extending transversely of the axis of movement of said member and journaled on said frame beyond the other end of said coil spring, an articulated connecting rod connecting the throw of said crank shaft with said inertia member to compress said spring said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, rotatable driving means freely rotatable on said crank shaft, means providing for limited relative angular movement between said driving means and crank shaft whereby said crank shaft may accelerate in reference to said driving means in response to spring recoil,

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power means for rotating said driving means at a substantially uniform angular velocity, and means for holding a tool in alignment with said inertia member and in position to be struck thereby upon recoil movement thereof.

3. A power hammer comprising a reciprocating inertia member, a frame including a guide way for said member, a coil spring having one end bearing against said inertia member, and the other secured within said guide way, a single throw crank shaft extending transversely of the axis of movement of said member and journaled on said frame beyond the other end of said coil spring and on opposite sides of the axis, an articulated connecting rod connecting the throw of said crank shaft with said inertia member to compress said spring said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, rotatable driving means freely rotatable on said crank shaft, means providing for limited relative angular movement between said driving means and crank shaft whereby said crank shaft may accelerate in reference to said driving means in response to spring recoil, power means for rotating said driving means at a substantially uniform angular velocity, means for holding a tool in alignment with said inertia member and in position to be struck thereby upon recoil movement thereof, and means including a connection to said power means for rotating said holding means.

4. A power hammer comprising a reciprocating inertia member, a frame including a guide way for said member, a coil spring having one end bearing against said inertia member, and the other secured within said guide way, a single throw crank shaft extending transversely of the axis of movement of said member and journaled on said frame beyond the other end of said coil spring, an articulated connecting rod connecting the throw of said crank shaft with said inertia member to compress said spring, said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, rotatable driving means freely rotatable on said crank shaft, means providing for limited relative angular movement between said driving means and crank shaft whereby said crank shaft may accelerate in reference to said driving means in response to spring recoil, said means comprising an arcuate slot on one of said rotatable means and crank shaft, and a crank pin angularly rotatable there-within on the other, and power means for rotating said driving means at a substantially uniform angular velocity.

5. A power hammer comprising a reciprocating inertia member, a frame including a guide way for said member, a coil spring having one end bearing against said inertia member, and the other secured within said guide way, a single throw crank shaft extending transversely of the axis of movement of said member and journaled on said frame beyond the other end of said coil spring, an articulated connecting rod connecting the throw of said crank shaft with said inertia member to compress said spring, said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, rotatable driving means freely rotatable on said crank shaft, means providing for limited relative angular movement between said driving means and crank shaft whereby said crank shaft may accelerate in reference to said driving means in response to spring recoil, said means comprising an arcuate slot on one of said rotatable means and crank shaft, and a crank pin angularly rotatable there-within on the other, power means for rotating said driving means at a substantially uniform angular velocity, and means for holding a tool in alignment with said inertia member and in position to be struck thereby upon recoil movement thereof.

6. A power hammer comprising a reciprocating inertia member, a frame including a guide way for said member, a coil spring having one end bearing against said inertia member, and the other secured within said guide way,

a single throw crank shaft extending transversely of the axis of movement of said member and journaled on said frame beyond the other end of said coil spring, an articulated connecting rod connecting the throw of said crank shaft with said inertia member to compress said spring, said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, rotatable driving means freely rotatable on said crank shaft, means providing for limited relative angular movement between said driving means and crank shaft whereby said crank shaft may accelerate in reference to said driving means in response to spring recoil, said means comprising an arcuate slot on one of said rotatable means and crank shaft, and a crank pin angularly rotatable therewithin on the other, power means for rotating said driving means at a substantially uniform angular velocity, means for holding a tool in alignment with said inertia member and in position to be struck thereby upon recoil movement thereof, and means including a connection to said power means for rotating said holding means.

7. A power hammer comprising a tubular guide way, a bearing frame mounted at one end thereof, a reciprocating inertia member having a head end located in said guide way adjacent the other end thereof, a coil spring having one end anchored within said tubular guide way adjacent said bearing frame and the other end bearing on said inertia member, a single throw crank shaft journaled in said bearing frame and extending transversely to and across the axis of said guide way and supported on bearings on opposite sides of the axis, an articulated multi-serially connected link connecting rod having at least two pivotal joints extending transversely of the guide way axis connecting the crank shaft throw and said inertia member and extending through said spring for compressing said spring, driving means journaled on said crank shaft having limited relative angular movement with respect to said crank shaft whereby said crankshaft may accelerate free of said driving means in response to spring recoil, power means for driving said driving means at a substantially uniform speed, a tool holder journaled in the other end of said guide way beyond said inertia member and having an aperture therethrough coaxial with said guide way for receiving the shank of a tool with its end adapted to be struck by said head end, and gearing connecting said power means with said tool holder to rotate the latter.

8. A power hammer comprising a tubular guide way, a bearing frame mounted at one end thereof, a reciprocating inertia member having a head end located in said guide way adjacent the other end thereof, a coil spring having one end anchored within said tubular guide way adjacent said bearing frame and the other end bearing on said inertia member, a single throw crank shaft journaled in said bearing frame and extending transversely to the axis of said guide way, an articulated connecting rod connecting the crank shaft throw and said inertia member and extending through said spring for compressing said spring, said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, driving means journaled on said crank shaft having limited relative angular movement with respect to said

crank shaft whereby said crank shaft may accelerate free of said driving means in response to spring recoil, said driving means comprising a member journaled freely on said crank shaft having an arcuate slot thereon and a crank pin fixed to said crank shaft extending into said slot, power means for driving said driving means at a substantially uniform speed, a tool holder journaled in the other end of said guide way beyond said inertia member and having an aperture therethrough coaxial with said guide way for receiving the shank of a tool with its end adapted to be struck by said head end, and gearing connecting said power means with said tool holder to rotate the latter.

9. A power hammer comprising a guide way, a reciprocating inertia member located therein, a spring for recoil driving of said member, a crank shaft having a throw journaled transversely of said guide way at one end of said guide way, an articulated connecting rod extending between said crank shaft throw and inertia member adapted to compress said spring preparatory to recoil driving of said member, said connecting rod comprising a plurality of short links pivoted serially together on axes parallel with said crank shaft, and driving means for said crank shaft comprising a driving member freely rotatable on said crank shaft having an arcuate slot, and a member affixed to said shaft having a crank pin projecting into said slot whereby to provide relative angular lost motion between said driving member and crank pin member confined to the arcuate length of said slot whereby said crank upon passing top dead center may accelerate with respect to said driving means in response to spring recoil driving of said inertia member.

10. A power hammer comprising a tubular guide way, a bearing frame mounted at one end thereof, a reciprocating inertia member having a head end located in said guide way adjacent the other end thereof, a coil spring having one end anchored within said tubular guide way adjacent said bearing frame and the other end bearing on said inertia member, a single throw crank shaft journaled in said bearing frame and extending transversely to the axis of said guide way, an articulated connecting rod connecting the crank shaft throw and said inertia member and extending through said spring, for compressing said spring, said rod being composed of at least three links serially and pivotally connected on axes parallel with said shaft, driving means journaled on said crank shaft having limited relative angular movement with respect to said crank shaft whereby said crank shaft may accelerate free of said driving means in response to spring recoil, an electric motor mounted above said frame with its shaft aligned with said tubular guide way, and gearing between said motor shaft and driving means.

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