Dec. 12, 1967 C. V. ADAMS ETAL 3,357,315

POWER HAMMER

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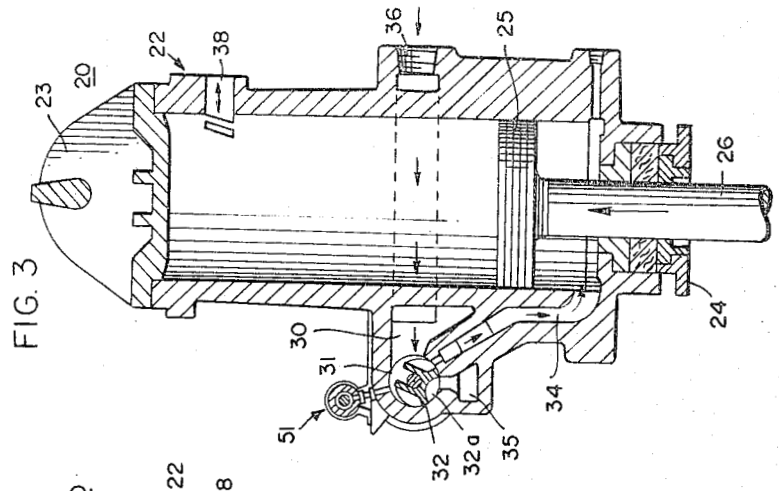

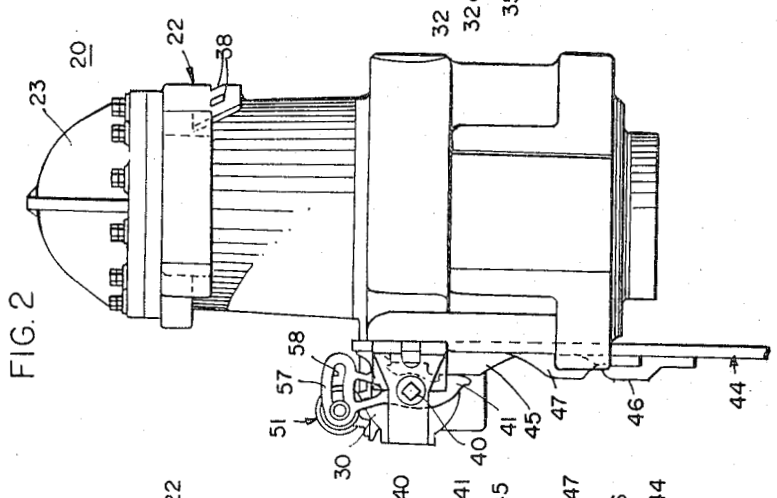

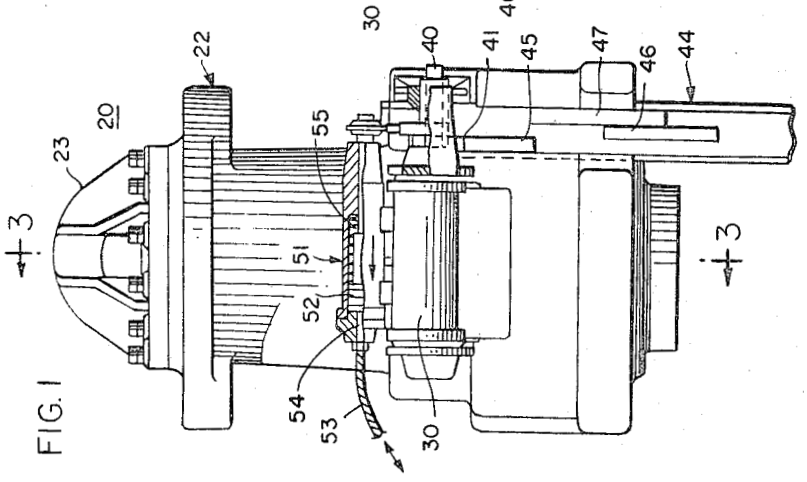

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POWER HAMMER

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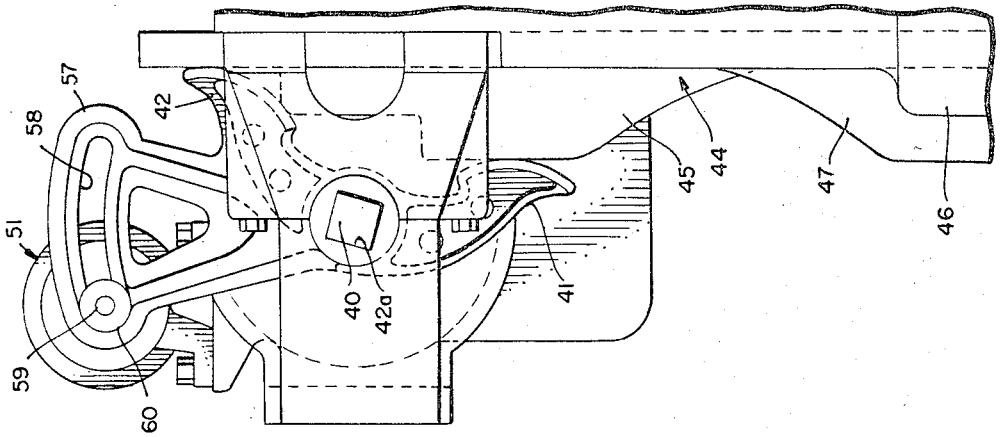

FIG. 5

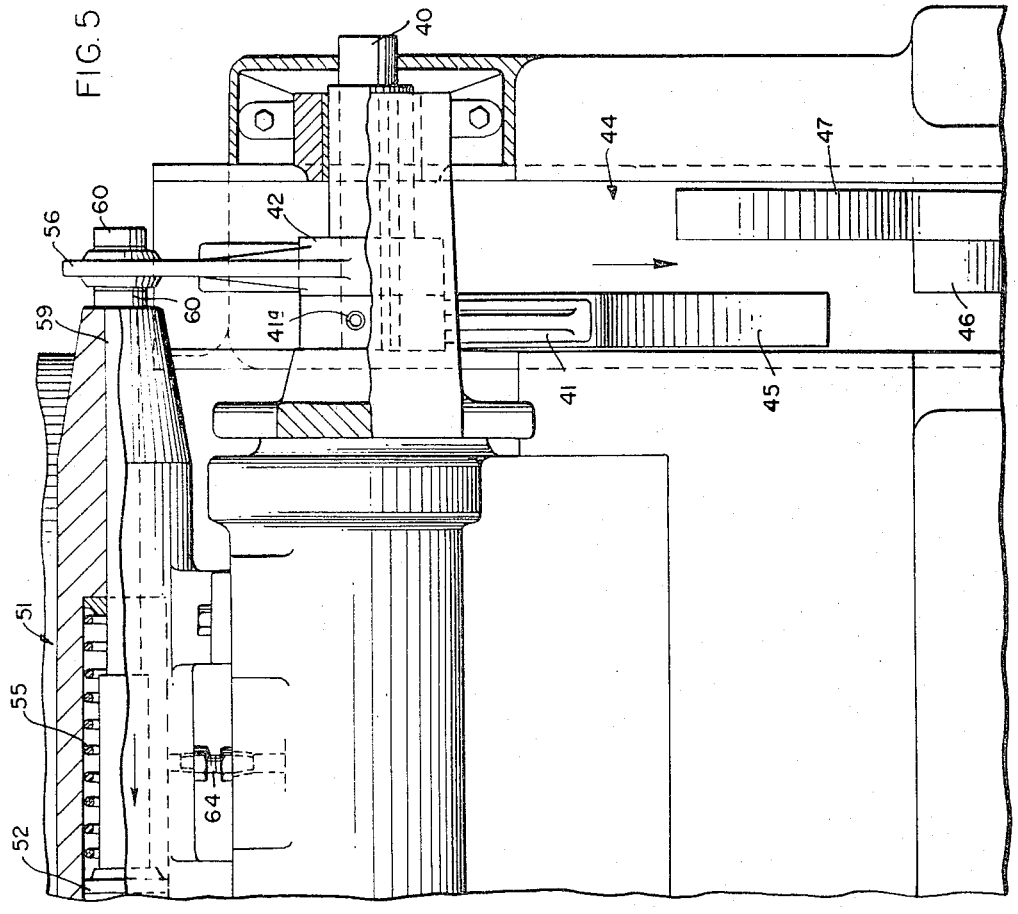

FIG. 4

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POWER HAMMER

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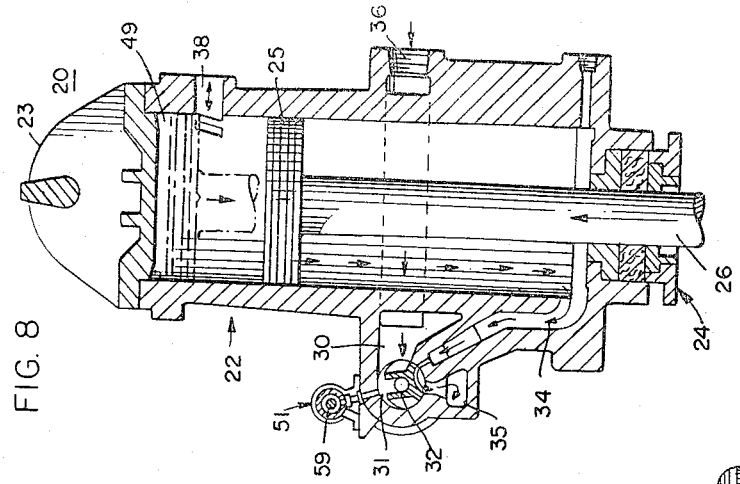

FIG. 8

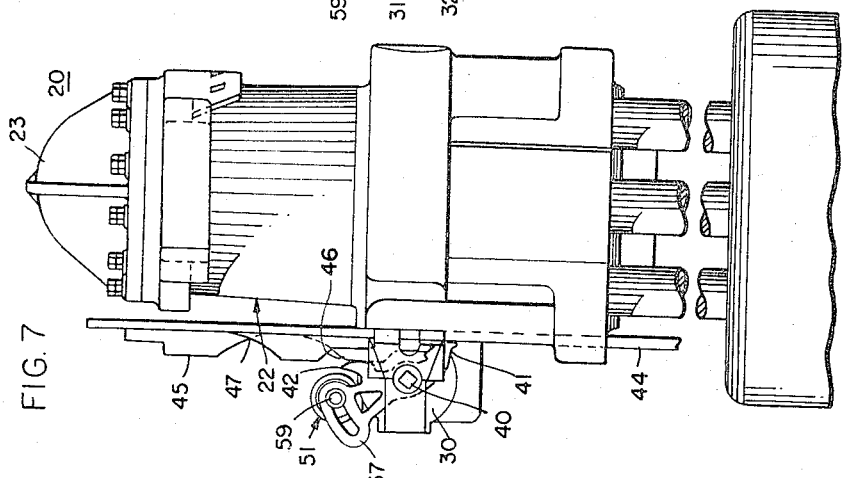

FIG. 7

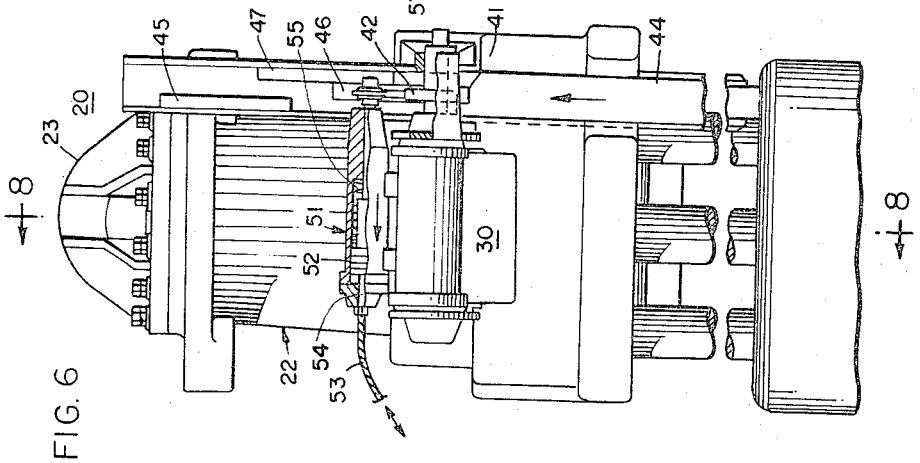

FIG. 6

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FIG. 10

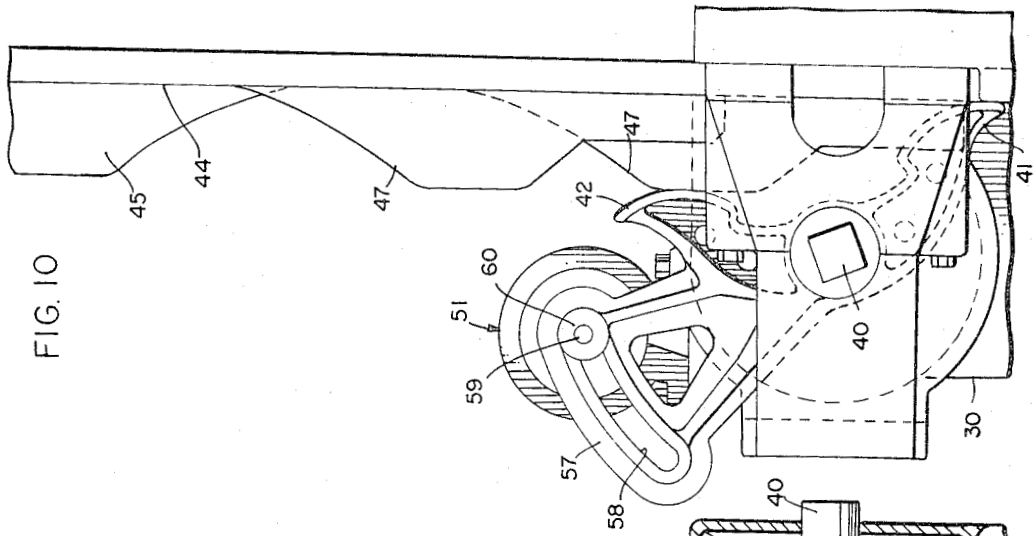
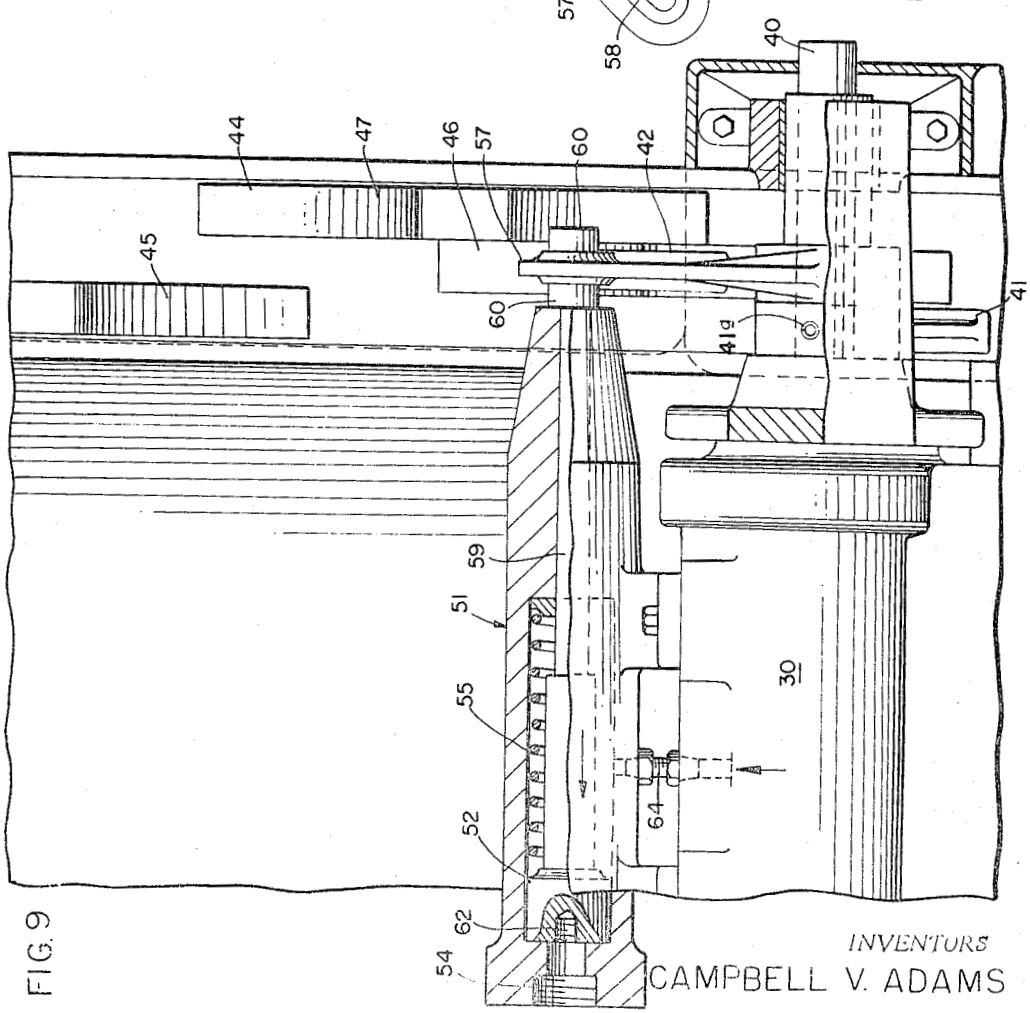


FIG. 9



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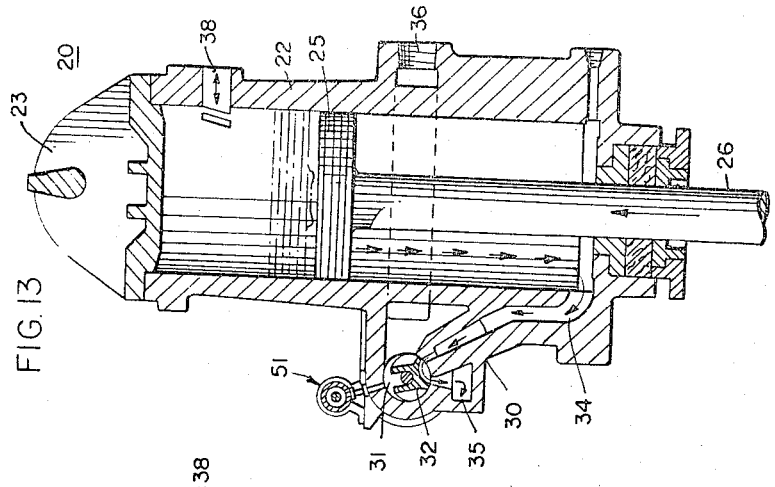

FIG. 13

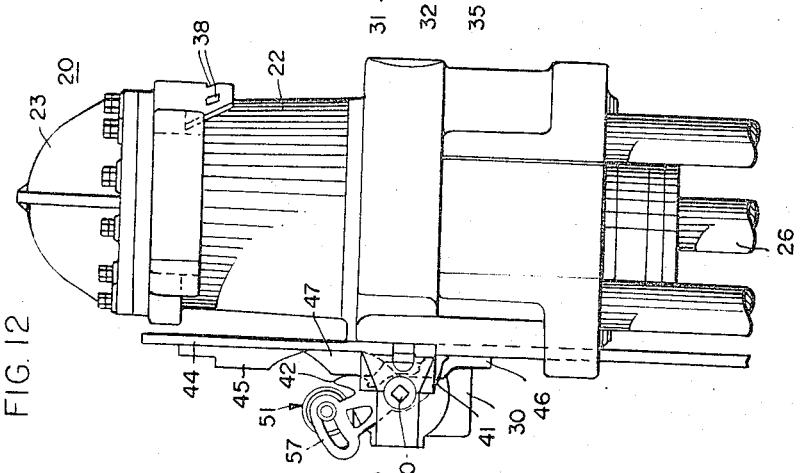

FIG. 12

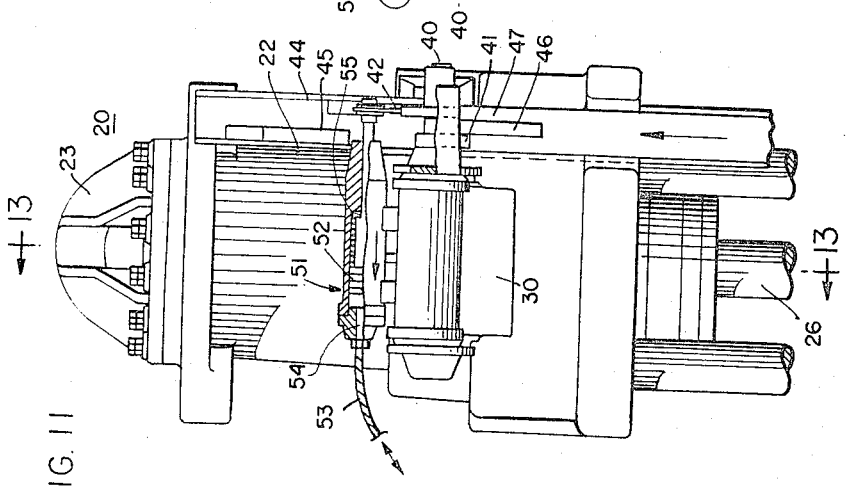

FIG. 11

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POWER HAMMER

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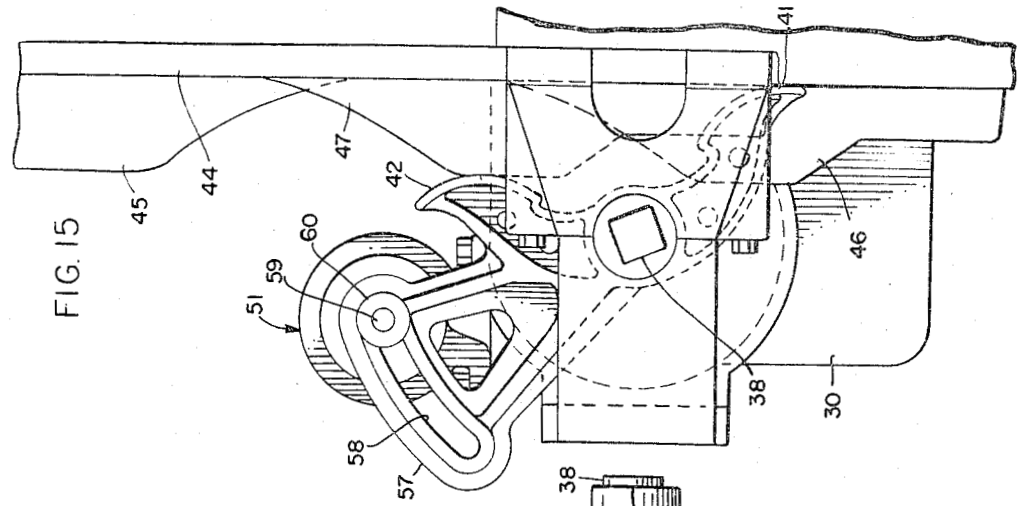

FIG. 15

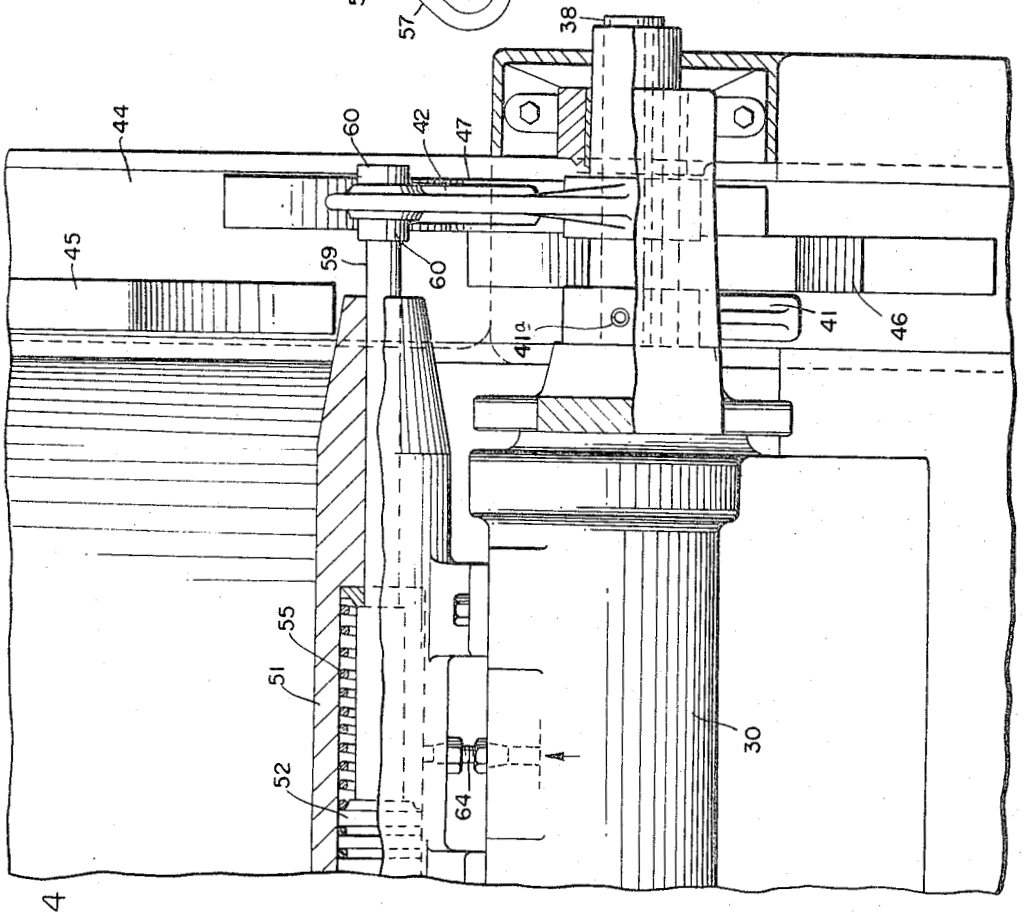

FIG. 14

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United States Patent Office 3,357,315
Patented Dec. 12, 1967

3,357,315

POWER HAMMER

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Filed June 8, 1966, Ser. No. 556,119
11 Claims. (Cl. 91—277)

ABSTRACT OF THE DISCLOSURE

A single acting pile driver is provided with a remotely controllable selector valve to lift the hammer piston through either a short or a normal stroke. Suitable actuating cams are provided on the slide bar of the pile driving hammer to release the fluidized pressure acting below the piston tending to raise the piston at one of two vertical piston positions. Separate cams on the slide bar actuate the steam control valve.

This invention relates broadly to power hammers and more particularly to hammers in which a ram is automatically operated by motive fluid supplied to the cylinder to impart motion to the ram. One known power hammer is described and illustrated in my prior Patent No. 2,004,180, issued June 11, 1935.

Power hammers include a cylinder member and a piston member operatively positioned within the cylinder. Motive fluid is supplied to the cylinder to automatically operate the piston. A heavy weight or ram is operatively connected to the piston to deliver heavy pile driving blows against an anvil which in turn transmits the blows to the pile. One common type of hammer known as the single-acting hammer utilizes the motive fluid on the upstroke of the piston to raise the ram and thereafter exhaust the motive fluid to permit the piston and the ram to fall by gravity and strike a blow.

It has been found that in the large size hammers it is often required during the initial stages of driving a pile to deliberately reduce the intensity of the blows on the pile. This is readily accomplished by reducing the length of stroke of the piston thereby reducing the distance that the ram falls. Accordingly it is known to provide single-acting power hammers of comparatively large size with means for lifting the piston through a normal upstroke, and additionally with means for tripping the piston to release the piston at the end of a short upstroke. Heretofore such change in the length of the stroke has required an attendant to twice climb up the leaders to the pile driving hammer during a pile driving operation to manually effect a change in the stroke of the hammer so that a short stroke is provided for initially driving the pile, and thence for the attendant to later return up the leaders to the hammer, to make requisite adjustments to restore stroke to original normal length. Such alternation of the hammer is both hazardous and time delaying during the pile driving operation.

Accordingly it is an object of the present invention to provide a new and improved pile driving hammer which overcomes the aforementioned crude and laborious method previously employed.

A further object of the present invention is to provide a new and improved pile driving hammer.

Yet another object of the present invention is the provision of a new and improved pile driving hammer which may be remotely and automatically actuated to selectively provide for changing the stroke of the piston from its normal to a short stroke.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterizes the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with these and other objects, there is provided an improved pile driving hammer of the type including a piston movable within a cylinder and having a ram connected to and driven by the piston. Suitable valve means are provided including a multi-position valve element which is movable between a first position wherein pressurized fluid is supplied to the cylinder below the piston to raise the piston, and thence the valve element is movable to a position to exhaust the fluid from below the piston to permit the piston and ram to drop by gravity. The valve element is actuated between its first and second positions by a pair of suitable trip arms or cam followers, a first one of which is permanently secured in place on the valve element stem and is cooperable with a cam effective when the piston is near the bottom of its stroke to trip the valve to supply pressurized fluid to the cylinder thereby to raise the piston. The second trip arm is slideably mounted on the valve stem and thereby is selectively responsive to one of a pair of cams, a first one of the cams actuating the valve element when the piston approaches the top of its normal upstroke, and the other of the cams being effective to trip the valve element when the piston approaches the top of its short upstroke intermediate the length of the normal stroke. In accordance with the present invention a control member is provided for remotely and automatically moving the second trip to make it responsive selectively to either the normal stroke cam or the short stroke cam thus eliminating the need for an attendant to climb up to the pile hammer to make the modification.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein;

FIG. 1 is a fragmentary front elevational view of a power hammer according to the present invention showing the valve and valve operating elements and illustrated with the piston beginning its upstroke;

FIG. 2 is a fragmentary side elevational view of the power hammer of FIG. 1;

FIG. 3 is a fragmentary cross sectional view of the power hammer of FIG. 1, taken along line 3—3 of FIG. 1;

FIG. 4 is a fragmentary front elevational view of the valve operating elements in the position of FIG. 1, and drawn to a larger scale;

FIG. 5 is a fragmentary side elevational view of the valve and valve operating elements of FIG. 4;

FIG. 6 is a fragmentary front elevational view of a power hammer according to the present invention showing the valve and valve operating element and illustrated with the piston approaching the top of its normal stroke;

FIG. 7 is a fragmentary side elevational view of the power hammer of FIG. 6;

FIG. 8 is a fragmentary cross sectional view of the power hammer of FIG. 6, taken along line 8—8 of FIG. 6;

FIG. 9 is a detail view of the valve and valve operating elements of FIG. 6, drawn to a larger scale;

FIG. 10 is a side detail view of the valve and valve operating elements of FIG. 9;

FIG. 11 is a fragmentary front elevational view of a power hammer according to the present invention showing the valve and valve operating elements and illustrated with the piston approaching the top of its short stroke;

FIG. 12 is a fragmentary side elevational view of the power hammer of FIG. 11;

FIG. 13 is a fragmentary cross sectional view of the power hammer of FIG. 11, taken along line 13—13 of FIG. 11;

FIG. 14 is a front elevational view of the valve and valve operating elements of the power hammer of FIG. 11, and drawn to a large scale; and

FIG. 15 is a side elevational view of the valve and valve operating elements of FIG. 14.

Referring now to the drawings, and particularly to FIGS. 1 through 5, there is fragmentarily illustrated a percussion type pile driving hammer **20** of the single-acting type, although it is understood that the invention may be equally applicable to other types of hammers. The hammer **20** includes a cylinder **22** closed at its upper end by a suitable head **23** and at its lower end by suitable gland packing assembly **24**, FIG. 3. A piston **25** is slideably received within the cylinder **22** and is operatively connected to a suitable ram by means of a piston rod **26** extending through the packing assembly **24**.

For controlling the admission and exhaust of fluidized pressure, hereinafter referred to as steam, into the cylinder **22**, there is provided a steam chest **30** including a valve chamber **31** and a rotatably mounted multi-position valve element **32**. Moreover there is provided a suitable steam passageway **34** communicating between the valve chamber **31** and the cylinder **22** below the piston **25** therein. An exhaust passageway **35** communicates between the valve chamber **31** and the atmosphere. Steam supply means or passageway **36** provides for connection to the source of steam for operating the hammer **20**. Moreover the cylinder **22** is provided with a relief port **38** near its upper end which serves to open the upper end of the cylinder **22** above the piston **25** to the ingress and egress of the atmosphere, and further serves to provide for entrapping a quantity of air to cushion the upward stroke of the piston, as will hereinafter become apparent and as best illustrated in FIG. 8. Referring now again specifically to FIG. 3, it will be seen that the valve element **32**, in the illustrated embodiment, is effective to direct steam from the passageway **36**, through the steam chest **30** and the valve chamber **31**, into the steam passageway **34** and below the piston **25**, thereby to drive the piston **25** and associated components upwardly. However rotation of the valve element **32** approximately an eighth turn counterclockwise will bring a recess **32***a* in the valve element to connect the steam passageway **34** with the exhaust passageway **35**, as hereinafter more fully described, thereby to exhaust the steam from below the piston **25** and to permit the piston **25** and associated components to drop by gravity.

To control the movement of the valve element **32** between its steam admission position and its exhaust position, the valve element **32** is provided with a valve stem **40** extending through the end wall of the valve chamber **31** and carrying suitable control members. More specifically there is provided an admission trip arm or cam follower **41** fixedly secured to the valve stem **40** in any suitable manner as by a roll pin **41***a* and effective, when pivoted clockwise, to oscillate the valve element **32** into the steam admission position as indicated in FIG. 3. Additionally there is provided an exhaust trip arm or cam follower **42** (FIG. 7), which, when rocked counterclockwise, is effective to move the valve element **32** from the admission position illustrated in FIGS. 1 through 5 to an exhaust position as illustrated in the remainder of the figures. The exhaust trip arm **42** is slideably mounted on the valve stem **40**, and to this end, the valve stem **40** may be of any suitable configuration but in the illustrated embodiment has a square cross section so that the trip arm **42** may be provided with a cooperating square opening **42***a* slideably received on the valve stems **40** to permit relative sliding movement, but prohibiting relative rotational movement between the trip arm **42** and the valve element **32**.

For actuating the trip arms **41** and **42**, there is provided a slide bare **44** vertically movable with the piston **25** and containing a plurality of cams for controlling the trip arms **41** and **42**. More specifically, near the top of the slide bar there is provided an admission cam **45** aligned to cooperate with the admission trip arm **41**. Additionally

there is provided a first exhaust cam **46** positioned on the slide bar **44** to one side of the admission cam **45**, and a second exhaust cam **47** positioned on the other side of the exhaust cam **46** from the admission cam **45** so that the cams **45**, **46**, and **47** move in a fixed side by side relation with the slide bar **44** vertically past the trip arms **41** and **42** in response to vertical movement of the piston **25**. The first exhaust cam **46** is positioned on the slide bar **44** to actuate the trip arm **42** in response to a normal stroke of the piston **25**, while the exhaust cam **47** is positioned along the slide bar **44** corresponding to the short stroke of the piston **25**.

As will be understood from FIGS. 1 through 5, as the piston **25** and its associated ram drop by gravity during its power stroke, the slide bar **44** will move downwardly with the piston **25** and the admission cam **45** will strike the admission trip arm **41**, rotating the valve element **32** clockwise to the position best illustrated in FIG. 3 and providing for the admission of fluid below the piston **25**, thereby to initiate the upstroke of the piston **25** and associated ram.

To control the length of the upstroke of the piston **25** selectively to either its normal stroke, as illustrated in FIGS. 6 through 10, or to limit the upstroke to the short stroke of the piston **25**, as illustrated in FIGS. 11 through 15, the exhaust trip arm **42** is positioned along the valve stem **40** so as to align with a selected one of the exhaust cams **46** and **47**, thereby to trip the valve element **32** at the proper time to provide the desired stroke. Referring, for example, first to the normal stroke of the piston **25**, as illustrated in FIGS. 6 through 10, the exhaust trip arm **42** is positioned on the valve stem **40** so as to align with the line of travel of the exhaust cam **46** which controls the normal stroke of the piston **25**. More specifically as the piston **25** reaches the position illustrated in solid in FIG. 8, the exhaust cam **46** strikes the exhaust trip member **42**, shutting off the admission of steam and releasing the same from the cylinder **22**. Thereafter the piston **25** will continue to rise under the influence of inertia and momentum. It will be understood that as the top of the piston **25** approaches the relief port **38** the air from above the piston **25** will be expelled through the relief port **38**. However as soon as the top of the piston **25** passes the relief port **38**, there will be a chamber **49** of air entrapped above the piston **25** which will be compressed and serve as a cushion for the piston **25** and associated ram thus preventing the piston **25** from striking against the head **23** of the hammer as well as storing the energy of compression for assisting in accelerating the downstroke of the piston **25**.

In order to remotely and selectively provide for a short stroke of the piston **25**, there is provided a fluid actuated thrust cylinder **51**. The thrust cylinder **51** is provided with a fluid actuated piston **52** which may be remotely controlled through a fluid line **53** extending through a threaded opening **54** in one end of the cylinder **51**. The piston **52** is spring biased by a compression spring **55** to the left, but may be moved to the right, as viewed in FIGS. 4, 9, and 14, upon the admission of pressurized fluid through the fluid line **53** to overcome the return bias of the spring **55**. Admission of pressurized fluid **53** shifting the piston **52** to the right, as viewed in FIG. 14, is effective to shift the exhaust trip arm **42** axially along the valve stem **40** so as to align the exhaust trip arm **42** for actuation by the exhaust cam **47** governing the short stroke of the piston **25**. To this end the exhaust trip arm **42** is provided with a generally upwardly extending trip projection **57** having an arcuate slot **58**, and the piston **52** is provided with a piston rod **59** extending out of one end of the thrust cylinder **51** and extending into the arcuate slot **58**. A pair of spaced collars **60** on respective sides of the trip projection **57** loosely engage the sides of the slotted projection so as to drive the exhaust trip arm **42** along the valve stem **40** in response to movement of the piston **52**, while at the same time permitting relative oscillatory movement of the exhaust trip arm **42** relative to the piston rod **59**.

Thus it will be understood that when it is desired to provide for a short stroke of the piston 25, the thrust cylinder 51 is activated with fluid pressure through the fluid line 53 to drive the piston, and therefore the exhaust trip arm 42, to the right as illustrated in FIG. 14 so as to align the exhaust trip arm 42 for actuation by the exhaust cam 47 corresponding to a short stroke of the piston 25. Release of the fluidized pressure from the fluid line 53 will cause the spring 55 to drive the piston 52 back to the left, as viewed in FIG. 14, to the position illustrated in FIG. 9 and thereby return the exhaust trip arm 42 for actuation by the exhaust cam 46 to return the hammer 20 to its normal stroke.

When it is desired to secure the exhaust trip arm 42 in its normal position, over a long period of time, it may readily be fixed by removing the fluid line 53 and threading a cap screw into threaded hole 62, FIG. 9, of the piston 52.

Fluid is bled from the steam chest 30 through a steam line 64 and into the rod end of the cylinder 51 to provide a return force on the piston 52. More specifically fluid of the same pressure is supplied to both sides of the piston 25, but since the exposed area of the piston at the rod side thereof is smaller by the area of the rod than that of the opposite side, the net result of the force will drive the piston 52 to the right, as illustrated in FIGS. 4, 9, and 14. Moreover the force of the fluid on the rod end of the cylinder 51 will be effectiev to provide a positive return drive to the piston 25 while at the same time preventing flutter or vibration of the piston.

From the foregoing description, the operation of the improved percussion hammer is believed clear. However, briefly, it is understood that movement of the piston 25 within the cylinder 22 is controlled by the valve element 32. The valve element 32 has a valve stem on which is permanently secured an admission trip arm 41, designed to pivot the valve element into the steam admission position wherein the steam is admitted to the cylinder 22 below the piston 25 to raise the piston. Additionally an exhaust trip arm 42 is provided, slideably mounted on the valve stem 40 and designed to pivot the valve element 32 into a position where the steam within the cylinder 22 is exhausted.

return drive to the piston 25 while at the same time predetermined point in the operation of the hammer, there is provided the slide bar 44 containing a plurality of cams operatively associated with the trip arms. More specifically an admission cam 45 is effective to engage the admission trip arm 41 when the piston 25 is at the lower portion of its stroke, thereby to admit steam within the cylinder 22 and to raise the piston. For a normal stroke blow of the ram connected to the piston, the piston will take a full or normal stroke as illustrated in FIGS. 6 through 10. Under these conditions the exhaust cam 46 is provided which will engage the exhaust trip arm 42 at the preselected point to exhaust the steam from the cylinder 22 to atmosphere. Alongside the exhaust cam 46 is a second exhaust cam 47, positioned for a short stroke. In order to bring the exhaust trip arm 42 into operative relation with the short stroke exhaust cam 47, there is provided the thrust cylinder 51 which is effective to shift the exhaust trip arm 42 laterally into alignment with the exhaust cam 47, thereby rendering the exhaust cam 46 ineffective to actuate the exhaust trip arm 42 and at the same time rendering the exhaust cam 47 effective to engage the exhaust trip arm 42.

Advantageously the percussion hammer 20 according to the present invention can be readily controlled to provide a full normal stroke, or to provide a comparatively shorter stroke, thereby resulting in a lighter blow whenever such a lighter blow is desirable. Moreover such change in the length of the piston stroke is readily accomplished remotely and automatically by an operator without the necessity of an attendant climbing up to the percussion hammer and making manual modification or alternations of the device.

Although the present invention has been described by reference to only a single embodiment thereof, it will be apparent that numerous other modifications and embodiments may be devised by those skilled in the art and it is intended by the appended claims to cover all modifications and embodiments which will fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. The combination in a pile driving hammer of:
a cylinder,
a piston selectively operable in said cylinder through a normal and a short upstroke, and adapted to drive a ram,
valve means including a valve chamber and a multiposition valve element movable in said chamber,
passageway means connecting said valve chamber with said cylinder below said piston,
exhaust passage means connecting said valve chamber to ambient,
supply means adapted for connecting said valve chamber to a source of pressurized fluid,
said valve element being movable between a first position connecting said passageway means with said supply means to lift said piston and a second position connecting said passageway means with said exhaust passage means to release said piston,
cam means for moving said valve element to its first position when said piston is near the bottom of its stroke to supply pressurized fluid to said cylinder to raise said piston, and
cam means remotely selectable to respond to said piston approaching the top of its normal stroke and the top of its short stroke for moving said valve element to its second position to exhaust said cylinder thereby remotely and selectively providing for movement of said piston through a normal or short stroke.

2. The combination in a pile driving hammer of:
a cylinder,
a piston selectively operable in said cylinder through a normal and a short upstroke, and adapted to drive a ram,
valve means including a valve chamber and a multiposition valve element movable in said chamber, said valve element being rotatable and provided with a valve stem extending out of said valve chamber,
passageway means connecting said valve chamber with said cylinder below said piston,
exhaust passage means connecting said valve chamber to ambient,
supply means adapted for connecting said valve chamber to a source of pressurized fluid,
said valve element being movable between a first position connecting said passageway means with said supply means and a second position connecting said passageway means with said exhaust passage means,
actuating means for moving said valve element to its first position when said piston is near the bottom of its stroke to supply pressurized fluid to said cylinder to raise said piston, and
actuating means remotely selectable to respond to said piston approaching the top of its normal stroke and the top of its short stroke for moving said valve element to its second position to exhaust said cylinder thereby remotely and selectively providing for movement of said piston through a normal or short stroke and including a normal stroke cam and a short stroke cam both movable with said piston, and a cam follower remotely selectable automatically to cooperate with a predetermined one of said cams to provide for remote control of said piston to attain its normal and its short stroke.

3. The combination as set forth in claim 2 wherein said cam follower is slideably mounted on said valve stem, and said cams are mounted for movement along side-by-side paths so that shifting of said cam follower along said valve stem will render said cam follower effective to be contacted by a selected one of said cams.

4. The combination as set forth in claim 3 above and including a control member connected to shift said cam follower for actuation by the selected one of said cams.

5. The combination as set forth in claim 4 above wherein said control member includes a connecting portion movable in a path parallel to the axis of said valve stem, and said cam follower is provided with a projection having an arcuate slot receiving said connecting portion so that said cam follower may be slid axially on said valve stem by said control element for engagement with a selected one of said cams while permitting oscillatory movement of said follower in response to the selected one of said cams.

6. The combination as set forth in claim 5 above wherein said control member is a fluid thrust cylinder.

7. The combination as set forth in claim 6 above wherein said connecting portion is spring biased to hold said follower operatively aligned with the normal stroke cam.

8. The combination as set forth in claim 6 above wherein said connecting portion is fluid pressure biased to hold said follower operatively aligned with the normal stroke cam.

9. The combination as set forth in claim 3 above and including a slide bar vertically movable with said piston, said cams being carried on said slide bar.

10. The combination in a pile driving hammer of:

a cylinder,

a piston selectively operable in said cylinder through a normal and a short upstroke, and adapted to drive a ram,

valve means including a valve chamber and a multiposition valve element movable in said chamber,

passageway means connecting said valve chamber with said cylinder below said piston,

exhaust passage means connecting said valve chamber to ambient,

supply means adapted for connecting said valve chamber to a source of pressurized fluid,

said valve element being movable between a first position connecting said passageway means with said supply means and a second position connecting said passageway means with said exhaust passage means,

actuating means for moving said valve element to its first position when said piston is near the bottom of its stroke to supply pressurized fluid to said cylinder to raise said piston, and

actuating means remotely selectable to respond to said piston approaching the top of its normal stroke and

the top of its short stroke for moving said valve element to its second position to exhaust said cylinder thereby remotely and selectively providing for movement of said piston through a normal or short stroke,

said cylinder being provided with an atmospheric exhaust port spaced below the top of said cylinder and above the upper travel of the short stroke of said piston.

11. The combination in a pile driving hammer of:

a cylinder,

a piston selectively operable in said cylinder through a normal and a short upstroke, and adapted to drive a ram,

valve means including a valve chamber and a multiposition valve element movable in said chamber,

passageway means connecting said valve chamber with said cylinder below said piston,

exhaust passage means connecting said valve chamber to ambient,

supply means adapted for connecting said valve chamber to a source of pressurized fluid,

said valve element being rotatable between a first position connecting said passageway means with said supply means and a second position connecting said passageway means with said exhaust passage means, and being provided with a valve stem extending out of said valve chamber,

actuating means including a cam movable with said piston and a cooperable cam follower connected to said stem for moving said valve element to its first position when said piston is near the bottom of its stroke to supply pressurized fluid to said cylinder to raise said piston, and

actuating means remotely selectable to respond to said piston approaching the top of its normal stroke and the top of its short stroke for moving said valve element to its second position to exhaust said cylinder thereby remotely and selectively providing for movement of said piston through a normal or short stroke.

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