Dec. 19, 1967 R. FERWERDA 3,358,778

SPRING DRIVEN POWER HAMMER

Filed Aug. 19, 1965 2 Sheets-Sheet 1

Fig. 1

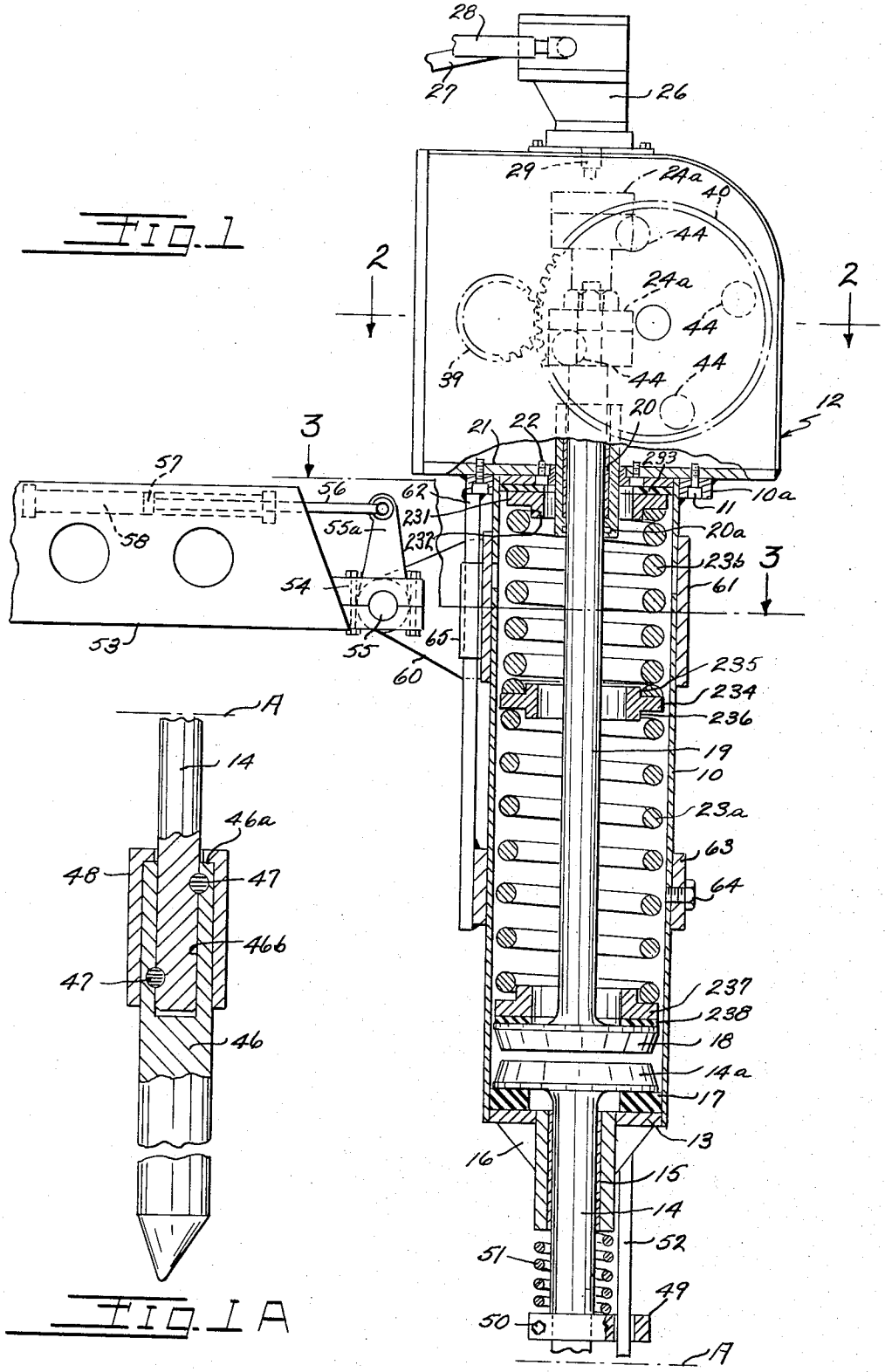

Fig. 1A

Dec. 19, 1967 R. FERWERDA 3,358,778

SPRING DRIVEN POWER HAMMER

Filed Aug. 19, 1965 2 Sheets-Sheet 2

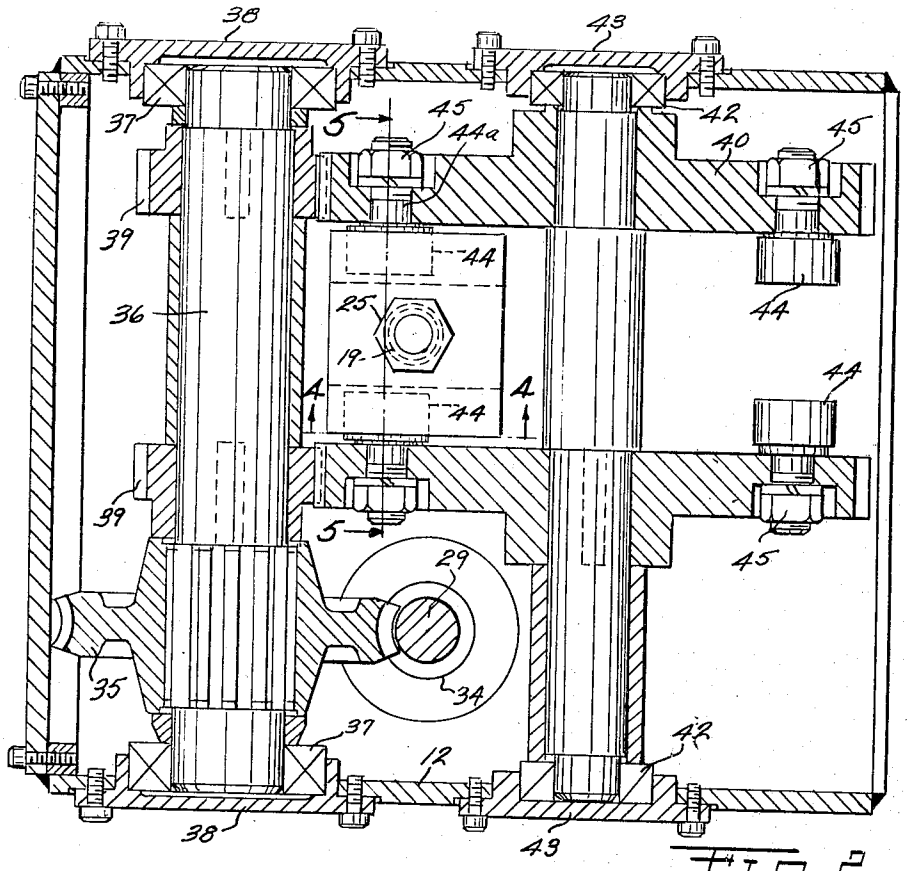

FIG. 2

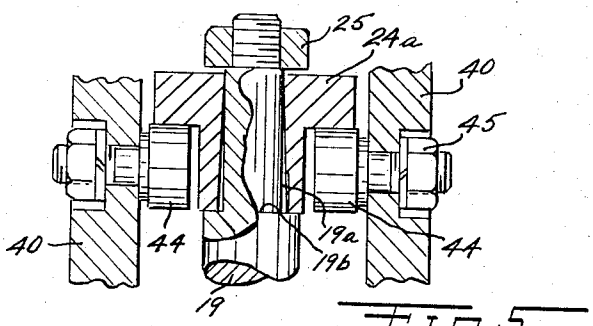

FIG. 5

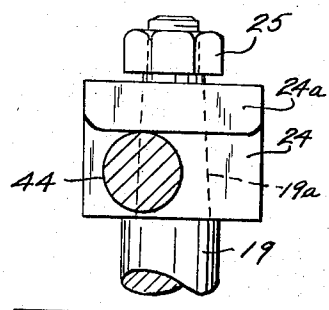

FIG. 4

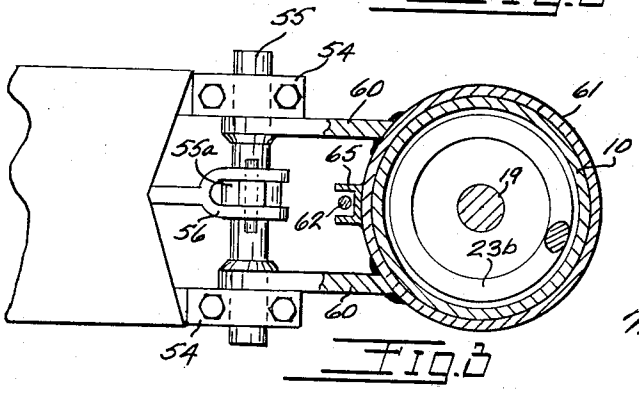

FIG. 3

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SPRING DRIVEN POWER HAMMER

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ABSTRACT OF THE DISCLOSURE

A very heavy duty hammer suitable for pile driving and pavement breaking includes an elongated cylindrical housing carrying a working tool at the lower end thereof which tool has a shaft extending into the lower end of the housing and terminating inside of the housing with a blow receiving and transmitting anvil extension, together with a hammer reciprocatably mounted in the housing toward and away from the anvil extension to deliver repeated blows thereagainst. The hammer has an elongated axial extension which projects out of the upper end of the housing and is there provided with power means for repeatedly retracting the hammer away from the anvil and then suddenly releasing it. A two-part helical spring surrounds the hammer extension and is disposed between the hammer and the upper end of the housing so that the spring means is compressed when the power means lifts the hammer, after which the spring means causes the hammer to deliver a very powerful blow against the anvil when released by the power means. The novel feature of this invention is that the spring means includes at least two separate helical springs in end to end relationship differing from each other in frequency of vibration sufficiently so that they exert a mutual dampening effect upon spring release thus preventing destruction of the hammer and its driving spring.

This invention relates to improvements in a power hammer of a very powerful character useful for pile driving, pavement breaking and any other purposes requiring great power.

One of the objects of the present invention is to provide a self-contained hammer comprising a housing with a tool carrying member extending into the housing at one end, generally the lower end, and with an anvil lying inside of the housing adapted to deliver a blow to the tool carrying member when struck by the hammer. The hammer is reciprocatably mounted in the housing for movement toward and away from the anvil. The blow is delivered by a powerful helical spring means surrounding a hammer extension and engaged between the hammer and the portion of the housing and always urging the hammer toward the anvil. Power means is carried by the housing and constructed and arranged to engage the end of the hammer extension remote from the hammer, usually at the upper end thereof, and to lift the hammer so as to compress the spring and thereafter to suddenly release the hammer extension, whereby the spring then drives the hammer with great force against the anvil to deliver a blow to the tool.

The present invention is specifically directed to a spring means comprising a plurality of helical springs surrounding the hammer extension and concentric therewith and the present invention is described in connection with two such springs, although it will be understood that more might be used if desired. One of the difficulties in prior devices of this sort related to the vibration of a long powerful spring after it was suddenly released during operation of the hammer. Such vibration was so destructive that the assembly was destroyed within a few hours of use. In the present invention, at least two separate springs are provided differing from each other in frequency of vibration sufficiently so that they exert a mutual

dampening effect, upon release of the compressed springs, thus preventing destruction of the hammer.

Other objects and advantages of the present invention will be set forth in the accompanying drawings and description and the essential features thereof will be summarized in the appended claims.

In the drawings:

FIG. 1 is a central sectional view through one embodiment of this invention and means for mounting the hammer on a boom carrying vehicle adapted to hold and manipulate the same;

FIG. 1A is a continuation of FIG. 1 at the lower end thereof showing the tool carrying member located below the line A indicated in both figures;

FIG. 2 is a sectional view, enlarged, taken along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a fragmental sectional view taken along the line 4—4 of FIG. 2; while

FIG.5 is a sectional view taken along the line 5—5 of FIG. 2.

Referring to FIG. 1, the hammer of this invention is shown compactly assembled in connection with a housing which comprises a cylindrical member **10** carrying at its upper end rigid therewith a flange **10***a* which is secured by means of screws or bolts **11** to a housing head **12**. The cylinder **10** is provided with a head member **13** at its lower end, welded to the cylinder **10**, and having a central opening through which enters an anvil shaft **14** coaxial with the cylinder **10** and carrying integral therewith at its upper end the anvil **14***a*. The anvil shaft **14** passes through a suitable bearing sleeve **15** which is rigidly connected to the head member **13** and cylinder **10** by means of gussets **16** welded in place. Preferably, a recoil absorbing cushion **17** is provided in the form of a polyurethane annulus surrounding the anvil shaft **14** and lying against the head member **13**. It should be understood that the anvil shaft **14** is freely slidable in the head member **13** to carry the anvil **14***a* axially of the cylinder **10**.

A hammer is provided for delivering a blow to the anvil **14***a*. This hammer is axially aligned with the anvil and is provided with a hammer extension **19** extending axially upwardly through the cylinder **10**, concentrically thereof, and extending axially and out the upper end thereof through a sleeve bearing **20** which is held in proper position by means of a bearing cap **21** to which the bearing is welded; and the cap in turn is secured to the lower wall of the housing head portion **12** by means of screws or bolts **22**. An oil seal **20***a* prevents leakage of lubricant out of the housing means **12**.

A powerful helical spring means, **23***a* and **23***b*, approximately one foot in diameter and almost three feet long (for a four to five ton blow) surrounds the hammer extension **19** within the cylinder **10** for compression between the hammer **18** and the bearing cap **21** which lies against the lower wall of the housing head portion **12**. A hard, abrasion resistant annular steel ring **231** abuts the upper end of the spring **23***b* and has a shoulder **232** for centering the upper end of that spring. This disk is backed up by a polyurethane cushion **233**. Another hard annular steel disk **234** lies between the springs **23***a* and **23***b* and is provided with centering shoulders **235** and **236** to hold the two springs in proper concentric arrangement. Another hard abrasion resistant steel disk **237** is provided at the lower end of spring **23***a* backed up by a polyurethane cushion **238** lying between the disk **237** and the hammer head **18**.

The purpose of the two springs **23***a* and **23***b* is to provide at least two separate springs differing from each other in frequency of vibration sufficiently so that they

exert a mutual dampening effect preventing destruction of the hammer. While more than two spring members might be provided in such end-to-end relationship, two such springs are sufficient to provide the improved performance of hammer operation envisioned by this invention. The springs **23***a* and **23***b* have parameters of length, diameter, pitch, number of working coils, diameter of spring wire and torsional modulus of elasticity and the two springs must differ from each other in at least one of these parameters sufficiently to cause the above mentioned dampening effect. In one embodiment the spring **23***a* has a length of twenty inches, a diameter of twelve inches, seven working coils, three inch pitch, and a spring rod material 1¾ inches in diameter. The spring **23***b* has a length of 13½ inches, a spring diameter of 11⅞ inches, six working coils, 2½ inch pitch, and spring rod material 1⅞ inches in diameter. The torsional modulus of the elasticity of the two springs may be varied by varying the analysis of the steel slightly or by changing the tempering of similar steels so as to cause a variation in the two springs.

In carrying out this invention, any suitable means may be provided for lifting the hammer to compress the springs **23***a* and **23***b* and thereafter to release the hammer so that the springs cause a tremendous blow against the anvil head **14***a*. The lifting means here shown comprises a T-shape member **24** having a vertically extending central bore which fits on a reduced diameter portion **19***a* of the hammer extension which terminates at a shoulder **19***b* against which the T-shape member **24** rests. A nut **25** holds the member **24** in position. The T-shape member has laterally extending arms **24***a* on opposite sides thereof for the purpose of engagement by a lifting device about to be described.

The power means for lifting the hammer extension comprises an hydraulic motor **26** bolted to the wall of the housing head means **12** and supplied with hydraulic power through flexible tubular connections **27** and **28** from any suitable source. This motor terminates in a drive shaft **29** which extends vertically downwardly into the housing **12** for rotation of a unitary worm **34** which in turn meshes with a cone drive worm gear **35** with a mechanical advantage of about twenty to one. The worm gear **35** is keyed to a shaft **36** which in turn is journaled in bearing **37** carried by suitable bearing caps **38** secured to the housing **12**. Keyed to the shaft **36** are a pair of pinions **39** each of which is aligned with a gear wheel **40** meshing with the pinions **39** and having a mechanical advantage of approximately three to one. Each of the gear wheels **40** is keyed to a shaft **41** which is journaled in suitable bearings **42** carried by the bearing caps **43** in the housing **12**. A pair of cam rollers **44** are secured to each of the gear wheels **40** diametrically opposite to each other by means of stub shafts **44***a* and held in position by nuts **45** and suitable lock washers. The cam rollers **44** on each gear wheel are aligned to engage beneath the opposite arms **24***a* of the T-member **24** so as to lift the hammer extension **19** and the hammer head **18**. It will be noted in FIG. 1 that each cam roller **44** in the dotted position of FIG. 1 engages beneath one of the T-shape arms **24***a* toward the left side thereof and lifts the T-shape member while the cam roller **44** moves through an arc of slightly more than ninety degrees causing the cam roller to reach the dot-dash position of FIG. 1 after which it rolls out of contact with the arm **24***a*, thus releasing the arm suddenly so that it is urged downwardly impelled by springs **23***a* and **23***b* which in this embodiment is compressed approximately ten inches of its total vertical length.

It should be understood that a suitable tool **46** is carried at the lower end of anvil shaft **14**. The tool will depend upon the kind of work to be performed. The tool attachment of this embodiment is clearly shown in FIG. 1A.

Stop means is provided on the anvil shaft **14** to prevent it being driven up inside of the cylinder **10** so that the anvil head **14***a* always remains spaced below the blow delivering hammer **18**. This stop is shown at **49** and comprises a split collar threaded on the shaft **14** and held in position by bolt **50**. This collar will strike the lower end of the bearing sleeve **15** on the rebound after a blow is delivered so as to stop the upward motion of the anvil member **14***a*. Preferably, but not necessarily, a recoil spring **51** is provided surrounding the shaft **14** and held between the collar **49** and the bearing **15** to cushion the recoil at this point after a blow is delivered.

The collar **49** may be provided with means for preventing rotation of the tool **46** about its own axis if desired. Such a device is shown as a bar **52** rigidly welded to the housing cylinder **10** and extending freely through a hole **48***a* in the collar **49**.

Means may be provided if desired for holding the hammer of this invention and for manipulating the same from a boom **53** which may be of any suitable type but is here shown as a telescopic boom of a vehicle shown in United States Patent No. 2,541,045, granted to Ray and Koop Ferwerda, Feb. 13, 1951. Bearing caps **54** are bolted to boom **53** and journal a shaft **55** which carries a crank arm **56** which in turn is pivotally connected to a clevis rod **56** controlled by a piston **57** reciprocatable in cylinder **58** on the boom **53** by suitable hydraulic fluid supply means. Movement of piston **57** will tilt the hammer about shaft pivot **55**. Welded to shaft **55** are a pair of parallel ears **60** in turn welded to a sleeve **61** in which the cylinder **10** is held snugly but freely reciprocal in a vertical direction as blows are delivered. To hold the cylinder **10** from rotating the sleeve **61**, a vertical bar **62** is welded to the flange **10***a* at the top and to a collar **63** at the bottom, which in turn is bolted to the cylinder **10** at **64**. Parallel flanges **65** welded to sleeve **61** on opposite sides of bar **62** prevent relative rotation at this point.

The mechanism herein described provides approximately a ten inch stroke of the hammer from sixty to seventy-five times per minute, thus delivering eight to ten thousand foot pounds for each blow or slightly over five hundred to six hundred thousand foot pounds per minute.

Power hammers of the type herein described previously known in the prior art and utilizing a single spring in place of the springs **23***a* and **23***b* tore themselves apart in a relatively few hours of operation. The reason for this apparently lay in the powerful forces released when a spring almost three feet long and a foot in diameter and made of heavy spring wire or rod in the neighborhood of 1¾ to two inches in diameter suddenly released tremendous vibratory forces. The present invention seems to overcome this problem because the springs **23***a* and **23***b* differ from each other in frequency of vibration sufficiently so that they exert a mutual dampening effect after the spring means is released to deliver a blow of the hammer on the anvil.

What is claimed is:

1. A pile driving and pavement breaking hammer comprising a housing; a tool-carrying member having a shaft extending into said housing at one end thereof; said shaft having a blow receiving and transmitting anvil extension disposed within said housing; a hammer reciprocatably mounted in said housing for a stroke movement in line with said shaft toward and away from said anvil extension; said hammer having an elongated extension coaxial with said shaft and extending in said housing away from said hammer and said anvil extension; a helical spring means surrounding said hammer extension and disposed between said hammer and the end of said housing opposite said one end; said spring means including at least two separate helical springs in end to end relationship differing from each other in frequency of vibration sufficiently so that they exert a mutual dampening effect upon release of the loaded spring means and

prevent destruction of the hammer and spring means; said spring means delivering a blow of spring-means-destructive force when delivered by a single spring; a rigid wear plate between said two separate springs and holding them concentric; and power means carried by said housing including means repeatedly retracting said hammer extension and said hammer against the bias of said spring means and then suddenly releasing them, in use of said hammer, thereby permitting said spring means to cause said hammer to deliver sequential blows against said anvil extension.

2. A hammer as defined in claim 1 wherein said two separate springs have parameters of length, diameter, pitch, number of working coils, diameter of spring wire and torsional modulus of elasticity, and said springs differ in at least one of said parameters.

3. A hammer as defined in claim 2 wherein said two

springs have approximately the same means diameter and are longitudinally aligned so that their vibratory forces substantially directly oppose each other.

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