

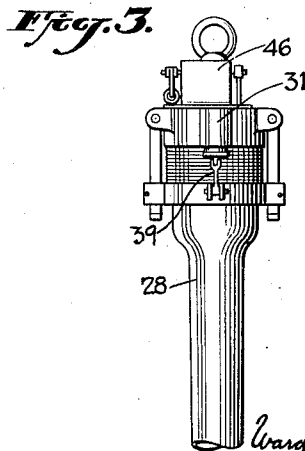
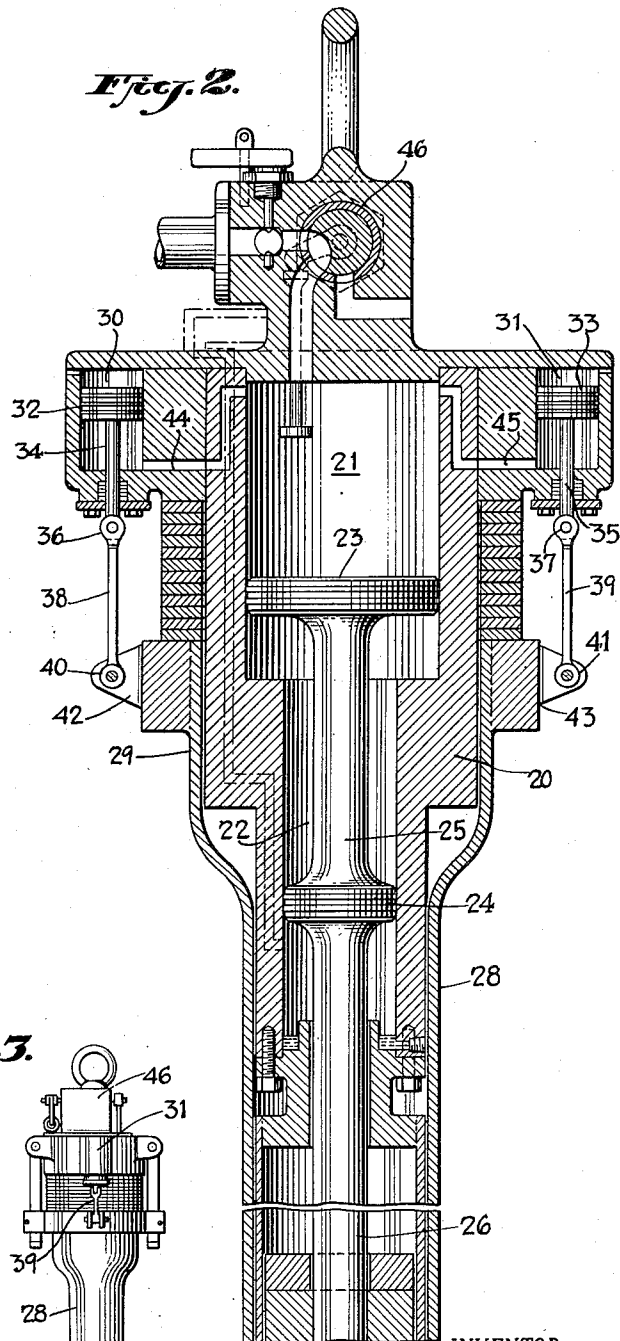
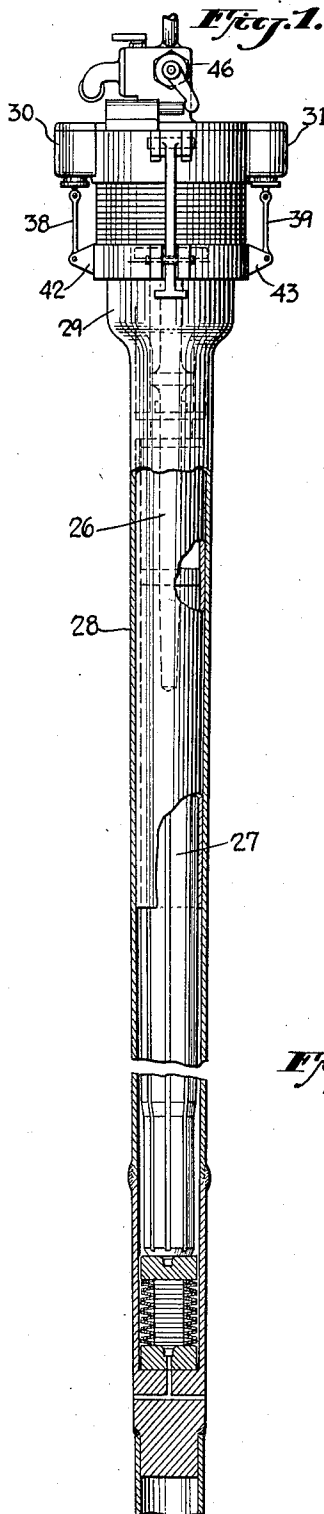
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HAMMER FOR DRIVING PILES AND THE LIKE

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2,791,097

HAMMER FOR DRIVING PILES AND THE LIKE

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4 Claims. (Cl. 61—76)

This invention relates to novel and improved piston-type power hammer constructions particularly adapted among other possibilities for the use in the installation of piles and the like. The invention will be explained in connection with a form of differential hammer adapted for driving hollow metal cores such as are placed inside of metal pile shells for driving the latter into place, but it will be understood that various features of the invention are adapted for other possible uses.

An improved form of double-acting, piston-type hammer is disclosed in U. S. Patent No. 2,598,455, issued May 27, 1952, to Edward A. Smith. In hammers of this type having a ram of fixed weight and a stroke of fixed length, the energy delivered per blow to the pile will vary in accordance with the magnitude of the steam pressure being delivered to the hammer cylinder assembly. Thus as the steam pressure increases, so also will the energy output increase. However, as was pointed out in the aforesaid Smith patent when a differential piston-type power hammer is acting on the downstroke, the pressure within the larger cylinder will not only act downwardly but will also react upwardly against the top cylinder head and, therefore, if the steam pressure is increased beyond a certain point, an upward force great enough to cause the hammer to rise slightly with each blow will result, thereby producing a jumping or dancing effect. Any further increase of steam pressure beyond this amount will, of course, increase this jumping or dancing effect, thereby producing a condition which, if not controlled, may soon injure the hammer. On the other hand, if the steam input pressure is held at a value below the amount necessary to produce this dancing effect, the hammer body will not rise at all, but the energy delivered per blow will be less than that possible when the steam pressure is at the dancing value. Therefore, the maximum efficiency of this type hammer is realized when the steam delivered pressure is at that value at which a slight dancing effect commences.

Just what steam input pressure will cause dancing in any given hammer of this type will, of course, depend upon the total effective hold-down force which opposes the dancing action. The weight of the hammer assembly itself, of course, tends to counteract this upward reactive force but since, as was pointed out in the aforesaid Smith patent, it is desirable to keep that cylinder weight within reasonable limits, a temporary gripping or hold-down means was provided which causes the hammer frictionally to grip the core during a substantial portion of its driving stroke, thereby providing a hold-down force in addition to the weight of the hammer which tends to counteract the upward reactive force above described. Therefore, the total effective hold-down force being exerted by such a power hammer depends upon two factors: first, the total weight of the hammer assembly and, secondly, the force being exerted by this hold-down means. Hence control of these two factors in the initial design of the hammer will determine the steam pressure at which dancing will commence.

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The importance of so designing a hammer to produce dancing thereof at an exactly known steam pressure lies in the following. One of the most critical factors involved in pile driving is the necessity of operating under conditions which will readily permit the calculation of the bearing capacity of a pile as driven. Many formulas are presently in use to determine such bearing capacity, but the most generally accepted one is

$$P = \frac{2E}{S + 0.1}$$

wherein P is the safe pile load in pounds, E is the energy delivered to the pile per hammer blow in foot pounds, and S is the inches of penetration of the pile per hammer blow for the last few blows of a driving operation. Since the energy per hammer blow will for any given differential piston-type hammer assembly, having a ram of fixed weight and a stroke of fixed length, vary in accordance with the steam pressure being delivered to the cylinder assembly, it is quite obvious that in order to be able to calculate the safe pile load by use of the above formula, it will be necessary to know the exact steam pressure in that assembly at the time of the last few driving blows. While initially it might be assumed that some type of gage could be employed to indicate this pressure accurately, it has been found that shocks and jars to which such a power hammer is customarily subjected make it difficult if not impossible from a practical standpoint to design a successful gage for this purpose or one which will be simple and dependable and with a dial suitable for easy reading. However, as has been mentioned above, this type of power hammer operates at maximum efficiency when there is a slight dancing effect and such dancing action can be easily observed by anyone standing 100 or more feet away from the hammer. Therefore, provided the hammer has been designed to dance at a known steam pressure, such an observer can upon seeing the hammer dance be assured accurately as to the value of this steam delivery pressure without the benefit of a gauge and knowing the steam pressure can readily calculate the energy being delivered per blow, which is a very important factor to know, since from this the bearing capacity of the pile in accordance with the above-stated formula may be determined with assurance.

Of course, in order for the steam pressure necessary to produce dancing to be such a known value, it is necessary to initially design the hammer having a known total effective hold-down force. To accomplish this, the aforesaid two factors making up this force must be known. Obviously, the weight of the hammer assembly is a known constant and hence to accomplish the aforesaid objective, it is necessary to provide a hold-down means which will exert a known hold-down force. As will be more fully described herein below, the instant invention provides means for accomplishing such a known hold-down force, to wit, a vertical hold-down cylinder and piston means which is secured to the core directly through suitable linkage. This hold-down cylinder and piston means is preferably subject to the same steam pressure as in the hammer cylinder assembly and, therefore, will exert a known hold-down force dependent upon the pressure supplied to the latter cylinder assembly. On the other hand, if the hold-down means such as is disclosed in the above-mentioned patent is arranged to frictionally grip the pile core, then the gripping effect cannot be accurately predetermined but may vary depending on the nature of the frictional contact between the frictionally engaging surfaces which may, for example, bear a certain amount of oil or for other reasons may not present a predetermined frictional condition.

Further objects, features and advantages of the inven-

tion hereof will appear from the detailed description given below taken in connection with the accompanying drawings which form a part of this specification and illustrate by way of example preferred embodiments of the invention.

In the drawings:

Fig. 1 is an elevational view partly in section showing the upper end portions of a pile core with a differential steam hammer, having hold-down cylinder means assembled therewith in accordance with the invention;

Fig. 2 is an enlarged vertical sectional view of the upper portion of the apparatus of Fig. 1 and showing in detail the vertical hold-down cylinders of the invention; and

Fig. 3 is a fragmentary elevational view of the upper end of the apparatus of Fig. 1, the same being rotated 90° from the position shown in Fig. 1.

Referring now to the drawings and particularly to Figs. 1 and 2 thereof, it will be noted that the hammer assembly of the invention may in many respects be similar in design to the hammer disclosed in the aforesaid E. A. Smith Patent No. 2,598,455, and it should be understood that except as hereinafter specifically set forth the construction and mode of operation of the instant hammer assembly may correspond to that of said patent. As shown, the hammer assembly comprises a hammer body or cylinder assembly 20 which includes an upper cylinder 21 of relatively large diameter and a lower cylinder 22 of smaller diameter with pistons 23 and 24 of corresponding sizes being respectively positioned in said cylinders. These pistons are integral with or rigidly mounted upon a single piston rod 25 having a lower portion 26 fitted within the upper end of a ram 27. As pointed out in the aforesaid Smith patent, the lower smaller cylinder of the hammer body and the ram are adapted to be received within the working portion 28 of a core which is of normal diameter, whereas the lower part at least of the larger cylinder portion of the hammer body is received in an enlarged upper portion 29 of said core. However, of course, the invention is applicable to hammers adapted for use with other types of cores or other driven elements.

The hold-down means according to the invention hereof comprise a pair of vertically disposed cylinders 30 and 31 positioned on opposite sides of the hammer body 20 and each containing a piston 32, 33 adapted to reciprocate therein. To the underside of these pistons 32, 33 are connected piston rods 34, 35 adapted to extend downwardly through suitable apertures provided in the lower end walls of the hold-down cylinders with their projecting ends being pivotally connected as at 36, 37 to the upper ends of connecting links 38, 39, the lower ends of said links being pivotally secured as at 40, 41 to a pair of laterally projecting lugs 42, 43 provided on the core portion 29. The lower ends of the hold-down cylinders 30 and 31 and hence the undersides of their respective pistons 32, 33 preferably are maintained in constant communication with the space above the large hammer piston 24 by means of open passageways 44 and 45. While two such hold-down cylinders 30, 31 have been shown, it should be understood that a greater number thereof could readily be provided, but preferably some are evenly distributed around the axis of the hammer body so as to equalize the pull, although in some cases possibly a single hold-down cylinder might be used.

The steam passage and valve arrangements for controlling the operation of the hammer pistons may (although not necessarily) correspond to those described and shown in Smith Patent No. 2,598,455, that is, the arrangement of valves is such that the steam supply is connected to the space between the pistons 23, 24, whereas pressure is supplied to the space above the large piston 23 only during the greater part of the downstroke and momentarily during the final part of the upstroke to cushion the final upward movement. That is, just before the moment of impact of the ram, the steam pressure in the space above the piston is released, and a pas-

sage from this space remains open to exhaust until the upstroke is nearly completed, whereupon pressure is again supplied above the piston 23 to cushion and stop the upstroke. Admission of the fluid pressure above the upper piston thereafter is continued and acts with the aid of gravity to force the piston assembly down again, the effective piston area then being equivalent to the area of piston 24. As shown, the main control valve 46 for this cycle of operation is of the Corliss type and is mounted on the top of the hammer body in exactly the same manner as shown and described in the aforesaid Smith patent. However, it should be understood that other types of control valves and arrangements of steam passages could be employed so long as the aforesaid steam operating cycle is preserved.

Since passages 44 and 45 continuously connect the spaces beneath the pistons in the hold-down cylinders 30 and 31 with the space above the large hammer piston 23, it will be apparent that during the aforescribed steam cycle these hold-down cylinders will exert a hold-down force upon the hammer body during the greater part of the downstroke of the hammer pistons and until just prior to the impact by the ram; that is, since the steam under pressure is supplied to the space above the large piston 23 during the greater portion of its downstroke, that same steam pressure will be delivered through passages 44 and 45 to the space beneath pistons 32 and 33, thereby forcing its pistons upwardly in their respective hold-down cylinders. This upward travel of these pistons will cause them to pull against or hold on to the core portion 29 through their piston rods 34 and 35 and connecting links 38 and 39, which action will, in turn, exert a downward force upon the hammer body 20. This hold-down force will be of known magnitude being dependent only on the size of the hold-down cylinders which can be predetermined in the initial design of the hammer and the magnitude of the steam pressure being delivered to the hammer body 20.

As stated above, this hold-down force will be active throughout the greater portion of the downward stroke of the hammer pistons 23 and 24 and will be released just prior to the impact of the ram, at which time the upper portion of cylinder 21 will be vented through the action of control valve 46 to the atmosphere, thereby promptly opening the underside of the hold-down pistons 32 and 33 to the atmosphere and permitting said pistons to slide freely in their respective cylinders with the hold-down cylinders thus vented to atmosphere. Thus immediately prior to the moment of impact the core is free to be driven downwardly into the earth by the impact without any resistance being offered by the hold-down means. As has been pointed out above because of the fact that the hold-down force being exerted by such hold-down cylinders 30 and 31 can be exactly calculated, it will be possible to design a hammer of this type which will begin to dance at an exactly known steam delivery pressure, thereby permitting an observer to recognize when this pressure has been reached by simply checking visually for the commencement of the hammer dancing effect.

Although a particular embodiment of the invention is herein disclosed for purposes of explanation, various further modifications thereof after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A double-acting, fluid pressure operated hammer adapted to be assembled with respect to an element to be driven, said hammer having a fluid pressure operated cylinder and piston means with connections positioned and arranged to pull against such element in a direction opposite to the direction of the driving of such element and passage means for bringing the fluid pressure which

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operates the hammer during predetermined portions of its stroke into communication with said piston and cylinder means to cause the piston to pull against such element during said portions of the stroke.

2. A fluid pressure operated hammer adapted to be assembled with respect to a casing or the like to be driven by the hammer, said hammer having fluid pressure operated means thereon movable generally parallel to the axis of the casing, means for positively connecting such casing and said pressure operated means, fluid connection means for bringing the fluid pressure which operates the hammer into communication with said fluid pressure operating means, said fluid connection means including means automatically to release the pressure from said fluid pressure operating means at a time close to the moment of impact of the hammer, thereby releasing such casing to permit such casing to be freely driven by impact.

3. A fluid pressure operated hammer adapted for co-axial assembly with respect to a casing or the like, to be

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driven, said hammer having fluid pressure operated means disposed to operate along an axis generally parallel to the axis of said hammer and means for positively connecting such casing and such fluid pressure operated means to prevent movement of the hammer with respect to the casing.

4. A fluid pressure operated hammer adapted for assembly with respect to an element to be driven, said hammer having fluid pressure operated piston means positioned to operate along an axis generally parallel to the main axis of said hammer, conduit means extending from said piston means to the same source of fluid pressure as provided to operate the hammer, and means for connecting said piston means to such element in such manner as to exert a known hold-down force on said element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,598,455

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