Diesel Power Hammer

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This invention relates generally to diesel power hammers and more particularly to a diesel power hammer wherein the weight ratio of the cylinder relative to the ram is substantially a one to one ratio.

Starting is one of the problems of a diesel power hammer. Usually the power hammer is started on a piling standing on the surface of the ground and its initial penetration is usually fast because the ground is soft. Under these conditions it is difficult to start the diesel hammer of the present art because the minimum volume of the combustion chamber is material. The ram weighs considerably more than the cylinder which follows the soft earth and thus reduces the compression. This is not conducive to good starting characteristics.

One of the important objects of this invention is to provide a diesel hammer with a combustion chamber, the minimum volume of which is substantially zero. Thus any movement of the cylinder following the piling is not as effective in reducing the compression for starting the diesel hammer.

Another important object is the provision of a diesel hammer having a cylinder substantially the same weight as the ram which still follows the piling but provides a better balance for the ram and thus improves the starting characteristics.

Another object of this invention is the provision of a diesel power hammer that has a compression ratio of approximately 16 to 1 on a soft moving piling and 12 to 1 on a hard moving piling. If when starting the high compression ratio is not used the energy expended to produce this compression is transferred to sink the piling. This provides easy starting and more efficient operation.

Another object is the provision of a flat piston and a cooperating opposed flat cylinder providing the diesel combustion chamber that can be made to reduce to substantially a zero minimum volume. This improvement is further augmented by the use of inlet and exhaust ports that create a swirling action in this minimum and flat compression combustion chamber. This improvement is further augmented by the use of a unit type injector that receives the fuel at a low pressure and injects it under high pressure into the swirling compressed gases of the combustion chamber.

Another object is the provision of a diesel hammer having a unit type injector that receives fuel at low pressures and injects the same at high pressure into the cylinder after partial compression of the gases therein. This also contemplates a novel mode of fastening the injector in place and a jerk line to operate the same.

Another object is the provision of a spaced retainer member connected to the diesel cylinder member by guides on which the ram weight is slideable. The ram weight is provided with a hammer engaging portion. The guides are tubes which space between the members and take the wear. Bolts passing through the tubes hold the parts in assembled relation. This provides an open hammer structure that is readily cooled.

The retainer carries a pile cap in the form of a simple annular plate held captive in the retainer. The ram weight is secured to one end of the diesel piston rod by springs to dispel in inertia of the diesel piston when the ram weight strikes the pile cap plate.

Other objects and advantages of this invention appear hereinafter in the following description and claims.

The accompanying drawings show for the purpose of exemplification without limiting this invention or the claims thereto, certain practical embodiments illustrating the principles of this invention, wherein:

Fig. 1 is a view in vertical section of the diesel power hammer comprising this invention.

Fig. 2 is a view in side elevation of the power hammer.

Fig. 3 is a view in horizontal section taken along the line 3—3 of Fig. 1.

Fig. 4 is a view in horizontal section taken along the line 4—4 of Fig. 1.

Fig. 5 is a view in enlarged detail showing a lock retaining member for the ram lift mechanism.

Fig. 6 is a view in enlarged detail showing a modified ram hoist.

Referring to the drawings the diesel hammer of this invention consists of a diesel cylinder member 1 and the retainer 2 which are connected together by the four guides 3, each of which comprises an inner rod member 4 that passes through aligned openings in the bottom of the cylinder 1 and the retainer 2 and are secured by the nuts 5. Opposed sockets 6 are provided in the bottom of the diesel cylinder 1 and the top of the retainer 2 to receive the ends of the tube 7 which surround the rods 4 and function as wearing surfaces for the ram weight 8 which has aligned holes to receive each of the guides and reciprocates thereon as illustrated in the drawings and particularly in Fig. 4 it will be noted that there are four of the tie bolts 4 spaced in symmetric quadrangular relation.

The bore of the diesel cylinder 1 is divided into two sections 10 and 11 by the diesel piston 12 which is formed integral with the piston rod 13 that is connected with the ram weight 8. The piston 12 has a series of seal rings 14 to properly seal the piston within the diesel cylinder 1 and separate the combustion chamber 10 on one side of the piston from the air compressor chamber 11 on the opposite side of the piston.

The bottom of the piston 12 is provided with a flat annular surface 15 which in turn is opposed by the flat annular surface 16 on the head 17 that closes the end of the diesel cylinder 1. The head 17 is provided with a bore to receive the piston 13 which has a bell shaped throat 18 to receive the fillet between the piston rod 13 and the piston 12. The bore of the head 17 has a series of metal packing rings 20 which are separated by spacing rings and which is closed by the gland member 21 that is bolted in place by suitable bolts as illustrated in Fig. 2. Thus the rings 14 and 20 seal both sides of the combustion chamber 10 and the piston may be moved to fully engage with the head 17 thereby diminishing the combustion chamber to zero. If the speed of movement of the piston in compressing the combustion chamber gases is fast, as when dropping the weight and piston for firing, the piston of course will not engage the head 17 as the compression builds up pressure and prevents a metal to metal contact but if the piston is slowly lowered and the ram weight has nothing to engage it is possible for the piston to come to rest on the cylinder head 17 as the air would have ample time to leak past the piston thereby completely reducing the combustion chamber to substantially zero volume. This feature has a considerable advantage in this invention which will be described hereinafter.
It will be noted that the ports 22 on one side of the combustion chamber and the ports 23 on the other side of the combustion chamber connect the exterior or atmosphere with the bore of the diesel cylinder 1 and are employed to supply air not only to the compression chamber 10, but also to the combustion chamber 1 and it will also be noted that the piston is materially shorter than the distance between these ports and the cylinder head 17 so that the ports have adequate time in which to function for both the combustion chamber and the compressor chamber.

As shown in Fig. 4 the ports 22 are substantially rectangular in cross section and there are six shown, each of which is separated by a dividing wall 24 and on the opposite side ports 23 are also shown to be six in number and separated by the dividing walls 25. Extensions of the dividing walls 24 and 25 between the ports 22 and 23 would of course be tangent to arcs drawn within the cylinder 1. These ports 22 and 23 both function as exhaust and inlet ports. It is possible that they could be tangent to a single circle or to circles of different diameters. However the important thing is that the sloping of these walls provides a swirling action in the base charge and the inlet of gases to come from the bore of the cylinder 1. Since the end walls of the combustion chamber are absolutely flat the dividing walls are guiding the air in swirling action. This results from the annular disposition of the walls 24 and 25 and will cause the gases when discharging to swirl through the ports and also cause the inlet air that is in the combustion chamber to swirl in the same direction in the combustion chamber. This action produces good scavenging of gases from the combustion chamber 10 and also provides continued motion to the gases being compressed before the injection of fuel into the combustion chamber. Thus after the piston 12 has closed the ports on the compression stroke the gases will continue to swirl in the combustion chamber 10 and when the fuel is injected in turn, it provides for proper mixing of air and fuel which under compression will burn and drive the piston upwardly.

It should also be noted in Fig. 1 that the ports 22 and 23 taper inwardly. This shape permits the continued expansion of the gases as they are discharged to the atmosphere from the combustion chamber and also aids in retaining and guiding the flow of the air that is taken into the ports. This tapering action is also shown in the horizontal section as illustrated in Fig. 4 for the same purpose. The ports 22 and 23 are in horizontal alignment with each other.

The compression side of the cylinder 1 is approximately three to four times the length of the combustion chamber side and it terminates in a solid head 26 that closes and completely seals the top of the cylinder 1 and spaced from the upper end of this cylinder are a series of ports 27 which pass through the wall and are connected with the tanks 28 which are formed integral with the side of the cylinder 1 and are flat across their face. These tanks act as a reservoir to permit the compression of the air in the upper portion of the cylinder as indicated at 11 which air is released under pressure upon the descending of the piston 12 to aid in forcing the latter downwardly by the amount of energy stored in this compressed air. The tanks 28 for receiving the compressed air, in effect, take the place of an open cylinder that is used in connection to the combustion of the cylinder 1. It is not feasible to have such a long piston rod or a machine to store the energy by raising the piston as high as possible. Thus the tanks holding the compressed air function to maintain the hammer in its shortest dimension. When the piston 12 passes the ports 22 of the air tank, the air that is in the tank is compressed to prevent the latter from engaging the head. If the space above these ports is deemed to be too large the piston 12 which is shown to be hollow is closed and thus aids in restricting the sides of the cushion chamber which is indicated in the drawings by the reference numeral 30.

The opposite side of the diesel cylinder is provided with the tanks 31 and 32 for fuel oil and lubricating oil respectively. These tanks are provided with suitable openings to fill the same and suitable connections to drain the oil from the tanks and supply the same to the injector means in the case of the fuel oil and to the lubricating pump in the case of the lubricating oil. Such structures are common in the art and therefore not shown.

The sides of the diesel cylinder 1, the ram weight 8 and the retainer 2 are provided with the ways 33 to receive the guides 34 for the purpose of holding the diesel hammer vertical. The guides 34 are usually attached to the holst that raises the diesel hammer. However this hammer may be employed without such guides or leads. It will be noted that the inlet and exhaust ports have free access to the atmosphere as they do not conflict with the leads 34 nor with the guides 3 that extend between the diesel cylinder 1 and the retainer 2.

The ram weight 8 is provided with a central recess in the form of the annular bore 35 in which the stem 36 or the bore plate 37 is extended preferably as a shrink fit so that the latter is retained by the ram weight and becomes a part thereof but may be pressed therefrom if it becomes broken or otherwise destroyed through use. The ram point 37 is smaller in diameter than the bore 38 in the retainer 2 and owing to the guiding action of the guides it will always enter the bore 38 and strike a flat plate 40 which is the pile cap. This pile cap is an annular disc and is retained in the groove 41 by the annular sleeve 42 that is held in place by the bolts 43. It is preferable to have the ram weight engage the retainer 2 rather than permit the ram point 37 to engage the plate 40 when the latter is resting on the ring 42.

The ring 42 is tapered as indicated at 44 for the reception of a piling 45. The top of the piling is engaged by the flat plate or pile cap 40. If the piling is not square or if it is sloping the strength of these materials will withstand the force of the hammer in striking the member even though it is not in good flat engagement as illustrated.

A second bore 46 in the ram weight 8 is provided to receive the series of pressure washers 47 which are merely trusto conical washers that may be flattened out by the application of pressure. Four of these washers are illustrated and they rest on the shoulder 48 at the bottom of the bores 46. The washers are engaged at the other end by the shoulder 50 on the nut 51 that is threadably secured to the end of the piston rod 13 and is held in place by the pin 52. The nut 51 has an arcuate face 53 which is engaged by the arcuate surface 54 of the split ring 55 that is bolted against the shoulder 56 at the bottom of the bore 57 of the ram weight 8, but when the split ring 55 is bolted in place, it engages the opposite surface of the shoulder 59 and forces the same in tight engagement with the spring 47 and may partially pre-compress the same. However when the ram descends the inertia of the piston 12 and the piston rod 13 creates additional compression of the spring washers 47 when the ram weight 8 is stopped by impact against the pile. This avoids rupture of any part of the piston rod 13 or the juncture between this piston rod and its piston.

The ram weight 8 is provided with additional openings 60 and 61 in the upper piston line 62 and the jerk line 63 that operates the fuel injector. The lower end of the slot or opening 60 is provided with a seat 64 to receive the head 65 of the wedge type cable socket 66 which is received in the socket 67 of the retainer 2. The cable 62 is secured by wedging metal between the socket and the cable head 26 and the piston 12 is compressed to prevent the latter from engaging the head. If the space above these ports is deemed to be too large the piston 12 which is shown to be hollow is closed and thus aids in restricting the sides of the cushion chamber which is indicated in the drawings by the reference numeral 30.
readily move out of the socket 67 even though there is some friction between the cable 62 and the slotted groove 60. However when the hoist line 62 is raised, it pulls the cable socket 66 out of the socket 67 and the detent 70 thereby pushes out the ram 65 and permits the socket 66 to move upward so that its head 65 can engage the seat 64 and thereby raise the ram and all the structure connected therewith. The ram will then raise until its perimeter 72 engages the stop 73 on the underside of the cylinder 1. This stop is preferably made of a nonmetallic material and the ram may hit the same if it is raised slowly and the hoist is permitted to feed around the piston when it is at the top of the cylinder. However when the ram is raised at a fast rate of speed the compression at the top of the cylinder prevents the ram weight from engaging the stop 73 until the air has had an opportunity to leak past the piston which takes a considerable time. Ordinarily as soon as the ram raised to the proximity of the stop 73 the hoist line is released to permit the ram to fall and compress the gases and actuate the injector causing the hammer to function as a diesel powered hammer.

As the ram falls it will strike the moving abutment 74 on the end of the jerk line 63 and cause the jerk line to actuate the lever 75 which in turn pivots on the pivot 76 and forces the plungers 77 of the fuel injectors to sequester a supply of fuel oil into the combustion chamber 18. The fuel injector 78 is provided with a rack and pinion structure as indicated at 79 that is connected to one end of the bell crank lever 80, the other end of which is connected to the hydraulic fuel control 81 which is supplied with a fluid pressure line which functions as a solid control to move its piston and thereby actuate the bell crank arm 82 against the biasing spring member 83.

Thus different positions of the piston in the hydraulic fuel control member 81 will seat the rack at different positions to determine the amount of fuel to be supplied upon each stroke of the ram. The fuel being supplied through the line 83 to the injector 78.

A hold down clamp 84 which has a head member 85 and a tail member 86 is employed to hold the fuel injector 78 in place. The fuel injector has an arcuate socket 87 for receiving the arcuate portion of the head 85. Intermediate of the head and tail 85 and 86, the hold down clamp is provided with an arcuate abutment 89 against which a washer 89 bears when the nut 90 is screwed on its stud member 96. By this arrangement the injector 78 is held in position and is protected on three sides by the abutment stop 73.

An abutment 74 fits in the socket 92 of the retainer 2 and is connected by means of the spring 93 so that it will not be pulled out of position. Adequate clearance is provided between the jerk line 63 and slot or passage 61 so as to void false operation of the fuel injector.

In the structure as shown in Fig. 6 the hoist and starting line 62 is secured to the plug member 65 which has an annular groove 68. However the wall 67 has been increased in size and its lower end is indicated at 94 and is provided with the dual pivot pins 95 that support their respective bell crank levers 96, the heads 97 of which engage in the groove 68 to hold the plug 65 down when the diesel hammer is operated. The other end of the bell crank levers 96 have connected thereto the lines 99 that extend to the cross bar 100 and the manual control line 101. By pulling on the manual control line, one may engage the device 102 which picks up the plug and the weight 8 when the plug engages the socket 64. The spring 102 urges the heads 97 into the path of the plug 65 and onto the groove 68 when the latter is in its lowered position. Although the bell crank levers with their large pivots 95 could be employed to hoist the whole of the die 64, the plug 65 and the plug weight 8, it is preferable to release the plug 65 and permit it to engage the socket 64 and the ram weight together with the piston until the hook member 103 on the upper end of the line 62 engages in the socket at the upper end of the cylinder thereby transferring all the weight of the diesel hammer to the hook member 103. At this time the stop member 73 may be engaged by the ram weight 8 or the stop 73 may be employed as a safety device which would permit the hook 103 to engage the lifting socket 104 before the ram weight 8 engages the stop 73. In other words the stop 73 would be used only when the diesel charge was sufficient to carry the piston to engage the stop 73. However the length of the cable 62 may be arranged so that the hook 103 does not engage the stop 104 but permits the ram weight 8 to engage the stop 73 to permit the latter to raise the whole of the diesel hammer.

I claim:

1. A diesel power hammer comprising a housing including a diesel cylinder and an anvil carrying retainer spaced from each other and connected together by a pair of parallel guides, a ram including an anvil engaging weight slidable on said guides and detachably connected to one end of a piston rod the other end of which is connected to a diesel piston operably mounted in said cylinder, the mass of said weight being materially greater than the mass of said piston and the mass of said housing being opposed and having a ratio of approximately one to one.

2. A diesel power hammer comprising a diesel cylinder, a diesel piston operably mounted in said cylinder and forming therewith a combustion chamber at one end of said cylinder, chamber means on said cylinder, ports connecting selected of said chamber means and the interior of said cylinder, said ports being spaced from the other end of said chamber to provide stop cushion for said piston, an anvil carrying retainer, parallel guides connecting said retainer and said cylinder, a ram weight having hammer striking means and detachably connected to said piston and slidable on said guides, and aligned lead grooves formed between said chamber means on opposite sides of said cylinder and on said retainer and on said ram weight.

3. A diesel power hammer comprising a diesel cylinder, a diesel piston operably mounted in said cylinder and forming therewith a combustion chamber at one end of said cylinder, a retainer, guides connecting said retainer and said cylinder, a ram weight having hammer striking means and connected to said piston and slidable on said guides, a piston lift line passing through said ram weight and having a head to engage the retainer means and to lift said ram weight and piston, a latch means on said retainer to hold the head on said piston lift line when said ram weight is operating by said diesel hammer.

4. A diesel hammer piston hoist mechanism comprising a hammer retaining means, a piston ram operating above said retainer, a hoist line having a head to engage under said piston ram to raise the same, and a dent carried by said retainer to hold said head when said piston ram is operating.

5. The structure of claim 4 characterized in that said head has a socket and said dent is a spring-biased finger carried by said retaining means and is urged into said socket in said head to hold the same.

6. The structure of claim 4 characterized in that said head has a shoulder and said dent is a spring-biased latch lever pivot on said retainer means and is urged onto said shoulder on said head to hold the same, a second lever means pivot on said retainer means to engage said biased latch lever means from said shoulder, and means cooperating with said second lever means to swing it and retract said first lever means.

7. A diesel power hammer having a connected piston and ram weight characterized in said connection including a piston rod joined at one end with the piston, a shoulder on the opposite end of said piston rod, spring washer means between said shoulder and said ram weight, and an abutment secured to said ram weight and engaging
the opposite side of said shoulder to retain the same against said spring washer means, said spring washer means being flexed by the inertia of said piston upon impact of ram weight.

8. A diesel power hammer comprising a diesel cylinder, a diesel piston operably mounted in said cylinder and forming therewith a combustion chamber at one end of said cylinder, an anvil carrying retainer, parallel guides connecting said retainer and said cylinder, a ram weight slidable on said guides between said cylinder and said retainer and having a hammer striking means, a piston rod detachably connecting said piston and said ram weight, said piston trapping gas at the ends of said cylinder upon operation to limit the movement of said piston within said cylinder, and a stop mounted on the outside of said cylinder for engagement by said ram weight when said piston is slowly raised to and held in spaced relation from the top of said cylinder.

9. A diesel power hammer fuel control comprising a diesel cylinder, a diesel piston operably mounted in said cylinder and forming therewith a combustion chamber at one end of said cylinder, a retainer, guides connecting said retainer and said cylinder, a ram weight having a hammer striking means and slidable on said guides, a piston rod connecting said piston and ram weight, a fuel injection means mounted on said cylinder to supply fuel to said combustion chamber, a jerk line extending from said fuel pump to said retainer, and an abutment on said jerk line and in the path of said ram weight to actuate said fuel injection means as the ram weight approaches said retainer.

10. A diesel power hammer comprising a diesel cylinder and a retainer connected by guides, a diesel piston operable in said cylinder, a ram weight with a hammer engaging means slidable on said guides and connected by a piston rod to said piston, said guides including tie rods secured at their opposite ends to said cylinder and said retainer, a tube on each tie rod having its ends seated on said cylinder and retainer to function as a wearing surface and gauge the distance therebetween.

11. A diesel power hammer comprising a diesel cylinder and a retainer connected by guides, a diesel piston operable in said cylinder, a ram weight with a hammer engaging means slidable on said guides and connected by a piston rod to said piston, said retainer having an opening to receive said hammer engaging means, and a transverse plate retained in said opening to engage a pile on one side and to be engaged by said hammer engaging means on said ram weight.

12. A diesel power hammer comprising a housing including a diesel cylinder and a retainer connected together by spaced guides, a ram including a ram weight slidable on said guides and a diesel piston operably mounted in said diesel cylinder and connected to said ram by a piston rod extending through the bottom of said diesel cylinder, a unit type injector means on said diesel cylinder on one side of said piston rod and actuated by said ram, and a remotely operated control means on said injector means to change the volume of fuel supplied by one operation of said injector means.

13. The structure of claim 12 characterized in that said control means includes a remotely controlled fluid actuated cylinder to change the charge of fuel to said injector means.

14. The structure of claim 12 characterized in that said injector means is mounted and held in place by an arcuate shaped clamp having a head engaging the injector, a hasp and a tail engaging said diesel cylinder, an arcuate shoulder intermediate said head and tail, and bolt means engaging said arcuate head.

15. A diesel power hammer comprising a diesel cylinder having a cylinder head closing the lower end thereof to form a diesel chamber, an anvil, a ram weight, a guide means on said diesel cylinder and said retainer, a diesel piston operable in said cylinder, a piston rod connected to said piston and extending through said cylinder head and in sealed relation therewith, a hammer- engaging ram weight slidable on said open guides between said diesel cylinder and said retainer, detachable means connecting said piston rod to said ram weight, the face of said piston surrounding said piston rod being flat from the connection of the piston rod to the periphery of said piston, and the face of said cylinder head in said diesel chamber being flat to mate in surface engagement with said face on said piston to produce a diesel chamber of substantially zero volume.

16. A diesel hammer consisting of a diesel cylinder having a cylinder head closing the lower end thereof to form a diesel chamber, an anvil-carrying retainer, open guides connecting said diesel cylinder and said retainer, a hammer-engaging ram weight slidable on said open guides between said cylinder and said retainer, a diesel piston operably mounted in said cylinder and cooperating with said combustion chamber, a piston rod extending through said cylinder head, detachable means connecting said piston rod and said ram weight, air inlet and outlet ports in the walls of said cylinder and opened and closed by said piston, fuel injection means on said head to supply fuel to said diesel chamber, and jerk connections independent of said open guides and extending between said fuel injection means and said ram weight and when engaged by the latter to inject fuel by the operation of said ram weight, the end face of said cylinder head in said diesel chamber being flat to mate in surface engagement with said face on said piston to produce a diesel chamber of substantially zero volume.

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