Sept. 3, 1957 K. HAAGE 2,804,857

PILE PULLER

Filed March 31, 1955 4 Sheets-Sheet 1

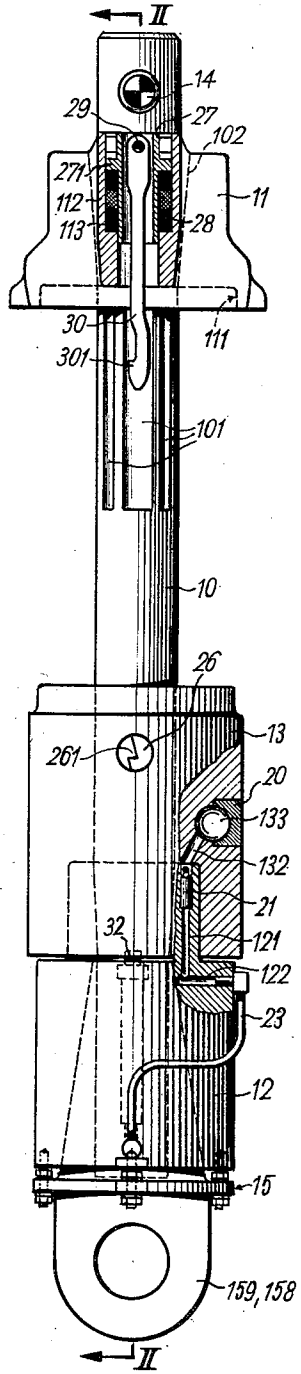


Fig. 1

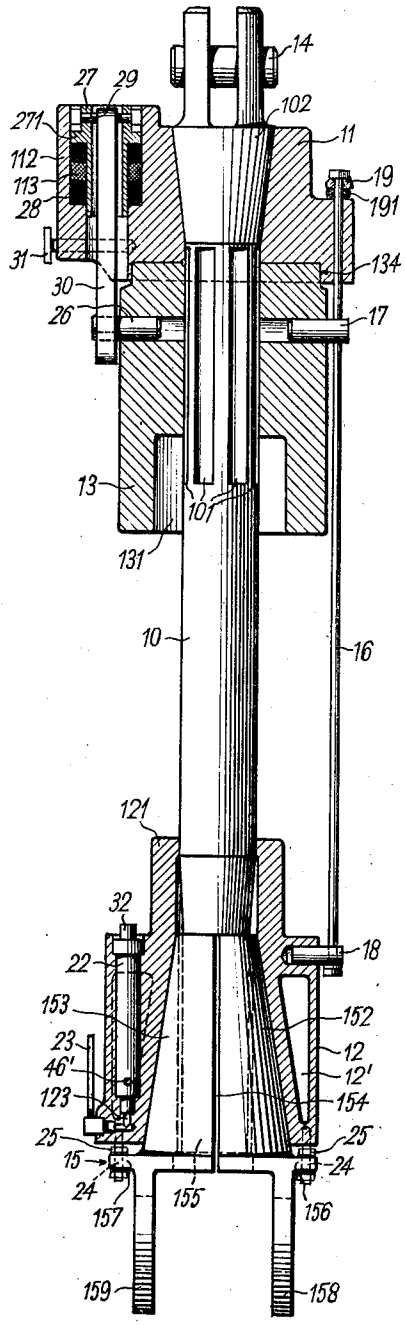


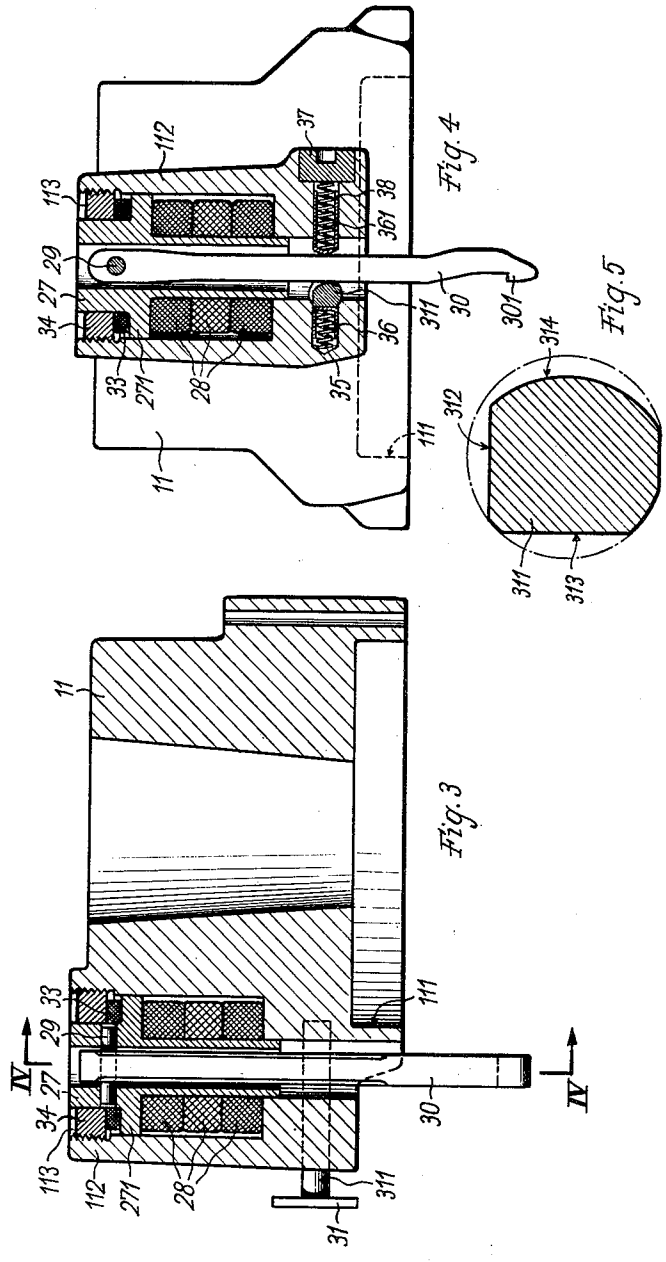
Fig. 2

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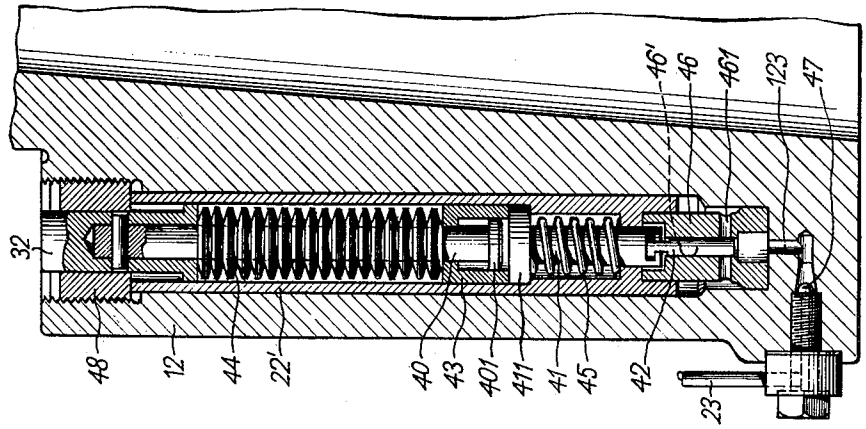


Fig. 8

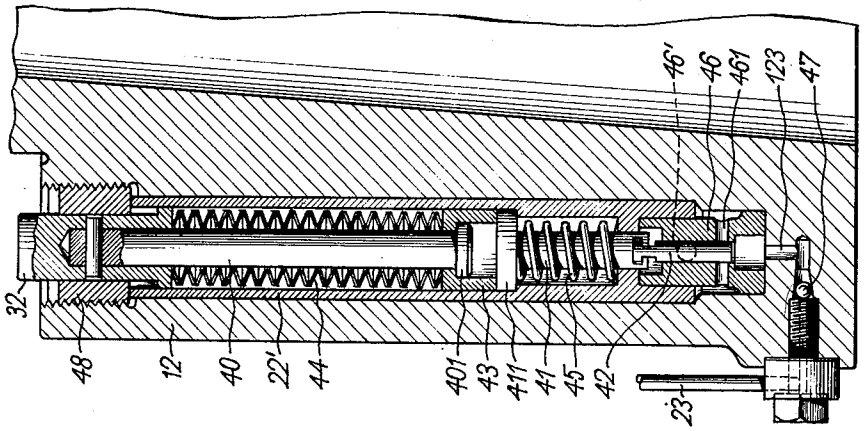


Fig. 7

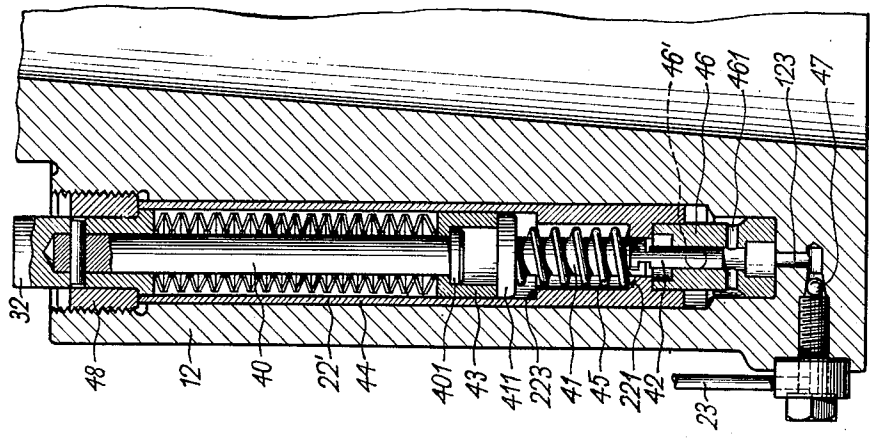


Fig. 6

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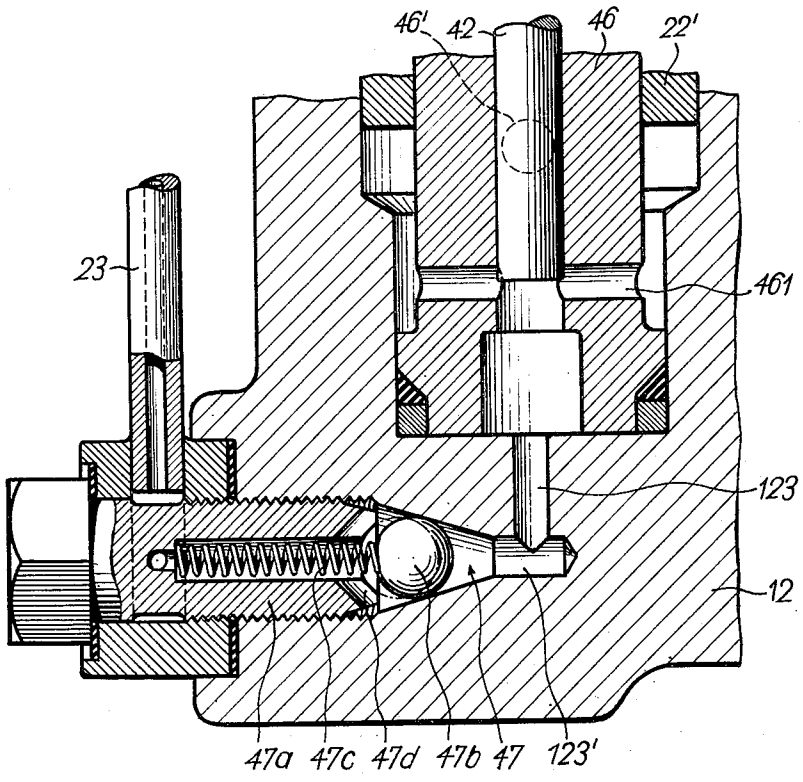


Fig. 9

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PILE PULLER

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Application March 31, 1955, Serial No. 498,398

Claims priority, application Germany April 1, 1954

12 Claims. (Cl. 123—7)

The present invention relates to apparatus for pulling piles.

One of the objects of the present invention is to provide a pile puller with a source of energy operating on the same principle as a diesel engine.

Another object of the present invention is to provide a pile puller with an exceedingly simple and secure means for carrying tongs to be attached to the pile to be pulled.

A further object of the present invention is to provide a pile puller of the above type with a means for automatically displacing combustion gases out of a cylinder of the pile puller.

An additional object of the present invention is to provide a pile puller with an automatically operable injection pump means for injecting fuel, to be exploded, into a cylinder.

Still another object of the present invention is to provide a manually adjustable automatically operable catch means for catching a movable cylinder at the top of its stroke.

Furthermore, it is an object of the present invention to provide structure for accomplishing all of the above objects and at the same time composed of simple, rugged parts capable of operating reliably for a long period of time.

With the above objects in view, the present invention mainly consists of a pile puller which includes an elongated guide bar having a stop member fixed to an upper portion thereof and formed with outer axially extending grooves extending downwardly from the stop member. A piston is fixed to the guide bar adjacent the lower end thereof and serves to fix to the guide bar a means for carrying tongs to engage the pile to be pulled. A cylinder is formed with an axial bore through which the guide bar slidably extends and is located on the latter between the piston and stop member, this cylinder being movable along the guide bar between a bottom position where the piston is located completely within the cylinder and a top position where the cylinder engages the stop member, air trapped between the stop member and cylinder moving through the grooves of the guide bar into the cylinder to displace exhaust gases therefrom. A catch lever is turnably carried by the stop member and a catch member on the cylinder is engaged by the catch lever to maintain the cylinder in its upper position, this catch lever being manually movable to and from an operative position in the path of the catch member. An injection pump is carried by the piston for injecting fuel into the cylinder and this injection pump has a plunger provided with a top free end engaged by the cylinder when the latter has almost reached its bottom position so that the injection pump is in this way automatically actuated by the cylinder.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific

embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is an elevational view of a pile puller constructed in accordance with the present invention, the tongs carried by the bottom end of the structure of Fig. 1 and the structure connected to the top end of the structure of Fig. 1, for supporting the latter, being omitted from Fig. 1;

Fig. 2 is a sectional view taken along line II—II of Fig. 1 in the direction of the arrows with the cylinder of Fig. 1 shown in a different position in Fig. 2;

Fig. 3 shows on an enlarged scale, in a central sectional elevational view, the stop member of the invention together with the catch structure carried thereby;

Fig. 4 is a sectional view taken along line IV—IV of Fig. 3 in the direction of the arrows;

Fig. 5 is a transverse sectional view through a shaft turnably carried by the stop member of Figs. 3 and 4 for positioning a catch lever shown in Figs. 3 and 4;

Fig. 6 is a fragmentary, elevational, sectional view on an enlarged scale through part of a piston of the invention showing the details of an injection pump carried by this piston;

Figs. 7 and 8 respectively show the structure of Fig. 6 in different positions; and

Fig. 9 is a fragmentary sectional view on an enlarged scale showing the lower portion of the injection pump together with conduit and valve means associated with the injection pump.

Referring now to the drawings and to Figs. 1 and 2 in particular, it will be seen that the structure of the invention includes an elongated cylindrical guide bar **10** carrying a stop member **11** adjacent its upper end and a piston **12** adjacent its lower end. The ramming member of the invention is formed by the cylinder **13** which is located between piston **12** and stop member **11** and which is formed with an axial bore through which the guide bar slidably extends so that the cylinder **13** is slidable between a bottommost position shown in Fig. 1 and a topmost position shown in Fig. 2.

The guide bar **10** carries a transverse pin **14** at its top end which serves to suspend the structure of the invention from any suitable support, such as a block and tackle capable of raising the structure shown in Figs. 1 and 2. A pair of tongs, not shown in the drawings, are adapted to grip the pile to be pulled, and the guide bar **10** carries structure for supporting such tongs at the bottom end of the guide bar **10**. Of this latter structure only the carrier structure **15** is shown in the drawings, this structure **15** including a pair of bored ears **158** and **159** across which a pin extends to pivotally support the tongs.

In order to prevent the ramming cylinder **13** from turning about its axis, a rod **16** extends between piston **12** and stop member **11** in a direction parallel to the guide bar **10**. This rod **16** extends slidably through a bore formed in a pin **17** fixed to and extending radially from the cylinder **13**. The bottom end of the rod **16** is connected to a pin **18** fixed to and extending radially from piston **12** while the top end of the rod **16** extends through a bore of stop member **11** and through a pair of at least partly elastic washers **19** and **191**, a nut at the top of rod **16** bearing against the uppermost washer **19** and the bottom washer **191** engaging an upwardly directed outer surface portion of the stop member **11**.

The bottom end portion of cylinder **13** is formed with the cylindrical space **131** through which guide bar **10** extends coaxially, this space **131** being open at its bottom. The piston **12** includes an upper piston portion **121** corresponding in shape to the cylindrical space **131** and extending completely into and substantially filling this cylindrical space when the cylinder **13** is in its lowermost position indicated in Fig. 1. In the illustrated example, the

piston portion **121** is integral with the remainder of piston **12**. The cylinder **13** is formed with a bore **132** communicating with cylindrical space **131** and with a spherical turbulence chamber **133** formed in a solid part of cylinder **13**. For manufacturing purposes, one half of this turbulence chamber is formed by a member **20** inserted into a recess of member **13** in the manner indicted in Fig. 1.

An injection nozzle **21** is mounted in the piston portion **121** adjacent the top end thereof for directing fuel into and along the passage **132**. The piston **12** is formed with bores **122** for leading fuel to the nozzle **21**.

Fuel is delivered to the nozzle **21** by an injection pump **22** shown schematically in Fig. 2, this injection pump communicating with bores **122** through bores **123** and tubular conduit **23** in the manner indicated diagrammatically in Figs. 1 and 2.

As is apparent from Figs. 1 and 2, the piston **12** is axially bored to receive the lower portion of guide bar **10**, and part of the bore of the piston **12** is conical. This conical portion of the piston bore receives conical nut sections **152** and **153** which are separated from each other by a pair of gaps **154**, one of which is shown in Fig. 2. The inner surfaces of the nut sections **152** and **153** are formed with threads which provide a rib and groove means to cooperate with another rib and groove means in the form of threads located at the bottom end of guide bar **10**. Thus, it will be seen that with this arrangement the piston **12** is constantly urged by the falling cylinder **13** downwardly onto the members **152** and **153** which are located beside each other against the guide bar **10** to wedge these members on the guide bar and to urge the rib and groove means of members **152** and **153** radially toward the axis of the guide bar into the rib and groove means of the latter. The nut member **152** is integral with a semi-circular flange **156** and the nut member **153** is integral with a semi-circular flange **157**, these latter flanges being respectively integral with ears **158** and **159**. Thus, these elements form a bifurcated carrier **15** for carrying the pivot pin of a pair of tongs, as mentioned above. Screw members **24** extend freely through bores in flanges **156** and **157** into threaded engagement with piston **12** to urge the latter toward these flanges so as to press the nut members **152** and **153** radially toward the axis of guide bar **10**. Nut members **25** are carried by screw members **24** for releasing the connection between piston **12** and carrier **15**. Thus, when it is desired to separate parts **12** and **15** from each other, screws **24** are turned outwardly from the piston **12** while still remaining in connection therewith and the nuts **25** are then turned against the flanges **156** and **157** to pull the screws **24** upwardly with respect to these flanges so as to raise piston **12** through a distance sufficient to enable the threads of nut members **152** and **153** to be moved away from and out of engagement with the threads at the bottom end of guide bar **10**.

It will be seen that with this construction the engagement of the ramming cylinder **13** with the piston **12** is transmitted into forces directing members **152** and **153** inwardly toward guide bar **10** into tighter engagement with the threads thereof. Thus, a very secure connection is provided between carrier **15** and guide bar **10**, and this connection does not rely on any screw members or the like which are subject to extremely large stresses. A screw connection of this latter type could never provide the secure connection provided by the above-described structure at the bottom end of guide bar **10**.

The ramming cylinder **13** is provided at its top end with a cylindrical, upwardly-directed projection **134** which extends into and substantially fills a correspondingly shaped recess **111**, formed in the bottom face of the stop member **11**, when the ramming cylinder **13** is in its topmost position shown in Fig. 2. The guide bar **10** is formed in its outer surface with axially extending grooves **101** extending downwardly from stop member **11** through a distance greater than the length of the bored portion of cylinder **13** which engages the guide bar **10**, as is evident from Fig. 2. Thus, when the cylinder **13** is thrown upwardly against the stop member **11** to provide an upward force on the pile to be pulled, the projection **134** entering into recess **11** causes air trapped between cylinder **13** and stop member **11** to be driven downwardly through grooves **101** into the cylindrical space **131** so as to clean the cylindrical space by driving products of combustion therefrom.

The ramming cylinder **13** carries in addition to the guide pin **17** a pin **26** which serves as a catch member, this pin **26** being provided at its outer free end with a tooth **261**. The catch member **26** cooperates with the remainder of a catch means carried by the stop member **11**.

The stop member **11** is provided with a lateral extension **112** formed with a bore which is open at its top and bottom and which is provided intermediate its end with a shoulder, Fig. 2 clearly showing that the bore portion of extension **112** located above the shoulder is of a greater diameter than the bore portion located below the shoulder. A sleeve **27** is located within the larger bore portion and has a bottom outer surface portion in slidable engagement with the lower bore portion. Furthermore, the sleeve **27** is provided with an outwardly extending annular flange **271** whose outer periphery is in slidable engagement with the surface of the larger part of the bore in extension **112**. Between the flange **271** and the shoulder a spring means **113** is located, and this spring means **113** may take the form of washers **28** made of rubber or the like, located one above the other about the sleeve **27**, and yieldably resisting downward movement thereof. The top part of the sleeve **27** carries a cross-pin **29** on which a catch lever **30** is pivoted, this catch lever **30** extending freely through the bore of extension **112** downwardly below the stop member **11**. The bottom end of the catch lever **30** is provided with a hook-like catch portion **301** which cooperates with the tooth **261** of the catch member **26**. An additional spring means described below yieldably urges and maintains the catch lever **30** in the position thereof shown in Fig. 1, and in this position the catch lever will be engaged by catch member **26** when the cylinder **13** is almost at its uppermost position. When the cylinder **13** reaches its topmost position shown in Fig. 2, the hook portion **301** snaps beneath the tooth **261** and prevents downward movement of the cylinder **13**, and it will be noted that the cylinder **13** is actuated on by the catch means at the precise moment when the cylinder **13** stops its upward movement, the kinetic of the cylinder **13** being at a minimum at this moment. A manually operable structure not shown in Fig. 1 and only diagrammatically indicated in Fig. 2 where the manually operated element **31** is shown is provided to move the catch lever **30** from its operative position indicated in Fig. 1 to an inoperative position where the catch lever **30** is inclined with respect to the position shown in Fig. 1 to an extent sufficient to locate the catch lever **30** out of the path of movement of the catch member **26**. Thus, in this inoperative position of catch lever **30** the catch means will not operate and the ramming cylinder **13** will simply rise and fall continuously. This catch lever **30** is returned to its operative position when it is desired to stop the operation of the pile puller so as to retain the ramming cylinder in its uppermost position, and when operation is again started the catch lever **30** is again moved to its inoperative position in order to release the cylinder **13** which falls by gravity in order to start the operations. The spring means **113** resiliently resists downward movement of the ramming cylinder **13** when the catch member **26** is engaged by the catch lever **30**.

The above described structure illustrated in Figs. 1 and 2 operates as follows:

From the starting position shown in Fig. 2 the ramming cylinder **13** is released when the operator turns lever **31** so as to move the catch lever **30** to its inoperative position. The falling ramming cylinder **13** starts to compress

gases within the cylindrical chamber **131** as soon as the piston portion **121** enters into the cylinder portion **131**. When the cylinder **13** has almost reached its bottommost position it strikes against the top free end **32** of a plunger of the injection pump **22** and depresses this plunger so that the injection pump injects fuel through the conduit **23** and bores **123** and **122** as well as through suitable non-return valves into the nozzle **21** and the fuel issues from the nozzle **21** along the passage **132** into the turbulence chamber **133** where combustion takes place. The resulting explosion causes the ramming cylinder **13** to be thrown upwardly and to completely uncover the piston portion **121** so that in this way part of the exhaust gases are distributed to the atmosphere. The remainder of the exhaust gases are cleaned out of the cylinder space **131** when the ramming cylinder **13** moves with its upper portion **134** into the recess **111** shortly before the ramming cylinder **13** strikes the stop member **11** to exert a sudden upward pull on the pile. The air trapped within the recess **111** during upward movement of the cylinder **13** is compelled to flow downwardly through the grooves **101** and through the cylindrical space **131** to the outer atmosphere, so that in this way the products of combustion in the cylindrical space **131** are displaced by fresh air.

The stop member **11** is retained on the guide bar **10** by its wedging engagement with a conical enlargement **102** of the guide bar **10**, this enlargement **102** being located within a conical part of an axial bore of the stop member **11** through which the guide bar extends. When the ramming cylinder **13** strikes the stop member **11**, the upward force is transmitted through the conical enlargement **102** to the guide bar **10** and from the latter through the carrier structure **15** to a pair of tongs carried by this carrier structure and gripping the pile to be pulled. As long as the catch lever **30** is maintained in an inoperative position the ramming cylinder **13** falls after it strikes the stop member **11** and then the above described operations are repeated. The repeated blows of the ramming cylinder **13** against the stop member **11** loosen the pile and eventually draw it up.

At the end of the operations, the member **31** is actuated by the operator to allow the catch lever **30** to return to its operative position shown in Fig. 1, and then when the ramming cylinder **13** reaches its uppermost position, the catch member **26** is engaged by the lever **30** to retain the cylinder **13** in its uppermost position. It is a fairly simple matter with the structure of the invention to arrange the catch means **26**, **30** to retain the ramming cylinder **13** in its topmost position because the stop member **11** provides a precise limit to the upward movement of cylinder **13** and thus the cylinder **13** is positioned precisely by the stop member **11** in order to be engaged by this catch means. In other words, with the disclosed structure of the invention the ramming cylinder **13** is compelled to move up and down through strokes which are always of exactly the same length. Therefore it is possible to set the parts so that the hook portion **301** snaps beneath the tooth **261** exactly at that moment when the ramming cylinder **13** would change its direction of movement and when the kinetic energy of the cylinder **13** is at a minimum.

The part of the catch means which is carried by the stop member **11** is illustrated in greater detail and on an enlarged scale in Figs. 3–5. Thus, referring to Figs. 3–5 it will be seen that the annular flange **271** is located between the topmost washer **28** and another washer **33** of rubber or the like, this washer **33** being urged downwardly against the top face of flange **271** by an outwardly threaded ring **34** which engages threads formed in the topmost part of the bore of the extension **112**.

Furthermore, Figs. 3–5 show the shaft **311** which is turnably carried by the stop member **11** and which has the handle **31** located at its outer end so that the shaft **311** may be turned by the operator. This shaft **311** extends transversely through the bore of extension **112** through which the catch lever **30** passes, as is particularly evident from Fig. 4. As is shown most clearly in Fig. 5, the shaft **311** is provided with a pair of side faces **312** and **313** which are substantially at right angles to each other and with an eccentric curved face **314**. The flat side faces **312** and **313** serve to retain the shaft **311** in its end positions corresponding to the operative and inoperative positions of the catch lever **30**. These flat faces **312** and **313** cooperate with the flat right face of a cup-shaped member **36**, as viewed in Fig. 4, this cup-shaped member **36** being slidable within a suitable bore formed in extension **112** and being urged by the spring **35** outwardly toward the shaft **311**. As is evident particularly from Fig. 5, when the face **313** engages the cup member **36** the catch lever **30** will be located in its operative position, while when the shaft **311** is turned in a counterclockwise direction, as viewed in Fig. 5, through 90° so that the face **312** engages the cup member **36**, the shaft **311** will turn the catch lever **30** in a counterclockwise direction about pin **29**, as viewed in Fig. 4, to an inoperative position. It is only necessary to turn the shaft **311** back to the position indicated in Fig. 5 in order to return the catch lever **30** to its operative position. Of course, the shaft **311** is mounted on the extension **112** with a clearance sufficient to enable the shaft **311** to be turned to its end positions. The extension **112** is provided with an additional bore which accommodates a substantially cup-shaped member **38** urged by the spring **361** to the left, as viewed in Fig. 4, so that the spring **361** constantly urges the catch lever **30** to its operative position. A plug **37** is threaded into the extension **112** in order to regulate the force with which the spring **361** presses the member **38** toward the lever **30** as well as to provide a surface against which the spring **361** abuts. In this way, the catch lever **30** is always maintained against the eccentric surface **314** of the shaft **311**.

The details of the injection pump **22** are illustrated in Figs. 6–9. This injection pump includes an upper plunger **40**, a lower plunger **41**, and a third plunger in the form of a piston **42** which is connected to the plunger **41** for movement therewith. As is evident from Figs. 6–8, the bottom end portion of the plunger **41** is formed with a T-slot into which the T-shaped top end of the plunger **42** extends so that in this way plunger **42** is constrained to move together with the plunger **41**. The piston **12** is formed with a bore to accommodate the injection pump **22**, and a cylindrical sleeve **22'** forms the housing of the injection pump and is located within this bore in the manner indicated in Figs. 6–8. This sleeve **22'** slidably engages outwardly extending bottom annular flange of a head piece **32** which is fixed rigidly to the top end of the plunger **40** and which may be formed integrally therewith if desired. Furthermore, the sleeve **22'** slidably engages at its inner surface the outer surface of a cylindrical cup-shaped member **43** having a top wall formed with a bore through which the plunger **40** extends. The plunger **40** is provided at its bottom end with an enlargement **401** which engages the bottom surface of the top wall of the cup-shaped member **43** in the position of the parts shown in Figs. 6 and 7 so that the member **43** cannot move downwardly with respect to plunger **40** beyond the position indicated in Figs. 6 and 7. A relatively strong spring means **44** is located about the plunger **40** between head piece **32** and cup-shaped member **43** and in engagement with members **32** and **43**. The spring means **44** may be made up of individual dish springs located one above the other in the manner indicated in Figs. 6–8 and formed with aligned openings through which the plunger freely extends. Thus, the spring means **44** by its engagement with members **32** and **43** constantly urges the member **32** upwardly with respect to member **43** so as to press the enlargement **401** against the underside of the top wall of member **43**. Spring means **44** must be compressed before the enlargement

401 can move downwardly into the cup-shaped member 43 beyond the position indicated in Figs. 6 and 7. The cup-shaped member 43 bears at its bottom surface against an enlarged top end 411 of the second plunger 41, and it will be noted that the plunger 41 extends downwardly into a bore portion of sleeve 22' which is of a smaller diameter than the bore portion in which 40 is located, these two bore portions of different diameters being separated by the shoulder 223. Beneath the shoulder 223 the sleeve 22' is formed with an additional shoulder 221 against which the bottom end of a second spring means 45 bears. This second spring means 45 is in the form of a coil spring coiled about the plunger 41 and abuts also against the under surface of the enlarged top end 411 of plunger 41. Spring means 45 is weaker than spring means 44 so that when the latter spring means is compressed by depression of head piece 32 the cup-shaped member 43 will move down moving the plunger 41 down and compressing the spring 45 until the top end 411 of plunger 41 engages the shoulder 223.

The shoulder 221 forms the top surface of an inwardly extending annular flange of the sleeve 22', the bottom surface of this flange engaging the top surface of a cylinder 46 into which the plunger 42 slidably extends. The bottom end of cylinder 46 bears against the bottom surface of the bore of piston 12 in which the sleeve 22' is located. As is apparent from Figs. 6–9, considerable clearance is provided in the bore of piston 12 about an intermediate portion of the cylinder 46. The piston 12 is formed with an annular hollow space 12' (Fig. 2) which serves as a reservoir for fuel. Any suitable plug closes a threaded opening through which the reservoir 12' may be filled. This reservoir communicates with an opening 46' formed in the piston 12, and this opening 46' in turn communicates with the space which surrounds the outer surface of the cylinder 46. The cylinder 46 is formed with radial bores 461 communicating with the axial bore in which piston 42 extends and with the space about piston 46 so that fuel in the reservoir 12' may flow through the bore 46' to the space about the cylinder 46 and from this space through the bores 461 into the interior of the cylinder 46. When the piston 42 moves downwardly below the bores 461, the fuel beneath the piston 42 is displaced by the latter through the bores 123 formed in piston 12 and through a non-return valve 47 to the conduit 23. As was mentioned above, the fuel then flows along conduit 23 and bores 122 to the nozzle 21.

As is most clearly shown in Fig. 9, the non-return valve 47 includes a tubular member 47*a* threaded into the piston 12 and formed with suitable bores to provide communication between conduit 23 and bore 123. A part 123' of the bore 123 is conical and serves as a valve seat for the non-return valve member 47*b*. A spring 47*c* in the tube 47*a* urges the spherical member 47*b* against its seat to close the valve 47, and in this way flow of fuel from conduit 23 to bore 123 is prevented. When the plunger 42 moves downwardly below the radial bores 461, the pressure of the fuel moves the valve member 47*b*, as viewed in Fig. 9, to press the spring 47*c*, and the valve member 47*b* in its open position rests against a plurality of ribs 47*d* extending forwardly from the right end face of the tubular member 47*a*, as viewed in Fig. 9.

The above-described injection pump operates as follows:

The falling ramming cylinder 13 strikes against the head piece 32 shortly before the ramming cylinder 13 reaches its bottom dead-center position. It will be noted from Figs. 6–8 that this head piece 32 is guided not only by the sleeve 22' but also by the inner surface of a tubular member 48 provided with outer threads and threaded into the bore of piston 12 into engagement with the top end of sleeve 22' in order to press the latter downwardly against the top of the cylinder 46. The downwardly moving ramming cylinder 13 thus moves the head piece 32 and the plunger 40 therewith downwardly from the position of Fig. 6 toward that of Fig. 7 as the ramming cylinder approaches its bottom dead-center position. During this phase of the operation, the spring means 44 is not compressed and only the weaker spring means 45 is compressed so that the top enlarged end 411 of plunger 41 moves toward the shoulder 223 while elements 40 and 43 move together without changing their relative position. This movement continues until the top portion 411 of plunger 41 engages the shoulder 223, and during this phase of the operation the piston 42 moves downwardly in the cylinder 46 from the position of Fig. 6 to that of Fig. 7 in order to displace fuel through the non-return valve 47, conduit 23, and nozzle 21. In this way a metered amount of fuel is delivered to the cylinder. After the ramming cylinder has depressed the plungers to the position indicated in Fig. 7, the ramming cylinder 13 continues to move down to its bottom dead-center position, to depress head piece 32 and plunger 40 from the position of Fig. 7 to that of Fig. 8. Since the enlarged end 411 of plunger 41 engages shoulder 223, the plunger 41 cannot move downwardly any more and therefore this plunger 41 together with the plunger 42 remains stationary during this phase of the operation, and of course the cup-shaped member 43 also cannot move downwardly. Thus, during this phase of the operation the spring means 44 is compressed and the head piece 32 moves down until its top surface is flush with the adjacent top surface of the piston 12, the bottom enlarged end 401 of plunger 40 descending into the cup-shaped member 43 from the position of Fig. 7 to that of Fig. 8. Thus, the ramming cylinder 13 can move downwardly through a short distance after the fuel is injected and just before the explosion. After the explosion takes place, the ramming cylinder is thrown upwardly as was described above, and then the elements of the injection pump 22 return to their rest position indicated in Fig. 6, the upward movement of the plunger 42 creating a suction in the cylinder 46 which draws onto the latter an additional charge of fuel to be displaced from the cylinder at the next operation.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of pile pullers differing from the types described above.

While the invention has been illustrated and described as embodied in diesel type pile pullers, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

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

1. A pile puller comprising, in combination, an elongated guide bar; a piston fixed to said guide bar at a lower portion thereof; a stop member fixed to said guide bar at an upper portion thereof; and a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder

has a top end portion thereof located next to a bottom end portion of said stop member, one of said end portions being formed with a recess and the other of said end portions having a projection extending into said recess when said cylinder is in said upper position thereof, said cylinder having an inner surface portion defining the axial bore thereof through which said guide bar slidably extends and said guide bar having an outer surface portion surrounded by and extending beyond said inner surface portion of said cylinder when the latter is in its upper position and formed with a plurality of axially extending grooves longer than said inner surface portion of said cylinder so that as said cylinder approaches its upper position air trapped between said cylinder and stop member will flow through said grooves to expel combustion gases from the interior of said cylinder.

2. A pile puller comprising, in combination, an elongated guide bar; a piston fixed to said guide bar at a lower portion thereof; a stop member fixed to said guide bar at an upper portion thereof; a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder is located next to said stop member; catch means carried by said cylinder and stop member for retaining said cylinder in its upper position, said catch means including a catch member carried by said stop member for movement between an operative and an inoperative position; and means carried by said stop member for moving said catch member between said positions thereof.

3. A pile puller comprising, in combination, an elongated guide bar; a piston fixed to said guide bar at a lower portion thereof; a stop member fixed to said guide bar at an upper portion thereof; a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder is located next to said stop member; catch means carried by said cylinder and stop member for retaining said cylinder in its upper position, said catch means including a catch member carried by said stop member for movement between an operative and an inoperative position; means carried by said stop member for moving said catch member between said positions thereof; and means carried by said stop member for yieldably resisting downward movement of said catch member.

4. A pile puller comprising, in combination, an elongated guide bar formed at a lower end portion with rib and groove means; a pair of tong supporting members located beside each other, having inner surfaces formed with rib and groove means mating with and engaging said rib and groove means of said guide bar and respectively having outer surfaces which respectively form parts of the same cone, said supporting members being adapted to carry a pair of tongs which grip a pile to be pulled; a piston formed with an axial bore through which said guide bar extends, said axial bore of said piston being partly conical and engaging said outer surfaces of said supporting members so that the latter are radially wedged by said piston inwardly toward the axis of said guide bar; a stop member fixed to said guide bar at an upper portion thereof; and a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder is located next to said stop member.

5. In a pile puller, in combination, a stop member having a bottom face formed with a recess; a guide bar having an upper portion fixed to said stop member, said guide bar extending downwardly from said stop member through said recess thereof and being formed in its outer surface with a plurality of axial grooves extending through a given distance downwardly from said stop member from the interior of said recess thereof; and a cylinder adapted to move up and down said guide bar and formed with an axial bore, shorter than said distance, through which said guide bar slidably extends, said cylinder having a top end portion shaped in correspondence to said recess to extend into and fill the latter when said cylinder is in an uppermost position in engagement with said stop member so that as said cylinder approaches said uppermost position said top end portion thereof will drive air from the interior of said recess downwardly through said grooves into said cylinder.

6. In a pile puller, in combination, a guide bar; a stop member fixed to an upper portion of said guide bar; a cylinder formed with an axial bore through which said guide bar slidably extends so that said cylinder may move along said guide bar to and from an upper position where said cylinder engages said stop member; a catch lever turnably carried by said stop member and having a free bottom catch portion located at a lower elevation than said stop member; a catch member carried by said cylinder and movable with the latter along a path intersecting said catch lever when the latter is in an operative position to engage said catch lever for maintaining said cylinder in its uppermost position; and manually operable means carried by said stop member and engaging said catch lever for moving and maintaining the same out of its operative position.

7. In a pile puller, in combination, a guide bar; a stop member fixed to an upper portion of said guide bar; a cylinder formed with an axial bore through which said guide bar slidably extends so that said cylinder may move along said guide bar to and from an upper position where said cylinder engages said stop member; a catch lever turnably carried by said stop member and having a free bottom catch portion located at a lower elevation than said stop member; a catch member carried by said cylinder and movable with the latter along a path intersecting said catch lever when the latter is in an operative position to engage said catch lever for maintaining said cylinder in its uppermost position; manually operable means carried by said stop member and engaging said catch lever for moving and maintaining the same; and spring means carried by said stop member and operatively connected to said catch lever for yieldably resisting downward movement thereof.

8. In a pile puller, in combination, a guide bar; a stop member fixed to an upper portion of said guide bar; a cylinder formed with an axial bore through which said guide bar slidably extends so that said cylinder may move along said guide bar to and from an upper position where said cylinder engages said stop member; a catch lever turnably carried by said stop member and having a free bottom catch portion located at a lower elevation than said stop member; a catch member carried by said cylinder and movable with the latter along a path intersecting said catch lever when the latter is in an operative position to engage said catch lever for maintaining said cylinder in its uppermost position; manually operable means carried by said stop member and engaging said catch lever for moving and maintaining the same out of its operative position; and spring means carried by said stop member and operatively engaging said catch lever for

yieldably maintaining the same in said operative position thereof.

9. In a pile puller, in combination, a guide bar; a stop member fixed to an upper portion of said guide bar; a cylinder formed with an axial bore through which said guide bar slidably extends so that said cylinder may move along said guide bar to and from an upper position where said cylinder engages said stop member; a catch lever turnably carried by said stop member and having a free bottom catch portion located at a lower elevation than said stop member; a catch member carried by said cylinder and movable with the latter along a path intersecting said catch lever when the latter is in an operative position to engage said catch lever for maintaining said cylinder in its uppermost position; and manually operable means carried by said stop member and engaging said catch lever for moving and maintaining the same out of its operative position, said manually operable means including a shaft turnably carried by said stop member for movement about its axis and having an outer surface portion eccentric with respect to the axis of said shaft and engaging said catch lever.

10. A pile puller comprising, in combination, an elongated guide bar; a piston fixed to said guide bar at a lower portion thereof; a stop member fixed to said guide bar at an upper portion thereof; and a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder is located next to said stop member, said cylinder having an inner surface portion defining the axial bore thereof through which said guide bar slidably extends and said guide bar having an outer surface portion surrounded by said inner surface portion of said cylinder when the latter is in said upper position thereof, one of said surface portions being formed with at least one axial groove extending along the entire length thereof so that as said cylinder approaches its upper position air trapped between said cylinder and stop member will flow through said groove to expel combustion gases from the interior of said cylinder.

11. A pile puller comprising, in combination, an elongated guide bar; a piston fixed to said guide bar at a lower portion thereof; a stop member fixed to said guide bar at an upper portion thereof; and a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion

therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder has a top end portion thereof located next to a bottom end portion of said stop member, one of said end portions being formed with a recess and the other of said end portions having a projection extending into said recess when said cylinder is in said upper position thereof, said cylinder having an inner surface portion defining the axial bore thereof through which said guide bar slidably extends and said guide bar having an outer surface portion surrounded by said inner surface portion of said cylinder when the latter is in said upper position thereof, one of said surface portions being formed with at least one axial groove extending along the entire length thereof so that as said cylinder approaches its upper position air trapped between said cylinder and stop member will flow through said groove to expel combustion gases from the interior of said cylinder.

12. A pile puller comprising, in combination, an elongated guide bar; a piston fixed to said guide bar at a lower portion thereof; a stop member fixed to said guide bar at an upper portion thereof; and a cylinder formed with an axial bore through which said guide bar slidably extends and located on the latter between said piston and stop member, said cylinder being slidable along said guide bar from a bottom position, where said piston is located completely within said cylinder to create an explosion therein for throwing said cylinder upwardly along said guide bar into engagement with said stop member, to an upper position where said cylinder has a top end portion thereof located next to a bottom end portion of said stop member, one of said end portions being formed with a recess and the other of said end portions having a projection extending into and substantially filling said recess when said cylinder is in said upper position thereof, said cylinder having an inner surface portion defining the axial bore thereof through which said guide bar slidably extends and said guide bar having an outer surface portion surrounded by said inner surface portion of said cylinder when the latter is in said upper position thereof, one of said surface portions being formed with at least one axial groove extending along the entire length thereof so that as said cylinder approaches its upper position air trapped between said cylinder and stop member will flow through said groove to expel combustion gases from the interior of said cylinder.

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