

July 29, 1941.

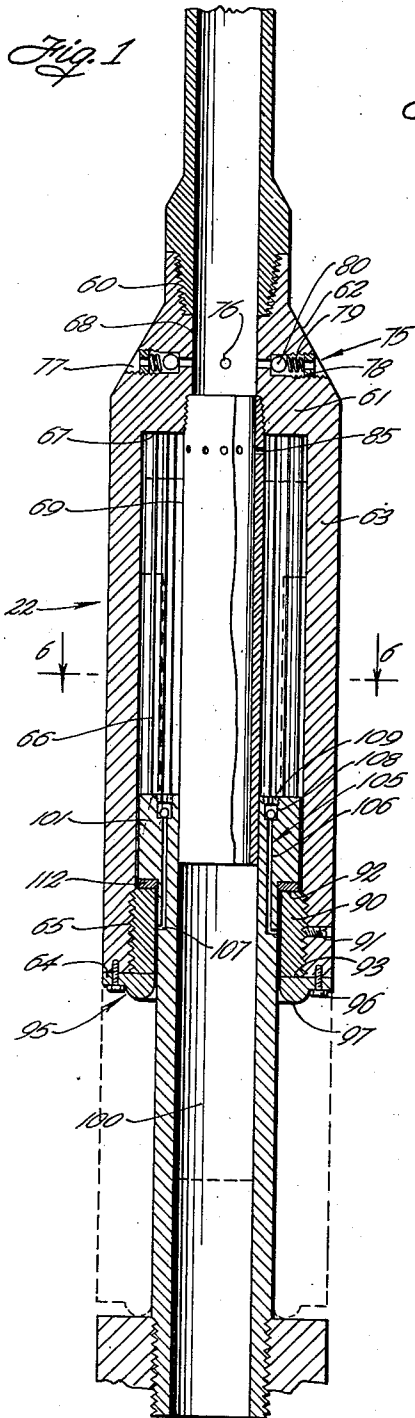
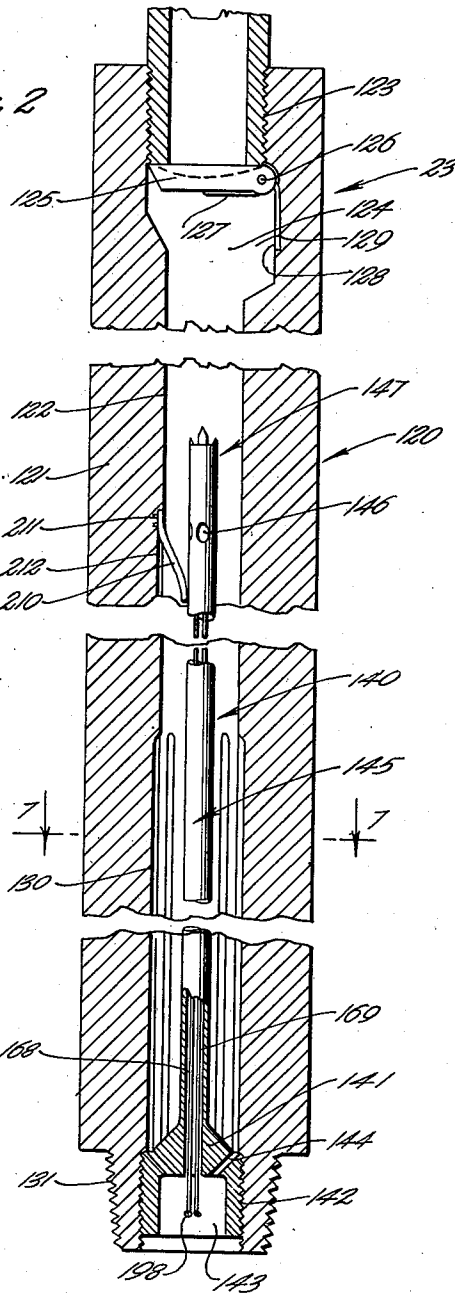
E. W. DODGE

2,250,574

EXPLOSIVE ROTARY JAR FOR DEEP WELL EQUIPMENT

Filed March 1, 1939

3 Sheets-Sheet 1



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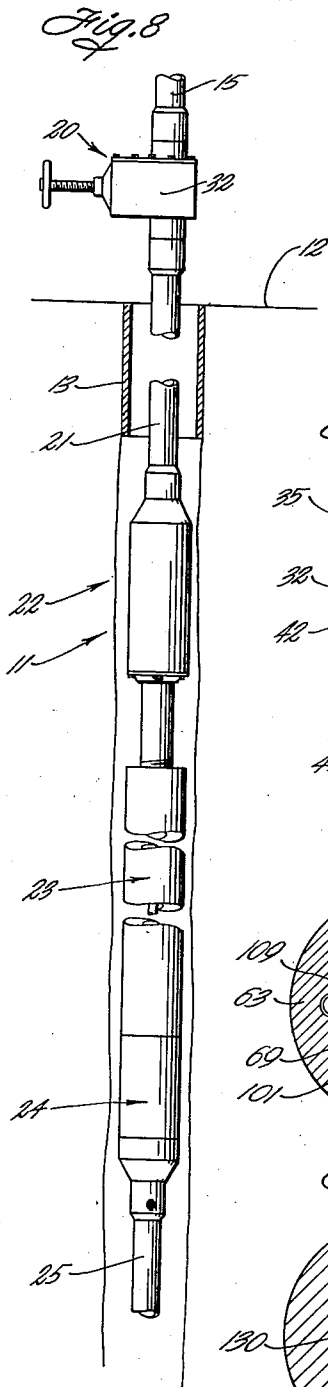
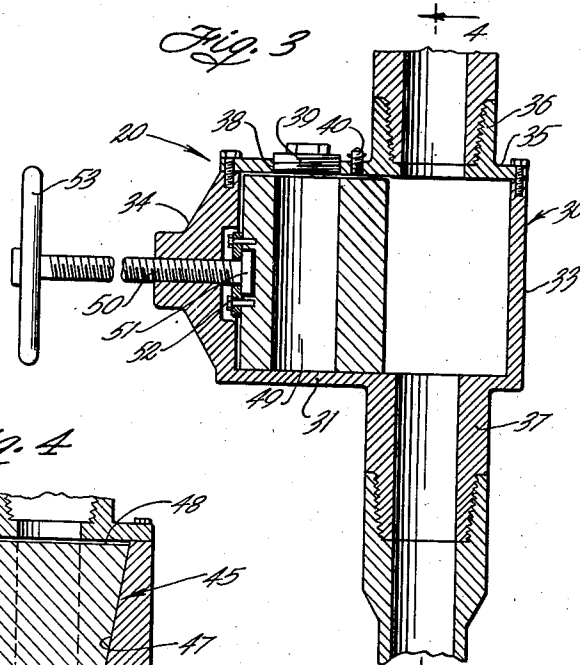
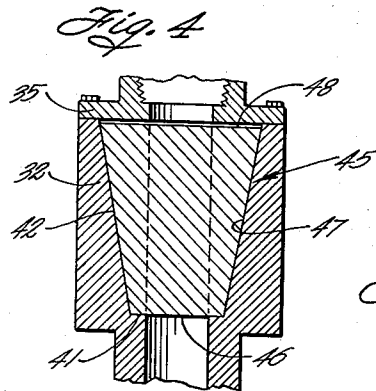
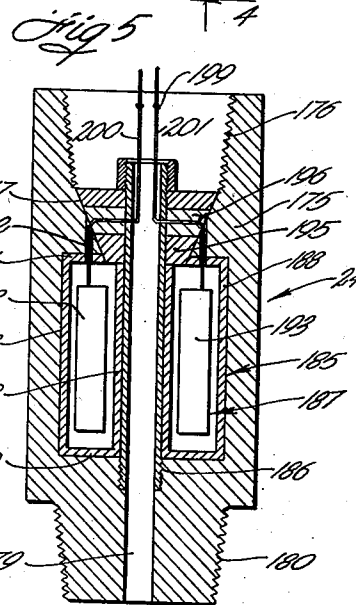
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EXPLOSIVE ROTARY JAR FOR DEEP WELL EQUIPMENT

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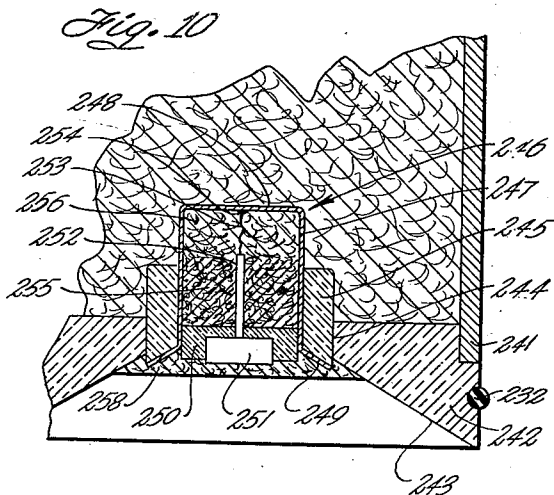
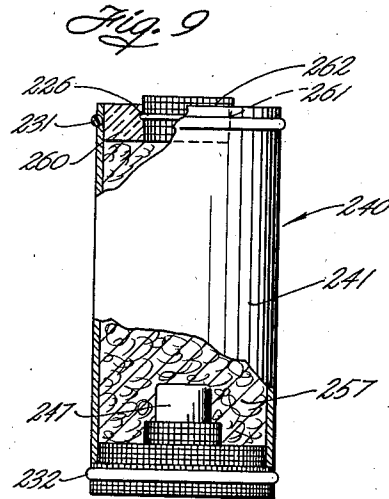
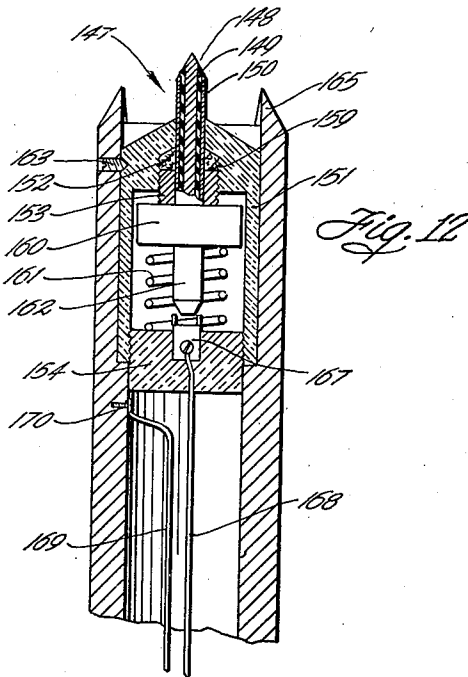
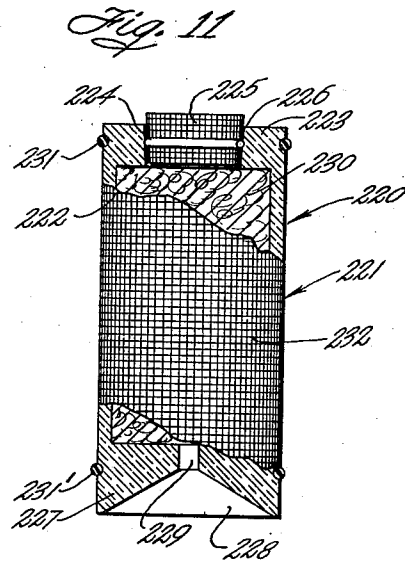
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EXPLOSIVE ROTARY JAR FOR DEEP WELL EQUIPMENT

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,250,574

EXPLOSIVE ROTARY JAR FOR DEEP WELL EQUIPMENT

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Application March 1, 1939, Serial No. 259,152

26 Claims. (Cl. 255—27)

My invention relates to jars of the type used in rotary hydraulic drilling of deep wells in which the jars are used to loosen or disengage tools stuck or as designated in the trade "frozen" in the well or tools which are partly caught in the well as by a sanding up, etc. and are somewhat difficult to remove, and also in the removal of well casing. There are many types of mechanically actuated jars utilized for this purpose. Most of these operate on the principle of exerting an upward pull on the drill string to cause a decided tension in the string of drill pipes. While under tension a rotary strain or torque is also developed as by the rotary table at the top of the well, then by a trip action and release one of the elements under tension gives an upward stroke with an upwardly directed hammer-like action producing the jarring blow.

In contradistinction to these types of jars my invention comprehends the use of an explosive in my particular type of assembly of jars, and the force of the blows delivered while the upward pull is at its maximum and such jars being inserted in the string of tools above the portion of the drilling equipment to be removed. Then on the discharge of the explosive an exceedingly high pressure is directed downwardly through the hydraulic fluid. This causes a discharge at the bottom of the tool under exceedingly high pressure and giving an upward or jarring action on the assembly of tools caught in the well and producing an upward movement of the lower movable element of the explosive operated jar.

In view of the fact that more than one explosive may be necessary and in fact quite a large number would usually be needed another feature of my invention includes an equipment for charging explosive cartridges into a string of drill pipe and having these carried downwardly by the downward flowing hydraulic fluid in its circulation under pump pressure. This involves an equipment of a valve by which the cartridge may be inserted and bodily moved until in alignment with the flow of the slushing fluid, that is, in vertical alignment with the string of drill pipe and then is carried downwardly by the slushing fluid. This necessitates a valve which may be closed and sealed against the high pressure of the hydraulic fluid.

Another feature of my invention involves the construction of an explosion and firing chamber for the cartridges in which a firing pin is centrally positioned and causes the ignition of the cartridge dropping and forced downwardly by the hydraulic fluid. Above this chamber I em-

ploy a check valve, this being normally opened when the fluid is circulating downwardly but which becomes closed due to the pressure of the explosion which manifestly exerts a force both upwardly and downwardly and when the check valve is closed there is no upward flow of the slushing mud and the flow of slushing mud is directed downwardly under exceedingly high pressure.

My invention has further characteristics in the type of cartridges used. Where the hydraulic pressures are more or less moderate I use a cartridge of a type which is blown to pieces and made of such material and constructed so that the shell of the cartridge breaks up into a multitude of small pieces which are carried out by the slushing fluid. If the natural flow of this fluid by a pumping does not completely carry out the disintegrated cartridge the remaining particles are blown out with the slushing fluid on the succeeding explosions.

My invention also comprehends a type of electrically discharged cartridge designed principally for use at great depths where the hydraulic pressure is very great. In this case the shell of the cartridge is made of a substantial tube but in both type of cartridges the ends may blow out. In the electrically fired construction the jar in the lower portion is provided with a sealed in electric battery with electric leads extending to the firing pin and firing equipment, this being so designed together with the base of the cartridge as to cause an explosion when the cartridge strikes the firing pin. As the tubing type of shell does not destroy the tubing I provide a space below the firing chamber for the accumulation of the discharged cartridges, this being done by mounting the firing pin on a long pipe with an annular space between such pipe and the wall of the barrel part of the explosion chamber.

A further feature and characteristic of my invention is that I provide for a rotary drive between the upper and lower parts of the jar which have relative longitudinal movement in order to carry the rotational torque from the rotary table at the top of the well to the drill bit or other tool at the bottom and I also provide for a complete flow of the circulating fluid and during the period of explosion for the release and outward flow of the fluid above the explosion chamber. My invention also comprehends devices for admitting hydraulic fluid to the jar and a string of drill pipe in order that this may not enter the hole dry but may become filled with

the slushing fluid as the equipment descends in the well.

As jars are frequently employed to remove tubular tools or equipment from a well such as drill pipe with drill bits stuck in the well and frequently designated as a "fish" and also for removing casing, the equipment below the jar proper and below the explosion chamber may be directly connected to the tubular tools such as drill pipe and casing, therefore the liquid below the explosion chamber is forcefully discharged downwardly through the tubular structure below the explosion chamber and through the tubular "fish" such as drill pipe or the casing and thus produces a violent upward flow through the material freezing the "fish" in the well hole or adjacent the formation in the casing to be removed.

My invention is illustrated in connection with the accompanying drawings, in which:

Fig. 1 is a vertical diametrical section of an upper portion of the jars.

Fig. 2 is a similar diametrical section continuing with the lower portion of the jars, there being a partial overlap of Figs. 1 and 2.

Fig. 3 is a vertical diametrical section of a cartridge injection or insertion valve located above the ground level and illustrated connected to a string of drill pipe.

Fig. 4 is a detail section on the line 4—4 of Fig. 3 with the plug of the valve in a partial valve closing position.

Fig. 5 is a vertical diametrical section showing an electric battery assembly connected to the bottom of the lower portion of the jars.

Fig. 6 is a horizontal section on the line 6—6 of Fig. 1 in the direction of the arrows.

Fig. 7 is a horizontal section on the line 7—7 of Fig. 2 in the direction of the arrows.

Fig. 8 is an elevation assembly drawing with various parts broken illustrating in diagram the jars as inserted in the well.

Fig. 9 is a side elevation partly broken away of one form of cartridge for operating at great depths where the pressure is excessive, such cartridge being of a type to blow out at the ends.

Fig. 10 is an enlarged diametrical section through the ignition devices of the cartridge of Fig. 9.

Fig. 11 is a side elevation partly broken away of another form of cartridge of suitable and lesser depths and pressures and of a type entirely disintegrating under the action of explosion.

Fig. 12 is a vertical diametrical section of the upper end of the firing rod and the firing pins.

Referring first to the construction as illustrated in Fig. 8, the well bore is indicated by the numeral 11 extending downwardly from the ground surface 12 and there being a casing 13 extending partly downwardly into the well. Manifestly the horizontal measurements are considerably greater than the vertical to give an adequate illustration. Employing the jars as in my invention an upper length of drill or equivalent pipe 15 is by the common practice suspended by the well derrick by cables or the like so that an upward pull may be given on the whole assembly and also by means of a swivel such as well known in the art a connection is made for pumping the hydraulic slushing fluid downwardly through the drill pipe and system to the end of the drill string and a tool mounted thereon. An injection valve 20 is also located above the ground level and this is connected to the string of drill pipe, the connection being illustrated in Figs. 3

and 4. Connected below the valve there is a string of drill or other pipe designated 21 to which is connected the upper portion of the jar 22 and suspended below the upper portion there is the lower portion 23 which may telescope upwardly into such upper portion. Attached to the bottom end of the lower portion of the jar I provide the electric battery sub 24. 25 illustrates a string of drill pipe or the equivalent which leads downwardly to the tool or the other well equipment to be removed from the well. This may have fishing tools attached thereto where it is necessary to remove the tools or articles from the well by a fishing operation.

Considering the various elements in detail, the valve 20 has a valve housing designated 30, this presenting a bottom wall 31, two similar sides 32, an end wall 33, a front wall 34 and a removable cover or top 35. The cover has preferably formed integral therewith a threaded box 36 for threading the assembly on the drill string or pipes 15. Also formed integral with the bottom wall 31 there is a stub pipe 37 illustrated as having a threaded end to have a threaded engagement with the drill string 21. The cap has a cartridge inserting opening 38 which is tightly closed by a removable plug 39. There is also a grease applying fitting 40 preferably attached to the top.

The cross sectional shape of the valve housing presents a flat bottom 41 and inclined opposite sides 42, the inside of the top also being flat. The valve plug designated by the assembly numeral 45 is made of the same cross section as the inside of the housing, this plug therefore having a flat bottom surface 46 with two similar inclined surfaces 47 and a flat top 48. There is a vertical cartridge receiving opening 49 through the plug from top to bottom. The plug is moved in the housing by means of a threaded valve stem 50, this being threaded through an opening in the front end 34. A circular head 51 is mounted in a recess in the inner end of the plug and this head retained in place by a ring 52 attached to the plug by screws or the like. A hand operated wheel 53 is utilized to move the plug.

In view of the tremendous hydraulic pressure developed by the slushing fluid being pumped downwardly through the drill string, the jars and hence through the valve 20, it is necessary to have a tight seal at the plug but yet allow this to move with sufficient freedom. Therefore grease is forced in under high pressure through the grease applying fitting 40 and forms a film tightly packed at all of the contact surfaces of the plug with the housing and especially filling the slight space between the top of the plug and the removable top of the housing. Therefore the plug 39 may be unthreaded from the opening 38 and with the plug in the retracted position a cartridge may be inserted through the opening 38 into the cartridge receiving opening, the lower end of the cartridge resting on the flat bottom 31 of the housing. The plug 39 is then replaced and the valve may be moved from the position of Fig. 3 to align the cartridge from the tubular drill string and the pipe section 37. The downward flowing slushing fluid then carries the cartridge with it. A movement of the plug and cartridge may be done so rapidly that there is very little interruption of the flow of the slushing fluid however if desired for the short time that the plug intersects the line of flow of the slushing fluid the pumps may be stopped. When the

cartridge is discharged downwardly the plug is again retracted to its inactive position of Fig. 3.

As above mentioned the lengths of drill pipe 21 are connected by a threaded joint to the threaded end of the pipe 37 of the cartridge injection valve. This length of pipe may be as long as desired and necessary and has attached to the bottom end thereof the upper portion 22 of the jars. This upper portion may be considered as the channel part of the jars and is illustrated with a box construction 60 connected by a threaded joint to the bottom end of the string of drill pipes. There is a substantial shoulder portion 61 preferably with a cone shaped slope 62 on the exterior. A heavy depending skirt 63 has a transverse lower end 64 and has an interior screw threaded portion 65 adjacent the bottom. Extending above this on the inside there is a fluted or splined section 66 extending to the top shoulder 67. The shoulder portion has a large diameter bore 68 preferably equal to that of the drill pipe and by means of a screw threaded connection a guide pipe 69 is threaded in the shoulder portion. There are a series of adjustable check by-pass valves 75, each of which is illustrated as having a port 76 communicating with the bore 68, a threaded enlarged recess 77 leading to the outside together with an adjusting threaded ring 78, a complete spring 79 and a ball 80 forming normally a seal against the port 76. These are set so that in the normal operation the pressure of the slushing fluid being forced downwardly does not open these check valves, however when the downward flow of the slushing fluid is stopped by the explosive action hereunder described these check valves open and allow discharge of the slushing fluid, thus the pumps may continuously operate. The guide pipe 69 is also provided with a series of ports 85 which communicate with the annular space between such guide pipe and the inside of the skirt 63, that is, at the fluted section and open to the interior of the guide pipe. A thrust ring 90 is threaded exteriorally and cylindrical on its inside surface. This has a threaded engagement with the internal threads 65 on the skirt. A set screw 91 retains this collar in place. It preferably has a transverse upper surface 92 and also a transverse lower surface 93, this latter being in alignment with the bottom surface 64 of the skirt. A composition packing 95 is attached to the lower edge 64 of the skirt as by screws 96. This has a substantially half circle rim 97. This composition may expand and become distorted under pressure and provides a fluid seal for the circulating fluid when the jars are in their collapsed or contacting position, that is, when the lower jaw element hereunder described contacts the composition ring 95. The lower portion 23 of the jars has a tubular shank 100, this being cylindrical on its outside surface and having a bore preferably slightly greater than the bore 86. The inside bore is cylindrical so that the lower end of the guide pipe 69 extends therein and the shank may be driven up over this guide pipe. The shank has an enlargement or head 101 which is fluted or splined on the outside to fit the internal splined or fluted section 66 of the skirt 63. Inflow check valves 105, of which there are a series, include fluid ducts 106 extending vertically through the head 101 and having an intake port 107 which when the jars are in the position of Fig. 1 is covered by the collar 90. However, there is sufficient space between such collar 90 and the outside of the shank 100 for the inflow of slushing fluid. A ball check

valve 108 is retained in place by a ring 109. These check valves 105 are for the purpose of allowing an inflow of slushing fluid while the drill string and jars are being lowered into a well in order to lower the equipment so that it becomes filled with fluid instead of flowing this in dry or empty. The ports 85 in the guide pipe are for discharge or bleeding of the slushing fluid trapped in the fluted annular space inside of the skirt. A bronze packing ring 112 is mounted at the lower end of the head 101 of the shank and seats on the upper surface 92 of the collar 90. This is for the purpose of forming a fluid seal when the jars are under an upward strain and as they are being lowered into the well.

The shank 100 has a screw threaded connection with the gun portion 120 of the lower or male part of the jars. This gun portion has a heavy wall structure indicated at 121. It is preferably cylindrical on the outside surface and has a cylindrical bore 122. The shank has the threaded connection 123 to the upper part of this gun structure. A large recess 124 forms an enlargement of the bore 122 and provides for the movement of a flap valve 125, this being hinged on the pintle 126 which may be driven through the wall structure 121. A spring 127 has a thrust end 128 engaging one side of the recess and urges the flap valve to its closed position. This flap valve seats against the lower part of the shank 100 at its screw threaded connection 123 and forms a complete closure when in the closed position of Fig. 2, however this valve is curved and so shaped that when forced downwardly to fit in the lateral portion 129 of the recess, there is sufficient room for the cartridge to completely pass the flap valve. The spring tension urging this valve closed is however not sufficient to stop the flow of the slushing fluid, as such fluid being forced downwardly under pump pressure maintains the flap valve open a sufficient amount for the proper flow of slushing fluid. The lower portion of the bore 122 of the gun structure has a series of relatively deep longitudinal grooves 130, these being quite long and depending upon the length of the gun structure. The bottom of the gun structure is shown as having a threaded pin joint 131 for attachment to the electric battery sub 24 which is described in detail hereunder.

The firing rod assembly 140 has a substantial block base 141 externally threaded and with a threaded support 142 on the interior of the hollow gun structure preferably adjacent the pin joint 131. This head has a recess 143 extending upwardly from the bottom and is provided with a plurality of slushing fluid discharge ducts 144, these being of sufficient number and size to accommodate the downward flow of the slushing fluid and positioned to communicate with the deep grooves 130. A tubular firing rod 145 extends upwardly from the block 141, this being of considerable length and having perforations 146 to accommodate a portion of the downward flow of the slushing fluid. There is a central firing assembly 147 which is illustrated in detail in Fig. 12. This includes a pointed firing pin 148 encased in an insulating sleeve 149, the latter being surrounded by a metal sleeve 150. This is slidable through an opening in the cap of an insulated sleeve 151 which is mounted in a recess in the upper part of the tubular firing rod 145, the sleeve 151 being seated on a shoulder. A packing 152 and packing gland 153 form a liquid tight seal. A plug 154 is threaded into the lower end of the sleeve 151, thus there is a chamber

within the sleeve which is filled with oil. A collar 160 is secured to the sleeve 150 of the firing pin and forms an abutment with the compression spring 161, this reacting against the plug 154. The firing pin has a downward conducting extension 162 for purposes hereunder described. A set screw 163 retains the sleeve 151 in place and from rotation. The firing rod 145 has its upper end shaped into two diametrically opposite piercing prongs 165. When the firing of the cartridge is done electrically the plug 154 which is made of insulating material is provided with a contact plate 167 with an electric lead 168 extending downwardly. Another lead 169 is connected to a terminal 170 to the pipe. The sleeve 151 including the cap 153 is of non-electrical conducting material so that the center firing pin 153 is electrically insulated from the prongs 165.

The battery sub 24, note particularly Fig. 5, has the following details. This is provided with a substantial body structure 175 which has its upper end forming an internally threaded box 176, this being screw threaded on the pin 131 of the lower jar section 23. Below the box there is a downwardly and cone-shaped taper surface 177 and below this a large hollow space 178 for the battery. A slushing fluid duct 179 extends downwardly through the block and the lower end is illustrated as having an external pin thread 180.

The battery assembly and electrical connections designated 185 includes an insulating sleeve 186 which is illustrated as threaded in the block below the large space 178 and in alignment with the duct 179 and this sleeve extends upwardly into the box 176. There is an annular insulating battery liner 187 which has an outside wall 188, an inside wall 189 forming a snug fit with the sleeve 186, an annular base 190 and a cap 191. The electrodes 192 and 193 of the battery are suitably mounted in the battery chamber and this contains an acid solution. An insulating plug 195 is tapered and fits the inside tapered surface 177. This plug has a tight fit at an annular opening in the cap 191 and on the upper edge of the inner wall 189. The plug has a passage 196 filled with insulating material and is snugly held in place by a collar 197 threaded on the sleeve 186 and exerting a downward thrust on the plug. The electric leads designated 168 and 169 of Fig. 11 extend downwardly into the recess 143 and have connectors 198 at the ends. There is a certain slackness of the electric lead so that these connectors are attached to complementary connectors 199 on leads 200 and 201 which extend downwardly from the box 176, note Fig. 5, part of the length of the sleeve 186, then these diverge through perforations in the sleeve, extend outwardly through the packing 196 and extend through perforations 202 in the block 175. Such perforations are filled with electrically insulating material. The electric leads of course are thoroughly insulated. Thus when the various parts are assembled there is an electrical connection from the electrodes of the battery upwardly to the firing pin assembly.

To use one form of shell I make provision of a series of leaf springs 210 having their upper ends secured as at 211 in recesses 212, these being formed in the bore 122 of the heavy wall structure 121. These springs are secured at the top and are located below the top of the firing rod, the purpose being to catch the cylindrical part of one type of the shell and allow these to drop past the springs and stack one above an-

other from the block 141 upwardly around the firing rod.

I illustrate two forms of cartridges, the type presented in Fig. 11 and designated by the numeral 220 which is of a shattering type. This includes the explosive case 221 which has a cylindrical wall 222, a cap 223 with a tapered opening 224. A plug 225 is fitted in this opening and has a ring gasket 226. The base 227 is conical on its lower surface 228 and is provided with a perforation having a percussion cap 229 therein. The explosive indicated at 230 fills the explosive case. Sealing rings 231 and 231' are fitted in annular grooves in the wall of the explosive case, these being for the purpose of having a close fit in the receiving opening 49 of the valve and to have a relatively close fit in the string of drill pipes so that the cartridge is positively forced downwardly by the flow of the slushing fluid. The cartridge has its exterior surfaces checked as indicated at 232 and the whole of the case as well as the plug 225 is made of a composition which on discharge of the explosive shatters into small pieces, these being sufficiently reduced in size so that they may be washed out, through the perforations 146 in the hollow filing rod 145 and through the fluid discharge ducts 144 in the base 141. The cartridge is fired by being forced downwardly by the downward flow of the slushing fluid through the flap valve 125 and the percussion cap 229 striking the firing pin 148. The two prongs 165 function to center the cartridge as they may engage the conical bottom 228. Of course in the mounting of the firing pin this may be driven down slightly against the action of the compression spring 161 but it is brought to a stop against the contact plate 167.

The non-disintegrating cartridge designated by the assembly numeral 240, note Figs. 9 and 10, has a brass or copper cylindrical shell 241 with a composition base 242 secured thereto, this base having a conical bottom surface 243 terminating at a circular opening 244. An electrical non-conducting sleeve 245 is fitted in this recess and snugly fitted to the sleeve is an inverted conducting cup such as of copper 246, this having a cylindrical wall 247, a top 248 and a flared flange or rim 249. A non-conducting plug 250 is fitted in the open mouth of the cup and this has fitted therein a central contact 251 made in the form of a disk with a conducting pin 252 extending upwardly through the plug and into the cup. This center plug contact is connected by a fusible wire 253 connected from the conducting pin to the closed top 248, being preferably connected by solder 254 or the equivalent. The cup is filled in the lower portion with a fulminating compound 255 and above this with meal gun-cotton or the like 256. The remaining portion of the cartridge is filled with the explosive powder 257. A plastic 258 forms a seal at the bottom of the cup, that is, covering the plug 250, the contact 251, the flared rim 249 and extending to the coned surface 243 of the bottom 242. The upper end of the cartridge has a composition cap 260 with a tapered opening 261 in which is inserted a removable plug 262, there being a ring gasket 226 forming a seal between the opening 261 and the plug 262 similar to the construction of Fig. 11. There are also sealing rings 231 and 232 similar to Fig. 11.

A manner of operation and functioning of the cartridge of Figs. 9 and 10, which as above mentioned is specially designed to operate at great

depths where the hydraulic pressure is very high, therefore this is a stronger cartridge than that of Fig. 11. This cartridge is inserted through the injection valve at the top of the assembly, is carried down by the slushing fluid, forced through the flap valve 125 and strikes the top of the firing rod 145. The firing pin 148 penetrates the plastic composition 258 and forms an electric contact with the central contact 251. The two piercing prongs 165 of the firing rod also perforate this plastic and contact the flange 249 which as above mentioned is of conducting material. The firing pin is forced downwardly against the action of the spring 161, note Fig. 12, bringing the lower end 162 into engagement with the contact plate 167. As above mentioned this contact plate is connected by a wire 169 to the electric battery and by means of an electric lead 169 and the terminal 170, an electrical connection is made to the firing rod adjacent its upper end. An electric circuit is therefore completed, the sharp points of the firing pin and the prong becoming slightly imbedded in the contact 251 and the flange 249 through the pin 252 and the fusible wire 253. This wire may be made of iridium and platinum. It need not fuse but it becomes white hot and incandescent when the electric current passes therethrough, thereby igniting the meal gun-cotton 256 which in turn explodes the fulminating compound 255 and both of these destroy the cup 246 and ignite the powder or other explosive 257 in the cartridge. Both ends of the cartridge blow out and being made of a composition and the plug 262 also being made of a composition, disintegrate under the action of the explosion. The cup is also destroyed as is the insulating sleeve 245, the central contact 241 is likewise blown to pieces, the only parts being left intact of this cartridge is the copper or bronze shell or cylinder 241. This drops downwardly after the explosion fitting over the firing pin 245, the first shell resting on the bottom block 241. In succeeding explosions of the following shells, these hollow sleeves of the cartridges also stack up in the annular space between the firing rod 145 inside of the enlarged bore 122 of the heavy walled structure 121.

The action of the explosion with either type of shell is substantially as follows: There is an immediate back pressure on the slushing fluid which normally flows downwardly through the flap valve 125, the spring being normally insufficient to retain this closed against the pressure of the flowing fluid but the back pressure closes this valve and prevents an upward flow of the slushing fluid. This fluid is therefore under extremely high pressure and is driven downwardly, some of this flowing through the ducts 144 in the block base 141 and thence downwardly through the tubular space in the battery assembly unit 24. As above mentioned this central duct is formed by the insulating sleeve 186 and the duct 179, the slushing fluid then being driven downwardly through the string of drill pipe 25 to the tool or other equipment to be removed from the well. As this downward discharge of the slushing fluid is at very high pressure, together with the upward reaction, causes an upward movement of the lower part 23 of the jars relative to the upper part 22 which is suspended by the string of drill pipe or the like. This produces an upward movement of the shank 100 together with its head 101 in the chamber inside of the skirt 63. Due to the flutes and splines 66 in the skirt 63 and the complementary flutes or

splines in the head 101, there is a straight vertical movement. This causes a high pressure on the fluid trapped in the skirt and causes this to flow inwardly through the ports 85 in the guide pipe 69.

At the instant that the flap valve 125 closes there is a resistance to the downward flow of the slushing fluid which is actuated by the pumps at the top of the well and this forces the bypass check valve 75 to open, allowing a discharge of the slushing fluid into the bore of the well outside of the assembly. The slushing liquid which is also forced inwardly through the ports 85 also flows outwardly through the check valves. Of course a certain amount of this liquid trapped in the skirt is forced downwardly on the outside of the head 101 and between the shank 100 and the collar 90. It is not intended that there be a hammer blow between the head 101 and the top shoulder 67 of the skirt or between the composition packing 95 and the upper end of the heavy walled structure 121 of the lower part 23 of the jars, however, when these parts occupy the dotted line position of Fig. 1, the composition ring expands and provides a fluid seal for the circulating fluid so that the flow is downwardly through the center elements and thence to the tool.

The purpose of the grooves 130 in the lower portion of the heavy walled structure 121 is to give sufficient cross sectional area for the downward flow of the slushing liquid when a number of the copper cylinders or shells 241 of the cartridge are stacked one on top of the other extending upwardly from the block base 141. The various ducts and grooves are proportioned to give adequate area for the downward discharge of the slushing fluid. It will be seen therefore that by the use of explosives and by my construction of jars, forcible upward reactions may be developed in regard to the tools or other equipment to be loosened and removed from a well or for any other purpose for which a jar may be utilized.

The string of drill pipe 25 in some classes of work such as in a fishing job involving drill pipe with drilling tools frozen in the well may be attached directly to the frozen drill string, this being sometimes done by the direct threading or attaching equipment. Where it is desired to remove casing, the drill string 25 may also be connected to such casing, hence on account of the frozen drill pipe or tubing being tubular and the casing also being tubular, the surge of liquid downwardly through the pipe 25 continues through the tubular "fish" or the casing. This downward surge and flow of the liquid under high pressure is operative to loosen the material such as sand or other wedging formation which freezes the "fish" in the well. Such material is therefore loosened and to a great extent washed out facilitating the removal of the "fish". Where the equipment is used to remove casing this violent downward discharge of the liquid at the bottom of the casing is operative to loosen the casing from the well hole and thus facilitate its further loosening and lifting by the jar.

Various changes may be made in the details of the construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. In a device as described the combination of an upper hollow jar structure and a lower complementary tubular jar structure having a

telescoping mounting in the first jar structure, means to lower a cartridge having explosive through the first and into the second jar structure, means in the second structure initiating the explosion of the cartridge.

2. In a device as described and claimed in claim 1, means to flow a slushing fluid downwardly through the jar structures and means in the second jar structure to restrict the upward flow of the slushing fluid under the influence of the explosion of the cartridge.

3. In a device as described and claimed in claim 1, the means to lower the cartridge including a cartridge injection valve with a valve plug having a cartridge receiving opening, means to move the plug from a position having the opening to one side of the axis of the jar structures to alignment therewith and a connection of piping leading from the valve to the first jar structure.

4. In a device as described the combination of an upper hollow jar structure having means for connection to a string of drill pipe at the top and being provided with a depending skirt with an internal collar and a guide pipe centered as to the skirt, the lower tubular guide structure having a shank with a head telescopically mounted in the skirt, a firing pin mounted in the lower structure and positioned to cause the explosion of a cartridge passing downwardly through the guide pipe and the shank to engage the firing pin.

5. In a device as described and claimed in claim 4, the lower jar structure having a connecting means for a lower structural element leading to a tool and passages for the flow of slushing fluid through the shank adjacent the firing pin and communicating with the lower structural element and a check valve operative to close and prevent the upward flow of slushing fluid on the explosion of a cartridge by the firing pin.

6. In a device as described and claimed in claim 4, the upper jar structure having outlet check valves for the flow of slushing fluid and the lower jar structure having a check valve closeable on the explosion of a cartridge whereby the slushing fluid flowing downwardly through the drill pipe is discharged at the outlet check valves.

7. In a device as described and claimed in claim 4, the firing pin being mounted on a firing rod and such rod supported by a base block attached to the lower portion of the lower jar structure, there being ducts for the flow of slushing fluid downwardly through the lower portion of the lower jar structure adapted to transmit a flow of the slushing fluid to a tool or the like connected to the jars.

8. In a device as described and claimed in claim 4, a cartridge injection valve mounted on the top of the drill string and having a clear passage for the flow of slushing fluid, a slidable plug having a cartridge receiving opening, the valve having means for inserting a cartridge in such opening, the valve plug being shiftable to align the cartridge opening with the clear passage for the slushing fluid whereby the cartridge is carried downwardly by the flow of the slushing fluid.

9. In a device as described and claimed in claim 4, the firing pin being mounted on a firing rod with means connecting such rod to the lower portion of the lower jar structure, electrical contact means connecting with the firing pin for igniting a cartridge which strikes the firing pin, there being an annular space between the firing rod and a wall structure of the lower jar structure to provide for stacking up of portions of the exploded cartridges.

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10. In a device as described the combination of an upper portion of a jar having means constructed and adapted for connection to a string of drill pipe whereby such jar portion may be suspended in a well, the upper jar portion having a skirt with an internal collar and having a guide pipe concentric with the shell and alignable with the string of drill pipe, a lower jar portion having a tubular heavy wall with a shank extending upwardly therefrom, said shank being slidable through the collar, a head on the shank within the skirt, such skirt and head having rectilinear guide means, a firing rod having a firing pin located in the lower jar portion with means connecting the firing rod to a lower part of the said heavy wall, there being ducts for the downward flow of slushing fluid in the heavy wall of the lower jar portion with means for communicating the flow of slushing fluid to a tool or the like connected to the lower jar portion and means to insert a cartridge in the suspending drill pipe to be carried downwardly by the flow of the slushing fluid, such downward movement of the cartridge bringing the cartridge in contact with the firing pin.

11. In a device as described and claimed in claim 10, the lower portion of the jar having an upwardly closing check valve above the firing pin constructed and adapted to allow a downward flow of the slushing fluid and downward passage of the cartridge but to prevent upward flow of slushing fluid under the action of the explosion of the cartridge, the guide pipe being provided with ports communicating with a space between the said skirt, the wash pipe and the head on the shank whereby on the relative telescopic movement of the said shank and head in relation to the skirt and fluid trapped in said skirt is forced inwardly through the said ports to the guide pipe and outwardly reacting check valves in the upper portion of the jar operative to open for the continued flow of the slushing fluid.

12. In a device as described, the combination of tubular telescopically connected upper and lower jar structures constructed and adapted for suspending in a well and for connection to a tool, such jar structures having ducts and spaces to be filled with a liquid and means to explode an explosive in the lower jar structure and thereby exert an expulsive force on the liquid.

13. In a device as described and claimed in claim 12, an upwardly reacting check valve in the lower jar structure constructed and adapted for a downward flow of liquid to fill the jar structures and adapted to form a closure against the upward flow of the liquid under the pressure of the explosion.

14. In a device as described the combination of telescopically arranged tubular upper and lower jar structures, the upper structure having means for suspension by a pipe in the well and the lower structure having means for a tubular connection to a tool, means to flow a liquid downwardly through the jar structures to a tool, means to discharge an explosive in the lower jar structure and a pressure reacting means to prevent upward flow of the liquid in the lower jar structure under the pressure developed by the explosion whereby the liquid is forced downwardly towards the tool.

15. In a device as described, an upper and a lower tubular jar structure having a telescopic connection, the upper structure having means for suspension in a well by a pipe and a lower

structure having means for a tubular connection to a tool, a firing rod having a firing pin located in the lower structure, the pin pointing upwardly, a cartridge having an explosive therein and having a confining means therefor which shatters on explosion, there being ducts and passages for the downward flow of a liquid whereby a liquid forced downwardly through the tubular jars discharges the shattered portion of the cartridge.

16. In a device as described and claimed in claim 15, an electric battery with a supporting connection from one of the jar structures and an electrical connection to contacts, one of which being the firing pin, the cartridge having an electrical igniting element and electrical conductors to close a circuit on engaging the contacts of the firing pin.

17. In a device as described a cartridge having a composition wall constructed and adapted to shatter into small pieces, an explosive therein, a percussion cap, a guide means to guide the cartridge in a vertical drop, a firing pin positioned to engage the percussion cap whereby the cartridge may be exploded, there being passages for the downward flow of a liquid and the discharge with the liquid of the shattered cartridge.

18. In a device as described, the combination of a cartridge having a shell with destructible base and cap connected thereto, an inverted conducting cup mounted in the base and having a rim forming an electric conductor, a central contact with a conducting element extending into the cup, the cup containing an igniting explosive and the shell containing the main explosive, and a firing pin assembly including a central pin and at least one piercing prong with electrical connections to the central pin and the prongs whereby on contact of the central pin and prongs with the central contact and the rim of the cup, an electric circuit is completed as to the said cup and the igniting explosive therein.

19. In a well tool having a structure to engage a tool to be pulled and a pulling structure extending to the upper part of the well, there being an intermediate chamber structure adapted to contain a liquid, said chamber having means to receive an explosive, means providing for the explosion of the explosive, there being a passage for the downflow of liquid from the chamber due to the expulsion of liquid by the explosive action whereby such liquid may loosen the tool to be pulled from the well.

20. In a well tool having a lower drill tube to engage a tool to be pulled from a well, an upper drill tube leading to the top of the well for the pulling action, said tubes being adapted for the downward flow of liquid, a chamber structure intermediate the upper and lower tubes and through which the liquid flows, said chamber having means for the introduction of an explosive, means to ignite such explosive, means to restrain the upward flow of the liquid due to the explosive gases of an explosion whereby the liquid is directed mainly downwardly through the lower drill tube and adapted to exert a force to loosen the tool to be removed from the well.

21. In a fishing tool having a lower tube constructed and adapted for attaching to a fish to be removed from a well, an upper tube adapted for lowering the fishing tool and for pulling the same upwardly, telescopic chamber structures forming

a connection between the lower and upper tubes, the said tubes and the chamber structures being adapted for the downward flow of a slushing liquid, said liquid being adapted to convey an explosive downwardly into the said chamber, means to ignite the explosive therein, means to restrain the upward flow of liquid due to the gases produced in the explosion, the expulsive force of the explosion being adapted to discharge liquid downwardly under high pressure and velocity through the lower tubular structure operative to loosen the fish from the well.

22. In a fishing tool having a lower tube constructed and adapted for attachment to a fish to be removed from a well, an upper tube for lowering the fishing tool and pulling the same upwardly, an upper chamber structure connected to the upper tube, a lower chamber structure connected to the lower tube, means forming a telescopic connection between said chambers, the tubes and the said chambers being adapted for the downward flow of a slushing liquid and to convey an explosive charge to the lower chamber, means in the lower chamber to explode the said charge, a check means restraining the upward surge of the trapped liquid from the lower chamber whereby liquid in the lower chamber and in the lower tube is forced downwardly by the action of the explosive to thereby loosen a fish, a liquid outlet operatively connected to the upper chamber whereby on the telescopic action of the chamber connections and the stoppage of the downward flow of the slushing liquid, such liquid is forced outwardly into the well through the liquid outlet.

23. In the method of recovering a fish from a well which includes effecting a connection between a drill pipe and a fish, the pipe having liquid therein, exploding an explosive in the pipe to loosen the fish and withdrawing the pipe and fish from the well.

24. In the method of recovering a fish from a well which includes effecting a connection between a drill pipe and a fish, the pipe having liquid therein, exploding an explosive in the pipe closely above the fish to loosen the fish and withdrawing the pipe and fish from the well.

25. In the method of recovering a fish from a well which includes effecting a connection between a drill pipe and a fish, the pipe having liquid therein, exploding an explosive in the pipe closely above the fish to loosen the fish causing the explosive to be effective to force liquid downwardly through the drill pipe by resisting upward flow through the drill pipe above the locality of the explosion and withdrawing the pipe and fish from the well.

26. The method of recovering a fish from a well which includes effecting a connection between a drill pipe and a fish and having liquid in the pipe, conveying an explosive downwardly through the liquid by a free gravity descent, exploding such explosive in the drill pipe closely above the fish causing the explosive to be effective to force liquid downwardly through the drill pipe by resisting upward flow through the drill pipe above the locality of the explosion to loosen the fish and withdrawing the pipe and fish from the well.

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