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2,426,106

MEANS FOR EXPLOSIVELY INSERTING ORIFICES IN PIPE IN WELLS

Filed July 31, 1942

2 Sheets-Sheet 1

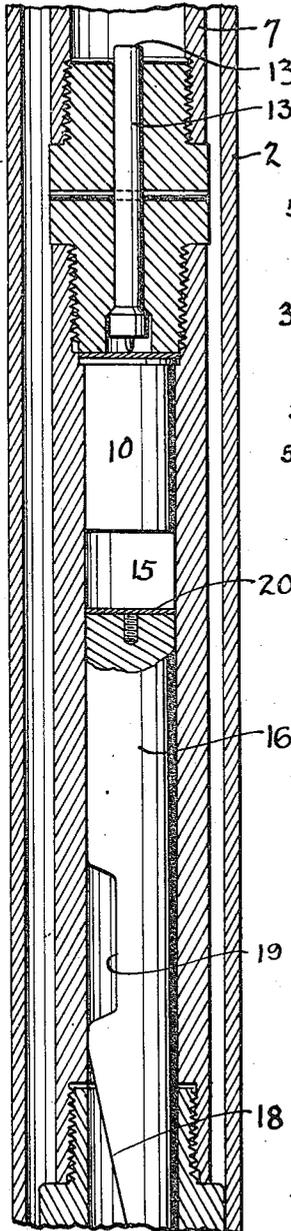


Fig. 1.

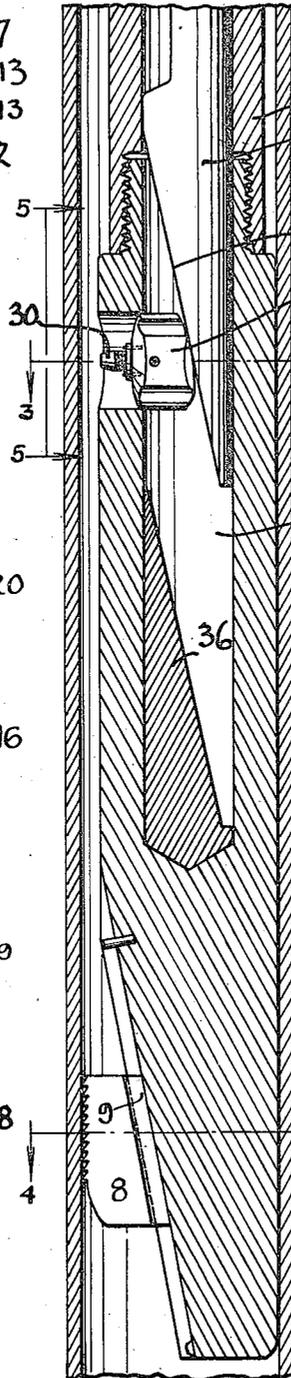


Fig. 2.

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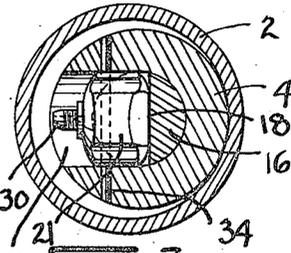


Fig. 3.

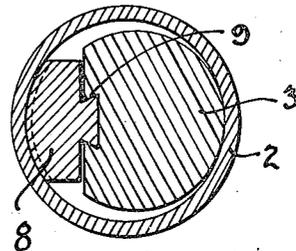


Fig. 4.

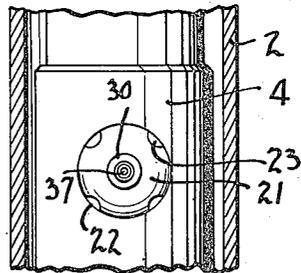


Fig. 5.

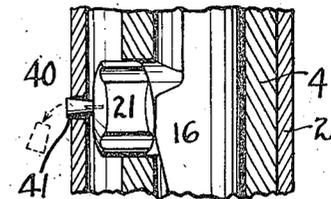


Fig. 6.

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2 Sheets-Sheet 2

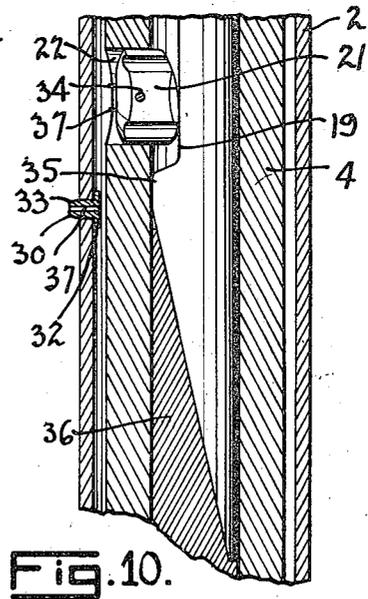
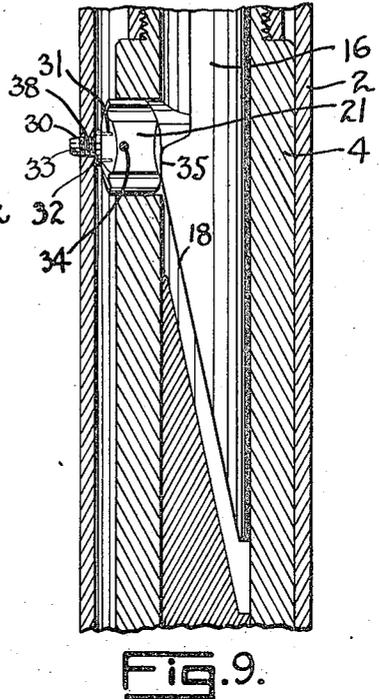
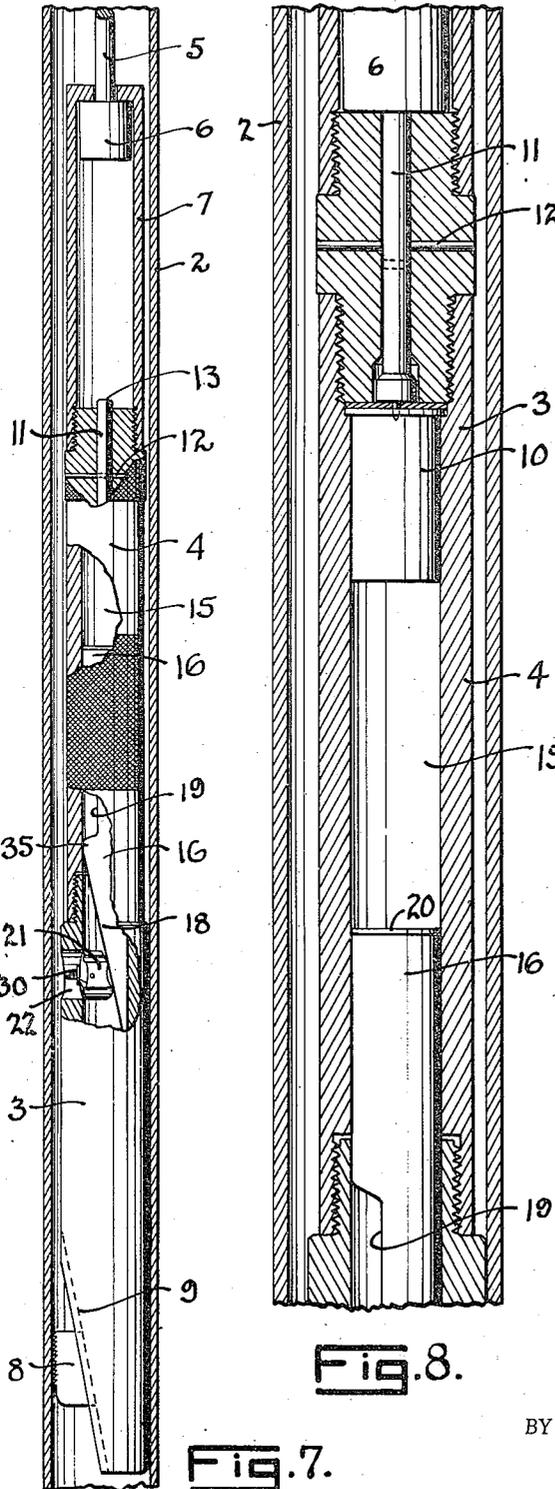


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 7.

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UNITED STATES PATENT OFFICE

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MEANS FOR EXPLOSIVELY INSERTING ORIFICES IN PIPE IN WELLS

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14 Claims. (Cl. 166-1)

1

The invention relates to a means for explosively inserting orifices in pipe while the pipe is disposed in a well bore.

The art of perforating pipe in position in the well bore is old, such perforations having been accomplished by shooting a bullet entirely thru the pipe to leave an opening thru which the fluid from the formation outside the pipe could enter. These bullets have been of a pointed construction, tending to deform the material of the pipe so as to leave the opening and it has been found that a majority of the openings, due to the fact that the bullet displaced the metal to form the opening, were surrounded with cracks or fissures in the metal and in some instances the bullet tended to split the pipe for a considerable distance on each side of the opening. Quite often also the opening would be of substantially greater size than the bullets, due to the fraying out of the metal as the bullet was caused to penetrate the metal.

The present invention contemplates a tool and particular types of punches and bushings whereby an opening of a predetermined size is provided in the pipe. The size may be predetermined by using a punch of a definite size to punch a slug of the metal from the pipe or to insert an orifice bushing in the pipe by a punching operation where such orifice bushing is of a predetermined size.

Another object of the invention is to provide a tool for shooting orifice bushings in the pipe in a well bore.

Another object of the invention is to provide an orifice bushing having a flange thereon to arrest its movement as it is punched into the pipe so that it will be definitely anchored in a predetermined position.

Still another object of the invention is to provide an explosively actuated bushing inserting tool for wells.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a vertical sectional view of the tool being assembled and mounted in the well bore.

Fig. 2 is a vertical sectional view which is a continuation of Fig. 1 and illustrating the lower portion of the tool.

Figs. 3, 4 and 5 are sectional views taken on lines 3-3, 4-4 and 5-5 respectively of Fig. 2.

Fig. 6 is a broken sectional view illustrating the punch used to remove a slug of metal from the pipe.

Fig. 7 is a side elevation with certain portions

2

shown in section of the entire tool as it is anchored in position ready to insert the bushing.

Fig. 8 illustrates the explosive mechanism of the tool.

Fig. 9 is an enlarged sectional view showing the wedge as having advanced the carrier to punch the bushing thru the pipe.

Fig. 10 is a vertical sectional view showing the bushing as having been inserted and the carrier returned to the housing.

Fig. 7 shows a pipe 2 which may be of any type disposed in a well bore, such as the tubing or casing. It is desired to provide an opening in this pipe to provide for a flow of fluid thru the wall of the pipe. The tool for accomplishing this is illustrated generally at 3 and constitutes a housing 4 which is supported upon a rod 5 which is, in turn, connected to a suitable cable or other means whereby the tool is lowered into and removed from the well bore.

This rod 5 has a head or weight 6 thereon which is arranged for reciprocation in the cap member 7 connected to the upper end of the housing 4. The housing is arranged to be anchored in the pipe 2 by means of a slip or another dog 8 which is dovetailed at 9 into the lower portion of the housing as best seen in Fig. 4.

It seems obvious that by sharply dropping the instrument, that the slip 8 will move along its inclined support and engage the periphery of the pipe, whereupon further lowering of the tool causes the slip to assume the load and to firmly fix the tool into the pipe at that elevation.

A force for punching the bushing into the pipe is created by an explosive action. A shell or cartridge 10 is shown in the upper end of the housing 4 and will contain a charge of powder. This cartridge will be exploded by a firing pin 11 which is shown in Fig. 7 as being retained in an inoperative position by a shear pin 12. The upper end 13 of this firing pin projects into the cap 7, so that it may be struck by the weight portion 6 of the supporting mechanism. When the tool is anchored with the slip 8, if the supporting cable is released sharply, the weight portion 6 will drop, striking the upper end 13 of the firing pin so as to shear the pin 12 and cause penetration of the cartridge by the firing pin as seen in Fig. 8.

The cartridge 10 is disposed in the chamber 15 which also receives the plunger or wedge member 16 which is slidably mounted in the chamber 15. This wedge member is best seen in Fig. 1 and has a lower wedge face 18 thereon

3

and a recess 19 positioned a short distance above the wedge. A suitable sealing gasket 20 may be provided on the upper end thereof to confine the pressure of the explosion. It seems obvious that when the explosion occurs, that this wedge member 16 will be forced sharply in the chamber 15 so that the wedge face 18 thereof will cause a carrier member 21 to be moved outwardly thru an opening 22 in the side of the housing 4. This carrier member may be of any desired configuration but is shown in front face elevation in Fig. 5 and is substantially circular with a plurality of grooves 23 along the side thereof so as to admit the flow of fluid around the carrier. This carrier is normally retracted as shown in Fig. 2 and forced against the inclined face 18 of the wedge member.

When the explosion occurs the wedge member is driven downwardly as shown in Figs. 8 and 9 so that due to the advancing wedge, the carrier member is forced laterally of the housing to cause the bushing 30 to be punched thru the pipe, as seen in Fig. 9. This bushing 30 is mounted on the outer face of the carrier 21 by means of the frangible pins 31. Thus, when the explosion occurs, the wedge member will move downwardly, forcing the carrier and the bushing outwardly until the flange portion 32 on the bushing engages the entire peripheral surface of the pipe. This arrests any further movement of the bushing and the rebound from this action will cause the shearing of the pins 31 so as to release the carrier from the bushing. The bushing will be wedged firmly into the opening in the pipe which has been punched by the inward tapered end 33 of the bushing. By the time this rebound occurs, the shoulder 35 of the wedge member will have passed the carrier and the recess 19 will have moved into position behind the carrier so that the rebound permits the carrier to move back into the housing, as seen in Fig. 10. The carrier will normally be retained in retracted position by a shear pin 34 which is released when the wedge member forces the carrier member outwardly. A body 35 of soft metal such as lead may be deposited in the lower portion of the chamber 15 so that the wedge member will abut against it and come to rest.

It will be particularly noted that the bushing 30 has an orifice 37 therein which may be of any desired size so as to admit the volume of flow desired when the pressure applied is considered. In view of the fact that the bushing is wedged firmly into the pipe and may be made of any suitable hard wear-resistant material, it seems that an orifice of a predetermined size has been punched into the pipe and is firmly anchored therein by a wedging action. If desired the periphery of this bushing may have a series of kerfs 38 thereon or it may be of a suitable taper to effect the wedging action in the opening.

Attention is also directed to the fact that the forward end 33 of the bushing is not pointed as the usual type of perforating bullet is constructed, but is constructed in the nature of a metal punch so as to punch a slug of metal from the pipe. In this manner splitting and fraying around the opening of the bushing is avoided because a certain amount of metal is completely removed and the bushing inserted in its place. In actual practice bushings inserted in this manner have been very firmly anchored and it has been practically impossible to remove them.

Fig. 6 shows another type of bushing which

4

has no orifice therethru but is in the form of a tapered punch 40, having the enlarged end 41 standing outwardly from the carrier. In this manner a definite punching action will occur to punch a slug of a definite size from the pipe. In actual operation a punch of this sort leaves a definite size opening which is clean and clear cut and avoids a splitting and fraying of the opening. It seems clear that by varying the size of this bushing or punch that any desired size of opening may be created.

While a bushing 30 of a length to merely penetrate the pipe is shown, a bushing of two or three inches in length may be provided so as to penetrate cement, a mud cake or the face of the formation so as to exclude loose materials in the well bore outside the pipe.

The invention has a particular advantage in connection with the flowing of wells where a well is brought in and has been flowing, due to the natural formation pressures. The usual practice is to merely insert a string of tubing and allow a flow to occur thru the tubing. After a period of time, however, the natural formation pressures begin to decrease due to the escape of the oil and the gas and very often it becomes necessary to introduce a flow of pressure fluid to elevate the oil from the well. The general practice at present is to remove the tubing and add thereto suitable flowing valves and control devices of various types whereby pressure introduced around the tubing will be admitted to the tubing to elevate the oil or liquid therein.

The present invention contemplates that the tool described may be lowered thru the tubing while the tubing remains in place in the well.

An orifice bushing having a suitable sized opening can be punched into the tubing to admit the pressure fluid from outside the tubing, the tool removed, and the flowing of the well continued. This operation obviously avoids the removal of the tubing and servicing of the well can be accomplished in a few minutes time and permits the creation of an orifice opening in any desired elevation. A number of such orifices may be positioned along the tubing if it is desired to admit pressure fluid at different elevations.

Broadly the invention contemplates a means and method of punching pipe in wells to leave a clear, clean cut opening of a predetermined size or to insert an orifice bushing having an orifice therein of a predetermined size.

What is claimed is:

1. A device for shooting orifice bushings into pipe in a well bore comprising a housing, means to anchor said housing in the pipe, a wedge member slidable within the housing, an explosive means to drive said member, a carrier disposed against the wedge face on said wedge member and movable laterally of said housing by movement of said wedge member by the explosive means, and an orifice bushing releasably mounted on said carrier and to be forced into the pipe by movement of the carrier, said bushing having an orifice of a predetermined size and being made of a wear resistant material.

2. A device for shooting orifice bushings into pipe in a well bore comprising a housing, means to anchor said housing in the pipe, a wedge member slidable within the housing, an explosive means to drive said member, a carrier disposed against the wedge face on said wedge member and movable laterally of said housing by movement of said wedge member by the explosive means, an orifice bushing releasably mounted on

said carrier and to be forced into the pipe by movement of the carrier, said bushing having an orifice of a predetermined size and being made of a wear resistant material, and a recess in said wedge member to permit said carrier to rebound into the housing due to the force of punching the orifice bushing into the pipe.

3. A device for shooting orifice bushings into pipe in a well bore comprising a housing, means to anchor said housing in the pipe, a wedge member slidable within the housing, an explosive means to drive said member, a carrier disposed against the wedge face on said wedge member and movable laterally of said housing by movement of said wedge member by the explosive means, an orifice bushing releasably mounted on said carrier and to be forced into the pipe by movement of the carrier, said bushing having an orifice of a predetermined size and being made of a wear resistant material, and a means to manipulate the device into and out of the well bore, to anchor and release it relative to the pipe and to initiate the explosion.

4. A gun perforator including a housing, an explosive actuated member therein, a bushing to be punched into a pipe in the well bore, and a bushing carrier actuated by said member, said bushing being of a predetermined size and disposed at the front of said carrier so as to punch an orifice in the pipe of a known size.

5. A gun perforator including a housing, an explosive actuated member therein, a bushing to be punched into a pipe in the well bore, and a bushing carrier actuated by said member, said bushing being disposed at the front of said carrier and of a hard wear resistant material having an orifice therethru of a known size whereby the size of the opening thus provided thru the pipe is known.

6. An orifice bushing to be forced into a well pipe in situ comprising a body portion, an outstanding flange at the rear end of said body, and an orifice extending thru the body and flange.

7. An orifice bushing to be punched into a well pipe in situ comprising a body portion, an outstanding flange at the rear end of said body, and an orifice extending thru the bushing body and flange which is small compared to the size of the bushing, the periphery of said body being tapered toward said flange so as to wedge itself in the opening punched in the pipe.

8. A tool for punching orifice bushings into a pipe in a well bore comprising a body, a wedge member carried thereby, means to actuate said wedge member, an orifice bushing adapted to punch a hole in the pipe and be forced into such hole, and means disposed against and operable by movement of said wedge member to force said bushing to punch the pipe.

9. In a tool for forcing orifice bushings into pipe in a well bore including a housing, an orifice bushing adapted to penetrate a pipe in a well, means in said housing supporting said bushing

for movement laterally of the housing, and a wedge member in the housing to bear against said means and force said bushing to punch into the pipe.

10. An orifice bushing for insertion in a pipe in situ in a well bore comprising a body of metal, a flow orifice therethrough which is small as compared to the diameter of the body, a forward end thereon to punch through the pipe, and a tapered area to wedge into the opening thus punched.

11. An orifice bushing for insertion in a pipe in situ in a well bore comprising a body of metal, a flow orifice therethrough which is small as compared to the size of the bushing, a forward end thereon to punch through the pipe, and a tapered area to wedge into the opening thus punched, said metal comprising a hardened wear resistant material.

12. An orifice bushing insert tool to be lowered into a pipe in the well bore including a body, a bushing therein, means to support the bushing, means including a tapered wedge engaging said first means to move such first means laterally to punch the bushing into the pipe, and means to support the tool in an anchored position in the pipe for operation.

13. An orifice bushing insert tool to be lowered into a pipe in the well bore including a body, a bushing therein, means to support the bushing, means including a tapered wedge engaging said first means to move such first means laterally to punch the bushing into the pipe, and means to support the tool in an anchored position for operation, said last means including slips to set the tool in the pipe.

14. A gun perforator including a housing, an explosive actuated plunger therein, a bushing to be punched into a pipe in the well bore, and a carrier for said bushing which carrier is actuated by said plunger, said bushing being disposed at the front end of said carrier and of a hard wear resistant material having an orifice therethrough of a known size whereby the size of the opening thus provided through the pipe is known, said bushing having a flange thereon to stop said bushing within the pipe.

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