April 28, 1959 J. C. BENDER 2,884,065

APPARATUS FOR AND METHOD OF LOOSENING A THREADED CONNECTION

Filed Nov. 18, 1955 2 Sheets-Sheet 1

Fig. 1

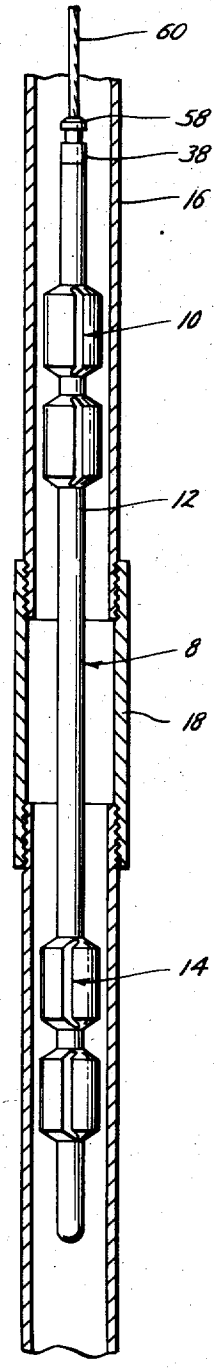


Fig. 3

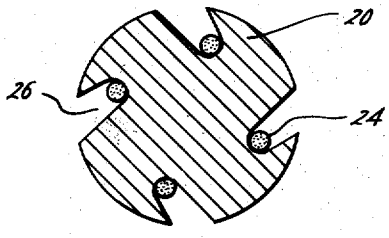
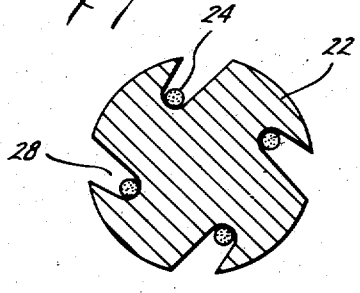


Fig. 4



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APPARATUS FOR AND METHOD OF LOOSENING A THREADED CONNECTION

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Fig. 2A

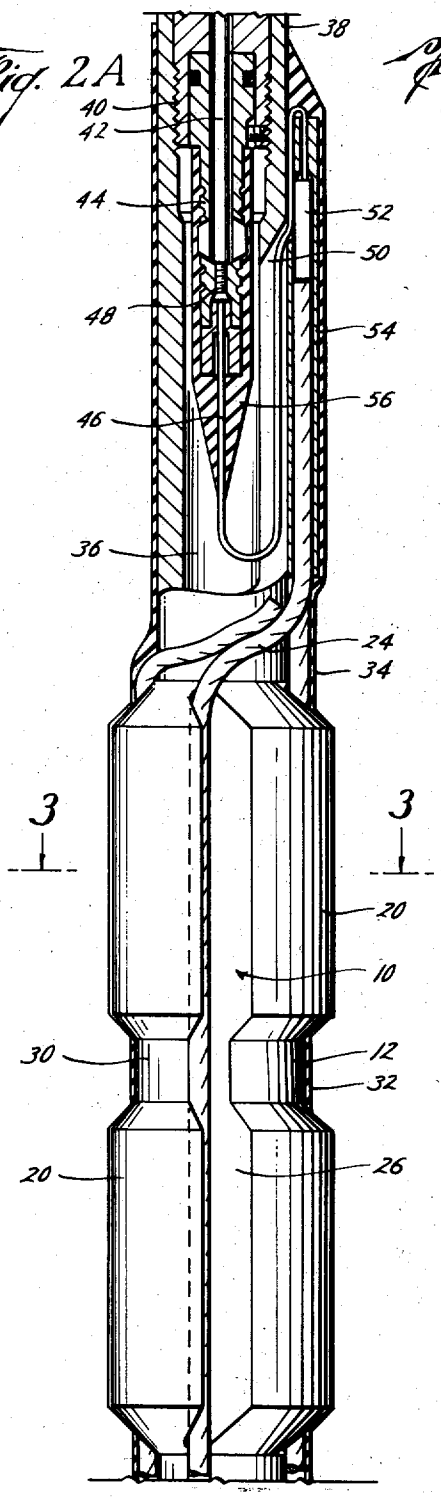
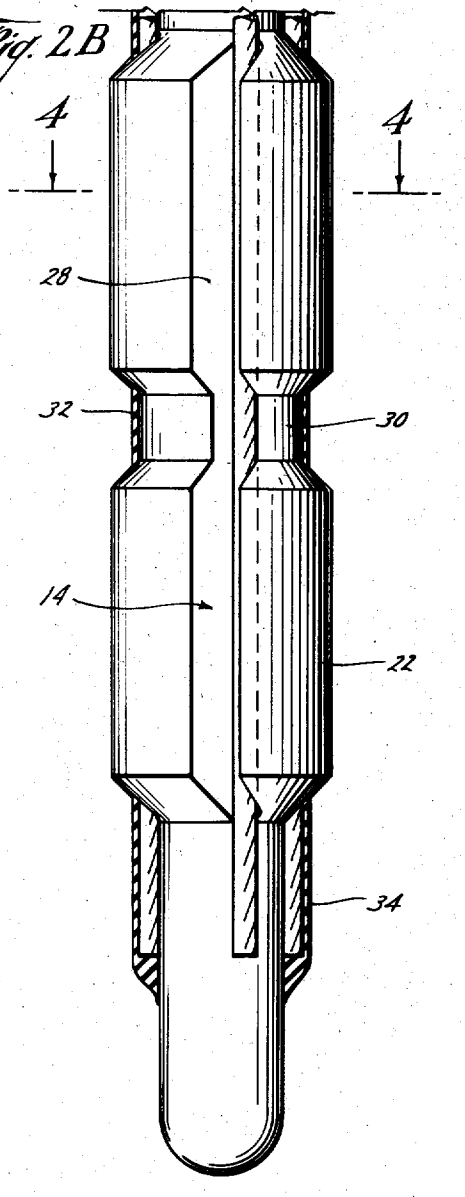


Fig. 2B



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APPARATUS FOR AND METHOD OF LOOSENING A THREADED CONNECTION

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Application November 18, 1955, Serial No. 547,772

11 Claims. (Cl. 166—36)

The present invention relates to a method of and apparatus for loosening a threaded connection in a string of pipe and more particularly relates to a method of and apparatus for initiating the unthreading of a string of pipe at a threaded connection in a well bore by the use of directed explosive forces.

In the drilling of oil, gas and sulfur wells and the like the operator is frequently confronted with the problem of having a string of pipe, such as drill pipe, become stuck in the well bore. In such cases it is highly desirable to provide a method of and means for disconnecting one or more threaded connections above the stuck point so that the portion of the pipe that is not stuck can be removed from the well bore and fishing or other operations performed to recover the stuck pipe, if possible.

To this end various methods and devices have been devised, such as the method described in U.S. Patent No. 2,305,261, issued December 15, 1942, to Myron M. Kinley for a method of removing pipe from wells in which an explosive charge is suspended in the pipe adjacent the connection desired to be unthreaded and is detonated while the pipe is torqued from the surface of the earth in a direction tending to unthread the connection. Such a method and means is also disclosed in my Patent No. 2,686,039, issued August 10, 1954, entitled Method of and Apparatus for Determining Physical Properties of Materials.

The methods and devices of the type just described, as well as others, depend upon the uncontrolled force of an explosive or an impacting force adjacent the threaded connection to cause jarring in the vicinity of the connection which is combined with torque placed on the pipe by mechanical means from the surface of the earth in a direction tending to unthread the connection.

It is a general object of the present invention to provide a method for and a means of directing the force of an explosion within a string of pipe so that these explosive forces themselves tend to loosen and in some instances disconnect the threaded connection.

Another object of the present invention is the provision of a method of and means for loosening a threaded connection in a string of pipe by providing means for and placing an explosive within the string of pipe on one side of the connection and another explosive within the pipe on the other side of the connection, the two explosives being secured against relative rotation, and upon detonation of the explosives jetting the force of each explosive against the internal wall of the string of pipe in opposite directions tending to unthread the threaded connection.

Still a further object of the present invention is to combine with the directed jet action of the explosive forces an additional torque force tending to unthread the threaded connection.

And yet a further object of the present invention is to provide such a method and apparatus in which the method is simple and efficient and the apparatus is rugged and economical to use, construct and maintain.

Still further features, objects and advantages will be apparent from the following description of an embodiment of the invention.

The present method and apparatus are particularly, but not necessarily, adapted for loosening threaded connections of stuck pipe in a well bore and the description of presently preferred embodiments are directed toward that use although other uses and adaptations of the invention will readily suggest themselves to those skilled in the various arts.

Accomplishment of the above and other objects will be apparent to those skilled in the art from the following description when taken in conjunction with the accompanying drawings, wherein like reference characters refer to like parts throughout the several views, and where:

Figure 1 is an elevational view illustrating an apparatus according to the present invention in place in a well casing,

Figure 2A is an enlarged fragmentary elevational view, in section, of the upper part of a device of Figure 1,

Figure 2B is a continuation of Figure 2A and illustrates the lower portion of the device of Figure 1,

Figure 3 is a cross-sectional view taken along the line 3—3 of Figure 2A, and

Figure 4 is a cross-sectional view taken along the line 4—4 of Figure 2B.

Referring now to the drawings, and particularly to Figure 1, the apparatus includes an elongate body **8** adapted to be inserted and moved in a string of pipe in a well bore, a first or upper set of explosive guides such as jet ports **10** in the body **8**, a rigid mandrel **12** as part of the body **8**, and a second or lower set of explosive guides such as jet ports **14** in the body **8**, the jet ports being axially spaced and oppositely directed. This apparatus may be designated as a torque gun and is hereafter referred to as such.

In use, the torque gun, as is shown in Figure 1, is placed in a string of pipe **16**, such as drill pipe used in an oil well, with the first set of explosive guides or jet ports **10** above a threaded connection **18** and with the second set of explosive guides or jet ports **14** below the threaded connection **18** at the place where it is desired to disconnect the pipe **16**. Ordinarily, this will be the first free joint above a stuck portion of the pipe **16**, which point may be located previously or concurrently with a suitable indicator. As mentioned previously, the first set of jet ports **10** are directed oppositely to those of the second set of jet ports **14** and relative movement between these two sets of jet ports is prohibited by the rigid mandrel **12** so that the full force of explosive jets erupting from the jet ports is directed against the wall of the pipe **16** and the jet forces are not dissipated by the reaction to such forces causing a spinning action of parts of the torque gun. The oppositely-directed jet ports are so directed that detonation of the torque gun applies jet forces to the pipe **16** in directions tending to unthread the pipe. If desired, a torque may be applied to the pipe at the surface tending to assist in initiating unthreading of the joint.

Referring now to Figures 2A and 2B a presently-preferred torque gun is illustrated in detail in which the first set of jet ports **10** are contained in the body **8** in a series of enlargements **20** which enlargements **20** are rigidly secured to the mandrel **12** or may be made integral therewith. The enlargements **20** are shown here as two in number but any desired number may be used. Similarly the second set of jet ports are contained in a like set of enlargements **22**.

In the particular form of the invention illustrated in the drawings the explosive means is illustrated as any suitable flexible cord-type explosive **24** such as the well

known Primacord, such as that manufactured by the Ensign-Bickford Company, Simsbury, Connecticut, which, generally speaking, is composed of a hollow fabric or plastic tube, the bore of which is filled with one of the well known detonatable chemical explosives such as pentaerythritoltetranitrate, which may be fired by applying a detonating shock at one end, the detonating wave traveling sufficiently rapidly through the length of the cord to produce substantially simultaneous detonation throughout the whole length of the explosive comprising the cord. To easily receive the cord-type explosive 24 the upper set of jet ports 10 include the grooves or slots 26 which are directed in one direction, the lower set of jet ports 14 being likewise grooves or slots 28 directed in an opposite direction. The direction of these grooves or slots and the placement of the cord-type explosive therein can best be seen in the cross-sectional views of Figures 3 and 4. Turning again to Figures 2A and 2B, both sets of grooves 26 and 28 are perpendicular to the axis of the pipe 16 so that jet force coming out of the grooves 26 and 28 are directed against the inner wall of the string of pipe 16 along a length of the pipe above and below the joint 18. Since both sets of jet ports 10 and 14 are stationary with respect to one another, the jetting force from the grooves 26 and 28 is oppositely directed against the inner wall of the string of pipe 16 at points above and below the joint 18 in a direction tending to cause the joint 18 to become unthreaded or to initiate unthreading thereof.

The enlargements 20 and 22 are advantageously provided to bring the mouths of the grooves 26 and 28 in close proximity to the inner wall of the string of pipe 16 to make more effective use of the jetting force. The reduced diameter portion 30 of mandrel 12 is provided between both the first set of enlargements 20 and the second set of enlargements 22 so that the cord-type explosive may be securely held within and against the base of the slots 26 and 28 as this reduced diameter portion 30 provides a convenient place for this purpose, such as by the tape 32. If the enlargements 20 and 22 are unduly extended in length, there is some danger of the cord-type explosive 24 slipping away from the base of the grooves 26 and 28. Likewise, the tape 34 around the mandrel 12 is used to hold the cord-type explosive in place along the mandrel between and beyond the upper or first set of enlargements 20 and the lower or second set 22. Of course other means for securing the cord-type explosive 24 in place could be used such as metal straps and the like.

The detonating means for the cord-type explosive 24 is best illustrated in Figure 2A. As shown there the upper end of mandrel 12 is hollow to form the chamber 36 with the upper portion of this chamber 36 receiving the lower end of a shooting head 38, which shooting head 38 is threadedly secured to the upper end of the mandrel 12 by the complementary threads 40. Passing longitudinally through the shooting head 38 is an electrical conductor 42 which extends into the seal assembly, generally indicated by the reference number 44, which extends below the lower end of the shooting head 38. The electrical conductor 42 makes electrical contact with lead wire 46 through a contact 48 within the seal assembly 44. This lead wire 46 passes out of chamber 36 through an opening 50 in the wall of the mandrel 12 to a conventional detonator 52. The electrical circuit to detonate the detonator 52 may be completed in any preferred manner, such as grounding the detonator 52 to the wall of the mandrel 12 and having another electrical conductor in electrical contact with the shooting head 38. Any suitable source of electrical energy and switching arrangement well known to the art may be used for supplying electrical energy for detonation. As shown in Figure 2A, the detonator 52 is preferably placed in a tube 54 into which the upper end of a length of cord-type explosive 24 is inserted to make contact with the detonator 52. This tube 54 is then taped to the side of the mandrel 12 to hold it in position.

As the well fluid normally present in the well bore may leak through the opening 50 into the chamber 36 in the upper part of mandrel 12, the portion of the lead wire 46 adjacent the seal assembly 44 and seal assembly 44 are taped as at 56 for insulation and to help hold the lead wire 46 in position against the electrical contact 48.

Referring now to Figure 1, the shooting head 38 is shown having a shoulder 58 to which a wire 60 or other type of line may be attached for lowering or raising the torque gun within the casing 16. Also, a conventional electrical connection is made with the detonator for detonating the same. Since any desired electrical connection can be made and there are numerous ones available, no detailed description thereof is deemed necessary. It is obvious that if for some reason it should be desired to utilize a torque gun with a string of pipe, the upper end of the shooting head 38 could have threads adapted to be threaded into the string of pipe.

In operation the cord-type explosive 24 is placed in the grooves 26 and 28 and held there by tape in the reduced diameter portions 30 and along the length of the mandrel 12. The various lengths of cord-type explosive are joined near the upper end of the uppermost enlargements 20 and placed in contact with detonator 52 contained in tube 54 taped to the exterior of mandrel 12. The lead wire is electrically connected to the electrical conductor 42 and the shooting head 38 secured to the upper end of mandrel 12. The torque gun is then lowered into the casing 16 by the wire line 60 until it reaches the position shown in Figure 1 at which time the cord-type explosive 24 is detonated causing oppositely directed explosive jet forces to come from the grooves 26 and 28 and be directed in opposite directions against the inner wall of the casing 16 causing explosive torque to be applied to the casing 16 to at least initiate unthreading of the casing 16 from the coupling 18. If desired, as previously mentioned, additional torque may be applied to the string of pipe when the explosive is detonated in a direction tending to unthread the connection 18 to aid in unthreading this connection 18. This additional torque may be applied in any way well known to the art such as by a rotary table, not shown, at the surface of the earth. While not necessary, the explosion of the cord-type explosive through the joint may assist in impacting or jarring the joint.

After the cord-type explosive 24 and the detonator 52 have been exploded and the torque gun removed from the pipe 16 the shooting head 38 is unthreaded from the upper end of the mandrel 12, and a new detonator 52 with its lead wire 46 is installed. Additionally, new cord-type explosive is inserted in the tube 54 and placed in the grooves 26 and 28 and taped in position as has been previously described. The torque gun it then ready for use again.

It seems obvious from the foregoing description of the invention that various types of detonating assemblies could be used to detonate the cord-type explosive 24 from that described in the preferred form of the invention without departing from the spirit of the invention. Further, the jet ports 10 and 14 may have other shapes than grooves and other types of explosives than cord-type explosive may be used. However, as cord-type explosive is easily available and as the grooves 26 and 28 are easily cut an inexpensive and reliably efficient torque gun is provided by the presently-preferred torque gun illustrated.

It seems obvious that while a preferred form of the apparatus is given other apparatus could be used in the method of the present invention of which the basic concept is the application of oppositely-directed explosive jet forces to the interior wall of a string of pipe on each side of a threaded connection tending to unthread the threaded connection.

In some instances it may only be necessary to apply

the jet force in one direction above or adjacent the threaded connection desired to be unthreaded as the stuck portion of the pipe on the other side of the connection serves as a back up for the directionally-applied unthreading force. Thus, the method and apparatus of the invention encompasses this aspect thereof.

It is therefore apparent that the present invention is well adapted to carry out the objects and attain the ends and advantages set forth as well as others inherent therein. Also, numerous changes in details of construction, arrangement of parts and steps of the process may be made which will readily suggest themselves to those skilled in the art and which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. An apparatus for loosening or disconnecting a threaded connection in a string of pipe comprising an elongate body adapted to be moved in a string of pipe, first and second guides for directing explosive jet forces from the body carried by the body in longitudinally spaced relationship with respect to one another so that when the elongate body is placed in the string of pipe adjacent a threaded connection the first said guide is disposed on one side of the threaded connection and the second said guide is disposed on the other side thereof, each said guide arranged in a plane generally perpendicular to and radially spaced from the axis of the body and intersecting the outer surface of the body at an acute angle thereto, said first guide being directed in an opposite direction to the second guide, explosive means in the guides, and means to detonate the explosive means.

2. Apparatus for loosening or disconnecting a threaded connection in a string of pipe comprising, a first explosive force-applying assembly including a first guide for directing explosive jet forces from the first assembly, said first guide arranged in a plane generally perpendicular to and radially spaced from the axis of the string of pipe when disposed in the pipe; a second explosive force-applying assembly including a guide for directing explosive jet forces from said second force-applying assembly, said second guide arranged in a plane generally perpendicular to and spaced from the axis of the string of pipe when disposed in the pipe and in an opposite direction from the first guide; said guides intersecting the outer surface of said assemblies at acute angles thereto; and a rigid member connecting said explosive force-applying assemblies in spaced relationship.

3. In an apparatus for loosening or disconnecting a threaded connection in a string of pipe, the improvement comprising a support for lowering and moving the apparatus in the pipe, an explosive jet assembly carried by the support, said explosive jet assembly including a guide for directing an explosive jet force from the explosive jet assembly, said guide arranged in a plane generally perpendicular to and radially spaced from the axis of the string of pipe when disposed in the pipe, said guide intersecting the outer surface of the support at an acute angle thereto.

4. Apparatus for loosening or disconnecting a threaded connection in a string of pipe comprising, an elongate body adapted to be moved in the string of pipe, first and second sets of jet ports disposed in longitudinally spaced relationship with respect to one another on said elongate body so that when the elongate body is placed in the string of pipe adjacent a threaded connection the first set of jet ports is disposed on one side of the threaded connection and the second set of jet ports is disposed on the other side thereof, the jet ports in each set being directed in one general direction in a plane generally perpendicular to and radially spaced from the axis of the body, each said set of jet ports being arranged to direct its jet forces in an opposite direction to the other set of jet ports thereby loosening the threaded connection, explosive means in the jet ports, and means to detonate the explosive means.

5. An apparatus for loosening or disconnecting a threaded connection in a string of pipe comprising, a mandrel adapted to be moved in the string of pipe, first and second sets of longitudinal slots in axially spaced relationship with respect to one another in the exterior of said mandrel so that when the mandrel is placed in the string of pipe adjacent a threaded connection the first set of slots is disposed on one side of the threaded connection and the second set of slots is on the other side thereof, the slots in each set being directed in one general direction in a plane generally perpendicular to and radially spaced from the axis of the mandrel, each such set of slots being directed in an opposite direction to the other set of slots, explosive means in the slots, and means to detonate the explosive means thereby directing jet force against the interior wall of the string of pipe in opposite directions on each side of the threaded connection thereby initiating unthreading of the connection.

6. A method for loosening or disconnecting a threaded connection in a string of pipe comprising the step of applying jet forces to the interior wall of said string of pipe on each side of the threaded connection and in the direction and at an angle to the interior wall of the pipe to unthread the threaded connection thereby initiating unthreading thereof.

7. A method of loosening or disconnecting a threaded connection in a string of pipe comprising placing a first explosive means directed approximately perpendicular to the axis of the string of pipe at an angle to the interior wall thereof and in the direction to unthread the threaded connection within the string of pipe on one side of the threaded connection, placing a second explosive means directed approximately perpendicular to the axis of the string of pipe and in an opposite direction to the first explosive means within the string of pipe on the other side of the threaded connection, and detonating the explosive means thereby directing explosive jet forces against the string of pipe in opposite directions on each side of the threaded connection thereby initiating unthreading of the connection.

8. The method of claim 7 wherein the explosive means is cord-type explosive.

9. The method of claim 7 including applying additional torque force to the string of pipe when the explosive jet forces are applied.

10. In a method of loosening or disconnecting a threaded connection in a string of pipe by applying an explosive force against the threaded connection, the improvement comprising directing the explosive force generally tangential to the pipe adjacent the threaded connection and in the direction to unthread the threaded connection.

11. In an apparatus for loosening or disconnecting a threaded connection in a string of pipe, the improvement comprising an elongate body adapted to be moved in a string of pipe, first and second guides for directing explosive jet forces from the body carried by the body in longitudinally spaced relationship with respect to one another so that when the elongate body is placed in the string of pipe adjacent a threaded connection the first said guide is disposed on one side of the threaded connection and the second said guide is disposed on the other side thereof, each said guide arranged in a plane generally perpendicular to and radially spaced from the axis of the body, said first guide being directed in an opposite direction to the second guide, said guides intersecting the outer surface of the body at acute angles thereto.

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