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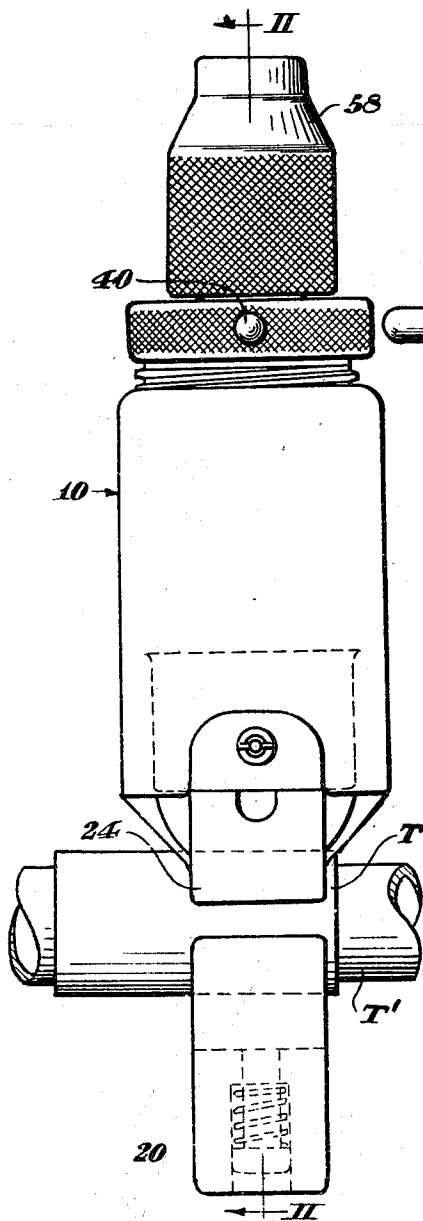


Fig. 1

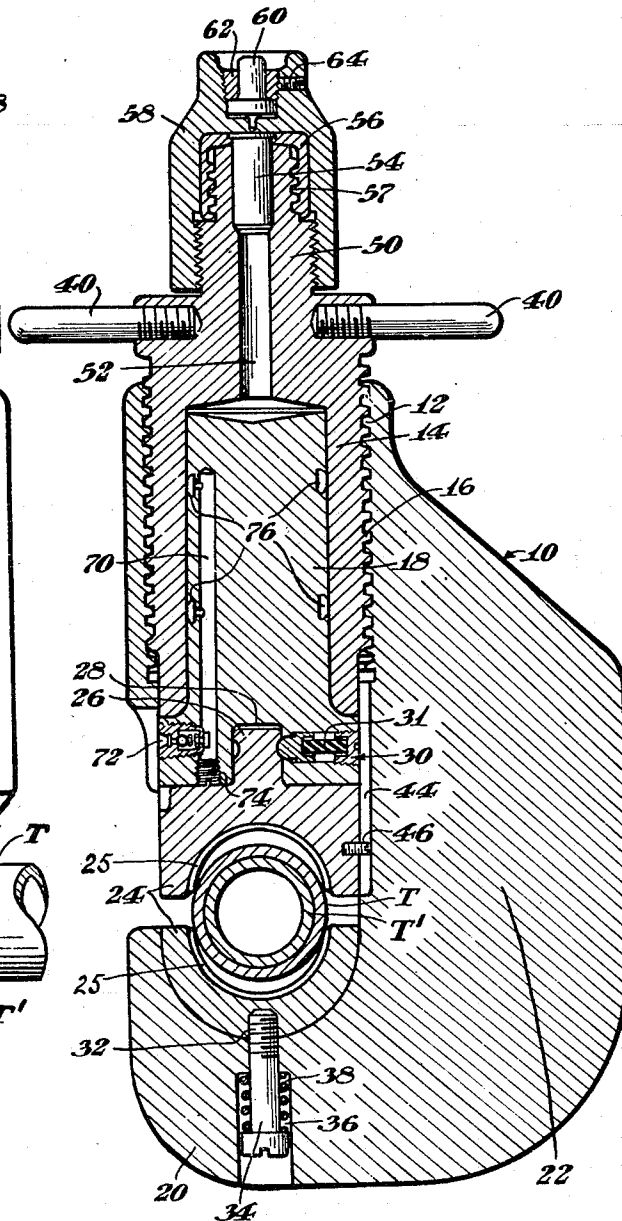


Fig. 2

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UNITED STATES PATENT OFFICE

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9 Claims. (Cl. 140—113)

This invention relates to methods and apparatus for forming joints, and more particularly is concerned with explosively actuated apparatus and the use of controlled explosive force for joining together tubular members, such as pipes and the like.

It is the general object of my invention to provide improved methods and apparatus for joining tubular conduits and the like together end to end.

Another object of my invention is the provision of a relatively light weight, easily operated apparatus for joining pipes together by a detonated explosive charge.

Another object of my invention is the provision of an improved method for joining pipes and similar members together end to end and wherein the members are first squeezed to an elliptical shape and are thereafter reduced in diameter all by an impact created by the detonation of an explosive charge.

Another object of my invention is to provide an apparatus for explosively compressing telescoped tubular members and wherein the compressing action is first achieved by a squeeze and thereafter by an impact, and wherein further changes in die sizes are readily effected.

The foregoing and other objects of my invention are achieved by the provision of apparatus for compressing a tubular member which includes a frame having a bore therein, a cylinder adjustably received in the bore, a piston slidably mounted in the cylinder, an anvil carried by the frame in alignment with the movement of the piston, and complementary dies removably carried by the piston and the anvil. Completing the combination are means for advancing the cylinder in the frame to bring the dies into engagement with the tubular member, and means associated with the cylinder for removably receiving and detonating an explosive charge behind the piston to force the dies into engagement around the tubular member.

In accordance with my improved method for joining two tubular members together, the members are telescoped one within the other and the relatively telescoped portions are thereafter squeezed to an elliptical shape by the force of a detonated explosive charge which effects a subsequent impacting of the tubular members to a circular shape of reduced diameter.

For a better understanding of my invention reference should be had to the accompanying drawing wherein Fig. 1 is a front elevation of an apparatus comprising one embodiment of my in-

vention; and Fig. 2 is a vertical cross sectional view taken on the line II—II of Fig. 1.

In the drawing the numeral 10 indicates generally a frame which is provided with a bore 12 adapted to adjustably receive a cylinder 14, as, for example, by the provision of complementary Acme threads 16. The cylinder 14 slidably receives a piston 18 for reciprocating movement toward and from an anvil portion 20 formed on the frame 10. Generally the anvil portion 20 takes the form of a C-shaped extension 22 of the frame 10, but it should be appreciated that instead of taking a C shape the support for the anvil may take the form of a U to thereby provide a leg on each side of the anvil.

The piston 18 and the anvil 20 removably carry a pair of semi-circular dies marked 24. The upper die 24 is removably carried by the piston 18, as, for example, by providing a stud 26 on the top of the die which is received in a recess 28 in the end of the piston. A spring-pressed detent 30 carried by the end of the piston 18 engages with the stud 26 to releasably hold it in the recess 28. I have found that using a rubber plug 31 as the spring element or using a metal spring with a cylindrical plug of rubber molded around it provides a structure which is longer lived and less subject to breakage than a standard coiled compression spring of metal. The lower die 24 is formed with a tapped opening 32 into which is threaded a cap screw 34 which is slidably carried in a recess 36 formed in the bottom of the anvil 20. A compression spring 38 carried between the head of the cap screw 34 and an appropriate shoulder in the recess 36 normally urges the cap screw and thus the lower die 24 down into firm load-bearing relation with the upper complementary surface of the anvil 20. I preferably form the upper and lower dies 24 with a plurality of relatively narrow circumferentially extending ribs 25 which are spaced longitudinally of the dies. In the operation of the apparatus the ribs form a series of longitudinally spaced circumferential grooves which improve the already excellent seal and mechanical strength of the joint.

The cylinder 14 is provided with suitable means, such as handles 40, whereby it can be rotated to move the cylinder in and out of the bore 12. In order to prevent the upper die 24 from rotating with the cylinder 14 and thus getting out of alignment with the bottom die, I provide some means for holding the upper die 24 against rotation while permitting it to have sliding vertical movement. Such means have been shown in the accompanying drawing as including a groove 44

formed in the side of the frame 10. The groove 44 receives the end of a pin 46 carried by the upper die 24.

The end of the cylinder 14 is adapted to removably receive an explosive charge for moving the piston 18 and to this end a boss 50 is formed integral with the cylinder 14. The boss 50 and the cylinder 14 are provided with an axial bore 52 which at one end is open to the piston 18 and which at the other end is slightly enlarged to receive an explosive charge which is conveniently in the form of a blank cartridge 54. The end of the boss 50 is reduced in diameter and is covered by an ejector cap 56 which is preferably threaded thereon with a coarse Acme thread 57 so that a slight turn of the cap lifts it to eject a fired cartridge 54 from the bore 52. The periphery of the boss 50 is threaded and removably receives a breech-block 58 which is provided with a firing pin 60 carried in an axial bore by a collar 62 which is locked in place by a screw 64.

I preferably provide some means for lubricating the movement of the piston 18 in the cylinder 14 and such means may conveniently take the form of a drilled hole 70 positioned off center of the piston 18 and connected by a standard lubricating gun fitting 72 with the outer surface of the piston head. The end of the drilled hole 70 is plugged by a member 74, as will be understood. Cooperating with the drilled hole 70 are a plurality of circumferentially extending grooves 76 which are connected by suitable passages to the drilled hole.

It is believed that the operation of the apparatus will be understood from the foregoing description. However, briefly reviewing the operation, the telescoped tubular members marked T and T', and, for example, in the form of a coupling sleeve and a tube, are positioned on the lower die 24 and thereafter the cylinder 14 is rotated by the handles 40 to screw the upper die 24 down in place against the upper side of the work which brings the parts into the position shown in Fig. 2. Thereafter the firing pin 60 is struck by a detonating hammer which explodes the cartridge 54 to cause the burning gases to expand under high pressure behind the piston 18. Inasmuch as the piston 18 is held against movement because the upper die 24 is already in engagement with the work, there is no movement until the force of the burning gases has built up to a point sufficient to force the ends of the upper die 24 past the sides of the tubular members T and T'. This initial movement of the dies together is in the form of a relatively slow squeeze and is characterized by the fact that the tubular members must first take an elliptical shape to allow the corners of the dies to move to a position where the dies fully surround the work. Once the corners of the dies have moved past the work the movement of the piston and the associated die 24 is in the nature of an impact due to the very rapid development of energy of the detonated explosive charge. The impact movement of the dies reduces the diameter of the tubular members T and T' in the region of the dies, as will be understood. This action very tightly compresses the outer tubular member T about the inner tubular member T' and inasmuch as the force generated by the detonated explosive charge is many thousands of pounds per square inch, as, for example, up to or over 50,000 pounds per square inch, the action of the

dies is to flow the metal of the tubular parts very intimately together and effect a perfect seal.

After firing, the handle 40 is turned in the opposite direction to bring the cylinder 14 back to its original position, the breech 58 is unscrewed, the ejector cap 56 is turned to eject the detonated cartridge and a new cartridge is inserted. Thereafter, the breech block 58 is replaced and a new workpiece is positioned between the dies whereupon the entire operation is repeated, as will be understood.

From the foregoing it will be recognized that the objects of my invention have been achieved by the provision of novel light weight apparatus for joining tubular members together and by the provision of an improved method for joining such members, wherein the compressing of the members is effected as by a squeezing action and thereafter by an impacting action. The dies in the apparatus can be readily changed to provide dies suitable for compressing work of various size and periodically the piston should be lubricated in its cylinder. The operation of the apparatus and the practice of the method is relatively simple and can be performed by the ordinary workman without extensive training or instruction. The tool of my improved method adapts itself particularly to portable operations and can be made in such sizes and weights as to be readily handled in the field.

I have specifically illustrated and described my invention for use with pipes or tubular members; however, it will be recognized that many of the advantages of my invention are retained in operations on rods, wires, cables and the like.

While in accordance with the patent statutes I have particularly described and illustrated one embodiment of my invention and have described in detail one manner of practicing my improved method, it should be understood that I am not to be limited thereto or thereby but that my invention is defined in the appended claims.

I claim:

1. In apparatus for compressing a tubular member or the like, a frame having a bore therein, a cylinder adjustably received in the bore, a piston slidably mounted in the cylinder, an anvil carried by the frame in alignment with the movement of the piston, complementary dies removably carried by the piston and anvil, means for advancing the cylinder in the frame to bring the dies into engagement with the tubular member, and means associated with the cylinder for removably receiving and detonating an explosive charge behind the piston to force the dies into complete engagement around the full circumference of the tubular member.
2. In apparatus for performing work on a tubular member or the like, a frame having a bore therein, a cylinder adjustably received in the bore, a piston slidably mounted in the cylinder, an anvil carried by the frame in alignment with the movement of the piston, dies on the piston and anvil, said dies having longitudinally spaced, circumferentially extending, relatively narrow ribs on the material-engaging faces thereof, means for advancing the cylinder in the frame to bring the dies into engagement with the tubular member, and means associated with the cylinder for removably receiving and detonating an explosive charge behind the piston.
3. In apparatus for performing work on a tubular member or the like, a frame having an internally threaded bore therein, a cylinder having a complementary thread on its exterior and

adjustably received in the bore, a piston slidably mounted in the cylinder, and means associated with the cylinder for removably receiving and detonating an explosive charge behind the piston.

4. The combination defined in claim 3 wherein further a die is rotatably carried by the piston, and cooperating means are provided between the die and frame for holding the die for sliding movement only relative to the frame.

5. In apparatus for performing work on a tubular member or the like, a frame, a piston slidably mounted in the frame, a cartridge-receiving breech associated with the frame, an ejector cap covering the breech and screwed thereon with a coarse thread, and a breech block removably secured to the frame and covering the ejector cap.

6. In apparatus for performing work on a tubular member or the like, a frame, a piston slidably mounted in the frame, an anvil carried by the frame in alignment with the movement of the piston, a pair of dies, one of said dies having a stud removably received in a recess in the piston, a spring detent including a compressible rubber plug for holding the stud in the recess, resilient means for holding the other die on the anvil, and means associated with the frame for removably receiving and detonating an explosive charge behind the piston to force the dies into engagement with the tubular member.

7. In apparatus for performing work on a tubular member or the like, a frame, a piston slidably mounted in the frame and having a sub-

stantially longitudinally extending passageway therein, a pressure lubricating fitting secured to the head of the piston and connected to the passageway, said piston having substantially circumferentially extending grooves on its outer surface connected to the passageway whereby the piston can be lubricated.

8. In apparatus for performing work on a tubular member or the like, a frame having a bore therein, a cylinder adjustably received in the bore, a piston slidably mounted in the cylinder, an anvil carried by the frame in alignment with the movement of the piston, dies on the piston and anvil, means for advancing the cylinder in the frame to bring the dies into engagement with the tubular member, and means associated with the cylinder for removably receiving and detonating an explosive charge behind the piston.

9. In apparatus for performing work on a tubular member or the like, a frame, a piston slidably mounted in the frame, an anvil carried by the frame in alignment with the movement of the piston, a pair of dies, one of said dies being removably held on the piston by means of a stud and recess, a spring detent including a compressible rubber plug for holding the stud in the recess, means for removably holding the other die on the anvil, and means associated with the frame for removably receiving and detonating an explosive charge behind the piston to force the dies into engagement with the tubular member.

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