July 4, 1961 P. D. MERRILL ET AL 2,990,731

FITTING FOR PERFORATING STEEL WALLED MEMBERS

Filed June 29, 1959

FIG. 1.

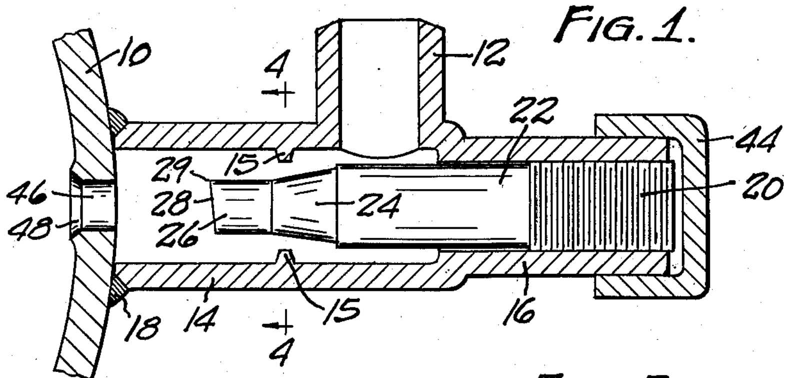


FIG. 2

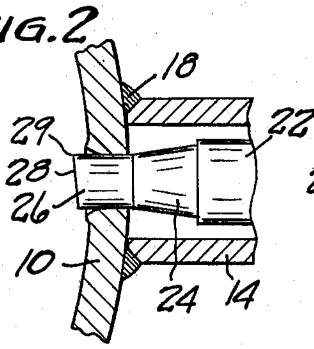


FIG. 3.

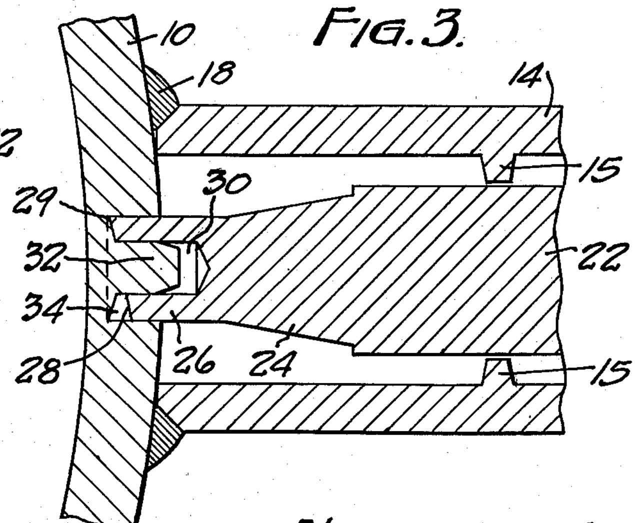


FIG. 4.

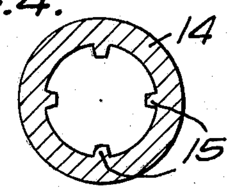


FIG. 5.

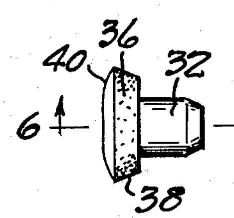


FIG. 7.

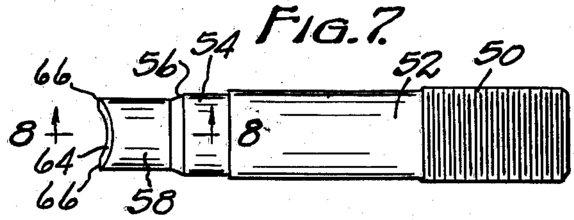


FIG. 6.

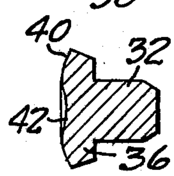
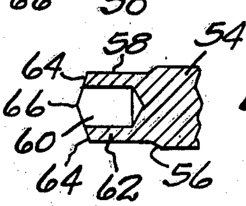


FIG. 8.



PATTERSON D. MERRILL.
WILLIAM A. CURTIS.
HENRY J. DE FREEUW.
INVENTORS.

BY Eugene C. Knoblock
ATTORNEY.

2,990,731

FITTING FOR PERFORATING STEEL WALLED MEMBERS

Patterson D. Merrill, William A. Curtis, and Henry J. De Freeuw, South Bend, Ind., assignors to M. B. Skinner Company, South Bend, Ind., a corporation of Indiana

Filed June 29, 1959, Ser. No. 823,595
5 Claims. (Cl. 77—37)

This invention relates to a fitting for perforating steel walled members, such as pipes and fluid containers, and is particularly well suited for use as a branch pipe fitting. The fitting is of the type and constitutes an improvement upon the fitting forming the subject matter of a patent application of Patterson D. Merrill and Harry T. Waite, Jr., for Fitting for Tapping Steel Walled Members, Serial No. 776,095, filed November 24, 1958 which issued as Patent No. 2,950,637, dated August 30, 1960.

The primary object of this invention is to provide a device of this character which is self-contained, in that perforating means forms a part thereof and is retained therein for dual use as a valve member to control the flow of fluid contents through the device and the perforation formed thereby.

A further object is to provide a device of this character which forms a perforation by removing a portion of a wall in the form of a slug in such a manner as to insure that the slug is completely separated from the wall in which it is formed and is prevented from hinging to said wall at the margin of the perforation.

A further object is to provide a device of this character having a novel perforating member capable of displacing metal in the form of a slug in a perforating operation, which metal displacement occurs with some of the characteristics of a metal extrusion.

A further object is to provide a device of this character having an elongated perforating member screw-threaded at the end thereof remote from the perforating end, and means for guiding said member with minimum friction to counteract forces acting on the perforator and tending to distort the same from true axial position during its use.

Other objects will be apparent from the following specification.

Referring to the drawing which illustrates the preferred embodiments of the invention,

FIG. 1 is a longitudinal sectional view of the device used upon a steel pipe and illustrating the same in use to permit flow therethrough from the pipe through the opening perforated thereby;

FIG. 2 is a fragmentary sectional view illustrating the tip of the perforating tool seated in the perforation formed thereby;

FIG. 3 is an enlarged fragmentary detail sectional view illustrating an intermediate step in the process of using the tool to perforate a steel wall;

FIG. 4 is a transverse sectional view taken on line 4—4 of FIG. 1;

FIG. 5 is a side view of a typical slug formed by the use of the device;

FIG. 6 is an axial sectional view of the slug shown in FIG. 5;

FIG. 7 is a view in side elevation illustrating a modified form of perforating member; and

FIG. 8 is a fragmentary axial sectional view taken on line 8—8 of FIG. 7.

Referring to the drawing, FIGS. 1 to 4, inclusive, illustrate one embodiment of the invention in the nature of a branch pipe fitting. The numeral **10** designates a steel pipe, such as pipe used in gas lines or mains in a gas distribution system. The pipe may be of any selected diameter, such as a diameter of from two inches to six inches or more. Alternatively, the member **10** may constitute the wall of a container having steel of the approximate composition, thickness and hardness of steel pipe.

A fitting, such as a branch pipe fitting, is secured to wall **10** by any suitable means and consists of a T having a branch or leg portion **12** communicating with a cross conduit, here shown as having a large diameter portion **14** with the inner end of which the leg **12** communicates, and a smaller portion **16** axially aligned with the portion **14**. The T is preferably secured to the wall **10** at the end of the part **14** thereof as by means of the weld **18** circumferentially of the part **14** to effect a seal between part **14** and the wall **10**. The reduced fitting portion **16** is preferably screw-threaded internally and externally. The leg **12** of the T may be beveled at its end as shown to accommodate a welded circumferential sealed joint with the end of a branch pipe (not shown) to which the contents of the pipe or container, of which the wall **10** forms a part, are to be supplied. The portion **16** has internal threads extending full length thereof which are preferably comparatively fine or of slow lead and preferably of the type having sixteen to twenty-four threads per inch although it is possible to use even finer threads than twenty-four threads per inch.

An elongated perforating member has an elongated externally screw-threaded portion **20** at one end thereof which is screw-threaded in the conduit or fitting portion **16**, and said end portion is preferably provided with hexagonal or other non-circular tool-receiving socket (not shown) in the end thereof to receive a tool for rotating the same. The perforating member has an elongated shank portion **22** of slightly less diameter than the diameter of the threaded part **20** from which projects a tapered coaxial portion **24**. A cylindrical coaxial free end portion **26** projects from the small diameter end of the tapered part **24**. The cylindrical end portion **26** terminates in a flat end surface **28** lying in a plane disposed obliquely to the axis of the perforating member and preferably displaced from ten to thirty-five degrees from a plane perpendicular to the axis of the perforating member. We prefer to provide said face with an angle from ten to fifteen degrees from a plane perpendicular to the axis of the member. The portion **26** of the perforating tool is tubular as defined by a bore **30** extending axially thereof and of a depth preferably greater than the thickness of the wall **10** to be perforated. The bore **30** is preferably of a diameter at least equal to the radius of part **26**.

By way of illustration and without intent to be limiting, it has been found that the device functions satisfactorily when a part **26** of three-eights inch (⅜″) diameter has a bore therein of seven thirty-seconds inches (7/32″) diameter, so that the wall thickness of the cylindrical wall of part **26** is approximately five sixty-fourths (5/64″) of an inch. In the case of a perforating member whose part **26** has a diameter of one-half inch (½″), the bore **30** thereof may be of a diameter of five-sixteenths of an inch (5/16″) and the wall thickness of the part **26** three thirty-seconds (3/32″) of an inch. In the event the part **26** is five-eighths of an inch (⅝″) in diameter, the bore thereof may be seven sixteenths of an inch (7/16″) in diameter and the wall thickness of the part **26** may be three thirty-seconds of an inch (3/32″).

In the use of the device after the T-fitting has been secured to the wall **10** to be perforated, the perforating tool is advanced by rotation thereof, the rate of advance being determined by the lead of the screw-threaded portion **20**. When the perforating tool advances, the tip portion **29** thereof spaced the greatest distance from the opposite end of the tool initially contacts the wall **10** and commences to displace the metal of the wall **10**. As the advance of the tool continues, a cold flow of the metal of wall **10** is caused in an action somewhat similar to extrusion, causing a central core portion **32** to be forced into the bore **30** of the tool as an annular groove **34** is formed in wall **10** and is progressively deepened by the rotating advance of the perforating tool as determined by the lead of the screw-thread part **20** of the tool. This groove forming action continues through the major portion of the thickness of the wall **10**. The extrusion action terminates before the perforation is completed, and thereafter the action is characterized by the requirement to exert greater torque to produce rotative advance of the perforating tool. The final perforating action of the tool may be likened to a swaging action and completes the perforation by forming a tapered or flared mouth **48** thereat.

The operation of the tool produces a slug of the character illustrated in FIG. 5 characterized by the stem portion **32** extruded in the tube bore **30** and having a diameter slightly less than the diameter of the bore **30** to accommodate rotation therein. An enlarged diameter head portion **36** completes the slug, and the same is usually characterized by a comparatively rough surface **38** of frusto conical shape whose inner or small diameter end is usually substantially equal to the diameter of the portion **26** of the tool. The outer end of the slug is usually displaced to convex shape at its margin **40** and usually is characterized by a convex central end portion **42**. The overall length of the slug is substantially greater than the wall thickness of the wall **10** from which it is formed and said dimension results from the extrusion of the stem portion **32** as illustrated, for example, in FIG. 3.

Inasmuch as the leading edge **29** of the tool is eccentric thereof, rotation of the tool tends to cause the tip of the tool to become laterally displaced. We have found that such lateral deflection and displacement can be limited by forming a plurality of circumferentially spaced inwardly projecting lugs **15** in the fitting portion **14** with their inner surfaces spaced from the axis of part **14** a distance slightly greater than the radius of the tool portion **22** which is located therein when the tip of the tool contacts the plate **10**. This provides free clearance for rotation of the tool without binding as long as the tool is free from lateral deflection and serves as positive means to limit lateral deflection of the tool in use.

When a slug has been cut from the plate **10** it is completely freed therefrom, and the extruded stem **32** thereof holds the same in a position preventing hinging thereof at a part of one edge thereof as the final separation of the slug occurs. In other words, the fitting of the stem **32** in the bore **30** of the tool prevents tilting of the slug which might otherwise permit it to hinge or swing at a limited portion of its margin at a time when the remainder of the margin thereof was cut free from the wall **10**. This complete separation of the slug from the wall **10** insures that the slug is free to fall to a position spaced from the opening **36** as it is disengaged from the tool incident to run out of the tool toward the position illustrated in FIG. 1. Thus it will be apparent that as the head portion **36** of the slug engages the inner mouth of the perforation it is stopped in its axial movement while the axial withdrawing movement of the tool continues, thereby separating the stem **32** from its seating socket **30** in the tool, and, when this separation is completed, the loose fit of the free stem **32** in the bore **46** prevents the slug from maintaining its position in the opening **46**, espeoially in cases where the axis of the bore **46** is substantially horizontal as shown, or in which the axis is tilted with the enlarged inner flared mouth portion **48** of the perforation positioned lowermost.

When the perforating tool has been run out to the position seen in FIG. 1, gas or other fluid may flow through the perforation **46** and the fitting portion **14** around the withdrawn perforating tool and into the leg or branch **12** of the fitting. The thread fit of the part **20** of the tool in the part **16** of the fitting is substantially free from leakage but a complete seal against leakage can be provided by threading a sealing cap **44** upon the external screw-threads of the fitting portion **16**. Thereafter, if it should become desirable to close the perforation **46**, this can be done by removing the cap **44** and again advancing the perforating tool until such time as the tapered portion **24** thereof seats in the outer end of the perforation **46** and thus acts as a valve to close the port **46**. It will also be understood that, if regulation of the rate of flow is desired, this can be accomplished by advancing the tool to a selected position adjacent the outer mouth of the aperture **46** and in such position as to restrict flow therethrough.

A modified construction of perforating tool is illustrated in FIGS. 7 and 8. In this construction the perforating tool has a threaded end portion **50**, a substantially cylindrical slightly reduced shank portion **52**, a further reduced shank portion **54**, a frusto conical or tapered portion **56**, and a cylindrical end portion **58**. The end portion **58** is tubular as defined by an axial bore **60** open at its end and extending for a length greater than the thickness of the wall **10** to be perforated thereby, so as to define a comparatively thin rigid tube wall **62**. The tip of the tool in this instance is defined by a pair of oblique flat end faces **64** extending at an angle to each other so as to define a substantially V-shaped contour, as seen in FIG. 8, with the apex **66** of the V located in a line extending diametrically of the tool, and thus providing two diametrically opposed aligned radial tool edges **66** or apices for contacting the work, such as the wall **10**. The angular displacement between the planes in which the faces **64** lie and the axis of the tool is preferably substantially equal. Faces **64** are preferably displaced from about ten degrees to twenty degrees or more from a plane perpendicular to the axis of the tool, so that the included angle between said planes of faces **64** is preferably from about 140 degrees to about 160 degrees.

This tool operates in the same manner described above and produces a slug similar to that illustrated in FIGS. 5 and 6 and characterized by an extruded stem portion **32**, an overall length greater than the thickness of the wall **10** from which it is removed, and an enlarged head portion **36** of roughened and substantially frusto conical circumferential outline and with a convex end **40** interrupted by a recessed center portion **42**.

The perforating member in all embodiments will preferably be formed of a low carbon tool steel which has been hardened to maximum toughness without making it brittle. One such steel which is particularly well suited for use in making this perforating member is known as Allegheny Ludlum No. 609, of 60–75 carbon steel. It is also possible to use mild steel of the type used for products to be processed on screw machines after the same has been carburized and hardened.

A series of tests have been made to ascertain the torque required to operate a perforating tool of the double bevel type shown in FIGS. 7 and 8. Ten tests of devices using a perforating tool having a ⅜ inch punch or leading end portion, with a one-quarter inch axial bore, wherein the angular displacement or included angle between the beveled faces **64** was 150 deg., and the threaded portion **50** of the tool had twenty threads per inch, revealed that in perforating the 5⁄16 inch thick wall of a steel pipe six inches in diameter, the average torque required to perforate the pipe as registered on a torque wrench was seventy pounds. Further tests of the same perforating apparatus used on steel pipe of lesser diameter, such as a two-inch pipe, showed that the same perforator described above with a 3/8 inch diameter tubular tip portion required an average of forty-five pounds pull on a torque wrench to perforate the wall **10**. A series of tests wherein a punch having a one-half inch diameter tubular tip of the double beveled character illustrated in FIG. 7 with a 5/16 inch axial bore and a 3/32 inch wall thickness, with a perforator threaded portion **50** having a lead of twenty threads per inch, was used to perforate a 5/16 inch thick wall of a steel pipe six inches in diameter, required one hundred pounds pull on a torque wrench. Thus it will be apparent that the force required to operate the device renders it particularly well suited for manual operation by the use of a long-handled wrench, and the device is well suited for use in the field under usual service conditions.

While the preferred embodiments of the invention have been illustrated and described, it will be understood that changes in the construction may be made within the scope of the appended claims without departing from the spirit of the invention.

We claim:

1. In means for perforating a wall of a steel member of substantially uniform thickness, comprising a tube secured to said wall to extend substantially perpendicularly to said wall and having an internally threaded end portion spaced from said wall and an elongated perforating tool screw-threaded at one end thereof to mate with said tube threads and formed of a metal harder than said wall, said tool having a reduced diameter substantially cylindrical concentric perforating end portion having an oblique end face, the improvement comprising an axial concentric bore in said perforating end portion open at said end face and of a depth greater than the thickness of said wall, said end face being defined by two oblique planes intersecting diametrically of said end face and defining a pair of aligned wall-engaging edges.

2. In means for perforating a wall of a steel member of substantially uniform thickness, comprising a tube secured to said wall to extend substantially perpendicularly to said wall and having an internally threaded end portion spaced from said wall and an elongated perforating tool screw-threaded at one end thereof to mate with said tube threads and formed of a metal harder than said wall, said tool having a reduced diameter substantially cylindrical concentric perforating end portion having an oblique end face, the improvement comprising an axial concentric bore in said perforating end portion open at said end face and of a depth greater than the thickness of said wall, said end face having a V-shaped profile defining a pair of aligned radial wall-engaging edges.

3. In means for perforating a wall of a steel member of substantially uniform thickness, comprising a tube secured to said wall to extend substantially perpendicularly to said wall and having an internally threaded end portion spaced from said wall and an elongated perforating tool screw-threaded at one end thereof to mate with said tube threads and formed of a metal harder than said wall, said tool having a reduced diameter substantially cylindrical concentric perforating end portion having an oblique end face, the improvement comprising an axial concentric bore in said perforating end portion open at said end face and of a depth greater than the thickness of said wall, said end face having a V-shaped profile defined by two oblique planes intersecting diametrically of said end face and displaced between 140 deg. and 160 deg.

4. Means for perforating a wall of a steel member of substantially uniform thickness, comprising a tube internally screw-threaded at one end and secured at its opposite end to said wall in substantially perpendicular relation thereto, and an elongated perforating tool having a threaded end mating with said tube threads and formed of a metal harder than said wall, said tool having an integral concentric reduced diameter cylindrical tubular end portion, the free edge of said tubular portion lying in oblique intersecting planes to define wall-engaging radial apices perpendicular to the axis of said end portion.

5. Means for perforating a wall of a steel member of substantially uniform thickness, comprising a tube internally screw-threaded at one end and secured at its opposite end to said wall in substantially perpendicular relation thereto, and an elongated perforating tool having a threaded end mating with said tube threads and formed of a metal harder than said wall, said tool having an integral concentric reduced diameter cylindrical tubular end portion, the free edge of said tubular portion lying in two oblique planes intersecting diametrically of said tubular portion to define aligned wall-engaging radial apices.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 24,199	McDonald	Aug. 21, 1956
1,020,302	Metz	Mar. 12, 1912
1,881,787	Mample et al.	Oct. 11, 1932
2,382,639	Kenard	Aug. 14, 1945
2,606,615	Pevey et al.	Aug. 12, 1952
2,950,637	Merrill et al.	Aug. 30, 1960