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Finney et al.

[11] **3,734,112**

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[54] **METHOD OF TAPPING A HOLE IN A MAIN THROUGH A FITTING**

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[73] Assignee: **Mueller Co.,** Decatur, Ill.

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[21] Appl. No.: **122,986**

Related U.S. Application Data

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[52] **U.S. Cl.** **137/15,** 137/318

[51] **Int. Cl.** **B23b 41/08**

[58] **Field of Search** 137/15, 318

[56] **References Cited**

UNITED STATES PATENTS

3,094,137 6/1963 Burke 137/318

Primary Examiner—Alan Cohan
Attorney—Cushman, Darby & Cushman

[57] **ABSTRACT**

A method for opening a flow-way in a main when a main is to be connected to a secondary main or service line. In opening the flow-way in the main, a perforator or tapping tool is utilized, which will progressively form the hole or aperture in the main by upsetting the material of the main outwardly of the same into the through bore of a fitting attached to the main, the upset material acting as a mechanical fastening means for increasing the resistance of a fitting to twist about the axis or center line of the main.

4 Claims, 11 Drawing Figures

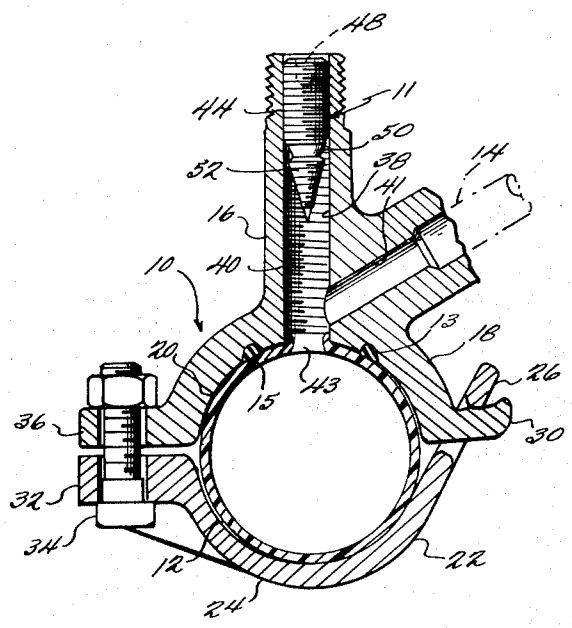


Fig. 1

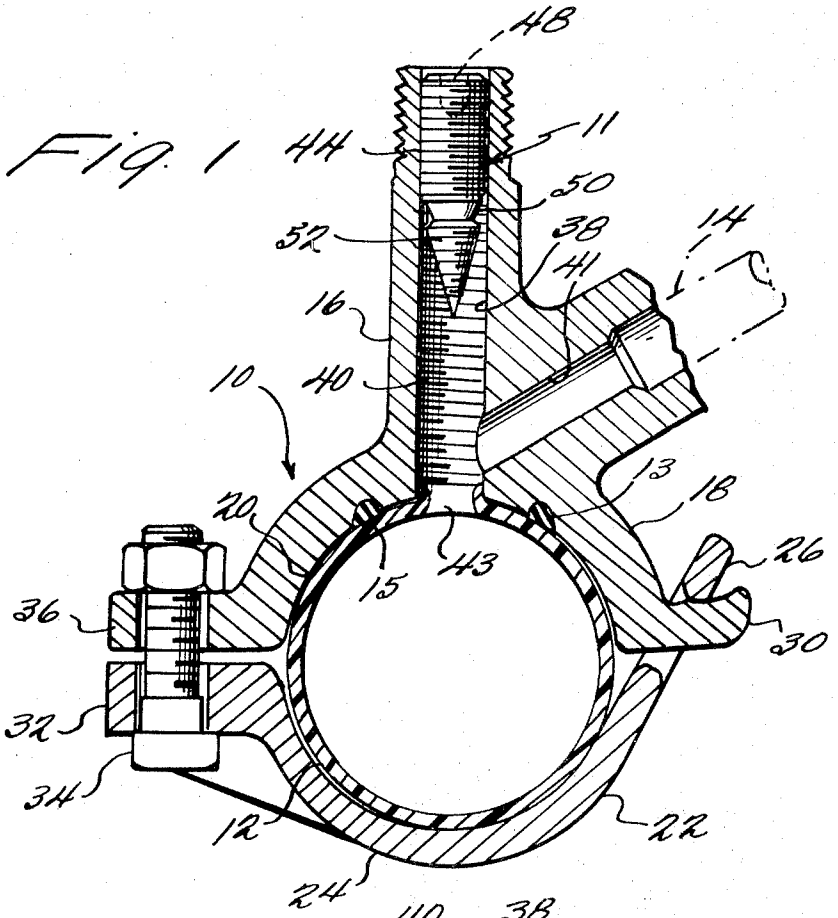

48
11
44
50
52
38
14
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15
43
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12
22
24

Fig. 2

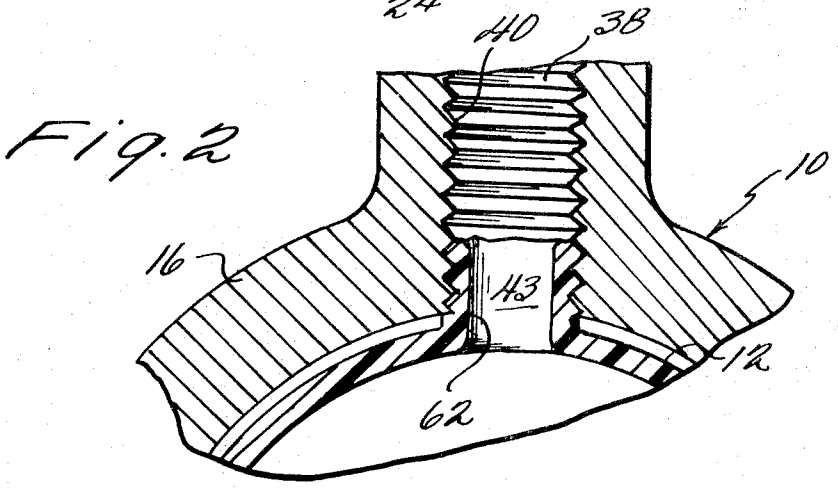

40
38
10
16
43
12
62

Fig. 3

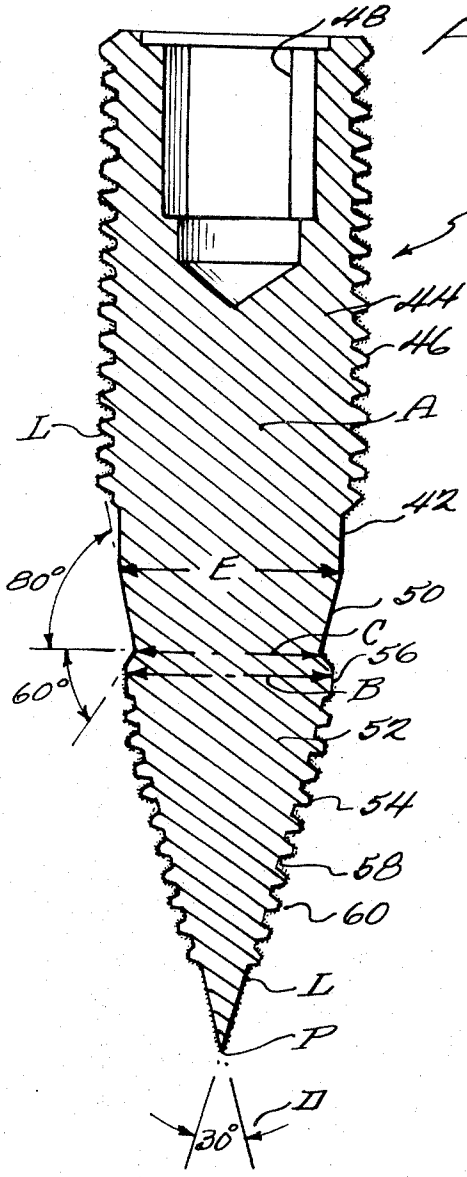
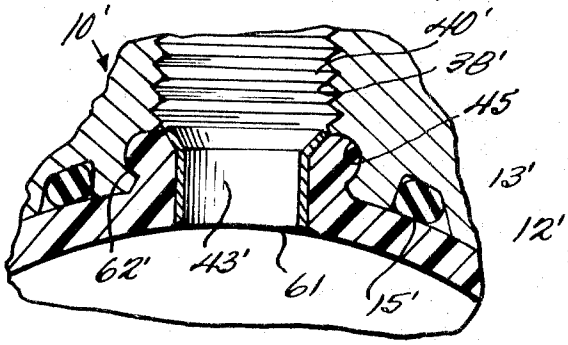


Fig. 6



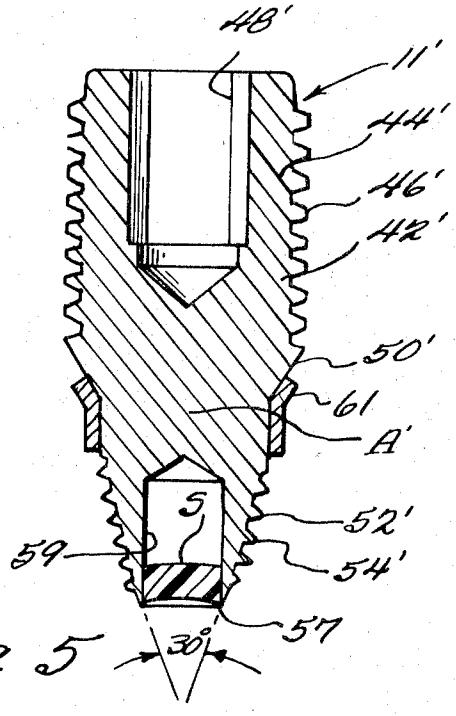
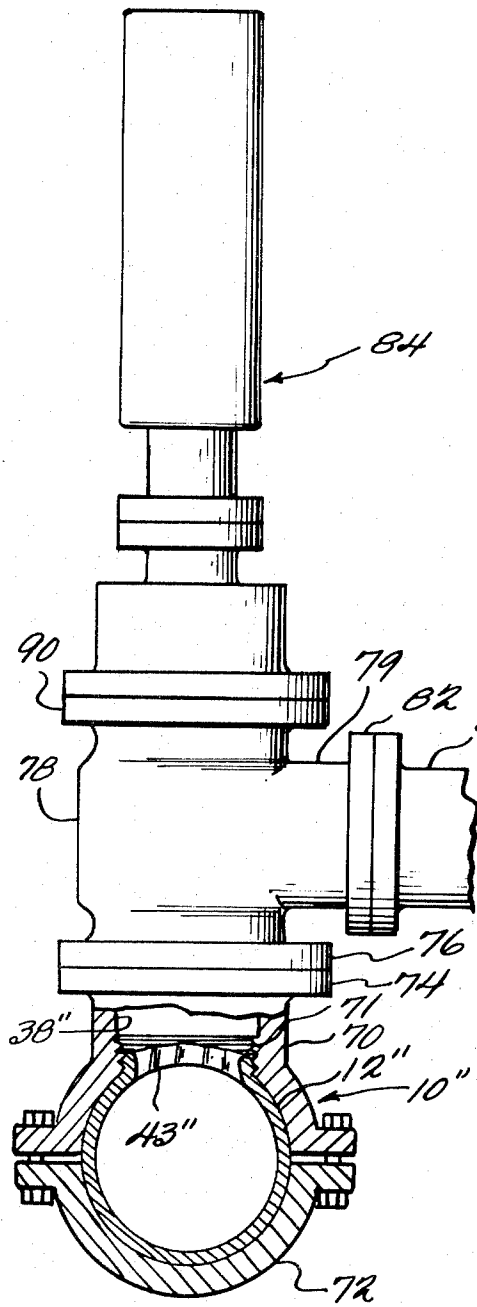


Fig. 5

Fig. 4


84
90
79
82
83
78
76
74
71
70
38"
12"
10"
43"
72

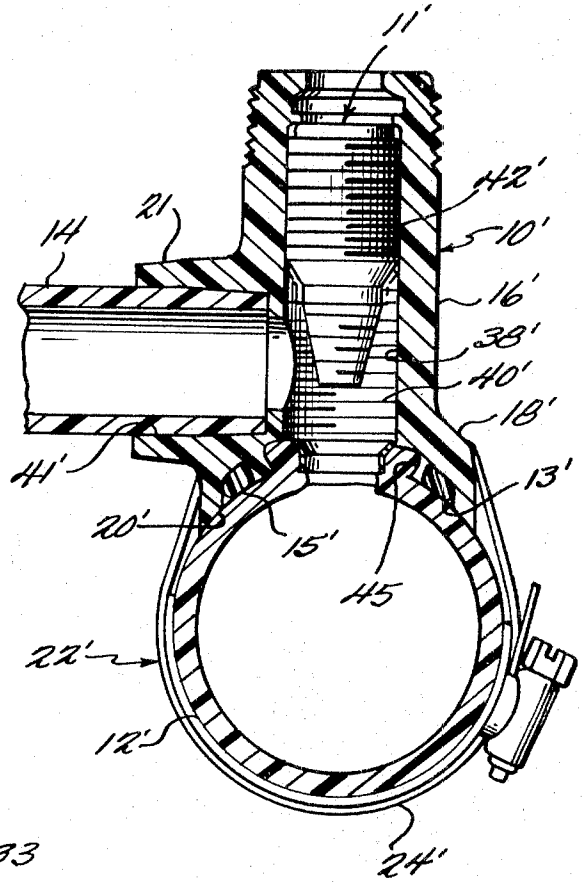
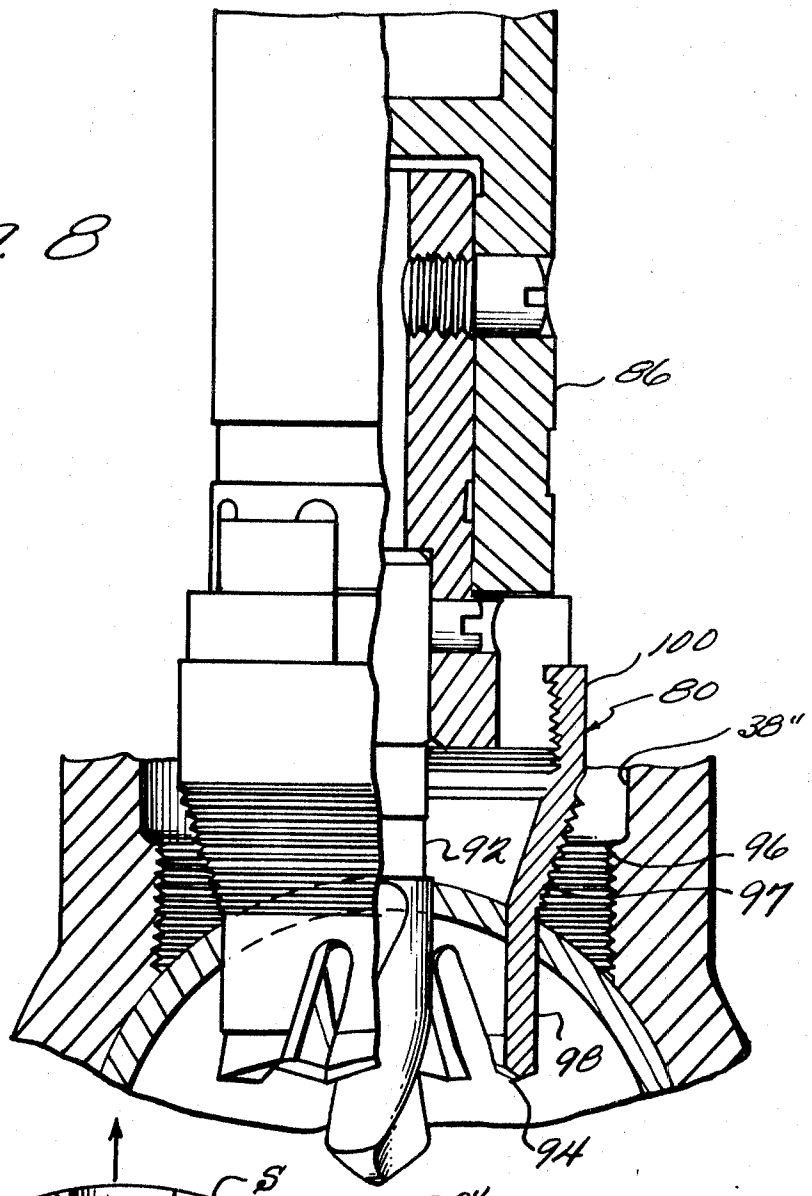

11'
42'
10'
14
21
16'
38'
40'
18'
41'
13'
20'
15'
45
22'
12'
24'

Fig. 7

Fig. 8



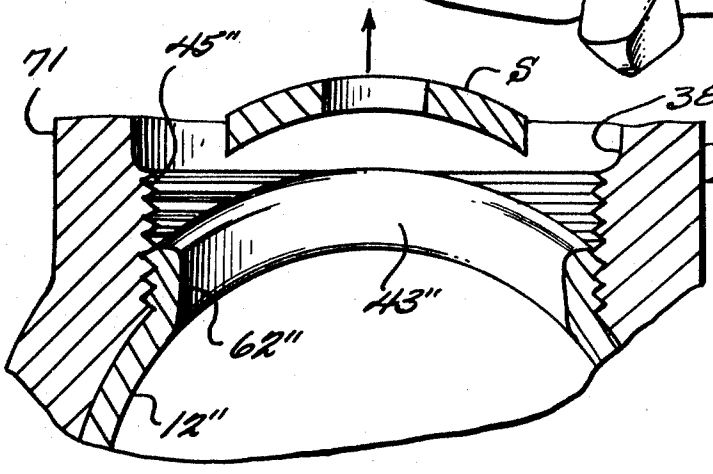


Fig. 9

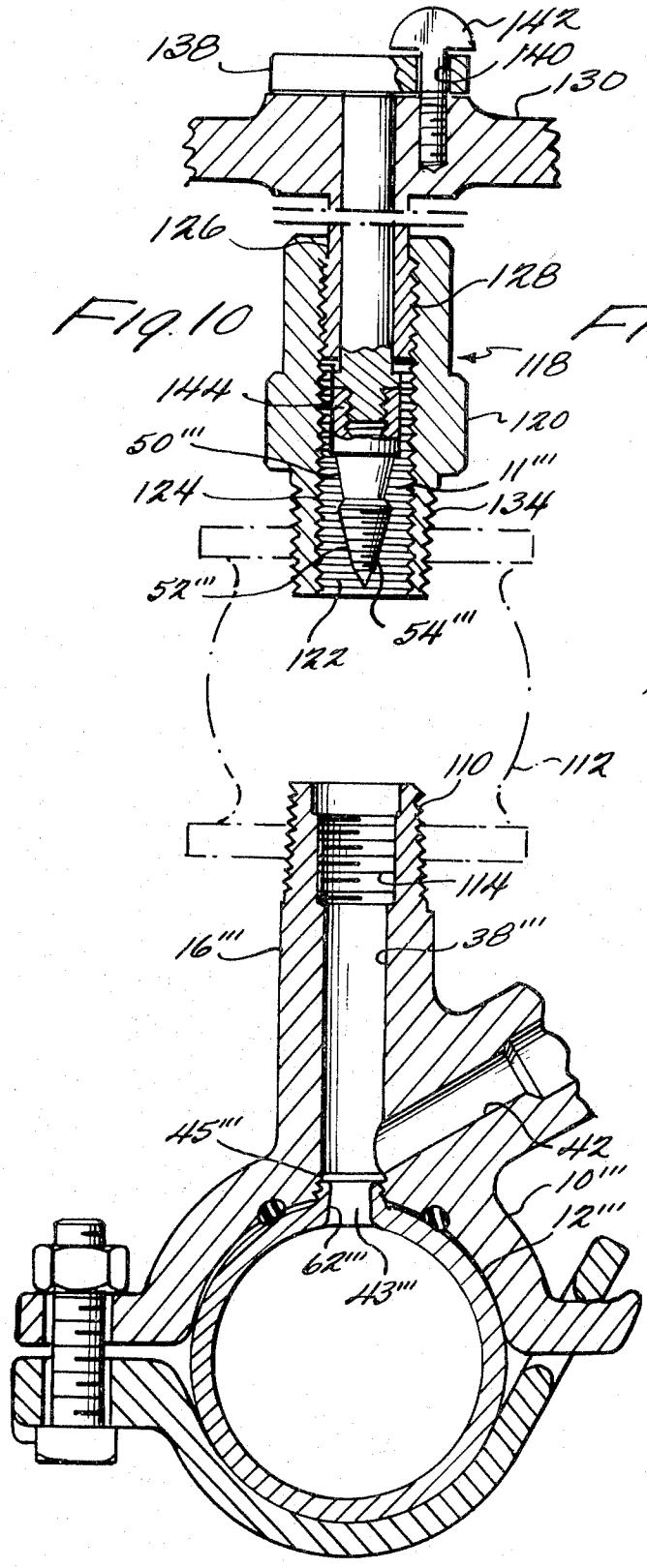

142
140
138
130
126
128
118
144
120
50'''
11'''
124
134
52'''
54'''
122
110
112
114
16'''
38'''
45'''
42
10'''
12'''
62'''
43'''

Fig. 10

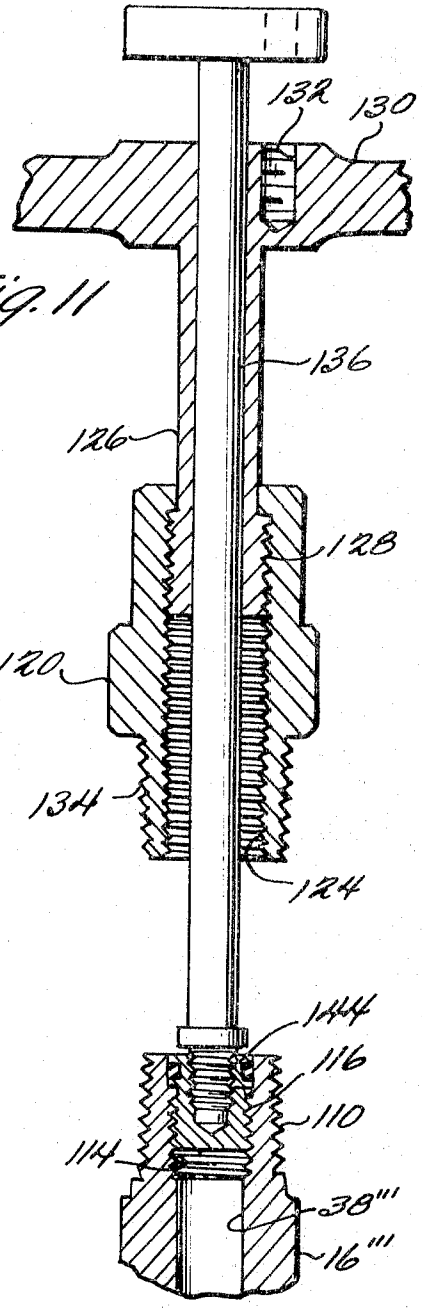

132
130
136
126
128
120
134
124
144
116
110
114
38'''
16'''

Fig. 11

METHOD OF TAPPING A HOLE IN A MAIN THROUGH A FITTING

This application is a division of our copending application Ser. No. 868,040 filed Oct. 21, 1969, and is entitled to the filing date thereof.

The present invention relates to improvements in a method and for tapping a main when setting up a flowway from the main to a secondary main or service line.

BACKGROUND OF THE INVENTION

Self-tapping fittings, such as service Tees, nipples, or the like, have been heretofore utilized in connecting a secondary main or service line to a main without the escape of fluid from the main to atmosphere. Such prior arrangements have utilized drilling machines connected to the fittings through which shell cutters or other drills were advanced through a valve and through the fitting to form the hole in a main. Additionally, some fittings have been provided with a through bore that is threaded interiorly, the through bore threadedly receiving the tapping tool which may be advanced by rotation. Such tapping tools had annular cutters for removing the coupon from the main or piercing members for punching a hole through the main. Typical prior art arrangements may be found in the following U.S. patents:

Number	Name	Date
2,736,335	Webber	Feb. 28, 1956
2,839,075	Mueller	June 17, 1958
2,852,967	Mueller et al.	Sept. 23, 1958
2,895,352	Mueller	July 21, 1959
2,950,637	Merrill et al.	Aug. 30, 1960
3,264,907	Mueller et al.	Aug. 9, 1966
3,302,493	Hulslander et al.	Feb. 7, 1967
3,349,792	Larkin	Oct. 31, 1967

In the above-mentioned prior art devices, the perforating of the main was accomplished by either removing a coupon from the main, the coupon being retained in the cutter as the cutter was withdrawn from the hole, or by piercing or swaging a hole inwardly of the main when utilizing a solely piercing member. Oftentimes the tapping tool was utilized as a valve means to plug the hole in the main until such time that service is needed.

BRIEF SUMMARY OF THE INVENTION

The present invention involves a method in which a hole or aperture is formed in a main through a bore in a fitting,at least preliminarily secured to the main,by upsetting the material of the main in a generally radial and outward direction into the bore of the fitting. The upset material surrounding the formed hole functions as a mechanical or secondary fastening means between the main and the fitting as it limits the amount the fitting will twist about the center line or axis of the main. In situations where the upset material is substantially in contact with the wall of the through bore, there is no slippage and an immediate lock. On the other hand, in situations where the upset material has a slight clearance with the wall of the through bore, there is a slight slippage before locking would be effected.

Further, the invention contemplates swagging the upset material into tight engagement with the walls of the bore of the fitting so as to assist in locking the fitting to the main against removal in not only a circumferential sense but also in a radial sense. This mechanical locking of the fitting to the main reduces the dependence of clamping straps and minimizes loosing which might take place due to corrosion under the straps.

By utilizing a perforating tool, which has a tapered portion with a thread thereon for swagging and/or cutting the hole, and by controlling the advancement and rotation of the perforating tool, which relation to the lead of the thread on tapered portion, the material being displaced during the progressive forming of the hole can be controlled so as to be upset outwardly of the main into the fitting and against the wall of the bore of the fitting. By upsetting the material outwardly of the main, the material does not extend inwardly of the main so as to interfere with normal flow through the main or restrict the inside diameter of the main. Additionally, the smooth upsetting of the material outwardly of the main into the through bore of the fitting results in a smooth, well-rounded opening, thereby maintaining a minimum pressure drop across the same.

Another aspect of the present invention is to provide a preliminary undersize hole or aperture in the main by cutting a coupon therefrom and then further forming the hole to a predetermined size by upsetting the material around the undersized hole outwardly of the main into the bore of the particular fitting used. This latter mentioned arrangement would be utilized especially where it is desired to provide a relatively large hole in a main, and thus the necessity of cutting an undersized hole first and retaining this coupon and then subsequently progressively increasing the size of the undersize hole by upsetting the material around the undersize hole by swaging such material into the bore of the fitting attached to the main.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross-sectional view of the assembly of the present invention, taken through a main, the assembly utilizing a saddle service Tee type of fitting.

FIG. 2 is an enlarged fragmentary sectional view illustrating the main of FIG. 1 having been perforated with the material from the hole being swaged or upset outwardly of the main into the through bore of the fitting.

FIG. 3 is an enlarged vertical sectional view of the perforating or tapping tool of the present invention.

FIG. 4 is a vertical sectional view similar to FIG. 1, but illustrating a plastic service Tee and a plastic pipe with a modified perforating or tapping tool.

FIG. 5 is an enlarged vertical sectional view of the tapping tool of FIG. 4.

FIG. 6 is an enlarged fragmentary vertical sectional view illustrating the tapping of a hole in a main by the tool shown in FIGS. 4 and 5.

FIG. 7 is a schematic drawing of a typical drilling machine attached to a fitting on a main, the fitting and the main being shown in vertical section with the main having been perforated, or tapped.

FIG. 8 illustrates a further modification of the present invention utilized with a shell cutter for the drilling machine of FIG. 7, the shell cutter functioning to cut a coupon when forming the undersized hole.

FIG. 9 is an enlarged fragmentary sectional view showing the main with the hole formed therein and with the coupon initially removed by the shell cutter of FIG. 8.

FIG. 10 is a still further modification of the present invention, the view being partially schematic and par-

tially in vertical section and illustrating a different type of hand-operated drilling machine; and

FIG. **11** is a vertical sectional view of the modified form of drilling machine shown in FIG. **10**, the view illustrating the drilling machine inserting a completion plug into the fitting or service Tee after the hole has been drilled.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings wherein like reference or character numerals represent like or similar parts, there is disclosed in FIGS. **1-3** one embodiment of the present invention for opening a flow way from a main to a service line or pipe. In more detail, there is disclosed a service fitting generally designated at **10** equipped with a tapping tool **11**, the service fitting being utilized to connect a main **12** of a fluid pressure system, such as a gas system or the like, to a service line **14**, extending to a point of use, such as a dwelling or the like. The main **12** and/or service line **14**, as disclosed in this particular environment of the invention, is made of metal but, as will be described later in the specification, the main and the service line may be plastic.

In the particular embodiment disclosed in FIG. **1**, the service fitting **10** is shown as a saddle clamp type of fitting having a unitary body member **16** made as a malleable iron casting or as a steel forging, the body member **16** being provided with an integral saddle part **18** having an arcuate surface **20** of a curvature complementary to the curvature of a portion of the external surface of the main **12**. Clamping means generally designated at **22** form part of the service fitting **10** and clamp the body member **16** in fluid type connection to the main **12**. The clamping means **22** include an arcuate strap-like member **24** with an eye **26** at one end thereof for fitting over a hook portion **30** on the body member **16** and a lug member **32** at the other end thereof, the lug member being provided with an aperture through which bolt means **34** extend. The body member **16** is provided with a similar lug **36**, and it will be understood that by tightening the bolt means **34**, the service fitting is positioned on the main **12**.

While the service fitting **10** is disclosed as a saddle clamp type of service fitting, it will be appreciated such service fitting may be a conventional service Tee welded directly to the main, or otherwise suitably secured thereto, or other types of fittings, some of which are shown in the drawing and which will be described later in the specification.

The body member **16** is provided with a through bore **38** opening to the arcuate surface **20** at its inner end and extending therefrom outwardly. The through bore **38** in the particular arrangement shown in FIGS. **1** and **2** is interiorly threaded at **40**, along its entire length for the functions to be described later in the specification. Body member **16** is also provided with a lateral bore **41** opening at the through bore at its inner end, the lateral bore being arranged to communicate with the service line **14** suitably connected to the fitting.

The tapping tool **11** for forming a hole or flow way **43** in the main **12** is shown in FIG. **1** in a retracted position in the through bore **38**, after the hole **43** has been formed. In more detail, and also referring to FIG. **3**, the tapping tool **11** is provided with a plug-like body member **42**, having a first body portion **44** with exterior threads **46** thereon that may be received in the interior threads **40** of the body member **16** of service fitting **10**. At the terminal end of the first body portion **44** of tapping tool **11**, there is provided a non-circular socket or recess **48**, for receiving an Allen wrench or other tool which can rotate the tapping tool on its longitudinal axis A and either advance or retract the same in the threaded through bore **38** of the service fitting **10**, depending on the direction of rotation. The body member **42** of the tapping tool is also provided with an intermediate body portion **50**, which is frusto-conical and tapers inwardly at an angle of 10° with respect to the longitudinal axis A of the tapping tool. Further, body member **42** is provided with a tapered or conical third body portion **52**, which has an external thread **54** of the same hand as the thread **46**. The largest diameter of the tapered body portion **54** at the line B is slightly greater than the smallest diameter of the intermediate body portion **50** at the line C, the purpose of which will be described in detail later in the specification. Additionally, the included angle D of the tapered body portion **52** defining the penetrating end of the tapping tool **11** is preferably 30°.

It will be noted that the thread **54** on the tapered body portion **52** starts at a slight distance from the point P, as the point P functions as a centering means and keeps the tip P aligned when the hole **43** is started and the thread **54** begins its work. The thread **54** terminates at its upper end, as viewed in FIG. **3**, in a buttress thread **56** for the last helix thereof, the purpose of providing such a buttress thread being to make the tapping tool stronger at this area where there could be damage to the thread by the material of the main **12** being upset. Preferably the thread **54**, other than where the buttress helix **56** is provided, has a blunt root, as indicated at **58**, and a sharp crest as indicated at **60**, so that it somewhat resembles the thread of a sheet metal screw. By having a blunt root at **58**, rather than a sharp root as in a conventional thread, stress rises, due to the upsetting of material from the main, are reduced and the thread can fully function to swage or move the material when the hole **43** is being formed.

In order to move or swage the material in a predetermined direction from around the hole **43** being formed, the lead or pitch of the helices of the thread **54** on the tapered body portion **52** of the tapping tool **11**, differs from the lead or pitch of the helices of the thread **46** on the first body portion **44**. In this respect, the thread **54** has a greater lead than the thread **46**, and consequently when the tapping tool **11** is positively advanced in the through bore **38** of the service fitting **10** and the tapered body portion **52** begins and is penetrating the wall of the main **12**, the material of the main **12** will be swaged or upset outwardly of the main, as indicated at **62** in FIG. **2** up into the through bore **38**. In order to obtain the desired movement of the material being upset and swaged from the main **12**, it has been found that the ratio between the helices driving thread **46** and the helices of the perforating or swaging thread **54**, should be in the order of five to four. In other words, the number of helices per inch of the thread **54** should be 80 percent of the number of helices per inch of the thread **46**.

If the tapping tool **11** of FIG. **3** is provided with its tapered body portion **52** and its tapered intermediate portion **50** considerably smaller than its body portion **44**, then the upset material will not be swagged radially outwardly into engagement with the wall of through bore **38**. However, this arrangement still provides a me-

chanical lock after there has been slight slippage between the fitting **10** and main **12.**

The tapping tool **11** is preferably made of fully hardened steel, at least when it is being used to form a hole in steel or iron pipe. In this respect, it has been found that the tapping tool **11** should be at least **15** Rockwell "C" points harder than the material of the main to be perforated or tapped and with respect to certain steel mains, such tapping tools **11** have been made with a 50 Rockwell "C" hardness number throughout. By providing a fully hardened or for that matter, a case hardened, tapping tool **11,** extensive galling of the threads **46** and **54** is prevented during operation.

The operation of the assembly heretofore described is as follows: First, the service fitting **10** is assembled on the main **12** at a location where it is desired to tap the hole **43** into the main for the purpose of connecting the main to the service line **14.** Usually the service fitting **10** is provided with a groove **13** on the surface **20** surrounding the lower opening of the through bore **38.** An O-ring **15** is provided in the groove **13,** the O-ring sealing against the exterior of the main around the location where the hole **43** is to be made. The service line **14** is then connected to the service fitting **10** and the main is ready to be tapped. By use of an Allen wrench or other tool, the tapping tool **11** is rotated in the threads **40** of the through bore **38** in such a manner as to advance the tapered end portion **52** of the tapping tool toward the main. The point P will begin penetration of the main and then the tapered thread **54** begins its work to progressively form the hole **43.** In this respect, for each revolution of the tapping tool **11,** it is positively advanced a predetermined distance, dependent upon the lead or pitch of the driving thread **46.** Since the lead or pitch of the thread **54** is greater than the lead or pitch of the thread **46,** the material being displaced by the thread **54** will be directed outwardly of the main **12** and upwardly into the lower end of the through bore **38.** The ultimate size of the hole in the main **12** is determined by the maximum diameter B of the tapered thread **54** on the tapered portion **52** of the body member **42.**

As soon as the last buttress helix **56** has performed its work there is a relief provided between the tool and the material upset from the hole **43,** due to the reduced diameter C of the tapered intermediate portion **50** directly above the buttress helix. Consequently, the operator, when turning the tapping tool **11,** will notice a momentary reduction in torque followed by an increase in torque and will be aware that only a few number of turns of the tapping tool **11** need now be made to complete the operation. The tapered intermediate portion **50** will now function as a further swaging surface, as its maximum diameter, as indicated at E, is greater than the maximum diameter of the buttress helix **56** of thread **54.** The purpose of the tapered intermediate portion **50** is to force the upset material **62** around the hole **43** radially outwardly of the hole, so that it fills the lowermost helices of the thread **40** of the through bore **38.** This positively locks the upset portion **62** to the service fitting **10,** so that the upset portion now functions to not only prevent the body member **16** from turning on the axis of the main **10,** but also functions to prevent the body member **16** from being easily removed even when the strap-like member **24** of the clamping means **22** is released.

Instead of running the thread **40** all the way to the opening of the through bore **38,** with the interior **20** of the saddle **18,** recesses, knurling, or grooves may be provided in the lower end of the through bore **38** for receiving the upset material **62** to anchor the same, as is shown in the drawings of other modifications of the invention.

The tapping tool **11** may be coated with a dry film lubricant L such as disclosed in the common assignee's U.S. Pat. No. 3,264,907, issued Aug. 9, 1966 on all of its surfaces, except the swaging surface of the smooth, tapered intermediate portion **50.** By leaving the dry film lubricant L off of the intermediate portion **50,** the operation of the tapping tool is enhanced as it gives the operator a greater feel when he has completed the penetration portion of the forming of the hole **43,** as there is a significant increase in torque when the upset portion **62** is swaged radially outwardly by the surface of the tapered portion **50.** Additionally, such an operation is accompanied by a squealing noise giving another clue to the completion of the operation.

Referring now in particular to FIGS. **4–6** inclusive, there is disclosed a modification of the assembly of the present invention which may be utilized for connecting a plastic main **12'** to a plastic service line **14'.** In this embodiment of the invention, a plastic service fitting or Tee **10'** is utilized, the same being somewhat similar to the common assignee's U.S. Pat. No. 2,839,075, issued June 17, 1958, or to the common assignee's U.S. Pat. No. 3,460,553, issued Aug. 12, 1969. In more detail, the plastic service fitting **10'** includes a body portion **16'** having at its lower end a saddle part **18'** provided with an arcuate shaped surface **20'** complementary to the exterior surface of the plastic main **12'.** A lateral outlet **21** provided with a lateral bore **41'** opens to an interiorly threaded through bore **38'.** The lateral outlet **21** is arranged to receive the plastic service line **14'.** A groove **13'** surrounding the opening of the through bore **38'** to the surface **20'** is provided for receiving an O-ring **15'.**

Clamping means **22',** such as a pair of hose clamps **24',** are arranged to extend about the main **12'** and the exterior of the saddle part **18'** so as to clamp the service fitting **10'** at least temporarily on the plastic main **12'.** Sufficient pressure is applied through the hose clamps **24'** to enable the O-ring **15'** to make fluid type contact between the saddle part **18'** and the plastic main **12'** during the forming of a solvent weld between the saddle part **18'** and the main **12',** if such is used.

The through bore **38'** is provided with an interior thread **40'** which extends from at least adjacent its upper end to a point spaced slightly from its lower end. At its lower end, the through bore **38'** is provided with an annular groove, or recess, **45,** which functions similarly to the lower helices of the thread **40** in the embodiment of FIGS. **1–3,** inclusive. In other words, the groove **45** is arranged to receive the upset material **62',** when such material is caused to flow or move radially outwardly of the formed hole or flow way **43'** to thereby provide a positive lock or anchor between the main and the service fitting.

A tapping tool **11'** somewhat similar to the tapping tool **11** is provided for forming the hole **43'.** In more detail, and referring to FIG. **5,** the tapping tool **11'** in provided with a plug-like body **42'** having a first body portion **44'** provided with an exterior driving thread **46',** which is received in the interior thread **40'** of the

through bore 38'. The first body portion 44' has a non-circular socket 48' in its outer end, in which an Allen wrench or other tool may be inserted for rotating the tapping tool 11' to advance or retract the same in the bore 38'.

An intermediate body portion 50', which is frusto-conical and tapers inwardly from the first body portion 44' at an angle in the order of 30° with respect to the longitudinal axis A' to a point where it is provided with a short cylindrical portion, is provided for swagging or moving the upset material 62' radially outwardly into the groove 45. The body member 42' is further provided with a tapered frusto-conical third body portion 52', the third body portion tapering inwardly from the lower end of the cylindrical portion of intermediate body portion 50', as viewed in FIG. 5. An external cutting or swaging thread 54' is provided on the exterior of body portion 52'. The included angle of the frusto-conical third body portion 54' is in the order of 30°, whereas the thread 54' is coarser than the driving thread 46'. With regard to the threads 46' and 54', the ratio between the helices of the driving thread 46' and the swaging thread 54' is in the order of five to four, so that the lead of the thread 54' which progressively forms the hole 43' is greater than the lead or pitch of the thread 46', and thus will upset material outwardly of the main 12'.

The end of the tapping tool 11' is provided with an annular cutting edge 57 and a longitudinally extending closed bottom bore or recess 59. When the tapping tool 11' initially engages the main 12', the cutting edge 57 cuts from the main 12' a coupon or slug S and forms a preliminary hole in the main 12'. Further, rotation with positive advancement of the tapping tool 11' in the through bore 38' will result in the threads 54' progressively forming the hole 43' and since the lead of the thread 54' is greater than the lead of the thread 46', the material being removed from around the hole will be progressively moved and upset outwardly of the main 12' into the through bore 38' until the last helix of the thread 54' has performed its work.

Plastic material used in plastic mains, as distinguished from metal used in mains, usually has a greater elastic memory. However, it is known that plastic material can be flowed past its elastic memory and this occurs when the hole 43' is being progressively formed by the tapered thread 54' and the material is being upset at 62'. However, in some instances, when the material of the plastic main 12' is moved or swaged radially outwardly by the swaging surface of intermediate body portion 52' into the groove 45, it may have a slight tendency to contract when the tapping tool 11' is withdrawn from the hole 43'. In order to eliminate any such tendency and further, in order to materially increase the resistance of the upset material 62' to shear, a reinforcing metallic ring 61, having an interior shape complementary to the shape of the intermediate portion 50', is loosely fit onto the tapping tool 11' prior to formation of the hole. When the hole 43' has been formed by the thread 54' and the tapping tool 11' is further advanced so that the upset portion 62' can be radially expanded into the groove 45, the material of the upset portion is forced outwardly by the reinforcing ring or sleeve 61 into the groove. When the tapping tool 11' is withdrawn, the ring 61, which has a loose fit on the tool, will remain embedded in the upset material 62' and will form the wall of the hole 43', thus reinforcing the upset material and increasing the amount of force necessary to produce failure from shear. Preferably, the overall longitudinal length of the ring 61 is approximately equal to the wall thickness of the main 12', plus the overall height of the upset material 62'.

As will now be apparent from the above-detailed description of the modification disclosed in FIGS. 4–6, the operation of the assembly is substantially similar to that described with respect to the assembly of FIGS. 1–3, with the exception that a coupon S is first cut from the main 12'. The tapping tool 11' is advanced a predetermined distance for each rotation of the same, and since this advancement differs from the lead of the tapered hole forming thread 54', the material removed will flow upwardly into the bore 38' of the service fitting.

While the cutting tool 11' has been illustrated and described in the use with a plastic service fitting for connecting a plastic main to a plastic service line, it will be understood that such a tool may be used in forming large diameter holes in metal mains. Of course, as previously mentioned, the tapping tool must be harder than the material of the main being perforated and the same is true of the tapping tool 11' regardless of whether it is utilized for perforating a plastic or a metal main.

Referring now in particular to FIGS. 7–9, there is disclosed a further modification of the present invention utilizing the same with a shell cutter operated by a drilling machine, the shell cutter being used in situations where a relatively large hole is to be provided in a relatively large main.

As disclosed in FIG. 7, an existing main 12'', in which it is desired to provide a lateral opening for connecting the same to a new supply main or service line (not shown) is provided at the area where the opening is made with a service fitting 10''. In this particular instance, the service fitting 10'' is a tapping sleeve which includes an upper body member 70 and a lower body member 72 bolted together about the main 12''. The upper body member 70 has a branch 71 with a through bore 38'' therein and a flange 74 at the upper end of the branch. A flanged end 76 of a conventional gate valve 78 is secured to the flange 74. A shell cutter 80 (FIG. 8) actuated by a drilling machine 84 may pass through the gate valve to cut the opening or hole 43'' in the main 12''. The gate valve 78 is provided with a body 70 having a flange 82, to which a bonnet 83 for valve is secured.

The drilling machine which is represented diagrammatically at 84 is connected to a flange 90 of the gate valve 78 in the usual manner, the drilling machine having the usual boring bar 86 (FIG. 8). Further, the drilling machine 84, which is of the conventional type, for example the type shown in the common assignee's U.S. Pat. Nos. 2,833,167, issued May 6, 1958; 2,884,808, issued May 5, 1959; and 2,907,229, issued Oct. 6, 1959, is provided with means for either manually or automatically rotating the boring bar 86 and advancing the same a predetermined distance for each revolution. Consequently, a detailed description of the drilling machine 84 will not be given.

The shell cutter 80 is attached to the lower end of the boring bar 86 and in this embodiment of the invention, such cutter defines the tapping tool. Usually a pilot drill 92 extends axially of the shell cutter 80 and projects beyond the cutting teeth 94 of the same. As is well known

in the art relating to shell cutters, the shell cutter **80** is rotated and advanced at a predetermined rate by the drilling machine. Its pilot drill is first to engage and bore a hole in the main. Once the hole has been bored in the main and the shell cutter **80** continues to rotate and advance, the teeth **94** of the shell cutter will then cut a coupon S from the main with the coupon being retained on the pilot drill by locking means (not shown). However, in this particular embodiment of the invention, the shell cutter is provided with an outwardly tapered portion **96** above its lower cylindrical portion **98,** the tapered portion **96** being provided with an external swaging thread **97** for enlarging the hole preliminarily cut. By providing the swaging thread **97** with a lead or pitch which is greater than the axial travel per revolution of the shell cutter, as determined by the boring bar **86,** the tapered thread **97** will progressively pull and upset the material from around the hole into the through bore **38''** of the tapping sleeve **70.**

A cylindrical swaging surface **100** is provided on the shell cutter **80** immediately above the last and largest helix of the thread **97,** this surface having a diameter at least as great as the diameter of the largest helix of the thread **97** so that the material upset, as indicated at **62'',** is swaged radially outwardly in a similar manner to the previous embodiments. As clearly shown in FIGS. **8** and **9,** the through bore **38''** of the tapping sleeve is provided at its lower end, when viewing these Figures, with a plurality of annular grooves or recesses **45'',** which receive the material from the upset portion **62''** when the same is swaged radially outwardly of the axis of the hole or opening **43''.** This mechanically locks the main **12''** to the tapping sleeve of the service fitting in a similar manner to that described with the previous embodiments of the invention.

Referring now to FIGS. **10** and **11,** there is disclosed a still further modification of the present invention wherein a manually operable drilling machine is utilized to take the place of the driving thread on the tapping tool **11** of the modifications of FIGS. **1–6,** inclusive.

In this particular embodiment of the invention, the service fitting **10'''** is a saddle clamp type of fitting substantially similar to the service fitting **10,** except that the through bore **38'''** is not provided with threads for advancing the tapping tool **11'''.** As clearly shown in FIG. **10,** the service fitting **10'''** has its body member **16'''** exteriorly threaded at **110** for threadedly receiving one end of a gate valve diagrammatically shown at **112.** The bore **38'''** is interiorly threaded as indicated at **114** adjacent its upper end for reception of a completion plug **116,** whereas its lower end of this bore is provided with annular recesses or grooves **45'''** capable of receiving material of the upset portion **62'''** of hole **43'''** formed in main **12'''.**

A manually operable drilling machine generally designated at **118** is provided with a body member **120** having a through bore **122,** the through bore **122** being provided with interior feed or drive thread, as indicated at **124.** A feed or drive sleeve **126** extends into the through bore **122** and is provided with an exterior feed or drive thread **128** for cooperating with the thread **124.** The portion of the feed sleeve **126** extending out of the body member **120** has a handle **130** fixed thereto, the handle **130** having a threaded bore **132** therein. Body member **120** at its lower end,as viewed in FIGS. **10** and **11,** is provided with an external thread **134** arranged to be received in the gate valve **112.**

An operating bar **136** extending through the upper end and freely slidable in the feed sleeve **126** is provided with a head **138** at its outer end exteriorly of the feed sleeve. The head **138** has a hole **140** therethrough, through which a thumb-screw **142** can be inserted and threaded into the bore **132** of the handle **130,** so as to lock the operating bar **136** both axially and rotatably with respect to the feed sleeve **126.** The inner end of the operating bar **136** is externally threaded, as indicated at **144** and is arranged to threadedly receive and support the tapping tool **11'''.**

Tapping tool **11'''** is identical to tapping tool **11** of FIG. **1** with respect to the tapered body portion **52'''**, and the tapered thread **54'''** on the exterior thereof. Additionally, the intermediate body portion **50'''** is identical to the intermediate portion **50** of the tapping tool **11** in that it provides a recess after work is completed by the thread **54'''** and functions as a swaging surface.

When it is desired to operate the assembly disclosed in FIG. **10,** the tapping tool **11'''** is threaded onto the threaded end **144** of the operating bar **136** and the operating bar is then moved to a position where the tapping tool **11'''** is completely retracted within the body member **120.** The body member **120** is assembled on the gate valve **112** and once this has been done, the operating bar **136,** once the valve has been opened, can be moved to the position where the tapping tool passes through the gate valve **112** and through the bore **38'''** to a point where the head **138** is flush against the handle **130** of the feed sleeve **126.** The thumb-screw **142** is then inserted through the head **138** and threaded into the handle **130** to lock these two elements together. By rotating the handle **130,** the feed sleeve **126** rotates and advances in the thread **124** of the body member **120.** This also causes rotation of the tapping tool **11'''** and a predetermined advancement of each revolution thereof. Since the threads **124** and **128** of the body member **120** and the feed sleeve **126,** respectively, have less of a lead than the tapered thread **54'''** on the tapping tool **11'''**, the hole **43'''**, being progressively formed, will have the material removed therefrom upset, as indicated at **62'''.** Once the thread **54'''** has completed its work, then the swaging surface of the intermediate portion **50'''** will urge the upset portion radially outwardly of the axis of the bore **38'''** into the recesses or grooves **45'''.** When this has been accomplished, the hole **43'''** is complete and the reverse procedure is accomplished to withdraw the tapping tool **11'''** through the gate valve **112.**

The gate valve **112** is then closed and the body member **120** is removed therefrom, so that the tapping tool **11'''** can be unthreaded from the end **144** of the operating bar. After this has been accomplished, then the completion plug **116** is inserted onto the threaded end **144** of the operating bar **136** and the body member **120** is reassembled onto the gate valve **112,** so that the insertion plug can be advanced through the gate valve when opened and threaded into the interiorly threaded upper end **114** of the bore **38'''**, as shown in FIG. **11.** After the completion plug **116** has been threaded into the upper end of bore **38'''**, then the rotation of the operating bar **136** in an opposite direction will cause it to separate from the completion plug **116.** The gate valve

112 may then be removed from the fitting 10''' and replaced by a closure (not shown).

The terminology used throughout the specification is for the purpose of description and not limitation, the scope of the invention being defined in the claims.

What is claimed is:

1. A method of tapping a hole in a main through a through bore in a fitting at least temporarily secured to the main, the fitting having a tapping tool with a threaded tapered portion for progressively forming the hole, the steps comprising: advancing and rotating the tapping tool toward and into engagement with the advancement per each revolution of the same being controlled to be less than the lead of the thread on the threaded tapered portion, causing the material around the hole being formed in the main to be swaged outwardly of the main into the through bore of the fitting to thereby eliminate obstruction within the main and to thereby provide a mechanical fastening between the main and the fitting to increase resistance of the fitting from twisting about the axis of the main.

2. A method as claimed in claim 1 including swaging the material upset by the threaded portion of the tool in a generally radial outward direction into engagement with the wall of the through bore in the fitting.

3. A method as claimed in claim 2, including the step of preliminarily cutting a hole in the main of a smaller diameter than a predetermined desired diameter, and then upsetting the material around the hole in the main to enlarge the hole to the predetermined diameter, the material being upset radially outwardly of the axis of the main into the through bore of the fitting.

4. A method as claimed in claim 3, including reinforcing the interior of the upset material defining the finished hole.

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