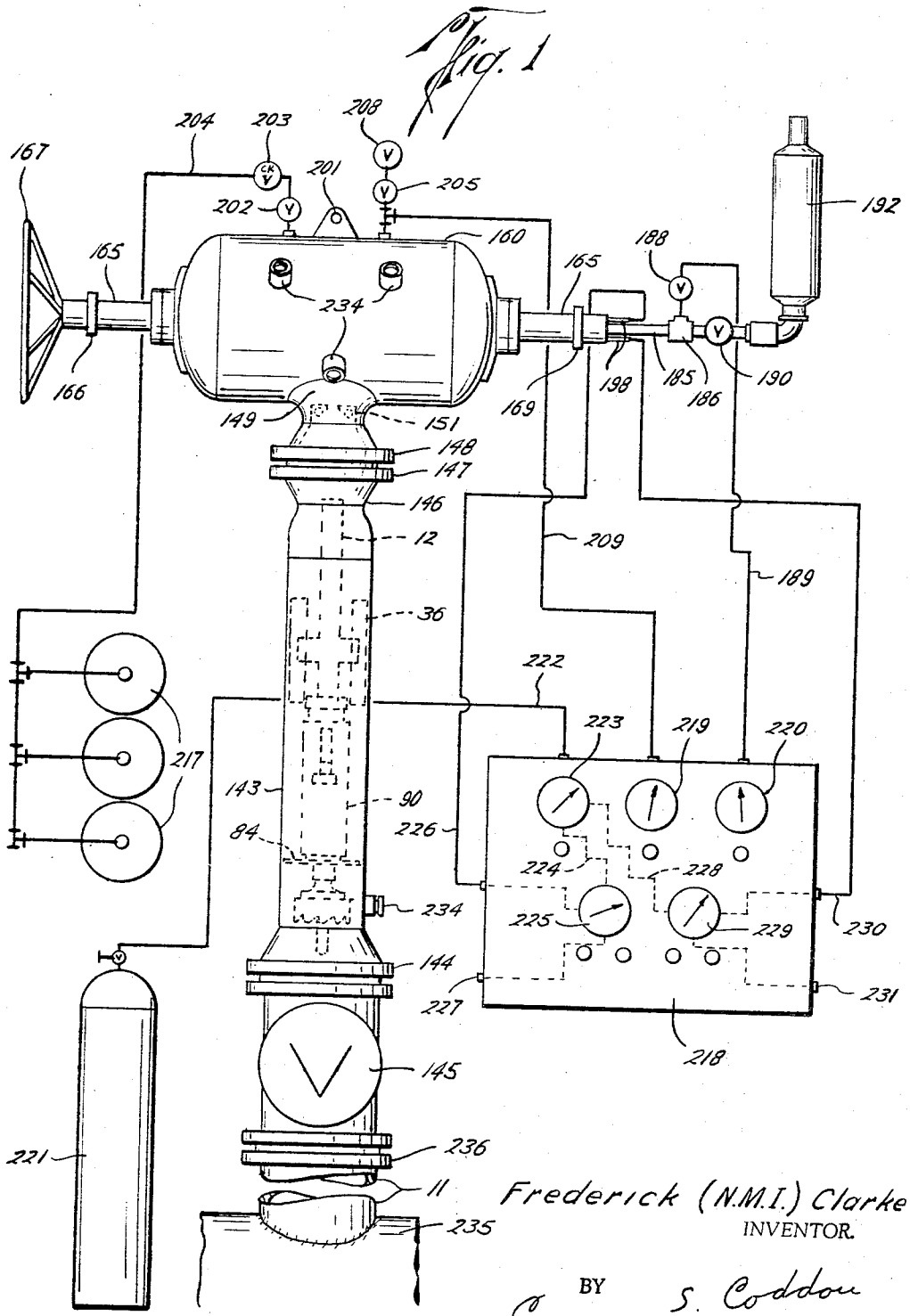
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TAPPING APPARATUS AND METHOD

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Fig. 1



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TAPPING APPARATUS AND METHOD

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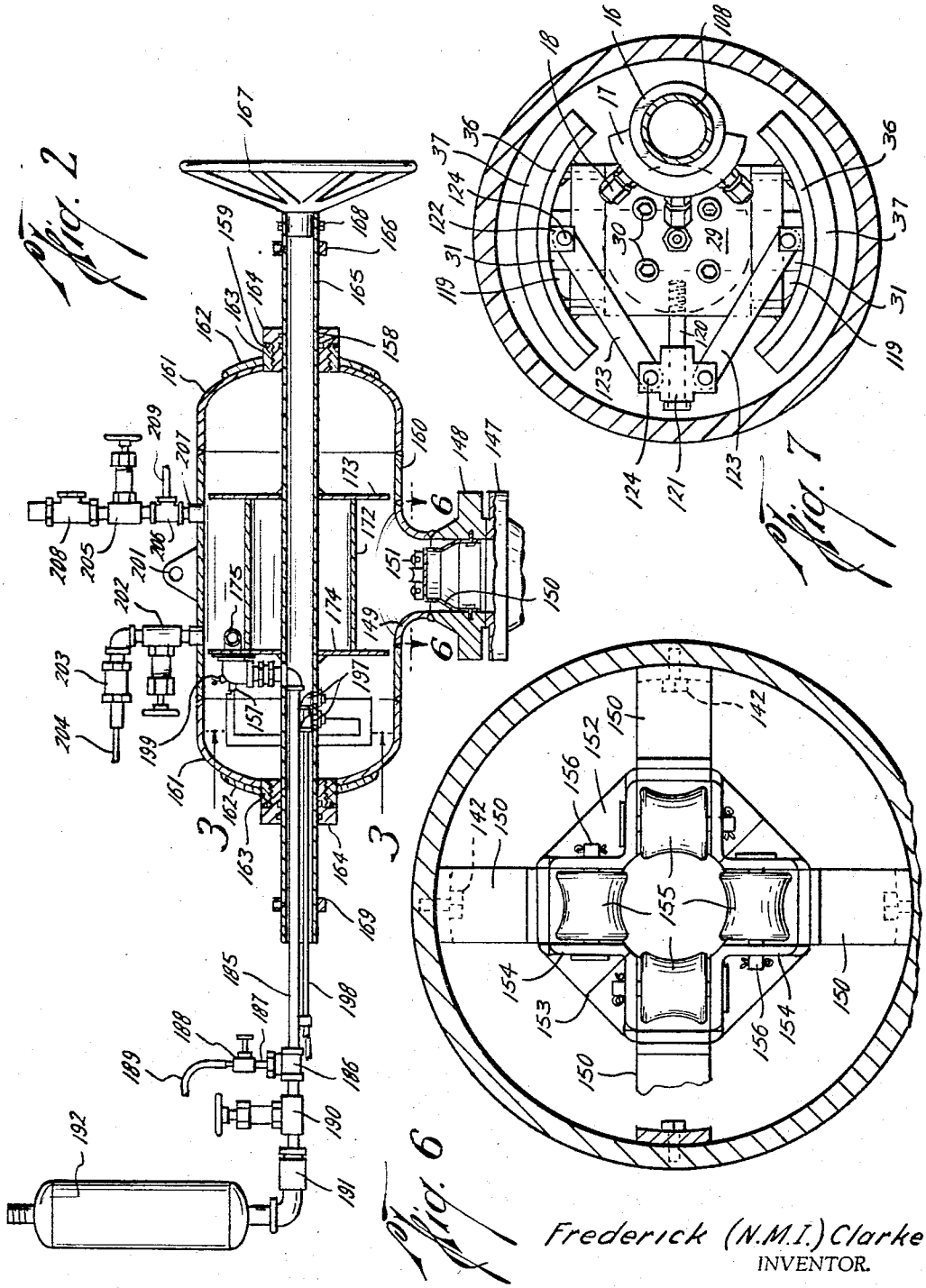


Fig. 2

Fig. 7

Fig. 6

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TAPPING APPARATUS AND METHOD

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Fig. 3

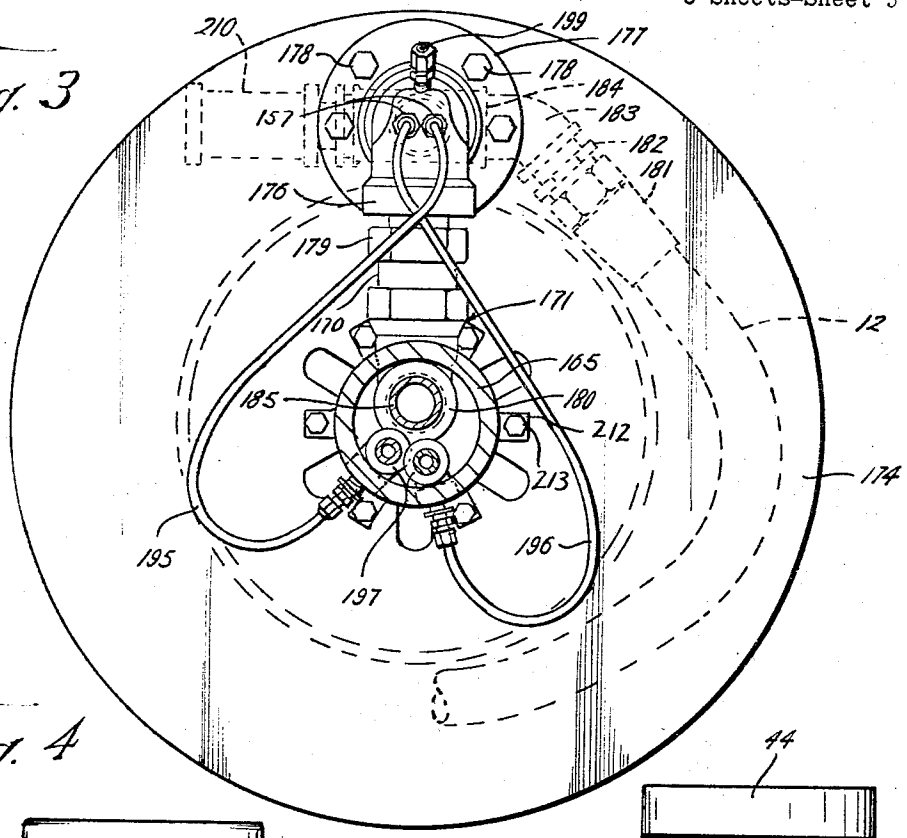


Fig. 4

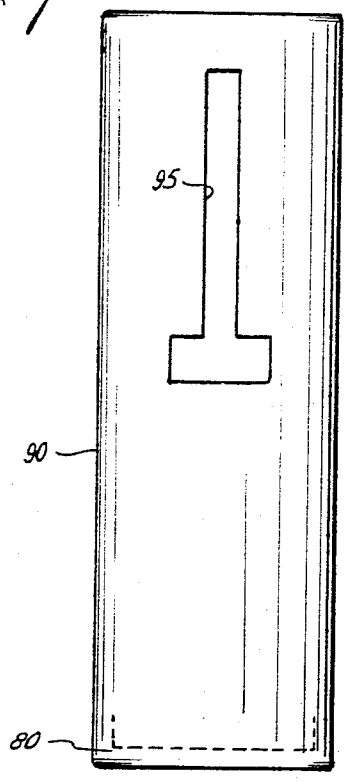
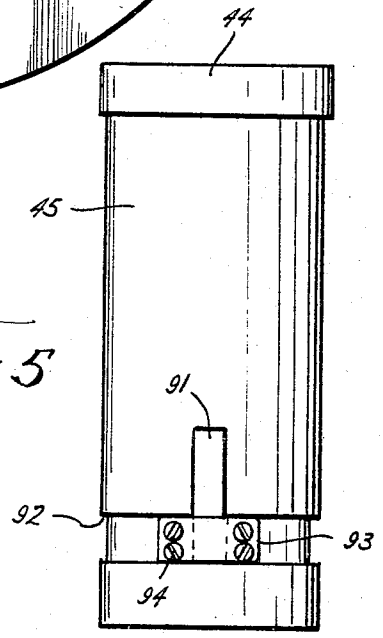


Fig. 5



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Fig. 8A

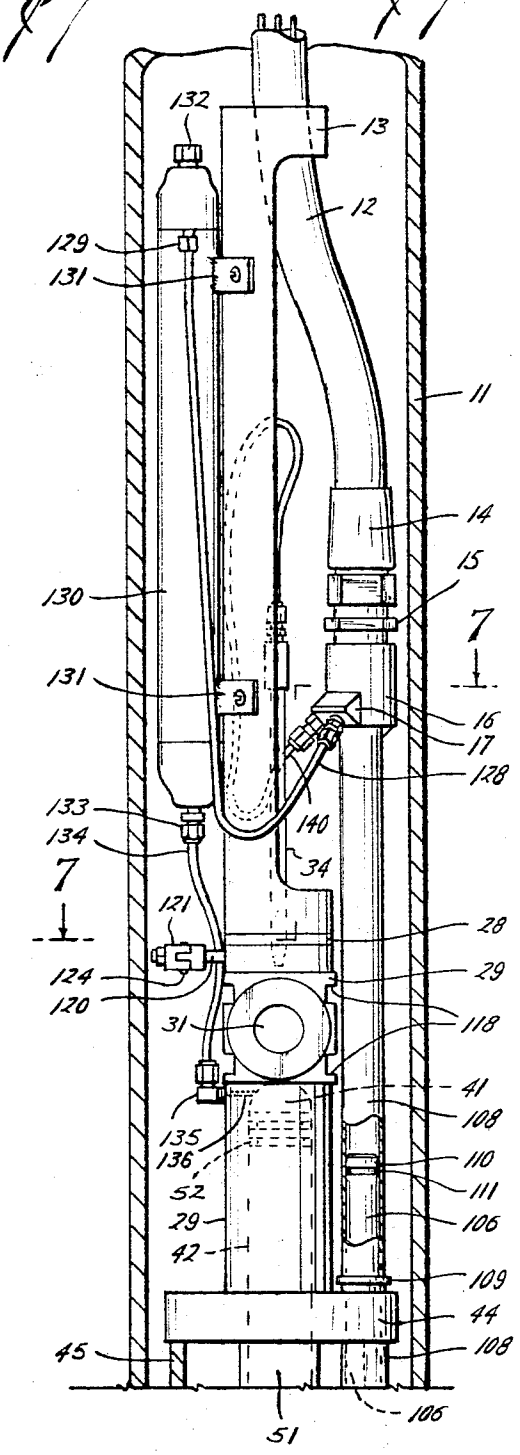
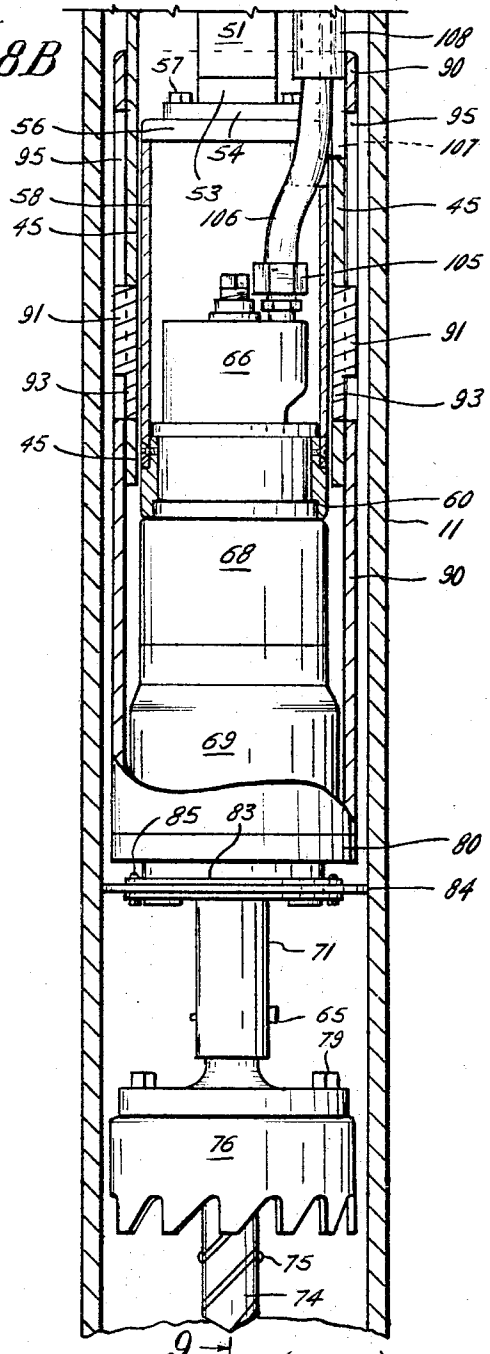


Fig. 8B



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TAPPING APPARATUS AND METHOD

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Fig. 9A

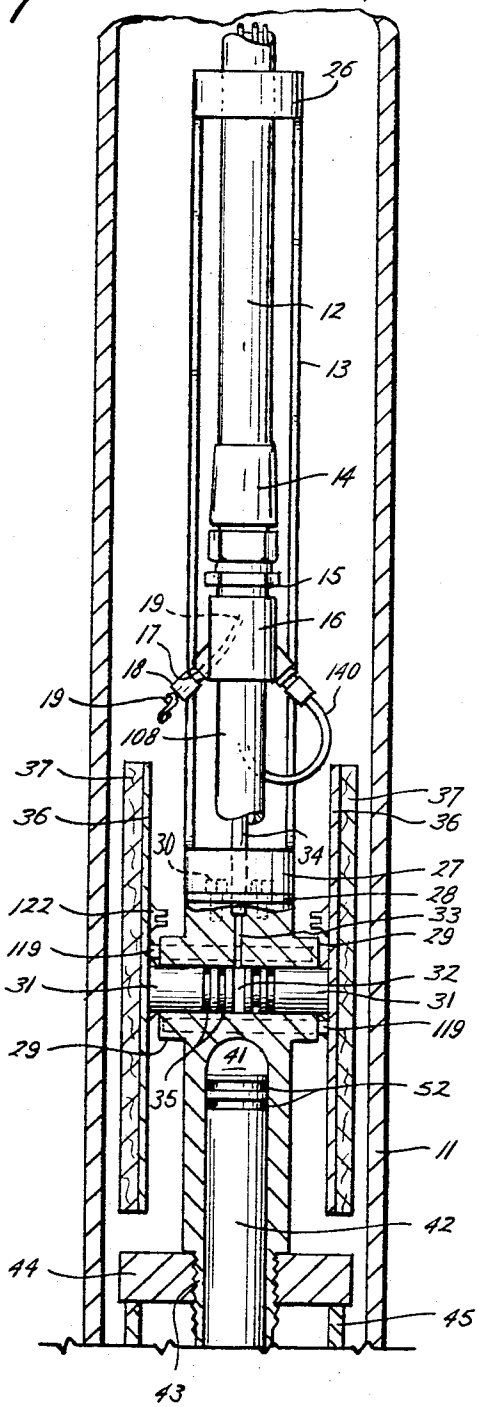
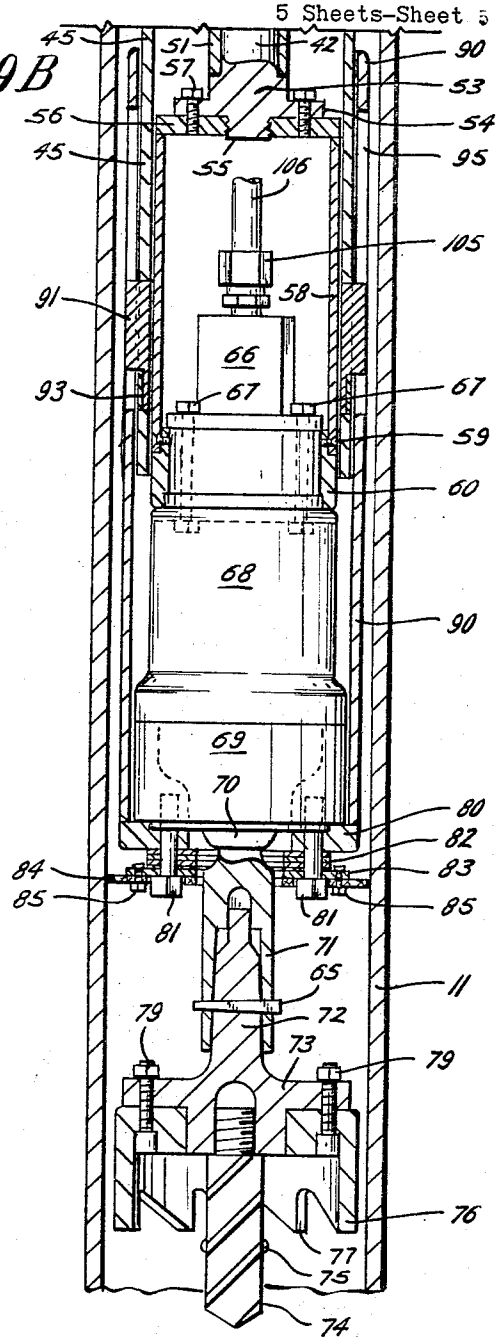


Fig. 9B



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United States Patent Office 3,374,521 Patented Mar. 26, 1968

3,374,521

TAPPING APPARATUS AND METHOD

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Filed Jan. 20, 1964, Ser. No. 338,751
20 Claims. (Cl. 29—157)

This invention relates to a tapping machine for cutting holes in pipelines, containers, and the like. More particularly, the invention relates to both a method and apparatus for performing a tapping operation on a container or a pipe, such as a pipeline which may be carrying gas under pressure, wherein the tap is performed without substantial loss of the gas to the atmosphere. Further, one embodiment of this invention relates to an apparatus and method for utilizing fluid pressure to operate drilling means for performing the tapping operation and wherein the fluid contained in the container being tapped may be utilized to provide a substantial part of the motive fluid to the fluid motor driving the cutting tool.

There are numerous problems associated with performing a tapping operation. Not only is it desirable to keep the loss of fluid from the container being tapped to a minimum but it is necessary to be able to seal off the opening made by the tapping operation after completion thereof by means of a valve or the like. In other instances it may be desirable to have this valve removed a considerable distance from the pipe being tapped, such as in the case of a submerged pipe, where it is desirable to have the valve situated above the ground or water surface. Hence, the tapping operation must in some instances be performed in a manner which will be characterized as a remote operation.

In addition, when advancing or feeding a drilling means into the pipe being tapped, it is also desirable to have a safety factor which will prevent breaking of the bit in case it becomes lodged, which is not present with some mechanical means for advancing the drilling means.

Moreover, it is sometimes advantageous to perform a hot tapping operation such that the riser connected to the pipeline may be connected on the side thereof and curved upwardly therefrom, thus permitting greater latitude in the positioning of the valve which controls the tap.

By having the valve controlling the tap positioned above water, there are many advantages derived therefrom, such as:

(a) No extension drive is necessary to operate the valve;
(b) It is easier to service the valve, such as providing the valve stem with packing from time to time;
(c) No valve seat lubricating lines leading upward from the valve to the surface are required.

The prior are is prolix with numerous examples of apparatus which have been developed for the purpose of accomplishing certain tapping operations, none of which have been as successful as is the instant invention, and none of which have been successful in remote operation. For example, certain prior art apparatuses have been developed for cutting a coupon from a pipeline wherein a riser is connected to the pipeline and some anchor means is connected to the coupon itself, which anchor means is used in advancing the cutting means. With this apparatus the manner in which the valve can be set on the riser and the direction in which the tap may be made is limited. Other tapping apparatuses utilize drills which operate through risers provided with a packing. Here again there is a great limitation on the direction and method in which the tapping may be performed. Other prior art patents have utilized mechanical means for advancing the cutter toward the pipe to be tapped but are not easily controllable in situations where the cutting means becomes

lodged, nor are they satisfactory when the tapping operation must be performed remotely.

It is, therefore, an object of the present invention to provide an improved method and apparatus for performing a tapping operation on a container which may have a fluid under pressure contained therein and wherein that fluid may be used to perform a portion of the cutting operation.

It is another object of this invention to provide an improved apparatus for performing a tapping operation on a container, which apparatus may be remotely operated.

Another object of this invention is to provide an improved apparatus for performing a tapping operation on a pipeline containing gas wherein the valve controlling the opening cut during the tapping operation may optionally be placed in a number of positions relative to the pipe.

At still further object of this invention is to provide a novel and improved drilling means for use in performing a hot tap operation wherein the drilling means is provided with a novel anchor means for securing the drilling means and novel means for advancing the cutter into the pipe.

Yet another object of this invention is to provide an improved and novel apparatus for performing a hot tap wherein the aforesaid drilling means may be lowered and raised through an elongate riser.

These and other objects of the invention will be obvious to those skilled in the art by reference to the drawings and the descriptions herein.

Briefly stated, this invention includes the method and apparatus for performing a tapping operation on a container which may have pressurized fluid contained therein such as a pipeline having pressurized gas therein.

An enclosed chamber is formed adjacent to the pipeline and in communication with the external wall of the pipeline where the opening is to be cut. This is done by either welding or otherwise securing a tap riser, nipple, leader, side branch or the like to the pipe to be tapped. The riser is provided with a full opening valve at its upper end and means for sealably attaching a fluid tight housing thereto.

This fluid tight housing is provided with a drilling means positioned in drilling engagement with the wall of the container to be tapped.

In one embodiment this drill bit may have an annular cutter connected with a driving means and a pilot bit centrally positioned therein and extending below the cutting edge of the annular cutter.

Means are provided for anchoring the drilling means in the riser and for advancing the drilling means toward the coupon or wall to be cut while the drilling means is actuated.

In one embodiment of this invention the motor is operated by fluid under pressure provided in the enclosed chamber or fluid tight housing. The cutting operation is started by applying this pressurized fluid to the drill motor and continuing the drilling until the pilot bit punctures the pipe being tapped, thereby permitting the escape of pressurized fluid from the pipe into the fluid tight housing. This escaping fluid may then be applied to the motor to thereby complete the cutting operation.

The cutting means is then withdrawn from the riser, the valve on the riser is closed, and the fluid tight housing removed, thus completing the tapping operation.

Reference to the drawings will further explain the invention wherein like numerals refer to like parts and in which:

FIG. 1 is a side elevation view, partially schematic, showing the position of the apparatus as it may be seen just prior to or subsequent to the actual cutting operation.

FIG. 2 is a central sectional view of the upper portion

of the apparatus showing a portion of the fluid tight chamber and the positioning of a reel therein.

FIG. 3 is a cross sectional view taken at line 3—3 of FIG. 2 showing certain details of the reel, the conduit means for operating certain portions of the drilling means and certain features of the exhaust means of the invention.

FIG. 4 is a side elevation view of the disassembled outer tubular shell of the drilling means showing the position of a slot therein.

FIG. 5 is a side elevation view in disassembled condition of the middle shell of the drilling means and showing one embodiment of the lug which performs the function of limiting telescopic and circumferential movement of the outer shell relative to the middle shell.

FIG. 6 is an enlarged cross sectional view taken at line 6—6 of FIG. 2 showing the novel arrangement of the hose centralizing means.

FIG. 7 is an enlarged cross sectional view taken at line 7—7 of FIG. 8A and showing certain details of the anchor shoe means, the exhaust hose and the drilling means block.

FIGS. 8A and 8B together form a side elevation view, partially in central vertical section, of the drilling means of the invention showing certain details of the arrangement of the cutting means, the motor, the anchor means, and associated elements.

FIGS. 9A and 9B form a central vertical sectional view, partially in elevation, of the drilling means of the apparatus taken at line 9—9 of FIG. 8.

Referring now to FIGS. 9A and 9B, the details of one embodiment of the drilling means, will now be discussed in detail. In that view the drilling means is centrally positioned in side branch or tap riser **11**. Exhaust hose **12** is suspended in riser **11** and passes downward through hose guide assembly **13** to annular fitting **14**, which in turn is connected to fitting adapter **15**, which is connected to and supports annular connector **16**.

Annular connector **16** is provided with a side weldment or connector lug **17**, which lug has a triangular shaped vertical cross section and extends circumferentially about half way around connector **16**. Connector lug **17** is provided with cable connector **18**. Support cable **19** is attached to and passes through connector **18**, through annular connector **16**, and thence upwardly through exhaust hose **12**. The weight of the drilling means is supported by support cable **19** during raising and lowering thereof.

Hose guide assembly **13** is an elongated member, arcuate in cross section and is provided with annular collar **26** at its upper end which encircles exhaust hose **12**.

The bottom portion of guide assembly **13** is also provided with a lower collar **27** having an annular guide assembly plate **28** attached to the bottom portion thereof. Plate **28** is secured to piston control block **29** by bolts **30**.

Piston control block **29** is provided with two separate piston means for actuating the anchor means of the invention and the drill-feeding means of the invention. Control block **29** is provided with a transverse annular opening therethrough, forming a cylinder, and in which is positioned for axial movement therein shoe pistons **31**, thus forming an annular fluid chamber **32** therebetween. Piston control block **29** is also provided with a vertically extending fluid channel **33** which communicates between fluid chamber **32** and shoe pressure conduit **34** extending downwardly through plate **28**, whereby fluidized shoe pressure may be supplied to fluid chamber **32** to actuate fluid pistons **31**.

Shoe pistons **31** are provided with annular O-rings **35** toward their radially inward end. Each piston **31** has attached at its radially outward end an anchor means conveniently shown in the form of shoes **36**, which extend vertically upward and downward from their connection to pistons **31** and are arcuate in cross-section, each defining a segment of a circle. The outside surface of shoes **36** are optionally provided with layer **37** of frictional surface material for contacting and gripping the internal wall of riser **11** when shoes **36** are actuated or moved radially outward to engagement with riser **11**.

The lower portion of piston control block **29** is formed with a vertically and downwardly extending cylindrical opening therein, forming fluid chamber **41** in which drill pressure piston **42** is positioned for axial movement therein.

The lower end of piston control block **29** has a reduced portion **43** which is provided with external threads on which is threadably mounted torque transfer plate **44**, which surrounds reduced portion **43** of piston block **29**. Plate **44** is secured on its lower side to the end of a tubular middle torsion hold shell **45**, the operation of which will be explained hereinafter.

Piston control block **29** also extends downwardly through plate **44**, which extension is tubular in shape and is indicated as piston control tube **51**, which forms the lower end of cylindrical fluid chamber **41**.

Drill pressure piston **42** is provided with O-ring seals **52** near its upper end and is attached to annular piston extension **53** at its lower end. Piston **42** is shown in the retracted position in FIGS. 9A and 9B. Piston extension **53** is of a slightly larger diameter than piston **42**, hence forming an upwardly facing shoulder which engages the bottom portion of piston control tube **51** when piston **42** is in the retracted position, as shown in FIGURES 9A and 9B.

Piston extension **53** is provided with an outwardly extending annular flange **54** and a reduced threaded portion **55** therebelow. Annular drill force transfer plate **56** has a centrally positioned annular opening therein which is threaded on to portion **55**. In addition, flange **54** of piston extension **53** is also secured to plate **56** by bolts **57**. Plate **56** is secured, as by welding, to the top end of another tubular member extending downwardly therefrom and conveniently shown in the form of inner drill force transfer shell **58**. The lower end of inner shell **58** is connected by radially extending screws **59** to annular motor drill press adapter ring **60**, which has a reduced upper portion which fits inside of inner shell **58**.

A fluid pressure motor of a type to be described hereinafter is mounted in housing **66**, which is secured to the upper portion of adapter ring **60** by bolts **67** which extend downwardly and connect to gear reduction box **68**, which likewise is a tubular member and has an enlarged lower portion forming a lower gear housing **69**.

For purposes of convenience, housing **66**, adapter ring **60**, gear box **68**, and lower gear housing **69** will generally be referred to as the motor housing. The drive shaft (not shown) of the motor positioned in housing **66** is rotatably driven through gears (not shown) provided in gear reduction box **68** and lower housing **69**, such that drive shaft connection **70**, which extends axially out from the lower end of lower housing **69**, is rotated thereby.

Drive shaft connection **70** is attached to a downwardly extending cutter adapter socket **71** for rotation therewith. Positioned inside of and extending out of the bottom opening of socket **71** is a cutter adapter **72**, which is held therein by adapter tie pin **65**. Adapter **72** has annular flange **73** extending radially outward therefrom, and is also provided with an axial and downwardly extending opening in which is threadably secured cutter pilot bit **74** having small spring loaded detent balls **75** projecting from the outside surface thereof and near the lower end. Pilot bit **74** is slotted on the lower end to allow passage of fluid and is designed for cutting through steel pipe and the like.

Surrounding pilot bit **74** and abutting against the lower end of adapter **72** is an annular cutter **76** having teeth **77** forming the cutter surface thereof. Teeth **77** may be of standard design or may be formed with arched back edges which thereby control the size of the bite of each successive tooth during rotation thereof. Cutter **76** is held in position by bolts **79** which are secured to flange **73**

of adapter 72. Thus it may be said that pilot bit 74 extends downwardly from the cutting surface of annular cutter 76.

Referring now to the lower end of lower gear housing 69, it will be observed that an annular ring having an axial opening therethrough is attached thereto, which ring will be referred to as outer shell base 80.

Outer shell base 80 is of a larger diameter than lower gear housing 69 and hence forms an upwardly facing shoulder to which is secured, as by welding, an upwardly extending tubular outer shell 90 which surrounds gear reduction box 68 adapter ring 60 and middle shell 45.

Referring now to FIG. 9B, the lower end of housing 69, and hence outer shell base 80, are centrally positioned inside of tap riser 11 by centralizer means which includes flat ring shaped bottom centralizer 84, the outside circumferential surface of which is adapted for sliding engagement with the inner surface of riser 11. Centralizer 84 is secured to housing 69 by means of screws 85 which pass therethrough and engage in ring shaped annular plate 83, which is spaced apart from base 80 by a plurality of ring shaped spacer plates 82, with a plurality of bolts 81 passing upwardly therethrough, the upper ends of which are threaded into housing 69. Thus, the lower end of housing 69 and base 80 are centrally or co-axially aligned in riser 11. This facilitates the holding of pilot bit 74 and annular cutter 76 centrally in riser 11 whereby a uniform coupon may be cut in the pipe being tapped.

In operating the tool, it is apparent that since inner shell 58 is fixedly secured to outer shell 90 through the motor housing, the two will move together, both axially and circumferentially. Hence, when cutter pilot bit 74 and annular cutter 76 are rotated by the motor and the cutting surfaces are engaged, counter torque will be exerted on inner shell 58 and outer shell 90. To prevent these elements from rotating or moving circumferentially with respect to middle shell 45, stop means are provided for preventing such rotation. Moreover, since inner shell 58 and outer shell 90 will likewise move telescopically with respect to middle shell 45 when piston 42 is actuated, means are also provided for limiting this telescopic movement. The foregoing means take the form of travel limit stop and torque transfer lug 91 secured to middle shell 45, as best seen in FIG. 5. Near the lower end of middle shell 45 there is provided an annular recess 92 thereabout. Lug 91 is provided with a transverse flange, forming an inverted T-shaped design, as seen in FIG. 5, wherein ears 93 extend transversely therefrom. Ears 93 are formed to be flush with the outside cylindrical surface of shell 45 and are secured in annular recess 92 by mounting screws 94. However, lug 91 projects radially outwardly from the outside cylindrical surface of outside middle shell 45 and engages in the inverted T-shaped slot 95 of outer shell 90, which slot is best shown in FIG. 4. The enlarged end of T slot 95 is merely for convenience in inserting lug 91 therethrough so that ears 93 will clear during assembly. The relative circumferential movement and the amount of telescopic movement is thus limited by lug 91.

Referring again to FIG. 9B, housing 66 is connected at its upper end with connector 105 and exhaust tubing 106, the purpose of which is to exhaust motive fluid from the motor positioned in housing 66 after the fluid has passed through the motor. It is to be understood that there is an appropriate inlet port (not shown) in the motor such that motive fluid present in riser 11 will operate the motor. Pressurized fluid contained within riser 11 has ready access to the inlet port of the motor and is exhausted therefrom by exhaust tubing 105.

Referring now to FIG. 8B, it will be observed that exhaust tubing 106 curves radially outward and through openings provided in plate 56 and flange 54 of piston extension 53 and also through a longitudinal slot 107 provided in the wall of middle shell 45. Exhaust tubing 106 then extends upwardly and into a downwardly opening exhaust cylinder 108. Cylinder 108 passes through an opening in middle shell plate 44 and is secured thereto by threaded connector sleeve 109 with exhaust cylinder 108 projecting upward thereabove.

Exhaust tube 106 terminates just above connector sleeve 109 where an exhaust tubing piston head 110 is connected thereto, which in turn is provided with O-ring seal 111. Thus during the telescopic movement of outer shell 90 and inner shell 58 relative to middle shell 45, piston head 110 moves back and forth inside exhaust cylinder 108.

The top end of exhaust cylinder 108 connects with connector 16, which communicates with exhaust hose 12. The foregoing generally explains one embodiment of the cutting means of the invention.

Referring now to FIGS. 7 and 8A, the operation of the anchor means of the drilling means will now be explained in detail. As previously explained, shoe pistons 31 are mounted for transverse movement in piston control block 29. Control block 29 is also provided with four transverse shoe guide channels 118, as best seen in FIG. 8A, with two channels being on either side of block 29 and spaced above and below piston 31.

Each shoe 36 has welded thereto two shoe guides 119, which guides are arranged to slide longitudinally in shoe guide channels 118. The purpose of shoe guides 119 is to prevent shoes 36 from twisting out of vertical alignment. Hence, each shoe has one shoe guide 119 connected for movement in one of the upper shoe guide channels 118 and another shoe guide 119 mounted for movement in the lower shoe guide channel 118 on the opposite side of shoe pistons 31.

In order to assure that both shoes 36 move radially outward in equal manner there is provided an equalizer mechanism in the form of shoe equalizer guide rod 120 which is threaded into the side of and extends radially outward from control block 29 at a point above upper guide channels 118. Guide rod 120 is provided with a T-shaped guide block 121, which is adapted to slide radially inward and outward thereon. Each of the shoes 36 is provided with a shoe bracket 122, which is positioned in the same general transverse plane as guide rod 120 and which project radially inward from the shoes. A pair of equalizer arms 123 are connected between shoe brackets 122 and guide block 121 by pins 124. Hence, as shoes 36 are expanded radially outward, guide block 121 is pulled radially inward, insuring that both shoes move equally and uniformly outward and inward.

Means are also provided for supplying a pressurized fluid to operate drill pressure piston 42 and shoe pistons 31. Referring again to FIGS. 7 and 8A, it will be observed that there are three identical connectors (one of which is designated as connector 18) emerging from and pointing downwardly from connector lug 17 on connector 16. As explained earlier, connector 18 is attached to support cable 19; another one of these connectors has drill pressure tubing 128 connected to and passing therethrough, which tubing communicates with upper connector 129 of a tubular drill press oil reservoir 130 mounted by upper and lower brackets 131 to hose guide assembly 13. At its upper end reservoir 130 is provided with plug 132 for filling reservoir 130 with oil or other liquid and the lower end of reservoir 130 is provided with lower connector 133 and connecting line 134, which leads downward to control tubing connector 135 having fixed orifice 136 leading into fluid chamber 41. The purpose of fixed orifice 136 is to prevent the rapid movement of piston 42 downward when vertical pressure is relieved on the drilling bit, upon complete penetration of pilot bit. Fluid to chamber 41 is supplied via oil reservoir 130 whenever pressure is supplied thereon through drill press tubing 128 which connects to a flexible conduit extending upwardly inside of exhaust hose 12.

Means are also provided to supply pressurized fluid to fluid chamber 32, to thereby operate shoe pistons 31, which

means are in the form of another conduit or flexible tube positioned inside of exhaust hose **12**, connected to and passing through another of the connectors emerging from connector lug **17**. Shoe pressure tubing **140** passes through and connects to that connector supplying the shoe pressure fluid and connects to the upper end of shoe pressure conduit **34**, as seen in FIGS. 8A and 9A. Hence, fluid pressure applied through the conduit in exhaust hose **12** and through shoe pressure tubing **140** to shoe pressure conduit **34** enters fluid channel **33** and fluid chamber **32** to force shoes **36** radially outward and to thereby releasably anchor the drilling means in a fixed relationship with riser **11**. The foregoing generally describes the drilling means portion of the invention.

Referring now to FIGS. 1 and 2, the means for raising and lowering the drilling means in riser **11** will be explained in greater detail. An elongate fluid tight housing adapted for securing to the top end of riser **11** is provided and is best shown in FIG. 1. Housing nipple pipe **143** is an elongate member forming a generally elongate chamber. The lower end of pipe **143** is provided with an outwardly expanding portion terminating in flange **144** which is adapted to be engaged in a sealing relationship with the top flange of full opening riser valve **145** by means of bolts and a gasket or the like.

The upper end of pipe **143** may be formed with a reduced area **146** (or an increasing area, or neither, depending on size of the housing nipple), and an outwardly flaring portion which terminates in top flange **147**. Top flange **147** is arranged to be secured to a drum access flange **148** on the bottom of annular access fitting **149**. It is to be understood that flange **147** and access flange **148** are held together in a fluid tight seal by bolts and a gasket or other conventional means. Mounted inside of access flange **148** and extending upwardly inside of access fitting **149** are four flat members or legs **150** which support a hose centralizer assembly generally designated by the numeral **151**. Legs **150** are secured at their lower ends to the inside surface of access flange **148** by leg bolts **142**.

Hose centralizer assembly **151** is comprised of base plate **152**, as best seen in FIG. 6. Base plate **152** is generally square in plane view, having the corners thereof clipped and is formed in two parts, which parts are held together at adjacent edges **153** by screw and bracket means (not shown) on the underside thereof. An opening is provided through base plate **152**, generally in the form of a cross. This cross-shaped pattern permits the mounting of four roller brackets **154**, which are generally V-shaped in cross-section and extend upwardly a short distance from base plate **152** and thereby provide a mounting for guide rollers **155**, which are mounted on roller pins **156**, which pins pass through brackets **154**. Hence, during raising and lowering of the drilling means, exhaust hose **12** will pass through centralizer assembly **151** and thereby be centrally positioned in pipe **143**.

Referring now to FIG. 2, the upper portion of the fluid tight housing of the apparatus is shown therein. Annular access fitting **149**, previously described, is welded or otherwise secured to the lower side of a large tubular member in the form of drum **160**. On each end of drum **160** an annular, dome-shaped drum end cap **161** is welded or otherwise secured thereto. Each drum end cap **161** has an annular opening therethrough, which opening is surrounded by end-plate **162** and in which seal bearing ring **163** is fitted. Inside of seal-bearing ring **163**, annular seal bearing **164** is inserted, having appropriate packing in the form of O-ring **159** therebetween. Reel shaft **165** is an elongated tubular member which passes through the fluid tight chamber and extends outside both ends of the housing and through seal bearings **164**, each of which is provided with a pair of seals in the form of O-rings **158** which contact the outside surface of reel shaft **165**. The right end of reel shaft **165**, as viewed in FIG. 2, is provided with stop ring **166** and hand wheel **167**, which wheel is secured to reel shaft **165** by hub bolt **168**. The opposite end of reel shaft **165** is likewise provided with stop ring **169**. Hence reel **165** may be turned by turning on hand wheel **167** and oscillated back and forth by pushing and pulling on hand wheel **167**.

Near the central portion of reel shaft **165** there is mounted an annular reel hub **172** held in position by two spaced apart reel flanges **173** and **174**. Thus, there is formed a reel on which the exhaust tube of the invention may be wound and supported thereby. Alternately, reel flanges **173** and **174** may be welded to reel shaft **165**, or preferably, bolted thereto, as shown in FIG. 3, to facilitate disassembly of the apparatus. There, flange **174** is shown as having a centrally positioned scalloped opening therethrough and is secured to reel shaft **165** by bolts **213** passing through lugs **212** attached to reel shaft **165**. This arrangement permits disassembly of the apparatus to allow removal of reel shaft **165** from the housing.

The exhaust hose (not shown in FIG. 2) is secured to a T and connecting nipple **175**. Nipple **175** passes through flange **174** and connects to exhaust elbow **176**, best seen in FIG. 3. Elbow **176** has an annular flange **177** which is secured to reel flange **174** by flange bolts **178**.

The lower end of elbow **176**, as seen in FIG. 3, is connected to coupling **179**, by means of nipple **170** which coupling in turn is connected to inside exhaust elbow **180** by means of another nipple **171**; exhaust elbow **180** being positioned inside of and extending radially out of reel shaft **165**. Hence, the exhaust hose **12**, shown in outline form in FIG. 3, communicates through connector **181**, adapter **182**, connection elbow **183**, exhaust T **184**, through nipple **175**, elbow **176**, nipple **170**, coupling **179**, nipple **171**, to inside exhaust elbow **180**.

Inside exhaust elbow **180** then connects to exhaust pipe **185**, which leads out the end of reel shaft **165**, as best seen in FIG. 2. The end of exhaust pipe **185** is connected to T **186**, which communicates with nipple **187**, to which is connected exhaust pressure control valve **188**, which valve is connected to panel exhaust control hose **189**.

T **186** also communicates through exhaust valve **190**, to coupling **191**, to muffler **192**, which communicates to the atmosphere.

The conduit means for supplping fluid pressure to the piston means and the drilling means, as previously explained, pass upwardly through exhaust hose **12** and follow a somewhat similar pattern of movement as the aforedescribed exhaust channel.

Referring to FIG. 3, these conduits emerge from exhaust elbow **176** through pressure seal tube fittings **157** and are shown as drill pressure tubing **195** and shoe pressure tubing **196**, which connect with identical and smaller elbows **197** inside of reel shaft **165**. Inside elbows **197** are then connected with a pair of pipe conduits **198**, which lead out the end of reel shaft **165**, as best seen in FIG. 2. The ends of pipe conduits **198** are provided with appropriate coupling means, the purpose of which will be explained hereinafter.

Thus, it may be seen that when reel shaft **165** is rotated, exhaust hose **12** is wound either on or off of reel hub **172** with exhaust hose **12**, passing up and down through hose centralizer assembly **151**. By oscillating reel shaft **165** back and forth manually, hose **12** may be wound uniformly onto reel hub **172**. Thus, no matter whether the exhaust hose is rolled out a short distance or a long distance, exhaust hose **12** and the tubing supplying fluid pressure to the piston means in piston control block **29** will still communicate with controls located outside of the fluid tight chamber. Furthermore, the support cable **19**, which also passes up through exhaust hose **12** and which supports the drilling means, also terminates at elbow **176** where it is secured by connector **199**.

Referring again to FIG. 2, the top part of the fluid tight chamber is provided with lifting eye **201** which is secured to top part of drum **160** and is for raising and lowering the apparatus. Means are also provided for supplying a fluid pressure to the fluid tight chamber in the form of

needle valve 202, which communicates with the inside of drum 160. The other side of valve 202 communicates through inlet check valve 203 and thence to tube 204, which leads to an appropriate supply of pressurized fluid, such as propane, for initially pressurizing the fluid tight chamber. Check valve 203 is set so as to prevent back pressure inside the fluid tight chamber from backing up through tube 204.

Also communicating with the fluid tight chamber is another valve means shown as needle valve 205, which is connected to T 206, which is secured to drum 160 by coupling 207. The top end of needle valve 205 communicates to drum relief valve 208. T 206 also connects with panel drum pressure indicating tube 209, which leads to the panel control, as will be explained hereinafter.

Referring to FIG. 3, an internal relief valve in the form of check valve 210 is connected to one end of exhaust T 184. The purpose of check valve 210 is to maintain the proper pressure differential between the fluid chamber and inside of exhaust hose 12. Hence, if the pressure differential exceeds a specified level, check valve 210 will be open to thereby prevent the collapse of exhaust hose 12. Such a sitaution might occur, for example, if the fluid motor, with which exhaust hose 12 communicates, should become plugged.

Referring now to FIG. 1, the hookup of the apparatus during operation will be described. Fluid pressure is supplied in the form of propane from bottles 217 which supply propane through tube 204, through inlet check valve 203, through needle valve 202, and into drum 160. Means for controlling the operation of the various fluid pressures are provided in the form of control panel board 218, which has several gauges. Drum pressure gauge 219 communicates with the drum 160 via panel drum control tube 209 and indicates the drum pressure or the pressure inside of the fluid tight housing. Exhaust pressure gauge 220 communicates with exhaust pressure control valve 183 via panel exhaust pressure indicating hose 189 and measures the exhaust pressure.

Another pressurized fluid supply in the form of nitrogen supply bottle 221 is connected by tube 222 to control supply gauge 223 which indicates the amount of pressure coming from nitrogen bottle 221. Tube 222 communicates with tube 224 which leads to shoe pressure gauge 225 which indicates the pressure being supplied to actuate shoe pistons 31 in the drilling means. Tube 224 also communicates with shoe feed tube 226 and shoe vent 227. By operating the feed and bleed controls just beneath shoe gauge 225, the amount of pressure supplied to shoe feed tube 226 can be controlled. Shoe feed tube 226 is connected with the shoe feed pipe conduit 198 which extends out the end of shaft 165.

Nitrogen supply tube 222 also communicates with tube 228, which leads to drill gauge 229, which indicates the pressure being applied to fluid chamber 41 which actuates drill pressure piston 42 in the drilling means. This pressure is similarly controlled by feed and bleed controls such that pressure from tube 228 may be diverted to either drill feed tube 230 or drill vent 231. Drill feed tube 230 likewise connects with the drill feed pipe conduit 198 leading into the end of reel shaft 165.

In order to observe the operation of portions of the tool, drum 160 is provided with a plurality of site glass housings 234. Also, near the bottom of housing nipple pipe 143, there is also provided another site glass housing 234.

In performing the hot tapping operation, riser 11 is welded or otherwise secured to pipe 235, which pipe may be a pipeline containing pressurized gas or other fluid. Riser 11 can be of any desired length, thus permitting a remote tapping operation. Riser 11 has an upper flange 236, which is secured to full opening valve 145 in a fluid tight relationship.

In operation of the tool, the housing, which includes drum 160 and housing nipple pipe 143, is lifted by lifting eye 201 into the position as shown in FIG. 1 and flange 144 is then secured to the top flange of full opening valve 145. The drilling means shown in outline form inside of housing nipple pipe 143 will have previously been assembled and held therein by exhaust hose 12 which is wound onto reel hub 172 and held there by holding or otherwise preventing the turning of hand wheel 167.

After flange 144 is secured to valve 145 by bolts or other means in a fluid tight seal, the propane supply is then connected to tube 204, which leads to drum 160. Exhaust valve 190 and needle valve 205 are closed. Needle valve 202, which controls the propane supply, is opened, thereby providing fluid pressure in the form of pressurized propane to the enclosed chamber formed by drum 160 and housing nipple pipe 143 and riser 11. The drum pressure at this point may conveniently be approximately 105 p.s.i. at 60 degrees F. The drum pressure will overcome the pressure in fluid chamber 41 and then cause drill pressure piston 42 to retract, which retracted position can be checked by viewing the relative axial position of outer shell 90 and middle shell 45 through sight glass 234, at which point the drilling means is lowered into riser 11 by turning on hand wheel 167. The drilling means is lowered until the pilot bit 74 engages the wall of pipe 235, with some slack being left in exhaust hose 12.

Drill feed tube 230 is then connected to the appropriate pipe conduit 198 leading into the end of reel shaft 165 and shoe feed tube 226 is similarly connected. In addition, exhaust pressure indicating hose 189 is connected to valve 188. The valves on panel board 218 controlling shoe vent 227 and drill vent 231 will be open. The valve controlling the pressure to supply gauge 223 will be closed, as will be the valve controlling the feed to shoe feed tube 226 and drill feed tube 230. The valve on nitrogen supply bottle 221 is then opened, thereby providing a nitrogen supply to the control panel.

At this point, nitrogen pressure can be directed to shoe feed tube 226 by closing shoe vent 227 and opening the shoe feed valve. Pressure is allowed to build up on shoe feed tube 226 to approximately 50 p.s.i. above the pressure inside of the fluid tight housing of the tool (drum pressure). Thus, shoe pistons 31 will be forced radially outward, thereby releasably anchoring the drilling means in riser 11.

Exhaust valve 190 is controllably opened, thereby permitting the escape of gas from exhaust pipe 185 until the pressure differential between the fluid tight housing (drum) and the exhaust is approximately 40 p.s.i. and the fluid motor in the drilling means is rotating the cutting means at approximately 40 to 45 r.p.m. It is this pressure differential which controls the rate of rotation of the fluid motor. As explained earlier, the fluid motor is positioned inside of housing 66. In one form of the invention, the motor is a positive displacement 5 cylinder axial piston air motor. There is a gear reduction of approximately 44 to 1 between the motor and the drill bit or cutting means. The motor thus causes pilot bit 74 and annular cutter 76 to rotate.

The feed valve controlling pressure to drill feed tube 230 is then opened, thereby supplying pressurized nitrogen to the top part of oil reservoir 130, which forces oil into fluid chamber 41, thus actuating or feeding piston 42 downward and advancing the cutting means against pipe 235. When the pressure on drill feed tube 230 equals the pressure inside of drum 160, the weight of the lower portion of the tool or the drilling means will be the only pressure applied to the drilling bit. By allowing the drilling means to operate for a short period under these conditions, safety checks and the like may be made.

The drill pressure on drill feed tube 230 is then slowly increased until a pressure of approximately 400 p.s.i. is reached. The motor is continuously operated, maintaining a drill bit speed of approximately 40 r.p.m. until pilot bit

74 initially punctures the wall of pipe 235. This initial penetration by pilot bit 74 will be signalled by an increase in drum pressure inside drum 160 and by the escape of gas from relief valve 208, which may be set at about 125 p.s.i., since line pressure or pressure inside the pipe being tapped will generally be much higher.

At this point exhaust valve 190 is closed, thereby stopping the operation of the motor. Needle valves 205 and 202 will also be closed.

The pressure inside drum 160 is then allowed to equalize with the pressure inside of pipe 235, which pressure will be referred to as line pressure. Pressure is then relieved on shoe feed tube 226, allowing shoes 36 to retract or release from an anchoring position, with the weight of the drilling means then being supported by pipe 235. Pressure is then re-applied to shoe feed tube 226 until there is a shoe pressure of approximately 12 p.s.i. applied to the contact surfaces of shoes 36 against inside wall of riser 11, thus again anchoring the drilling means in riser 11.

Exhaust valve 190 is then opened to start the motor, which will then be operating on the pressure of the fluid escaping from the pipe being tapped. Drill pressure is initially kept at drum pressure. The motor is operated at a pressure differential between the drum and exhaust of approximately 100 p.s.i. Drill pressure is then gradually increased to approximately 175 p.s.i. above line pressure with the drilling continuing until pilot bit 74 completely penetrates pipe 235.

At this point exhaust valve 190 will be closed again. Shoe pressure will once again be relieved as will drill pressure, to allow the shoes 36 and piston 42 to retract. Annular cutter 76 will then be engaging the coupon to be cut from pipe 235. Shoe pressure is then re-set at about 12 p.s.i. on the contact surfaces of shoes 36 against inside wall of riser 11 and exhaust valve 190 is again controllably opened until the motor is turning annular cutter 76 at approximately 32 r.p.m., at which point the differential between drum pressure and exhaust pressure may be approximately 100 p.s.i. Drill pressure is then increased on drill feed tube 230 until a pressure differential of 125 to 150 p.s.i. is reached. The cutting operation is continued so long as the motor shows no tendency of stalling and until the coupon is cut from pipe 235. If the motor has a tendency to stall due to hanging up of cutter 76, exhaust valve 190 may be closed and the trouble inspected and the bit retracted by relieving the drill pressure and by permitting the motor to run with reduced drill pressure thereagainst.

Complete penetration by cutter 76 will be indicated by a drop in drill pressure. At this point exhaust valve 190 is closed and pressure is taken off of shoe feed tube 226 and drill feed tube 230. Shoe feed tube 226 and drill feed tube 230 are then disconnected from their connections at the end of reel shaft 165 and exhaust pressure indicating hose 189 is disconnected from control valve 188, after that valve is closed. The drilling means of the apparatus is then raised in riser 11 by turning on hand wheel 167, with care being taken to uniformly roll exhaust hose 12 on to reel hub 172 by sliding reel shaft 165 back and forth.

The coupon cut from pipe 235 will be retained on pilot bit 74 by detent balls 75. When the coupon has cleared valve 145, that valve may be closed. Pressure may then be relieved on drum 160, and housing nipple pipe 143 may then be removed from the top of valve 145, thus completing the tapping operation.

There is thus provided a novel and improved method and apparatus for performing a tapping operation, wherein the fluid contained in the container being tapped can be used to perform a substantial part of the cutting operation. The apparatus may be operated remotely, as by passing down through a long riser that has been attached to the pipe being tapped.

Since the exhaust hose and the means for supporting the drilling means are flexible, the riser through which the drilling means is lowered may be attached to one side of the pipe and thence curve upwardly, permitting the valve closing the riser to be optionally positioned in a number of positions relative to the pipe being tapped.

The invention teaches the use of a novel releasable anchor means for holding the drilling means, which anchor means can be released and re-set from time to time as the cutting means advances. Moreover, the cutting means is advanced into the coupon by a fluid pressure actuated feeding means which is easily controllable and which acts as a safety factor by indicating a build up of pressure if the cutting means becomes lodged.

There are, of course, many alternatives of the foregoing apparatus which will still fall within the scope of the invention. For example, support cable 19 could be a flexible semi-rigid member such that when hose 12 is unrolled from the reel, the drilling means of the tool would be forced along in the riser or side branch by the semi-rigid member acting as a ram rod. Thus, the tool could be used in a horizontal side branch, without relying on gravity to advance the drilling means into the side branch.

Other anchor means could be used, as for example, only one shoe could be used, with the other side of piston control block 29 being supported by a rigid member.

Also, it is to be understood that when various parts are described as being connected to each other, this connection may be either a mechanical connection or an operational connection.

It is to be understood that the apparatus could be used to perform a tapping operation on a container which did not contain a pressurized fluid. After initial puncturing of the container, drilling could be continued as soon as pressure equalized, thus preventing the escape of gas to the atmosphere and still keeping the fluid tight housing pressurized to operate the drilling means.

Other modifications may be made in the invention as particularly described without departing from the scope of the invention. Accordingly, the foregoing description is to be construed illustratively only and is not to be construed as a limitation upon the invention as defined in the following claims.

What is claimed is:

1. The method of performing a hot tapping operation on a container having a first fluid under pressure contained therein, comprising the steps of:

forming an enclosed chamber adjacent to and in communication with a portion of the external wall of said container,

positioning a fluid pressure actuated drilling means with a drill bit within said chamber and holding said bit in drilling engagement with said wall,

applying a second fluid under pressure to said chamber to thereby operate said drilling means,

advancing said bit into said wall during operation of said drilling means,

continuing the application of said second fluid until said bit initially penetrates said wall, to thereby permit the escape of said first fluid from said container into said chamber,

applying said first fluid to operate said drilling means to complete the cutting of an opening into said container.

2. The method as claimed in claim 1 comprising the additional steps off:

withdrawing said drilling means to a portion of said chamber which is removed from said wall, and

sealing off that portion of said chamber from which said drilling means was removed.

3. The method of performing a hot tapping operation on a pipe containing a first fluid under pressure, whereby a coupon is cut from the wall of said pipe, comprising the steps of:

forming an elongate chamber with one end thereof in

communication with that portion of said wall of said pipe from which said coupon is to be cut,

placing a fluid pressure actuated drilling means having a drill bit within said chamber,

applying a second fluid under pressure to said chamber to thereby operate said drilling means by rotating said bit,

advancing said bit into said wall during rotation of said bit,

continuing the application of said second fluid to said drilling means until said bit initially penetrates said wall, to thereby permit the escape of said first fluid from said pipe to said chamber,

applying said first fluid to said drilling means to continue the rotation of said bit until a coupon is cut from said wall,

withdrawing said drilling means to a portion of said chamber which is spaced apart from said wall, and

sealing off a portion of said chamber from which said drilling means was withdrawn.

4. The method of remotely performing a hot tapping operation wherein a coupon is cut from a pipe containing a first gas under pressure, comprising the steps of:

securing an elongated tap riser to said pipe in a sealing relationship therewith and surrounding said coupon to be cut,

lowering a gas pressure actuated drilling means with a drill bit at the lower end thereof into said riser,

controllably closing the top end of said riser to form a chamber having communication with said wall from which said coupon is to be cut,

applying a second gas under pressure to said chamber to thereby operate said drilling means by rotating said bit,

advancing said bit into said wall during rotation of said bit,

continuing the application of said second gas to said drilling means until said bit initially penetrates said wall, to thereby permit the escape of said first gas from said pipe to said chamber,

applying said first gas to said drilling means to continue the rotation of said bit until a coupon is cut from said wall,

withdrawing said drilling means from said riser while maintaining the gas pressure therein, and

sealing off a portion of said riser from which said drilling means was withdrawn.

5. An apparatus for performing a hot tap operation on a container having a fluid under pressure contained therein, comprising:

an elongate fluid tight housing having an open end adapted for securing to said container and enclosing the section of the wall of said container which is to be tapped,

a cutting means disposed within said housing with the cutting surface thereof adapted to engage said wall,

driving means connected to said cutting means for rotating said cutting means during operation of the apparatus,

releasable anchor means connected to said driving means and releasably engaging the inside wall of said housing in a fixed relationship during operation of the apparatus, and

means for advancing said cutting means toward said wall while said anchor means is engaged.

6. An apparatus for performing a hot tap operation on a container having a first fluid under pressure contained therein, comprising:

an elongate fluid tight housing having an open end adapted for securing to the wall to said container and enclosing that portion of said wall which is to be tapped,

an annular cutter disposed within said housing with the cutting surface thereof adapted to engage said wall which is to be tapped,

a fluid pressure motor connected to said cutter for rotating said cutter during operation of the apparatus,

means for supplying a second fluid under pressure to said housing for operating said motor,

releasable anchor means connected to said motor and adapted to releasably engage the inside wall of said housing in a fixed relationship during operation of the apparatus, and

means for advancing said cutter toward said wall when said anchor means is engaged.

7. The apparatus as claimed in claim 6 wherein:

said anchor means are radially expandable and adapted to frictionally engage the inside wall of said housing, and wherein

said housing is provided with exhaust means for controllably releasing said second fluid from said motor.

8. An apparatus for cutting a coupon from a container having fluid under pressure contained therein, comprising:

a fluid tight housing defining an elongate chamber and having one end adapted to be connected to said container and to surround the coupon to be cut,

an annular cutter disposed within said housing with the cutting edge thereof adapted to engage said coupon,

a guide bit centrally positioned within and secured to said annular cutter and having the leading end thereof extending beyond said cutting edge of said annular cutter,

a fluid motor adapted to be operated by pressurized fluid contained in said chamber and connected to said cutter for rotating said cutter and said guide bit,

means for supplying a motive fluid under pressure to said chamber,

an exhaust means provided in said housing for controllably releasing said motive fluid from said motor and thence from said chamber,

means for feeding said cutter and said guide bit longitudinally in said chamber and against said coupon to be cut.

9. The apparatus as claimed in claim 8 wherein said exhaust means includes:

an exhaust valve provided in said housing, and

an exhaust tube connecting said valve and the exhaust port of said motor and forming an exhaust channel therebetween.

10. The apparatus as claimed in claim 8 wherein said means for feeding said cutter and said guide bit longitudinally in said chamber includes:

expandable anchor means connected to said motor for frictionally engaging the inside wall of said housing when in the expanded condition, and

fluid pressure actuated means for advancing said cutter and said bit toward said coupon.

11. The apparatus as claimed in claim 8 wherein:

the upper end of said housing defines an enlarged chamber communicating with said elongate chamber, and having

a reel provided in said enlarged chamber and journaled for rotation in said upper end, and

an elongate flexible support member connected to said cutter and adapted to roll on and off of said reel and to support said cutter during raising and lowering thereof.

12. A hot tapping apparatus for lowering into a side branch connected to a pipe containing a first fluid under pressure and for cutting a coupon from said pipe at a point inside of the lower end of said side branch, said apparatus comprising:

drilling means adapted for insertion into said side branch and including—

a fluid driven motor,

cutting means rotatably driven by said motor,

radially expandable anchor means connected to

said cutting means for frictionally engaging the inside walls of said side branch,

piston means connected to said anchor means for advancing said cutting means,

a pressurized housing adapted for communicating with and securing to the upper end of said riser in a fluid tight seal,

means for moving said drilling means into and out of said side branch and including a hose reel journaled for rotation in said housing,

a flexible hose supported on said reel, connected to said drilling means and communicating with the exhaust port of said motor,

means for supplying a motive fluid to said housing for operating said motor,

means for exhausting said motive fluid from said hose and said housing, and

conduit means supported by said reel for supplying another presurized fluid to operate said anchor means and said piston means.

13. The apparatus as claimed in claim 12 in which:

said motor is driven by said motive fluid contained in said housing, and

said anchor means includes at least two shoes which are radially expandable by a second piston means.

14. The apparatus as claimed in claim 12 wherein:

said means for raising and lowering said drilling means includes a support cable connected to said drilling means and supported on said reel.

15. The apparatus as claimed in claim 12 including:

a safety valve connected to said hose and communicating between the chamber inside said hose and the chamber inside said housing and for maintaining a pressure differential therebetween below a predetermined level.

16. A hot tapping apparatus for insertion into a side branch connected to a pipe containing a first gas under pressure and for cutting a coupon from said pipe at a point inside of said branch said apparatus comprising:

a fluid tight housing adapted for communicating with and securing to the open end of said branch in a sealing relationship,

valve means for supplying pressurized motive fluid to said housing,

drilling means adapted for movement through said branch and including

a fluid motor adapted to be driven by said motive fluid contained in said housing,

at least one shoe connected to said motor and which is radially expandable for functionally engaging the inside wall of said branch and anchoring said drilling means,

annular cutting means rotatably driven by said motor, and

means for advancing said cutting means relative to said anchor means,

means for moving said drilling means through said branch including

a reel journaled for rotation in said housing,

a flexible hose supported on said reel, connected to said drilling means, and communicating with the exhaust part of said motor, and

a support cable carried inside said hose for supporting said drilling means,

valve means for exhausting said motive fluid from said hose and said housing and for maintaining the pressure differential between said housing and inside said hose below a predetermined level,

conduit means carried inside said hose for supplying another pressurized fluid to operate said shoe and said means for advancing said cutting means

17. A hot tapping apparatus for lowering into a riser connected to a pipe containing a first pressurized gas and for cutting a coupon from said pipe at a point inside of said riser, said apparatus comprising:

a fluid tight housing adapted for communicating with and securing to the upper end of said riser in a sealing relationship,

valve means for supplying a second pressurized gas to said housing,

drilling means adapted for lowering in said riser and including:

a control block having a first and second piston means provided therein,

at least one anchor member connected to said block and radially expandable by said first piston means,

an inner tubular shell connected at one end to said second piston means and at the other end to a motor housing,

said motor housing extending downwardly from said inner shell,

on outer tubular shell, the lower end of which is secured to the lower portion of said motor housing in fixed relationship thereto,

a middle tubular shell connected to said block and positioned between said inner shell and said outer shell for telescopic movement therewith a specified distance,

stop means for limiting said telescopic movement and the relative circumferential movement between said inner and outer shells and said middle shell,

a fluid pressure motor mounted in said motor housing, and

an annular cutter driven by said motor and adapted to engage said pipe from which said coupon is to be cut,

means for raising and lowering said drilling means in said riser,

means for supplying another pressurized fluid to said first and second piston means, whereby said anchor may be expanded thereby and said inner and outer shells may be moved telescopically relative to said middle shell a predetermined distance.

18. The apparatus as claimed in claim 17 wherein:

said means for raising and lowering said drilling means includes:

a hose reel mounted in said housing,

a flexible hose supported on said reel and communicating between the exhaust part of said motor and the atmosphere, and

a support cable carried inside said hose for supporting said drilling means during raising and lowering thereof, and having

conduit means carried inside said hose for supplying another pressurized fluid to operate said first and second piston means.

19. The method of performing a hot tapping operation on a container having a fluid under pressure contained therein, comprising the steps of:

forming an enclosed chamber adjacent to and in communication with a portion of the external wall of said container,

placing a fluid pressure actuated drilling means within said chamber in drilling engagement with said portion of said wall,

cutting a fluid pressure releasing hole through said portion of said wall, to thereby permit the escape of said fluid from said container into said chamber,

applying said escaping fluid to operate said drilling means,

continuing the operation of said drilling means until a hole of predetermined size is formed in said portion of said wall.

20. An apparatus for cutting an opening in a container, said apparatus comprising:

an elongate fluid tight housing having an open end adapted for securing to said container and enclosing

the section of the wall of said container which is to be cut,

a fluid pressure actuated drilling means disposed within said housing in drilling engagement with said section of said wall,

means for supplying a fluid to said housing in sufficient quantities to pressurize said housing and to actuate said drilling means,

means for advancing said drilling means toward said section of said wall while said drilling means is actuated.

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