United States Patent [19]

Keys

[11] **3,791,011**

[45] **Feb. 12, 1974**

[54] **TUBE PULLING DEVICE**

[76] Inventor: **Joe H. Keys,** 315 N. Yupon St., Clute, Tex. 77531

[22] Filed: **Apr. 24, 1972**

[21] Appl. No.: **246,771**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 88,721, Nov. 20, 1970, abandoned.

[52] **U.S. Cl.** ..... **29/252,** 29/282, 29/202 R

[51] **Int. Cl.** **B23p 19/04**

[58] **Field of Search** . 29/202 R, 234, 252, 263, 264, 29/265, 282

[56] **References Cited**

UNITED STATES PATENTS

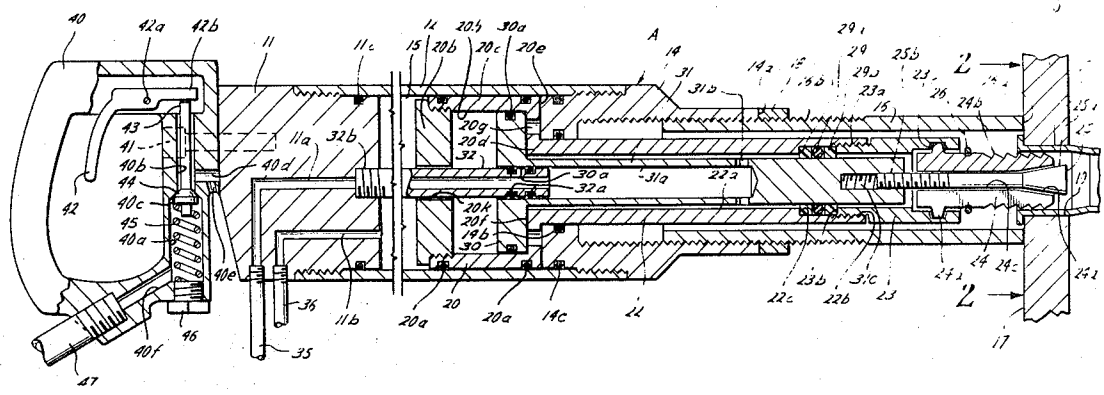
3,367,011	2/1968	Sipher	29/202 R
2,697,872	12/1954	Armstrong	29/252

Primary Examiner—Othell M. Simpson
Assistant Examiner—Harold P. Smith, Jr.
Attorney, Agent, or Firm—Pravel, Wilson & Matthews

[57] **ABSTRACT**

A tube pulling device for gripping and removing a tube, or tube end from a plate or tube sheet of a heat exchanger or the like, wherein a pair of pistons are arranged so as to coact with each other for movement in response to hydraulic fluid pressure for initially engaging a tube gripping means in the bore of the tube to be pulled and for thereafter exerting a pulling force on the tube relative to the plate or tube sheet in which the end of the tube is secured. The pistons are controlled without the use of one-way valves inside of the device and with the full hydraulic force applied to the pistons successively as required. The hydraulic fluid is supplied to the pistons from an external hydraulic system which is controlled by an air stream having a control at the device for manipulation by the operator.

6 Claims, 5 Drawing Figures



2 Sheets-Sheet 1

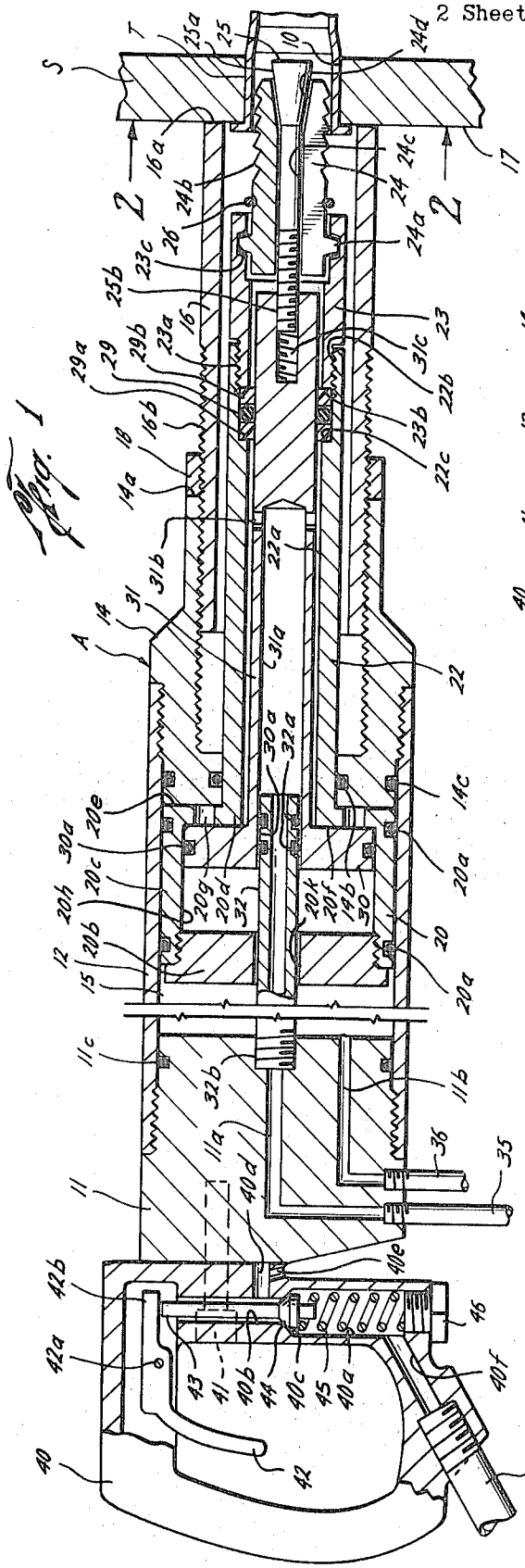


Fig. 1

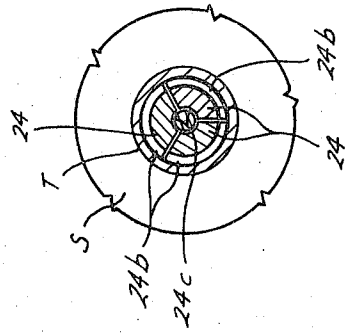


Fig. 2

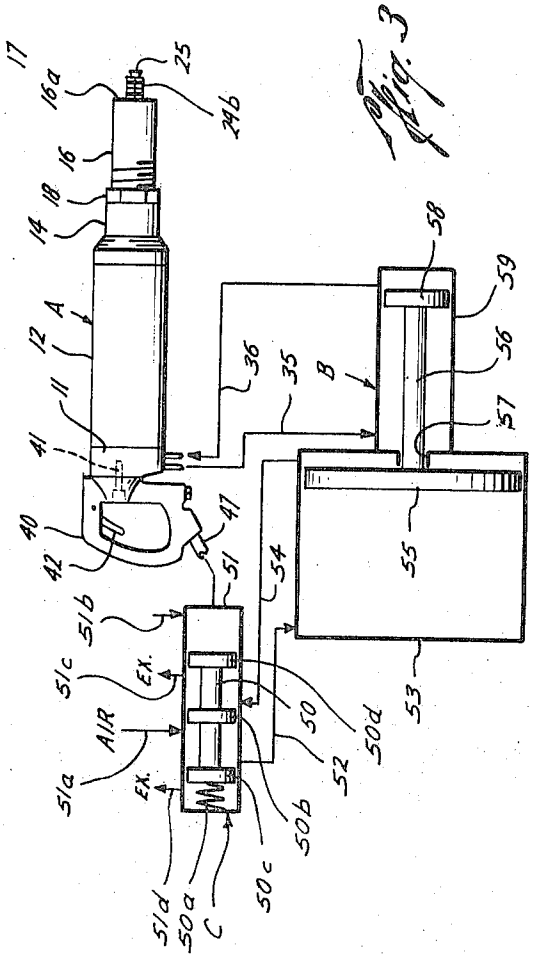


Fig. 3

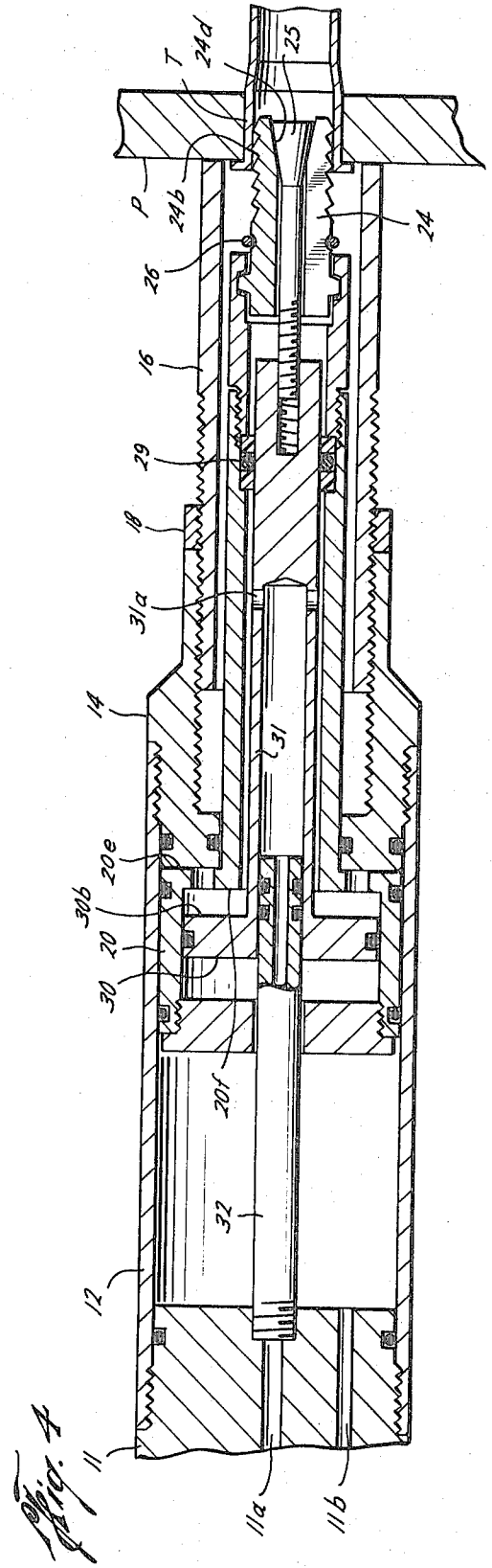

T
24d
25
P
24b
24
26
16
29
18
31a
14
31
20e
30b
20
30
20f
32
12
11
11a
11b

Fig. 4

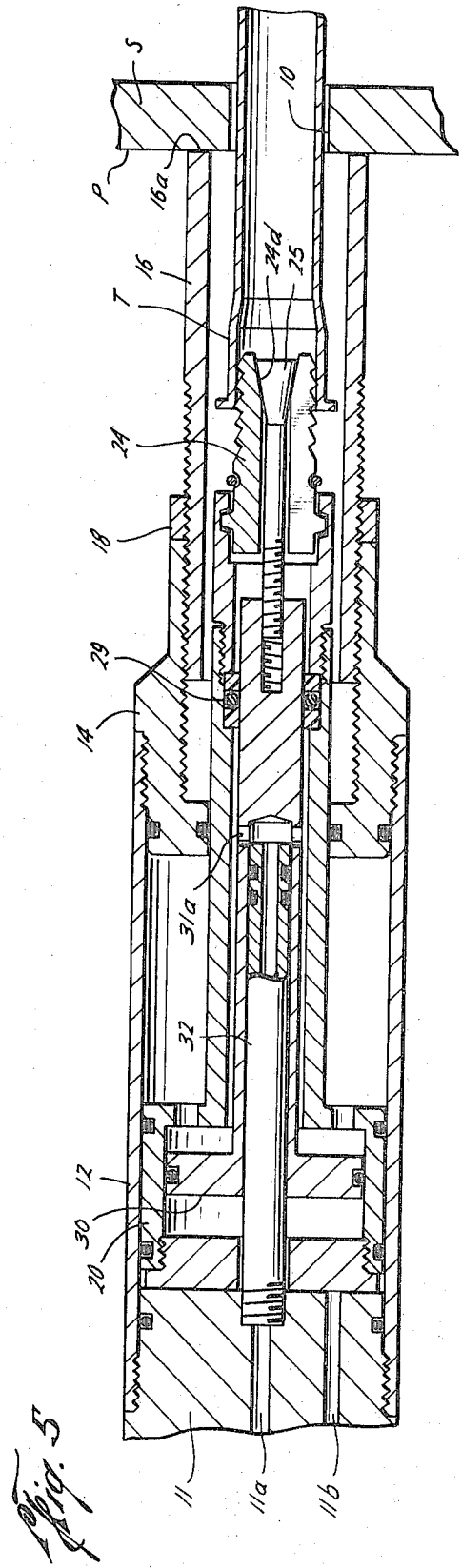

5
10
P
16a
16
T
24d
25
24
18
29
14
31a
32
12
30
20
11
11a
11b

Fig. 5

TUBE PULLING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. Pat. application, Ser. No. 88,721, filed Nov. 20, 1970, now abandoned.

BACKGROUND OF THE INVENTION

The field of this invention is devices for pulling tubes from tube sheets in heat exchangers, condensers and the like.

Various efforts have been made in the pst to develop a satisfactory tube pulling device, examples of which are shown in U.S. Pat. Nos. 2,697,872; 3,367,011; and 3,369,287. So far as is known, all of such prior art devices have either been rendered excessively complex by the use of internal valving or they have so arranged their pistons that the full fluid force could not be developed.

SUMMARY OF THE INVENTION

The present invention relates to a new and improved device for pulling tubes (the terms "tube" or "tubes" as used herein includes full or partial lengths of a tube or tubes) from a plate or tube sheet which may be from a heat exchanger, condenser or the like. In its specific embodiment, the tube pulling device has an inner piston connected to a tube gripping means for initially gripping the inside of the tube when fluid pressure is applied to the inner piston. An outer piston is exposed through open port means with the hydraulic fluid at the time of the gripping of the tube, but the fluid forces are substantially equalized thereon until tube gripping means is set in gripping engagement with the tube. The system for operating the tube pulling device is air-actuated to control hydraulic fluid used in exerting the gripping and pulling forces on the tubes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of the pulling devices of this invention, shown in position prior to pulling a tube from a tube sheet;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a schematic view illustrating the complete operating system with the tube pulling device of this invention, showing the combination air-hydraulic assembly;

FIG. 4 is partial sectional view of the apparatus of FIG. 1, after the gripping means has been moved to engage the wall of the bore of the tube which is to be pulled fromthe tube sheet; and

FIG. 5 is a view similar to FIG. 4, but showing the tube pulling device of this invention after it has pulled the tube from the hole in the tube sheet.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings, the letter A designates generally the tube pulling device of this invention which is operated by hydraulic fluid from a hydraulic system B which is controlled by an air control means C, as will be more fully explained hereinafter. The hydraulic system B and the air control means C are located at any suitable point remote from the tube pulling device A which is handled by an operator at the point of the tube T which is to be pulled from a hole **10** in a tube sheet S or other similar plate in a heat exchanger, condenser or the like.

The tube pulling device A includes a body which may be made in one piece, but as illustrated in FIG. **1**, the body includes a rear body section **11**, a body sleeve **12** and a forward body section **14**, which are threaded or are otherwise secured together as illustrated. A fluid chamber **15** is formed in the body between the body sections **11** and **14** and inwardly of the body sleeve **12**. A bucking sleeve **16** is threaded or is otherwise connected to the forward body section **14** so that the forward annular end **16*a*** can be placed in contact or in bucking position against the flat surface **17** of the tube sheet or plate S as illustrated in FIG. **1**. A locking nut **18** is threaded on the threads **16*b*** of the bucking sleeve **16** for abutment against the end **14*a*** of the forward body section **14** to prevent relative rotation between the bucking sleeve **16** and the forward body section **14** after they have been located at the desired position. By loosening the nut **18**, the bucking sleeve is adjustable longitudinally for a purpose to be hereinafter explained.

An outer piston **20** having a pair of O-ring seals **20*a*** formed of rubber or other resilient material, or other suitable resilient seals is disposed in the chamber **15** of the body sleeve **12**. The outer piston **20** includes a closure cap **20*b*** which may be threaded or otherwise connected to the annular portion **20*c*** of the piston **20**. The piston **20** also has a forward piston section **20*d*** which has a forward piston surface **20*e*** and a rearward piston surface **20*f***. Port means are provided through the piston section **20*d*** as indicated by the holes **20*g***, for a purpose to be hereinafter explained.

The outer piston **20** has a tubular means which includes a tube **22** that is preferably formed integrally with the piston section **20*d***, and which is provided with a bore **22*a***. The forward end of the tubular member **22** is preferably threaded at **22*b*** for receiving a special adapter sleeve **23** having threads **23*a*** engageable with the threads **22*b***. The tube **22** also has an annular shoulder **22*c*** which is spaced from the rearward end **23*b*** of the sleeve **23** for receiving a seal assembly which includes a resilient ring such as an O-ring **29** and anti-extrusion rings **29*a*** and **29*b*** on either side thereof. The sleeve **23** serves as a packing gland to compress the sealing assembly between the rearward end **23*b*** of the sleeve **23** and the shoulder **22*c***, as will be more evident hereinafter.

The sleeve **23** has an annular recess **23*c*** in its bore at its forward end for receiving projections or dogs on each of a plurality of gripping members **24**. Preferably, there are three of such gripping members **24** and they are shaped so as to form generally circular configuration when assembled. Each of the gripping members has gripping teeth **24*b*** which are adapted to engage the inside wall in the bore of the tube T which is to be pulled from the plate or sheet S, as will be more evident hereinafter.

The gripping members **24** are each formed with a curved inner surface **24*c*** so as to form a substantially cylindrical opening throughout its major extent and such surfaces **24*c*** are tapered at their forward end as indicated at **24*d*** (FIG. **1**) for receiving an expander or wedge member **24** having an annular wedge section **25*a***. Preferably, a resilient ring **26** surrounds the gripping members **24** and holds them in position on the expander member **25**. The projections **24*a*** in the annular recess **23*c*** may rock or pivot so that the gripping mem-

bers 24 may be moved radially outwardly in response to an enlarging force created by the movement of the wedge section 25*a* rearwardly so as to engage the teeth 24*b* in the tube T as will be more evident hereinafter.

An inner piston 30 is disposed in a chamber of the outer piston 20 defined by the annular wall 20*h* so as to move from the forward piston section 20*d* rearwardly to the piston closure or cap 20*b*, and vice-versa. The piston 30 has a suitable piston seal such as an O-ring 30*a* mounted in sealing engagement with the wall 20*h* of the piston 20.

A piston rod 31 is formed integrally with or is connected with the piston 30 and extends forwardly therefrom and it has a hollow bore 31*a* which extends for a portion of such rod 31, preferably terminating in proximity to one or more fluid ports 31*b* through the wall of the rod 31. The piston 30 has a central opening 30*a* therethrough which is in alignment with the bore 31*a* and also with a central opening 20*k* in the outer piston cap or closure 20*b* for receiving a fluid control tube 32 having seals 32*a* at its forward end for engagement in the bore 31*a* and 30*a*. The fluid control tube 32 is threaded or is otherwise secured to the body section 11 as indicated at 32*b* and it is in communication with a fluid passage 11*a* in the body section 11 which is connected with an external hose or fluid pressure line 35. The body section 11 also has a fluid passage 11*b* which communicates with the chamber 15 rearwardly of the piston closure 20 *b* and it communicates with a hose or fluid pressure line 36 externally thereof.

The forward end of the piston rod 31 is mounted so that its external surface is in sealing engagement with the seal assembly including the seal 29 so that fluid which enters the area between the rod 31 and the tube 22 is restricted from forward movement past such seal 29. Also, the expander rod 25 is connected by threads 25*b* on such rod 25 to internal threads 31*c* or other similar connecting means to provide for movements of the piston rod 31 and the expander member 25 together. Also, the threads 25*b* and 31*c* permit adjustment to change the effective diameter for the gripping members 24, as will be evident from the drawings and from the further description herein.

In addition to the seals heretofore mentioned, it should be noted that suitable seals such as O-rings 14*c* and 14*b* are provided with the body section 14, and an O-ring 11*c* is provided with the body section 11. This closes off the piston chamber 15 in which the outer piston 20 moves as a result of hydraulic fluid pressure acting thereon.

For handling the device A, which is generally done by a single man in the pulling of a tube T from the tube sheet S, it is desirable to have a handle 20 or other simiar handle means secured to the body 11 by one or more attaching bolts 41 which extend through the handle 40 into the body section 11 (FIG. 1). The handle 40 is of a typical pistol grip shape so as to be grasped by one hand of the operator, leaving his other hand for supporting the rest of the device A. A valve actuating trigger 42 is pivotally mounted on the handle 40 at a pivot pin 42*a* so that by the operator engaging the trigger 42 with one of his fingers while holding the handle 40, he may pivot the forward end 42*b* of the trigger 42 downwardly about the pivot pin 42*a*.

The trigger end 42*b* is normally urged upwardly by a valve rod 43 at the upper end of the valve member 44, which is urged to a seated position by a spring 45 or other suitable resilient means.

The handle 40 is preferably ported so as to provide a chamber 40*a* in which the spring 45 is disposed and which communicates with a counterbore 40*b* thereabove, with a valve seat 40*c* formed therebetween for engagement by the valve member 44. The bore 40*b* is vented to the atmosphere through ports 40*d* and 40*e*, but until the trigger 42 is actuated, the valve 44 seats to close off the port 40*b* so that there is no flow from the larger bore 40*a* to the vent 40*e* so long as the valve 44 is seated. A removable plug 46 is mounted in the lower end of the passage 40*a* to facilitate the insertion and removal of the spring 45 and the valve member 44 with its actuating rod 43 for cleaning and other purposes.

The handle 40 also has an inlet passage 40*f* which is in communication with the bore 40*a* and which is connected to a flexible line or hose 47 so that air under pressure is supplied to the chamber 40*a* and is confined therein so long as the valve 44 is seated. However, upon a squeezing of the trigger 45 to depress the rod 43 and open the valve 44, the air pressure in the line 47 then flows to the vent 40*e*, for a purpose to be hereinafter explained.

The air-hydraulic system which is used with the device A of this invention is schematically illustrated in FIG. 3 and as shown therein, it includes an air pivot valve C of conventional construction which is connected to the inlet hose or line 47 with the handle 40. It will be understood that the line 47 is of any predetermined length so that the device A may be operated at a point remote from the valve C and without any interference from such stationary position of the valve C. Likewise, the hoses 35 and 36 are of predetermined lengths so as to permit the hydraulic system B to be located at a stationary place remote from the device A so that there is no interference with the operator moving the device A within limits for removing tubes T from equipment located at various points.

The valve C includes a spool valve member 50 of conventional construction within a housing 51. Air under pressure is admitted through a port indicated at 51*a* in the housing 51 from a source of air pressure (not shown). The valve C is illustrated in FIG. 3 as being in the position that it assumes when the trigger 42 is not being squeezed by the operator. It is to be noted that air pressure is also introduced into the chamber 51 through a port 51*b* from the air supply and this pressure is sufficient to overcome a spring 50*a* to maintain the spool 50 in the position shown in FIG. 3 so that the area between the spool enlargements and seals 50*b* and 50*c* communicates with a flow line 52 leading from the spool valve 51 to conduct air under pressure to an actuating cylinder 53 with the hydraulic system B. Another line 54 at the other end of the actuating cylinder 53 communicates with the housing 51 at a point intermediate the enlargements 50*b* and 50*d* of the spool 50 which is permitted to exhaust at an exhaust port 51*c*.

When the trigger 42 is squeezed to open the valve 44 in the handle 40, as previously explained, the air pressure in the line 47 is vented to exhaust through the vent opening 40*e* and this enables the spring 50a to move the spool 50 to the right as viewed in FIG. 3 which shifts the alignment of the ports with respect to the spool 50 as is well known. As a result of the shift in the alignment of the spool 50 with the ports, the air supply

through line 51*a* is then directed between the spool seals 50*b* and 50*c* which are at that time communicating with the line 54. The line 52 is to the left of the spool seal 50*c* so that it is in communication with an exhaust port 51*d*. Thus, the air pressure is introduced into the cylinder 53 through the line 54 and it is exhausted therefrom through the line 52. When the trigger 42 is released by the operator, the valve 44 closes and the pressure in the line 44 and in the right hand end of the valve housing 51 again builds up due to its supply of air pressure through the line 51*b* and the valve spool 50 is shifted back to the left to again realign the air inlet 51*a* with the line 52 and the air exhaust 51*c* with the line 54 in the position shown in FIG. 3.

The hydraulic system B is actuated by the air supply as previously explained to move a piston 55 disposed in the housing or chamber 53. The piston 55 is connected by a piston rod 56 through a suitable seal 57 to a hydraulic piston 58 disposed in a housing 59.

Thus, hydraulic fluid is confined within the cylinder 59 and is separated from the air in the cylinder 53 by the seal 57. As the piston 58 moves within the cylinder 59, it controls the hydraulic fluid flow with respect to the lines 35 and 36 for controlling the operation of the device A. Thus, when the air piston 55 is to the extreme right as shown in FIG. 3, and the hydraulic piston 58 is to the extreme right, the hydraulic fluid has moved the outer piston 20 forwardly and also the inner piston 30 forwardly to the positions shown in FIG. 1 so that the device A is ready to be inserted into a tube T for beginning the pulling operation. When the trigger 42 is squeezed, to begin the pulling operation, the air is shifted, as previously explained to move the piston 55 to the left as viewed in FIG. 3 and such movement causes the hydraulic piston 58 to likewise move to the left to force fluid under pressure into the line 35 and to exhaust or return the hydraulic fluid back to the cylinder 59 through the line 36. Such fluid flow results in initially gripping the gripping members 24*b* with the inside wall of the tube T and then the pulling of the tube T from the tube sheet S, as will be more evident hereinafter. It is preferred that the capacity of the cylinder 59 be the same as, or substantially the same as, the capacity of the chamber 15 so that it is unnecessary to have an extra fluid reservoir for the hydraulic fluid and the fluid is simply transferred back and forth between such cylinders during normal operations.

In the operation or use of the device A of this invention, the air valve C and the hydraulic system B are in the positions shown in FIG. 3 prior to the pulling operation with the device A. The trigger 42 is in the position shown in FIG. 1, and the pistons 20 and 30 are in their forward positions so as to expose a predetermined number of gripping teeth 24*b* on the gripping member 24, forwardly of the bucking surface 16*a* (FIG. 3). The operator can predetermine the number of the teeth 24*b* which are thus exposed by adjusting the length of the bucking sleeve 16 relative to the forward housing section 14. This is accomplished by releasing the locking nut 18 and threading or unthreading the sleeve 16 with respect to the body section 14 and then relocking the nut 18 in position. Normally, it is preferable to have only about three of such gripping teeth 24 exposed at the time the gripping members 24 are initially inserted into the tube T.

it should also be noted that the initial outer diameter of the gripping members 24 may be adjusted by threading the expander 25 relative to the piston rod 31. This allows for adjustments to accommodate inner bore diameters of tubes within limits so as to more effectively pull tubes of different inner bore diameters. In any event, the expander 25 is set so that the teeth 24*b* do not actually engage the inner bore T at the time of insertion into the tube T, although they may drag slightly as they are inserted.

The bucking end 16*a* is placed against the tube sheet S as illustrated in FIG. 1 and this disposes the gripping teeth 24*b*, with about three of such teeth in the end of the tube T if the device A has been properly adjusted as heretofore described. Thereafter, the operator simply squeezes the trigger 42 and this causes the air system C to operate to move the piston 55 to the left as previously described and this moves the hydraulic piston 58 to the left as previously described. The hydraulic fluid thus passes through the line 35 and into the passage 11*a* and thence into the bore 31*a* of the rod 31. Since the ports 31*b* are always open, the fluid pressure then flows into the area between the hollow rod 31 and the tube 22 and exerts a pressure on the forward surface of the piston 30 to move it rearwardly relative to the piston 20.

It is to be noted that the openings 20*g* in the piston 20 are open at all times and no valve is provided therein, but nevertheless, only the piston 30 moves rearwardly at the outset because the pressure forces acting on the surfaces 20*f* and 20*e* of the piston 20 are essentially balanced at that time and until the piston 30 has stopped its rearward movement. The rearward movement of the piston 30 causes the expander 25, and particularly the wedge or expander surface 25*a* to move within the tapered inner surfaces 24*d* of the gripping members 24 to expand them outwardly to cause the teeth 24*b* to bite or grip the inner surface of the tube T. The extent of such movement is illustrated in FIG. 4 and this results in the gripping engagement between the teeth 24*b* and the tube T, prior to any movement of the piston 20.

After the movement of the piston 30 to the rear has stopped by reason of the engagement of the teeth 24*b* with the tube T, then the fluid pressures acting on the forward piston surface 30*b* and the rearward piston surface 20*f* essentially balance each other so that the fluid pressure then acting on the forward piston surface 20*e* results in a movement of the piston 20 rearwardly. The pressure is of course also acting on the surface 30*b* so that the pistons 20 and 30 move together as a unit rearwardly and such movement causes the entire gripping assembly to move rearwardly relative to the body, as illustrated in FIG. 5. Such rearward movement results in a pulling of the tube T from its opening 10 in the plate or tube sheet S. Once the end of the tube T is removed from the opening 10, the entire tube or a portion thereof as may be cut off, may then be completely removed from the sheet S as is well understood.

After the tube T has thus been released from the opening 10 of the sheet S, the operator releases the squeezing action on the trigger 42 so as to return the valve 44 to the closed position shown in FIG. 1. When the valve 44 thus closes off the vent 40*e*, the air pressure then developes in the air system to return the spool valve 50 to the position shown in FIG. 3 which results in the piston 55 moving back to the right to the position shown in FIG. 3. Such return also returns the piston 58 to the right to cause the pistons 20 and 30 to return to

the position of FIG. 1 so that the gripping teeth 24*b* are again exposed as shown in FIG. 3 for a subsequent pulling operation.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

I claim:

1. A tube pulling device, comprising:

a body having an operating chamber therein at the rearward end and having an open bucking sleeve connected thereto at the forward end for bucking engagement with a tube sheet or the like;

an outer piston disposed in said operating chamber for sealing engagement with the wall thereof and for movements therein in response to fluid pressure acting on opposite sides thereof;

a tubular assembly with said outer piston and extending forwardly therefrom in said bucking sleeve to form a forward piston surface;

tube gripping means mounted at the forward end of said tubular assembly for longitudinal movement therewith and for gripping engagement with the inner wall of a tube;

an inner piston slidably mounted in a rear-ward portion of said tubular assembly and forwardly of said outer piston for longitudinal movements relative to said outer piston and having a piston rod with a hollow bore forwardly thereof;

expander means operably connected to said inner piston by said piston rod for expanding said tube gripping means into gripping engagement with a tube upon a rearward longitudinal movement of said inner piston relative to said outer piston, and said expander means and gripping means having co-acting surfaces for preventing further rearward longitudinal movement of said inner piston relative to said outer piston after said gripping means is in gripping engagement with the tube:

fluid passage means mounted with said body and including a fluid control tube mounted in said operating chamber and extending through said outer piston and said inner piston for directing fluid forwardly of said inner piston and said outer piston;

said hollow bore of said piston rod receiving said tubular passage member and having an open port means establishing fluid communication with the forward side of said inner piston;

said tubular assembly having an open port means forwardly of said inner piston and establishing communication between the area forwardly of said inner piston and the area in said chamber forwardly of said forward piston surface for constantly exposing said outer piston to the fluid force acting on said inner piston but substantially equalizing said fluid force acting on said outer piston until the rearward movement of said inner piston relative to said outer piston is stopped by the coaction between said expander means and said gripping means; and

said outer piston having an inner piston surface with substantially the same area exposed to fluid pressure as the area of said inner piston for thereby cancelling the effectiveness of said fluid force acting on said inner piston surface and said inner piston when the rearward movement of the inner piston has stopped, whereby the fluid force then acts upon said outer piston surface to move said outer piston and said inner piston rearwardly together for pulling the tube from the tube sheet or the like.

2. The tube pulling device set forth in claim 1, including:

handle means connected to said body; and

control means with said handle means for controlling the fluid flow in said device for thereby controlling the gripping and pulling of tubes.

3. The tube pulling device set forth in claim 2, wherein said control means includes:

an air-actuated pilot valve operably connected to a source of air pressure and air pressure lines leading therefrom; and

a hydraulic system operably connected to said air pressure lines from said pivot valve for responding to air pressure flowing from said source of air pressure upon a manipulation of the portion of the control means with said handle means for thereby supplying hydraulic fluid to said device for operating said pistons.

4. The device set forth in claim 1, including:

seal means forwardly of said open port means in said fluid control tube and disposed between said tubular assembly and said fluid control tube for confining the hydraulic fluid rearwardly thereof.

5. The device set forth in claim 4, wherein:

said tubular assembly includes a longitudinally adjustable sleeve at the forward end and having a rear shoulder engageable with said seal means for confining and compressing same to provide said seal between said tubular assembly and said fluid control tube.

6. The device set forth in claim 1, wherein said fluid passage means includes:

a pair of fluid passage lines in the rearward end of said body, one of which communicates with said tubular passage member and the other of which communicates with the area of said chamber rearwardly of said outer piston, whereby fluid in the portion of chamber rearwardly of said outer piston is discharged therefrom as said outer piston moves rearwardly.

* * * * *