Inside pipe cutter apparatus which is particularly adapted for cutting off pipe such as offshore platform legs from the inside without requiring that personnel go down in the water outside of the platform legs or inside of such legs. The apparatus is lowered on a wireline or other suitable support and is actuated and controlled from the platform itself or from a barge alongside the platform.

9 Claims, 6 Drawing Figures
INSIDE PIPE CUTTER APPARATUS

BACKGROUND OF THE INVENTION

The field of this invention is apparatus for cutting pipe from the inside, particularly offshore platform legs.

In recent years, many offshore platforms have been built using pipes of relatively large inside diameters as the legs for such platforms. For example, offshore platform legs commonly have inside diameters of from 30 to 48 inches and these extend down from the platform, which is above the water, into the soil beneath the water. Although some efforts have been made to develop inside diameter pipe cutter apparatus, such as illustrated by U.S. Pat. Nos. 2,915,819 and 3,052,024, so far as is known, none of such prior apparatus has been satisfactory for actually cutting off platform legs. As a result, it has been common practice to send one or more divers down in the water outside of the platform legs with cutting torches for cutting off the platform legs. In some instances, divers have even gone down inside of the platform legs where the diameter of the legs is great enough to accommodate the diver and his equipment. Such operations are inherently very dangerous to the diver because of the danger of the leg shifting during or upon completion of the cut thereof, and the danger is multiplied when the diver is inside of the pipe. Furthermore, it is desirable, and sometimes even required by law, that the platform legs be cut off at or below the bottom of the water so as not to project upwardly from the bottom, which further increases the difficulties of cutting such legs, particularly from externally of the legs.

SUMMARY OF THE INVENTION

The present invention relates to a new and improved pipe cutter apparatus for cutting pipe from the inside thereof. The apparatus is lowered on a wireline inside of the pipe to the point at which the pipe is to be cut, the apparatus is then anchored to the inside wall of the pipe, gauge means are actuated to engage the pipe for positioning one or more cutter means in proximity to the inside wall of the pipe and then the cutter means is actuated to cut through the wall of the pipe as the cutter means is rotated. The controls for the apparatus are located at the upper end of the pipe or at any suitable location remote from the pipe which is accessible to an operator so that it is unnecessary for anyone to go down into the pipe or into the water outside of a pipe located offshore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view, partly in elevation, illustrating the apparatus of this invention disposed in a pipe, with the anchoring means in anchoring engagement with the inside wall of the pipe, and with the gauge means also in engagement with the inside wall of the pipe, but with the cutter means retracted;

FIG. 2 is a partial view of a portion of the apparatus illustrated in FIG. 1, but showing the cutter means after it has been actuated and has cut through the pipe;

FIG. 3 is a view taken on line 3—3 to illustrate further details of one of the anchoring shoes and the mounting thereof;

FIG. 4 is a sectional view taken on line 4—4 to further illustrate the adjustability of the anchoring shoes;

FIG. 5 is a sectional view taken on line 5—5 of FIG. 1 to illustrate further details of the apparatus of this invention; and

FIG. 6 is a general view in elevation of the preferred use of the apparatus of this invention for cutting pipes which form the platform legs on offshore platforms.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings, the letter A designates generally the apparatus of this invention which is adapted to be disposed in a pipe P (FIG. 1) which may form the leg of an offshore platform W (FIG. 6). The apparatus A is adapted to be lowered into a pipe such as platform leg P, on a wireline or other flexible support C which is supported by any suitable lowering and hoisting apparatus generally designated H (FIG. 6) and which is adapted to be positioned on the platform W. As illustrated in FIG. 6, the apparatus is adapted to cut each of the pipes or platform legs P off at a point P' which is below the ground G in a body of water B in which the offshore platform W is located. After the apparatus A has cut one or more of the platform pipes or legs P such as indicated at P', the well platform W with the portions of the legs P extending theretobe are preferably supported by and are movable with a relatively large barge S which may have a boom or crane therewith and which has lines 11 extending therefrom to the platform W as illustrated in FIG. 6. Thus, with the present invention, it is possible for all of the pipes forming the platform legs to be cut off below the ground level G in the body of water B, without an operator going down inside of the pipes or legs P and without requiring a diver or any other person to go down in the water B.

Considering now the details of the preferred form of the apparatus A, such apparatus A includes a frame assembly 12 which is preferably formed with a plurality of vertically extending frame members or strips 12 a which are arranged in spaced pairs (FIG. 3) and are spaced circumferentially with respect to each other so that at least two pairs of such frame members 12 a are positioned diametrically opposite from each other as best seen in FIG. 1. The vertical frame members 12 a are welded together or are interconnected by any suitable means such as substantially horizontally disposed bars or plates 14, 15, 16 and 17. It should also be understood that there may be more vertical frame members 12 a than those illustrated in the drawings and these would also be circumferentially spaced with respect to those that are shown and they would be welded or otherwise secured to the reinforcing frame members or plates 14—17 so as to rigidify the complete frame assembly A. An upper connecting bar or plate 18 is welded or is otherwise secured to the vertical frame members 12 a and it has a plate 18 a for attachment to the cable or wireline C which is used for supporting the apparatus A in the pipe P, as previously noted.

For the purpose of anchoring the frame assembly 12 to the inside wall or surface 20 of the pipe P, anchoring means, including a plurality of anchoring shoes 25 are mounted with the frame assembly 12 in a manner to be hereinafter described. Each of the anchoring shoes 25 is preferably formed with an arcuate external outer surface 25 a which is adapted to contact the inside wall surface 20 of the pipe P. The upper portion 25 b of each shoe 25 is curved inwardly away from the wall 20 so as to prevent such surface from prematurely digging into
the wall 20 when anchoring the shoes 25, as will be more evident hereinafter.

Each of the contact or anchoring shoes 25 is adjustably mounted in the outer end of a lever arm 26 which is disposed between a pair of the vertical frame members 12a and which is pivotally mounted thereto by a pivot bolt or pin 27 which extends through the pair of vertical frame members 12a (FIG. 3). Each lever arm 26 has an elongated slot 26a into which the pivot pin 27 extends (FIG. 1) for a purpose to be hereinafter explained.

The adjustability of each shoe is accomplished in any suitable manner such as by a telescoping stem 25c which slides in a recess 26b of the lever arm 26. Locking set screws 28 or other suitable means are provided for holding each stem 25c in the selected position relative to the lever arm 26 with which it is connected.

Each lever arm 26 extends inwardly to a vertical guide plate 30 having a longitudinal slot 30a therein which receives a guide pin 26c on the inner end of the lever arm 26 so as to cause such inner end of the lever arm 26 to move vertically in a predetermined path defined by the slot 30a. Each pin 26c extends through the slot 30a and into an elongated opening or slot 31a in a connecting link 31 which is pivoted at a pivot pin 31b to another vertical frame member 32 which is welded or otherwise secured between either the plates 14 and 15 or the plates 16 and 17 (FIG. 1). Thus, as shown in FIG. 1, there are four of such lever arms 26 with a contact or anchoring shoe 25 with each lever arm 26, and there are also four of the connecting links 31. Each pair of the anchoring shoes 25 is disposed in a longitudinally spaced relationship to the other pair as seen in FIG. 1. Each pair of the shoes 25 are preferably simultaneously actuated so as to pivot them from their downwardly inclined retracted position out of contact with the wall 20 to their gripping contact position shown in FIG. 1 wherein the lever arms 26 are still downwardly and inclined, but at a lesser angle than when they are retracted. For the purpose of moving such shoes 25 from the retracted position to the gripping or contact position with the inside wall 20, an anchoring actuator means is provided which includes for each pair of the lever arms 26, a piston 35 in a cylinder 36 to which hydraulic fluid is circulated through lines 36a and 36b as will be well understood. The piston 35 has a piston rod 35a therewith which has a connecting pin 35b extending laterally therefrom through aligned slots 31c in the overlapping inner ends of the links 31 so that each pair of links 31 is moved at the same time by the movement of the piston 35 to thereby simultaneously control the outward and inward pivotal movement of the anchoring shoes 25 relative to the frame assembly 12 and the pipe P. The lines 36a and 36b are flexible tubes which are placed at any convenient locations and are extended upwardly to the upper end of the pipe P, as indicated partially by the tubes 36a and 36b shown in FIG. 1 in proximity to the wireline or cable C. Such lines extend to a source of hydraulic fluid under pressure which is not shown because it is conventional and is well understood by those skilled in the art. Such hydraulic system is remotely located with respect to the pipe P and it may be operated by an operator on the platform W or even remotely from such platform W. When fluid is introduced under pressure through line 36b connected to one or both of the cylinders 36, the piston 35 is moved upwardly as viewed in FIG. 1 and such upward movement causes a pivoting of the links 31 and a resultant pivoting of the lever arms 26 so as to force the anchoring shoes 25 to move in an upward and outward arc for applying extreme pressure to the inside wall 20 for securely anchoring the apparatus A in the pipe P. Because of the pivotal action of the lever arms 26, a tremendous mechanical advantage may be developed and the pressure of the hydraulic fluid may be extremely high so that the location of the apparatus A at a predetermined point in the pipe P is assured. Upon reversing the flow of the hydraulic fluid to the cylinders 36 so that the fluid flows inwardly into the cylinders 36 from the lines 36a and returns through the lines 36b, the shoes 25 are caused to swing downwardly to a retracted position and are thus withdrawn for the purposes of moving the apparatus A within the pipe P so that the shoes 25 do not drag on the inside surface 20 during such movement.

It is to be noted that the cylinders 36 are welded or are otherwise secured to the plates 15 and 17 and they preferably are centrally disposed so that each cylinder 36 may be used as illustrated for a pair of the anchoring shoes 25 as explained.

A rotatable head which is preferably composed of a substantially circular plate 40 and a ring 41 secured thereto by any suitable means such as machine bolts 40a is located at the lower end of the frame assembly 12. The ring 41 has an annular guide projection 41a which is adapted to fit into contact with circular guide surfaces 42a of a plurality of rollers 42. The rollers 42 are mounted in a circular path around the ring 41 and are preferably supported by roller spindles 43 which extend through upper and lower roller support rings 44 and 45 which are welded or are otherwise secured to the vertical frame members 12a. The ring 41 has internal gears 41b which are adapted to be engaged by a drive gear 46 driven by a motor 47 which may be an electrical or hydraulic motor supplied with electricity or hydraulic fluid through any suitable lines such as 47a which extend to the surface of the platform W along with the cable C. Thus, when the motor gear 46 rotates, it drives the ring 41 and the circular plate 40 forming the rotatable head so that the annular projection 41a is rotated and is supported during rotation by the support rollers 42.

Gauge means which includes gauge rollers 50 for engagement with the inside wall or surface 20 of the pipe P are provided below the rotatable head or plate 40 for rotation therewith for predetermining the position of cutter means as explained hereinafter. Preferably, the gauge rollers 50 are mounted in diametrically disposed pairs of rollers as illustrated in FIG. 1 and they are radially movable from an inward retracted position out of contact with the wall surface 20 to a roller contact position shown in FIG. 1. The gauge rollers are preferably mounted on a gauge support body 51 (FIGS. 1 and 5) each of which has laterally extending flanges 51a which are received in supporting strips 52 having guide recesses 52a (FIG. 5). The strips 52 are secured to the lower part of the rotatable plate 40 by machine screws or bolts 52b or any other suitable attaching means. Thus, the gauge roller support body 51 may move radially and inwardly and outwardly relative to the pipe P as the flanges 51a slide in the guide recesses 52a. The movement radially for the body 51 and thus the gauge rollers 50 is accomplished in the preferred form of the invention by a piston 52 connected to a stem or rod 52a
which is welded or is otherwise affixed to each of the gauge support bodies 51. Each piston 52 is disposed in a cylinder 53, and suitable fluid pressure lines 53a and 53b are provided for controlling the fluid pressure supply and return with respect to each cylinder 53 in the known manner. Preferably, hydraulic fluid is supplied through a common flexible hose or tube 54 through a pressure compensating valve 54a to both of the inlet lines 53a to the cylinders 53 so that the pressure to the pistons 52 for urging the gauge bodies 51 and the rollers 50 outwardly is substantially the same and causes engagement of the rollers 50 with the inside surface 20 substantially simultaneously. The flexible tube or hose 54 is not shown as extending to the surface, but it will be understood that it will extend along side of the cable C to the platform W or at any point which is conveniently accessible to an operator so that the operator does not have to go down into the interior of the pipe P.

The cutter means of this invention includes one or more cutter blades 60 which are formed of tool steel or any suitable hard material which is capable of cutting through the steel or other material forming the wall of the pipe P. As illustrated in FIG. 1, there are two of such cutter blades 60, each of which is mounted in a cutter support 61 and is secured thereto by a releasable locking screw 60a of any conventional construction. Each of the support members 61 is supported for sliding movement in a radial direction inwardly and outwardly with respect to the pipe P, as specifically illustrated in FIGS. 1 and 5. Each support body 61 has side lips or flanges 61a (FIG. 5) which fit into corresponding guide recesses 62a of support strips 62. Each support stip 62 is secured to the lower surface of the gauge roller body 51 by machine screws or bolts 62b or any other suitable securing means.

The radial or other inward and outward movements of the cutter bodies 61 and the cutter blades 60 therewith is accomplished by providing a piston 62 and a piston rod 62z therewith which is connected to each of the cutter supports 61. Each piston 62 is mounted in a cylinder 63 having hydraulic fluid tubes 63a and 63b therewith. The tubes 63a and 63b are not shown as going to the surface where the platform W is located, but it will be understood that they do extend alongside of the cable C to the surface of the platform W or at any other suitable location for operation by an operator. The cutter blades 60 are forced outwardly to initially engage the inside wall or surface 20 of the pipe P after the gauge rollers 50 have thus been engaged, and thereafter, the continued hydraulic pressure acting on the pistons 62 forces the cutter blades 60 to cut through the wall of the pipe P as the cutter blades 60 are rotated together with the ring 41 and the rest of the cutter head 40. The extent of the cutting with the cutter blades 60 which is required depends upon the thickness of the wall of the pipe P and may be regulated by the length of the cutter blade 60 and to the extent of the movement thereof as to cut completely through the wall of the pipe P as illustrated in FIG. 2, thereby forming the cut P which is also illustrated in FIG. 6.

In the use or operation of the apparatus A of this invention, it is preferably lowered into the pipe P which is to be cut, by using a cable or wireline C which is controlled by any suitable hoisting or support mechanism H located at the upper end of the pipe P. When the pipe P is an offshore platform leg as illustrated in FIG. 6, the hoisting and control apparatus for the cable C is located on the platform W or at any other suitable location. The apparatus A may be lowered to a level in the pipe P which is below the bottom or ground G in the body of water B, with the shoes 25, gauge rollers 50 and cutter blades 60 all retracted so that they do not drag as the apparatus A is lowered in the pipe P. When the apparatus A has reached the desired elevation for begining the cut through the pipe wall, the lowering of the apparatus A is discontinued and the apparatus A is then supported on the line or cable C at the desired elevation. The operator then introduces fluid pressure through the supply lines 36a and 36b to initially cause a pivoting of the links 31 and the lever arms 26 to swing the shoes 25 arcuately upwardly and outwardly for binding them and locking them in anchoring engagement with the inside wall 20 of the pipe P. The wedging action which is developed is tremendous and can resist any subsequent tendency of the frame 12 to rotate or shift in the pipe P. Thereafter, hydraulic fluid is introduced through the line 54 from the surface so as to cause the gauge rollers 50 to be moved outwardly into contact with the inside surface of the pipe P as shown in FIG. 1 and such movement carries the cutter supports 61 and the cutter blades 60 therewith outwardly, but not to the point of contact with the inside surface 20 as best seen in FIG. 1. Thus, the gauge rollers 50 locate the blades 60 so that they are only a short distance from beginning their cutting operation, thereby making the full stroke of the pistons 62 available for the cutting action with each of the cutting blades 60. The hydraulic fluid is then introduced into the cylinders 63 to move the pistons 62 outwardly to engage the cutter blades 60 with the inside surface 20 of the pipe P and then the motor 47 is actuated to rotate the drive gear 46 and the ring 41 which in turn rotates the rotatable plate 40, the gauge rollers 50 and the cutter blades 60 relative to the pipe P and the frame assembly 12. The continued hydraulic pressure acting on the pistons 62 forces them outwardly and also forces the cutter blades 60 outwardly as they are all rotated by the motor 47 so that the blades 60 continue to cut into the wall of the pipe P until the blades 60 have cut all of the way through such walls of the pipe P as indicated in FIG. 2.

At that point, it is generally desirable to retract the blades 60 by reversing the flow of hydraulic fluid so that it is introduced through the lines 63b to cause the piston 62 to move inwardly and to pull the cutter blades 60 inwardly within the inside diameter 20 of the pipe P. The gauge rollers 50 are likewise retracted and then the shoes 25 are retracted, all by reversing the flow of the hydraulic fluid in their respective pistons and then the entire apparatus A may be removed from the pipe P by lifting upwardly on the cable C. The apparatus A may then be moved to another of the platform legs or pipes P for a subsequent cut in the same manner until all of the pipes P have been cut so that the platform can be removed from its location by the use of the barge S or any other suitable means.

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.

We claim:
1. Pipe cutter apparatus for cutting pipe from the inside thereof and adapted to be operated remotely from the point at which the pipe is cut, comprising:
a frame assembly having means therewith for lowering same into the inside of a pipe;
wall anchoring means mounted on said frame assembly at longitudinally spaced apart locations for engaging the inside wall of the pipe to be cut;
anchor actuating means mounted on said frame and operably connected with said wall anchoring means for moving said anchoring means from a retracted position out of contact with the inside wall of the pipe to an anchoring position in engagement with the inside wall of the pipe;
a rotatable cutting head mounted on said frame assembly for rotation relative thereto;
gauge means mounted on said cutting head for engaging the inside wall of the pipe at least two circumferentially spaced points for substantially centering the cutting assembly in the pipe; and
cutter means mounted on at least one of said gauge means for movement towards the inside wall of the pipe and relative to said gauge means after said gauge means engages the wall of the pipe for cutting through the wall of the pipe upon a rotation of said cutting head and said gauge means and said cutter means therewith.

2. The structure set forth in claim 1, including:
said gauge means being laterally movable relative to said frame assembly; and
gauge actuating means mounted on said rotatable cutting head and operably connected with said gauge means for moving same outwardly from a first position out of contact with the pipe to a second position in engagement with the inside wall of the pipe.

3. The structure set forth in claim 2, wherein said gauge actuating means includes:
compensating means connected with said gauge actuating means for urging all of said gauge means outwardly into engagement with the pipe wall substantially simultaneously.

4. The structure set forth in claim 1, including:
cutter actuating means mounted on said rotatable cutting head and operably connected to said cutter means for moving same relative to said gauge means and towards the pipe wall for cutting therethrough.

5. The structure set forth in claim 1, wherein:
said cutting head is a ring having internal gear teeth and an external annular guide projection; and
support rollers mounted on said frame assembly for receiving said annular guide projection on said ring for supporting said ring for rotation relative to said frame assembly.

6. The structure set forth in claim 5, including:
power means mounted on said frame assembly and having a drive gear operably engaged with said internal gear teeth on said ring for rotating same.

7. Pipe cutter apparatus for cutting pipe from the inside thereof and adapted to be operated remotely from the point at which the pipe is cut, comprising:
a frame assembly having means therewith for lowering same into the inside of a pipe;
wall anchoring means mounted on said frame assembly at longitudinally spaced apart locations for engaging the inside wall of the pipe to be cut wherein said wall anchoring means includes:
a plurality of circumferentially spaced wall contact anchoring shoes disposed at each longitudinally spaced location relative to said frame assembly;
a lever arm for each of said shoes; and
pivot means disposed intermediate the length of said lever arm for pivotally connecting each of said lever arms to said frame assembly about said pivot means;
anchor actuating means mounted on said frame and operably connected with said wall anchoring means for moving said anchoring means from a retracted position out of contact with the inside wall of the pipe to an anchoring position in engagement with the inside wall of the pipe;
connector means connecting each of said lever arms to said anchor actuating means for pivoting said lever arms to force said shoes to pivot and move outwardly for binding anchoring engagement with the inside wall of the pipe;
a rotatable cutting head mounted on said frame assembly for rotation relative thereto;
gauge means mounted on said cutting head for engaging the inside wall of the pipe at least two circumferentially spaced points for substantially centering the cutting assembly in the pipe; and
cutter means mounted on at least one of said gauge means for movement towards the inside wall of the pipe and relative to said gauge means after said gauge means engages the wall of the pipe for cutting through the wall of the pipe upon a rotation of said cutting head and said gauge means and said cutter means therewith.

8. The structure set forth in claim 7, wherein said connector means for said lever arms includes:
a pair of links pivotally mounted on said frame assembly and disposed between and slidably connected with a pair of said lever arms which are diametrically disposed with respect to each other for pivoting such pair of lever arms into anchoring contact with the pipe wall substantially simultaneously.

9. The structure set forth in claim 7, wherein:
each of said lever arms is pivotally mounted so as to extend downwardly when running into the pipe with the anchoring means in the retracted position and to remain in a downwardly inclined position but at a lesser angle with respect to the diameter of the pipe when the anchoring means is moved to the anchoring position.