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Blakeslee

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[54] TUBE CUTTER ASSEMBLY

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[52] **U.S. Cl.** **30/92.5**

[51] **Int. Cl.** **B23d 21/06**

[58] **Field of Search** 30/92, 92.5, 277, 30/290, 373, 378

[56] **References Cited**

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Assistant Examiner—J. C. Peters
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[57] **ABSTRACT**

A tube cutter tool assembly, preferably actuated by an air hammer, for facilitating the removal of metallic tubes, such as boiler tubes and the like, from the sheet of a vessel in which the end portions of the tubes are sealingly positioned, and from which sheet said end portions extend outwardly.

The tool assembly, when used in conjunction with an air hammer, forms two longitudinal, transversely spaced slots on the interior surface of the sheet-engaged end portion of the tube. The weakened longitudinal section of the tube wall between the slots may be forced inwardly to provide an elongate space in the tube that permits the end portions of the tube within the sheet, as well as the portion of the tube that extends outwardly therefrom, to be crushed by suitable transversely applied forces. The crushed end portion of the tube may then be removed easily from the opening in the sheet in which it was previously sealingly positioned.

4 Claims, 8 Drawing Figures

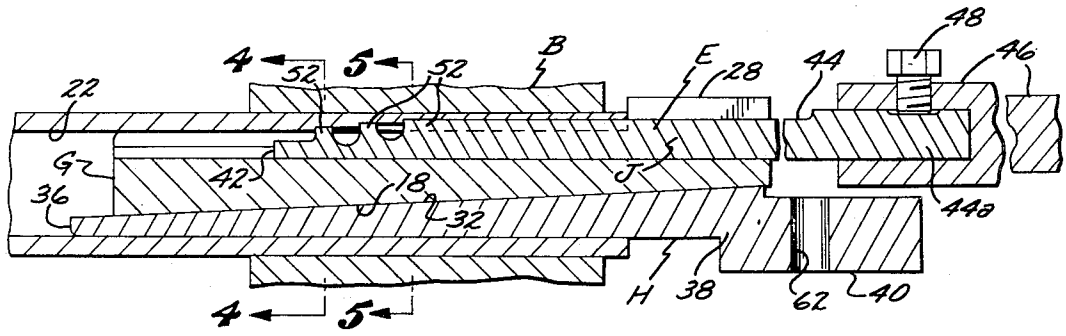


FIG. 1

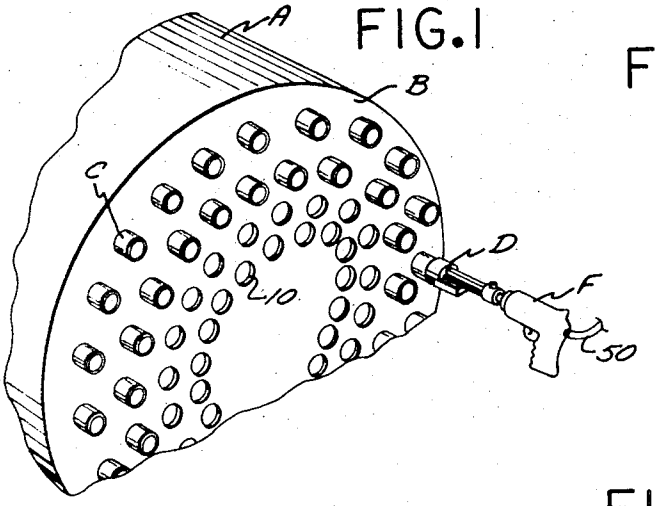


FIG. 4

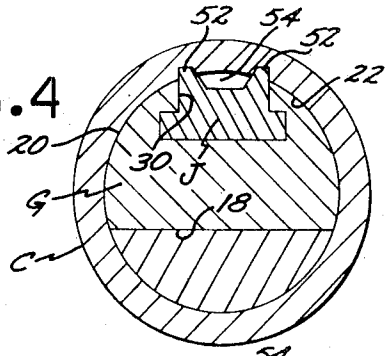


FIG. 5

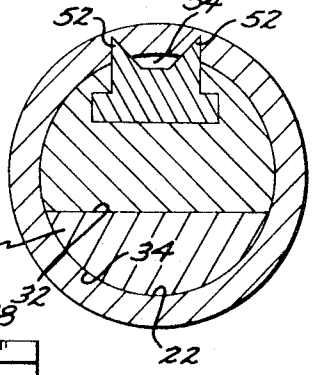


FIG. 2

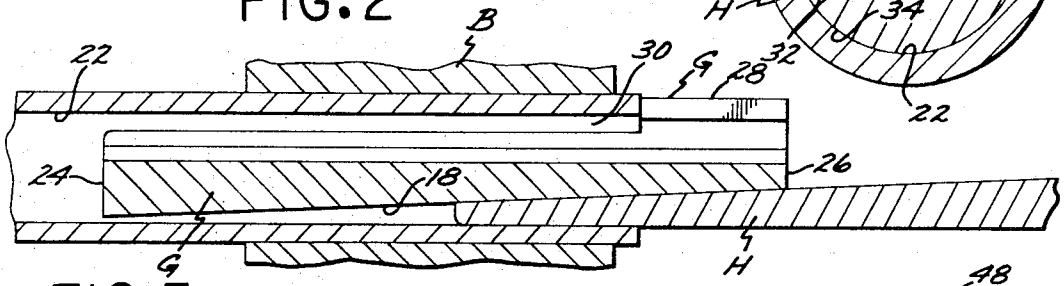


FIG. 3

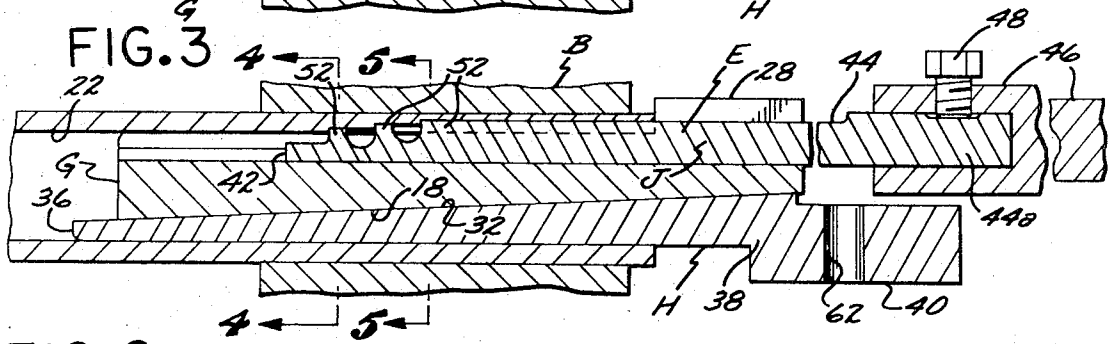


FIG. 6

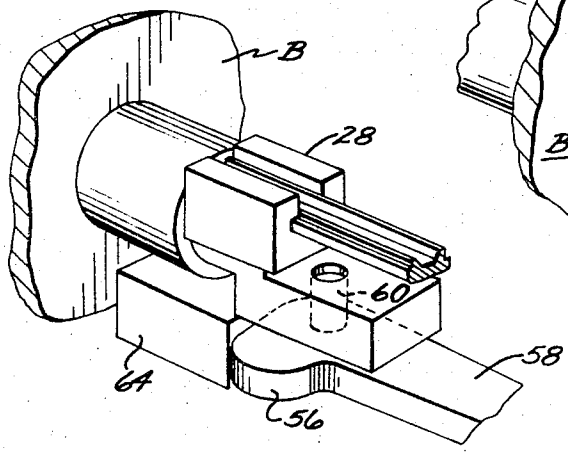


FIG. 7

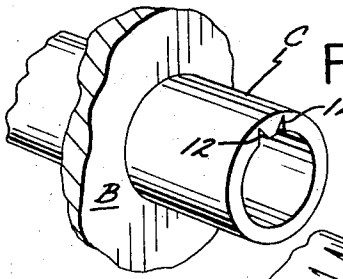
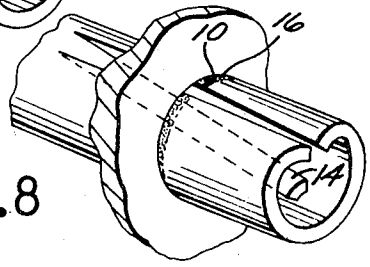


FIG. 8



TUBE CUTTER ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

Tube cutter tool assembly.

2. Description of the Prior Art

In many industrial installations, such as boilers, condensers and the like, a number of spaced, longitudinally aligned metallic tubes have the end portions thereof sealingly disposed in bores formed in metallic sheets, which sheets may be of substantial thickness. Periodically, in the maintenance of boilers, condensers and the like, the above-mentioned tubes must be removed from the sheets that are in sealing engagement with the end portions of the tubes. Removal of the tubes from supporting sheets has, in the past, been an arduous and time-consuming operation, and one that resulted in the maintenance cost on boilers, condensers and the like being excessively high due to the difficulty in separating the tubes from the sheets.

A major object of the present invention is to provide a tool assembly that is preferably actuated by an air hammer, and when so actuated is capable of longitudinally slitting the interior end portions of the tubes in the sheets without doing damage to the sheets, and the end portions of the tubes that have been slit being crushable by transversely applied forces thereto. The crushed end portions of the tubes are then easily pulled from the bores in the sheet in which they were previously sealingly mounted.

SUMMARY OF THE INVENTION

A first elongate member of such size as to be insertable in an end portion of a tube, which end portion is sealingly mounted in a sheet that forms a part of a boiler, condenser or the like. The first member has a longitudinal guide passage therein. A second elongate member may be moved longitudinally in the end portion of the tube to slidably engage the first member, with the first and second members, as a result of the movement of the second member, being forced into frictional pressure contact with the interior surface of the tube. An elongate cutting member is provided that is longitudinally and slidably movable in the passage, with the cutting member including a plurality of longitudinally spaced, transversely separated teeth that cut two slots in the interior surface of the tube end portion as the cutting member is forced longitudinally and forwardly therein. The cutting member preferably is actuated by an air hammer that subjects the cutting member to a sequence of intermittent pulsations.

The second elongate member includes a head adjacent the rearward end thereof, which head pivotally supports a manually operated cam, with the cam, when pivoted against a block of rigid material interposed between the sheet and cam, exerting a rearwardly directed force on the second member to pull the latter outwardly from the end portion of the tube. After the cam has been so actuated, the first and second members may be separated easily from one another and removed from the end portion of the tube.

The slots formed in the end portion of the tube do not extend completely through the side wall thereof, and as a consequence there is no damage to the sheet adjacent the tube. After the tool assembly has been removed from the tube, the longitudinal weakened section between the slots may be forced inwardly, and by the application of transverse forces to opposite sides of the end portion of the tube, the tube may be crushed to the extent that it is easily pulled from the bore in the sheet in which it was previously sealed.

The first elongate member includes a stop on the rearward end thereof that limits the extent to which the first member may be moved longitudinally into the end portion of the tube.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an end sheet of a boiler or condenser that has a plurality of tubes sealingly mounted in bores therein, with end portions of the tubes projecting from the sheet, and one of the end portions of the tubes being cut by the tool assembly that forms the subject matter of the present invention, and which tool assembly is actuated by a conventional air hammer;

FIG. 2 is a longitudinal cross-sectional view of a boiler tube that is sealingly disposed in a bore in an end sheet, and with the present invention being moved into the end portion of the tube;

FIG. 3 is the same longitudinal cross-sectional view shown in FIG. 2, but after the tool assembly has been disposed in frictional pressure contact with the interior surface of the tube, and an elongate cutting member has been longitudinally advanced in a passage in the first member by a conventional air hammer, to form two transversely spaced slots on the interior of the tube within the confines of the sheet;

FIG. 4 is a transverse, cross-sectional view of the tube, first and second members, and the cutting member, taken on the line 4—4 of FIG. 3;

FIG. 5 is a second transverse, cross-sectional view of the tube, first and second members, and cutting member, taken on the line 5—5 of FIG. 3;

FIG. 6 is a perspective view of a projecting end portion of a tube, with the first and second members, cutting member, and a cam and block arranged in the positions they will occupy prior to the cam being rotated to exert a rearwardly directed force on the second member to separate said second member from the first member and permit the assembly to be withdrawn from the tube;

FIG. 7 is a perspective view of the end portion of a tube after the tool assembly has cut two laterally spaced, longitudinally extending grooves therein, with the grooves not penetrating completely through the wall of the tube, but defining a weakened longitudinal tube wall section therebetween; and

FIG. 8 is the same view as shown in FIG. 7, but after the longitudinal tube wall section has been bent inwardly, and the outwardly disposed portion of the tube crushed by transversely aligned forces applied thereto, and the crushed end portion being separated from the bore in which it was previously sealingly mounted to the extent that the tube may now be longitudinally moved out of the sheet.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 it will be seen that a boiler or condenser A is provided that has an end sheet B in which a number of circumferentially spaced, longitudinally extending

bores **10** are formed that are engaged by the end portions C of metallic tubes, with the end portions C projecting outwardly from the sheet B. A tool assembly D of the detailed structure shown in FIGS. **2** and **3** may be slidably and removably inserted into each of the tube end portions C , and a cutter E that forms a part of the assembly being actuated by a conventional air hammer F to force the cutter forwardly into the end portion. As the cutter E is moved longitudinally into each of the tube end portions C, two longitudinally extending, transversely spaced slots **12** are formed therein, and the slots serving to define a weakened tube wall section **14** therebetween that may be bent inwardly, as shown in FIG. **8**. After the wall section **14** has been bent inwardly, oppositely directed, transverse forces may be applied to the tube end portion C by means not shown to crush the same as shown in FIG. **8**, and to the extent that the seal **16** between the exterior surface of the tube end portion C and the bore **10** in which it is disposed is broken, and the tube may be pulled manually or by other means from the bore **10**.

Tool assembly E, as may best be seen in FIGS. **2** through **6**, includes a first elongate member G that has an external surface that is defined by a first, flat, longitudinal wedge surface **18** and an arcuate surface **20** that conforms to a part of the interior surface **22** of tube end portion C in which it is disposed. The first member G has a forward end **24** and rearward end **26** from which a stop **28**, as shown in FIG. **6**, projects upwardly. The stop **28** and the arcuate shaped section **20** of first member G has a longitudinal guide passage **30** of inverted T-shaped cross section formed therein. A second elongate member H is provided that has an external surface defined by a flat, longitudinal wedge surface **32** and a second arcuate shaped surface **34** that conforms to the interior surface **22** of tube end portion C in which the tool assembly is being positioned, as shown in FIG. **2**.

Wedge-surfaces **18** and **32**, as may be seen in FIGS. **2** and **3**, are angularly disposed relative to the longitudinal axis of the tube C in which they are disposed, and as the second wedge surface **32** is moved forwardly relative to the first wedge surface **18**, the first and second arcuate surfaces **20** and **34** of the first and second members G and H are forced into frictional pressure contact with the interior surface **22** of the tube C. The second elongate member H has a forward end portion **36** and a rearward end portion **38** from which a head **40** extends. An elongate cutting member J that has an inverted T-shaped cross section is provided that slidably engages the guide passage **30**, as shown in FIGS. **4** and **5**, with the cutting member J having a forward end **42** and a rearward end **44**, the rearward end **44** having an engageable member **44a** extending rearwardly therefrom. The engageable member **44a** may be removably engaged by an engaging member **46** that forms a part of the air hammer F, and the engageable and engaging members, when removably locked together by a set screw or bolt **48**, as shown in FIG. **3**, being subjected to a series of intermittent pulsations from the air hammer F as the hammer receives air under pressure from a hose **50**.

The cutting member J, as best seen in FIGS. **3**, **4** and **5**, has a series of longitudinally spaced, transversely positioned teeth **52** defined thereon, which teeth cooperate with the cutting member to define a chip receiving space **54**. The teeth **52** are so related to the cutting member J that the chip space **54** remains of substantially constant transverse cross section as the elongate cutting member J is moved forwardly into the confines of the tube C. It will be particularly noted in FIGS. **3** and **5** that the rearward teeth **52** are of a different and sharper configuration and much greater length than the forward teeth **52**, and the rearward teeth **52** cutting slots **12** into the tube end portion C that are of such depth as to almost sever the wall thereof. After the slots **12** have been formed in the projecting portion of tube C, as well as the portion that extends through the sheet B, the weakened portion **14** of the tube wall between the slots **12** is bent inwardly, as shown in FIG. **8**, with the tube thereafter being crushed by transversely applied forces, as also shown in FIG. **8**, to separate the tube from the bore **10** in which it was previously seated, and permits the tube to be removed from the bore **10**.

Prior to the operation shown in FIGS. **7** and **8** being conducted, it is necessary to remove the tool assembly B from the tube end portion C in which it is positioned. To this end, a cam **56** is provided that has a handle **58** and a pin **60** projecting upwardly from the cam that removably engages a transverse bore **62** formed in the head **40**. A block **64** of rigid material is interposed between the exterior surface of the sheet B and the cam **56**, and the handle **58** is then manually rotated in a clockwise direction, as shown in FIG. **6**. Rotation of the cam **56** against the block **64** exerts a rearwardly directed force on the second elongate member H and to the extend that the surfaces **18** and **32** of first and second elongate members G and H are separated from one another. Separation of the surfaces **18** and **32** permits the first member G, second member H, and the cutting member J to be removed from the tube end portion C as an integral unit.

The operation above described is now performed on another one of the projecting end portions of tube C until all of the tubes, or a desired number of the tubes, have been separated from the sheet B.

The use and operation of the invention has previously been described in detail and need not be repeated.

I claim:

1. In combination with an air hammer having a forwardly positioned engaging member that may be subjected to intermittent forwardly directed pulsations that are transmitted to a tool assembly at least partially disposed in an end portion of a metallic tube sealingly disposed in a bore in a sheet of a vessel to form two longitudinal, transversely spaced slots on the interior surface of said end portion within said bore, as well as a part of said end portion that projects outwardly from said sheet, said slots cooperating to define a weakened longitudinal tube wall section therebetween that may be bent inwardly after said tool assembly is removed from said end portion, with said end portion after said section has been bent inwardly being crushed by transversely applied forces to permit said crushed end portion to be pulled from said bore in said sheet, said tool assembly including:

a. a first elongate rigid member having forward and rearward ends, with the external surface of said

first member being defined by a first, elongate, flat wedge surface and a first arcuate surface that conforms to the interior surface of said tube in which said first member is removably positioned, a stop that extends outwardly from said second surface adjacent said rearward end, and a longitudinal guide groove in said arcuate surface that extends through said stop;

b. a second elongate rigid member having forward and rearward ends, with the exterior surface of said second member being defined by a second flat wedge surface and a second arcuate surface that conforms to the interior of said tube, said first and second members of such size that when said first member is longitudinally positioned in said tube end portion with said stop in contact with the outer extremity of said tube portion said second member may be moved longitudinally into said tube end portion, with the movement of said second wedge surface relative to said first wedge surface forcing said first and second members to positions where said first and second arcuate shaped surfaces frictionally pressure contact the interior surface of said tube portion so that said first and second members are firmly held therein, and said second member including a head adjacent said rearward end thereof;

c. an elongate cutting member having a forward and rearward end which is slidably movable in said guide groove when said first and second members are disposed in said tube end portion, said cutting member including a plurality of longitudinally spaced, transversely separated teeth that cooperate to define a chip receiving space therebetween, said cutting member including an engageable member adjacent said rearward end that is removably engaged by said engaging member for said pulsations from said air gun to force said cutting member forwardly in said groove for said teeth to form said two slots on the interior surface of said tube portion, said slots being of insufficient depth to extend completely through the wall of said tube portion to contact said sheet; and

d. means for moving said second member rearwardly relative to said first member after said slots have been formed for said first and second members to be removed from said tube end portion to permit said weakened section to be bent inwardly and said tube end portion crushed and said tube end portion thereafter pulled from said sheet.

2. The combination as defined in claim 1 in which said means is a manually operated cam rotatably supported from said head, and said combination in addition including:

e. a rigid block that removably contacts said sheet and contacts said cam, with said cam when rotated bearing against said block and forcing said second member rearwardly relative to said first member.

3. The combination as defined in claim 2 in which said cam includes a handle that projects outwardly therefrom and a pin that rotatably engages an opening in said head.

4. The combination as defined in claim 1 in which said teeth vary in depth and are so related that the transverse cross section of said ship-receiving space remains constant as said cutting member is moved forwardly in said groove.

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