May 10, 1960 W. G. SWEETMAN 2,935,944

EXPLOSIVE CUTTING TOOL

Original Filed March 2, 1948

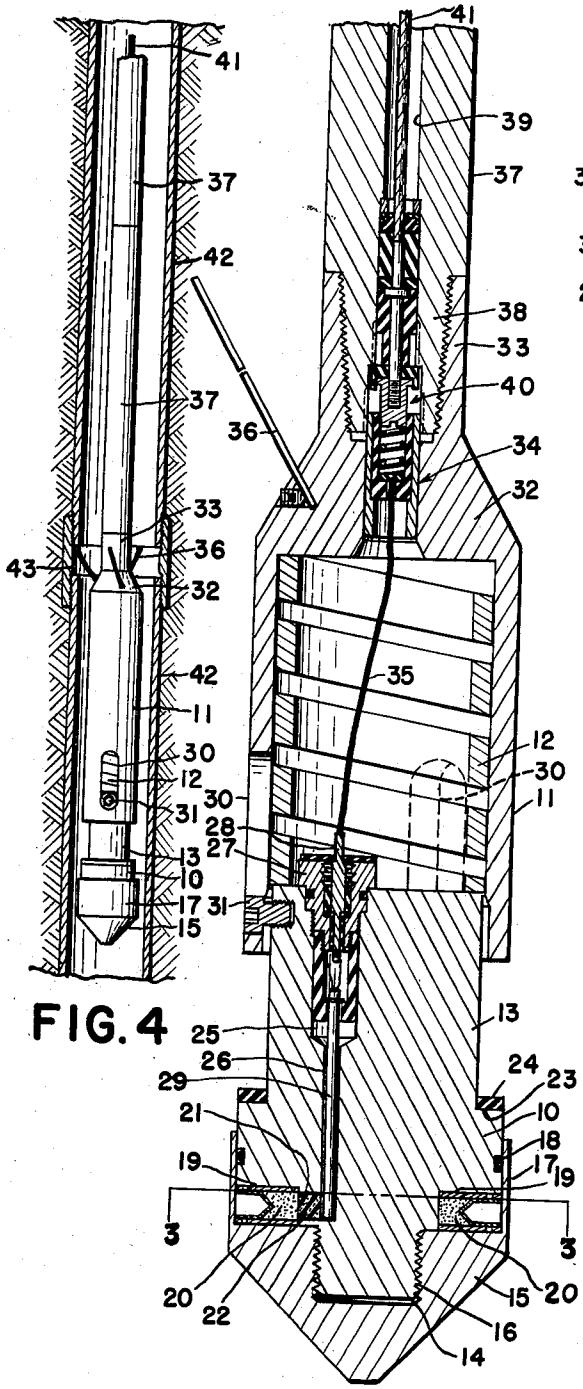


FIG. 1

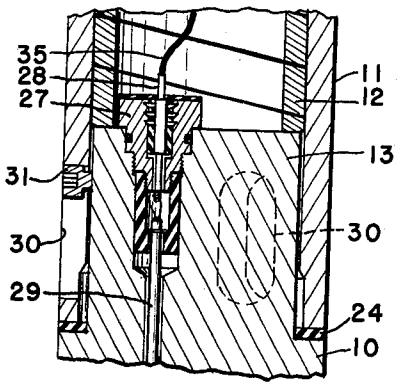


FIG. 2

FIG. 4

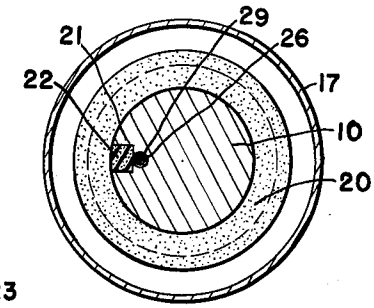


FIG. 3

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EXPLOSIVE CUTTING TOOL

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Continuation of application Serial No. 12,543, March 2, 1948. This application August 7, 1957, Serial No. 676,899

12 Claims. (Cl. 102—20)

This invention relates to a cutting tool for severing pipe. More particularly, the invention pertains to a tool adapted to employ a detonating explosive charge for cutting pipe, and similar tubular objects, in a well. This application is a continuation of my co-pending U.S. application Serial No. 12,543, filed March 2, 1948, now abandoned.

In my co-pending application, Serial No. 709,246, filed November 12, 1946, now Patent No. 2,587,244, issued February 26, 1952, there are disclosed methods and apparatus for cutting various objects and particularly for cutting pipe in the well by means of a detonating explosive charge which is preformed to a configuration corresponding to the line of the cut to be made and which has the face, which is directed toward the object to be cut, dished or concaved so that upon detonation, generated high velocity gases will strike the object to be cut in a narrow jet along the line of the cut and perform the cutting of the object by means of the jet itself.

More specifically, in the aforementioned application there is described apparatus for cutting a well pipe, or the like, by means of a ring-shaped detonating explosive, the periphery of which is conically, or otherwise dished or concaved in a suitable manner, and suitably supported in a cylindrical body which is adapted to be lowered into a well casing to the point where the cut is to be made, whereupon the explosive charge may be detonated and a radially projected circular jet of the resulting gases directed against the inner surface of the pipe to effect the severing thereof.

Such methods and apparatus have now been put to extensive and successful commercial use and this invention is directed particularly to improvements in the form of the tool employed, particularly for the cutting of well casing or other pipe in a well. It is found, for example, that when cutting pipe in the manner described, the tool which normally carries the ring-shaped explosive charge mounted in the periphery thereof, will be severed at approximately the line where the charge is mounted. The portion of the tool immediately adjacent and below the explosive charge will be destroyed or severed and lost in the well. Moreover, it has been found that with such tools of the earlier design, the shock of the explosion may bulge or otherwise damage the remaining portion of the tool and connected mechanism, and since the clearance between the tool and the pipe is necessarily made quite small, this portion of the tool may become lodged in the well and be difficult to remove, or may otherwise become so damaged that it may not be readily re-used.

Accordingly, it is a principal object of the present invention to provide an improved design for such cutting tools which overcomes damage to the unsevered portion of the tool.

It is an important object to provide an improved form of cutting tool employing shaped explosive charges for effecting the desired cutting operation.

An additional important object is to provide an improved cutting tool for use in cutting well casing by means of shaped explosive charges.

Another object is to provide an improved form of explosive cutting tool which is adapted to absorb the shock attendant upon detonation of the explosive to thereby minimize the damage to the tool and its supporting mechanism.

A more specific object is to provide a cutting tool in accordance with this invention, wherein a recoil absorbing mechanism is interposed between the explosive-carrying head and the elements employed for suspending it in a well.

Other and more specific objects and advantages of this invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate a useful embodiment in accordance with this invention.

In the drawings:

Fig. 1 is a longitudinal sectional view through a cutting tool in accordance with this invention;

Fig. 2 is a view similar to Fig. 1 showing parts of the tool in their relative positions following detonation of the explosive charge;

Fig. 3 is a cross-sectional view taken along line 3—3 of Fig. 1;

Fig. 4 is a view showing the tool disposed in the well casing preparatory to cutting the casing.

Referring to the drawings, the improved cutting tool, in accordance with the illustrative embodiment of this invention, comprises a generally cylindrical head member **10** which is adapted to carry the explosive charge, a generally tubular cylinder member **11** telescopically connected to the head member in such a manner as to permit relative longitudinal movement between the members, and resilient means, such as a coil spring **12**, mounted in compression between members **10** and **11** to serve as a shock absorber or recoil cushioning means between members **10** and **11**.

More particularly, head member **10** is in the form of a generally cylindrical solid body preferably constructed of metal, such as steel, but which may be constructed of any other suitable solid material such as solid plastic molded or machined to the desired shape. One end of body member **10** is reduced in diameter to form a shank **13** while the opposite end carries an externally threaded boss **14** by means of which a cone shaped cap **15**, which has an internally threaded box **16** for receiving boss **14**, may be tightly attached to the end of the body member. Cap **15** has an upstanding annular rim **17** which surrounds the exterior of body member **10** in a close sliding fit when cap **15** is screwed on boss **14**. A suitable sealing means, such as an O-ring **18**, is mounted in the periphery of body member **10** and adapted to form a fluid tight seal between the body member and rim **17**. The end of body member **10** adjacent cap **15** is provided with an annular recess **19** extending inwardly from the exterior of the body and dimensioned to receive an explosive charge of the desired size to be carried by the device. A ring-shaped hollowed explosive charge **20**, composed of a suitable detonating chemical of well known character, is seated in recess **19**. This form of charge, when detonated, is adapted to generate a radially directed circular jet of gases which will cut through rim **17** and sever the pipe in which the tool is inserted. The specific details of charge **20** have been described in the aforementioned applications and in themselves do not form a part of this invention. A recess **21**, of generally tubular shape, is provided in body member **10** communicating radially with a point along the inner wall of recess **19**. Recess **21** is adapted to receive an explosive pellet **22** in abutting relationship to the explosive charge **20** to serve as

a booster for the latter. The arrangement, as best seen in Fig. 3, wherein the booster pellet **22** is disposed in contact with the inner periphery of charge **20** at a single point of relatively small area inherently acts to cause the detonation wave in charge **20** to propagate circumferentially in both directions from the booster pellet so that there is no interference with the detonation wave except at a point diametrically opposite the booster charge. This arrangement results in the formation of an annular cutting jet which will produce a clean continuous cut throughout the pipe circumference.

At the point where body member **10** is reduced in diameter to form shank **13**, there is provided an annular shoulder **23** on which is mounted a ring **24** constructed of rubber, or other resilient material, which is employed for purposes to be described hereinafter. A fuse receptacle **25** is bored longitudinally in the upper end of shank **13** and is continued in the form of an elongated narrow passageway **26** which extends to a point in body member **10** adjacent the inner end of recess **22**. An electrical fuse plug **27**, having a suitably insulated conductor pin **28** extending axially therethrough, is adapted to be screwed tightly into receptacle **25**, and includes an elongated detonating fuse **29** of a type conventionally employed for detonating high explosive charges. Fuse **29** is electrically connected in a suitable and conventional manner to connector pin **28** and extends from the lower end of receptacle **25** through passageway **26** to a point adjacent the inner end of booster pellet **22**.

Cylinder member **11**, which is preferably of metallic construction, has an internal diameter slightly greater than the external diameter of shank **13**, whereby the upper end of the latter may be inserted into the open end of cylinder member **11** for longitudinal movement therein. The external diameter of cylinder member **11** is preferably made approximately equal to that of body member **10** so that the tool as a whole will have a substantially uniform external diameter. A plurality of angularly spaced elongated slots **30** are cut through the wall of the cylinder member. Studs **31** are adapted to extend through slots **30** and to be screwed into the portion of shank **13** extending into cylinder member **11**. With this arrangement it will be seen that relative longitudinal movement may occur between cylinder member **11** and shank **13**, which is limited by the engagement of the upper and lower ends of slots **30** with studs **31**. Coil spring **12**, which is preferably of relatively heavy construction and of high compressive strength, is mounted in compression between the upper end of shank **13** and a head **32** carried by the upper end of cylinder member **11**. Coil spring **12** will normally tend to urge members **10** and **11** apart and resist relative movement of these parts toward each other. Head **32** is provided at its upper end with a hollow internally threaded box portion **33**. An electrical contact member, designated generally by the numeral **34**, is mounted axially of head **32** and extends into box portion **33**. A flexible electrical lead **35** connects contact member **34** with contact pin **28** of the fuse plug. A plurality of angularly spaced flexible fingers **36** extend upwardly and radially outwardly from the surface of head **32** and are of such length that when in normal position, a circle enclosing their outer ends will be somewhat larger in diameter than that of the pipe in which the tool is to be used. A tubular rod **37** is provided with a threaded pin member **38** adapted to be secured in box portion **33**, and has a hollow bore **39** in the lower end of which is mounted an electrical contact member, designated generally by the numeral **40**, of suitable construction adapted to make electrical contact with contact member **34** when pin member **38** is screwed into box portion **33**. An electrical cable **41** is threaded through bore **39** and is connected to contact member **40**. Cable **41** which is adapted to carry current to fuse **29** also supports the cutting tool and is employed to lower the tool in a well. It will be understood that cable **41** will be connected to a suitable source of electric current and conventional switch means (not shown) located on the surface and operative in the usual manner to initiate the flow of current to fuse **29**. Rod **37** is preferably constructed of heavy metal and is employed as a sinker or weight-supplying device in order to overcome the buoyancy of the tool, particularly when it is being run in a well casing which is filled with fluids such as drilling muds. One or more sections of rod **37** may be employed to provide whatever weight may be required for this purpose.

In assembling the cutting tool preparatory to lowering in a well, booster pellet **22** will be inserted in recess **21** and explosive charge **20**, performed to the desired ring shape and normally enclosed within a suitable housing of corresponding shape, will be slipped over the lower end of body member **10** and seated in recess **19**. Cap **15** will then be screwed on boss **14** to hold charge **20** firmly in place and, by means of rim **17**, form a fluid-tight closure about the periphery of the charge. Ring **24** will be slipped over the upper end of shank **13** and seated on shoulder **23**. Fuse plug **27** and fuse **29** will be installed as a unit in shank **13**. Contact member **34**, having one end of lead **35** previously connected thereto, will have been installed in head **32**. Coil spring **12** will be inserted in the bore of cylinder member **11**, and the other end of lead **35** will be soldered or otherwise suitably connected to contact pin **28**. The upper end of shank **13** will then be inserted in the open end of cylinder member **11** against the lower end of spring **12** and studs **31** will be inserted through slots **30** and screwed into the inserted end of the shank. Fingers **36** will be installed in head **32**. One or more of the rods **37** will in the meantime, have been assembled and connected to the end of cable **41**, and when pin member **38** is screwed into box portion **33** the tool will be ready for lowering in a well.

With the tool thus assembled, it will be lowered on cable **41** into a well casing **42** (Fig. 4). As the tool moves downwardly through the casing, fingers **36** will be compressed inwardly so as to slide through the casing. When the tool reaches the approximate area of the cut to be made, which will normally be along a casing section previously selected from suitable measurements, the tool will be drawn upwardly until the first joint in the casing, above the point to which the tool was initially lowered, is contacted by fingers **36**, whereupon the fingers will expand into the space or crevice usually present between the ends of adjacent sections of the casing where they are inserted in a conventional coupling **43**. The outer ends of the fingers **36** will thereby lodge against the lower end of the upper one of the adjacent casing sections and will resist further upward movement of the tool under any normal strain applied to the cable. This will fix the position of the cutting tool relative to the particular casing section which was selected to be cut. The electrical initiator at the surface may now be actuated to set off fuse **29**. The latter will detonate booster pellet **22** which will, in turn, detonate main charge **20**. The latter, in response to the single small area point of contact with booster pellet **22**, will generate the jet of cutting gases which will effect the desired severing of the casing.

When the detonation occurs, the lower portion of body **10** will normally be severed or destroyed, while the remainder of body **10** will recoil upwardly. Fig. 2 illustrates the position of the parts of the tool upon recoil following detonation of the charge. It will be seen that shank **13** has moved inwardly of cylinder member **11**, compressing spring **12**, which thus absorbs the shock of the recoil. At the same time the lower rim of cylinder member **11** will contact resilient ring **24** which acts as a cushion therefor to prevent battering or deformation of the end of the cylinder member. The remaining parts of the tool, which are thus protected against damage, may

then be withdrawn from the well, only sufficient strain being necessary to be placed on cable **41** to bend fingers **36** sufficiently to cause them to be pulled out of their contact with the casing. Since these fingers are normally constructed of relatively light wire, no great strain on cable **41** will be required. When the tool has been thus withdrawn from the well, the remainder of body member **10** will be disconnected from cylinder member **11**, and all of the latter and its supporting elements will be available for re-use merely by the connection of a new body member **10** carrying a fresh charge of explosive and a new fuse assembly.

It will be understood that other specific forms of shock absorbing mechanisms may be substituted for coil spring **12**, as for example, a hydraulic or pneumatic type of shock absorber of well known design. In many instances coil spring **12** may be eliminated and the shock absorbed entirely by a resilient ring such as ring **24**. Other changes and alterations may also be made in the details of the illustrative embodiment herein described within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member adapted to be positioned longitudinally in the pipe and having mounted therein an annular explosive charge concentrically spaced about the longitudinal axis of the body member, a cylinder member telescopically engaged with said body member for limited relative longitudinal movement and having means on its outer end for connection to a suspending cable, and a recoil absorbing mechanism interposed between said body member and said cylinder member.

2. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member having mounted therein an annular explosive charge concentrically spaced about the longitudinal axis of the body member, a tubular cylinder member having one end telescopically engaged with said body member for limited relative longitudinal movement, a head for the opposite end of said cylinder member carrying a connector member for connecting said cylinder member to a suspending cable, and a recoil absorbing element mounted in said cylinder member between said body member and said head.

3. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member having mounted therein an annular explosive charge concentrically spaced about the longitudinal axis of the body member, a tubular cylinder member having one end telescopically engaged with said body member for limited relative longitudinal movement, a head for the opposite end of said cylinder member carrying a connector member for connecting said cylinder member to a suspending cable, and a recoil absorbing element comprising a coil spring mounted in said cylinder member in compression between said body member and said head.

4. A tool for cutting pipes in a well by means of explosives, comprising, a body member having mounted therein an annular explosive charge concentrically spaced about the longitudinal axis of the body member and carrying electrical detonating means for said charge, a connector member for connecting said body member to a suspending cable and carrying means for forming an electrical connection between said detonating means and said cable, means connecting said connector member to said body member for limited relative longitudinal movement, and a shock absorbing member interposed between said body member and said connector member.

5. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member having mounted therein an annular explosive charge concentrically spaced about the longitudinal axis of the body member and carrying electrical detonating means for said charge, a cylinder member telescopically engaged with said body member for limited relative longitudinal movement and having means for connection to a current-carrying suspending cable, means carried by said cylinder member for forming an electrical connection between said detonating means and said cable, and a recoil absorbing mechanism interposed between said body member and said cylinder member.

6. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member, an annular recess in the lower end thereof adapted to receive a ring-shaped explosive charge, a cap removably mounted on the lower end of said body having an upstanding rim to enclose said charge, a tubular cylinder slidably enclosing the upper end of said body member, inter-engaging elements connecting said cylinder member to said body member for limited relative longitudinal movement, a head for the opposite end of said cylinder member carrying a connector member for connecting said cylinder member to a suspending cable, and a coil spring mounted in said cylinder member in compression between said body member and said head.

7. A tool for cutting pipes in a well by means of explosives, comprising, a body member having mounted therein an annular explosive charge concentrically spaced about the longitudinal axis of the body member, a connector member for connecting said body member to a suspending cable, means connecting said connector member to said body member for limited relative longitudinal movement, and a shock-absorbing member interposed between said body member and said connector member, said shock-absorbing member being composed of resilient composition material.

8. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member carrying a ring-shaped explosive charge seated in the periphery thereof, said body member having an upwardly extending stem portion of reduced diameter, an upwardly facing shoulder on said body about said stem portion, a tubular member having its lower end telescopically enclosing said stem portion and connected thereto for limited relative longitudinal movement, means for connecting the upper end of said tubular member to a suspending cable, and a shock-absorbing member interposed between said shoulder and the lower end of said tubular member.

9. A tool for cutting pipes in a well by means of explosives, comprising, a generally cylindrical body member carrying a ring-shaped explosive charge seated in the periphery thereof, said body member having an upwardly extending stem portion of reduced diameter, an upwardly facing shoulder on said body about said stem portion, a tubular member having its lower end telescopically enclosing said stem portion and connected thereto for limited relative longitudinal movement, a head member for connecting the upper end of said tubular member to a suspending cable, a shock-absorbing member mounted in said tubular member between said stem portion and said head member, and a second shock-absorbing member interposed between said shoulder and the lower end of said tubular member.

10. In a device for cutting pipe in a well, a cutting unit, comprising, an annular high explosive charge having an annular hollow throughout its outer periphery, an annular liner seated in said hollow, said charge having a single point of initiation of detonation comprising a small body of a booster explosive disposed in contact with a single small area along a single small fraction of the circumferential length of the inner peripheral surface of said charge and projecting radially inwardly therefrom, the remainder of said inner peripheral surface of said charge being free from contact with booster explosive, and an initiating element disposed in contact with the inner end of said body of booster explosive.

11. In a device for cutting pipe in a well, a cutting unit comprising a ring shaped explosive charge having an annular hollow completely around its outer periphery, an annular liner seated in said hollow, said charge having a single point of initiation of detonation comprising a pellet of booster explosive substantially smaller than the central opening through said charge, said pellet being offset radially from the central axis of said charge and disposed in contact with a single small area along a single small fraction of the circumferential length of the inner peripheral surface of said charge, the remainder of said inner peripheral surface of said charge being free from contact with booster explosive, and an explosion initiating element in contact with said pellet.

12. In a device for insertion in a pipe for cutting such pipe, a cutting unit comprising a ring shaped explosive charge having an annular hollow completely around its outer periphery, an annular liner in said hollow, said charge having a single point of initiation of detonation

comprising a small pellet of booster explosive positioned in contact with a single small area along a single small fraction of the circumferential length of the inner periphery of said ring shaped explosive charge and extending radially inwardly therefrom with the inner end of said pellet terminating short of the central axis of said charge, the remainder of said inner periphery of said ring shaped explosive charge being free from contact with booster explosive, and an explosion initiating element offset radially from such central axis and disposed in engagement with said inner end of said pellet.

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