

[54] WELL CASING CUTTER AND SEALER
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[58] Field of Search. 166/297, 53, 55,
166/55.1, 63, 72; 251/1; 137/315

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Primary Examiner—David H. Brown
Attorney—John W. Behringer et al.

[57] ABSTRACT

Apparatus for rapidly terminating flow through a well upon sensing of an unsafe well condition. A housing surrounds the well casing and defines a chamber within which a blade is located with its cutting edge adjacent the well casing. An explosive charge positioned against the blade is electrically connected to sensors in the area of the well outlet. When a sensor detects an unsafe condition, the explosive charge is initiated, driving the blade through the well casing without crushing of the casing. When the unsafe condition is corrected, a plug is withdrawn, permitting retraction of the blade and replacement of the explosive charge, thus making the apparatus ready for reuse.

9 Claims, 6 Drawing Figures

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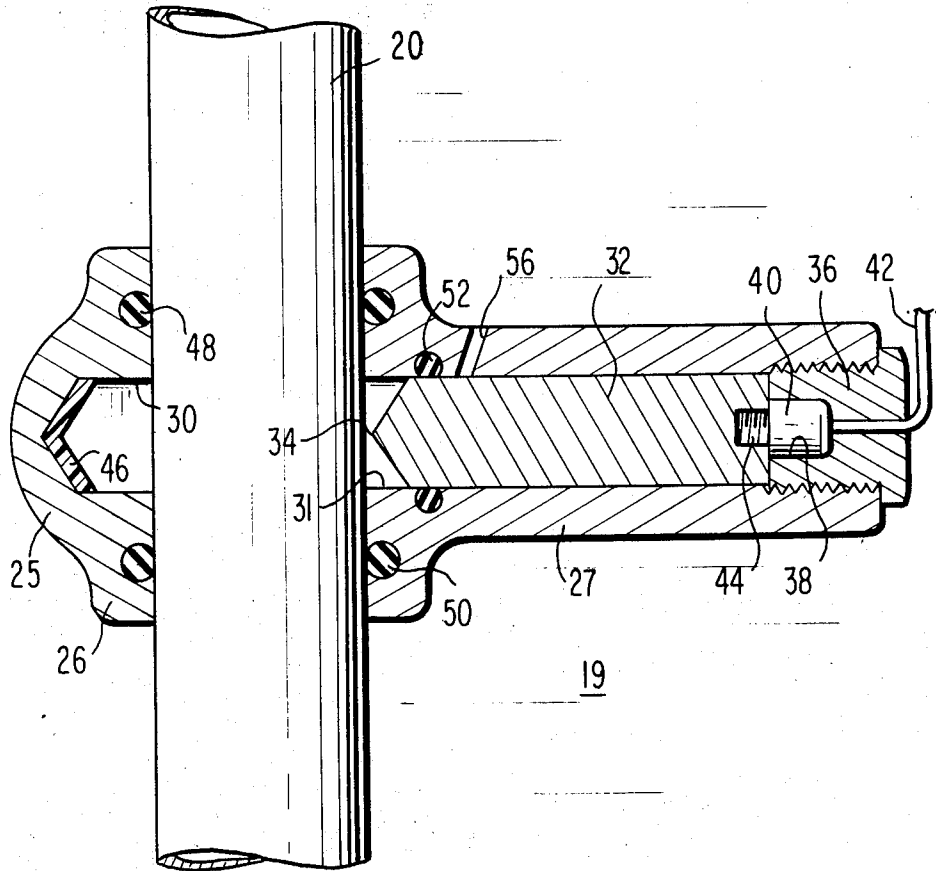


FIG. 1

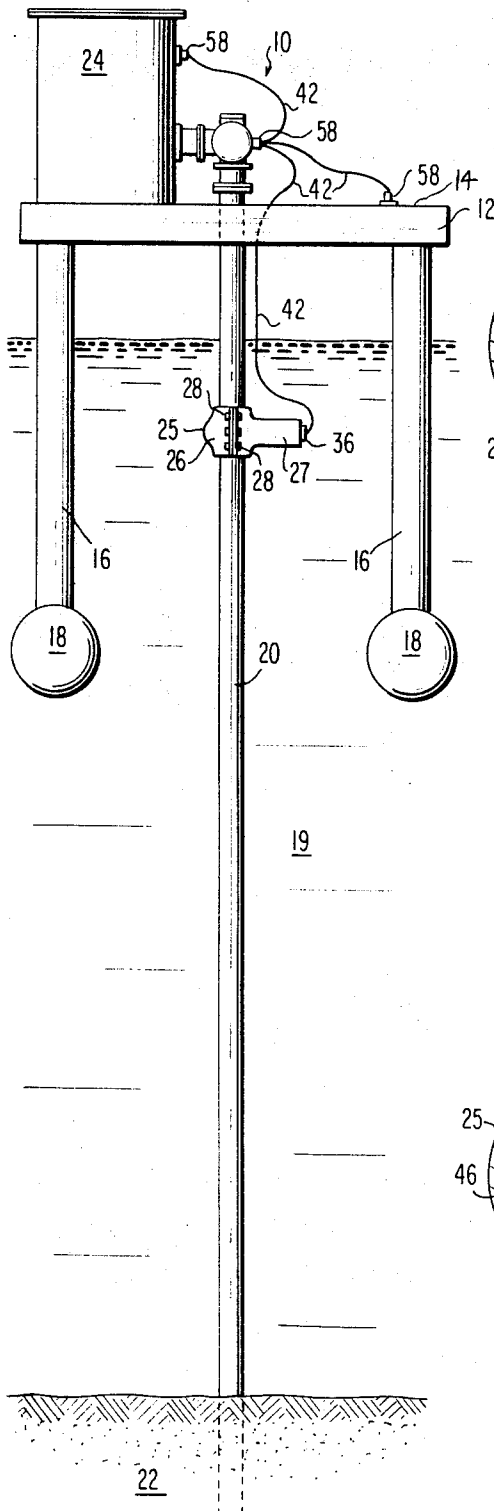


FIG. 2

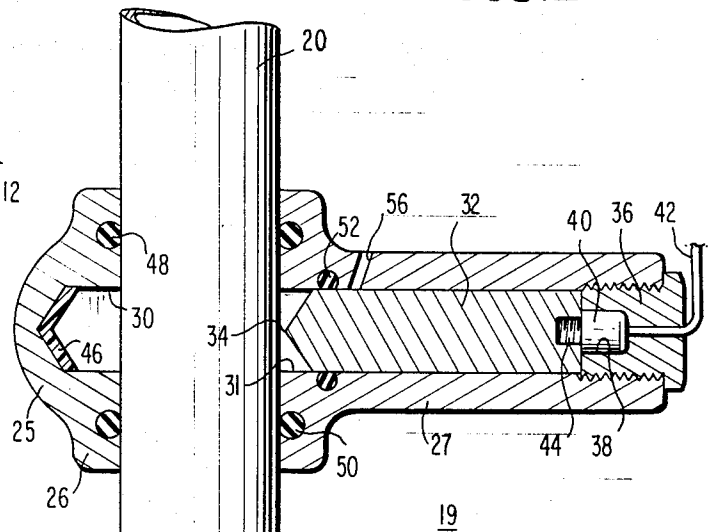
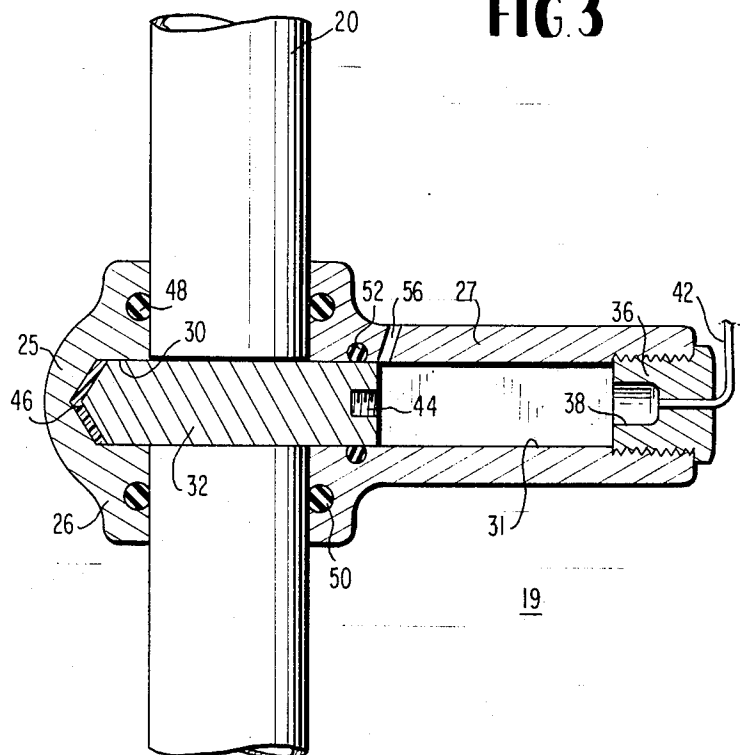


FIG. 3



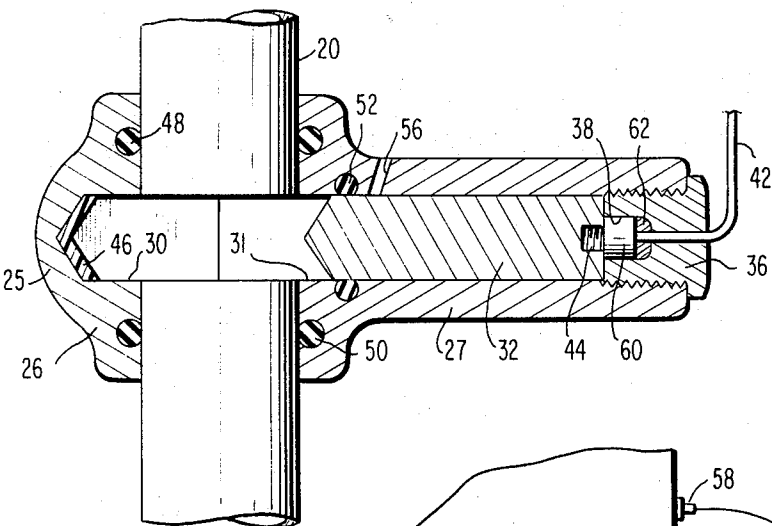


FIG 4

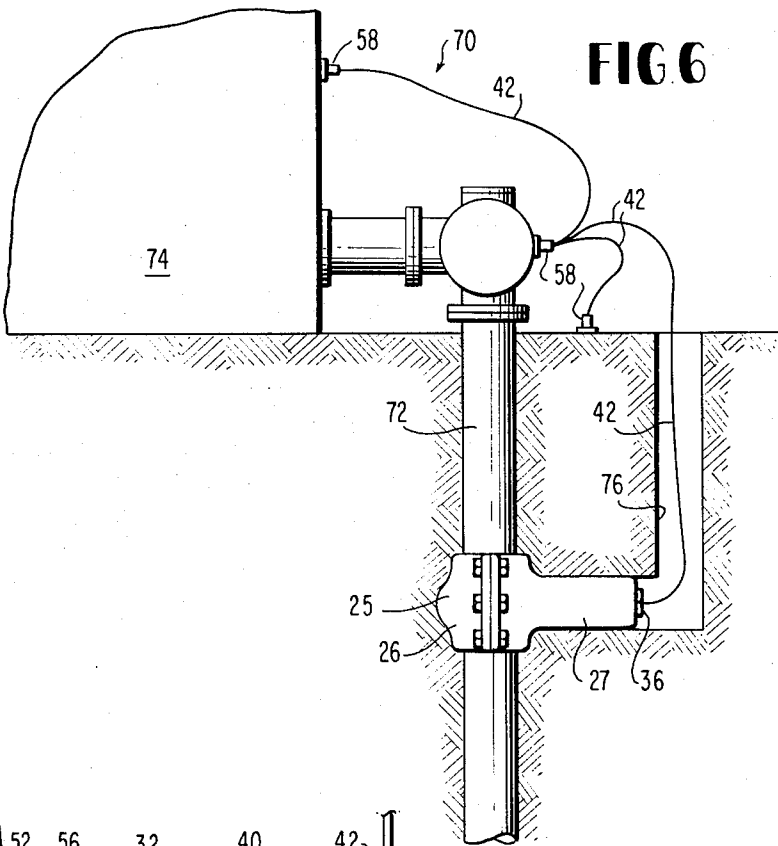


FIG 6

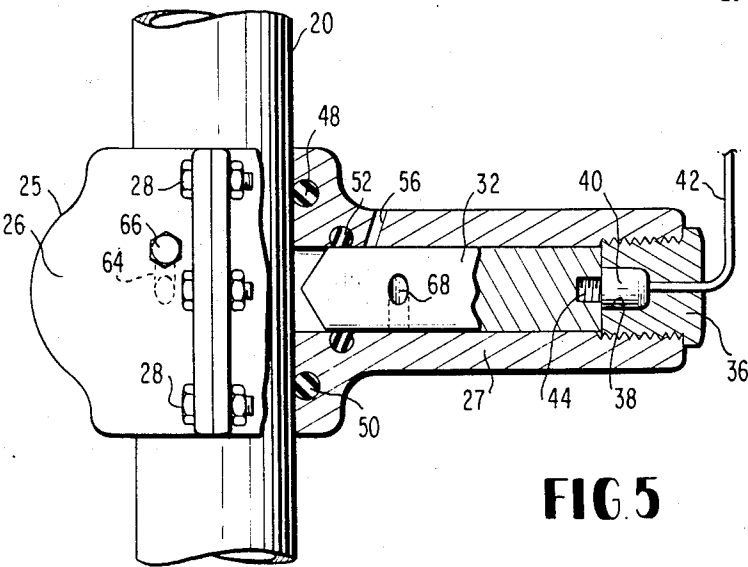


FIG 5

WELL CASING CUTTER AND SEALER

The present invention pertains to a well sealer. More particularly, the present invention pertains to apparatus for automatically and rapidly sealing a well to cut off flow therefrom in the event of a blow-out, fire or other hazardous condition.

There have been numerous costly disasters involving fires on oil wells. Many of these have been on land-based wells. Other disasters have been on wells on sea platforms, pumping petroleum from beneath the sea bed. Ordinarily, a well pumping petroleum products operates in a safe and efficient manner with no damage to people or equipment in the area. All too often, however, accidents occur which result in oil from the well being lost. Frequently, such accidents involve fire, since the oil is highly combustible. Continued emission of oil from a well provides a continuous source of fuel for a fire. Consequently, when a fire occurs on a well, it generally is of major proportions, involving considerable loss, both loss of life and monetary loss. Putting out an oil well fire is an extremely difficult, hazardous and time-consuming thing. Heretofore, it generally has involved attempting to cap the well at its outlet. This is very difficult with a land based well. It is even more difficult with a well based on a sea platform. In addition, a well based on a sea platform presents the further hazard of there being no place for people to escape, since the platform is of limited area and is surrounded by water, for example an ocean, and since the fire frequently consumes the entire platform. Oil well platforms usually have several wells operating simultaneously, any one of which could cause a fire that would then involve all of the wells and the entire platform. A disastrous fire can end production from the site.

There have been developed, devices for terminating the flow of oil through a well. U.S. Pat. Nos. 3,272,222, 3,416,767, and 3,561,526 illustrate typical known apparatus. Such apparatus frequently operate by crushing the well casing and tubing to block flow therethrough. Once such apparatus has been used, the well casing and tubing must be replaced, since they have been crushed. This, of course, is an expensive and time-consuming task. In addition, the apparatus must be installed at the time the well is initially installed. Consequently, that apparatus cannot be utilized with existing wells. Since the apparatus is hydraulically or hand-operated, an appreciable time delay exists between the detection of the need for terminating the oil flow and the operation of the device to terminate the oil flow.

The present invention is an apparatus for sensing the need to terminate flow from a well and to terminate that flow automatically and rapidly and yet in a manner which readily permits the flow to be resumed. Wells sometimes include an outer pipe, referred to as the well casing, and an inner pipe, referred to as a well tubing. Other times, only a single pipe is provided in a well. In the following specification and claims, the pipes of both of these types of wells are referred to as well pipe. In accordance with the present invention, a well pipe has a housing placed around it over a portion of its length, with a blade positioned within the housing and adjacent the well pipe. An explosive charge in a position to actuate the blade is connected to sensors in the area of the well outlet. If a sensor detects a condition which makes it desirable to rapidly terminate flow from the well, the explosive charge is initiated, driving the blade through

the well pipe to terminate flow from the well. The sharp blade and the rapid, high powered energy, resulting from the explosive charge, result in the pipe being severed with little or no crushing. With flow from the well terminated, the undesirable condition can be corrected. Once the condition has been corrected, the blade is withdrawn, permitting flow to resume. A new explosive charge can then be installed, making the apparatus ready for reuse.

These and other aspects and advantages of the present invention are more apparent in the following detailed description and claims, particularly when considered in conjunction with the accompanying drawings in which like parts bear like reference numerals. In the drawings:

FIG. 1 is a schematic illustration of a well based on a sea platform and incorporating flow-terminating apparatus in accordance with the present invention;

FIG. 2 is a sectional view of flow-terminating apparatus in accordance with the present invention ready for actuation;

FIG. 3 is a sectional view of the apparatus of FIG. 2 but after actuation and in a position preventing flow through a well pipe;

FIG. 4 is a sectional view of the apparatus of FIG. 2 after actuation and returned to its initial position ready for reuse;

FIG. 5 is a sectional view of a modified embodiment of flow-terminating apparatus in accordance with the present invention; and

FIG. 6 is a schematic illustration of flow-terminating apparatus in accordance with the present invention installed for use on a land-based well.

FIG. 1 illustrates an oil well 10 based on a sea platform 12. Platform 12 includes upper surface 14 and a plurality of support members 16 extending downwardly from surface 14 into the sea water 19. Each support member 16 has a stabilizing member 18 at its lower end. Well pipe 20 extends from beneath the sea bed 22 through upper surface 14 to equipment 24 which controls the pumping, storage and shipment of oil from an area beneath sea bed 22 through well pipe 20. This much of the sea-based oil well 10 is conventional, known equipment.

Housing 26 encircles pipe 20 over a portion of its length at a depth beneath the surface of the sea. As illustrated in FIG. 1, housing 26 preferably is made up of a smaller portion 25 and a larger portion 27 which are placed about pipe 20. After housing portions 25 and 27 are in place, the two portions are secured together by means such as bolts 28.

As seen in FIG. 2, within portion 27 of housing 26 is chamber 31 within which is blade 32. The sharpened tip 34 of blade 32 is adjacent pipe 20, and plug 36 seals the opposite end of portion 27. By way of illustration, plug 36 can threadably engage housing portion 27. Recess 38 is formed on the inner surface of plug 36 and contains an explosive charge 40. Wires 42 pass from charge 40 to sensors 58 on upper platform 14. A threaded recess 44 is provided in the surface of blade 32 adjacent plug 36.

Within housing portion 25 is chamber 30, aligned with chamber 31. Anvil 46 is positioned at the end of chamber 30 opposite pipe 20. Preferably, means are provided to ensure a fluid-tight seal of housing 26 about casing 20. Thus, sealing rings 48 and 50 seal the housing on opposite sides of chambers 30 and 31. Like-

wise, sealing ring 52 is positioned about chamber 31 to encircle blade 32. Orifice 56 passes through housing portion 27, intersecting chamber 31 between sealing ring 52 and plug 36.

Wires 42 are connected to a suitable energy source and to sensors 58 on upper surface 14 of platform 12. As illustrated, a plurality of sensors 58 can be provided at various locations on surface 14 to ensure rapid detection of hazards at these various locations. If desired, additional sensors 58 can be positioned beneath surface 14, for example on stabilizing members 18 or on pipe 20. The sensors 58 might be adapted to detect such unsafe conditions as fire, smoke, high temperatures, escape of oil or a combination of such conditions. Since housing 26 is made up of portions 25 and 27, the apparatus can be installed around already operating wells.

When an unsafe condition is detected by one or more of the sensors 58, that sensor causes an electrical signal to be applied via lines 42 to initiate explosive charge 40. As a consequence, a high thrust is applied to blade 32, driving the blade rapidly through well pipe 20, without crushing the pipe. Blade 32 blocks passage of oil through pipe 20, terminating flow from well 10. Anvil 46 prevents blade 32 from rupturing housing portion 25. Sealing rings 48, 50, and 52 prevent escape of oil from within housing 26. Once blade 32 has reached the position of FIG. 3, additional gases resulting from initiation of explosive charge 40 escape through orifice 56.

When the unsafe condition which has caused actuation of the apparatus has been corrected, plug 36 is removed, for example by a diver. A threaded tool is then inserted to engage threaded opening 44, and blade 32 is retracted. A new explosive charge 60 is inserted into recess 38, and plug 36 is again threaded into housing 26. As illustrated in FIG. 4, well pipe 20 remains in its severed condition with housing 26 bridging the gap between the sections of pipe 20. Sealing rings 48, 50, and 52 continue to prevent escape of oil. Should another unsafe condition be detected, making it necessary to again utilize the apparatus, less energy is required since well pipe 20 is already severed. Therefore, explosive charge 60 is considerably smaller than the initial explosive charge 40, and, if desired, spacer 62 can be utilized to reduce the volume of recess 38 into which explosive charge 60 is spaced. With plug 36 replaced and explosive charge 60 in place and connected to sensors 58, the apparatus is ready for reuse.

FIG. 5 illustrates a modified embodiment of apparatus in accordance with the present invention. An opening 64 is provided through the wall of housing 26 and is closed by plug 66. A similar opening 68 passes through blade 32 at an angle from a side of blade 32 to the lower surface of blade 32. Openings 64 and 68 are positioned so that opening 68 is aligned with opening 64 after the device has been actuated to move blade 32 to its position across pipe 20. If blade 32 is not a sufficient seal to terminate flow from the well, plug 66 is removed, and a sealant is introduced through openings 64 and 66, thereby assuring termination of flow.

FIG. 6 depicts a land-based well 70, including well pipe 72 which passes from the earth's surface to a petroleum bed beneath the earth's surface. Equipment 74 is provided to pump oil from that petroleum bed to suitable receiving means. Housing 26 encircles pipe 72 over a portion of its length and has its wires 42 connected to sensors 58 at suitable locations on equipment

74. Thus, if one or more of the sensors 58 detects an unsafe condition, the apparatus is actuated to terminate flow of oil from well 70. A small shaft 76 extends from the earth's surface to a point permitting removal of plug 36 for retraction of blade 32 and replacement of explosive charge 40.

While the above description has been with reference to an oil well, the apparatus of the present invention is equally suited for use in rapidly sensing unsafe conditions and terminating flow from other types of wells. Although the present invention has been described with reference to preferred embodiments, numerous modifications and rearrangements could be made and still the result would come within the scope of the invention.

What is claimed is:

1. Apparatus for rapidly terminating flow from a well upon sensing of an unsafe well condition comprising:
 - a housing adapted to encircle a well pipe over a portion of the length thereof to define a chamber;
 - a blade within the chamber adapted for positioning with the blade cutting edge adjacent the well pipe, the blade having a threaded recess in an end opposite the blade cutting edge;
 - means defining a recess within said housing, adjacent said blade threaded recess, and adapted to hold an explosive charge;
 - a plug threadedly mating with said housing recess, whereby, upon removal of said plug from said housing recess, a threaded tool can be threadedly inserted into the blade threaded recess to permit retraction of said blade; and
 - circuit means connected to the housing recess and adapted for connection to sensing means for initiating an explosive charge within the housing recess in response to sensing of an unsafe well condition to drive said blade through the well pipe, terminating flow therethrough.
2. Apparatus as claimed in claim 1 in which said housing comprises a first housing portion, a second housing portion, and means for joining said first and second housing portions about a well pipe.
3. Apparatus as claimed in claim 1 further comprising sensing means connected to said circuit means for sensing unsafe well conditions.
4. Apparatus as claimed in claim 3 further comprising an explosive charge within said housing recess.
5. Apparatus for rapidly terminating flow from a well upon sensing of an unsafe well condition comprising:
 - a housing adapted to encircle a well pipe over a portion of the length thereof to define a chamber;
 - a blade within the chamber adapted for positioning with the blade cutting edge adjacent the well pipe;
 - means defining a recess adjacent said blade and adapted to hold an explosive charge; and
 - circuit means connected to the recess and adapted for connection to sensing means for initiating an explosive charge within the recess in response to sensing of an unsafe well condition to drive said blade through the well pipe, terminating flow therethrough;
 - said housing having an opening through a wall thereof and said blade having an opening therethrough, said blade opening aligned with said housing opening when said blade is across a well pipe in a flow-terminating position, for passage of a sealant through the openings.

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6. Apparatus as claimed in claim 5, in which said housing comprises a first housing portion, a second housing portion, and means for joining said first and second housing portions about a well pipe.

7. Apparatus for rapidly terminating flow from a well upon sensing of an unsafe well condition comprising:
a housing adapted to encircle a well pipe over a portion of the length thereof to define a chamber;
a blade within the chamber adapted for positioning with the blade cutting edge adjacent the well pipe;
means defining a recess adjacent said blade and adapted to hold an explosive charge;
said housing having an opening thereinto at a point intermediate the blade cutting edge and said defining means;
sealing means intermediate the opening and the blade cutting edge for preventing leakage from a

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well pipe out the opening; and
circuit means connected to the recess and adapted for connection to sensing means for initiating an explosive charge within the recess in response to sensing of an unsafe well condition to drive said blade through the well pipe, terminating flow therethrough.

8. Apparatus as claimed in claim 7 further comprising additional sealing means adapted to encircle a well pipe on opposite sides of the chamber for preventing leakage from a well pipe out of said apparatus.

9. Apparatus as claimed in claim 7, in which said housing comprises a first housing portion, a second housing portion, and means for joining said first and second housing portions about a well pipe.

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