United States Patent

Brown

[15] **3,693,715**

[45] **Sept. 26, 1972**

[54] **APPARATUS FOR BLOCKING FLUID FLOW IN A WELL CASING**

[72] Inventor: **John M. Brown,** 5787 Pine Grove Road, R.D. # 3, Clay, N.Y. 13041

[22] Filed: **May 14, 1971**

[21] Appl. No.: **143,406**

[52] **U.S. Cl.** **166/55,** 166/93

[51] **Int. Cl.** **E21b 29/00**

[58] **Field of Search**.....166/55, 55.1, 297, 298, 92, 166/93; 251/1

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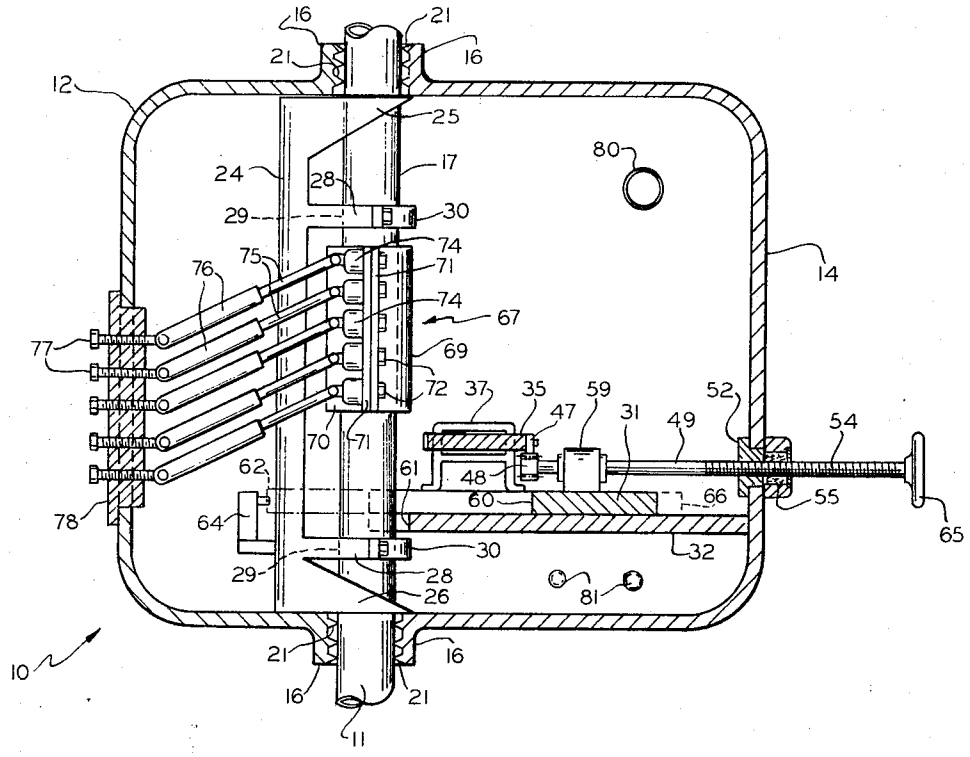
Primary Examiner—David H. Brown

Attorney—Bruns & Jenney

[57] **ABSTRACT**

Apparatus for blocking fluid flow in a well casing where the well is out of control due to blowout, fire or casing leaks. A shell comprised of two hingedly connected mating parts is mounted on the casing so as to enclose a portion thereof in a sealed manner. A metal cutting saw blade in the shell is provided with power means to reciprocate it and move it into the casing whereby the blade cuts through the casing. The width of the blade is greater than the casing diameter so that upon completion of the cut the blade blocks the fluid flow. This permits a shut off valve or other control means to be installed in the casing above the shell after which the saw can be withdrawn and the shell removed for re-use.

10 Claims, 8 Drawing Figures



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SHEET 1 OF 3

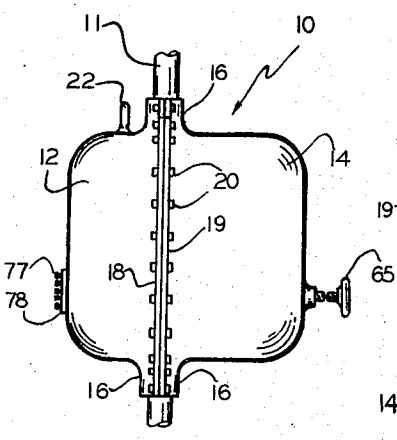


Fig. 2

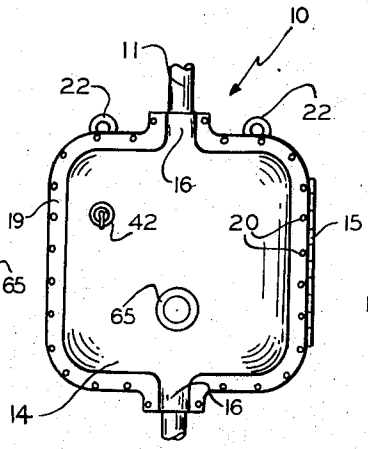


Fig. 1

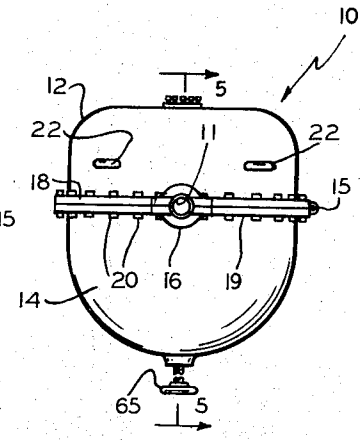


Fig. 3

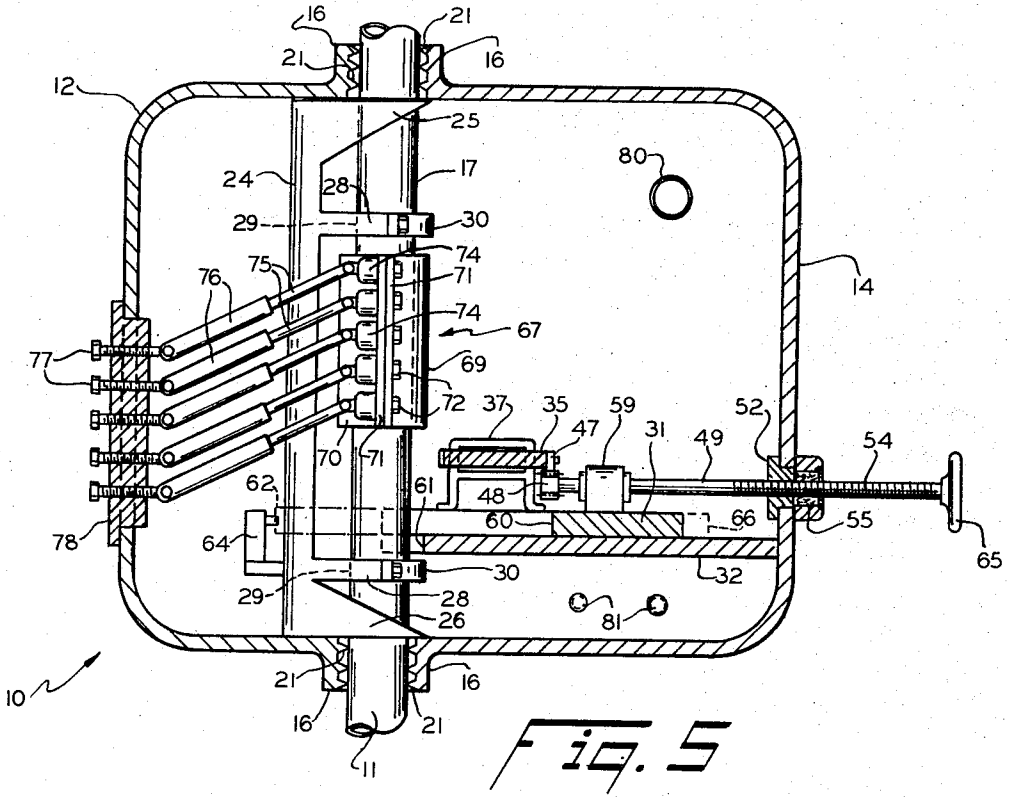


Fig. 5

INVENTOR.
JOHN M. BROWN

BY

Bruns & Jenney,
ATTORNEYS

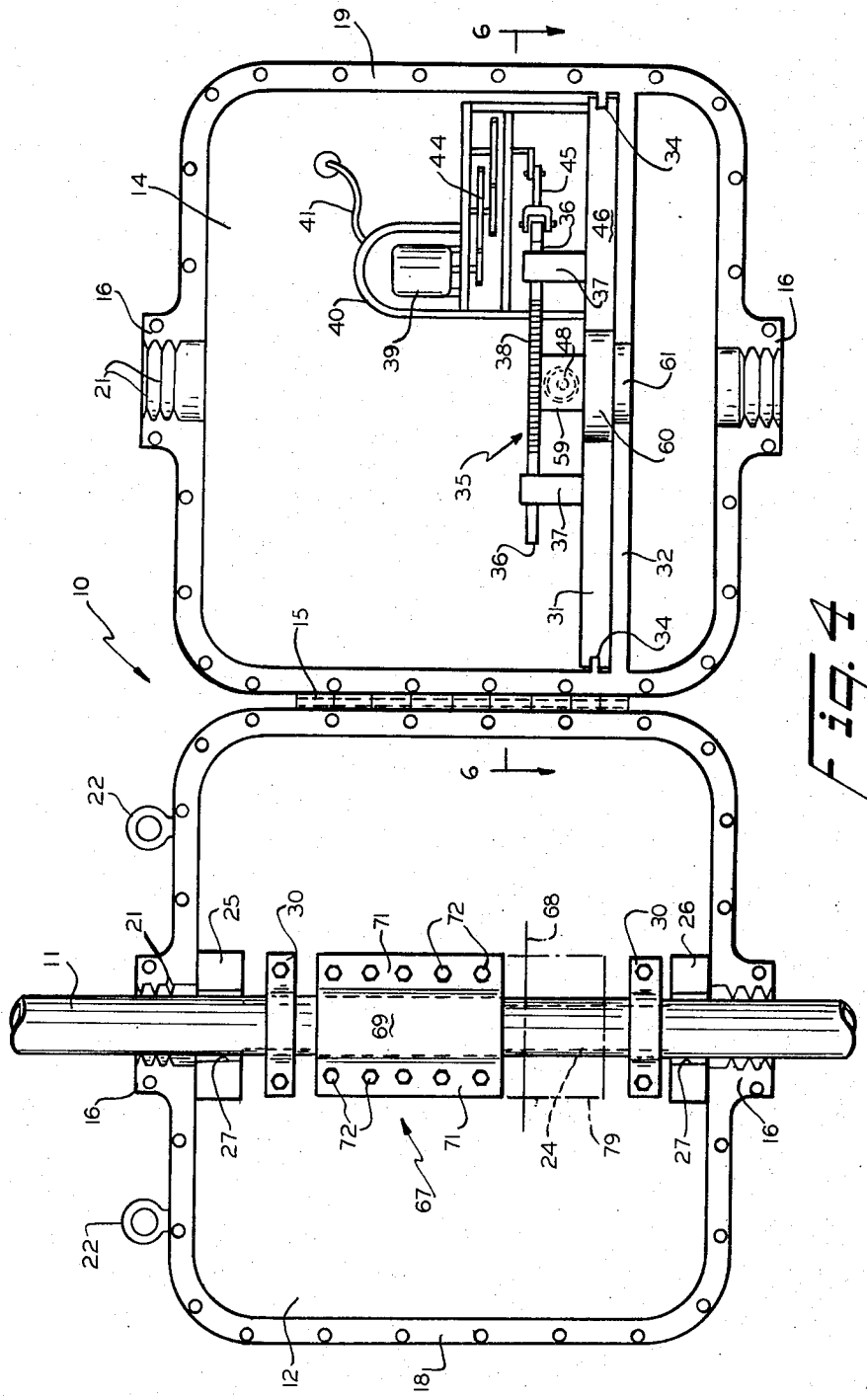


Fig. 4

INVENTOR.
JOHN M. BROWN

BY
Bruns & Jenney,
ATTORNEYS

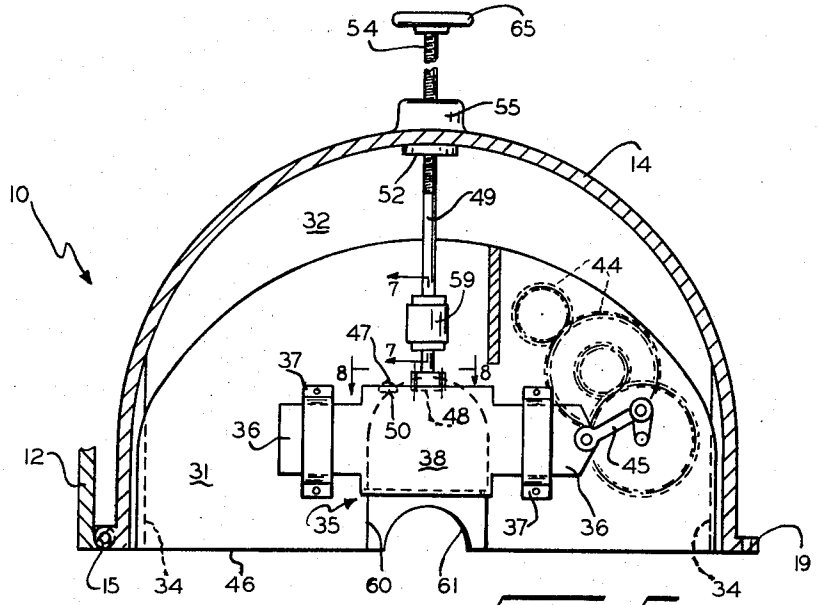


Fig. 6

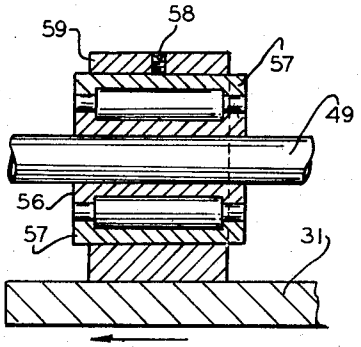


Fig. 7

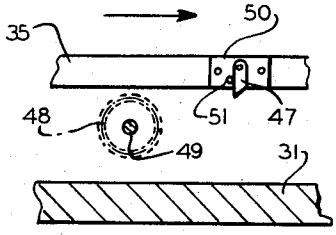


Fig. 8

INVENTOR.
JOHN M. BROWN
BY
Burns & Jenney,
ATTORNEYS

APPARATUS FOR BLOCKING FLUID FLOW IN A WELL CASING

BACKGROUND OF THE INVENTION

This invention relates generally to well drilling equipment, and has particular reference to novel apparatus for blocking the fluid flow in a well casing where the well is out of control due to blowout, fire or casing leaks.

As is well known, an out of control hydrocarbon well can cause enormous damage by pollution as well as a substantial economic loss due to the escape or destruction of the oil or gas. Many devices and methods have been developed for solving this ever-present problem but often the proposed solutions are in themselves hazardous and uncertain of success. Other proposed solutions, while perhaps safer and surer, are very complex and expensive.

Particular difficulty has been encountered in off-shore drilling operations where well malfunctions are complicated by the surrounding water and escaping oil can severely pollute beaches and kill untold numbers of sea birds and fish. To the best of applicant's knowledge, no practical and effective means has heretofore been developed for coping with an offshore well that is malfunctioning.

SUMMARY OF THE INVENTION

The apparatus of the present invention is particularly adapted for blocking the flow of the fluid in an off-shore well casing, but it will be apparent as the description proceeds that it can also be advantageously utilized for on-shore oil or gas wells.

The apparatus comprises a hollow shell or capsule which is constructed so that it can be mounted, as by divers, on a well casing to enclose a portion of the casing in a sealed manner. The shell contains a carriage that is movable towards and away from the casing, and a metal cutting saw blade is mounted on the carriage for reciprocating movement relative to the casing. Power means are provided to reciprocate the saw and this in turn causes the carriage to advance toward the casing whereby the latter is cut by the saw.

The width of the saw blade is greater than the diameter of the well casing and upon completion of the cut, means are actuated which stop the saw and carriage movement whereby the saw blade spans the inner diameter of the casing and blocks the flow of fluid therein. This allows workers to install a shut off valve or other control device at a point above the shell, and after this has been done the saw blade is withdrawn from the casing by means operable from outside the shell.

In the shell interior there is also a sleeve assembly that is releasably held on the casing above the plane of the saw blade. After the blade has been withdrawn from the casing, this sleeve is permitted to slide down on the casing so that it encircles the saw cut. The sleeve can then be secured in this position so that it seals the cut, the flow now being controlled by the valve that was installed above the shell when the saw blade blocked the fluid flow. This enables the shell to be removed from the casing for re-use, except for the sleeve which is left to seal the saw cut.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diminutive front elevation of a fluid flow blocking apparatus embodying the invention;

FIG. **2** is a diminutive left side elevation thereof;

FIG. **3** is a diminutive top plan view thereof;

FIG. **4** is a front elevation of the apparatus with the hinged mating parts in open position as the apparatus is being mounted on the well casing;

FIG. **5** is a vertical sectional view taken on line **5—5** on FIG. **3**;

FIG. **6** is a horizontal sectional view taken on line **6—6** of FIG. **4**;

FIG. **7** is an enlarged vertical sectional view of a detail of the construction taken on line **7—7** of FIG. **6**; and

FIG. **8** is an enlarged vertical sectional view of a detail taken on line **8—8** of FIG. **6**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Having reference now to the drawings, and with particular reference to FIGS. **1—3**, the fluid flow blocking apparatus of the invention is indicated generally by the reference number **10** and is shown mounted on a well casing **11**. In the description to follow, the apparatus is described in conjunction with an off-shore well wherein the casing **11** is under water but it will be apparent as the description proceeds that the apparatus can be employed with equal effectiveness with on-shore well casings in oil or gas wells.

The flow blocking apparatus **10** is in the form of a hollow shell comprised of two mating parts **12,14** hingedly connected together along a vertical edge as at **15**. Each mating part is formed with upper and lower vertically aligned semi-cylindrical bosses **16** which permit the parts when closed to fit around the casing **11** and enclose a portion **17** thereof, FIG. **5**, within the shell in a sealed manner. To this end, the parts **12** and **14**, which are of relatively heavy gauge metal, are formed with mating peripheral flanges **18,19** adapted to be bolted together as by bolts **20** with a sealing gasket (not shown) therebetween. In addition, the bosses **16** are provided on their inner surfaces with a plurality of mating, semi-annular knife edged ridges **21** that bite into the casing and help form a seal between it and the shell.

The shell, which may be 4–6 feet across and equally high, is lowered into position by cable from a boat on the surface, the cable or cables being secured to eyes **22** welded to the top of the shell. The shell is mounted on the casing **11** by divers at a point, for example, several feet below a leak. To this end, the part **12** of the shell is provided with a relatively heavy vertical stanchion **24** rigidly secured to the top and bottom of the part and formed with upper and lower projections **25,26** having semi-annular recesses **27** for receiving the casing therein. Between the projections **25** and **26**, the stanchion is formed with a pair of spaced arms **28**, FIGS. **4** and **5**, which also have semi-annular recesses for receiving the casing as indicated at **29** in FIG. **5**.

With the shell parts in open position as shown in FIG. **4**, the part **12** is brought into engagement with the casing so that the latter is positioned in the recesses of the projections **25,26** and arms **28**, and semi-annular brackets or clamp members **30** are then bolted to the

arms to rigidly secure the part **12**, and thus the complete shell, in position on the casing. Thereafter, the part **14** is swung into engagement with part **12** and the shell is closed by bolting the mating flanges **18** and **19** together with a gasket therebetween as described above.

The other shell part **14** is provided with a carriage **31** in the form of a flat plate member that is movable towards and away from the casing, the carriage being slidable on a supporting plate **32** and guided by ways **34**, FIG. **4**. A heavy metal cutting saw blade **35** is mounted on the carriage for reciprocating movement relative thereto and to the casing, the saw being slidably supported at its reduced end portions **36** by supports **37** secured to the carriage as best shown in FIGS. **4** and **6**. It is an important feature of the invention that the width of the toothed central portion **38** of the saw blade is greater than the outside diameter of the casing **11**.

In accord with the invention, means are provided to reciprocate the saw and at the same time advance the carriage **31** towards the casing so that the saw cuts through the latter and upon completion of the cut blocks the flow of fluid in the casing because of its width. The saw blade reciprocation is effected by an electric motor **39**, FIG. **4**, located in a sealed, fluid-tight housing **40**, the motor having a power connection **41** to a fitting **42** on the exterior of the shell, FIG. **1**. The fitting **42** includes an on-off switch and a receptacle for a power cable from the boat above, the fitting components being sealed against the water in a manner known in the art.

The motor **39** operates through a gear train **44** to actuate a crank mechanism **45** and reciprocate the saw blade. This permits the saw to make in the order of **90** strokes per minute with the cutting being done in the pushing direction. In this connection, proper functioning of the saw is aided by off-setting its longitudinal axis a very small amount out of parallelism with the straight front edge **46** of the carriage **31**, FIG. **6**. This offset, which may be no more than 1°–20° between the saw axis and edge **46**, positions the right end of the saw blade slightly farther away from the edge than the left end as shown in FIG, **6** with the cutting taking place as the saw moves from right to left on the push stroke.

Movement of the carriage **31** to advance the saw blade into the casing is effected by the reciprocating movement of the saw itself. This is accomplished by the engagement of a ratchet tooth **47** carried by the saw with a pinion **48** fixed on the end of a horizontal shaft **49**, FIGS. **6** and **8**. The tooth **47** is pivotally connected to a bracket **50** mounted on the rear edge of the central portion **38** of the saw and is arranged to engage and turn the pinion a few degrees on each push stroke of the saw. Thus, as viewed in FIG. **8** looking at the back of the saw blade, on movement of the saw to the right during a push stroke the tooth **47** drives the pinion since it is held against pivoting by a stop **51** on the bracket **50**. In FIG. **8**, the blade is shown at the end of a push stroke. On the return or pull stroke in the opposite direction, the ratchet tooth is allowed to pivot and simply passes over the pinion without engagement.

The shaft **49** extends from the pinion **48** out through the wall of the shell, passing through a fitting **52** in the shell part **14**, FIG. **5**. Adjacent the fitting, the shaft is formed with a screw thread **54** that meshes with a corresponding internal thread (not shown) in the fitting, the fitting also being provided with a packing gland **55** or the like. With this construction, the rotation of the pinion **48** by ratchet tooth **47** causes the shaft **49** to move longitudinally towards the casing.

Shaft **49** is connected to carriage **31** by a bearing connection shown in FIGS. **6** and **7**. In this connection, the inner race **56** of a roller or ball bearing is fixed on the shaft as by a press fit while the outer race **57** is fixed as by a set screw **58** in a support **59** secured to the carriage. With this arrangement, the carriage, and consequently the saw blade, will move with the shaft so that the saw will be advanced into the casing as it reciprocates. To enable the carriage to travel far enough for the saw to cut all the way through the casing, the carriage is formed with an elongated central cut-out **60** so that it can in effect straddle the casing as it moves forward. The carriage supporting plate **32**, which is fixed, is also provided with a central cut-out **61** to accommodate the casing as shown in FIG. **6**.

When the saw blade has cut completely through the casing, the carriage will have advanced to the position indicated by phantom lines at **62** in FIG. **5** where it engages a limit switch **64** that shuts off the motor. At this time, the saw because of its width spans the casing and blocks the further flow of fluid therein. With the fluid flow blocked, diver workmen can install a shut off valve (not shown) or other control means between the top of the shell and the leak. Thereafter, the saw is withdrawn from the casing which can be done manually from outside the shell by turning a handwheel **65** on the outer end of shaft **49** until the carriage reaches the limit of its rearward movement indicated by phantom lines at **66** in FIG. **5**.

When the shell is first mounted on the casing as indicated in FIG. **4**, and before the two parts are closed and bolted together, a sleeve assembly **67** is also mounted on the casing between the arms **28** and above the plane of the saw blade, the centerline of the saw cut in the casing being shown at **68** in FIG. **4**. This sleeve assembly comprises a pair of mating semi-cylindrical members **69,70** that fit around the casing and are secured together by nuts and bolts that pass through abutting side flanges **71** on the members. In installing the assembly on the casing, the nuts (not shown) are tightened just enough to hold the assembly in the position shown in FIGS. **4** and **5**.

The heads **72** of the bolts are welded to the semi-cylindrical member **69** and after tightening the nuts as above described, wrench sockets **74** are positioned on the nuts, each socket being pivotally connected to a shaft **75** telescopically received in one end of a tube **76**. At their opposite ends, the tubes are pivotally connected to bolts **77** which pass through tapped holes in a plate **78** in the wall of the shell part **12** so that the heads of the bolts are outside the shell. Relative rotation between shafts **75** and tubes **76** is prevented as by keying.

After the saw blade has made its cut and has been manually withdrawn from the casing by means of the handwheel **65**, and with the shell still closed, the bolts **77** are turned from outside the shell which loosens the nuts on the sleeve assembly **67**. This permits the sleeve to slide down on the casing under its own weight until

the bottom of the sleeve rests on the supporting plate **32**, this position of the sleeve being indicated by phantom lines at **79** in FIG. **4**. As the sleeve slides down on the casing, the shafts **75** for the sleeve nuts move farther into the tubes **76** to compensate for the shortening of the distance between the sleeve and the actuating bolts **77**.

With the sleeve assembly resting on the plate **32**, it will be apparent from FIGS. **4** and **5** that it encircles the saw cut made in the casing. Once in this position, the sleeve nuts are tightened from outside the shell by means of the bolts **77** whereby the saw cut is substantially sealed. Thereafter, the shell is opened to the position shown in FIG. **4**, the wrench sockets **74** are disconnected from the sleeve nuts by pushing shafts **75** farther into tubes **76**, and the clamping brackets **30** are unbolted from stanchion arms **28**. Except for the sleeve assembly **67**, which remains on the casing and may if necessary be welded in place, the shell can now be removed for re-use since the fluid flow can be controlled by the valve that was installed above the shell as previously described.

It is contemplated that the shell will be provided with a normally capped pipe fitting **80**, FIG. **5**, so that if desired, while the shell is still mounted on the casing, fluid that fills the shell can be diverted to another conduit. In addition, the shell may be provided with fittings **81** for drainage or introducing blow-out air into the shell.

From the foregoing description it will be apparent that the invention provides a novel and very effective apparatus for blocking fluid flow in a well casing. As will be understood by those familiar with the art, the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof.

I claim:

1. In an apparatus for blocking fluid flow in a well casing, a shell arranged to enclose a portion of the casing in a sealed manner, a carriage supported in the shell for movement towards and away from the casing, a saw blade mounted on the carriage for reciprocating movement relative thereto, the width of the saw blade being greater than the outside diameter of the casing, means in the shell to reciprocate the saw blade, and means operable when the blade is reciprocating to move the carriage toward the casing whereby the blade cuts through the casing and, because of its width, blocks the flow of fluid therein.

2. Apparatus as defined in claim **1** wherein the shell comprises two mating parts one of which includes means for releasably mounting it on the casing, and releasable means to secure the parts together to enclose a portion of the casing after the one part has been mounted thereon.

3. Apparatus as defined in claim **1** wherein the means to reciprocate the saw blade is a motor, the apparatus including external means to start the motor and internal means to stop it after the saw blade has cut through the casing.

4. Apparatus as defined in claim **1** wherein the means for moving the carriage toward the casing is operated by the reciprocating movement of the saw blade.

5. Apparatus as defined in claim **1** together with external means on the shell for moving the carriage away from the casing to withdraw the saw blade therefrom after the cutting operation.

6. Apparatus as defined in claim **5** together with a sleeve assembly releasably mounted on the casing above the plane of the saw blade, and means on the shell to enable the sleeve assembly to slide down on the casing and encircle the saw cut therein after the saw blade has been withdrawn from the casing.

7. An apparatus for blocking fluid flow in a well casing comprising a shell arranged to enclose a portion of the casing in a sealed manner, the shell having two hingedly connected mating parts to enable it to be mounted on the casing; a carriage supported on one part of the shell for movement towards and away from the casing; a metal cutting saw blade mounted on the carriage for reciprocating movement relative to the casing, the width of the saw blade being greater than the outside diameter of the casing and the plane of the blade being substantially perpendicular to the longitudinal axis of the casing; motor means in the shell to reciprocate the saw blade; means operated by the reciprocating movement of the blade to advance the carriage toward the casing whereby the blade cuts through it and, because of its width, blocks the flow of fluid therein upon completion of the cut; means forming a part of the carriage advancement means to move the carriage away from the casing and withdraw the saw blade therefrom after the cutting operation; a sleeve assembly in the shell encircling the casing, the assembly being releasably held on the casing above the plane of the saw blade during the cutting operation; and means on the shell to enable the sleeve assembly to slide down on the casing and encircle the saw cut after the saw blade has been withdrawn from the casing.

8. Apparatus as defined in claim **7** including means on the exterior of the shell to start the motor means, and means in the shell operable to stop the motor means after the saw blade has cut through the casing.

9. Apparatus as defined in claim **7** wherein the carriage advancing means includes a screw shaft extending from the exterior into the interior of the shell through a screw threaded fitting, a pinion on the inner end of the shaft adjacent the saw blade, a ratchet tooth on the blade engageable with the pinion during movement of the blade in one direction whereby the pinion is turned and the shaft moved longitudinally, and means connecting the shaft with the carriage so that it moves with the shaft.

10. Apparatus as defined in claim **9** wherein the means for moving the carriage away from the casing comprises a handwheel outside the shell on the outer end of the screw shaft.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,693,715 Dated September 26, 1972

Inventor(s) John M. Brown

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 43, "20°" should read -- 2° --.

Column 6, line 19, next to the last word, "on" should read -- in --.

Signed and sealed this 13th day of February 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.