Nov. 4, 1952 J. L. FOSTER 2,616,370

WELL EXPLOSIVE

Filed Sept. 10, 1946 2 SHEETS—SHEET 1

Fig. 1

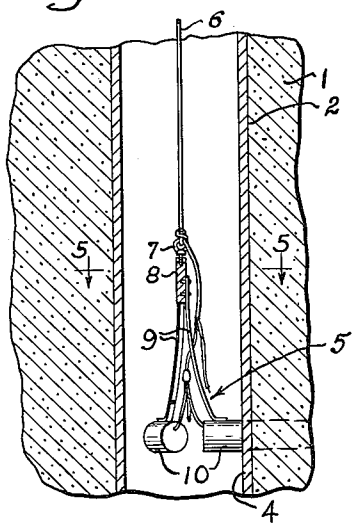


Fig. 2

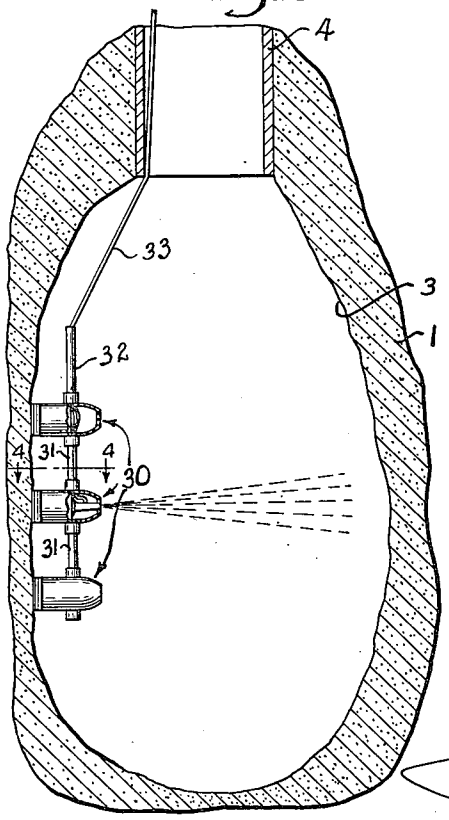


Fig. 3

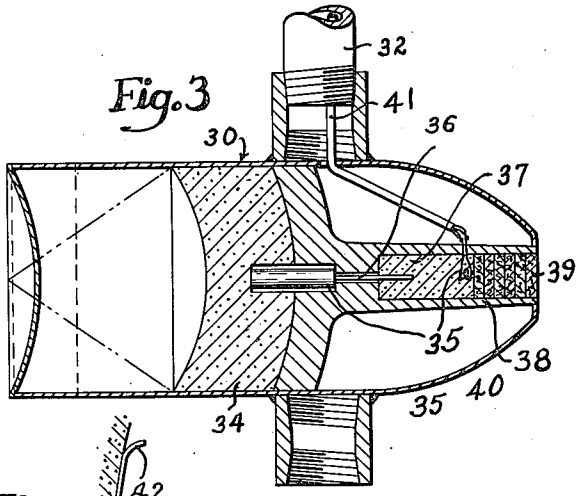


Fig. 4

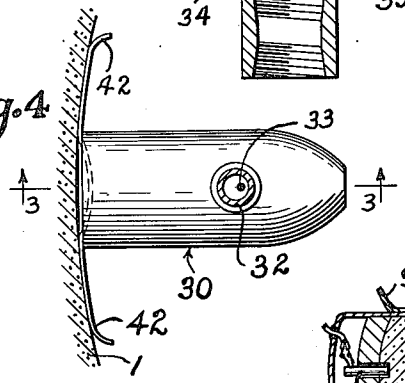


Fig. 6

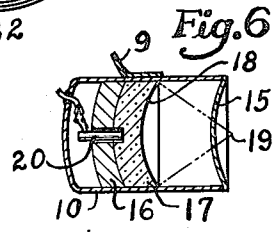
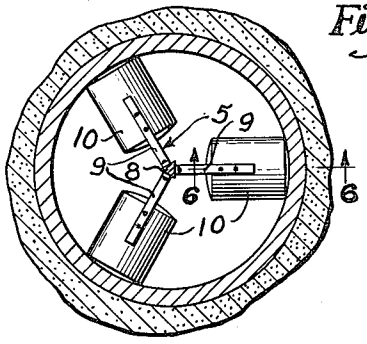


Fig. 5



James Lewis Foster
INVENTOR.

BY

J. Preston Swecker ATTORNEY.

Nov. 4, 1952 J. L. FOSTER 2,616,370

WELL EXPLOSIVE

Filed Sept. 10, 1946 2 SHEETS--SHEET 2

Fig. 7

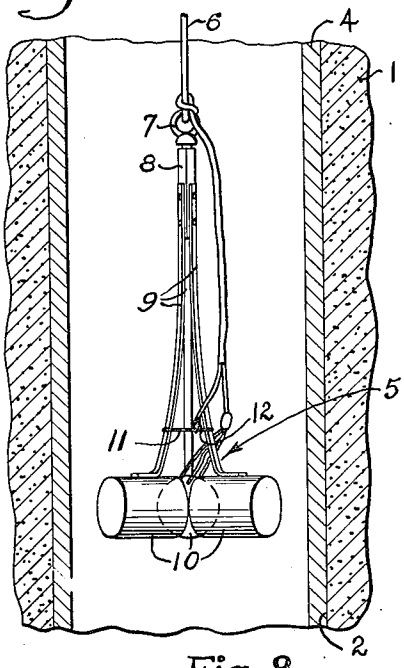


Fig. 9

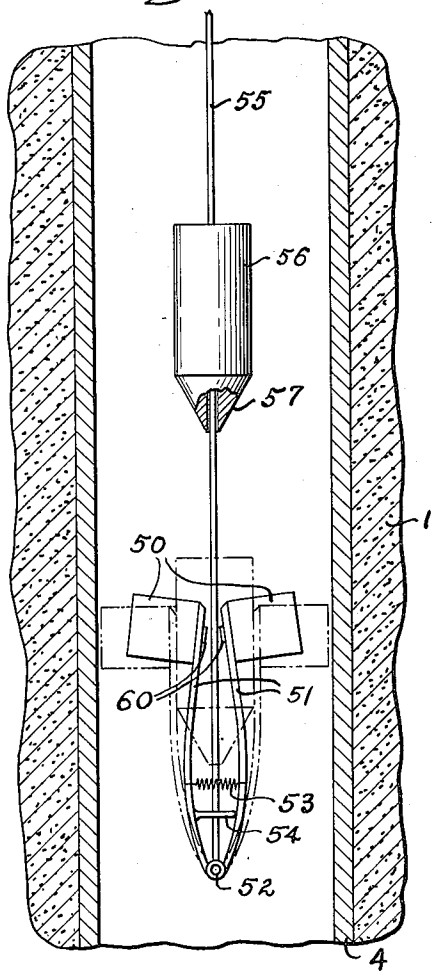


Fig. 8

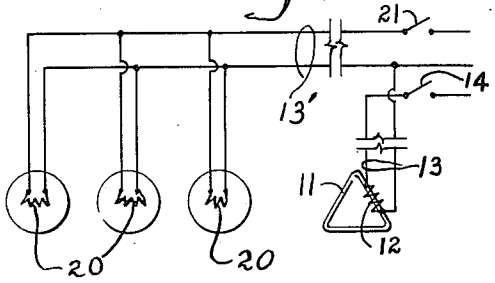
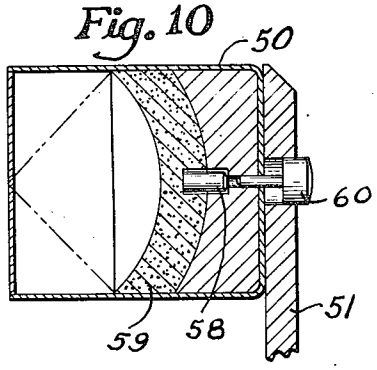


Fig. 10



James Lewis Foster
INVENTOR.

BY J. Foster Swecker
ATTORNEY.

Patented Nov. 4, 1952

2,616,370

UNITED STATES PATENT OFFICE

2,616,370

WELL EXPLOSIVE

James Lewis Foster, Wichita Falls, Tex.

Application September 10, 1946, Serial No. 695,913

1 Claim. (Cl. 102—20)

1

This invention relates to improvements in well explosives, and more particularly to such explosives as are used for penetrating the casing or wall of a well, for the purpose and as described in my prior patent, No. 2,307,729, granted January 5, 1943.

When a well is drilled into a subterranean formation, particularly into the oil or fluid-bearing formation, it is often necessary to open up the surrounding wall to permit the fluid to flow into the well for withdrawal therefrom. The practice heretofore has involved generally the "shooting" of such wells by placing a large charge of nitroglycerine or high explosive within the bore hole of the well where it is detonated. This depends upon the concussion and reverberation for its effect on the fluid-bearing formation. It has been proposed also to place small charges by means of projectiles that penetrate the surrounding formation from the bore hole and subsequently detonating these charges in the manner set forth in my prior patent, No. 2,307,729, to shatter the base of the formation and cause the fluid to flow into the well. The latter has involved the placing of the explosive by means of a tool of substantial weight which must be lowered into a hole and then removed. Such a tool is relatively heavy and expensive, and must be removed and serviced at additional expense before it can be re-used. While it has considerable advantage over the "shooting" practice in use heretofore, it has been said to be subject to the objections mentioned, and in some instances does not justify the added expense.

The object of this invention is to cause a penetration of the surrounding subterranean formation from within the bore hole without the expense incident to the tool that projectiles of the character described, by simplifying the character of the penetrating charge and likewise the character of the tool used therewith, while nevertheless effectively penetrating the surrounding casing or wall of the well to a sufficient extent so as to permit the fluid to flow into the well and to produce channels and basins in the formation which will assist in the recovery of oil or other fluid therefrom.

I have discovered that this object may be accomplished by penetrating the fluid-bearing formation by the use of the channelling or penetrating effect of a small charge of explosive so shaped as to focus the point of action thereof so that a relatively small area of the wall of the well or bore hole will be acted on at one time by the detonating force, which will nevertheless be effective to penetrate the steel case or the rock wall in an effective action directed at a point. This concentration of force will create one or more cavities in the formation, thus increasing

2

the recovery area thereof, especially when used in oil wells, thereby increasing the effective production of such wells.

The effective charge may be produced by shaping the face thereof substantially in the form of a concave lens having the focal point at or adjacent the end of the charge container whereby, when presented to the surrounding wall of the formation or the casing, the concentration of force at the focal point of the surface will be effective to disintegrate the wall or casing and form a hole or cavity therein which will continue into the formation to an extent depending upon the effective charge of the charge container.

Certain embodiments of the invention are illustrated in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view through a bore hole forming a well and having a surrounding casing therein, showing one form of tool adapted for use according to this invention;

Fig. 2 is a similar view showing the bottom of the bore hole below the casing and illustrating a modified form of tool according to this invention;

Fig. 3 is a longitudinal section through a charge container device of the character used with the tool shown in Fig. 2, on the line 3—3 of Fig. 4;

Fig. 4 is a top plan view thereof with a portion in section and taken on the line 4—4 of Fig. 2;

Fig. 5 is a cross-section through the well on the line 5—5 of Fig. 1;

Fig. 6 is a longitudinal section through the charge container thereof on the line 6—6 of Fig. 5;

Fig. 7 is a view similar to Fig. 1 but shows the charge containers retracted;

Fig. 8 is a diagrammatic view of the wiring connections of the tool shown in Figs. 1, and 5 to 7;

Fig. 9 is a vertical sectional view through a cased well showing still another form of tool operatively mounted therein; and

Fig. 10 is a sectional view through the charge container used in the tool shown in Fig. 9.

The invention is illustrated and described as applied to a bore hole or well in a subterranean formation where it has special utility for opening up the formation either through the casing that surrounds the bore hole or at the bottom of the bore hole below the casing, to increase the circulation of fluid, particularly oil, from the surrounding formation into the bore hole, for the purposes set forth more in detail in my prior patent, No. 2,307,729.

As illustrated, the well is formed by drilling a hole downwardly from the surface into sur-

rounding fluid-bearing formation generally as indicated at 1, which hole is shown at 2 and often has an enlarged cavity 3 at the bottom thereof. The bore hole 2 usually is lined with a steel casing 4 that extends downwardly from the surface throughout the major portion of the length of the bore hole and is shown as extending to the cavity 3. Frequently it is desired to penetrate the surrounding casing 4 particularly at a point near the bottom of the well and into the fluid-bearing formation 1, and also to penetrate the surrounding wall of the cavity 3 by tunnels or cavities of the character set forth in my prior patent, No. 2,307,729, to provide for the flow of oil or other fluid from the surrounding formation into the well.

One form of tool for this purpose is shown generally in Figs. 1 and 7, and more in detail in Figs. 5 and 6. This tool uses a plurality of explosive devices which cooperate in an assembled relation to form a tool generally as indicated at 5 in Figs. 1 and 7. This tool 5 is suspended by a cable 6 that is adapted to be lowered into the well from the surface of the ground for suspending the tool therein at the proper point where the surrounding wall of the well is to be penetrated. This cable 6 may be an electrical cable through which the wires for directing the electric current extend or it may be a suspending cable having the wires associated therewith, whichever may be desired.

The lower end of the cable 6 is shown as suspending thereby an eyelet 7, to which is secured and suspended a body 8. The body 8 supports a plurality of yieldable members 9, preferably in the form of leaf springs, one end of each of which is attached to a side of the body 8, and the other end carries an explosive device 10.

The yieldable supports 9 normally are so formed as to position the charge containers 10 in laterally expanded relation substantially as shown in Figs. 1 and 5, bearing axially against the inner wall of the well or the casing 4. However, provision is made for holding these in contracted relation during the lowering of the device into the well, as shown in Fig. 7. For this purpose I have provided thereon an encircling member 11 which extends around the yieldable supports 9, as shown in Fig. 7, at a point above the charge containers 10. This restraining device 11 may be constructed of any suitable material that has sufficient strength to hold these yieldable supports in contracted relation and yet is capable of being released readily when the tool has been lowered to the desired point in the well. Thus it may be formed of a low fusion metal, or of a cord such as cotton or fibre saturated with a combustible substance or an explosive, which will fuse or ignite sufficiently to release the yieldable supports 9. Such a releasing may be accomplished by an electric coil, shown at 12 in Fig. 8, arranged in heat exchange relation with the restraining device 11, as surrounding one side thereof, and adapted to be connected with a source of electrical supply through a circuit 13. A control switch 14 may be used at the surface of the ground which, when closed, will electrically energize the coil 12 to disintegrate the restraining device 11 and release the latter from its holding encirclement of the yieldable supports 9. This will permit lateral expansion of these supports to direct the outer ends of the charge containers 10 against the surrounding wall of the well or the casing 4, as shown in Fig. 5.

One form of explosive device is shown in section in Fig. 6, in which the device 10 is in the form of a cylindrical container closed at opposite ends but in which the closed outer end 15 is shown as concave. Fixed in the casing of the explosive device is a head 16 which forms an abutment for the explosive charge 17. This explosive charge is shown as concavo-convex with a spherically concave face 18 facing the concave end wall 15 of the casing and having a focal point substantially at or beyond the end wall as indicated at 19. Thus the lens-shaped explosive charge 17 is so formed as to focus its detonating effect substantially in the direction indicated by dotted lines in Fig. 6 toward the focal point 19 adjacent or beyond the end wall of the casing.

It is preferred for the best effect to use an explosive composition which has high speed detonation, such as TNT or nitroglycerine. However, many other detonating explosives will produce this effect to varying degrees, such as dynamite. Such a detonating explosive appears to function by its high concentration of explosive action substantially in a conical effect, as described, which will direct its intensity substantially at the apex of the cone in a manner effectively to disintegrate steel, rock or earth formation to an extent depending upon the amount of explosive composition used until its force has been expended.

The ignition of the explosive charge may be accomplished by an electric detonator generally indicated at 20 in Figs. 6 and 8, one such heating element or detonator being provided for each charge and adapted to be connected with the electrical circuit 13' connected in parallel with the circuit 13, but controlled by a switch 21 located at the surface of the ground. This detonator is shown as enclosed within the casing of the charge container 10, which casing is watertight when lowered into the well, and sealed at the point where the electric wires pass through the wall casing.

In using this form of tool, the parts are lowered into the well to the desired point for penetration of the surrounding wall or the casing, substantially as illustrated in Fig. 7. When the tool reaches substantially the depth where perforation is desired, the lowering action of the cable 6 is suspended and then the switch 14 is closed to energize the coil 12. This disintegrates the encircling element 11 and allows the natural resiliency of the spring supports 9 to expand the charge containers 10 outwardly against the wall of the well or the casing 4, substantially as indicated in Figs. 1 and 5.

Then upon the closing of the switch 21 the electric detonators 20 will cause an ignition of the explosive charge 17 in each of the charge containers. This will have the effect described above, of concentrating the explosive force of the lens-like explosive substantially at the focus thereof which is located adjacent or externally of the end wall of the charge container. With the charge container substantially in bearing relation with the surrounding wall of the well this explosive action will so concentrate the force thereof as to penetrate the wall and into the formation to an extent desired until the force of the explosive is expended.

One or more of these charge containers may be used as desired, according to the number of openings which may be needed in the surrounding formation. Three such charge containers are shown merely for the purpose of illustration, but it will be understood that the number thereof

may be increased or decreased as desired, and that these may be used either above or below the lower end of the casing in like manner.

When it is impractical to use yieldable supports that will tend to direct the charge containers against the surrounding wall of the bore hole, as for instance when a large cavity 3 is encountered therein, as indicated in Fig. 2, a similar effect may be accomplished by the form of tool shown in Figs. 2 to 4.

In this form is shown a plurality of vertically spaced charge containers generally designated at 30 held in spaced relation by tubes 31 and with a tube 32 projecting upwardly therefrom to which is secured a supporting cable 33 that extends upwardly to the surface of the ground. This cable supports the tool as it is lowered to the desired point in the bore hole or the cavity 3.

Each charge container 30 is shown in Fig. 3 as formed by surrounding casing with a lens-like explosive charge 34 similar in character and effect to the charge 17 described above, and adapted to be ignited by an electrical detonator 35. This detonator 35 is ignited by a fuse 36 that extends therefrom into an explosive charge 37 located in a barrel 38.

The barrel 38 is mounted centrally of the charge container 30 and opens toward the rear of the latter, as shown in Fig. 3, with its end normally closed by wadding 39. The latter is removable readily by the initial explosion of the explosive charge 37 when ignited, as by an electrical heating element 40 embedded in the end of the explosive charge 37. The effect of thus igniting the explosive charge will be to expel the wadding 39 from the open end of the barrel 38 and then to direct a jet-like action or discharge through the open end of the barrel which will have the effect of propelling the charge container 30 in the opposite direction against the face of the cavity 3, as indicated in Fig. 2, and continuing until the force of the explosive charge 37 is spent. This should be so proportioned as to confine the charge container against the face and until after the igniting of the fuse 36 and the action of the detonator 35 to cause combustion of the explosive mixture 34 when the action of the latter will hold the charge container in this position during its effective operation. The electric heating element 40 may be energized through the electric wire generally indicated at 41.

Where several charge containers are used in an assembly substantially as shown in Fig. 2, these will function simultaneously to form holes into the formation at vertically spaced points. However, they may be turned at angles to each other if desired instead of located in the parallel relation illustrated.

It is preferable to use an extended strip or shoe, generally indicated at 42, at the end of the charge container 30, which abuts against the face of the bore hole, so as to stabilize the charge container in its bearing action against the face until the action of the shaped charge takes place. This strip 42 thus will hold the charge container against the face substantially at right angles thereto in position for effective action on the surrounding formation by the concentrated force of the burning or explosive charge shaped in the manner described.

Still another form of tool is shown in Figs. 9 and 10, in which a plurality of charge containers 50 are shown as mounted on upwardly extending arms 51 preferably pivoted together at 52 and

normally contracted by a coiled spring 53 connected therebetween. Any desired number of these charge containers may be used, although two are shown for purpose of illustration. The arms 51 normally are held in spaced relation by a spacer 54.

The pivotal support 52 preferably is in the form of a spider suspended by a cable 55 that extends upwardly to the surface of the ground. A tool 56, shown as having a conical lower face 57, is slidably mounted freely on the cable 55 in position to be dropped downward along the cable for detonating the charge containers 50.

Accordingly each of the charge containers 50 is shown in Fig. 10 as having a percussion cap 58 arranged to detonate a shaped charge 59 in the charge container when actuated by a firing pin 60. The shaped charge 59 preferably is of the character described above and having like effect in use.

When the tool 56 is dropped by gravity along the cable 55 the conical end thereof will enter between the charge containers 50 and cause these to be spread outward from the full line to the dotted line position shown in Fig. 9. At the same time this tool will actuate the firing pin 60 to discharge the percussion cap 58 and cause ignition of the shaped charge 59, which will then effectively penetrate the surrounding wall, and the casing if used, of the formation.

While the invention has been described in certain embodiments, it is recognized that these are merely illustrative of various forms of the invention, and that other variations and changes may be made therein without departing from the invention, except as specified in the claim.

I claim:

A well explosive comprising a plurality of containers each having a shaped charge therein spaced from a wall thereof, resilient supports secured to said containers, means for retaining said resilient supports in retracted position, said means comprising a band extending around said resilient supports, means for causing the disintegration of said band preparatory to detonating said shaped charges, means for spreading said resilient supports outward simultaneously to bring said ends of said containers into contact with the wall of a well, and means to detonate said shaped charges for the penetration of the wall of the well.

JAMES LEWIS FOSTER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
615,321	Straub et al.	Dec. 6, 1898
1,560,815	Hill	Nov. 10, 1925
1,582,184	Mims	Apr. 27, 1926
2,233,930	Witt	Mar. 4, 1941
2,399,211	Davis et al.	Apr. 30, 1946
2,494,256	Muskat	Jan. 10, 1950

FOREIGN PATENTS

Number	Country	Date
28,030	Great Britain	1911

OTHER REFERENCES

The Explosives Engineer, July-August 1945; pps. 160–163; 102–56 (X).

Zeitschrift fur das Gesamte Schiess und Sprengstoffwesen, May 15, 1914, pps. 183–187.

The Oil Weekly, July 8, 1946, pps. 56 and 58.