July 2, 1957 M. A. RYAN 2,797,892

EXPLOSIVE APPARATUS

Filed Dec. 12, 1949

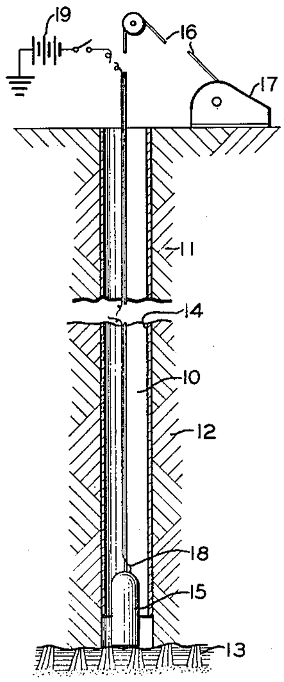

FIG. 1.

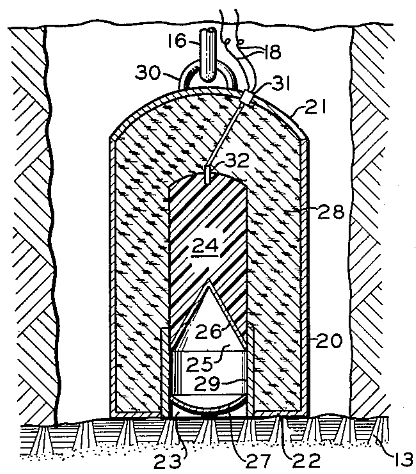

FIG. 2.

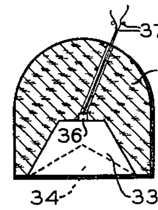

FIG. 3.

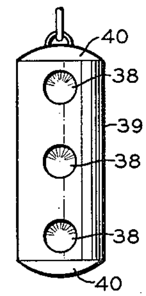

FIG. 4.

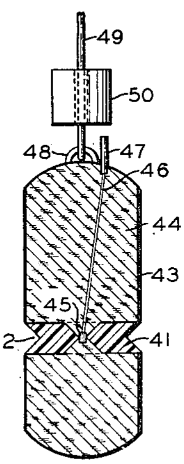

FIG. 5.

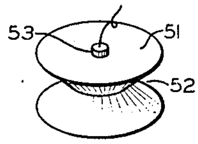

FIG. 6.

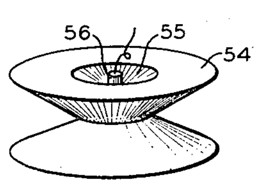

FIG. 7.

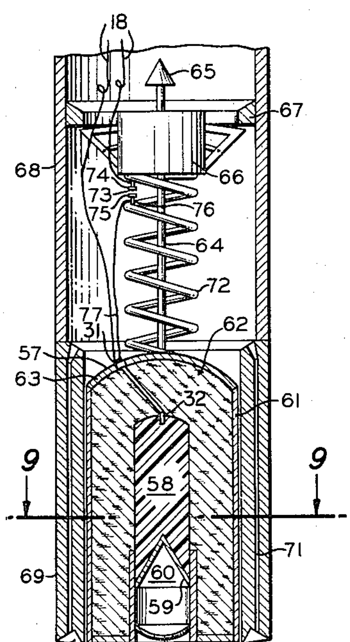

FIG. 8.

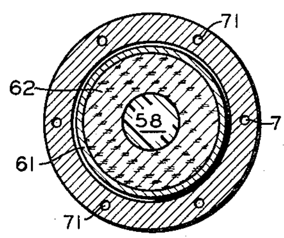

FIG. 9.

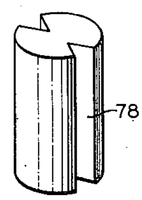

FIG. 10.

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EXPLOSIVE APPARATUS

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3 Claims. (Cl. 255—1)

This invention relates to an explosive apparatus so adapted as to direct its explosive force to perform a maximum amount of work with a minimum amount of damage to surrounding areas. In one of its aspects, this invention relates to an explosive apparatus adapted to direct an explosive force over a preselected area and to absorb forces escaping in other directions. In another of its aspects, it relates to a bomb having a shaped explosive charge and having a special shock and heat absorbing means for absorbing explosive forces radiating from the explosive charge in a manner which would normally be undesirable. In still another of its aspects, this invention relates to a bomb especially adapted to be employed inside of a drilling bit to shatter earth formations thereunder and yet to prevent damage to the surrounding drill bit.

In the prior art, it is known that an explosive charge which is shaped by providing a cavity or a hollowed out portion therein will cause its explosive force to be concentrated in a line or plane coincident with the cavity, which is placed so as to face the object to be penetrated. Upon detonation of the charge, an indentation will be made on the object to be penetrated, the diameter of which will be roughly equal to the diameter of the hollowed-out or cavity portion of the charge, and the depth of which will vary increasingly with the depth of the hollowed-out portion. It is further known that the penetrative force of such a shaped explosive charge can be further increased by inserting a metal liner into the cavity of the explosive and still further increased by moving the charge away from the object to be penetrated to provide a suitable "stand-off" distance. The explosion of such a shaped charge results in a round entrance hole in the object to be penetrated, which tapers down gradually to a relatively great depth. The directed explosive force is thus concentrated, for the most part, over a limited area. The exact area can be regulated and adjusted by shaping the explosive charge in a predetermined fashion.

Although a major portion of the explosive force is directed along the desired line or plane, a portion of the explosive force escapes in other directions and will damage surrounding areas if a means is not provided to prevent such damage.

It is an object of this invention to provide an explosive apparatus especially adapted to direct an explosive force in a predetermined line or plane and to absorb explosive forces escaping in other directions in order to prevent damage to surrounding areas.

It is another object of this invention to provide an explosive apparatus comprising a shaped explosive charge encased in an insulating material in such a manner that the explosive apparatus can be employed to shatter earth formations encountered in the drilling of wells without causing damage to the walls of the bore hole.

Still another object is to provide an explosive apparatus adapted to cut or slot a drill stem or other structures which it is desired to perforate.

Yet another object of this invention is to provide an explosive apparatus which can be employed inside of a drilling bit or inside of a well casing to shatter earth formations without damaging the bit, the well casing or a drill stem.

Other objects and advantages of this invention will be readily apparent to one skilled in the art upon reading the specification and appended claims.

The attached drawings illustrate the explosive apparatus of this invention in some of its preferred embodiments. In the drawings, Figure 1 represents generally a bore hole of a well with the explosive apparatus of this invention therein. Figure 2 is a cross-sectional view of the preferred form of the explosive apparatus. Figures 3, 4 and 5 illustrate other embodiments of this invention. Figures 6 and 7 represent some of the forms of an explosive charge adapted to be employed in the explosive apparatus of this invention. Figures 8 and 9 illustrate an explosive apparatus especially adapted to be employed inside of a conduit such as a drill stem and drill bit. Fig. 10 illustrates an explosive charge shape.

In Figure 1, well 10 has been sunk through formations 11 and 12 to the upper surface of a very hard formation 13. Well casing 14 can be inserted in well hole 10 to any desired depth to prevent water intrusion, cave-ins, etc. Explosive apparatus 15 is located on top of formation 13 by means of cable 16 and winch 17. Detonator wire 18 leads from explosive apparatus 15 to a detonator actuator 19 shown schematically in the drawing as a source of electrical current. However, other types of well-known detonators can be employed to explode apparatus 15 in well hole 10.

In Figure 2, explosive apparatus 15 of Figure 1 is shown in detail and located on hard formation 13 in well hole 10. Explosive apparatus 15 is comprised of a casing 20 which is closed at one end by a plate 21. The other end of casing 20 is partially closed by plate 22 having an outer and an inner circumference which forms an opening 23 therein.

Disposed in casing 20 is a shaped explosive charge 24 which has a cavity 25 therein. Explosive charge 24 is situated in casing 20 so that cavity 25 faces the object to be penetrated, i. e. formation 13. Thus, charge 24 is placed with cavity 25 opposite opening 23 and with the end of charge 24 which is nearest opening 23 spaced from the said opening to provide a suitable "stand-off" distance for charge 24. Cavity 25 of charge 24 can be lined with a cavity liner 26 adapted to fit into the cavity. Liner 26 can be metallic in which case it is preferable to use a drillable metal e. g. aluminum, instead of a non-drillable metal, such as steel, since any fragments of the latter which remain in the drill hole after an explosion will damage a drilling bit in subsequent drilling operations. Removable closure 27 can be fitted into opening 23 to prevent intrusion of liquids, dirt, etc. into casing 20. Closure 27 can be metallic or it can be formed of a plastic material such as Bakelite and is preferably semi-spherical in shape to resist external hydrostatic pressure. It is secured at its edges to inner liner 29 by any suitable means such as welding, grooved seats, etc. If closure 27 is made of metal, it is preferable to employ a drillable metal, such as aluminum, brass, bronze, etc. to prevent damage to drill bits which may contact pieces of it while drilling after the explosive operation has occurred.

In constructing the explosive apparatus shown in Figure 2, the following dimensions have been found of value. Comparative dimensions can be used in constructing the other embodiment of this invention described herein. Obviously, results of value will be obtained with an explosive charge constructed with dimensions outside the ranges given. When liner **26** is made of aluminum, copper or brass, its thickness should be from about 2 percent to 6 percent of the diameter of charge **24**. If made of steel, its thickness should be from about 1 to 3 percent of the diameter of the charge. When using other metals or plastics, the thickness should be in proportion to hardness, ductility, etc. of the material used. The overall length of charge **24** should be from about 1.5 to 3 times the diameter of the charge. The stand-off distance from the end of the charge to the surface of the object to be penetrated should be about 0.5 to 2 times the diameter of charge **24**. The cavity **25** in charge **24** is preferably conical in shape and the angle at its apex can vary from about 30 to 80 degrees. Obviously cavity **25** can assume other configurations than that of a cone, however, it has been found that a conical shape will most efficiently direct the explosive force to the surface to be penetrated.

According to this invention, an insulating material **28** is placed in casing **20** around charge **24** so as to provide a shock-absorbing and heat-absorbing medium therefor. Although insulating material **28** can be any porous solid having shock absorbing characteristics, it is preferably a resilient medium which is capable of absorbing the explosive shock. Sponge rubber can be used but it is preferable to employ a harder sponge rubber than a softer sponge rubber. A foam rubber having a rather stiff action can be advantageously employed. Pumice and artificial pumice-like materials, such as spongy glass and porous sponge-like materials made of various plastics can also be employed. Further, materials which depend at least in part upon their crushability for their shock absorbing characteristics can likewise be employed. In selecting an insulating material, one of the principal requirements is that the material have many gas spaces therein with compartment walls therebetween which can resiliently stretch, yield, and/or burst independently and at irregular intervals in response to the force of an explosive shock and at the same time resist and absorb the force of the explosion. This will protect either the vertical walls of well **10** from caving or any pipe or other equipment in the well from damage.

An inner liner **29** can be inserted into opening **23** to prevent the accidental loss or displacement of insulating material in the lower part of casing **20**.

Attached to one end of casing **20** is bail **30** to which is attached cable **16** as shown in Figure 1. Detonator wires **18** extend down well hole **10** with cable **16** and pass through casing **20** at seal **31** to detonator **32** situated adjacent or in explosive charge **24**.

Casing **20**, plates **21** and **22** and inner liner **29** can be comprised of any material suitable for containing the charge in a water-tight case and for supporting insulating material **28** around charge **24**. Although steel can be used to form these parts, it is preferable to employ a drillable metal, e. g. brass or bronze because the explosive force of charge **24** may under exceptional circumstances, cause casing **20** to be somewhat deformed and difficult to remove from bore hole **10** and it will then be easier to drill it out instead of fishing out the casing, etc. If steel were used, it would be necessary to remove all of such metal from bore hole **10** before proceeding with any further drilling with conventional well drilling tools such as roller bits. Drillable metals, on the other hand, do not harm roller bits and the failure to remove casing **20** and other metal parts when made of such metals would not result in any drilling difficulty. Plastic materials such as phenol-formaldehyde, urea-formaldehyde, acrylic, etc. products can also be used.

Although it is ordinarily desirable to employ casing **20** in order to permit the ready removal of the explosive apparatus as a single piece from the well after the charge has been fired as well as to help prevent damage to insulating material **28** when placing or removing the explosive apparatus from its position in a well, it may be desirable at times to omit it from the structure shown in

Figure 2. In such case, it is preferable to form the body of insulating material from a single piece of material having a plurality of gas spaces therein each separated from the other by common walls so as to provide a maximum of shock absorbing capacity and yet prevent infiltration of liquids into the gas spaces of the material to thereby destroy its shock absorbing properties. However, if the body of insulating material is to be formed from several pieces of insulating material each having the desired gas spaces, it can be cast into proper form with the aid of a binder, such as glue, tar, a cement, etc. Also it may be desirable to not employ inner liner **29** and it can be omitted also. Further, plate **22** can be omitted either by itself or in conjunction with casing **20** and/or liner **29**. However, if drill hole **10** is filled with a liquid, such as a drilling mud, it is often desirable to employ both casing **20**, plate **22** and inner liner **29** to protect the explosive charge and insulating material contained therein.

In operation, explosive apparatus **15** is lowered into well hole **10** by means of cable **16** suspended from winch drum **17**. When the explosive apparatus has reached the bottom of the hole and is resting on formation **13**, the charge **24** is exploded by detonator **32** which has been actuated by detonator actuator **19** through detonator wire **18**. The explosive force generated by explosive charge **24** causes the cavity liner **26** to collapse radially, symmetrically and inwardly thereby causing the explosive pressure along the longitudinal axis of the depression to increase to a point above and beyond the pressure generated by the detonation wave. As a result, there is formed a jet of explosive force which is projected out of casing **20** through opening **23** and into the hard formation **13** thereby rupturing it to permit a ready penetration by drilling tools.

As stated, a major portion of the explosive force generated by firing charge **24** is directed through opening **23** in casing **20**. A lesser portion of the explosive force which is large enough to damage surrounding areas and equipment, is not exerted through opening **23** but unavoidably acts to generate a pressure wave around charge **24** which radiates outwardly in all directions from the explosive charge. It was first attempted to absorb the shock by positioning the charge in a housing therefor in such a manner (not shown) that a space filled with a fluid, preferably gas, existed between the charge and the housing. In such apparatus, a pressure wave radiating from the explosive charge in a direction other than that coaxial with the cavity in the charge would pass substantially undiminished in force through the gas space, would slap or strike the housing sharply, distorting the same, and be transmitted through the surrounding water in the well to slap, or strike casing or tubing in the well so hard and so sharply as to distort and injure the same, especially at threaded couplings, breaking or jamming the threads. If housing around the charge is made very thick (not shown) with no space between it and the charge, the pressure wave will be similarly transmitted through the wall of the housing and surrounding well fluid to act on the bore hole walls and injure any adjacent equipment, such as bore hole casing. Thus, an ordinary solid of any practical thickness does not prevent the pressure waves from exerting a force where it is not desired. However, by surrounding an explosive charge with an insulating material according to this invention, the plurality of irregularly spaced, or regularly staggered, gas spaces in the material and the resiliently yieldable and/or rupturable walls around each of the gas spaces will absorb the pressure waves by making the wave front elements out of phase with each other, because of different velocities of travel through a non-homogeneous material with different velocities of sound transmission in the different materials, so that the out-of-phase elements will destroy each other by destructive interference, and the waves will dissipate their energy in heat and in destruction and/or stressing the hundreds of walls around the gas spaces, before they can be transmitted to a point where they could cause damage. Thus, the main pressure wave, as well as any lesser waves, radiating from the explosive charge is, in effect divided into many portions as is passes through the insulating material and each of these portions is dissipated by compression of the gas in each gas space and by the concomittant flexing and/or bursting of the walls of the insulating material around each gas space. The irregular spacing and varying sizes of the gas spaces in the insulating material sets up "dampening" pressure waves which act to oppose the main pressure wave thereby causing even more rapid shock obsorption. As a result, the undesirable pressure wave is absorbed or dissipated by the insulating material before it can exert any sharp and sudden application of force on the housing surrounding the explosive apparatus, on the walls of a bore hole or on any adjacent equipment.

The explosive reaction of charge **24** also releases large quantities of heat which, if permitted to escape freely into drill hole **10**, would damage any casing liner located in the immediate area around the bottom of well hole **10**. The insulating material further protects casing **20** preventing it from melting due to the intense heat of the explosion.

Thus the insulating material serves to cushion well hole **10** from any unwanted explosive shock as well as to protect any casing liner and the explosive charge container from high temperatures.

After the explosive apparatus has been detonated, cable **16** is wound back onto winch drum **17** thus removing explosive apparatus **15** from the well. When explosive apparatus is contained in a casing **20** as shown in Figure 2, the entire explosive apparatus can be withdrawn as a unit without leaving behind any undesirable pieces of explosive apparatus since the insulating material **28** prevents any substantial disintegration or deformation of the casing **20**. It also prevents the explosive force generated by charge **24** from causing cave-ins of the walls of the bore hole.

Another embodiment of this invention is shown in Figure 3. In that figure, an explosive charge **33** is conical in shape and has a conical cavity **34** therein. Surrounding charge **33** is insulating material **35** having the same composition and properties as insulating material **28** of Figure 2, and which can be molded into any desirable shape adapted to surround charge **33** on all sides except the area encompassed by conical cavity **34**. Detonator **36** is inserted in charge **33** and is connected to an actuating mechanism by wires **37**. In this particular embodiment, there is not provided a casing to surround insulating material **35**.

In operation, the explosive apparatus shown in Figure 3 is lowered into a bore hole by any suitable means such as a cable, etc. until it reaches the bottom of the hole. The explosive apparatus can then be raised slightly from the bottom to provide a suitable stand-off distance, if desired. Alternatively, charge **33** can be recessed a sufficient distance into insulating material **35** to permit the latter to rest on the bottom of the bore hole and yet provide a satisfactory stand-off distance. The conical shape of the cavity in the charge **33** acts as an air pocket to prevent liquids in the well hole from completely filling the cavity. It is often desirable to coat the outer surfaces of insulating material **35** with a waterproof film, such as tar, suitable thermostable plastic materials, etc. so that the explosive apparatus retains a maximum degree of porosity within the interstices of insulating material **35** thereby preserving its shock absorbing properties.

In Figure 4 is shown an explosive apparatus adapted to shatter the walls of a bore hole. In the figure, explosive charges **38** are spaced along the longitudinal axis of the explosive apparatus. Charges **38** can be so positioned as to yield any desired explosive pattern when fired. Thus, for example, the charges **38** can be placed so that their explosive lines of force are all directed to a single point on the object to be penetrated thereby concentrating all available explosive force at a single point. The charges can be situated with their axes horizontal, i. e. The explosive directing cavities therein are faced horizontally outward from the outer surface of the explosive apparatus to shatter an extended area of the bore hole. The charges are surrounded by insulating medium **39** except that their cavities are left uncovered to provide an easy avenue of escape of the directed explosive force. Caps **40** can be attached to each end of the explosive apparatus and can be fabricated of any suitable material such as brass, bronze, etc. The explosive apparatus of Figure 4 can also be used as a gun to perforate well casing as each explosive charge **38** will form a hole through any pipe or cement outside the pipe in a well and into the surrounding formation permitting liquids to flow into the well. Charges **38** can be fired separately or simultaneously but it is preferable to fire them substantially simultaneously with a few microseconds between each explosion. If fired simultaneously, the aggregate explosion may develop an excessive pressure in the bore hole. If fired separately, one explosion may damage the detonating mechanism of the other charges and prevent firing of any succeeding charge. However, if fired with a few microseconds of time between each shot, all charges can be exploded without developing excessively high pressures and without permitting sufficient time for the explosive wave to damage other charges.

Figure 5 illustrates a pipe or casing severing apparatus which can be employed to cut a metal pipe while the pipe remains in position in the bore hole. In the apparatus is situated a spool **41** of explosive material having an annular cavity **42** therein. The surface of the cavity **42** is preferably lined with a sheet of material similar to **26** of Figure 2. Housing **43** is provided to contain charge **41** as well as insulating material **44** having the same composition and properties as insulating material **28** of Figure 2 and which cushions any longitudinal shock generated when charge **41** is exploded. A suitable stand-off distance can be provided by forming charge **41** to have a diameter small enough to provide a stand-off distance between it and a surrounding casing, but preferably housing **43** can have a larger diameter than charge **41** thereby providing the desired stand-off distance and acting as a guide to center the charge. A casing similar to casing **20** of Figure 2 can surround the entire explosive apparatus of Figure 5, that is, entirely surround charge **41** and insulating material **44** or it can only surround charge **41** so that cavity **42** is prevented from filling with liquid. A gas-filled stand-off space **42** is more effective in concentrating an explosive force than a liquid-filled stand-off space. Charge **41** is preferably cut away at detonator **45** and the resulting depression likewise filled with insulating material. Detonator **45** is situated at the axis of the charge and is actuated through wire **46** which are connected to a firing mechanism **47** situated at the top of casing **43** near the point **48** where cable **49** is attached to the casing.

In operating of the pipe cutting apparatus of Figure 5, the apparatus is lowered inside the pipe to be cut by means of cable **49**. Go-devil **50** is then dropped down cable **49** to actuate firing mechanism **47** which in turn causes charge **41** to explode thereby severing the pipe surrounding the apparatus. It is apparent that since cavity **42** is annular, the explosive force generated by charge **41** will be directed uniformly against the circumference of any surrounding pipe thereby ensuring complete severance thereof. If desired, explosive charge **41** can be formed into circumferentially divided radial segments to provide an explosive pattern adapted to pierce a surrounding pipe in a slotted fashion.

Figure 6 and 7 illustrate the forms that explosive charge **41** of Figure 5 can take. In Figure 6, the charge is shown as a spool 51 having an annular groove 52 therein and also having a detonator 53 located at the central axis thereof. The surface of groove 52 is preferably lined with a material similar to 26 of Figure 2. The explosive spool 54 of Figure 7 is similar to that of Figure 6 except that a conical depression 55 is provided in both its upper surface and its lower surface. Detonator 56 is then situated at the junction of the apices of the two conical depressions.

Still another embodiment of this invention is illustrated in Figure 8. In the figure, 57 is an explosive apparatus similar in structure to that shown in Figure 2 having an explosive charge 58, a cavity liner 59 situated in cavity 60 of charge 58. The charge is contained in metal casing 61 containing insulating material 62, all similar to Figure 2. Attached to cover plate 63 is a rod 64 containing a disengaging attachment 65 and having slidably mounted thereon, a latching head 66 adapted to coact with shoulders 67 so as to lock explosive apparatus 57 in place at the bottom of the well. Drill stem 68 terminates in a conventional core bit 69 which has the core barrel removed and not shown and which contains cutters 70 and fluid passageways 71 which supply drilling fluid to cutters 70. Casing 61 is adapted to fit rather snugly inside of core bit 69 to replace the conventional core barrel so that the walls of core bit 69 provide bearing surface for casing 61 when charge 58 is fired. In Figure 9, which is a cross-sectional view taken on line 9—9 of Figure 8, the arrangement of the casing 61 within core bit 69 is shown.

Spring 72 is attached at one end to latching head 66 and at the other end to cover plate 63 so that when explosive apparatus 57 is placed in core bit 69 and latching head 66 has been engaged by shoulders 67, spring 72 will cause the end of apparatus 57 to extend slightly beyond the end of core bit 69. Switch 73 is comprised of a first contact point 74 attached to latching head 66 and of a second contact point 75 mounted on rod 76 which in turn is rigidly attached to a coil of spring 72. Wire 77 connects contact point 75 to a detonator 32 located adjacent to charge 58.

In the operation of the embodiment shown in Figure 8, core bit 69 is permitted to remain in the bore hole after a formation has been encountered which it is desired to subject to an explosive shock. Any internal core formed by core bit 69 can be removed as a core by a conventional core barrel (not shown) or broken into cuttings during drilling by a conventional core buster (not shown). Core bit 69 is then raised slightly from the bottom of the bore hole and apparatus 57 is lowered inside a drill stem 68 by means of a cable (not shown), removably attached to disengaging attachment 65 until latching head 66 becomes engaged by shoulders 67, or apparatus 57 is dropped, or pumped down into place. Drill bit 69 is then lowered until it rests upon the bottom of the hole to compress spring 72 slightly and cause contact points 74 and 75 to meet and thereby detonate explosive charge 58.

The major portion of the explosive force generated by charge 58 is directed by cavity 60 out of the opening in the end of the explosive apparatus to shatter the formation below. However, some of the explosive force will take radial and upward paths. The radial force will be absorbed and dissipated by insulating material 62 and by the elasticity of the casing 61. The walls of core bit 69 prevent the casing 61 from expanding beyond its elastic limit because the clearance between the walls of bit 69 and casing 61 is adjusted to be sufficiently small so as to prevent any permanent distortion of casing 61. The explosive force which acts in an upward direction is absorbed and dissipated by the insulating material above charge 58 and by compression of spring 72.

It is thus apparent that the explosive apparatus shown in Figures 8 and 9 can be readily employed inside a drill bit without damage to the drill bit since insulating material 62 and spring 72 absorb and dissipate all excessive explosive force which would tend to damage the bit. It is further apparent that the high temperatures generated by the explosion of charge 58 will be effectively prevented by insulating material 62 interposed between charge 58 and bit 69 from damaging bit 69 and rollers 70. The insulating material likewise prevents the high temperatures from melting and distorting casing 61 which would make its removal from the bore hole difficult after the explosion has occurred. Thus, it is possible to insert explosive apparatus 57 in bit 69, explode it and then withdraw the exploded apparatus as a unit without having to resort to expensive fishing operations to recover any pieces of shattered bit or explosive apparatus parts.

Although the means for exploding apparatus 57 of Figure 8 has been described as a raising and lowering operation for bit 69, the explosive apparatus can be exploded by other means. For example, spring 72 can be compressed to close switch 73 thereby causing charge 58 to explode by dropping a go-devil into drill stem 68. Thus, it is not necessary to raise and lower bit 69 in order to explode charge 58. Also, charge 58 can be exploded by locating switch 73 at the top of the bore hole and then manually closing the switch. In such case, it will obviously be necessary to have detonator wire 77 extend to the top of the bore hole. If a cable is employed to lower explosive apparatus 57 into bit 69, wire 77 can be incorporated therein thereby making it unnecessary to lower a plurality of separate wires and cables into the bore hole.

Although the foregoing description has been devoted to explosive apparatus adapted to shatter earth formations and to sever casing, it is possible to form the explosive charge in many shapes so as to obtain varied explosive patterns. For example, the charge can be shaped as shown in Figure 10 with grooves 78 extending longitudinally therethrough. This type of charge is especially adapted to slot well casing, etc. Other charges (not shown) can be scored with horizontal and vertical networks of grooves to fragment case or to scour the walls of a well free of drilling mud. The explosive apparatus described, particularly that shown in Figures 2 and 3, can be advantageously employed in seismic prospecting. Thus the explosive apparatus of Figure 2, for example, can be placed on top of the earth's surface or in a shot hole and then detonated without destroying the shot hole thereby eliminating any preliminary clean-outs before any further shots in the same hole. In each case, however, according to this invention, there is provided a solid porous crushable and/or resilient shock resisting material to cushion the shock and prevent the explosive from doing damage in other directions than along the line, or plane, in which the destructive force is directed.

The explosive charges employed in the apparatus of this invention can be almost any high explosive such as commercial dynamite, nitroglycerin, cast TNT, etc. The amount of charge to be employed will depend upon the explosive force needed to accomplish the task at hand.

While a number of specific embodiments of this invention have been shown for purposes of illustration, the invention obviously is not limited thereto, but is defined as to scope by the following claims.

I claim:

1. An explosive apparatus especially adapted to be employed with an annular drill bit in drilling a well which comprises, in combination, a hollow cylindrical casing adapted to be inserted coaxially in said bit, the diameter of said casing being smaller than the inner diameter of said bit to provide a space therebetween sufficient to permit elastic deformation of said casing without exceeding the elastic limit of the material forming said casing, a curved plate closing one end of said casing, an annular plate having an inner and an outer circumference disposed across the other end of said an-

nular casing and attached thereto at said outer circumference, a cylindrical inner liner extending into said casing and attached at its outer end to said inner circumference of said annular plate, a cylindrical explosive charge having a diameter equal to the inside diameter of said inner liner, said explosive charge having a conical cavity and disposed coaxially with and adjacent to said inner liner so that the end of said explosive charge having said cavity therein extends partially into said inner liner, a compressible insulating material disposed within said casing around said explosive charge so that all its surface except said conical cavity is contacted by said insulating material, a conical linear disposed in said cavity of said explosive charge, a semi-spherical closure inserted in said inner liner, a spring attached at one end to said curved plate closing one end of said casing and the other end to a latching device adapted to coact with and be held in position by the walls of a conduit attached to said drill bit, a detonating means for said charge, a switch having a first contact point attached to said latching means and a second contact point rigidly attached to said spring and flexibly attached to said detonating means so that compression of said spring will cause said first and second contact points to contact and thereby actuate detonating means to explode said charge.

2. An explosive apparatus especially adapted to be employed with an annular drill bit in drilling a well which comprises, in combination, a casing adapted to be inserted coaxially in said bit, the circumference of said casing being smaller than the inner circumference of said bit to provide a space therebetween sufficient to permit elastic deformation of said casing without exceeding the elastic limit of the material forming said casing, a first plate closing one end of said casing, a second plate having an inner and an outer circumference disposed across the other end of said casing and attached thereto at said outer circumference, an inner liner extending into said casing and attached at its outer end to said inner circumference of said second plate, an explosive charge having a conical cavity therein adjacent to said inner liner so that the end of said explosive charge having said cavity therein extends partially into said inner liner, a compressible insulating material disposed within said casing around said explosive charge so that all its surface except said conical cavity is contacted by said insulating material, a conical

liner disposed in said cavity of said explosive charge, a closure inserted in said inner liner; a spring attached at one end to said first plate closing one end of said casing and the other end to a latching device adapted to coact with and be held in position by the walls of a conduit attached to said drill bit, a detonating means for said charge, a switch having a first contact point attached to said latching means, a second contact point attached to said detonating means so that compression of said spring will cause said first and second contact points to contact and thereby detonate said charge.

3. An explosive apparatus especially adapted to be employed with a drill bit in drilling a well which comprises, in combination, a casing adapted to be inserted coaxially in said bit and having one end at least partially open, an explosive charge having a cavity therein disposed in said casing so that said cavity faces said open end of said casing, a compressible insulating material disposed within said casing around said explosive charge so that all its surface except said cavity is contacted by said insulating material, a liner disposed in said cavity of said explosive charge, a detonating means for said charge, a spring attached at one end to said casing and the other end to a latching means adapted to coact with and be held in a fixed position by said bit, a switch having a first contact point attached to said latching means, a second contact point flexibly attached to said detonator so that compression of said spring will cause said first and second contact points to contact and thereby detonate said charge.

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