

May 21, 1968

D. E. FRITSCHÉ
DETONATOR ASSEMBLY FOR RUPTURE DISC
HAVING EXPLOSIVE STRIPS THEREON
Filed July 25, 1966

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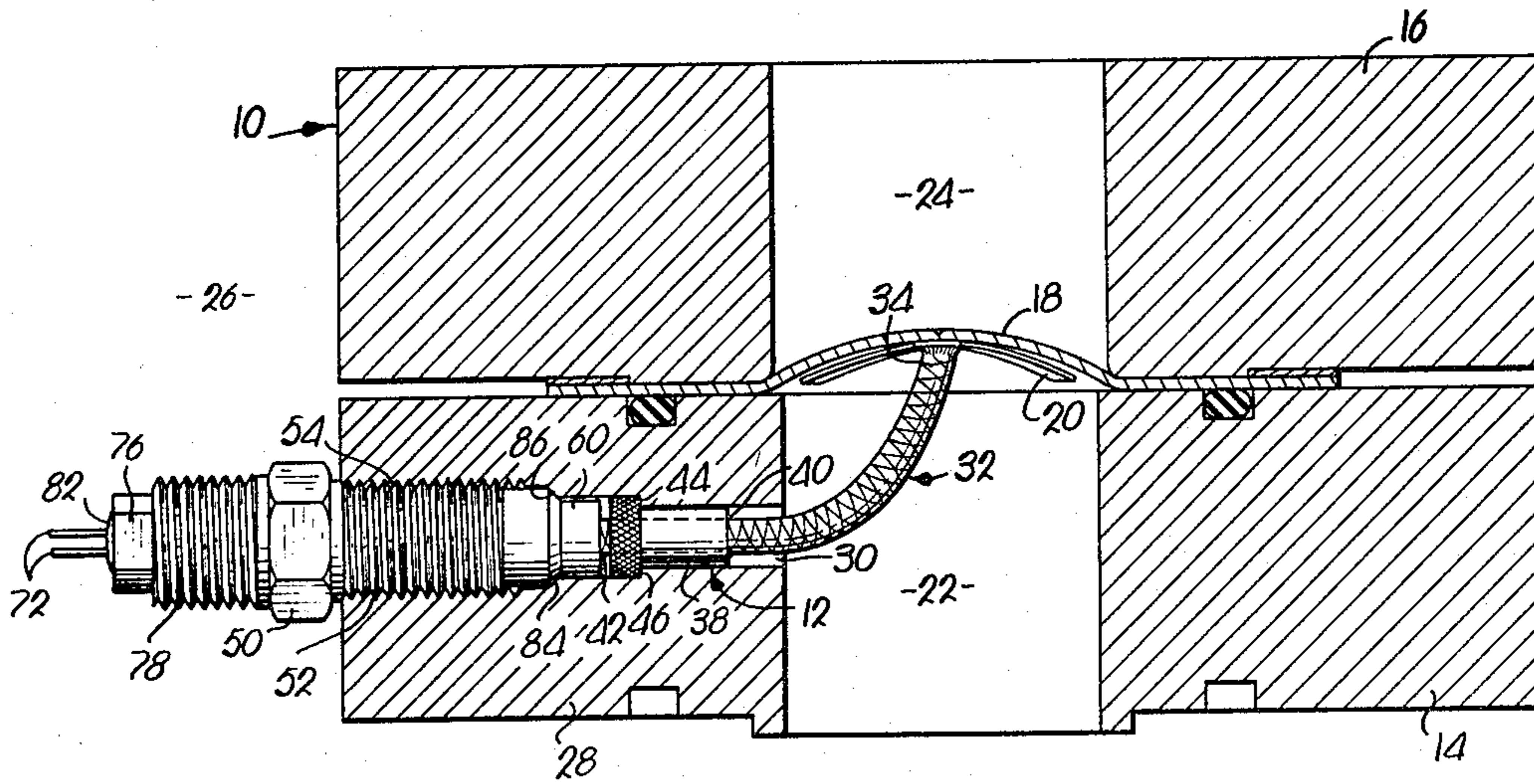


Fig. 1.

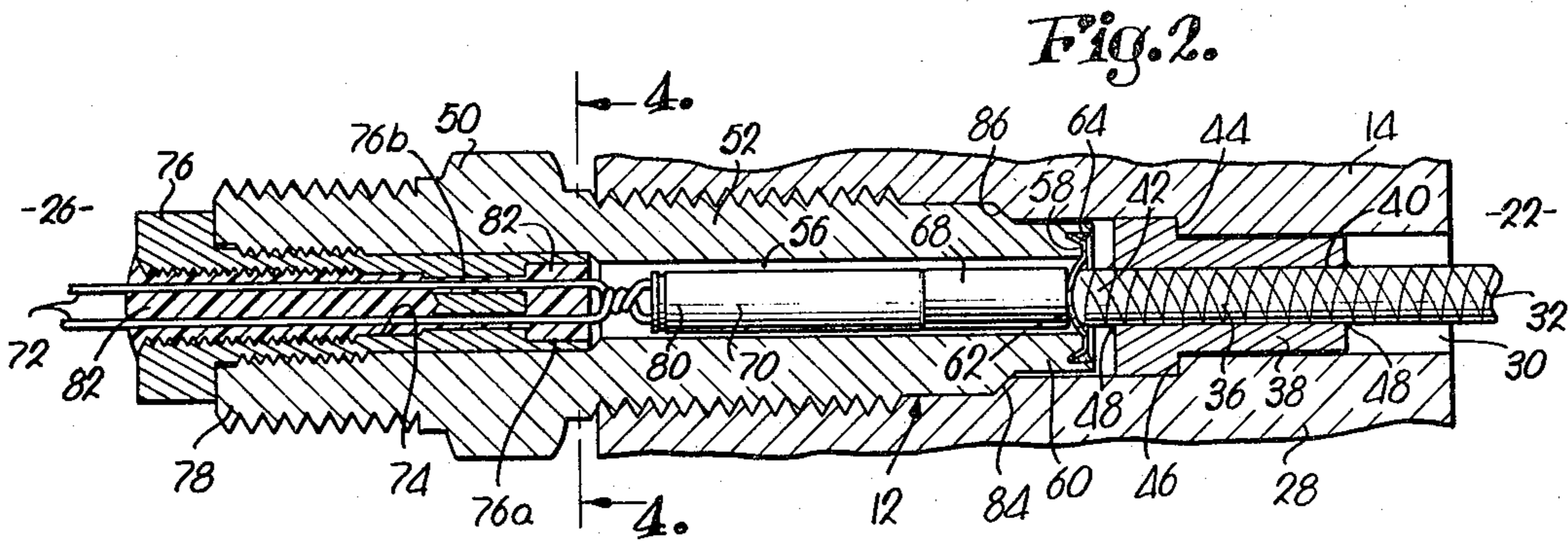


Fig. 2.

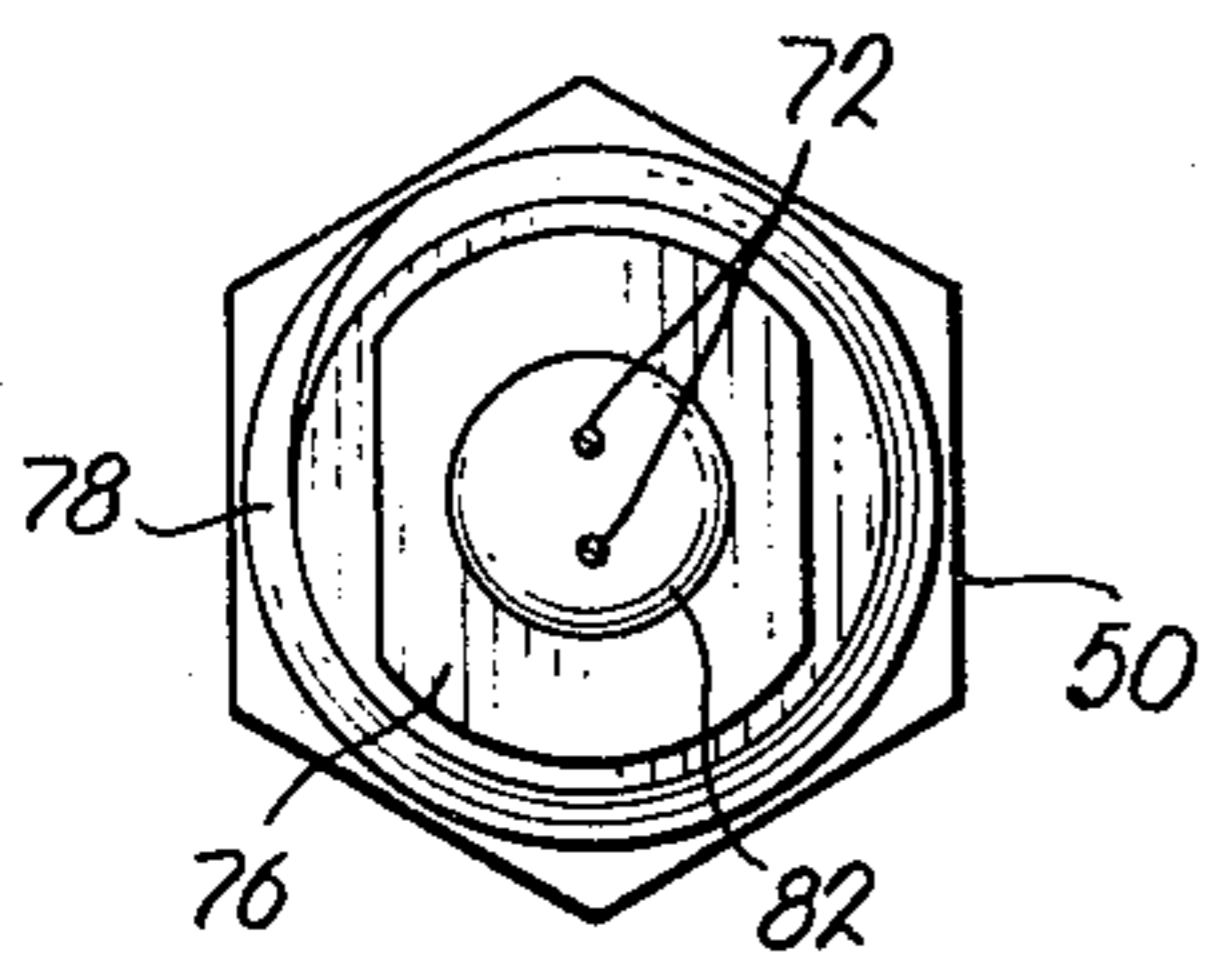


Fig. 3.

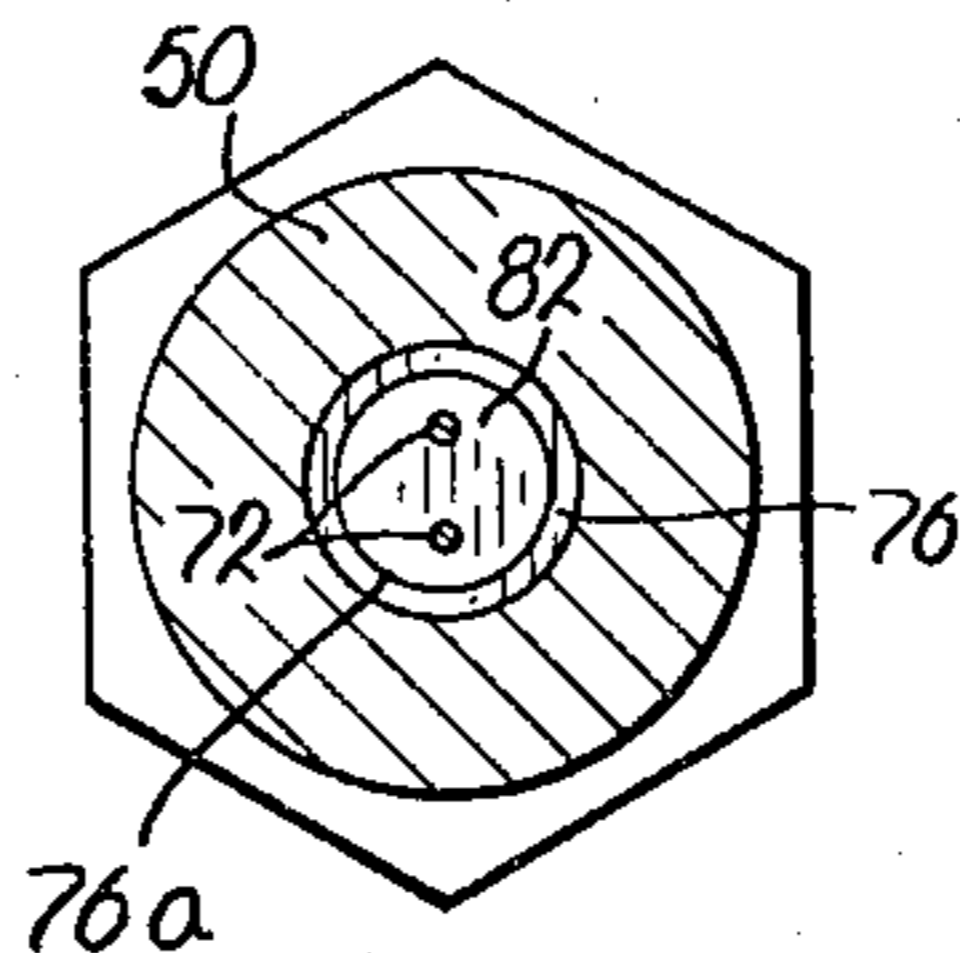


Fig. 4.

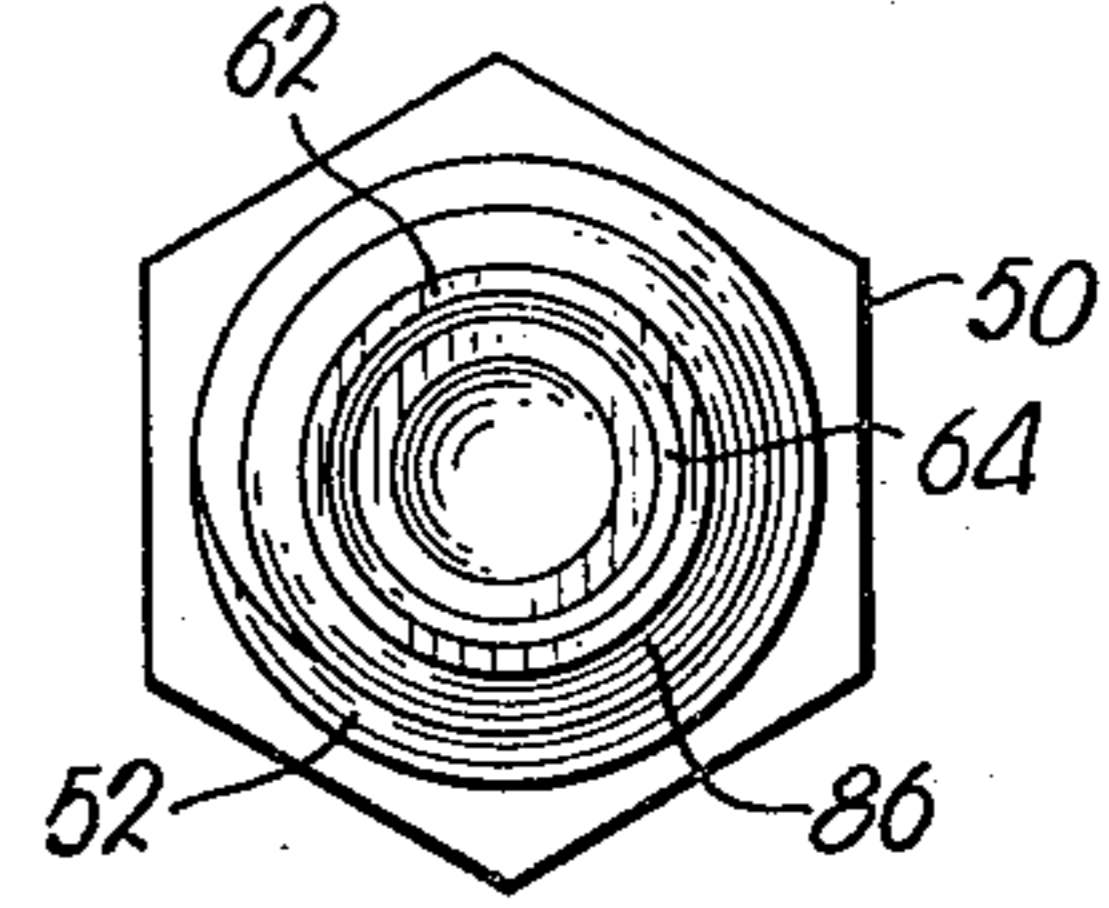


Fig. 5.

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**DETONATOR ASSEMBLY FOR RUPTURE DISC
HAVING EXPLOSIVE STRIPS THEREON**

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Filed July 25, 1966, Ser. No. 567,490

6 Claims. (Cl. 220-47)

This invention relates to a detonator assembly having particular utility when used in conjunction with rupture disc structures provided with a quantity of explosive material on the the disc, as disclosed, for example, in U.S. Letters Patent No. 3,109,553, issued Nov. 5, 1963, and entitled, "Rupture Disc Unit."

Rupture discs are utilized for normally blocking the flow of fluid between areas of different pressure and for bursting and thereby permitting flow in response to a predetermined pressure differential across the disc. It has been observed, as indicated in the above referenced patent, that such discs may be provided with a quantity of explosive material on the disc so that the latter may be ruptured in response to an external signal by exploding the material and thereby bursting the disc. The explosive material on the disc is often disposed in a pressurized zone and because the signal initiation point is generally outside the pressurized zone, means must be provided for transmitting the signal through a pressure barrier. Furthermore, conventional electrically actuated blasting caps are pressure sensitive and are not considered to be suitable for disposition within the pressurized zone.

Therefore, it is the primary object of the instant invention to provide a detonator assembly for an explosive train leading to an explosive charge mounted on a rupture disc located in a pressurized zone having structure permitting a pressure sensitive detonator cap forming a part of the assembly to be disposed externally of the pressurized zone whereby failure of the cap because of excessive pressure maintained thereon, or premature detonation of the cap and thereby the charge because of the pressure, is precluded.

As a corollary to the foregoing object, it is an important aim of the instant invention to provide rupturable pressure sealing means in the pressure barrier between the cap and the explosive train connected to the charge for normally isolating the cap from the pressure in the zone whereby the rupturable means is ruptured upon detonation of the cap to permit controlled detonation of the charge.

A very important object of the invention is to provide novel positioning structure for maintaining the detonator assembly including a cap and a booster charge, in intimate contact with the pressure sealing means which in turn is maintained in firm engagement with the explosive train leading to the charge on the main rupture disc whereby detonation of the cap effects rupture of the seal and at the same time causes detonation of the train and thereby the charge secured to the rupture disc.

An important object of the invention is the provision of a collar for the explosive train and a shoulder in the barrier engageable with the collar for maintaining the latter in a fixed position, to the end that the collar may be attached to the explosive train and then engaged with the shoulder to thereby fix the position of the explosive train relative to the shoulder and thus with respect to the detonator assembly to assure proper rupture of the main rupture disc under varying operating conditions.

Yet another important object of the present invention is to provide a housing for the detonator assembly having the rupturable means affixed at one end of a bore there-through so that the detonator assembly may be positioned adjacent the rupturable means and the bore then filled

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with a quantity of initially pourable cementitious material whereby one end of the detonator assembly is held tightly against the rupturable means.

In its broad aspects, the present invention provides structure permitting a pressure sensitive, externally activated detonator to be used for detonating an explosive charge disposed within a zone subjected to high pressure without exposing the detonator to the high pressure and yet without substantial likelihood of misfire.

In the drawing:

FIGURE 1 is a side elevational view, partly in cross section, of a rupture disc assembly provided with detonator means embodying the concepts of the instant invention;

FIG. 2 is an enlarged, cross-sectional view similar to FIG. 1 illustrating the details of the detonator means;

FIG. 3 is a left-hand end view of the detonator housing shown in FIG. 2;

FIG. 4 is a cross-sectional view of the detonator housing taken along line 4-4 of FIG. 2; and

FIG. 5 is a right-hand end view of the detonator housing shown in FIG. 2 after removal of the same from the rupture disc assembly base.

An explosion device embodying the concepts of the instant invention in the nature of a rupture disc structure broadly designated by the numeral 10 is shown in FIG. 1 and is adapted to be ruptured through the medium of a detonator assembly designated generally by the numeral 12 operatively coupled to disc structure 10 by explosive train 32. Structure 10 includes a base 14, a hold-down 16, and a concavo-convex, frangible disc 18 clamped or welded therebetween. Disc 18 has an explosive charge 20 disposed thereon in a manner familiar to those skilled in the art. Base 14, hold-down 16, disc 18 and explosive charge 20 are described in the above referenced patent and in an application for United States Letters Patent entitled "Rupture Disc Assembly," Ser. No. 514,855, filed Dec. 20, 1965, and which is assigned to the assignee of the present invention and, therefore, further detailed explanation of these components is unnecessary except in relationship to the present invention.

It is to be understood that disc 18 is disposed between a zone 22 and a zone 24 of different pressures, the pressure in zone 22 normally being higher than the pressure in zone 24. In this respect, it is preferred, although not absolutely necessary, that the explosive charge 20 be disposed on the concave, high pressure side of disc 18 to reduce uncontrolled bursting of disc 18 as explained in the aforementioned patent application. Furthermore, it is to be understood that while zone 24 may have a lower pressure therein than zone 22, the pressure in zone 24 may still be higher than the pressure in an exterior zone 26 surrounding structure 10. Hence, detonator assembly 12 would have utility in detonating a charge such as 20 disposed on the convex side of disc 18. In this case, it will be appreciated that assembly 12 would be carried by hold-down 16 rather than base 14 as shown in FIG. 1.

Base 14 has a wall 28 providing a pressure barrier between high pressure zone 22 and the exterior zone 26. Wall 28 has an opening 30 extending therethrough. The elongated explosive train 32 is substantially circular in cross-sectional configuration and has one end 34 operably connected to explosive charge 20, while the opposite end 36 thereof extends partially through opening 30. It is to be understood that explosive train 32 is preferably constructed from a high order explosive similar to that used in the construction of charge 20.

It has been found that a product manufactured by E. I. du Pont de Nemours & Co., and sold under the name "Deta Sheet C" gives satisfactory results when utilized for forming charge 20, the principal constituent thereof being pentaerythritol tetranitrate (PETN); and a similar prod-

uct designated "Deta-Cord C" comprising the same major constituent has been found to be satisfactory for use in the construction of explosive train 32. Collar means in the nature of an annular sleeve 38 has a central aperture 40 therethrough. Aperture 40 is circular in transverse cross-sectional configuration and has a diameter substantially coextensive in size with the diameter of end 36 of explosive train 32, the latter being received by aperture 40 with a tip 42 protruding therefrom as best shown in FIG. 2. Wall 28 of base 14 has an annular shoulder 44 coaxial with opening 30 and disposed for engagement with an annular lip 46 on sleeve 38. It is to be understood that sleeve 38 is mounted on end 36 externally of the explosive train with the longitudinal dimension of tip 42 closely controlled at a predetermined value. Sleeve 38 is glued or otherwise secured to end 36 at points 48, and the entire explosive train 32 passed through opening 30 and into zone 22 (before the same is pressurized) and then end 34 is glued or otherwise connected to charge 20. In this manner, sleeve 38 is maintained in a fixed position within opening 30 with lip 46 engaging shoulder 44 and tip 42 is thereby also maintained in a fixed position within opening 30.

Detonator assembly 12 is provided with an elongated housing 50 having a threaded section 52, and wall 28 has mating threads 54 within opening 30 adjacent zone 26 receiving sections 52. Housing 50 has a central bore 56 extending therethrough longitudinally of the same, and an annular shelf 58 coaxial with bore 56 is provided in the extremity of housing 50 disposed within opening 30. Rupturable means in the nature of a concavo-convex, frangible disc 62 is disposed in mated engagement with shelf 58 and in spanning relationship with respect to bore 56. Disc 62 is welded or otherwise secured to extremity 60 of housing 50 as at 64. The principal explosive component of assembly 12 comprises a primary detonator in the nature of an electrically activated blasting or detonator cap 70 disposed within bore 56, along with a secondary detonator comprising an elongated booster charge 68 between detonator cap 70 and disc 62. Charge 68 may comprise a short length of "Deta-Cord C." The booster charge 68 engages the convex surface of disc 62 in firm contact therewith as shown in FIG. 2. Use of booster charge 68 provides assurance that sufficient explosive force is transmitted to explosive train 32 to effectively propagate an explosion therealong and thus insuring detonation of the charge on disc 10.

A pair of electrical conductors 72 are operably connected to cap 70 and extend outwardly from the latter into zone 26 through cavity 76a in an elongated adapter 76, then through passages 76b and finally through port means 74 located longitudinally through adapter 76, the latter being received in bore 56 adjacent the opposite extremity 78 of housing 50.

In the construction of detonator assembly 12, conductors 72 are threaded through adapter 76 as shown in FIG. 2, and cavity 76a as well as port means 74 are filled with an initially pourable, self-curing, thermosetting synthetic resin containing calcium carbonate and barium sulfate as fillers therein. It is to be noted that the detonator cap 70 extends from cavity 76a of adapter 76 and the conductors are twisted or coiled into configuration imparting resiliency to the unit but at the same time causing the cap to be retained in a fixed, selected position relative to adapter 76. The resin product manufactured by Reliance Dental Manufacturing Company, of Chicago, Illinois, and sold under the name "Dura Kore," performs in a satisfactory manner for this application and is, therefore, the preferred material for cement 82.

Since the booster charge 68 may be cut of selected length, it can be seen that by controlling the position of detonator 70 relative to adapter 76 during fabrication of assembly 12, so that the distance between the end of detonator 70 proximal to adapter 76 is somewhat greater than the final distance therebetween upon assembly of the components, threading of adapter 76 into housing 50

to the full extent causes detonator 70 to be forced into firm engagement with booster charge 68 and likewise forces the latter into firm, complementary engagement with disc 62. A unitary assembly is thereby presented which may be packaged and sold as a unit for installation by personnel at the point of use. This is important because of the need to replace disc 10, explosive train 32 and assembly 12 each time disc 18 is ruptured.

Wall 28 is provided with an inclined, annular lip 84 coaxial with opening 30 and disposed internally with respect to threads 54. An annular wedging surface 86 is located on housing 50 for mated engagement with lip 84. The interengagement between lip 84 and surface 86 provides a high pressure, metal to metal seal and prevents insertion of housing 50 into wall 28 beyond a predetermined point with the concave surface of disc 62 firmly engaging tip 42 of detonator 32. The inclined disposition of lip 84 and surface 86 permits gradual tightening to occur therebetween, thus facilitating the use of a torque wrench or the like in positioning disc 62 in proper relationship with respect to tip 42 of detonator 32. A torque range for tightening of the assembly is normally specified and marked on assembly 12 for the convenience of the user.

It has been found that detonator assemblies embodying the principles of the instant invention effectively prevent premature, uncontrolled detonation or failure of pressure sensitive detonator caps by shielding the same from elevated pressures and yet provide positive operable connection between such caps and explosive charges to be detonated thereby disposed within a high pressure zone. Manifestly, assemblies such as 12, are more easily constructed than prior art devices because tolerances, such as the length of tip 42, are closely controllable.

It can be seen that all of the objects of the instant invention have been fulfilled to a considerable degree and a substantial step forward in the pertinent art field has been achieved.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a rupture disc structure provided with a frangible member adapted to be disposed between zones of differing pressures, an explosive charge on the member, a base mounting the member and having a wall with an opening therethrough separating the high pressure zone from an exterior zone, and an elongated explosive train operably connected to the charge and having an end extending into said opening, the combination with said explosive train and said base of a detonator assembly comprising:

collar means attached to said explosive train adjacent said end thereof, there being shoulder means on said wall within said opening engageable with said collar means for maintaining the latter and thereby said end of the explosive train in a fixed position within the opening;

an elongated housing carried by said wall and having an extremity disposed within said opening adjacent said end of the explosive train, said housing having a central longitudinally extending bore therein;

rupturable means on said extremity of the housing disposed in full spanning and pressure sealing relationship with respect to said bore and in engagement with said one end of the explosive train; and

a detonator assembly in said bore engaging said rupturable means.

2. The invention of claim 1, wherein said housing has an annular shelf coaxial with said bore at said extremity thereof, said rupturable means comprising a rupture disc disposed on said shelf, there being means maintaining said disc in tight engagement with the shelf.

3. The invention of claim 1, wherein said shoulder is annular and surrounds said opening, said collar comprising an annular sleeve having a central aperture extending therethrough receiving said end of the explosive train therein, said end having a tip protruding beyond said sleeve and engaging the rupturable means.

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4. The invention of claim 1, wherein said housing has a threaded section, there being mating threads therefor on said wall in said opening, said wall having an inclined annular lip surrounding the opening, said housing having a wedging surface thereon in mated engagement with said lip for providing a pressure seal and preventing insertion of said extremity of the housing into said opening beyond a certain point and permitting gradual tightening of the surface against said lip as said extremity approaches said point.

5. The invention of claim 1, wherein said detonator assembly includes a portion of high order explosive adjacent said rupturable means and an electrically actuated blasting cap engaging said portion and spaced from said rupturable means, said cap having a pair of electrical conductors extending through said bore and protruding from the other end of the housing, there being provided a quantity of initially pourable, self-hardening, synthetic resin material filling said bore in surrounding relationship to said conductors and maintaining said cap in tight engagement with said portion and thereby the latter against said rupturable means.

6. In an explosion device for detonating an explosive charge disposed within a high pressure zone separated from an exterior zone by a wall, there being an opening in said wall, said charge being provided with an elongated

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explosive train operably connected thereto and having an end extending into said opening, the combination with said explosive train of:

collar means attached to said explosive train adjacent said end thereof, there being shoulder means on said wall within said opening engageable with said collar means for maintaining the latter and thereby said end of the explosive train in a fixed position within the opening;

an elongated housing carried by said wall and having an extremity disposed within said opening adjacent said end of the explosive train, said housing having a central longitudinally extending bore therein;

rupturable means on said extremity of the housing disposed in full spanning and pressure sealing relationship with respect to said bore and in engagement with said one end of the explosive train; and

a detonator assembly in said bore engaging said rupturable means.

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THERON E. CONDON, *Primary Examiner.*

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