

PATENT SPECIFICATION

(11)

1 248 432

DRAWINGS ATTACHED.

- (21) Application No. 13837/71 (22) Filed 8 Oct. 1968
(62) Divided out of No. 1 248 431
(31) Convention Application Nos. 673 594 (32) Filed 9 Oct. 1967
724 942 29 April 1968 in
(3) United States of America (US)
(45) Complete Specification published 6 Oct. 1971
(51) International Classification F 42 b 3/00
F 42 c 19/10
G 01 v 1/08//1/12 1/38
(52) Index at acceptance
H4D G7P G8
F3A C1A1 C1A2 C4 C5E



9

(54) IMPROVEMENTS IN OR RELATING TO SEISMIC CHARGE ASSEMBLIES FOR MARINE EXPLORATION PURPOSES

(71) We, HERCULES INCORPORATED, a corporation organized under the laws of the State of Delaware, one of the United States of America, of 910 Market Street, City of Wilmington, State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a complete explosive charge assembly containing a percussion initiatable primer element and having particular application as an energy source in under water seismic exploration.

Seismic exploration involves the introduction of energy into the earth to initiate wave action for determination of characteristics of sub-surface structures, and is based on the generation of sound, or seismic, waves which are reflected or refracted from buried strata interfaces, and the like.

It has been a general practice, in the past, to detonate high explosives as the energy source for seismic exploration inasmuch as the energy generated provides for excellent seismic records. Unfortunately, in off-shore exploration, shock energy from detonation of high explosives, particularly in large amounts, is unduly damaging to certain marine life including many of the important food and game species. Transport of high explosive seismic charges to the off-shore seismic shooting site is subject to the limited quantity that governing authorities permit on the loading dock at any one time to minimise the safety hazards involved, which, in turn, limits the amount of high explosives that can be handled on the dock and impairs the efficiency at which the explosives can be loaded across the dock and transported to the exploration site. Particularly for these reasons the industry, in off-shore practice has turned to

the use of the nitrocarbonitrate (NCN) type seismic charges.

In off-shore seismic exploration practice, the complete seismic charges are assembled on deck of a boat moving through the test area and then emplaced from the boat and detonated. General off-shore technique in the handling of NCN charges on board ship has involved inserting a primer into the charge, inserting an electrically actuated detonator into the primer, attaching a depth control (float and string to the assembled charge), and placing the charge in the water. Concurrently the boat travels at about six knots for a period sufficient to place a predetermined length of firing cable (position locator). Each such cycle requires a minimum of about 2 minutes, and accordingly, requires large charges, generally of from 50 to 100 pounds, in order that a sufficiently strong signal be emitted at each test point.

The use of such large NCN charges is disadvantageous in many respects, viz. (1) explosive force from each detonation imparts damage to the hydrophone cable unless the cable is carried at a great distance from the detonation, and accordingly, general practice has been to utilise an additional boat for the cable thus incurring marked increase in costs; (2) a large quantity of these charges is necessarily maintained aboard ship which, in addition to the safety hazards involved, is economically undesirable from the standpoint of space, already at a premium, that must be available for storage; (3) such charges are of size and weight that they are difficult to handle aboard ship and particularly in heavy seas; and they require extensive man power for loading at the dock and for being handled aboard ship for assembly and emplacement; (4) use of large NCN charges, in some instances, results in unduly high fish kill; and (5) communi-

[Price 25p]

cation lines from the boat deck to the charge, and auxiliary equipment, are always susceptible to becoming entangled to impair success of the shot, sometimes resulting in loss of the charge.

According to the present invention, there is provided a complete seismic charge assembly ready for firing, comprising (a) a closed cartridge shell containing from 1/8th to 3 pounds of a nitrocarbonitrate charge as the main seismic explosive charge, and (b) a percussion-initiatable primer device within the cartridge shell, the primer device comprising a closed elongated shell, including a wall member disposed across one end of said elongated shell in closing relationship therewith; an ignition charge within said elongated shell supported in confinement on said wall member so as to be compressed in response to percussion applied to said wall member from outside said elongated shell, and ignitable in response to compression resulting from said percussion; a high explosive as a base charge within said elongated shell and spaced from said ignition charge, and a primer charge within said elongated shell, intermediate said ignition charge and said base charge; said base charge being detonatable in response to the detonation of said primer charge and arranged in detonating relationship therewith, and said primer charge being detonatable in response to ignition of said ignition charge and spaced in detonating relationship therewith.

Such a seismic charge assembly is particularly suitable for use in the seismic exploration method according to our co-pending Application No. 47697/68 (Serial No. 1248431), wherein a supply of explosively operated percussively initiated solid seismic charges is stored above a marine seismic area to be explored; a firing station is submersed in water in said area; a charge is transported from storage to the submersed firing station; and the seismic charge is impacted to initiate the same, with subsequent detonation thereof.

In a preferred form, the primer device of the seismic charge assembly of the present invention is closed at its ignition end, that is the end thereof containing the ignition charge, by an empty primed rim-fired or center-fired rifle cartridge case; the primer charge preferably comprises a diazodinitrophenol wafer together with a mass of diazodinitrophenol, as more fully described hereinafter; and the high explosive charge is any that is suitable as a base charge in a conventional blasting cap, but present in a somewhat higher proportion—PETN being often advantageously utilised.

The primer device extends into the cartridge shell for the NCN charge, through

one end thereof, with its base charge in a detonating relationship with the main explosive charge, and with its wall closure member spaced from the interior of the cartridge shell sufficiently to be at least flush with the cartridge end closure. In preferred practice, the primer device extends into the cartridge shell with its wall closure member substantially seated on the cartridge end closure outside the cartridge shell.

A particularly preferred form of seismic charge assembly according to the present invention for use in the seismic exploration method of Application No. 47697/68 (Serial No. 1248431) is one provided with means for effecting delay of detonation of the explosive charge after initiation of the ignition charge. For this purpose, the primer device can contain a delay fuse intermediate the ignition charge and the primer charge, to delay detonation of the base charge and hence the main explosive charge after percussion initiation of the ignition charge. A preferred feature of the seismic charge assembly from the point of view of ease of handling, particularly when using the aforesaid apparatus to be described hereinafter, is that the cartridge shell be provided with wall closure means positioned from an end of the cartridge shell to form a resulting open recessed cartridge shell portion.

For a better understanding of the invention, and to show how the same can be carried into effect, reference will now be made, by way of example only, to the accompanying drawings, in which:—

Figures 1 and 2 are longitudinal cross-sectional views of filled cartridge shells for containing primer devices in the formation of seismic charge assemblies according to the present invention;

Figures 3, 3A and 3B are longitudinal cross-sections (Figures 3A and 3B, in part only) through primer devices which together with the filled cartridge shells of Figures 1 and 2 can constitute seismic charge assemblies according to the present invention;

Figure 4 is a longitudinal section through a complete seismic charge assembly according to the present invention;

Figures 5A to 5C show (Figures 5B and 5C in part only) a longitudinal section through an alternative form of primer device for use with a seismic charge to form a seismic charge assembly according to the present invention;

Figure 5D is a side view, partly in section, through a seismic charge assembly according to the present invention, and

Figure 5E is a view of part of the cartridge case of Figure 5D prior to insertion of a primer device, and

the
as:
en

5 pr
tri
cu
cu

10 in
(S

se
el
su

15 ar
sf
re

di
ti

20 of
di
te

25 l
cl
p

ti
ir

30 ti
b
l

c
l

35 l
c

a

40 l
s
e

45 l
c

50

55

60

65

Figure 6 is a diagrammatic illustration of the manner in which the seismic charge assembly of Figures 5D and 5E can be emplaced off-shore and fired.

5 With reference to Fig. 1 is shown a now preferred embodiment of the seismic cartridge unit for association with the percussion initiatable primer device and percussion firing in a firing mechanism shown in Figure 1 of application No. 47697/68 (Serial No. 1248431). Referring to Fig. 1, seismic cartridge unit 111 comprises elongated cartridge shell 112 closed by any suitable bottom end closure member 113 and by opposite wall closure member 114 spaced from open top end 116 to form a resulting top recessed shell portion 117 in direct and unobstructed open communication with the outside of shell 112.

20 End closure 114 contains passageway, or opening, 118 extending therethrough to directly communicate recess 117 and interior shell portion 119. Well member 121 extends closed end first through opening 118 into operative contact with seismic charge 122 of the NCN type to support a primer device in detonating relationship therewith; and is supported at its open end in wall 114 in watertight relationship therewith in any suitable manner, generally by support of its integral lipped open end 123, on the exterior surface of the wall closure 114 immediately adjacent opening 18, often within a recessed portion of wall 35 114 immediately adjacent and surrounding opening 118, as illustrated.

Ridge member 124 extends peripherally and outwardly from cartridge shell 112, preferably as an integral part thereof in a plane generally normal to the cartridge shell axis and at a point intermediate the ends of the cartridge and closer to top end 116. Ridge member 124 generally extends outwardly from the remaining exterior surface of shell 10 a distance in the order of from 0.07 to 0.08 inch.

With reference to Fig. 2 in which parts corresponding to those of Fig. 1 are shown by the same, but primed, numbers, is illustrated another embodiment of the seismic cartridge unit (for association with a percussion initiatable primer device) which is the same as that of Fig. 1 except that the wall closure 114' including opening 118' and primer well member 121', secured at its lipped open end 123' to wall 114', is disposed as a closure for shell 112 at the top end 116' thereof. Protruding ridge member 124a is peripherally disposed around shell 60 112' at the top and is of substantially the same dimension as that of member 124 of Fig. 1. Ridge member 124a is advantageously formed during manufacture of cartridge shell 122 by forming a peripheral 65 flange about the end of the shell and then

rolling the flange back to form the resulting peripherally disposed ridge, or bead, 124a at the top end of the cartridge shell.

Protruding ridge, or wall portion, members such as 124 and 124a of Figs. 1 and 2 serve as detention members for engaging detention structure, such as shoulder 37 of Fig. 1, of application No. 47697/68 (Serial No. 1248431) associated with a muzzle member (e.g. member 18, Fig. 1 of said application) to detain a cartridge assembly for emplacement, initiation and ejection. Any suitable protruding cartridge wall portion can be utilized as detention means and can be located at any point on the cartridge wall or at the open end as desired, and the presence of recessed structure, e.g. recess 117, is optional, although it is advantageously utilized in preferred practice.

Although in preferred practice the protruding wall portion, as a detent, on the exterior surface of the shell of the cartridge unit, e.g., ridge member 124 of Fig. 1 is outwardly protruding, it can be inwardly protruding into the shell, e.g. as a peripherally extending groove about the outside wall of the shell. In that embodiment the muzzle assembly contains a suitable detent element for the cartridge assembly such as a spring actuated bolt member, in the side wall, normally spring biased to extend into the muzzle member in a direction substantially normal to the longitudinal axis thereof a sufficient distance to be forced to retract against the spring biasing force in response to initial contact with the forward traveling cartridge assembly in the muzzle but to spring into biased locking contact with the groove member when the groove is disposed in direct alignment therewith. The ejection force of the firing device then overcomes the spring biasing force to cause retraction of the detent and the subsequent ejection.

With reference to Figs. 3-3B is illustrated a percussion initiatable primer device utilized in practice of the invention as a primer element in combination with a cartridge unit of Figs. 1 and 2 to provide a complete percussion initiatable seismic explosive charge assembly of the invention.

With reference to Fig. 3 elongated shell 126 of primer device 127 contains a high explosive base charge 128 such as PETN, adjacent closed end 129. Wall or cap closure 131 is disposed in any suitable manner on, and across, top open end portion 132 of shell 127 in closing relationship therewith. Ignition charge 133 in shell 127 is supported in confinement, in any suitable manner, on wall 131 such as in a partially closed cavity 136 about the entire periphery of cap closure 131. Inasmuch as open end 132 is adjacent the ignition charge

133 and communicates charge 133 with the remainder of the components of the device it (open portion 132) is also referred to herein as the ignition end 132 of shell 126.

5 Confined ignition charge 133 is any suitable ignition composition which ignites to produce a flame in response to compression resulting from percussion applied to the exterior surface 136' of closure cap 10 131. Primer charge 137 in shell 126 is any suitable primer composition intermediate high explosive charge 128 and ignition charge 133. Delay fuse 139, of composition and design conventionally used in electric 15 delay blasting caps, comprises in preferred practice a suitable pressed delay fuse composition 143. The particular fuse composition, the degree of press of the fuse composition, and the length and diameter thereof, determine the time of burning; and in 20 most instances, selection of a specific fuse composition 143 and correlation of same with the remaining variables is such as to provide a delay in burning time in the 25 order of from 0.5 to about 1.5 seconds.

Delay fuse composition 143 is ignitable in response to direct contact with flame emitted from ignition of ignition charge 133 and is spaced in such ignitable relationship 30 therewith. Primer composition 137 is detonatable in response to heat and flame emitted from burning of delay fuse composition 143 and is disposed subjacent delay fuse 143 in detonating relationship 35 therewith. High explosive charge 128 is detonatable in response to detonation of primer 137 and is disposed subjacent primer 137 in that detonating relationship.

In the primer device such as illustrated 40 with reference to Fig. 3, primer charge and base charge components are advantageously those utilized as such in the blasting cap art, for example, base high explosive charges such as pentaerythritol tetranitrate, 45 pentolite, cyclonite, tetryl, RDX and cyclotol, and primer charges such as diazodinitrophenol, lead azide and mercury fulminate; confined ignition charge components include potassium perchlorate, 50 lead styphnate, mercury fulminate, antimony sulphide and lead azide, and mixtures of such materials, as are well known in the munitions art, and are preferably those often utilized as the "primer" charge in 55 0.22 caliber rifle cartridges; and delay fuse compositions include those normally utilized as such in the delay blasting cap art, those now preferred including lead oxide/boron, 98/2; red lead/boron 98/2; 60 barium peroxide/tellurium/selenium 40/40/20; barium peroxide/selenium 84/16; and barium peroxide/tellurium 60/40 (all weight ratios). Delay fuse assemblies, well known in the delay blasting cap art, 65 comprising a metal tube, generally lead,

containing the fuse composition pressed in the core, are also advantageously utilized as the delay element in the primer assembly.

In preferred practice primer charge 137 70 comprises a diazodinitrophenol wafer 137a pressed above, and superposed on elongated capsule 137b which extends within and substantially co-axially with shell 126 in closing, or near closing, relationship 75 therewith. Capsule 137b is open at each end and is superposed on base charge 128 and contains a second diazodinitrophenol charge 137c of density lower than that of primer wafer 137a. Wafer charge 137a is 80 of sufficiently high density to be ignitable in response to contact with flame from ignition of delay fuse composition 143 as above described and diazodinitrophenol charge 137c is of sufficiently low density to 85 be detonatable in response to heat developed by ignition of wafer charge 137c to thereby in turn cause detonation of base charge 128.

Although the complete seismic charge 90 assembly of the invention contemplates any suitable percussion initiator means therefor, Figs. 3A and 3B, in which each 95 lettered index number refers to a like part of Fig. 3 identified therein by the same, but unlettered number, show now preferred structure. With reference to Fig. 3A, the 100 ignition end 132a of shell 126a is closed by a conventional rim-fired empty primed rifle cartridge casing 142, which includes end closure 131a with charge 133a for rim firing; and with reference to Fig. 3B the 105 ignition end 132b of shell 126b is closed by a conventional center fired empty primed rifle cartridge casing 144 which includes end closure 131b with charge 133b for 110 center firing. Shell casings 142 and 144 are of outside diameters sufficiently less, respectively, than the inside diameters of shells 126a and 126b to provide, in each instance, for an interference or friction fit 115 of the casing closure in the primer shell.

A complete percussion initiatable seismic charge assembly of the invention is illustrated with reference to Fig. 4, which 120 shows, as the now preferred embodiment, the cartridge unit of Fig. 1 containing a rim-fired percussion initiatable primer of Figs. 3 and 3A positioned in the primer 125 well. All primed index numbers of Fig. 4 refer to like parts of Figs. 1, 3 and 3A identified by the same but unprimed index numbers. Thus as further illustrated with 130 reference to Fig. 4, primer assembly 127' extends into primer well 121", percussion end 131a' last, and terminates in detonating contact with main charge 122" in 135 cartridge shell 112". Primer assembly 127' is preferably disposed entirely within cartridge interior 119" except to permit the primer end closure 131a', at its outside 140

surfa
terior
in c
to p
the
trude
closu
117'
force
10 devic
comj
133a
W
fired
15 an c
asser
can
the
abou
20 is ge
is v
ignit
plate
cylind
25 abou
0.236

55

60

65

70

75

80

85

surface, to be at least flush with the exterior surface of the open end of well 121" in cartridge closure 114" and preferably to permit both primer closure 131a' and the ignition charge 133a' thereon to protrude from primer well 121" and end closure member 114" into recessed area 117' to facilitate application of percussion force by the piston assembly of the firing device, to the exterior of closure 131a' for compression and ignition of the charge 133a'.

When utilizing an empty primed rim-fired or center-fired rifle cartridge case as an enclosure for the primer device of the assembly of Fig. 3, the rifle case portion can be of any desired length, such as in the order of about 3/8 inch; and from about 0.3 to 0.4 grain of the ignition charge is generally employed although the amount is variable dependent upon the particular ignition and the primer charges contemplated. The primer device 127, generally cylindrical, is in most embodiments from about 2-1/4 to 3 inches in length by about 0.236 to 0.238 inch in diameter.

The amount of high explosive base charge 128 in an assembly 127 of Fig. 3 is generally greater than that utilized as base charge in a conventional No. 8 blasting cap. For example, the amount of PETN, as explosive charge is generally in the order of from 0.8 to 1.5 grams as compared with the conventional amount of 0.4 gram utilized as base charge in a No. 8 electric blasting cap. The amount of primer charge, e.g. charge 137 (137a + 137c) is generally about the same as utilized in a conventional No. 8 blasting cap, e.g. from 0.28 to 0.30 gram. The amount, degree of press and dimensions of delay fuse 143 in an assembly of Fig. 3, is dependent on the correlation of those variables with the desired burning rate, from 0.3 to 0.4 gram of delay fuse composition often being utilized.

The following is a tabulation of data exemplary, and further illustrative of a complete percussion initiatable seismic charge assembly of the invention, all index numbers referring to like numbered parts of Fig. 4.

PRIMER UNIT

Metal Shell 126d

Length, inches

Diameter, inches

inside

outside

Ignition End Closure 131a'

metal — cylindrical

2.98

0.22

0.24

Empty, primed rim-fired cartridge case for 0.22 cal. short ammunition

Delay Fuse 143'

Fuse Powder

BaO₃/Te/Se/Pb-Sn (32/32/16/20*—ratio by weight)

Pressed, p.s.i.

Grams

Length, inches

Diameter "

Spaced from ignition end, inches

4700

0.4

0.16

0.22

0.43

Primer-Ignition 137'

Diazodinitrophenol, grams

above capsule (137a')

below capsule (137b')

0.29

pressed at 3700 p.s.i.

loose

Base Charge 128'

PETN, grams

1.5 — pressed at 3700 p.s.i.

CARTRIDGE UNIT

Metal Shell 112"

Length, inches

Diameter, inches

inside

outside

Recess 117', inches

length

Detent Ridge 124', inches

Distance from wall closure 114"

Protrusion from shell 112"

Width at base

Contour of external surface

metal — cylindrical

4.68

2.04

2.09

0.41

0.97

0.07

0.19

circular

NCN Charge 122"

Weight, grams	250
Length, inches	3.27
Diameter, inches	2.04
Composition, wt. percent	
Ammonium nitrate	78.7
DNT	5.0
Fuel Oil	1.5
Particulate aluminum	14.8

* Pb/Sn, 85/15

The main charge of the complete seismic charge assembly is a nitrocarbonitrate by which term ("nitrocarbonitrate") is meant there are no sensitizers or other ingredients in that composition which are high explosives, and the mixture will not detonate with a No. 8 blasting cap when packed for shipment.

Nitrocarbonitrate type explosive charges, as is well known, contain at least one inorganic oxidizer salt, a fuel, and a suitable sensitizer together with various other well known ingredients such as one or more of an antiset agent, water repellent coating material or the like. Most often ammonium nitrate is the chief inorganic oxidizer salt ingredient alone, or with sodium nitrate or other suitable inorganic oxidizer salts. Further exemplary of inorganic oxidizer salts that can be used alone or together with ammonium nitrate as the inorganic oxidizer salt ingredient of nitrocarbonitrates are alkali metal and alkaline earth metal nitrates and perchlorates (including ammonium) as for example sodium nitrate, magnesium nitrate, calcium nitrate, potassium nitrate, barium nitrate, sodium perchlorate, ammonium perchlorate, calcium perchlorate and magnesium perchlorate. Well known sensitizer materials for nitrocarbonitrates include DNT and particulate aluminum alone or together with suitable fuels such as, for example, powdered coal, fuel oil, ferrosilicon, ferrophosphorous and the like. The following formulations (weight percent bases) are further illustrative of nitrocarbonitrate type charges above described and now preferred in practice of the invention:

	A	B	C	D	E	F
Ammonium Nitrate ⁽¹⁾	82	91	86	79	91	78
Sodium Nitrate	—	—	—	10	—	—
DNT ⁽²⁾	—	5	—	5½	5	5
Aluminum ⁽³⁾	6	—	10	—	—	12
Fuel Oil	4	—	—	1½	—	1
Ferrosilicon	8	—	—	—	—	—
Ground Coal	—	4	4	4	4	4
(1) Ground prills, formulations A, B, C and D; granular, formulations E and F						
(2) Dinitrotoluene oil, formulations B, D						

and E; solid dinitrotoluene, formulation F

(3) Flake, formulations A and C; granular, formulation F

The generally preferred nitrocarbonitrates contain (weight basis) from about 75 to 95 percent total inorganic oxidizer salt and at least 5 percent of a suitable sensitizer component together with a separate fuel component when desired. More often ammonium nitrate, preferably in the form of ground prills, is the only inorganic oxidizer salt although it can be advantageously utilized as such, in an amount of from 75 to 90 percent together with from about 1 to 15 percent sodium nitrate. Now preferred sensitizer components are DNT oil, DNT solids, particulate aluminum, and mixtures of any two or more thereof, in a total amount of from about 5 to 20 percent, at least about 5 percent of the particulate aluminum being flake. Also, in preferred practice, the nitrocarbonitrate charge contains, as a separate fuel component, fuel oil, ground coal, granular aluminum or a mixture of two or more thereof, in any suitable amount, generally from 2 to 15 percent.

When referring herein to small nitrocarbonitrate seismic charges, it is meant those which have a weight from 1/8 to 3 lbs. and a diameter of at least 1/2 inch and usually not exceeding about 3 inches.

Although, with reference to Figures 3, 3A and 4, we have described preferred embodiments of percussion initiatable primer together with cartridge assembly containing same and particularly adaptable to seismic system and assembly disclosed and illustrated in application No. 47697/68 (Serial No. 1248431), other embodiments of primer and cartridge assembly, are within the scope of the invention as illustrated with reference to Figures 5A-E inclusive and Figure 6.

Thus referring to Figures 5A to C the primer device shown therein is similar to that shown in Figures 3, 3A and 3B, except for the absence of a delay charge. Otherwise the description of Figures 3, 3A and

3B
Fig
3 a5 251
252
253
254
255
256
257
258
259
260
261
262
263
264
265I
20 nu
ide
ber
ver
car
25 po
all
Figinc
30 5A
un
ch
ca
26
35 cri
en
26
pa
di
40 ax
26fir
26
45 su
in
be
is
cl
50 2
tc
cl
w
p
55 e
p
2
c60 n
c
c
2
v
65 i

3B is applicable here. The features in Figures 5A identical with features in Figure 3 are shown in the drawings as follows:

- 5 251 — elongated shell
- 252 — primer device in general
- 253 — explosive base charge
- 254 — closed end of shell
- 255 — wall, or cap, closure for shell
- 60 256 — open end of shell
- 257 — ignition charge
- 258 — partially closed cavity in shell
- 259 — outer surface of shell
- 260 — primer charge in shell
- 65 260a — diazodinitrophenol wafer
- 260b — elongated capsule
- 260c — second diazodinitrophenol charge

In Figures 5B and 5C, each letter index number refers to a like part of Figure 5A identified by the same, but un-lettered, number and, in addition, 261 represents a conventional pin-fired empty primed rifle cartridge casing having a cylindrical casing portion 251a' or 251b'. The features are all the same as corresponding features in Figures 3A and 3B.

With reference to Fig. 5D, all primed index numbers refer to like parts of Fig. 5A identified therein by the same, but unprimed, index number. Complete seismic charge assembly 263 comprises elongated cartridge shell 264 closed at the bottom end 265 by any suitable closure means such as crimped on closure 266 and at the other end by closure means 267 secured to shell 264 in any suitable manner and containing passageway 268 extending therethrough in direct communication, and in substantially axial alignment with, the interior of shell 264.

Primer assembly 252' extends end 254' first, through passageway 268 of end closure 267 into well member 269 in shell 264, sufficiently to dispose explosive charge 253' in detonating relationship with nitrocarbonitrate charge 270. Primer assembly 252' is preferably disposed entirely within closure 267 and nitrocarbonitrate charge 270 except to permit primer end closure 255' to be flush with the exterior surface of closure 267, and preferably to permit both wall closure 255' and charge 257' thereon to protrude from the end of member 267, in either event, to enable direct application of percussion force outside shell 264 to surface 259' for compression and ignition of charge 257'.

Passageway 268, and support for well member 269, in closure 267 are more clearly shown in Fig. 5E, which is a view of end portion 271 of cartridge assembly 263 without primer device 252'. Primer device 252' in well member 269 is supported in opening 268 in the end member 267 of

assembly 263 in any suitable manner, as for example by a bushed frictional fit in the open end of well 269. Well 269 is supported in opening 268 in watertight relationship with the interior of shell 264 in any suitable manner such as by flange, or lip, 269a integral with well member 269 at the open end thereof and seated and sealed in recess 269b in closure 267 immediately below, and coaxial with, recess 273. Washer 274, in recessed portion 273 of closure 267 immediately subjacent closure 255', encompasses opening 268 as an anvil type support for closure member 255' at the time percussion force is applied to compress and responsively ignite ignition charge 257'. In one such embodiment closure 267 is advantageously formed from a plastic material, and shell 251' of primer device 252' is metal and is firmly supported in passageway 274 at its upper end.

End closure 267, in assembly 263, is advantageously a plastic material of contour the same as that of the inner wall of shell 264 and is inserted into watertight closing relationship with shell 264. In the embodiment shown, plastic end member 267 and shell 264 can be a plastic unit of integral construction formed by injection molding. Now-preferred plastic materials for the formation of the integral unit of shell 264 and closure 267 are polypropylene, polystyrene, and the like.

When utilizing an empty primed rim-fired, or center-fired rifle cartridge case as an end closure for the primer device of Figs. 5A-C, the rifle case portion can be of any desired length, such as in the order of about 3/8 inch. From about 3 to 4 grains of the ignition charge 257a or 257b is generally employed although the amount is variable dependent upon the particular ignition and primer charges contemplated. The primer device 252, generally cylindrical, is generally from about 2 1/4 to 3 inches in length by about 0.224 to 0.226 inch in diameter.

The amount of high explosive 253, in the device of Fig. 5A, is generally greater than that utilized as base charge in a conventional No. 8 blasting cap. For example, the amount of PETN, as charge 253 in Fig. 5A, is generally in the order of from 0.8 to 1.5 grams as compared with a conventional amount of 0.4 gram utilized as base charge in a No. 8 electric blasting cap. The amount of primer charge, e.g. charge 260, is generally about the same as utilized in a conventional No. 8 blasting cap, e.g. from 0.28 to 0.30 gram.

In one form of practice, the initiator primer device, such as of Figs. 5B and 5C, can be fabricated by insertion of an empty primed rim-fired, or center-fired, rifle cartridge casing as the open end closure,

in a fuse cap of standard design which is an elongated shell containing a base explosive charge and a primer composition superposed thereon and containing an empty (open) end portion for accepting a detonating fuse for initiation of the primer.

One method in accordance with which the complete seismic charge assembly of the invention can be delivered to the underwater shooting zone, and then fired, comprises towing a delivery tube, and a rigid impact body, from the deck of a boat moving along the water surface above the shooting zone, the delivery tube extending from the boat deck into the shooting zone and terminating therein in spaced apart relationship with the rigid impact body. The rigid impact body is advantageously a plate disposed in a plane substantially normal to the axis of the tube at its terminating end, and is secured to the tube, or directly to the boat, in any suitable manner. As the tube and plate member are towed through the shooting zone, the seismic charge assembly is passed, primer end first, from the boat deck through the delivery tube and into direct contact of the primer end with the rigid impact member. The resulting force of percussion on the primer end causes compression and responsive ignition of the confined ignition charge, thus initiating the primer device with subsequent detonation of the main seismic charge.

The above-described method for emplacement of, and firing, a complete seismic charge assembly of the invention, is further illustrated with reference to Fig. 6 in which all primed numbers refer to like parts of Fig. 50 identified therein by the same, but unprimed or less-primed, number. Referring to Fig. 6, a seismic charge assembly loader 275 secured on deck of a towboat

(not shown) is loaded with seismic charge assembly 263' for delivery of same, closed end 267' first, to the underwater shooting zone. Assembly 263' is then passed through tube 276 into the underwater shooting zone and, from tube 276, into direct contact of the closure member 255" of primer device 252" with impact plate 277. Plate 277 is supported in the shooting zone, by attachment to the terminating end of tube 276 therein by connecting cables 278, and paravanes 279. Cables 278 and paravane members 279 serve, collectively, to stabilize the position of impact plate 277, substantially in its position as shown, during towing.

Air, under pressure from compressor 281 secured on the boat deck, is passed through line 280 into loader 275 against the assembly 263' at its end 266' to provide the necessary momentum for impact of assembly 263' with plate 277 to accomplish the required force of percussion on closure 255" for compression and ignition of charge 257".

Impact plate 277 is spaced from the end of tube 276 in the underwater shooting zone a sufficient distance to permit assembly 263' to emerge completely from tube 276 before being fired to preclude damage to the tube so that it can be available for multishots.

By way of test, 25 assemblies of Fig. 5D were initiated by percussion force of a free falling hammer on the primer surface 259'. The ignition system in each assembly, including element 255', was an empty primed cartridge case 261 of Fig. 5B. In each instance the main charge 270 was completely detonated.

Each of the 25 assemblies had the same specifications, which are tabulated as follows:



COMPLETE ASSEMBLY 263

Primer 252'

Metal Shell 251'

Length, inches

Diameter, inches

Inside

Outside

Ignition End 255'

Primer — Ignition 260*

Diazodinitrophenol, grams

Above capsule

Below capsule

Base Explosive Charge 253'

PETN, grams

Aluminum — cylindrical

2.25

0.225

0.246

0.22 caliber empty short primed
rim-fired rifle cartridge case

0.29

pressed under 3700 p.s.i.

loose

1.2, pressed under 3700 p.s.i.

Shell 264

Length, inches

Diameter, inches

Inside

Outside

Aluminum — cylindrical

6.0

1.92

2.00

Main Explosive Charge 270

Weight, lb

Length, inches

Diameter, inches

Density, gms./cc.

Composition, wt. percent

Ammonium nitrate

DNT

Paraffin oil

Particulate aluminum

0.5

4.25

1 $\frac{1}{2}$

1.02

78.7

5.0

1.5

14.8

*Index number not shown in Fig. 6

When desired, a delay fuse is positioned in shell 251 of Fig. 5A superposed on primer composition 260 so as to delay detonation of explosive charge 253 after percussion initiation of ignition 257, as illustrated with reference to delay fuse 143 of the primer assembly of Fig. 3.

WHAT WE CLAIM IS:—

1. A complete seismic charge assembly ready for firing, comprising (a) a closed cartridge shell containing from 1/8th to 3 pounds of a nitrocarbonitrate charge as the main seismic explosive charge and (b) a percussion-initiatable primer device within the cartridge shell, the primer device comprising a closed elongated shell, including a wall member disposed across one end of said elongated shell in closing relationship therewith; an ignition charge within said elongated shell supported in confinement on said wall member so as to be compressed in response to percussion applied to said wall member from outside said elongated shell, and ignitable in response to compression resulting from said percussion; a high explosive as a base charge within said elongated shell and

spaced from said ignition charge, and a primer charge within said elongated shell, intermediate said ignition charge and said base charge; said base charge being detonatable in response to detonation of said primer charge and arranged in detonating relationship therewith, and said primer charge being detonatable in response to ignition of said ignition charge and spaced in detonating relationship therewith.

2. A seismic charge assembly according to Claim 1, wherein the primer device comprises an empty primed rifle cartridge casing constituting said wall member, in said closing relationship with said elongated shell.

3. A seismic charge assembly according to Claim 2, wherein said empty primed rifle cartridge casing is rim fired.

4. A seismic charge assembly according to Claim 2, wherein said empty primed rifle cartridge casing is center fired.

5. A seismic charge assembly according to Claim 3 or 4, wherein said empty primed rifle cartridge casing is 0.22 caliber.

6. A seismic charge assembly according to any one of the preceding claims, wherein said primer charge of the primer device



COMPLETE ASSEMBLY 263

<i>Primer 252'</i>		
5	Metal Shell 251'	Aluminum — cylindrical
	Length, inches	2.25
	Diameter, inches	
	Inside	0.225
	Outside	0.246
	Ignition End 255'	0.22 caliber empty short primed rim-fired rifle cartridge case
10	Primer — Ignition 260*	
	Diazodinitrophenol, grams	0.29
	Above capsule	pressed under 3700 p.s.i.
	Below capsule	loose
	Base Explosive Charge 253'	
	PETN, grams	1.2, pressed under 3700 p.s.i.
15	<i>Shell 264</i>	Aluminum — cylindrical
	Length, inches	6.0
	Diameter, inches	
	Inside	1.92
	Outside	2.00
20	<i>Main Explosive Charge 270</i>	
	Weight, lb	0.5
	Length, inches	4.25
	Diameter, inches	1½
	Density, gms./cc.	1.02
25	Composition, wt. percent	
	Ammonium nitrate	78.7
	DNT	5.0
	Paraffin oil	1.5
	Particulate aluminum	14.8

30 *Index number not shown in Fig. 6

When desired, a delay fuse is positioned in shell 251 of Fig. 5A superposed on primer composition 260 so as to delay
 35 detonation of explosive charge 253 after percussion initiation of ignition 257, as illustrated with reference to delay fuse 143 of the primer assembly of Fig. 3.

40 WHAT WE CLAIM IS:—

1. A complete seismic charge assembly ready for firing, comprising (a) a closed cartridge shell containing from 1/8th to 3 pounds of a nitrocarbonitrate charge as
 45 the main seismic explosive charge and (b) a percussion-initiatable primer device within the cartridge shell, the primer device comprising a closed elongated shell, including a wall member disposed across one
 50 end of said elongated shell in closing relationship therewith; an ignition charge within said elongated shell supported in confinement on said wall member so as to be compressed in response to percussion
 55 applied to said wall member from outside said elongated shell, and ignitable in response to compression resulting from said percussion; a high explosive as a base charge within said elongated shell and

spaced from said ignition charge, and a 60 primer charge within said elongated shell, intermediate said ignition charge and said base charge; said base charge being detonatable in response to detonation of said primer charge and arranged in detonating
 65 relationship therewith, and said primer charge being detonatable in response to ignition of said ignition charge and spaced in detonating relationship therewith.

2. A seismic charge assembly according 70 to Claim 1, wherein the primer device comprises an empty primed rifle cartridge casing constituting said wall member, in said closing relationship with said elongated
 75 shell.

3. A seismic charge assembly according to Claim 2, wherein said empty primed rifle cartridge casing is rim fired.

4. A seismic charge assembly according to Claim 2, wherein said empty primed 80 rifle cartridge casing is center fired.

5. A seismic charge assembly according to Claim 3 or 4, wherein said empty primed rifle cartridge casing is 0.22 caliber.

6. A seismic charge assembly according 85 to any one of the preceding claims, wherein said primer charge of the primer device

comprises a combination of a diazodinitrophenol wafer in direct open communication with said ignition charge, and of sufficiently high density to ignite in response to direct contact with flame from ignition of said ignition charge, and a mass of diazodinitrophenol intermediate said wafer and said base charge, and of sufficiently low density to detonate in response to ignition of said wafer.

7. A seismic charge assembly according to any one of the preceding claims, including a delay fuse intermediate said ignition charge and said primer charge, to delay detonation of said base charge after percussion initiation of said ignition charge.

8. A seismic charge assembly according to any one of the preceding claims, wherein the nitrocarbonitrate charge comprises from 75 to 95% by weight of one or more inorganic oxidiser salts and at least 5% by weight of one sensitiser.

9. A seismic charge assembly according to Claim 8, wherein the nitrocarbonitrate charge comprises from 75% to 90% by weight ammonium nitrate and from 1 to 15% by weight sodium nitrate.

10. A seismic charge assembly as claimed in any one of Claims 1 to 7, wherein the nitrocarbonitrate charge comprises from 75 to 95% by weight ammonium nitrate, and as a sensitiser component, 5 to 20% by weight of at least one sensitiser selected from the group consisting of DNT oil, DNT solids and particulate aluminium containing at least 5% of its weight in flake form.

11. A seismic charge assembly according to any one of Claims 8 to 10, wherein the ammonium nitrate is in the form of ground prills.

12. A seismic charge assembly according to any one of the preceding claims, wherein the nitrocarbonitrate charge also contains, as a separate fuel component, from 2 to 15% by weight of at least one fuel selected from the group consisting of a fuel oil, ground coal and granular aluminium.

13. A seismic charge assembly according to any one of the preceding claims, wherein the nitrocarbonitrate charge has a

diameter of from 1.75 to 3 inches.

14. A seismic charge assembly according to any one of the preceding claims, wherein the closed cartridge shell of the main charge is provided with a protruding exterior side portion for engaging an external stop means therefor during travel of the charge assembly through a passageway containing such stop means.

15. A seismic charge assembly according to Claim 14, wherein the protruding side portion comprises a ridge member peripherally extending about said cartridge shell as an integral part thereof.

16. A seismic charge assembly according to Claim 14 or 15, wherein the said cartridge shell is provided with end wall closure means for enclosing at least a portion of the interior of said shell, the primer device extending into the cartridge shell through the wall closure means into operative contact with the main explosive charge, which wall closure means is positioned from an end of the cartridge shell to form a resulting open recessed end portion.

17. A seismic charge assembly according to Claim 16, wherein the wall closure means is spaced from an end of said cartridge shell to form a resulting open recessed cartridge shell end portion, and is of sufficient rigidity to support power impact for ejection of the seismic charge assembly through a passageway.

18. A seismic charge assembly, substantially as hereinbefore described, with reference to and as shown in Figure 4, or Figure 4 as modified by either or both of Figures 2 and 3B of the accompanying drawings.

19. A seismic charge assembly, substantially as hereinbefore described, with reference to and as shown in Figures 5D and 5E or Figures 5D and 5E as modified by either of Figures 5B and 5C, of the accompanying drawings.

HASELTINE, LAKE & CO.,

Chartered Patent Agents,

28 Southampton Buildings,

Chancery Lane, London, WC2A 1AT

Agents for the Applicants.

