

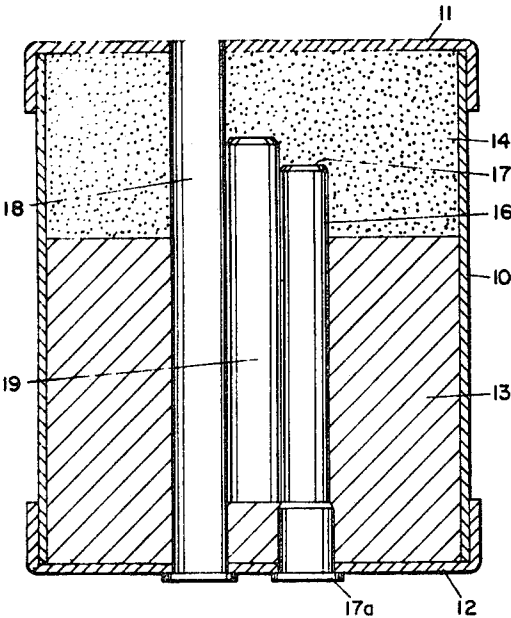
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[45] Patented Sept. 14, 1971
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[54] CAST BOOSTER ASSEMBLY
14 Claims, 4 Drawing Figs.
[52] U.S. Cl. 102/24
[51] Int. Cl. F42b 1/00
[50] Field of Search 102/24, 27

[56] References Cited
UNITED STATES PATENTS
3,212,438 10/1965 Lawrence 102/24
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ABSTRACT: The invention provides a booster assembly for a main explosive wherein the booster charge is formed from TNT and PETN and/or RDX and contains less RDX and/or PETN than required in comparably performing conventional booster charges of the cyclotol and pentolite types. The booster charge is a layer of a cast explosive of the group of pentolites, cyclotols and mixtures thereof, and a layer of cast TNT contiguous thereto. On a weight ratio basis, preferred pentolites contain PETN/TNT of from 60/40 to 40/60; and preferred cyclotols contain RDX/TNT of from 75/25 to 50/50, including Composition B which is a 60/40 RDX/TNT containing 1 percent of a microcrystalline wax.



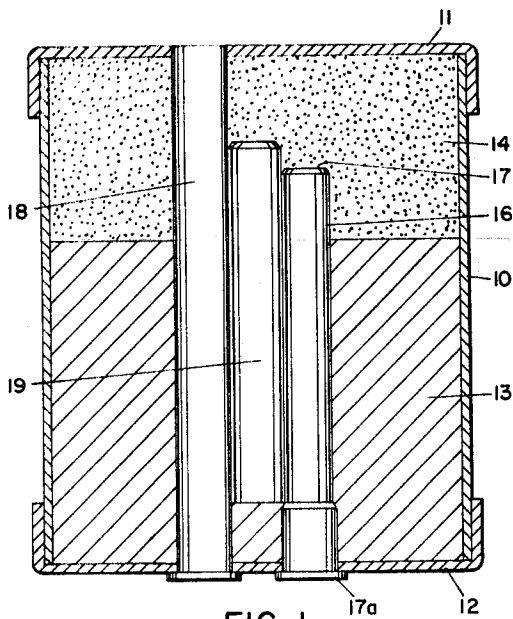


FIG. 1

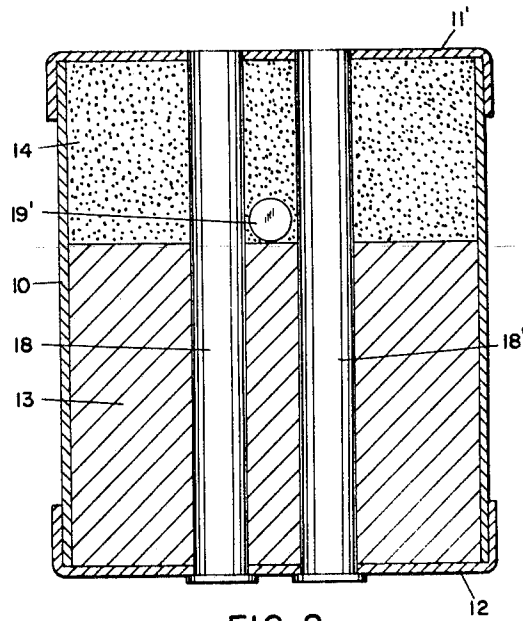


FIG. 2

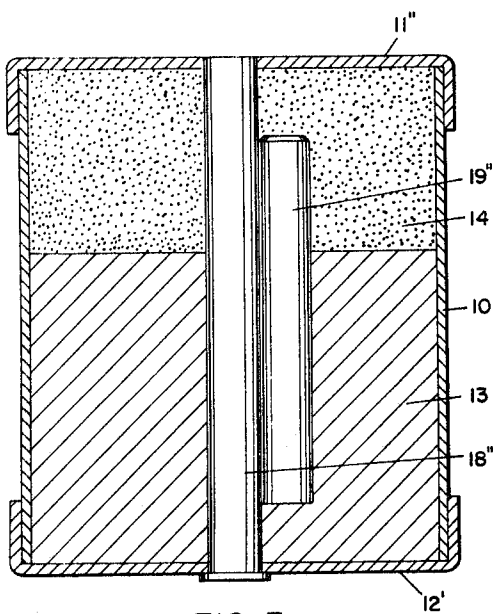


FIG. 3

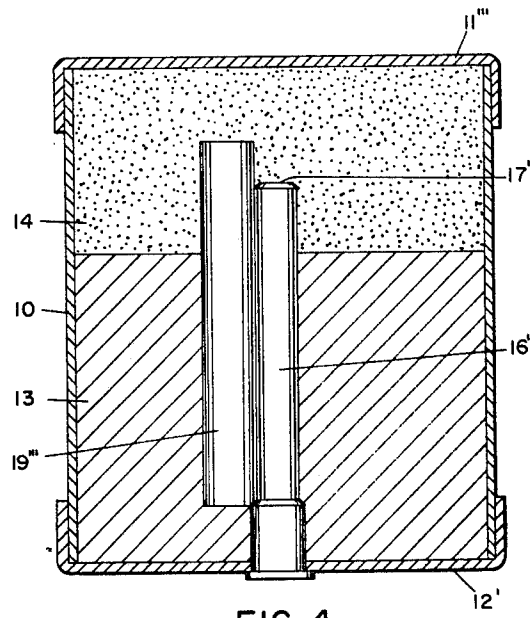


FIG. 4

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CAST BOOSTER ASSEMBLY

This invention relates to booster-type initiator assemblies for main explosive charges. In one aspect this invention relates to booster assemblies above-described wherein the booster charge comprises contiguous cast layers of TNT and a mixture of TNT with PETN and/or RDX, to provide for improved economics and safety in utilization of booster charges of the pentolite and cyclotol-types. In another aspect thin invention relates to booster assemblies above described wherein the booster charge is a layer of said TNT together with a layer of pentolite or a cyclotol-type explosive. Other aspects of the invention will be apparent in light of the accompanying disclosure and the appended claims.

A complete explosive assembly ready for firing comprises a main explosive charge and means for initiating detonation of same. One such complete assembly comprises a combination of a cap-insensitive charge as a main explosive charge, a booster unit containing a booster type explosive charge as a secondary initiator, and an electric blasting cap or a detonating fuse as the primary initiator. The booster charge is detonated in response to actuation of the primary initiator, and the main charge is detonated in response to detonation of the booster charge, to provide the full explosive force of the assembly. Booster-type initiators for explosives generally comprise a closed shell and a booster type explosive charge therein together with means or support of a primary initiator, such as a blasting cap and/or a detonating fuse, in detonating relationship with the booster charge. Usually, a well extending into the booster charge, and/or one or more tunnels extending through the booster charge, or a combination of both, serves to support a blasting cap or detonating fuse or a combination of the two. Dependent upon the particular booster charge, a blasting cap may be sufficient as the primary initiator. However, the blasting cap may be utilizable with one or more strands of detonating fuse, or, one or more strands of detonating fuse may be utilized independently of the use of a blasting cap. In all events, such a booster assembly generally contains a single well, and/or one or more tunnels depending upon the need at hand. In some instances a small portion of supplemental explosive or "inner sensitizer" of sensitivity greater than that of the booster charge is present as an "insert" in the booster charge in detonating relationship with the primary initiator and in turn with the booster charge to facilitate detonation of the booster charge in response to initiation of the primary initiator.

Most often the booster charge is PETN or RDX cast in admixture with TNT to form a resulting two ingredient charge, the art referring to the PETN/TNT mixtures as pentolites, and to the RDX/TNT mixtures as cyclotols or, cyclotols containing RDX in a specific ratio to TNT (60/40) and additionally about 1 percent wax, are also referred to as composition B. Pentolite, cyclotol and Composition B-type booster charges are well known in the art.

Both PETN and RDX involve reactants, and process steps, leading to high costs in their manufacture and hence the use of those materials, as booster charge ingredients, has been disadvantageous from an economics standpoint. Further, these materials are highly sensitive and it is accordingly desirable, for safety reasons, that they be utilized in as small proportions as are feasible.

This invention is concerned with booster assemblies in which the booster charge contains TNT together with one or both of PETN and RDX, utilizing smaller RDX and PETN proportions than those required in conventional cyclotol and pentolite-type booster charges of comparable performance; and is safer to handle and is less costly than are the conventional pentolite and cyclotol cast charges.

In accordance with the invention a booster assembly for a main explosive is provided in which the booster charge comprises TNT together with RDX and/or PETN and contains less of the RDX and/or PETN than required in comparably performing booster charges of the cyclotol and pentolite-type;

said booster charge comprising a layer of cast explosive selected from the group consisting of pentolites, cyclotols, and mixtures thereof, and a layer of cast TNT contiguous thereto.

In preferred practice, the booster charge is formed from one layer of TNT and one layer of pentolite or of cyclotol. When desired, both RDX and PETN are ingredients with TNT to constitute a layer of cast cyclotol-pentolite mixture contiguous to the cast TNT. Also, when the top layer is the pentolite and/or cyclotol, it can be covered to "topped," when desired, with an additional layer of the less sensitive TNT for improved safety in handling and storage; and that practice is particularly advantageous when the pentolite and/or cyclotol layer to be so covered is relatively thin, inasmuch as the covering TNT layer then also imparts strength to the thin pentolite and/or cyclotol layer for increased resistance to physical failure during handling and storage.

Generally, the booster charge has an overall weight (all layers) of from about 85 to about 2500 grams, with variation of size of each of the two layers over a broad range. The thickness of the cast layer of pentolite and/or cyclotol can be greater or less than that of the TNT layer, often varying from a thickness of say one-eighth inch up to 3 inches or more. The weight ratio of the cast TNT layer to the pentolite and/or cyclotol layer is generally within the range of from about 0.2:1 to about 8:1, although any suitable ratio outside the range can be utilized. Although the booster assembly of the invention can be of any suitable shape, the thickness of each layer is generally at least about 1 inch and preferably within the range of from 1½ to 3 inches.

In preferred practice of the invention, the pentolite contains PETN in a weight ratio to TNT of from about 60/40 to 40/60; the cyclotol layer contains RDX in a weight ratio to TNT of from about 75/25 to 50/50 and of course, Composition B, a cyclotol, is a 60/40 RDX/TNT containing 1 percent of microcrystalline wax. On the above bases, the amount of PETN or RDX in the booster assembly of the invention is generally from about 10 to 50 percent of that which would be utilized in a conventional cast pentolite or cyclotol booster charge of comparable sensitivity on, and initiator strength. The invention is further illustrated with reference to the drawings of which FIG. 1 shows a layered booster assembly of the invention containing a cast pentolite layer superposed on, and contiguous with, a cast TNT layer together with an insert extending into the pentolite layer in conjunction with a single tunnel and a cap well each as primary initiator support means; FIG. 2 shows an assembly, the same as FIG. 1 except that it illustrates a double tunnel structure as support means for the primary initiator, with the insert supported entirely within the pentolite layer; FIG. 3 shows an assembly the same as FIG. 1 except that it illustrates a single tunnel as support for the primary initiator and an insert extending into the pentolite layer; and FIG. 4 is the same as FIG. 3 except that it shows a cap well, as support means for the primary initiator. It is to be understood that although, in all figures, the drawings illustrate an insert, as an element of the assembly, the structure is optional dependent upon the particular initiation requirements. Similarly, whether support means for the primary initiator is one or more tunnel member or a cap well, or any combination of those elements, is a matter of choice to be made in light of the particular initiation requirements.

Referring to FIG. 1, booster shell 10, closed at one end by closure 11 and at the other end by closure 12 contains cast TNT layer 13 and cast pentolite layer 14 superposed on layer 13 and contiguous thereto. Layer 14 contains PETN in a weight ratio to TNT preferably in the order of about 0.6:1 to 1.5:1.

Well member 16, having closed end 17, extends into shell 10, closed end 17 first, through end closure 12 with closed end 17 terminating within pentolite layer 14; and with the opposite, and open end 17a supported in closure 12 in open communication with the outside of shell 10, generally disposed about flush, or nearly so, with the external wall of closure 12. A tube member 18, open at both ends extends

through closure 12, layers 13 and 14 and closure 11, to form a tunnel 18 extending throughout the booster assembly in open communication at each end with the outside of shell 10. Conventional "insert" member 19 in shell 10 is a closed tube, containing additional explosive and extending from within layer 13 into layer 14 to be detonatable in response to action of a primary initiator supported in well 16 or in tunnel 18 serve respectively to support an electric blasting cap, and detonating fuse, as primary initiator means for the layer charge 13-14; and are supported so as always to be disposed, at least in part, in pentolite layer 14. Detonating relationship with layer 14. The "insert" explosive is advantageously PETN which has greater sensitivity than that of either layers 13 or 14; and it serves basically to facilitated detonation of the cast explosive 14 in response to initiation of the primary initiator.

In the fabrication of the assembly of FIG. 1 well member 16 and a tube member for the formation of tunnel 18 are supported in closure 12 and emplaced in cylindrical shell 10 in position as shown except that end closure 11 is not yet emplaced. Molten TNT, at about 180° F. is poured into shell 10 through the open end thereof to fill at least about one-half the shell. Insert 19 is then inserted into shell 10 through the open end thereof and in the still molten TNT layer, preferably supported in spaced position from the end closure 12, but in all events protruding from within layer 13 into the top and unfilled portion of shell 10. The TNT layer is then allowed to cool to about 190° F. and solidify and molten pentolite at about 190° F. is then poured into shell 10 to form layer 14 on top of, and contiguous with, layer 13. The molten pentolite layer is then allowed to solidify by cooling. Closure member 11 is fastened in engaging relationship with tube 18, as support therefor, before or after solidification of the pentolite layer 14, as desired.

In FIGS. 2, 3 and 4 are shown embodiments of booster assembly of the invention containing like parts of FIG. 1 which are, therefore, like numbered. Parts of FIGS. 2, 3 and 4 corresponding to similar, but not identical, parts of FIG. 1 are numbered by the same but primed numbers. Referring to FIG. 2, the assembly shown differs from that of FIG. 1 in respect of primary initiator support means, and location of the inset member. Thus, the assembly of FIG. 2 contains tunnels 18 and 18' extending through charge layers 13 and 14 and shell closures 11' and 12, in the same manner as described with reference to tunnel 18 of FIG. 1, to provide a plurality of tunnels

for support of two separate strands of detonating fuse as the primary initiator for the layered charge. The insert 19', as shown, is optionally disposed horizontally, and entirely, within the pentolite layer between the two tunnel members.

Referring to FIG. 3 tunnel 18'' extends through layers 13 and 14 and shell closures 11' and 12' as described with reference to tunnel 18 of FIG. 1 to support a single strand of detonating fuse as the primary initiator for the layered charge. Optionally disposed insert 19'', in shell 10, extends from within layer 13 into layer 14 as described with reference to insert 19 of FIG. 1 and is supported on the outer wall of tube 18'' so as to be in direct detonating relationship with fuse type primary initiator means when supported in tunnel 18''.

With reference to FIG. 4 well member 16' extends through shell closure 12' and layer 13 into layer 14 terminating with closed end 17' with layer 14 in direct contact therewith. Optionally disposed insert 19''', within shell 10, extends from within layer 13 into layer 14 as described with reference to insert 19 of FIG. 1 and is supported on the wall of well 16' in detonating relationship with a blasting cap when supported in well 16 as a primary initiator for the layered charge. As stated with reference to the drawings, an "insert" member is optional dependent on the need at hand. However, an insert is often advantageously utilized in the detonation of the less sensitive of the layers 14 utilized such as a pentolite layer 14 of PETN/TNT weight ratio of 40/60 or 45/55. Exemplary of suitable insert members, are those in the order of from about 0.1 to 3 grams, of PETN, RCS, and tetryl, although sizes outside that range can be utilized when desired.

Any suitable primary initiator can be utilized in combination with a booster assembly of the invention, albeit it is always supported, at least in part, within the cast layer 14 as illustrated with reference to the drawings.

The invention is further illustrated with reference to the following examples.

A number of booster assemblies of FIG. 1 (except see footnote 2, Table 1) were fabricated, the insert consisting of 2.25 grams of PETN and the two layers 13 and 14 filling a closed paper tube 3 inches in length by 3 inches in diameter. In all tests the layer 14 was pentolite having a PETN to TNT weight ratio of 45/55. In several series of tests, the various assemblies were detonated with either an electric blasting cap or a detonating fuse and the force of the shots were measured in accordance with the standard steel witness plate test.

The test are summarized as follows:

TABLE 1

Series	TNT:Pentolite, ¹ weight ratio	Grams		Primary initiator		Diameter of hole cut in witness plate, inches
		TNT (layer 13)	Pentolite ¹ (layer 14)	EB cap, number	Primacord, grains	
A.....	About 1:1, Test No.:					
	1.....	240	246.5	.....	50	4 7/8
	2.....	240	260.7	.....	50	5 3/8
	3.....	240	244.3	.....	50	5 1/4
	4.....	240	239.4	.....	50	5 1/4
	5.....	240	248.5	.....	50	5
B.....	About 1:1, Test No.:					
	1.....	240	248.4	6	.....	5
	2.....	240	244	6	.....	5
	3.....	240	242	6	.....	6
	4.....	240	233	6	.....	5 1/2
	5.....	240	227	6	.....	4 3/4
C.....	About 1.5:1, Test No.:					
	1.....	286	193.5	.....	50	5
	2.....	286	202	.....	50	5
	3.....	286	198.5	.....	50	4 3/4
	4.....	286	193.5	.....	50	4 3/4
	5.....	286	197.5	.....	50	4 3/4
D.....	About 1.5:1, Test No.:					
	1.....	286	196.5	6	.....	6 1/8
	2.....	286	193.6	6	.....	5 3/4
	3.....	286	190	6	.....	4 1/2
	4.....	286	199	6	.....	4 3/4
	5.....	286	193	6	.....	5 1/2

TABLE 1 - (continued)

Series	TNT:Pentolite, ¹ weight ratio	Grams		Primary Initiator		Diameter of hole cut in witness plate, inches
		TNT (layer 13)	Pento- lite ¹ (layer 14)	EB cap, number	Prima- cord, grains	
E...	About 2.3:1, Test No.:					
	1.....	336	143	-----	50	5¼
	2.....	336	137	-----	50	4½
	3.....	336	149	-----	50	6½
	4.....	336	142	-----	50	4½
	5.....	336	138	-----	50	4½
	1.....	336	149	6	-----	5
	2.....	336	155	6	-----	5½
	3.....	336	148	6	-----	4½
	4.....	336	140	6	-----	4½
	5.....	336	145	6	-----	4½
F...	About 4:1, ² Test No.:					
	1.....	384	103	-----	50	4½
	2.....	384	110	-----	50	Failed
	3.....	384	105	-----	50	4½
	4.....	384	101	-----	50	Failed
	5.....	384	99	-----	50	4½
	1.....	384	117	6	-----	5½
	2.....	384	104	6	-----	4½
	3.....	384	95.5	6	-----	Failed
	4.....	384	94	6	-----	Failed
	5.....	384	100	6	-----	4½
G.....	No TNT (100% Pentolite) Test No.:					
	1.....		479	-----	50	5¼
	2.....		476	-----	50	4½
	3.....		470	-----	50	5
	1.....		476	6	-----	5¼
	2.....		474	6	-----	5
	3.....		481	6	-----	5¼

¹ PETN:TNT weight ratio was 45/55.
² In these tests, the insert, supported within the TNT layer 13, did not extend into layer 14 but did extend to the interface of the two layers 13 and 14. Failures shown at Tests 2 and 4 (Primacord) and 3 and 4 (No. 6 Cap) demonstrate need for the insert to be disposed, at least partially, within the layer 13.

In another series of tests several booster assemblies of varying proportions of cast layers, of FIG. 1, were fabricated, each including the same PETN:TNT weight ratio in the Pentolite layer 14, and insert member, the same as described with reference to the tests summarized in the preceding table. Each booster was shot with a No. 8 electric blasting cap. Energy release data were determined in the manner indicated by Cole (Cole, H. D., *Underwater Explosions*, Princeton University Press, Princeton, N.J. (1948), pages 228 to 285) and as reported by Sadwin (Sadwin, L. D., Cooley C. M., Porter, S. J., Stresau, R. H., *Underwater Evaluation of the Performance of Explosives*, "International Symposium on Mining Research," Missouri, Feb. 1961, vol. 1) and his collaborators with some minor modifications. The results of the tests are summarized in the following tabulation:

TABLE 2

Booster charge, TNT:Pentolite (weight ratio)	Test Number	Grams TNT (layer 13)	Density, gms./cc.	Bubble energy, ft. Lbs./lb. X 10 ³	Shock energy, ft. Lbs./lb. X 10 ³	Total energy, ft. Lbs./lb. X 10 ³	Volume energy, ft. Lbs./ft. ³ X 10 ³	Shock energy compared to 100% Pentolite shock energy
About 1:1.	1	240	1.53	804	690	1,494	1,426	.99
	2	240	1.53	760	677	1,437	1,372	.96
About 1.5:1	1	286	1.54	776	673	1,449	1,392	.96
	2	286	1.56	750	641	1,391	1,354	.92
About 2.3:1	1	336	1.54	746	613	1,359	1,306	.90
	2	336	1.54	766	575	1,341	1,289	.89
About 4:1	1	384	1.59	751	569	1,320	1,309	.88
	2	384	1.59	747	514	1,261	1,251	.84
1 pound Pentolite ¹			1.53	766	733	1,499	1,431	1.0

¹ Cast Pentolite, PETN:TNT weight ratio—45/55.

The preceding examples demonstrate the sensitivity and energy release obtained with a booster assembly of the invention to not differ significantly from that of a conventional cast pentolite booster of about the same size. The examples demonstrate the marked reduction on overall content of PETN in a pentolite booster charge accomplished in accordance with the invention without significant loss in booster charge performance.

Although the drawings and working examples are directed to reduction of proportions of PETN in cast PETN-TNT-type booster charges, the invention is, of course, similarly applicable to the reduction of RDX proportions in the cast RDX-NTN booster compositions, in all instances, without significant loss in booster performance.

When referring herein to comparable performance of pentolite and cyclotol booster type charges of the prior art, it is ment particularly to refer to energy and sensitivity characteristics. Thus a layered charge of a booster assembly of the invention provides for a marked reduction in proportions of RDX and/or PETN required to accomplish substantially the same energy and sensitivity characteristics of a conventional cyclotol or pentolite cast charge.

As will be evident to those skilled in the art, various modifi-

cations can be made or followed, in the light of the foregoing disclosure and discussion, without departing from the spirit or scope of the disclosure or from the scope of the claims.

What I claim and desire to protect by Letters Patent is:

1. In a booster assembly for a main explosive, wherein the booster charge is formed from TNT together with RDX and/or PETN, the improvement comprising as said booster charge a layer of a cast explosive selected from the group consisting of

pentolites, cyclotols, and mixtures thereof, and a layer of cast TNT, each said layer having a transverse surface of substantially the same size and shape as of the other and contiguous with the other only on an interface common to all of each said surface, said booster charge thereby requiring less RDX and/or PETN than required in conventional cyclotol and pentolite-type booster charges of comparable performance.

2. In a booster assembly of claim 1, means for support of a primary initiator for said booster charge within said layer of cast explosive contiguous to said TNT.

3. A booster assembly of claim 2 wherein the thickness of said layer contiguous to said TNT is from about one-eighth to 3 inches and the weight ratio of said cast TNT to said layer of explosive contiguous thereto is within the range of from about 0.2:1 to 8:1.

4. In a booster assembly of claim 3, said pentolite containing PETN in a weight ratio to TNT of from about 60/40 to 40/60, and said cyclotol containing RDX in a weight ratio to TNT of from about 75/25 to 50/50; and an insert member, within said charge, containing from 0.1 to 3 grams of an explosive of the group of PETN, tetryl, and RDX and disposed, at least in part within said layer of cast explosive contiguous to said TNT for detonation in response to action of a primary initiator when supported as described.

5. A booster assembly of claim 4, wherein said explosive contained in said insert is PETN, and said layer of explosive contiguous with said TNT is a pentolite.

6. A booster assembly of claim 5 wherein said pentolite contains PETN in a weight ratio to TNT of 45/55, and about 2.25 grams of said PETN is contained in said insert member.

7. A booster assembly of claim 5 wherein said booster charge has an overall weight in the range of from 85 to about 2500 grams.

8. A booster assembly of claim 7 wherein said layer of explosive contiguous to said layer of cast TNT is a top layer of said booster charge, and a cover layer of cast TNT superposed on said top layer.

9. In a booster assembly of claim 2 at least one tunnel member extending through said booster charge for support of a detonating fuse as said primary initiator.

10. In a booster assembly of claim 2, an insert member containing an explosive of the group of PETN, tetryl, and RDX; and disposed, at least in part, with said layer of cast explosive contiguous to said TNT for detonation in response to action of a primary initiator supported as described.

11. In a booster assembly of claim 2 a well member extending into said booster charge and terminating within said layer of cast explosive contiguous to said TNT for support of a blasting cap as said primary initiator.

12. In a booster assembly for a main explosive, wherein the booster charge is formed from TNT together with RDX and/or PETN, the improvement comprising as said booster charge a cylindrical layer of a cast explosive selected from the group consisting of pentolites, cyclotols and mixtures thereof, and acylindrical layer of cast TNT; and said cylindrical layers disposed contiguous with the other in abutted end-to-end relationship, said booster charge thereby requiring less RDX and/or PETN than required in conventional cyclotol and pentolite type booster charges of comparable performance.

13. In a booster assembly of claim 12, means for support of a primary initiator for said booster charge within said layer of cast explosive contiguous to said TNT; said pentolite containing PETN in a weight ratio to TNT of from about 60/40 to 40/60 and said cyclotol containing RDX in a weight ratio to TNT of from about 75/25 to 50/50; and an insert member within said charge, containing from 0.1 to 3 grams of an explosive of the group of PETN, tetryl and RDX and disposed, at least in part, within said layer of cast explosive contiguous to said TNT for detonation in response to action of a primary initiator when supported as described.

14. A booster assembly of claim 13 wherein said explosive contained in said insert member is PETN, and a cylindrical layer of cast pentolite in said end-to-end relationship with said cylindrical layer of TNT.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,604,353 Dated September 14, 1971

Inventor(s) Phillip G. Newman (Case 4)

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

- Column 1, line 9, "thin" should read --this--
- Column 1, line 27*, "or" should read --for--
- Column 2, line 1, "of cast" should read --of a cast--
- Column 2, line 9, "to" should read --or--
- Column 2, line 25*, "the" should read --that--
- Column 2, line 54*, "drawings illustrate" should read
--drawing illustrates--
- Column 3, line 6, after "layer 14" insert --and disposed
so as --
- Column 3, line 7, after "18" insert -- . (period)--
- Column 3, line 7, after "18." insert --Cap well 16 and
tunnel 18--
- Column 3, line 11, the sentence reading "Detonating
relationship with layer 14." should be deleted
- Column 3, line 27*, "190°" should read --172°--
- Column 4, line 6, " 11' " should read --11"--
- Column 4, line 16, "with" should read --within--
- Column 4, line 28*, "RCS" should read --RDX--
- Column 5, table 1, line 5 of footnotes, "layer 13" should
read --layer 14--

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,604,353 Dated September 14, 1971

Inventor(s) Phillip G. Newman (Case 4

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

Page 2

Column 5, line 38, "and insert" should read --and an insert--

Column 6, line 39, "NTN" should read --TNT--

Column 6, line 43, "ment" should read --meant--

Column 7, line 12, Claim 3, "if" should read --is--
(second occurrence)

Column 7, line 27, "in"/should read --is--

Column 7, line 33, Claim 7, after " . " --19-- should be deleted

Column 8, line 6, Claim 10, "with" should read --within--

Column 8, line 18, Claim 12, "acylindrical" should read --a cylindrical--

Signed and sealed this 21st day of March 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents