Nov. 24, 1959 J. D. HAYES 2,913,982

PRIMING DEVICE

Filed Dec. 29, 1952

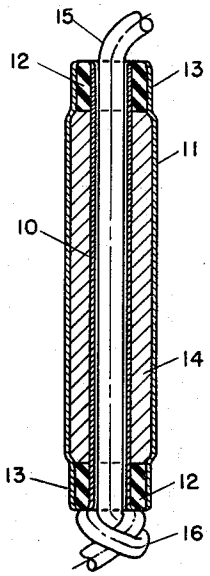

FIG. 1

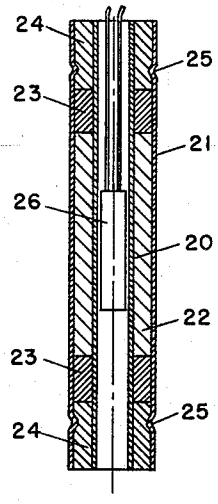

FIG. 2

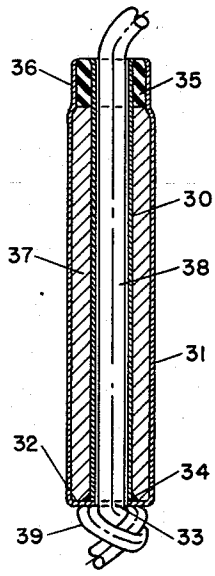

FIG. 3

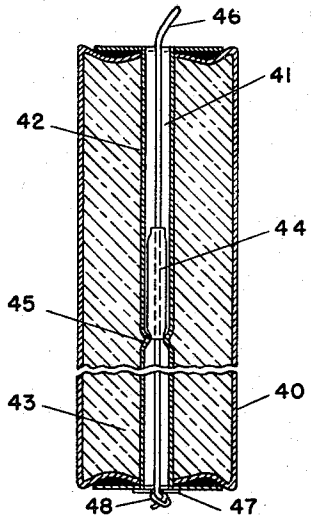

FIG. 4

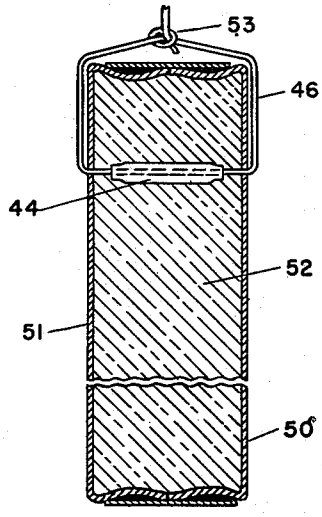

FIG. 5

JACK D. HAYES
INVENTOR.

BY Ernest G. Peterson

AGENT.

United States Patent Office

2,913,982

Patented Nov. 24, 1959

2,913,982

PRIMING DEVICE

Jack D. Hayes, Wilmington, Del., assignor to Hercules Powder Company, Wilmington, Del., a corporation of Delaware

Application December 29, 1952, Serial No. 328,405

22 Claims. (Cl. 102—24)

This invention relates to a detonating means for explosive charges and in particular to detonating devices especially adapted for use in explosive operations where relatively insensitive explosive or blasting agent is employed or where advanced temperatures are encountered which render the use of conventional blasting initiators undesirable.

In recent years there has been a decided trend toward the use of relatively insensitive blasting agents which contain little or no nitroglycerin or similar explosive oil and depend primarily for explosive strength on inorganic salts such as ammonium nitrate. Although such blasting agents, when brought to detonation, are characterized by adequate strength for most blasting operations, they are normally not detonatable by commercially available blasting caps. In fact, the test employed to determine the sensitivity characteristics of these insensitive blasting compositions is usually one in which their resistance to detonation by either a No. 6 or a No. 8 cap is determined.

The usual methods for detonating such explosive compositions have involved the use of separate priming cartridges containing high explosive such as trinitrotoluene and which are brought to detonation by detonating fuse or else a high potential booster cap is employed. Such booster caps are normally an oversized conventional cap containing a base charge of about 10 to about 30 g. of pentaerythritol tetranitrate or equivalent explosive. While both of these means of initiating explosives are operable, they still necessitate the use of electrical blasting initiators which are expensive and which themselves contain components more sensitive to both heat and shock than the relatively insensitive blasting agent itself. Thus, the safety for which the insensitive blasting compositions were originally designed is still not always obtainable in the degree desired by the art.

Special difficulties also have been encountered by the art in shooting hot holes in which the temperatures generated by underground fires in the region of the borehole often reach a point high enough to cause premature detonation of conventional blasting caps. A means for initiating these insensitive compositions which does not require the presence of large amounts of sensitive high explosive or heat-sensitive electric blasting caps in the borehole itself is therefore to be desired.

Now in accordance with the present invention, there has been developed an economical means for initiating insensitive blasting agents and explosives generally which does not require the presence of either large amounts of sensitive high explosive compositions or electric initiators of any sort in the immediate vicinity of the charge to be detonated. However, conventional blasting caps may be used in the invention if safety conditions permit.

Generally described, the present invention is a priming device for detonative blasting compositions which comprises an outer shell and a hollow open-ended inner member passing therethrough, spaced sealing means disposed between the inner surface of the shell and the exterior surface of the inner member to provide an enclosed space between the outer shell and inner member, and a charge of commercial detonating fuse-sensitive, crystalline high explosive disposed in the enclosed space and around the inner member.

In accordance with the present invention, both the outer shell and the hollow inner member are preferably made of metal such as aluminum or bronze. However, other materials, including plastics and various paper and fabric compositions, may be employed if desired. In accordance with one embodiment of the invention, concentric metal tubes are employed with sealing means disposed in the annular space therebetween adjacent the ends to form an enclosed space between the two tubes. This space is filled with the desired explosive material.

It is preferred to employ rubber washers as the sealing means and to form the seal by crimping the outer tube in the region of the rubber washer to compress the washer against the inner tube in sealing relationship. In place of the rubber sealing washers, however, there may be employed other resilient masses, thermoplastic or thermosetting plastic masses, or conventional sealing materials such as asphalt and molten sulfur may be poured into the annulus between the tubes in order to form the desired number or type of sealing layers.

In accordance with a further preferred embodiment of the invention, the outer tube will be open at one end but will be partially closed at the other end by means of a centrally orificed end wall. The open end of the inner member or tube registers with the orifice in the end wall and is suitably affixed in registered position by any suitable sealing means such as soldered or welded joints or by electrically sweating the two members together in sealed relationship. The crystalline explosive is then loaded into the annular space between the inner and outer tubes and the remaining seal effected by means of a rubber washer or other suitable body in the annulus between the tube ends. In preparing any of the primers in accordance with the invention, it is preferred to have one seal in place prior to loading the crystalline explosive.

As previously stated, the enclosed space or cavity between the shell and inner member is filled with crystalline high explosive which is sensitive to detonation by commercially available detonating fuse such as Primacord (pentaerythritol tetranitrate or cyclonite core covered with fabric or plastic sheath) or Cordeau (trinitrotoluene core covered with thin lead tubing). Such compositions are known to the art and include PETN (pentaerythritol tetranitrate), RDX (cyclonite or cyclotrimethylenetrinitramine), tetryl (tetranitromethylaniline), pentolite (mixtures of PETN and TNT), mixtures of RDX and PETN, and mixtures of RDX and/or PETN with TNT (trinitrotoluene). Trinitrotoluene by itself is not sufficiently sensitive for use in the invention. Consequently, when TNT is used in admixture with the more sensitive explosives, the amount of TNT employed will depend on the strength of the particular detonating fuse. In the case of pentolite, for instance, it is usually desirable to employ at least 40% of PETN. It is generally preferred that all mixtures employed have a detonation sensitivity at least as great as that of a pentolite containing 40% PETN and 60% TNT. Mixtures of equal parts of RDX and TNT are very satisfactory. RDX, PETN and tetryl are the preferred crystalline explosives. It is preferred to employ the explosive in particulate form although those containing TNT may be cast if desired. When employing particulate material it is desirable to press the explosive in place, preferably in increments, to obtain a density of about 1.45 g./cc. The amount of crystalline explosive employed in each device will depend on the priming strength desired. For most purposes 20

g. of explosive has been found to be adequate, although any desired amount can be used.

In employing the priming device of the invention, a length of detonating fuse such as Cordeau or Primacord is preferably disposed in the hollow inner tube or member or passes completely through the hollow inner tube or member as desired. A conventional electric initiator may be placed within the tube, if desired, although for the reasons hereinabove set forth the use of electric initiators is not preferred. The priming device is then placed within the charge to be detonated and where the preferred detonating fuse is employed, the fuse will be detonated by a conventional means at the desired distance from the charge.

In a preferred embodiment the priming device of the invention will be employed with a special primer cartridge which will consist of a container filled with a blasting composition which is insensitive to the normal commercially available blasting cap and has a passageway extending therethrough or a well disposed therein. The priming device will be disposed in such a passageway or well and the resulting primer cartridge will be employed at the desired point in the explosive charge to effect positive detonation. Preferably the primer cartridge will be a cylindrical cartridge having a hollow coaxial core formed by a coaxially disposed tube. The priming device will be disposed in the hollow core with a length of Primacord extending through the priming device and suitably secured to the primer cartridge. The detonating fuse may be suitably secured by passing it completely through the coaxial core and through a centrally orificed disk or other orificed body larger than the diameter of the coaxial core and then knotting the fuse to prevent withdrawal. Alternatively, the leading end of the detonating fuse can be tied or otherwise secured to the fuse above the cartridge. In either of these modifications the primer cartridge can be lowered into a borehole by means of the detonating fuse. Suitable priming cartridges may also be made in the field with conventional explosive cartridges as will be hereinafter described.

Having generally described the invention, specific embodiments thereof will be more specifically described with reference to the accompanying drawing in which like symbols refer to like elements.

Figs. 1, 2, and 3 are part elevational, part sectional views of priming devices in accordance with the invention. Fig. 4 is a part sectional, part elevational view of an embodiment of a primer cartridge in accordance with the invention. Fig. 5 is a part sectional, part elevational view of a further embodiment of a primer cartridge in accordance with the invention.

In Fig. 1 a hollow inner tube 10 is concentrically disposed within a hollow outer tube 11. Rubber washers 12 are disposed in the annulus between the tubes 10 and 11 adjacent the ends thereof and are compressed between the two tubes by crimps as shown at 13. A charge 14 of a crystalline explosive such as cyclonite is disposed in the annular space between the tubes 10 and 11. A length of detonating fuse 15 extends through the hollow inner tube 10 and is knotted at 16 to prevent withdrawal.

In Fig. 2 a hollow inner tube 20 is concentrically disposed in an outer tube 21. A charge 22 of crystalline high explosive such as PETN is disposed in the annular space between the tubes 20 and 21. A layer of asphaltic compound 23 is disposed above and below the charge of explosive nad an additional sealing layer 24 of sulfur is disposed outwardly of the device from the asphaltic layers 23. Detents 25 retain the sulfur layers in position. An electric blasting cap 26 is disposed within the interior of the inner tube 20.

In Fig. 3, a metallic inner tube 30 is concentrically disposed within an outer metallic tube 31. The tube 31 is open at its upper end but is partially closed at its lower end by an end wall 32 provided with a central orifice 33. The end of the tube 30 registers with the orifice 33. The end of the tube 30 is soldered in sealing relationship to the end wall 32 at 34. A rubber washer 35 is disposed in the annular space between the tubes 30 and 31 at the opposite end of the device. A crimp 36 is formed in the outer tube 31 to compress the rubber washer 35 between the tubes 30 and 31. A body of crystalline high explosive 37 is disposed in the remaining annular space between the tubes 30 and 31. A length of Primacord 38 is disposed in the inner tube 30 and is prevented from being withdrawn by knot 39.

In Fig. 4, a primer cartridge 40 contains a coaxial bore or passage 41 formed by a cellulose acetate tube 42. The cartridge contains a charge 43 of commercially insensitive blasting exposive disposed about the tube 42. A priming device 44 similar to any of those shown in Figs. 1–3 is positioned within the coaxial bore 41 and is prevented from further progress through the tube by indentation 45. A length of detonating fuse 46 such as Primacord passes through the bore 41, the inner tube of the device 44, and through a centrally orificed wooden disk 47 and is knotted as at 48 to prevent withdrawal from the cartridge.

In Fig. 5, a conventional cartridge 50 is formed from a spirally wound paper shell 51 filled with commercial dynamite 52. A priming device 44 similar to any of those shown in Figs. 1 through 3 is disposed in the dynamite 52. A length of detonating fuse 46 such as Primacord passes through the shell 51, the dynamite 52, the inner tube of the priming device 44, the dynamite 52 and out through the opposite side of the shell 51. The detonating fuse is knotted above the cartridge as at 53. Preferably the cartridge shown in Fig. 5 will be made up in the field as follows. The leading end of the fuse 46 is initially threaded through the inner tube of the priming device 44. The leading end of the fuse is then secured to a suitable powder punch and the fuse is threaded through a conventional cartridge at the desired point, thus providing a passage through the cartridge. The priming device 44 is then forced through the shell 51 and pushed into the central portion of the cartridge by a powder punch or other suitable means. The fuse is then knotted as shown at 53.

Having generally described and illustrated the invention, the following examples are given to specifically illustrate the use of the invention in blasting operations.

Example 1

A plurality of boreholes were loaded with commercial blasting cap insensitive blasting agent. In the central portion of the charge a primer cartridge such as that shown in Fig. 4 was located. The primer cartridge consisted of a specially prepared cartridge having a cellulose acetate tube passing coaxially through the cartridge. A priming device similar to that shown in Fig. 1 was employed. Primacord was employed as the detonating fuse. The holes in which this shot was made are considered by the art as hot holes due to underground fires in the vicinity. Primacord leading to each hole was detonated at a safe distance from the holes by blasting caps. The shot was normal in all respects with all holes firing completely.

Example 2

A plurality of boreholes were loaded with semigelatin dynamite and were primed with a primer cartridge made in the field and similar to that shown in Fig. 5. A priming device similar to that shown in Fig. 1 was threaded on a length of Primacord and the Primacord was threaded diametrically through the upper portion of a conventional cartridge containing semigelatin dynamite by means of a powder punch. The priming device was then pushed through the wall of the cartridge with the fingers and pushed into a central position by the powder punch. The Primacord was knotted as shown in Fig. 5. A primer

cartridge thus formed was disposed in the central portion of the charge in each borehole. The holes were fired by detonating the Primacord at a safe distance with blasting caps. All holes fired normally and completely.

It is apparent that various structural combinations in accordance with the invention may be employed for particular applications. For example, where it is desired to obtain optimum resistance to heat, it is preferred to employ cyclonite as the crystalline high explosive. On the other hand, where it is desired to obtain adequate resistance to heat and greater sensitivity to detonation, it is preferred to employ PETN or tetryl as the crystalline high explosive. Although the use of metal tubing is preferred for the inner and outer members, it is apparent that other materials of construction may be employed, although they may be less desirable. For example, concentric plastic tubes may be employed or, if desired, a structure such as that defined by the tubes **30** and **31** of Fig. 3 can be produced by making a single injection molding of a suitable plastic and, after loading the charge of explosive into the space between the tubular members, the annulus at the open end may be suitably sealed by means of an annular stopper of resilient material such as rubber or by an annular plug of the same or different plastic material which will form a bond with the tubes **30** and **31** when suitably moistened with a mutual solvent.

When sealing layers are employed as in both ends of Figs. 1 and 2 and in the one end of Fig. 3, it is preferred to employ a rubber washer in order to readily and economically effect a strong waterproof seal. Buna-S or reclaimed rubber is the preferred rubber material from which such washers are made and it is preferred that the rubber have a durometer hardness of about 80 or more. Softer materials are operable but are not characterized by as great a resistance to water pressure as those having the durometer hardness of 80. In fact, it has been found that when employing a Buna-S or reclaimed rubber washer formed from a material having a durometer hardness of 80, complete waterproofing was obtained when the devices were subjected to water pressures of 100 pounds for a period of 24 hours or more. As indicated in Fig. 2, sealing layers of asphalt and/or sulfur may also be employed and various types of plastic materials such as polyvinyl chloride, ethyl cellulose, cellulose acetate, neoprene, and the like are also operable.

While the invention has been specifically illustrated with blasting cartridges comprising paper shells, it will be understood that the cartridge shell may be made of any desirable material of construction including, without limitation, metal, plastic, cardboard, or suitable composition. Furthermore, the invention is not restricted to the specific blasting agents or explosives disclosed, since any desired blasting explosive may be employed.

Since further modification within the scope of the invention will be apparent to those in the art, it is intended that the invention be limited only by the appended claims.

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

1. A priming device for detonative blasting compositions which comprises a cylindrical outer metal shell, a substantially coextensive hollow metal tube coaxially disposed within the shell to form an annular space therebetween, a body of resilient sealing material disposed at each end of said shell in the annular space between shell and tube to provide an enclosed space between said shell and said tube, a crimp formed adjacent each end of the outer shell to compress the sealing material, and a charge of commercial detonating fuse-sensitive, crystalline high explosive disposed in the said enclosed space.

2. A priming device for detonative blasting compositions which comprises a cylindrical outer metal shell, a substantially coextensive hollow metal tube coaxially disposed within the shell to form an annular space therebetween, a rubber sealing washer disposed about each end of the tube, a crimp formed adjacent each end of the outer shell to compress the rubber washers between tube and shell, and a charge of pressed, particulate, commercial detonating fuse-sensitive, crystalline high explosive disposed in the enclosed space.

3. A priming device according to claim 2 in which the crystalline high explosive is cyclonite.

4. A priming device according to claim 2 in which the crystalline high explosive is pentaerythritol tetranitrate.

5. A priming device according to claim 2 in which the crystalline high explosive is tetryl.

6. A priming device for detonative blasting compositions which comprises a cylindrical outer metal shell having one end open and the other end partially closed by a centrally perforated end wall, a substantially coextensive hollow metal tube coaxially disposed within the shell, one end of said tube registering with the orifice in the end wall and affixed in sealing relationship with the end wall adjacent the orifice, a body of resilient sealing material disposed in the annular space adjacent the opposite end of the tube, a crimp formed adjacent the open end of the shell to compress the resilient body, and a charge of commercial detonating fuse-sensitive, crystalline high explosive disposed in the annular space.

7. A priming device for detonative blasting compositions which comprises a cylindrical outer metal shell having one end open and the other end partially closed by a centrally perforated end wall, a substantially coextensive hollow metal tube coaxially disposed within the shell, one end of said tube registering with the orifice in the end wall and being soldered in sealing relationship with the shell bottom adjacent the orifice, a rubber sealing washer disposed about the opposite end of the tube, a crimp formed adjacent the open end of the shell to compress the rubber washer between tube and shell, and a charge of pressed, particulate, commercial detonating fuse-sensitive, crystalline high explosive disposed in the enclosed space.

8. A priming device according to claim 7 in which the crystalline high explosive is cyclonite.

9. A priming device according to claim 7 in which the crystalline high explosive is pentaerythritol tetranitrate.

10. A priming device according to claim 7 in which the crystalline high explosive is tetryl.

11. A priming device for detonative blasting compositions which comprises an elongated shell; a conduit in said shell extending entirely therethrough and spaced from the shell inner wall to form an annulus; said annulus being closed at spaced apart points to form an enclosed space between said conduit and said shell inner wall; a body of resilient sealing material disposed in the said annulus around said conduit and against the inner shell wall as the resulting closure at at least one of said spaced apart points; a body of detonating fuse-sensitive crystalline high explosive in the said enclosed space; and a crimp formed around each shell portion containing said body of sealing material to compress said body.

12. A priming device of claim 11 wherein said conduit is substantially coextensive, and coaxial, with said shell, and said shell and conduit are each cylindrical and formed from metal.

13. An explosive charge comprising an elongated cartridge and a detonable blasting composition therein; a priming assembly, disposed in said composition, comprising an elongated shell; a conduit in said shell extending entirely therethrough and spaced from the shell inner wall to form an annulus; said annulus being closed at spaced apart points to form an enclosed space between said conduit and said shell inner wall; a body of sealing material disposed in the said annulus around said conduit and against the inner shell wall as the resulting closure at at least one of said spaced apart points; a body of detonating fuse-sensitive crystalline high explosive in the said enclosed space; a crimp formed around each shell portion containing said body of sealing material to compress said body; a length of detonating fuse,

extending entirely through said conduit and on to a point external to said cartridge and secured at its extended end to prevent its withdrawal from said conduit.

14. A primed explosive charge comprising a cylindrical cartridge containing a passageway extending longitudinally, and entirely, therethrough; a charge of detonatable blasting composition disposed in the said cartridge adjacent and around the said passage; and a priming device disposed in the said passage which comprises a cylindrical outer metal shell; an open metal tube coaxially disposed within the said shell, and substantially coextensive therewith, to form an annulus; said annulus being closed at spaced apart points to form an enclosed space between said tube and the shell inner wall; a body of resilient sealing material disposed in the said annulus around said tube and against the shell inner wall as the resulting closure at at least one of said spaced apart points; a detonating fuse-sensitive crystalline high explosive disposed within the said enclosed space; and a length of detonating fuse extending entirely through the said tube and said passage secured at its extended end, external to said cartridge, to prevent its withdrawal from said tube.

15. A charge of claim 13 wherein said detonating fuse is engaged at its said extended end with a centrally orificed member of cross section greater than that of said passageway to prevent withdrawal of said fuse from said passage.

16. A charge of claim 13 wherein said detonating fuse is knotted at its said extended end to prevent said withdrawal.

17. A priming device for detonative blasting compositions which comprises a cylindrical outer metal shell; a metal tube disposed within said shell coaxial, and substantially coextensive, therewith, to form an annulus; said annulus being closed at spaced apart points, each in close proximity to an end of said shell, to form an enclosed space in said annulus; a body of resilient sealing material within said annulus disposed at each of said points around the said tube and in contact with the shell inner wall as a portion of each resulting closure; a body of sulfur in the said annulus around the said tube and in contact with the shell inner wall adjacent each said body of resilient material and intermediate said resilient material and the end of said shell associated therewith as above described; a body of detonating fuse-sensitive crystalline high explosive in the said enclosed space; and a crimp formed around each shell end containing a body of sulfur as described, to support said sulfur body as a remaining portion of each said closure.

18. A primed explosive charge comprising a cylindrical cartridge, and a detonatable blasting composition in said cartridge; an elongated priming device within said blasting composition disposed transversely to the longitudinal axis of said cartridge; said priming device comprising an elongated shell; a conduit in said shell extending entirely therethrough and spaced from the shell inner wall to form an annulus; said annulus being closed at spaced apart points to form an enclosed space between said conduit and said shell inner wall; a body of sealing material disposed in the said annulus around said conduit and against the inner shell wall as the resulting closure at at least one of said spaced apart points; a body of detonating fuse-sensitive crystalline high explosive in the said enclosed space; a crimp formed around each shell portion containing said body of sealing material to compress said body; and a length of detonating fuse extending from a point external to said cartridge through a side wall thereof into, and entirely through, said conduit and then through another cartridge wall portion back to said external point, and tied at said point so as to form a bail for said cartridge.

19. A priming device of claim 11 wherein said crystalline high explosive has a detonation sensitivity at least as great as that of a pentolite containing 40 percent pentaerythritol tetranitrate and 60 percent trinitrotoluene.

20. A priming device for detonative blasting compositions which comprises an elongated shell; a conduit in said shell extending entirely therethrough and spaced from the shell inner wall to form an annulus; said annulus being closed at spaced apart points to form an enclosed space between said conduit and said shell inner wall; a body of resilient sealing material compressed in the said annulus around said conduit and against the inner shell wall as the resulting closure at at least one of said spaced apart points; and a body of detonating fuse-sensitive crystalline high explosive in the said enclosed space.

21. An explosive charge of claim 13 wherein said body of sealing material disposed in said annulus is resilient.

22. A priming device for detonative blasting compositions which comprises an elongated shell; a conduit in said shell extending entirely therethrough and spaced from the shell inner wall to form an annulus; said annulus being closed at spaced apart points to form an enclosed space between said conduit and said shell inner wall; a body of resilient sealing material compressed in the said annulus around said conduit and against the inner shell wall as a portion of the resulting closure at at least one of said spaced apart points; a body of sulfur in the said annulus around said conduit and in contact with the shell inner wall, adjacent the said body of resilient material and outside said enclosed space; a body of detonating fuse-sensitive crystalline high explosive in the said enclosed space; and a crimp formed around each shell portion containing a body of said sulfur to support said sulfur body as an additional portion of said closure.

References Cited in the file of this patent

UNITED STATES PATENTS

58,656	Lucas	Oct. 9, 1866
415,899	Butterfield et al.	Nov. 26, 1889
1,140,633	Trucano	May 25, 1915
1,406,844	Gelm	Feb. 14, 1922
2,037,906	Holran et al.	Apr. 21, 1936
2,311,721	Wilson	Feb. 23, 1943
2,448,658	Carey	Sept. 7, 1948
2,487,317	Davidson	Nov. 8, 1949
2,706,949	Kessenich	Apr. 26, 1955
2,707,437	Noddin et al.	May 3, 1955
2,708,408	Sweetman	May 17, 1955
2,733,658	Moat	Feb. 7, 1956
2,775,200	Guenter	Dec. 25, 1956
2,839,997	Church et al.	June 24, 1958

FOREIGN PATENTS

14,548	Great Britain	of 1893
440,273	Germany	Jan. 29, 1927