United States Patent [19]

Maes et al.

[11] **3,768,411**

[45] **Oct. 30, 1973**

[54] **SAFETY BLASTING APPARATUS AND METHOD**

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[73] Assignee: **Explosives Corporation of America**, Issaquah, Wash.

[22] Filed: **Nov. 29, 1971**

[21] Appl. No.: **202,876**

[52] **U.S. Cl.** ..... **102/24 R**, 102/23, 102/70 R

[51] **Int. Cl.** **F42b 3/00**, F42d 1/06, F42d 3/04

[58] **Field of Search** ..... 102/28, 57, 58, 24 R, 102/23, 70 R

[56] **References Cited**

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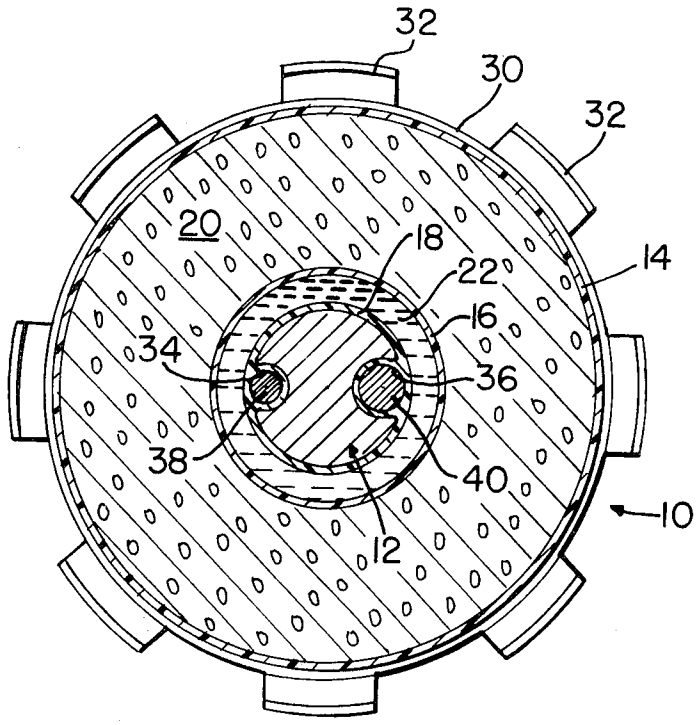
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Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—J. V. Doramus
Attorney—John O. Graybeal et al.

[57] **ABSTRACT**

A two component explosive mix package having two component containing chambers separated by a rupturable wall. A detonating cord is arranged in sufficient proximity to the rupturable wall so that detonation of the cord ruptures the wall to cause mixing of the two components to make an explosive mixture. Thereafter activation of other detonating means causes the mixture to explode.

10 Claims, 9 Drawing Figures



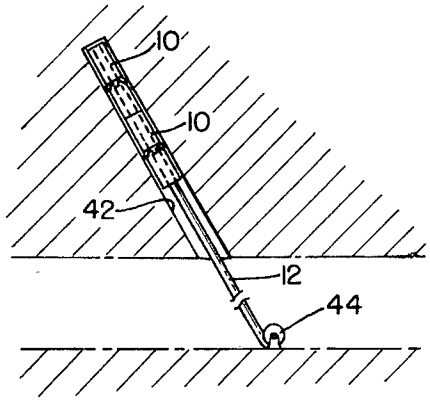


FIG. 1

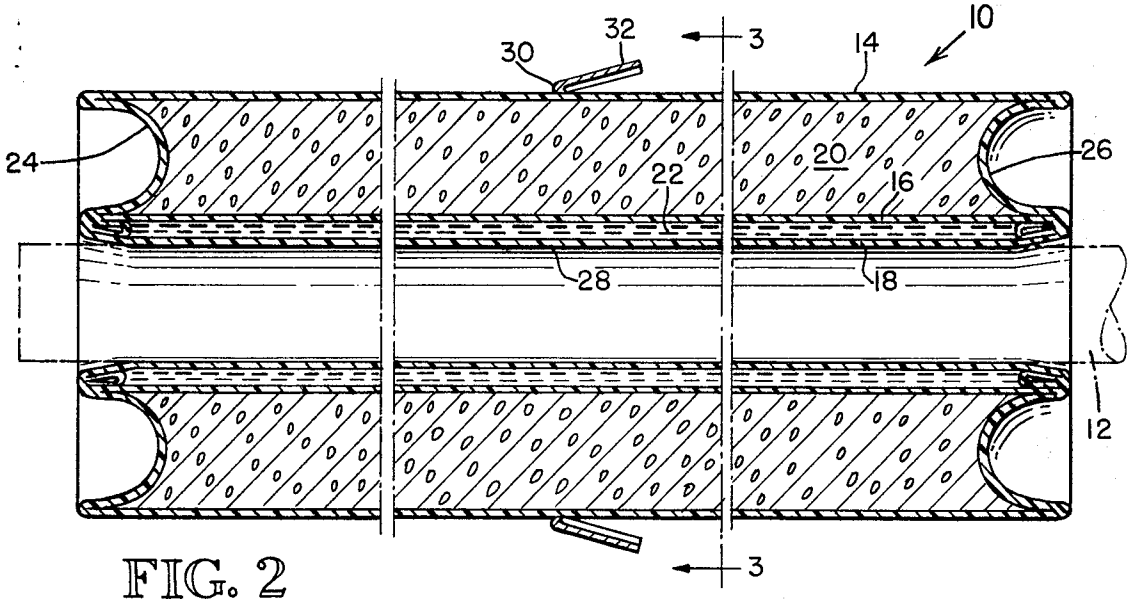


FIG. 2

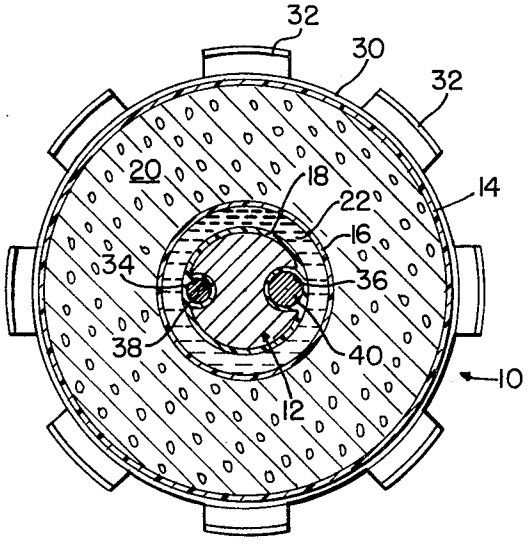


FIG. 3

FIG. 4

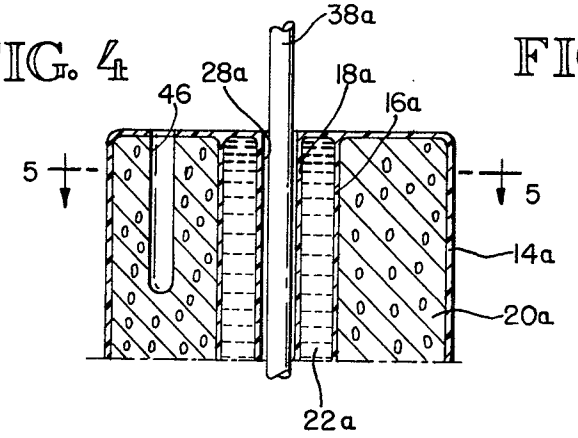


FIG. 5

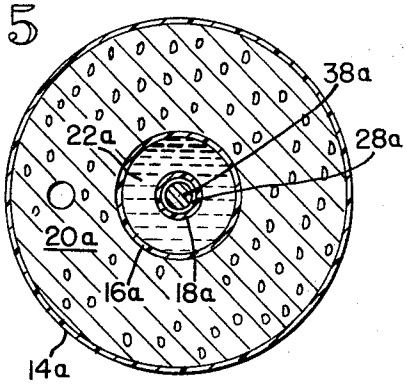


FIG. 6

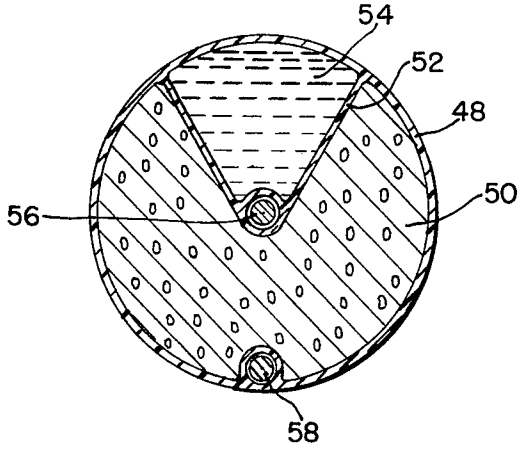


FIG. 7

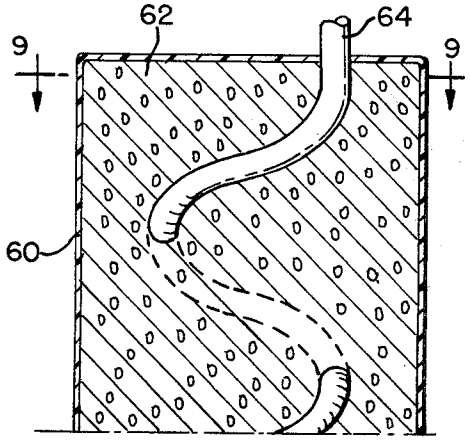


FIG. 8

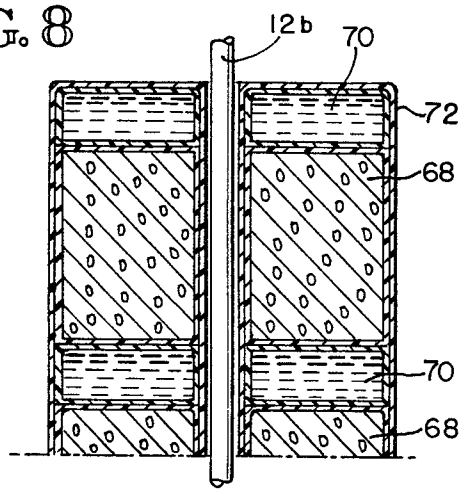
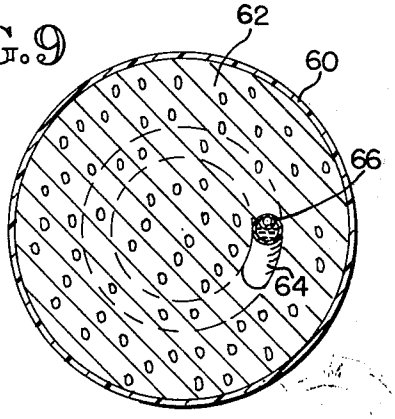


FIG. 9



SAFETY BLASTING APPARATUS AND METHOD

In a first embodiment there are one or more packages, each having an inner and an outer annular component containing chamber. An elongate actuating member reaches through the center of the package or packages, and has along its length two detonating cords spaced from one another. Detonation of the first cord causes the rupturable wall to open to cause the two components to mix, and detonation of the second cord causes explosion of the mixture. The second embodiment is similar to the first embodiment, except that there is only a first detonating cord in the center passageway of the package to cause mixing of the two components, and a detonating well is provided in the package to detonate the explosive mixture.

In a third embodiment, there is a cylindrical container defining a first chamber, and a longitudinal rupturable wall member defining a second chamber formed in transverse section as an arcuate section of the cylindrical first chamber.

In a fourth embodiment, there is a cylindrical container defining a first chamber, and a coiled tubular member within the first container to contain a second explosive mix component. The detonating mixing cord is disposed along the length of the second coiled containing member.

In a fifth embodiment there are separate packages of the first and second explosive mix component stacked alternately. Each package has a center opening to receive an actuating member having two detonating cords as in the first embodiment.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus and method for field mixing of a two component explosive, and more particularly to an apparatus and method for mixing of a two component explosive installation in a bore hole.

2. Description of the Prior Art

Several prior art patents show containers or packages having two separate explosive mix components which by mechanical means are caused to be intermixed. Typical of these are: Lewis U.S. Pat. No. 2,929,325; Hopkins U.S. Pat. No. 2,426,269 and Maes U.S. Pat. No. 3,580,171.

SUMMARY OF THE INVENTION

In the present invention, there is a blasting package assembly having first and second chambers containing respective first and second explosive mix components, and having explosively openable separating means for said two components. Actuation of a first explosive mixing means causes said separating means to open to permit intermixing of the two components to form an explosive mixture which can then be detonated by detonating means.

In a first embodiment, there is a blasting package having annular, circumjacent, longitudinally aligned first and second chambers separated by a rupturable wall or membrane. An elongate actuating member fits through a center opening in the package. This actuating member has two longitudinally aligned, circumferentially spaced detonating cords, one for rupturing the separating wall to cause mixing of the two components and the other to detonate the explosive mixture.

A second embodiment, similar to the first embodiment, has only a single detonating cord in a center

opening, and a detonating well formed in the package for exploding the mixture.

In a third embodiment, there is a cylindrical container defining the first chamber, with a rupturable wall defining a longitudinal, arcuate section out of the cyindrical container as the second chamber. There is a centrally disposed explosive mixing cord, and a cord located proximate the outside wall of the container to detonate the explosive mixture.

In a fourth embodiment there is a cylindrical container defining the first chamber, and a tubular container coiled therein to define the second chamber. The explosive mixing cord is disposed lengthwise in the coiled tubular container.

In a fifth embodiment, a plurality of separate first and second packages containing, respectively, first and second explosive mix components, are stacked alternately on top of one another. An actuating member, similar to that of the first embodiment, extends through these packages for first mixing and then detonating the resulting explosive mixture.

In the process of the present invention, one or more two component package assemblies are inserted into a bore hole in their unmixed condition and can be stored there for a period of time. The explosive mixing means is then detonated to rupture the separating means to cause intermixing of the two explosive mix components. Then the explosive mixture is detonated.

In the particular process of the first embodiment, one or more of the two component packages are moved along the actuating member into the bore hole. In other embodiments, the one or more packages can be strung on the explosive mixing cord downwardly to a bore hole.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view illustrating the process of the present invention;

FIG. 2 is a longitudinal sectional view of the apparatus of the first embodiment of the present invention;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2;

FIG. 4 is a partial longitudinal sectional view of a second embodiment of the present invention;

FIG. 5 is a transverse sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is a sectional view similar to FIG. 5, illustrating a third embodiment of the present invention;

FIG. 7 is a view similar to FIG. 4, illustrating a fourth embodiment of the present invention;

FIG. 8 is a view similar to FIG. 7, illustrating yet a fifth embodiment of the present invention, and

FIG. 9 is a transverse sectional view taken along line 9—9 of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The first embodiment of the invention is shown in FIGS. 1, 2 and 3. The main components are one or more component blasting packages 10 and an actuating member 12 to cause first mixing and then detonation of the explosive components in the package or packages 10.

One such blasting package is illustrated in detail in FIGS. 2 and 3. The blasting package 10 comprises concentric cylindrical walls, namely an outer wall 14, an intermediate wall 16, and an inner wall 18. The outer

and intermediate walls **14** and **16** define a first annular chamber **20**, containing a first solid explosive mix component, such as ammonium nitrate in powdered or granular form. The intermediate and inner walls **16** and **18** define a second annular inner chamber **22** containing a second liquid explosive mix component, such as hydrazine or a mixture of hydrazine and water. The two chambers **20** and **22** are closed by front and rear closure caps **24** and **26**, respectively. The entire package can be made of polyethylene or other suitable material, and can be a flexible package.

The inner wall **18** defines a center through opening **28** adapted to receive the aforementioned elongate actuating member **12**. A locking collar **30** is mounted around the outer wall **14**. This collar **30** has circumferentially spaced outwardly and rearwardly protruding ears **32**, the function of the ears **32** being to hold the package **10** in place after the package **10** is pushed into a bore hole.

The actuating member **12** has an elongate cylindrical configuration, is desirably made of flexible plastic, and has formed thereon two longitudinal grooves **34** and **36**. In the groove **34** is a relatively small detonating cord **38** which serves the function of explosively mixing the two explosive mix components in the chambers **22** and **20**. In the groove **36** is a second larger detonating cord **40** which serves to detonate the resulting explosive mixture. The two detonating cords **38** and **40** are circumferentially spaced on the rod **12** (as shown herein in diametrically opposed relationship) so that detonation of the cord **38** will not cause premature detonation of the cord **40**.

The operation of the present invention can best be described with reference to FIG. **1**, wherein there is shown an upwardly directed drilled passageway or bore hole **42** in an ore formation. First, a length of actuating member **12** is taken from a spool **44** (shown porportionately smaller for convenience of illustration) on which the member **12** is wound, and this length **12** is inserted upwardly into the hole **42**. Then one or more blasting packages **10** are slipped over the member **12** (with the member **12** extending through the package center opening **28**), and the one or more packages **10** are pushed upwardly into the hole **42**. This can be accomplished, for example, by means of a pipe fitting over the member **12** being used as a pusher or a ram. The ears **32** function to bear against the surrounding hole wall to hold the packages in place in the hole **42**. In this condition, the explosive assembly is quite safe, since the two separate explosive mix components are separately non-detonable. This assembly can be left in place in the hole **42** for a period of months.

When it is desired to blast in the hole **42**, first the explosive mixing detonating cord **38** is detonated. The explosive shock from the cord **38** travels outwardly against the liquid component in the chamber **22** rupturing the intermediate wall **16**. The moderate explosive force also forces some of the liquid mix component into the outer chamber **20**. In a short time (e.g. **15** to **30** seconds) the liquid component soaks into the solid explosive mix component to make an explosive mixture. The detonating cord **40** is then detonated to cause the mixture of the first and second mix components to explode.

The second embodiment is shown in FIGS. **4** and **5**. Since this second embodiment is quite similar to the first embodiment, like components will be given like numerical designations, with an "*a*" suffix distinguishing those of the second embodiment.

There is a package **10***a* having a plurality of concentric cylindrical walls **14***a*, **16***a* and **18***a* defining two concentric chambers **20***a* and **22***a*. However, the center opening **28***a* is of a smaller diameter than in the first embodiment, and receives only an explosive mixing cord **38***a*. In one end of the package **10***a* there is formed a detonator well **46** to receive either a detonating cord or other detonator, such as an electric or fuse type detonator.

As in the first embodiment, one or more packages **10***a* are placed in a bore hole, with a mixing detonating cord in the center thereof. The mixing cord **38***a* is detonated to cause mixing of the two components, and the explosive mixture can then be detonated in a suitable manner by means of a detonator in the well **46**.

The third embodiment is illustrated in FIG. **6**. There is a cylindrical container **48** defining a first component chamber **50**. Within the container **48** is a longitudinal wall member **52** defining an elongate arcuate chamber **54**, which is the second component chamber. In a center opening of the container **48**, adjacent the longitudinal apex of the wall member **52** is a first detonating cord **56**, which serves as the explosive mixing means. A second detonating cord **58** adjacent the outer wall of the container **48**, serves to detonate the explosive mixture. The mode of operation is substantially the same as in the second embodiment.

The fourth embodiment is shown in FIGS. **7** and **9**. There is a cylindrical container **60** defining a first component chamber **62**. Coiled in the chamber **62** is a tubular container **64** containing the second explosive mix component. Running the length of the tubular container **64** and adjacent the wall thereof, is an explosive mixing cord **66**. Detonating the cord **66** causes the two components to mix to form an explosive mixture. Then other detonating means can be used to cause explosion of the mixture.

The fifth embodiment is illustrated in FIG. **8**. In the fifth embodiment there is a cylindrical actuating member **12***b*, similar in configuration and function to the aforementioned actuating member **12** of the first embodiment. Thus this member **12***b* has running the length thereof two spaced detonating cords, similar to those shown in FIG. **3**, one for mixing the two components and the other for causing detonation of the explosive mixture.

In this fifth embodiment, there are first and second annular packages **68** and **70**, respectively. The one or more packages **68** contain the first explosive mix component and the one or more packages **70** contain the second explosive mix component. Either one set of packages **68** and **70**, or several sets of the packages **68** and **70** are placed in the bore hole onto the actuating member **12***b*. When several packages **68** and **70** are used, they are stacked in alternate relationship. If desired, these packages **68** and **70** can be encased in a cylindrical container **72**. In other respects, the mode of operating is substantially the same as in the first embodiment.

What is claimed is:

1. A safety two component explosive assembly adapted for down hole mixing and subsequent detonation, said assembly comprising:

a. blasting package means having first and second containing means contiguous to one another, in-

cluding separating means for said containing means,

b. first and second separately non-explosive mix components in, respectively, said first and second containing means,

c. an explosive mixing means positioned in said package means in a manner to explosively open said separating means upon activation of said explosive mixing means to cause mixing of the said two components into an explosive mixture, and

d. a detonating means operable separately from said explosive mixing means and spaced sufficiently from said explosive mixing means so that activation of said explosive mixing means does not cause premature activation of said detonating means, said detonating means being so disposed in said assembly as to cause detonation of said explosive mixture upon activation thereof,

whereby initial activation of said explosive mixing means causes formation of said explosive mixture, and subsequent independent activation of said detonating means causes said explosive mixture to detonate.

2. The assembly as recited in claim **1**, further comprising an elongate actuating member positioned in proximity with said package means, said explosive mixing means comprising a first detonating cord positioned along the length of said actuating member, and said detonating means comprising a second detonating cord positioned along said actuating member in spaced relationship with respect to said first detonating cord.

3. The assembly as recited in claim **2**, wherein said package means has an annular configuration with an internal through opening, and said actuating means is positioned in said opening.

4. The assembly as recited in claim **3**, wherein said package means has an annular configuration with an interior through opening, and said explosive mixing means comprises a detonating cord positioned in said through opening, and said detonating means comprises a second detonating cord positioned in proximity to said package means at a location spaced outwardly from said first detonating cord.

5. The assembly as recited in claim **2**, wherein said first and second containing means comprises first and second packages in stacked relationship along the length of said actuating member.

6. The assembly as recited in claim **5**, wherein there is a plurality of stacked first and second packages with said first and second packages being stacked alternately.

7. A method of in-hole mixing and detonation of an explosive composition, said method comprising:

a. placing in a hole a blasting package means having first and second containing means contiguous to one another, containing, respectively, first and second independently non-explosive mix components, with separating means separating said components,

b. also placing in proximity to said package means a first explosive mixing means and a second detonating means spaced from said explosive mixing means,

c. activating said explosive mixing means to open said separating means and effect intermixing of said first and second components to form an explosive mixture,

d. subsequent to the mixing of the two components to form an explosive mixture, activating the detonating means to cause detonation of said explosive mixture.

8. The method as recited in claim **7**, wherein one of said components comprises ammonium nitrate, and the other component comprises a liquid selected from a group consisting of hydrazine and a mixture of hydrazine and water, and said mixing of said two components is accomplished by explosively opening said containing means to cause said liquid component to wet said ammonium nitrate.

9. A method of mixing a two-component explosive in a relatively narrow passageway and detonating the same, said method comprising:

a. inserting in said passageway an elongate actuating member having mounted thereto an explosive mixing detonating cord,

b. mounting to said actuating member explosive package means having first and second containing means containing, respectively "to a position where said first and second containing means are contiguous to one another", first and second independently non-explosive components,

c. moving said package means along said member into said passageway,

d. actuating said detonating cord to cause mixing of said first and second components to form an explosive mixture, and

e. subsequent to said mixing, detonating said explosive mixture.

10. The method as recited in claim **9**, wherein said actuating member is inserted into said hole with second detonating cord means mounted thereon in spaced relationship to said first named detonating cord, and detonating said explosive mixture by actuating said second detonating cord.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,768,411 **Dated** October 30, 1973

Inventor(s) Michel E. Maes et al

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

Column 6, lines 34, 35, and 36, beginning on line 34, after "respectively" delete --"to a position where said first and second containing means are contiguous to one another"--.

Column 6, line 39, after "passageway" insert -- to a position where said first and second containing means are contiguous to one another--.

Signed and sealed this 29th day of April 1975.

(SEAL)
Attest:

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Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks