United States Patent Office 3,361,604
Patented Jan. 2, 1968

3,361,604

EXPLOSIVE SLURRIES CONTAINING AN INORGANIC OXIDIZER SALT AND PARTICULATE FIBROUS NATURALLY WET PULPY PLANT MATTER

George L. Griffith, Coopersburg, Pa., assignor to Trojan Powder Company, Allentown, Pa., a corporation of New York

No Drawing. Filed July 25, 1966, Ser. No. 567,407
17 Claims. (Cl. 149—44)

This invention relates to explosive slurries based on ammonium nitrate and optionally an explosive sensitizer, with particulate fibrous pulpy plant matter such as, for example, vegetables and/or fruit, as thickening agent and fuel, as well as a source of suspending liquid for the solid ingredients.

Explosive mixtures containing relatively large amounts of water or other solids-suspending medium such as oil have recently become of considerable interest in the explosives art. They have greater versatility than dry mixtures, because they can be used under conditions where water or other liquids cannot be excluded. The liquid content of the mixture is more than that which is absorbed by the components of the mixture, and is sufficient to act as a suspending agent for the mixture. Such a liquid content in most cases may range from about 7 to about 50%, depending upon the materials present in the mixture and upon the consistency desired.

A slurry having a reasonably stiff consistency containing as little as 10% liquid may be preferred for use in bulk in wet bore holes, where the composition may be diluted with water already present. Thickening or gelatinizing agents are employed when thick slurries are required, containing high proportions of liquid.

A problem in the formulation of slurried explosives has been the maintenance of a uniform mixture until detonation is effected. Slurries are formulated using an explosive sensitizer and an oxidizer, and may contain a metal and/or a carbonaceous fuel in addition to the thickening agent and slurrying medium. These components are desirably insoluble in the slurrying medium, usually water. The explosive sensitizers generally used, for example, are water- and oil-insoluble. Fuel oil, which is frequently employed in explosive mixtures, is of course water-immiscible. Both of these components tend to separate out, and this separation is avoided partly due to the fact that only relatively small amounts are used, and partly due to the thickness of the slurry, which also aids in keeping the mixture uniform.

Fuels other than fuel oil that are more dispersible or compatible in aqueous slurries would be useful, but the available fuels have presented additional problems. It is more difficult to slurry a solid than a liquid to form a suspension that can be kept a reasonably homogeneous mixture, and most other carbonaceous and metallic fuels are of course solids. Furthermore, in the absence of a sensitizing explosive, detonation becomes more difficult, which limits the types of fuels that can be used to those that form detonatable mixtures with inorganic nitrate.

Oxygen balance is dependent, in part, upon the particular fuel used and in part upon the extent of homogeneity of the slurry. Thus, it is essential that the fuel used be capable of being uniformly dispersed throughout the slurry so that a reasonably homogeneous mixture and oxygen balance thereof can be obtained.

The instant invention furnishes explosive slurries based on ammonium nitrate and a fuel, and optionally, an explosive sensitizer, employing a fuel that is easily and homogeneously dispersible therein, and that has a very slight if any, tendency to separate out, thereby forming uniform slurries that remain relatively uniform on storage, and thereby facilitating maintenance of uniform oxygen balance of such slurries.

In preparing explosive slurries it has become necessary to store, handle and work with many different materials. The greater the variety of materials in a slurry, the greater the problem of maintaining uniformity and homogeneity. Consequently, it has become a desideratum in the field of explosives to reduce the number of materials and additives needed in formulating explosive mixtures and thereby reduce the complexity in preparing such mixtures to a minimum.

In accordance with the instant invention, explosive slurries are provided based on particulate and preferably homogeneously disintegrated plant matter, including vegetables and fruit, as a combined thickening agent and fuel, as well as a source of slurrying liquid. Thus, when such materials are used in an explosive slurry, the number of different materials needed in formulating the slurry is reduced, and consequently the preparation of the slurry is less complex. In addition, since the slurry is substantially homogeneous, it can easily be oxygen-balanced. Such materials may also increase sensitivity of the composition.

The fibrous pulpy plant matter contemplated for use in accordance with the invention includes vegetables and fruit in any particulate form, such as, for example, peaches, potatoes, bananas, pears, plums, apricots, grapes, pineapples, apples, cherries, sugar beets, oranges, figs, dates, tomatoes, lemons, grapefruit, various berries, such as, for example, strawberries, raspberries, blueberries, blackberries, various beans, such as, chick beans, string beans, lima beans, wax beans, peas, cabbage, lettuce, squash, asparagus, rhubarb, caraway, cottonseed, sunflower seed, hops, pimentos, and the like. Furthermore, such plant matter includes weeds of all types, whether used alone or with vegetables and fruit.

Accordingly, the instant invention provides a good way of utilizing plant matter which normally is discarded as waste. In fact, spoiled and/or fermented plant matter is especially useful in this invention, in that the formation of alcohol and/or acetic and/or formic acids which are formed in the spoilage process of the plant are good explosive sensitizers. Furthermore, plant matter that includes gums and mucilages can also serve as a thickening agent.

The fibrous pulpy plant matter of the invention is to be distinguished from the carbonaceous plant derivatives heretofore employed as fuels in explosive compositions. The latter are dried particulate materials of a nonpulpy nature, such as nut shell meals and like meals, whereas the materials of the invention contain virtually all of the original components of the whole vegetable or fruit, including the fibrous material and the pulpy material, plus any plant juices and liquids, unaltered except as may occur by enzymatic or bacterial action in decay and decomposition of the plant, and by subdividing or disintegrating the plant into particulate form.

The term "particulate" is used to refer generally to subdivision of the plant material into particles. The term "homogeneously disintegrated plant matter" as used herein refers to whole vegetables and fruit, including, if desired, their seeds, stems, core, leaves, roots, flowers and pulp, in natural or fermented form, or hydrolyzed, oxidized, cooked, enzyme-treated or digested, and decomposed in any way. Many waste forms of these materials thus can be used, such as peelings, pulp, and mash.

The essential components of the explosive slurries of the invention, in addition to the particulate plant matter which serves as a fuel and thickener, are an inorganic oxidizer and optionally, an explosive sensitizer.

Particulate plant matter can be used with conventional explosive sensitizers, oxidizing agents, suspending fluids,

fuels, antacids and thickening agents employed in preparing explosive slurries. Depending upon the amount and type of ingredients present in the slurry, the plant matter can be employed in amounts within the range from about 0.1 to about 30% by weight of the slurried mixtures, depending upon the slurry viscosity desired, and the amount of fuel necessary for oxygen balance.

The oxidizing agent employed in the explosive slurry of this invention should be an inorganic oxidizer. Ammonium nitrate and nitrates of the alkali and alkaline earth metals, such as sodium nitrate, potassium nitrate, calcium nitrate, magnesium nitrate, strontium nitrate and barium nitrate, are exemplary inorganic nitrates. Mixtures of several nitrates such as, for example, mixtures of sodium and ammonium nitrates, also yield excellent results.

As the inorganic oxidizer there can also be used a chlorate or a perchlorate of an alkali or alkaline earth metal, such as sodium chlorate, potassium chlorate, barium chlorate, sodium perchlorate, potassium perchlorate, barium perchlorate, and calcium perchlorate. Mixtures of nitrates, chlorates and perchlorates, of nitrates and chlorates, of nitrates and perchlorates, and of chlorates and perchlorates, can be used.

When mixtures of ammonium oxidizer and the other oxidizer are used, the relative proportion of ammonium oxidizer is important for good explosive shock and power. The ammonium oxidizer is employed in a proportion within the range from about 50 to 95% by weight of the total oxidizer, and the other oxidizer or oxidizers in the proportion of from about 5 to about 50% of the total oxidizer. For optimum power, the proportions are from 80 to 90% ammonium oxidizer, and from 10 to 20% other oxidizer or oxidizers. The proportions of oxidizers selected within these ranges will depend upon the sensitivity and explosive effect desired, and these in turn are dependent upon the particular oxidizer used.

The inorganic oxidizer can be fine, coarse, or a blend of fine and coarse materials. Mill and prill inorganic oxidizers are quite satisfactory. For best results, the inorganic oxidizers should be fine-grained.

In addition to the oxidizers and plant matter, which serves as both thickening agent and fuel, as well as a source of slurrying liquid, the explosive slurries in accordance with the instant invention can contain other fuels, if desired, including metal fuels and carbonaceous fuels, and an amount of water or water and oil sufficient to give the mixture the consistency desired, be it the consistency of a semi-solid material or the consistency of a free-flowing slurry. As indicated hereinbefore, a sensitizing explosive can also be included, as an optional component.

The preferred sensitizing explosive is nitrostarch, but any sensitizing explosive known to the art can be used, alone or in admixture. Known sensitizing explosives which are useful include, for example, trinitrotoluene, dinitrotoluene, pentaerythritol tetranitrate, nitrostarch, trimethylolethane trinitrate, pentolite (a mixture of equal parts by weight of pentaerythritol tetranitrate and trinitrotoluene), cyclonite (RDX, cyclotrimethylene trinitramine), nitrocellulose, Composition B (a mixture of up to 60% RDX, up to 40% TNT and 1 to 4% wax), Cyclotol (Composition B without the wax), tetryl, and smokeless powder such as carbine ball powder.

The relative proportions of inorganic oxidizer, and of sensitizing explosive, if used, will depend upon the sensitivity and explosive shock wave desired and these, again, are dependent upon the particular nitrate and sensitizing explosive. The proportions are not critical in any way. For optimum effect, the inorganic oxidizer is used in an amount within the range from about 10 to about 95%, and the sensitizing explosive can be used in an amount within the range from 0 to about 40% by weight of the explosive composition. From about 25 to about 30% sensitizing explosive and from about 50 to about 70% inorganic oxidizer give the best results.

When the amount of sensitizing explosive is in the lower part of the range, or zero, a large booster is needed. At amounts beyond 40%, the sensitizing effect falls off, and is no longer proportional to the amount of sensitizing explosive added, and therefore amounts beyond 40% are not usually used.

Sensitizing explosive of any particle size can be used. They can, for example, be fine, coarse, or a blend of fine and coarse material. Some materials, such as nitrostarch, are commercially available as very finely-divided powders, and so also is trinitrotoluene. Such available materials are employed to advantage, because in most cases they tend to produce compositions having a greater explosive effect and sensitivity.

In addition to these materials, as has been indicated, the explosive compositions of the invention can include, in addition to the plant matter, an active metal fuel, usually, aluminum and preferably in particulate form, for example aluminum powder, atomized aluminum, granular aluminum, or flake aluminum, which also serves as a lubricity-improving agent. Aluminum can be used in the form of alloys such as aluminum-magnesium alloys. Other metal fuels can also be used alone or in conjunction with the aluminum, such as, for example, magnesium, ferrosilicon, beryllium, and lithium, and nonmetal element fuels, such as boron.

The metal fuel will usually comprise from about 0.5% to about 30% and preferably from 0.5 to 20% of the composition; preferably at least 50% of the metal fuel is aluminum.

In addition to the metal or nonmetal fuel, a carbonaceous fuel other than plant matter can be included, such as powdered coal, petroleum oil, and coke dust, and plant matter derivatives such as charcoal, bagasse, dextrine, starch, wood meal, flour bran, pecan meal, and similar nut shell meals.

The total carbonaceous fuel, including both plant matter and supplemental carbonaceous fuel, will comprise from about 0.1 to about 30% of the mixture. Of this, the plant matter is present in a major proportion. Mixtures of metal and carbonaceous fuels can be used, if desired.

An antacid, or other stabilizing material, such as zinc oxide, calcium carbonate, aluminum oxide and sodium carbonate, can be added, if desired. Such ingredients will comprise from about 0.3 to about 2% of the mixture.

The consistency of the slurry for any given amount of liquid can be increased to meet any need by using additional thickening agent. The choice of thickening agents will depend on the slurrying liquid. For example, where the slurrying medium is oil, noncarbonaceous inorganic oil thickeners useful in making thickened oils and greases such as finely divided silica, available under the trade names Cab-O-Sil and Ludox and silica aerogels, for example, Santocel ARD and Santocel C, and like inorganic gelling agents, such as alumina, attapulgite and bentonite can be used. Other gelling agents are disclosed in U.S. Patent Nos. 2,655,476 and 2,711,393. These are well known materials, and any of these known to the art can be used. The amount of such thickening agent will depend on the consistency desired, and usually will be within the range from 0 up to about 5%. Enough thickener can be added to gel the oil, and water-proofing agents such as are disclosed in U.S. Patent Nos. 2,554,222, 2,655,476 and 2,711,393 can be incorporated as well, to impart water resistance to the gelled slurry.

When relatively large proportions of water are present, additional water-soluble or water-dispersible thickeners can be added, for example, such as carboxymethyl cellulose, methyl cellulose, guar gum, psyllium seed mucilage, and pregelatinized starches such as Hydroseal 3B. The amount of such thickening agent will depend on the consistency desired, and usually will be within the range from 0 to about 5%.

The explosive slurries of the invention contain enough liquid to act as a suspending medium for the solid in-

gredients. Some explosive sensitizers are capable of absorbing surprisingly large amounts of liquid. Thus, the liquid added in the slurries of the invention is always enough more than this amount to suspend the mixture. Usually, 7% of the liquid is enough to barely slurry the mixture, but more may be required, e.g., up to 50% or higher, to make the slurry flowable.

Water is the preferred slurrying liquid, and is most generally used. However, oil slurries have several advantages over aqueous slurries. The oil serves a dual function, not only as a carbonaceous fuel but also as a suspending medium. It is considerably less volatile than water, and therefore there is less danger of the slurry drying out in storage.

Any oil can be used as the suspending medium. The petroleum-derived hydrocarbon oils are readily available, and are preferred because of their low cost. The viscosity can range from very thin, such as 50 SSU at 100° F., to quite heavy oils, up to about 1200 SSU at 100° F. Kerosene, fuel oil, 100 SSU paraffin oil, light straw paraffin oil, SAE 10 to 50 lubricating oils and hydraulic oils, are exemplary. Water may be added in a small amount to the oil so that the slurry is sufficienty sensitive to fire under the desired conditions. However, the amount of water added is always less than will result in separation of oil or conversion of the slurry into an aqueous slurry, that is, a slurry with water as the suspending medium.

Examples of slurries in which the particulate plant matter of the invention can be used as a thickener and fuel include slurries of the type described in U.S. Patent No. 2,930,685 to Cook and Farnam, patented March 29, 1960, an example of which is composed of ammonium nitrate sensitized with TNT and may contain powdered aluminum and is slurried with water. In addition, aqueous slurries such as are disclosed in U.S. Patent No. 3,083,126 to Griffith and Wells, patented March 26, 1963, can be used. An example of the Griffith et al. slurry is an aqueous slurry containing from about 35 to about 75% inorganic nitrate and from about 10 to about 30% nitrostarch slurried with from about 7 to about 50% water. U.S. Patent No. 3,216,872 to wells, patented November 9, 1965, discloses aqueous slurries containing, for example, from about 35 to 75% inorganic nitrates of which from about 5 to about 95% is ammonium nitrate, and from about 10 to about 30% of a fine grained explosive sensitizer such as dinitrotoluene, trinitrotoluene, pentaerythritol tetranitrate, pentolite, cyclonite, Composition B, cyclotol and tetryl, containing from about 7 to about 50% water may also be used herein. Furthermore, plant matter may be used as thickener and fuel in the aqueous explosive slurries disclosed in U.S. Patent No. 3,222,232 to Schwoyer, patented December 7, 1965. This explosive slurry is resistant to expansion upon exposure to elevated temperatures because of its unusually low coefficient of expansion with temperature, and is comprised of inorganic nitrates, aluminum, water and a small amount of a thiosulfate or organic sulfonate.

In addition to aqueous slurried explosives, particulate plant matter can be used in conjunction with oil-slurried explosives, such as are disclosed in U.S. Patent No. 3,147,163 to Griffith and Wells, patented September 1, 1964. An example of such an oil slurried explosive comprises from about 35 to about 75% of inorganic nitrate oxidizer, from about 10 to about 35% of an explosive sensitizer and from about 7 to about 50% oil.

The explosive mixture containing the particulate plant matter as the thickening agent and fuel is readily prepared by simple mixing of the ingredients. The solid materials, including the oxidizer and sensitizer if present, and homogeneously disintegrated plant matter, and if desired the additional fuel and antacid, if any, would usually be mixed first to form a homogeneous blend, and then sufficient water and/or oil, and water and/or oil thickening agent, if required, would be added to bring the mixture to the desired consistency.

The explosive slurry will ordinarily be fired with the aid of a blasting cap or fuse, or a booster charge, depending on sensitivity, and under high confinement. Combinations of the explosive slurry and a booster in the same container or separately packaged as a composite in one container can be prepared and marketed as a combined blasting agent. Any conventional booster charge available in the art can be employed, of which pentaerythritol tetranitrate and pentolite are exemplary. Blasting caps can be used as the booster when the slurry is sufficiently sensitive.

The following examples in the opinion of the invention represent the best embodiments of the invention.

Example 1

Apples were homogeneously disintegrated to a pulp and used to prepare an explosive slurry using as the explosive components dry mill nitrostarch and mill ammonium nitrate, and water. The first three materials were mixed thoroughly, and then the water was added. The proportions were as follows:

Ingredients:	Parts by weight
Dry mill nitrostarch	20.0
Mill ammonium nitrate	50.0
Apple pulp	20.0
Guar gum	1.0
Water	9.0
	100.0

The resulting thick slurry had a high viscosity.

The density, ballistic pendulum value, sensitivity in 2 inch pipe, rate of detonation in 2-inch pipe, and crater value were determined for the slurry. In the sensitivity tests, when the scope of the standard caps had been passed there were used progressively as more powerful initiators 3-gram pentaerythritol tetranitrate boosters, and then 5, 10, 15, 20, 25, 30, 40, 50, 60, 75, 100, 125, 150, 250 gram and then ½-pound, 1-pound, and 2-pound cast pentolite boosters. The following data was taken:

Density	1.40
Ballistic pendulum value	9.50
Sensitivity in 2-inch pipe (g. pentolite)	50
Rate of detonation in 2-inch pipe (meters per second)	>3500

Example 2

An oil slurry was prepared using dry mill nitrostarch, ammonium nitrate, sodium nitrate and water. The ammonium nitrate comprised 50% prills and 50%-30 mesh grained ammonium nitrate. The sodium nitrate was 20 mesh. The three solid materials were mixed thoroughly. There was then added crushed oranges, homogeneously disintegrated to a pulp, as a thickener and fuel, and then water and oil were added. The proportions of the final explosive slurry were as follows:

Components:	Parts by weight
Dry mill nitrostarch	20.0
Ammonium nitrate	44.6
Orange pulp	25.0
Modified guar gum	0.4
Water	5.0
100 SSU paraffin oil	5.0
	100.0

This mixture had a viscosity of about 300 cps.

The density, the ballistic pendulum, sensitivity in a 1½ inch pipe, and crater value were determined, with the following results:

Density	1.35
Ballistic pendulum value	10.00
Sensitivity in 1½-inch pipe (g. pentolite)	50

Rates of detonation were run in 1½-inch pipe. The rate was above 3600 meters per second.

Example 3

An aqueous slurry was prepared, composed of mill ammonium nitrate and mill sodium nitrate, and fine-grained trinitrotoluene, with rotten potatoes, homogeneously disintegrated to a mash, as fuel and thickening agent, plus water. The proportions of the final explosive slurry were as follows:

Ingredients:	Parts by weight
Fine TNT	20
Mill ammonium nitrate	56.5
Mill sodium nitrate	5.0
Rotten potato mash	30.0
Guar gum	0.5
Water	5.0

This mixture had a viscosity of about 4000 cps.

The comparative tests of Example 1 gave the following results on this slurry:

Density	1.32
Ballistic pendulum value	10.00
Sensitivity in 1½-inch pipe (g. pentolite)	80
Rate of detonation in 1½-inch pipe (meters per second)	>3650

Examples 4 to 6

Three explosive mixtures were prepared using ammonium nitrate prills, flake aluminum, coal, sugar beets, homogeneously distintegrated to a pulp, guar gum and water. The proportions and properties of the final explosive slurries were as follows:

Ingredients	Example No. 4	5	6
	Parts by Weight		
Mill Ammonium Nitrate	79.20	73.70	66.70
Flake Aluminum	4.50		
Coal		4.00	3.00
Guar Gum	0.30	0.30	0.30
Sugar Beets	16.00	22.00	30.00
Density	1.05	1.10	1.00
Ballistic Pendulum Value	10.00	9.80	8.60

Example 7

An aqueous slurry was prepared using ammonium nitrate prills. The ammonium nitrate was mixed thoroughly with potato mash, potatoes, homogeneously disintegrated to a pulp, as a thickener and fuel, and then coal and guar gum were added. The proportions of the final explosive slurry were as follows:

Components:	Parts by weight
Ammonium nitrate	78.6
Potato mash	16.5
Coal	4.7
Guar gum	0.2
	100.0

This mixture had a thick but readily flowable consistency.

The density and the ballistic pendulum value were determined, with the following results:

Density	1.36
Ballistic pendulum value	10.00

The explosive slurry was readily detonated in a 2½ bore hole using a ½-lb. Pentolite primer with good explosive effect.

Examples 8 to 10

Three explosive slurries were prepared using ammonium nitrate prills, alfalfa, guar gum and water. The proportions and properties of the final explosive slurries were as follows:

Ingredients	Example No. 8	9	10
	Parts by Weight		
Ammonium Nitrate	74.70	74.70	
Alfalfa FD	24.0		
Alfalfa KD		24.0	
Alfalfa, cut			24.0
Guar Gum	0.3	0.3	0.3
Water	16.0	16.0	16.0
Density	1.25	1.25	1.19
Ballistic Pendulum Value	8.8	9.1	9.0

The compositions were thin flowable slurries.

Having regard to the foregoing disclosure, the following is claimed as the inventive and patentable embodiments thereof:

1. An explosive slurry consisting essentially of an inorganic oxidizer salt, sufficient particulate fibrous naturally wet pulpy plant matter to oxygen-balance the oxidizer and to act as a thickening agent, and sufficient liquid to act as a suspending medium for the solid ingredients.

2. An explosive slurry in accordance with claim **1** in which the inorganic oxidizer is an inorganic nitrate.

3. An explosive slurry in accordance with claim **2** in which the inorganic nitrate is at least one member selected from the group consisting of ammonium nitrate and alkali and alkaline earth metal nitrates.

4. An explosive slurry in accordance with claim **1** in which the liquid suspending medium is water.

5. An explosive slurry in accordance with claim **1** in which the liquid suspending medium is oil.

6. An explosive slurry in accordance with claim **1** including in addition an explosive sensitizer which is a member selected from the group consisting of nitrostarch, trinitrotoluene, dinitrotoluene, pentaerythritol, tetranitrate, trimethylolethane trinitrate, pentolite, cyclonite, nitrocellulose, Composition B, cyclotol, tetryl, smokeless powder and ball powder.

7. An explosive slurry in accordance with claim **1** including in addition a metal fuel.

8. An explosive slurry in accordance with claim **7** wherein the metal fuel is particulate aluminum.

9. An explosive slurry in accordance with claim **1** including in addition a carbonaceous fuel.

10. An explosive slurry in accordance with claim **1** including in addition to the plant matter another thickening agent.

11. An explosive slurry in accordance with claim **10** in which the additional thickening agent is guar gum.

12. An explosive slurry in accordance with claim **1** wherein the plant matter is apples.

13. An explosive slurry in accordance with claim **12** wherein the plant matter is sugar beets.

14. An explosive slurry in accordance with claim **12** wherein the plant matter is potatoes.

15. An explosive slurry in accordance with claim **12** wherein the plant matter is oranges.

16. An explosive slurry in accordance with claim **12** wherein the plant matter is alfalfa.

17. An explosive slurry consisting essentially of from about 10 to about 95% by weight of an inorganic oxidizer salt, from about 0.1 to about 30% by weight homogeneously disintegrated fibrous naturally wet pulpy plant matter, from about 0 to about 40% by weight of an explosive sensitizer selected from the group consisting of nitrostarch, trinitrotoluene, dinitrotoluene, pentaerythritol tetranitrate, trimethylolethane trinitrate, pentolite, cyclonite, nitrocellulose, Composition B, cyclotol, tetryl, smokeless powder and ball powder, and sufficient liquid within

the range from about 7 to about 50% by weight to act as a suspending medium for the solid ingredients.

References Cited

UNITED STATES PATENTS

1,908,569	5/1933	Stoops	149—60 X
2,356,149	8/1944	Davis	149—39 X
2,537,039	1/1951	Downard	149—60 X
2,541,389	2/1951	Taylor	149—60 X
2,589,532	3/1952	Byers	149—38 X
2,732,800	1/1956	Coursen	149—60 X

CARL D. QUARFORTH, *Primary Examiner.*

BENJAMIN R. PADGETT, *Examiner.*

S. J. LECHERT, JR., *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,361,604 January 2, 1968

George L. Griffith

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 23, for "sufficienty" read -- sufficiently --; line 41, for "wells" read -- Wells --; column 7, line 29, for "distintegrated" read -- disintegrated --; column 8, lines 57, 59, 61 and 63, for the claim reference numeral "12", each occurrence, read -- 1 --.

Signed and sealed this 1st day of April 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents