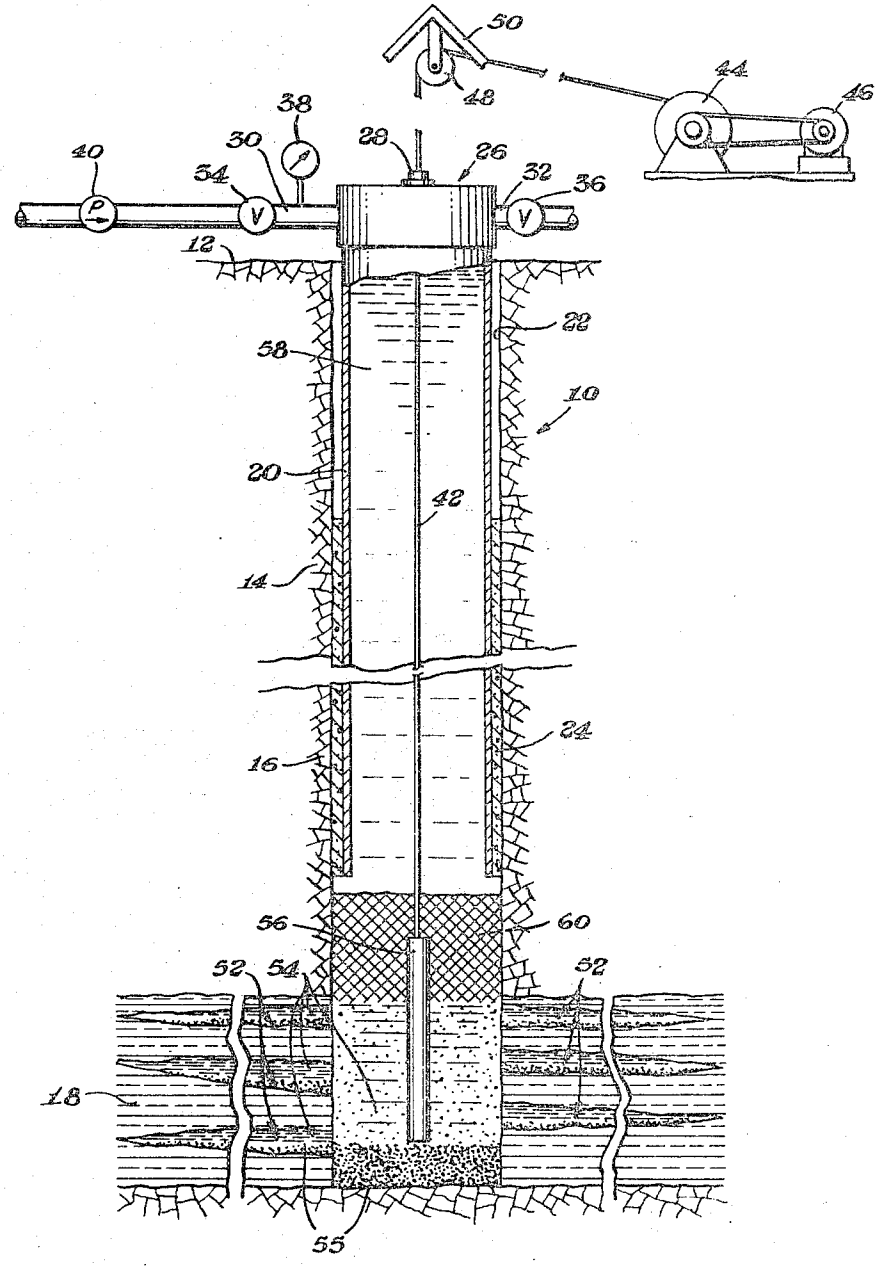
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METHOD OF DETONATING AMMONIUM NITRATE BASE EXPLOSIVES

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INVENTORS.
Joseph R. Hradel
Parke D. Muir
Harold E. Staadt
BY Griswold & Burdick
ATTORNEYS

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METHOD OF DETONATING AMMONIUM NITRATE BASE EXPLOSIVES

Joseph R. Hradel, Mount Pleasant, Mich., and Harold E. Staadt and Parke D. Muir, Tulsa, Okla., assignors to The Dow Chemical Company, Midland, Mich., a corporation of Delaware

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This invention relates to a method of treating an earth well and particularly to a method of bringing about the explosion of an ammonium nitrate base explosive charge in an earth well.

Oil and gas wells have heretofore been treated by pumping a slurry of ammonium nitrate in petroleum oil into the well bore, forcing the slurry into oil or gas bearing formations, and then detonating the explodable components of the slurry by means of shaped charges which produce Munroe jet type explosions.

The shaped charges are commonly detonated either by means of a time delay type detonator or the detonation is initiated through electrical cable means which is coupled to a suitable control unit disposed near the well head.

The arming of the shaped charge detonating devices at the well head constitutes a safety hazard which can be minimized by good explosives handling technique but which cannot be entirely overcome.

Also, if the explosive detonating devices fail to fire in the well bore, their removal from the well is hazardous.

In addition, shaped charges, in order to insure the most extensive explosion of the ammonium nitrate, should either be disposed in a slurry of ammonium nitrate or have the jets directed into the slurry when the shaped charges are detonated. When the slurry is mainly disposed in fissures communicating with a well bore wall, it is often difficult to accurately dispose the shaped charges so as to direct the explosive jets into the slurry.

Accordingly, a principal object of this invention is to provide a safer, more effective method of exploding ammonium nitrate in an earth well.

In accordance with this invention a slurry of ammonium nitrate is pumped into an earth well, a container of Thermit-type explosion initiation material is disposed in the well in communication with the slurry, the slurry and explosion initiating material are placed under pressure, and the Thermit-type explosion initiating material is ignited. The high temperatures and increased gas pressure resulting from the burning of the Thermit detonate the explodable elements in the slurry.

The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawing. The drawing shows, in diagrammatical form, a well bore having ammonium nitrate slurry therein and an explosion initiating device of the Thermit type communicating with the slurry, the well being under pressure.

Referring to the drawing, there is shown a well bore, indicated generally by the numeral 10, which extends from the surface 12 of the earth through a number of earth formations 14, 16 and an oil bearing formation 18. A string of casing 20 extends into the well bore 10 and is bonded to the well bore wall 22 by cement 24. The upper end of the casing 20 terminates in a header, indicated generally by the numeral 26, to the top of which is attached a stuffing box 28. Two sections of pipe, 30, 32 are coupled to the header 26. Valves 34, 36 are provided in the pipe sections 30, 32, respectively. A pressure gauge 38 is coupled to the pipe 30 between the valve 34 and the header 26. A pump 40 is coupled to the pipe 30 on the side of the valve 34 which is remote from the header 26.

A cable 42 extends from a draw works 44 (driven by a suitable motor 46) over a sheave 48 suspended from a derrick 50, through the stuffing box 28, and down the well bore 10 to near the pay or oil producing formation 18.

In practicing this invention a pumpable slurry 54 comprising ammonium nitrate and a suitable liquid is pumped into the well bore 10 and, usually, forced under pressure into fissures 52 in the producing formation 18. Some of the slurry may be left in the well bore 10 as shown at 54. After the injection is made ammonium nitrate particles usually settle out of the slurry, forming a more or less continuous train 55 of nitrate particles on the bottom of the fissures 52 and well bore 10. A Thermit type igniter-detonating device 56 is placed in the well bore adjacent to or in the slurry 54 or the settled ammonium nitrate particles thereof. The device 56 may either be lowered into the well bore 10 on a cable 42, as illustrated, or may be dropped into the well bore 10. The igniter-detonating device 56 may be actuated electrically through electrical conductors of a cable (such as the cable 42, for example) to permit control of the detonation from the earth's surface 12. Alternatively, the device 56 may be actuated by a suitable timing mechanism enclosed within the device 56. The device 56 may be disposed in the slurry 54 or just above the slurry so that molten combustion products from the device 56 may drop into the slurry 54, and reach ammonium nitrate particles 55.

A suitable igniter-detonating device 56 comprises a fluid-tight container of a Thermit-type material, commonly aluminum and ferric oxide (in the ratio of 3 mols of aluminum to 3 mols of ferric oxide), plus igniting powder capable of being ignited by a hot wire, and an electrical squib which is connected to a control circuit (self contained or otherwise). However, other Thermit-type mixtures, such as a copper oxide and aluminum mixture, may be used in practicing this invention.

That part of the well bore 10 and fissures 52 in which the slurry 54 is disposed is placed under at least 300 pounds per square inch of pressure before detonation of the slurry 54 (or the explosive part of the slurry 54) takes place. The pressure of 300 pounds per square inch may be induced by a fluid column, such as the column 58, or by closing the valves 34, 36 and stuffing the box 28 to maintain the well bore 10 under hydrostatic pressure. Alternatively, tamping 60 may be deposited in the lower end of the well bore 10 and the minimum pressure of 300 pounds per square inch induced by the rapid formation of gases as the Thermit and slurry burns after the igniter-detonating device 56 is actuated.

A combination of hydrostatic pressure on the slurry and tamping above the slurry may also be used to advantage. The tamping, in such applications, usually serves to somewhat limit the upward blast of the explosion of the slurry.

The Thermit, being ignited while the slurry 54 is under pressure as described above, rapidly burns with intense heat through the slurry 54, the heat and resultant pressure thus initiating the explosion of the explodable elements within the slurry.

The slurry 54 commonly comprises particulated ammonium nitrate mixed with enough petroleum, other oil, or Diver's liquid to make the mixture flowable. Three hundred to four hundred gallons of petroleum oil per ton of particulated material has been found to make a pumpable slurry.

One slurry which was detonated successfully in accordance with this invention contained prelled and fine particles of ammonium nitrate. The fine particles had the following sieve analysis:

Sieve:	Percentage
Through 10, retained on 20	7
Through 20, retained on 40	31.4
Through 40, retained on 60	13.0
Through 60, retained on 100	36.6
Through 100, retained on 200	12.0

The prelled particles of ammonium nitrate has the following sieve analysis:

Sieve:	Percentage
Through 6, retained on 10	22.9
Through 10, retained on 20	76.5
Through 20, retained on 40	0.6

The composition of the ammonium nitrate particles used in the above described slurry is: paraffin 0.7 percent, diatomaceous earth 0.5 percent, the remainder being ammonium nitrate.

We claim:

1. The method of initiating the explosion of explodable material in a slurry comprising ammonium nitrate as a major constituent thereof, comprising pumping said slurry into a well bore, depositing a Thermit type igniter-detonator device adjacent to said slurry, igniting said igniter-detonator device and maintaining said slurry under pressure of at least three hundred pounds per square inch while said igniter-detonator device burns.

2. The method of treating a well having a bore which penetrates earth formations, comprising pumping a slurry which comprises ammonium nitrate as a major constituent thereof into said bore, depositing a Thermit type igniter-detonator device in said bore above the lower level of said slurry, placing said slurry in said well bore under pressure of at least three hundred pounds per square inch, igniting said igniter-detonator device and dispersing molten combustion products thereof into said slurry.

3. The method of initiating the explosion of explodable material in a slurry comprising ammonium nitrate as a major constituent thereof, comprising pumping said slurry into a well bore, depositing a Thermit type igniter-detonator device adjacent to said slurry, depositing tamping material in said well bore above said slurry, igniting said igniter-detonator device and maintaining said slurry under pressure of at least three hundred pounds per square inch while said igniter-detonator device burns.

4. The method of treating a well having a bore which penetrates earth formations, comprising pumping a slurry which comprises ammonium nitrate as a major constituent thereof and a petroleum oil into said bore, depositing a Thermit type igniter-detonator device in said bore above the lower level of said slurry, placing said slurry in said well bore under pressure of at least three hundred pounds per square inch, igniting said igniter-detonator device and dispersing molten combustion products thereof into said slurry.

5. The method of initiating the explosion of explodable material in a slurry containing ammonium nitrate as a major constituent thereof, comprising pumping said slurry into a well bore, depositing a Thermit type igniter-detonator device adjacent to said slurry, filling at least a part of said well bore with a liquid to maintain said slurry under pressure of at least three hundred pounds per square inch, and igniting said igniter-detonator device to disperse molten combustion materials through said slurry.

6. The method of treating a well having a bore which penetrates earth formations, comprising pumping a slurry which comprises ammonium nitrate and Diver's liquid as the major constituents thereof into said bore, depositing a Thermit type igniter-detonator device in said bore above the lower level of said slurry, placing said slurry in said well bore under pressure of at least three hundred pounds per square inch, igniting said igniter-detonator device and dispersing molten combustion products thereof into said slurry.

7. The method of treating a well having a bore which penetrates earth formations, comprising pumping a slurry which comprises ammonium nitrate as a major constituent thereof, ammonia and water into said bore, depositing a Thermit type ignited-detonator device in said bore above the lower level of said slurry, placing said slurry in said well bore under pressure of at least three hundred pounds per square inch, igniting said igniter-detonator device and dispersing molten combustion products thereof into said slurry.

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