

[54] **APPARATUS FOR STORING,
TRANSPORTING, MIXING AND
DELIVERING BLASTING MATERIAL**

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[51] Int. Cl. **B02c 21/02**

[58] Field of Search .. **241/15, 101 M, 101 B, 101.7,
241/101.6; 175/1, 2; 137/268**

[56] **References Cited**

UNITED STATES PATENTS

2,230,146	1/1941	Myers.....	241/101 B
2,348,880	5/1944	Berg et al.....	241/101 M X
3,414,163	12/1968	Gaddis.....	137/268 X
3,600,477	8/1971	Friedel et al.....	241/15 X

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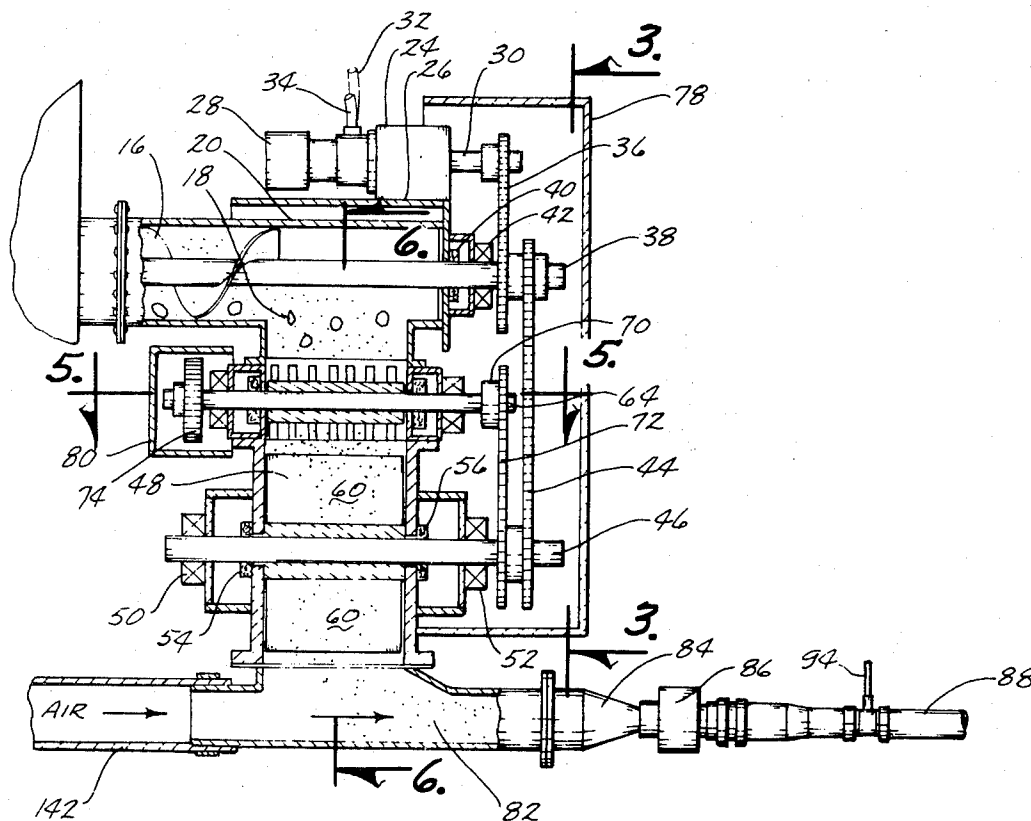
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ABSTRACT

An apparatus for storing, transporting, mixing and delivering blasting material to a bore hole comprising a truck having an ammonium nitrate storage tank and a fuel oil storage tank mounted thereon. The apparatus is adapted to convey the ammonium nitrate from the storage tank to a lump breaker which grinds the material to a sufficient size to permit the efficient handling thereof. The ground material is passed through an air lock chamber into a stream of air under pressure. The ground material is directed into a hose which is in communication with the bore hole. Fuel oil is sprayed into the air-ammonium nitrate mixture between the air lock chamber and the hose. A control means is provided to permit the precise selective metering of the ammonium nitrate and fuel oil.

13 Claims, 7 Drawing Figures



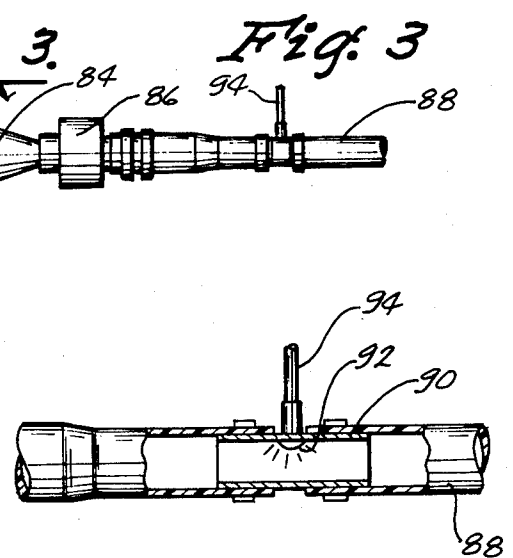
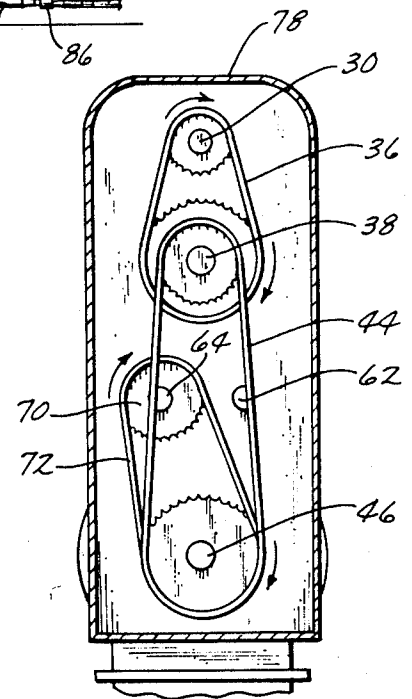
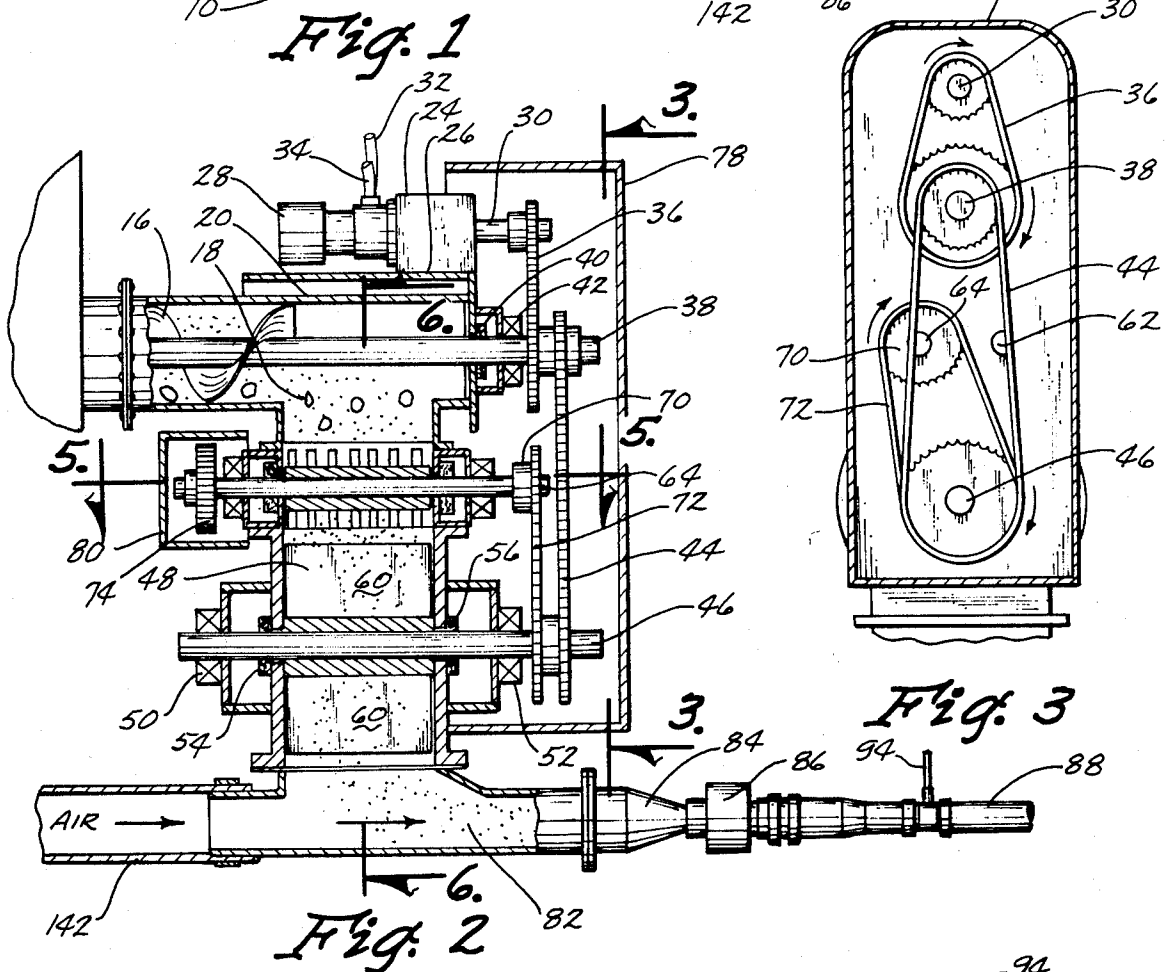
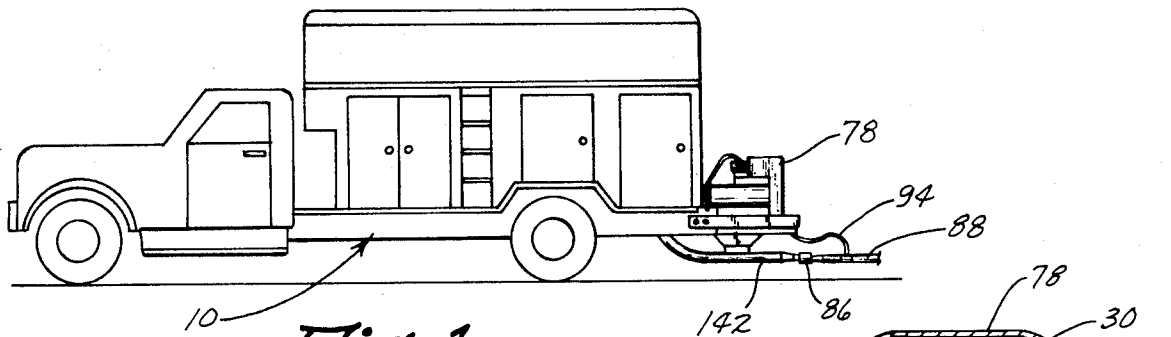


Fig. 4

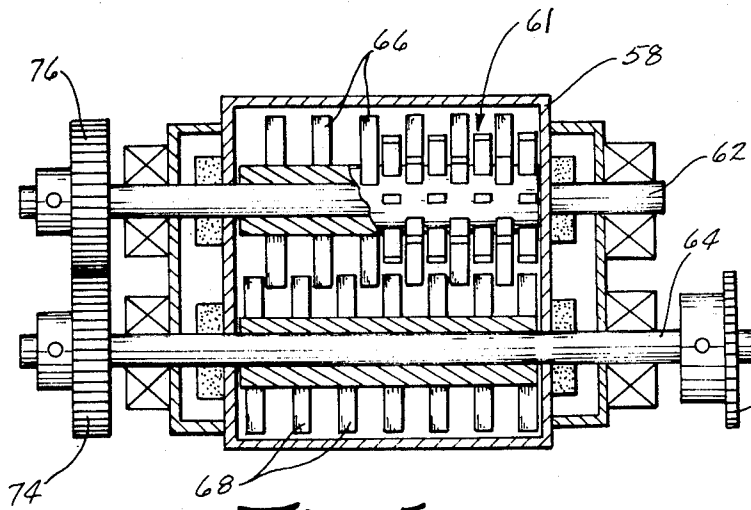


Fig. 5

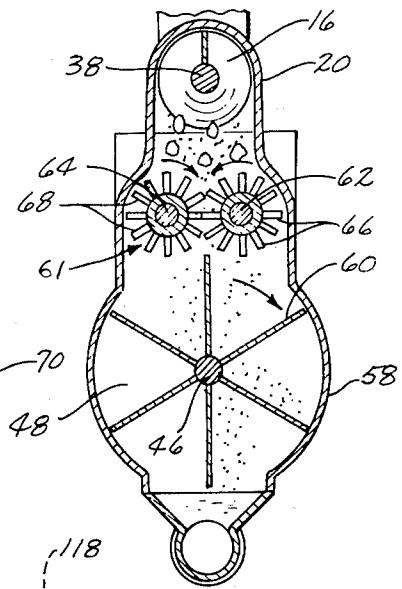


Fig. 6

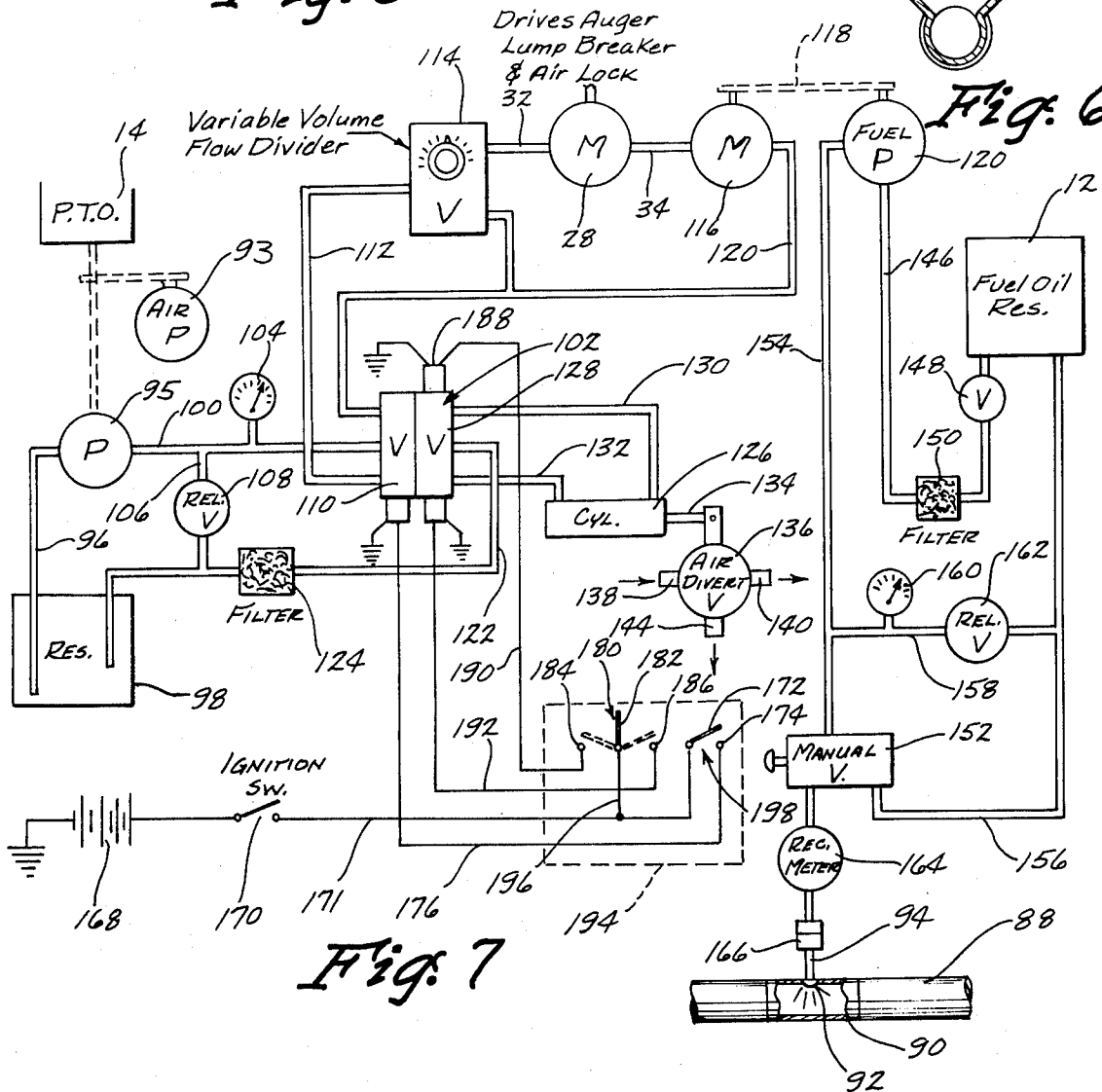


Fig. 7

APPARATUS FOR STORING, TRANSPORTING, MIXING AND DELIVERING BLASTING MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for storing, transporting, mixing and delivering blasting material to a bore hole and more particularly to an apparatus for storing, transporting, mixing and delivering an ammonium nitrate and fuel oil mixture to a bore hole.

Mining and quarrying ordinarily involve blasting operations. The blasting is achieved by drilling a plurality of bore holes in the rock or the like. Dynamite or ANFO is ordinarily placed in the bore holes to achieve the necessary blasting. ANFO is comprised of ammonium nitrate mixed with fuel oil and is less expensive than the dynamite. ANFO is relatively inexpensive explosive material which is ordinarily detonated with primers and dynamite caps. The ammonium nitrate is mixed with the fuel oil at the blasting site as a safety precaution.

One of the problems associated with the mixing of the ammonium nitrate and fuel oil is the lumps which sometimes are present in the ammonium nitrate. The lumps reduce the mixing efficiency and result in a somewhat less efficient detonation. A further problem associated with the loading of the ANFO into the bore hole is the presence of water therein. A further consideration in the loading of the bore holes is the small diameter of the bore holes which requires that the ammonium nitrate be relatively free of lumps.

A still further problem associated with the mixing of the ammonium nitrate and the fuel oil is the precise metering of the respective products.

Therefore, it is a principal object of the invention to provide an apparatus for storing, transporting, mixing and delivering blasting material.

A further object of the invention is to provide an apparatus which breaks up ammonium nitrate lumps prior to it being mixed with fuel.

A further object of the invention is to provide an apparatus for storing, transporting, mixing and delivering blasting material wherein means is provided for controlling the precise metering of the respective products.

A further object of the invention is to provide an apparatus for storing, transporting, mixing and delivering blasting material including means for overcoming the water problem ordinarily associated with bore holes.

A further object of the invention is to provide an apparatus for storing, transporting, mixing and delivering blasting material including control means therefor.

A still further object of the invention is to provide an apparatus for storing, transporting, mixing and delivering blasting material which is efficient in operation.

These and other objects will be apparent to those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention consists in the construction, arrangements and combination of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in the claims, and illustrated in the accompanying drawings, in which:

FIG. 1 is a side view of the apparatus of this invention:

FIG. 2 is a partial sectional view illustrating the lump breaker, air lock, and air line:

FIG. 3 is a sectional view seen on lines 3—3 of FIG. 2:

FIG. 4 is a fragmentary sectional view of the means for spraying fuel oil into the air stream:

FIG. 5 is a sectional view seen on lines 5—5 of FIG. 2:

FIG. 6 is a sectional view seen on lines 6—6 of FIG. 2; and

FIG. 7 is a schematic view of the circuitry of the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The numeral 10 refers generally to a truck having a storage tank provided thereon for storing ammonium nitrate therein. Truck 10 also is provided with a fuel oil storage tank or reservoir 12. The truck 10 includes a P.T.O. generally referred to by the reference numeral 14.

The numeral 16 refers to an axially mounted auger which is in communication with the ammonium nitrate storage tank so that the ammonium nitrate particles 18 may be conveyed rearwardly therefrom. For purposes of description, the numeral 20 will be used to refer to the housing enclosing the rearward end of the auger 16. A bearing box 24 is mounted on a support 26 which is secured to the housing 20 as illustrated in FIG. 2. A hydraulic motor 28 is operatively connected to the bearing box 24 adapted to drive the drive shaft 30 extending from the bearing box 24. A pair of hydraulic hoses 32 and 34 extend from the hydraulic motor 28 as will be explained in more detail hereinafter.

As seen in FIG. 2, drive chain 36 interconnects the drive shaft 30 and the shaft 38 of auger 16. Shaft 38 is provided with an external seal 40 and an external bearing 42 as illustrated in FIG. 2. Drive chain 44 connects drive shaft 38 and a drive shaft 46 which rotatably extends through an air lock chamber generally referred to by the reference numeral 48. Shaft 46 is provided with externally mounted bearings 50 and 52 adjacent its opposite ends as well as externally mounted seals 54 and 56. Air lock 48 is defined by a housing 58 which extends downwardly from and which is in communication with housing 20 as illustrated in FIGS. 2 and 6. A plurality of radially extending vanes 60 are mounted on the shaft 46 for rotation therewith as will be described in more detail hereinafter.

The numeral 61 refers generally to a lump break apparatus which is positioned in the housing 58 between the air lock chamber 48 and the housing 20. A pair of shafts 62 and 64 rotatably extend through the housing 58 as seen in FIG. 5 and are provided with externally mounted seals and bearings at the opposite ends thereof. A plurality of radially extending fingers 66 are provided on the shaft 62 and a plurality of radially extending fingers 68 are mounted on the shaft 64. As seen in FIG. 5, the fingers 66 and 68 overlap during the rotation thereof. Shaft 64 has a sprocket 70 at one end thereof having a drive chain 72 extending therearound which is connected to a sprocket on the drive shaft 46. Gears 74 and 76 are secured to one end of each of the shafts 64 and 62 respectively and are in mesh with each other as seen in FIG. 5. The numeral 78 refers to a chain guard extending around some of the various chains, sprockets, and the like. The numeral 80 refers

to a guard extending around the gears 74 and 76 as seen in FIG. 2.

The lower end of the air lock compartment 48 is in communication with a conduit 82 having one end thereof in communication with a source of air under high pressure. An adaptor 84 is provided at one end of the conduit 82 to permit various sizes of air hoses to be connected thereto. The numeral 86 refers to an air hose quick connector coupler which is secured to the adaptor 84. The numeral 88 refers to a semi-conductive air hose secured to the quick connector coupler 86. Preferably, the hose 88 would have a length of at least fifty feet. A sleeve 90 is mounted in the hose 88 as seen in FIG. 4 and has a nozzle 92 provided thereon which is in communication with a fuel oil hose 94 to permit the fuel oil to be sprayed into the interior of the sleeve 90.

The control circuitry of this apparatus is illustrated in FIG. 7. As seen in FIG. 7, the P.T.O. 14 is operatively connected to a high pressure-high volume air pump 93 to a hydraulic pump 95. Hydraulic pump 95 has a suction line 96 in communication with a hydraulic reservoir 98. Discharge line 100 extends from the pump 95 to an electric solenoid valve bank 102. Hydraulic pressure gauge 104 is provided in the line 100. A hydraulic relief line 106 extends from the discharge line 100 to the reservoir 98. Hydraulic relief valve 108 is provided in the relief line 106.

Solenoid valve 110 of valve bank 102 has a discharge line 112 extending therefrom which is in communication with a variable volume flow divider 114. Flow divider 114 is operatively connected to the hydraulic hose 32 which extends to the hydraulic motor 28.

Hydraulic hose 34 is connected to a hydraulic motor 116 which is connected by a chain drive 118 to a fuel oil pump 120. A return line 120 extends from the hydraulic motor 116 to the valve 110. Return line 122 extends from the valve bank 102 to the hydraulic reservoir 98. Filter 124 is provided in the return line 122. Hydraulic cylinder 126 is connected to the valve 128 of valve bank 102 by means of the lines 130 and 132. The two-way hydraulic cylinder 126 has its piston rod 134 connected to an air diverting valve 136. Air diverting valve 136 has an inlet conduit 138 which is in communication with the air pump 93. Air diverting valve 136 has a discharge conduit 140 which is in communication with the air line or air conduit 142 which is in communication with the conduit 82. Air diverting valve 136 also has a conduit 144 which is in communication with the atmosphere.

The fuel pump 120 is connected to the fuel reservoir 12 by means of line 146 which has a manually controlled valve 148 and filter 150 imposed therein. The fuel pump 120 is connected to a manual selector valve 152 by line 154. Line 156 connects the manual selector valve 152 and the fuel oil reservoir 12 as seen in FIG. 7. A by-pass line 158 extends between the lines 154 and 156 and has a pressure gauge 160 and relief valve 162 imposed therein. Manual selector valve 152 is connected to recording meter 164 which is connected to a quick connect hose coupler 166 which is in communication with the hose 94.

The numeral 168 refers to a battery which is electrically connected to the ignition switch 170. Ignition switch 170 is connected to switch arm 172 which is adapted to close upon contact 174 at times. Contact 174 is electrically connected to the solenoid of the

valve 110 by lead 176. Lead 180 connects lead 171 and the switch arm 182. As seen in FIG. 7, switch arm 182 is adapted to electrically engage either of the contacts 184 and 196. Contact 184 is electrically connected to the solenoid 188 of valve bank 102 by lead 190 while contact 186 is connected to the solenoid of the valve 128 by lead 192. For purposes of description, the numeral 194 will be used to identify the pendant switch which includes the switch arms 182 and 172 and associated contacts.

The normal method of operation is as follows. The truck P.T.O. is engaged and the truck engine is run at approximately 2,000 rpm. The switch 170 is then turned on which provides current for the solenoid valve. The operator then secures the rubber coated electric pendant switch 194 to his belt so that his hands are free to control the various other operations of the apparatus. The switch 194 would have approximately fifty feet of cord attached thereto to provide the operator with sufficient mobility. The operator then places the semi-conductive air hose 88 in the bore hole and starts the air flow with the three-way switch 196 on the pendant switch 194. The operator then actuates the hydraulic motor switch 198 on the pendant switch 194 which actuates the auger, lump breaker and air lock. Actuation of the hydraulic motor 28 causes the auger 16 to convey the ammonium nitrate rearwardly from the ammonium nitrate storage tank so that the particles thereof are fed to the lump breaker apparatus 61. The fingers on the oppositely rotating shafts 62 and 64 break any lumps present in the ammonium nitrate so the ammonium nitrate is reduced to a sufficiently fine material which will not plug up the small diameter air hose. The material is dropped downwardly into the air lock compartment 48 with the vanes 60 rotating to cause into the conduit 82 where the particles are injected into the air stream. The configuration of the vane members 60 is such that air is prevented from passing upwardly through the air lock compartment 48.

Since the hydraulic motor 116 which operates the fuel oil pump 120 is in series with the hydraulic motor 28, the motor 116 is operated in direct proportion to the flow in the motor lines. By using the proper chain drive ratio, the fuel oil pump 120 sprays oil into the ammonium nitrate material or prills in the air line 88 to provide 6 percent oil ratio to continuously manufacture ANFO. The prills are evenly coated as they travel through the approximately fifty foot semi-conductive air hose. If more or less ANFO is desired, the variable volume flow divider valve 114 is adjusted to provide the correct ANFO demand. Since both of the motors 28 and 116 are in series, varying the speed of the auger 16 automatically adjusts the fuel oil flow to provide the 6 percent ratio. When the bore hole is filled with the ANFO, the operator shuts off the prill flow and then diverts the air flow to the atmosphere. This feature permits the operator to move to the next bore hole without blowing ANFO, fuel oil or dust around the shot area.

If the operator wishes to unload the truck without mixing fuel in the ammonium nitrate, he actuates the manual selector valve 152 and diverts the fuel oil to the fuel oil reservoir 12. This permits him to unload into the overhead storage bin or any other storage area. The high pressure air pump 93 is driven by the truck P. T. O. or by a hydraulic motor driven by the P. T. O. The high pressure-high volume air conveys the ANFO into the bore hole with enough force to pack the ANFO

therein which increases the density and provides more explosive power per hole. If the hole has been dewatered, the increased density delays intrusion by water sufficiently long enough to allow ANFO to be used.

Thus it can be seen that an extremely efficient apparatus has been provided for storing, transporting, mixing and delivering plastic material to a bore or shot hole. The apparatus of this invention permits the proper ratio of ammonium nitrate and fuel oil to be supplied to the bore hole with sufficient volume and pressure so that an efficient detonation may be achieved. The apparatus of this invention permits the precise metering of the ammonium nitrate and fuel oil to the shot hole. The lump breaker permits the use of a small diameter loading hose which permits loading explosive holes of a two inch diameter and larger. The hydraulic flow divider in the hydraulic motor circuit permits the operator infinite ANFO loading capabilities between zero and 500 pounds per minute. The hydraulic circuit automatically controls the fuel oil pump in relation to the auger speed to provide the proper 6 percent fuel oil ratio. This allows loading of all diameter holes with a simple dial adjustment.

The fact that the lump breaker is positioned ahead of the oil introduction area allows the non-sensitive ammonium nitrate to be broken so that it will pass through a small diameter loading hose. As previously stated, all of the bearings and the seal are externally mounted to prevent contact with ammonium nitrate or sensitized ANFO. The semi-conductive hose 88 is used for ANFO loading to prevent premature detonation of the primer by static electricity created by the ANFO traveling in the tube under high velocity. The semi-conductive hose 88 also prevents accidentally conducting a current through the hose to the primer from an external source on the surface. The fuel pump 120 is a positive displacement rotary pump without any valves. The simple design of the fuel pump insures proper fuel oil ratio and eliminates fuel problems and the related improper fuel oil ratios.

Thus it can be seen that the apparatus accomplishes at least all of its stated objectives.

I Claim:

1. An apparatus for storing, transporting, mixing and delivering blasting material to a bore hole, comprising,
 - a wheeled frame means having a first storage tank mounted thereon and having a first material conveyor means extending from the lower portion thereof,
 - a lump breaker apparatus positioned below the discharge end of said first material conveyor means and being in communication therewith and adapted to break the lumps in the material being supplied thereto by said first material conveyor means,
 - an air lock apparatus positioned below said lump breaker apparatus and being in communication therewith for permitting said material to pass there-through,
 - an air conduit in communication with said air lock apparatus and being in communication with a source of air under pressure so as to convey the material being supplied thereto,
 - a source of fuel oil under pressure in communication

with said air conduit for injecting fuel oil into the air material mixture,

means for driving said first material conveyor means, said lump breaker apparatus and said air lock apparatus,

and control means for controlling the operation of said conveyor means, said source of air under pressure and the injection of said fuel oil into said air material mixture.

2. The apparatus of claim 1 wherein said air conduit comprises a housing positioned below said air lock apparatus and having inlet and outlet ends, the inlet end of said housing being in communication with said source of air under pressure, said outlet end of said housing being in operative communication with an elongated flexible hose means.

3. The apparatus of claim 2 wherein said hose means is semi-conductive.

4. The apparatus of claim 2 wherein fuel injection means is in communication with the interior of said hose means adjacent the inlet end thereof, said fuel injection means being in communication with said source of fuel oil under pressure.

5. The apparatus of claim 4 wherein said source of fuel oil under pressure comprises a first hydraulic motor operatively connected to a fuel pump; a second hydraulic motor operatively connected to said first material conveyor means for driving the same; said first and second hydraulic motors being connected in series.

6. The apparatus of claim 5 wherein said control means comprises a variable volume flow divider operatively connected to said first and second hydraulic motors.

7. The apparatus of claim 5 wherein said control means comprises a solenoid actuated valve means operatively connected to said first and second hydraulic motors for selectively controlling the operation of said hydraulic motors.

8. The apparatus of claim 7 wherein said second hydraulic motor is operatively connected to said lump breaker apparatus and said air lock apparatus for driving the same.

9. The apparatus of claim 1 wherein said lump breaker apparatus comprises a pair of parallel rotatable shafts having a plurality of radially extending fingers extending therefrom which mesh with the fingers of the other shaft.

10. The apparatus of claim 9 wherein said first and second shafts are rotated in opposite directions.

11. The apparatus of claim 1 wherein said air lock apparatus comprises a rotatable shaft having a plurality of radially extending vanes mounted thereon, a housing extending around said shaft and vanes, said vanes being disposed on said shaft to permit the flow of material through said air lock apparatus as said shaft is rotated while preventing the flow of air upwardly through said housing as said shaft is rotated.

12. The apparatus of claim 1 wherein source of air under pressure comprises a high pressure-high volume air pump.

13. The apparatus of claim 12 wherein said control means comprises means for delivering blasting material to the bore between 0 and 500 pounds per minute.

* * * * *