

[54] MIXING APPARATUS

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[58] Field of Search 239/336, 379, 428, 433

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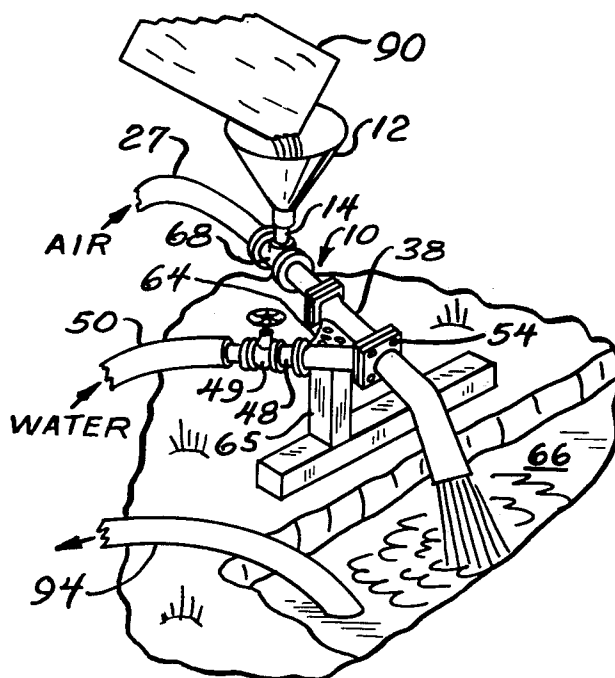
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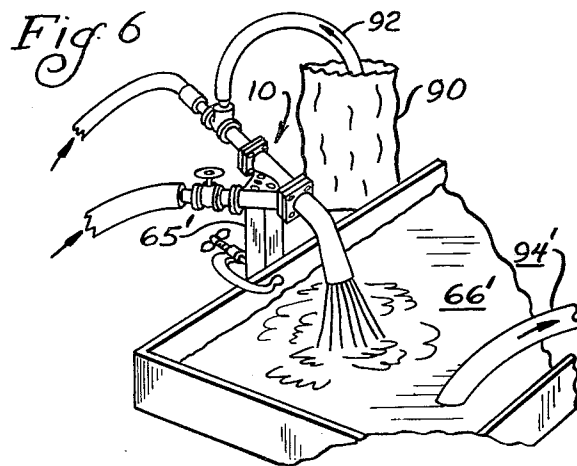
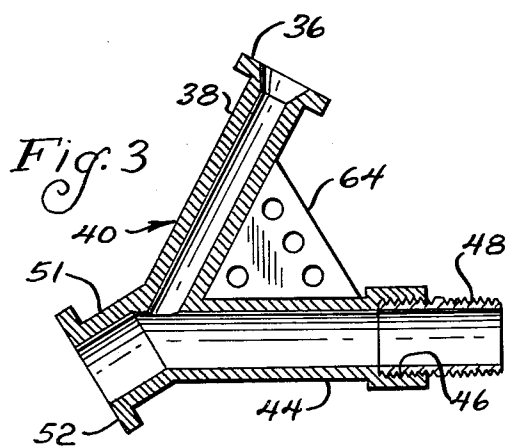
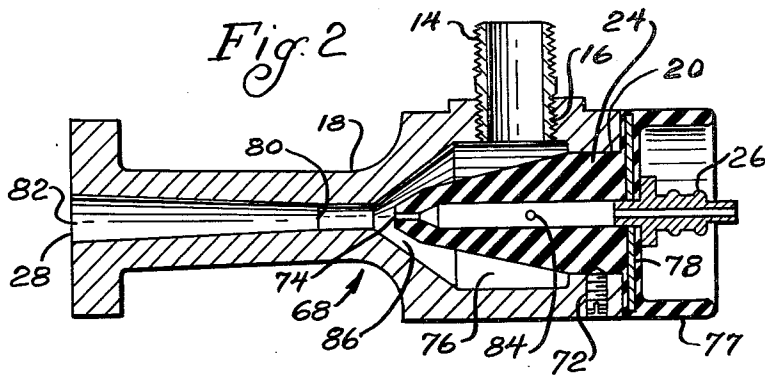
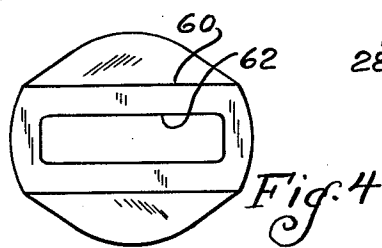
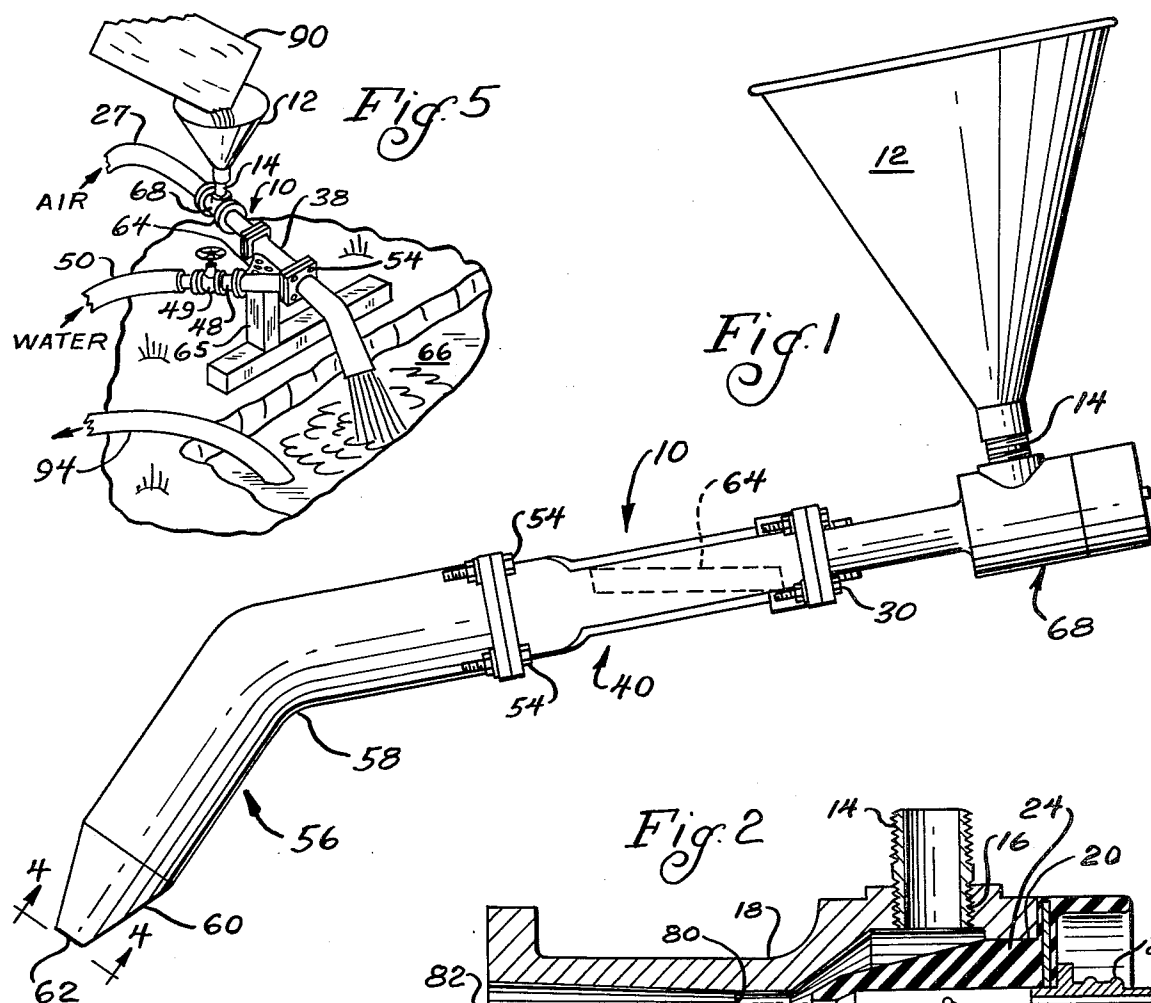
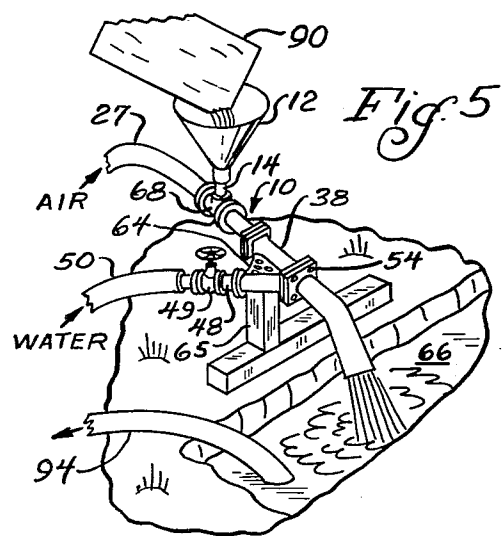
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ABSTRACT

Improved mixing apparatus permits dry powdered material such as guar gum drilling fluid additives to be mixed with water quickly and completely and without having the powder form hard-to-eliminate gum balls. The apparatus comprises a wye fitting having a pair of side by side inlet pipe branches or arms for receiving water and powder, respectively. The inlet branches are joined to each other at a 60° angle and define a mixing chamber at their juncture. The stem of the wye fitting is joined to an outlet nozzle which has an internal diameter greater than the internal diameter of the inlet branches. During operation, powder is fed through one of the inlet branches from a hopper or suction hose into contact with a water stream fed into the mixing chamber by the other of the inlet branches. The powder is carried to the mixing chamber by a stream of compressed air which sucks the powder from the supply hopper or through a suction hose from a remote bag by means of an eductor. The improved mixing apparatus is capable of providing complete mixing at much greater feed rates than prior art mixers.

8 Claims, 6 Drawing Figures





MIXING APPARATUS

BACKGROUND OF THE INVENTION

In drilling wells, it is common to employ drilling fluids or muds which have a greater viscosity than water in order to bring the particles produced during drilling to the surface where they may be disposed of. One particularly good drilling fluid additive is guar gum, an organic substance which becomes quite viscous when mixed with water in about a 0.8 percent concentration by weight. This particular additive has the property, when mixed with water, of breaking down in viscosity through the action of enzymes after about 3½ days. This change in viscosity permits the additive to be easily removed from the well after it has served its purpose of providing sufficient time for installation of a well casing, screen, and gravel. The aforementioned additive must normally be mixed very carefully and slowly, such as by sifting it into turbulent water. Without such mixing, the additive material tends to form "gumballs" having a wetted, gelatinous surface. The gumballs can almost never be broken down by agitation after they are formed and are wasteful of material since the powder inside them is not active. The waste factor is of extreme importance since the guar gum additive generally costs more than five times as much per pound as bentonite, another drilling additive. When the additives are thoroughly mixed, the guar gum is less expensive since about 85-90 percent less of it is required than bentonite to achieve a given viscosity level.

Various mixing methods have been tried, such as hand stirring, mechanical agitation, and fluid eductors, with varying degrees of success. One of the better prior art mixing devices comprises an eductor in which water is brought in around the outlet of a funnel which contains the powder. However, the device is limited in utility due to its inability to provide thorough mixing at high rates of addition of guar gum powder. For example, prior art mixers are capable of mixing about 150-200 pounds of powder per hour. Although the drilling fluid is usually mixed at the beginning of a drilling job, and fluid containing 150 pounds of powder additive is adequate for many jobs, it is obvious that if the fluid can be mixed in fifteen or twenty minutes rather than one hour, significant savings in equipment and labor costs are possible since the active drilling work can start and be finished more quickly.

SUMMARY

It is among the objects of the present invention to provide a mixing device for mixing powdered material into liquid which is capable of mixing such material more rapidly and at much greater feed rates than prior devices.

These and other objects are attained by the mixing device of the present invention which basically comprises an eductor assembly for providing a supply stream of dry powder and air, and a mixing assembly in which the powder-air stream is directed against a liquid stream in a mixing chamber. A similar device fashioned in large part from various pipe fittings is disclosed in copending application Ser. No. 328,802 assigned to a common assignee. The apparatus of the present invention is an improvement over the apparatus of Ser. No. 328,802 in that it is easier to build, lighter in weight, easier to clean and has a much higher mixing rate

(450-550 pounds of powder per hour as compared to about 300 pounds per hour).

The eductor assembly is placed in one arm of a tee-shaped casting and connected to a supply of compressed air at its outer end. A hopper is attached to the body of the tee-shaped casting with its large end upward for receiving powder. The other arm of the tee-shaped casting is connected by four bolts to one branch of a wye-shaped casting in such a manner that the branch of the wye-shaped casting which receives the powder from the hopper and eductor assembly is positioned beside the inlet branch which receives the water. A web containing mounting holes joins the inlet branches and is formed at a 10° angle to the plane containing the axes of the inlet branches. In use, the web is mounted in a horizontal plane. This positioning insures that water will always drain and not wet the powder inlet pipe when the unit is properly turned off since any such wetting would cause a buildup on the walls of the inlet pipe which would reduce its flow. The inlet pipe carrying the powder is sized so as to maintain a high velocity of the powder/air mixture. The internal diameter of the powder pipe is much smaller than the inlet pipe carrying the water so as to cause the powder to be directed against the fluid stream at a slight distance from the downstream pipe walls so that the wetted powder will have a short time to be hydrated or dissolved in the water before it contacts the pipe walls. By discharging the powder-liquid mixture from the wye-shaped casting through a casting containing a 45° elbow and wide nozzle, even more thorough mixing is obtained. Thus, in the case of using the device to make guar gum drilling fluids, the fluid is ready to use almost immediately, minimizing the time the fluid must stand in order to permit the powder to be hydrated until the fluid is at its working viscosity.

It has been found that the device works very well when the inlet branches of the wye-shaped casting are at about a 60° angle to each other. It has also been found that the feed rates of powder addition are increased when a small amount of air is mixed with the powder in the eductor before the powder is pulled into the eductor venturi by the compressed air. The aforementioned air is preferably provided by drilling a small hole in the eductor air nozzle in the powder chamber under the hopper. It is presumed that the additional air tends to fluidize the powder so that it offers less resistance to being pulled into the main air stream.

The manner in which the mixing apparatus is operated is extremely important and quite contrary to existing "mud guns" in which the water flow is initiated before the powder is added. In the instant apparatus the air is turned on at its maximum flow rate first. To provide the fastest mixing, the water is then gradually turned on until the operator can feel a slight loss of vacuum at the bottom of the empty hopper and then the flow is reduced to provide greatest vacuum. Greater water flow rates would cause the water to back up into the powder pipe and produce undesirable wetting of the surface thereof. The powder is then poured into the hopper until the amount required has been added to the water. After the powder has completely run out of the hopper and eductor, the water is turned off. Finally, the air is turned off, leaving the wye fitting clean and dry. If desired, a valve can be inserted at the bottom of the hopper to control the flow of powder. A vacuum gauge could also be added below the hopper to permit

an operator to easily ascertain when the water flow is at the desired maximum without placing his hand in the hopper. In place of the hopper, a flexible suction pipe can be connected to the tee-shaped casting in order to draw powder direct from a sack or other container.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a side view of the improved mixing apparatus;

FIG. 2 shows an enlarged side sectional view of the eductor assembly shown in FIG. 1;

FIG. 3 shows an enlarged side sectional view of the wye-fitting shown in FIG. 1;

FIG. 4 shows an enlarged end view of the exit nozzle shown in FIG. 1;

FIG. 5 shows a perspective view of the apparatus of FIG. 1 during use; and

FIG. 6 shows a perspective view of a modification of the apparatus of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, the improved mixing apparatus is indicated generally at 10. The apparatus 10 includes a conical-shaped hopper member 12 having an open upper end into which powder may be placed. The bottom of the hopper 12 terminates in an internally threaded exit portion which is threadedly retained by a close nipple 14 in the center opening 16 of a cast, generally tee-shaped coupling member 18. The tee coupling 18 includes a first arm opening 20 into which an air nozzle assembly 24 is placed. The outer end of the air nozzle assembly 24 is engaged with an air hose coupling member 26 so that a source 27 (FIG. 5) of compressed air can be quickly attached to the apparatus. A second arm opening 28 in the tee coupling 18 is attached by bolts 30 to end portion 36 of a first inlet branch portion 38 of a cast wye-shaped member indicated generally at 40. The first inlet branch portion 38 is joined to a second inlet branch portion 44 which terminates at an outer threaded end portion 46 which is adapted to be connected by a nipple 48 and valve 49 to a supply line 50 of water or other liquid under pressure. The inlet branches 38, 44 are integrally joined to a stem portion 51 having a larger diameter than the branch portions. The stem 51 has an outlet end portion 52 which is attached by bolts 54 to a nozzle member 56 having a 45° elbow portion 58 and an exit nozzle portion 60 having an elongated end opening 62. A perforated mounting web 64 on the wye member 40 is adapted to be fastened to the top of a mounting post 65 adjacent a storage tank (commonly called a mud pit) 66 (FIG. 5). The mixer assembly 10 is preferably mounted at the 10° angle shown in FIG. 1 to insure that the powder pipe 38 will always stay clean and dry.

Referring to FIG. 2, the elements 14-28, which constitute an eductor assembly 68, are shown in cross-section. The air nozzle member 24 is mounted within the opening 20 in eductor assembly 68 by means of a set screw 72. The air nozzle 24, which is preferably molded of 90-95 durometer neoprene rubber is of a progressively smaller internal diameter from its outer end, to which the air hose coupling member 26 is attached, to its inner end which comprises an exit nozzle opening 74. Surrounding the body of the air nozzle member 24 within the tee coupling 18 is a chamber 76 which is in communication with the hopper 12 and thus adapted to

receive powder to be mixed with air leaving the nozzle 74. To protect the hose coupling 26, the air nozzle member 24 is molded to include a skirt portion 77. A metal washer 78 molded between the nozzle 24 and skirt 77 provides increased strength to the assembly and includes threads which anchor coupling 26.

The exit portion of the eductor assembly 68 constitutes an expansion nozzle having a narrow entrance region 80 and a tapered larger diameter exit region 82 for receiving air from the nozzle opening 74. By providing a small opening 84 in the side wall of air nozzle 24 in communication with the chamber 76, it has been found possible to increase the amount of powder which can be fed by the eductor assembly 68 through the tapered annular exit opening 86. As previously mentioned, it appears that leakage of air through the opening 84 tends to fluidize the powder in the chamber 76 and thus decreases its natural resistance to movement through the opening 86. For maximum mixing capability it is important that all of the inside surfaces of the member 18 be polished. A surface finish of 63 microinches has been found to be satisfactory. Preferably, all of the castings 68, 40 and 56 are of aluminum, but could also be made of other materials such as plastic.

After the powder-air mixture leaves the exit end 82 of the eductor assembly 68, it enters inlet branch 38 of the wye member 40. FIG. 3 shows an enlarged cross-sectional view of the interior of the wye member 40. The powder-air inlet branch pipe 38 is at about a 60° angle to the water branch 44 and of a much smaller diameter so that the powder will flow into the water stream at a high velocity so as to promote better mixing. Good mixing is also promoted by the elongated nozzle opening 62 (FIG. 4) which sprays the powder and water over a large area.

FIG. 5 illustrates the apparatus 10 in an actual use situation with the mounting web 64 being positioned on the top of a support post 65 to maintain the apparatus at the 10° angle shown in FIG. 1 and about 12 inches above the surface of the water in the mud pit 66. Since it is most important that water not get into the powder-/air branch 38 of the wye member 40, the air supply 27, preferably at a pressure of 75 to 125 psi, is snapped onto fitting 26. The water supply 50, preferably capable of delivering water at 20 to 50 gallons per minute, is connected to nipple 48 in water branch 44 with the valve 49 shut off. The air supply 27 is then turned on full causing a suction of the bottom of funnel 12. The water supply valve 49 is then turned on until the gallons per minute is approximately equal to one third of the air pressure. For example, mixing rates of over 500 pounds per hour have been achieved when the air is at 90-100 psi and the water at 30-135 gallons per minute. In a prototype apparatus, the internal diameter of powder/air branch 38 was 0.75 in. while the water branch 44 was 1.5 in. The exit internal diameter of the stem portion 51 was 1.75 in. When water flow rate cannot be determined, a satisfactory mixing can be achieved by gradually increasing water flow until suction can barely be felt by hand in the bottom of funnel 12, and then reducing the water flow by 50 percent.

After the proper air and water flow relationship is established the powdered drilling fluid additive can be poured into the funnel 12 from bag 90. After the powder has all been mixed with water, the water is shut off and then the air is shut off. As the unit 10 is removed from the mixing site, it should be carried so as to pre-

vent water from entering branch 38 of wye member 40. If water does get inside the wye member 40 or eductor assembly 68, the unit can be fairly easily disassembled for cleaning.

FIG. 6 shows a modification which differs from the FIG. 5 embodiment of apparatus 10 only in that a hose 92 is attached to nipple 14 in place of the funnel 12 shown in FIG. 5. With the hose 92, powder can be drawn directly from a bag 90. This arrangement is especially good when it is raining since it prevents water from entering the eductor assembly 68. FIG. 6 also shown an above ground mut pit 66' which functions the same as the inground mut pit 66 of FIG. 5. The mixing apparatus shown in FIG. 6 is mounted to a clamped vertical member 65'. In FIGS. 5 and 6, the mixed drilling additive is pumped out of the pits 66, 66' by pump hoses 94, 94' which carry the additive, or mud, to the hole being drilled (not shown).

We claim as our invention:

1. Apparatus for continuously feeding a supply of powdered material into a liquid stream and mixing it therewith comprising a powder supply portion adapted to receive compressed gas and powdered material and to selectively supply a mixture of compressed gas and powdered material to a molded wye-shaped mixing portion removably attached thereto, said mixing portion comprising a pair of hollow inlet branch portions arranged side by side at an angle of less than 90° to each other and forming a common hollow outlet stem portion, said inlet arm portions each having a smaller cross-sectional area than said outlet portion, said inlet and outlet portions being blended together to define a smooth-walled mixing chamber, said powder supply portion being removably attached to one of said pair of inlet branch portions and the other of said pair of inlet portions being adapted to be removably attached to a source of liquid, an outlet nozzle removably attached

to said outlet stem portion, said outlet nozzle including an angled flow path, and bracket means on said apparatus for mounting said apparatus so that said pair of side by side branch portions will lie in a common plane which is positioned at a small angle to the horizontal to facilitate drainage.

2. The apparatus of claim 1 wherein said pair of hollow inlet branch portions are arranged at an angle of about 60° to each other.

3. The apparatus of claim 1 wherein said powder supply portion comprises an eductor assembly including a gas nozzle, a powder chamber surrounding said gas nozzle, and an expansion nozzle downstream from said gas nozzle, said nozzles cooperating to cause powder in said powder chamber to be continuously drawn into said expansion nozzle by the flow of gas through said nozzles.

4. The apparatus of claim 3 wherein said powder supply portion further comprises a hopper for receiving batches of powder, said hopper being connected to said powder chamber.

5. The apparatus of claim 3 wherein said powder supply portion further comprises a suction hose for drawing powder into said powder chamber from an isolated supply of powder.

6. The apparatus of claim 4 wherein said gas nozzle has a small aperture in its side wall which permits a small amount of gas to be leaked into said powder chamber upstream of the outlet opening of said gas nozzle.

7. The apparatus of claim 1 wherein said outlet nozzle has a generally elongated oval shape.

8. The apparatus of claim 1 wherein the said one inlet branch portion which is connected to said powder supply portion has an internal diameter which is less than the internal diameter of the other inlet branch portion.

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