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[54] **NOZZLE FOR HIGH-PRESSURE BLASTING APPARATUS**
9 Claims, 5 Drawing Figs.

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[51] Int. Cl. **B05b 7/06**

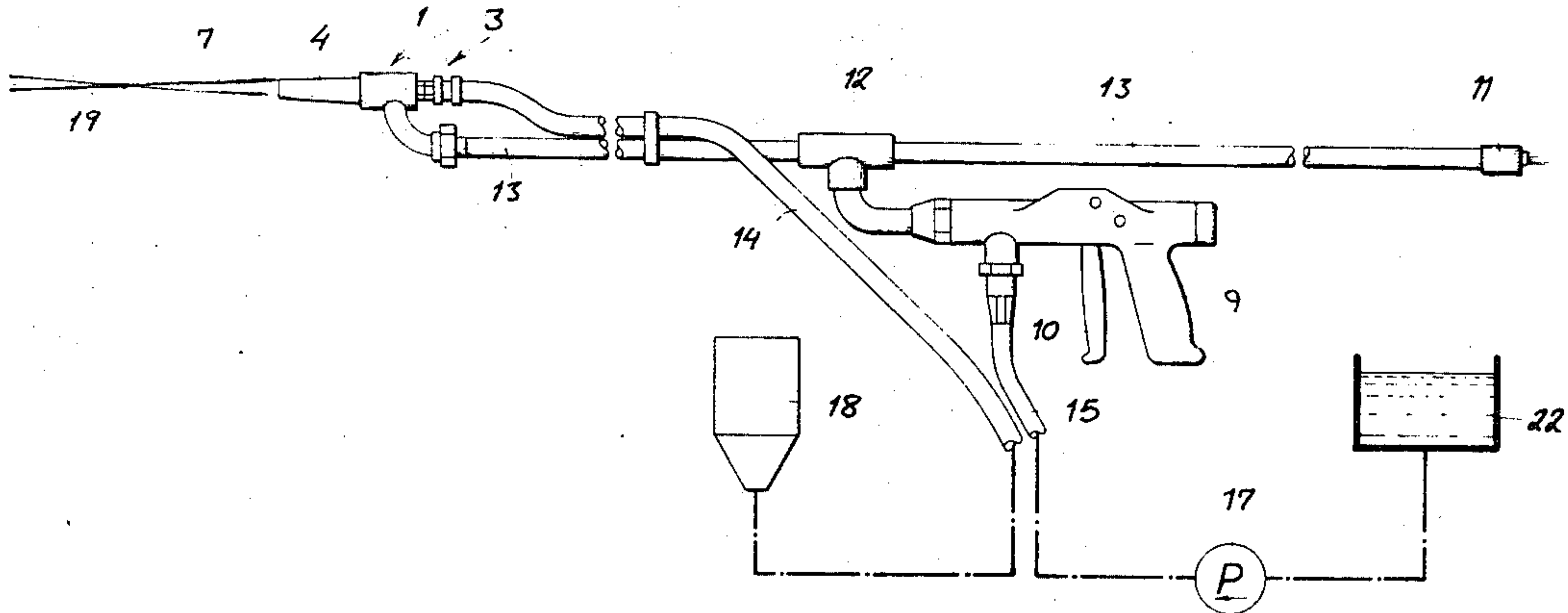
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 433, 434.5, 419, 591, 265.15, 427.3; 51/8, 11

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ABSTRACT: A nozzle for high-pressure blasting apparatus usable with water at pressures between 300 and 600 atmospheres has a nozzle housing in which a tubular body is fitted. One end face of the tubular body is formed with a group of small slits surrounding the central bore of the tube and directed slightly inwardly toward the axis of the tube. Sand, corundum (silicon carbide) or metal particles are fed through the central bore of the tube and water is forced through the small openings in a crownlike array. A sleeve is tightly fitted in the tube to act as a particle-accelerating restriction. The forward end of the sleeve can be recessed from, can be flush with, or can extend beyond the front face of the tubular body, according to desired operating characteristics.



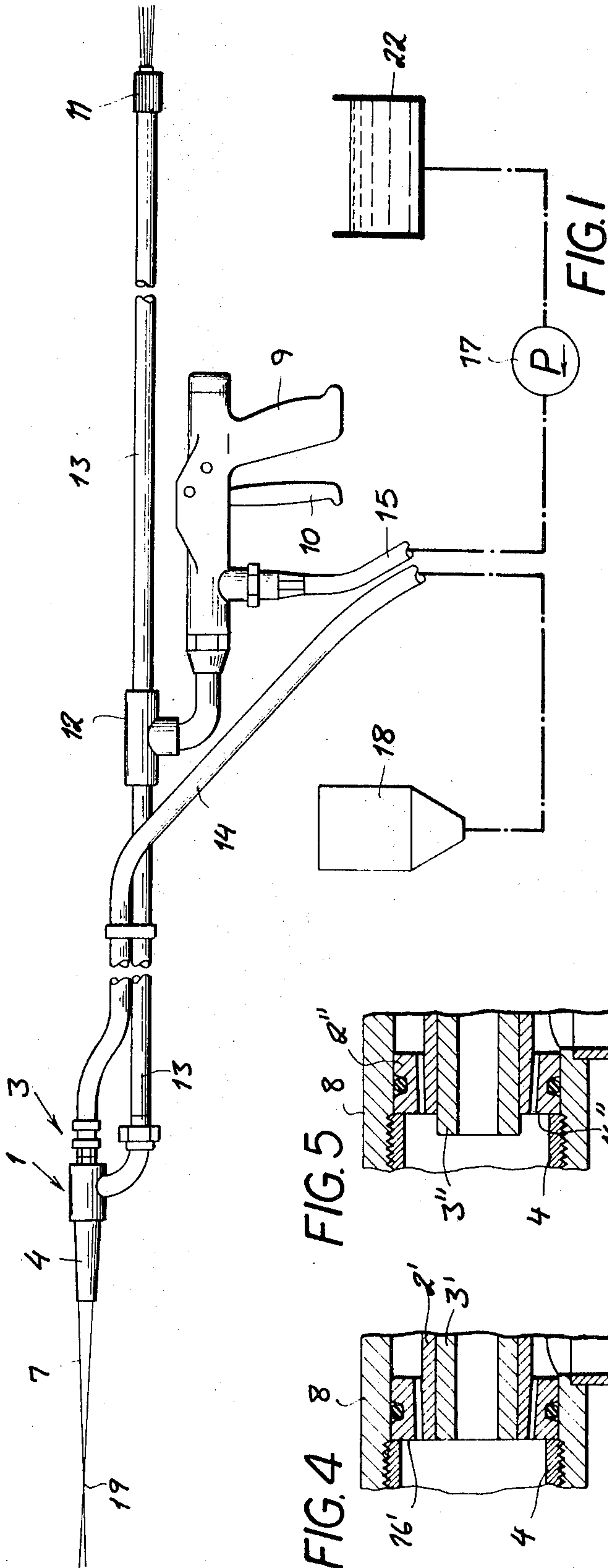


FIG. 1

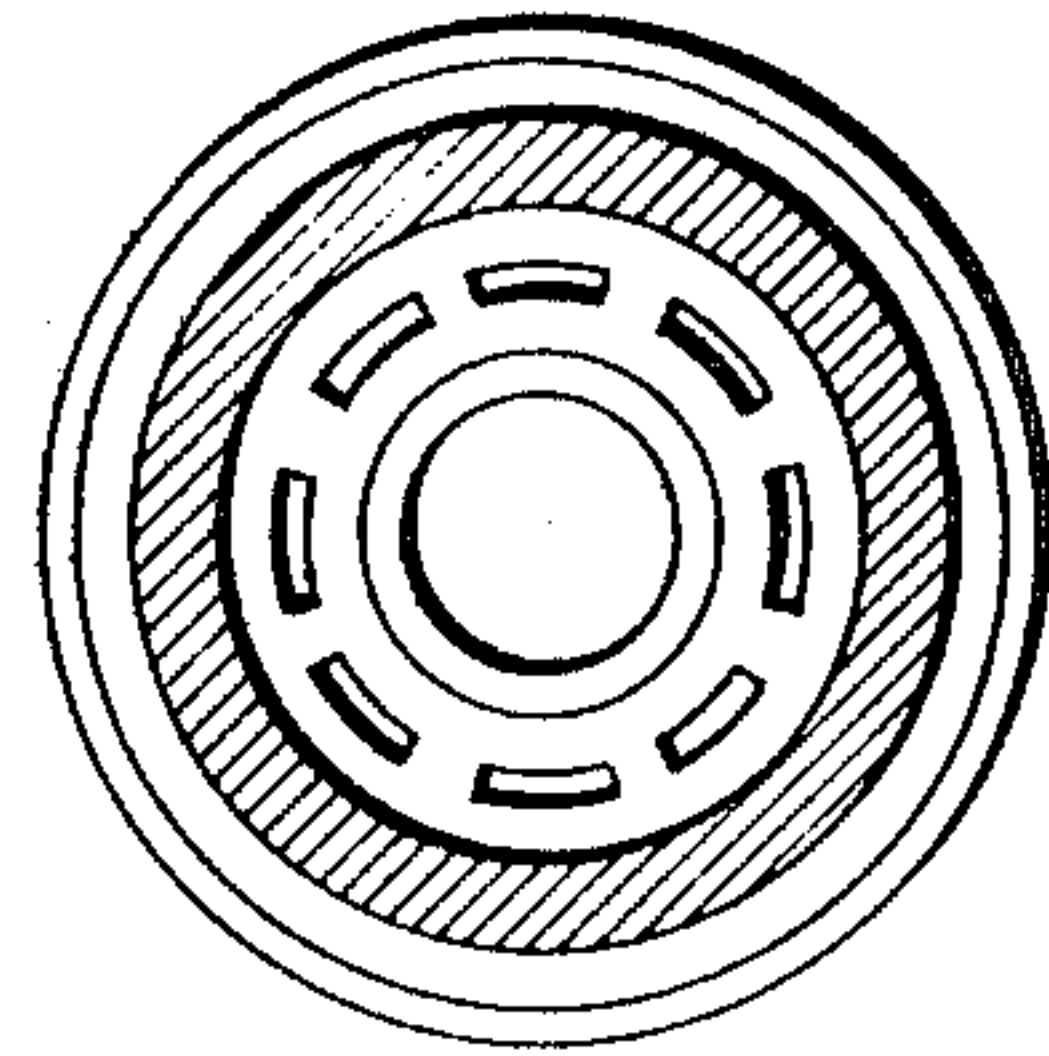


FIG. 3

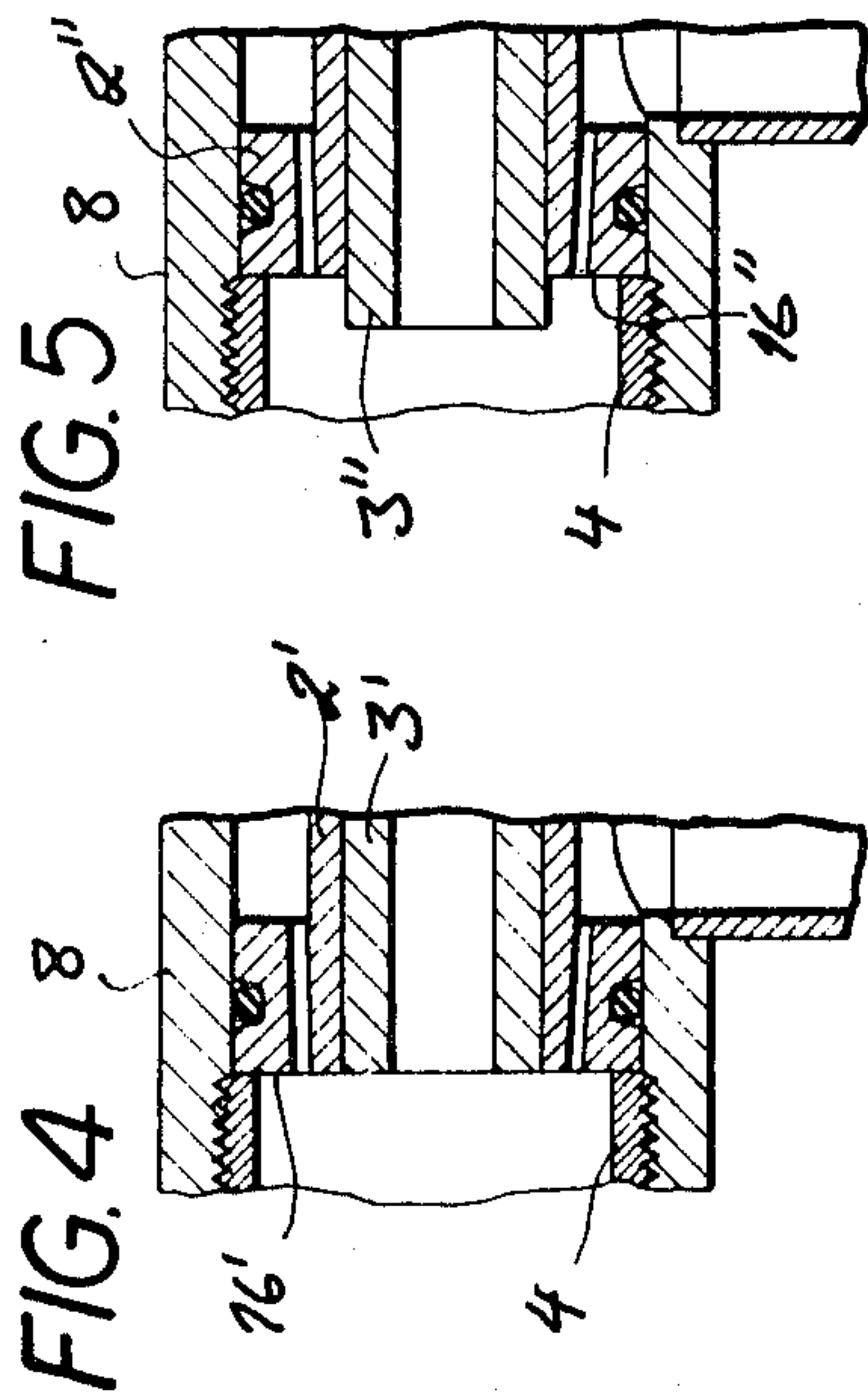


FIG. 4

FIG. 5

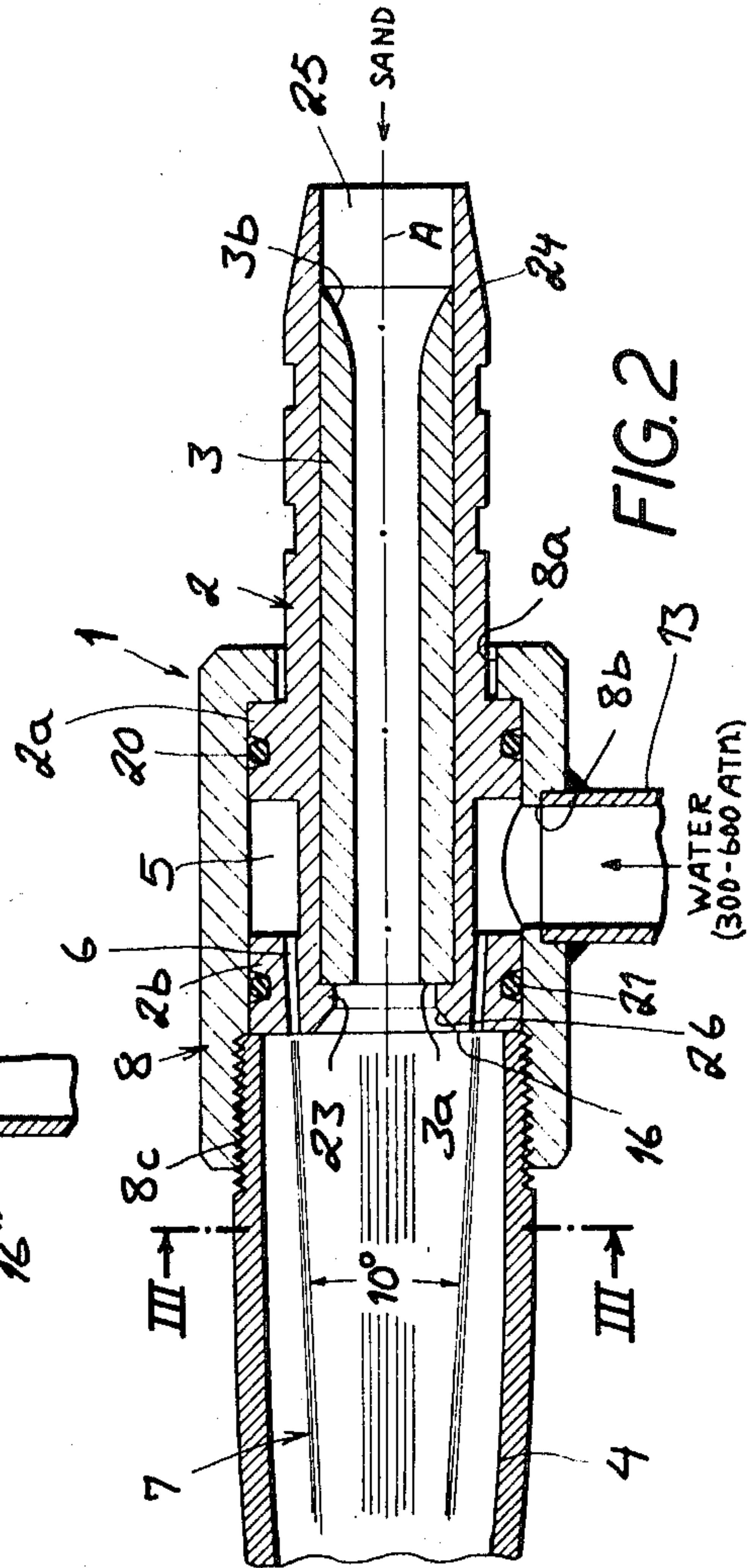


FIG. 2

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NOZZLE FOR HIGH-PRESSURE BLASTING APPARATUS

My present invention relates to a mixing nozzle for a high-pressure sandblasting apparatus and, more particularly, to such an apparatus intended to be used under water.

Sandblasting devices of many different sorts are known. They generally use a mixture of some particulate material such as sand, quartz sand, corundum, aloxite, metal particles, or the like, carried by and mixed with a high-pressure stream of air. It has also been proposed to use another fluid, e.g. water, instead of air. In general, such systems are quite effective for surface cleaning and treating; however, they are almost completely ineffective when used under water.

For sandblasting underwater, or even under certain conditions on land, it is necessary to work with very great pressures—in the neighborhood of 300–600 atmospheres (gauge). Furthermore, it has been found to be desirable to accelerate the particles as they enter the fluid stream to impart high kinetic energies to the particles.

It is therefore the principal object of my present invention to provide an improved nozzle-mixing arrangement for a high-pressure sandblasting apparatus.

More specifically, it is an object of my present invention to provide a mixing nozzle for a high-pressure sandblasting apparatus which overcomes the above-mentioned disadvantages.

The above and other objects are attained, in accordance with the principal features of my invention, by the provision of a high-pressure mixing-nozzle arrangement wherein an elongated tubular body is received in a hollow housing. The body and the housing form an annular chamber which communicates with an end of the body through a plurality of apertures lying generally on the surface of a right-circular cone coaxial with the housing. The bore in the tubular body is provided with a sleeve which serves as an elongated constriction which accelerates the particles greatly.

I have found that the provision of such a sleeve-like constriction in the feed bore for the particulate material, which decreases the effective cross section of the particle-supply duct shortly before the mixing chamber and is cylindrical (without further constriction), in the immediate vicinity thereof, greatly accelerates the particles especially when the constriction reduces the diameter to about half its original diameter and the length of the sleeve is about eight to 12 times its internal diameter (after the constriction) without adversely affecting the supply of particles to the nozzle, so that the nozzle is of increased effectiveness by comparison with a similar nozzle omitting the sleeve. Great kinetic energy is imparted to these particles with a very steep, velocity-distribution curve for the individual particles.

Due to the conical shape of the jet the particles are entrained by convection while being effectively shrouded by the water, which can be under pressures as great as 300–600 atmospheres (gauge). Thus, even when used underwater at great depth the particles will not be slowed by the surrounding water since this viscous medium appears to retard only the passage of the fluid shroud serving to project the particles.

Further features of my invention include a tapered tube attached to the front end of the nozzle with a conicity corresponding to that of the jet. Furthermore, the front end of the sleeve is preferably level or flush with the front end face of the nozzle body; it also may be recessed from the front end face, in which case a rim may be provided in the bore receiving the body to retain it in place.

The above and other objects, features, and advantages of my present invention will be more fully described in the following, with reference to the accompanying drawing, in which:

FIG. 1 is a side view of a nozzle-mixing arrangement according to my invention;

FIG. 2 is an axial section through a detail of FIG. 1;

FIG. 3 is a cross section along the line III—III of FIG. 2; and

FIGS. 4 and 5 are sectional details of two further embodiments of my present invention.

FIG. 1 shows a nozzle arrangement 1 mounted on two conduits 13 and 14. The conduit 14 leads to a hopper 18 loaded with particulate material, in this case sand. The conduit 13 opens at 11 and is connected by a T joint 12 in the middle to a piston-grip valve 9 as described in my commonly assigned U.S. Pat. No. 3,394,890 or in my commonly assigned application Ser. No. 798,030 filed on Feb. 10, 1969 (now abandoned) and entitled "High-Pressure Valve with Axially Aligned Valve Body and Control Rod." From this valve 9 a tube 15 leads to a pump 17 connected to a water reservoir 22.

As shown in more detail in FIG. 2, the nozzle 1 consists of a housing cup 8 having a rear opening 8a, a lateral bore 8b, and a threaded front opening 8c. A nozzle body or center piece 2 is received in the housing 8 with a rearwardly extending tubular portion 24 projecting through the opening 8a. This body 2 defines between its rims 2a and 2b an annular chamber 5 which communicates through the bore 8b with the conduit 13. The front rim or ledge 2b is formed with eight apertures or slots 6 (see also FIG. 3) which lie on the surface of an imaginary right-circular cone that is coaxial with an axis A of the body 2 and has an apex angle of 10°. O-rings 20 and 21 seal the rims 2a and 2b, respectively, against the interior of the housing 8.

An internal bore 25 in the body 2 snugly receives a sleeve 3 with a flat front end 3a butting against a rim 23 in the bore 25 and a rear end 3b which is somewhat tapered to allow for reasonably smooth flow of sand thereinto. An extreme front end 26 of the bore 25 is advantageously flared. Thus, the end 3a of the sleeve 3 is recessed from a front face 16 of the body 2, which face is perpendicular to the axis A.

A tube 4 which is advantageously frustoconical with the same taper or conicity as the above-mentioned cone of the openings 6 is screwed into the end 8c of the housing 8. The tube 4 however ends before a point 19 which marks the apex of a conical jet 7 produced by the openings 6.

The nozzle functions when a lever 10 on the grip 9 is actuated. This action forces very highly pressurized water—300–600 atmospheres (gauge)—into the chamber 5 and out through the openings 6 to form the conical jet 7. Some water escapes at 11 also to mitigate the effects of recoil. Such a jet draws sand out through the bore 25 and projects it at very great speed against some object preferably held slightly beyond the apex point 19. As the sand passes through the sleeve 3 it is greatly accelerated.

Although the apertures 6 have been shown to be of elongated, slightly curved cross section, they can also be round, or formed by a single circular slot.

FIG. 4 shows a sleeve 3' which is flush with an end face 16' of a nozzle body 2'. In FIG. 5 a sleeve 3'' extends beyond an end face 16'' of a nozzle body 2''. Both of these embodiments provide slightly different operating characteristics useful with different pressures, fluids, and particulate materials. Thus the term "sandblasting" as used herein is intended to encompass the use of any particulate material, some of which have been mentioned above.

I claim:

1. A high-pressure nozzle-mixing arrangement comprising:
 - a housing having a hollow interior;
 - an elongated tubular body in said housing having an end face and formed with a longitudinal cylindrical bore opening at said face, said body forming with said housing an annular chamber surrounding said body;
 - conduit means for supplying dry particulate material to said bore at an end of said body opposite said face;
 - means for supplying fluid under pressure to said chamber;
 - aperture means in said body communicating with said chamber and opening at said face for forming a conical jet of said fluid coaxial with said bore and forwardly of said face;
 - a sleeve wholly received in said bore and forming a constriction therein for accelerating said material, said conduit means having a cross-sectional area greater than that of said constriction; and

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an elongated substantially frustoconical tube attached to said housing coaxial with said body, said tube having substantially the same conicity as said conical jet and converging away from said housing.

2. The arrangement defined in claim 1 wherein said sleeve has a front end lying in substantially the same plane as said end face of said body.

3. The arrangement defined in claim 1 wherein said fluid is water at a pressure between 300 and 600 atmospheres.

4. The arrangement defined in claim 1 wherein said aperture means includes a plurality of apertures in said body extending between said face and said chamber and lying substantially on the surface of a right-circular cone coaxial with said bore.

5. The arrangement defined in claim 4 wherein each of said

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apertures is of elongate and arcuate cross section.

6. The arrangement defined in claim 1 wherein said sleeve has a front end and said body is formed in said bore with a rim adjacent said face, said front end of said sleeve abutting said rim of said body.

7. The arrangement defined in claim 1 wherein said bore is formed with a flared front end.

8. The arrangement defined in claim 1 wherein said sleeve has a longitudinal passage having a rear end, said passage being flared at said rear end.

9. The arrangement defined in claim 1 wherein said sleeve has a circular flow cross section with a diameter approximately half the diameter of said bore and a length about eight to 12 times the diameter of its circular flow cross section.

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