E. A. FALLER.

APPARATUS FOR COMBINING COMMINUTED SOLIDS AND LIQUID.

APPLICATION FILED MAY 19, 1911.

998,762. Patented July 25, 1911.

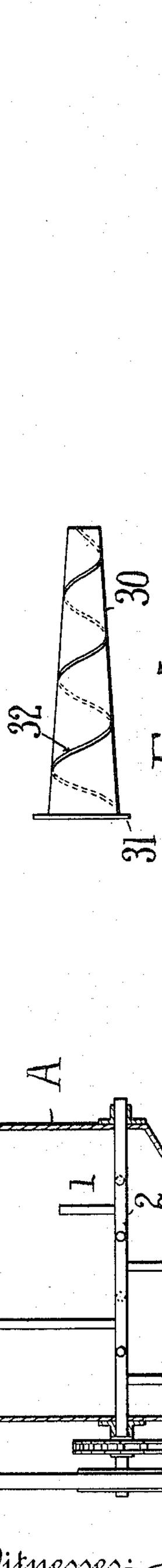

Fig. 5.

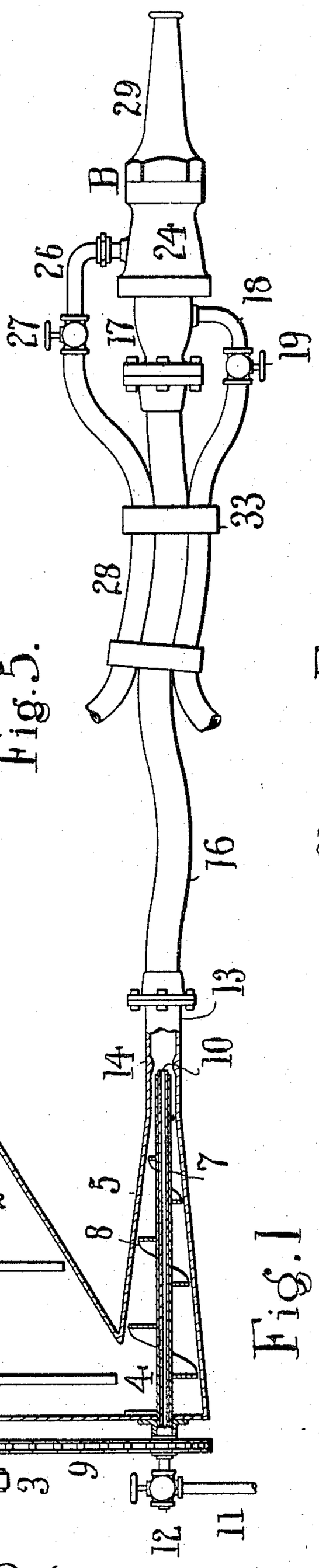

Fig. 1

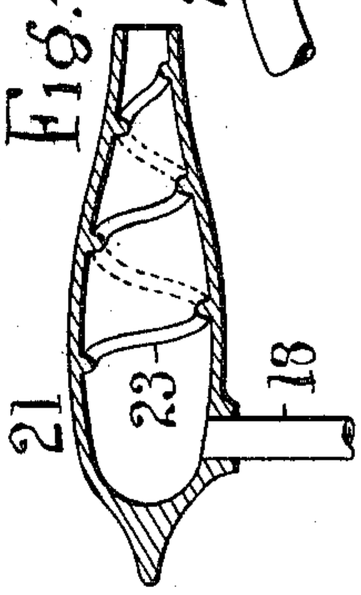

Fig. 4.

Fig. 3.

Fig. 2.

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UNITED STATES PATENT OFFICE.

ERNEST A. FALLER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO CEMENT APPLIANCES COMPANY, A CORPORATION OF NEW YORK.

APPARATUS FOR COMBINING COMMINUTED SOLIDS AND LIQUID.

998,762. Specification of Letters Patent. Patented July 25, 1911.

Application filed May 19, 1911. Serial No. 628,161.

To all whom it may concern:

Be it known that I, ERNEST A. FALLER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented a certain new and useful Improvement in Apparatus for Combining Comminuted Solids and Liquid, of which the following is a specification.

The invention is an apparatus for combining a substantially dry comminuted solid with a tempering liquid, and for delivering the compound in a wet or plastic state.

The principle is as follows: To produce in a suitable conduit a current of air, wherein solid particles are suspended, and to deliver into said current a jet of liquid. By reason of the separation of the solid particles in the air current, they are thus brought into contact with the liquid in the conduit, so that a more or less plastic compound is delivered from said conduit. In order to secure more intimate mixture of the particles and the liquid, I may impart either to the air current or to the liquid jet, or to both, a movement of axial rotation, preferably just before escape of the compound from the conduit. In carrying this principle into practical effect, I provide apparatus organized and operating as follows: (*a*) To move the comminuted dry solid out of its receptacle and force the same into the duct by positively acting mechanical means. (*b*) To mingle the comminuted solid in said duct with an air jet, the said solid reaching said jet preferably in the form of a thin annular inclosing stream. In this way, a current of air with the solid particles suspended therein is blown through the duct to a nozzle containing a mixing chamber communicating with the delivery orifice. (*c*) To restore such energy as may be lost by the current in traversing the duct, and to create suction therein, by directing a new air jet into said duct just before said current reaches the mixing chamber in the nozzle, which jet also imparts to said current a movement of rotation. (*d*) To combine the rotating current with a surrounding oppositely rotating coaxial liquid jet in said mixing chamber, whereby the solid particles and liquid become most intimately mingled, and finally escape from the nozzle in wet or plastic condition.

The apparatus may be used for many purposes. As for example, to mix various ingredients. The dry comminuted material may be cementitious—such as lime or Portland cement—and the tempering liquid may be water, the cement then becoming hydrated by the liquid. Or the dry comminuted material may enter into chemical combination with the liquid, as in mixtures for producing "artificial stone". Or the dry comminuted material and the tempering liquid may be mutually inert, the liquid then serving to bring the particles of the material into closer juxtaposition so that they remain cohesive, after drying—as in the case of magnesia-asbestos coatings for heat insulation. The resulting compound, made of any degree of liquid fluidity, may be caused to flow directly from the nozzle at any desired speed as a stream or as a jet. It may be employed to fill and consolidate faults and fissures in rock, or the spaces around tunnel or pipe linings, for concrete building construction, or for any other utilization where it is desired to direct a mass of wet or plastic material to some special place of deposit. By increasing the speed of flow, plastic cementitious material, if made suitably fluid, may be projected from the nozzle in the form of a jet, against surfaces to be covered therewith.

In the accompanying drawings—Figure 1 shows the apparatus with the receptacle for comminuted solids in vertical section on the line *x*, *x* of Fig. 2, and the nozzle and connections in elevation. For clearness, the nozzle is here shown on a larger scale than the receptacle. Fig. 2 is an end elevation of the said receptacle. Fig. 3 is a longitudinal section of the nozzle and connections. Fig. 4 is a similar section of the air nozzle, and Fig. 5 is a separate view of the detachable lining for the nozzle.

Similar letters and numbers of reference indicate like parts.

The comminuted dry solid, such as cement or lime, with or without an added amount of sand, is placed in the receptacle A, where it is agitated and prevented from packing by means of the beater arms 1 on shaft 2; said shaft being journaled in the walls of said receptacle and rotated by the belt pulley 3: Three of the receptacle walls are inclined at their lower portions to form a funnel leading to the escape orifice 4, through which the dry comminuted solid passes into the tapered casing 5. In said

casing is a hollow shaft 7, which carries spiral conveyer blades 8, and is rotated from shaft 2 by a chain and sprocket gear 9. Within the hollow shaft 7 is a pipe 10 which, by pipe 11, provided with valve 12, communicates with any suitable source of air under pressure. The pipe 10 extends beyond the small end of casing 5, and terminates just in front of a constriction 14 in the tube 13, to which tube the nozzle B is flexibly connected, preferably by a hose 16.

The nozzle B is constructed as follows: To the end of hose 16 is coupled a nozzle 17, which first swells outwardly and then contracts. The pipe 18, provided with valve 19, which communicates with a source of air under pressure, preferably by means of a hose 20, enters said nozzle through the wall thereof, and supports an inner coaxial nozzle 21, shaped approximately to conform thereto, so that between the outer periphery of said nozzle 21 and the inner periphery of the nozzle 17, an annular passage 22, first enlarging and then contracting in diameter, is produced. On the exterior of air nozzle 21 is a conical projection 21^{x}. On the interior of air nozzle 21 is a spiral rib or rifling 23. The delivery end of air nozzle 21 extends into the tapering portion of the nozzle 17, and terminates before it reaches the extremity thereof. The nozzle 17 is externally threaded to receive a sleeve 24, the inner periphery of which is tapered to conform to the shape of said nozzle, but is of larger diameter, so that an annular tapering chamber 25 is formed between said nozzle and sleeve. Communicating with said chamber is a pipe 26, provided with valve 27, which is connected, preferably by means of hose 28, to any suitable source of tempering liquid—such as water—under pressure. The outer end of sleeve 24 is shouldered and threaded to receive the correspondingly shouldered tapered delivery nozzle 29. Within nozzle 29 is placed a closely fitting removable lining 30, preferably of thin metal, provided with a flange 31 which, when the nozzle 29 is in place, is clamped between the shouldered portions of said nozzle and sleeve 24. On the inner periphery of lining 30 is formed a spiral rib or rifling 32. The direction of the turns of the spiral rib 32 is opposite to that of the turns of spiral rib 23 in nozzle 21. The nozzle 17 terminates within the nozzle 29. For convenience in manipulating the delivery nozzle B, the three hose ducts may be bound together, as shown at 33.

The operation of the apparatus is as follows: The dry comminuted solid, such as cement or cement and sand, is placed in the receptacle A, and is kept stirred by the revolving beaters 1, which also break up any lumps, and prevent packing of the mass which escapes by gravity through the lower orifice into the tapered casing 5. By the positive action of the spiral conveyer in said casing, the escape opening in the receptacle is always kept free. The solid particles are positively forced through said casing to the smaller end thereof, and there meet the air jet delivered by tube 10. Said particles are then in the form of a comparatively thin annular stream, which by means of the constriction in tube 13 becomes contracted just in front of the escape orifice in tube 13. The air jet therefore acts upon small quantities of the solid particles to inject the same suspended in it into and through the duct or hose 16 which communicates with the nozzle B. Attention is particularly called to the fact that the hose 16 is not filled with packed dry material, nor is any attempt made to force such material through the duct by air pressure applied above the mass in the receptacle or into the mass before it enters the duct. I produce here really a dust injector, which by its blast entrains a thin annular stream of solid particles and literally blows a current of air and solid particles therein suspended through the hose to the nozzle B. As the current enters this nozzle, it meets first the pointed projection 21^{x} which guides it gradually into the enlarging portion of the annular chamber 25. This prevents sudden loss of energy of the blast which would follow its striking upon an extended surface on the exterior of air nozzle 21, and the consequent abrasion and wear resulting therefrom, and also possible accumulation of solid material at that point. The dust blast now enters the contracting portion of nozzle 17, and then meets the second air jet delivered by nozzle 21. This second air jet performs several functions. Thus (*a*) it produces suction in the duct or hose 16, which assists the movement of the current therein, and also prevents said duct from becoming choked or stopped; (*b*) it reduces the density of the current of solid particles and air, so as to expose the particles more completely to the action of the liquid; (*c*) is restores the energy of the current lost by friction in traversing the duct, and (*d*) it sets said current in axial rotation. The last result is effected by the rifling or spiral rib, in the air nozzle 21, which gives the outgoing jet a rotary motion on its axis, which jet, in the space between the end of air nozzle 21 and the end of nozzle 17, imparts that motion to the current. While this is going on in said space, water or other tempering liquid is entering under pressure into the annular chamber 25 which surrounds nozzle 17. The liquid then passes into the mixing chamber C in nozzle 29 in the form of an annular stream, which moves in the same direction and is coaxial with the rotating air and dust blast escaping into said chamber. Note that the dust

stream does not meet the water jet tangentially or on one side. In such case, the water jet merely obstructs the outflow of the stream, and combines with only a very small quantity of the solid particles suspended therein. But the air and dust blast is here the core of the liquid jet, and is completely inclosed in it. And, furthermore, because of the spiral rib or rifling 32 in lining 30, the liquid jet, like the dust blast, is given a rotary motion on its axis, but in the reverse direction to that of the air and dust blast. This because of the reverse directions of spiral ribs 32 and 32. The consequence is complete mixture of the rotating dust and air blast and the oppositely rotating liquid jet, in the nozzle chamber C, and just prior to the escape of the combined materials in wet or plastic state from said nozzle. It is to be especially noted that this mixing is done in the nozzle B, and hence before, and not after, the combined materials are finally permitted to escape from said nozzle; and that the whole apparatus is organized with this object in view.

While it is preferable to insure more intimate mixture of the solid particles and liquid, to cause the currents of both to rotate, I may rotate but one of said currents, in which event the rifling in either air nozzle 21 or lining 30, as the case might be, would be omitted. When the liquid jet is shut off to enable the apparatus to deliver a blast of dry solid particles only, it would be desirable to have the projected jet rotate after leaving the nozzle in order to increase its abrasive action, or to cause the solid particles to be distributed over larger surface areas—as when the device is used for applying powdered insecticides to trees, plants, etc. In such event, the rifling may be omitted, as already stated, in either nozzle 21 or lining 30, or the direction of the rifling in both nozzle and lining may be made the same.

The valves in the several supply pipes for air and liquid permit of the pressures of air and liquid to be adjusted relatively to one another. They also control the proportions of solid and liquid in the compound delivered. The speed of outflow may in like manner be regulated, so that there may be a slow escaping stream, which may be caused to pour or flow into or upon the place of deposit, or a powerful jet may be caused to impinge on and so cover a surface, or by its force pack a plastic mass into a cavity or pocket. The conveyer below the receptacle for dry material not only positively moves that material to the duct or hose 16, but keeps the escape opening from said receptacle always free. The lining 30 may be cheaply stamped from sheet metal, and is easily replaced whenever impaired by wear or otherwise.

I claim:

1. An apparatus for combining a comminuted solid and a liquid comprising a duct, and, at the inlet end of said duct, means for injecting an air jet, and means for gradually feeding solid particles to said jet to form a current of solid particles and air traversing said duct, and, near the outlet end of said duct, means for delivering liquid under pressure into said current.

2. An apparatus for combining a comminuted solid and a liquid comprising a duct, and, at the inlet end of said duct, means for injecting an air jet, and means for gradually feeding solid particles to said jet to form a current of solid particles and air traversing said duct, and, near the outlet end of said duct, means for directing a second air jet into said current, and means for delivering liquid under pressure into said current.

3. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for said solid, a nozzle having an internal chamber provided with an inlet for liquid under pressure and communicating with a delivery orifice, means in said inlet for imparting rotation to said liquid, means for supplying to said chamber a current of solid particles and air, and means for imparting rotation to said current.

4. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for said solid, a nozzle having an internal chamber provided with an inlet for liquid under pressure and communicating with a delivery orifice, means in said inlet for imparting rotation to said liquid, means for supplying to said chamber a current of solid particles and air, and means for imparting rotation to said current in a reverse direction to that of the liquid current.

5. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for said solid, a duct communicating with said receptacle, means for mechanically moving said solid from said receptacle to said duct, a pipe communicating with a source of air under pressure and opening into said duct to produce a current of solid particles and air therein, and a nozzle having an internal mixing chamber; the said chamber communicating with said duct and having an inlet for liquid under pressure, in which chamber said particles and liquid become combined before escaping at the final delivery opening and means for forcing liquid under pressure to said inlet.

6. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for said solid, a duct communicating with said receptacle, means for mechanically moving said solid from said receptacle to said duct, a pipe communicating with a source of air under pressure and opening

into said duct to produce a current of solid particles and air therein, a nozzle, and a pipe communicating with a source of air under pressure opening into said nozzle; the said nozzle being provided with an internal chamber having an inlet for liquid under pressure and receiving said current of air and solid particles, in which chamber said particles and liquid become combined before escaping at the final delivery opening.

7. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for said solid, a duct communicating with said receptacle, means for mechanically moving said solid from said receptacle to said duct, a pipe communicating with a source of air under pressure and opening into said duct to produce a current of solid particles and air therein, a delivery nozzle formed in three portions, namely, an end nozzle, a second nozzle supporting said end nozzle and entering therein, and a third nozzle communicating with a source of air under pressure and supported within said second nozzle—there being a clearance space between said end nozzle and said second nozzle provided with an inlet for liquid under pressure—and means for supplying to said second nozzle a current of solid particles and air.

8. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a duct communicating therewith, a pipe delivering air under pressure into said duct, means for mechanically conveying said solid from said receptacle to a point immediately in front of said pipe orifice, a nozzle on said duct having an inlet for liquid under pressure, means for forcing liquid under pressure to said inlet, and a second pipe delivering air under pressure into said nozzle.

9. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a conical casing below the same and communicating therewith, a mechanical conveyer in said casing, a pipe longitudinally coaxial with said chamber and terminating at the delivery end thereof, a nozzle having an inlet for liquid under pressure, means for forcing liquid under pressure to said inlet, and a duct extending between said chamber and said nozzle.

10. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a conical casing below the same, a hollow rotary shaft longitudinally coaxial with said casing, a spiral conveyer on said shaft, a pipe extending through said shaft and terminating at the delivery end thereof, a nozzle having an inlet for liquid under pressure, means for forcing liquid under pressure to said inlet, and a duct extending between said chamber and said nozzle.

11. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a nozzle having an inlet for liquid under pressure, a duct extending between said receptacle and said nozzle, means for delivering air under pressure into said duct at a point near said receptacle, and means for delivering air under pressure into said nozzle; the said nozzle near its delivery end being internally rifled.

12. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a nozzle having an inlet for liquid under pressure, a duct extending between said receptacle and said nozzle, means for delivering air under pressure into said duct at a point near said receptacle, and in said nozzle an internally rifled detachable lining.

13. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a nozzle having an inlet for liquid under pressure, a duct extending between said receptacle and said nozzle, means for delivering air under pressure into said duct at a point near said receptacle, and an air pipe entering said nozzle and having its end portion disposed longitudinally coaxial therewith and internally rifled.

14. An apparatus for combining a comminuted solid and a liquid comprising a receptacle for comminuted solid, a nozzle having an inlet for liquid under pressure, a duct extending between said receptacle and said nozzle, means for delivering air under pressure into said duct at a point near said receptacle, the said nozzle near its delivery end being internally rifled, and an air pipe entering said nozzle and having its end portion disposed longitudinally coaxial therewith; the rifling in said nozzle and air pipe being in relatively opposite directions.

In testimony whereof I have affixed my signature in presence of two witnesses.

ERNEST A. FALLER.

Witnesses:

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