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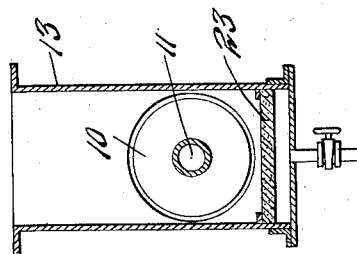
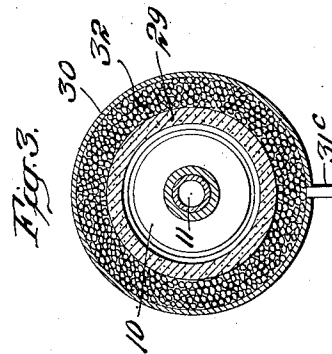
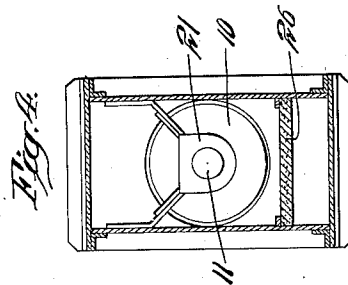
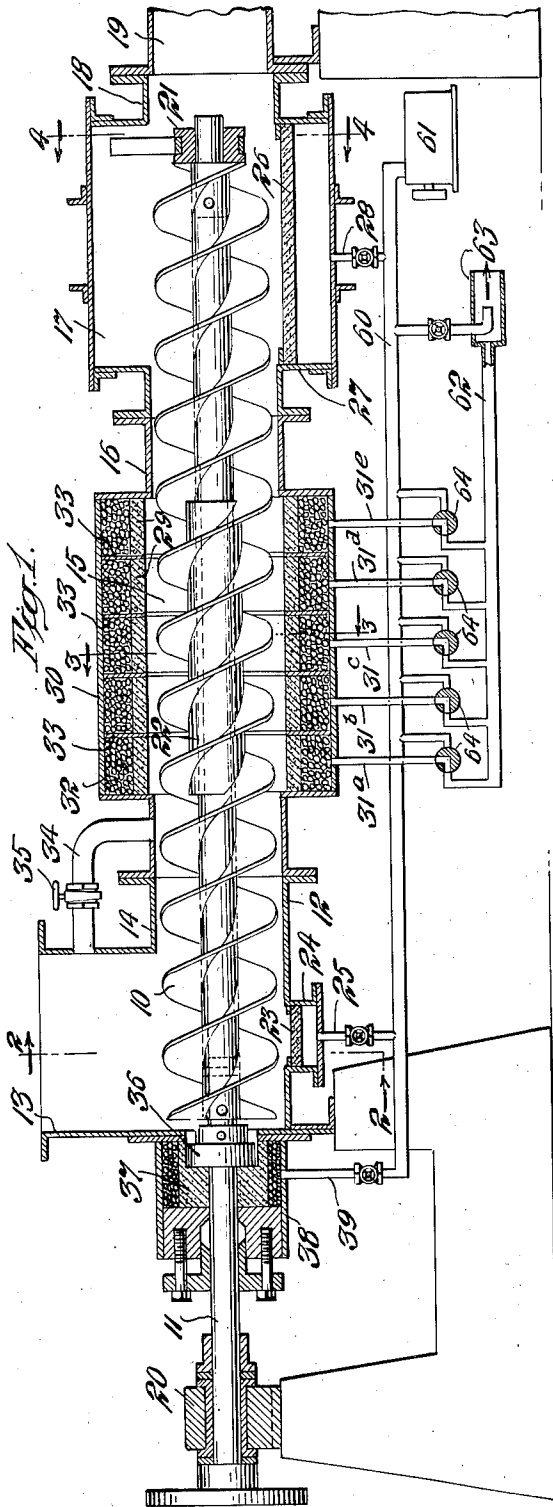
H. STRUCKMANN

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CONVEYING PULVERIZED MATERIAL

Filed Nov. 16, 1943

2 Sheets-Sheet 1



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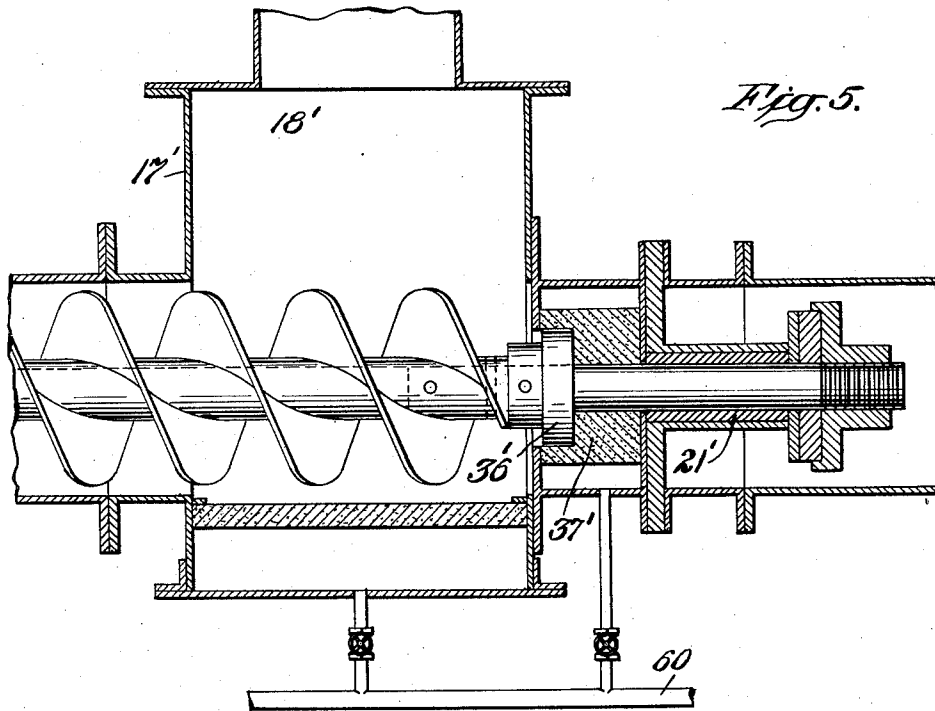
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2,448,745

CONVEYING PULVERIZED MATERIAL

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4 Claims. (Cl. 302—50)

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This invention relates to conveying pulverized material and provides an improved apparatus for this purpose.

Pulverized material which has been aerated has the properties of a fluid and may be pumped through closed conduits like a fluid. To give the pulverized material this property it must be uniformly mixed with a small volume of air.

It has been proposed to aerate pulverized material by projecting jets of compressed air into a compact mass of the material. This method introduced too much air and fails to achieve uniform aeration.

I have found that uniform aeration of pulverized material may be achieved by allowing air to seep slowly into the material and that this is particularly effective when the pulverized material is mechanically agitated while the air seeps into it. As a result of this discovery I have devised a new apparatus for pumping and aerating pulverized material. In the form which I consider most desirable this apparatus consists of a pump having a continuously moving impeller, means for causing air to seep into the pulverized material through a porous medium while the material is in contact with the impeller, and means for forming a seal to prevent blow-back.

A further feature of my invention consists in an improved means for forming a seal against back pressure in a pump provided with a screw impeller. The seal is formed by de-aerating the material at an intermediate part of the screw impeller.

A further feature of my invention consists in means for maintaining a passage of small cross-section surrounding the impeller always full of material to insure a good seal and also to feed the pulverized material at a uniform rate.

In order that my invention may clearly be understood, I will describe in detail the new apparatus involving my invention which is shown in the accompanying drawings in which:

Fig. 1 is a side elevation of a screw-impeller pump vertically sectioned on the axis of the impeller;

Figs. 2, 3 and 4 are transverse sections on the lines 2—2, 3—3, 4—4 of Fig. 1; and

Fig. 5 is a sectional side elevation of a screw-impeller pump like that shown in Fig. 1, and shows a modification in which the rear bearing

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of the impeller shaft is outside the pump casing.

The pump shown in Figs. 1-4 has a screw impeller 10 fixed on a rotary shaft 11 and surrounded by a casing 12 which provides a passage including a rectangular hopper 13, a cylindrical neck 14, a cylindrical de-aeration chamber 15, a cylindrical neck 16, a rectangular aeration chamber 17 having a discharge orifice 18 connected to a closed conduit 19. The impeller shaft has a bearing 20 outside the casing and a hanger bearing 21 in the aeration chamber 17 of the casing. The shaft has an enlarged portion 22 within the de-aeration chamber 15 of the casing.

Means are provided for causing air or other gas to seep into pulverized material in the hopper 13 and in the aeration chamber 17 and for withdrawing air from the pulverized material in the de-aeration chamber 15. For this purpose, part of the floor of the chambers 13 and 17 and the entire wall of the de-aeration chamber 15 are formed of blocks of a porous medium having numerous tortuous minute passages through which air may seep. The porous block 23 forming part of the floor of the hopper 13 is externally covered by a casing 24 forming a chamber into which compressed air may be introduced through a pipe 25. A porous block 26 forms the entire floor of the aeration chamber 17 and is externally covered by a casing 27 forming a chamber through which air under pressure may be forced through a pipe 28.

The porous blocks 29 which form the wall of the de-aeration chamber 15 have the form of hollow cylinders coaxial with the impeller and are externally covered by a casing 30 forming a chamber from which air may be exhausted through pipes 31a, 31b, 31c, 31d, 31e. The casing 30 is most desirably filled with nodular material 32 to support the blocks 29 and is divided into sections by partitions 33. Substantial clearance is allowed between the blocks 29 and the blade of the impeller.

The porous medium used for the block 26 and the block 23 should have about 50 to 100 minute pores per square inch of surface, and the number of pores per square inch should be uniform throughout the inner surface of the block so that the air will seep through the block uniformly. To insure uniform seepage of the air from the surface of the block it is desirable that the pas-

sages through the block be such as to offer a substantial resistance to the flow of air. For optimum conditions this resistance should be such that the drop in pressure between the outer and inner surfaces of the block is about equal to the pressure at the inner face of the block. Thus, if the pressure in the aeration chamber 17 is 10 pounds per square inch, the drop in pressure of the air passing through the block 26 should be about 10 pounds per square inch, so that if the air in the chamber provided by the casing 27 is at a pressure of 20 pounds per square inch the air will seep in evenly through the block and enter the chamber 17 gently.

Any one of a number of known types of porous media may be used, including (1) clean graded sand or similar material bonded together by the fusion of a bonding agent, (2) various dry concrete mixes, and (3) micro-porous porcelains and vitrified clays. Most of the available porous media allow air to pass through them more freely than is desirable in my apparatus but any one of them may be made to have the optimum characteristics above indicated by partially blocking or plugging their pores, as, for example, by painting their outer surfaces.

The shaft bearing 20 is protected from the pulverized material by a sealing collar 36 fixed on the shaft 11 and a porous block 37 fixed to the end of the casing 12 and formed to engage both the outer face and the periphery of the sealing collar. The block 37 may be made of the same porous material as the blocks 26 and 23. The outer face of the block is surrounded by a casing 38 to which air under pressure may be admitted by a pipe 39, so that the air seeping through the porous block prevents the pulverized material from passing around the sealing collar.

In the modification shown in Fig. 5, the rear bearing 21' of the impeller shaft is also placed outside the main casing and is protected from the pulverized material by a collar 36' and porous block 37' like those used to protect the bearing 20. In this case the discharge orifice 18' is in the top of the aeration chamber 17' instead of in the end of the chamber.

A pressure line 60 from a compressor 61 connects with the pipes 25, 28 and 39 which are provided with suitable control valves. A vacuum line 62 from a vacuum pump 63 connects with the pipes 31a-31e. Three-way valves 64 are provided so that any one of these pipes may be disconnected from the vacuum line and connected to the pressure line to clear out the pores of any of the blocks 29 while the pump is in operation.

The operation of the pump shown in Figs. 1-4 is as follows:

The screw impeller is rotated slowly, for example at about 100 revolutions per minute. The pulverized material to be conveyed is fed into the hopper 13 where it comes in contact with the front part of the screw impeller. While it is in contact with this part of the impeller it is aerated by air seeping in through the block 23. The aerated material is carried through the neck 14 by the impeller and at the end of this neck strikes a passage of smaller cross-section owing to the enlargement 22 of the shaft in the de-aeration chamber 15. This insures a complete filling of the de-aeration chamber with pulverized material. This results in feeding and transporting the pulverized material at a uniform rate. Any excess of pulverized material which cannot enter the de-aeration chamber is returned to the hop-

per 13 through a by-pass pipe 34 controlled by a valve 35.

As the pulverized material is moved by the screw conveyor through the de-aeration chamber 15 the air which it contains is sucked out through the porous blocks 29 so that the de-aerated material is compacted by the screw to form a seal. The seal is a sort of forward-moving block of material within the flights of the conveyor and a wall of pulverized material sucked and held against the blocks 29. An effective seal is thus provided by the material itself so that a substantial clearance may be allowed between the impeller blade and the blocks 29. This prevents injuring the apparatus by any lumps of hard material which may accidentally be present in the pulverized material. The seal prevents the pressure developed by the pump at its discharge end from causing any back-flow into the hopper.

After the pulverized material passes through the neck 16 and enters the rectangular aeration chamber 17, it is no longer compacted by the screw but is agitated by the blade of the screw. It is evenly and effectively aerated during such agitation by the air seeping in through the porous block 26, and thus acquires the properties of a fluid so that it flows out through the discharge opening 18 of the pump and through the conduit 19 with which the pump is connected.

During the operation, air is supplied to the pressure chambers outside the porous blocks 26, 23 and 37 at a constant rate. If a dense mass of the pulverized material momentarily blocks the flow through any of the pores of any one of the porous blocks, the decreased flow through the block results in building up a higher pressure behind the block which blows out the pores that have been temporarily obstructed.

What I claim is:

1. Apparatus for conveying pulverized material, comprising a screw impeller; a casing surrounding the screw impeller and providing a feed hopper at the entrance end of the screw conveyor, a porous cylindrical wall surrounding an intermediate part of the screw impeller and a non-cylindrical portion having a porous floor under the rear portion of the screw impeller; means providing a chamber surrounding said cylindrical wall and means for maintaining a partial vacuum in said chamber; and means for providing a chamber under said porous floor and means for maintaining a super-atmospheric pressure in said chamber.

2. Apparatus for conveying pulverized material, comprising the combination with a screw impeller, of a porous cylindrical wall surrounding a part of the screw impeller, and means for drawing gas out through said wall to de-aerate the material in contact with a portion of the conveyor to form a seal.

3. Apparatus for conveying pulverized material, comprising a screw impeller, a casing surrounding the impeller and formed to provide a hopper, the impeller and casing cooperating to form a passage extending from the hopper and having a part of relatively small cross-section, means for aerating pulverized material in the hopper, and a feedback conduit extending to the hopper from a point of said passage adjacent to the entrance end of the small cross-section part of the passage.

4. Apparatus for conveying pulverized material, comprising a screw impeller whose shaft has an enlarged portion at an intermediate part of

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the impeller, a casing surrounding the front part of the impeller and providing a hopper and a neck, a porous cylinder surrounding the enlarged portion of the impeller shaft, means for introducing gas into the hopper to aerate the material therein, means for withdrawing gas through the porous cylinder to de-aerate the material therein, and a feedback conduit extending to the hopper from a point of the neck near the entrance to the porous cylinder.

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