Jan. 30, 1940. J. JACOBOVICS 2,188,716

APPARATUS FOR PROJECTING GRANULAR MATERIAL

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Fig. 1

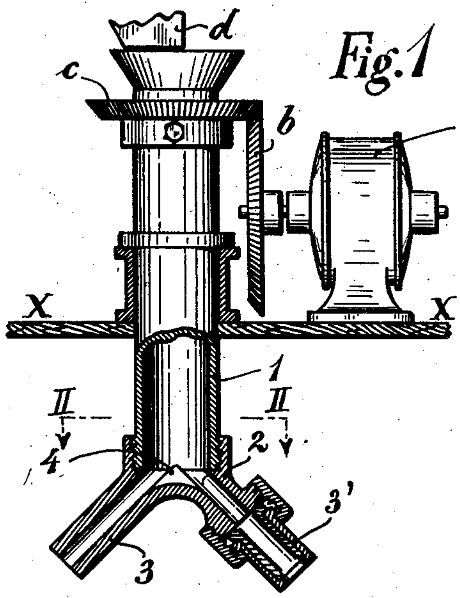

Fig. 2

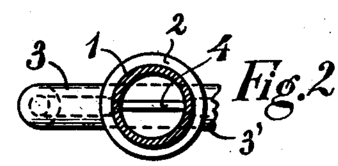

Fig. 5

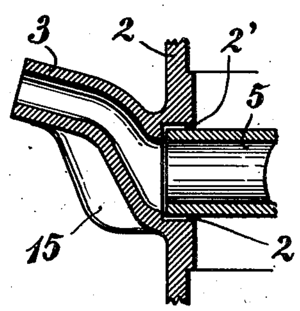

Fig. 3

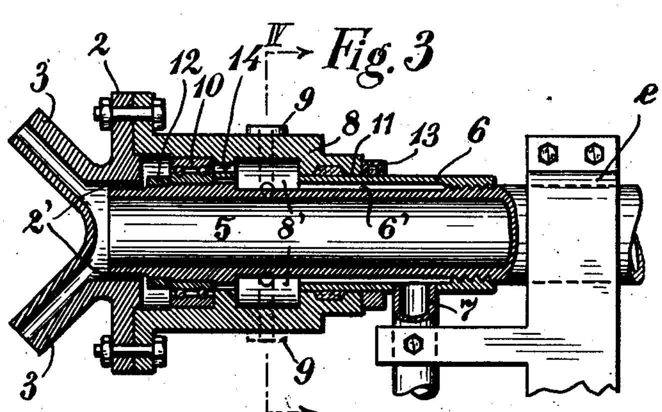

Fig. 4

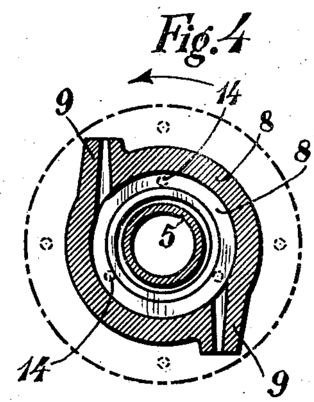

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Fig. 6

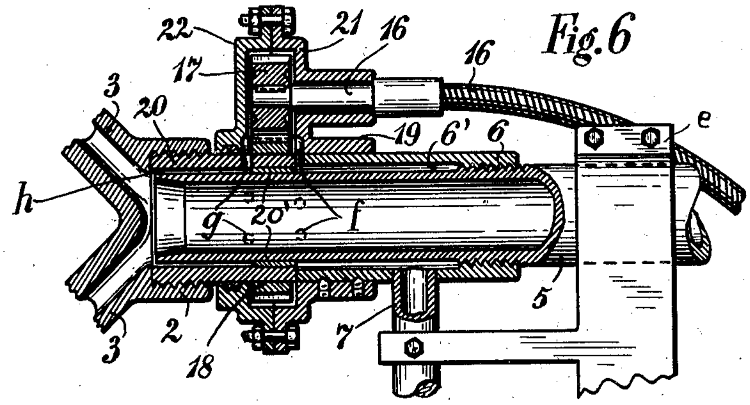


Fig. 7

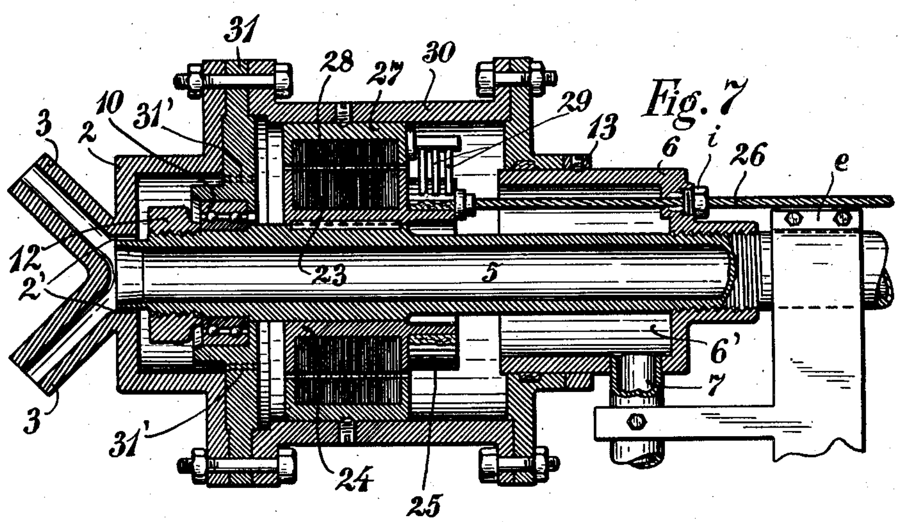
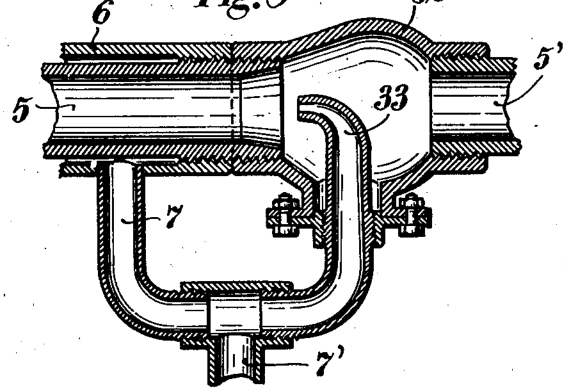


Fig. 8



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Patented Jan. 30, 1940

2,188,716

UNITED STATES PATENT OFFICE

2,188,716

APPARATUS FOR PROJECTING GRANULAR MATERIAL

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Application June 22, 1938, Serial No. 215,162
In Switzerland April 12, 1938

11 Claims. (Cl. 51—9)

This invention relates to apparatus for projecting granular material and is more especially concerned with sand-projecting apparatus.

Known sand-blasting devices operating with compressed air have the disadvantages of a very high air consumption and in consequence require a substantial power input. The cause of this inefficiency is to be found in the circumstance that for a particular blasting operation a particular flow of sand is necessary, which determines the size of the nozzle bore, and the nozzle size determines both the air and power consumption. This rises very greatly with increasing size of the nozzle bore. This disadvantage has been effectively obviated by accelerating the sand particles, not by compressed air, but by projecting them by means of a so-called centrifugal sand throwing device whereby a performance equal to that of the sand-blasting type is obtained with only a fraction of the power previously required. However these centrifugal sand throwing devices introduce other disadvantages. The accelerating vanes always provided in them are subjected to an extraordinarily rapid abrasion, and so far it has not been possible to prevent this by covering the vanes with hard material such as is used for example for abrasion-resisting nozzles. A further disadvantage of these devices is that the sand is continuously distributed over a relatively large area so that projection of the sand into the angles and corners of an article being treated is difficult or ineffective; and finally they are so bulky that they are not generally capable of use in situations where the sand stream must be traversed over large surfaces (de-rusting operations on large ferrous structures, cleaning of large castings and so forth); consequently they are not capable of use where previously free sand-blasting devices were employed.

According to the present invention the advantages of both kinds of sand projecting devices are combined without their disadvantages by accelerating the sand centrifugally and causing it to be projected out of at least one rotating nozzle.

By nozzle in the sense of the invention is to be understood any suitable tubular member of any suitable inner profile.

These nozzles no longer determine the air consumption by their cross section, since centrifugal force instead of the velocity of the escaping carrying medium (compressed air or steam) is employed for accelerating the granular material projected. The rotating nozzles, or only one nozzle in certain cases, can be disposed on a rotary head, with which they rotate, at any desired angle to the axis of rotation, so that it is possible to obtain a narrowly concentrated sand stream and to operate on relatively small surfaces of the article being treated. The reduction of the abrasion by the sand being projected by the use of material of great hardness, which is still not possible in the ordinary centrifugal sand throwing devices and which would be extremely costly in these, can be easily carried out with the improved nozzle-like construction of the means guiding the stream flowing out, in the manner employed in the known abrasion-resisting sand-blasting nozzles.

The idea of giving a rotary movement to the known sand-blasting nozzles, that is to say those operating with compressed air, is not broadly new. Such constructions have been attempted in which a nozzle head having two nozzles displaced at 180° is set in rapid rotation by the force of reaction of the discharging mixture of air and sand, with the object of obtaining an improved result for many purposes such as for example cleaning the inside of tubes. These rotating nozzles however could naturally not overcome the above-mentioned disadvantage of the dependence of the nozzle cross section on the flow of sand necessary for the blasting operation; they have therefore the large air and power consumption of all previously known sand-blasting nozzles. Further, it was found that with these constructions sand quickly got into the bearings of the rotating parts on the fixed (non-rotating) part of the device and interrupted the operation of the apparatus.

In the arrangement according to this invention the driving member of the part of the device carrying the nozzles is kept clear of the sand-air mixture being discharged. Accordingly with mechanical blowers the driving means for the hollow shaft can generally be kept outside the sand-filled chambers. However where on account of the kind of use the driving means for the rotating nozzles must remain in their immediate neighbourhood, as is convenient when the device has to be traversed over long lengths and large areas, the above-mentioned drawback of the rotating nozzles, namely the jamming of sand in the bearings between the stationary and rotating parts of the device, can be avoided by admitting compressed air from the driving side into the bearing space between the stationary and rotating parts. Lengthy tests have shown that this flushes the bearing spaces and thus prevents the sanding-up of the bearings.

In all cases where owing to the design of the device the sand does not fall by gravity to the rotating head carrying the nozzles as for example in the above-mentioned machine blower having a vertical shaft, the sand may be delivered into the rotating head by compressed air which in this case however, as it has only to supply the energy for moving the medium to be projected but not the blowing work, may have a very low pressure and thus absorb only little energy. In order to eliminate a special blower for this compressed air serving only for the delivery of the medium to be projected, it is convenient to provide an injector in advance of the driving means for the rotatable head carrying the nozzles.

In cases where it is advantageous to permit the projected medium to escape from only one nozzle, the centrifugal force due to the latter may be balanced by a suitable counterweight arranged to exert the same centrifugal force.

A plurality of constructional examples of the invention are shown in the accompanying drawings in which:

Fig. 1 is a vertical section through one constructional form in which a rotating head is directly connected with the hollow shaft, having on the left a directly connected nozzle and on the right a detachable (abrasion-resisting) nozzle,

Fig. 2 is a section on the line II—II of Fig. 1 through the delivery tube,

Fig. 3 is a longitudinal section through a constructional example of the device having an air motor drive,

Fig. 4 is a section on the line IV—IV through the air turbine of Fig. 3,

Fig. 5 is a longitudinal section through part of another example having a rotatable head with only one nozzle and a counterweight,

Fig. 6 is a longitudinal section through an example driven by a flexible shaft and a pair of gear wheels,

Fig. 7 is a longitudinal section through a construction with a drive by an electric motor, and

Fig. 8 is a longitudinal section through an example with an injector disposed in front of the driving means.

In the example shown in Figs. 1 and 2 the rotatable head 2 is rigidly connected with the rotatable sand delivery tube 1. The drive of this tube is disposed outside the sand filled working chamber, that is in the space over the wall X—X which represents any suitable partition. The drive of the hollow shaft is effected by an electric motor *a* through a bevel gear *b*, *c* the pinion *c* of which is rigid with the sand delivery tube 1.

As soon as the sand in consequence of its weight falls from the funnel *d* and through the hollow shaft 1 into the rotary head or nozzle head 2, it is picked up by the inner surfaces of the nozzles 3, 3′ rotating with the tube, of which the one is rigidly connected with the nozzle head 2 and the other is a screwed-in abrasion resisting nozzle. In consequence of centrifugal force the sand is discharged at high speed on to the article being blasted. In order to guide the particles of sand, which fall in the neighbourhood of the longitudinal axis of the tube 1 to the nozzle head 2, rapidly and positively to the entry ends of the nozzles it may be desirable to provide a division wall 4 in the medial plane of the nozzle head.

Figs. 3 and 4 show an example of the invention with the drive of the nozzle head by means of an air turbine. Sand, which is moved by compressed air at such a low pressure that just sufficient transport velocity for it is obtained, flows through the tube 5 which is held by a clamp *e* and to the right is extended as necessary by a tube or hose duct. Tests have shown that in using fine and medium sand about one atmosphere is quite sufficient, for which only a very small compresser is required. The sleeve 6 is rigid, and sealed with respect to, the tube 5. It is provided with an inlet 7 for the admission of the driving compressed air, on which inlet likewise any suitable tube or hose duct can be connected leading to the source of compresed air. The driving air passes through the annular chamber 6′ into the inner chamber 8′ of the air turbine casing 8 and escapes from here by the nozzles 9 set tangentially to the housing, causing the turbine to rotate with high velocity in the direction of the arrow shown in Fig. 4 (on the principle of the Seegner water wheel). The nozzle head 2 is flange mounted on the turbine casing and in this example carries two nozzles 3 which are thickened on the side subjected to abrasion. The rotating part of this construction is supported on the one hand by the ball bearing 10 (obviously two also may be used if desired), and on the other hand by the bearing surface 11 against the stationary (non-rotating) parts 5 and 6, and it is prevented from moving axially by the locating rings 12 and 13. In order to keep the ball-bearing housing and the clearance space 2′ between the tube 5 and the nozzle head 2 free from sand, a part of the driving air is led, for example through ports 14, through the ball bearing and through the space 2′.

Instead of the very simple form of air turbine shown which is not the most efficient, obviously any other kind of air motor may be employed while maintaining the same basic constructional features, particularly the admission of the driving and flushing air.

In Fig. 5 is shown an example having only one nozzle 3 on the nozzle head 2, and here the projection 15 is of such a size that, according to its weight and the position of its centre of gravity, it produces exactly the same centrifugal force as the nozzle itself. Obviously in this case also an abrasion-resisting nozzle can be used as shown in Fig. 1 or a strengthened construction as in Fig. 3.

Since driving by compressed air is inefficient and as in many conditions of operation supplies of compressed air are not available, it is often necessary to select other kinds of drive for the device. Thus Fig. 6 shows a drive by means of a flexible shaft 16 and a pair of toothed wheels 17 and 18. Here there is fixed to the sleeve 6 a saddle 19 in which the end 16′ of the flexible shaft is journalled. On this is keyed the driving wheel 17 while the co-operating wheel 18 is mounted on a bush 20. This bush 20 which carries the nozzle head 2 surrounds a part of the tube 5 mounted in a clamp *e* and is journalled at 20′ on it. The two gear wheels are completely encased by the casing 21, 22. The compressed air coming from the inlet 7 and the annular chamber 6′ passes through passages *f*, between the gears 17, 18, and through passages *g* to the space *h* between the tube 5 and the bush 20, so that it flushes the gear and the space *h* and so keeps them free from sand. The necessary supply of compressed air for this flushing can be kept very small.

The drive for the nozzle head can also be effected electrically, and Fig. 7 gives an example of such a drive. In order to avoid the construction, possible in itself but particularly inconvenient for small examples, involving a standard dust-tight enclosed motor, the transposition of the arrangement of rotor and stator shown in the example is adopted.

On the tube 5, which again is held by a clamp *e*, is keyed the bush 24 carrying the stator 23 which also carries the commutator 25. The current supply cable 26 is passed through the wall of the sleeve 6 through a bushing *i* sealed in an air-tight manner with respect to the wall. The bush 27, which carries the rotor 28 and the brushes 29, is rigidly connected with the motor casing 30 so that it is constrained to rotate with the division plate 31 and the nozzle head 2. The whole rotating system is supported on one hand on the ball bearing 10 and on the other hand on the outer surface of the sleeve 6 and is prevented from moving axially by the locating rings 12 and 13. The flushing air, which serves also as cooling air for removal of the heat of the motor, passes from the inlet 7 and the inner chamber 6′ of the sleeve 6 into the air gap between stator and rotor, thence passes through the ball bearing 10 and (since on acount of the double object which the air has to serve, namely cooling and flushing so that its rate of flow must be relatively large) it flows as an auxiliary outlet stream, also through the holes 31′ in the division plate 31 carrying the ball bearing and then through the space 2′ into the nozzle head 2.

In order to avoid the necessity for providing a special apparatus (blower) for the conveyance of the sand through the tube 5 common to all the examples except that in Figs. 1 and 2, an injector may be inserted in front of the driving means, as shown in Fig. 8. The housing 32 is inserted in the tube 5 and the extension 5′ and the injector nozzle 33 projects on the axis of this. The driving air can be admitted independently through a connection, or as shown in the example by a branch from the inlet 7′ which is here arranged as a T-piece, the left branch 7 serving as an air duct for the driving or flushing air and the right for the injector operation. Naturally the size of the injector nozzle and the presure of the injector air depend on the flow of sand to be delivered, on the length of the associated duct, on the difference in height between the sand container and the place of operation, and so forth. For estimating these conditions it is important that in consequence of the ejection of the particles of air passing with the sand into the nozzle head a partial vacuum exists continuously in the tube 5 with reference to the atmosphere, which favourably influences the ejector action.

The hereinbefore described devices serve promarily for the purposes for which sand-blasting devices were previously employed. They can however also obviously be employed for the projection of moulding sand in foundries or for the projection of cement and so forth.

I claim:

1. A device for projecting granular material, comprising a feed tube, a hollow head rotatably mounted on the end of said feed tube, a bearing between said hollow head and said feed tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a rapid discharge of granular material by centrifugal force, and means for producing a continuous air-stream between said bearing and said nozzle towards the latter to prevent the granular material from entering the bearing.

2. A device for projecting granular material, comprising a feed tube, a hollow head rotatably mounted on the end of said feed tube, a bearing between said hollow head and said feed tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a rapid discharge of granular material by centrifugal force, a first air-line for providing in said feed tube a draft to transport the granular material to the revolving head in any position of the device, and a second air-line branched from said first-mentioned air-line for producing a continuous air-stream between said bearing and said nozzle towards the latter to prevent the granular material from entering the bearing.

3. A device for projecting granular material, comprising a feed tube, a sleeve rigid with said feed tube and surrounding a part thereof with clearance, a revolvable hollow head coaxial and communicating with said tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a discharge of granular material by centrifugal force, a tubular driving member rigid with said head and journalled on said tube and sleeve, and means for rapidly revolving said driving member, said revolving means including an air motor in communication with said clearance between the feed tube and the sleeve, and an inlet for compressed air on said sleeve.

4. A device for projecting granular material, comprising a feed tube, a sleeve rigid with said feed tube and surrounding a part thereof with clearance, a revolvable hollow head coaxial and communicating with said tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a discharge of granular material by centrifugal force, a tubular driving member rigid with said head and journalled on said tube and sleeve, and means for rapidly revolving said driving member, said revolving means including an enclosed toothed wheel gearing mounted on said sleeve, and a flexible shaft.

5. A device for projecting granular material, comprising a feed tube, a sleeve rigid with said feed tube and surrounding a part thereof with clearance, a revoluble hollow head coaxial and communicating with said tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a discharge of granular material by centrifugal force, a tubular driving member rigid with said head and journalled on said tube and sleeve, and means for rapidly revolving said driving member, said revolving means including an electro-motor having its stator mounted on said feed tube and its rotor rigidly secured in said tubular driving member.

6. A device for projecting granular material, comprising a feed tube, a sleeve rigid with said feed tube and surrounding a part thereof with clearance, a revoluble hollow head coaxial and communicating with said tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a discharge of granular material by centrifugal force, a tubular driving member rigid with said head and journalled on said tube and sleeve, and means for rapidly revolving said driving member, said revolving means including an electro-motor having its stator mounted on said feed tube and its rotor rigidly secured in said tubular driving mem-

ber, and a supply cable for said motor, said cable passing through said sleeve outside said tube.

7. A device for projecting granular material, comprising a feed tube, a sleeve rigid with and surrounding with clearance a part of said feed tube, a revoluble hollow head, coaxial and communicating with said tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a discharge of granular material by centrifugal force, a tubular driving member rigid with said head and journalled on said sleeve, means for rapidly revolving said driving member, a bearing for said driving member disposed adjacent the end of said feed tube, an inlet for compressed air on said sleeve, and an air passage between said sleeve and said tubular driving member to produce a continuous air-stream between said bearing and said nozzle towards the latter to prevent the granular material from entering the bearing.

8. A device, as claimed in claim 7, comprising further a first air-line for providing in said feed tube a draft to transport the granular material to the revolving head in any position of the device, and a second air-line branched from said first air-line and connected to said air inlet on said sleeve.

9. A device, as claimed in claim 7, in which said means for revolving the driving member includes an air motor secured to the driving member, said air motor being in communication with said clearance between the feed tube and the sleeve on the one hand and with the tubular space surrounded by the driving member on the other hand.

10. A device, as claimed in claim 7, in which said means for revolving said driving member comprises an electro-motor having its stator mounted on said feed tube and its rotor rigidly secured in said tubular driving member, the air passage between said sleeve and tubular driving member being of a size to admit a sufficient quantity of air for cooling the motor.

11. A device for projecting granular material, comprising a feed tube, a sleeve rigid with said feed tube and surrounding with clearance a part of the latter short of the end thereof, a revoluble hollow head coaxial and communicating with said tube, at least one nozzle extending from said head at an angle to the latter's axis of rotation to cause a discharge of granular material by centrifugal force, a housing rigid with said head and journalled on said sleeve, an electro-motor having its stator mounted on said feed tube between the end thereof and said sleeve and adjacent the latter and its rotor rigidly secured in said housing, an annular wall in said housing between said head and said rotor, a ball bearing supporting said annular wall on said feed tube, and an inlet for compressed air on said sleeve, said sleeve and housing being in communication to admit a sufficient quantity of air for cooling the motor, and said annular wall being provided with a port serving to pass at least a fraction of the used cooling air to the part of the housing between the wall and the head, to set up an air-draft between the bearing and the nozzle towards the latter and to prevent the granular material from entering the bearing.

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