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PNEUMATIC DEVICE FOR RAISING AND CONVEYING SEMI-SOLIDS
Filed Nov. 14, 1940

Serial No.
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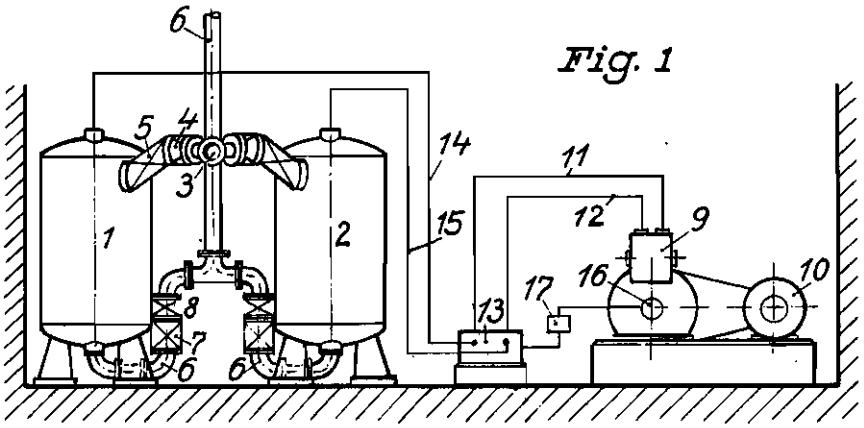
2 Sheets-Sheet 1

Fig. 1



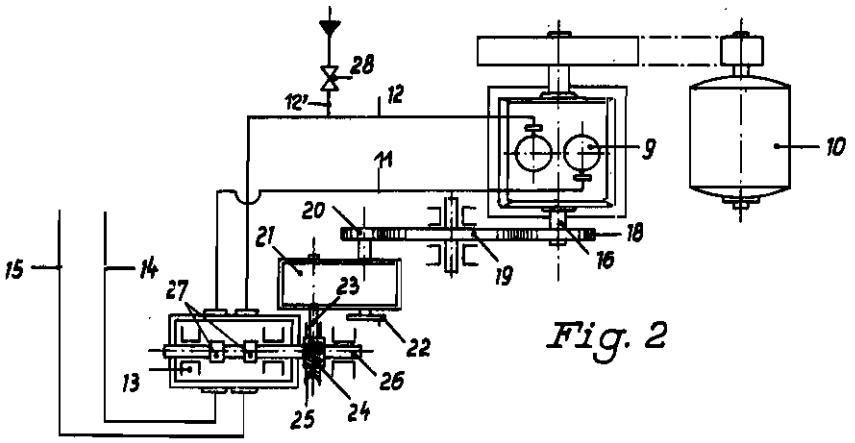


Fig. 2

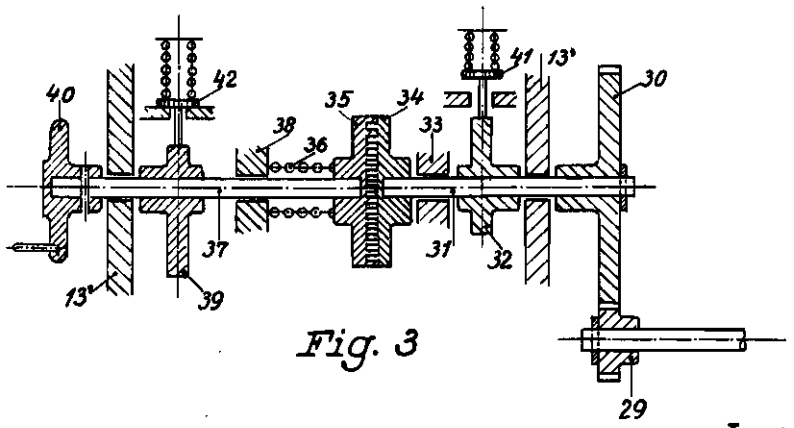


Fig. 3

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Fig. 5

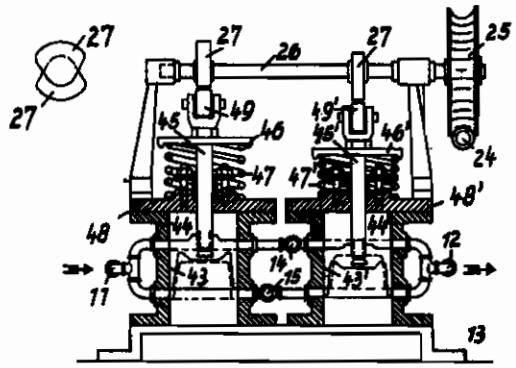

Fig. 4

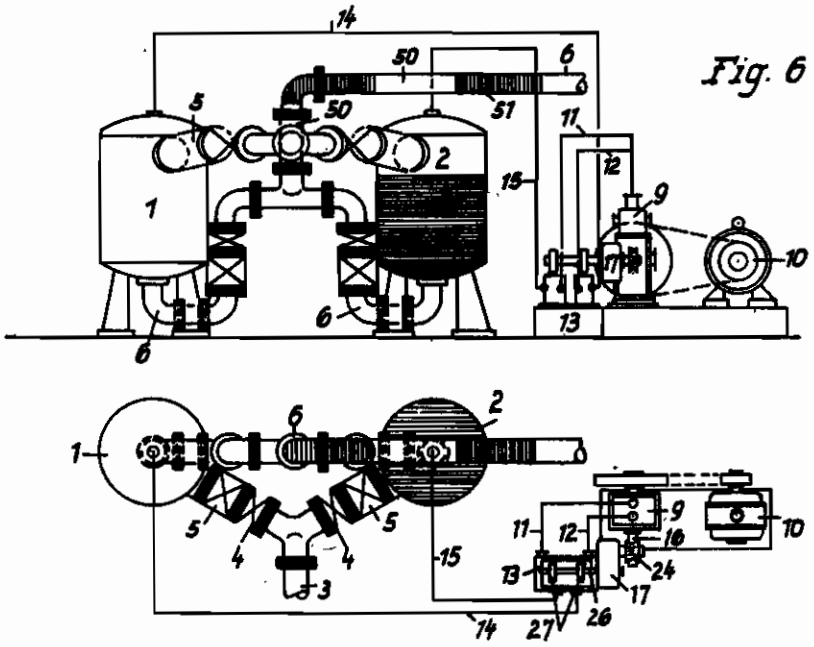

Fig. 6

Fig. 7

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ALIEN PROPERTY CUSTODIAN

PNEUMATIC DEVICE FOR RAISING AND CONVEYING SEMI-SOLIDS

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This invention relates to lifting devices and is particularly directed to a device for raising semi-solid masses, such as ore-bearing muds or cellulose used in the manufacture of paper or artificial wool, with the aid of compressed air.

The problem of raising semi-solids by mechanical means is difficult indeed and its satisfactory solution has offered almost insurmountable difficulties so far, not only in the metallurgical industry, but also in chemical enterprises of various types.

Attention is called to the practice prevailing in smelting establishments of draining the waste-water of blast-furnaces through settling-reservoirs in which the solid ore-bearing constituents are separated from the liquid. Such ore-bearing deposits contain a large percentage (in many cases up to 60%) of iron, and for that reason are valuable enough to be passed through another smelting process. In order to convey such almost solid and sticky muds to the place where they are subjected to another treatment it has been the custom so far to add to them a comparatively large percentage of water and to pump the whole to its place of destination, whereupon the solid constituents had again to be separated from the water before the actual treatment could begin. That a method of this kind, because of the waste of water and energy and the machinery needed to effect the separation, is an extremely costly affair needs hardly any explaining.

It has further been tried to mix these semi-solid and sticky masses with water and air, provided that the particular nature of the mass in question permitted such mixing. However, this method was likewise found uneconomic, because of the heavy consumption of water and air, and frequently resulted in the formation of lumps and incrustation and clogging of the pipes.

Attention is also invited to the difficulties encountered in the transportation of the oil-bearing muds of oil-fields. In order to increase the liquidity of this sticky material to such a degree that it can be pumped to refineries it has to be heated, while the pipes have to be insulated in order to prevent the dropping of the temperature, which naturally is complicated and expensive.

Plunger-pumps and centrifugal pumps of normal construction are too delicately designed to be used for the raising of mud-like masses, and also the hitherto known pneumatic systems have proved to be unsuited for the purpose in question. It was impossible to raise these semi-solid and sticky muds without the danger for the controlling means (floats) arranged in the lifting chambers to become encrusted with mud and tied up in the latter, so that they could no longer perform their controlling function. It was further impossible to move these sticky masses in a satisfactory manner through pressure pipes of frequently several hundreds or thousands of meters. The losses through friction in pipe lines like that are so considerable that an orderly conveyance of the masses is practically impossible, not to mention the constant danger of incrustation of the pipes and the high expense involved by a system like that.

Equally unsuited for the conveyance of mud-like masses is a known device for raising liquids, according to which a column of liquid is supposed to be lifted with the aid of air-bubbles rising in a vertically disposed pipe containing that column of liquid. It is understood that means like that are ineffective for the raising of masses of great density and a high specific weight like mud and similar substances, and they are completely out of place in cases where the mud-like masses have to be forced through horizontally disposed pipe-lines.

The present invention overcomes the aforesaid disadvantages of the known devices and solves the problem of raising semi-solid or mud-like masses with the aid of compressed air in a simple and efficient way by providing the raising means with a regulatably driven controlling mechanism for the valves which connect the pressure pipe with the ejectors and by devising that controlling mechanism in such a way that the valves are closed at a predetermined moment succeeding the moment of the completed ejection of the masses from the ejectors.

In pneumatic lifting devices into which the semi-solids enter by gravitation the control of the pressure air can be effected in a simple way if between the compresser and the controlling means a speed regulating mechanism is arranged by which the speed of rotation of the controlling means, which are driven from the compressor shaft, is slowed down, so that the controlling means rotate at a reduced speed. In this way it is possible to supply to the ejector more compressed air than will be needed for the jection of the charge. After the dispatch of compressed air to the ejector has been completed the ejector is connected by the controlling means with the atmosphere, so that the surplus air can escape and that the semi-solids can gravitate into the ejector as before.

Overloading of the ejector-tanks by the masses

entering from the feed pipe can be no matter of concern, as the pressure pipes run into the tops of the ejector-tanks at higher spots than the discharge branches of the feed pipe. If, nevertheless, some of the muds should enter the pressure pipes they will be blown back into the tanks by the compressed air as soon as the pressure pipes are connected by the controlling mechanism with the pressure side of the compressor. The lengthening of the pressure period caused by the slower rotation of the controlling means will have the result that, after the ejection of the charge from the tank is completed, an additional supply of compressed air will be forced into the ejector and into the discharge pipe. The fact that because of the reduced speed of rotation of the controlling means also the airing period will be prolonged is of no importance in the operation of the device.

The additional supply of compressed air forced into the discharge pipe at the end of each ejection forms in the discharge pipe behind each of the ejected charges an elastic cushion of air, which will not mix with the semi-solid and sticky masses and whose extension will depend upon the speed of rotation of the controlling means, so that the volume of these air-cushions can be regulated at the controlling means. Because of these alternate charges of semi-solids and compressed air the semi-solids will not be in frictional contact with the walls of the pipes throughout the entire length of the pipe line, so that the friction in the pipe line will be reduced considerably and that the pressure needed for operating the device will not be an excessive one. Another advantage of the arrangement resides in the fact that incrustation of the ejector tanks is sure to be avoided because of the cleaning action effected by the additional supplies of compressed air at the end of each ejection.

It is also possible to devise the arrangement in such a way that the ejector tanks are alternately connected with the pressure side and with the suction side of a compressor. In this case the invention contemplates to provide the controlling means with a pair of adjustable cams for operating a pair of valves arranged respectively in the path of the pressure pipe and the suction pipe and adapted to effect the connection of the ejectors with the pressure side and the suction side of the compressor in alternate succession. Here, again, the controlling means will be driven from the compressor shaft and the cams will be adjusted with respect to each other and with regard to prevailing conditions in such a position that the suction periods are accurately timed to ensure the complete filling of the tanks, while the pressure periods are so timed that after each ejection a cushion of air is formed behind the ejected charge. The valve arranged in the path of the pressure pipe will be opened by its appertaining cam at the moment the filling of the tank has been completed, and will be kept open until the tank has been cleaned out completely and until a cushion of air of a predetermined length has been dispatched into the discharge pipe behind the blown-out semi-solids. A speed-regulating mechanism (of the floating-regulation type—contrary to stepwise regulation) arranged between the compressor and the controlling mechanism will make it possible to increase or to reduce according to prevailing conditions the speed of the controlling means, i. e. their number of rotations in a unit of time. If the work accomplished by the air-pump is assumed to be a constant one it is self-evident that any modification of the speed of rotation of the controlling means must necessarily change the volume of the charge fed into the ejector tank. If the speed of rotation of the controlling means is accelerated, the length of the suction period will be correspondingly reduced, so that the tank will be incompletely filled. If, on the other hand, the speed of rotation is reduced, the end of the suction period will be reached at a later moment, so that more semi-solids will flow in and increase the volume of the charge.

It is obvious, therefore, that through the provision of the adjustable cams in combination with the speed regulating mechanism of the floating regulation type the controlling means of pneumatic ejectors operating with pressure-air and suction-air will be improved to such an extent that perfect adjustment to prevailing conditions is possible and that faultless operation of the device is guaranteed.

The invention will be best understood from the consideration of the following detailed description taken in connection with the accompanying drawings, forming a part of the specification, and in which similar reference numerals indicate like parts in the different figures, with the understanding, however, that the invention is not confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appending claims.

In the drawings:

Fig. 1 is a diagrammatical illustration of the essential elements of the device;

Fig. 2 is a diagrammatical illustration of the compressor, the speed regulating mechanism, and the control box;

Fig. 3 is a detail sectional view of a control box, showing the adjustable cams and their position with respect to each other;

Fig. 4 is a detail sectional view of a controlling device used in cooperation with a speed regulating mechanism, showing how the valves are arranged in the path of the pressure- and suction-pipes and how they are operated by the cams;

Fig. 5 is a diagrammatical illustration of the cams of Fig. 4, showing the position of the cams arranged at an angle of 180° with respect to each other;

Fig. 6 is a diagrammatical illustration of the device in operation;

Fig. 7 is a bottom-plan view of the device illustrated in Fig. 6.

Referring now to the drawings in detail the reference numerals 1 and 2 denote the ejector tanks into which the semi-solids gravitate from the feed-pipe 3, which is provided for each of the tanks with a slide-shutter 4 and a return-flap 5. The semi-solids are discharged through the discharge pipes 6 provided with the return-flaps 7 and the slide-shutters 8.

The compressed air is produced in a compressor 9 actuated by an electric motor 10. The compressor 9 is connected with the control box 13 on the pressure side through the pipe 11, and on the suction side through the pipe 12, while the controlling device 13 is connected with the ejector-tanks 1 and 2 through the pipes 14 and 15. The air pipes 14 and 15 are so arranged that at their spot of highest elevation they exceed in height the highest inflow-level of the semi-solids. By means of valves provided in the control-

ling device 13 the air pipes 14 and 15 are connected in alternate succession with the pressure-side of the compressor, i. e. with the pipe 11, so that through the surplus-pressure created in the ejector tanks the semi-solids are forced out of the latter. Hence, when the ejector tank 1 is connected through the air pipe 14 with the pressure pipe 11, the ejector tank 2 is connected via its air pipe 15 with the open air, and vice versa. The suction-pipe 12 is constantly kept open at the controlling device and also terminates in the open air. The controlling device 13 is driven from the compressor shaft 16, whereby between the shaft and the controlling device a speed-regulating mechanism 17 of the floating regulation type is arranged.

Fig. 2 shows how the controlling device, the speed-regulating mechanism and the compressor are arranged. Mounted on the compressor shaft 16 is a gear wheel 18, which via a gear wheel 19 transfers its rotary motion to the gear 20 of the speed-regulating mechanism 21, whose speed may be regulated with the aid of a regulating wheel 22. Arranged on the shaft 23 is a worm 24, which meshes with a worm wheel 25 mounted on the shaft 26 of the control box 13 for driving that shaft. The shaft 26 is provided with two cams 27 which are disposed at an angle of 180° with respect to each other and adapted to actuate valves which alternately connect the air pipes 14 and 15 with the pressure pipe 11 and with the open air, while the suction pipe 12 remains open constantly. For the sake of simplicity the two valves have not been shown in this figure. In order to ensure the connection of the suction pipe 12 with the atmosphere the invention contemplates to provide the pipe 12 with a branch 12' in which may be arranged a slide 28, which will be kept open and thus guarantees the connection with the open air. But it is also possible to devise the construction in such a way that the suction branch of the air-pump 9, or the pipe connection to the controlling mechanism 13 terminates freely in the open air.

Fig. 3 shows a simplified construction of a controlling mechanism adapted to be used in combination with an ejector operated by air suction and air compression. The driving power derived from the compressor shaft 16 is transferred via the speed-regulating mechanism 17 (Fig. 1) to the gear wheel 29, which meshes with the gear wheel 30 mounted on the cam-shaft 31. The cam on the right 32 is arranged on the shaft 31, which latter is journaled in the casing 13' of the controlling mechanism 13 and in the bearing 33. Mounted on the end of the shaft 31 is a coupling-member 34 which meshes with another coupling-member 35, which is likewise arranged on the end of a shaft 37 and secured in coupling engagement with the member 35 by the pressure of a spring 36. The shaft 37 is journaled in the casing 13' and the bearing 38 and provided with a cam 39. The shaft 37 passes through the casing 13' and carries at its free end a handle 40. The cams 32 and 39 are adapted to actuate the spring-loaded valves 41 and 42 of which in the embodiment illustrated in Fig. 3 the valve 42 is shown in closed position while the valve 41 is shown in opened position. In an arrangement of this type the air pipes 14 and 15 will be alternately connected with the pressure pipe 11 and with the suction pipe 12, in per se known manner.

In order to alter the position of the cams 32 and 39 with respect to each other it is merely necessary to disengage the coupling member 35 from the coupling-member 34 by pulling the handle 40 of the shaft 37 in outward direction against the pressure of the spring 36 and to rotate the shaft 37 and the cam 39 mounted on the latter through the necessary angle, whereupon the coupling member 35 may be permitted to reengage the coupling member 34 as before. In this way it is possible to adjust the position of the cams with respect to each other and with regard to prevailing conditions and to regulate the length of the pressure periods in such a way that after each completed ejection a cushion of air of a predetermined length is formed behind the blown-out semi-solids in the discharge-pipe.

A controlling device adapted to be used in combination with the speed-regulating mechanism 17 (of Fig. 1) has been illustrated by way of example in Figs. 4 and 5 of the drawings. A controlling mechanism like this is per se known. In Fig. 4 the reference numeral 24 designates the worm which meshes with the worm-wheel 25 of the controlling mechanism and thus rotates the shaft 26 on which are secured the cams 27 at an angle of 180° with respect to each other, as illustrated in Fig. 5. The controlling mechanism includes two pistons 43 and 43' which reciprocate in the cylinders 44 and 44' and which are provided with the piston-rods 45 and 45'. Mounted on the piston rods are the compression springs 47 and 47' which at one end bear against the plates 46 and 46' secured to the ends of the piston rods, and at the other end against the cylinder covers 46 and 48'. Secured to the ends of the piston rods are the rolls 49 and 49', which are engaged by the cams 27. In the embodiment illustrated in Fig. 4 the cam-plate on the left is in its uppermost position enabling the compression spring 47 to lift the piston 43 into the position in which the pressure pipe 11 is connected with tank 2 through pipe 15, while simultaneously in the cylinder 44' the branch leading to pipe 15 is closed up by the piston 43', which at this moment has been forced by the cam-plate on the right against the pressure of spring 47' into its lowermost position in which it connects the suction-pipe 12 through pipe 14 with tank 1. When after this the cam-shaft 28 continues its rotation through an angle of 180° the piston 43 will reach its lowermost position in which it connects the pressure-pipe 11 through pipe 14 with tank 1, while simultaneously the piston 43' will rise to its uppermost position in which it connects the suction-pipe 12 through pipe 15 with tank 2.

The Figs. 6 and 7 show the device at a moment of its operation. The ejector tank 2 has just been filled, while the charge of tank 1 has just been blown out. But the connection between tank 1 and the discharge pipe 6 is still open, so that a cushion of air 50 will form in pipe 6 behind the charge of mud 51 that has just been ejected. A moment later the connection between tank 1 and the suction pipe 12 of the compressor will be established, so that a new charge of mud will flow into the tank, while at the same time the pressure pipe 11 will be brought in connection with the ejector tank 2 and admit to that tank a charge of compressed air to discharge the mud.

Instead of providing the device with return-flaps 5 and 7, it is also possible to use exclusively the slide-shutters 4 and 8, which in known manner may be controlled either electrically or hydraulically or by means of compressed air. If electrical controlling means are to be employed it is suggested to secure to the cam-shaft 29 (of

Fig. 2) an auxiliary shaft and to equip this auxiliary shaft with electrical contacts in such a way that the slide-cutter 4 of tank 1 is closed and the slide-shutter 8 of that tank is open when the charge of that tank is being ejected, while on the other hand slide 4 will be open and slide 8 will be closed when the filling of the tank takes place. The same would apply to the slide-shutters of tank 2. However, an arrangement like that is known to the art and therefore not illustrated in the present invention.

Before the operation of the lifting device is brought to a stop all of the elevated material should be discharged from the discharge pipe 6. For that purpose the slide-shutters 4 have to be closed, so that further semi-solids are prevented from being sucked or from flowing into the tanks 1 and 2. But in spite of the closing of the shutters 4 the operation of the plant is continued until all of the semi-solids are discharged by the air-pressure from the tanks and from the discharge pipe. While this discharge-operation is going on the slide-shutter 28 provided in a branch of the suction pipe 12 has to be open in order to enable the compressor to draw the pressure air direct from the atmosphere. At the same time the controlling mechanism should be adjusted in such a way that the periods of pressure are lengthened as much as possible, so that the cleaning of the pipes will be accomplished in a minimum of time. A manometer arranged in the path of the pressure-pipe 11 will indicate by sudden drop of the pressure when the discharge pipe has been emptied. After this the device can be stopped without danger for the discharge pipe to become clogged by the lodgment of dried up solid matter therein.

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