March 7, 1967 S. I. ASHWORTH 3,307,296

ABRADING MACHINES

Filed Feb. 26, 1964

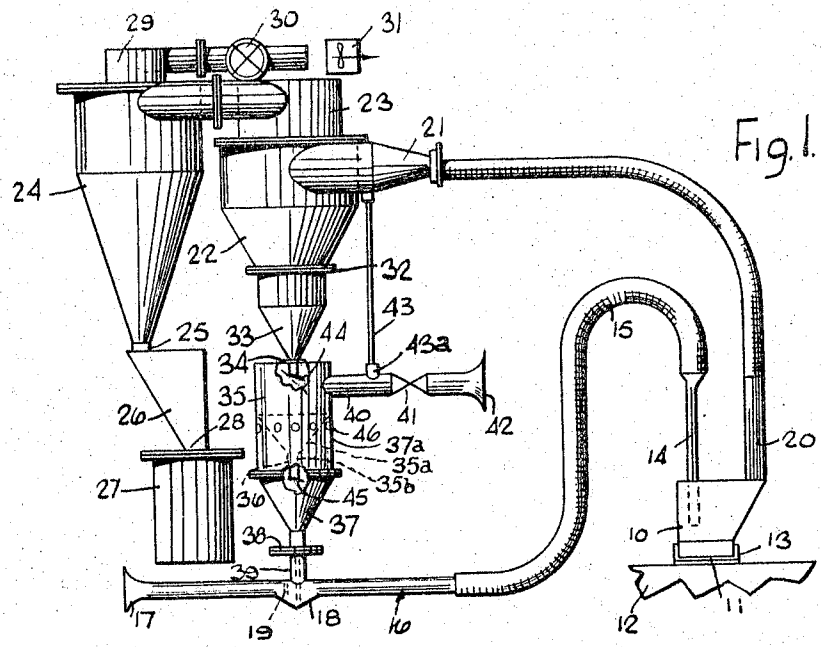

Fig. 1.

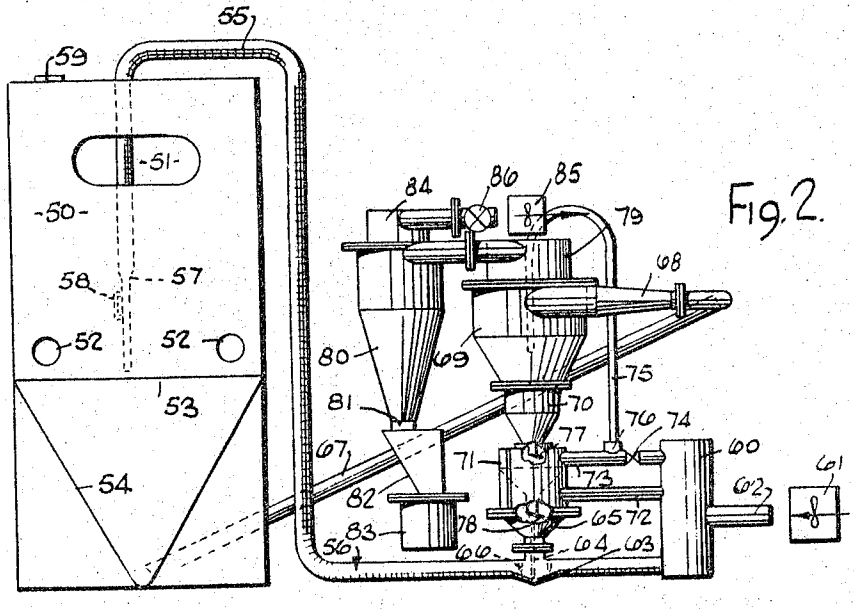

Fig. 2.

United States Patent Office 3,307,296 Patented Mar. 7, 1967

3,307,296

ABRADING MACHINES

Stewart Ives Ashworth, Crimond, Outhill, near Studley, England, assignor to Abrasive Developments Limited, Solihull, England, a British company

Filed Feb. 26, 1964, Ser. No. 347,589
Claims priority, application Great Britain, Feb. 27, 1963, 7,808/63; Nov. 9, 1963, 44,305/63
5 Claims. (Cl. 51—8)

This invention relates to abrading machines. In such machines, a stream of air and abrasive is directed against a workpiece and abrasive and detritus are removed from adjacent the workpiece by means of suction. It is often necessary to separate from the suction air stream the abrasive which can be reused on the one hand and to discard the shattered abrasive and detritus on the other hand. Having separated the reusable abrasive from the waste, it is then necessary to feed such abrasive back into the system. Since the input pipe containing the air and abrasive being fed to abrade the workpiece will be at a greater pressure than the suction pipe in which the abrasive and detritus is removed from adjacent the workpiece, it is necessary to provide some form of airlock to accomplish this recirculation of the abrasive.

Accordingly it is an object of the invention to provide an abrading machine in which simple means is provided for re-circulating the abrasive.

Two embodiments of the invention will now be described in detail by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a diagram of a first embodiment of the invention, and

FIGURE 2 is a similar diagram of a second embodiment of the invention.

Referring now to FIGURE 1, the abrading machine comprises a portable blasting chamber **10** which presents at one face an opening **11** adapted to be placed on a flat surface of a workpiece **12** with the edge portions of the opening close to the surface. The edges of the opening are provided with a seal **13** which may comprise rollers, rubber or plastic shielding or bristles or a combination of any of these elements.

Into the top of the box **10** there extends directing means in the form of an accelerating nozzle **14** which is attached to the end of a flexible portion **15** of an input pipe indicated generally at **16**. The other end of the input pipe **16** is provided with a bell-mouth **17** which constitutes an air intake and is open to atmosphere. Between the air intake **17** and the nozzle **14** there is provided in the input pipe a recess **18** in the lower wall thereof and a baffle **19** is provided up-stream of the recess **18** so that air flowing through the input pipe from the air intake **17** to the nozzle **14** is forced to flow through the recess **18**.

The upper end of the blasting chamber **10** is also connected to one end of a suction pipe **20** which at its other end is connected to the inlet **21** of a first cyclone separator **22**. The cyclone is of conventional form having a rubber lining and is deliberately made relatively ineffective so that only the heavier particles contained in the air stream entering the cyclone are separated and fall to the bottom of the cyclone, the lighter particles being carried out of the outlet **23** of the cyclone into a second cyclone **24**. The cylone **24** is of a high reentrant type which operates under a fairly high vacuum and effectively separates out the finer particles.

The effectiveness of the second cyclone is believed to be due not only to the low pressure within the cyclone but also because the low pressure leads to adiabatic cooling within the central spinning whirl of the cyclone so that any moisture in the air stream condenses on the dust

particles thus increasing their weight and increasing the separating effect of the cyclone. This theory is supported by the fact that if the dust is inspected immediately after being separated by the second cyclone **24** it is slightly damp and is at a low temperature.

The lower outlet **25** from the cyclone **24** leads to an intermediate box **26** which in turn leads to a dust collecting box **27**. As will be seen from the drawing, the intermediate box **26** is of such a shape that the inlet **28** to the dust collecting box is off-set from the vertical axis of the cyclone **24**. This prevents the whirling air in the cyclone **24** from disturbing the dust in the dust collecting box **27**.

The cyclone **24** has an upper outlet **29** which is connected through an adjustable valve **30** to a multistage centrifugal fan **31**. The valve **30** regulates the intensity of the vacuum created within the cyclone and therefore controls the entry of air into the intake **17**.

The first cyclone **22** has a lower outlet **32** which is connected to the upper end of an upper hopper **33**. The upper hopper in turn has a lower outlet **34** which discharges into a middle hopper **35**. The middle hopper **35** has a downwardly converging lower wall **35***a* leading to a pipe **35***b* at the bottom of which is an outlet **36** which discharges into a lower hopper **37** and the lower hopper **37** surrounds the wall **35***a* and has an outlet **38** which discharges into a metering tube **39** whose lower end is received in the recess **18** in the input pipe.

Communicating with the middle hopper is a pipe **40** which contains first valve means **41** and which terminates in a bell-mouth **42** which is open to atmosphere. The valve means **41** is driven by cycling means so that the valve is alternately opened and closed. The pipe **40** is connected by a pipe **43** to the inlet **21** to the first cyclone **22**. A restrictor **43***a* is inserted between the pipe **40** and the pipe **43**.

At the outlet **34** of the upper hopper is provided second valve means **44** in the form of a flap valve. The valve is freely hinged and is operated by differences between the pressures existing in the upper and middle hoppers. When the pressure in the middle hopper is greater than the pressure in the upper hopper the second valve means will close. Conversely, when the pressure in the upper hopper is greater than the pressure in the middle hopper, the second valve means will open.

Third valve means **45** are provided at the outlet **36** of the middle hopper and these valve means operate in a manner similar to the second valve means **44**. Thus when the pressure in the lower hopper is greater than the pressure in the middle hopper the third valve means **45** will close whereas when the pressure in the middle hopper is greater than the pressure in the lower hopper, the third valve means will open.

It is apparent that any abrasive stored above either of the valve means **44** or **45** will tend to cause them to open even when the pressure below the valve means is slightly greater than the pressure above the valve means. However, the pressure differences are arranged to take into account the weight of such abrasive and to maintain the valve means closed when required.

In operation, the centrifugal pump **31** is set in operation and the valve **30** is opened to induce suction in the suction pipe as far as the blasting chamber **10**. When the blasting chamber **10** is in contact with the workpiece **12** so that the seal **13** substantially seals the aperture **11** to the workpiece, the suction is applied to the input pipe **16** and air starts to flow through the input pipe **16** from the air intake **17** to the nozzle **14**. As the air flows along the input pipe **16** it will be deflected by the baffle **19** to flow through the recess **18**. As will hereinafter be described, abrasive is delivered into the recess **18** through

the metering tube 39. The abrasive is entrained in the air stream and passes with the air along the input pipe 16 to the accelerating nozzle 14. The abrasive particles are accelerated in the nozzle and will impinge upon the surface of the workpiece 12 and will abrade the surface thereof. The spent abrasive and air will then pass along the suction pipe 20 to the inlet 21 of the first cyclone 22. As has been mentioned above, this cyclone is somewhat ineffective and it is thus able to separate the reusable abrasive which has not been shattered from the spent abrasive which has been shattered into dust. The reusable abrasive passes to the bottom of the first cyclone 22 into the upper hopper 33.

The shattered abrasive and the detritus from the surface of the workpiece remain in the air stream and pass through the outlet 23 of the first cyclone 22 to the second cyclone 24. In this cyclone, the spent abrasive and detritus are separated from the air and the latter passes through the outlet from the cyclone through the valve 30 to the centrifugal fan 31. The dust, comprising shattered abrasive and detritus falls to the outlet 25 of the second cyclone 24 passes into the intermediate box 26 and thus into the dust collecting box 27.

Returning now to the reusable abrasive, this collects in the upper hopper 33. Assuming that the first valve means 41 is in a position such that the middle hopper 35 is in communication with atmosphere, the pressure in the middle hopper will be greater than the pressure in the upper hopper, the latter pressure being equal to the pressure in the cyclone 22. The valve 44 will thus be shut and abrasive will build up in the upper hopper 33. The lower hopper 37 is always at atmospheric pressure by virtue of apertures 46 in the upper part of the wall 37*a* thereof which surrounds the converging wall 35*a* of the middle hopper 35. It follows that, when the pressure in the middle hopper is atmospheric, any abrasive in the middle hopper above the third valve means 45 will open the valve means since the air pressure is the same on both sides thereof and the abrasive will fall into the lower hopper 37 and from thence to the metering tube 39 and the input pipe 16.

If now the first valve means 41 moves to a position such that the middle hopper 35 is in communication with the cyclone inlet 21, the air pressure on both sides of the second valve means 44 will be equal and any abrasive in the upper hopper will thus cause the second valve means to open 44 and the abrasive will pass to the middle hopper 35. In this situation, since the middle hopper is at a lower pressure than atmospheric, the third valve means 45 will be shut so that the abrasive delivered to the middle hopper will remain therein until the first valve means again places the middle hopper in communication with atmosphere. The first valve means are arranged to cycle at a predetermined rate so that there is a constant supply of abrasive being passed from the cyclone 22 to the metering tube 39 through the upper, middle and lower hoppers.

The metering tube 39 is adjustably mounted in the input pipe 16 so that the bottom of the metering pipe may be adjusted with respect to the bottom of the recess 18. By this means, the amount of abrasive entrained in the air stream can be varied.

Turning now to FIGURE 2, the abrading machine there shown comprises a generally rectangular cabinet 50 having in its upper portion an observation window 51. The cabinet is provided with arm-holes 52 which lead into rubber gloves so that an operator of the machine can place his hands in the gloves and manipulate a workpiece inside the cabinet. The workpiece is arranged to rest upon a grille 53 extending across the cabinet approximately half way up the cabinet. Beneath the grille is a sump 54 of inverted pyramidical form.

Mounted inside the cabinet on a flexible part 55 of an input pipe 56 is a nozzle 57 which accelerates the air and abrasive passing therethrough. The nozzle is provided with a handle 58 to assist in manipulation thereof. In the top of the cabinet is a ventilator 59 to allow additional air to enter the cabinet.

At its other end, the input pipe 56 is connected to a pressure manifold 60 which in turn is connected to the outlet of a centrifugal fan or blower 61 by means of a pipe 62. The fan 61 is arranged to deliver air to the manifold 60 at a pressure of approximately 5 p.s.i. The input pipe is provided with a recess 63 in its lower wall and into this recess projects a metering pipe 64 from a lower hopper 65 as will hereinafter be described. A baffle 66 is arranged in the input pipe upstream of the recess 63 and this baffle ensures that air passing along the input pipe 56 passes through the recess 63.

The abrasive falls through the grille 53 into the sump 54 after having acted on the workpiece and the abrasive and air in the cabinet is removed by means of a suction pipe 67, which is connected to the inlet 68 of a first cyclone 69. The bottom outlet of the first cyclone 69 is connected to an upper hopper 70 the lower outlet of which is connected in turn to a middle hopper 71 and the lower outlet of the middle hopper 71 is connected to the lower hopper 65. The lower hopper 65 is also connected by a pipe 72 to the manifold 60. The middle hopper 71 is connected by means of a pipe 73 to the manifold 60 through first valve means 74. The pipe 73 is also connected by means of a pipe 75 to the central portion of the first cyclone 69. The pipe 75 contains a restrictor 76.

Second valve means 77 are arranged at the outlet of the upper hopper 70 and third valve means 78 are arranged at the bottom of the middle hopper 71. The valve means are operated by a pressure difference between the hoppers in the same manner as the valve means 44 and 45 in the embodiment shown in FIGURE 1.

The first cyclone 69 has an upper outlet 79 which is connected to the inlet of a second cyclone 80. The second cyclone 80 has a lower outlet 81 which is connected to an intermediate box 82 and a dust collecting box 83 in a manner similar to that described with reference to the first embodiment. The upper outlet 84 of the cyclone is connected to a centrifugal fan 85 through a valve 86.

Except that the system is under a low pressure of some p.s.i. induced by the centrifugal fan 61, it operates in the same manner as does the embodiment described with reference to FIGURE 1. Thus when the centrifugal fans 85 and 61 are started, air is blown into the cabinet and entrains abrasive from the recess 63, the abrasive being delivered by the nozzle 57 onto the workpiece in the cabinet. The used abrasive, detritus and air is removed from the cabinet by means of the suction pipe 67 and delivered to the first cyclone 69. In the first cyclone, the reusable abrasive is separated out and collects in the upper hopper 70. The reusable abrasive passes to the metering tube 64 in the same manner as described with reference to the first embodiment except that in this case, since the inlet pipe is at the pressure of the manifold 60, the lower hopper is connected to the manifold 60 by the pipe 72 and the first valve means 74 is also connected to the manifold 60 so that the pressure in the middle hopper alternates between that in the manifold 60 and that in the centre of the first cyclone 69.

By way of example, the timing of the operation of the first valve means may be arranged so that there will be no build-up of abrasive in either the upper or middle hoppers. For example, the first valve means may be arranged to open for ten seconds followed by a closed period of ten seconds followed by an open period of ten seconds and so on.

I claim:

1. An abrading machine comprising directing means for directing air and abrasive against a workpiece, an input pipe for conveying air and abrasive to the directing means, a suction pipe for conveying a mixture of air, reusable abrasive, shattered abrasive and detritus from adjacent the workpiece, a separator to which the suction pipe delivers said mixture and which separates re-

usable abrasive from the remainder of the mixture, an upper hopper connected to the separator to be fed with reusable abrasive therefrom, means placing the upper hopper in communication with the suction pipe, a lower hopper to deliver abrasive by gravity into the input pipe, means continuously maintaining the interior of the lower hopper at substantially the same pressure as that in the input pipe, a middle hopper interposed between the upper and lower hoppers and communicating with them both, first valve means for selectively placing the middle hopper at one of the pressures of the suction pipe and the input pipe, cycling means for operating the first valve means so that the pressure in the middle hopper is changed continually, and abrasive controlling second and third valve means between the upper and middle hoppers and the middle and lower hoppers respectively, each of said second and third valve means comprising a valve member freely movable between open and closed positions in response to the net resultant force exerted on the member by differences in the pressures in the hoppers between which the valve member is interposed and the downward force exerted on the member by any abrasive in the hopper above the valve member, the second valve means opening and the third valve means closing when the middle hopper is at suction pipe pressure, and the second valve means closing and the third valve means opening when the middle hopper is at input pipe pressure.

2. An abrading machine according to claim 1 including a continuously open conduit between the middle hopper and one of the suction pipe and the separator and a restrictor in said conduit and wherein the first valve means is interposed between the middle hopper and one of the atmosphere and a source of super-atmospheric pressure.

3. An abrading machine according to claim 1 wherein each of said valve members is a pivoted flap.

4. An abrading machine according to claim 1, including means continuously placing the lower hopper and the input pipe open to atmosphere.

5. An abrading machine according to claim 1, including means continuously subjecting the lower hopper and the input pipe to a super-atmospheric pressure.

References Cited by the Examiner

UNITED STATES PATENTS

2,521,931	9/1950	Mead	51—12
2,628,456	2/1953	Berg	51—8
2,810,991	10/1957	Mead et al.	51—8

LESTER M. SWINGLE, *Primary Examiner.*