

PATENT SPECIFICATION

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(54) AN ABRASIVE THROWING MACHINE

(71) We, WORLDWIDE BLAST CLEANING LIMITED, a company organised under the Commonwealth of the Bahamas, of P.O. Box N-7788, Nassau, Bahamas, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a surface cleaning machine of the type by which a surface to be cleaned is subjected to an abrasive blast which is produced for example by a vaned blast wheel rotating at high speed, to fling or project the abrasive material with great force on to the surface so as to blast-clean from it all dirt. The abrasive material used is usually lead shot and such material will be referred to herein for brevity simply as "shot". Dirt to be cleaned from the surface may be of various kinds, for example dust, paint, oil, rust, or other contaminants or coverings, and mixtures of them: these will be referred to herein for brevity simply as "dirt".

Various machines of the type referred to are known, see for example British Patent Specification No. 1,496,268 and U.S. Patent Specifications Nos. 3,034,262; 3,380,196; and 3,691,689.

A machine of the type referred to will be required to clean various kinds of surfaces having various kinds of surface contamination. For example a concrete floor surface may be covered with a mixture of oil and dust, or a metallic tank surface may be covered with a mixture of paint and rust, and so on. But it has been found that satisfactory and quick cleaning of various surfaces and contaminations involves different cleaning conditions. For example some surfaces and contaminations can be cleaned more easily than others: thus a lighter weight of shot could be used, or a less powerful blast effect could be used, or a combination of both. Existing machines of the type referred to cannot however give the necessary versatility, particularly in terms of varying the blast-cleaning effect of the shot on the surface.

It has been found in using machines of the type referred to that if shot is projected from a blast wheel at a maximum angle of approximately 80° to the surface being cleaned, the blast-cleaning effect is greatest. Thus it is the practice to mount the blast wheel and its drive motor so that the shot is flung generally at right angles to the axis of rotation of the wheel along an incident path inclined at 80° to the horizontal, if the machine is used for cleaning a floor or other horizontal surface. If the machine is used for cleaning a wall or other vertical surface, then the incident path will be at 80° to the vertical. When the shot is projected at the surface at 80° thereto, there is a substantial rebound effect, which is used, together with an air flow, in reclaiming the shot for further use and in transporting the dirt for subsequent removal from a part of the machine remote from the surface.

It has also been found that if the angle is reduced, the blast-cleaning effect will be reduced. Thus for severe contamination, an angle of 80° could be used, but for less severe contamination, a lesser angle could be used.

The invention is therefore based on the problem of providing a surface cleaning machine of the kind referred to above, which can be readily used for cleaning different kinds of surfaces with different kinds of surface contaminants.

According to this invention there is provided a surface cleaning machine of the kind in which abrasive grit is projected at high velocity against a surface to be cleaned, the machine comprising:—

- i) an enclosure with an opening therein
- ii) sealing means disposed around the opening so as to contact the surface to be cleaned and so as substantially to retain abrasive grit and removed dirt within the enclosure
- iii) a projecting device for projecting abrasive grit at high velocity along an incident path through the opening to a zone of the surface to be cleaned
- iv) a reclaim channel through which passes

- abrasive grit and dirt from the cleaned surface zone
- v) an air inlet near the said opening for providing an air flow through the reclaim channel
 - vi) a receiving container to receive abrasive grit from the reclaim channel for return of the abrasive grit to the projecting device,
- characterized in that the device for projecting abrasive grit is so mounted in the machine that the angle between the incident path of the projected abrasive grit and the said surface is adjustably variable.
- Thus if the projecting device is a vaned blast wheel rotatable at high speed, it may be so mounted in the machine that its axis of rotation may be moved, to change the angle of the incident path. Preferably a driving motor, a shaft carrying the blast wheel, and the blast wheel, together with housing parts forming a channel along which the grit is projected, constitute a unit or head which is tiltable as a whole about a hingeing axis. Preferably also the cross-sectional area of the reclaim channel is adjustably variable.
- When the angle between the incident path and the surface to be cleaned is reduced, the rebound effect is reduced and it is necessary to rely more on a flow of air within the machine to reclaim the grit and remove the dirt. It is therefore also necessary to provide for a greater flow of air in the machine than has previously been required. But with known machines, greater air flow produces a higher speed of air flow in the reclaim channel, particularly in that in some machines there is a venturi effect by virtue of the shape of the reclaim channel. This produces various disadvantages: the grit, by virtue of its speed of movement and by virtue of the air pressure, can become compacted in the receiving container or hopper to which it is returned before being fed to the blast wheel for re-use; and the grit, by virtue of the friction imparted to it by its high velocity motion in contact with the walls of the reclaim channel, becomes heated, so that some kinds of removed dirt, for example paint, cling to the grit and cannot be easily separated from the grit and evacuated to a dirt collector, which is usually a container to which strong suction is applied and which is usually also the source of the air flow through the machine. Thus, with a greater flow of air to transport dirt away from the cleaned surface zone and along the reclaim path to the receiving container, the air is preferably largely removed from the air flow so as to reduce the effect of the air flow on the dirt before it reaches the hopper. Preferably a wall of the reclaim channel has an opening or openings which may be in the form of louvres through which

the air and some of the dirt is removed to the dirt collector. Preferably the louvres are adjustably movable to provide for variation of their area, to suit various operating conditions, whereby a greater or lesser amount of air can be removed from the reclaim channel.

The reclaim channel may be in the known form of a closed channel of rectangular cross-section, except that the cross-section is the same or virtually the same throughout the length of the channel from the cleaned surface zone to the additional receiving container when the projecting device is in the position for maximum blast-cleaning effect.

The invention will now be described by way of example with reference to the drawings, in which:—

Figure 1 is a diagrammatic section through a machine in accordance with the invention, as seen on the vertical plane in which the axis of the blast wheel lies;

Figure 2 is a diagrammatic section as seen on a plane at right angles to the plane of Figure 1 and looking towards the blast wheel; and

Figure 3 is a diagrammatic enlarged detail section of part of Figure 1.

Referring to the drawings, there is seen a surface cleaning machine of the kind in which a surface 1 to be cleaned is subjected to a high velocity blast 2 of abrasive grit which blast is produced by a vaned blast wheel 3 mounted on a shaft 3A and driven by a hydraulic motor 3B at high speed, for example 3400 to 3850 r.p.m. The machine has an enclosure, formed by the various plates seen in Figure 1, as will be described, and the enclosure has an opening 4 at the surface 1. The opening 4 is rectangular in plan and has sealing means around it; this sealing means comprises double sealing strip members 5A, 5B, 5C and 5D respectively at each side of the opening. The area of the surface 1 within the opening 4 at any time is the zone to which abrasive material in the form of shot 6 is flung by the blast wheel 3 along an incident path. In the position shown in full lines in Figure 1 the incident path includes an angle of approximately 80° with the surface 1.

The machine is mounted for movement on a forward castor wheel 7A and rear driven wheels 7B, 7C driven by a motor (not shown).

The enclosure is formed by a curved front reclaim channel plate 8A; parallel spaced side plates of which one is seen at 8B; and a rear reclaim channel plate 8C which is pivotally swingable about a hinge axis 9 from the full line position to the dot-dash line position shown; it will be seen that in the latter position the plate 8C is still below the upper edges of the spaced side plates

8B, one of which upper edges is indicated at 8B'. The enclosure is also formed by the several plates enclosing the blast wheel: a front plate 10A, rear plate 10B, side plates 10C and top plate 10D.

The machine also includes a primary or lower hopper 11 which includes inclined forward and rear plates 11A, 11B respectively; a secondary or upper hopper 12 which also includes inclined forward and rear plates 12A, 12B respectively; and a return channel 13 for air and dirt and having upper and lower walls 13A, 13B respectively. At the front of the machine is a dirt collector 14, into which dust and so on removed from the cleaned surface by the shot is sucked and stored, somewhat in the manner of a vacuum cleaner. The dirt collector 14 has an outer box-like casing 14A, the rear wall of which is open at 14B for movement of air and dirt into it. The collector 14 also includes dust bags 15 with support cages 15A. Air flow for the dirt collector and for the whole machine is provided by a fan 16 driven by a hydraulic motor 16A and having an exhaust 16B. A quick release, adjustably programmable electronic pulsar valve 16C and associated air tank 16D are mounted on the casing 14A as shown.

The shot projecting or blasting device comprises the vaned blast wheel 3, with its shaft 3A and motor 3B, and the various plates enclosing the blast wheel. This constitutes a unitary structure or head which can be pivotally, adjustably moved about a hinge 17 mounted on the machine side plates 8B. In one embodiment, the blast wheel is 13½ inches in diameter and has seven curved vanes. An operator's handle is seen at 18. The shot projecting device or structure is movable from the full lines position to the dot-dash lines position and can be fixed in either position, or in an intermediate position, by means not shown. In the full lines or 80° position there is maximum cleaning effect and maximum shot rebound effect. These effects decrease progressively in various positions of the head until the minimum dot-dash lines position is reached, when the rebound effect cannot be used to any extent for shot reclaim, so that reliance must be placed more on air flow for reclaim of shot. Shot is fed from the primary hopper 11 to the blast wheel through a shot flow control valve 19 and extensible flexible corrugated ducting 20. An extensible gas-controlled strut device 21 supports the shot projecting device and is connected at its forward end to brackets 21A fixed to the side plates 8B and at its rear end to brackets 21B on the plate 10A. The rear reclaim channel plate 8C is hingedly connected at the pivot point shown in Fig. 1 to the plate 10A, so that when the

shot projecting device is moved, the plate 8C moves with it about the hinge 9, and between the side plates 8B.

Within the housing formed by the several plates 10A-10D is a blast liner; this comprises an inner housing of heavy cast metal to contain the shot; it surrounds the blast wheel, as indicated at 23 (Fig. 2) and also defines the path of the projected shot, as indicated at 24. A heavy liner is needed to withstand the wear caused by the shot; normal steel plating as used for other parts of the machine would very quickly be worn away.

The double front and rear sealing members 5A, 5B are all preferably of a resilient urethane strip. There is an additional outer front seal 5E. The double side sealing members comprise an inner manganese steel strip and an outer resilient urethane strip.

An air intake 25 to the cleaning zone includes a brush-like screen 25A which permits entry of air, but retains shot and dirt. The intake 25 is adjustable, for control of the amount of air drawn in. The air intake 25 is at the top of the channel seen in Fig. 1 which opens downwardly near the surface 1 at the rear of the zone 4. The indrawn air is thus drawn downwardly in a controlled amount to the zone 4; this keeps in motion any shot or dirt which tends to become idle near the rear sealing members 5B.

As seen in Figure 1 the reclaim path or channel is curved and parallel-sided in the full-line position, so that the air flow upwardly in the reclaim channel is not subject to a venturi effect and its speed is not increased. The construction is such that its cross-sectional area at the level of the hinge 9 remains constant, even when the rear reclaim channel wall 8C is swung upwardly to the dash-dot line position, so that in that position the speed increase of the air flow is not significant. The air outlet and an outlet for some of the dirt, from the reclaim channel is by way of rockable louvres or flaps 26, see the arrows in Figure 1, and also see Figure 3. The construction of these flaps is not shown in detail; they are pivotally mounted and can be opened or closed to the required degree by an arrangement of rollers 26A mounted on a rod 26B movable by a handle 26C as indicated by the double-headed arrow. It will be noted that the air is largely removed from the reclaim path upstream of the hoppers 12 and 11, so that downstream of the louvres 26 the air speed and pressure is low whereby compaction of the shot in the upper hopper 12 is not increased.

The wall 13B forms the upper surface of the hopper 12 and is a continuation of the wall 8A downstream of the louvres 26. The wall 13B is curved and provides for smooth

flow of the shot to the secondary hopper 12 and in practice most of the impact of the reclaimed shot is absorbed by the surface of the mass of reclaimed shot already in the hopper 12.

From the secondary hopper 12 the reclaimed shot falls by way of a weight-controlled flap valve 27 down into the primary hopper 11. The flap valve 27 operates in dependence on the weight of shot in the secondary or upper hopper. The less the shot, the less the fall and vice versa. The shot falls in the form of a curtain. In the wall 11A of the hopper 11 is a controllable air inlet flap valve 28, through which air can be drawn in so as to pass through the falling curtain of shot and remove more dirt from it; the removed dirt travels along the path indicated by the arrows through the return channel 13 and thence to the dirt collector 14 through the opening 14B. Passage of the air through the curtain of shot assists in further cooling the latter, as well as cleaning it.

The cleaned and cooled shot collects as a mass in the primary hopper and is returned by way of the controllable valve 19 and ducting 20 to the blast wheel.

In one set of adjusted operating conditions of the machine of the invention, shot flow from the blast wheel is 800 lbs. per minute air flow in the machine is 1200 to 1600 cu.ft. per minute which is a number $1\frac{1}{2}$ to 2 times the shot flow number). The cross-sectional area of the reclaim channel at the level of the hinge axis 9 is approximately 80 sq. inches (which is a number 10% of the shot flow number or say 1 square inch per 10 lbs. of shot per minute). The size of the reclaim channel in the present embodiment is 18 inches x 44 inches, the latter dimension being that in the plane of the drawing. The total maximum area of the louvres 26 is 27 sq. inches, approximately one third of the area of the reclaim channel. The air intake is 18 sq. inches, approximately two thirds of the area of the louvres. The above is one set of operating conditions. By adjustment of the various parts, other sets of conditions can be provided, according to the cleaning requirement, weight of shot, and so on. For example the degree of opening of the louvres can be varied, as can that of the valve 28, to control the air flow. If necessary louvres of different sizes could be interchangeably fitted.

Other features of the machine described above are claimed in our co-pending application No. 20720/78 (Serial No. 1 603 308), from which the present application was divided.

WHAT WE CLAIM IS:

1. A surface cleaning machine of the

kind in which abrasive grit is projected at high velocity against a surface to be cleaned, the machine comprising:—

- i) an enclosure with an opening therein
- ii) sealing means disposed around the opening so as to contact the surface to be cleaned and so as substantially to retain abrasive grit and removed dirt within the enclosure
- iii) a projecting device for projecting abrasive grit at high velocity along an incident path through the opening to a zone of the surface to be cleaned
- iv) a reclaim channel through which passes abrasive grit and dirt from the cleaned surface zone
- v) an air inlet near the said opening for providing an air flow through the reclaim channel
- vi) a receiving container to receive abrasive grit from the reclaim channel for return of the abrasive grit to the projecting device,

characterized in that the device for projecting abrasive grit is so mounted in the machine that the angle between the incident path of the projected abrasive grit and the surface is adjustably variable.

2. A machine according to claim 1 characterized in that the reclaim channel is of adjustable variable cross-sectional area.

3. A machine according to claim 1 or claim 2 in which the projecting device comprises a varied blast wheel and a motor both mounted by a housing which communicates with the said opening which constitutes a passage through which the abrasive grit is projected by the blast wheel at high velocity to the opening, characterized in that the housing is mounted by a hinging device and in that the blast wheel, motor and housing constitute a unitary structure which is pivotally adjustable about the axis of the hinging device.

4. A machine according to claim 3 characterized in that the rear wall of the reclaim channel is movably mounted relative to the front wall to permit adjustable variation of the cross-sectional area of the reclaim channel.

5. A machine according to claim 4 characterized in that the said rear wall has upper and lower connections to permit movement of the rear wall relative to the front wall of the reclaim channel.

6. A machine according to claim 5 characterized in that the said connections are hinge connections, the hinge connection connecting the rear wall to a wall of the said housing.

flow of the shot to the secondary hopper 12 and in practice most of the impact of the reclaimed shot is absorbed by the surface of the mass of reclaimed shot already in the hopper 12.

From the secondary hopper 12 the reclaimed shot falls by way of a weight-controlled flap valve 27 down into the primary hopper 11. The flap valve 27 operates in dependence on the weight of shot in the secondary or upper hopper. The less the shot, the less the fall and vice versa. The shot falls in the form of a curtain. In the wall 11A of the hopper 11 is a controllable air inlet flap valve 28, through which air can be drawn in so as to pass through the falling curtain of shot and remove more dirt from it; the removed dirt travels along the path indicated by the arrows through the return channel 13 and thence to the dirt collector 14 through the opening 14B. Passage of the air through the curtain of shot assists in further cooling the latter, as well as cleaning it.

The cleaned and cooled shot collects as a mass in the primary hopper and is returned by way of the controllable valve 19 and ducting 20 to the blast wheel.

In one set of adjusted operating conditions of the machine of the invention, shot flow from the blast wheel is 800 lbs. per minute air flow in the machine is 1200 to 1600 cu.ft. per minute which is a number $1\frac{1}{2}$ to 2 times the shot flow number). The cross-sectional area of the reclaim channel at the level of the hinge axis 9 is approximately 80 sq. inches (which is a number 10% of the shot flow number or say 1 square inch per 10 lbs. of shot per minute). The size of the reclaim channel in the present embodiment is 18 inches x $4\frac{1}{2}$ inches, the latter dimension being that in the plane of the drawing. The total maximum area of the louvres 26 is 27 sq. inches; approximately one third of the area of the reclaim channel. The air intake is 18 sq. inches, approximately two thirds of the area of the louvres. The above is one set of operating conditions. By adjustment of the various parts, other sets of conditions can be provided, according to the cleaning requirement, weight of shot, and so on. For example the degree of opening of the louvres can be varied, as can that of the valve 28, to control the air flow. If necessary louvres of different sizes could be interchangeably fitted.

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- iv) a reclaim channel through which passes abrasive grit and dirt from the cleaned surface zone
- v) an air inlet near the said opening for providing an air flow through the reclaim channel
- vi) a receiving container to receive abrasive grit from the reclaim channel for return of the abrasive grit to the projecting device.

characterized in that the device for projecting abrasive grit is so mounted in the machine that the angle between the incident path of the projected abrasive grit and the surface is adjustably variable.

2. A machine according to claim 1 characterized in that the reclaim channel is of adjustable variable cross-sectional area.

3. A machine according to claim 1 or claim 2 in which the projecting device comprises a varied blast wheel and a motor both mounted by a housing which communicates with the said opening which constitutes a passage through which the abrasive grit is projected by the blast wheel at high velocity to the opening, characterized in that the housing is mounted by a hingeing device and in that the blast wheel, motor and housing constitute a unitary structure which is pivotally adjustable about the axis of the hingeing device.

4. A machine according to claim 3 characterized in that the rear wall of the reclaim channel is movably mounted relative to the front wall to permit adjustable variation of the cross-sectional area of the reclaim channel.

5. A machine according to claim 4 characterized in that the said rear wall has upper and lower connections to permit movement of the rear wall relative to the front wall of the reclaim channel.

6. A machine according to claim 5 characterized in that the said connections are hinge connections, the hinge connection connecting the rear wall to a wall of the said housing.



7. A machine according to any preceding claim characterized in that a passage for the return of abrasive grit from the receiving container to the projecting device
5 is in the form of extensible corrugated ducting.

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