This invention, which may be manufactured for and used by or for the Government of the United States for governmental purposes without payment of any royalties thereon, generally relates to abrasive cleaning and methods and apparatus and, in more particular, relates to reduced pressure control means for these abrasive blasts.

One of the more troublesome problems connected with blast cleaning arises from the ricocheting and freely-flying spent blast particles which form an ever-present source of personal injury and which also may lodge in bearings and other parts of such complex machinery as may be within the blast area. One rather successful method of overcoming these difficulties involves the use of a blasting hood and a reduced pressure discharge conveyor to safely remove all the spent particles and foreign matter from the interior of a hood. More specifically, such apparatus includes the use of an open-ended hood adapted to be placed against and moved along the surface to be cleaned; the blast stream emanating from conventional nozzles mounted in the closed end of the hood and the hood being in communication with a vacuum conveying system adapted to convey the spent particles to a recovery system which then is capable of filtering, cleaning and, if desired, returning the particles.

For some cleaning operations, such as the treatment of relatively small objects or surfaces, the equipment has proven to be satisfactory principally because the hood itself can be quite compact with the result that the vacuum conveying is fairly efficient. However, where unusually large surface areas, such as the hulls of ships or the sides of buildings, require treatment, the blast-enclosing hood must be proportionately larger if the area is to be covered in a reasonable time, and it is in these larger hoods that the difficulties toward which the present invention is directed have been experienced. Thus, it is understandable that efficient particle removal to a large extent depends upon the establishment within the hood of a sufficiently strong air current between atmosphere and the low pressure area, and, as would be expected, in hoods having large interior areas it is quite difficult to obtain such a strong, smooth and properly directed current. Such an air flow not only must have sufficient strength to pick up the ricocheting particles and carry them to the discharge conduit but, if the current is running at all counter to the general path of these ricocheting particles, it should have sufficient strength to change the particle direction and divert them into its own stream. Obviously, if any eddy currents or counter-flow conditions exist, the ability of the current to accomplish these tasks is materially reduced and it has been in this regard that the previously-developed hood designs have been found somewhat deficient.

Thus, in one type of hood, the necessary air current is established by providing the hood with an air-permeable lip or surface-engaging portion through which the air necessary for the current is drawn. In such a hood, it will be apparent that the air current initially is traveling from the outer lip of the hood inwardly toward the nozzle, while the nozzle, on the other hand, is impelling the blast particles in the opposite direction or toward the surface to be cleaned. As a consequence, the natural rush or pull of air produced by the velocity of the impelled blast squarely meets the air flowing in through the lip member with the undesirable result that eddy currents are developed in the vicinity of the ricocheting particles. In addition, it can be understood that the path of the ricocheting particles which, generally, is toward the lip portion of the hood, is somewhat counter to the inrushing air so that, at least, the air current through the lip is required to change the direction of these flying particles and, of course, any eddy currents in this vicinity would reduce the ability of current to so change the direction.

Another difficulty with the hoods of the type just described is the fact that their permeable lip members customarily are formed of rather dense bristles which are supposed to form an effective barrier against the escape of the flying particles. However, it has been found that occasionally, during the blasting, the blast hose becomes temporarily clogged with the blast particles and, when these blast particles finally are blown out, the resulting high pressures impart sufficient force to cause the particles to break through the bristle barrier. When this happens, the dangers of personal injury and machine damage again exist.

Accordingly, one of the principal objects of the invention is to provide a reduced-pressure, abrasive blasting hood capable of establishing a smooth, uninterrupted air current flowing in the same direction as the ricocheting particles.

Another object is to provide such a hood with a lip portion capable of creating a thoroughly effective barrier against ricocheting particles under all pressure conditions encountered.

Still another object is to provide a method of accomplishing the above objects in a simple manner that is effective for all sizes of hoods practically employed. These and other objects will become apparent from the detailed description of the accompanying drawings.

In the present invention, the difficulties referred to in the foregoing paragraphs are avoided primarily by establishing an air current within the hood which travels in the same general direction as the direction of the blast and the path of the ricocheting particles. Preferably, such an air current is established by mounting the nozzle in the customary manner at the closed end of the hood and admitting atmosphere into the hood in the vicinity of this nozzle. Further, the open end of the hood, which as usual, is adapted to engage the periphery of the surface area being cleaned, is provided with a flexible or resilient air-impermeable lip member so as to avoid the establishment of any air currents flowing upwardly into the hood through this lip portion. Stated in another manner, the lip of the present hood is provided with a member capable of sealing the open end against atmosphere. Further, the reduced pressure discharge means normally used to establish the air current is communicated with the hood in close proximity to the entire inner circumference of this lip member. With such an arrangement, atmosphere admitted in the vicinity of the nozzle then is drawn in a direction which is parallel to the path of the blast stream with the results that the eddy currents normally set-up by opposing air streams are avoided. Further, in the preferred embodiment of the invention, this air stream,
which is traveling concentrically about the blast stream, is diverted as it reaches the lip of the hood so as to be directed in the same general path as the ricocheting particles and, when diverted it proceeds directly into the chamber which, in turn, may empty into a discharge hopper. Most suitably, the diversion is accomplished by means of an inwardly tapered lip portion that, for reasons to be considered later in more detail, is formed of a plurality of flexible, shingle-like flaps arranged in an overlapping relationship one to the other. As can be surmised, all of this inward tapering of the surface portion of the hood may set so with regard to the blast pattern and the pattern of the ricocheting particles as to turn the air current into the path of these particles. The principal function of the over-lapping flaps is to effectively resist any particle blow-out such as might be produced upon sudden pressure surges and this resistance is provided because, as will be understood, any such surges only will tend to press the flaps into a tighter, over-lapping and sealing engagement. In addition, such a flap arrangement facilitates movement of the hood across the surface.

The invention is illustrated in the accompanying drawings in which Fig. 1 is a partially sectioned side elevation of the hood, and Fig. 2 a partial rear elevation of the same hood.

Referring to the drawings, the blast apparatus 2 generally indicated by numeral 2, comprises a conical-shaped hood 4 having in a rear wall 6 mounting a sleeve 8 for supporting a blast nozzle 10 which may be of any conventional type adapted to impel a radially-restricted stream or jet of abrasive material, although, if desired, a plurality of nozzles may be employed. The nozzle is directed toward a mouth 12 in the front end of the hood through which the air-propelled abrasive flow is projected to impinge upon a surface 13 that is delineated by the inner circumference of the mouth. To carry-off the propelled abrasive after it has performed its job, the forward end of the hood is provided with a ring-shaped vacuum exhaust or plenum chamber 14 having an inner annular opening 15 leading into the hood. Also, the bottom end of the vacuum chamber may be formed with a hopper 16 connected to a conventional suction pump (not shown) by the line 11.

As presently contemplated, hood 4 is suitably supported in such a manner that it can be brought into contact with the portion of surface to be cleaned and, once this portion has been cleaned the hood is then moved on to cover all the remaining portions. In prior practices, this movement was permitted by various means which included the use of a dense bristle lip portion adapted to permit a flow of air into the hood while still permitting movement of the hood over the surface. For reasons already expressed, this type of lip did not form an effective barrier during sudden pressure surges and, in addition, it will be appreciated that any air flowing inwardly through it would meet the flow of air being drawn toward the surface by the velocity of the blast stream, and such a meeting or collision would cause undesirable eddy currents.

In the present invention, a lip portion is provided which is capable of excluding or sealing the air so that no such eddy-producing control flow is possible and, most suitably, a flaps is formed of a plurality of laterally-disposed shingle-like flaps 17 formed of a flexible material, such as rubber, and disposed in an overlapping relationship one to the other. As will be seen, each flap has one end secured by bolts 18 to the leading edge of the hood, while the free ends of these flaps project outwardly at an inwardly-converging angle to engage the surface to be cleaned. Consequently, any pressure between atmosphere and the interior of the hood causes these flaps to be drawn tightly together so as to effect an air seal and, of equal importance, any sudden pressure surges arising within the hood serve only to press the flaps tighter together to form an even more effective barrier to abrasive particle escape. Further, these flaps facilitate movement of the hood surface and, being flexible, the flaps themselves can resiliently ride over small obstructions without breaking the air seal. To protect the flaps and further facilitate hood movement, rollers 22 are resiliently mounted on brackets 24 which, in turn, arebonded to the outside wall of exhaust chamber 14.

One of the more important features of the invention involves the establishment of the air current customarily used to pick up the spent and flying abrasive particles and carry them into discharge conveyors. In general, the invention contemplates establishing an air current flowing in the same direction as the blast stream and, to accomplish this, one or more air inlet ports 26 are provided in rear wall 6 of the hood, these ports preferably being covered with screens 28 to filter any undesirable foreign matter. In the preferred form, these ports are spaced laterally around nozzle sleeve 8 with the result that air admitted through them promptly is picked up by the forwardly rushing abrasive stream and inductively carried with this stream throughout the longitudinal extent of the hood. Of course, at some point during the air flow, the reduced pressure chamber 14 adds its pulling force so that, in effect, the strength of the reduced pressure conveyor is supplemented by the air flow induced by the blast stream.

The function of the air current, which proceeds along the path indicated by arrows 30 is to pick up spent and flying particles ricocheting from the surface under treatment and carry these particles into the discharge conduit and, from such observations, it is known that these spent particles rebound into a rather high angle of incidence toward the outer extents of the hood wall and toward the area in which chamber 14 is formed. Also, as previously mentioned, it is desirable to have an air current flowing in the same general direction as the particles to be picked up and, in the present invention, this system is directed in the same general path as the ricocheting particles by the presence of inwardly converging flaps 17 which, as seen, are in the form of a truncated cone. Thus, flaps 17 are disposed at such an angle as to divert the air flow proceeding from ports 26 into a path leading directly into opening 15 of exhaust chamber 14. Thus, the air flow, as seen by the arrows, moves first in a direction parallel to the abrasive stream and then at least a portion of it is turned by flaps 17 into exhaust chamber 4 and, of course, as the current flows into the chamber, it picks up particles flying in that general direction. In addition, the air flow being free of eddy currents and also being acted upon by the vacuum as well as the stream induction, is sufficiently strong to pick up any stray particles rebounding onto the conical wall portion of the hood so that, this current forms an unusually efficient means for rapidly removing particles from the hood. Further, as will be appreciated, such rapid removal has the additional advantage of preventing any interference between the flying particles and those ricocheting from the surface. If desired, hood 4 and exhaust chamber 14 both may be provided with a rubber lining 32 to protect the metal surfaces from abrasion.

Another advantageous feature which may be incorporated in the present structure, if desired, is concerned with the creation of sudden pressure surges by the clogging of supply line 29 and, more specifically, with the avoidance of such bends in the supply line as might produce such a clogging. To understand this feature, it first should be noted that this supply line, as well as the exhaust conduit, always should remain in a vertical, depending position since any deviation from this position might produce the undesirable bends. However, in certain operations, it is desirable to move the hood.
in an arcuate path over the surface to be treated and, of course, the lines also will be swung by the arcuate movement and possibly produce bends. This can be avoided by mounting the hood in a roller assembly 34 which, in turn, is supported on a trunnion assembly 36 that permits the hood to be pivoted about a horizontal axis. Roller assembly 34, as may be noted, is formed of a base ring 38 bolted to a frame plate 40 which may be secured to the hood and strengthened by suitable channels 42. Base ring 38, in turn, mounts roller plate 39 and both of these members provide a track for a plurality of rollers 44 mounted between spaced plates 46 that are secured to an outer ring 48 by bolts 50. Felt rings 52 are supported between each pair of retainer plates 39 and ring plate 54.

As a pivoted support for the rotatable assembly, outer ring 48 may be provided with a pair of trunnions 56 journaled in bearing cap 58 formed integrally with the upper ends of bearing-spaced support arms 60. Each trunnion extends through the bearing caps to support a friction brake assembly 62 formed of a drum 64 keyed to the trunnion and encircled by a pair of brake shoes 66 hinged at one end on a pin 67 that is anchored to arm 60. The free ends of the brake shoes are urged together by a suitable spring 68 adjustable by rotation of a nut 69. This trunnion assembly for supporting the inner rotatable ring, in turn, is supported by a cross-arm 70 fixed to support arm 60 and, most appropriately, adjustably mounted on a clamp 72 which may be secured to the power system, or support means being used to move the hood along the surface. With such a roller assembly it will be obvious that any arcuate movement of the hood produces a rotation of inner ring 38 on which the hood is carried and, since the supply and exhaust lines are connected to the hood, such a rotation will permit these lines to remain in a vertical position regardless of the hood movement. Such a vertical disposition avoids the formation of undesirable bends which might choke the supply line and cause such pressure surges as might otherwise deleteriously affect the strength of the air current.

As can be appreciated from the foregoing description, the present hood is adapted in all details to provide a smooth and powerful air current capable of rapidly carrying all ricocheting particles into the discharge conduit. One of the principal improvements resides in the fact that such eddy currents are previously produced by admitting air through the lip portion of the hood are eliminated and, as will be appreciated, all air flow within the hood proceeds from the rear forwardly. Such directional flow is permissible because of the sealed engagement of the hood with the surface and, as a further advantage, this sealed engagement assures the containment of all particles within the hood. Added to these obvious advantages is the fact that the hood is so mounted as to avoid pressure surges such as might be caused by the formation of bends in the supply exhaust lines.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

1. Abrasive blast surface-treating apparatus comprising an open-ended hood, air-impermeable sealing means projecting outwardly from said open end for sealably engaging said hood with a surface to be treated, a nozzle mounted in the closed end of the hood and directed substantially axially of the hood for projecting a blast pattern centrally therethrough toward said open end, and reduced pressure discharge means communicated with said hood proximate to said open end sealing means, said closed end hood portion being provided with air-inlet openings radially spaced from said nozzle for admitting air into said hood concentrically about blast pattern, said admitted air forming an air stream capable of flowing into said discharge means in substantially the same general direction as blast particles rebounding from said treated surface.

2. Abrasive blast surface-treating apparatus comprising an open-ended hood, air-impermeable sealing means projecting outwardly from said open end for sealably engaging said hood with a surface to be treated, a nozzle mounted in the closed end of the hood and directed substantially axially of the hood for projecting a blast pattern centrally therethrough toward said open end, and reduced pressure discharge means, communicated with said hood proximate to said open end sealing means, said closed end hood portion being provided with air-inlet openings radially spaced from and axially aligned with said nozzle for admitting air into said hood concentrically about blast pattern, said admitted air forming an air stream capable of flowing into said discharge means in substantially the same general direction as blast particles rebounding from said treated surface, and said sealing means being capable of maintaining said impermeability under normal operating conditions.

3. Abrasive blast surface-treating apparatus comprising an open-ended hood, air-impermeable sealing means projecting outwardly from said open end for sealably engaging said hood with a surface to be treated, a nozzle mounted in the closed end of the hood and directed substantially axially of the hood for projecting a blast pattern centrally therethrough toward said open end, a plenum chamber communicated with said hood and formed circumferentially about said open end, and reduced pressure discharge means communicated with said plenum chamber, said closed end hood portion being provided with air-inlet openings radially spaced from said nozzle for admitting air into said hood concentrically about blast pattern, said admitted air forming an air stream capable of flowing into said plenum chamber in substantially the same direction as blast particles rebounding from said treated surface, and said sealing means being capable of maintaining said impermeability under normal operating conditions.

4. Abrasive blast surface-treating apparatus comprising an open-ended hood, air-impermeable sealing means projecting outwardly from said open end for sealably engaging said hood with a surface to be treated, a nozzle mounted in the closed end of the hood and directed substantially axially of the hood for projecting a blast pattern centrally therethrough toward said open end, a plenum chamber communicated with said hood and formed circumferentially about said open end, and reduced pressure discharge means communicated with said plenum chamber, said closed end hood portion being provided with air-inlet openings radially spaced from said nozzle for admitting air forming an air stream capable of flowing into said plenum chamber in substantially the same general direction as blast particles rebounding from said treated surface, said sealing means being formed of resilient overlapping flaps angularly projected for forming a baffle to direct said stream from said hood into said plenum.

5. Abrasive blast surface-treating apparatus comprising an open-ended hood, air-impermeable sealing means projecting outwardly from said open end for sealably engaging said hood with a surface to be treated, a nozzle mounted in the closed end of the hood and directed substantially axially of the hood for projecting a blast pattern centrally therethrough toward said open end, and reduced pressure discharge means communicated with said hood proximate to said open end sealing means, said closed end hood portion being provided with air-inlet openings radially spaced from said nozzle for admitting air into said hood concentrically about blast pattern, said admitted air forming an air stream capable of flowing into said discharge means in substantially the same
general direction as blast particles rebounding from said treated surface, and roller means for rotatably supporting said hood about a horizontal axis, and said sealing means being capable of maintaining said impermeability under normal operating conditions.

References Cited in the file of this patent

UNITED STATES PATENTS

2,230,690 Lanza ------------------ Feb. 4, 1941

2,257,144 Worsham ------------------ Sept. 30, 1941
2,455,514 Mead ------------------ Dec. 7, 1948
2,483,176 Bishop ------------------ Sept. 27, 1949
2,494,773 Mead ------------------ Jan. 17, 1950
2,521,931 Mead ------------------ Sept. 12, 1950
2,628,456 Berg ------------------ Feb. 17, 1953
2,723,498 Hastrup et al. ---------- Nov. 15, 1955