United States Patent [19]

Hutchins

[11] **3,785,092**

[45] **Jan. 15, 1974**

[54] **ABRADING TOOL HAVING SUCTION SYSTEM FOR COLLECTING ABRADED PARTICLES**

[76] Inventor: **Alma A. Hutchins,** 49 N. Lotus Ave., Pasadena, Calif. 91107

[22] Filed: **Dec. 28, 1971**

[21] Appl. No.: **213,018**

[52] **U.S. Cl.** ..... **51/170 MT,** 51/273

[51] **Int. Cl.** **B24b 23/00,** B24b 55/06

[58] **Field of Search** ..... 51/170 T, 170 TL, 51/170 MT, 273

[56] **References Cited**

UNITED STATES PATENTS

2,143,970	1/1939	Blood	51/170 T
2,000,930	5/1935	De Nagy	51/170 T
1,800,341	4/1931	Davies	51/170 T
2,929,177	3/1960	Sheps	51/170 MT
2,764,852	10/1956	Emmons	51/273 X
3,638,362	2/1972	Stoll	51/273
2,499,933	3/1950	Smul	51/273 X

Primary Examiner—James L. Jones, Jr.
Attorney—William P. Green

[57] **ABSTRACT**

A portable tool for sanding or otherwise abrading a work surface and having an air motor which drives the abrading part or unit, with an air suction system being provided for sucking dust and other abraded particles from the work surface to prevent their escape into the surrounding air, and with the suction effect desirably being created by energy derived from the exhaust of the air motor, preferably through an aspirator action.

16 Claims, 11 Drawing Figures

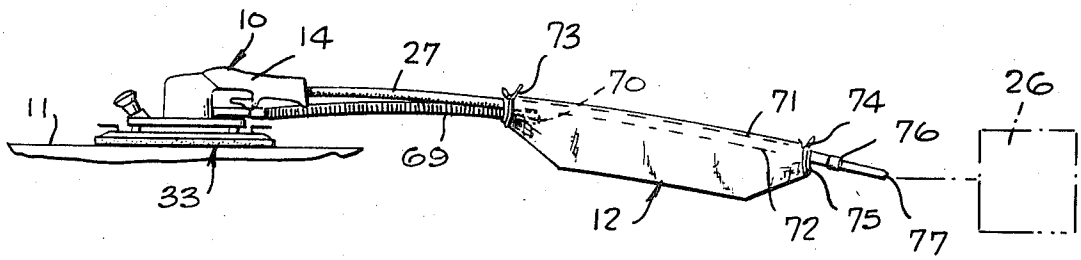


Fig. 1

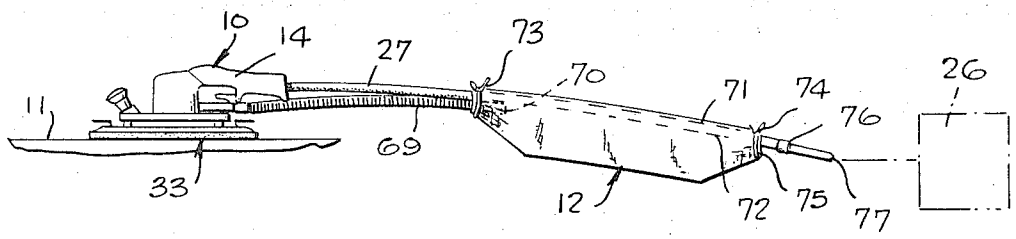
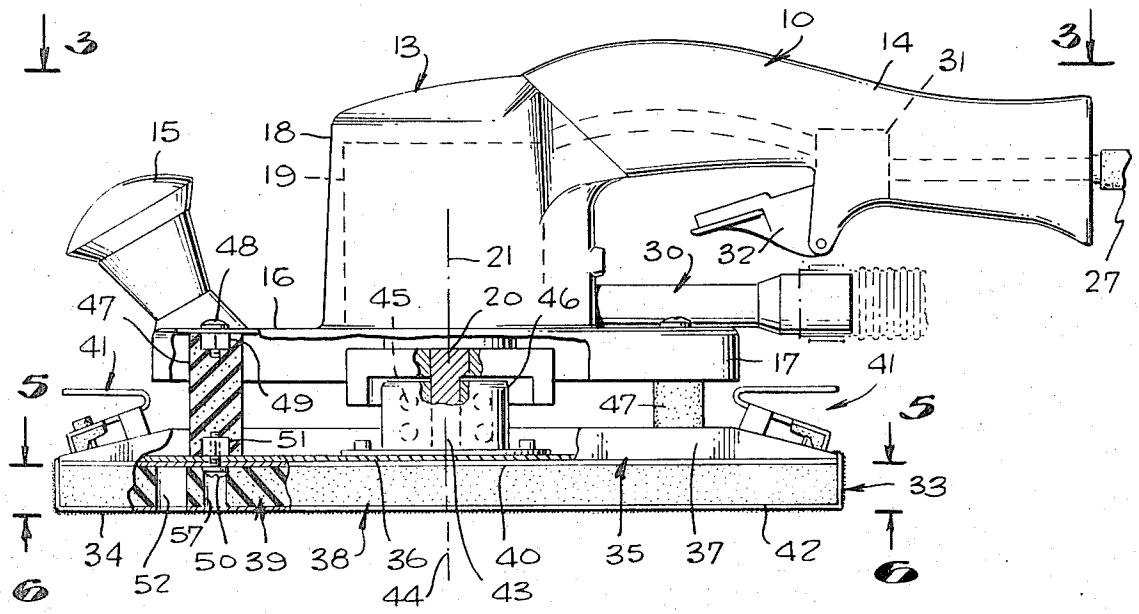


Fig. 2



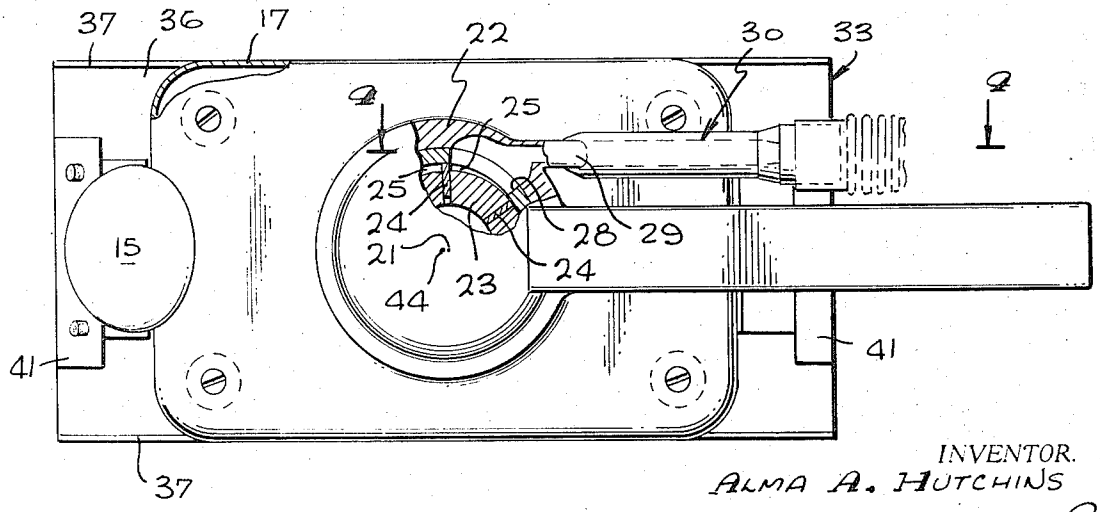


Fig. 3

INVENTOR.
ALMA A. HUTCHINS
BY
William P. Green
ATTORNEY

Fig. 4

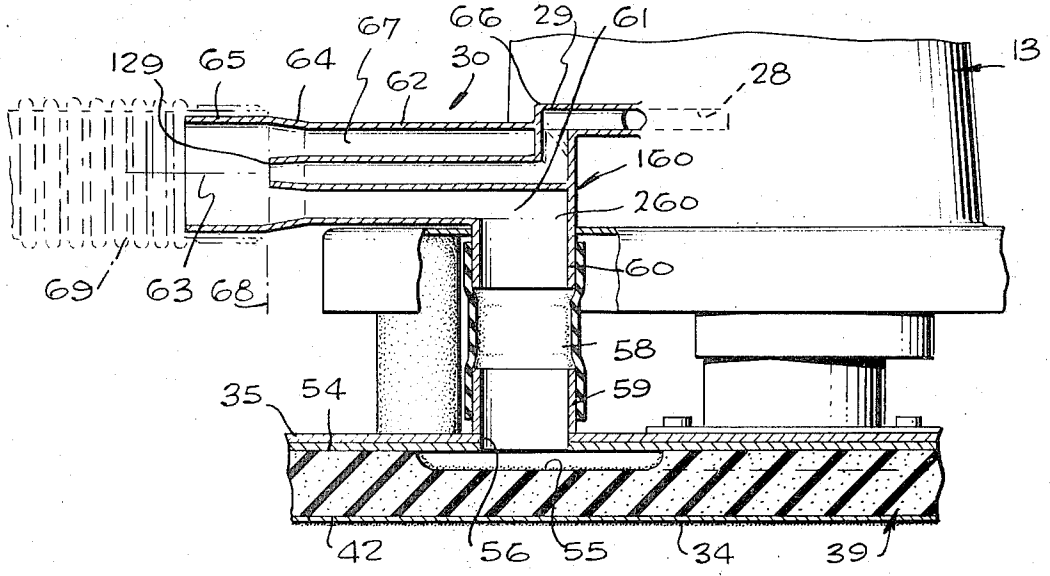


Fig. 5

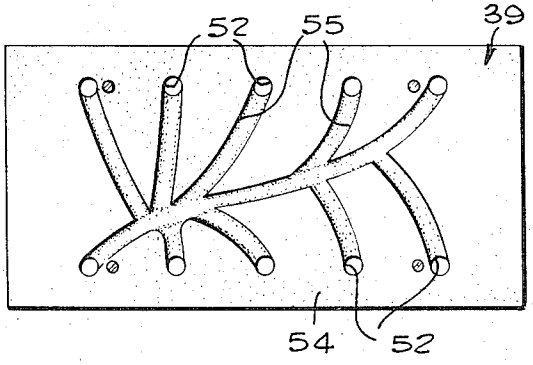


Fig. 6

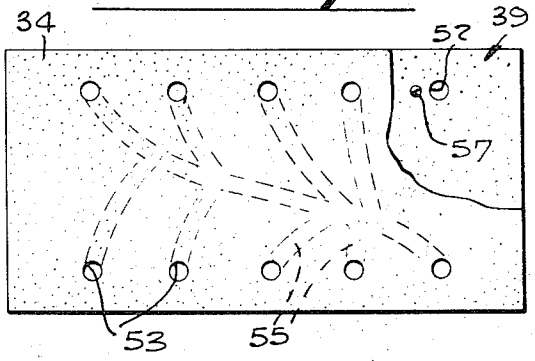


Fig. 7

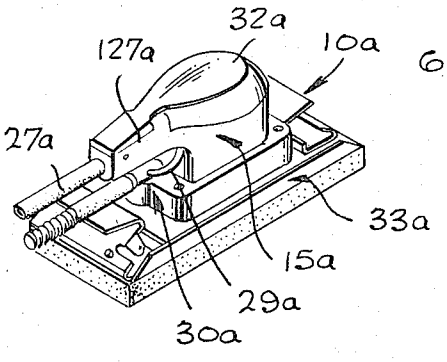
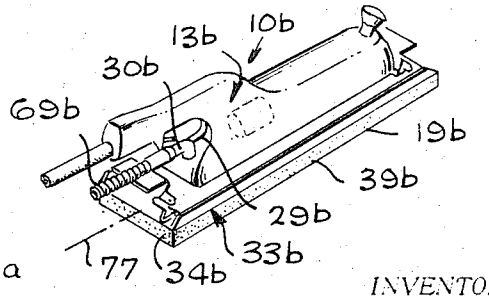


Fig. 8



INVENTOR.
ALMA A. HUTCHINS
BY
William P. Green
ATTORNEY

Fig. 9

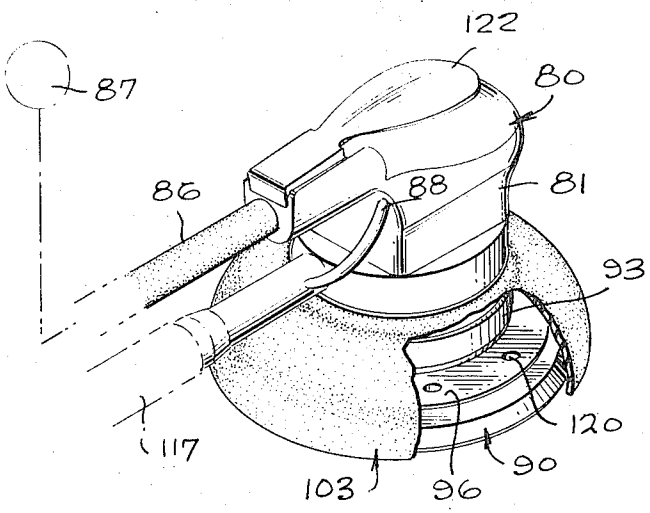
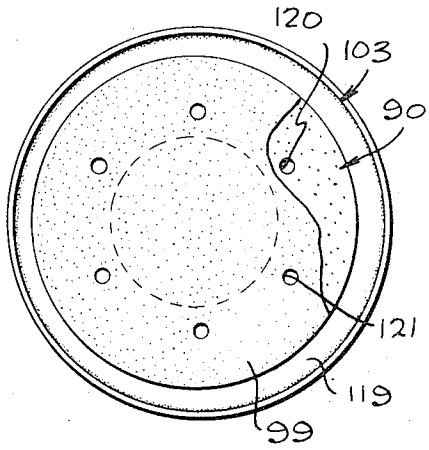


Fig. 11



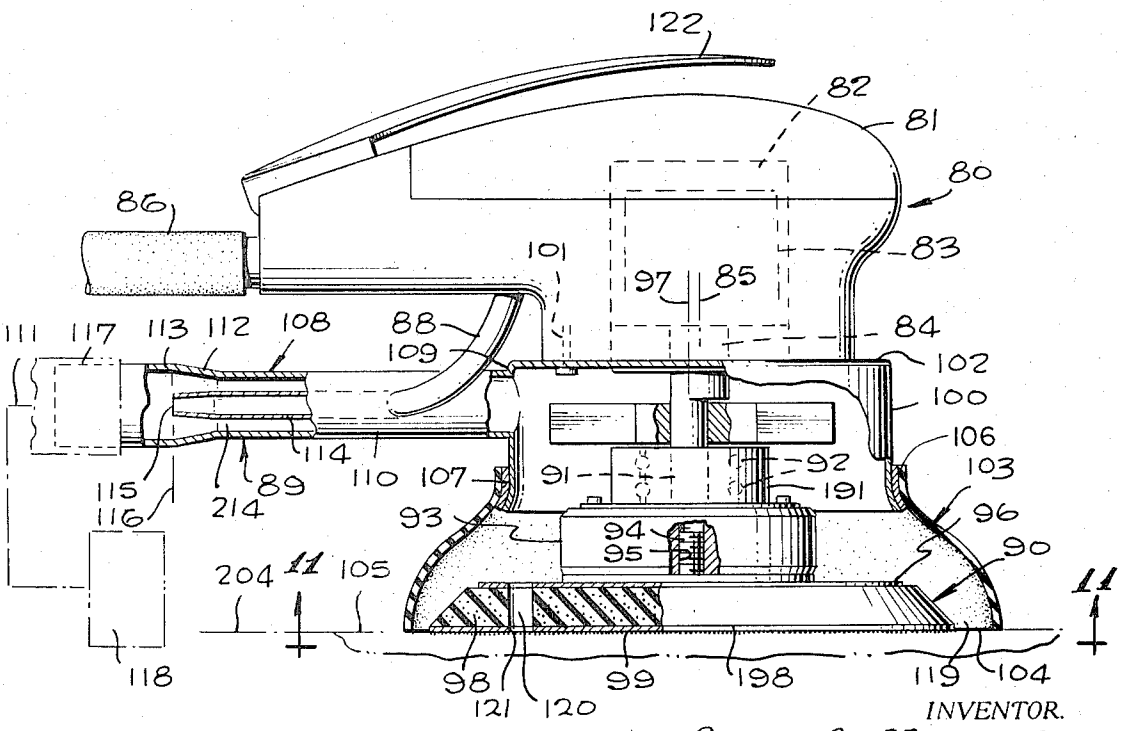


Fig. 10

INVENTOR.
ALMA A. HUTCHINS
BY
William P. Green
ATTORNEY

ABRADING TOOL HAVING SUCTION SYSTEM FOR COLLECTING ABRADED PARTICLES

BACKGROUND OF THE INVENTION

This invention relates to improved portable work abrading tools, such as for example sanding tools or the like.

In using a portable sanding tool or the like, the abrading material or element inherently tends to produce substantial quantities of particles abraded from the workpiece and forming essentially a dust-like mass covering the workpiece and tool and escaping into the air. This dust interferes with the sanding operation, and can be both unpleasant and physically harmful to the operator of the tool, who is forced to breathe the air into which the dust escapes. Attempts have been made in the past to provide means for collecting the produced dust, but all such prior arrangements of which I am aware have resulted in an overall tool assembly which was unduly complicated and expensive to manufacture, and very cumbersome to handle.

SUMMARY OF THE INVENTION

The present invention provides a unique abrading tool in which the produced dust can be collected with maximum simplicity of structure and operation. In spite of this simplicity, however, the dust removing action is extremely positive and complete, and is adapted for reliable operation substantially indefinitely and with a minimum of repair.

Many of the advantages of the tools embodying the invention are attained by employing a motor of a type in which a stream of air flows through or past the motor in operation, and by then utilizing that flow of air after it leaves the motor as a source of energy for producing a suction effect acting to withdraw the abraded particles from the vicinity of the work surface. Preferably, the air flow is passed through a simple aspirator, which produces the desired suction by aspirator action and then blows the withdrawn dust or particles into a collection bag or other container. In the optimum arrangement, the motor is of an air driven type, so that a single flow of compressed air can function first to drive the motor and then produce the suction effect. In such a system, the connection of the suction equipment into the exhaust line from the air motor also attains a highly beneficial secondary result of essentially silencing or substantially muffling the sound produced by the air motor.

The actual work abrading operation can be performed by a power driven shoe or unit, which can be driven either orbitally, reciprocally, rotatively, or in any other desired mode relative to the body of the tool, to perform the sanding or other abrading function. Desirably, this power driven unit contains a passage or passages through which the abraded particles can be drawn from the workpiece by the suction apparatus, with a sheet of sand-paper or the like preferably being carried by the power driven unit and containing apertures communicating with the mentioned suction passages to place the suction effect right at the work surface. For best results, the mentioned passages may be formed directly in and extend through a cushioning deformable pad portion of the movable abrading unit.

Certain additional features of the invention relate to the provision of a shroud about the abrading unit in some forms of the invention, with the shroud projecting into close proximity to the work surface to define an essentially closed space through which the dust collecting suction is communicated to the work surface. The shroud may be formed of a deformable material, and desirably is mounted for adjusting movement toward and away from the work surface to assure proper engagement therewith and to compensate for use of abrading heads of different thicknesses.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and objects of the invention will be better understood from the following detailed description of the typical embodiments illustrated in the accompanying drawings in which:

FIG. 1 is a side view of a first form of sanding tool constructed in accordance with the invention;

FIG. 2 is an enlarged side view of the FIG. 1 tool, partially broken away to reveal some of its inner construction;

FIG. 3 is a plan view taken primarily on line 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary vertical section through the aspirator and taken on line 4—4 of FIG. 3;

FIG. 5 is a horizontal section taken on line 5—5 of FIG. 2 and showing the pattern of air passages in the sandpaper engaging cushion of the device;

FIG. 6 is a bottom plan view taken on line 6—6 of FIG. 2;

FIGS. 7, 8, and 9 are perspective representations of three other forms of the invention;

FIG. 10 is primarily a vertical section through the tool of FIG. 9; and

FIG. 11 is a reduced bottom plan view taken on line 11—11 of FIG. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The first illustrated form of the invention, shown in FIGS. 1 to 6, takes the form of a power operated sander 10, for abrading and smoothing a work surface typically represented at 11 in FIG. 1. The tool is manipulated by hand over the work surface, and includes a collection bag 12 into which particles or dust abraded from work surface 11 are drawn by suction.

As seen best in FIG. 2, the tool includes a main portable body 13 having appropriate handles by which a user can grasp and carry the tool, and move it over the work surface 11. These handles may include a rearwardly projecting handle 14 and a forwardly and upwardly projecting knob 15 to be grasped by the two hands of the operator. Body 13 may have a lower essentially rectangular portion 16 which in the FIG. 2 position extends horizontally and may have a peripheral depending flange 17. At the center of its lower horizontal portion 16, body 13 may have an upwardly projecting hollow portion 18 connected to handle 14 and containing an air motor 19 having a driven shaft 20 turning about a vertical axis 21. The motor 19 may be of any conventional type, but preferably is a vane type motor, as seen partially in FIG. 3, including an outer cylindrical nonrotating housing part 22 secured to body 13 in fixed position relative thereto, and a rotor 23 located eccentrically within a cylindrical chamber in part 22 and mounted to turn relative thereto about the previously mentioned vertical axis 21. A series of circularly spaced radially extending vanes 24 are movably contained within slots in rotor 23, to define a series of com-

partments 25 which change progressively in size as the rotor turns. Compressed air from a source represented at 26 in FIG. 1 is fed through a flexible supply hose 27 and passages contained in handle 14 and part 22 to compartments 25, to cause rotation of rotor 23 about axis 21. After thus driving the rotor, the compressed air is exhausted from the interior of part 22 through a discharge opening 28 formed in a side of part 22 and communicating with a tube 29 of an aspirator 30 which will be described in greater detail at a later point. The air as it leaves the motor and passes into and through tube 29 is still at a substantially superatmospheric pressure, say for example about 70 pounds per square inch, to move rapidly through tube 29 in a manner attaining an effective aspirator action. The delivery of compressed air to the motor may be controlled by a valve 31 contained within handle 14, and actuated between closed and opened positions by a finger operated trigger element 32 carried at the underside of the handle.

At a location spaced beneath and parallel to portion 16 of body 13, this body movably carries an orbitally moving unit or assembly 33 which is power driven by motor 19 and carries at its underside a rectangular downwardly facing sheet of sandpaper or other abrasive material 34. As seen in FIG. 2, unit 33 includes a rigid shoe element 35 preferably formed of sheet metal and which has a main planar horizontal rectangular portion 36 (FIG. 3) typically reinforced by parallel upstanding flanges 37 formed along its opposite sides. At its underside, shoe 35 removably carries a rectangular pad assembly 38, including a layer of resiliently deformable rubber or other cushioning material 39 appropriately adhered by suitable cement or the like to a more rigid typically sheet metal plate 40 extending across the upper side of cushion 39. Two releasable spring actuated clips 41 may be carried at the upper side of portion 36 of shoe 35, near the opposite ends thereof, for engaging and releasably retaining opposite ends of the sandpaper sheet 34, with the main portion of the sandpaper sheet extending horizontally along the horizontal undersurface 42 of cushion 39. The sandpaper is thus pressed yieldingly downwardly by the cushion and the weight of the tool against work surface 11, in a planar condition, to perform an effective sanding operation on the work surface.

Shoe 35 and the carried pad assembly 38 and sandpaper sheet are driven orbitally by motor 19 through a downwardly projecting lower end portion 43 (FIG. 2) of motor shaft 20, which portion 43 may be externally cylindrical but have its vertical axis 44 offset laterally from and parallel to the main vertical axis 21 of the motor. This eccentric lower portion 43 of shaft 20 extends downwardly within the inner races of a pair of ball bearings 45 whose outer races are confined in fixed position relative to shoe 35 by reception within a hollow housing 46 attached to the shoe. Thus, as shaft 20 turns about axis 21, the lower portion 43 of the shaft moves orbitally about axis 21 and causes corresponding orbital movement of shoe 35 and the carried pad assembly 38 and sandpaper. At the same time, however, the shoe and carried parts are retained against rotation about vertical axis 21 by four flexible resilient essentially vertical connector posts 47, desirably formed of rubber or the like, and having sufficient stiffness to retain the shoe in an essentially fixed orientation with respect to the body 13, while at the same time permitting the desired slight captive orbital movement of the shoe relative to the body. The upper ends of posts 47 can be connected to portion 16 of body 13 by screws 48 extending downwardly into connector nuts 49 molded into the upper ends of the posts. Similarly, the lower ends of the posts may be secured to shoe 35 by screws 50 extending upwardly through portion 36 of the shoe and into nuts 51 molded into the lower ends of posts 47.

As seen in FIGS. 5 and 6, the deformable cushion 39 which backs up sandpaper sheet 34 contains a number of spaced apertures 52 which extend upwardly through the cushion and function as suction lines for drawing abraded particles away from the work surface 11. The sandpaper sheet 34 contains the particles same number of apertures 53, registering with apertures 52, to pass FIG. 4) abraded particles upwardly through the sandpaper into apertures 52. In the particular arrangement illustrated in FIGS. 5 and 6, there are 10 of these apertures in each of the elements 39 and 34, preferably arranged in two spaced rows each including five apertures.

The upper surface 54 of cushion 39 is planar and parallel to undersurface 42 except for the provision of a number of intercommunicating recesses or grooves 55 formed in upper surface 54 and communicating at their ends with apertures 52 (see FIG. 5). These grooves 55 conduct suction air and abraded particles from apertures 52 to the location of an opening 56 (see FIG.4) formed in horizontal plate 40. As will be apparent, plate 40 closes the upper side of grooves 55 except at the location of the aperture 56, and is cemented to surface 54 of cushion 39 entirely about all of the grooves 55 and apertures 52 and about opening 56, in air-tight sealed relation preventing leakage of any air into or out of grooves 55 except through opening 56 or apertures 52. As seen in FIG. 2, the pad assembly 38, including cushion 39 and plate 40, is detachably secured to the underside of shoe 35 by the same screws 50 which attach the shoe to deformable posts 47. To allow access to the heads of screws 50, cushion 39 may contain additional apertures 57 at the locations of these screws through which a screwdriver may extend upwardly into engagement with the screws.

The suction air and entrained dust are drawn upwardly from apertures 56 of FIG. 4 into a flexible vertically extending tube 58, typically formed of an appropriate flexible resinous plastic material such as a suitable vinyl or the like. The lower end of this tube 58 may be a tight fit about a short cylindrical upwardly projecting tube 59 secured to and projecting upwardly from shoe 35 at a location of alignment with and communication with aperture 56 in plate 40 of the pad assembly. At its upper end, tube 58 is similarly received tightly about a downwardly projecting externally cylindrical portion 60 of a main tube or conduit 160 of the previously mentioned aspirator 30, which aspirator is secured in fixed position to body 13. The tight frictional engagement of flexible tube 58 with the rigid tubular elements 59 and 60, with resilience of the material of tube 58 tending to constrict this tube inwardly against the outer surfaces of tubes 59 and 60, forms two annular airtight seals at the upper and lower ends of tube 58, while at the same time allowing slight orbital deformation of tube 58 in correspondence with the oribital movement of shoe 35 and with the deformation of posts 47.

In extending upwardly above its point of sealed connection to flexible tube **58**, the main rigid tube **160** of aspirator **30** first extends upwardly through an aperture **260** in portion **16** of body **13**, and then forms a right angle elbow which curves horizontally at **61** (leftwardly as viewed in FIG. 4) to define a straight cylindrical horizontally extending portion **62** of tube **160** centered about a horizontal axis **63**. Beyond straight cylindrical portion **62**, tube **160** of aspirator **30** has a frustoconically flaring annular portion **64**, still centered about axis **63**; and beyond this flaring portion the side wall of the tube may have a second straight cylindrical portion **65**, of an increased internal diameter as compared with that of portion **62**.

The previously mentioned tube **29** which communicates with the air outlet **28** of motor **19** extends through an opening in the tube **160** at **66**, in sealed relation with respect thereto (or may be molded or cast integrally with tube **160**), and then continues within portion **62** of tube **160** in concentric relation with respect thereto, that is, along the axis **63** of portion **62**, with an annular air passage or space **67** being provided between tube **29** and portion **62**. Desirably, the tube **29** continues leftwardly to a point at least partially within the frustoconical flaring portion **64** of the outer wall of the aspirator, and for best results terminates in the transverse plane **68** at which the flaring portion **64** reaches its maximum diameter. It is also helpful if the end portion of tube **29** tapers frustoconically, as shown at **129** in FIG. **4**, desirably within the flaring portion **64** of the outer tube.

A short distance beyond flaring portion **64**, the portion **65** of the outer tube of the aspirator is connected to a flexible hose **69** which extends along and generally parallel to the air inlet hose **27**, and which terminates at **70** (FIG. **1**) within the dust collection bag **12**. Bag **12** is formed of an appropriate porous material, preferably woven material of the type commonly utilized in vacuum cleaners and the like, adapted to pass through the material of the bag to its exterior the air exhausted from the air motor, while having a close enough weave or pore pattern to prevent the abraded dust particles from the work surface from leaving the bag with the air. The material forming the bag may be double stitched along two parallel lines **71** and **72** near its upper edge, to define an elongated passageway within which hose **27** may pass, to thereby support bag **12** from hose **27**. A tie string **73**, clamp or other attaching element may be carried by the bag at its leftward end in FIG. **1**, and be tightenable about both of the tubes **27** and **70** to form an airtight closure of the bag at that location. Similarly, another tie string **74** or its equivalent may be provided at the second end **75** to close that end of the bag about hose **27**, while at the same time allowing emptying of the bag from its right end by loosening of the tie string **74**.

To now describe the manner of use of the tool of FIGS. **1** to **6**, assume that the tool is assembled as illustrated in FIG. **1**, and that the air supply hose **27** has been connected at **76** to a hose **77** leading from compressed air source **26**. Assume also that the sandpaper sheet has been connected by clamps **41** to the shoe of the device as illustrated in FIG. **2**. An operator then grasps the tool by its two handles **14** and **15**, and places the tool on the work surface **11** in the FIG. **1** position, and then actuates trigger **32** to admit air from source **26** to motor **19**. This air acts against the vanes **24** of rotor **23** to cause rapid rotation of the rotor about axis **21**, and shaft **20** then acts through its eccentric portion **43** to orbitally oscillate the shoe unit or assembly **33** and carried sandpaper **34** relative to body **13** of the device. This oscillatory motion abrades the work surface **11**, and smooths that surface, but at the same time produces a dust on the surface composed of particles abraded from the work-piece. These dust particles are drawn upwardly through apertures **53** in the sandpaper sheet, and through apertures **52** in cushion **39**, into passages **55** of FIG. **5**. From these passages, the suction flow of air and particles moves upwardly through tube **58** of FIG. **4**, and then advances first upwardly and then horizontally through portions **60, 62, 64**, and **65** of conduit **160**, for ultimate discharge through flexible hose **69** into bag **12**, in which the dust particles are entrapped while the air escapes through the porous wall of the bag.

As previously indicated, this movement of suction air is produced by aspirator action, as a result of the rapid movement of air exhausted from motor **19** leftwardly in FIG. **4** through tube **29**, and into the end portion **65** of the outer tube of the aspirator. The rate of discharge of this air from the end **129** of tube **29** is sufficiently rapid to attain a very effective aspirator action, and to produce a subatmospheric partial vacuum at the work surface adequate to effectively withdraw all of the produced dust from the work surface by suction. In addition, the provision of the aspirator and dust collection bag **12** in the path of the exhaust air from motor **19** serves the additional function of very substantially reducing the amount of noise produced by the air motor, since the air is no longer exhausted from that motor directly into the atmosphere.

FIG. **7** shows the manner of application of the present invention to a sanding tool **10*a*** which is very similar to that of FIGS. **1** to **6**, except that the upwardly projecting portion of the body **15a** of the tool serves itself as the handle of the device, with the air inlet valve being actuable by downward deflection of an upper platelike element **32*a***. With this body and handle arrangement, the aspirator **30*a*** may be located at a laterally central position, essentially directly beneath the air inlet line **27*a*** and the air inlet portion **127*a*** of the tool body, rather than at a laterally offset position as in FIG. **3**. The exhaust air from the air motor within body **13*a*** may be led by a suitable tube represented at **29*a*** into the interior of the aspirator. The orbitally movable sandpaper carrying shoe assembly or unit **33*a*** may be mounted and driven in essentially the same manner as in FIGS. **1** to **6**, with suction air being drawn by aspirator **30*a*** from the work surface through apertures and passages formed in the shoe assembly, and apertures in the sandpaper, as previously discussed. The interior construction of the aspirator **30*a*** may be essentially the same as described in connection with FIG. **4**, to attain the same type of suction effect by aspirator action.

FIG. **8** illustrates diagrammatically the application of the present invention to an 'in-line' type of sanding tool **10*b***, in which the sandpaper carrying shoe assembly **33*b*** is mounted to the hand carried body **13*b*** of the device for straight line reciprocating motion along axis **77** parallel to the work surface and relative to body **10*b***. An air driven motor **13*b*** within body **10*b*** acts through an appropriate drive mechanism to produce such reciprocating relative motion of the shoe assembly. The sandpaper **34*b*** contains apertures corresponding to those shown at **53** in FIG. **6**, communicating with regis-

tering apertures and passages in rubber pad **39***b*, as illustrated at **52** and **55** in FIGS. **5** and **6**, with these suction apertures and passages leading into an aspirator **30***b* into which exhaust air from motor **19***b* is led through a tube **29***b*. Aspirator **30***b* functions in essentially the same manner as aspirator **30** of FIGS. **1** to **6**, to produce a suction at the underside of shoe assembly **33***b* resulting from the aspirator action of the rapidly moving exhaust air from line **29***b*, causing air and dust particles to be drawn through hose **69***b* into a collection bag such as that shown at **12** in FIG. **1**. As in FIG. **1**, this suction system keeps the work surface clean, prevents escape of the produced dust particles into the air, and muffles the sound produced by motor **19***b*.

FIGS. **9**, **10**, and **11** show another sanding tool **80** embodying the invention, including a hollow handle body **81** externally contoured to be easily grasped by a user. This body **81** contains a rotary preferably vane type air motor **82** having a rotor **83** driving a shaft **84** about a vertical axis **85** relative to body **81**. Compressed air is supplied to the motor through an inlet hose **86** from a compressed air source **87**. The air exhausted from the motor after driving its rotor **83** discharges through an outlet tube **88** which may connect into a side of handle body **81** and extend downwardly therefrom to the location of an aspirator **89**. This discharging air in exhaust line **88**, even after passing through and driving the motor, is still at a substantially superatmospheric pressure, say for example about 70 p.s.i.

At its lower end, shaft **84** of the motor drives a removable circular sanding head **90**, which is driven orbitally with respect to axis **85**. For this purpose, the lower end of shaft **84** has an eccentrically offset externally cylindrical portion **91** whose axis **97** is parallel to but offset from axis **95**. Shaft portion **91** is received within and secured to the inner races of two aligned ball bearings **92**, whose outer races are contained within and connected to a hollow cylindrical part **191**, to mount that part and a connected circular member **93** for rotation relative to eccentric portion **91** of the shaft and about axis **97**. The circular head **90** has an upwardly projecting externally threaded screw or stud **94** which is removably connectible into an internally threaded bore **95** in member **93** centered about axis **97**, to secure the head **90** thereto. Head **90** may have a rigid circular backing plate **96** disposed transversely of and centered about axis **97** of screw **94** and shaft portion **91**, with a resiliently deformable cushion of rubber or the like **98** being positioned at the forward side of backing plate **96**, and being circular and centered about axis **97**, to carry and back up a correspondingly circular disc **99** of sandpaper. This paper may be secured in any manner to the front face **198** of cushioning material **98**, as by an appropriate adhesive. As a result of this discussed mounting of head **90**, the head and carried sandpaper disc rotate orbitally about main axis **85** of motor **82** as the motor is driven.

Beneath the level of motor **82**, body **81** of the tool rigidly carries a downwardly projecting rigid annular cylindrical flange or skirt **100**, centered about the main axis **85** of the motor and tool, and secured appropriately to body **81** as by screws **101** extending upwardly through an annular inturned horizontal flange **102** of part **100**. To the outside of part **100**, there is mounted a shroud **103**, which may be formed of a resiliently deformable material, such as a suitable rubber, and which flares downwardly and outwardly to an increased diameter lower circular edge **104** of the shroud for annularly engaging a work surface **105** at a location about and spaced outwardly from sanding head **90**. Edge **104** is desirably positioned to lie in the transverse plane **204** of sandpaper **99**, which plane is perpendicular to axes **85** and **97**. In some arrangements, the upper circular edge portion **106** of annular shroud **103** may be permanently secured in fixed position relative to part **100**, to thereby tend to locate edge **104** of the shroud in a correspondingly essentially fixed position, from which it can be displaced only by deformation of the material of the shroud. Preferably, however, the entire shroud **103** is mounted for limited upward and downward movement relative to part **100** and sanding head **90** and along axis **85** of the tool, as by connecting the upper edge **106** of the shroud to an annular more rigid part **107**, typically formed of metal or the like, with this part **107** being a fairly close fit on the outer cylindrical surface of part **100**, but being movable upwardly and downwardly on part **100** with shroud **103** to raise and lower the shroud relative to sanding head **90**. This upward and downward movement of the shroud relative to the tool body and head **90** allows the lower edge **104** of the shroud to always fall by gravity into annular contact with work surface **105**, and additionally allows the shroud to be adjusted upwardly and downwardly to compensate for use of sanding heads **90** having different effective vertical thicknesses.

The aspirator **89** includes a main outer tube **108** whose left end as viewed in FIG. **10** is connected at **109** into a side of cylindrical flange part **100**, to communicate with the interior of that flange part and the interior of shroud **103**. Tube **108** may have a first straight cylindrical portion **110** centered about a horizontal axis **111**, and merging into a frustroconically flaring portion **112** and then a second straight cylindrical but increased diameter portion **113**, with these latter two portions **112** and **113** also being centered about axis **111**. The air exhaust tube **88** from air motor **82** extending through a side wall of tube **108**, and then forms a tube **114** extending along and centered about axis **111** and spaced radially from the wall of tube **108** to form an annular space **214** through which air and dust particles from within the shroud can move leftwardly in FIG. **10** under aspirator action. Desirably the extremity **115** of tube **114** terminates in essentially the same transverse plane **116** in which frustoconical portion **112** of tube **108** reaches its maximum diameter. At its left end, tube **108** is connected to a hose **117** leading to a dust collection bag **118** or the like, formed of a porous material through which air can escape from the bag while entrapping the abraded particles from work surface **105** in the bag.

The dust produced by abrasion of surface **105** is withdrawn upwardly within shroud **103** through the space **119** about head **90**, and also through a series of circularly spaced apertures **120** extending upwardly through the head, including both its backing plate **96** and cushion **98**. Corresponding apertures **121** are provided in the sandpaper sheet **99**, registering with and directly axially opposite apertures **120**, to pass the dust particles upwardly through the sandpaper at these aperture locations and into apertures **120** in the head, and then upwardly through those apertures into the interior of shroud **103**.

To place the tool of FIGS. 9 to 11 in use, an operator grips the handle body 81, and in doing so automatically presses downwardly on an upper depressible platelike element 122 which operates an inlet valve for admitting compressed air from source 87 to motor 82. The body is so manipulated as to move sandpaper disc 99 into engagement with the work surface 105, with edge 104 of the shroud annularly engaging the work surface about the sanding head. The air discharging from motor 82 through tube 88 is exhausted leftwardly from the end 115 of inner tube 114 of the aspirator 89, and causes a corresponding leftward movement of air within tube 108 and about tube 114 by aspirator action, thus creating a partial vacuum or suction within shroud 103 drawing abraded particles upwardly from work surface 105 through space 119 about head 90 and through apertures 120 and 121. The work surface is thus kept clean, the dust is prevented from escaping into the atmosphere, and the provision of the aspirator and collection bag 118 in the exhaust line from the motor substantially reduces the noise produced by the motor.

Another possible form of the invention which will be understood without the necessity for further illustration is one in which the sanding head 90 of FIG. 10 is driven rotatably about axis 85 by motor 82, rather than being oscillated orbitally as above discussed. In this event, head 90 would be concentric with shroud 103, rather than eccentric as illustrated in FIG. 11, but with the aspirator still functioning to produce a suction drawing air and dust particles upwardly through a space about and apertures in the rotary head and then from within the shroud to bag 118.

While certain specific embodiments of the present invention have been disclosed as typical, the invention is of course not limited to these particular forms, but rather is applicable broadly to all such variations as fall within the scope of the appended claims.

I claim:

1. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing and forming a motor chamber through which compressed air flows; said motor including a movable part in said chamber which is driven by said compressed air and in turn drives said unit; and an aspirator structure located outside and downstream of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation outside the confines of said motor chamber; said primary air flow path being connected to said chamber to receive air discharged therefrom after it has driven said movable part; said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air beyond said motor chamber, in a relation inducing the flow of air and particles along said secondary path by movement of said motor discharge air; said aspirator structure being constructed and located to direct said primary flow of motor discharge air into contact with said secondary flow of air and abraded particles downstream of and only after said discharge air has left said chamber and in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contact with said movable part.

2. A A portable abrading tool as recited in claim 1, in which said aspirator structure includes a conduit at the outside of said motor chamber communicating through a first inlet end with the work surface to receive air and abraded particles therefrom, and through which conduit said air and abraded particles flow in a predetermined direction toward a second discharge end of the conduit, said aspirator structure including means defining a portion of said primary air flow path and receiving air discharged from and downstream of said chamber and forming an opening through which the motor discharge air is emitted at high velocity into said conduit in said predetermined direction toward said outlet end of the conduit to induce said secondary flow of air and particles through the conduit, said movable unit for abrading a work surface containing an air passage having a suction end located closely adjacent the work surface and through which said aspirator structure withdraws air and abraded particles from the work surface by suction.

3. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing and forming a motor chamber through which compressed air flows; said motor including a rotor in said chamber which is driven rotatably relative to the chamber by said compressed air, and which in turn drives said unit; and an aspirator structure located outside of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation downstream of said motor chamber; said primary air flow path being connected to said chamber to receive air discharged there-from after it has driven said rotor, said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air downstream of said motor chamber, in a relation inducing the flow of air and particles along secondary path by movement of said motor discharge air; said aspirator structure being constructed, and located outside of said motor chamber, to direct said primary flow of motor discharge air into contact with said secondary flow of air and abraded particles only after said discharge air has left said chamber, and in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contact with said rotor.

4. A portable abrading tool as recited in claim 3, including a porous dust collection bag to which air and abraded particles are discharged from said aspirator structure, said movable unit including a shoe carrying a sheet of abrasive material and containing a passage for receiving air and abraded particles from the work surface, said aspirator structure being carried by said body structure, and there being a flexible conduit connected to a first end to said shoe to receive air and particles from said passage therein and connected at its opposite end to said aspirator structure to deliver said air and particles thereto as said secondary flow.

5. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing and forming a motor chamber through which compressed air flows; said motor including a movable part in said chamber which is driven by said compressed air and in turn drives said unit; and an

aspirator structure located outside of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation; said primary air flow path being connected to said chamber to receive air discharged therefrom after it has driven said movable part; said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air, in a relation inducing the flow of air and particles along said secondary path by movement of said motor discharge air; said secondary flow of air and abraded particles meeting said primary flow of motor discharge air only after said discharge air has left said chamber in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contact with said movable part, said aspirator structure including a tube at the outside of and downstream of said motor chamber and containing and defining a portion of said primary air flow path and having an outlet end through which air discharged from said motor leaves said tube, said aspirator structure including a conduit disposed about said tube in spaced relation and defining a portion of said secondary air flow path between the tube and conduit through which a flow of air is induced by the aspirator action of air discharging from said outlet end of the tube.

6. A portable abrading tool as recited in claim **4,** in which said conduit increases in cross-sectional area at approximately said outlet end of said tube.

7. A portable abrading tool as recited in claim **4,** in which said conduit has a portion flaring progressively to an increased diameter, said tube having a discharge end projecting into said flaring portion of the conduit and terminating at said outlet at approximately the location at which said conduit reaches its maximum diameter.

8. A portable abrading tool as recited in claim **4,** in which said conduit has a portion flaring progressively to an increased diameter, said tube having a discharge end projecting into said flaring portion of the conduit and terminating at approximately the location at which said conduit reaches its maximum diameter, said conduit having a first essentially uniform diameter straight cylindrical portion upstream of and merging with and aligned axially with said flaring portion, and having a second and larger diameter essentially straight cylindrical portion downstream of and merging with and aligned axially with said flaring portion of the conduit.

9. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing and forming a motor chamber through which compressed air flows; said motor including a movable part in said chamber which is driven by said compressed air and in turn drives said unit; and an aspirator structure located outside of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation; said primary air flow path being connected to said chamber to receive air discharged therefrom after it has driven said movable part; said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air, in a relation inducing the flow of air and particles along said secondary path by movement of said motor discharge air; said secondary flow of air and abraded particles meeting said primary flow of motor discharge air only after said discharge air has left said chamber in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contract with said movable part, said movable unit including a cushion having a working face adjacent which a sheet of abrasive material is carried in use, said cushion containing one or more air passages opening through said working face of the cushion to a location adjacent the sheet of abrasive material and through which said aspirator structure withdraws air and abraded particles by suction from near the work surface, said passages in said cushion being defined as apertures extending through the cushion from an upper side thereof to said working face, and communicating recesses formed in said upper side of the cushion, there being a plate extending across the upper side of the cushion and closing said recesses at that location.

10. A portable abrading tool as recited in claim **8,** including said sheet of abrasive material as an element of the claim, said sheet containing apertures communicating with said passages in the cushion.

11. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing and forming a motor chamber through which compressed air flows; said motor including a movable part in said chamber which is driven by said compressed air and in turn drives said unit; and an aspirator structure located outside of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation; said primary air flow path being connected to said chamber to receive air discharged therefrom after it has driven said movable part; said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air, in a relation inducing the flow of air and particles along said secondary path by movement of said motor discharge air; said secondary flow of air and abraded particles meeting said primary flow of motor discharge air only after said discharge air has left said chamber in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contact with said movable part, said movable unit containing at least one passage for receiving abraded particles from the work surface, said aspirator structure being carried by said body structure, there being a flexible conduit connected at a first end to said movable unit to receive air and particles from said passage therein and connected at its opposite end to said aspirator structure to deliver air and particles thereto as said secondary flow.

12. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing and forming a motor chamber through which compressed air flows; said motor including a movable part in said chamber which is driven by said compressed air and in turn drives said unit; and an aspirator structure located outside of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation; said primary air flow path being connected to said chamber to receive air discharged therefrom after it has driven said movable

part; said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air, in a relation inducing the flow of air and particles along said secondary path by movement of said motor discharge air; said secondary flow of air and abraded particles meeting said primary flow of motor discharge air only after said discharge air has left said chamber in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contact with said movable part, said movable unit including a working shoe which, when the tool is utilized for abrading an upwardly facing horizonal work surface, extends essentially horizontally at the upper side of said work surface, and which carries at its underside a sheet of abrasive material for contacting the work surface, said shoe containing at least one passage through which air and abraded particles flow from the work surface, said body structure including a body part extending essentially horizontally at a location spaced above said shoe and carrying said aspirator structure, there being a flexible conduit connected at one end to said passage in the shoe and connected at its opposite end to said aspirator structure to conduct air and abraded particles from the shoe passage through said flexible conduit to the aspirator structure.

13. A portable abrading tool as recited in claim **11**, in which said aspirator structure includes a second conduit carried at the upper side of said body part and extending generally horizontally at that location and through which said flow of air and abraded particles from said flexible conduit flow in a predetermined direction, and a third conduit leading from said motor chamber and emitting said motor discharge air into said second conduit in said predetermined direction to induce the flow of said air and particles from the work surface, there being a porous particle entrapment bag into which air and entrained abraded particles are delivered from said aspirator structure and formed of a porous material through which said air can escape while entrapping said particles in the bag.

14. A portable abrading tool comprising a body structure; a unit movable relative to said body structure to abrade a work surface; an air motor for moving said unit and containing said forming a motor chamber through which compressed air flows; said motor including a movable part in said chamber which is driven by said compressed air and in turn drives said unit; and an aspirator structure located outside of said motor chamber and defining primary and secondary air flow paths which meet in aspirating relation; said primary air flow path being connected to said chamber to receive air discharged therefrom after it has driven said movable part; said secondary air flow path being in communication with the work surface to direct a secondary flow of air, and particles abraded from the work surface, to a location of aspirating contact with said motor discharge air, in a relation inducing the flow of air and particles along said secondary path by movement of said motor discharge air; said secondary flow of air and abraded particles meeting said primary flow of motor discharge air only after said discharge air has left said chamber in a relation thereby avoiding flow of said secondary air and particles through said chamber or into contact with said movable part, said movable unit being a circular head power driven by said motor at the underside of said body structure and carrying an abrasive disc, there being an essentially circular shroud of deformable material extending about said circular head to contact the work surface essentially thereabout and defining an essentially closed space communicating with the aspirator structure and communicating with the work surface through passages in said head and through a space radially between the head and shroud to withdraw air and particles from the work surface to the aspirator structure.

15. A portable abrading tool as recited in claim **13**, including means mounting said shroud adjustably to said body structure for movement relative thereto and relative to said circular head and toward and away from said work surface.

16. A portable abrading tool comprising a body structure, a unit movable relative to said body structure to abrade a work surface, a motor for moving said unit to abrade the work surface and containing a space within which a moving part is located and through which a primary flow of air passes, and an aspirator through which said primary flow of air passes after it leaves said space in the motor and which is energized by said primary flow to induce a secondary flow of air and abraded particles to said aspirator without passage of said secondary flow through said space or in contact with said moving part, said work abrading unit containing a suction passage through which said secondary flow passes, said aspirator being carried by said body, there being a flexible conduit for conducting said secondary flow of air and particles from said unit to said aspirator.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,785,092 Dated January 15, 1974

Alma A. Hutchins

It is certified that error appears in the above identified United States Letters Patent and that said Letters Patent are hereby corrected as follows:

In claim 4, line 9, "to", first occurrence, should read--at--. In claims 6, 7 and 8, line 1 in each, the claim reference numeral "4" should read--5--. In claim 10, line 1, the claim reference numeral "8" should read--9--. In claim 13, line 1, the claim reference numeral "11" should read--12--. In claim 14, line 4, the word "said" should read--and--. In claim 15, line 1, the claim reference numeral "13" should read--14--.

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents