Oct. 15, 1968 J. E. HARPER 3,405,481

SURFACE MODIFICATION APPARATUS

Filed June 22, 1966 4 Sheets-Sheet 1

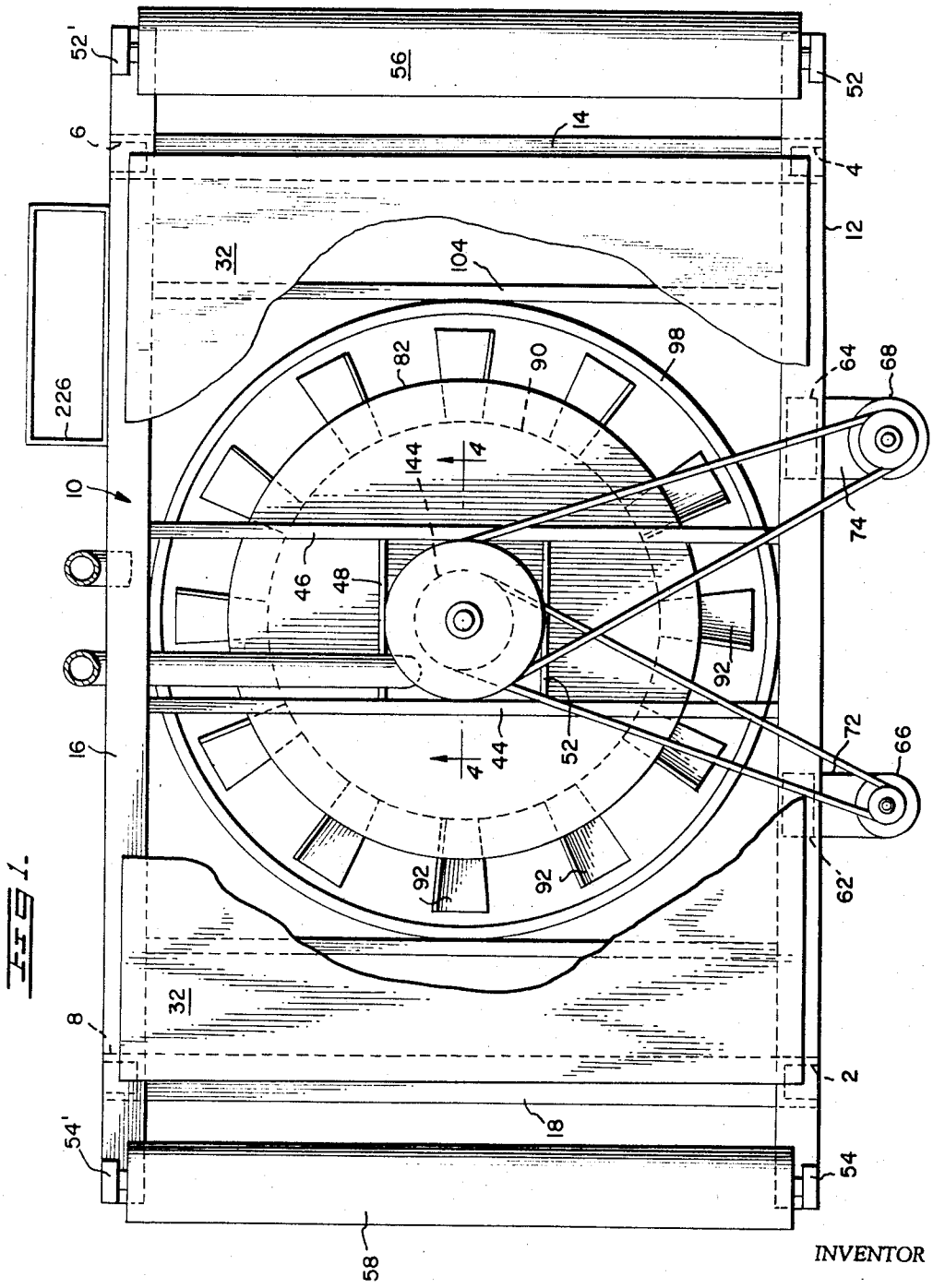


FIG. 1.

INVENTOR

JAMES E. HARPER

BY Smith, Michael, Bradford and Gardiner

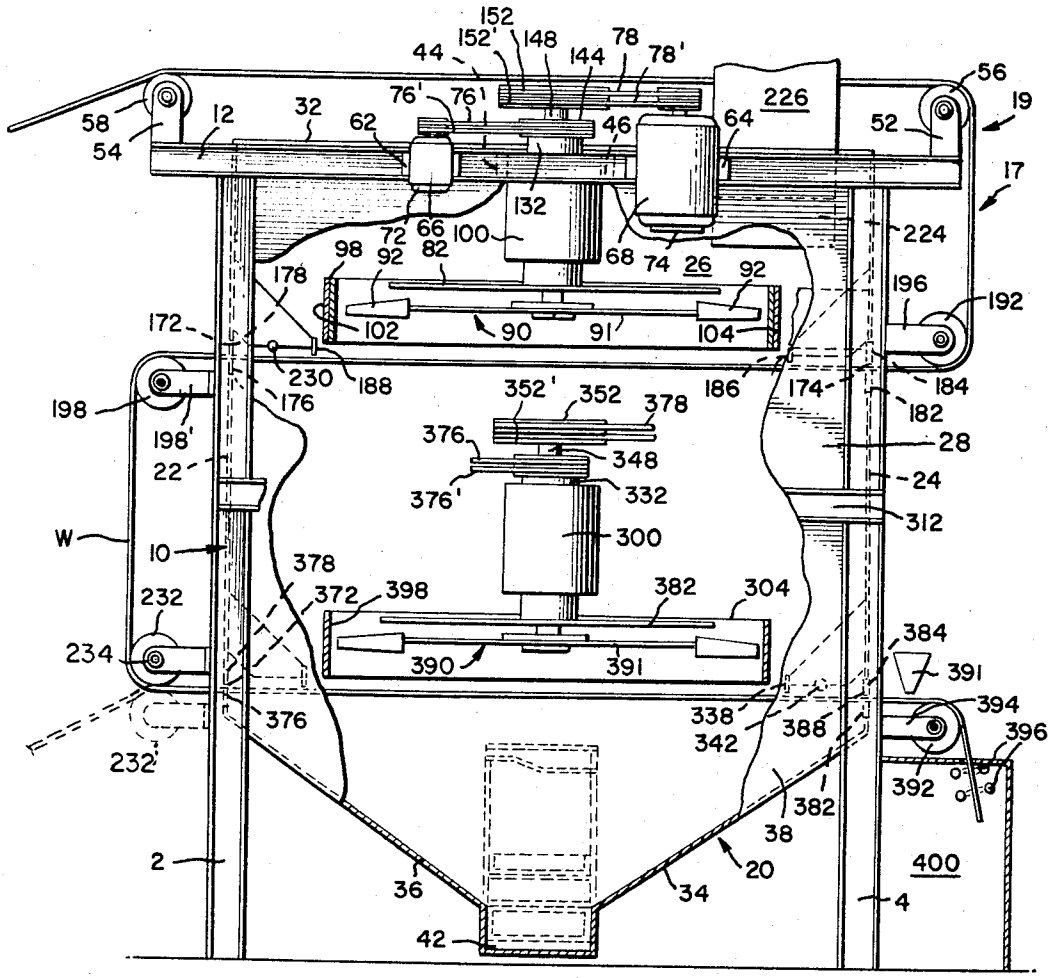
ATTORNEYS

Oct. 15, 1968 J. E. HARPER 3,405,481

SURFACE MODIFICATION APPARATUS

Filed June 22, 1966 4 Sheets-Sheet 2

Fig 2.



INVENTOR

JAMES E. HARPER

BY Smith, Michael, Bradford and Gardiner

ATTORNEYS

Oct. 15, 1968 J. E. HARPER 3,405,481

SURFACE MODIFICATION APPARATUS

Filed June 22, 1966 4 Sheets-Sheet 3

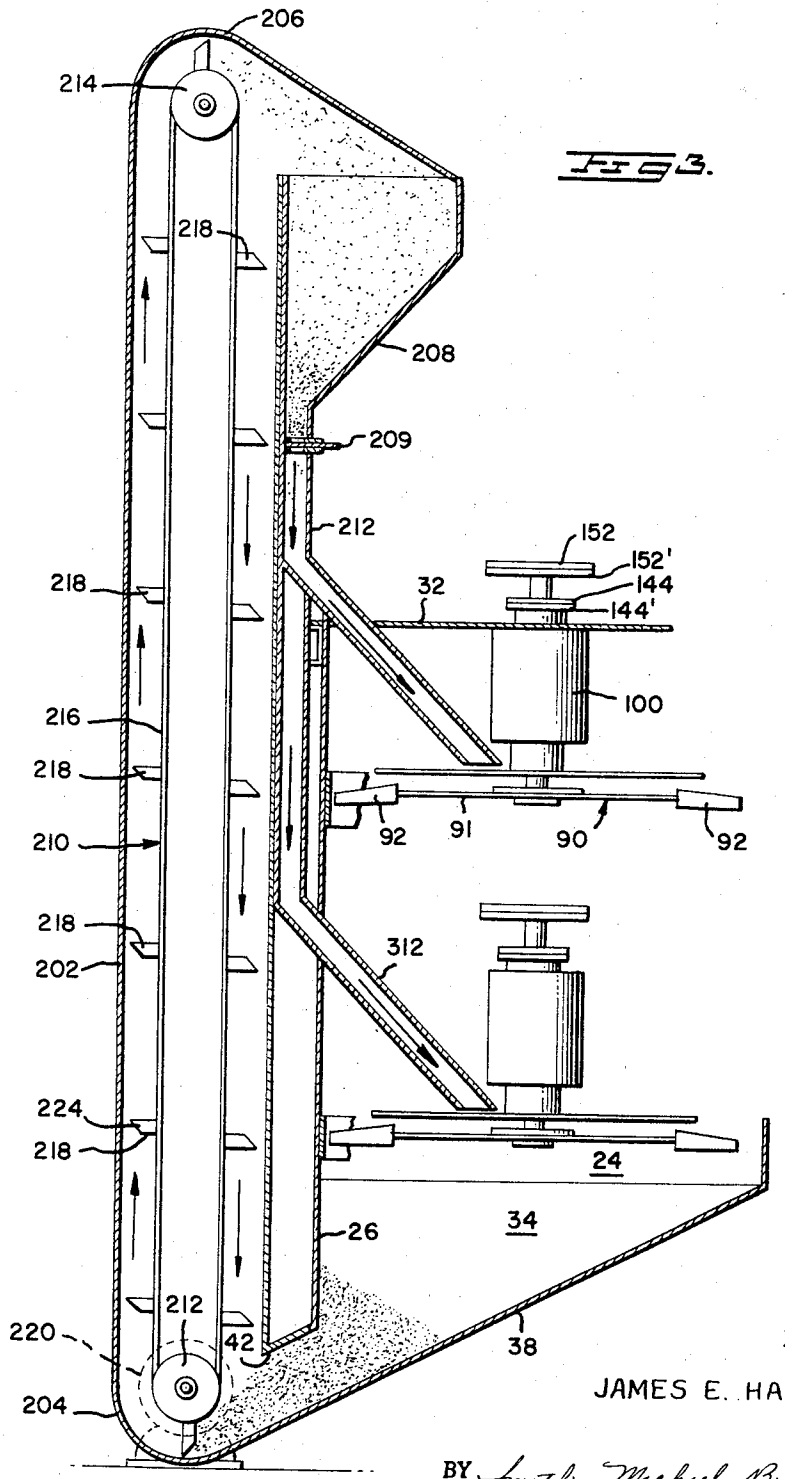


Fig 3.

INVENTOR

JAMES E. HARPER

BY Smith, Pickel, Bradford and Gardiner

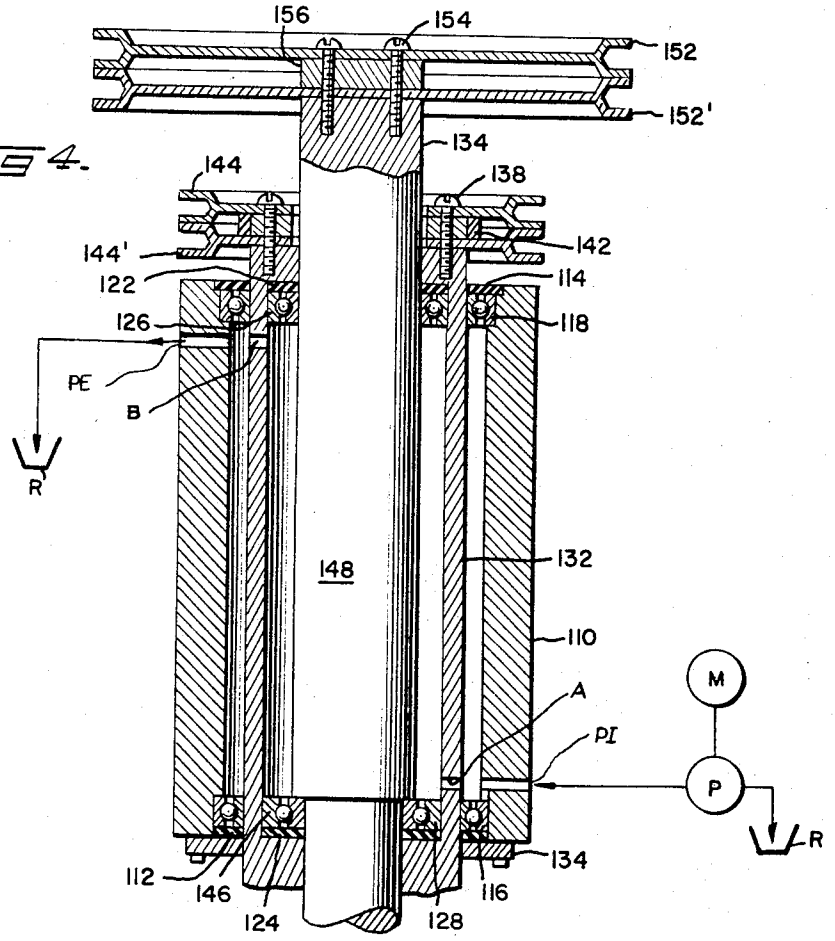
ATTORNEYS

Oct. 15, 1968 J. E. HARPER 3,405,481

SURFACE MODIFICATION APPARATUS

Filed June 22, 1966 4 Sheets-Sheet 4

Fig 4.



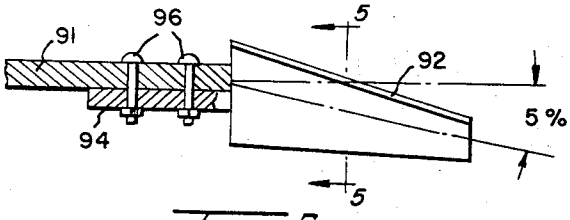


Fig 5.

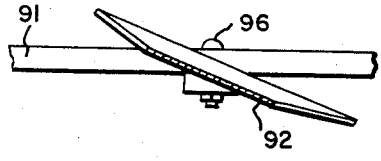


Fig 6.

INVENTOR

JAMES E. HARPER

BY Smith, Michael, Bradford and Gardiner

ATTORNEYS

United States Patent Office 3,405,481 Patented Oct. 15, 1968

3,405,481

SURFACE MODIFICATION APPARATUS

James E. Harper, Rosecroft Park, Md.
(6040 Haverhill St., Oxon Hill, Md. 20022)

Filed June 22, 1966, Ser. No. 559,493
11 Claims. (Cl. 51—9)

ABSTRACT OF THE DISCLOSURE

The device is designed to produce uniform matte finishes on materials, primarily sheet metal, in a continuous process and comprises a novel abrasive feeding and application arrangement formed of a co-axial slowly rotating flat diffuser disc and a multi-bladed impeller disposed in vertically spaced planes, the impeller blades being angled downwardly and also having a pitch angle designed to cooperate with a surrounding blast ring to sweep abrasive across the surface of the material being treated to produce a uniform matte finish on the surface.

The present invention is concerned with an apparatus for the application of particulate material to the surface of moving webs or sheets for the purpose of modifying said surfaces. While various modifications and modes of utility for the apparatus will occur to those skilled in the art, same will be described in terms of the application of abrasive materials to the surfaces of metal webs such as aluminum, or the like, for the purpose of producing a completely uniformally abraded surface hereinafter referred to as a "matte" finished surface.

A particular application of the apparatus comprising the invention is in a process for manufacturing printing plates of various types wherein an aluminum backing may be provided with an abraded surface to which are applied one or more of a variety of materials comprising photosensitive compounds, "glassing" compounds and the like in various combinations so that the finished product, when exposed to light through a mask of one form or another and thereafter treated to remove or fix the light-struck areas, can be used directly on a lithographic press to reproduce images corresponding to the characters retained on the base surface.

So called "matte" finishes on metal surfaces have been produced before by any one of a variety of methods and apparatus ranging from manual sand-blasting through highly complex machines, an example of which is shown in a number of prior art patents, such as 2,276,594, among others. Such methods and apparatus as have been used prior hereto are subject to deficient performance and lack of versatility which has resulted in the failure of such methods and apparatus to produce completely uniform edge-to-edge treatment of the base surface to the desired and selected degree and with a consistency that permits of rapid continuous treatment of the base with assured results, be it in web or sheet form.

It is thus an object of the invention, then, to produce an apparatus for the surface treatment of sheet or web materials to produce a uniform application of particulate material thereon.

It is a further object of the invention to produce a machine capable of providing an extremely uniform matte finish on metal plates, sheets, foils and the like in a continuous operation.

It is an additional object of the invention to produce a machine capable of forming a variable depth but highly uniform edge-to-edge matte finish on a variety of base materials, such as aluminum, plastics, stone and the like.

An additional object of the invention is to produce a machine having selectively variable performance characteristics for treating the surfaces of metal webs or sheets

in the production of printing plates, and the like, as, for example, lithographic printing plates.

Still another object of the invention is to produce a machine for abrading and thus producing a "matte" finish, on the surface of various articles such as metal webs, plates, plastic materials, stone, ceramic materials, and the like, where a highly uniform finish is desired for improving surface adherence characteristics or surface ornamentation of the material in question.

An additional object of the invention is to produce an apparatus capable of causing an unusually uniform application of particulate material to a flat surface.

These and other objects of the invention, not specifically set forth but inherent therein and readily apparent to those skilled in the art, may be attained by the present invention comprising a closed housing having shielded material entry and exit slots; means for conveying the material to be treated through said housing in a horizontal position; means disposed above the surface of the material to be treated for applying particulate material to the surface thereof, said last mentioned means comprising a source of particulate material having a discharge opening within the housing; a driven flat diffuser disc disposed within the housing to receive the particulate material discharged from said opening; a multi-bladed impeller means disposed below and coaxial with said disc; means for driving said disc and said impeller means in the same direction at different rotational speeds; ring means surrounding said impeller means and spaced from the periphery thereof, said impeller means including blades pitched and inclined relative to the horizontal plane of the impeller whereby the particulate material is swept downwardly in a swirling, generally circular motion onto and across the surface of the material to be treated.

Preferably, though not necessarily, the disc and impeller are carried in a pressurized bearing cartridge, while the impeller blades and ring are surfaced with or formed from an abrasive resistant material such as "Neoprene," or the like, and, further, means may be provided to both recover the particulate material for reuse where desirable and to clean the treated material before same passes through the exit slot in the housing.

Having thus described the invention in broad concept, the mode of operation and structure thereof will be readily apparent from consideration of the following descriptive matter and drawing referred to herein and where:

FIG. 1 is a top plan view of the apparatus, certain parts being broken away for clarity,

FIG. 2 is a side elevation of the apparatus shown in FIG. 1, again certain parts being broken away or shown in section for clarity,

FIG. 3 is a further elevational view, largely schematic, of the apparatus shown in FIG. 1, certain parts being removed or sectioned,

FIG. 4 is a sectional view through the disc-impeller cartridge bearing, shown particularly in FIGS. 1 and 2, and taken along the line 4—4 of FIG. 1, and

FIGS. 5 and 6 are front and sectional views of a blade mounted on the impeller shown in FIGS. 1, 2 and 3.

Turning first to FIGS. 1 and 2, it will be seen that the apparatus includes a closed generally box-like rectangular housing **10** including vertical columns **2**, **4**, **6** and **8** suitably laced together by top cross beams **12**, **14**, **16** and **18**. The terminal ends of beams **12** and **16** are cantilevered, as shown, slightly outwardly beyond beams **14** and **18**.

The framework defined by the columns and beams is completely closed by means of sheet metal walls **22**, **24**, **26** and **28** (FIGS. 2 and 3) and a sheet metal top **32**.

The bottom of the housing **10** is also closed by a plurality of sloping sheet metal members **34**, **36** and **38**

(FIGS. 2 and 3), same merging at their lower ends to define a hopper **20**.

As is also shown in FIG. 1, the cross beams **12** and **16** are further tied together, intermediate their ends by cross braces **44**, **46** which also serve as diffuser and impeller supports along with tie members **48** and **52**.

As mentioned, the ends of beams **12** and **16** are cantilevered outwardly and each end portion carried thereon bracket members **52**, **52'** and **54**, **54'** respectively, same being of conventional construction and in which are supported horizontal and parallel web-guide rollers **56** and **58** respectively.

Also externally mounted on the framework of housing **10**, specifically on beam **12**, are a pair of motor mounting pads **62** and **64** upon which are mounted electric motors **66** and **68**, as shown. Motors **66** and **68** include the usual mounting brackets **72**, **74** bolted to pads **62**, **64** via elongated slot and bolt connectors, both purely conventional, whereby the motors may be adjusted longitudinally, to a limited degree, of beam **12**.

Both of the motors **66** and **68** are in turn connected to a bearing cartridge **100**, to be described, via belts **76**, **76'** and **78**, **78'** whereby the motors may drive, independently, and respectively, a diffuser disc **82** and an impeller assembly **90** fixed to and suspended for rotation beneath the cartridge **100**.

It might be added that cartridge **100** is supported rigidly in cross members **44**, **46** and tie members **48** and **52** so as to be approximately centered within housing **10**.

As is obvious from an inspection of the drawings, the diffuser disc **82** is simply a flat disc having a diameter such that its circumferential edge overlies a multiple series of blades **92**, shown as twelve in number, which are, in turn, mounted on a further flat disc **91**, of smaller diameter than diffuser disc **82**.

Digressing momentarily to FIGS. 5 and 6, it will be seen that the blades **92** include mounting lugs **94** which are removably fixed to the disc **91** as by bolts **96** or the like. Each blade **92** is generally rectangular in plan form and it is important to note that each is disposed so as to define a pitch angle of approximately 25 degrees to the horizontal while also being depressed in a root to tip angle of approximately 5 degrees below the horizontal as clearly illustrated in the drawings. While the impeller assembly disclosed includes 12 blades **92** disposed in equal spaced apart angular positions on impeller disc **91**, a greater or lesser number of blades may be used depending on the results desired and the fineness of the particulate material applied to the surface to be treated. For forming material, usually aluminum, into a base for lithographic printing plates, a very excellent "matte" finish is produced on aluminum by the use of twelve blades at a rotational speed of about 800 to 1000 r.p.m. of the impeller assembly **90** with the diffuser disc **82** rotating in the same direction as the impeller assembly, but, only at about 40 r.p.m. Different materials, however, even different grades of aluminum may require different rotational speeds of diffuser disc **82** and impeller assembly **90**, hence the former is designed to be driven at speeds from 25 to 60 r.p.m., while the impeller may be driven at from 700 to 1500 r.p.m., as may be desired, to produce given results on a particular article being processed.

As shown in FIGS. 1 and 2, the outer periphery of the impeller assembly **90** is surrounded by a ring member, hereinafter called a blast ring, **98**, same being supported on channel members **102**, **104** extending across the housing **10**. Blast ring **98** may be formed of especially hardened, abrasive resistant steel, the same material being used in the fabrication of impeller blades **92**. However, a readily available substitute material is common, heavy gage sheet steel, same being provided with an abrasion resistant coating such as "Neoprene" rubber, a commercial product sold on the open market for applications where abrasion resistance is essential.

As is self-evident, the interior of housing **10** is continuously filled with particulate material, be it abrasive or whatever, when the apparatus is in operation. Thus, having in mind that the impeller assembly **90** and the diffuser disc **82** must be driven by means within the housing, it becomes apparent that it is most desirable to prevent the particulate material from causing excessive wear on bearings which carry these instrumentalities. Also, it is desirable to provide the most simple means of driving the impeller assembly **90** and diffuser disc **82** which must be coaxial and in relatively close vertical relation. This means comprises the bearing cartridge illustrated in FIG. 4.

As shown in FIG. 4, the bearing cartridge is comprised of a cylindrical support shell **110** having annular, high pressure fluid seals **112**, **114** disposed at either terminal end thereof. Immediately behind the seals **112**, **114** are annular bearings **116**, **118** of the anti-friction type, said bearing **118** being press fit within shell **110** while bearing **116**, of the roller, thrust-bearing type is retained in place by a bearing retainer **134** bolted or otherwise removably fixed to the lower end of shell **110**.

Riding within the shell **110**, supported on and retained in place by bearings **116**, **118** is a drive shell **132** also of hollow, cylindrical form. The upper and lower ends of the drive shell **132** project outwardly above and below the ends of support shell **110**; the upper end having fixed thereto, as by bolts **138** and spacer **142**, a pair of drive pulleys **144**, **144'** which, when driven, rotate the drive shell **132** within the support shell **110**. As evident in FIG. 2, the drive shell **132** has affixed to its lower end, by any suitable means, the diffuser disc **82** which it both supports and drives.

Drive shell **132**, as stated, is also a hollow cylinder. Therefore further high pressure, fluid seals **122**, **124** may be and are carried interiorly of this element; bearing **128** being a roller-thrust bearing engaging an annular land **146** formed on a drive shaft **148** extending interiorly of and through drive shell **132**.

As clearly shown in FIG. 4, the opposite ends of shaft **148** extend above and below drive shell **132** in which it is rotatably supported. The top of this shaft is provided with pulleys **152**, **152'** suitably fixed in place by bolts **154** and spacer **156**. The lower end of shaft **148**, in turn, carries a flat disc **91** comprising a part of impeller assembly **90** to which the blades **92** are fastened as per FIG. 5.

As seen in FIGS. 1 and 2, belts **76**, **76'** and **78**, **78'** are trained over pulleys **144**, **144'** and **152**, **152'** respectively so that electric motors **66** and **68** may drive diffuser disc **82** and impeller assembly **90** at different rotational speeds, as may prove desirable.

It will be noted that chambers are formed between support shell **110** and drive shell **132** and drive shell **132** and shaft **148**. It will also be noted that support shell **110** is provided with parts PI and PE, while drive shell **132** is provided with parts A and B. Thus the entire interior of the bearing cartridge can be pressurized by oil under pressure passing therethrough by a pump P, driven by motor M and supplied with oil from reservoir R. The reservoir R also receives the oil flow from port PE as is schematically shown in FIG. 4.

The web or sheet material W to be abraded or otherwise treated with particulate material is passed through housing **10** immediately below and in close proximity to impeller assembly **90** and blast ring **98** as clearly shown in FIG. 2. In order to permit entry of the material W into housing **10** and also it's egress therefrom, the sheet metal walls **22** and **24** are provided with suitable openings, **172**, **174**, in this case, in the form of elongated slots. The peripheral edges of these openings are provided with coplannar, vertically spaced flexible seal members **176**, **178**, **182**, **184**, respectively. Preferably these members are of a non-marring material such as reinforced rubber or the like so that the article or web to be treated will not be scratched if it should contact the upper and lower peripheral edges thereof during movement through the apparatus.

Disposed inwardly of each of the seals **178** and **184** are baffle members **186, 188** respectively, quite similar in substance and shape to those which characterize seals **178, 184**. These baffle elements **186, 188** are disposed close to the top surface of the material to be treated and, with seals **178, 184**, form what may be defined as trap chambers to prevent the escape of the particulate material from the interior of housing **10**.

For the purpose of guiding the base material through the openings **172, 174**; in the described embodiment, same comprising a contniuous web, a pair of rollers **192, 198** are mounted via brackets **196, 198'** on columns **2** and **8** and **4** and **6**, respectively. These rollers are rotatable about horizontal axes and are so positioned that the periphery thereof is located relative to openings **172, 174** so as to guide the web W therethrough.

As thus described, the apparatus is capable of performing the objects set forth herein above. However, for the purpose of showing a complete apparatus, such as would be efficiently and completely installed in a commercial establishment, consideration will now be given to FIG. 3, which is, as has been stated, largely in schematic form, much of the structure having been previously described.

As seen in FIG. 3, the opening **42** in the hopper-like bottom of housing **10** provides access from the bottom, beneath metal wall **26** to a vertically extending duct **202** which has its upper end disposed substantially above the vertical extent of housing **10**. Both the lower and upper ends of duct **202** are closed by curved housings **204**, and **206**; the lower housing **204** being in communication with the hopper-like bottom of housing **10**.

The upper housing **206** provides a passage placing the upper end of duct **202** in sealed communication with a hopper **208** of conventional sheet metal construction.

Disposed within duct **202** and supported by and on a frame assembly, not shown, is an endless bucket conveyor **210**. Conveyor **210** is comprised of upper and lower sprockets **214, 212** over which is trained an endless belt **216** of rubber, canvas or the ilke.

Affixed to the belt **216** by any suitable means, such as rivets, bolts or the like, are a plurality of buckets **218**. These buckets, readily fabricated of sheet metal are comprised of a back wall **222** affixed to belt **216** and an outwardly sloped front wall **224**.

The conveyor is driven from an electric motor **220** which may be directly and mechanically connected to sprocket **212**. Thus, as the buckets **218** are moved downwardly, they will scoop up material which accumulates in the hopper-like bottom of housing **10** and convey same upwardly in duct **202**. The speed of the conveyor is so regulated that as the buckets approach the top of duct **202** and change direction over sprocket **214** the material contained therein will be caused to be discharged by a combination of gravitational and directional forces so to be slung out of the buckets, due to the sloping wall **224**, and against the housing **206** which directs it into the aforesaid hopper **208**. While other and more elaborate conveying arrangements are perfectly feasible, it has been found that the described system is adaquate for the intended purpose.

As also clearly shown in FIG. 3, the hopper **208** discharges the particulate material, by gravity, down a supply tube **212** having an opening directly above the diffuser disc **82** and located as near as possible to the center of the diffuser disc **82**. Thus the particulate material is continually circulated through the apparatus.

For the purpose of removing fines and dust created within housing **10** as some of the particulate material is broken down by continued reuse, the upper end of the housing may be provided with an opening in wall **26**, at **224**, in communication with a duct **226** which leads to a conventional exhaust fan, not shown, fines are sucked out of housing **10** through this duct.

In the drawings, the apparatus is shown as it might be applied to an abrading process for base material used in

the manufacture of printing plates. In this case the material, aluminum, is in web form and is to be treated for a two-side, matte finish. The web W is fed from a conventional unwind stand, not shown, over the top of housing **10**, guided by rollers **58** and **56**; down the vertical side **24** over roller **192**, then through entry slot **174** beneath the impeller assembly **90**. The web then passes beneath baffle **188** and before it leaves the housing is exposed to a cleaning apparatus **230**, which may either blow or vacuum the web free of residue. Thereafter, it passes out of exit slot **172** over roller **194** and vertically downwardly to a second roller **232** mounted on bracket **234**.

As is shown a second applicator unit is positioned in housing **10** directly beneath the unit previously described. Since the two-diffuser, and impeller-units are identical and driven in precisely the same manner, the lower unit need not be described in detail, identical parts being identified by three hundred series reference numerals, having the last two digits corresponding to the last two digits of the previously used reference numerals.

After passage beneath impeller assembly **390**, the web passes out slot **388**, but is again cleaned by a suitable pressure or suction nozzle **342** spaced behind baffle **338**. After exit from the housing the web is vacuumed at vacuum means **391** and passes into a wash chamber **400** where jets of water emitted from sprays **396** complete the cleaning operation.

If one side treatment, only, is desired the web can be passed beneath the upper unit **90** or directly beneath lower unit **390**, depending on which side is to be treated. In this case, roll **232** is mounted below slot **372** as shown in phantom in FIG. 2 or roll **192** may be moved below slot **72** in a similar manner depending on which unit is utilized.

If sheet material is to be treated suitable conveyor means may be trained through housing **10** to carry the sheets beneath the treating units.

The operation of the apparatus, insofar as application of particulate material is concerned is as follows: The particulate material, be it sand or Carborundum or the equivalent, is discharged downwardly from hopper **208** through regulating valve **209**, shown as a simple manually operated gate valve, through feed tube and down to the center of the rotating diffuser disc **82**. This disc, rotating at a relatively slow r.p.m. gradually spins the abrasive material outwardly in a completely uniform pattern. Eventually centrifugal force causes the abrasive to drop over the peripheral edge of the diffuser at a constant rate and uniformly about the full 360° circumference.

This uniform discharge of abrasive falls directly into blades **92** of impeller assembly **90** where the pitch angle of the blades directs it downwardly and inwardly in a swirling, circular motion across the surface of the web W. The blast ring **98** acts to prevent circumferential spin-off of abrasive from the tips of blades **92**, assuring that all of the abrasive and the energy imported thereto, both downwardly and circularly, is dissipated by the action of the particles against the surface of the web. In addition, because the blades **92** do not extend inwardly to the center of the impeller hub, but are evenly spaced above the periphery of disc **91**, no Venturi effect is created tending to suck up the particles. Instead the particles impact and sweep across the surface producing an exceptionally uniform pitted surface or matte finish from one edge to the other of the web.

Having thus described the invention in detail, it will be apparent that various uses for and modifications thereof will occur to those skilled in the art, same being within the spirit and scope of the concepts which are limited as defined hereinafter.

What is claimed is:

1. An apparatus for applying particulate material to the surface of material to be provided with a matte finish comprising a housing means; a source of particulate material

discharging within the housing means, diffuser means comprising a flat, rotating disc disposed below said source; impeller means disposed below and co-axial with said diffuser means, said impeller means including a central disc-like support and a plurality of angularly spaced blades positioned around the circumferential edge of said support and immediately below the circumferential edge of said diffuser means; a blast ring surrounding the impeller means, said blades being provided with a pitch angle and inclined downwardly relative to a horizontal plane passing through said diffuser means and co-operating with said blast ring to direct flow of the particulate material dropping from the edge of said diffuser means downwardly in a swirling motion onto the treatment surface of the material; means for rotating said diffuser means and said impeller means at different rotational speeds and means for moving the material to be treated beneath and generally parallel to the plane of said impeller means.

2. An apparatus as defined in claim **1**, wherein the pitch angle of said blades is approximately 25° and the angle of downward inclination, root to tip, is 5° below the horizontal.

3. An apparatus as defined in claim **1** including means for recovering particulate material swept over the surface being treated and returning same to the source for reuse.

4. An apparatus as defined in claim **1**, wherein the central disc-like support of said impeller means has a diameter less than that of said diffuser disc; said blades being removably fixed to said central disc-like support and of a length comprising substantially less than one-half of the total overall diameter of said impeller means.

5. An apparatus as defined in claim **1**, wherein said impeller means and said blast ring are comprised of wear resistant material and said particulate material is an abrasive.

6. An apparatus as defined in claim **1**, wherein said housing means is provided with entrance and exit apertures for the material to be treated and said apertures are provided with flexible baffles at least one of which is spaced inwardly of the housing defining therewith a trap chamber between the interior of the housing and the aperture with which it is associated.

7. In a sheet metal abrading apparatus for producing a matte finish on the surface of the metal a rotating disc; a rotating impeller means disposed beneath and co-axial with said disc; ring means surrounding the impeller means, said impeller means comprising a further disc having a diameter less than that of said first mentioned disc, blades mounted thereon in angularly spaced relationship about the periphery thereof, said blades being inclined downwardly from and twisted relative to the plane of the further disc and common means including co-axial driven means rotating in a sealed, fluid filled pressurized bearing cartridge for supporting said rotating disc and said rotating impeller means.

8. In a sheet metal abrading apparatus as defined in claim **7**, said cartridge comprising a first stationary cylindrical shell; a second cylindrical shell rotatable within and supported by said stationary shell, a shaft rotatably journaled within and carried by said second mentioned cylindrical shell, apertured chambers formed between said first and said second shells and said second shell and said shaft, bearing means within each of said chambers and seal means closing said chambers to the atmosphere and means for supplying oil under pressure to said chambers, said second cylindrical shell carrying the first rotating disc, said shaft carrying the impeller means.

9. An apparatus as defined in claim **8**, including means for driving said shaft and said second mentioned, rotatable shell at different angular velocities.

10. An apparatus as defined in claim **8**, including further means for supplying abrasive material to the upper surface of said first mentioned disc at the center thereof.

11. An apparatus as defined in claim **7** wherein said impeller means and said ring means are fabricated of abrasive resistant materials.

References Cited

UNITED STATES PATENTS

469,642	2/1892	Nehr	51—9
1,876,688	9/1932	Kasser	51—14
2,204,636	6/1940	Turnbull	51—14 X
2,765,588	10/1956	Puhr-Westerheide	51—9
3,217,447	11/1965	Canole	51—14 X

LESTER M. SWINGLE, *Primary Examiner.*