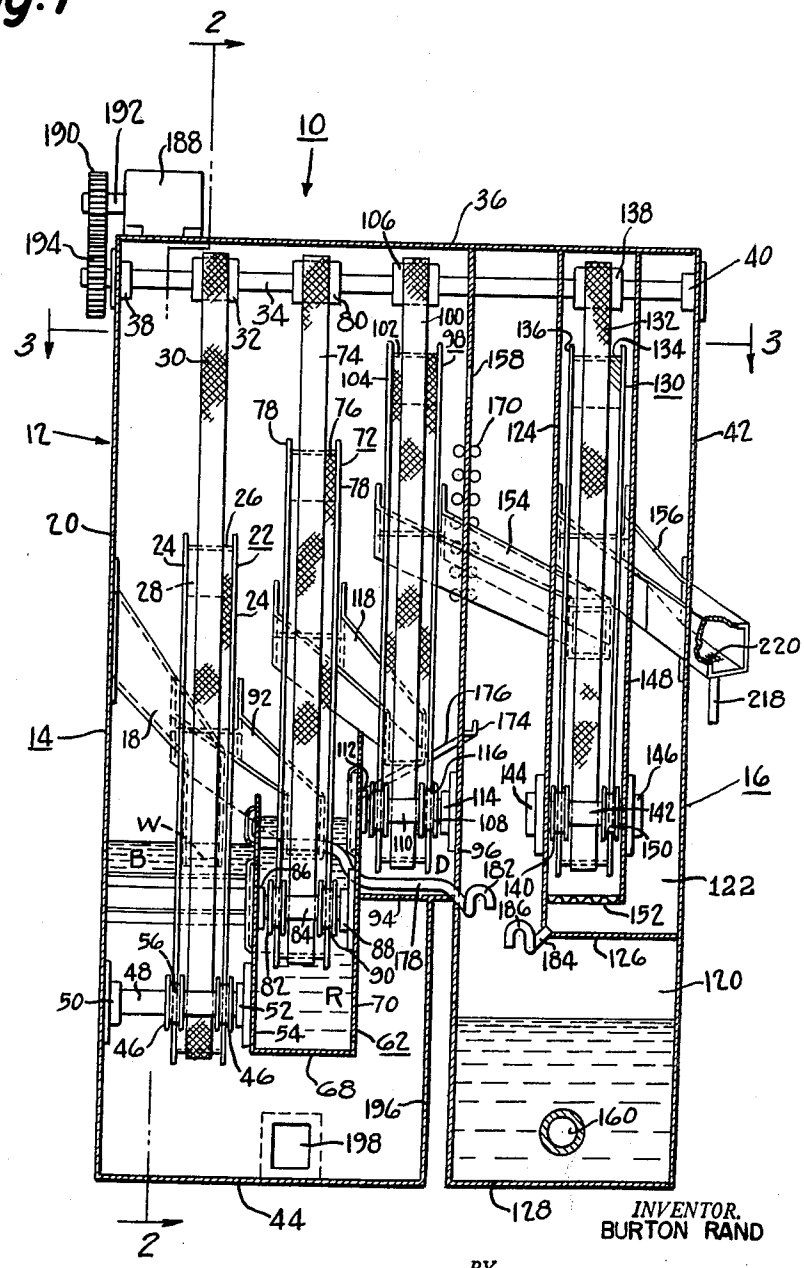
Feb. 26, 1963 B. RAND 3,078,860

CLEANING APPARATUS WITH CLOSED AIR CIRCULATION SYSTEM

Filed March 7, 1961 3 Sheets-Sheet 1

Fig. 1



INVENTOR.
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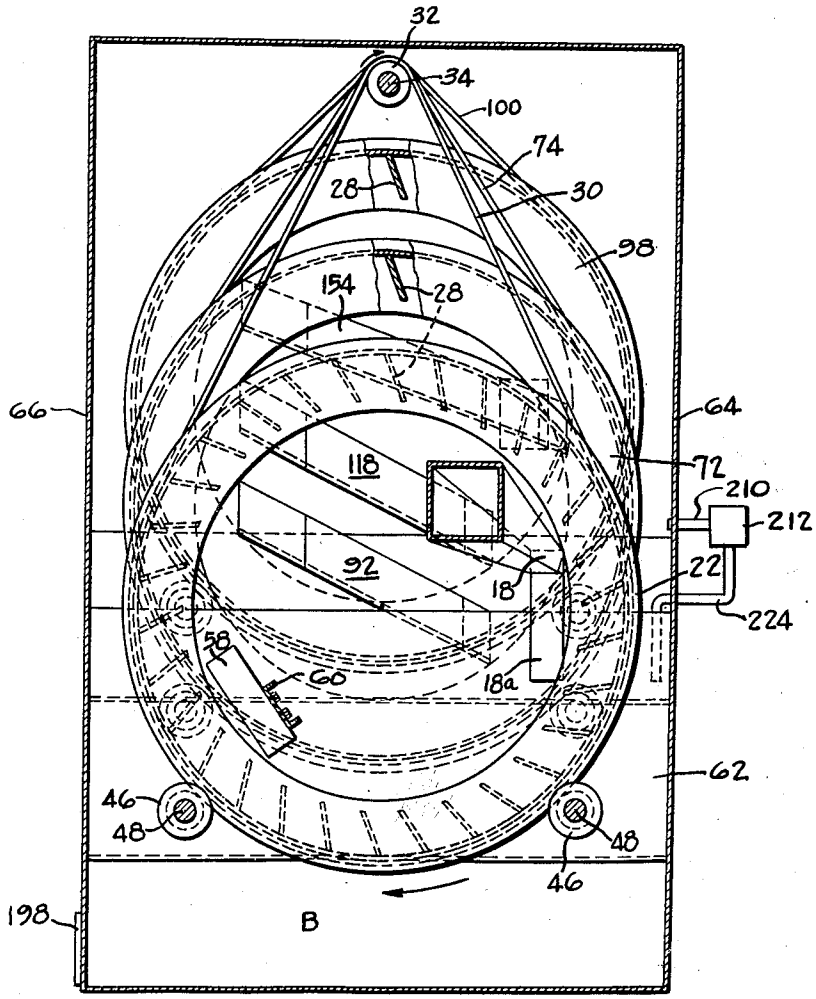
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CLEANING APPARATUS WITH CLOSED AIR CIRCULATION SYSTEM

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Fig. 2



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Fig. 3

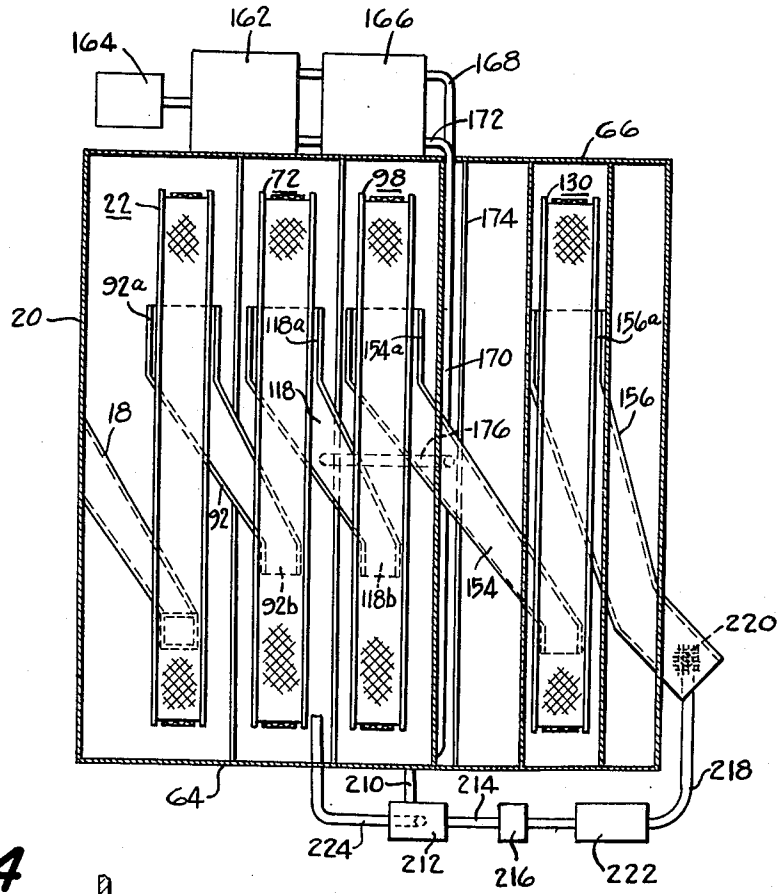
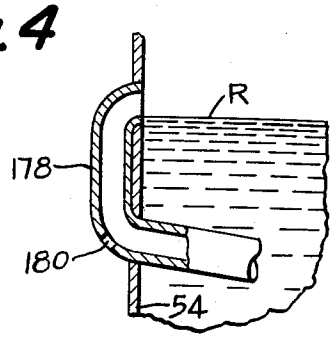


Fig. 4



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United States Patent Office

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3,078,860

CLEANING APPARATUS WITH CLOSED AIR CIRCULATION SYSTEM

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Filed Mar. 7, 1961, Ser. No. 93,890
6 Claims. (Cl. 134—69)

The present invention relates to cleaning apparatus, and more particularly to a closed air circulation system in a cleaning apparatus for removing grease and hydrocarbon deposits plus associated dirt or soil from machine parts by treatment with solvents such as florinated hydrocarbons, chlorinated hydrocrarbons, such as trichlorethylene or the like.

This application is a continuation-in-part of my copending application Serial No. 827,321 filed July 15, 1959, now Patent No. 3,011,500, and entitled Cleaning Apparatus.

The satisfactory and rapid cleaning of small machined parts, as for example small machined parts which have been buffed, lapped, ground, or the like presents a most difficult problem. Experience has shown that notwithstanding repeated submergence in solvents effected by conventional cleaning equipment, an appreciable amount of contaminate in the nature of adhering dirt or the like remains with the machined parts, particularly in the hollows of interstices thereof. This, of course, is most undesirable, since the presence of contaminate adversely affects the machined parts. In particular, if such machined parts are utilized where close tolerances are required, the presence of adhering contaminate constitutes a most serious problem.

Heretofore, such small machined parts have been generally cleaned by a batch process. That is, the machined parts are discharged from the processing machine into a container. When the container is filled, it is manually carried to a centrally located cleaning machine. This batch method of cleaning small machined parts not only requires additional handling of the machined parts, but is also time consuming. Therefore, it would be most desirable to have a cleaning apparatus which would receive the machined parts directly from the processing machine, and will continuously clean the machined parts.

The apparatus set forth in said copending application has performed very satisfactorily. I have discovered that apparatus of this type is not capable of being used in areas where it is desired to have a controlled atmosphere, areas of an explosive nature, etc. I have found that some vaporized solvent escapes through the outlet of the apparatus to the surrounding atmosphere. This results in a depletion of the solvent and is objectionable where the apparatus is used continuously for a substantial period of time.

The present invention improves the apparatus set forth in said copending application by providing a closed air circulation system which prevents vaporized solvent from escaping from the outlet of the apparatus.

It is an object of the present invention to provide a novel cleaning apparatus.

It is another object of the present invention to provide a cleaning apparatus which is capable of achieving a high degree of cleaning at a high cleaning rate with small machined parts.

It is still another object of the present invention to provide a light, easily transportable cleaning apparatus of high efficiency for small machined parts, and yet of relatively low cost to manufacture.

It is a further object of the present invention to provide a cleaning apparatus for small machined parts which can receive the machined parts directly from a processing machine, and will continuously clean the machined parts.

It is still a further object of the present invention to prevent the escape of vaporized solvent by use of a closed air circulation system.

Other objects will appear hereinafter.

For the purpose of illustrating the invention there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Referring to the drawings wherein like reference characters refer to like parts:

FIGURE 1 is a sectional view, partly in elevation, of the cleaning apparatus of the present invention.

FIGURE 2 is a sectional view taken along the lines 2—2 of FIGURE 1.

FIGURE 3 is a sectional view taken along the lines 3—3 of FIGURE 1.

FIGURE 4 is a sectional view of the overflow tube of the cleaning apparatus of the present invention.

The cleaning apparatus of the present invention is generally designated as **10**. Cleaning apparatus **10** comprises an upright housing **12** which includes a cleaning section **14**, and a solvent distillation section **16**.

Referring initially to the cleaning section **14**, the inlet **18** for the cleaning section **14** comprises a chute into which the machined parts having adhering contaminate are fed, such machined parts decending through such inlet **18** by gravity.

The inlet chute **18** passes through the wall **20** of housing **12**. Within the cleaning section **14**, the inlet chute **18** extends downwardly and angularly away from the wall **20** to a point within and adjacent to the inner periphery of the conveyor wheel **22**. The end portion **18***a* of the inlet chute **18** extends substantially vertically downwardly through the main bath of chlorinated hydrocarbon (designated B) to the inner periphery of the conveyor wheel **22**. A layer of water (designated W) is superposed above the portion of the main bath B within the end portion **18***a* of the inlet chute **18**. The layer of water W provides a water seal and reduces the loss of volatile chlorinated hydrocarbon from the main bath B.

The conveyor wheel **22** comprises a pair of flat, annular side walls **24** connected together in spaced, parallel relation by a cylindrical outer wall **26**. The outer diameter of the cylindrical outer wall **26** is slightly less than the outer diameters of the side walls **24** so that the outer wall **26** is spaced radially inwardly from the outer edges of the side walls **24**. A plurality of circumferentially spaced baffles **28** are secured between the side walls **24** within the outer wall **26** (see FIGURE 2). Baffles **28** extend inwardly from the outer wall **26** at an angle to the radius of the conveyor wheel **22** in the direction of rotation of the conveyor wheel **22**. Thus, upon rotation of the conveyor wheel **22**, as the baffles **28** reach the outlet end of the inlet chute **18**, the baffles **28** are at an angle to catch the machined parts dropping from the chute **18** and direct the machined parts outwardly to the outer wall **26**. The outer wall **26** is preferably formed of wire mesh. The side walls **24** may be also formed of wire mesh or of sheet metal.

Conveyor wheel **22** is supported in an upright position for rotation about a horizontal axis by an endless belt **30** which extends around the outer surface of the outer wall **26** between the side walls **24**. Endless belt **30** extends upwardly from the conveyor wheel **22**, and passes over a pulley **32** mounted on a shaft **34**. Shaft **34** extends across the housing **12** adjacent the top wall **36** of the housing **12**, and is rotatably supported in bearings **38** and **40** mounted on the walls **20** and **42** respectively of the housing **12**. Thus, the conveyor wheel **22** is supported from the shaft **34** by the endless belt **30**.

Endless belt 30 is of a length so that slightly less than one-half of the conveyor wheel 22 is immersed in the main bath B. The main bath B extends down to the basal floor 44 of the cleaning section 14 of housing 12, the entire bottom of the cleaning section 14 being occupied by the bath B for maximum solvent inventory.

The conveyor wheel 22 is seated on two pairs of guide rollers 46. Each pair of guide rollers 46 is mounted on a shaft 48. Each shaft 48 is rotatably supported in bearings 50 and 52 which are mounted on the wall 20 and wall 54 respectively. Each of the rollers 46 has an annular groove 56 in its outer periphery in which the outer peripheral edge of a side wall 24 of the conveyor wheel 22 is guided. Thus, the rollers 46 guide the conveyor wheel 22 during the rotation of the conveyor wheel 22, and prevent axial movement of the conveyor wheel 22.

As shown in FIGURE 2, means for introducing vibration of ultrasonic frequency, designated 58, is disposed within the main bath B and adjacent the conveyor wheel 22. The vibration inducing means 58 is mounted on a channel bracket 60 which is secured between the wall 20 and the wall 54. Such means 58 may comprise piezoceramic transducers of conventional construction. For example, such piezoceramic transducers may be molded or otherwise fashioned from ceramic material, such as barium titanate or the like, having piezoelectric properties. Such piezoelectric transducers are preferably provided with silver coatings in the form of electrodes. As illustrative of suitable piezoceramic transducers may be mentioned transducers of the type disclosed in Kearney Patent 2,802,476 issued August 13, 1957. However, it is to be understood that in place of the piezoceramic transducers above-mentioned, other means for generating or inducing high frequency ultrasonic vibrations with the bath, whose construction is well known to those skilled in the art, may be used for the means designated 58.

A U-shaped trough 62 is secured between the walls 64 and 66 of the housing 12. The trough 62 extends parallel to the conveyor wheel 22, and is positioned between the conveyor wheel 22 and the solvent distillation section 16 of the housing 12. The trough 62 comprises a floor 68, which is spaced above the floor 44 of the cleaning section 14 of the housing 12, the upright wall 54, and and upright wall 70. The upright walls 54 and 70 of the trough 62 extend vertically above the level of the main bath B, and the upright wall 70 is higher than the upright wall 54. The trough 62 contains the rinse bath R which comprises the identical chlorinated hydrocarbon solvent used in the main bath B. However, the chlorinated hydrocarbon solvent within rinse bath R is appreciably cleaner than the chlorinated hydrocarbon solvent which forms the main bath B.

A conveyor wheel 72 is supported within the trough 62 for rotation about a horizontal axis by an endless belt 74. Conveyor wheel 72 is identical in construction to the conveyor wheel 22. Endless belt 74 extends around the outer surface of the outer wall 76 of the conveyor wheel 72 between the side walls 78 of the conveyor wheel 72. Endless belt 74 extends upwardly from the conveyor wheel 72, and extends around a pulley 80 mounted on the shaft 34. Thus, the conveyor wheel 72 is supported from the shaft 34 by the endless belt 74 for rotation simultaneously with the conveyor wheel 22. Endless belt 74 is of a length so that less than half of the conveyor wheel 72 is immersed in the rinse bath R. Since, as shown in FIGURE 1, the liquid level of the rinse bath R is higher than the liquid level of the main bath B, the axis of rotation of the conveyor wheel 72 is vertically higher than the axis of rotation of the conveyor wheel 22.

Conveyor wheel 72 is seated on two pairs of guide rollers 82. Each pair of the guide rollers 82 are mounted on a shaft 84. Each of the shafts 84 is rotatably supported in bearings 86 and 88 which are mounted on the walls 54 and 70 respectively of the trough 62. Each of the rollers 82 has an annular groove 90 in its outer periphery in which the outer peripheral edge of a side wall 78 of the conveyor wheel 72 is guided. Thus, the guide rollers 82 guide the conveyor wheel 72 during the rotation of the conveyor wheel 72, and prevent axial movement of the conveyor wheel 72.

A transfer chute 92 extends downwardly from the inner periphery of the conveyor wheel 22 to the inner periphery of the conveyor wheel 72 to transfer the cleaned machined parts from the conveyor wheel 22 to the conveyor wheel 72. The inlet end 92*a* of the transfer chute 92 is positioned adjacent the inner periphery of the conveyor wheel 22 at a point substantially diametrically opposite to the outlet end of the inlet chute 18. Thus, as shown in FIGURE 2, upon the rotation of the conveyor wheel 22, as the baffles 28 of the conveyor wheel 22 reach the inlet end 92*a* of the transfer chute 92, the baffles 28 are angled downwardly to permit the machined parts to fall from the conveyor wheel 22 onto the transfer chute 92. The outlet end 92*b* of the transfer chute 92 is positioned adjacent the inner periphery of the conveyor wheel 72 at a point corresponding to the position of the outlet end of the inlet chute 18 with respect to the conveyor wheel 22. Thus, upon the rotation of the conveyor wheel 72, as the baffles, not shown, of the conveyor wheel 72 reach the outlet end 92*b* of the transfer chute 92, the baffles of the conveyor wheel 72 are angled upwardly to catch the machined parts descending the transfer chute 92, and guide the machined parts to the outer wall 76 of the conveyor wheel 72.

A floor 94 extends horizontally between the walls 64 and 66 of the housing 12, and between the wall 70 of the trough 62 and the wall 96. Floor 94 is spaced vertically above the floor 68 of the trough 62. The trough formed by the wall 70, floor 94, and wall 96 forms a drying chamber, designated as D.

A conveyor wheel 98 is supported in the drying chamber D for rotation about a horizontal axis by an endless belt 100. Conveyor wheel 98 is of a construction identical to the conveyor wheels 22 and 72. Endless belt 100 extends around the outer surface of the outer wall 102 of the conveyor wheel 98 between the side walls 104 of the conveyor wheel 98. The endless belt 100 extends upwardly from the conveyor wheel 98, and extends around a pulley 106 mounted on the shaft 34. Thus, the conveyor wheel 98 is supported from the shaft 34 by the endless belt 100 for rotation simultaneously with the conveyor wheels 22 and 72. The axis of rotation of the conveyor wheel 98 is vertically higher than the axis of rotation of the conveyor wheel 72.

Conveyor wheel 98 is seated on two pairs of guide rollers 108. Each pair of the guide rollers 108 is mounted on a shaft 110. Each of the shaft 110 is rotatably supported in bearings 112 and 114 which are mounted on the walls 70 and 96 respectively. Each of the guide rollers 108 has an annular groove 116 in its outer periphery in which the outer peripheral edge of a side wall 104 of the conveyor wheel 98 is guided. Thus, the guide rollers 108 guide the conveyor wheel 98 during the rotation of the conveyor wheel 98, and prevent axial movement of the conveyor wheel 98.

A transfer chute 118 extends downwardly from the inner periphery of the conveyor wheel 72 to the inner periphery of the conveyor wheel 98. The inlet end 118*a* of the transfer chute 118 is positioned adjacent the inner periphery of the conveyor wheel 72 at a point diametrically opposite to the outlet end 92*b* of the transfer chute 92. Thus, the inlet end 118*a* of the transfer chute 118 is in a position to receive the machined parts discharged from the conveyor wheel 72. The outlet end 118*b* of the transfer chute 118 is positioned adjacent the inner periphery of the conveyor wheel 98 at a point corresponding to the position of the outlet end of inlet chute 18 with respect to the conveyor wheel 22. Thus, the outlet end 118*b* of the transfer chute 118 is in

a position to discharge the machined parts descending through the transfer chute 118 onto the baffles, not shown, of the conveyor wheel 98.

The solvent distillation section 16 of the housing 12 comprises a vapor generator chamber 120, and a second drying chamber 122.

The second drying chamber 122 is formed intermediate the walls 42 and 124, the floor 126 and the top wall 36 of the housing 12. The wall 124 of the drying chamber 122 is spaced from the wall 96 of the solvent distillation section 16, and the floor 126 of the drying chamber 122 is spaced above the basal floor 128 of the solvent distillation section 16. A conveyor wheel 130 is supported within the second drying chamber 122 for rotation about a horizontal axis by an endless belt 132. Conveyor wheel 130 is of a construction identical to the conveyor wheels 22, 72, and 98. Endless belt 132 extends around the outer surface of the outer wall 134 of the conveyor wheel 130 between the side walls 136 of the conveyor wheel 130. Endless belt 132 extends upwardly from the conveyor wheel 130, and extends around a pulley 138 mounted on the shaft 34. Thus, the conveyor wheel 130 is supported from the shaft 34 by the endless belt 132 for rotation simultaneously with the conveyor wheels 22, 72, and 98.

The conveyor wheel 130 is seated on two pairs of guide rollers 140. Each pair of the guide rollers 140 is mounted on a shaft 142. Each of the shafts 142 is rotatably supported in bearings 144 and 146 which are mounted on the wall 124 and a wall 148 respectively. Each of the guide rollers 140 has an annular groove 150 in its outer periphery in which the outer peripheral edge of a side wall 136 of the conveyor wheel 130 is guided. Thus, the guide rollers 140 guide the conveyor wheel 130 during the rotation of the conveyor wheel 130, and prevent axial movement of the conveyor wheel 130. A wire mesh screen 152 is secured between the wall 124 and the wall 148 beneath the conveyor wheel 130.

A transfer chute 154 extends downwardly from the inner periphery of the conveyor wheel 98 through the vapor generator chamber 120 to the inner periphery of the conveyor wheel 130. The inlet end 154*a* of the transfer chute 154 is positioned adjacent the inner periphery of the conveyor wheel 98 diametrically opposite the outlet end 118*b* of the transfer chute 118. Thus, the inlet end 154*a* of the transfer chute 154 is positioned to receive the machined parts discharged from the conveyor wheel 98. The outlet end 154*b* of the transfer chute 154 is positioned adjacent the inner periphery of the conveyor wheel 130 at a point corresponding to the conveyor wheel 22. Thus, the outlet end 154*b* of the transfer chute 154 is positioned to distransfer chute 154 onto the baffles, not shown, of the conveyor wheel 130.

An outlet chute 156 for the cleaning apparatus 10 extends downwardly from the inner periphery of the conveyor wheel 130 through the wall 148 and wall 42 of the housing 12. The inlet end 156*a* of the outlet chute 156 is positioned adjacent the inner periphery of the conveyor wheel 130 diametrically opposite the outlet end 154*b* of the transfer chute 154. Thus, the inlet end 156*a* of the outlet chute 156 is positioned to receive the machined parts discharged from the conveyor wheel 130.

The vapor generator chamber 120 is formed intermediate the walls 96, 124, and 42, the floors 128 and 126, and the top wall 36 of the housing 12. A pressure relief port 158 extends intermediate the vapor generating chamber 120 and the cleaning section 14 through the upper portion of the wall 96. Heater means 160 is provided at the bottom of the vapor generator chamber 120. Such heater means 160 comprises conventional means for disseminating heat, and serves to heat the liquid inventory of the vapor generator chamber 120.

Refrigeration means comprising a standard coolant gas compressor 162, a motor 164 for operating the compressor 162, and an evaporator 166 is mounted on the wall 66 of the casing 12. A wide variety of refrigeration means may be utilized including those which deliver aqueous brine coolant, and those which deliver coolant gases. Alternatively, cold tap water may be used for refrigeration draining to a sewer.

The refrigerant fluid from the evaporator 166 is passed therefrom through duct 168 into the coil 170 which extends along opposite sides of the wall 96. The coil 170 serves to cool the wall 96, whereby such wall 96 serves as a condenser onto which volatized liquid may be condensed. In addition, the cool wall 96 serves to cool the drying chamber portion of the cleaning apparatus 10 which is adjacent the wall 96. The return end of the coil 170 is connected to the condenser 162 through a duct 172.

A condensate collecting trough 174 extends along the side of the wall 96 within the vapor generator chamber 120 beneath the cooling coil 170. The condensate collecting trough 174 is tilted to provide a low point. A duct 176 extends downwardly from the low point of the condensate collecting trough 174 across the drying chamber D, through the wall 70 of the rinse trough 62, and into the rinse bath R.

The level of liquid within the rinse bath R in the rinse trough 62 is controlled by an overflow pipe 178, which also controls the pipe of the main bath B. As shown in FIGURES 1 and 4, the inlet end of the overflow pipe 178 extends through the wall 54 of the rinse trough 62 at the level of the liquid of the rinse bath R. The overflow pipe 178 extends downwardly along the outer side of the wall 54 to the level of the liquid of the main bath B. At the point of the level of the liquid of the main bath B, the overflow pipe 178 has an aperture 180 therethrough by which the level of the main bath B is controlled. The overflow pipe 178 then extends back through the wall 54, and downwardly across the rinse trough 62, across the bottom of the drying chamber D, and through the wall 96 into the vapor generator chamber 120. The outlet end of the overflow pipe 178, which is within the vapor generator chamber 120, is provided with a U-shaped trap 182 to prevent the vapors within the vapor generator chamber 120 from passing up through the overflow pipe 178.

A drain pipe 184 extends downwardly from the bottom of the second drying chamber 122 into the vapor generator chamber 120. Drain pipe 184 is provided with a U-shaped trap 186 to prevent the vapors in the vapor generator chamber 120 from passing through the drain pipe 184 into the drying chamber 122. A similar drain pipe, not shown, is provided from the bottom of the drying chamber D into the vapor generator chamber 120.

The shaft 34 is driven by an electric motor 188 mounted on the top wall 36 of the housing 12. A gear 190 mounted on the motor shaft 192, meshes with a gear 194 mounted on the shaft 34 to drivingly connect the motor 188 to the shaft 34.

The cleaning section 14 of the housing 12 includes a vertical wall 196 extending between the floor 44 and the floor 94 of the drying chamber D. The wall 196 is spaced from the wall 96, and forms one wall of the reservoir for the main bath B. The air space between the wall 196 and the wall 96 thermally insulates the main bath B from the vapor generator chamber 120 whereby flashing of the chlorinated hydrocarbon solvent is prevented.

As shown more clearly in FIGURE 3, a condenser 212 is connected to the drying chamber D by a conduit 210. Condenser 212 is commercially available and per se forms no part of the present invention. A fan 216 is connected to an outlet of the condenser by a conduit 214. A conduit 218 extends from the outlet side of the fan 216 to a screen 220 on the bottom wall of the outlet chute 156. A heater 222 surrounds a portion of the conduit 218. A conduit 224 extends from a drain outlet on the condenser 212 through the wall 64 into the rinse bath R.

The operation of the cleaning apparatus 10 of the present invention is as follows:

The electric motor 188 is turned on to rotate the shaft 34, and thereby rotate the conveyor wheels 22, 72, 98, and 130. Machined parts bearing an adhering contaminant are introduced into the cleaning apparatus 10 through the inlet chute 18. The machined parts descend the inlet chute 18 to the conveyor wheel 22. During the descent the machined parts pass through the water seal W, which is the water level on top of the main bath B of chlorinated hydrocarbon solvent within the inlet chute 18, and which water seal serves to prevent the volatilization of the chlorinated hydrocarbon solvent from the main bath B.

The machined parts are fed from the inlet chute 18 onto the baffles 28 of the rotating conveyor wheel 22. Since the baffles 28 are inclined downwardly when they are adjacent the outlet end of the inlet chute 18, the baffles 28 guide the machined parts to the outer wall 26 of the conveyor wheel 22. The machined parts are then carried by the conveyor wheel 22 through the main bath B. Since at least the outer wall 26 of the conveyor wheel 22 is formed of wire mesh, the liquid of the main bath B fills the chambers of the conveyor wheel 22 between the baffles 28 so that the machined parts are completely immersed in the main bath B.

As the machined parts are carried by the conveyor wheel 22 past the means for inducing vibrations of ultrasonic frequency 58, such parts are subjected to ultrasonic cleaning and the conveyor wheel 22 and its belt 30 are likewise kept free of sludge and carbon. This facilitates in the removal of adhering contaminant which is disposed within interstices, and voids within the machined parts. The conveyor arrangement shown in the drawings effects cleaning and draining of blind holes on the rotation of the conveyor wheel 22.

After being ultrasonically cleaned, the machined parts are carried by the conveyor wheel 22 out of the main bath B to the inlet end 92*a* of the transfer chute 92. When the baffles 28 of the conveyor wheel 22 reach a position above the inlet end 92*a* of the transfer chute 92, the baffles 28 are angled downwardly away from the outer wall 26 of the conveyor wheel 22 so that the machined parts fall from the conveyor wheel 22 onto the inlet end 92*a* of the transfer chute 92. The machined parts then descend the transfer chute 92 to the conveyor wheel 72.

The machined parts are fed from the transfer chute 92 into the conveyor wheel 72 in the same manner as the machined parts were fed from the inlet chute 18 into the conveyor wheel 22. The conveyor wheel 72 carries the machined parts through the rinse bath R. The rinse bath R comprises chlorinated hydrocarbon solvent which is considerably cleaner than the solvent inventory of the main bath B so that rinsing of the cleaned parts is effected within the rinse bath R. The conveyor wheel 72 carries the machined parts from the rinse bath R to the inlet end 118*a* of the transfer chute 118 where the machined parts are transferred from the conveyor wheel 72 to the transfer chute 118.

The machined parts descend the transfer chute 118 to the conveyor wheel 98 where the machined parts are fed into the conveyor wheel 98. Conveyor wheel 98 carries the machined parts through the drying chamber D where the solvent is drained and evaporated from the machined parts. The solvent drained from the machined parts in the conveyor wheel 98 passes through the wire mesh outer wall 102 of the conveyor wheel 98, and is collected on the floor 94 of the drying chamber D. The solvent collected on the floor 94 of the drying chamber D passes from the drying chamber into the vapor generator chamber 120 through the drain pipe, not shown.

After passing through the drying chamber D, the machined parts are transferred from the conveyor wheel 98 to the transfer chute 154. The machined parts descend the transfer chute 154 to the conveyor wheel 130. The conveyor wheel 130 carries the machined parts through the second drying chamber 122 to obtain a complete drying of the machined parts. Any solvent which may drain from the machined parts in the conveyor wheel 130 passes through the wire mesh outer wall 134 of the conveyor wheel 130, and is collected on the floor 126 of the second drying chamber 122. The solvent collected on the floor 126 is drained from the second drying chamber 122 to the vapor generator chamber 120 through the drain pipe 184.

After passing through the second drying chamber 122, the machined parts are transferred from the conveyor wheel 130 onto the outlet chute 156 which carries the machined parts from the cleaning machine 10.

Within the vapor generator chamber 120, chlorinated hydrocarbon solvent is distilled off from the bottom of the chamber by heater 160. The vaporized chlorinated hydrocarbon condenses on the wall 96 which is cooled by the cooling coil 170. The condensate flows down the wall 96 and is collected in the condensate collecting trough 174. The collected condensate leaves the trough 174 as cooled liquid through the duct 176. The duct 176 carries the condensate to the rinse bath R within the trough 62.

The level of the chlorinated hydrocarbon solvent within the rinse bath R is maintained at a constant height by the overflow pipe 178. Thus, overflow from the rinse bath R leaves through the overflow pipe 178 and is carried back into the vapor generator chamber 120. The overflow pipe 178 also maintains the level of the chlorinated hydrocarbon solvent within the main bath B at a constant height. If the level of the solvent of the main bath B drops below the level of the opening 180 in the overflow pipe 178, the overflow from the rinse bath R passing through the overflow pipe 178 flows through the opening 180 to raise the level of the main bath B back to the level of the opening 180. If the level of the main bath B becomes higher than the level of the opening 180, the excess solvent of the main bath B will flow through the opening 180 into the overflow pipe 178, and will be carried back to the vapor generator chamber 120.

The suction of fan 216 causes vaporized solvent disposed within the upper portion of chamber D and clinging to the machined parts to be drawn into the condenser 212. The condenser 212 separates the vaporized solvent into liquid solvent and cool air. The cool air passes from condenser 212 by way of conduit 214 into the inlet side of fan 216. The cool air is warmed by the heater 222 as it passes through conduit 218.

The outlet end of conduit 218 is disposed at an angle with respect to the plane of wall 42 as shown in FIGURE 1. The warm air passes from the conduit 218 through the screen 220 into the discharge chute 156. Since the warm air is at a temperature which is higher than that of the atmosphere at the outlet end of chute 156, the warm air rises up the chute 156, thereby sealing the chute 156 with a warm air barrier. Since the discharge end of inlet chute 18 is below the level of the solvent in the main bath B, and since the warm air delivered to chute 156 is the same air sucked out of chamber D, a closed circuit air circulation system has been provided.

The condensate of liquid solvent formed in the condenser 212 is conveyed by conduit 224 to the rinse bath R. Preferably, the conduit is connected to the bottom of the condenser 212 and is positioned so that liquid solvent flows in the rinse bath R by gravity.

The fan 216 need only have a delivery capacity which produces a waft of air in the chute 156. The term waft of air is to be interpreted as movement of air which is barely perceptible. The amount of air movement varies with the size of the machine. In a machine having a 60 gallon main bath, the fan capacity need only be 5 cubic feet per minute. This waft of air is too insignificant to suck atmospheric air in through the chute 156. Further,

the waft of air dries the machined parts as they pass through the chute 156. In actual use, I have found that only twelve ounces of solvent were lost from the sixty gallon main bath B after eight hours of continuous use.

It will be understood that the condenser 212, fan 216 and heater 222 are only shown schematically outside of the housing 12 for purposes of illustration. These elements may be mounted on the wall 36 above the apparatus 10 or within the housing 12.

Gradually as the cleaning apparatus 10 is utilized, there is a build-up of contaminant within the main bath B, and it will become necessary to close the cleaning apparatus down and drain away the solvent inventory. The solvent may be drained from the main bath B through a door 198.

Since the cleaning apparatus 10 of the present invention is compact, and relatively small in size, the cleaning apparatus 10 can be placed next to a processing machine so that the small machined parts can be discharged from the processing machine directly into the inlet chute 18 of the cleaning apparatus 10. Thus, the cleaning apparatus 10 of the present invention can continuously clean the small machined parts as they are received directly from the processing machine.

The present invention may be embodied in other specific forms wtihout departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. Cleaning apparatus for degreasing machined parts including a cleaning section and a solvent distillation section, a party wall intermediate said cleaning section and said solvent distillation section, a volatile solvent bath sump disposed at the bottom of said cleaning section, a volatile solvent rinse trough extending across the cleaning section adjacent said bath sump, a drying chamber extending across said cleaning section adjacent said rinse trough, a plurality of annular conveyor wheels supported in parallel relation within said cleaning section for rotation about horizontal axes, one of said conveyor wheels passing through said bath sump, a second of said conveyor wheels passing through said rinse trough, a third of said conveyor wheels passing through said drying chamber, an inlet means for feeding machined parts to said one conveyor wheel, means for transferring the machined parts from said one conveyor wheel to said second conveyor wheel, means for transferring the machined parts from said second conveyor wheel to said third conveyor wheel, means for transferring machined parts from the third conveyor wheel and delivering said parts to an outlet means, and means providing a closed circuit air circulation system for preventing the escape of vaporized solvent from said outlet means, said means providing a closed circuit air circulation system including a condenser in communication with said drying chamber, a suction means for causing vaporized solvent to move from said drying chamber into said condenser, said suction means causing cool air from said condenser to pass through a conduit into said outlet means, heater means for heating the cool air in said last-mentioned conduit, and a conduit for conveying liquid solvent from said condenser to said rinse trough.

2. In a cleaning apparatus comprising a housing, a main volatile solvent bath in said housing, a volatile solvent rinse bath in said housing, a drying section within said housing, said rinse bath being intermediate said main bath and said drying section, means disposed entirely within said housing for conveying machined parts through said baths and said drying section to a discharge chute on said housing, and means on said housing providing a closed circuit air circulation system to prevent vaporized solvent within said housing from escaping through said discharge chute by withdrawing a mixture of air and vaporized solvent from said housing and returning the air to the discharge chute on said housing in a state substantially free from vaporized solvent.

3. In a cleaning apparatus comprising a housing, a main volatile solvent bath in said housing, a volatile solvent rinse bath in said housing, a drying section within said housing, means for conveying machined parts through said bath and said drying section to a discharge chute on said housing, said discharge chute being angled so that the discharge end of said chute is lower than the other end of said discharge chute, a screen forming a portion of a bottom wall of said discharge chute adjacent said discharge end, means providing a closed circuit air circulation system to prevent vaporized solvent within said housing from escaping through said discharge chute, said last-mentioned means being in communication with said housing and including an element capable of withdrawing a mixture of air and vaporized solvent from said housing, said last-mentioned means also including an element capable of separating a mixture of air and vaporized solvent into air and liquid solvent, and said last-mentioned means also including a conduit for delivering warm air through said screen into said discharge chute thereby providing a blanket of warm air within said discharge chute.

4. In an apparatus in accordance with claim 3 including an inlet chute to said housing, the discharge end of said inlet chute being disposed within said main bath, and said warm air being delivered to said discharge chute in the nature of a waft of air.

5. In an apparatus in accordance with claim 2 wherein said last-mentioned means includes a condenser in communication with said drying section, said last-mentioned means including a suction device for causing air and vaporized solvent to move from said drying section into said condenser, said suction device causing cool air from said condenser to pass through a conduit into said discharge chute, and a conduit for conveying liquid solvent from said condenser to said rinse bath.

6. In a cleaning apparatus comprising a housing, a main volatile solvent bath in said housing, a volatile solvent rinse bath in said housing, a drying section within said housing, said rinse bath being intermediate said main bath and said drying section, means disposed entirely within said housing for conveying machined parts through said baths and said drying section to a discharge chute on said housing, means on said housing providing a closed circuit air circulation system to prevent vaporized solvent within said housing from escaping through said discharge chute by withdrawing a mixture of air and vaporized solvent from said housing and returning the air to said housing in a state substantially free from vaporized solvent, said last-mentioned means including a pump, said pump having a small delivery capacity so that air is returned to said housing at a delivery rate constituting only a waft of air.

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