

Aug. 24, 1954

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2,686,991

BLAST CLEANING APPARATUS AND METHOD

Filed Nov. 7, 1950

4 Sheets-Sheet 1

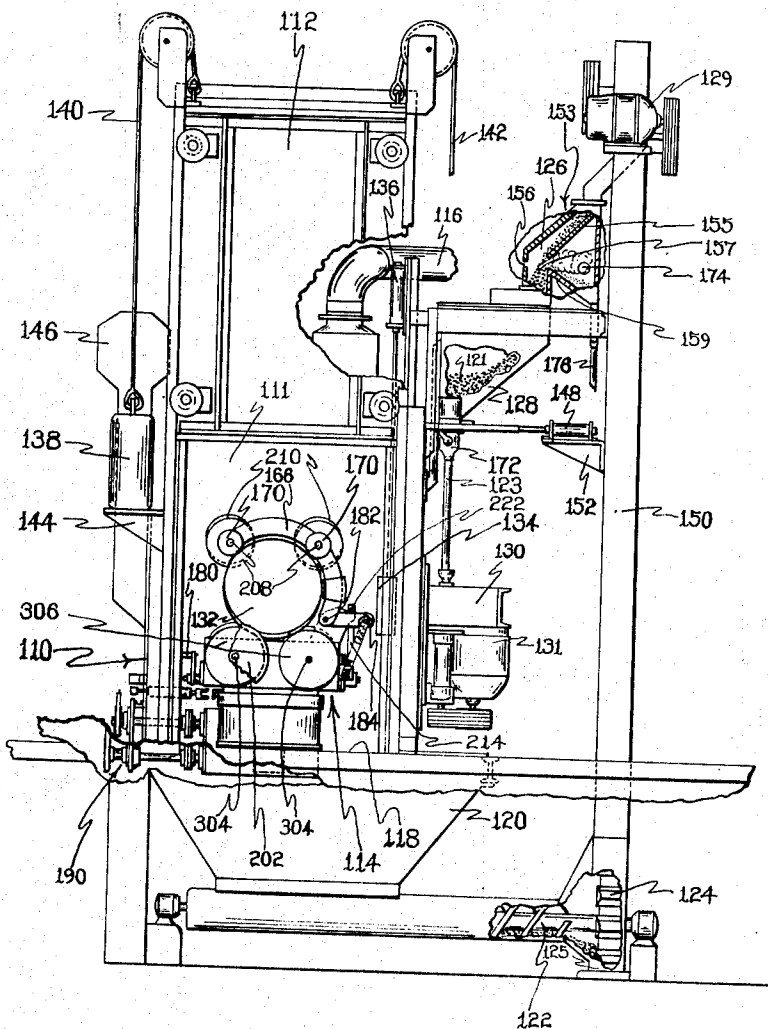


FIG. 1

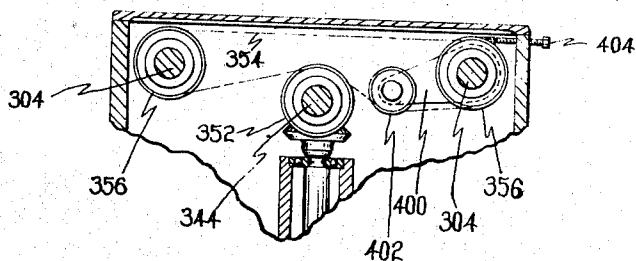


FIG. 4

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4 Sheets-Sheet 2

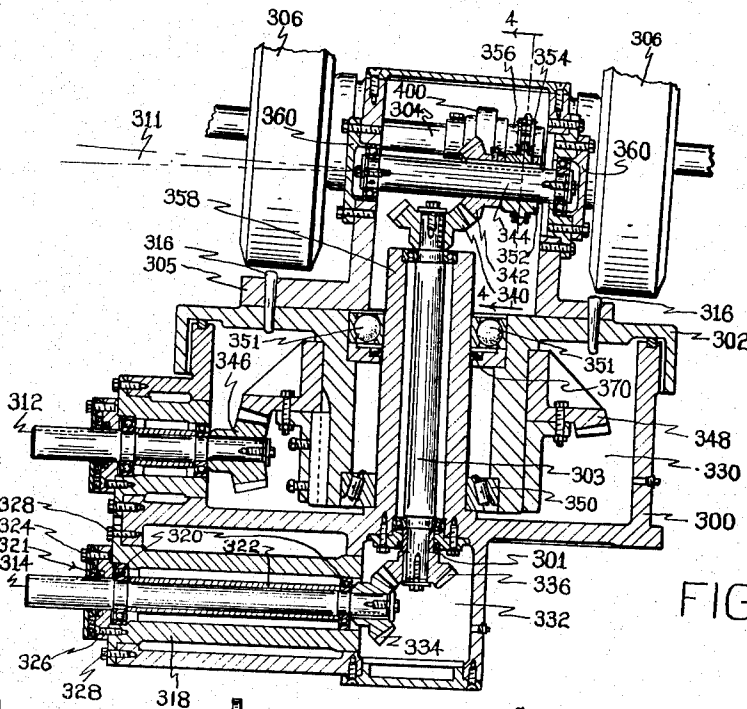


FIG. 3

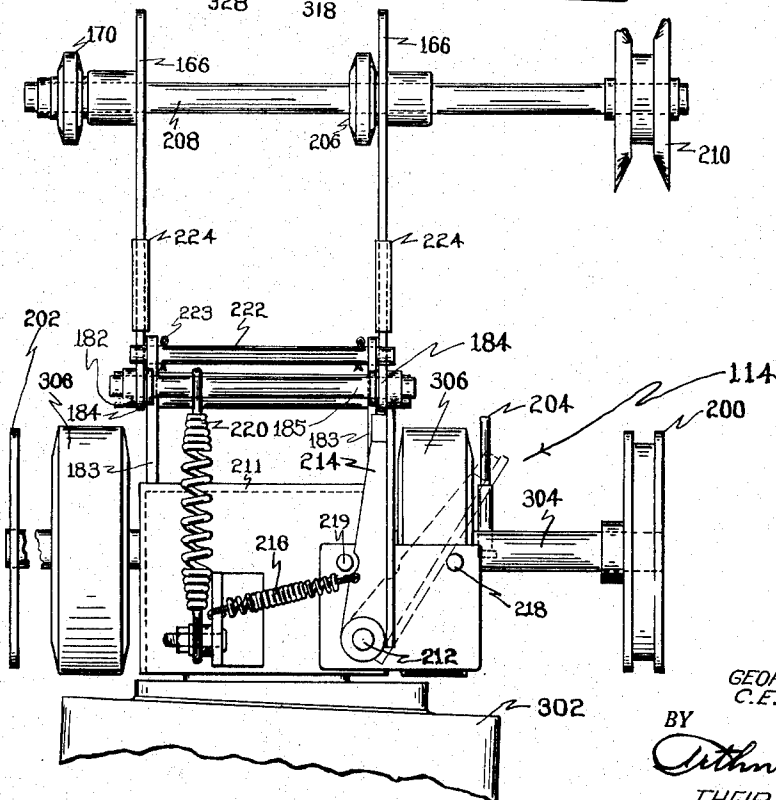


FIG. 2

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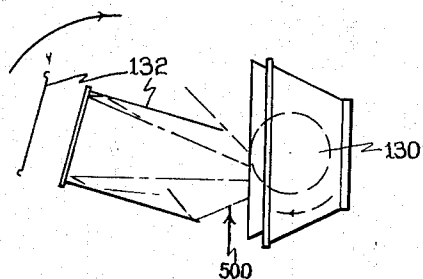


FIG. 5

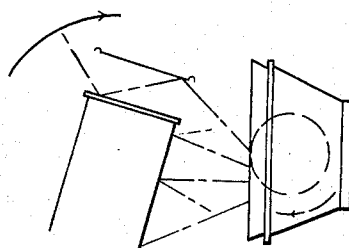


FIG. 6

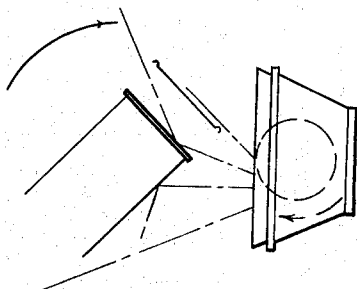


FIG. 7

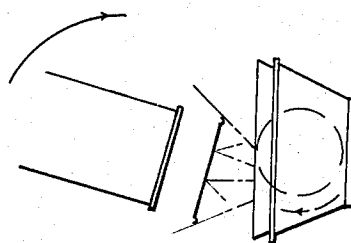


FIG. 8

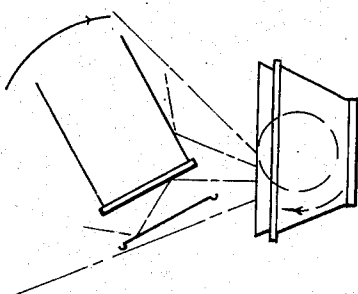


FIG. 9

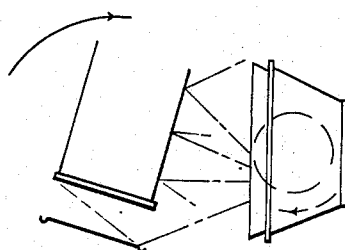


FIG. 10

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4 Sheets-Sheet 4

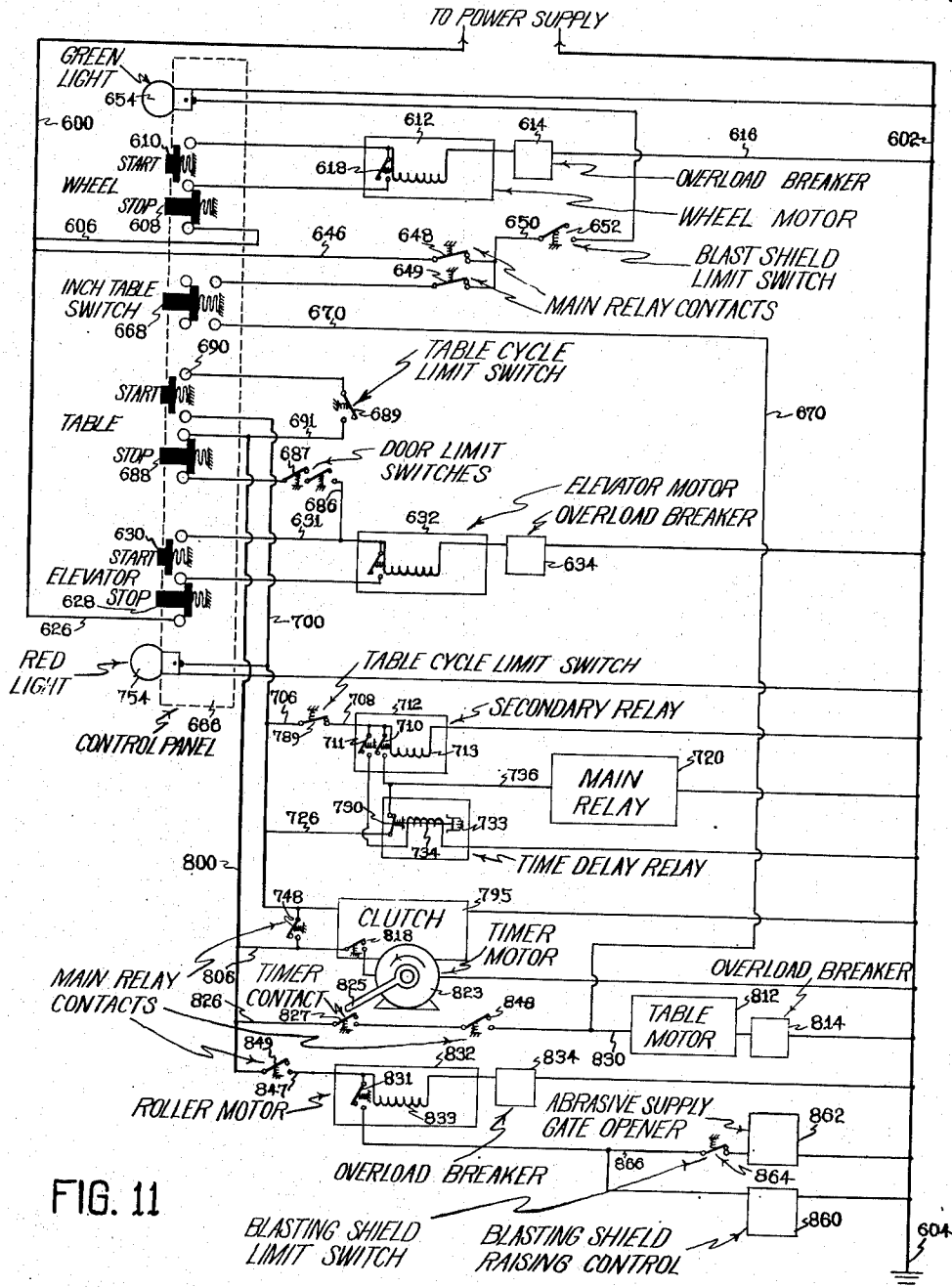


FIG. 11

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2,686,991

BLAST CLEANING APPARATUS AND METHOD

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Application November 7, 1950, Serial No. 194,420

11 Claims. (Cl. 51-14)

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The present invention relates to blast cleaning, that is the removal of foreign substances including corrosion products, from surfaces by means of a strong stream of abrasive particles.

One of the most significant advantages of blast cleaning is that it can be made automatic so that articles can be treated with a minimum of labor and expense. Heretofore, however, the automatic treatment of the entire surface of large articles such as drums, has not been effected, probably because of the complicated handling required.

Among the objects of the present invention is the provision of an apparatus and method for thoroughly cleaning such large articles with a minimum of labor.

Further objects of the invention include automatic machines for blast cleaning the inner as well as the outer surfaces of tubular articles.

An additional object of the invention is the provision of a machine for simultaneously blast cleaning a tubular article such as a drum together with a cover for this article, with a minimum of handling.

The above as well as still further objects of the present invention will be more readily understood from the following description of several of its exemplifications, reference being made to the appended drawings wherein:

Fig. 1 is a front elevation view of a blast cleaning machine, exemplifying the present invention, various parts being shifted or broken away to more clearly show some of the specific details, and a work piece being shown mounted in place;

Fig. 2 is a broken elevation view of the work supporting structure of the machine of Fig. 1, taken from the right in Fig. 1, with the work removed for clarity;

Fig. 3 is a vertical cross sectional view of a drive mechanism for the work supporting structure of Fig. 2;

Fig. 4 is a somewhat diagrammatic cross sectional view of the upper portion of the drive mechanism of Fig. 3, taken along section line 4-4;

Figs. 5, 6, 7, 8, 9 and 10 are diagrammatic plan views illustrating some of the operational details of the machine; and

Fig. 11 is a circuit diagram of one form of control assembly for the machine of Figs. 1 to 4 inclusive.

According to the present invention, a cylindrical or tubular article is arranged to be rotated about its longitudinal axis, a stream of abrasive particles is directed at the rotating article, and

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the article is revolved in the plane of the stream so that all parts of its surface, including internal parts where the article is tubular, are exposed to the cleaning effect of the particles. A cover for the tubular article can also be disposed alongside the article so that both cover and article can be simultaneously cleaned in pairs, the ricocheting action of the particles being taken advantage of to reach obstructed portions of the surfaces.

Referring to the embodiment of the blast cleaning machine illustrated in Fig. 1, said machine comprises a cabinet 110 made preferably of steel plate and a structural framework. The front of cabinet 110 is provided with a rubber sealed lift door 112 to give full opening to the cabinet for free access to insert and remove work pieces, such as drum 132. The rear wall 111 of cabinet 110 is preferably provided with a mandoor, not shown, to further facilitate maintenance. The ceiling of cabinet 110 has an air outlet hood 116, and an air inlet conduit 146 is connected to one side for ventilation purposes.

A floor grating and support framework 118 within cabinet 110, generally a grid of metal plates supported by steel framework, holds a work supporting structure indicated at 114.

A centrifugal throwing wheel 130 and its driving motor 131 are mounted upon the side wall of cabinet 110. Wheel 130 is preferably mounted with its axis vertical so that it rotates in an approximately horizontal plane to propel abrasive particles against the surface of work piece 132.

A safety plate 134 is disposed before the discharge outlet of wheel 130. This plate 134 is automatically operated, in this instance by air cylinder 136, and is lowered in front of wheel 130 when the cabinet door 112 is raised. Safety plate 134 keeps the abrasive particles from flying into cabinet 110 while the operator removes the work pieces 132. When door 112 is lowered to close cabinet 110, plate 134 is automatically raised out of the abrasive projecting path.

Cabinet door 112 has counter-weights such as 138 connected by means of cables 140 and 142 at both sides of the cabinet. A stop such as 144 may be positioned on the side of cabinet 110 for limiting the downward movement of weights 138 and hence the upward movement of door 112.

Abrasive particles 121 such as metal shot or chopped wire are supplied to the wheel 130 from a storage bin 128, by means of a conduit 123. Air cylinder 148, suitably supported as by means of bracket 152, is connected to a valve 172 in conduit 123 to regulate the flow of abrasive

particles from the storage bin to the throwing wheel.

A hopper 120 is provided to receive spent abrasive which falls through the floor grating 118. A screw conveyor 122, positioned in the bottom of hopper 120, conveys the spent abrasive to a well 125, and an elevator bucket conveyor 150 having a series of endlessly connected buckets 124 carries the abrasive to an overhead separator 126, from which it falls into storage bin 128. The elevator conveyor is operated by electric motor 129.

Separator 126 is provided to eliminate abrasive particles which are no longer suitable for reuse. As shown the separator is in the form of a housing 153 having an abrasive conduit 155 at the lower end of which are opposed openings or gaps 156, 157. Below gap 157 is a separating wall 159 one side of which leads to the storage bin 128, and the other side to a waste conduit 176. A suction pipe 174, which is connected to the ventilating-air exhaust system, draws in air from opening 156, through the stream of abrasive falling from elevator 150, and thereby separates the finer particles which are sucked over wall 159 and drop out through waste pipe 176. The reusable abrasive continues its travel to storage bin 128.

The work supporting structure 114 is shown in more detail in Figs. 2, 3, and 4. In Fig. 3 the lower portion of this structure is shown as including a base 300 which carries revolvable table 302, which in turn carries driving head 305. Driving head 305 is fixed to table 302 by taper pins 316 and additional bolts, if desired. Mounted in said table top 305 is a set of work rotating shafts 304 (see also Fig. 4) and a drive shaft 344. Each work rotating shaft 304 carries a set of work driving rollers 306 as well as a keeper roller 202 and a sheave 200 (Fig. 2).

Extending from the base 300, which is in the form of a metal casting, are two work input shafts 312 and 314. These shafts are suitably driven as by variable speed electric motors from without cabinet 110 through a system of linkage such as that shown at 190 in Fig. 1. Shaft 312 carries a pinion gear 346 and thereby transmits power to a driven ring gear 348 rigidly fixed to the underside of table 302. Table 302 is thereby revolved on bearings 350 and 351 about the vertical axis of a housing 358 projecting up from the base. Since driving head 305 is pinned to table 302, and since work pieces 132 are supported by rollers 306, 302 and sheaves 200 (see Fig. 2) carried by table top 305, said work pieces 132 are thereby caused to revolve about the vertical axis of housing 358.

Simultaneous with said revolution about a vertical axis, power is transmitted by input shaft 314 to a pinion gear 334 which drives another pinion gear 336 and hence to vertical shaft 303 which passes longitudinally through housing 358. At the top of shaft 303, pinion gear 340 transmits power to driven gear 342 fixed upon drive shaft 344. Drive shaft 344 is connected to drive work rotating shafts 304, and thereby rotate work driving rollers 306, 302 and sheaves 200. As said driving rollers and sheaves rotate, the cylindrical work pieces such as drum 132, are rotated around their cylindrical axes.

The particular method illustrated in Figs. 3 and 4 for transmitting power from drive shaft 344 to rotating shafts 304 is by means of a chain and sprocket drive. A sprocket 352 mounted on the drive shaft 344 transmits power through chain 354 to sprockets 356 mounted on shafts 304. This drive is diagrammatically shown in Fig. 4.

Also illustrated in Fig. 4 is a method of adjusting the tension of chain 354. On one of the work rotating shafts 304 is journaled one end of an elongated adjustment plate 400. The other end of said plate 400 holds an idler wheel 402 in contact with chain 354. An adjustment bolt 404, which can be manipulated from the outside of head 305 through a threaded hole, can be screwed inwardly to turn plate 400 counterclockwise (as seen in this view) about shaft 304 and so bear down on and increase the tension of chain 354.

It may be seen in Fig. 3 that the whole drive mechanism of work support structure 114 is so constructed as to facilitate manufacture and maintenance. Power input shaft 314 with its gear 334 may be first pre-assembled on bearings 320 separated by tubular spacer 322, in a cart-ridge-like casing 318, by means of cap assembly 321 which is bolted to said casing 318 by a set of bolts some of which are shown at 324 and 326. Casing 318, containing the whole shaft assembly, may then be secured to the base 300 by bolts 328 and is easily removed for maintenance or replacement. Shaft 312 is similarly mounted in the base. Work rotating shafts 304 and drive shaft 344 may be mounted in head 305 as by means of flange caps 350 used to hold shaft 344, so that they also may be individually accessible.

It is further shown in Fig. 3 that oil seals 391, 370 are so placed as to not only prevent leakage of lubricant but to divide work support structure 114 into three lubrication compartments. Head 305 forms one compartment, while base 302 is divided into upper compartment 330 and lower compartment 332. It is thereby made possible to separately maintain the proper lubricant level in each compartment so as to avoid the loss of power through the friction and other detrimental effects caused by excessive lubricant. The above compartmentation also simplifies maintenance by necessitating the drainage of only one compartment for access to any one set of gears.

As explained above, shafts 304 rotate work driving rollers 306, sheaves 200, and keeper roller 202. Rollers 306 frictionally rotate the cylindrical work pieces 132, in this case the drum shown in Figs. 1, 5, 6, 7, 8, 9 and 10, while at the same time sheaves 200 rotate the drum head or cover used to close off the open end of the drum. Shafts 304 are preferably tilted up to about 10° in a vertical plane as indicated at 311 in Fig. 3. Keeper roller 202 prevents the drum 132 from working off of rollers 306 in one direction, while drum stop 204 fixed to the head prevents such movement in the opposite direction.

For holding the drum and/or drum head, a set of arcuately shaped retractable holding arms 166 is mounted on a cover 211 fixed over head 302 and carries a set of retaining sheaves 210 and two sets of retaining rollers 170 and 206 on a pair of idler shafts 208. When said holding arms 166 are in the illustrated closed position, rollers 170 and 206 retain the drum 132 in place on the work rotating rollers 306 (see Fig. 1), while sheaves 178 perform a similar function with the drum head.

The holding arms 166 are pivoted on a pin 182 carried by ears 183 standing up from the cover 211, and are retracted by manipulation of a handle 180 (see Fig. 1) on one end of a rotatable shaft 212 extending through the cover 211 outside the head 302. The opposite end of shaft 212 carries a stop latch 214 biased as by spring 216 toward a vertical position, shown in solid lines, where it fits underneath one of a pair of crank legs 184 projecting out from the arms, and pre-

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vents retraction of the holding arms. Stop pins 218, 219 limit the rotary travel of the latch 214. Upon rotation of the handle 180 to move the latch toward stop pin 218, as shown by the dash lines in Fig. 2, the tension of a stretched spring 220 hooked over a shaft 185 connecting crank legs 184 then rotates the holding arms 166 about pin 182 (see also Fig. 1) into the retracted, or open, position to allow the insertion or removal of a drum and/or head. When the work pieces are loaded in place the holding arms 166 are returned to the closed position illustrated in Fig. 1, and handle 180 is then permitted to return to the locking position.

For protection from excessive wear, the portion of holding arms 166 which come through the path of abrasive propelled from throwing wheel 132, are shielded by steel wear plates 224.

A limit bar 222 is shown as held by cotter pins 223 between the ears 183 to define a closing as well as a retracting stop for the arms 160.

A feature of the present invention is the fact that both a drum and its cover will be simultaneously cleaned when they are treated in the above apparatus. This is explained by following through the rotation and revolution that these work pieces are subjected to during the blasting. Successive steps in this treatment are represented in Figs. 5, 6, 7, 8, 9 and 10.

Fig. 5 is the initial, or load, position in which the cylindrical work pieces 132 are mounted and remain for a period of time commensurate with the type of surface to be cleaned, all the while continually rotating about their cylindrical axis. The horizontally directed stream of abrasive particles, which may in cross-section have a vertical depth much smaller than the work pieces but which extend over a substantial horizontal swath, is indicated by lines 500. These particles enter the interior of the drum 132, ricochet around, and cleanse it with an abrading-scouring type of action. Upon expiration of the selected time period, the interior of the drum 132 is clean and the drum and head are automatically revolved in a clockwise direction (as seen in this view) about a vertical axis, through the successive positions shown in Figs. 6, 7, 8, 9 and 10. During this revolution, the cylindrical rotation of the drum and head 132 is maintained. Fig. 6 shows how, at this position of the work revolution, the blast reaches not only the cylindrical drum exterior but effectively ricocheting particles also reach the outer surface of the drum bottom and the inner surface of the drum head, both of which surfaces are hidden.

In the position of Fig. 7, the outer surface of the drum bottom is further blasted, followed by an intense exposure of the outer surface of the head in Fig. 8. The action in the position of Figs. 9 and 10 are similar to that in Fig. 6. When the revolution is ended and the work pieces are brought around again to the position of Fig. 5, they are both thoroughly clean and can be removed.

The time necessary for the drum and head 132 to complete one revolution, from the position in Fig. 5 through the positions in Figs. 6, 7, 8, 9 and 10 and back to the position in Fig. 5, is selected according to the desired cleaning intensity, so that the cleansing will be completed with one such revolution.

The above operation can be made entirely automatic. Thus for example, an electrical or mechanical interlock can be provided to keep the

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wheel 130 as well as the balance of the apparatus from operating when the elevator or the ventilator is not functioning. Also the safety plate and abrasive control valve may be connected so that when the door 112 is open, no abrasive is delivered to the wheel and no abrasive already in the wheel can be projected into the cabinet 110. The wheel 130, by reason of its extremely rapid rotation, is very slow to stop and start and can advantageously be kept running at all times while the apparatus is being attended, particularly during loading and unloading.

Upon the initiation of the cleaning cycle, the following operations can be made to occur automatically: cabinet door 112 is closed, safety door 134 over the opening of throwing wheel 130 is raised, valve 172 controlling the flow of abrasive to wheel 130 opened, and an automatic table rotating timer controlled drive started. When the table revolution has been finished, the following operations can be made to occur automatically: revolution of the table and rotation of the drum and head stop, abrasive control valve 172 closes, safety door 134 lowers, and cabinet door 112 raises. A worker may then safely enter cabinet 112 to substitute a new work piece for the one already processed.

It is also advisable to provide a manual control so that the work supporting table may be revolved a limited amount in either direction or momentarily stopped to effect a little extra cleaning during any portion of the cycle or to run more rapidly from one portion to another. This control may also be arranged to allow drum and head 132 to be revolved to the load position in Fig. 5 if the cleaning cycle is interrupted where the cycling apparatus is arranged only to provide automatic complete cycles. Said control is desirable also as a safety stop in the event any part of the cleaning mechanism should begin to operate improperly.

The cleaning operation will proceed with equal effectiveness whether either one or both of the combination of drum and drum head are present on work support structure 114, and any other combination of cylindrical work pieces can be correspondingly treated.

Fig. 11 shows one highly practical form of control assembly for the above apparatus. A suitable power supply is shown as energizing a principal pair of conductor busses 600, 602 and one of these may be grounded as shown at 604. From the ungrounded principal bus 600, a lead 606 is connected through a normally closed stop switch 608 and then through a normally open start switch 610 to a blasting wheel energizing control such as the windings of relay 612. From these windings the current is returned through overload breaker 614 and lead 616 to the grounded conductor 602. A normally open set of holding contacts 618 operated by relay 612 is shunted across the start switch 610 to hold the energizing circuit for relay 612 after the start switch 610 is operated to start the wheel motor, and then released. One or more additional contacts of this relay (not shown) is arranged to complete the energizing circuit for the wheel motor itself upon actuation of relay 612. Overload breaker 614 can be the standard motor control type of thermally operated breaker but can be connected as shown to open the relay control circuit rather than the motor circuit itself. Where the wheel motor is of the 3-phase type a pair of overload breaker contacts are usually connected indi-

vidually in two of the three 3-phase conductors, and may be connected in series to provide the overload breaker 614 of Fig. 11.

Another lead 626 supplies current from main bus 606 through a normally closed elevator motor stop switch 628 and then through a normally open start switch 630 and by means of conductor 631 through the windings of elevator motor control 632 and overload breaker 634 in a manner similar to that for the wheel motor.

A third lead 646 runs from principal bus 600 through a pair of normally closed main relay contacts 648, link 650, a normally opened blast shield limit switch 652 and green pilot light 654 to the grounded conductor 602. The main relay contacts 648 are opened by the energization of the main relay 720 as described below.

From elevator starting switch lead 631 a branch conductor 686 is connected through normally opened door limit switches 687, normally closed table rotation stop switch 688, lead 691, normally open table cycle limit switch 689, and normally open table rotation starting switch 690 to provide a second bus 700. A red pilot light 754 is connected between this second bus 700 and grounded conductor 602. In addition lead 706 from bus 700 connects through a normally closed table cycle limit switch 789, through lead 708 and the windings 713 of a secondary relay 712, to grounded conductor 602. A further conductor 726 connects from the bus 700 through normally closed contacts 730 of a time delay relay 733, through conductor 736, to energize main relay 720, and from there to grounded bus 602. The energization of the windings 734 of time delay relay 733 is provided through normally open contacts 711 of secondary relay 713 and lead 708, which connects through table cycle limit switch 789 and lead 706 to the second bus 700. An additional set of normally open secondary relay contacts 710 connects lead 708 directly to main relay lead 736.

A table holding timing control is arranged for actuation by an electrically operated clutch 795 directly connected between busses 700 and 602. The timing mechanism is operated through a third bus 800 connected to lead 691 and having a take-off line 806 connected through a normally open set of clutch contacts 818, to timer motor 823, and thence to ground return bus 602. Take off lead 806 is also connected to second bus 700 through a pair of normally open main relay contacts 748. Timer motor 823, through clutch 795, operates a timer arm diagrammatically shown at 825 which at a suitably controlled time closes a set of normally open contacts 827 and establishes through lead 826 an energizing circuit from bus 800, another normally open set of main relay contacts 848, to lead 830 and table rotating motor control 812. This control 812 may be similar to the motor controls 612, 632 but need not have an additional set of holding contacts. An overload breaker 814 may be provided with the table motor and can be connected in the return line from table motor control 812 to the ground bus 602.

A motor for rotating the work supporting rollers 306, is shown as under the control of a roller motor relay 832 having windings 833 connected to bus 800 through a lead 847 and a further set of main relay contacts 849, and returned to ground bus 602 through overload breaker 834. Between lead 847 and ground bus 602 a blast shield raising control 860 and an abrasive supply gate opener 862 is energized

through a line 866 and a normally open set of contacts 831 on relay 832. Additional normally closed contacts 864 of a blasting shield limit switch are inserted in the line 860 to the abrasive supply gate opener alone.

The various starting and stopping switches as well as pilot lights are shown as all contained in a control panel 666 which also includes a normally open table inching switch 668 which can be closed to supply power from lead 650 through an additional set of normally closed main relay contacts 649 to a conductor 670 which is led directly to table rotating motor lead 830.

With the power supply connected the control apparatus of Fig. 11 can be operated by first closing the wheel and elevator starting switches 610 and 630. Only momentary operation of these switches are needed since holding contacts as indicated at 618 automatically close and keep these motors energized. Inasmuch as the blast shield when deenergized drops into shielding position and thereby closes its limit switch 652, so long as the main relay contacts 648 are not open by energization of the main relay 720 the green pilot light 654 remains lit. With the elevator and wheel motors operating and with door limit switches 687 held closed by the closed position of door 112 as well as the auxiliary clean out opening (not shown), bus 800 becomes energized through table stop switch 688. However, the main relay supply circuit through bus 700 remain open. The table motor, blast shield, abrasive supply gate and timer motor will accordingly be cut off.

The work can now be loaded in the cabinet, the opening of the doors opening the auxiliary supply to busses 700, 800 at the door limit switches 687 to safeguard against inadvertent blasting or work rotation. After the loading is completed and the doors again closed, the table cycling switch 690 can then be operated and if the table is in the loading position of the cycle where it holds limit switch 699 closed, bus 700 becomes energized. Thereupon the red light 754 goes on and main relay 720 is energized through lead 736, time delay relay contacts 730 and lead 726. This causes all the main relay contacts to be operated. The opening of contact 648 extinguishes the green light 654 while the inching switch 668 is rendered inactive by opening of contact 649. At the same time closing of main relay contacts 849 energizes the work rotating motor control 832 and raises the blast shield through holding contacts 831 of this control. The raising of the blast shield causes contacts 864 to close, thereby opening the abrasive supply gate through control 862. In addition main relay contact 848 prepares an operating circuit through lead 826 for the table cycling motor control 812, and a further set of contacts 748 interconnects busses 700 and 800.

The energization of bus 700 actuates clutch 795 thereby connecting arm 825 for operation by the timer motor, and at the same time actuation of the clutch closes contacts 818 energizing this motor. With the table in the loading position, table limit switch 789 is kept open so that the secondary and time delay relays cannot be energized. The apparatus will now begin blasting the inside of the drum with the drum rotating around its longitudinal axis but with the table not revolving. Should the work rotating motor stop either by tripping of the overload breaker 834 or for any other cause the blast shield will be released to drop into shielding position thereby

opening switch 864 and stopping the flow of abrasive. If the elevator motor should stop, the opening of its holding contacts will deenergize busses 700 and 800 also shutting off the abrasive and lowering the blasting shield, stopping the timer, deenergizing the main relay, extinguishing the red light and lighting the green light. Should the table be displaced from its loading position when the start switch 690 is operated, the open position of the cycle limit switch 689 will keep the main relay from becoming energized so that its contacts 848 keep the table motor from operation, and in addition none of the other automatic controls can be operated. However, the table can be brought to the loading position by operation of inching switch 668 which is energized from line 646 through the closed non-operated condition of main relay contacts 648, 649. The inching switch is held closed the required amount of time until the table is observed to have reached the proper loading position. If desired, the inching switch can be further connected to operate an indicator light such as red light 734 and the table cycle limit switch interconnected to automatically open this additional light circuit when the table reaches the loading position.

With the blasting started as indicated above the timer motor is preset to close its timer contacts 827 after the elapse of sufficient time to assure that the internal surfaces of the drum are thoroughly cleaned. At the end of this interval of time, arm 825 closes contacts 827 and the table motor control is now energized, contact 848 being held closed by the main relay. As soon as the table has rotated away from its loading position the table cycle limit switches return to their normal positions. Contacts 689 of these switches thereby open so that bus 700 is now energized solely through main relay contacts 748. At the same time the closing of contacts 789 of these switches energizes secondary relay 713 and causes contacts 710 and 711 to close. Secondary relay contact 710 establishes another energizing circuit for main relay 720 through the cycle limit switch 789, while secondary relay contacts 711 cause time delay relay to open the previous main relay energizing circuit at its contact 730. If desired, the secondary and time delay relays might also be connected to deenergize the timer motor and/or clutch at this point.

With the table motor operating in the position just reached, the main relay is placed under the control of table cycle limit switch 789, main relay contact 748, table limit switch 689, door limit switches 687 and elevator motor controls in series. The wheel motor control may also be added to this series. The work in the meantime is now having its external surfaces blasted. When the external surface portion of the cycle is completed and the table returns again to its loading position, the cycle switch contacts 789 are opened, deenergizing the main relay. The main relay contacts thereby deenergize bus 700, the table motor control 812, the motor roller control 832, and the abrasive supply gate and the blast shield are permitted to close. Opening of the cycle limit switch 789 also causes time delay relay 733 to be de-actuated to restore the original main relay energizing circuit through lead 726, but a time delay is here injected so that the circuit restoring contacts 730 are not closed until after the main relay deenergization is entirely completed and the blasting sequence is stopped. Should the table stop switch 688 be operated during the

table rotation busses 800 and 700 also become deenergized, releasing clutch 795 so that the timer returns to its table rotation delaying timing position. From here the blasting can be resumed by first operating inching switch 688 to carry the table to the load position.

When the blasting cycle is completed, red light 754 becomes extinguished, and green light 654 is lit to indicate that the work is ready for unloading. The cabinet door can then be opened and the work replaced by a fresh workpiece so that the next blasting cycle can be initiated. Closing of the cabinet door with the fresh piece in place prepares the apparatus for the next blasting cycle by closing switches 687.

Other forms of control operations are also satisfactory for use. Thus for example, premature table stopping as by switch 688 can be arranged to merely interrupt the cycle and not to cut it off completely, as by arranging for the main relay to remain actuated when this stop switch is opened. In addition the door limit switches 687 can be connected to directly control the energization of the abrasive supply gate and the blast shield so that the doors can be opened without doing more than keeping the cycle interrupted. As an additional modification the blasting wheel control may have a second set of holding contacts connected in series in the elevator motor control circuit so that the elevator motor cannot be operated unless the wheel is rotating. If desired the motor starting and/or stopping switches 608, 610 for instance, can be of the permanently shifting type rather than the momentary operated variety shown.

Although the apparatus described above shows a pair of rollers upon which a generally tubular workpiece can be supported for rotation during blasting, a single work rotating roller can also be used for this purpose, as by providing a pair of side guards which keep the workpiece positioned so that it rests on the roller and rotates with it.

In the control arrangement of Fig. 11, the timer is suitably provided with a timing interval adjustable over the range from about 0.2 to about 120 seconds. When cleaning 30 or 55 gallon drums substantially all portions of this range are used depending upon the condition of the internal surfaces of the drums. By mounting the timer adjustment in or near the control panel 666, the operator can even make adjustments for the individual drums. The table rotation speed need not have very much adjustment with the usual drums inasmuch as the lid and the external surfaces of the drum are generally completely cleaned at table speeds of about $\frac{1}{2}$ to about 3 revolutions per minute. The drum rotation on rollers 306 is suitably effected with fixed speed rollers, the peripheries of which have a linear speed of about 70 to about 300 feet per minute as by rotating rollers 15 inches in diameter at 36 revolutions per minute. Both 30 and 55 gallon drums will be suitably treated in this manner, the smaller drum rotating at 30, and the larger at 24 revolutions per minute.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope hereof, it is to be understood that the invention is not limited to the specific embodiments hereof, except as defined in the appended claims. Thus the internal cleaning step of the apparatus can be shifted to any portion of the cleaning cycle, and a fluid-propelled stream of abrasive particles can be used in place of the throwing wheel.

What is claimed is:

1. A blast cleaning machine for cleaning the surfaces of cylindrical workpieces, said machine comprising a cabinet enclosing a work supporting structure having at least one roller positioned for supporting one of said workpieces by a portion of its cylindrical surface, drive elements connected for rotating said roller about an axis parallel to the longitudinal axis of said surface for rotating said workpiece about its longitudinal axis, said drive elements also being connected for revolving the work supporting structure in a plane of revolution about an axis approximately perpendicular to said longitudinal axis simultaneously with said rotation, and abrasive projecting structure for projecting a stream of abrasive particles approximately in said plane of revolution for cleaning all surfaces of the workpiece.
2. The blast cleaning machine defined by claim 1 wherein the abrasive projecting structure is a centrifugal throwing wheel.
3. The blast cleaning machine defined by claim 2 wherein the centrifugal throwing wheel is fixed in position.
4. A blast cleaning machine for cleaning the surfaces of tubular workpieces, said machine comprising a cabinet enclosing a substantially horizontally disposed work supporting structure having at least one roller positioned for supporting one of said workpieces by a portion of its tubular surface, drive elements connected for rotating said roller about a substantially horizontal axis, said drive elements also being connected for revolving the work supporting structure in a plane of revolution about a substantially vertical axis while said roller is being rotated, and a centrifugal throwing wheel positioned for projecting a stream of abrasive particles substantially in said plane of revolution for cleaning both the internal and the external surfaces of the workpiece.
5. A blast cleaning machine for simultaneously cleaning metallic drums and drum heads, said machine comprising a cabinet enclosing an approximately horizontally disposed work-supporting structure having two substantially parallel spaced rollers for cradling one of said drums and one of said drum heads by a portion of their peripheral surfaces, arcuate shaped holding arms being disposed at each end of said work supporting structure for co-operating with said rollers to support said drum and said drum head, drive elements connected for rotating said rollers about an approximately horizontal axis, said drive elements also being connected for revolving the work supporting structure in a plane of revolution about an approximately vertical axis, and a centrifugal throwing wheel for projecting a stream of abrasive particles in said plane of revolution

for cleaning all the surfaces of both the drum and the drum head.

6. The blast cleaning machine defined by claim 5 wherein the centrifugal throwing wheel is fixed in position.

7. The blast cleaning machine defined by claim 6 and including driving mechanism for regulating the rate of revolution of said work supporting structure.

8. The blast cleaning machine defined by claim 7 and including a catch mechanism connected to said arcuate shaped arms for moving said arms into a drum receiving position and for locking said arms in a drum holding position.

9. A process for simultaneously cleaning all the surfaces of a drum and drum head which process comprises positioning the drum head adjacent to but spaced from the bottom of the drum, rotating the so-positioned elements about the drum axis, projecting a fixed external stream of abrasive particles against the rotating elements, and revolving the rotating elements in the plane of the stream to expose all portions of the drum and drum head surface to the blast.

10. A process for cleaning all the surfaces of generally cylindrical work pieces, which process comprises lowering such a work piece into surface contact with a supporting roller mechanism, rotating said roller mechanism to cause rotation of the supported work piece about its cylindrical axis, projecting a fixed external stream of abrasive particles against the rotating work-piece, and simultaneously revolving the supported mechanism one complete turn about a second axis perpendicular to the plane defined by the work piece and the stream to expose all portions of the work piece to the blast.

11. A process for cleaning all internal and external surfaces of apertured work pieces in a single blast cleaning operation comprising the step of projecting a narrow confined blast stream into the aperture of such a work piece and simultaneously presenting all internal and external surfaces of the work piece to said abrasive stream by rotating the work piece about two different axes, each said axis passing through the work piece.

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