United States Patent [19]

Germain et al.

[11] **3,854,899**

[45] **Dec. 17, 1974**

[54] **AUTOMATIC MOLD CLEANING**

[75] Inventors: **Andrew Gerald Germain,** Itasca; **William George Dressel,** Elk Grove Village, both of Ill.; **Louis Sandor,** Hammond, Ind.

[73] Assignee: **AMSTED Industries Incorporated,** Chicago, Ill.

[22] Filed: **June 4, 1973**

[21] Appl. No.: **367,355**

[52] **U.S. Cl.** **51/319**

[51] **Int. Cl.** **B24c 1/00**

[58] **Field of Search** 51/319, 320, 321, 8, 14, 51/15, 11

[56] **References Cited**

UNITED STATES PATENTS

2,479,299	8/1949	Biggs	51/8
2,951,319	9/1960	Kornhaus	51/8
3,103,765	9/1963	Nolan	51/8

Primary Examiner—Donald G. Kelly

[57] **ABSTRACT**

Graphite molds are provided with a refractory coating which must be removed and renewed between each pour. An apparatus and method are provided for sand blasting the coated mold surfaces under controlled conditions to remove the refractory coating without eroding the graphite mold.

7 Claims, 6 Drawing Figures

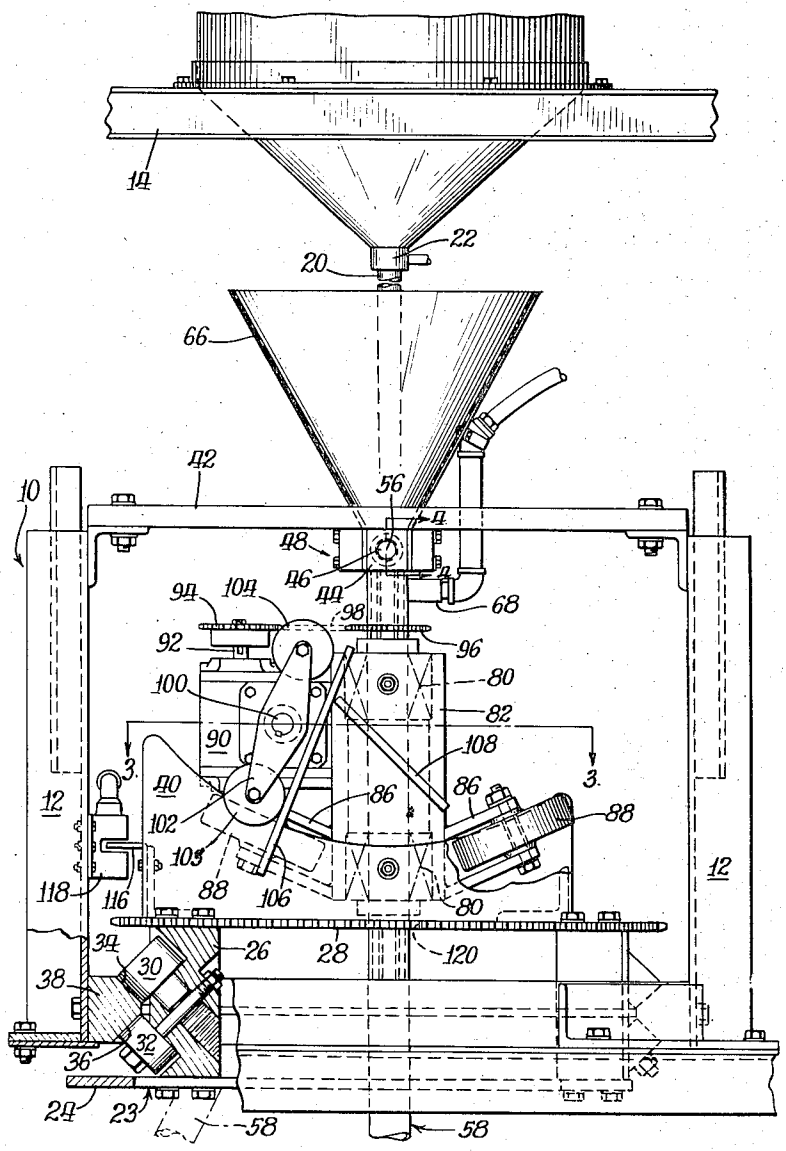


Fig. 1

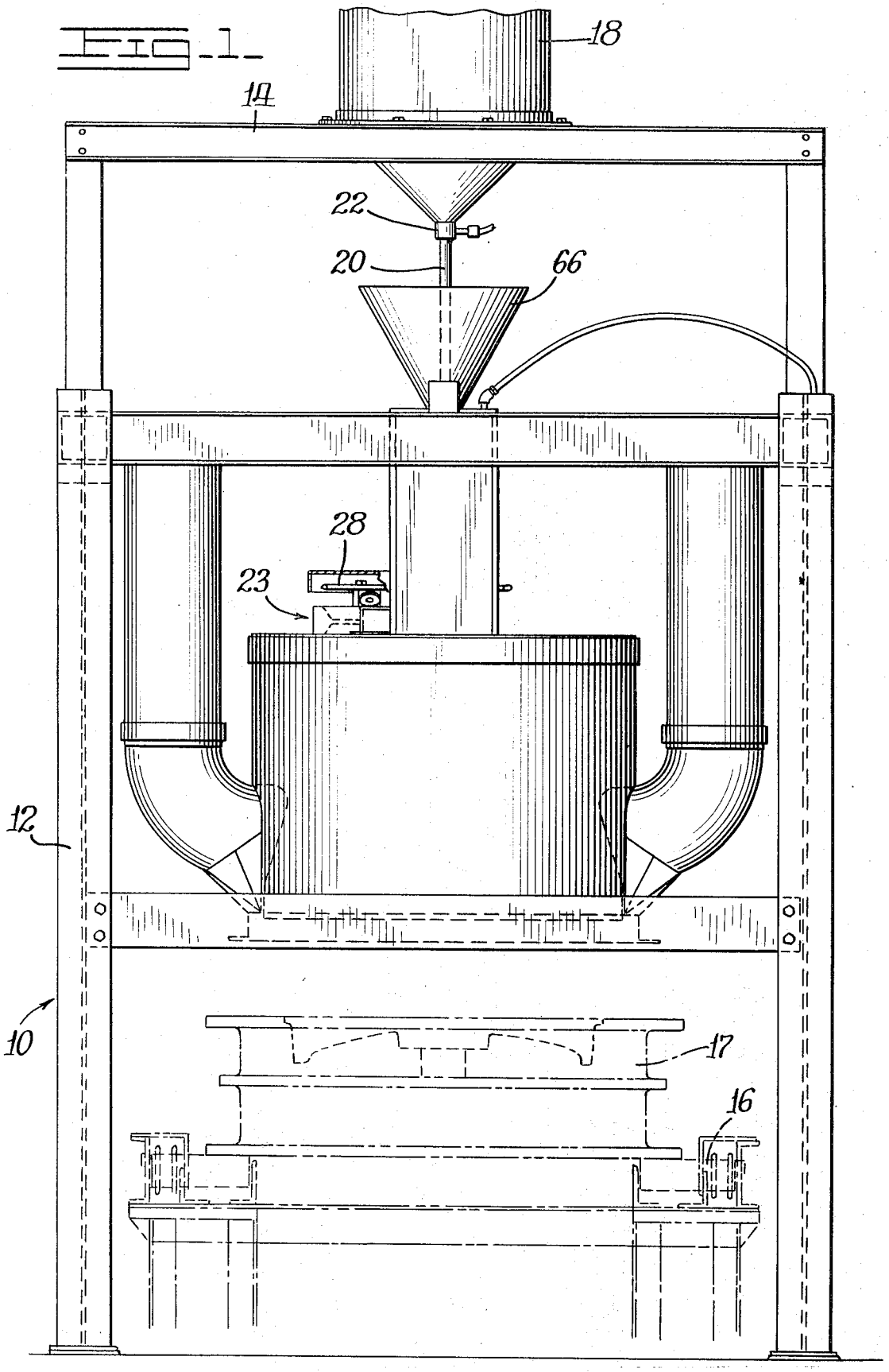


Fig. 2

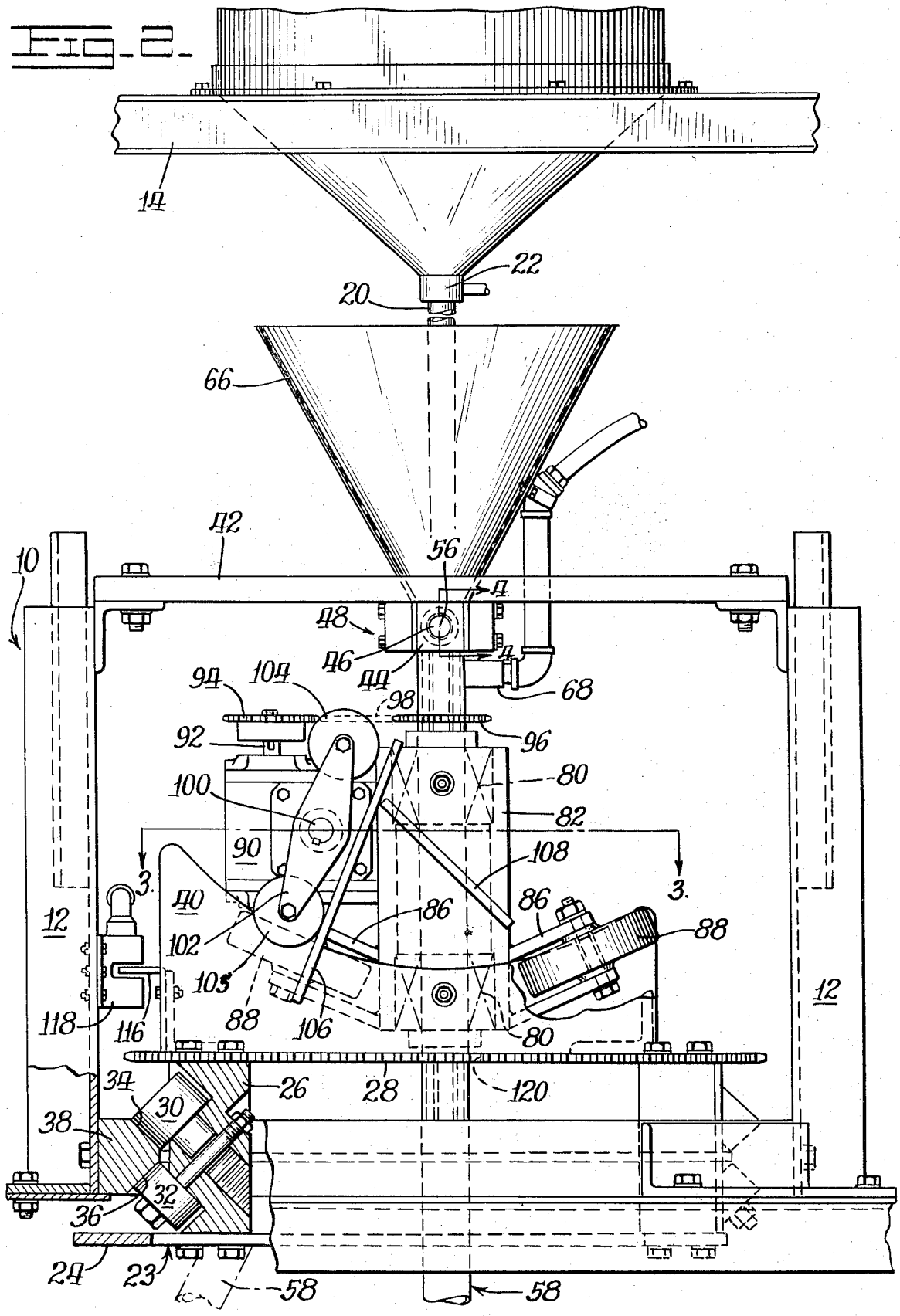

14
22
20
66
42
10
56
4
48
46
44
94
104
98
68
92
96
100
80
82
90
108
3.
40
12
86
86
88
102
103
88
106
80
118
116
34
26
28
120
30
38
32
36
24
23
58
58

Fig-3

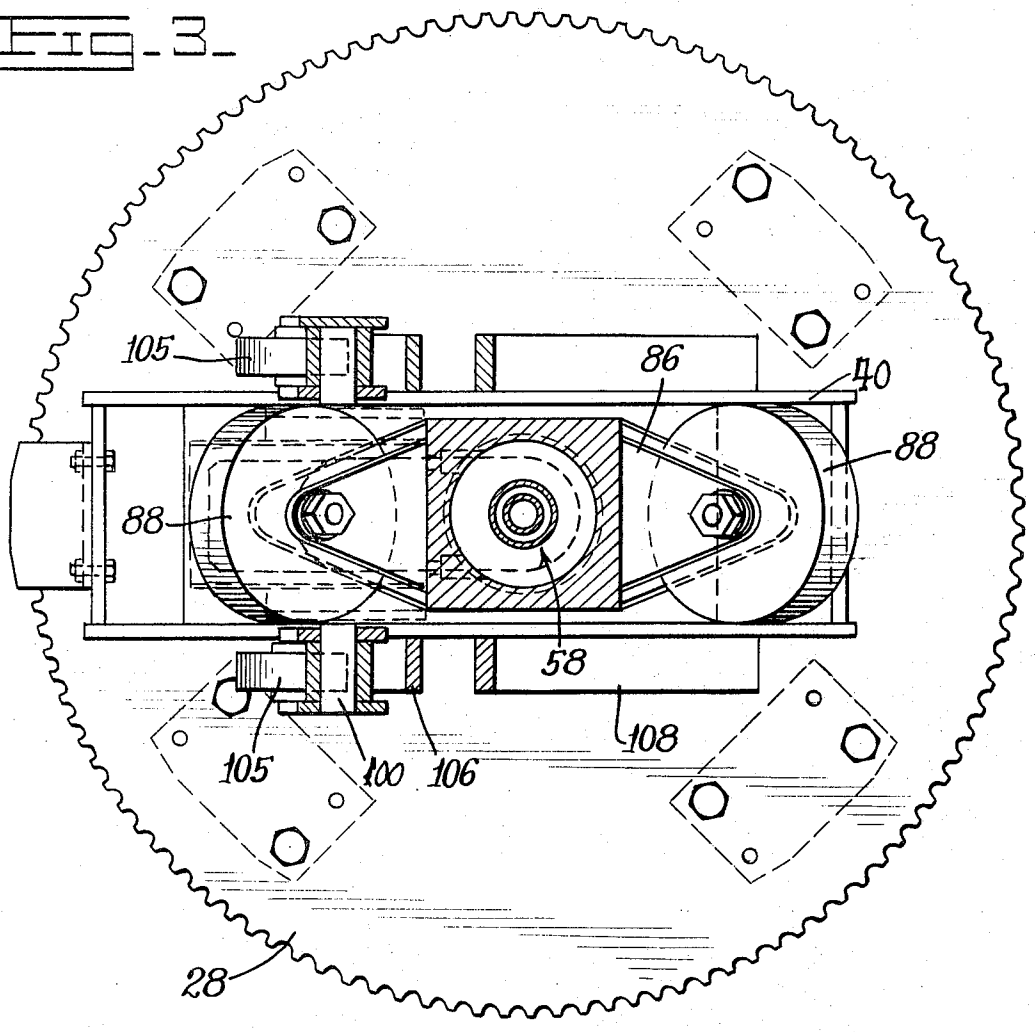
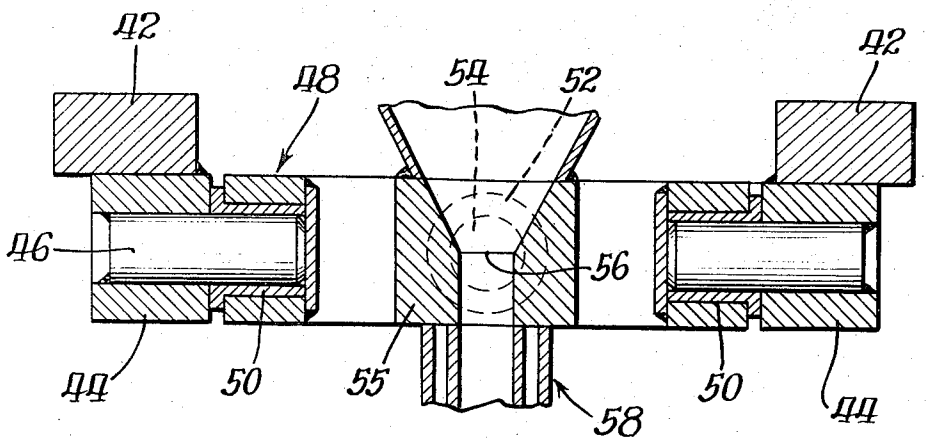

105
86
40
88
88
58
108
105
100
106
28

Fig-4


42
48
54
52
42
46
56
44
50
55
50
44
58

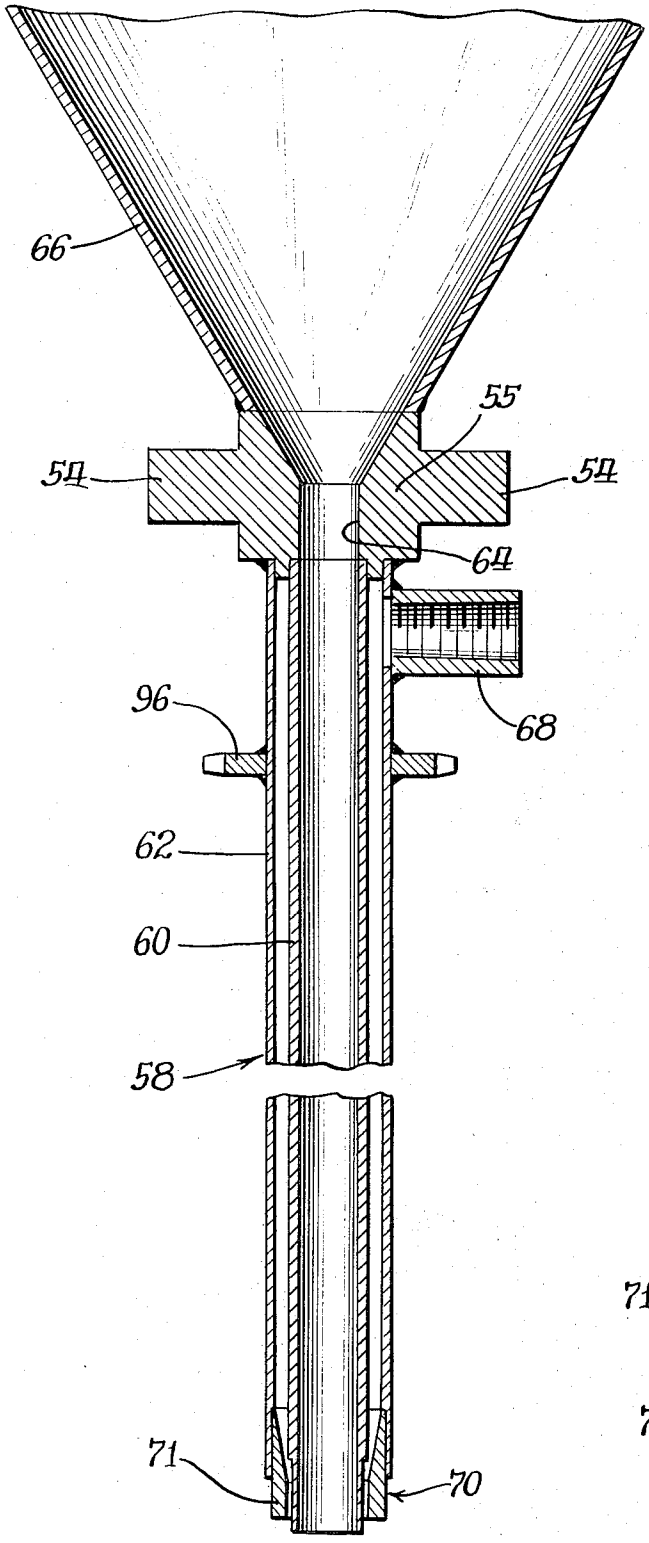
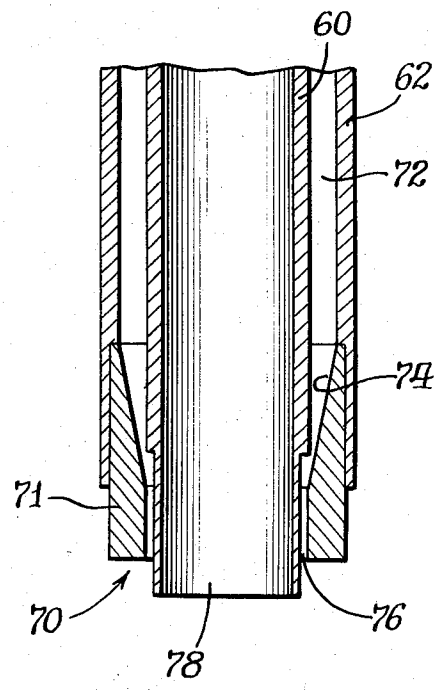


Fig. 5.

Fig. 6.



AUTOMATIC MOLD CLEANING

Cast steel articles, including railway car wheels, may be advantageously poured in permanent graphite molds. Both to protect the casting surface of such molds from excessive erosion and to eliminate defects on the surface of articles cast in such molds, the mold surfaces are spray coated with a refractory coating of quartz, zircon, crystobalite or the like. After each use of the mold, the coating must be removed and a new coating applied before the mold can be reused. In prior practice, the coating was removed by manually rubbing the coated surface with, for example, steel wool or burlap. This method of removal was not only time consuming and expensive but due to the mold temperature being at approximately 550° F., the cleaning was inconsistent and defects occurred in the cast articles in areas corresponding to improperly cleaned mold areas. A further disadvantage was that the rubbing action wore off the sharp corners at the mold parting line, resulting in fins on castings poured in such molds. Such worn conditions could only be corrected by the costly and time consuming job of re-machining the mold surface. The high temperature of the molds also contributed to a high turnover of the operators assigned to the cleaning job, and the proximity of the operators to the fine refractory particles constituted a potential health hazzard.

It is a primary object of the present invention to provide a method of and apparatus for removing the refractory coating from a used graphite mold without damaging the mold itself.

It is a further object of the invention to provide a device which will automatically project an abrasive against the mold surface to be cleaned in a controlled manner so that the area cleaned in a given unit of time is a constant.

Another object is to remove a coating from a mold surface by controlled blasting of the surface with properly selected abrasive particles and a blasting force sufficient to remove the coating but insufficient to erode the material of which the mold is made.

These and other objects will become apparent from the following description and accompanying drawings wherein:

FIG. **1** is a front elevation view of the preferred embodiment of the mold cleaning device;

FIG. **2** is a view similar to FIG. **1** but with certain portions shown in greater detail while eliminating other portions;

FIG. **3** is a sectional view taken along line **3—3** of FIG. **2**;

FIG. **4** is a sectional view taken along the line **4—4** of FIG. **2**;

FIG. **5** is a vertical sectional view taken through the sand spray gun; and

FIG. **6** is an enlarged sectional view of the nozzle portion of the sand gun.

Referring to the drawings and particularly to FIGS. **1** and **2**, the device comprises a framework **10** including a plurality of vertical members **12** and cross members **14**. The frame straddles a conveyor, shown in phantom at **16**, arranged to carry a succession of molds **17** into position for cleaning. Supported on the cross members **14** is a reservoir **18** for supplying the sand to the spray cleaning device. The sand is fed from the reservoir through a feed pipe **20** and the flow thereof may be controlled by a shut-off valve **22**, which may be, for example, a conventional solenoid operated slide valve.

The basic support for the sand cleaning portion of the arrangement comprises a rotatable drive assembly, generally indicated at **23**, which includes a bottom ring **24** having mounted thereon a plurality of spacer blocks **26** to which is secured a horizontally disposed drive sprocket **28**. Mounted in each spacer block **26** is an angularly disposed upper roller bearing **30** and a lower roller bearing **32** which ride an opposed bearing surfaces **34** and **36** of a stationary bearing ring **38** secured to frame members **12**. Secured to sprocket **28** for rotation therewith are a pair of opposed parallel drive plates **40**, the purpose of which will be explained hereinafter.

At a point between the drive assembly **23** and the cross members **14** there are provided a pair of spaced trunnion bars **42** having opposed depending lugs **44** (see also FIG. **4**) from which project inwardly thereof trunnions **46**. Suspended for pivotal motion on the trunnions **46** is a universal joint **48** (FIGS. **2** and **4**) having bearings **50** receiving the trunnions. The joint **48** also is provided with a pair of bearings **52**, at right angles to the bearings **50**, arranged to receive opposed trunnions **54** of trunnion block **55** which forms a part of the sand spray gun **58**. It is apparent that the sand spray gun therefore is free to pivot in any direction about a pivotal axis **56**, the point of intersection of the center lines of the two pairs of trunnions **46** and **54**.

The sand gun, generally indicated at **58** and shown in greater detail in FIG. **5**, comprises generally an inner pipe **60** concentric with an outer pipe **62**, both pipes being welded to the trunnion block **55**. The trunnion block is provided with an opening **64** communicating with a funnel **66** secured to the block and positioned below the reservoir **18**. An air inlet **68** is provided whereby air can be forced through the gun into the space between the inner and outer pipes.

The nozzle portion of the spray gun is indicated generally at **70** and is shown in greater detail in FIG. **6**. Referring to this figure, it is seen that the outer pipe **62** is counterbored to receive a nozzle adapter **71**. The upper inner portion of the nozzle adapter is tapered upwardly and outwardly so that air may flow through an air passage **72** between the two concentric pipes of the gun and along the tapered surface **74** through a constricted air outlet **76**. The blast of air through the constricted outlet **76** produces a slight negative pressure, or vacuum, at the sand orifice, which may be varied by regulating the air pressure so as to modulate the velocity of the exiting sand. The separate adapter is provided primarily to accommodate variable blasting requirements. The lower end of the inner pipe **60** is open as at **78** to provide an outlet for the sand.

It is seen from the above that the sand gun assembly, being mounted in a universal joint, is free to pivot in any direction but is not free to rotate about its longitudinal axis.

As best seen in FIGS. **2** and **3**, a rotatable bearing block **82** is mounted on spaced bearings **80** received on the outer pipe **62**. Secured to and projecting laterally from the bearing block **82** are a pair of brackets **86** arranged to receive a pair of spaced guide wheels positioned such that the longitudinal axis of each guide wheel passes through the axis **56** of the trunnion assembly **48**.

Also secured to the bearing block for rotation therewith is a gear box **90** having an input shaft **92** on which is mounted a sprocket **94** connected by a chain **98** to a sprocket **96** non-rotatably secured to the outer pipe **62** of the sand gun. The output shaft **100** of the gear box has mounted thereon a cam bar, or crank, **102** carrying at each end thereof cam wheels **104** and **105.** The cam wheels are offset as best seen in FIG. **2** so that, at any particular time, only one of them is free to contact a cam plate **106** which is carried by a plurality of cam plate supports **108** welded or otherwise secured to drive plates **40.** In the present device and to accommodate the usual range of sizes of wheel molds, the cam plate **106** has been positioned at an angle of approximately 20° from the vertical. However, this angle may be varied considerably without changing the basic principle of operation of the device.

Also secured to the sprocket **28** for rotation therewith is a vane **116** movable through the sensing portion of an electric pulse counter **118.**

In order to operate the sand blasting apparatus in a mold cleaning operation, the cope or drag portion of a mold from which a casting has just been removed is positioned beneath the sand gun as shown in FIG. **1.** The shut-off valve **22** is opened to feed sand into the funnel **66** and thence through the inner pipe **60,** while air is admitted through inlet **68** into the air flow passage **72.** Simultaneously the sprocket **28** is rotated by means of a suitable motor, preferably at a speed of about fifteen revolutions per minute, thereby rotating the entire drive assembly **23** including the base plate **24** and the opposed drive plates **40.** The drive plates **40** are parallel and positioned at a distance which is slightly greater than the outside diameter of the guide wheels **88** and, as they rotate, they will, through the guide wheels, rotate the bearing block and the components affixed thereto. Because of the fact that the sprocket **96** is non-rotatably secured to the sand gun, the sprocket **94** is forced to move in a circular path about the longitudinal axis of the sand gun causing the input shaft **92** of gear box **90** to rotate at the same R.P.M. as the sprocket **28.** With a preferred 20 to 1 reduction in the gear box, the output shaft **100** will rotate at 1/20 of the speed of the sprocket **28.** This rotation, in a counter-clockwise direction, rotates the crank **102** so as to urge the cam wheel **105** against cam plate **106.** The cam wheel of necessity rolls up the plate thereby pivoting the sand gun outwardly toward the position shown by the phantom lines in FIG. **2.** A slot **120** is provided in sprocket **28** to accommodate the movement. The pivotal motion of the sand gun, together with the rotational motion of the bearing block and its components, causes the nozzle end of the sand gun to move in a spiral path outwardly across the mold surface which is to be cleaned.

The device is timed so that one outward and inward cycle of the gun is completed in ten revolutions of the sprocket **28** and one half of a revolution of the output shaft **100.** Furthermore, because the cam wheel **104** is moving in approximately a circular path, the speed at which the pivoting action of the sand gun takes place is variable, and the rate of variation is in the form of a modified sinusoidal curve whereby the laterally outward speed of the sand gun decreases as the distance from the center line of the device increases. However, the area of the mold which must be covered per revolution also increases with increasing distance from the center line. It is seen then, that the area traversed by the sand gun per each unit of time is approximately constant. It is possible therefore to provide complete cleaning of all areas of the mold with a minimum of blasting and consequently with a minimum of erosion of the mold surface.

Through a complete cycle, the sand gun, which was originally positioned at the center of the mold, was moved radially and circularly in the spiral path out to the mold periphery and then on a similar spiral path back to the center line of the mold to complete the cycle. Meanwhile the vane **116** with each revolution of the gear **28** was passing the electronic counter **118,** which may be regulated in a conventional manner to shut off the flow of sand after a predetermined number of revolutions of the sprocket **28** and to stop the device completely after another predetermined number of revolutions (preferably **10**) which is a complete cleaning cycle.

Because the apparatus was designed to treat soft material such as graphite, it has been found most advantageous to utilize round silica sand of about 135 to 150 A.F.S. fineness. If the sand is appreciably courser, mold erosion could occur while if the sand is appreciably finer, the efficiency of the cleaning will be decreased.

It has been found that the apparatus operates satisfactory with the nozzle portion of the sand gun in its original position being about 24 inches from the mold surface and utilizing air pressure at about 40 pounds per square inch. As the gun swings outwardly toward the periphery of the mold, the nozzle is moving in an arcuate radial path and therefore is moving away from the mold surface. To obtain a constant cleaning effectiveness, it has been found that air pressure is preferably gradually increased from the starting pressure of about 40 PSI to approximately 50 PSI at the outer limit of the cycle. Obviously these distances and pressures may be varied and adjusted as required at the time of the original set up of the equipment. However, to accommodate the above variables, it is preferred to use a conventional variable air pressure regulator programmed such that the pressure will automatically increase from 40 pounds per square inch at minimum gun angle to approximately 50 pounds per square inch in the maximum gun angle. This of course is accomplished with conventional equipment which does not form part of the present invention.

The apparatus is also provided with an exhaust system whereby the used sand and the coating removed thereby are sucked away from the mold and into a separator wherein the sand, which is reusable, is separated from the coating dust which is discarded.

What is claimed is:

1. A method of removing a foreign material from the surface of a graphite mold, comprising the steps of: suspending a sand spray gun from a universal joint over the axis of the mold with the lower end of the gun spaced from the mold; then dropping sand through an inner gun passage and forcing air through an outer gun passage so that sand is forcefully ejected against the mold surface, while simultaneously moving the lower end of the gun in a spiral path toward the periphery of the mold, the rate of speed of the circular component of said path being constant and the rate of speed of the radial component of said path being at a decreasing rate.

2. A method according to claim 1, and including the step of increasing the air pressure and thereby the sand velocity as the lower end of the gun moves from the axis to the outer periphery of the mold.

3. A method according to claim 1, wherein the sand is silica and of about 135 to 150 A.F.S. fineness.

4. A method of removing a mold coating from the casting surface of a graphite mold, comprising the steps of:

suspending a sand spray gun on the axis of the mold and spaced from the mold, and then, while forcing sand through the spray gun and against the mold surface, moving the spray gun in a spiral path toward the periphery of the mold, the rate of outward radial motion of the gun decreasing substantially proportionally to the increase in distance from the mold axis so that approximately equal areas of the mold are cleaned in equal increments of time.

5. Sand blasting apparatus comprising, a frame; a sand blasting gun having its upper end suspended from the frame for universal pivotal movement; a first means for moving the lower end of said gun in a radial direction; and a second means for simultaneously moving the lower end of said gun in a rotary path so that the combined motions cause the lower end of the gun to move in a spiral path, said first means comprising a rotatable shaft movable with said gun in radial direction; a crank secured to the shaft for rotation therewith; a cam wheel at the outer end of the crank; a cam plate immovable in a direction radially of said gun; said cam wheel being movable, upon rotation of said shaft, along the cam plate to force said shaft and said gun radially outward at a decreasing rate of speed.

6. Sand blasting apparatus according to claim 5 wherein said first means includes a bearing block rotatably mounted on the gun below the pivotal axis thereof; a gear box secured to said block for rotation therewith; a sprocket secured to the gear box input shaft; a sprocket nonrotatably secured to the gun; a chain interconnecting said sprockets; an output shaft on the gear box; a cam bar secured to the output shaft for rotation therewith; a cam wheel carried by the cam bar; and an angularly disposed cam plate engageable by the cam wheel as the output shaft rotates.

7. Sand blasting apparatus according to claim 5 wherein said second means comprising a pair of guide wheels rotatably mounted on opposite sides of said block for rotation therewith, the axis of each wheel being disposed to pass through the pivotal axis of the gun; a rotatable drive assembly carried by the frame and positioned concentric with the gun and below said bearing block; spaced parallel guide plates secured to the upper portion of said drive assembly for rotation therewith; said guide plates straddling said guide wheels and being engageable therewith; and means for rotating said drive assembly.

* * * * *