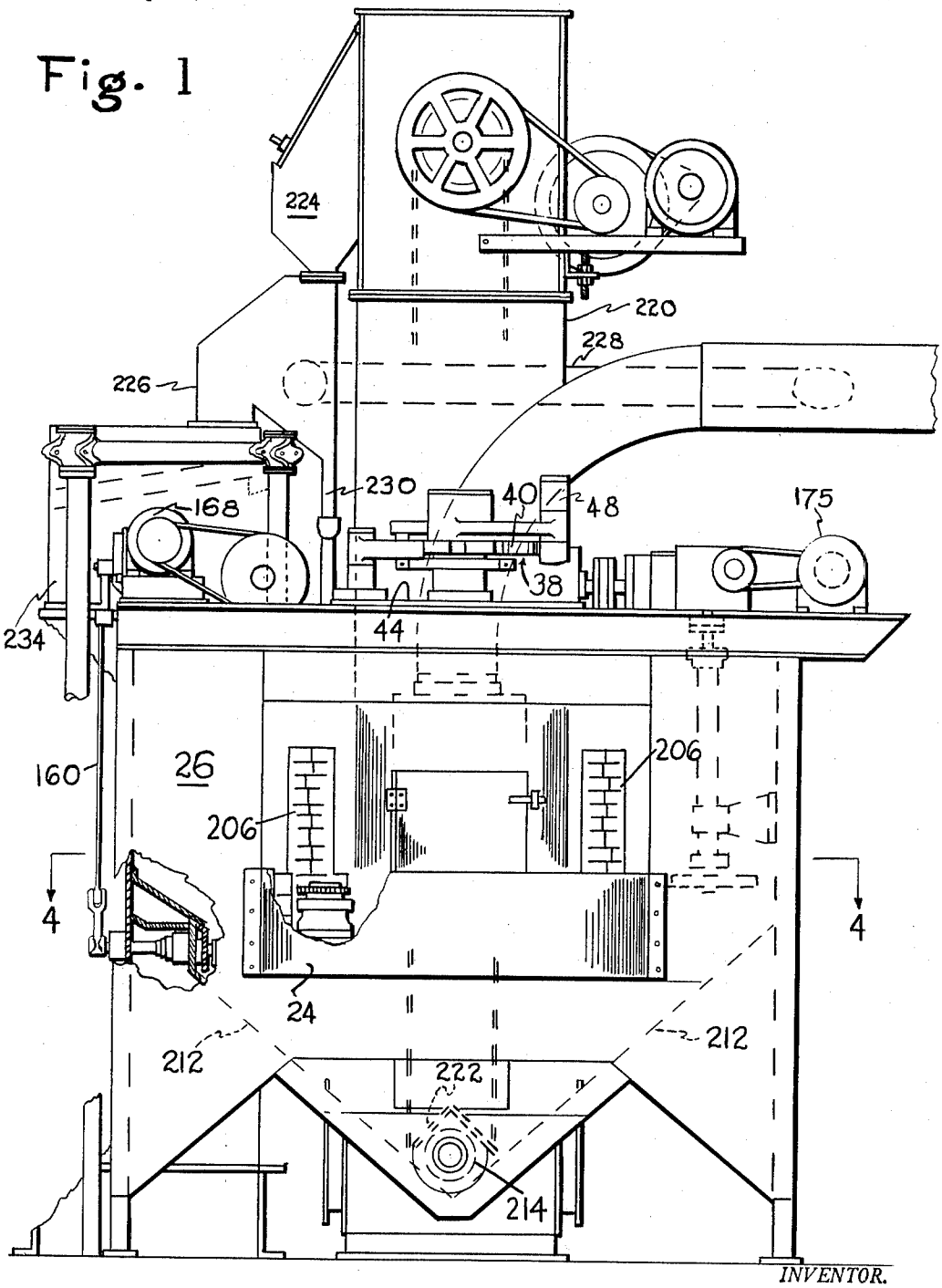
Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 1

Fig. 1




INVENTOR.

M. E. FAHRNEY

BY Connally & Hutz

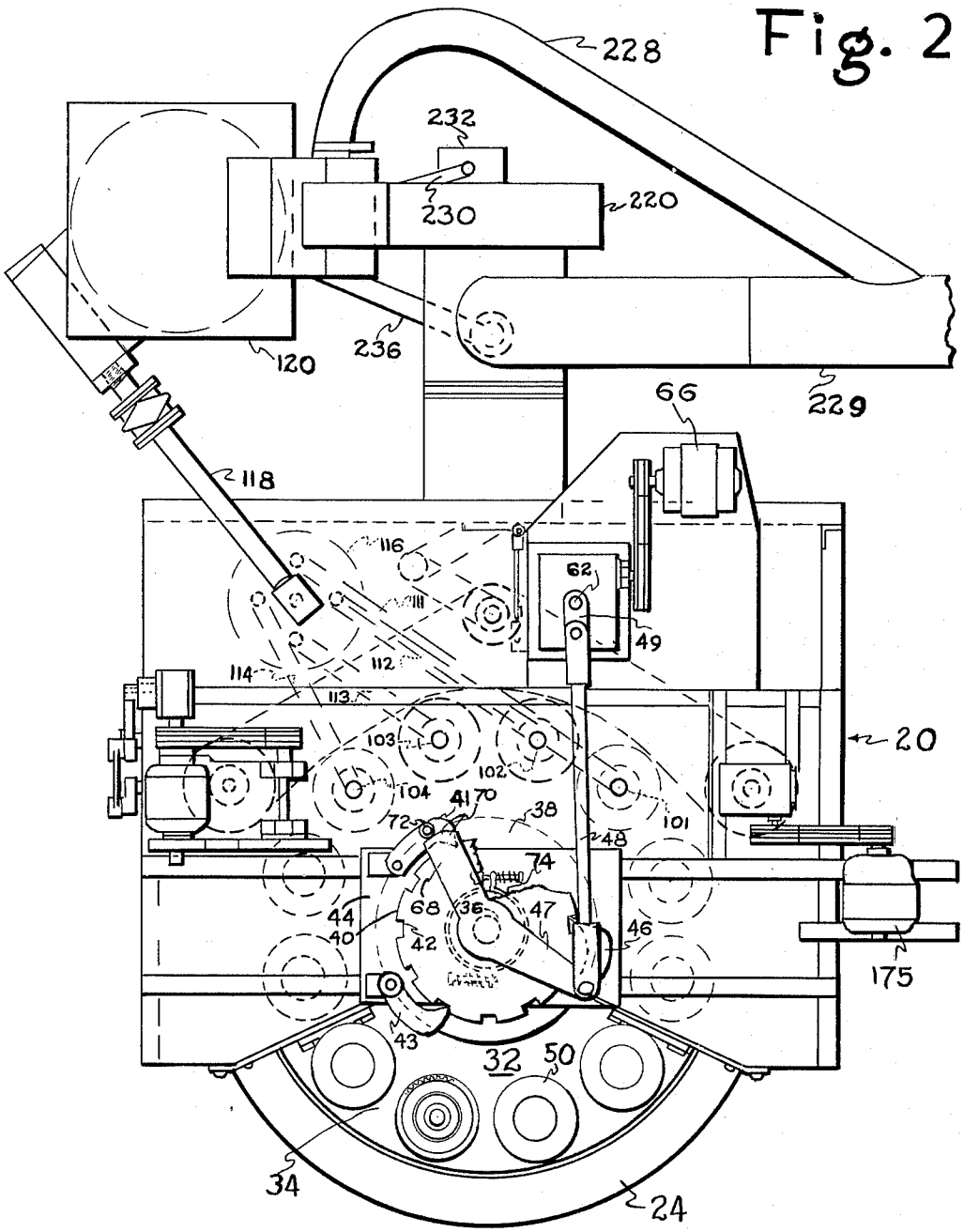
HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 2

Fig. 2




*INVENTOR.*

M. E. FAHRNEY

BY Connolly & Hutz

HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 3

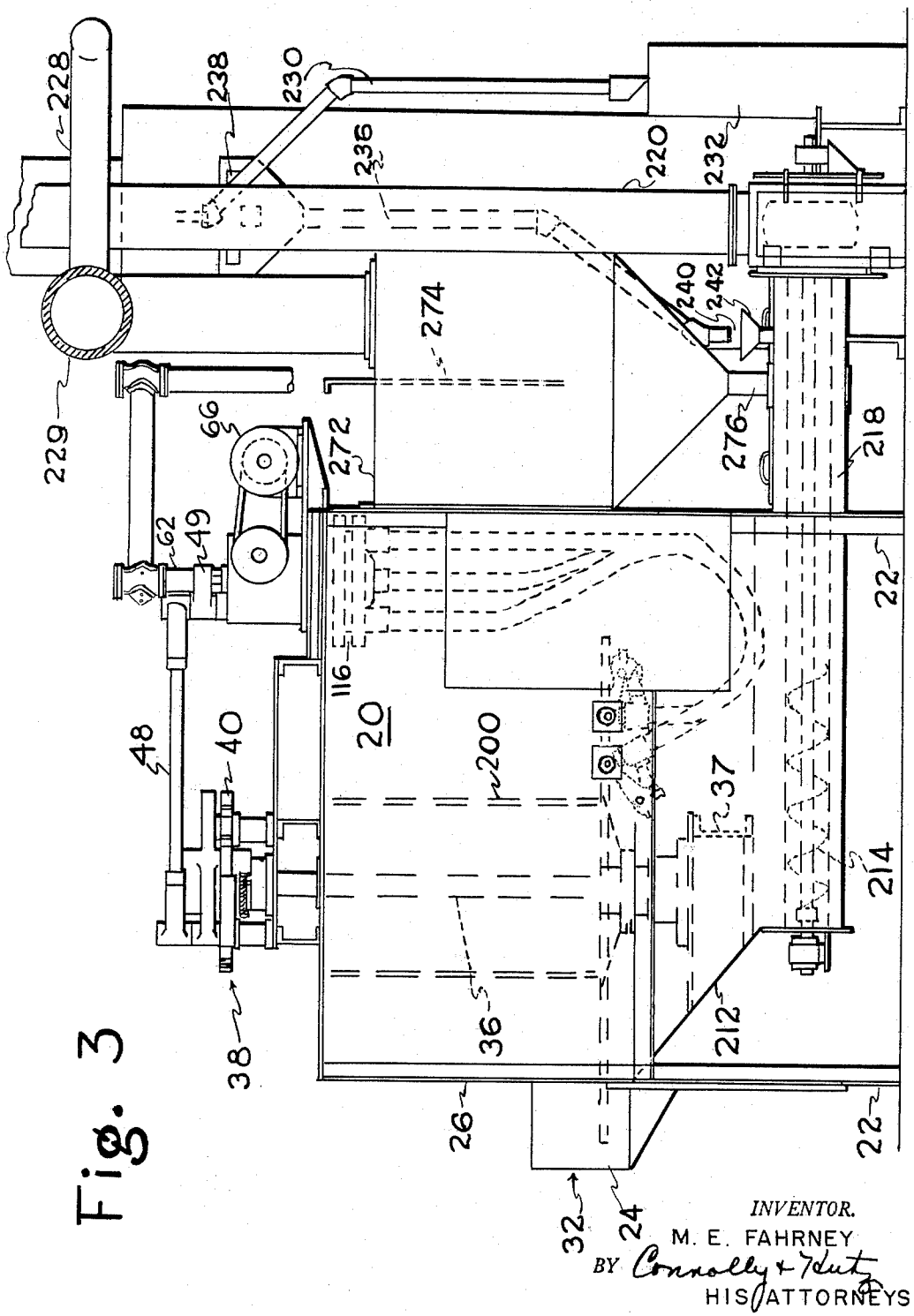



Fig. 3

INVENTOR.
M. E. FAHRNEY
BY Connolly & Hutz
HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 4

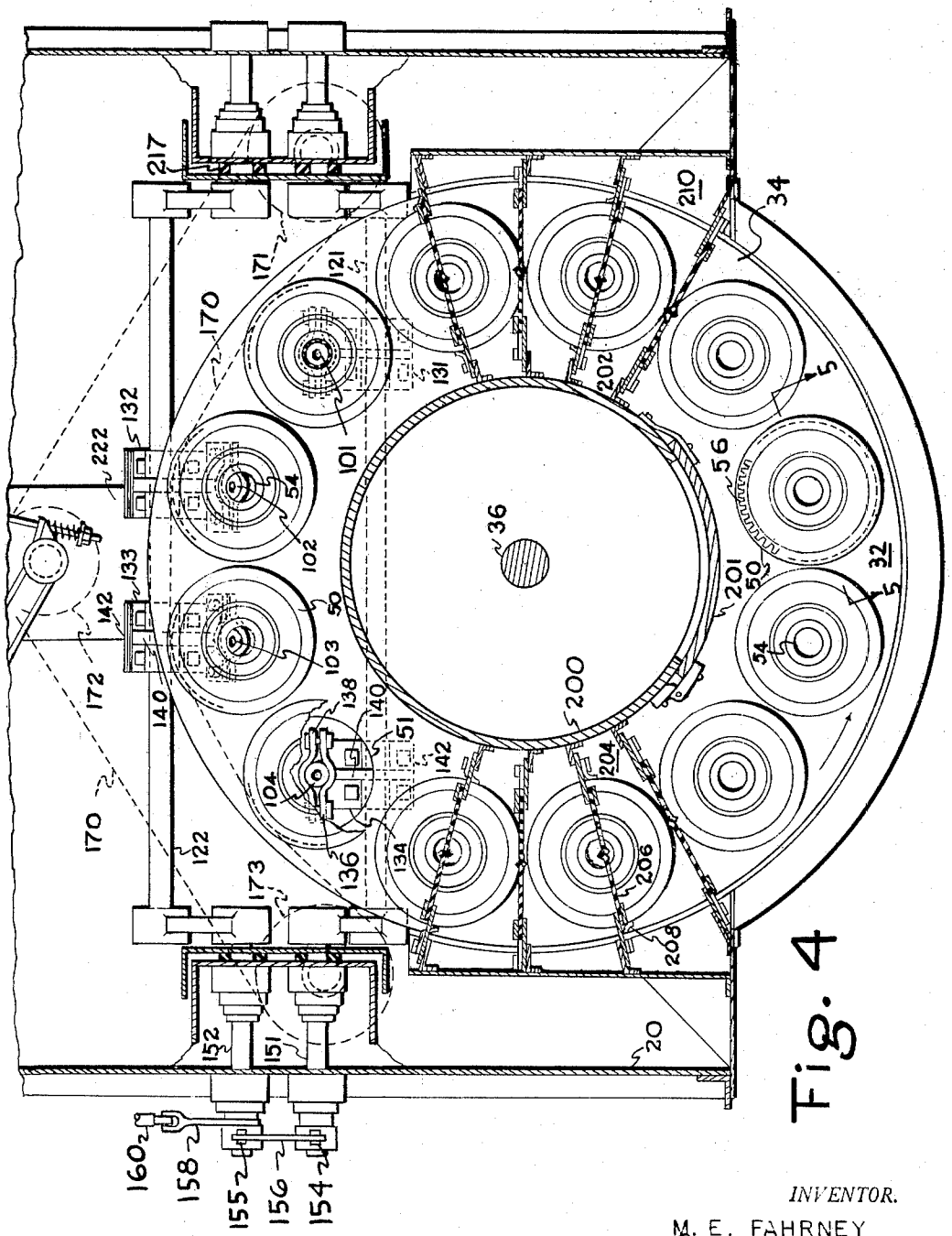



Fig. 4

*INVENTOR.*

M. E. FAHRNEY

BY Connally & Hutz

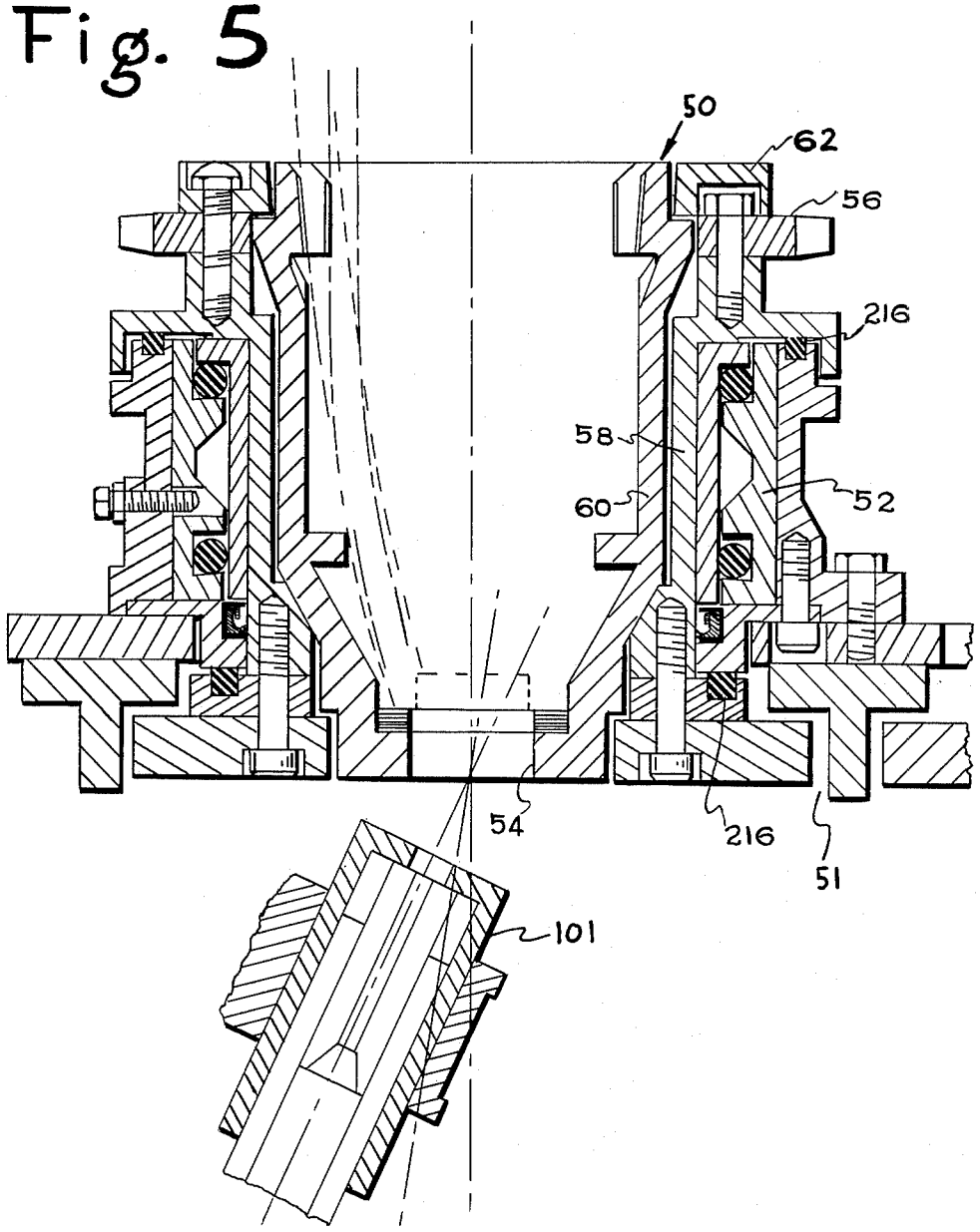
HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 5

Fig. 5




*INVENTOR.*

M. E. FAHRNEY

BY Connolly & Hutz

HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 6

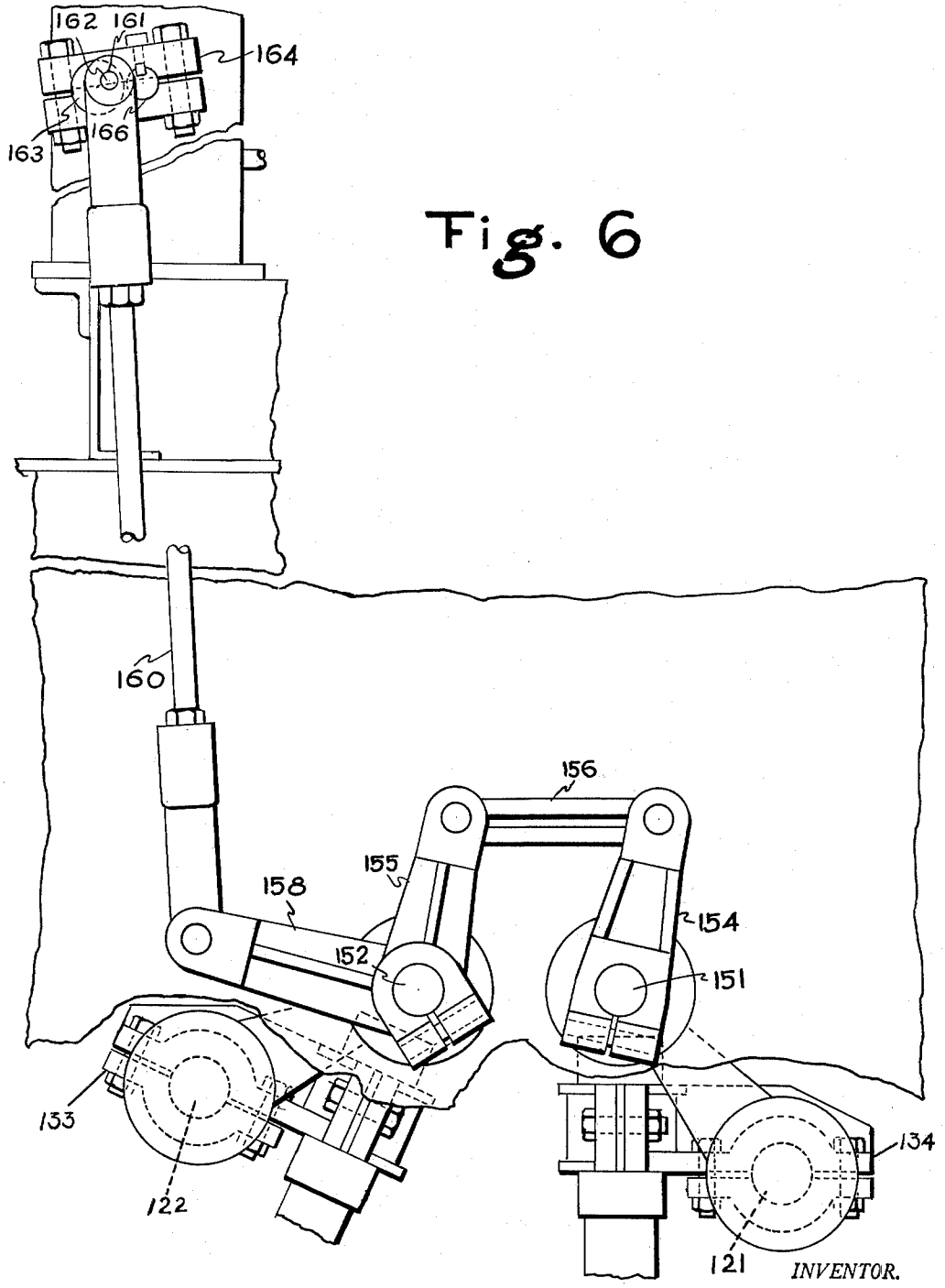



Fig. 6

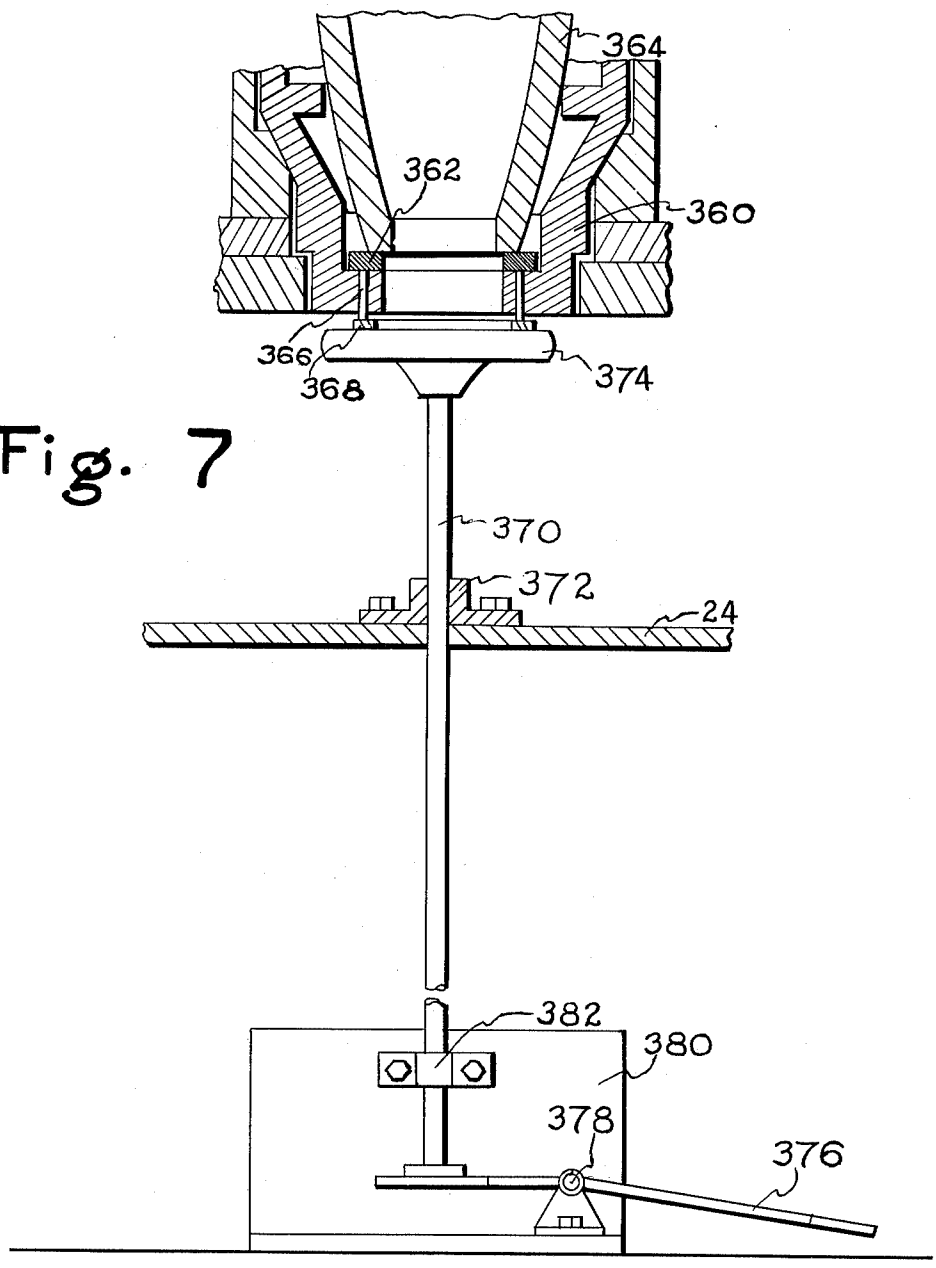
INVENTOR.
M. E. FAHRNEY
BY Connolly & Hutz
HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 7

Fig. 7




*INVENTOR.*

M. E. FAHRNEY

*BY* Connolly & Hutz

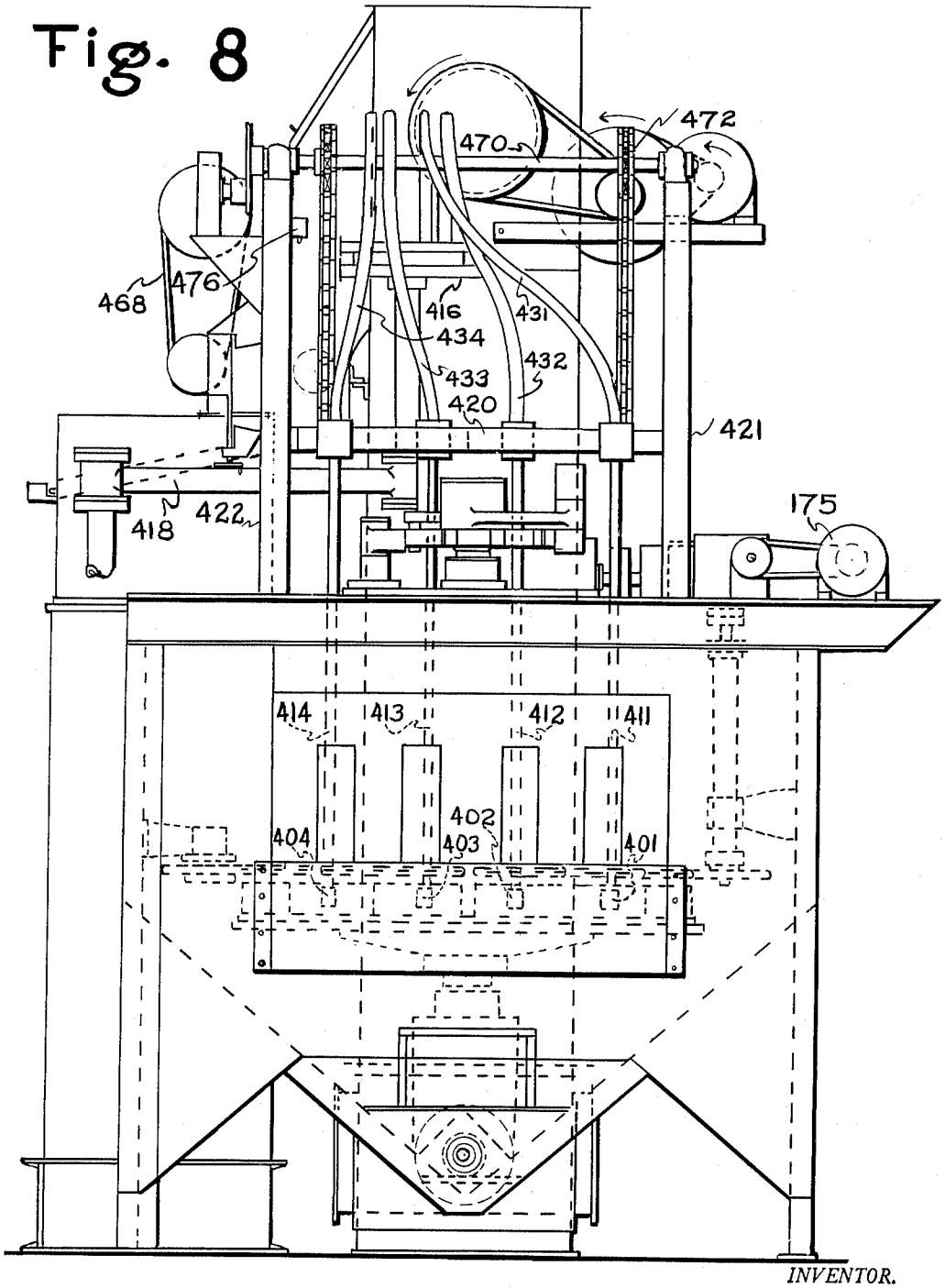
HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 8

Fig. 8



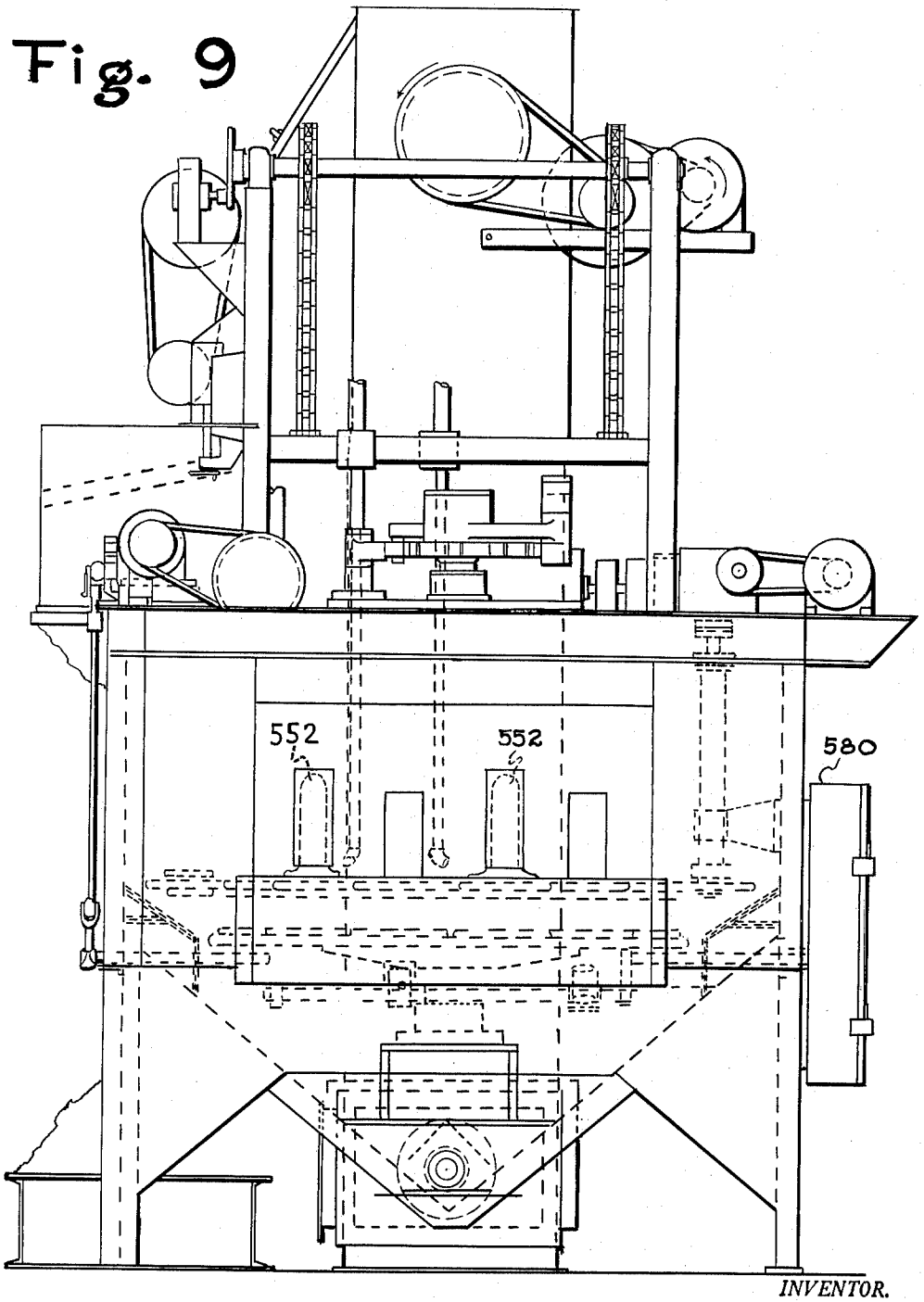

INVENTOR.
M. E. FAHRNEY
BY Connally & Hutz
HIS ATTORNEYS

Oct. 4, 1955 M. E. FAHRNEY 2,719,387

BLASTING APPARATUS

Filed July 11, 1952 9 Sheets-Sheet 9

Fig. 9




INVENTOR.
M. E. FAHRNEY
BY Connolly & Hutz
HIS ATTORNEYS

United States Patent Office 2,719,387 Patented Oct. 4, 1955



2,719,387

# BLASTING APPARATUS

Maxwell Edwin Fahrney, Hagerstown, Md., assignor to Pangborn Corporation, Hagerstown, Md., a corporation of Maryland

Application July 11, 1952, Serial No. 298,344

15 Claims. (Cl. 51—15)

The present invention relates to blasting apparatus, more particularly to such apparatus in which a stream of blastant particles is projected at a work piece to abrade its surface, as for example to clean, debur, peen or grain the work piece.

Among the objects of the present invention is the provision of a blasting apparatus in which the internal surfaces of open-ended hollow work pieces are very effectively abraded.

Additional objects of the present invention include the provision of a blasting apparatus having a blasting chamber provided with novel blastant sealing and recycling mechanism.

The above as well as additional objects of the present invention will be more clearly understood from the following description of several of its exemplifications, reference being made to the accompanying drawings wherein:

Figs. 1, 2 and 3 are a front elevation, plan and side views respectively, of the apparatus embodying the present invention with parts removed in the interest of clarity;

Fig. 4 is a horizontal sectional view of a portion of the apparatus of Fig. 1, taken generally along the line 4—4 of Fig. 1;

Fig. 5 is a vertical section along the line 5—5 of Fig. 4;

Fig. 6 is a fragmentary side view from the left of the apparatus of Fig. 1;

Fig. 7 is a detail cross-sectional view generally similar to Fig. 1 of a modified form of the invention; and

Figs. 8 and 9 are views similar to Fig. 1 of further modifications of blasting apparatus embodying the present invention.

According to the present invention, there is provided a blasting apparatus having a set of holders each shaped to receive a hollow open-ended work piece and hold it with its open end oriented in a predetermined direction, operating mechanism connected to step-wise advance the holders of said set around an endless path including a blasting zone, blasting nozzle structure at said blasting zone and adjacent the stepped position of the holders, said structure including blast impelling means connected to project a stream of blastant particles and traverse elements connected to cause the blastant stream to sweep during the blasting over the inner surfaces of the work pieces and said operating mechanism being connected to rotate the holders during the blasting to cause the internal surface of the work pieces to be blasted over their entire circumference.

The blasting zone is conveniently in the form of a chamber having an exposed loading and unloading station, an entrance passageway and an exit passageway communicating between the chamber and the station, and a barrier defining a wall of the chamber and immediately between the blasting zone and the station, said passageways each being curved around the respective sides of the barrier and each having a plurality of curtains forming a succession of blastant seals. For improved positioning accuracy, particularly at variable operating speeds, the holders are actuated by a ratchet mechanism accurately driven by a crank and cooperating with a brake which frictionally keeps the sockets from even slight movement except when positively actuated by the ratchet.



The blasting is very simple to supervise when effected by a blastant projector feed from a recirculating system connected to collect the blastant particles projected against the work pieces, separate and return the reusable collected particles for additional blasting and including a feed mechanism having a holder connected to carry the returning particles and store them for feeding the blastant projector, the holder having an overflow line connected at a predetermined level and said line providing a visible overflow connected to empty into another portion of the blastant recirculattion path to positively indicate by the absence of visible blastant overflow that the supply of blastant is below the predetermined level and should be replenished.

Referring more particularly to the drawings, Figs. 1 to 7 inclusive show an apparatus having a principal enclosure 20 mounted on legs 22 and fitted with a forwardly protruding ledge 24. Above the ledge the front wall 26 is recessed inwardly to provide an open station 32.

Within the chamber bounded by enclosure 20 a circular table 34 is rotatably mounted on a vertical post 36 that extends up through the chamber's roof and rests on supports 37 secured to the chamber's floor. A rotating mechanism shown as a ratchet drive assembly 38 including ratchet gear 40 is connected to the projecting post top to rotate the post and thereby rotate the table. Distributed around the table are a series of work holders 50. In the illustrated construction twelve such holders are shown as fitted over equally spaced openings 51 near the table's periphery, each journalled in a bearing ring 52 for rotation around a vertical axis as more clearly seen in Fig. 5. The rings 52 are fixed to the table around the openings 51 and the work holders 50 are generally cup-shaped with openings 54 in their bottoms. Each holder carries on its exterior a rotating member such as the sprocket gears 56. The holders can, if desired, be of two part construction, as for example the wedged-together outer cup 58 and inner socket 60, and kept from separating by a retainer ring 63.

The ratchet mechanism is arranged to rotate the table around in steps each of which is equal to the angular separation between successive holders 50. For this purpose the ratchet wheel 40 has its periphery provided with notches 42 corresponding in number to the number of steps desired per complete rotation, and cooperates with two latching pawls 41, 43 pivoted to a support plate 44 and biased toward engagement with the ratchet wheel.

Pawl 41 is shaped to coact with the notches 42 and keep the ratchet wheel from rotating in the counterclockwise direction as seen in Fig. 3, while pawl 43 correspondingly keeps it from rotating in the clockwise direction. An advancing pawl 46 is carried by a lever 47 and is also biased toward engagement with the ratchet roller. Lever 47 is pivoted around shaft 36 and is connected for arcuate reciprocation by a crank rod 48 which in turn is linked by a crank arm 49 suitably pivoted for rotation around pin 62 and driven as by motor 66. Lever 47 also includes an integral extension 68 that has a terminal cam edge 70 shaped to coact with a boss such as roller 72 carried by pawl 41 to lift this pawl out of latching position when the advancing pawl 46 is brought to the beginning of its advancing stroke, as illustrated in Fig. 3.

In addition, the drive assembly can advantageously include a brake that applies a frictional drag to the table's rotation. Such a brake is shown in Fig. 2 as merely a set of external brake shoes 74 fitted with suitable brake lining and biased into frictional engagement with a brake surface provided on shaft 36 and/or ratchet wheel 40.

Within the blasting chamber there is a blasting zone in which are located a set of blasting nozzles 101, 102,

103, 104 connected as by flexible hoses 111, 112, 113, 114 respectively to a source of blastant such as a distribution manifold 116. This manifold is shown as supplied by a conduit 118 from a mixing unit 120 where blastant particles such as metal shot or sand are mixed with compressed air or other propelling medium.

As best seen in Fig. 5, the nozzles are positioned to direct their streams of blastant up through the bottom openings 54 of the work holder sockets 60 in the blast zone every time the table is stepped forward. The blasting can be continued through the indexing travel or if desired it can be interrupted at those times. The nozzles which are generally tubular are, as best shown in Figs. 4 and 5, carried on a pair of shafts 121, 122 by clamps 131, 132, 133, 134 each of which has a split cylindrical section 136 clamped about the nozzle by means of opposed sets of clamping ears 138. A web 140 formed on one part of the section 136 carries a second split section 142 which is similarly clamped to a shaft. Nozzles 101 and 104 are fastened to shaft 121 while the other two nozzles are on the other shaft. Both shafts are shown as parallel to each other and eccentrically mounted to pivot about horizontal axes spaced from the shaft itself. This is arranged by offsetting the ends 151, 152 of the respective shafts and journalling these ends in the housing wall 20. It should be noted that the shafts 121 and 122 are arranged to rotate about axes which intersect the longitudinal axes of their corresponding sockets 60. It should also be noted that the nozzles are connected to the crank shafts in such manner that the longitudinal axes of the nozzles intersect the longitudinal axis of their respective crank shafts. The arrangement is such that the center of the arc of movement of the nozzle structure is at the mid-point of the lower end of the work supporting sockets.

The nozzles are arranged to direct their blastant streams up through the openings 54 in the bottom of some of the holders 50. In addition, the shafts are rocked to and fro to cause these streams to traverse across and sweep over the surface of the work pieces held in the holders. Where the work pieces are hollow open-ended articles such as artillery shells and they are placed in the holders 50 with their open ends down, their internal surfaces are very effectively and thoroughly blasted with a total nozzle tilt of only about 25 to 30 degrees from the vertical to one side of the vertical. For this purpose the offset shaft ends 151, 152 are linked to a reciprocating mechanism best shown in Fig. 6 as including a rocker arm 154 fixed to one end 151 of shaft 121 and a rocker lever 155 fixed to the corresponding end 152 of shaft 122. The two rockers 154, 155 are connected together as by link 156 and actuated by a second lever arm 158 forming part of rocker 155. In the form shown, the arm 158 is reciprocated up and down about the shaft end 152 by a crank bar 160 which at its upper end is fitted by eccentric pin 162 to a split crank 164 rotated around axle 166 as by means of electric motor 168 shown in Fig. 1. The amplitude of reciprocation is readily adjustable by merely loosening split crank 164, shown in Fig. 6, and suitably varying the orientation of the projecting portion 161 of eccentric pin 162 with respect to its clamped portion 163 to thereby change the radius of the rotation through which this pin carries the upper end of bar 160. Tightening the split crank 164 keeps the adjustment from shifting.

The work holders are also arranged to rotate the work articles so that the streams of blastant sweeping with the tilting nozzles reach the entire circumference of the surface of the work pieces. As shown in Fig. 4, this is readily effected by providing the blasting chamber with a drive such as a belt or chain 170 that automatically engages the sprocket gears 56 and rotates them as the holders on which they are fitted reach the blasting zone. The belt or chain 170 is illustrated as looped around a set of sprockets 171, 172, 173 and impelled as by driving one of the sprockets, 171 for example, from a motor 175 shown in Fig. 1 as mounted above the chamber. One of the rollers, as indicated at 172, can also be adjustably positioned to control the chain tension. The holder rotation can be limited to the four positions at which the blasting nozzles are located.

A feature of the above construction is that the nozzle sweep and work rotation combine to effectively play the blastant stream over the internal surface of the work pieces. This is particularly efficacious where the nozzle tilts about a pivot point adjacent the open end of the work pieces or the work holders. This technique gives the stream a very broad sweep range with about the least possible interference by the mouths of the work pieces or their holders.

According to the present invention the blasting chamber is carefully sealed to minimize the escape of blastant particles from the blasting zone. To this end the table is provided with a barrier in the form of a cylindrical wall 200 directly interposed between the blasting zone and the loading and unloading station 34. This wall also surrounds the table-carrying post 36 and thereby helps shield the supports for this post from the blastant. An access door 201 is advisedly incorporated in the barrier. In addition there are an entrance passageway 202 and an exit passageway 204 communicating between the station 34 and the blasting zone, and these passageways are curved to diminish the ability of blastant particles to fly out. The passageways are also fitted with shield curtains of rubber or rubbery material which are conveniently in laterally projecting pairs of flaps that can be pushed open by the work piece and/or holder, yet automatically close after the articles have passed and block the ricocheting out of blastant. A plurality of curtains are preferably provided for each passageway, the individual curtains of each set being spaced from each other by less than the distance between successive holders. As illustrated, there are four curtains per set with the distance between successive curtains about half the distance between successive holders.

The curtains need not be of uniform width but can have their width varied as desired. Thus where the work pieces are narrower than their holders, the upper portions of the curtains which only need coact with the work pieces can be narrower as shown at 206. The lower portions 208 can be wide enough to permit passage of the holders, and can even be made of flaps that are not wide enough to come together, although better results can be obtained when they overlap as shown for the narrower portions 206. The individual flaps are easily made self-adjusting for articles of varying height by slitting the flaps into horizontal strips, as more clearly shown in Fig. 1.

Where the sides of the passageways 202, 204 are spaced from the edges of the table, a deflector plate or baffle 210 can be inserted to close the spacing gap and keep the blastant particles from by-passing the curtains.

The apparatus of the present invention includes a blastant recirculation system. Blastant particles projected into the blasting zone drop down to the lower portion of the chamber, the side walls of which are hopper shaped as indicated at 212 and converge at their lower ends to a screw conveyor 214. Additional shields, either metallic or rubbery, or packing can be used where it is desired to help reduce the exposure of sensitive components. Thus the various bearings are advantageously protected by gaskets as indicated at 216 in Fig. 5, and at 217 in Fig. 4.

The screw conveyor 214 which is actuated in any convenient manner carries the blastant particles rearwardly through a connecting duct 218 to the lower end of a bucket elevator 220. The conveyor can be covered as by angle plate 222 where it passes under the blasting zone, the cover being held spaced from the hopper walls to enable the blastant falling down the hopper walls to find its way to the conveyor. The bucket elevator 220, which is of any desired construction such as one having metal buckets

fitted on a rubber belt, lifts the blastant particles and drops them into a collector **224** from which they fall through a separator **226**. In the separator the lighter fragmentized particles of blastant are separated out as by the use of a stream of air sucked transversely through the falling column of blastant. The stream of air is conveniently supplied by connecting a suction line **228** between the separator and source of suction such as a dust collector or air filter (not illustrated). As described in copending Powell et al. application, Serial No. 194,420 filed November 7, 1950, the falling column of blastant is arranged to drop beside a deflector edge and the air movement is oriented to blow the particles towards that edge. The lighter particles are blown onto the deflector edge and are guided by the deflector to a discharge chute which drops them through line **230** into a waste receptacle **232** which can be made removable to dispose of the collected material.

The recirculating particles that are not separated out by the separator **226** are dropped into a storage hopper **234** where they are collected and remain until needed for the next trip to the blasting nozzle.

A feature of the present invention is the provision of an overflow conduit **236** connected as by means of passageway **238** to a predetermined level in storage hopper **234**. Conduit **236** leads at its lower end to the connecting duct **218**, but provides a blastant path which includes a transparent section at which the movement of blastant particles can be readily detected by merely looking. In the form shown, the transparent section is simply a gap **240** between the lower end of the conduit **236** and the opening in duct **218**. This opening can include a funnel-shaped fitting **242** to assure that the dropping of blasting particles are all collected. By this means, the operator of the apparatus can readily determine whether the supply of blastant particles in the machine is sufficient, or whether an additional quantity should be added. A glance at gap **240** will immediately tell whether blastant particles are dropping through this gap and thereby indicate the level of the blastant in the storage hopper with respect to the overflow level at **238**.

From the storage hopper **234** the blastant particles are fed to a mixing tank of the ordinary type, not shown, where they are mixed with compressed air or other impelling medium and then carried as by means of pipe **118** to the nozzle supply system as indicated above. The mixing tank can be of any desired form and a very effective construction is shown by way of example in U. S. Patent No. 1,901,450 granted March 14, 1933. In this combination the particles are continuously mixed with the impelling medium under high pressure while additional particles are fed from the low pressure in the storage hopper without interrupting the mixing. This is provided by an air lock construction more particularly set forth in the above-mentioned patent. The mixing itself can be readily accomplished by pouring the particles into a line through which compressed air is moving. A simple pipe **T** is sufficient for this purpose although somewhat better results are obtained by using standard types of mixing chambers such as that shown in U. S. Patent No. 1,710,168 granted April 23, 1929. More than one mixing chamber can be used with the mixing tank either connected together for simultaneous use in parallel, or as alternate chambers so that when one clogs the other can be connected without shutting down the entire apparatus.

For more efficient operation, the apparatus is directly connected to a dust collector to exhaust all the particles that tend to float in the blasting chamber and thereby keep these particles from escaping out into the surroundings where they can be very annoying and dangerous to the health of any nearby personnel. The dust collector, as pointed out above, is connected to the exhaust line **229**, shown in Fig. 3, which opens into the rear of the housing **20** by way of an intervening trap **272**. In this trap the heavier particles that are sucked out by the dust collector are caused to strike a baffle **274** so that they drop to the bottom of the trap without filling the exhausting air. These particles flow from the trap bottom through conduit **276** into the duct **218** so that they are thereby recirculated with the bulk of the blastant particles. The baffle **274** can be desirably made in the form of a slide so that it is readily adjustable to thereby vary the grade of particles that are trapped. The adjustments can be made in accordance with the grade of blastant materials that are utilized.

If desired, the dust collector can also be directly connected to the waste conduit **230** to carry these particles off so that the handling of a separate refuse container **232** becomes unnecessary.

Where the work articles blasted in the above apparatus fit closely in the individual sockets **60**, they sometimes tend to become wedged in place, even though the inside surface of the holder is provided with protuberances such as those shown in Fig. 5.

Fig. 7 shows a modification of the apparatus by which the work articles can be dislodged or jarred loose so that they can be readily removed and replaced. In this construction the holder **360** carries a supporting ring **362** upon which the work piece **364** is arranged to rest. From the supporting ring a succession of pins **366** project downwardly through suitably provided apertures in the lower surface of the holder. At their lower ends pins **366** can be connected by a collar **368**. A piston **370** is mounted below a stepped position of the holder **360**, as by means of guide block **372** secured to the lower wall of ledge **24**. The piston can have its upper end enlarged as shown at **374** to provide a head for engagement with the collar **368**. At its lower end the piston **370** is fitted with a simple device such as a solenoid or the foot lever **376** for example. By pivoting the foot lever at a location **378** close to the piston sufficient leverage can be obtained to readily discharge the work piece. The lever **376** can be mounted on a base **380** which can also carry an additional guide block **382**. An electrically operated discharging mechanism can be entirely held on the machine's housing so that the piston need not project from it.

The sweep of the blasting nozzle, according to the present invention, is not limited to being made from below and can also be effected from above. In addition, this sweep can be accomplished by linearly traversing the nozzle across the inner surface of the work piece instead of tilting it.

Fig. 8 shows a form of the invention in which the linear traverse is used exclusively. Here the apparatus is generally similar to that shown in Figs. 1 to 7 inclusive except that the nozzles below the table are eliminated along with their tilting mechanism. Instead, blasting nozzles **401**, **402**, **403**, **404** are mounted on a set of upwardly extending lance-type pipes **411**, **412**, **413** and **414** respectively. These pipes extend through the roof of the blasting chamber and connect at their upper end with a set of couplings carried by a bar **420**. The ends of the bar are slidably fitted within vertically disposed slide guides **421**, **422** also mounted above the blasting chamber. The couplings carried by the bar connect the lance pipes **411** to **414** inclusive to flexible lines **431**, **432**, **433**, **434** which lead to a distributor **416** suitably connected to a source of blastant fed by means of conduit **418**.

Traverse of the nozzle carrying bar **420** is shown as effected by a separate actuating device such as motor assembly **468** connected to rotate a drive shaft **470** suitably supported on the guides **421**, **422**. A pair of sprockets **472** carried by the drive shaft are connected as by means of chains **474** to the bar **420**. The upper ends of the chains can be directly anchored to the respective sprockets **472** so that rotation of the drive shaft in one direction will lift the nozzle carrying bar. Lowering of this bar can be effected by merely disconnecting the drive

and permitting the bar and nozzle assembly to fall under the influence of their own weight. To make sure the drive mechanism does not lift the bar up too high, a limit switch as indicated at **476** can be provided to automatically deenergize the drive. The disconnection of the drive is suitably timed to take place after the table has stopped moving into a stepped position, and a synchronizing switch operated by the table or stepping mechanism is suitable for this purpose. Such a switch is conveniently in the form of a limit switch for operating with a cam rotated with shaft **62** and arranged to hold the switch open during the forward motion of the ratchet rod **48**, and hold it closed during the return motion of this rod. Alternatively such a limit switch can also be located for operation by holding pawl **43** so that it keeps the lifting mechanism connected whenever this pawl is withdrawn from notch **42** and disconnects the mechanism when this pawl drops into one of these notches.

As another variation of the present invention, the traverse mechanism can be made to be positively driven in both directions of its travel. For this purpose it is only necessary to provide an additional sprocket drive below the bar **420** to pull the bar down at the appropriate time. In fact, both sets of sprockets can be interconnected using a single chain which is looped around a vertically aligned pair and fixed at one place to the bar **420**. The drive mechanism **468** can then be made reversible so that it will selectively lift and lower the nozzle assembly.

The nozzles **401**, **402**, **403**, **404** can be arranged to direct a blastant stream laterally, either at right angles to the axis of rotation for the work pieces, or at any other angle of inclination. A slight downward tilt gives them somewhat greater effectiveness in blasting the lowest portion of the internal surface of the work piece, but this is not necessary unless particular attention is needed at that point.

Fig. 9 shows a further embodiment of the present invention. In this construction some of the blasting nozzles are of the tilting type and some of the linear traverse kind. The tilting nozzles can be mounted and actuated in the same way illustrated above in connection with Figs. 1 to 7 inclusive. The other nozzles can be operated as in the construction of Fig. 9, and can be used for either the internal or external surfaces of the work pieces. In the form shown, the overhead traverse nozzles are arranged to blast the external surfaces, while the lower tilting nozzles blast against the internal surfaces.

For better results, the work holders can be made of two different types, one to engage a work piece from its exterior, so as not to obstruct its interior blasting, and the other to engage it from its interior so as not to obstruct its exterior blasting. For use in a single combination such as the apparatus of Fig. 9, the holders can be alternately arranged around the table, and the table connected to rotate at every step by an amount equal to the space between three adjacent work holders. This type of arrangement is shown in Fig. 9 where every other work holder is fitted with an upwardly projecting plug **552** which can be fixed in place as by suitably located bolts. The lower tilting nozzles are shown as two in number, spaced so that each is positioned under a hollow type work holder. The overhead lance-type nozzles are positioned to traverse vertically alongside two adjacent plug holders **552**, and can also be arranged so as to face toward these holders from different attitudes. These nozzles are preferably located so as not to lie in the path of the loaded or empty holders so as to reduce the possibility of inadvertent difficulties. In operation the blasting of the construction of Fig. 9 is generally similar to that of the other figures except that where both the internal and external surfaces of the same articles are being blasted, these articles are first passed through on one work holder, and then shifted for a second pass on an adjacent work holder of the opposite type. However, two different work pieces can be simultaneously blasted in this machine, one on its exterior and the other on its interior. Alternatively work pieces can be blasted on either side merely by shutting down the operation of the nozzles that blast the other side.

The various electrical connections for the operation of the apparatus as described above can be conveniently centralized in a single supply compartment shown as **580** in Fig. 9. A ladder can also be supplied to make more readily accessible these components of the apparatus which are out of reach from below. Thus for example screens normally provided in the blastant recirculation path to strain out coarse particles, etc., sometimes have to be removed, cleaned and replaced. Drive belts and other mechanisms generally require maintenance such as belt tightening, lubrication, etc. Additional access doors can be provided in other suitable locations such as the sides and rear of enclosure **20**, the elevator **220** and the conveyor duct **218**.

The apparatus of the present invention is highly effective in the blasting of elongated hollow work pieces such as artillery shell projectiles or casings. In this manner, shell projectiles of this type can be very rapidly cleaned of scale, corrosion, foreign matter, etc., and can be deburred. By way of example, recoilless shell casings which have side walls that are perforated can have these perforations very easily cleaned of any burrs that are normally produced during the perforating operation. The above as well as other work pieces of the same general type can be blasted with their open ends either pointed up or down.

In operation the apparatus of the present invention is loaded with abrasive as by introducing a quantity into the storage hopper, the separator, or the screw conveyor duct. The blasting can then be started by means of the blasting medium, until the blastant particles reach the mixing chamber and begin to be projected from the nozzles. Work pieces are then loaded into the holders at the loading station, and the equipment adjusted for the desired blasting cycle. The duration of the blasting at every step of the table can be varied from about one or two seconds to about thirty or more seconds as desired by merely controlling the speed of the ratchet advancing mechanism. No adjustment need be made to the nozzle tilting unit so long as the tilt goes through at least one complete cycle at every step of the table.

If desired the blasting can be arranged to be interrupted while the table is being stepped, although this is not necessary, and there is no serious erosion of the table or work holders if the blasting is maintained during the table movement. Best results from this type of interrupted blasting are obtained when the flow of abrasive to the mixing chamber is cut off before the flow of blasting medium, and the blasting resumed by restoring the flow of blasting medium before the flow of blastant particles. For this purpose a synchronizing switch such as the one described above in connection with Fig. 9 can be connected to close two electric circuits while the ratchet drive is in the advancing position. One circuit is connected to energize a solenoid operated blastant particle control slide valve fitted in the mixing chamber or mixing tank. The other circuit is similarly connected to shut off the flow of compressed air to the mixing chamber. By using sets of contacts arranged for one to be always first in closing and last in opening, the desired operation is readily obtained.

Another feature of the present invention is the fact that the crank operated ratchet mechanism described above provides a highly accurate indexing arrangement which does not lose its accuracy with changes in table rotating speed. The mechanism of Figs. 1 to 7 inclusive can be arranged to move a table over five and one-half feet in diameter loaded with heavy artillery shells in steps that are completed in about one second, and the lengthening of the stepping time to ten or more seconds does not change the alignment of the work holders with the nozzles.

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.

What is claimed is:

1. In a blasting apparatus for automatically projecting blastant particles against the internal and external surfaces of hollow open-ended work pieces, a first set of holders each shaped to receive the outside of one work piece and hold it with its open end oriented in a predetermined direction, a second set of holders each shaped to fit into and engage the open end of a work piece, operating mechanism connected to step-wise advance the holders of said sets around an endless path including a blasting zone, blasting nozzle structure at said blasting zone and adjacent the stepped position of the holders, said structure including blast impelling means connected to project a plurality of streams of blastant particles, and traverse elements connected to cause at least one blastant stream to sweep during the blasting over the inner surface of an externally held work piece from said open end to the opposite end, and to cause at least one other stream to sweep across the outer surface of an internally held work piece and said operating mechanism being connected to rotate the holders during the blasting around an axis passing through said open end to cause the surfaces of the work pieces to be blasted over their entire circumference by the sweeping blastant streams.

2. In a blasting apparatus having a rotatable work carrying table including spaced work article supports, a blasting chamber enclosing at least a portion of said table and providing a blasting station for cleaning the articles supported on said table, means within said chamber for directing blastant particles upon said work articles, an entrance and an exit passageway communicating between said enclosed chamber and an unloading station externally of said chamber, said passageways being arcuate and each including a series of curtains forming a succession of blastant seals, the curtains being laterally connected to the side walls bounding the entrance and exit spaced apart a distance equal to one-half of the spacing between successive work article supports carried by said table and so arranged with respect to said blasting station as to position one curtain of said series intermediate an adjacent pair of work article supports and a second curtain of said series transversely of the center of one of said adjacent work article supports.

3. In a blasting apparatus as set forth in claim 2 the further improvement in which each said curtain comprises a pair of spaced panels, each panel pair forming a junction with overlapping edges at the center of said passageway.

4. In a blasting apparatus as set forth in claim 3 in which said overlapping edges are slit at spaced intervals to provide a plurality of laterally directed flaps extending towards each other and meeting in an overlap at the center of said arcuate passageway.

5. In a blasting apparatus for abrasively treating the internal surfaces of open-ended hollow work pieces, a set of rotatably mounted tubular support sockets, each shaped to receive one work piece and hold it with its open end down, operating mechanism connected to step-wise advance the sockets of said set around an endless path including a blasting zone, blasting nozzle structure at said blasting zone and below the stepped position of the sockets, said structure including blast impelling means connected to project a stream of blastant particles up from the nozzle structure through the socket and into the open end of the work pieces to impinge against their internal surface while the work support sockets in said blasting zone are individually rotating but while said sockets are held from advancing around said endless path, said nozzle structure including tilting elements connected to change the direction of the blastant stream entering the open end of said work pieces and comprising a rockable support member positioned to rotate about an axis which intersects the longitudinal axis of said tubular support sockets adjacent the lower end thereof, whereby as said support member is rocked, said nozzle traverses an arcuate path having a center of curvature on the longitudinal axis of said support socket at the open end of said work piece.

6. In a blasting apparatus as set forth in claim 5 the further improvement in which said rockable support member comprises a crank shaft having a spaced supporting arm connected to said nozzle in such manner that the longitudinal axis of said nozzle intersects the rotational axis of said crank shaft.

7. In a blasting apparatus for abrasively treating the internal surfaces of open-ended hollow work pieces, a set of rotatably mounted tubular support sockets, each shaped to receive one work piece and hold it with its open end down, operating mechanism connected to stepwise advance the sockets of said set around an endless path including a blasting zone, blasting nozzle structure at said blasting zone and below the stepped position of the sockets, said structure including blast impelling means connected to project a stream of blastant particles up from the nozzle structure through the socket and into the open end of the work pieces to impinge against their internal surface while the work support sockets in said blasting zone are individually rotating but while said sockets are held from advancing around said endless path, means for supporting said blasting nozzle structure below said sockets comprising an eccentric throw crank shaft having its axis of rotation positioned to intersect at least two of said tubular support sockets along the longitudinal center line of said sockets adjacent the lower open end thereof, said nozzle structure being connected with said eccentric throw of said crank shaft for movement in an arc beneath the said tubular support socket with the midpoint of the lower open end of said socket as a center.

8. A blasting apparatus as set forth in claim 7 including a second eccentric throw crank shaft positioned to support additional blasting nozzle structure at said blasting zone, said second crank shaft being substantially identical to said first crank shaft.

9. A blasting apparatus as set forth in claim 8 including means connecting the rotational axes of said crank shafts for synchronized movement.

10. A blasting apparatus as set forth in claim 8 in which each said crank shaft supports a pair of blasting nozzles, one said crank shaft positioning said respective pair of nozzles to direct a blasting stream into two adjacent tubular support sockets, and said second crank shaft positioning the second pair of nozzles to direct a blastant stream into respective tubular work support sockets that are in annular alignment with said first two work support sockets.

11. In a blasting apparatus for abrasively treating the internal surfaces of open-ended hollow work pieces, a set of rotatably mounted tubular support sockets, each shaped to receive one work piece and hold it with its open end down, operating mechanism connected to stepwise advance the sockets of said set around an endless path including a blasting zone, blasting nozzle structure at said blasting zone and below the stepped position of the sockets, said structure including blast impelling means connected to project a stream of blastant particles up from the nozzle structure through the socket and into the open end of the work pieces to impinge against their internal surface while the work support sockets in said blasting zone are individually rotating but while said sockets are held from advancing around said endless path, means for rotating said blasting nozzle structure in an arc having a center along the longitudinal axis of at least one of said tubular work support sockets at a point adjacent the lower open end thereof.

12. A blasting apparatus as set forth in claim 11 in which said means for rotating said blasting nozzle structure includes an eccentric-throw crank shaft supporting said nozzle structure and means for rotating said crank shaft including a separate revolving crank arm and a link member connected with said crank shaft, said revolving crank arm including structure for varying the position of said link to provide a variation in the stroke of said crank shaft.

13. In a blasting apparatus for abrasively treating the internal surfaces of open-ended hollow work pieces, a set of tubular support sockets, each shaped to receive one work piece and hold it with its open end down, operating mechanism connected to step-wise advance the sockets of said set around an endless path including a blasting zone, blasting nozzle structure at said blasting zone and below the stepped position of the sockets, said structure including blast impelling means connected to project a stream of blastant particles up from the nozzle structure through the socket and into the open end of the work pieces to impinge against their internal surface, and movable means carried by said sockets comprising a vertically raisable member adapted to engage and support said work pieces, and control means for raising said movable means to facilitate ejection of a cleaned work piece.

14. A blasting apparatus, a chamber, a blast projector for projecting a stream of abrasive particles at work pieces within said chamber, a collector for collecting said abrasive particles after the abrading process, conveyor means for conveying said particles from said collector to a separator, said separator being adapted to separate the relatively heavier reusable particles from the relatively lighter non-reusable particles, a storage means, means to convey said reusable particles to said storage means, overflow means connected to said storage means for causing particles to flow out of said storage means when the level of the mass of particles in said storage means rises above a predetermined level, passage means connecting said overflow means to said conveyor means, and means interposed in said passage means for providing a visual indication of the flow through said passage means.



15. The blasting apparatus of claim 14 wherein said means for providing a visual indication comprises a gap in said passage means.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 727,030 | Tilghman | May 5, 1903 |
| 1,713,965 | Hull | May 21, 1929 |
| 1,819,308 | Walker | Aug. 18, 1931 |
| 1,826,559 | Meier | Oct. 6, 1931 |
| 2,310,488 | Guite | Feb. 9, 1943 |
| 2,351,272 | Le Tourneau | June 13, 1944 |
| 2,457,128 | Churnell | Dec. 28, 1948 |
| 2,629,207 | Gladfelter et al. | Feb. 24, 1953 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 627,873 | Germany | Mar. 25, 1936 |
| 642,615 | Great Britain | Sept. 6, 1950 |
| 789,684 | France | Aug. 26, 1935 |
| 860,226 | France | Jan. 9, 1941 |