3,271,992

METAL SHOT PRODUCING APPARATUS

Orald L. Stewart, Lakewood, Ohio, assignor to The Cleveland Metal Abrasive Co., Cleveland, Ohio, a corporation of Ohio

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5 Claims. (Cl. 72—476)

This invention concerns an apparatus for increasing the yield of fine metal shot from a single heat of metal and a machine for converting metal grit to shot for use therein.

In its broadest sense, the method of the invention comprises a procedure whereby the randomly sized metal shot particles produced by a single heat of metal may be treated by breaking up the larger shot to produce fine fractured particles of shot called grit, and impacting the grit repeatedly until it is shaped into the approximate spherical shape of shot to give a larger inventory of the finer sizes of shot than are normally produced.

In the metal shot industry it has been found that a relatively small amount of metal shot in the fine sizes, for example, from .005 to .015 of an inch in diameter, results from the prior art methods of pouring a heat of molten metal through a liquid bath to produce the metal shot. This fact has presented inventory problems to shot manufacturers in that the demand per ton for the fine metal shot is consistently greater in relation to the demand per ton for the larger sizes of shot which are produced in making the fine shot. Accordingly, metal shot producers have been forced, in order to meet the demands for fine shot, to produce and store larger amounts of the relatively larger sizes of shot than would otherwise be dictated by demand. Also, for this reason, the finer shot has demanded a higher price per ton on the market because of the inability of the shot producers to inexpensively produce large amounts of the fine shot from a given heat of metal.

The instant invention then is the heat of the inventory control system which produces a greater yield of the fine metal shot which can be sold at a higher price per ton than the larger shot.

The novel method utilizes a novel machine for converting metal grit to shot comprising a horizontal driven shaft which has elongated blade means rigidly mounted to extend radially thereabout to propel grit against an elongated target means of non-uniform thickness mounted within means which encloses the blades. These components are of shapes and dimensions such that the thickest portions of the target means are located on the inside of the enclosure means relatively near the path of the blades. Appropriate feed and collection means are provided in the machine to permit the cycling of the grit until it is impacted against the target by means of the rotating blades a sufficient number of times to form the grit into the approximate spherical shape of shot.

By use of this novel machine in the method of this invention, an inventory of fine shot normally produced by a given heat of molten metal being poured through a liquid bath is increased such that a higher total price per ton of the shot produced may be obtained. The target means are provided of non-uniform thickness and mounted with the thickest portions at the points inside of the enclosure relatively near the path of the blades so that with a minimum of material cost a long period of effective wear of the target means is accomplished. In addition to this fact, the shape of the target means insures that they may be cast in manufacturing with a directional solidification resulting which gives a porosity free target.

Accordingly, it will be seen that this invention relates to the method of increasing the yield of fine metal shot from a single heat of metal by utilizing a novel machine

for converting metal grit to shot which machine includes an inexpensive, cast target means which is free of porosity for long use in the method and machine combination.

The prior art has attempted many variations of production procedures to provide for an increased yield of fine metal shot for use in abrasive blasting, but none of these prior art methods have produced a fine shot in a manner which is inexpensive enough to significantly increase the supply of the fine metal shot without also creating a large amount of larger and relatively inexpensive shot to be stored and sold at relatively low prices per ton. Consequently, the manufacturers of metal shot have had inventory problems in storage of larger shot as a direct result of attempts to meet the demand for the finer and more scarce shot. By fine shot we mean shot in the neighborhood of from .005 to .015 of an inch screen size which is of substantially spherical shape.

As modern metalworking industries turn more and more to abrasive cleaning and shot peening of parts to improve the strength and appearance of cast and welded parts, the demand for fine abrasive shot has increased disproportionately to the demand for larger more available shot since present metal shot production methods produce only a certain small percentage of fine shot in relation to the larger shot for each heat of metal poured through a liquid bath to produce the shot. The problem of obtaining a better yield of fine shot accordingly has become more critical in the industry.

It is an object of the invention to provide a novel machine for converting metal grit to shot which efficiently utilizes kinetic energy imparted to the grit by impelling blades so that the grit is efficiently converted into the approximate spherical shape of shot so that it may be used to supplement the inventory of fine shot.

Known compositions and procedures for making metal abrasive shot are disclosed in the Hutcheson patent, U.S. Patent No. 2,670,281, for example. As is noted in the Hutcheson patent, however, shot is obtained which ranges randomly in size from as small as .0054 inch in diameter to as large as .156 inch in diameter. It has been found that in this range a distribution of shot approximating a Gaussion curve is produced and accordingly, it is an object of the method of this invention to enable the larger sizes of shot, thus produced, to be converted to grit and then to increased amounts of shot at the lower end of said range—particularly in the .005 to .015 range.

It is a further object of this invention to provide a machine for impacting grit and converting and deforming it to shot which has components capable of long life under the repeated impacting of said material.

It is still a further object of the invention to provide a novel shaped target means for use in the machine for converting and deforming metal grit to shot so as to provide better and longer life for the target means within the novel machine.

Other and more specific objects of the invention will be apparent from the detailed description to follow.

FIG. 1 illustrates the front elevational view of the novel machine for converting metal grit to shot in the novel method of this invention.

FIG. 2 illustrates a top plan view of the machine of FIG. 1.

FIG. 3 illustrates a side elevational view of the machine of FIG. 1.

FIG. 4 is a detailed fragmentary cross-sectional view taken along the line 4—4 of FIG. 3.

FIG. 5 is a fragmentary cross-sectional view taken along the line 5—5 of FIG. 4.

FIG. 6 is a fragmentary cross-sectional view taken along the line 6—6 of FIG. 5.

In the illustrated embodiment of the novel machine for converting metal grit to shot the numeral 1 generally

designates the machine combination. The apparatus comprises a base 3 having legs 4 and a platform 5 upon which is mounted an electric motor 6 connected by suitable drive means 7 to a horizontal shaft 8 journaled in pillow blocks 9 and 10 on the platform 5.

The belt 7 drives the shaft 8 by means of pulleys 11 and 12 on the motor shaft 13 and the drive shaft 8. Platform 5 has an opening 15 therein through which an enclosure generally designated by the numeral 20 extends. The enclosure 20 has a removable top cover 21 and a bottom section 22. Channel members 23 and 24 are on the left and right sides of the opening of the housing 20 as seen in FIG. 4, for instance, such that their lower outstanding flange members 25 and 26 rest on the platform 5 extending along the opening 15. The enclosure 20 is substantially square in size and is oriented so that the corners are located at its vertical and horizontal extremes.

The horizontal drive shaft 8 extends past the pillow block 10 into the enclosure 20 through an opening 27 in the channel member 23 and the wall of the lower or bottom section 22 of the enclosure 20. A reduced diameter portion 29 is provided on the end of the shaft 8 which projects into the housing 20 for receipt of a hub member 20 which is appropriately keyed to the shaft and held by means of set screw 31 to provide for rotational drive of the hub 30.

Mounted by means of bolts 33 and 34 and hub 30 are two spaced discs 35 and 36 having a plurality of blades 37 mounted therebetween as by means of set screws 39. The discs 35 and 36 are maintained in spaced relation by bridging members 38 as seen in FIG. 6. On the end of the shaft 8 and hub 30 coaxial therewith and in alignment with the blades 37 between the discs 35 and 36 is an impeller means 40 of the type well known in the centrifigal blasting machine art. The impeller 40 has an opening 41 on its side opposite the hub 30 and shaft 8 which is in direct communication with a feed tube 42 such that material flowing down the tube 42 may enter the center of the impeller 40 and be discharged out of openings 43 directly onto all of the radially innermost ends 44 of the throwing blades 37.

An appropriate seal, as shown at 45, is supplied in connection with guard structure 46 mounted on the inside of the enclosure around an opening 47 in the enclosure 22 and beam 24 through which the gravity feed to 42 extends. Such structure is old as seen, for example, in the Rosenburger et al. patent, U.S. Patent No. 2,352,588, issued June 27, 1944, and acts to prevent the material being thrown from damaging the environmental structure.

Thus, it will be seen that with the material being gravity fed down the tube or conduit 42 and the shaft 8 being driven by the motor 6 the material will be passed into the impeller and out of the openings 43 directly onto the ends 44 of the blades 37 so that centrifugal force is imparted to it to throw it from the radially outermost ends of the blades with great force.

The grit material is supplied to the feed tube 42 by means of an hopper extension 48 thereon located directly under a surge storage bin hopper 50. The hopper 50 has a shape such that it is tapered in a downward direction with a valve 51 on its lower end located immediately above the feed funnel or hopper extension 48.

As illustrated in FIGS. 1 and 3 the surge hopper 50 is supplied by means of a vertical conveyor 55 driven by a motor 56 through a belt 57 connected to an upper driven sprocketed drive shaft 58. Motor 56 is mounted on a suitable support 59 on top of the surge hopper 50. The conveyor 55 has individual buckets 60 and an endless chain 61 in a conventional manner and extends from the top of the surge hopper 50 to an idler sprocket 62 near the base of the conveyor. A suitable structure 63 is provided to enclose and shield the conveyor 55.

At the lower end of the throwing wheel enclosure 20 is an opening 65 which is flanged or otherwise suitably

mounted on top of a discharge hopper or collector bin 66. At the lower end of the discharge bin 66 and in communication therewith is a Y valve 67 which has a straight through passage leg or conduit 68 leading to a fill hopper 70 and an angular discharge leg or conduit 69 oriented such that when the valve 67 is in the condition to close the conduit 68 to the throw hopper 70, the conduit 69 is open to act as a discharge conduit from which the treated material may be collected.

Extending laterally out of the discharge conduit 66 is a conduit 72 leading to a conventional dust collector means 73 such that undesirable dust and fines which are in the discharge means 66 or passing through it by means of gravity will be sucked into the dust collector 73 and not be discharged into the fill hopper or be discharged out of the conduit 69 with the finished product. At the lower end of the dust collector 73 is a suitable dust pipe 74 to discharge the collected dust. An air duct 75 supplies a suction through the conduit 72 and dust collector 73 as will be readily recognized by those skilled in the art. A suitable baffle arrangement schematically illustrated as at 76 in FIG. 1 is provided to prevent the dust from going directly through the conduit 75.

It will be recognized that any other suitable dust collecting arrangement can be used to clean the product after it has left the enclosure 22.

On the inner walls of the enclosure 20 which face the ends of the blades 37 are mounted target means 80 having sides 81 in face-to-face engagement with respective ones of the inside walls of the wheel enclosure 20. The target means 80 have faces 82 and 83 respectively mounted parallel to the axis of the shaft 8 but the faces 82 and 83 are in nonparallel relationship to the faces 81 in engagement with the side surfaces of the enclosure 20. This provides for a converging of the faces 81 with each of the respective faces 82 and 83 such that a tapered cross-sectional structure is provided with the thickest portions of the target means 80 being located at points along the respective sides of the enclosure 20 relatively near to the path of rotation of said blades 37.

The shape of the target means 80 because of its generally tapered configuration provides for a directional solidification in casting of the device of abrasive resistant alloy since the casting is gated in the thickest region so that cooling starts from the thinner ends. This insures that the casting is sound throughout with no porosity so that it can resist the impact of the material against it.

An additional advantage of this configuration is that it gives more metal for wear at the center or intermediate the ends of the housing wall in the area relatively near to the path of rotation of the throwing blades. The housing liner or target means 80 are secured to the inside walls of the housing 20 by bolts through suitable apertures 85 or in some other suitable manner such as welding.

It should be noted that the target means 80 in the upper or top section 21 of the housing 20 are somewhat shorter in length than those in the lower section because the top or upper section 21 is somewhat smaller than the lower bottom section 22. The extensions of the walls of the cover 21 which are part of the lower housing section 22 have small additional target means 86 and 87 of general rectangular shape since these are in the areas of relatively small wear due to their relatively larger distance from the rotational path of the throwing wheels 37.

In view of the function of the target means 80 in converting a regularly shaped and abrasive metal grit into fine generally spherical shaped shot by actually cold forming the particles it is apparent that the target must possess certain physical properties.

In this regard it is significant to note that the grit, as such, is produced by breaking up larger shot particles to provide fractured highly abrasive grit particles which are sharp and irregularly shaped having a Rockwell hardness of from 40–45 on the "C" scale.

A flat generally rectangularly shaped target was constructed from an austenitic manganese steel, commercially known as "Hadfield Manganese" generally comprising about 1.0% to 1.4% carbon and from about 10% to 14% manganese and work hardenable to from 49 to 52 Rockwell C, and used in an apparatus such as described above operating at (1) about 2,500 r.p.m., (2) a circulatory rate of 25 tons per hour; and (3) a capacity of 1 ton per twenty-four hour day and it was found that the target was spent in about two months.

During the course of further experimentation, other flat generally rectangular targets of the noted characteristics were prepared from alloys comprising from .30% to 1.50% silicon, from .30% to 1.50% manganese, from 12% to 18% chromium, from 1.5% to 4% molybdenum, from 2.5% to 4% carbon and the remainder iron; and it was found that these targets had an average life under the aforementioned operating conditions of up to six months. A particularly suitable alloy to produce a target of long life was found to contain about .50% silicon, .50% manganese, 15% chromium, 3% molybdenum, 3% carbon and the remainder (78%) iron.

Another group of generally double wedge shaped target plates configured similarly to the target plate 80 were prepared from alloys having constituents within the above ranges and cast by techniques utilizing solidification from the thin section to the thicker section to obtain an optimum density with negligible porosity. This group of targets was heated to approximately 1,800° F. and air cooled and had a Rockwell hardness of about 60 on the C scale.

The shape of the target means becomes important because it allows directional solidification from the thinner end sections to the thicker center section giving a member having a corresponding higher density and lower porosity than members cast by other techniques. The wedge shaped target means with alloys having from .30% to 1.50% silicon, from .30% to 1.50% manganese, from 12% to 18% chromium, from 1.5% to 4% molybdenum, from 2.5% to 4% carbon and the remainder 75% to 84% iron were suitable to give a life of about one year under these operating conditions. The preferred alloy, however, comprises about .35% to about .6% silicon, from about .35% to about .6% manganese, from about 14% to 16% chromium, from about 2.5% to 3.5% molybdenum, from about 2.8% to 3.4% carbon with the remainder being iron and more particularly, an alloy comprising about .50% silicon, .50% manganese, 15% chromium, .3% molybdenum, 3% carbon and the remainder (78%) iron.

It is apparent from the results obtained from these experiments that optimum target life can be obtained by the use of the particular type of alloy noted which is cast into a wedge shaped plate by the technique of casting from the thinner sections to the thicker sections to thereby obtain optimum density and negligible porosity.

For ease of description the principles of the invention have been set forth in connection with but a single illustrated embodiment. It is not my intention that the illustrated embodiment nor the terminology employed in describing it be limiting inasmuch as variations in these may be made without departing from the spirit of the invention. Rather, I desire to be restricted only by the scope of the appended claims.

I claim:

1. A machine for converting and deforming metal grit to shot comprising:
   - frame means,
   - horizontal shaft means mounted on said frame means,
   - driving means connected to said shaft means,
   - elongated blade means rigidly mounted to extend radially about said shaft means,
   - enclosure means substantially surrounding said blade means,
   - elongated target means of nonuniform thickness mounted within said enclosure means substantially to surround said blade means with the thickest portions of said target means located at points on the inside of said enclosure means relatively near to the path of said blade means,
   - feed means in communication with the innermost ends of said blade means, and
   - collection means in communication with said enclosure means at a point on the inside of said enclosure means relatively far from the path of said blade means and below said shaft means.

2. The structure of claim 1 in which the target means have impact faces which define a plurality of nonparallel planes parallel to the axis of said shaft means.

3. In an apparatus for deforming grit into shot, an impact receiving means having at least two converging surfaces adapted to receive the impact of propelled abrasive particles, said means consisting substantially of a ferrous alloy containing from .30% to 1.50% silicon, from .30% to 1.50% manganese, from 12% to 18% chromium, from 1.5% to 4% molybdenum, from 2.5% to 4% carbon and the remainder iron.

4. The impact receiving means of claim 3 further characterized in that the ferrous alloy contains .5% silicon, .5% manganese, 15% chromium, 3% molybdenum and 3% carbon.

5. The impact receiving means of claim 3 in which the surfaces have a hardness of from about 33% to 50% more than the hardness of the propelled abrasive particles.

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JOHN F. CAMPBELL, *Primary Examiner.*

THOMAS H. EAGER, *Examiner.*

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FIG. 1

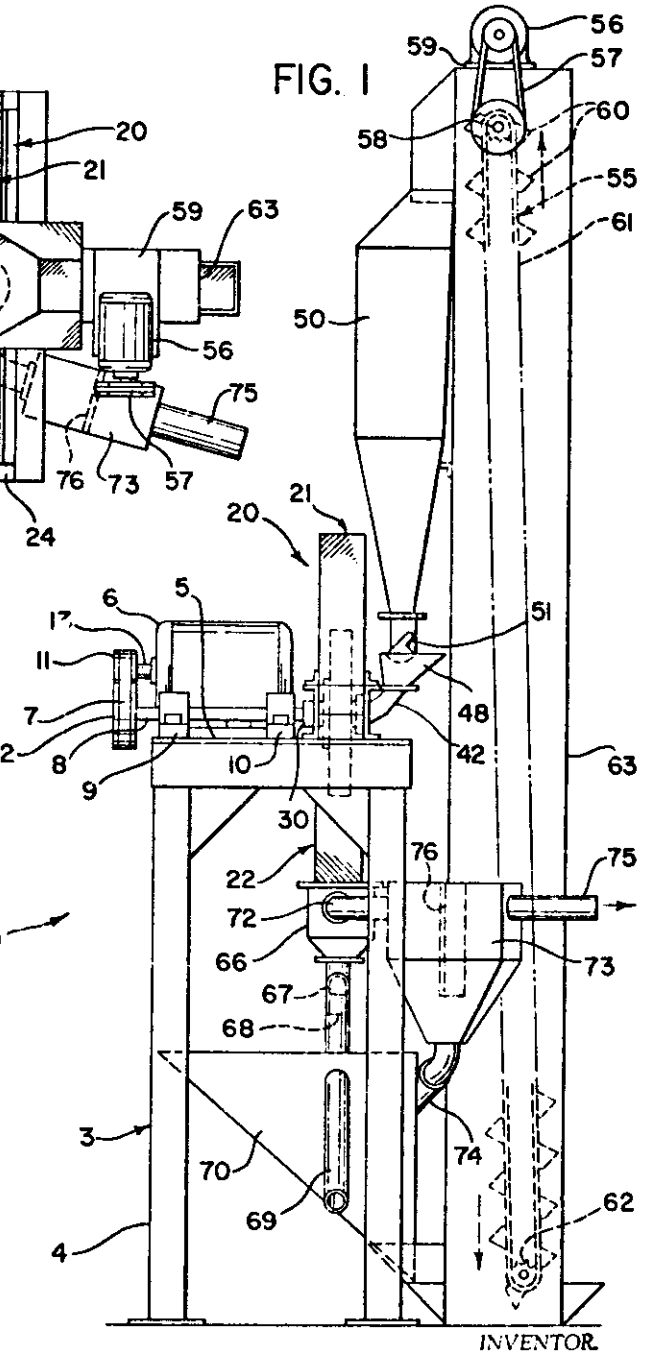
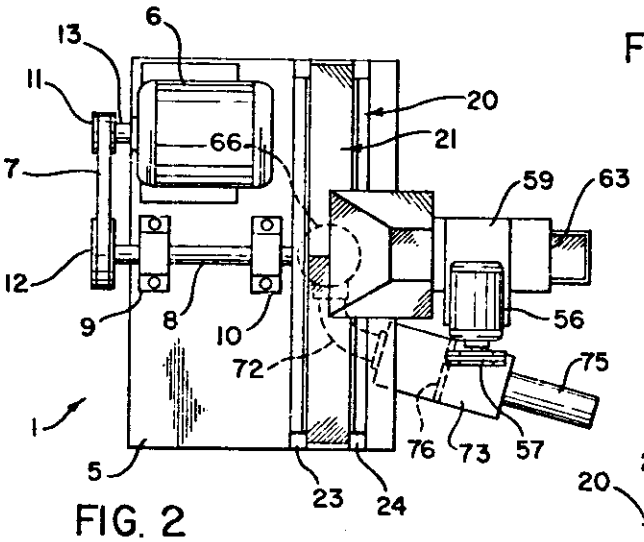


FIG. 2



INVENTOR
ORALD L. STEWART

BY

Fay & Fay

ATTORNEYS

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FIG. 3

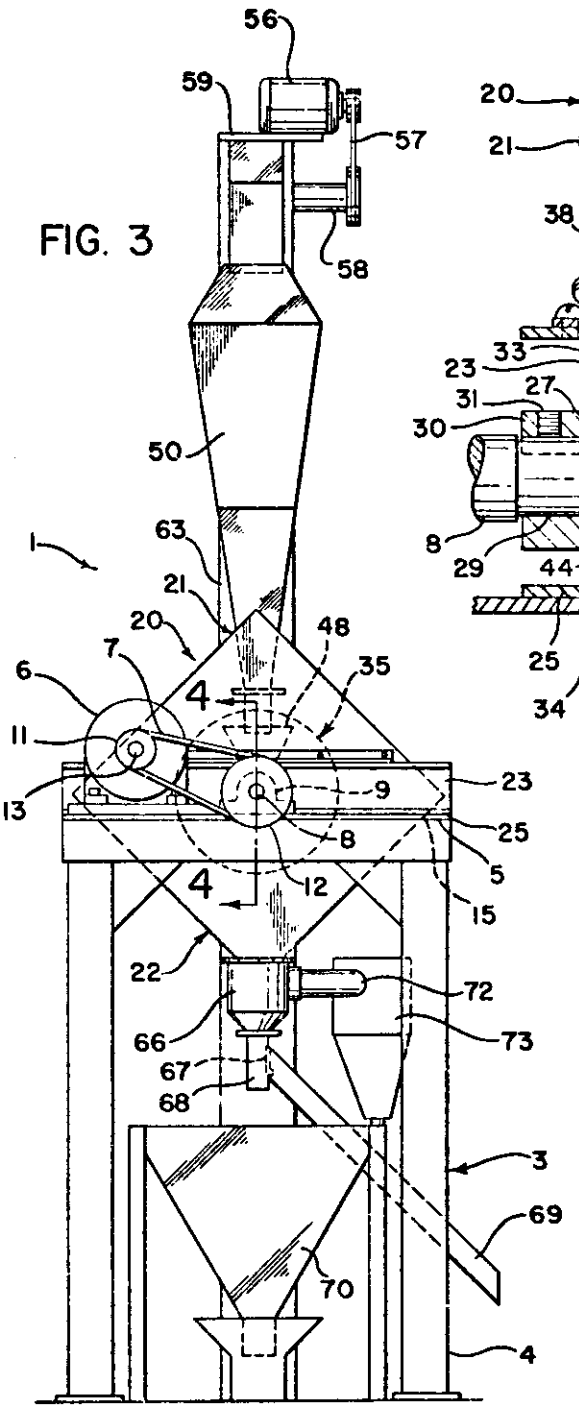
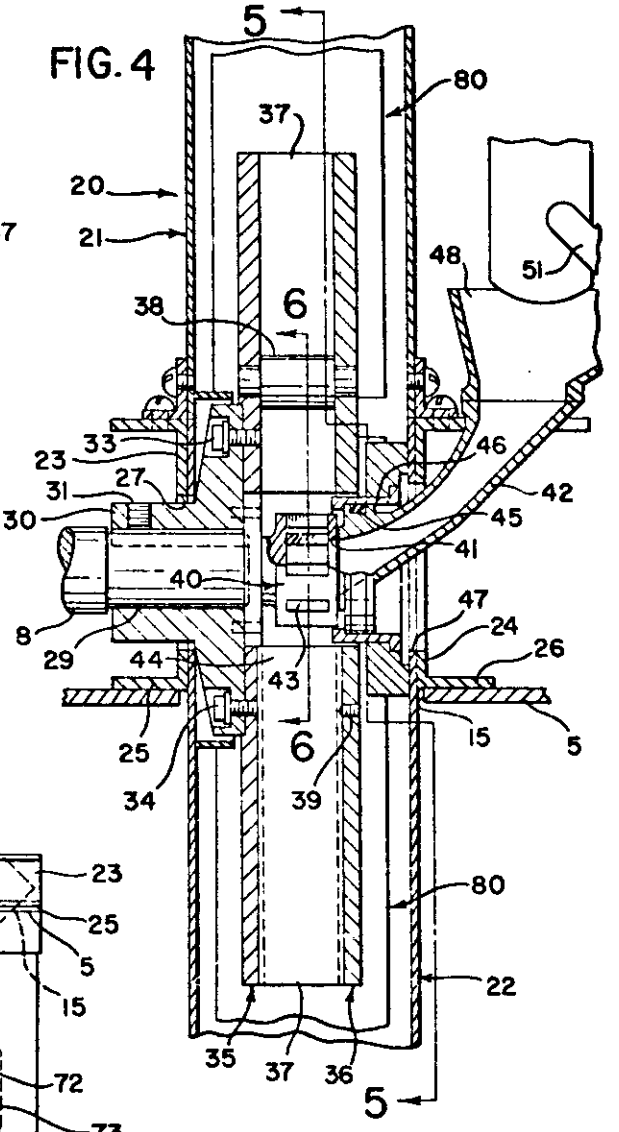


FIG. 4



INVENTOR
ORALD L. STEWART

BY

Fay & Fay

ATTORNEYS

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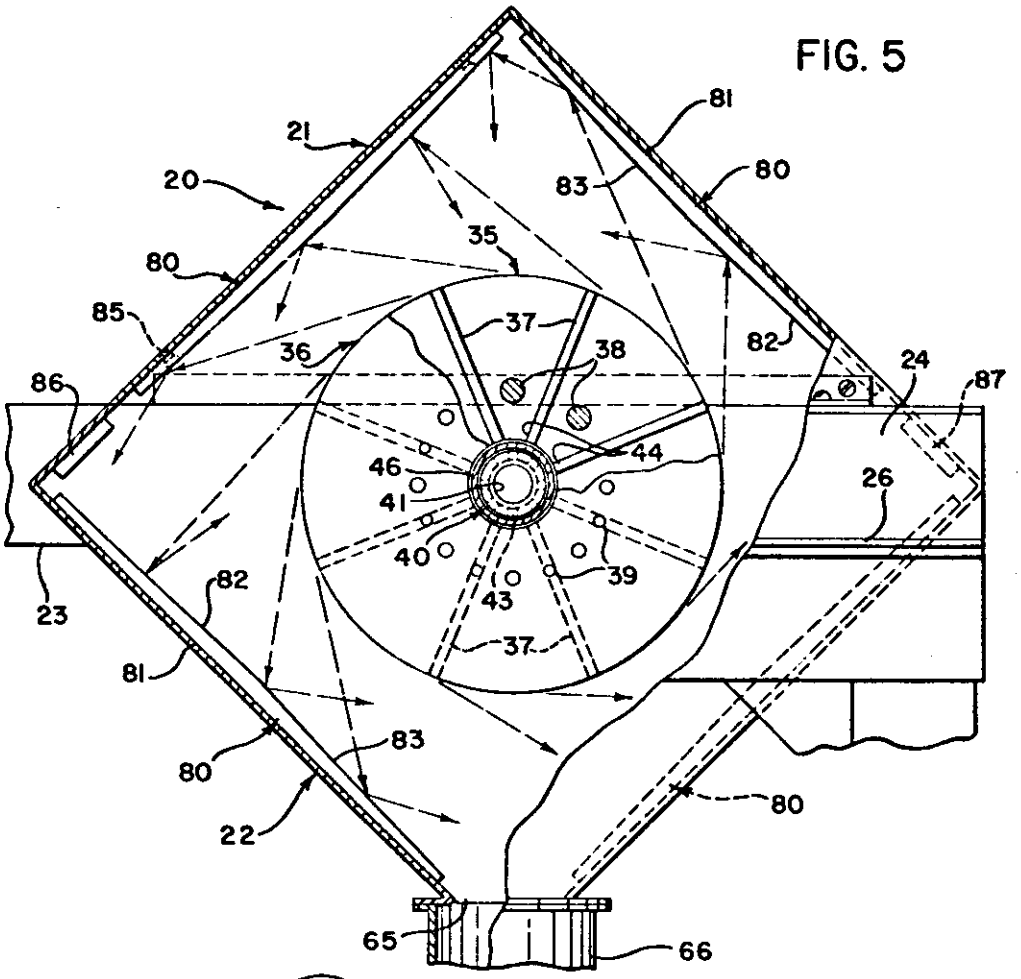
FIG. 5



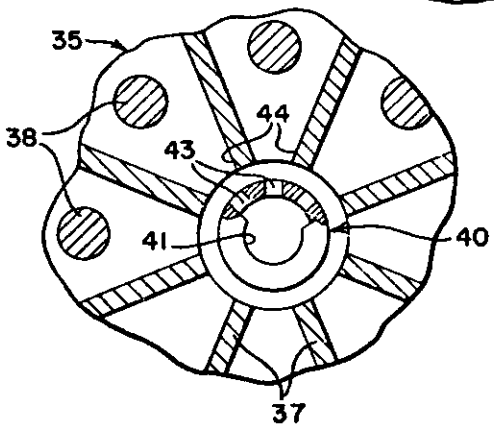


FIG. 6

INVENTOR.
ORALD L. STEWART

BY

Fay & Fay

ATTORNEYS