Jan. 6, 1953 F. S. SMITH 2,624,517

FLUID CURRENT COMMINUTOR, WITH CYLINDRICAL ABUTMENT IMPACT TARGET

Filed March 5, 1949 5 Sheets-Sheet 1

FIG. 1.

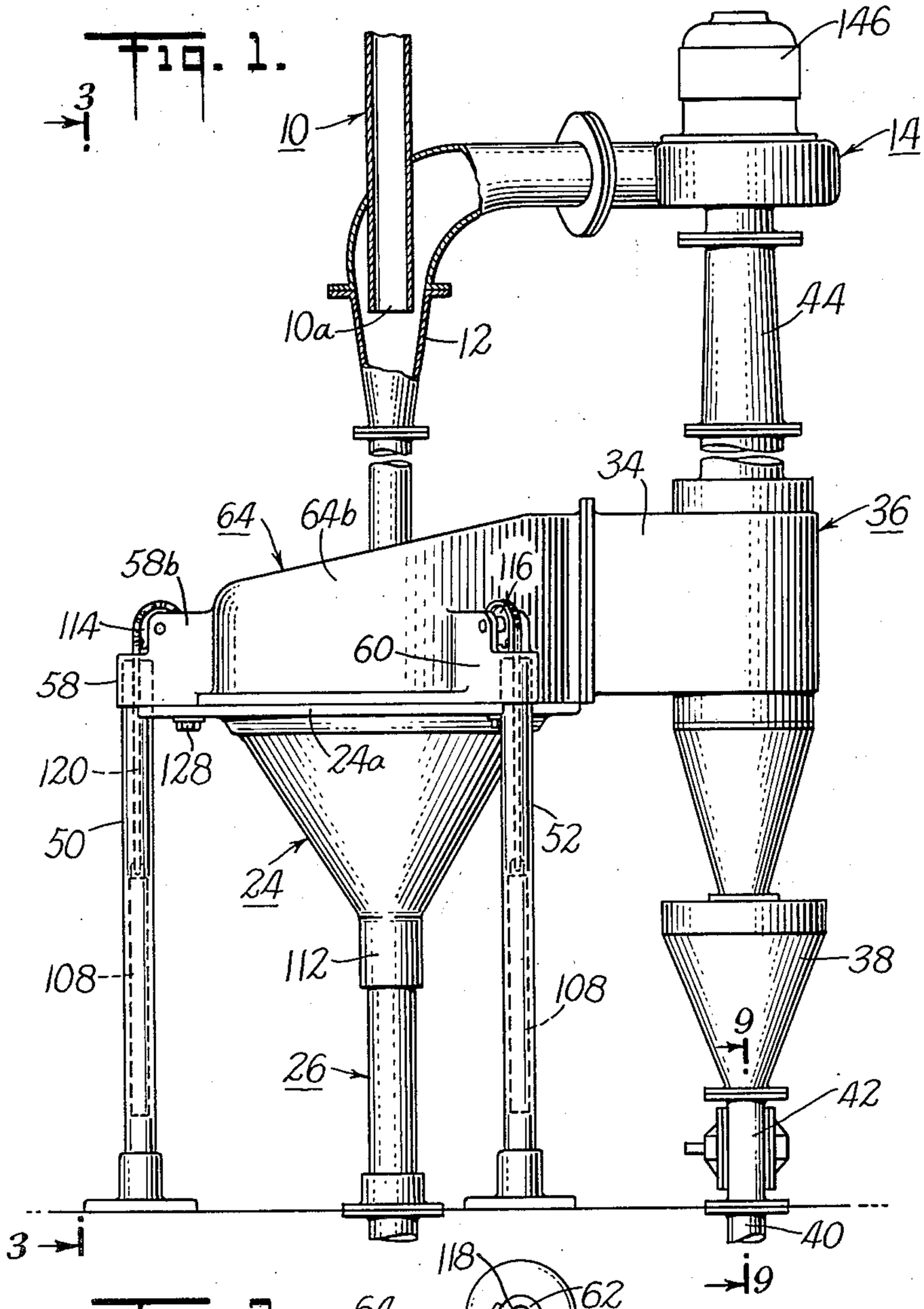

FIG. 2.

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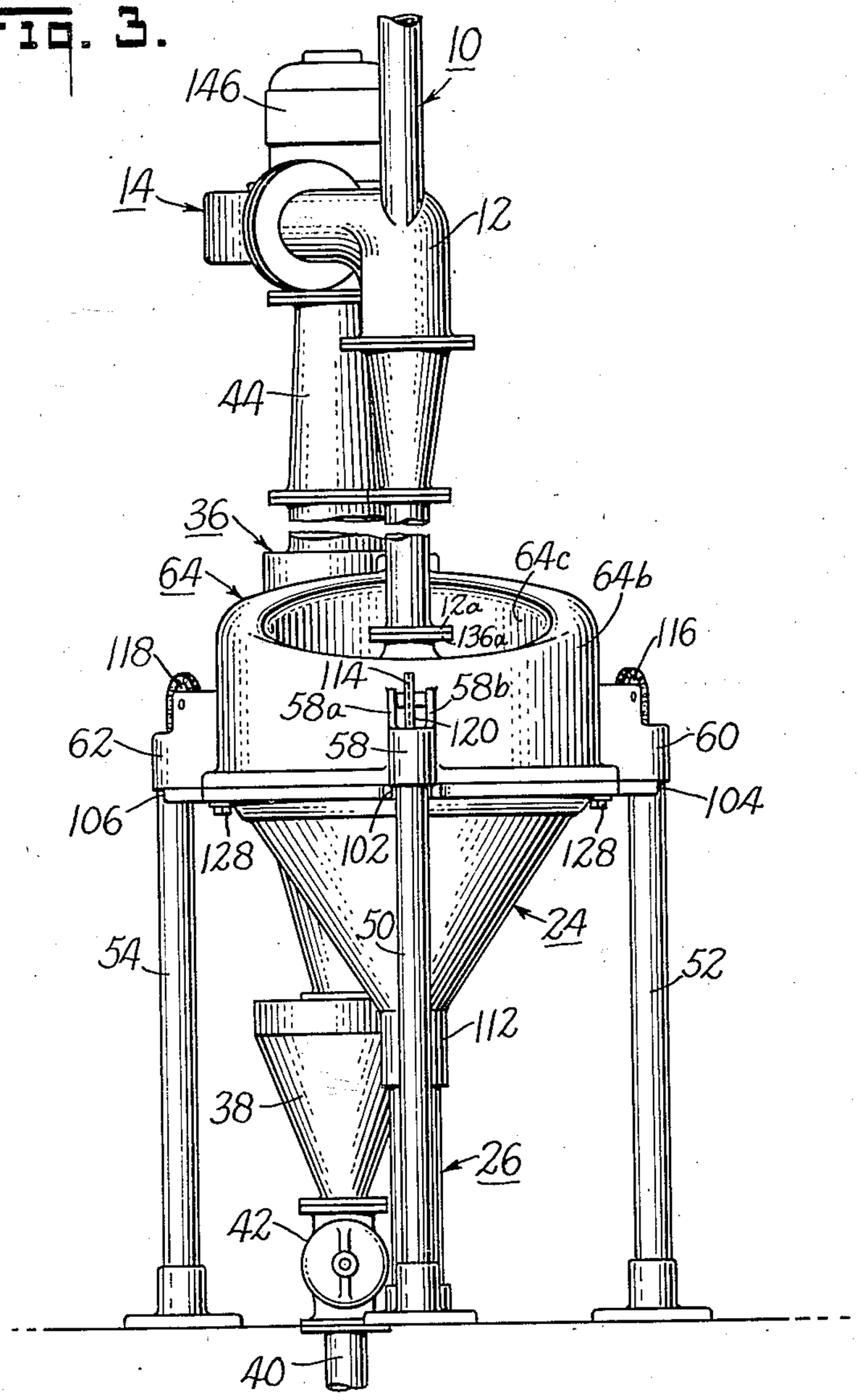
FLUID CURRENT COMMINUTOR, WITH CYLINDRICAL ABUTMENT IMPACT TARGET

Filed March 5, 1949 5 Sheets-Sheet 2

Fig. 3.



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FLUID CURRENT COMMINUTOR, WITH CYLINDRICAL ABUTMENT IMPACT TARGET

Filed March 5, 1949 5 Sheets-Sheet 3

Fig. 4.

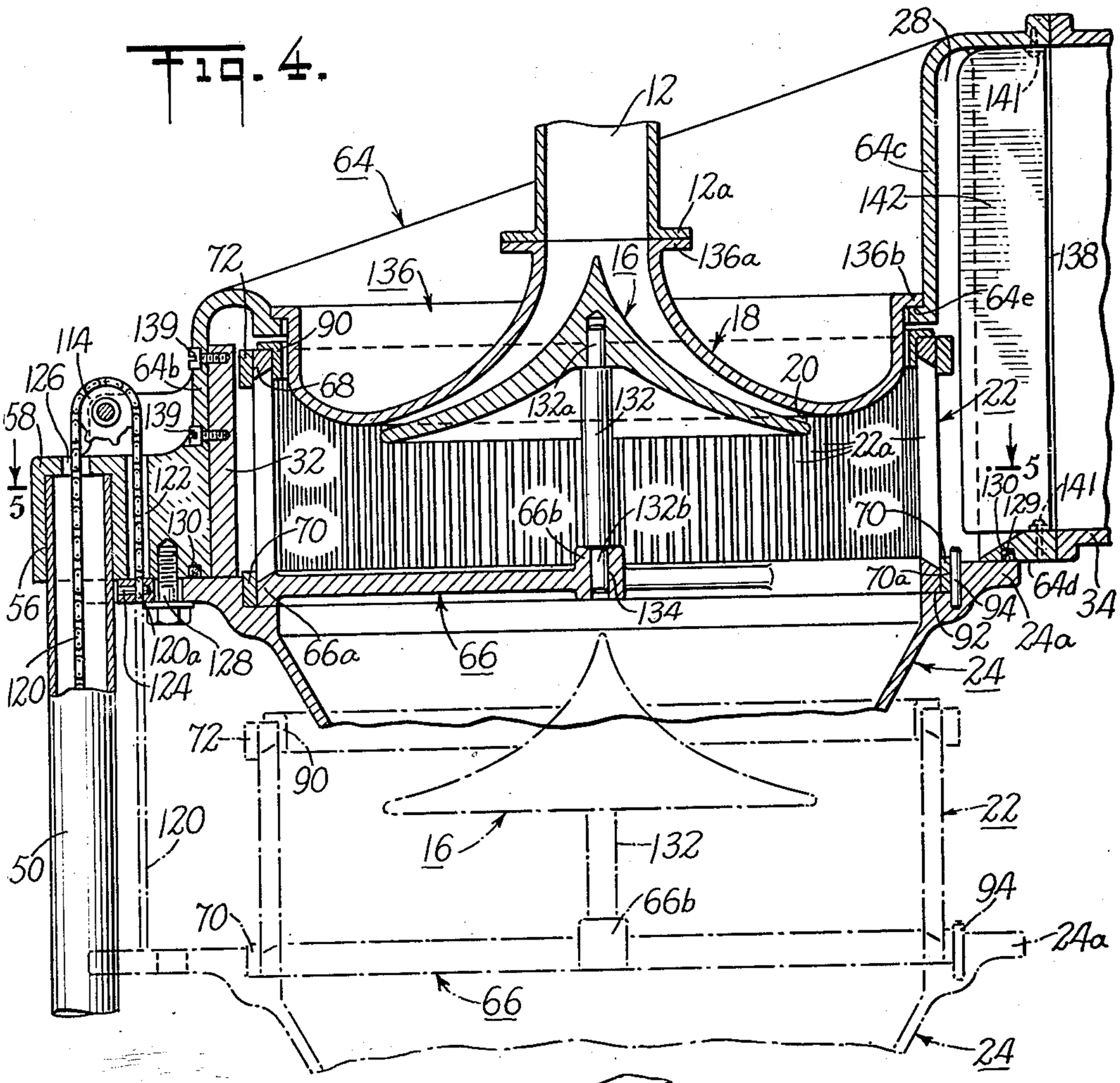
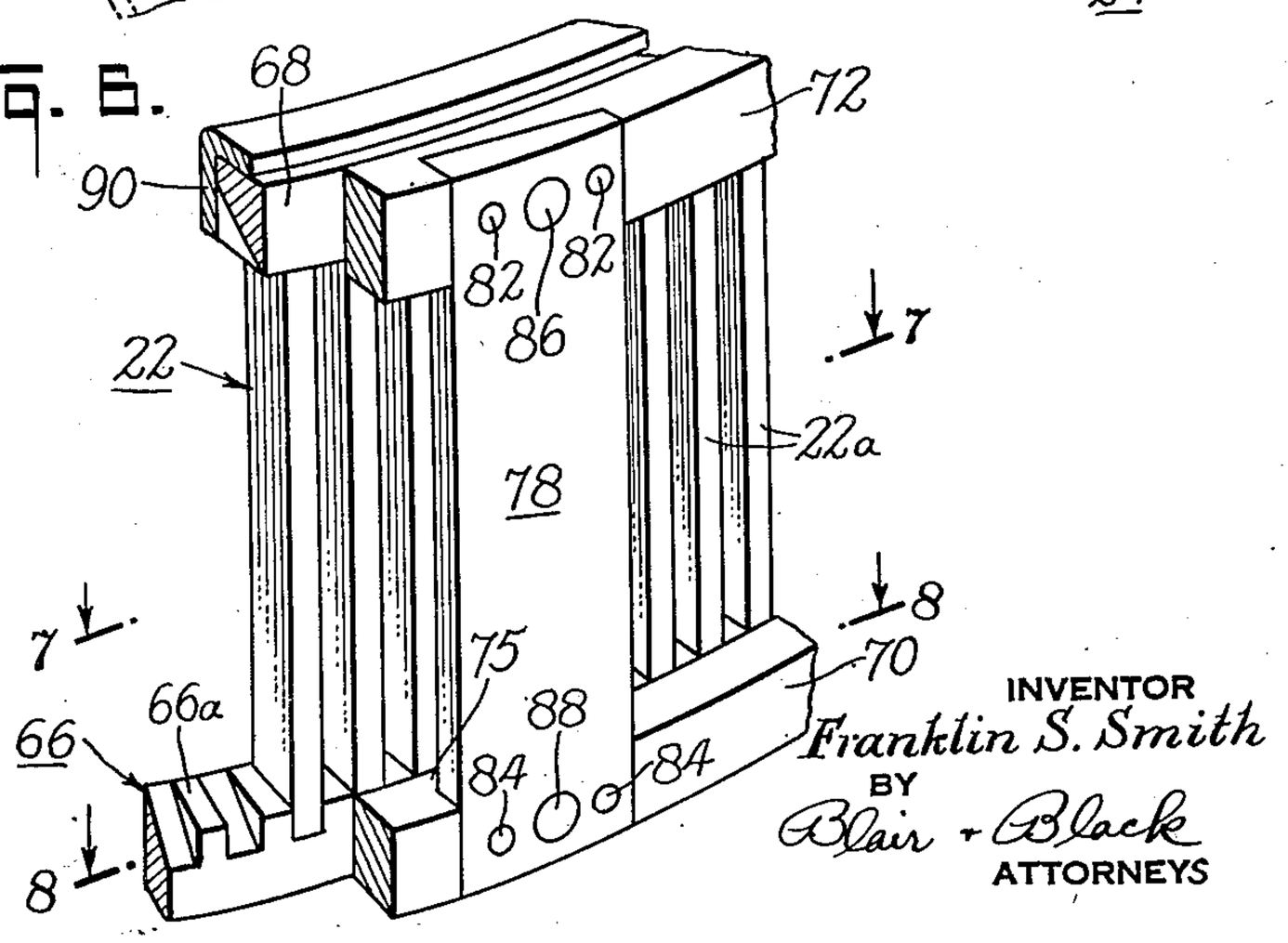


Fig. 6.



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Filed March 5, 1949 5 Sheets-Sheet 4

Fig. 5.

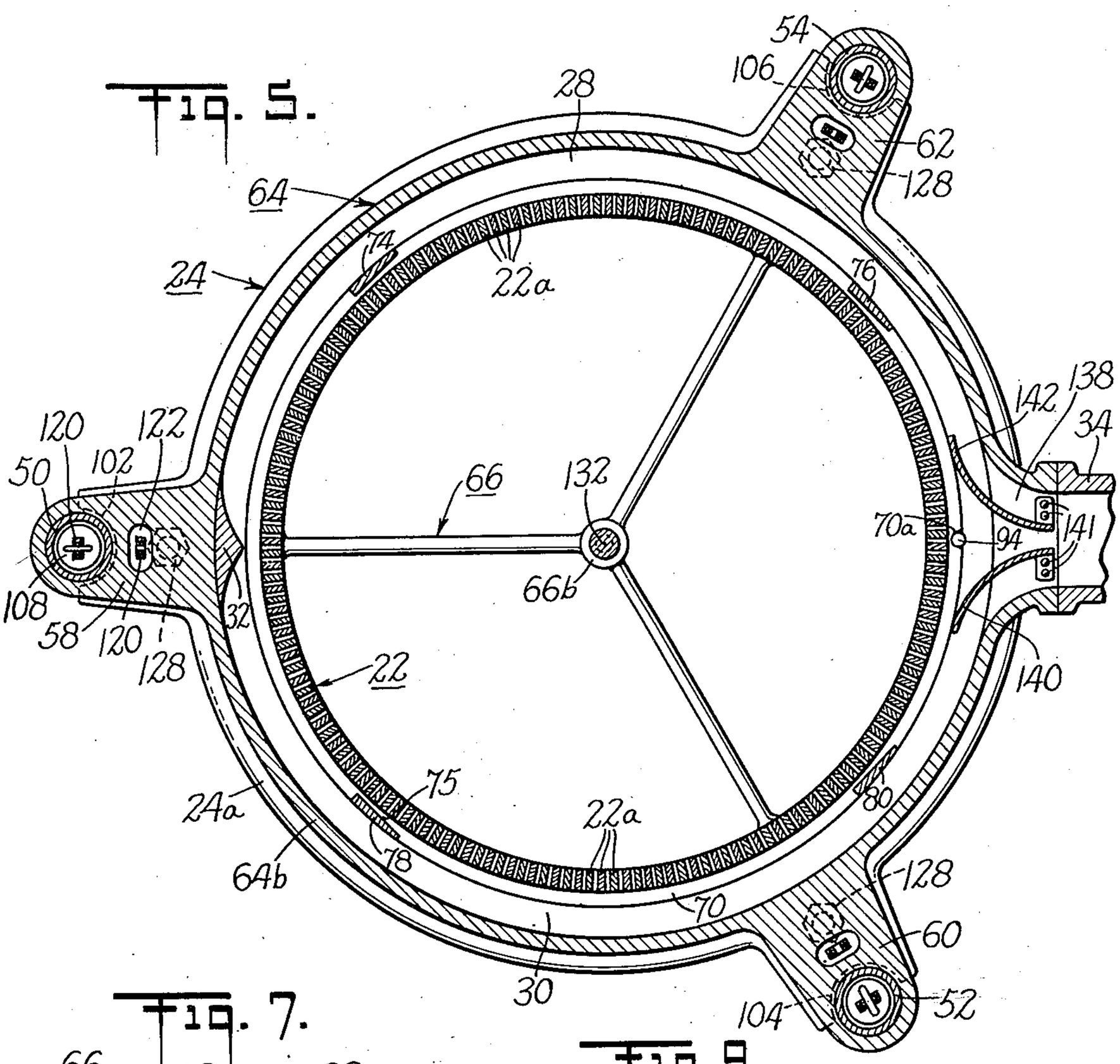


Fig. 7.

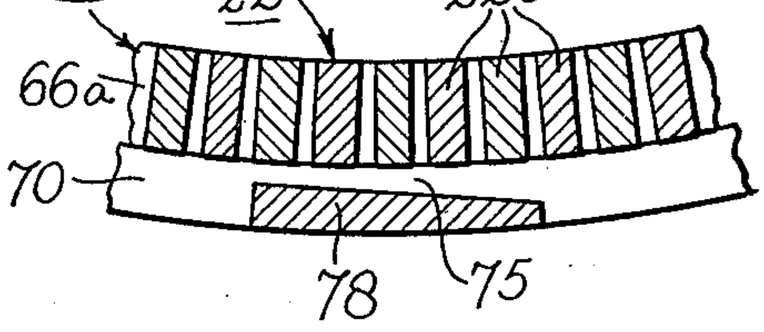


Fig. 8.

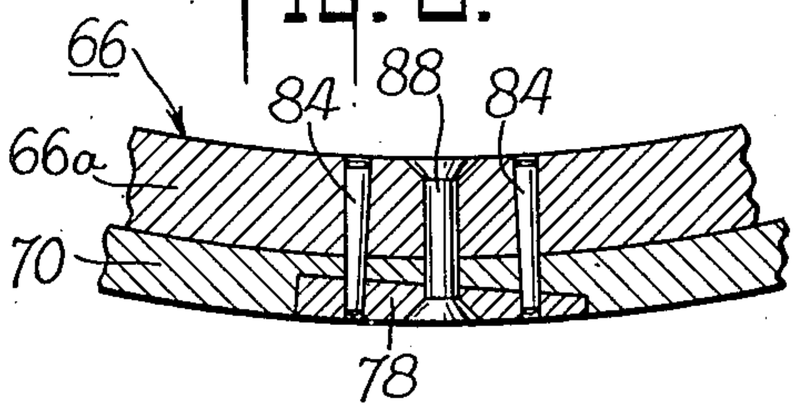
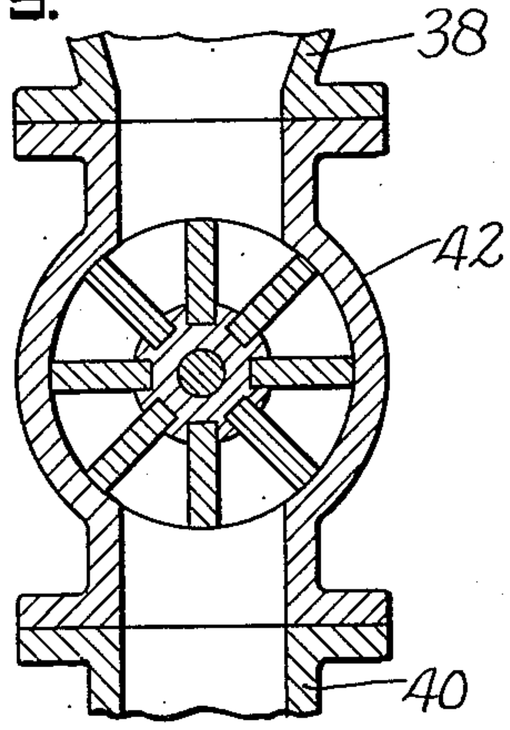


Fig. 9.



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FLUID CURRENT COMMINUTOR, WITH CYLINDRICAL ABUTMENT IMPACT TARGET

Filed March 5, 1949 5 Sheets-Sheet 5

Fig. 10.

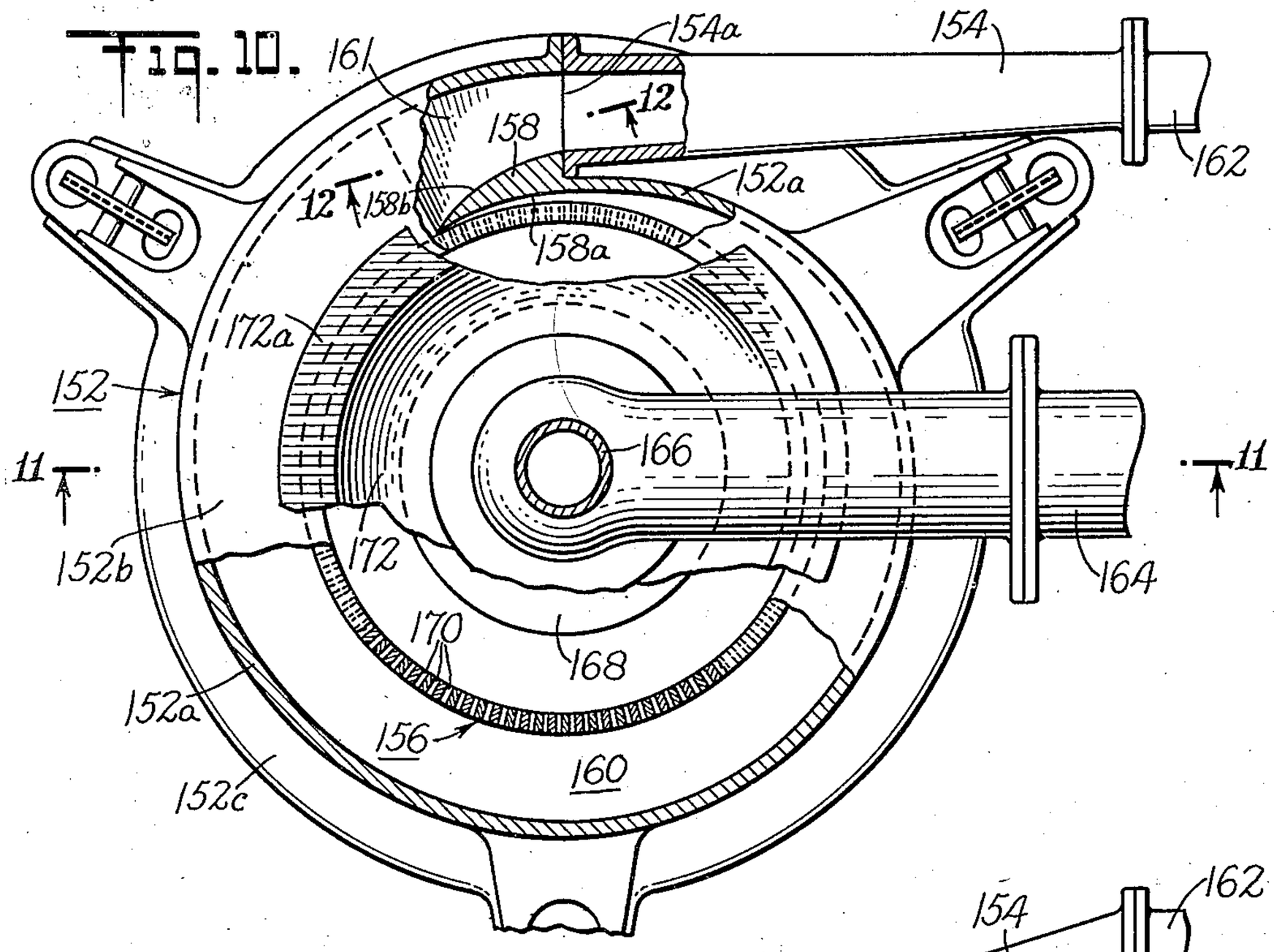


Fig. 11.

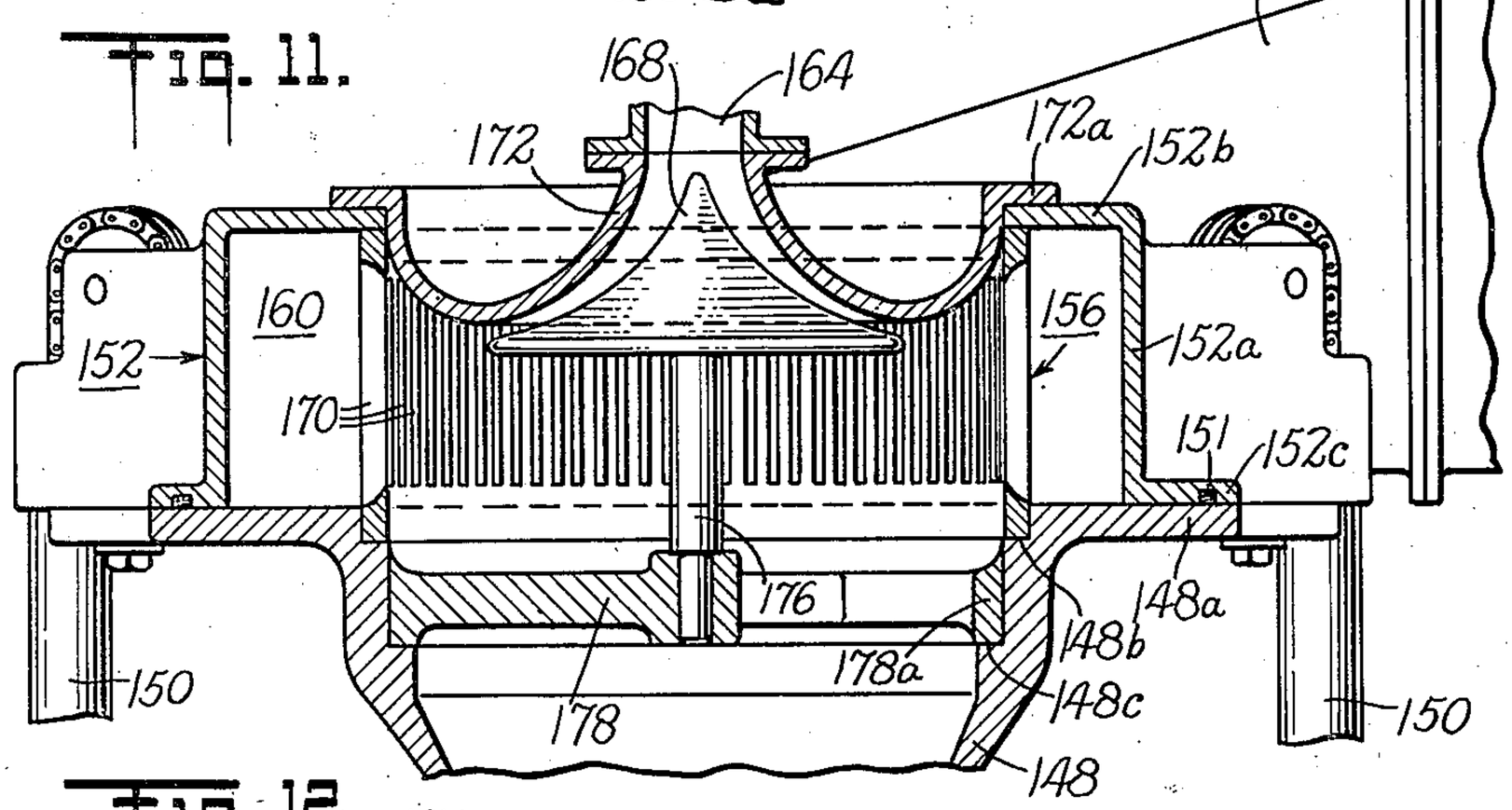


Fig. 12.

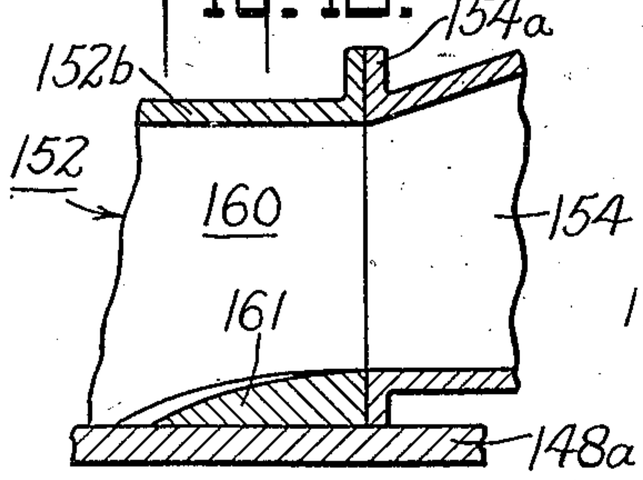
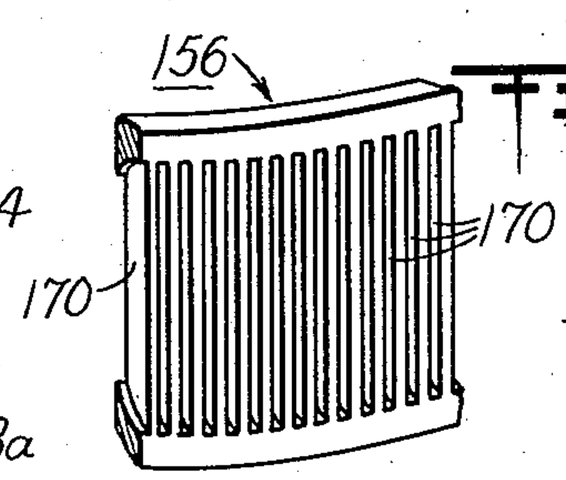


Fig. 13.



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Patented Jan. 6, 1953

2,624,517

UNITED STATES PATENT OFFICE

2,624,517

FLUID CURRENT COMMINUTOR WITH CYLINDRICAL ABUTMENT IMPACT TARGET

Franklin S. Smith, North Haven, Conn.

Application March 5, 1949, Serial No. 79,860

12 Claims. (Cl. 241—40)

1

This invention relates to impact milling apparatus.

One of the objects of this invention is to provide new and improved apparatus for impact milling. Another object is to provide apparatus of the above character which is simple, practical, and thoroughly durable. Another object is to provide apparatus of the above character, in which the particles of the milled product are classified in accordance with size. Another object is to provide apparatus of the above character in which the force of the impact may be readily controlled by the operator. Another object is to provide apparatus of the above character which is readily adaptable to milling products of different sizes and characteristics. Another object is to provide apparatus of the above character in which the classification of the sizes of particles from the milled product may be readily changed. Another object is to provide apparatus of the above character in which a maximum of cereal may be milled in a minimum of time. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the relation and order of each of the same to one or more of the others, all as will be illustratively described herein and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which are shown one illustrative embodiment of the invention and a modification thereof:

Figure 1 is a side elevation of the milling apparatus, certain parts being broken away for purposes of illustration;

Figure 2 is a top plan of the apparatus shown in Figure 1;

Figure 3 is a side elevation of the apparatus taken from the line 3—3 of Figure 1;

Figure 4 is a vertical section on an enlarged scale taken on the line 4—4 of Figure 2;

Figure 5 is a horizontal section taken on the line 5—5 of Figure 4;

Figure 6 is a perspective view on an enlarged scale of a portion of the target array;

Figure 7 is a horizontal section taken on the line 7—7 of Figure 6;

Figure 8 is a horizontal section taken on the line 8—8 of Figure 6;

Figure 9 is a vertical section on an enlarged scale taken on the line 9—9 of Figure 1;

Figure 10 is a plan illustrating a modification of a portion of the apparatus shown in Figure 1;

2

Figure 11 is a vertical section taken on the line 11—11 of Figure 10;

Figure 12 is a vertical section on an enlarged scale taken on the line 12—12 of Figure 10; and

Figure 13 is a perspective view on an enlarged scale of a portion of the target array used in the apparatus shown in Figure 11.

Similar reference characters refer to similar parts throughout the several views of the drawings.

In general, the milling apparatus (Figure 1) includes a spout, generally indicated at 10, connected to a bin (not shown) containing the product to be milled. The nozzle 10*a* of spout 10 extends downwardly into a conduit 12 through which air is blown downwardly by a blower, generally indicated at 14. The product to be milled, such as wheat, flowing from nozzle 10*a* is carried downwardly by the air stream passing through conduit 12 onto a conoidal member 16 (Figure 4), which together with a shell 18 positioned thereabove, forms nozzle 20, which directs the cereal into an array of spaced vertically positioned targets, generally indicated at 22. The product being milled disintegrates on striking the targets, the larger particles falling downwardly from the targets into a hopper, generally indicated at 24, and thence downwardly into chute 26. The smaller particles pass through the space between the targets into passageways 28 and 30 (Figure 5).

Passageways 28 and 30 increase in depth throughout their lengths, the smaller ends of the passageways being positioned on opposite sides of guiding vane 32, which splits the air stream and milled product passing through the target array into passageways 28 and 30. Having passageways which increase in cross-sectional area throughout their lengths insures an even flow of the air stream into passageways 28 and 30 in all directions from nozzle 20 (Figure 4). The air streams in passageways 28 and 30 carry the particles which have passed through target array 22 around the outside of the target array to guiding plates 140 and 142, which direct the air streams into the tangential passageway 34 forming the intake of a cyclone collector, generally indicated at 36. Because of the constantly increasing size of both passageways, the air stream is slowed down so that the stream of air enters the cyclone collector at a velocity of fifty feet a second or less. The milled particles carried by the air stream into collector 36 fall into hopper 38, which is emptied into chute 40 by an air lock valve 42. The air in cyclone collector 36

passes upwardly through conduit 44 to the intake of blower 14, which recirculates most of the air entering the cyclone collector through the milling apparatus.

In detail, referring to Figures 1, 3 and 4, the apparatus is supported by three hollow legs 50, 52 and 54, the upper ends of which extend into sockets, such as socket 56 (Figure 4), in brackets 58, 60 and 62 formed on housing 64. Housing 64 supports hopper 24, which in turn supports target array 22. Target array 22 includes a plurality of equidistantly spaced vertically positioned targets 22*a* mounted upon a framework including a wheel-shaped member 66 (Figures 4 and 5), a supporting ring 68 and a pair of retaining rings 70 and 72. The upper and lower ends of each target are obliquely cut and fit in obliquely cut slots in the rim 66*a* of wheel-shaped member 66 and the lower surface of ring 68. Retaining rings 70 and 72, which prevent the targets from moving outwardly with respect to ring 68 and the rim 66*a* of wheel member 66, are maintained in spaced relationship with respect to each other by supporting members 74, 76, 78 and 80 (Figure 5), the upper and lower ends of which are positioned in recesses cut in rings 70 and 72 (Figure 6).

Supporting members 74, 76, 78 and 80 are connected to retaining rings 70 and 72, supporting ring 68 and the rim 66*a* of wheel 66 by means of taper pins, such as taper pins 82 and 84 (Figures 6 and 8) and rivets, such as rivets 86 and 88. Rivet 86 secures the top end of supporting member 78 to retaining ring 72 and supporting ring 68, while rivet 88 secures the bottom end of supporting member 78 to retaining ring 70 and connects the latter to the rim 66*a* of wheel-shaped member 66.

It will be noted that the inner surface of each supporting member lies in a plane which is tangent to the outer surface of the target array 22, so that as passageways 28 and 30 are followed to the right toward chute 34 (Figure 5), the passageway 75 (Figure 7) between the inner surface of each supporting member and the target array constantly increases. This causes the milled particles passing through the target array opposite supporting members 74, 76, 78 and 80 to flow with the air stream to the right (Figure 5) into passageways 28 and 30 and thus prevents them from clogging the space between the supporting members 74, 76, 78 and 80 and the target array.

Targets 22*a* are of rectangular shape in cross section and are preferably made of a molded abrasive, such as silicon carbide. When their upper and lower ends are positioned in the milled slots in the rim of wheel member 66 and supporting ring 68, a removable retaining ring 90 (Figure 4) is used to hold the upper ends of the targets in place on the target supporting framework. When ring 90 is removed, it is a simple matter to reverse the position of the targets if their inner edges are worn, or to replace them.

In order to make the target array accessible for purposes of both cleaning and repair, the hopper 24 on which the target array is mounted (Figures 1 and 4) may be moved downwardly with respect to the apparatus. To accomplish this, hopper 24 is provided with a flange 24*a* (Figure 4) extending outwardly from its upper edge. Flange 24*a* has a seat 92 formed therein to receive the lower outer edge of the framework of target array 22. A locating pin 94 (Figures 4 and 5) is provided in seat 92 and coacts with a notch 70*a* in retaining ring 70 to insure that the target array will always be correctly positioned in the apparatus if it is removed therefrom. Flange 24*a* is also provided with outwardly extending portions, in the outer ends of which are formed recesses 102, 104 and 106 (Figure 5) in which legs 50, 52 and 54 are positioned. To aid legs 50, 52 and 54 in guiding hopper 24 as it is moved upwardly, the lower end of hopper 24 is provided with an outlet chute connection 112 which fits chute 26 with a sliding fit. Thus, as hopper 24 moves upwardly and downwardly with respect to the apparatus, it is guided by legs 50, 52 and 54 and chute 26.

To aid the operator in lowering and raising hopper 24, it is counterbalanced by means of counterweights positioned in legs 50, 52 and 54. Referring to Figures 1, 3 and 4, sprocket wheels 114, 116 and 118 are rotatably mounted on flanges, such as flanges 58*a* and 58*b* (Figure 3) extending upwardly from brackets 58, 60 and 62, respectively. As the counterweight assembly associated with each sprocket wheel is substantially similar, detailed description will be limited to the assembly associated with sprocket wheel 114 (Figure 4). The sprocket chain 120, which runs over sprocket wheel 114, extends through a hole 122 in frame 64 and has one end 120*a* secured to frame 64 by means of a pin 124. The other end of sprocket chain 120 passes downwardly through a hole 126 in bracket 58 into the interior of leg 50 where it is connected to the upper end of counterweight 108 (Figure 1). The combined weight of the target array 22, member 16, and hopper 24 is greater than the combined weight of the counterweights, in legs 50, 52 and 54, and thus when the studs 128 (Figures 1 and 3) which connect hopper 24 to housing 64 are removed, the hopper assembly moves downwardly to the dotted line position shown in Figure 4. At this time, the target array may be removed, if desired, for purposes of repair or cleaning and also it will be noted that at this time the conoidal member 16 and the complete interior of housing 64 are accessible for cleaning and the target array and conoidal member may be removed if desired. The bottom surface 64*d* (Figure 4) of housing 64 is provided with a gasket 129 mounted in a groove 130. Thus, when hopper flange 24*a* is drawn into contact with surface 64*d*, gasket 129 seals this connection.

As described above, the air from blower 14 passes downwardly through conduit 12 and encounters the product to be milled, such as grain, flowing downwardly from nozzle 10*a* to spout 10. At this point, the air stream picks up grain in conduit 12 to increase its speed and carries it downwardly against conoidal member 16 (Figure 4). Member 16 is detachably mounted on a pin 132*a* on the upper end of a support 132, the lower end 132*b* of which is positioned in a hole 134 in the hub 66*b* of wheel-shaped member 66. Conoidal member 16 is a conoid, the upper surface of which from its axis to its periphery is cycloidal. A shell 136 is connected by a flange 136*a* to a flange 12*a* on the lower end of conduit 12 and has a flange 136*b* on its outer edge which rests upon a seat 64*e* (Figure 4) formed on the lower edge of the inner wall 64*c* (Figure 3) of passageways 28 and 30 (Figure 5). The undersurface of shell 136 juxtaposed to the surface of member 16 is somewhat cycloidal. It will be noted that as the passageway between the shell 136 and the surface of member 16 is followed downwardly it gradually diminishes in width, thus forming nozzle 20. As the grain passes through nozzle 20, its maximum

speed is approximately 200 feet a second. It should be pointed out here, however, that the velocity of the air stream in this apparatus is governed by the rate of speed of blower 14, so that the miller can set the velocity of the air stream at the rate required by the characteristics of the product being milled, by means of a variable speed motor.

When the product being milled strikes the targets, it is shattered, the smaller particles being carried by the stream of air through the gaps between the targets into passageways 28 and 30, and the larger particles falling downwardly within the target array into hopper 24. As the targets are of rectangular shape in cross section, and as the targets are radially positioned with respect to the axis of the target array as a whole, the gap between each pair of targets gradually increases in width from the inside to the outside of the target array. This prevents any of the slots from becoming clogged by particles of the product being milled.

All of the outer walls of passageways 28 and 30 (Figures 4 and 5), their top walls, and the upper portions of their inner walls are an integral unit formed by housing 64. The outer walls 64*b* of both passageways, when considered as one unit, form a cylindrically-shaped member equidistantly spaced at all points from target array 22 (Figure 4). The upper inner walls 64*c* (Figures 3 and 4) also form a cylindrically-shaped member when considered as one unit, and together with target array 22 form the inner walls of passageways 28 and 30. The depth of each passageway constantly increases as they are followed to the right (Figure 5). Thus, at any given point between vane 32 and port 138, the total cross-sectional area of either passageway is able to accommodate the entire flow into that passageway between the given point and vane 32 (Figures 4 and 5), which is secured to housing 64 by stud screws 139 (Figure 4). As a result, the air stream flows evenly through the target array, and each individual stream flows through an arc of 180°, joining each other at port 138 (Figure 5).

As the two streams passing through passageways 28 and 30 converge on port 138, to prevent swirling, they are directed by a pair of curved guiding plates 140 and 142 (Figures 4 and 5) into intake 34 of cyclone collector 36. Guiding plates are vertically positioned in passageways 28 and 30 and are connected to housing 64 by studs 141. As the velocity of the air stream has been slowed down in passageways 28 and 30, once in cyclone collector 36, the milled particles drop from the lower end of the cyclone collector 36 into hopper 38. Hopper 38 is emptied by air lock valve 42 (Figure 9), which prevents the air stream from passing downwardly into chute 40. This valve is driven at whatever rate it is necessary to empty hopper 38 into chute 40. Air from collector 36 (Figure 1) passes upwardly through conduit 44 into blower 14, which is driven by motor 146, and thence recirculated through the apparatus.

In operation, the miller selects the particular type of target array necessary for the classification which he wishes to produce and the type of milling to be done. This is inserted in the apparatus and the rate of motor 146 is set at a speed which will produce the velocity desired at nozzle 20 (Figure 4). When the motor is in operation, the product to be milled is permitted to flow through spout 10 (Figure 1). The air stream passing through conduit 12 projects the grain from nozzle 10*a* upon cycloidal member 16, which

with shell 136 forms a nozzle directing the product being milled against target array 22. The larger particles fall downwardly into hopper 24, and thus pass into chute 26 (Figure 1). The smaller particles pass through the target array into passageways 28 and 30 (Figure 5) and thence through port 138 into the intake 34 of cyclone collector 36, the air streams from passageways 28 and 30 being guided in the port by guiding plates 140 and 142. In the cyclone collector 36, the milled particles pass downwardly and the air passes upwardly through conduit 34 to blower 14. If there is a shortage of air in the apparatus, this shortage will be automatically taken care of by the air entering the apparatus through nozzle 10*a* with the stream of particles being milled. Any excess of air will flow down chute 26 (Figure 1).

Whenever it is desired to clean the target array and interior of the apparatus or change the target array, targets, or conoidal member, screws 128 (Figures 1 and 3) are loosened and hopper 24, target array 22, and cycloid 16 will drop downwardly, guided by legs 50, 52 and 54 and chute 26. The weight of these elements is counterbalanced, as pointed out hereinabove, by counterweights, such as counterweight 168 (Figure 1), positioned in the legs 50, 52 and 54. Thus, it will be seen that the machine is designed for maximum efficiency in all respects, in that the interior of the machine is readily accessible for cleaning, that the target array can be changed as a unit if differently spaced targets are desired, and the individual targets if worn can be readily replaced by removing retaining ring 90. Because of the manner in which targets 22*a* are formed, they may be reversed when they become worn so that unworn outer surfaces and edges form the target surface. After the machine is cleaned or the target array changed, it is a simple matter to raise the hopper, target array and cycloid into operative position and replace the screws 128 and the machine is again ready for operation.

Referring to Figures 10, 11, 12 and 13, in which is illustrated a modification of the apparatus shown in Figures 1–9, the machines are substantially similar in construction, with the exception of the passageway which connects the target array to the cyclone collector and the construction of the target array. In the apparatus shown in Figures 10, 11, 12 and 13, the hopper 148 positioned beneath the target array is detachably mounted on the machine, and when lowered is counterbalanced by counterweights positioned in its legs 150 in the same manner as hopper 24 in the embodiment shown in Figures 1–8 and the joint between hopper flange 148*a* and housing flange 152*c* being sealed by a gasket 151. The housing 152 includes a wall 152*a* which follows a logarithmic spiral beginning at the inner edge of the mouth 154*a* of conduit 154 (Figure 10). Walls 152*a*, top 152*b* and the outer surface of target array 156 form a volute 160 which gradually increases in width as the target array 156 is followed in a clockwise direction. At the end of wall 152*a* nearest target array 156 a cutoff 158 is provided, the inner surface 158*a* of which forms a continuation of wall 152*a* and curves inwardly to a point where it practically touches target array 156. The outer surface 158*b* of cutoff 158 serves to direct the air stream and milled particles from passageway 160 into conduit 154 which increases in cross-sectional area throughout its length and thence into the intake 162 of a cyclone collector (not shown). Referring to Figure 12, to permit passageway 160 to be con-

nected to conduit 154, a member 161 is provided which extends transversely across passageway 160. Member 161 and cutoff 158 permit conduit 154 to be connected to passageway 160 by means of its flange 154*a*.

The target array in this embodiment consists of a cylinder in which a series of slots 170 are milled extending longitudinally of the axis of the target array. The upper edge of the target array is positioned beneath the top wall 152*b* of housing 152 and it is mounted in a seat 148*b* formed on hopper 148. The shell 172, which covers the top of the space enclosed by the target array, is connected to the lower end of the conduit 164 and its flanged edge 172*a* rests upon the upper surface of top wall 152*b*. Conoidal member 168 is detachably mounted by a support 176 on the hub of a wheel-shaped member 178, the rim 178*a* of which rests on a seat 143*c* formed on hopper 148.

In operation, the air stream passing through conduit 164 (Figure 10) acts upon the product to be milled as it flows out of spout 166 and carries it against target array 156, the air stream and the product being milled being directed by conoidal member 168 against target array 170. Because of volute 160, the air stream carries the product being milled evenly against target array 156 in all directions. The larger particles resulting from the impact of the product being milled against the target array pass downwardly into hopper 148, while the smaller particles are carried through the slots between the targets into volute 160 (Figure 10). The air stream flows around volute 160 in a clockwise direction (Figure 10), enters conduit 154 which slows down the velocity of the air stream to fifty feet a second or less because of its constantly increasing size. The air stream then enters the intake 162 of a cyclone collector similar to collector 36 (Figure 1). The remainder of the apparatus is similar to that shown in Figure 1. In this embodiment, the hopper, which is counterbalanced, may be lowered as in the previous embodiment for purposes of cleaning the interior of the machine or removing the target array or conoidal member.

Thus it will be seen that a practical and efficient method of milling has been disclosed, together with new and improved apparatus of one type suitable for carrying out the method of milling disclosed herein. Furthermore, it will be noted that the product being milled is classified by this apparatus in a new and improved manner and that the classification may be easily and quickly changed by changing the target array. Also, it will be noted that this machine is readily controllable by the miller so that the apparatus may be easily set to suit the characteristics of the particular product being milled. It will now be clear that the several objects hereinabove mentioned, as well as many others, have been successfully accomplished.

As many possible embodiments may be made of the mechanical features of the above invention, and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In apparatus of the type described, a vertically positioned conduit, means to create a stream of air flowing downwardly through said

conduit, a stationary cone-shaped cycloid positioned beneath said conduit, a cylindrically-shaped target array having its inner wall positioned outwardly from the lower edge of said cycloid, said target array including a plurality of vertically positioned spaced targets, said stream of air carrying the product to be milled against said target array with sufficient force to disintegrate the particles of which said product is comprised, means forming a passageway externally of said target array for collecting the particles of said milled product passing through said target array, and a hopper positioned beneath said target array for collecting the particles of said milled product which do not pass through said target array.

2. In apparatus of the type described, a conduit, means to create a stream of air flowing through said conduit, means to introduce a product to be milled into said stream of air in said conduit, a stationary conoidal member, the axis of said conoidal member being vertically positioned and aligned with the axis of said conduit, means coacting with said conoidal member to form a nozzle opening at the lower edge of said cone-shaped member, a cylindrically-shaped target array including a plurality of vertically positioned spaced targets, said nozzle directing said stream of air and said product to be milled against said target array, the product being milled being carried by said stream of air into said target array with sufficient force to disintegrate the particles of which said product is comprised, passageway means positioned outwardly of said target array for collecting the particles of said milled product passing through said target array, and means positioned beneath said target array for collecting the particles of said milled product which do not pass through said target array.

3. In milling apparatus of the type described, a conduit, means to create a particle-carrying relatively high velocity stream of air through said conduit, means to introduce product particles to be milled into said high velocity stream of air to be airborne thereby, a cylindrically-shaped target array including a plurality of circumferentially spaced targets, realtively-fixed means for directing said stream of air and said airborne product particles to be milled radially out against said target array, and passageway means positioned exteriorally and circumambiently of said target array leading to discharge means, said passageway means being gradually increasing in cross section toward said discharge means from locality most remote from the latter so that said stream of air will flow evenly through said target array at substantially all circumferential points.

4. In apparatus of the type described, a conduit, means to create a stream of air flowing through said conduit, means to introduce a product to be milled into said stream of air, a cylindrically-shaped target array including a plurality of spaced targets, means for directing said stream of air and product to be milled against the inside of said target array, means forming a passageway positioned outwardly from said target array, an exhaust port for said passageway, means positioned in said passageway opposite said exhaust port dividing said passageway into two sections, each of said sections increasing in cross sectional area throughout their lengths, the enlarged ends of said sec-

tions opening into said exhaust port, means for collecting the particles of the milled product passing out of said exhaust port, and means for collecting the particles of the milled product which do not pass through said target array.

5. In milling apparatus of the type described, in combination, a conduit, means for creating a particle-carrying relatively high velocity stream of air flowing through said conduit, a cylindrically-shaped target array, a relatively-fixed conoidal member for directing said particle-laden stream of air against said target array and supported coaxially in and with the latter, said target array including a plurality of circumferentially spaced targets, said stream of air carrying the product being milled against said target array with sufficient force to disintegrate the particles of which said product is comprised, a housing forming a passageway positioned outwardly and circumambiently of said target array, said passageway collecting particles of said milled product passing through said target array, a hopper removably positioned beneath said target array, said target array being mounted on and supported by said hopper, and means detachably connecting said hopper to said housing to permit said hopper, said member and said target array to be detached together from said housing for purposes of cleaning or repair.

6. In apparatus of the type described, in combination, a vertically positioned conduit, a blower for creating a stream of air passing downwardly through said conduit, means for introducing a product to be milled into the air stream passing through said conduit, a cylindrically-shaped target array, a conoidal member for directing said stream of air and the product to be milled outwardly against the inside of said target array, said target array including a plurality of vertically positioned spaced targets, means forming a passageway externally of said target array for collecting the particles of said milled product passing through said target array, a hopper positioned beneath said target array, said target array and said conoidal member being mounted on said hopper, a framework, means detachably connecting said hopper to said framework, said hopper being movable downwardly away from said framework, and means for counterbalancing said hopper, target array and conoidal member when it is moved downwardly out of assembled relationship with respect to said framework, the interior of said passageway, said target array and said conoidal member being readily accessible for purposes of cleaning or repair when said hopper is detached from said framework.

7. In a target array for apparatus of the type described, in combination, a circularly-shaped supporting framework, a plurality of slots formed in the periphery of said framework, a ring member, a plurality of spaced slots formed in said ring member, means for supporting said ring member above the periphery of said supporting framework, said slots in said framework and ring member being aligned with respect to each other and being radially positioned with respect to the axis of the target array, a plurality of targets, each target being of rectangular shape in cross section, the upper and lower ends of each of said targets being positioned in aligned slots in said supporting framework and said ring member, and means for retaining the upper ends of said targets in the slots in said ring member and means for

retaining the lower ends of said targets in the slots in said supporting framework, said targets forming a cylindrically-shaped target array and being detachably mounted on said supporting framework and ring member.

8. In milling apparatus of the type described, in combination, a blower, a conduit, said blower forcing a stream of air through said conduit, means for introducing particles of a product to be milled into said conduit, a cylindrically-shaped target array including a plurality of circumferentially-spaced targets, relatively-fixed means for directing said stream of air and the product being milled radially out in all directions against said target array, a hopper positioned beneath said target array for collecting the particles of the product being milled which do not pass through said target array, a passageway in the shape of a volute positioned outwardly adjacent to and circumambiently of said target array to extend substantially 360° thereof and of gradually increasing capacity in a downstream direction toward its outlet to assure passage of substantially uniform quantities of air through said target array at substantially all radial points, and means to receive milled product-laden air from the passageway outlet and separate the milled product from the air stream.

9. In milling apparatus of the type described, in combination, a conduit, means to create a particle-carrying relatively high velocity stream of air in said conduit, means for introducing product particles to be milled into said stream of air, a cylindrically-shaped target array including a plurality of circumferentially-spaced targets, relatively-fixed circumambient nozzle means to direct said stream of air and the airborne product particles to be milled radially out against the inside of said cylindrically-shaped target array, said stream of air constituting the sole motive force for and carrying said product particles against said target array with sufficient force to disintegrate the particles of which said product is comprised, means forming a passageway positioned externally and circumambiently of said target array with the outer side of the latter defining the inner side of said passageway, said passageway extending completely around said target array and being in the shape of a volute of gradually increasing capacity in the downstream direction toward its outlet end, means for collecting the airborne milled particles passing through the open outlet end of said volute, and means for collecting the larger milled particles falling downwardly from within said target array.

10. In an apparatus of the type disclosed, a vertically positioned conduit, a blower for creating a stream of air flowing downwardly through said conduit, means for introducing kernels of grain into said downwardly flowing air stream, a stationary cone-shaped cycloid positioned beneath said conduit, the axis of said cycloid being aligned with the axis of said conduit, a cylindrically-shaped target array, the axis of said target array being aligned with the axis of said cycloid, a housing member positioned above said cycloid, said housing forming an annular nozzle with said cycloid, said nozzle directing grain outwardly radially with respect to the axis of said cycloid against said target array, said stream of air carrying the kernels of grain against said target array with sufficient force to disintegrate the kernels of grain, means forming a passageway externally of said target array for collecting the particles of said milled product passing through said

target array, means for separating the air stream carrying said product from said product, a conduit for leading said air stream to said blower and a hopper positioned beneath said target array for collecting the particles of said kernels of grain which do not pass through said target array.

11. In grain milling apparatus the combination comprising; feeding means to supply kernel-carrying, high velocity gaseous medium; a relatively fixed nozzle having an axial inlet opening connected to said feeding means and a circumferentially-arranged, circular, laterally-directed outlet orifice with the interior passage between said opening and orifice being bell-shaped and defined by substantially cycloidal converging walls; a drum-like, vertically-slotted target array arranged coaxially with and circumambiently of said nozzle outlet orifice, each of the targets of said array comprising an elongated bar substantially rectangular in cross-section having one of its edge faces facing said orifice substantially normal to a radius of said nozzle; a vertically-movable hopper disposed beneath said array for collection of coarse particles which do not pass laterally through said array with the lattter mounted on and supported by said hopper to be lowered and raised therewith; and casing means surrounding said array and forming therewith delivery passage means for fines-laden gaseous medium and terminating in an outlet for connection to separating apparatus, said delivery passage means being defined by gradually diverging walls for gradual increase of the capacity thereof as said outlet is approached to assure substantially even distribution of fines-laden gaseous medium through said array at substantially all circumferential points.

12. The grain milling apparatus as defined in claim 11 characterized by said array being in the form of an open, substantially cylindrical framework having top and bottom rings provided with opposed radial slots removably receivable of the ends of said targets, and means removably to hold said targets in said slots for removal and reversal at will.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
90,097	Hanford	May 18, 1869
139,782	Goodhart	June 10, 1873
414,431	Morse	Nov. 5, 1889
994,596	Marks	June 6, 1911
1,108,542	Anderson	Aug. 25, 1914
1,211,736	Marshal	Jan. 9, 1917
1,241,749	McCool	Oct. 2, 1917
1,512,323	Wallace	Oct. 21, 1924
1,608,717	Bell	Nov. 30, 1926
2,417,078	Jones	Mar. 11, 1947

FOREIGN PATENTS

Number	Country	Date
152,603	Great Britain	Feb. 15, 1922
556,058	France	July 11, 1923
452,306	Germany	Nov. 8, 1927