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Rampe

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[54] **VIBRATORY FINISHING MACHINE**

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Related U.S. Patent Documents

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[63] Continuation of Ser. No. 42,908, Dec. 11, 1970, abandoned.

[52] **U.S. Cl.** **51/163.1**
[51] **Int. Cl.²** **B24B 31/06**
[58] **Field of Search** 51/7, 163; 241/175; 259/72

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[57] **ABSTRACT**

A precision finishing machine characterized by orbital movement of bulk finishing media comprising supporting structure; a centrally disposed receptacle resiliently mounted on the supporting structure; a plurality of shaft-supported eccentrics mounted on opposing sides of said centrally disposed receptacle at substantially the level of the center of mass of the receptacle and its load, the longitudinal axes of said shaft-supported eccentrics paralleling one of the horizontal axes of the receptacle; flexible couplings connected to the eccentrics; and, connected to the couplings, a drive system including power means and auxiliary means for positioning, adjusting the position of, and controlling the power means.

14 Claims, 5 Drawing Figures

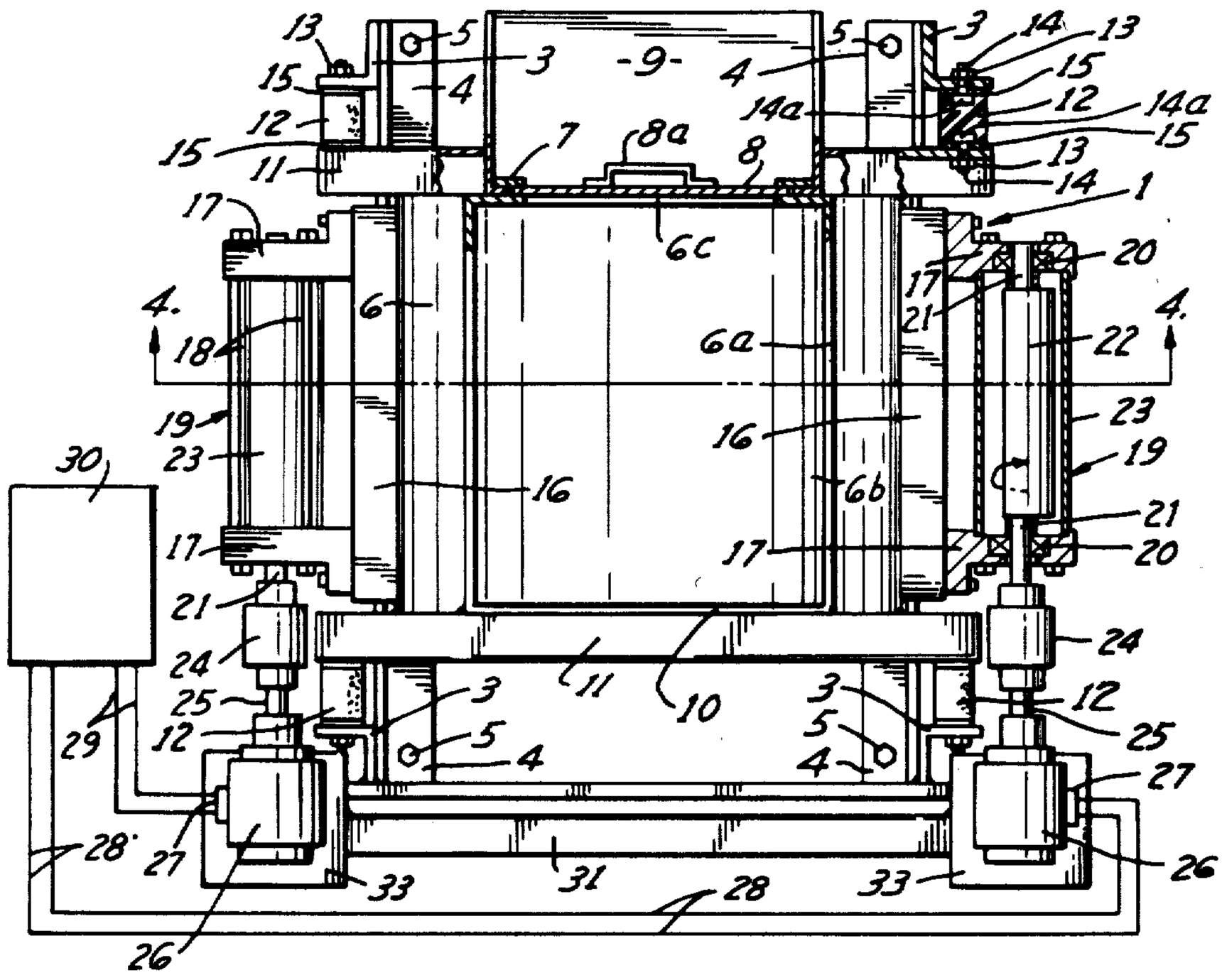


Fig. 1.

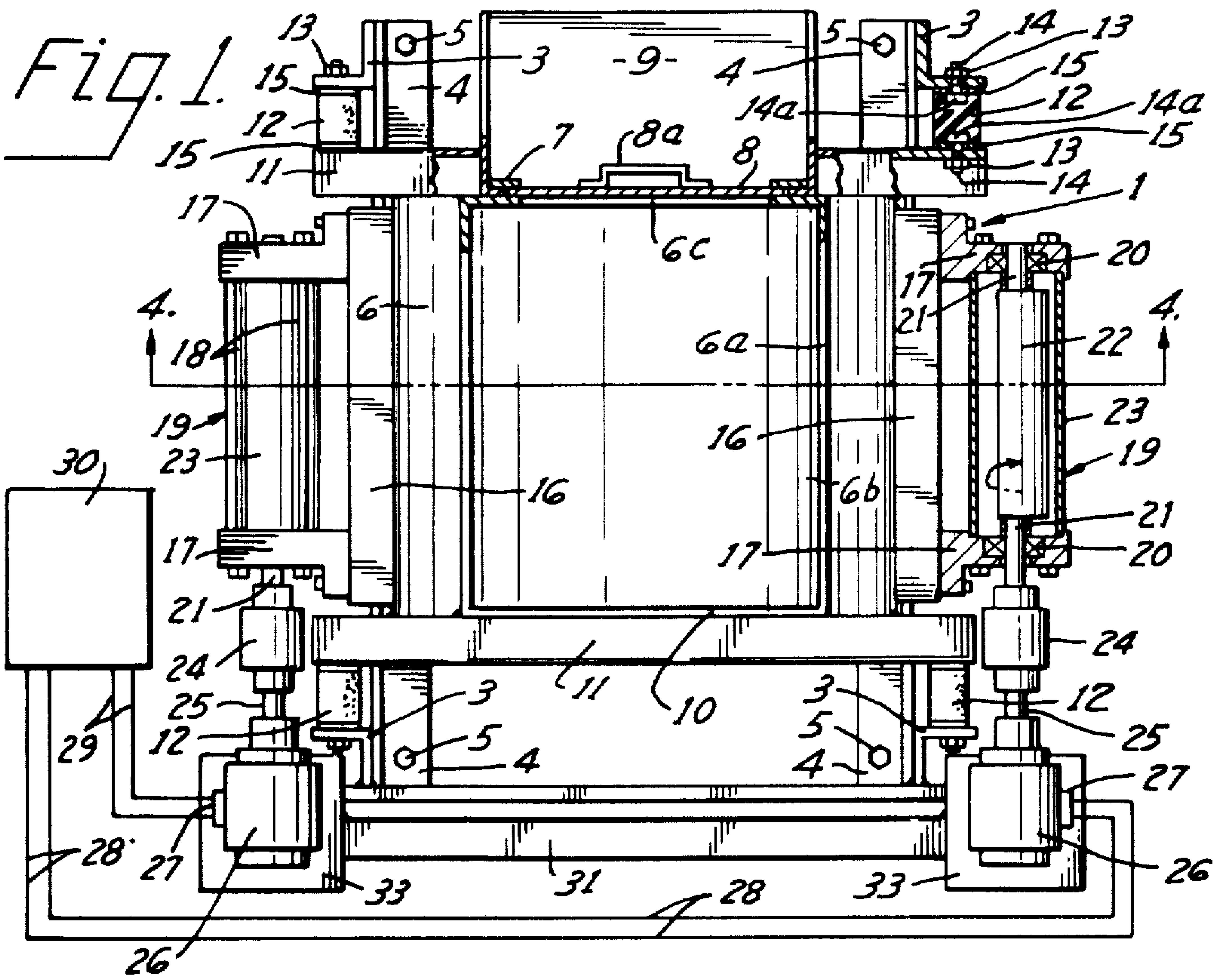
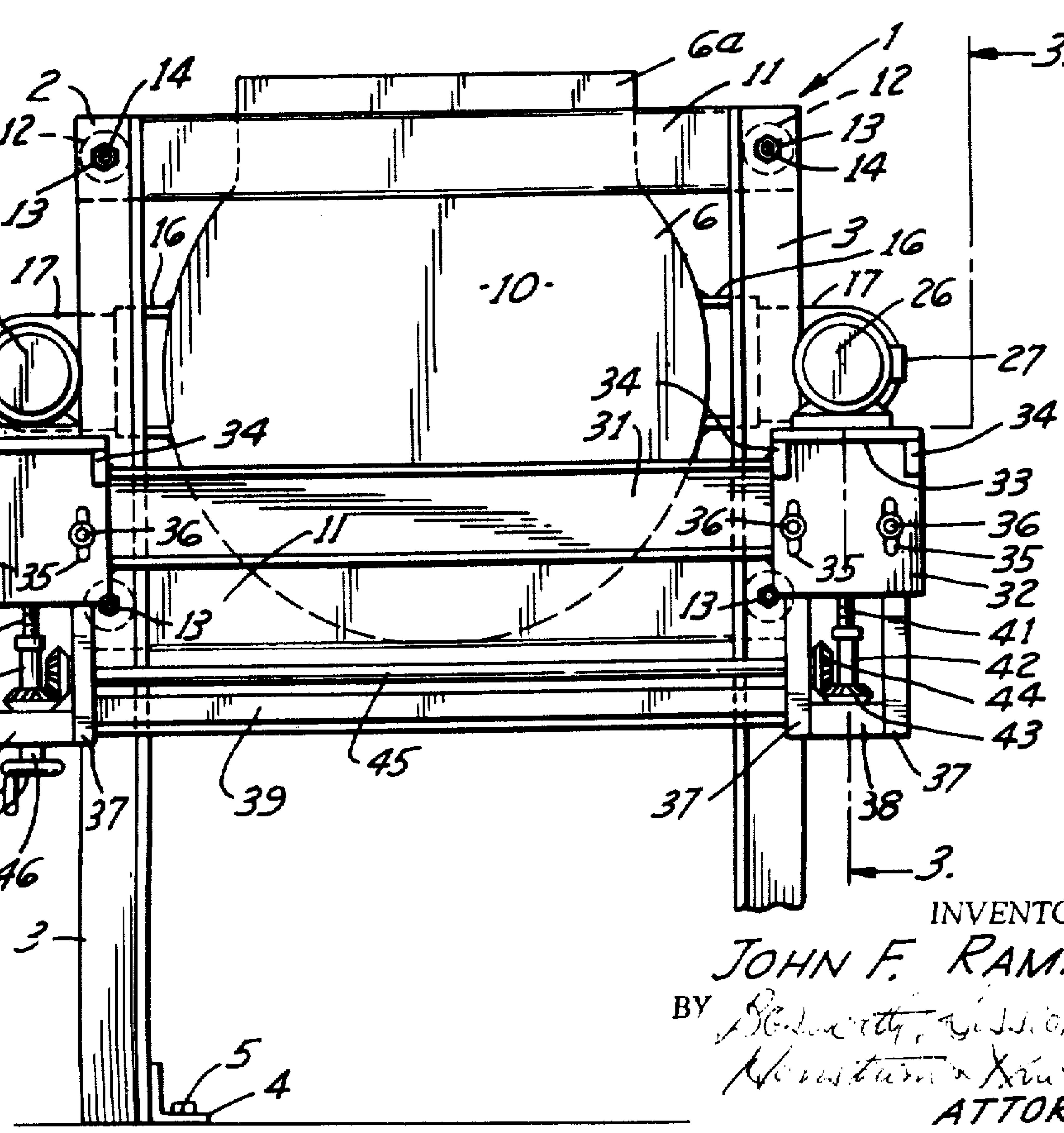


Fig. 2.



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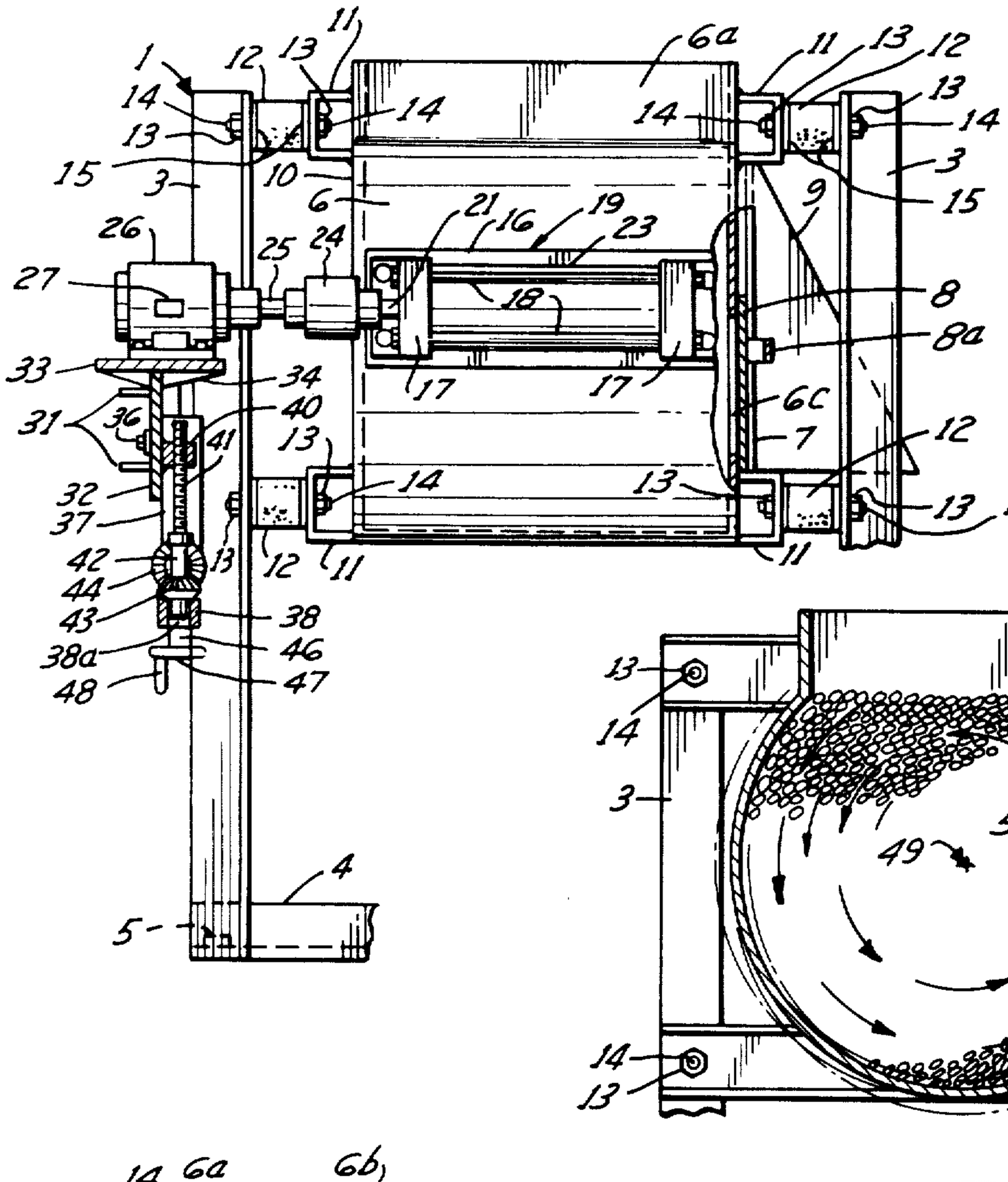

Fig. 3.

Fig. 5.

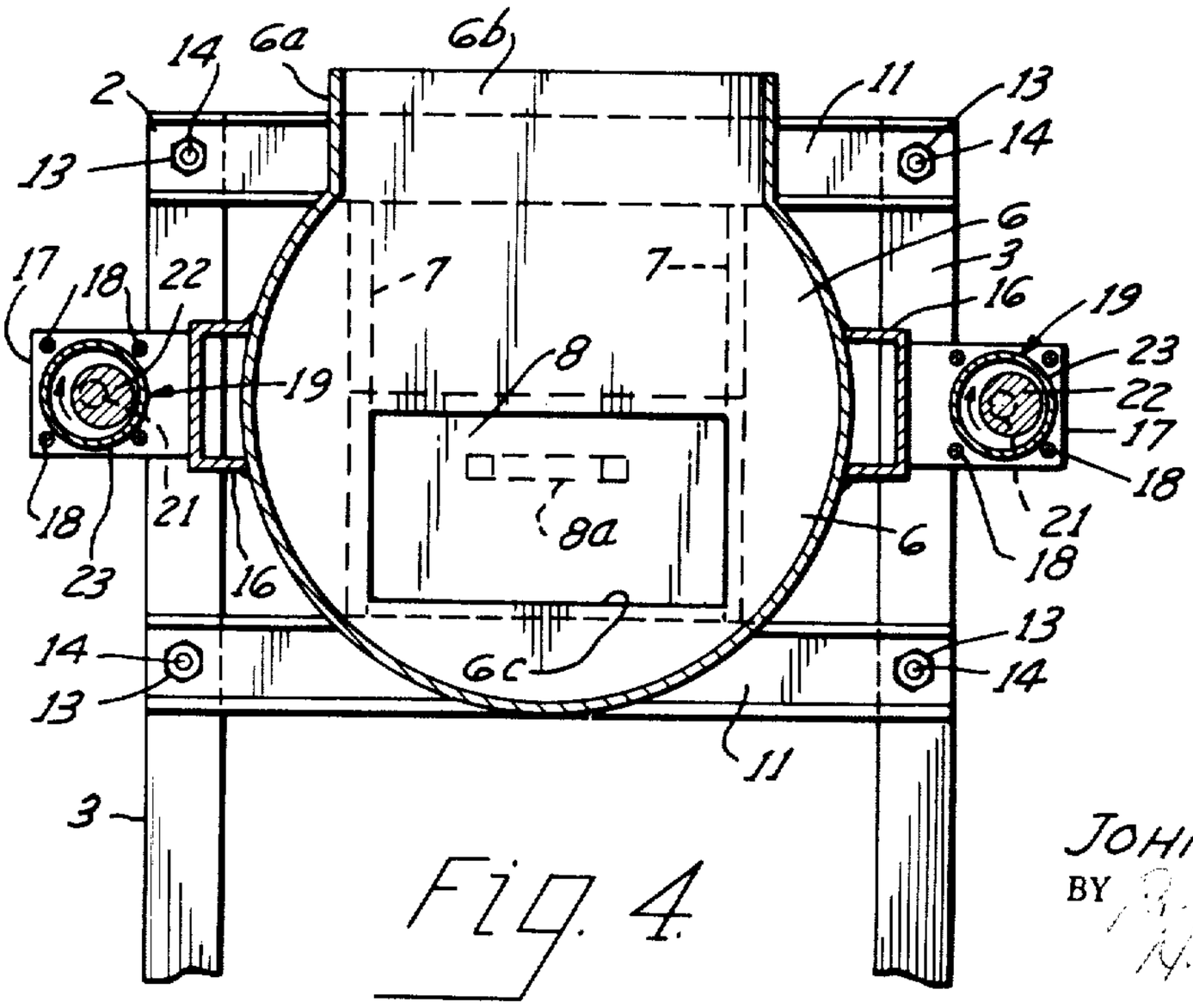

Fig. 4

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VIBRATORY FINISHING MACHINE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This application is a continuation of Ser. No. 42,908, filed Dec. 11, 1970, and now abandoned, which is a reissue application of U.S. Pat. No. 3,449,869.

This invention, which deals with a precision finishing machine of an orbital type that is characterized by circular movement of the finishing medium, constitutes an improvement on vibratory finishing machines such as those disclosed, inter alia, in prior patent Nos. 3,191,347, 3,191,348, 3,230,671, 3,300,908, 3,337,997 and 3,339,316, all in the name of John F. Rampe.

In general, the various types of commercial orbital finishing machines heretofore employed in the precision finishing of work pieces of metal, plastic or the like have been used for the most part only (mainly because they are relatively expensive) in those instances in which the goods do not lend themselves to finishing by the more conventional methods of grinding, buffing and polishing. The provision of a much simpler and considerably less expensive precision finishing machine that will accomplish to better advantage the purposes and objectives for which orbital finishing machines are commonly used is the major object of the present invention.

To that end, the invention provides a precision finishing machine of the orbital type that is at once simple, sturdy and, by comparison with the commercial orbital finishing machines of the prior art, much less expensive to assemble, service and repair. At the same time, the orbital finishing machine of the present invention is one that lends itself not only to use in the precision finishing of goods that cannot easily be finished by the commonly employed methods of grinding, buffing and polishing but also to economical use in the precision finishing of a wide variety of goods of types that are normally finished by just such methods. Thus the invention provides a vibratory finishing machine characterized by unusual versatility that is likely to appeal to a broader market than the more complex finishing machines heretofore available.

Further, the invention provides a precision finishing machine of the orbital type in which the center of mass and the geometrical center of the orbit of the finishing medium coincide under normal conditions of operation; viz., with the machine loaded to capacity. This result is brought about by designing, constructing and locating the vibration inducing components on opposite sides of the receptacle at, or very close to, the level of the center of mass of the receptacle and its contents. A correlative result is the development of an induced orbital movement of the finishing medium that is intrinsically circular; i.e., neither elliptical nor linear after the fashion of the resultant of a plurality of external forces acting on the machine more or less independently of each other (as, for example, horizontally and vertically) at one and the same time.

A further object of the invention is the provision of a precision finishing machine of the vibratory type in which the prime mover or movers and the power train associated therewith may be moved out of original

positions at a given level into new positions at higher or lower levels. For example, if, as frequently happens, sag of the receptacle and associated components develops to an extent that cannot be compensated by the use of self-aligning couplings, this feature makes it possible to move the power system to a level to which the couplings can effectively accommodate themselves. Thus it becomes possible to operate unhampered by the limitations imposed by conventional flexible couplings of kinds that provide a relatively narrow range of permissible deviation from true linearity.

Other objects, advantages and features of the invention will appear from the description and drawings, in which:

FIG. **1** is a top plan of a precision finishing machine of the orbital type incorporating the features of the present invention;

FIG. **2** is a front end elevation of the machine;

FIG. **3** is a side elevation of the machine with parts in section: see line **3—3** of FIG. **2**;

FIG. **4** is a central vertical section on line **4—4** of FIG. **1**; and

FIG. **5** is a fragmentary view similar to that of FIG. **4** illustrating in diagrammatic fashion the nature of the movement imparted to the finishing media.

In FIGS. **1, 2** and **3** is shown a precision finishing machine **1** constructed in conformity with the principles of the present invention. Supporting structure **2**, best seen in FIGS. **2** and **3**, consists of four vertical uprights **3** and, at floor level, two horizontal cross members **4** that are fastened to the floor by means of bolts **5**. Uprights **3**, of which there is one at each corner of the machine, and the two cross members preferably take the form of structural angles (see FIGS. **1** and **2**).

Within supporting structure **2** is a generally cylindrical receptacle **6**, usually referred to as the tub, of a type characterized, among other things, by a vertical top flange **6a** surrounding a symmetrically located oblong top opening **6b**. In addition to top opening **6b** there is an end opening **6c**, shown or indicated in FIGS. **1, 3** and **4**. Flanking the vertical sides of end opening **6c** is a plurality of rigidly supported guides **7** for a vertically slidable door **8** that is provided with a lifting handle **8a**. Disposed outwardly of end opening **6c** is a chute **9**, seen in FIGS. **1** and **3**. All of the parts referred to immediately above are at that one of the two flat ends of the tub which is seen at the right in FIG. **3**; the unbroken opposite end of the tub, designated **10**, is not only planar but substantially unobstructed except as hereinbelow indicated.

Welded to the flat ends of tub **6** are four horizontally extending U-shaped channels **11**, best seen in FIGS. **1** and **2**, of which two are ordinarily located at the same horizontal level at or very near the top of supporting structure **2** and two are located about half-way between the top and bottom of such supporting structure. Like the channels of the upper pair, those of the lower pair are at the same horizontal level. Channels **11** do not form part of but are spaced inwardly of the supporting structure, as will be apparent from FIG. **1**.

In addition to being welded to tub **6**, channels **11** are connected to uprights **3** through elastomeric spacers **12** made of neoprene, rubber or the like that are held in position by means of metal nuts **13**, studs **14**, and washers **15** to which the elastomer is bonded, as by vulcanization. Heads **14a** on the inner ends of studs **14** are likewise bonded to the elastomer, by which they are surrounded except where they engage washers **15**.

The opposite ends of spacers **12** are similarly constructed for attachment to uprights **3**.

Within the rather narrow limits imposed by spacers **12**, tub **6** is therefore free to move up, down and sideways within supporting structure **2**. When the machine is idle and tub **6** is empty or virtually empty, which is the condition illustrated in FIGS. **1** to **4**, the sag or downward displacement attributable to the weight of tub and associated components is small enough to be negligible for practical purposes; however, when tub **6** is filled to capacity, the downward displacement is as much as three-fourths of an inch, which is hardly a negligible factor.

Welded to and extending horizontally lengthwise of the widest portions of the two cylindrical sides of tub **6** are the relatively heavy structural channels **16** seen in FIGS. **1**, **2** and **4**. Mounted on channels **16** and projecting laterally from them in oppositely directed pairs are heavy-duty bearing mounts **17**, two on the left-hand side and two on the right side of the machine as seen in FIGS. **1** and **2**. Tie rods **18**, seen in FIGS. **1** and **4**, connect the oppositely facing bearing mounts of each pair. Inwardly of tie rods **18** are cartridges **19** each of which may be thought of as embracing two roller bearings **20**, a centrally located shaft **21**, a cylindrical eccentric **22** supported by shaft **21**, and an exterior housing **23** of cylindrical shape.

Shafts **21** and cylindrical eccentrics **22** rotate within housings **23** in the manner indicated in FIG. **4**. The eccentrics are so related to each other that they are in the same relative position at the same time; e.g., the three-o'clock position shown for illustrative purposes in FIG. **4**. In consequence, the action of each of the two eccentrics is to reinforce that of the other rather than to oppose it, as would be the case if they were offset by 180° from each other. A circular movement of limited dimensions is imparted to tub **6** by eccentric **22**; at the same time, as will appear below, a circular orbital path is imparted to any finishing media within the tub.

Coupled to eccentric shafts **21** by means of flexible or self-aligning couplings **24** are the two shafts **25** of two direct current motors **26** that should be operated in precise synchronism with each other. Leads **28** and **29** connect motors **26** through terminals **27** to a common control unit **30**, preferably a control unit of the selenium rectifier type. In describing motors **26** as of the direct current type and in referring to control unit **30** as incorporating a selenium rectifier, one must not overlook the fact that other kinds of motors and control systems may be used in lieu of those shown for illustrative purposes in FIGS. **1** to **3**.

Paralleling structural channels **11** is a third structural channel **31** located outside supporting structure **2**. It extends horizontally from a first zone a little to one side and somewhat below one of the two motors **26** to a second zone a little to the side and somewhat below the other of the two motors. As indicated in FIGS. **1** and **2**, channel **31** is welded at its ends to two upright support plates **32** on each of which is mounted a horizontally extending platform **33** that is preferably braced from beneath as by gussets **34**. Each of platforms **33** supports one of the two motors **26**.

Support plates **32** are provided with paired vertical slots **35**, one pair in each of the two support plates. Threaded studs **36** that project horizontally from vertically extending guides **37**, connected by cross pieces **38** (FIG. **2**), extend outwardly into and thence outwardly of slots **35**. There are two such studs for each support

plate, each equipped with a locking nut for holding the support plate in desired relation to guides **37**. Within limits, therefore, support plates **32** may be moved up or down in relation to studs **36**.

Tie bars **39** two of which, upper and lower, are usually employed in the installation (only one appears in the drawings) are used to connect the inner of the two guides on the left-hand side of the machine with the inner of the two guides on the right-hand side of the machine, seen as in FIG. **2**.

As has already been indicated, the invention contemplates the use of a plurality of vibration inducing components at the level of or, differently stated, in the horizontal plane including the center of mass of the tub and its contents. If tub **6** is filled to capacity, the normal condition, such plane will not only include the center of mass but will pass through the longitudinal axis of the tub. Whether or not the latter is the case, so long as the plane includes the center of mass, the orbital movement produced in the finishing medium will be circular or very nearly circular. This is desirable, because under such conditions the goods to be finished are kept from working their way to the bottom of the tub where, by striking each other, they might develop defects that would be difficult or impossible to remove.

If, in such circumstances, the direction of rotation of eccentric shafts **21** is clockwise, as indicated by the arrows in FIGS. **1** and **4**, the direction of movement of the finishing medium is counter-clockwise, as indicated in FIG. **5**; if the direction of rotation is counter-clockwise, the movement of the finishing medium is clockwise.

As previously noted, tub **6** tends to sag appreciably when filled to capacity, which is the normal condition; nevertheless, that it will at all times be filled to capacity does not follow, for it is quite possible to operate (although at the expense of efficiency) with the tub filled to a considerably lower level. However, in the former case, if the sag is great enough, it can exceed the ability of flexible couplings **24** to compensate for it. This makes it highly desirable, in order to avoid operating at less than capacity, to introduce adjusting means of the kind illustrated in the drawings and explained below.

Welded to the back face of each of the two support plates **32** is a nut **40** that is tapered to enable it to cooperate with the threaded upper end of a vertically extending adjusting screw **41**. There is one of these on each side of the machine, viewed as in FIG. **2**. Each is coupled at its lower end to a vertical shaft **42** the opposite end of which extends downwardly into an opening **38a** in cross piece **38** (see FIG. **3**). Each of the two vertical shafts **42** mounts a horizontally disposed bevel gear **43** that mates with a vertically disposed bevel gear **44** carried by a horizontally extending connecting shaft **45** (see FIG. **2**).

On the left-hand side of the machine, seen as in FIG. **2**, the downwardly projecting portion of vertical shaft **42** is coupled to the hub **46** of a hand wheel **47** operated by means of a handle **48**. By rotating hand wheel **47**, the vertical shaft on which it is mounted can be made to rotate the attached horizontally disposed bevel gear **43**. The latter in turn rotates the cooperating vertically disposed bevel gear **44** and shaft **45**. In consequence thereof, bevel gears **43** and **44** on the opposite side of the machine, the right-hand side in FIG. **2**, operate to turn vertical shaft **42** and screw **41**. As screws **41** turn within nuts **40**, they cause corresponding upward

or downward movement of support plates **32,** platforms **33** and motors **26.**

This arrangement makes it possible to bring the horizontal plane containing the axes of rotation of motor shafts **25** to a level in which such plane will coincide with the horizontal plane passing through the axes of rotation of eccentric shafts **21.** In such case, they will also pass through or close to the horizontal line including the center of mass; for example, the horizontal line represented by point **49** in FIG. **5.** When this condition obtains the desirable circular orbit illustrated by arrows in FIG. **5** will be representative of the action within the tub.

Note particularly the clockwise direction of rotation of the individual particles indicated at **50.** It will be observed that the latter are carried up or tend to work their way up inside the tub, although moving individually in generally clockwise fashion. Some will naturally be in contact with the interior wall of the tub, but most will be located well inwardly thereof. In general, the action of the mass as a whole is orbital, circular, and centered around the horizontal line indicated at **49** in FIG. **5.** This of course assumes that the vibration inducing systems on opposite sides of the tub are, so far as possible, at substantially the same level as such horizontal line.

Mention has already been made of the fact that in lieu of direct current motors **26** and a control unit **30** of the selenium rectifier type, various other systems for producing synchronous movement of eccentric shafts **21** may be employed. It is possible, for example, to use two synchronous motors, two alternating current motors of conventional type driven from a common variable speed drive, or two conventional motors the shafts of which are inter-connected by a power train of some sort other than the one shown in FIGS. **2** and **3.** If desired, a single motor may be mounted beneath tub **6;** if so, cog belts may be employed to drive the eccentric shafts from such motor.

In the practice of the invention, which among other things includes the concept of disposing the longitudinal axes of eccentric shafts **21** and motor shafts **25,** insofar as it may be possible to do so, in a common horizontal plane passing through the center of mass, it is not necessary to use eccentrics of the type hereinabove shown and described. Other vibration inducing components may be used instead: for example, magnetic and pneumatic vibration inducing components. In any case, an important precaution to be observed if possible is that the forces exerted by the vibration inducing components should be such as to reinforce rather than to oppose each other. Where circumstances permit, they should operate on the tub and its contents at the level of the center of mass so as to develop the above-described circular orbit.

It is intended that the patent shall cover, by summarization in appended claims, all features of patentable novelty residing in the invention.

What is claimed is:

1. A precision finishing machine characterized by orbital movement of bulk finishing media, comprising:

a. *a* supporting structure *including first and second spaced opposed upstanding structures;*

b. a centrally disposed receptacle *positioned longitudinally between said structures and having first and second regions positioned near said first and second structures, respectively;*

c. *elastomeric spacer means* resiliently **[** mounted **]** *mounting said receptacle* on the supporting structure *including a first plurality of elastomeric spacers interposed between said first region and said first structure, and a second plurality of elastomeric spacers interposed between said second region and said second structure;*

d. vibration-inducing means *including a plurality of shaft-supported eccentrics mounted* on opposite sides of the receptacle at substantially the level of the center of mass of the receptacle and its load **[**, such vibration-inducing means including **]**, *the longitudinal axes of said shaft supported eccentrics paralleling the longitudinal horizontal axis of the receptacle;*

e. power means *drivingly coupled to said vibration-inducing means;* **[** and, as an adjunct thereto **]** ;

f. an auxiliary system for positioning, adjusting the position of, and controlling the power means **[** . **]** ; *and,*

g. *said elastomeric spacers being arranged with their longitudinal mounting axes disposed generally parallel to the longitudinal horizontal axis of the receptacle and said vibration-inducing means being operative to impart vibrations to said tub in directions substantially transverse to the tub thereby subjecting said elastomeric spacers principally to shear forces as said regions move relative to said structures.*

2. A precision finishing machine according to claim **1** wherein the **[** vibration-inducing **]** *power* means include electric motors mounted on supports that may be raised and lowered in relation to the supporting structure **[** of the machine as a whole **]** *and said auxiliary system includes means for selectively raising and lowering said supports.*

3. A precision finishing machine **[** according to claim **2** wherein **]** *comprising:*

a. *a supporting structure including first and second spaced opposed upstanding structures;*

b. *a centrally disposed receptacle positioned between said structures and having first and second regions positioned near said first and second structures, respectively;*

c. *elastomeric spacer means resiliently mounting said receptacle on the supporting structure including a first plurality of elastomeric spacers interposed between said first region and said first structure, and a second plurality of elastomeric spacers interposed between said second region and said second structure;*

d. *vibration-inducing means on opposite sides of the receptacle at substantially the level of the center of mass of the receptacle and its load;*

e. *power means including electric motors drivingly coupled to said vibration inducing means;*

f. *an auxiliary system including motor supports and means adjustably positioning said motor supports for raising and lowering said motors relative to said supporting structure;*

g. *said vibration-inducing means being operative to impart vibrations to said tub in directions substantially transverse to the tub thereby subjecting said elastomeric spacers principally to shear forces as said regions move relative to said structures; and,*

h. *said auxiliary system additionally includes a common power train interconnecting* the motor supports **[** are connected through a common power train **]** *for concurrent movement.*

4. A precision finishing machine characterized by orbital movement of bulk finishing media, comprising:

a. a supporting structure *including first and second spaced opposed upstanding end structures;*

b. a centrally disposed receptacle *positioned longitudinally between said end structures and having first and second end regions positioned near said first and second end structure, respectively;*

c. elastomeric spacer means resiliently [mounted] *mounting said receptacle* on the supporting structure *including a first plurality of elastomeric spacers interposed between said first end region and said first end structure, and a second plurality of elastomeric spacers interposed between said second end region and said second end structure, said spacers each having their mounting axes disposed generally parallel to the longitudinal axis of the receptacle;*

d. a plurality of eccentrics mounted on opposite sides of the receptacle at the level of the center of mass with the axes of rotation of the eccentrics extending parallel to [one of] the horizontal [axes] *longitudinal axis* of the receptacle; [and,]

e. a drive system connected to the eccentrics [a drive system] including power means and auxiliary means for positioning, adjusting the position of, and controlling the power means [.] *; and,*

f. said vibration-inducing means being operative to impart vibrations to said tub in directions substantially transverse to the length of the tub thereby subjecting said elastomeric spacers principally to shear forces as said end regions move relative to said end structures.

5. A precision finishing machine according to claim 4 wherein the drive system includes a plurality of prime movers operated in synchronism with each other.

6. A precision finishing machine according to claim 5 wherein the prime movers are mounted on movable support means that may be raised and lowered in relation to the supporting structure for the machine as a whole.

7. A precision finishing machine according to claim 6 wherein the support means for the prime movers are coupled to a common power train.

8. A precision finishing machine characterized by orbital movement of bulk finishing media, comprising:

a. a supporting structure *including first and second spaced opposed upstanding end structures;*

b. a centrally disposed receptacle *positioned longitudinally between said end structures and having first and second end regions positioned near said first and second end structures, respectively;*

c. elastomeric spacer means resiliently [mounted on] *mounting said receptacle on* the supporting structure *including a first plurality of elastomeric spacers interposed between said first end region and said first end structure; and a second plurality of elastomeric spacers interposed between said second end region and said second end structure, said spacers each having their mounting axes disposed generally parallel to the longitudinal axis of the receptacle;*

d. a plurality of shaft-supported eccentrics mounted on opposing sides of said centrally disposed receptacle, the longitudinal axes of said shaft-supported eccentrics paralleling [one of] the horizontal [axes] *longitudinal axis* of the receptacle;

e. flexible couplings connected to the eccentrics; [and,]

f. a drive system connected to the couplings [, a drive system] including power means and auxiliary control means for the power means [.] *; and,*

g. said vibration-inducing means being operative to impart vibrations to said tub in directions substantially transverse to the length of the tub thereby subjecting said elastomeric spacers principally to shear forces as said end regions move relative to said end structures.

9. A precision finishing machine according to claim 8 wherein the drive system includes a plurality of electric motors operating in synchronism with each other.

10. A precision finishing machine according to claim 9 wherein the motors are of the synchronous type.

11. A precision finishing machine according to claim 9 wherein the electric motors are operated in synchronism with each other through the medium of a common control system.

12. A precision finishing machine according to claim 11 wherein the control means include a rectifier and the motors are direct current motors.

13. A precision finishing machine characterized by orbital movement of bulk finishing media, comprising:

a. a supporting structure;

b. a centrally disposed receptacle resiliently mounted on *elastomeric spacers connected to* the supporting structure;

c. a plurality of shaft-supported eccentrics mounted on opposing sides of said centrally disposed receptacle at substantially the level of the center of mass of the receptacle and its load, the longitudinal axes of said shaft-supported eccentrics paralleling one of the horizontal axes of the receptacle;

d. said elastomeric spacers being arranged with their longitudinal mounting axes disposed generally parallel to said eccentrics axes whereby such relative movements as are caused by said eccentrics between said receptacle and said supporting structure will subject said spacers principally to shear forces;

e. flexible couplings connected to the eccentrics; and,

f. a drive system connected to the couplings [a drive system] including power means and auxiliary control means for the power means.

14. A precision finishing machine characterized by orbital movement of bulk finishing media, comprising:

a. a supporting structure;

b. a centrally disposed receptacle;

c. elastomeric spacer means interposed between said receptacle and said supporting structure resiliently [mounted] *mounting said receptacle* on the supporting structure;

d. a plurality of shaft-supported eccentrics mounted on opposite sides of said centrally disposed receptacle at substantially the level of the center of mass of the receptacle and its load, the longitudinal axes of said shaft supported eccentrics paralleling [one of] the *longitudinal* horizontal [axes] axis of the receptacle;

e. said elastomeric spacer means including a plurality of elastomeric spacers each having first and second opposite end regions positioned along axes paralleling said longitudinal axis, said first end region being connected to said receptacle and said second end region being connected to said supporting structure;

f. flexible couplings connected to the eccentrics; and

g. a drive system connected to the couplings [, a drive system] including power means, vertically adjustable supports therefore, and control means for the power means.

* * * * *