US 20060054301A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0054301 A1**

McRay et al. (43) **Pub. Date: Mar. 16, 2006**

(54) **VARIABLE AREA MASS OR AREA AND MASS SPECIES TRANSFER DEVICE AND METHOD**

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(21) Appl. No.: **11/013,772**

(22) Filed: **Dec. 16, 2004**

Related U.S. Application Data

(60) Provisional application No. 60/546,583, filed on Feb. 19, 2004.

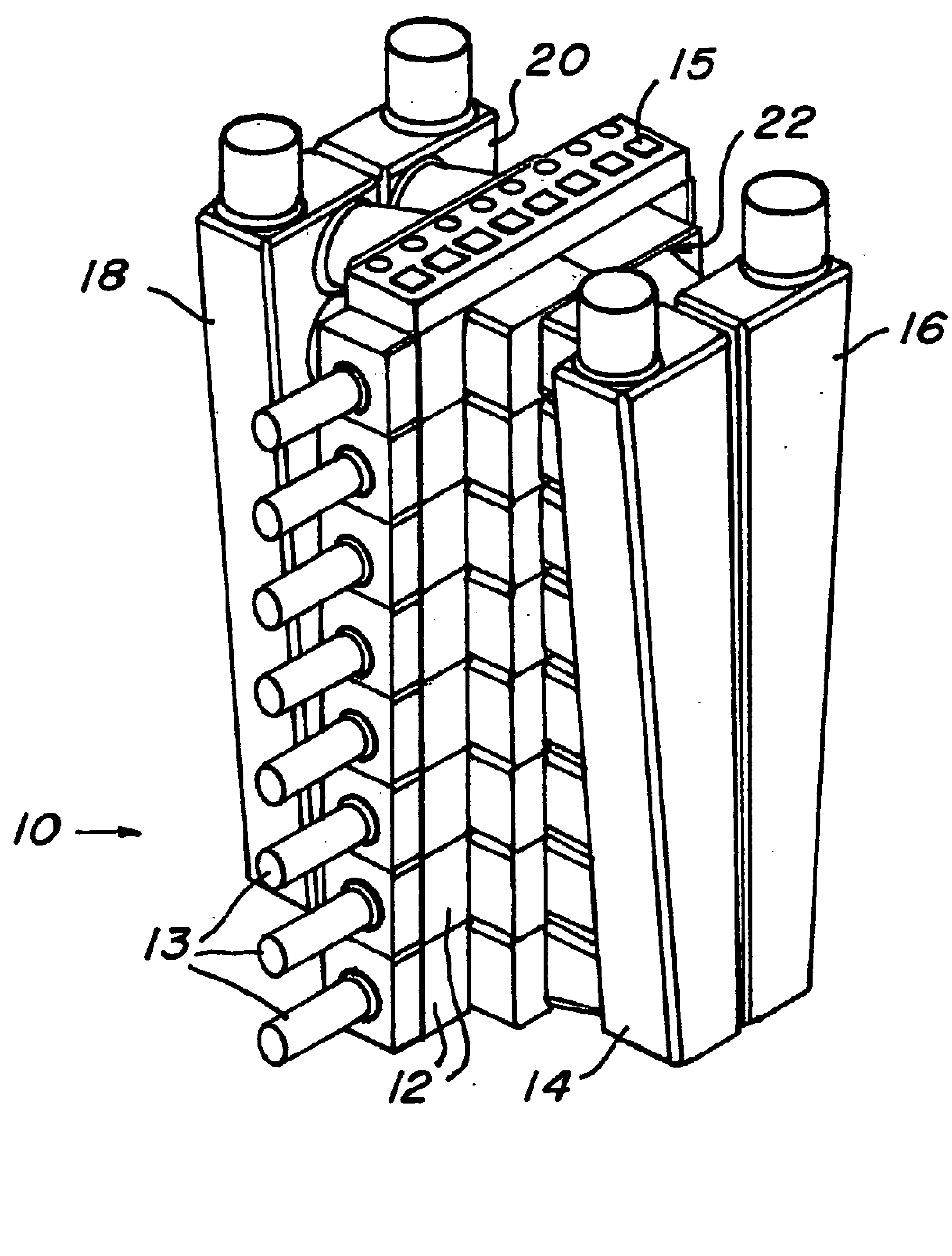
Publication Classification

(51) **Int. Cl.**
F23L 15/02 (2006.01)

(52) **U.S. Cl.** **165/6**

(57) **ABSTRACT**

Disclosed herein is a-variable-area or mass or area and mass ratio species transfer device, one embodiment with a plurality of species transfer masses. At least one actuator is disposed in communication with the species transfer masses, capable of selectively moving one or more of the masses independently of other one or more of the masses into at least contact with a first fluid stream and into contact with a second fluid stream. Yet further disclosed herein is a method for controlling species transfer in a species transfer device. The method includes: selecting an appropriate mass/area ratio between a portion of a variable area or mass or area and mass ratio species transfer device exposed to a higher-temperature fluid and a portion of the species transfer device exposed to a lower-temperature fluid; exposing one selected portion of the species transfer device to the higher-temperature fluid; and exposing another selected portion of the species transfer device to the lower-temperature fluid.



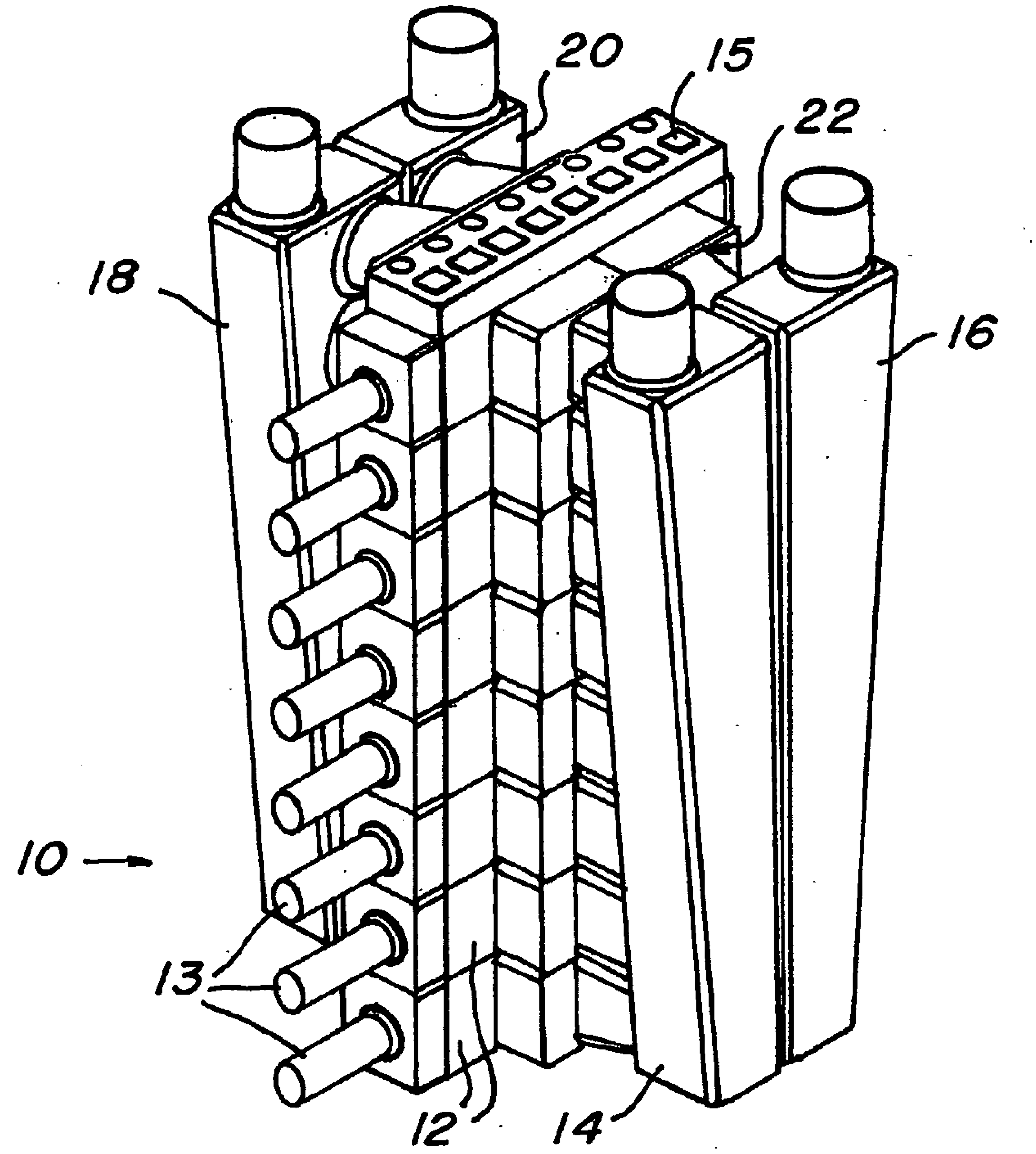


FIG. 1

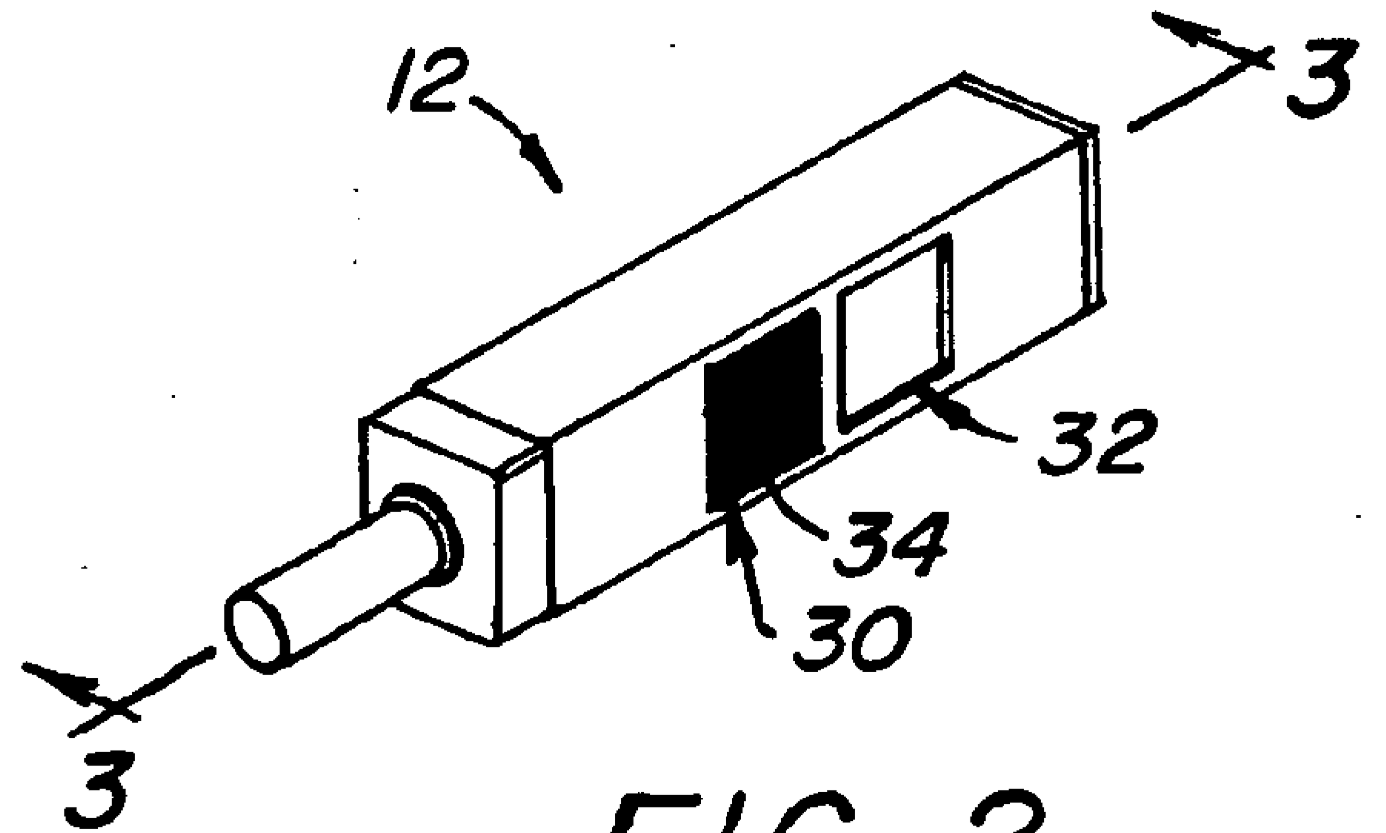


FIG. 2

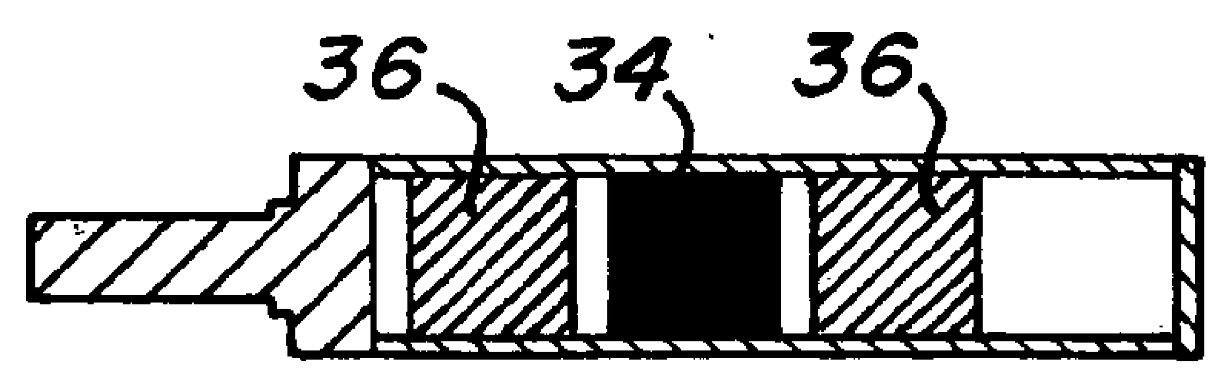


FIG. 3

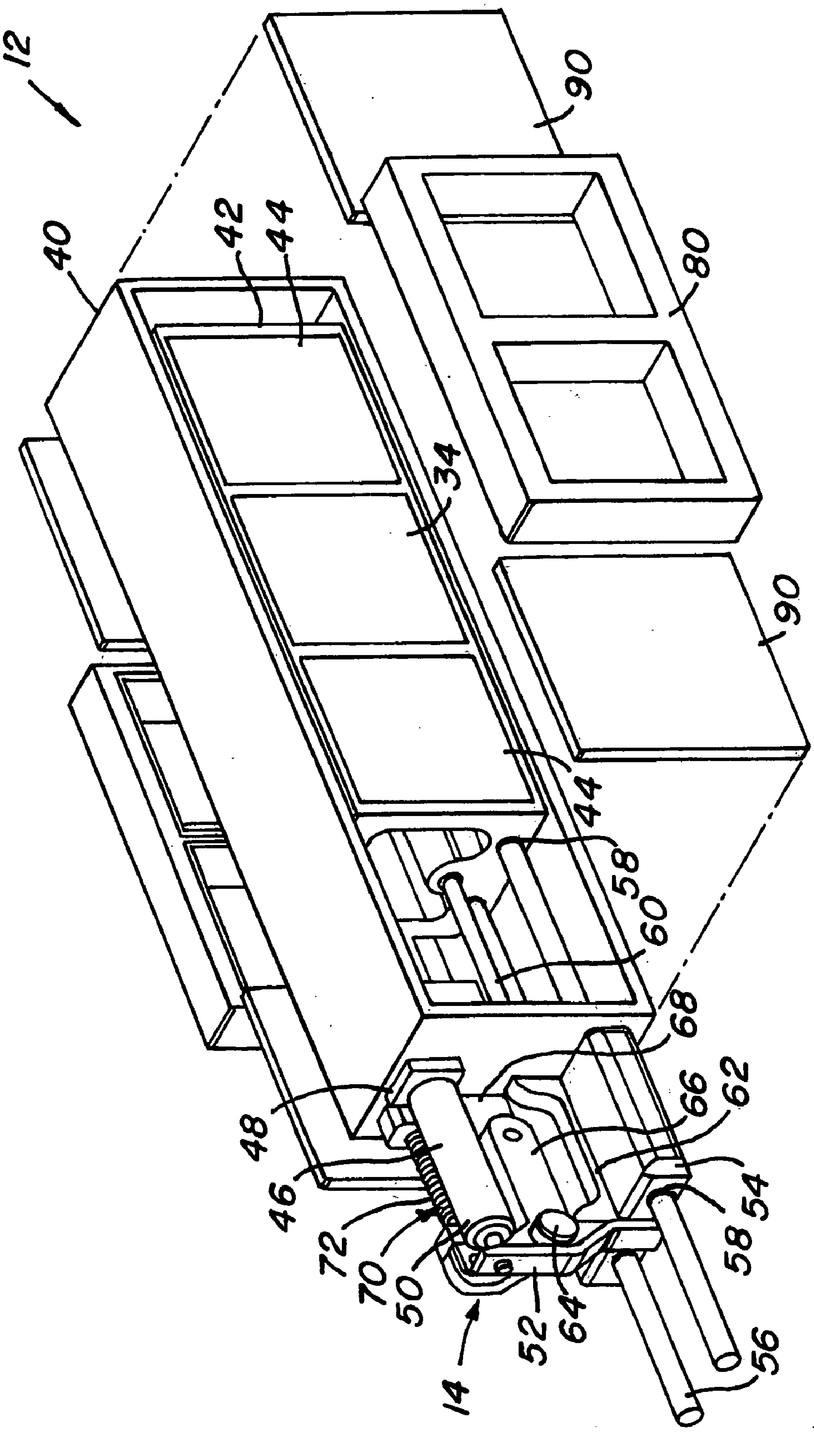

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FIG. 4

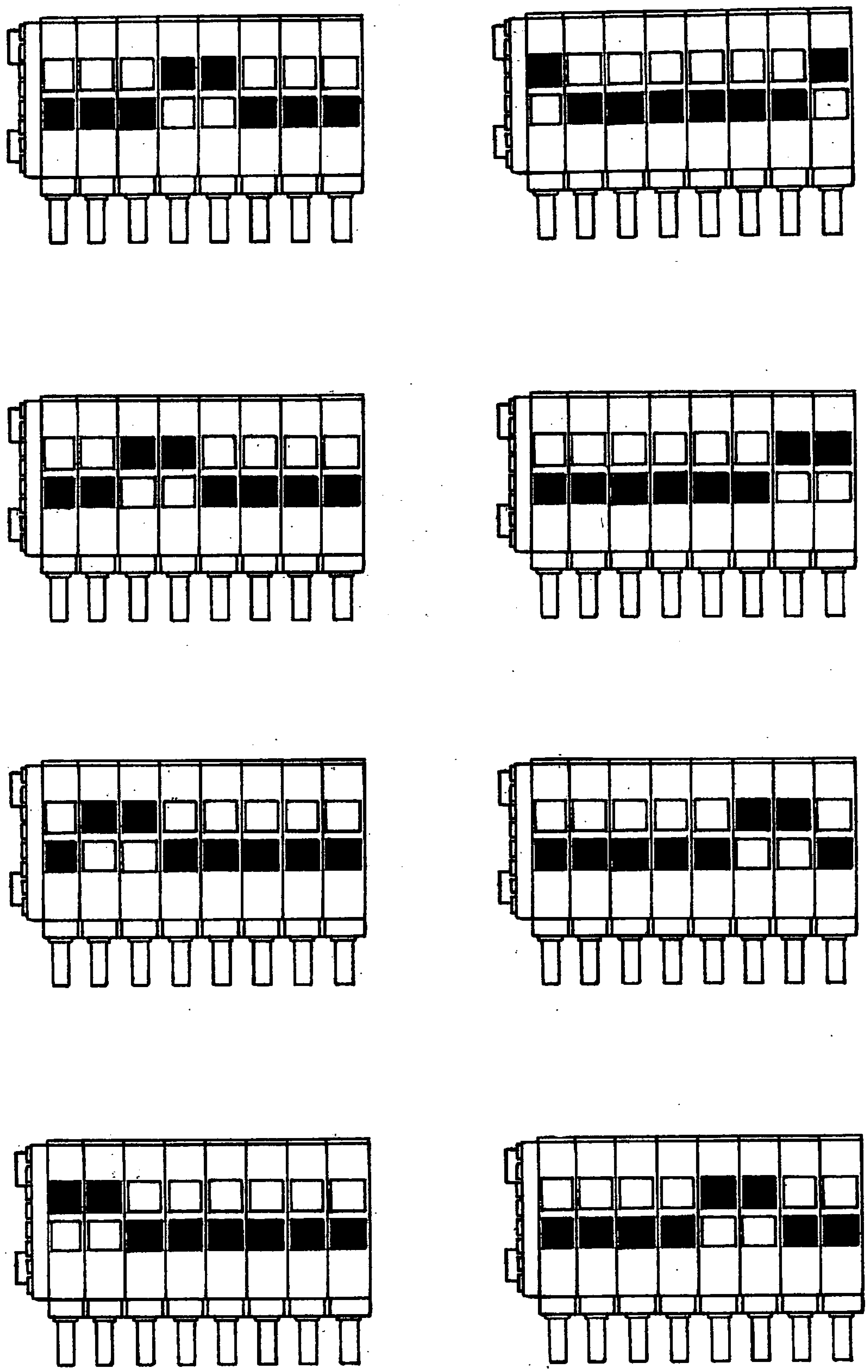

FIG. 5

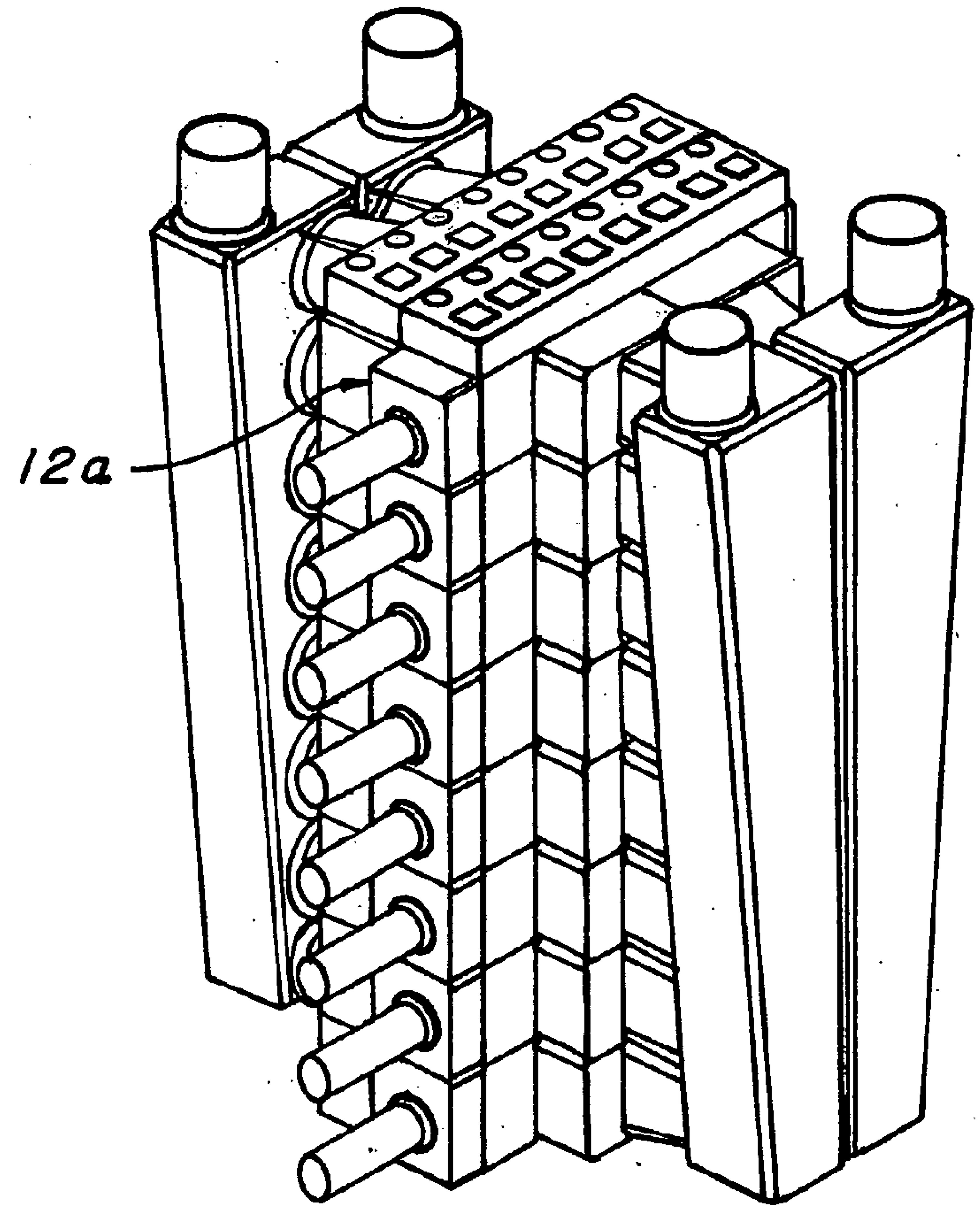

FIG. 6

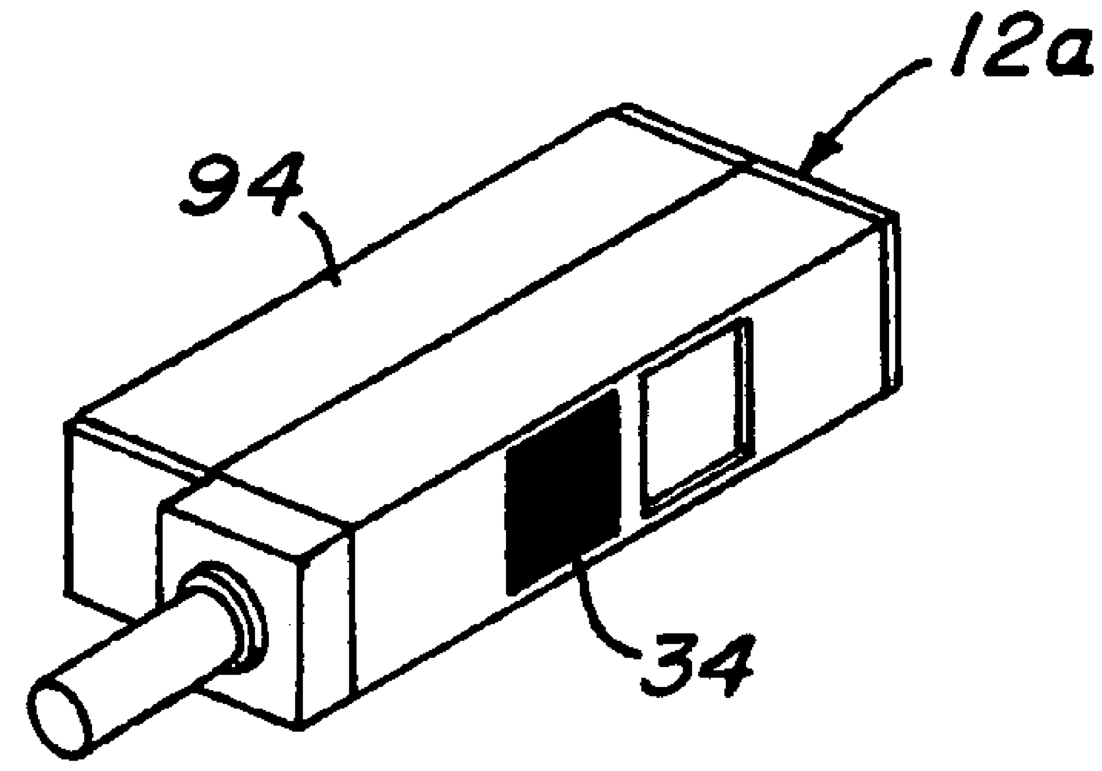

FIG. 7

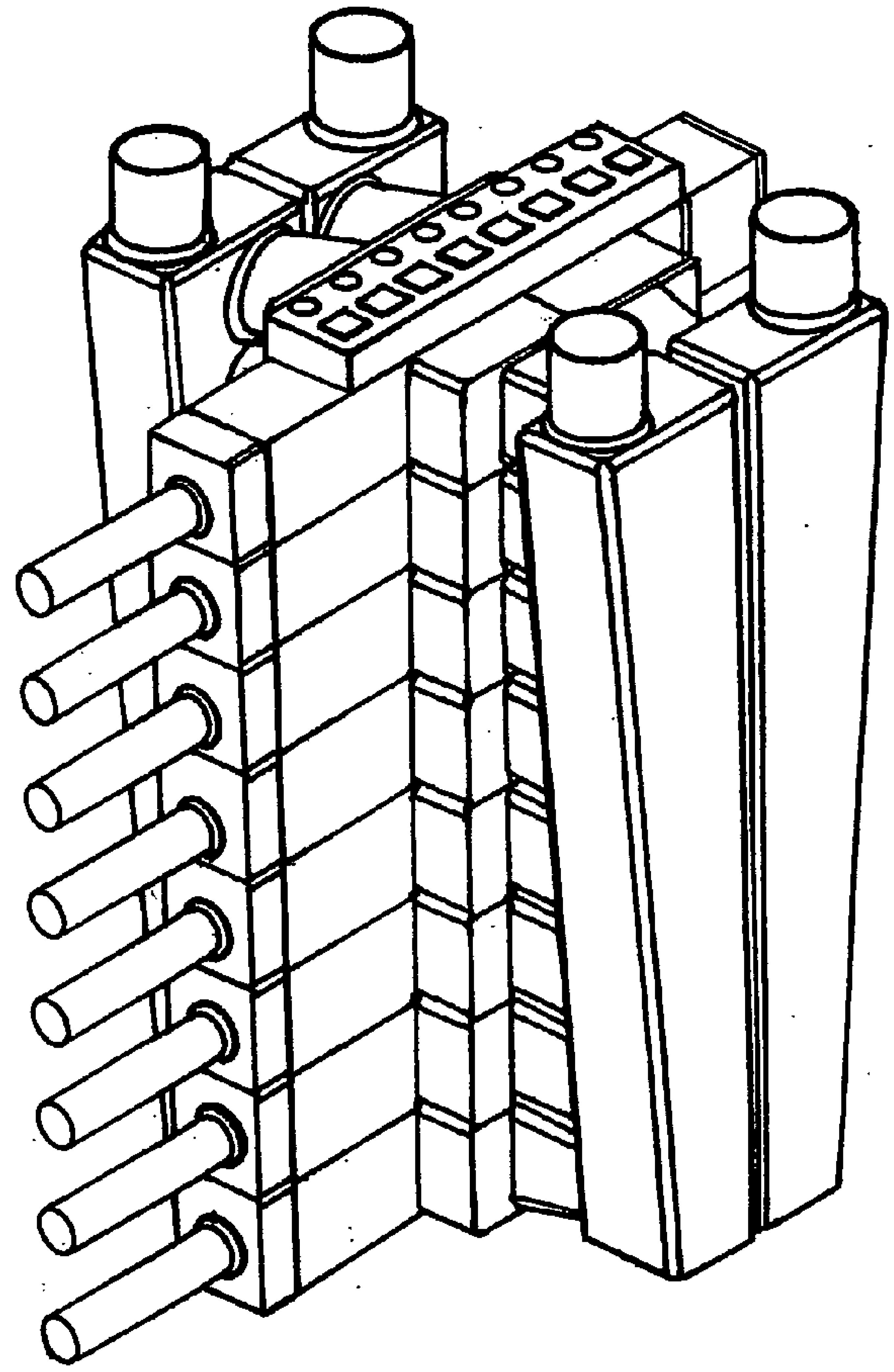

FIG. 8

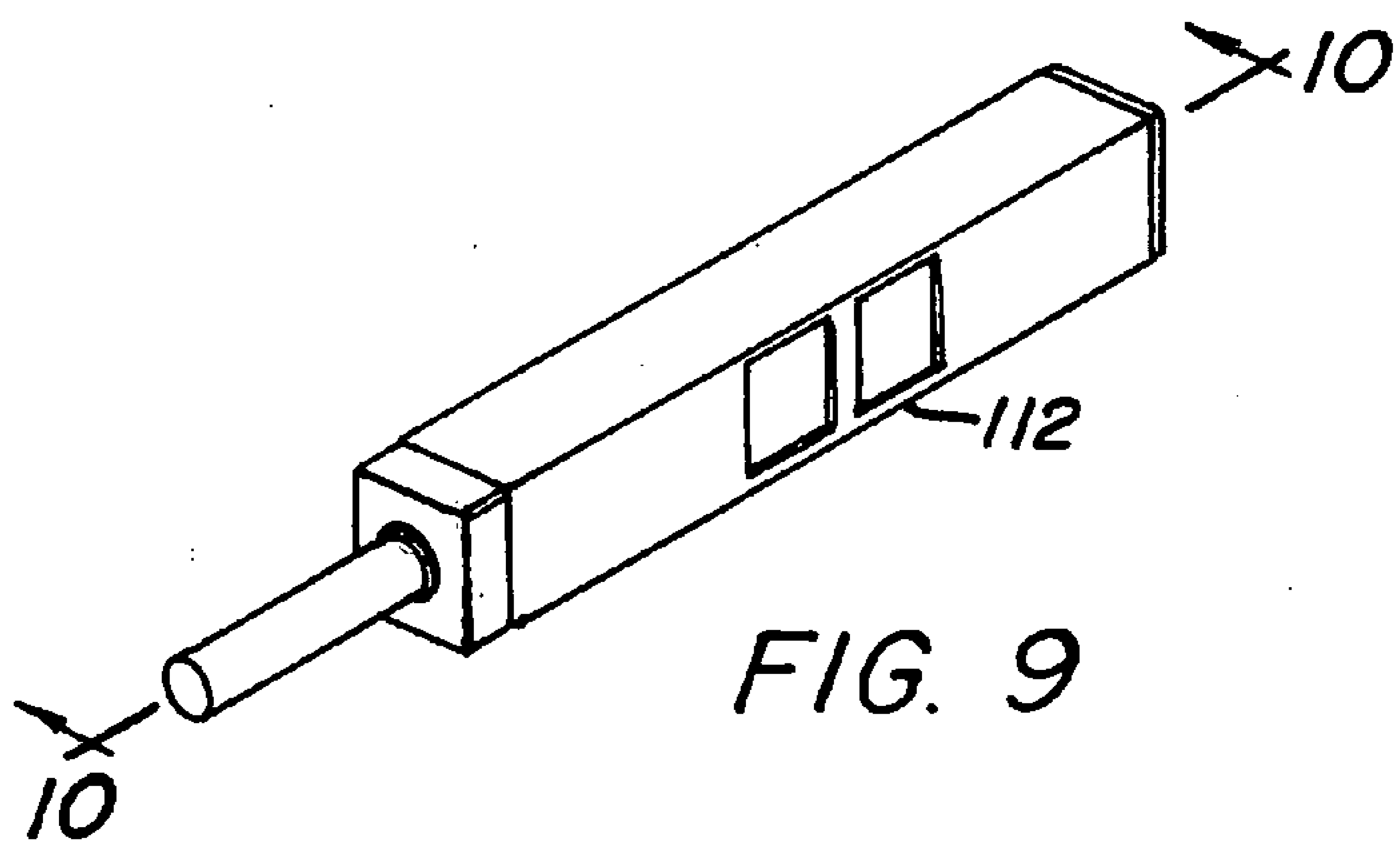

FIG. 9

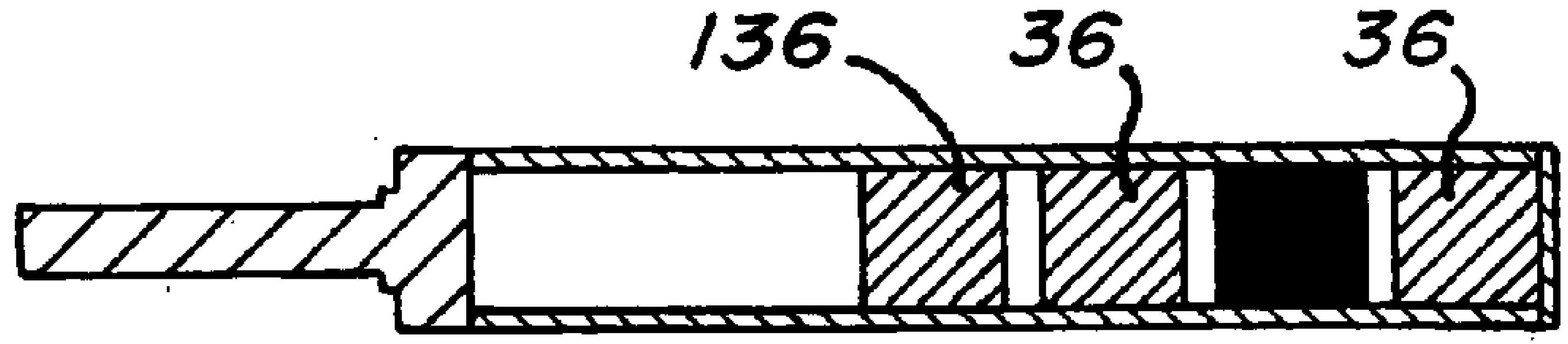

FIG. 10

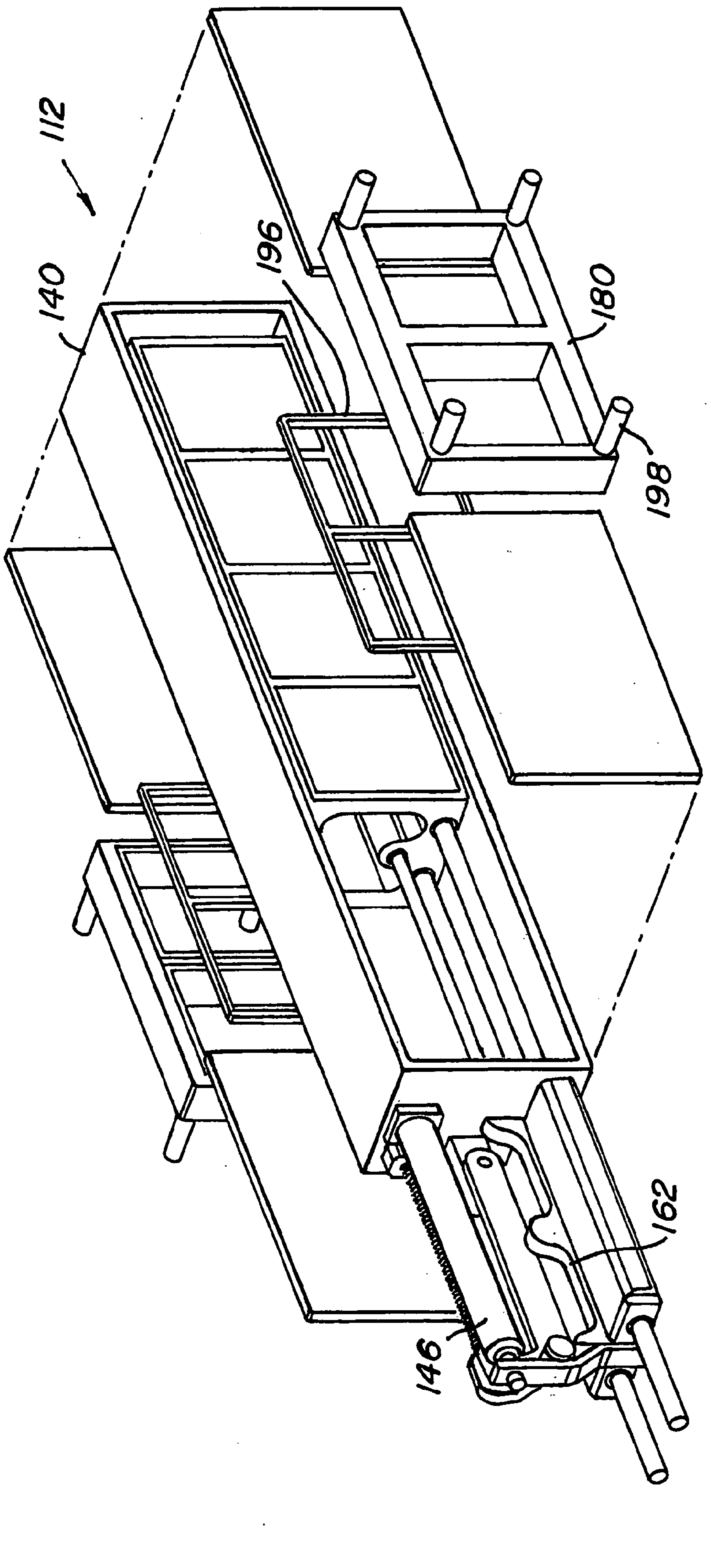

FIG. 11

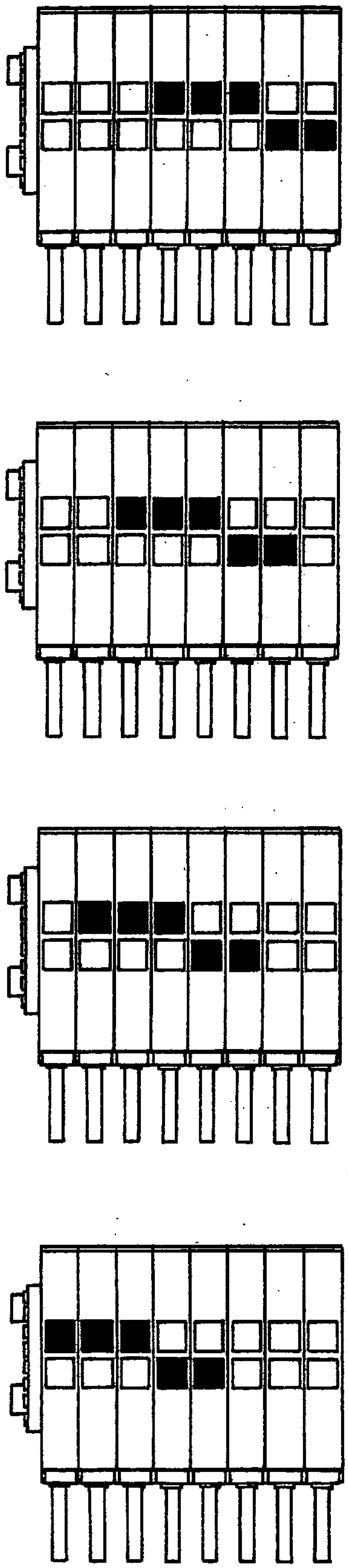

FIG. 12

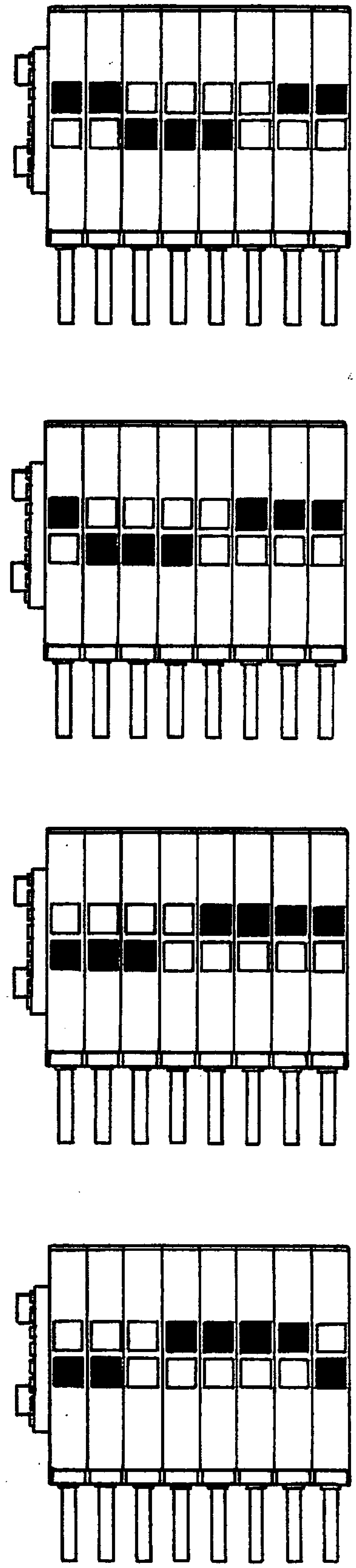

FIG. 13

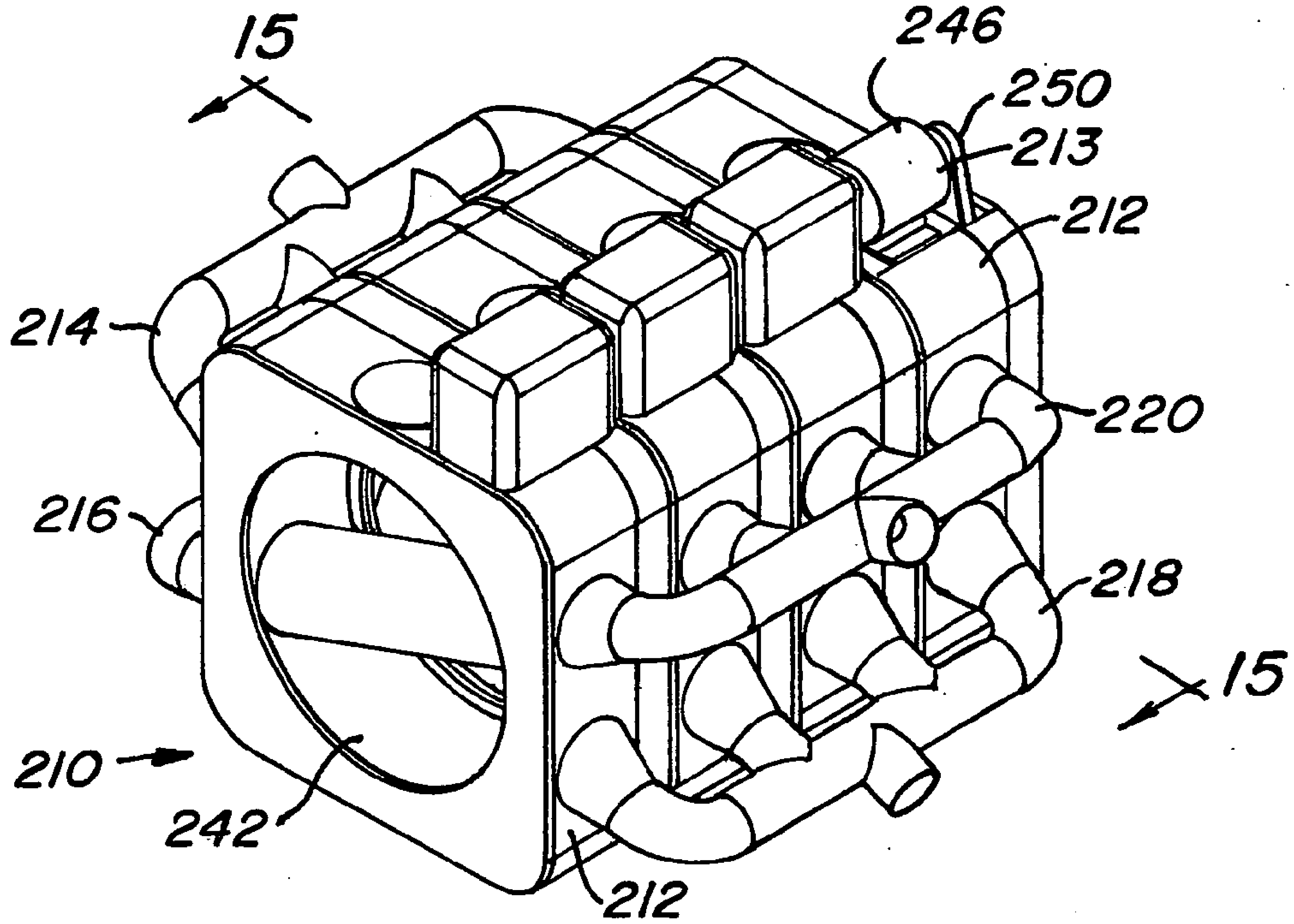
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FIG. 14

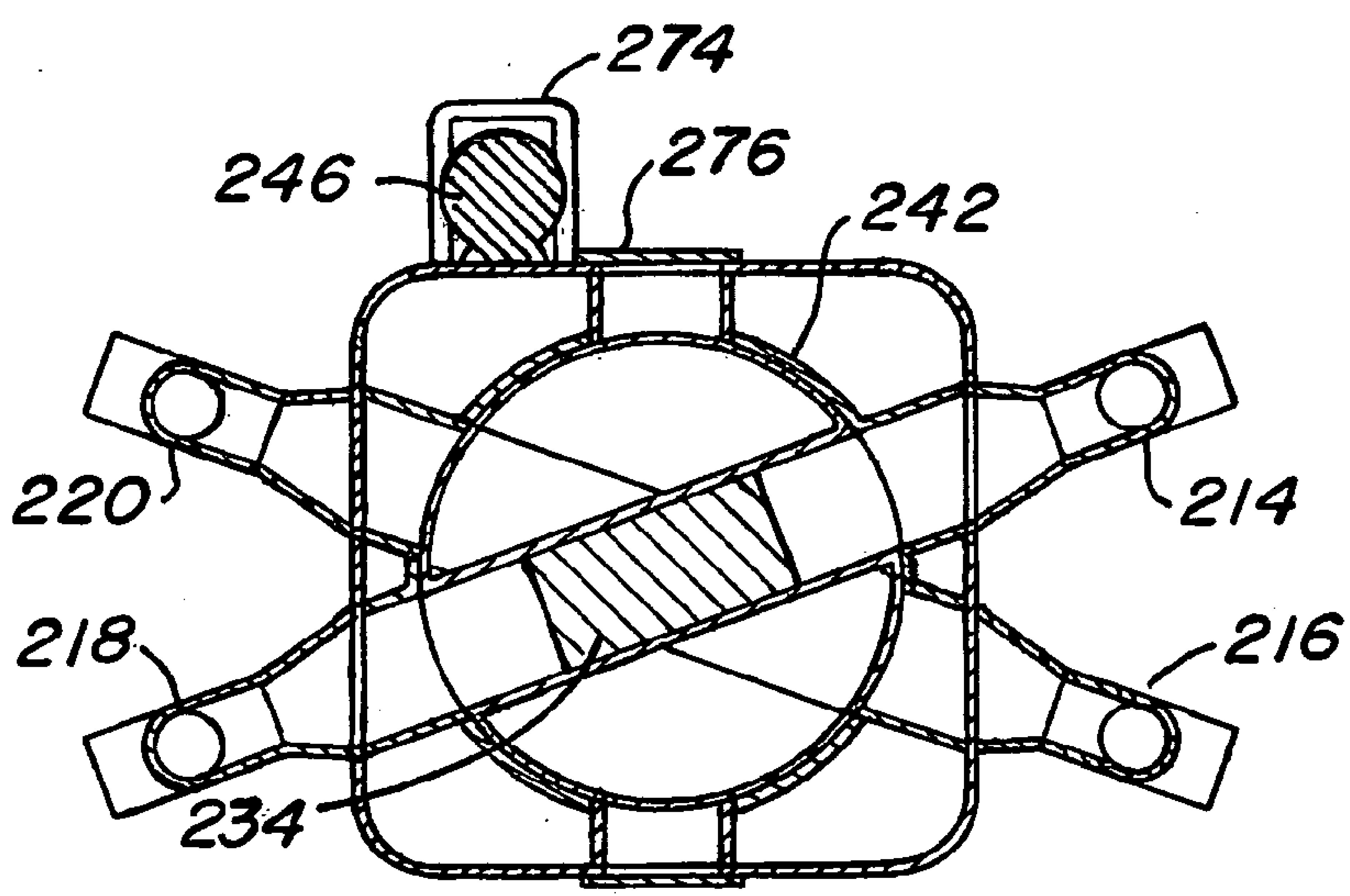
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FIG. 15

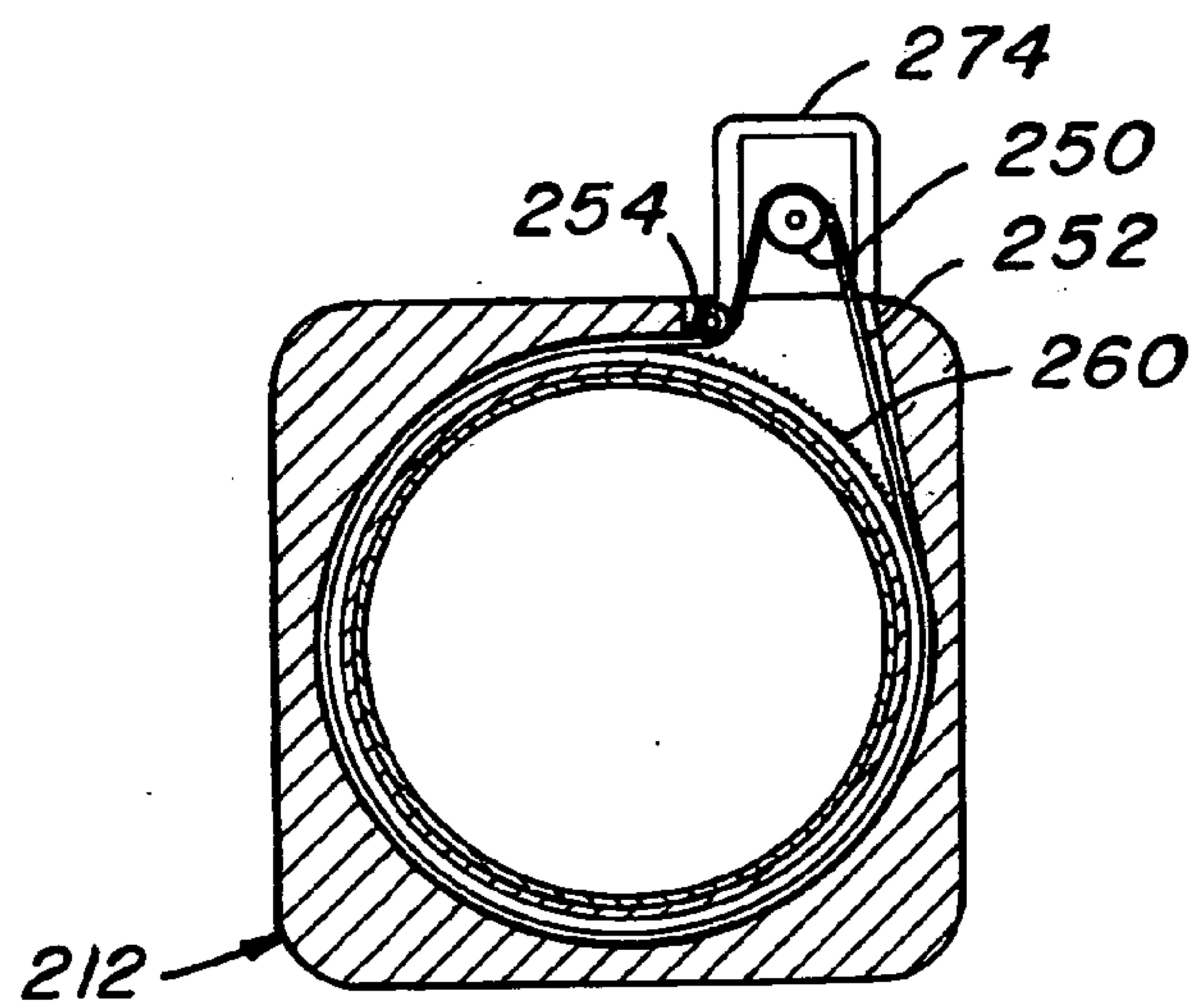
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FIG. 16

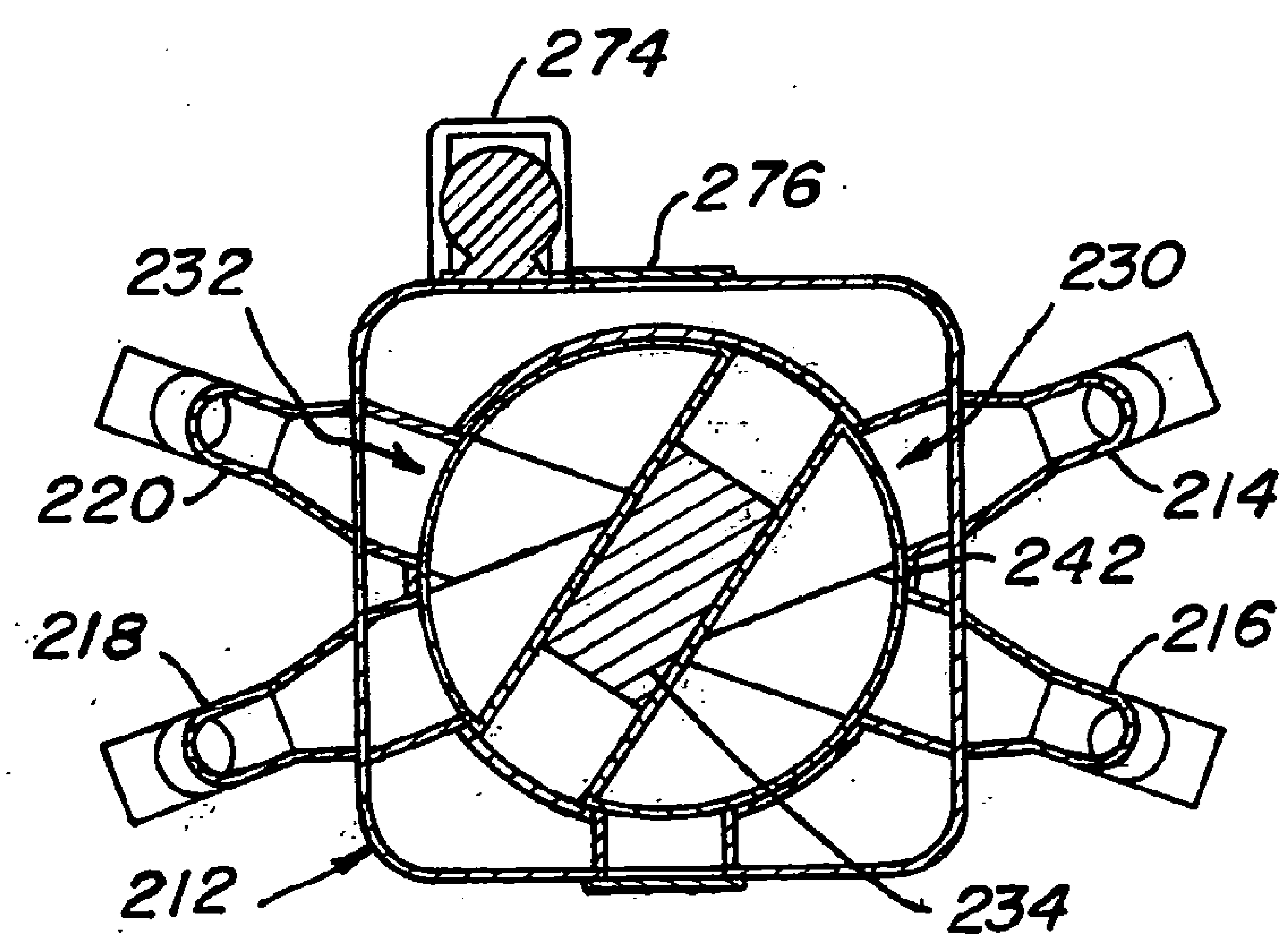
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FIG. 17

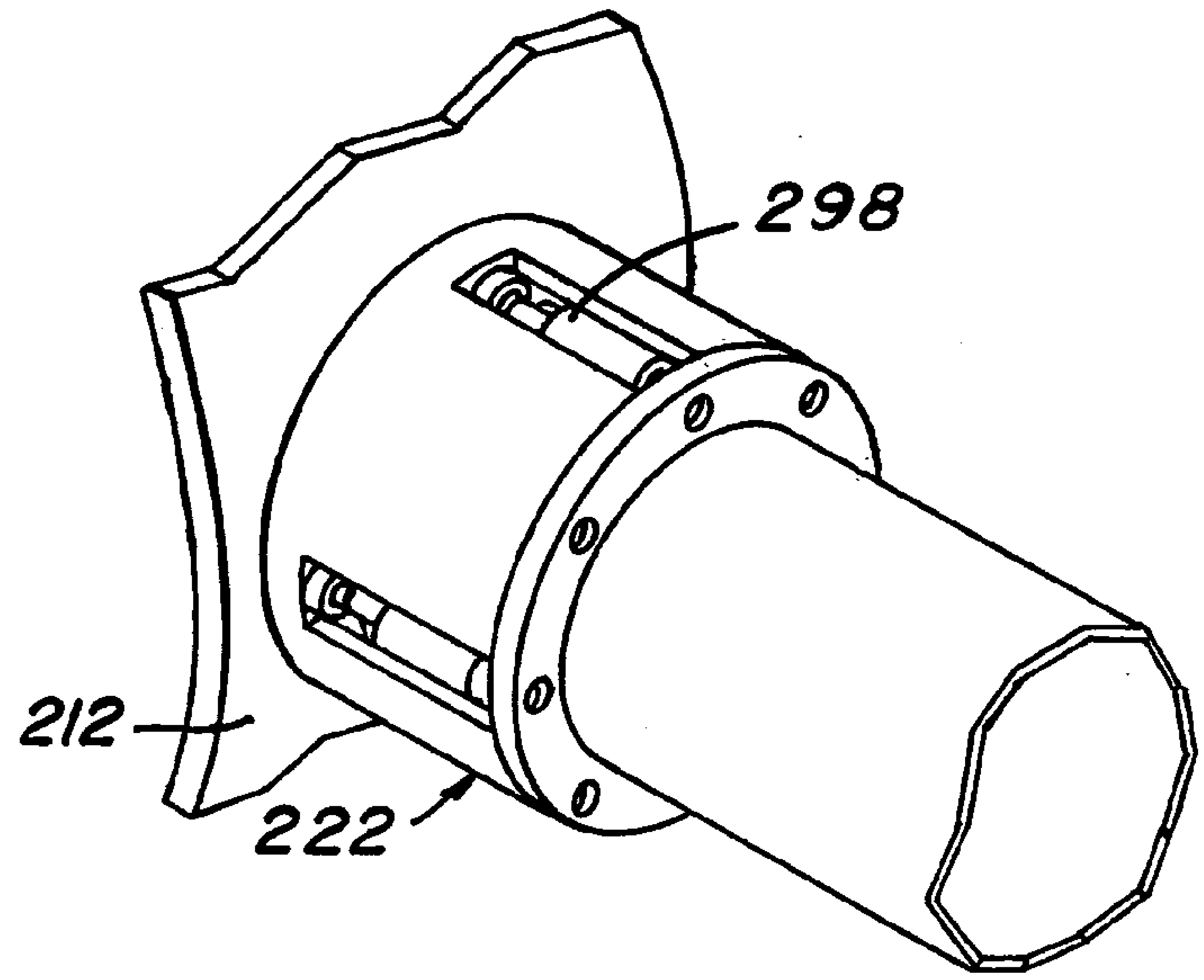

FIG. 18

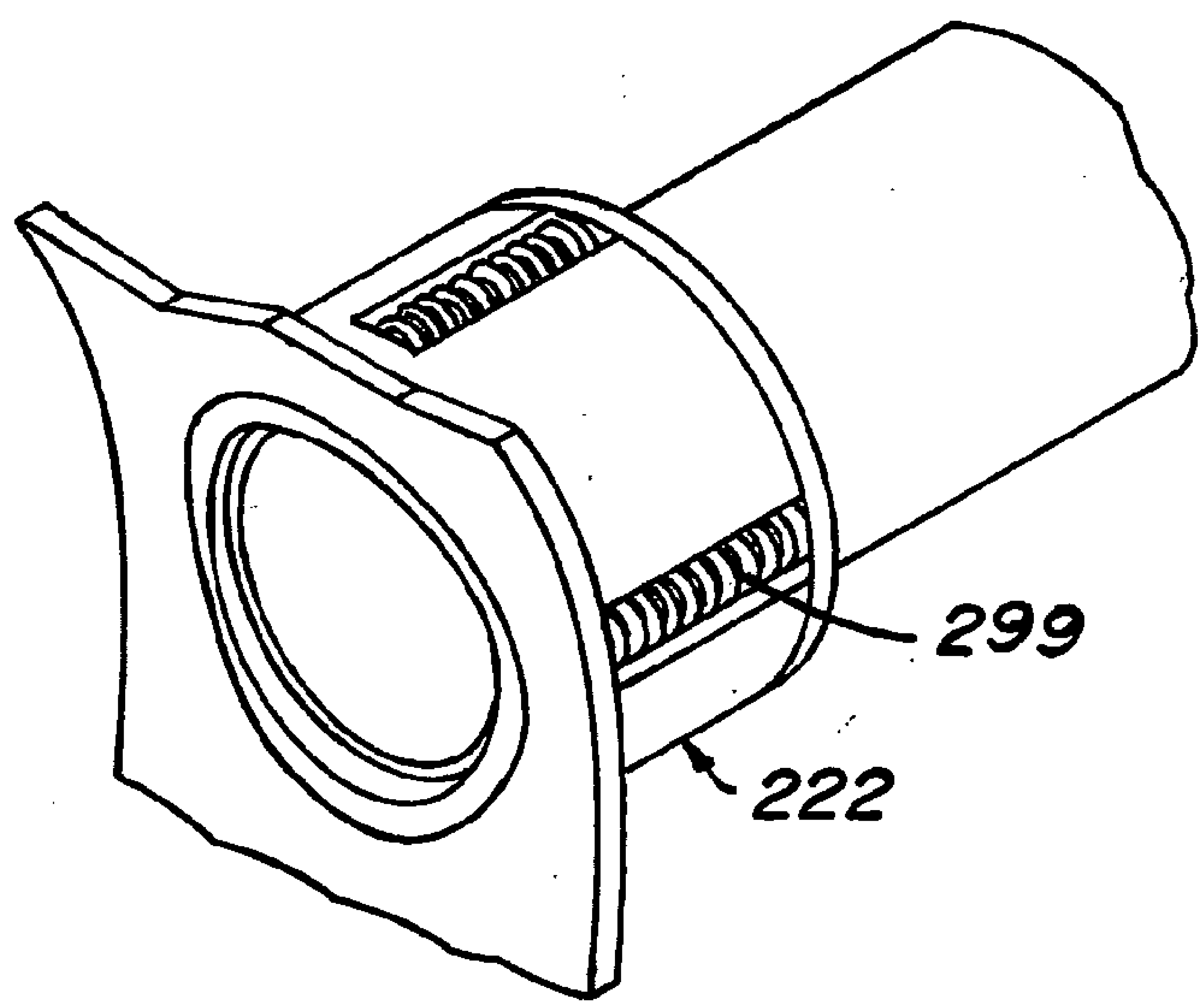

FIG. 19

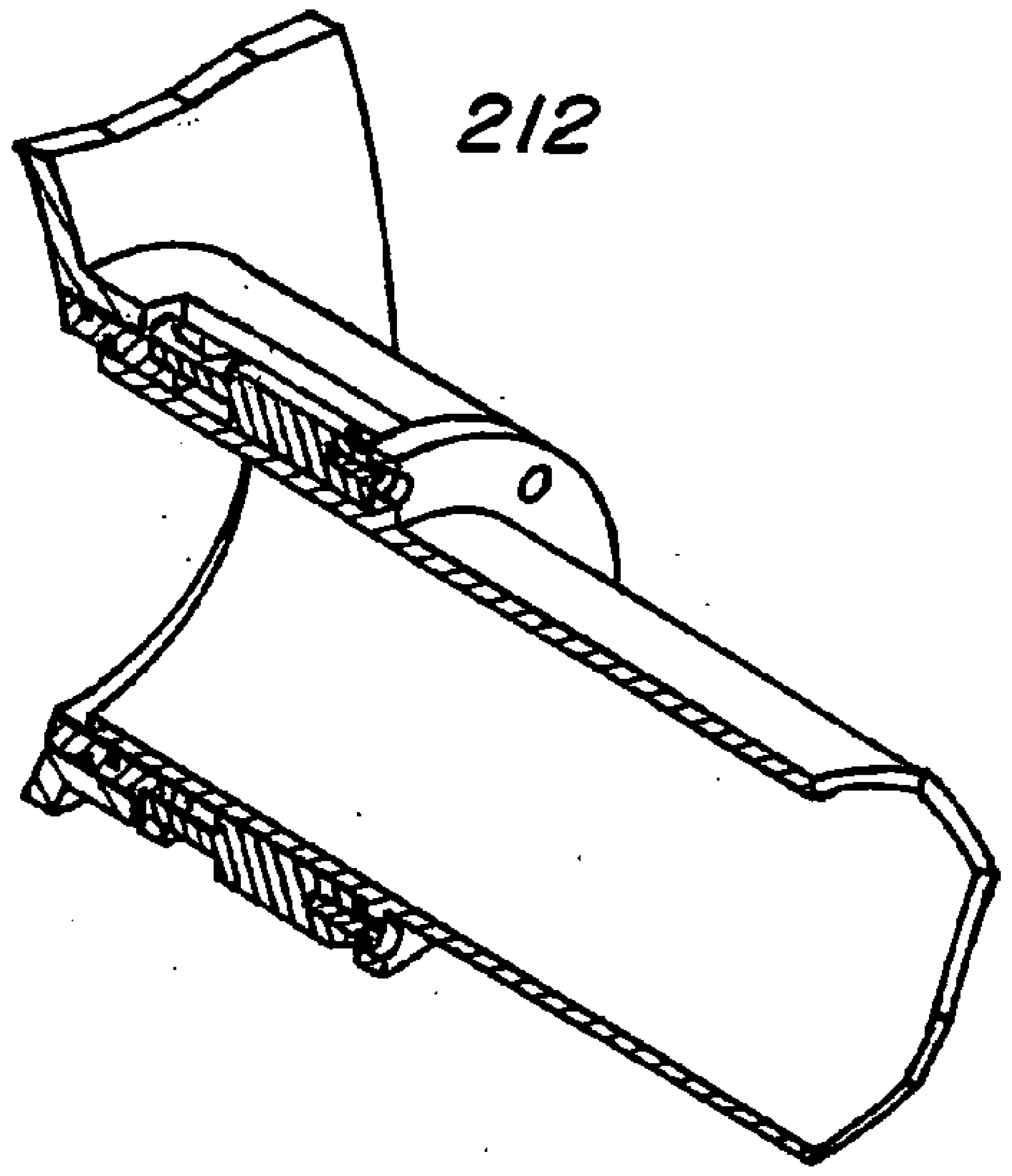

FIG. 20

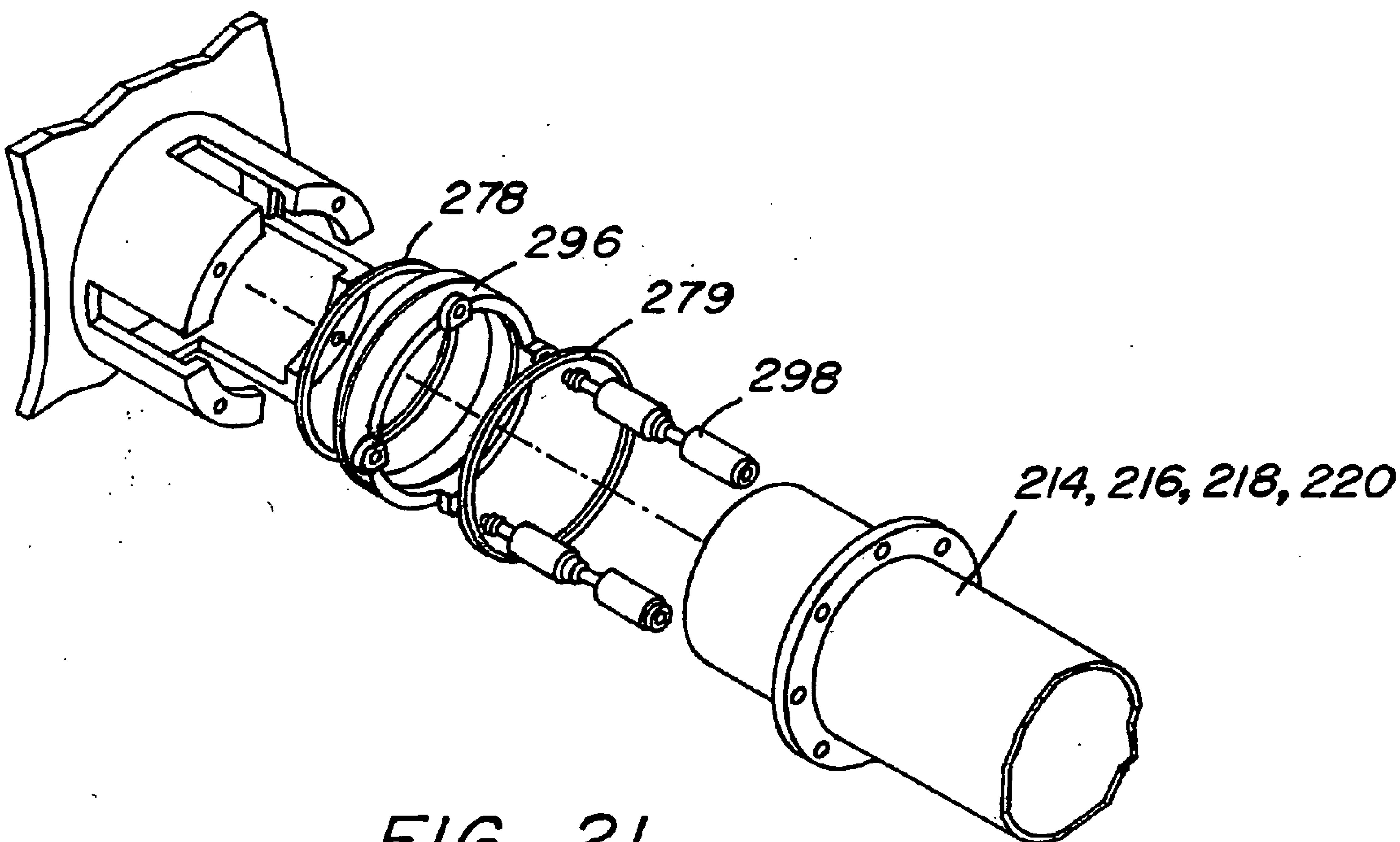

FIG. 21

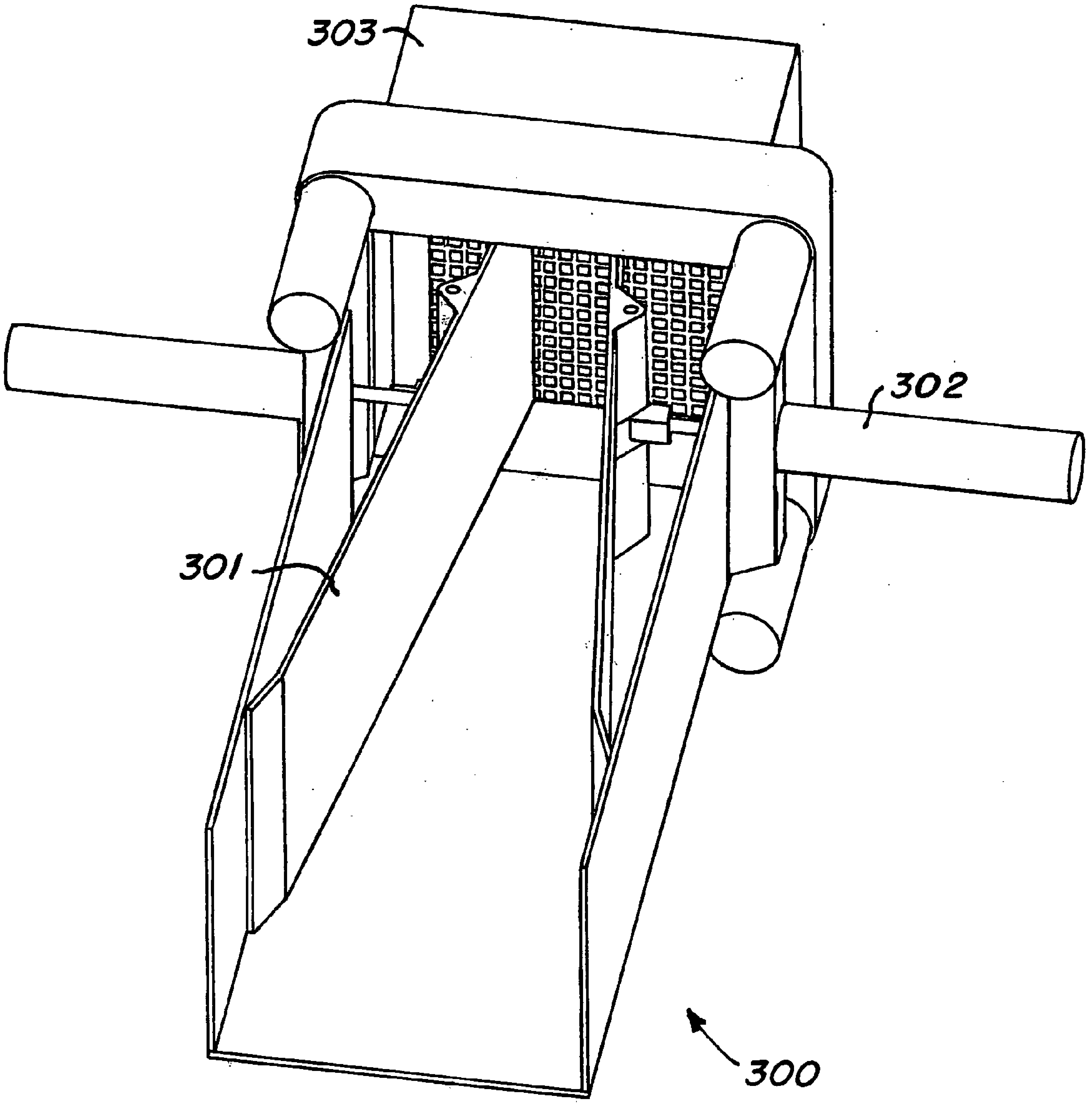

FIG. 22

VARIABLE AREA MASS OR AREA AND MASS SPECIES TRANSFER DEVICE AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of an earlier filing date from U.S. Provisional Application Ser. No. 60/546,583 filed Feb. 19, 2004, the entire contents of which is incorporated herein by reference.

BACKGROUND

[0002] Species transfer devices (e.g. regenerators, recuperators, etc.) are known to exist for many applications where recovery or transfer of species such as thermal energy is desirable. This includes applications employing turbines, fuel cells, other high-temperature machines and refrigeration type/low temperature machines as well. Traditionally, such species transfer devices have been custom designed for specific applications in order to operate at an optimum design point. Alternatively, a species transfer device designed for another application might be employed in a machine for which it was not designed to avoid cost (i.e. the custom-work cost) and where off-design-point operation is acceptable. This of course is at the expense of efficiency. Variable operation of machines also results in inefficiency with respect to the species transfer device. The foregoing has long been a problem because all of the prior-art devices employ a fixed area or mass or area and mass ratio between elements being heated and those being cooled (or other transfer regime). The only capability for variability with respect to transfer in these fixed-ratio designs is by changing the rate of element exchange. There is no capability within the prior art to change the area or mass or area and mass ratio of the species transfer device.

SUMMARY

[0003] Disclosed herein is a variable area or mass or area and mass ratio species transfer device. The species transfer device includes: a plurality of species transfer masses. Each of the masses are actuatable independently or actuatable as a subset of the plurality of masses to reside in at least one of a first fluid stream or a second fluid stream.

[0004] At least one actuator is disposed in operable communication with the species transfer masses, capable of selectively moving one or more of the masses independently of other one or more of the masses into at least contact with the first fluid stream and into contact with the second fluid stream (or other transfer regime).

[0005] Further disclosed herein is a real-time variable area or mass or area and mass ratio species transfer device. The species transfer device includes a transfer mass, an inlet having a variable-dimension fluid-contact area with the transfer mass; and an outlet having a variable-dimension fluid-contact area with said transfer mass.

[0006] Yet further disclosed herein is a method for controlling transfer in a species transfer device. The method includes: selecting an appropriate area or mass or area and mass ratio between a portion of a variable area or mass or area and mass ratio species transfer device exposed to a first fluid and a portion of the species transfer device exposed to a second fluid; exposing one selected portion of the species transfer device to the first fluid; and exposing another selected portion of the species transfer device to the second fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Referring now to the drawings wherein like elements are numbered alike in the several Figures:

[0008] **FIG. 1** is a schematic perspective view of a first embodiment species transfer device according to the teaching herein;

[0009] **FIG. 2** is a schematic perspective view of a species transfer module applicable to the species transfer device of **FIG. 1**;

[0010] **FIG. 3** is a cross-sectional view of the module of **FIG. 2** taken along section line **3-3**;

[0011] **FIG. 4** is a schematic perspective exploded view of a species transfer module like that of **FIG. 2** illustrating further detail;

[0012] **FIG. 5** is a process diagram illustrating movement of individual species transfer masses for an area or mass or area and mass ratio of 3:1;

[0013] **FIG. 6** is a schematic perspective view of a second-embodiment species transfer device according to the teaching herein;

[0014] **FIG. 7** is a schematic perspective view of a species transfer module applicable to the species transfer device of **FIG. 6**;

[0015] **FIG. 8** is a schematic perspective view of a third-embodiment species transfer device according to the teaching herein;

[0016] **FIG. 9** is a schematic perspective view of a species transfer module applicable to the species transfer device of **FIG. 8**;

[0017] **FIG. 10** is a cross-sectional view of **FIG. 9** taken along section line **10-10**;

[0018] **FIG. 11** is a schematic perspective exploded view of the species transfer module of **FIG. 9**;

[0019] **FIG. 12** is a process diagram illustrating movement of individual masses for an area ratio of 2:3;

[0020] **FIG. 13** is a process diagram illustrating movement of individual masses for an area ratio of 3:4;

[0021] **FIG. 14** is a schematic perspective view of a fourth-embodiment species transfer device according to the teaching herein;

[0022] **FIG. 15** is a cross-sectional view of **FIG. 14** taken along section line **15-15**;

[0023] **FIG. 16** is a cross-sectional view of the embodiment of **FIG. 14** taken perpendicular to the axis of the drive;

[0024] **FIG. 17** is a cross-sectional view illustrating a species transfer mass out of alignment with a flow stream;

[0025] **FIG. 18** is a perspective view of a lifting seal assembly;

[0026] **FIG. 19** is a perspective view of a scraping seal assembly;

[0027] **FIG. 20** is a cross-sectional view of the assembly of **FIG. 18**;

[0028] **FIG. 21** is an exploded perspective view of the assembly of **FIG. 18**; and

[0029] **FIG. 22** is a schematic perspective view of an adjustable duct.

DETAILED DESCRIPTION

[0030] The phrase 'species transfer device' as used herein is defined as a device that transfers heat energy (latent, sensible or both), humidity, and/or chemical species/ionic species by storing heat and/or chemical species/ionic species in or on a material (species transfer mass) received from one environment and releasing the species to another different environment. Further the terms are intended to encompass pressure or temperature swing adsorption for wanted or unwanted species including heat energy and chemical species acting as a molecular sieve. The material can be solid, porous, fibrous or cellular, and may be of any material such as polymeric material, metal or ceramic.

[0031] This disclosure relates to "active" species transfer devices, as that term is understood in the vernacular of the subject art. Active devices do not include valve driven species transfer devices, which would be considered "passive" species transfer devices. Another distinguishing characteristic of the species transfer device embodiments disclosed herein is that the average flow direction in each plenum is substantially unidirectional. Such characteristic enhances the speed at which incoming fluid contacts the species transfer mass. Active species transfer devices, due to the custom-design nature thereof, necessarily carry high price tags. Therefore, even if a particular consumer is amenable to tolerating an off-design-point operation in his particular application, the fact that the particular regenerator is not subject to bulk manufacturing, ensures the cost thereof will remain high, though lower than a unit specifically designed for the application. All machine arts that utilize species transfer devices would benefit from the species transfer device embodiments disclosed herein, which have the ability to vary the area or mass or area and mass ratio between fluid streams and the total area or mass or area and mass exposed to any fluid. Such species transfer devices are tailorable to specific applications and are mass producible, which suppresses product costs. Even greater benefits are realized, however, if the area or mass or area and mass ratio variability remains variable such that it may be varied even during operation of the dependent machine. With such capability, the regenerator is not only configurable to operate at optimum for the machine's steady-state design point but can be reconfigured continuously to optimize performance for whatever state at which the dependent machine is operating. Although most machines that utilize species transfer devices have a designed-in optimum operating state, often such machines are forced to operate in off-design-point conditions. Prior-art species transfer devices add to inefficiency of the machine already running inefficiently. The species transfer device embodiments disclosed herein eliminate the drawbacks inherent in the prior art. Yet another feature of the species transfer device disclosed herein is that because the area or the mass or both can be varied at will, the pressure drop across the device is also controllable. This means that the pressure drop can be lowered or raised at will and that the pressure drop can be maintained at a desired value while the mass fluid flow in the system is varied. It should also be noted that area and mass can be changed independently because differing materials can be used for different masses (discussed hereunder). For example, one mass could be formed from a foam ceramic with a very high surface area per cubic meter of material and another mass could be formed from a honeycomb structured material having a lower surface area per cubic meter of material. The same volumetric dimensions of these materials will have different masses.

[0032] Referring to **FIG. 1**, a schematic perspective view of a first regenerator embodiment **10** is illustrated. The species transfer device **10** comprises a plurality of species transfer modules **12** (see **FIG. 2** and **FIG. 3**). Modules **12** are actuatable by one or more actuators **13** (shown on each module **12** in this illustration but could be configured as one actuator to more of the modules at the expense of some variability or could be configured as more than one actuator for any module if desired) and controlled by a sequence-and-dwell controller **15** that determines the desired position of a particular module **12** and the period of time each particular mass should stay in a given fluid stream.

[0033] In fluid communication with the species transfer modules **12** are manifolds **14**, **16**, and **18** and **20**. Manifolds **14** and **18** and manifolds **16** and **20** are in communication with each other through the intermediary of the species transfer modules **12**. Each manifold pair is capable of conducting a fluid stream, and in one embodiment, each will conduct a fluid stream in opposing directions; it is noted that each can conduct in either direction, including in the same direction, and the direction could be reversed in either or both flows if desired. It is possible for such reversal to take place even during operation of the species transfer device/machine if the application called for such.

[0034] Interposed between the manifolds **14**, **16**, **18** and **20** and the modules **12** are seal modules **22**. Seal modules **22** comprise lifting seals utilizing the concept and similar mechanization as taught in U.S. Pat. No. 5,259,444 to David Gordon Wilson, which is incorporated herein in its entirety. The seals ensure that a fluid stream directed to a certain portion of module **12**, passes through that portion, enhancing efficiency of the system as do other seals but with lifting seals wear is minimized and longevity maximized. It is also anticipated that passive sliding or scraping seals could also be employed in some applications.

[0035] Referring now to **FIGS. 2**, **3** and **4**, a species transfer module **12** is described in detail. **FIG. 2** provides a schematic perspective view of a single module **12** in the same orientation in which it is represented in **FIG. 1**. **FIG. 2** serves to illustrate the two potential fluid passageways **30** and **32** that module **12** affords. It is to be noted that in this illustration, passageway **30** is illustrated as a species transfer mass **34** while passageway **32** is illustrated as blanked off. Flow is possible in this figure through passageway **30** and not through passageway **32**. Further, by mentally positioning the module **12** of **FIG. 2** into **FIG. 1** in the same orientation, it is apparent fluid communication is enabled between manifold **14** and manifold **18** while fluid communication is disenabled between manifold **16** and manifold **20**.

[0036] Referring now to **FIG. 3**, a schematic cross-section view of **FIG. 2** is shown. This figure illustrates the blanking areas **36** on either side of species transfer mass **34**, which allow one species transfer mass **34** to be positioned in either passage **30** or **32** while simultaneously positioning a blank **36** in the other passage **30** or **32**.

[**0037**] Referring now to **FIG. 4**, a schematic perspective exploded view of a module **12** is illustrated. Module **12** comprises a housing **40** configured to receive a slide box **42**. Slide box **42**, in this embodiment comprises a species transfer mass **34** flanked on each side by blanks **44**. Slide box **42** is slideable back and forth toward the left side of the drawing and toward the right side of the drawing to manipulate the position of the species transfer mass **34** from one fluid stream in passage **30** to another fluid stream in passage **32** and vice versa. Sliding of the slide box **42** is achieved by operation of actuator **14**. Actuator **14** comprises a mechanical, electromechanical, electrical, magnetic, hydraulic, pneumatic, etc. device capable of adjusting the position of the slide box **42** to a desired position. In one embodiment, as shown, actuator **14** comprises a linear actuator **46** as a direct movement effector. The linear actuator **46** may be a solenoid or other suitable linear device. Linear actuator **46** is connected at its base **48** to housing **40** and is connected at a piston **50** thereof to a tab **52**. Tab **52** is connected to a slide **54**, which is mounted on bearing shafts **56** through linear bearings **58**. The shafts **56** are stationary in this illustrated embodiment and extend as illustrated, substantially the length of housing **40** and out of one end thereof. It will be noted that the slide box **42** also rides on shafts **56** through linear bearings **58** to facilitate smooth cycling back and forth of the slide box **42** within housing **40**. Upon actuation of linear actuator **46**, piston **50** extends (thereby telescopically increasing the combined length of piston **50** and the housing of linear actuator **46**). In so doing, tab **52** is urged away from housing **40**, taking slide **54** therewith. When slide **54** moves, it moves a connecting rod **60**, which is in operable communication therewith. The connecting rod **60** is also in operable communication with the slide box **42** and is the impetus for the sliding movement of slide box **42** to position species transfer mass **34** in one of passageway **30** or passageway **32**.

[**0038**] Slide **54** further, in this embodiment, includes a cam **62** to assist with storage of movement energy occasioned by actuation of linear actuator **46**. Cam **62** interacts with a cam follower **64**, which is mounted to a lever **66**. The lever **66** is pivotally connected to a support **68** mounted at the housing **40**. At an opposite end of the lever **66**, the lever is connected to an energy storage mechanism **70** which may comprise a spring and interface for the lever **66**. Upon the movement of cam follower **64** onto a cam profile **62** (two illustrated in this figure), lever **66** transfers energy into the energy storage mechanism **70**, in this illustration, spring **72**. Upon subsequent movement of the slide box **42**, the stored energy is reintroduced to the system through cam follower **64**. Energy is stored in the spring during deceleration of slide box **42** and reintroduced during acceleration of slide box **42**. This reduces power consumption of the actuator merely to that necessary to overcome the friction or hysteresis losses of the device. It is to be noted that the foregoing explanation of the actuator is but one embodiment thereof and that other mechanical, electro mechanical, electrical, magnetic, hydraulic, pneumatic, etc. means are substitutable without departing from the scope of this invention.

[**0039**] To minimize leakage of the fluid streams, a seal module **80** is disposed at slide box **42**. Seal module **80** may be of a lifting-type seal arrangement, a scraping-type seal arrangement or a close-clearance type seal arrangement. Other seal arrangements may also be employed where applicable and sufficiently effective in reducing leaking of stream fluids for the particular application. Covers **90** are located on each longitudinal end of seal module **80** and mounted to housing **40** to complete the species transfer module **12**.

[**0040**] Referring to **FIG. 5**, a flow diagram is provided showing a sequence of movements of species transfer masses **34** through one complete cycle. The figure is self-explanatory, and represents, in this case, an area or mass or area and mass ratio of 3:1.

[**0041**] Referring now to **FIGS. 6 and 7**, an alternative embodiment of species transfer module **12**, identified as **12***a* is illustrated. The distinction in this embodiment is that the species transfer mass **34***a* is longer with respect to the flow path of the fluid stream. The extension box **94** of **12***a* may be of any flow length desired while considering practicality.

[**0042**] Referring now to **FIGS. 8, 9** and **10**, another alternative embodiment of a species transfer device is illustrated. This embodiment provides even more variability than the foregoing embodiments because not only can the mass/area subjected to each stream be varied; the entire mass/area available can be varied. From a review of **FIGS. 8, 9** and **10** it will be recognized that the overall construct of the species transfer device **110** is similar to that of species transfer device **10** (**FIG. 1**) except that the length of housing **40** is increased and is denoted **140** to distinguish the same. Considering **FIG. 10**, the reason for the increased length becomes apparent. On each side of species transfer mass **34** in module **112** is a blank **36** as is the case in the embodiment of **FIG. 1**. In the embodiment of **FIG. 10** however, another blank **136** is provided. The addition of the blank **136** allows the greater variability with respect to the species transfer device **110** as read above because it allows one whole module **112** to be closed off, thereby rendering the total area or mass or area and mass of species transfer mass material to be reduced either permanently or temporarily to tailor the species transfer device **110** to a smaller duty or to allow it to be optimized to any particular run state of a dependent device, respectively.

[**0043**] Referring to **FIG. 11**, the species transfer module **112** is in large part similar to that of module **12**. Numerals are employed on **FIG. 11** that are identical to **FIG. 4** if the component is identical or if the component differs only in length. The components discussed hereunder are those that differ from module **12** in construction and bear a **100** series equivalent numeral to that used in the discussion of module **12**.

[**0044**] Addressing actuator **146**, Cam **162** includes three profiles in this embodiment to allow for energy recovery at each potential stopping position for slide box **142**. Actuator **146** is in other respects the same as actuator **46**.

[**0045**] The seal module **180** illustrated in **FIG. 11** is specifically a lifting seal arrangement and therefore illustrates seal **196** and individual seal actuators **198**, which may be mechanical, electrical, electro mechanical, hydraulic, pneumatic, magnetic, etc. Seal **196** is lifted out of contact with slide box **142** instantaneously before slide box **142** is moved and then is reapplied instantaneously after slide box

142 is stopped. A minimum of seal wear and a maximum seal life are achieved. As with module **12**, sliding or scraping seals may also be employed.

[**0046**] Referring now to **FIGS. 12 and 13**, two flow diagrams are provided for enhanced understanding of the variability of the system. A 2:3 species transfer area ratio is illustrated in **FIG. 12** with an overall species transfer to total area ratio of 5:16. In **FIG. 13 a** 3:4 ratio for species transfer area is illustrated with an overall species transfer area to total area ratio of 7:16. One of skill in the art will readily appreciate the progression and the partial use of filly blanked-off modules **112** in these flow diagrams. The species transfer area ratios and overall ratios illustrated are but two of many possibilities based upon alternative combinations of blanked modules.

[**0047**] Referring now to **FIGS. 14, 15** and **16** a "rotary" species transfer device embodiment **210** exhibiting the properties of variability identified above is illustrated. For this device there are again four manifolds **214, 216, 218** and **220** wherein a first flow-stream passageway **230** is defined between manifolds **214** and **218** while a second flow-stream passageway **232** is defined between manifolds **216** and **220**. In this example of the rotary species transfer device **210** four species transfer modules **212** are illustrated. Each module includes a rotor **242** comprising a species transfer mass **234** (see **FIG. 15**) rotatable about an axis of rotation, which brings the species transfer mass **234** into alignment with one or the other of passageways **230** or **232** or can be positioned out of alignment with either of these passageways (see **FIG. 17**) for blanking off a particular module **212**.

[**0048**] Rotors **242** are driven by actuators **213**, which comprise, in the illustrated embodiment, a motor **246** having a drive wheel **250**. The motor may be of any type and in this embodiment is a direct current brushless motor with encoder. The encoder helps to ensure proper alignment of the rotors **242** with the manifolds **214/218** and **216/220**. Drive wheel **250** is operably engaged with a chain or belt member **252**, which extends around rotor **242** and engages therewith via drive ring **260**, which is operably connected to rotor **242**. The drive ring may be a sprocket for a chain or belt drive hub or other equivalents and is rotationally fixed relative to rotor **242** by adhesive, press fit, integral formation, welding, etc. An idler **254** is also provided as shown in **FIG. 16** to maintain proper tension on member **252**. A motor cover **274** may be added if desired for safety or aesthetics. Clear to one of skill in the art, this discussed actuator is but one possible arrangement. Other arrangements are also applicable such as configuring driven ring **260** as a worm gear and mounting a worm and a drive to selectively rotate the worm gear and rotor thereby. In one embodiment and as shown, species transfer mass cleaning or replacement access is provided in each module **212** at **276**.

[**0049**] Interposed between manifolds **214/216/218/220** and rotor module **242** are seal modules **222** having either a lifting (dynamic) or sliding/scraping (passive) seal similar to that described for use with module **12**. These seals are illustrated in **FIGS. 18 and 19** respectively, the difference being that the actuator **298** of the dynamic seal of **FIG. 18** is replaced by a spring **299** to get the passive version shown in **FIG. 19**. Referring now to **FIG. 20**, a perspective cross-section view of **FIG. 18** is illustrated, and referring to **FIG. 21**, a perspective exploded view is shown of **FIG. 18**. In operation, the seal ring **296** is pressed against or lifted away from the rotor **242** by actuator **298**, fastened to seal ring **296** on one end and inlet/outlet manifold **214/216/218/220** on the other. Leakage around the seal ring **296** is prevented by internal piston ring **278** and external piston ring **279**. Other sealing arrangements can also be employed such as metal bellows and elastomers for temperature compatible applications. Other than round seal bodies may also be used; in those cases, the piston rings are energized by metal, ceramic, or elastomeric springs to hold them against their respective sealing surfaces.

[**0050**] In operation, one or more of the species transfer masses in rotors **242** can be moved at whatever speed/frequency is desired between two flow streams or out of either flow stream providing a high degree of variability; this is exactly analogous to the operation of the linear version as illustrated in **FIGS. 12 and 13**.

[**0051**] In yet another variability embodiment, a more conventional species transfer device such as that disclosed in U.S. Pat. No. 5,259,444 to David Gordon Wilson is modified with an adjustable area duct between the manifolds and the species transfer mass to change the area of species transfer mass exposed to the incoming flow. This means of creating variability is accomplished by varying the cross-sectional area of the manifold by telescopically widening or narrowing that manifold thereby exposing more or less area of the species transfer mass to the incoming stream. These adjustments could be done initially during set up of the device and then fixed or could be done variably during operation of the device. By employing such a device, both the amount of species transferred and the pressure drop across the species transfer device can be adjusted.

[**0052**] **FIG. 22** shows an adjustable duct **300** with a wall surface removed for viewing. Movable walls **301** are moved by actuators **302** to a desired position as a means of exposing more or less of the species transfer mass **303**, and/or adjusting the pressure drop across the species transfer device. A similar arrangement can be implemented in a round duct by employing an iris, similar to that used in a conventional film camera.

[**0053**] While preferred embodiments have been shown and described, modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

What is claimed is:

1. A variable area or mass or area and mass ratio species transfer device comprising:

a plurality of species transfer masses, each mass actuatable independently or actuatable as a subset of the plurality of masses to reside in contact with a first species or a second species; and

at least one actuator in operable communication with said species transfer masses, capable of selectively moving one or more of the masses independently of other one or more of the masses into at least contact with the first species and into contact with the second species.

2. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the species transfer device further comprises a controller in operable communication with the at least one actuator.

3. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein each of the plurality of species transfer masses is embodied in a module which includes the at least one actuator.

4. A variable area or mass or area and mass ratio species transfer device as claimed in claim 3 wherein each module further includes blanks to stop flow through a selected passage.

5. A variable area or mass or area and mass ratio species transfer device as claimed in claim 4 wherein the blanks are arranged in position and in number to facilitate selection of a species transfer mass in one or the other of two species passageways.

6. A variable area or mass or area and mass ratio species transfer device as claimed in claim 5 wherein the blanks are arranged in position and in number to facilitate selection of a species transfer mass in one or in neither of the two species passageways.

7. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the device further comprises at least an inlet passageway wherein average fluid movement is substantially unidirectional.

8. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the plurality of species transfer masses is linearly moveable.

9. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein each of the plurality of species transfer masses is rotationally moveable.

10. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the first species is a higher temperature fluid stream.

11. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the second species is a lower temperature fluid stream.

12. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the first species is humidity.

13. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the first species is a species adsorbable at a first pressure and desorbable at a second pressure.

14. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein the device is in operable communication with a controller.

15. A real-time variable area or mass or area and mass ratio species transfer device comprising:

a transfer mass;

an inlet having a variable-dimension fluid-contact area with said transfer mass; and

an outlet having a variable-dimension fluid-contact area with said transfer mass.

16. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein said species transfer device includes a clamping seal.

17. A variable area or mass or area and mass ratio species transfer device as claimed in claim 16 wherein said species transfer mass is discontinuously moveable.

18. A variable area or mass or area and mass ratio species transfer device as claimed in claim 1 wherein said species transfer device includes a scraping or sliding seal.

19. A variable area or mass or area and mass ratio species transfer device as claimed in claim 18 wherein said species transfer device species transfer mass is discontinuously movable.

20. A variable area or mass or area and mass ratio species transfer device as claimed in claim 18 wherein said species transfer device species transfer mass is continuously movable.

21. A method for controlling species transfer in a species transfer device comprising:

selecting an appropriate mass/area ratio between a portion of a variable area or mass or area and mass ratio species transfer device exposed to first species and a portion of the species transfer device exposed to a second species;

exposing one selected portion of said species transfer device to said first species; and

exposing another selected portion of said species transfer device to said second species.

22. A method for controlling heat transfer in a species transfer device as claimed in claim 21 wherein each said exposing comprises moving one or more individual or groups of a plurality of species transfer masses.

23. A method for controlling heat transfer in a regenerator as claimed in claim 21 wherein each said exposing comprises changing a contact area of an inlet and a contact area of an outlet.

24. A method for controlling heat transfer in a regenerator as claimed in claim 21 wherein said first species is a higher-temperature fluid.

25. A method for controlling heat transfer in a regenerator as claimed in claim 21 wherein said second species is a lower-temperature fluid.

26. A method for controlling heat transfer in a regenerator as claimed in claim 21 wherein the method further comprises causing at least one of the first and second species to move substantially unidirectionally through a supply plenum.

27. A variable area or mass or area and mass ratio species transfer device comprising:

a species transfer mass; and

a variable size duct in fluid communication with the mass.

28. A variable area or mass or area and mass ratio species transfer device as claimed in claim 27 wherein the duct includes actuators to vary area of exposed mass.

29. A variable area or mass or area and mass ratio species transfer device as claimed in claim 27 wherein said duct comprises:

a housing receptive of fluid communication with a species transfer mass; and

a movable wall disposed at the housing and capable of adjusting an exit area of the duct thereby enlarging or restricting an area of the species transfer mass open to a fluid flow through the duct.

30. A variable area or mass or area and mass ratio species transfer device as claimed in claim 27 wherein average fluid flow through the duct is unidirectional.

31. A variable area or mass or area and mass ratio species transfer device as claimed in claim 27 wherein said duct is an adjustable opening iris.

32. A method for controlling species transfer in a species transfer device comprising:

adjusting an area of a species transfer mass exposed to a species.

33. A method for controlling species transfer in a species transfer device as claimed in claim 27 wherein the species is a fluid flow.

34. A variable area active species transfer device.

35. A variable ratio active species transfer device.

36. A variable mass active species transfer device.

37. An active species transfer device comprising:

a variable area or mass or area and mass species transfer mass;

a means for adjusting the area or mass or area and mass transfer mass.

38. An active species transfer device configured to modify a pressure drop thereacross while in operation.

39. A method for controlling pressure drop across an active species transfer device comprising:

measuring mass fluid flow incident the species transfer device; and

continuously or periodically adjusting an area of available fluid flow to maintain a steady pressure drop across the species transfer device.

40. A reversibly variable mass regenerator.

41. A reversibly variable area regenerator.

42. A method for modifying heat transfer in a regenerator comprising:

adjusting a mass of heat transfer material exposed to an incoming fluid at a selected time.

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