

EXHIBIT E



US006222525B1

(12) **United States Patent**
Armstrong

(10) **Patent No.:** US 6,222,525 B1
(45) **Date of Patent:** Apr. 24, 2001

(54) **IMAGE CONTROLLERS WITH SHEET CONNECTED SENSORS**

5,889,507 * 3/1999 Engle et al. 345/161
5,898,425 * 4/1999 Sekine 345/168

(76) **Inventor:** Brad A. Armstrong, 848 Inyo St., Chico, CA (US) 95928

* cited by examiner

Primary Examiner—Jeffery Brier

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(57) **ABSTRACT**

A sensor connecting sheet material for inclusion in appropriately structured multiple-axes controllers comprised of a single input member operable in 6 DOF relative to a reference member of the controller. The input member having return-to-center resiliency relative to the reference member on at least the three perpendicular linear axes. The input member can be of a continuously rotatable trackball-type or a limited rotation joystick-type, and the reference member can be a shaft, a base or a housing. The controllers include carriage structuring for influencing sheet connected sensors by hand-applied operation of the input member. The preferred structures provide cooperative interaction with movement or force influenced sensors in primarily a single area. Some, most, or all of the sensors are preferably supported on a generally single plane, such as on a printed flexible membrane sensor sheet or circuit board sheet. In an alternative embodiment, sensors and conductive traces are applied on a generally flat, flexible membrane sensor sheet, which is then bent into a three dimensional configuration which may in some cases reach a widely-spread 3-D constellation of 6 DOF and/or other sensor mountings. The use of sensors connected by a sheet member, whether finally applied in a flat or 3-D configuration, enables efficient circuit and sensor connection and placement during manufacture, resulting in low product costs and high reliability.

(21) **Appl. No.:** 08/677,378

(22) **Filed:** Jul. 5, 1996

Related U.S. Application Data

(63) Continuation-in-part of application No. 08/393,459, filed on Feb. 23, 1995, now Pat. No. 5,565,891, and a continuation-in-part of application No. 07/847,619, filed on Mar. 5, 1992, now Pat. No. 5,589,828.

(51) **Int. Cl.** G06F 3/033

(52) **U.S. Cl.** 345/161; 345/168

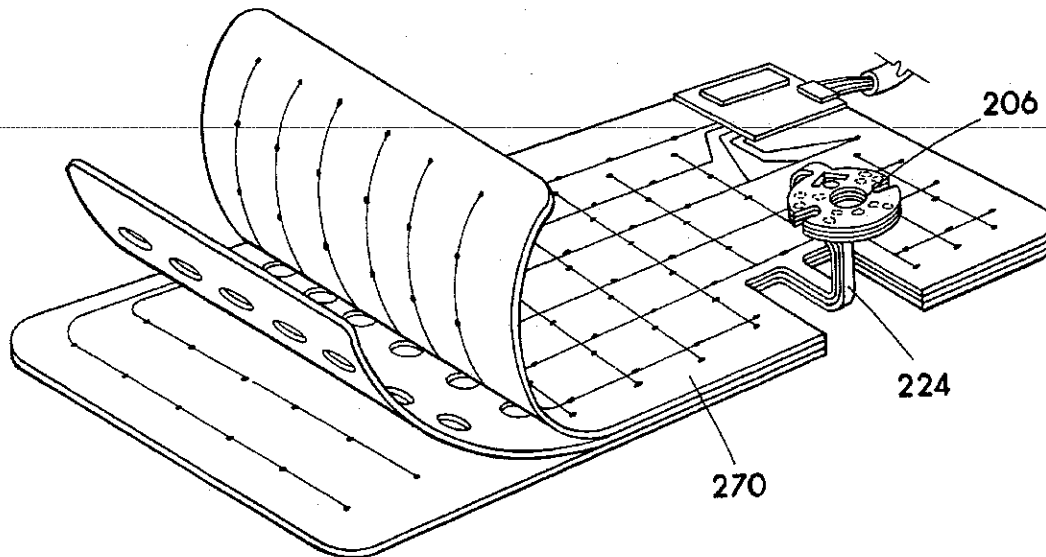
(58) **Field of Search** 345/156, 157, 345/161, 167, 173, 168

(56) **References Cited**

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5,565,891	* 10/1996	Armstrong	345/167

23 Claims, 40 Drawing Sheets



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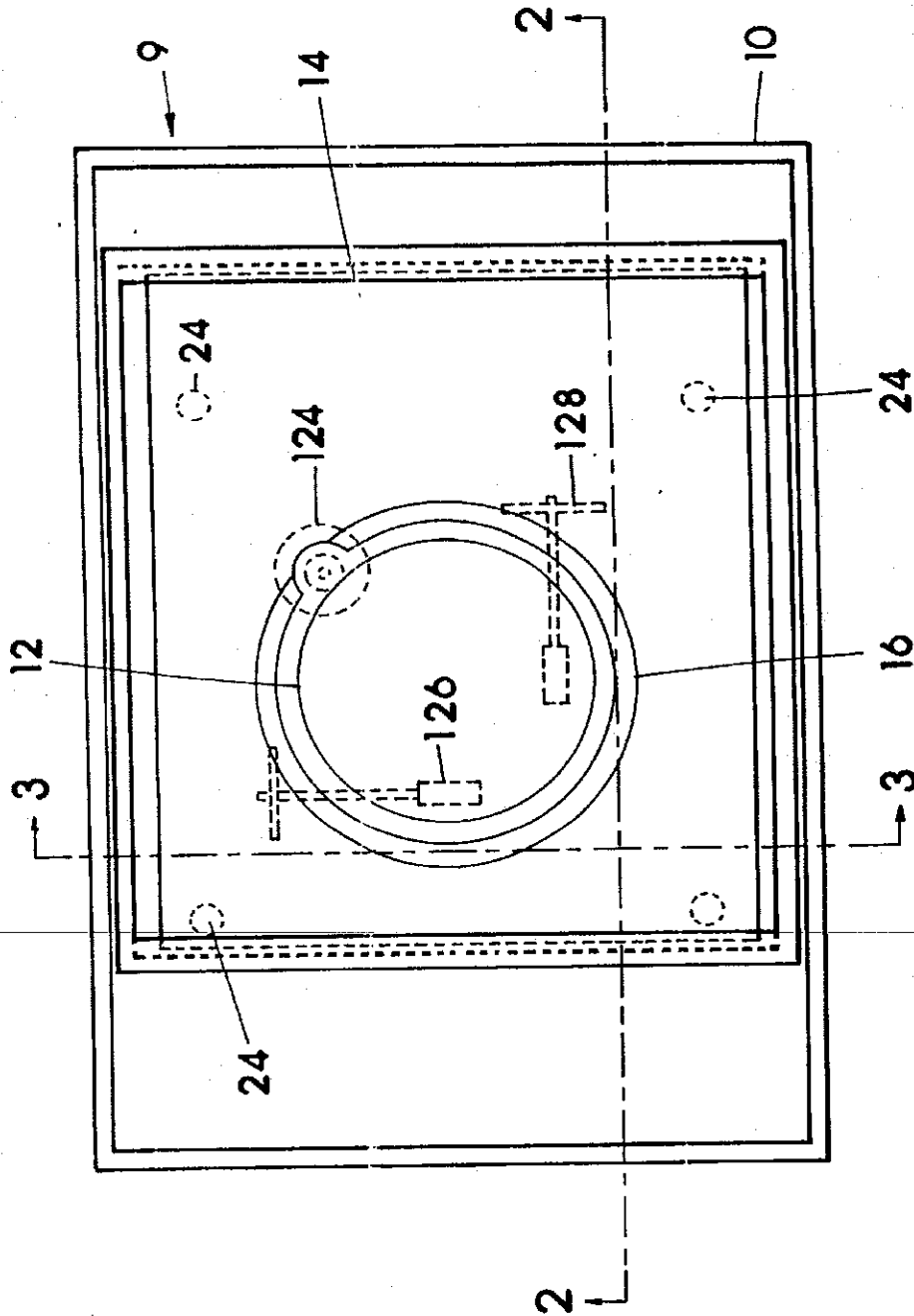
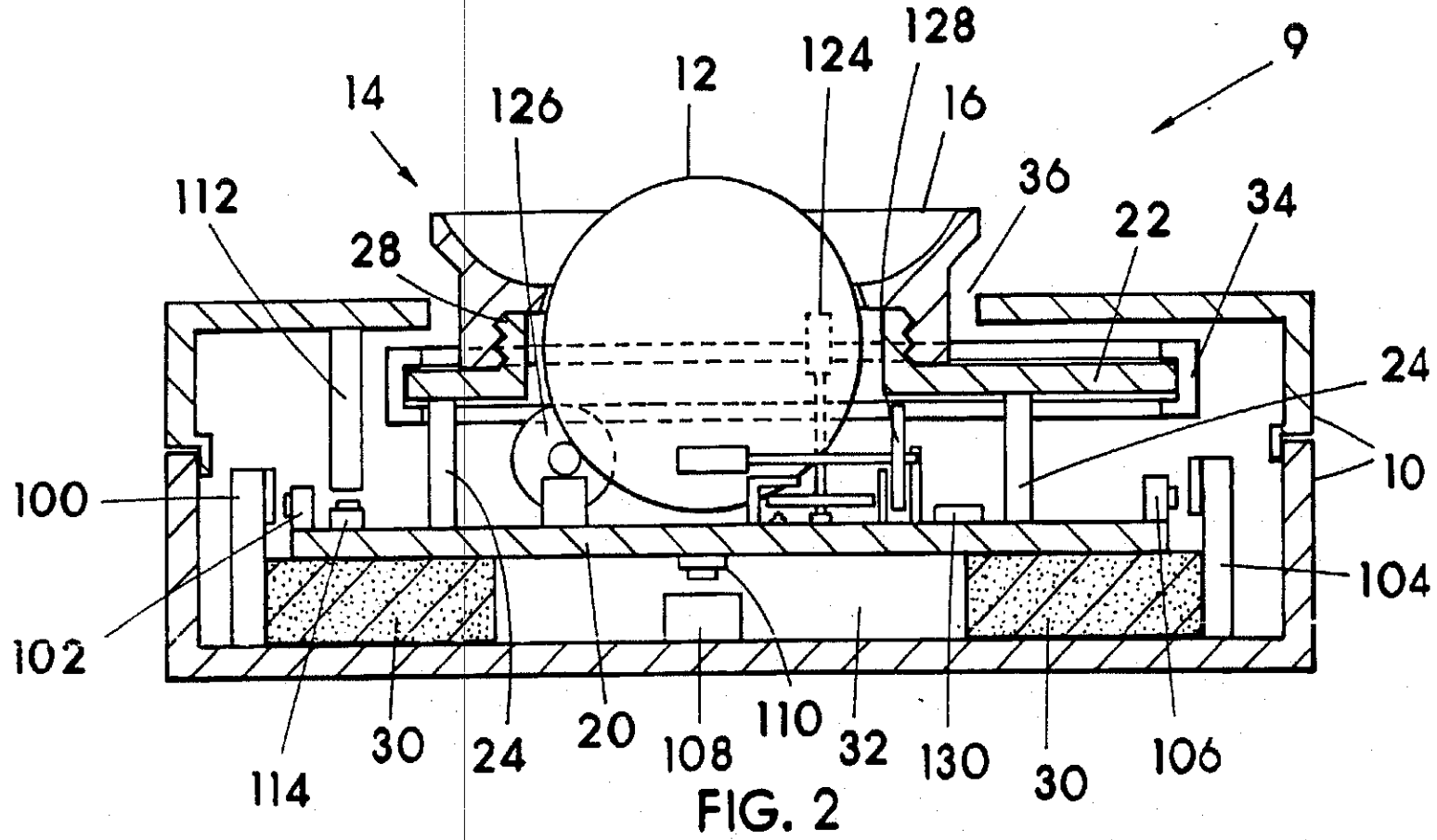


FIG. 1



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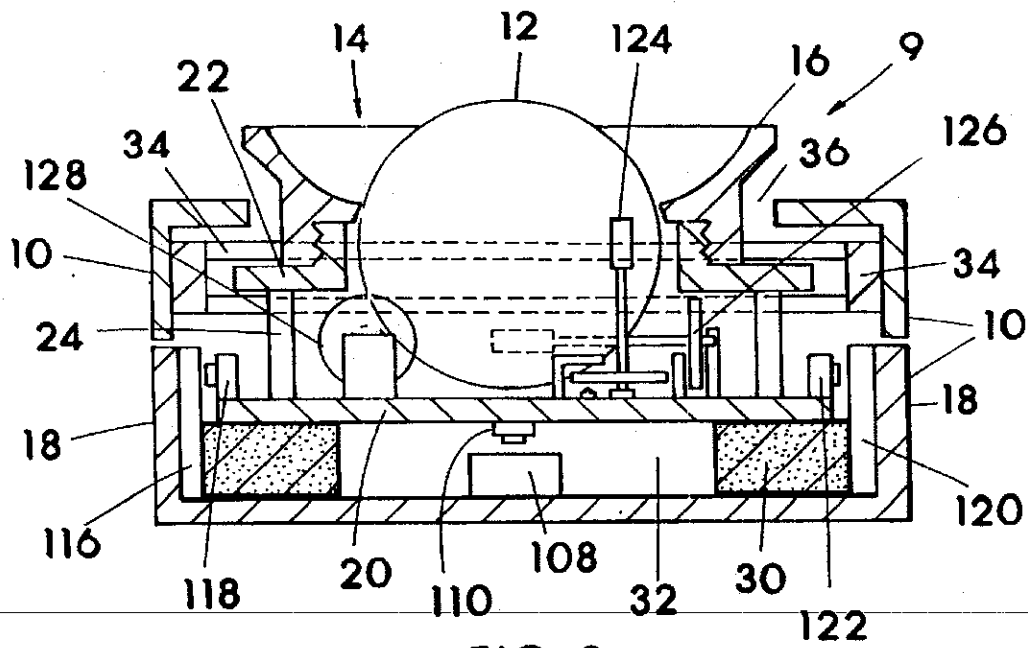


FIG. 3

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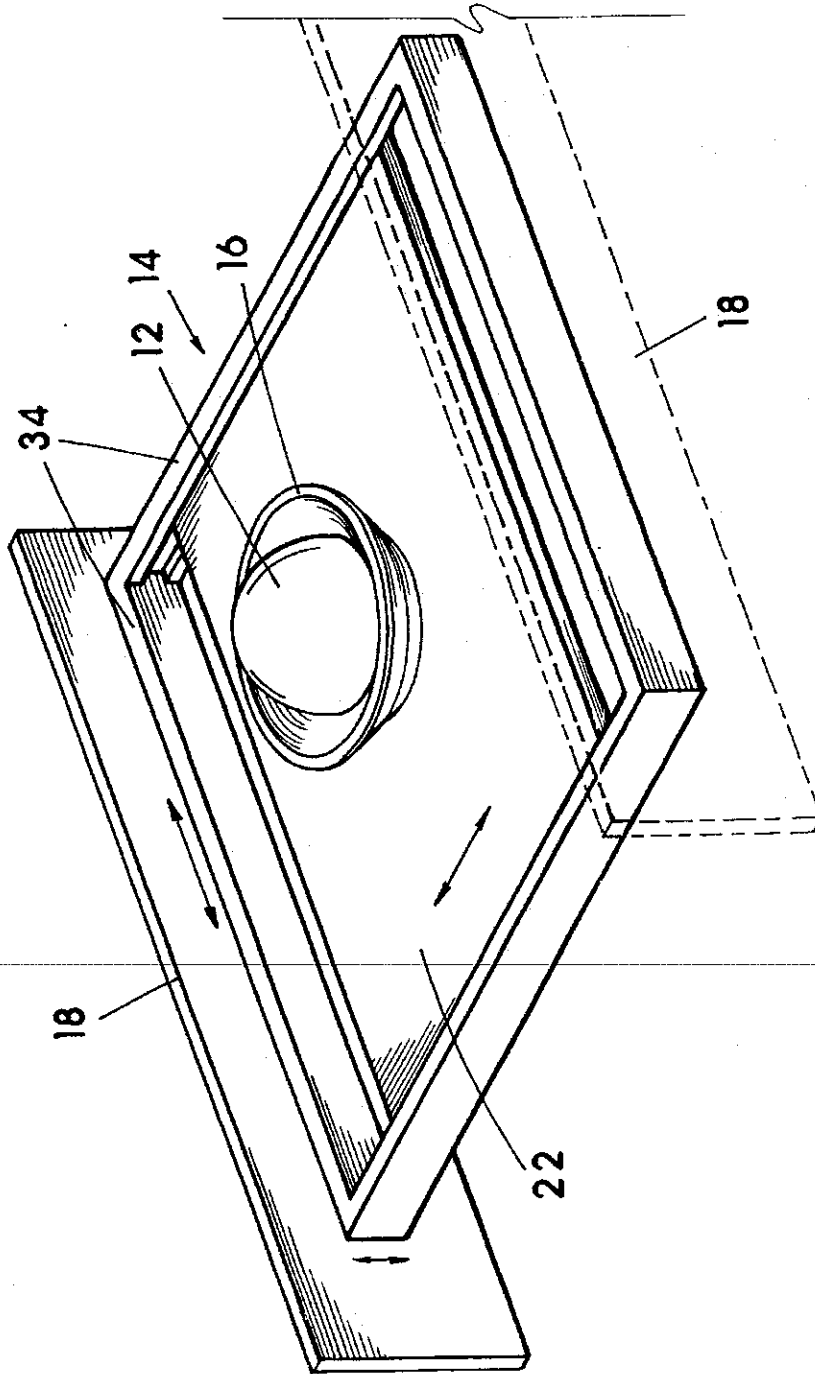


FIG. 4

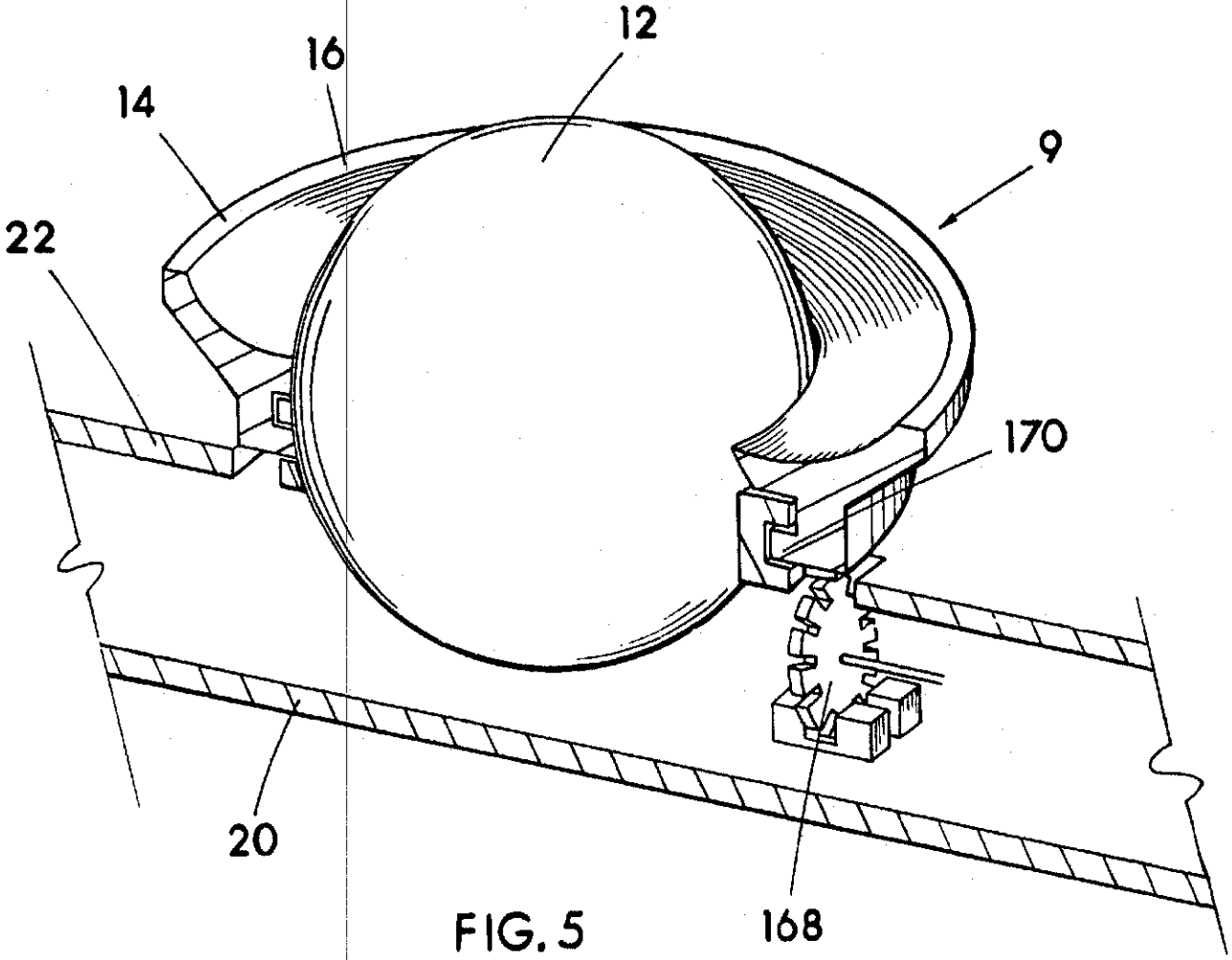
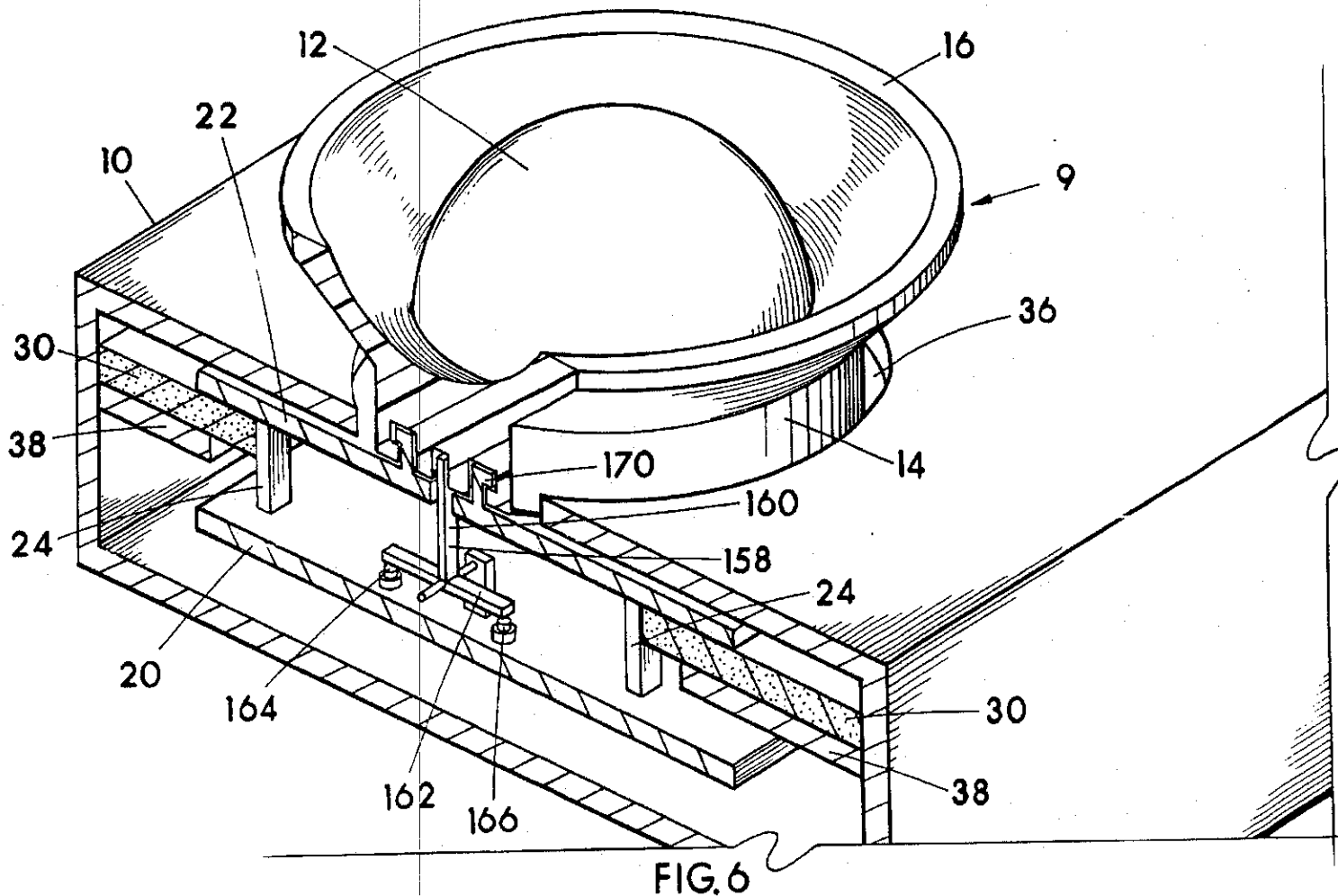


FIG. 5



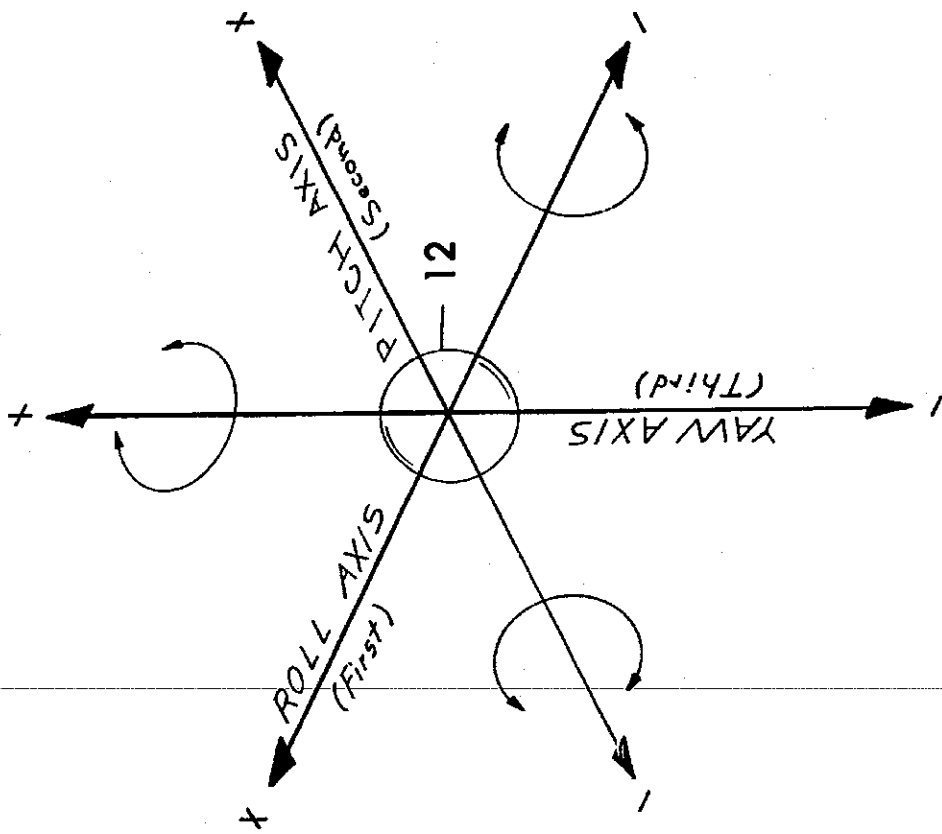


FIG. 7

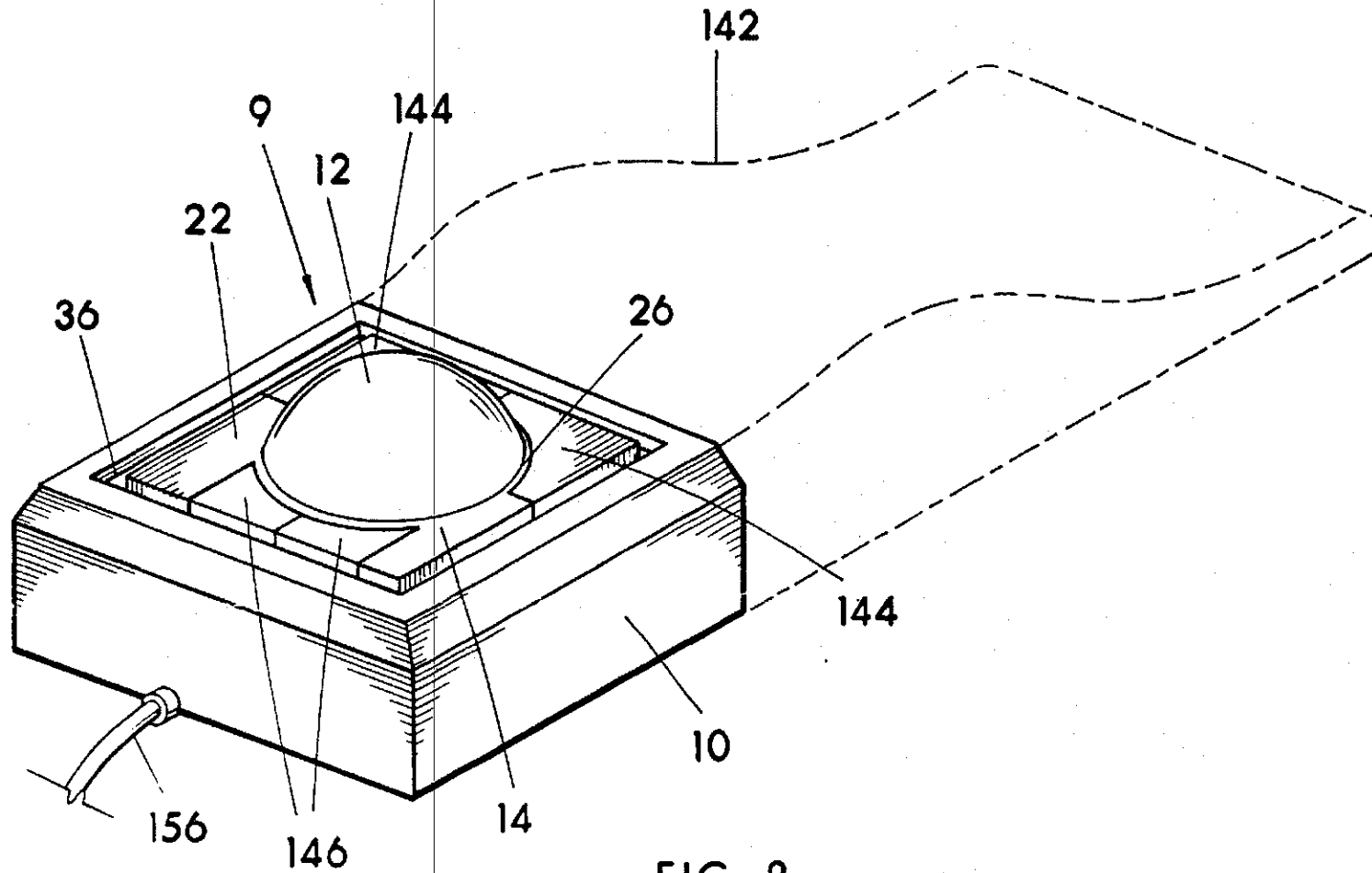


FIG. 8

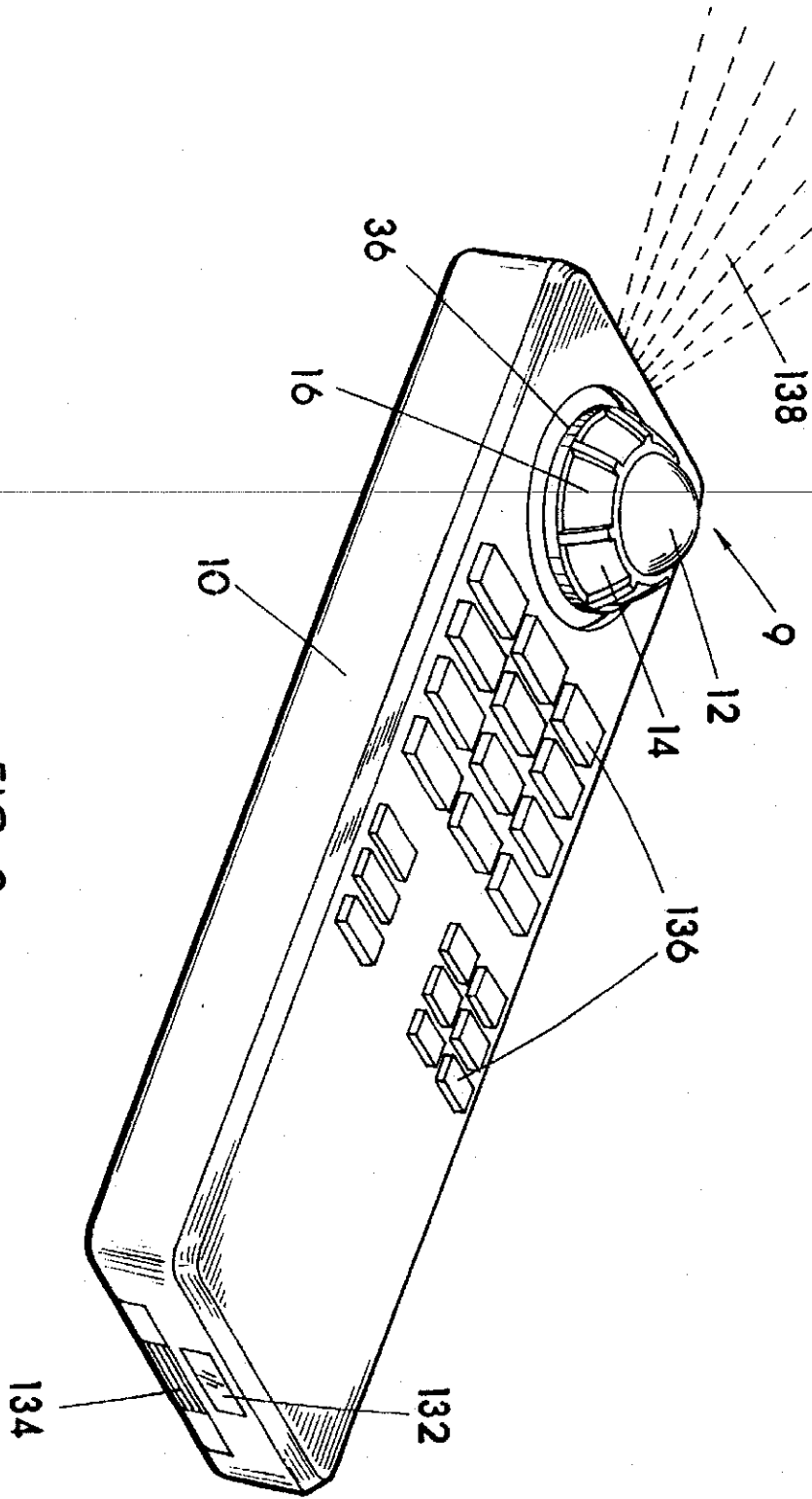


FIG. 9

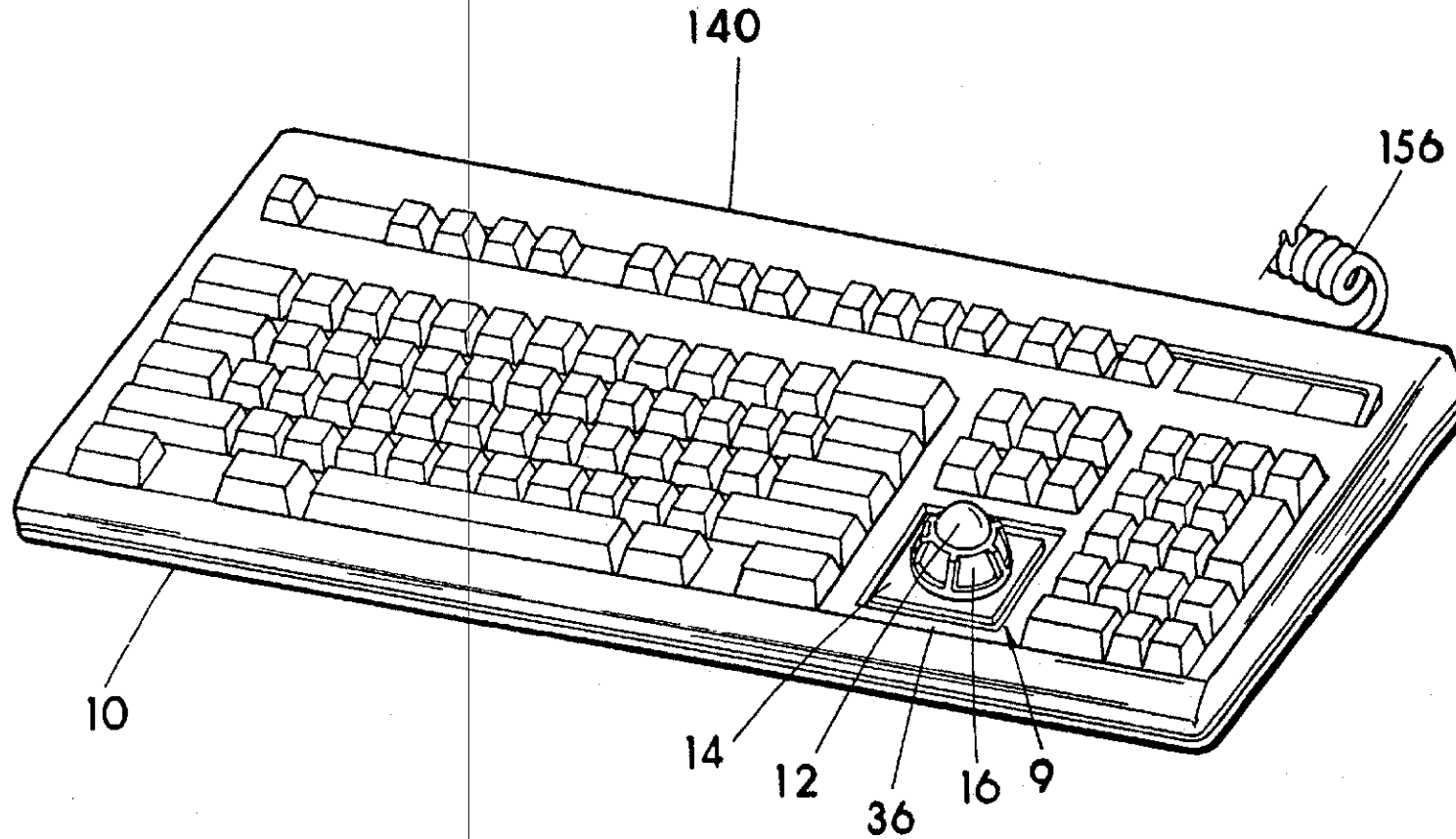


FIG. 10

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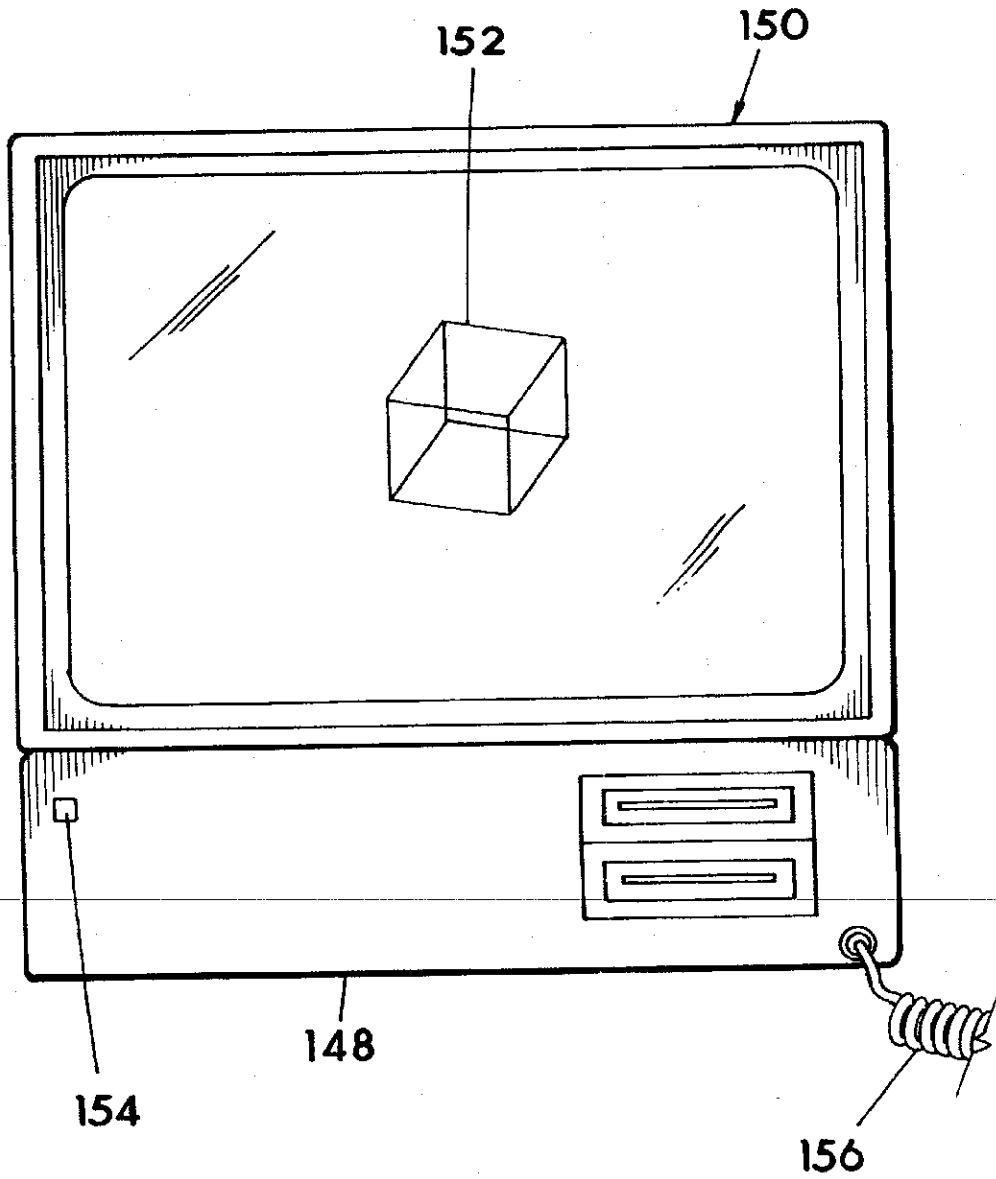


FIG. 11

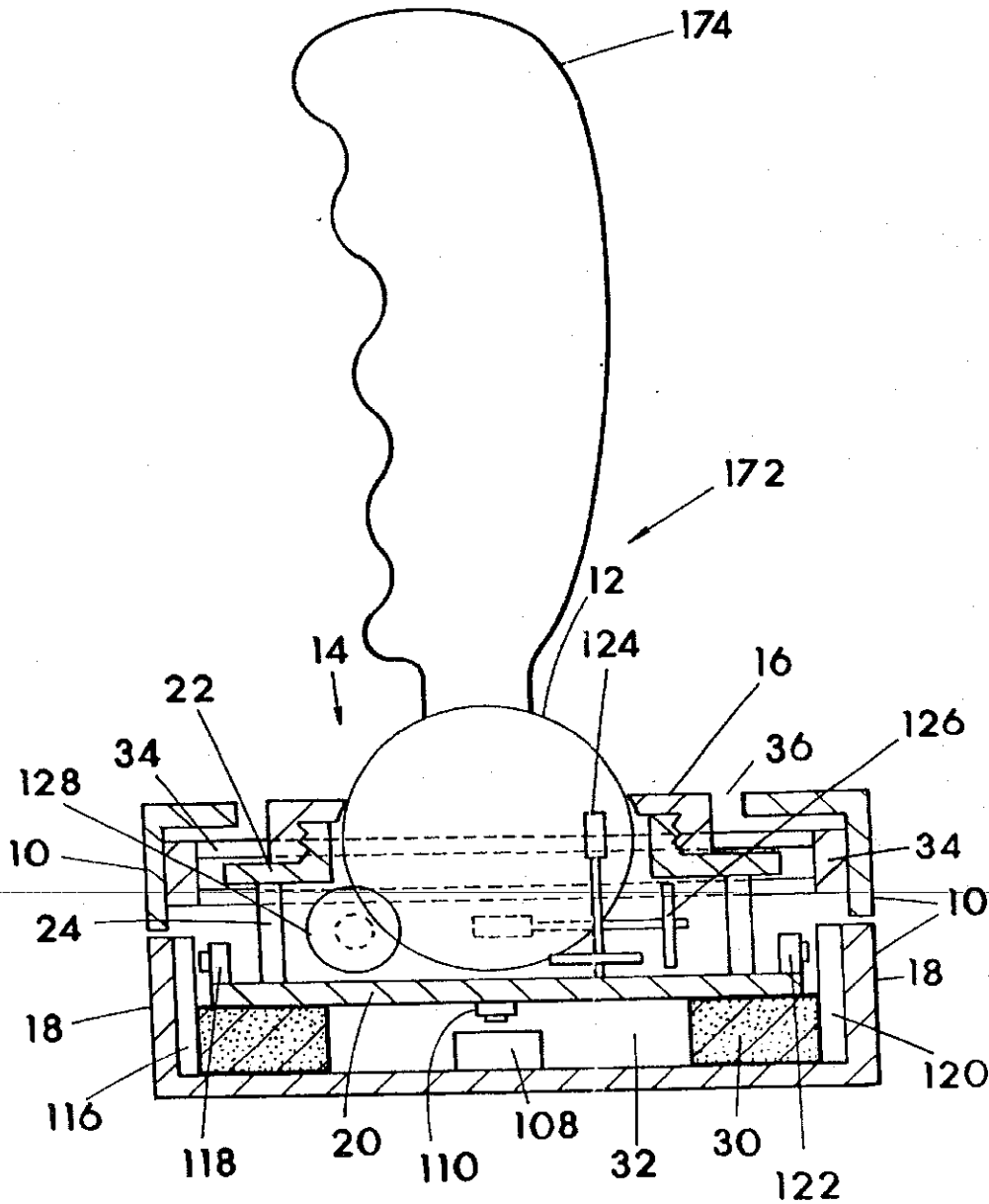


FIG. 12

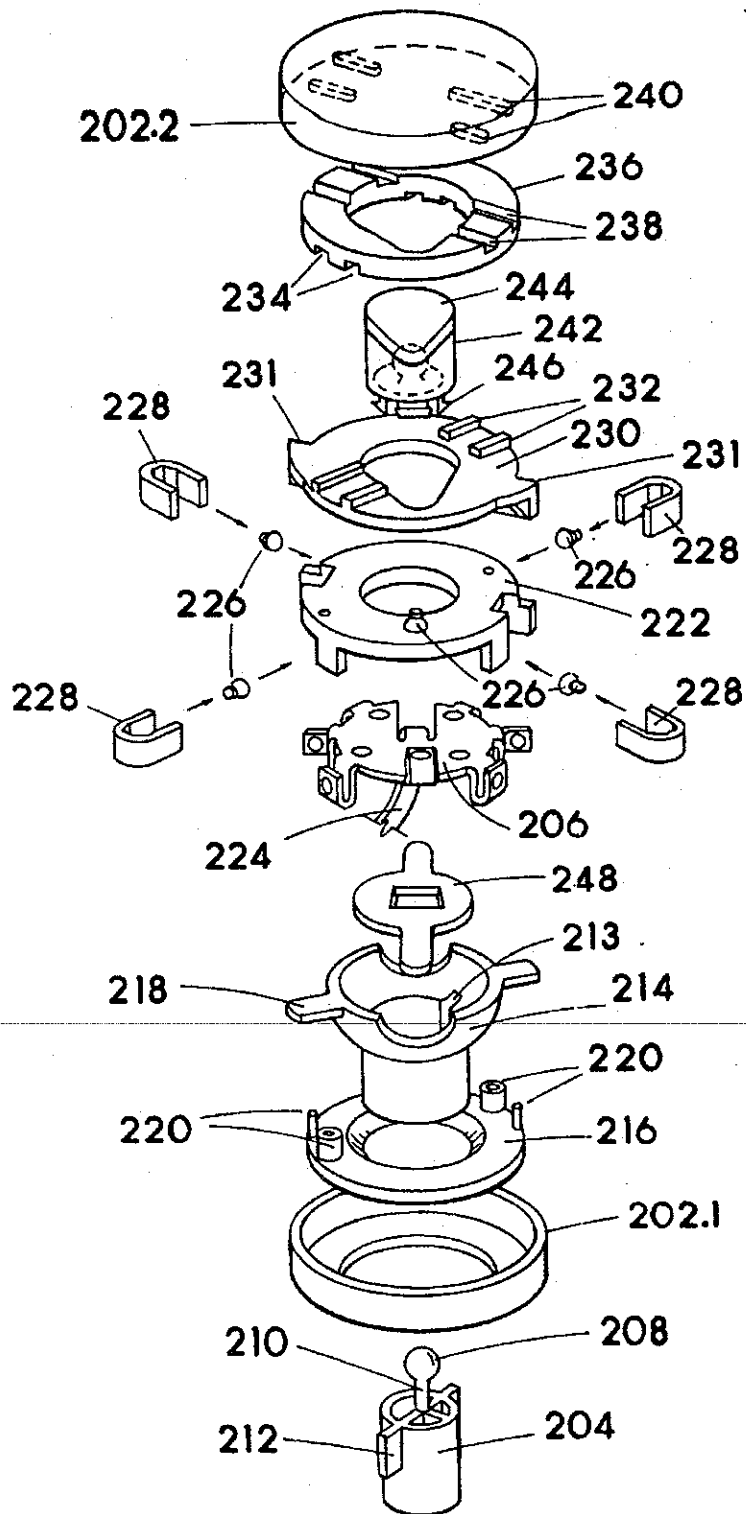


FIG. 13

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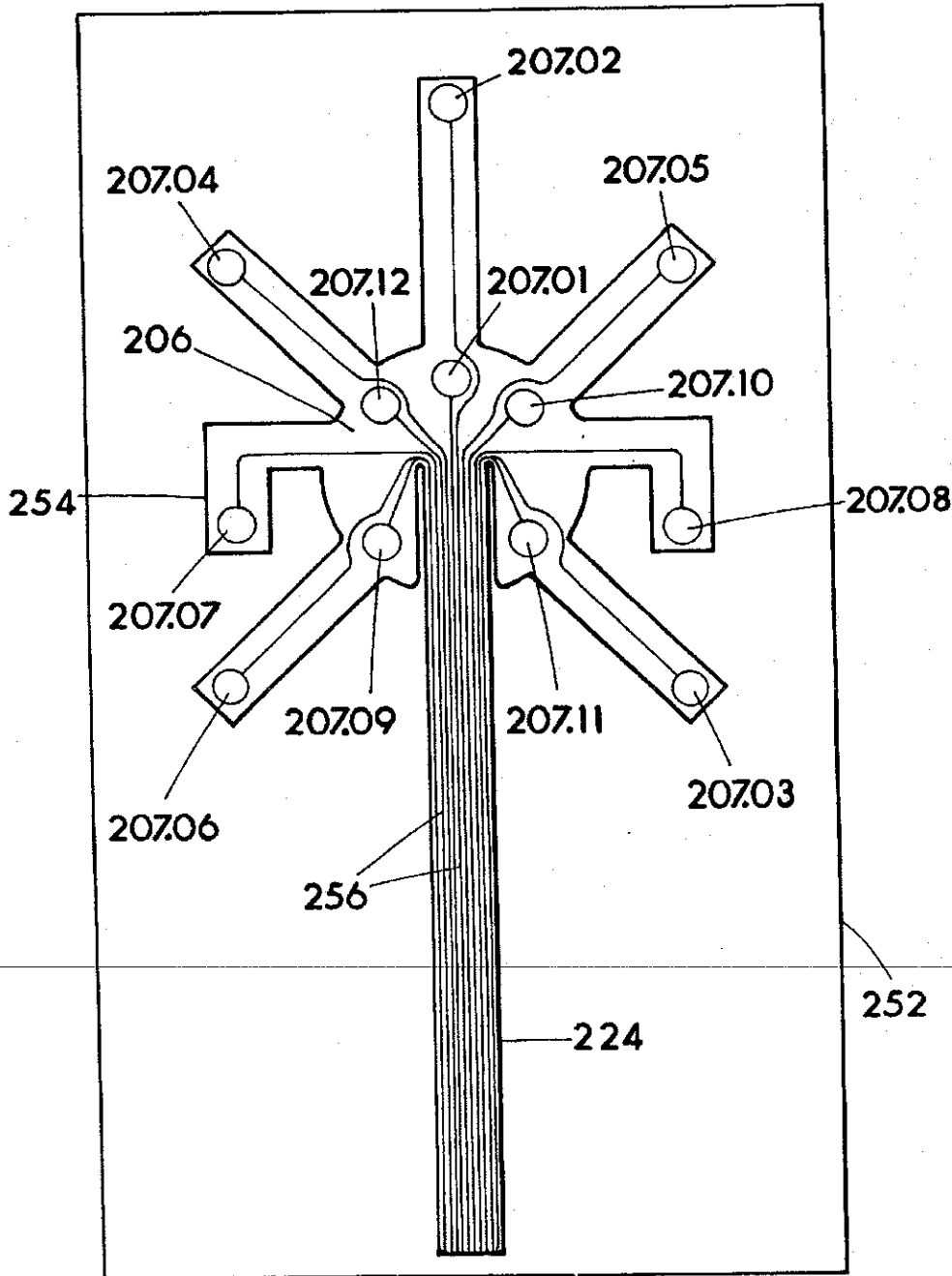


FIG. 14

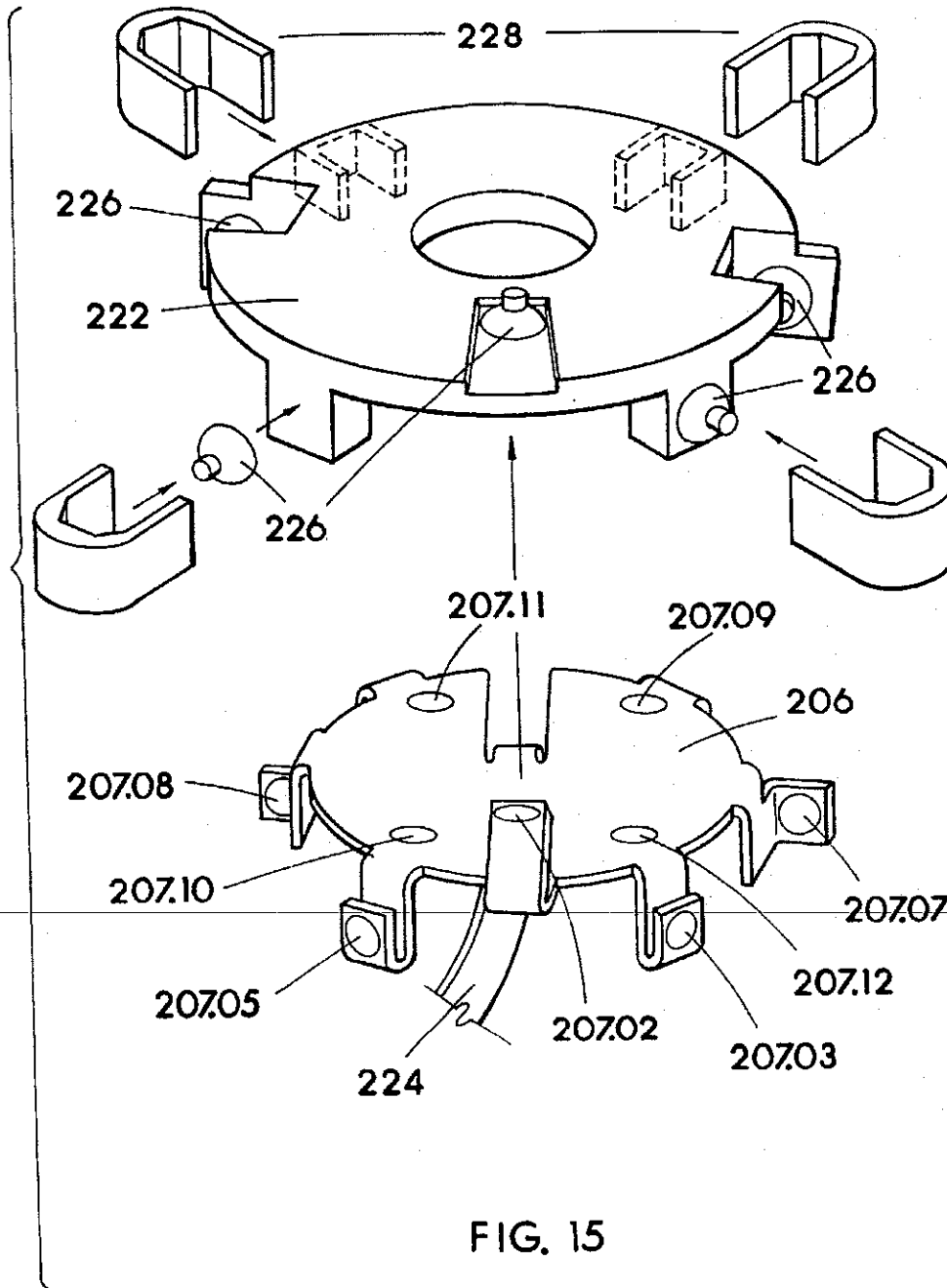


FIG. 15

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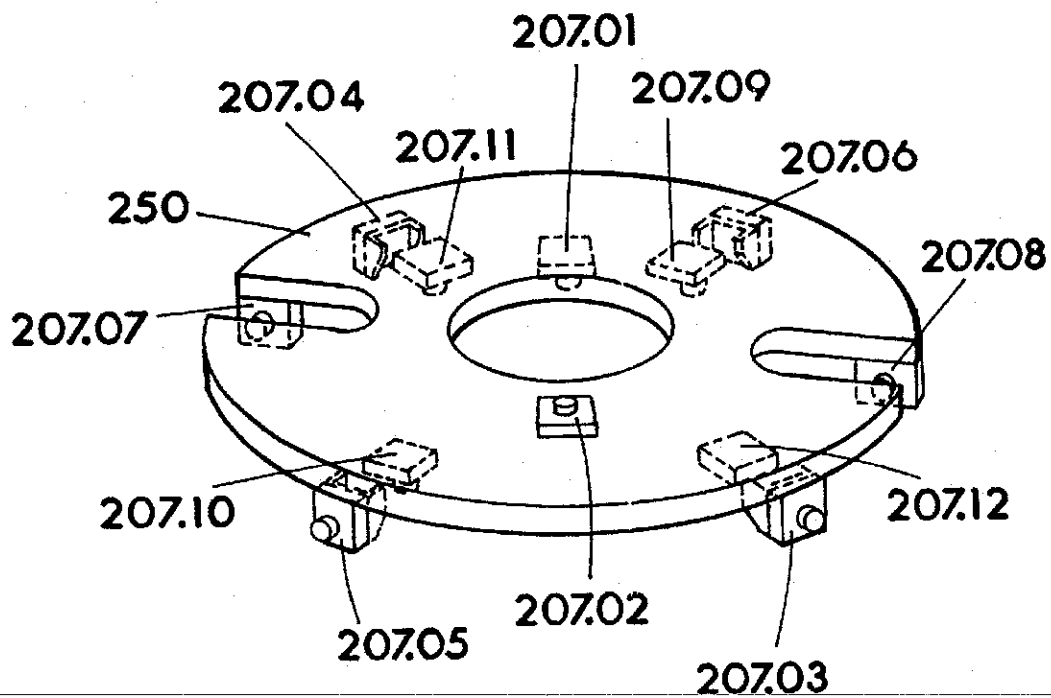


FIG. 16

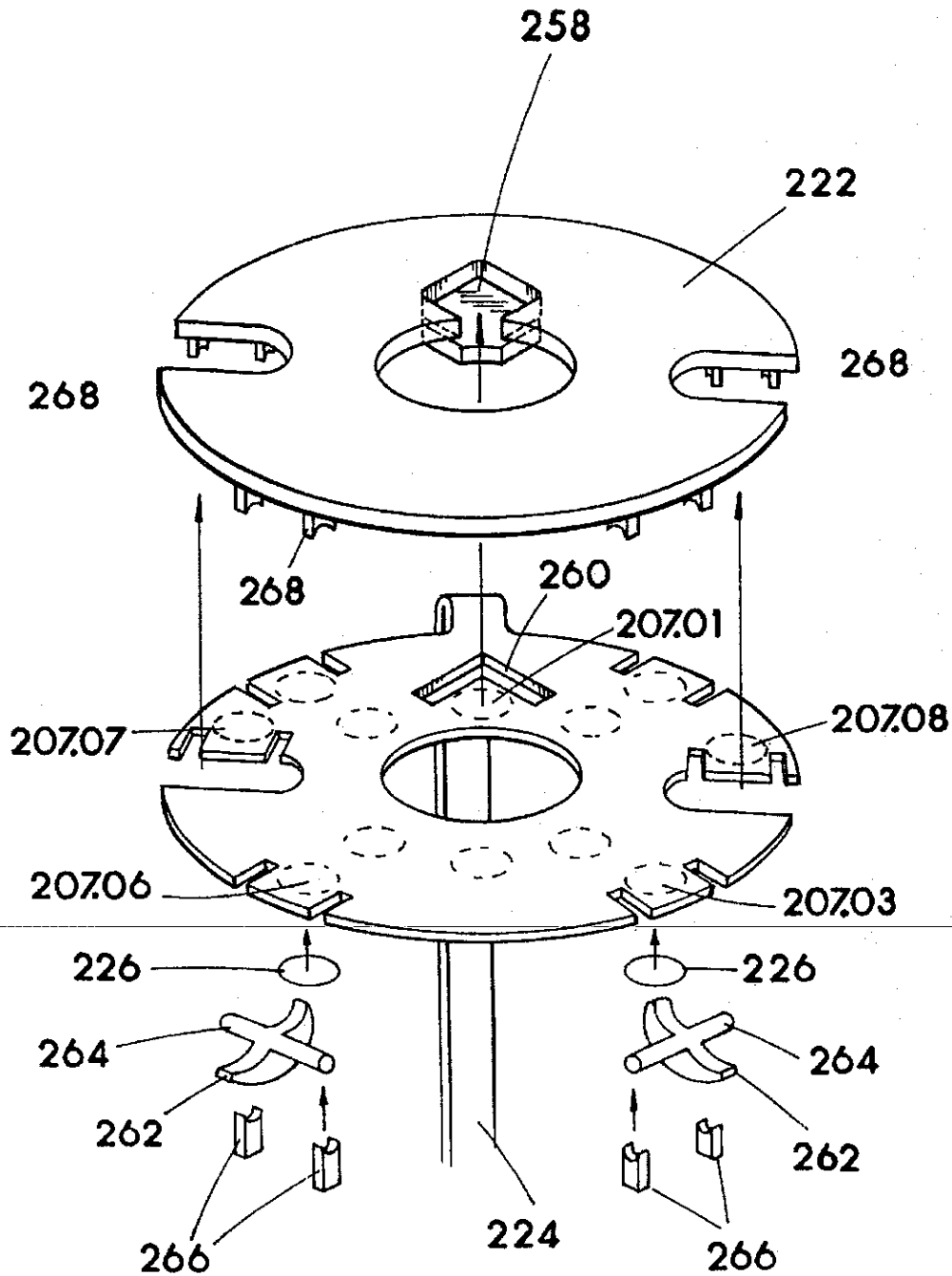


FIG. 17

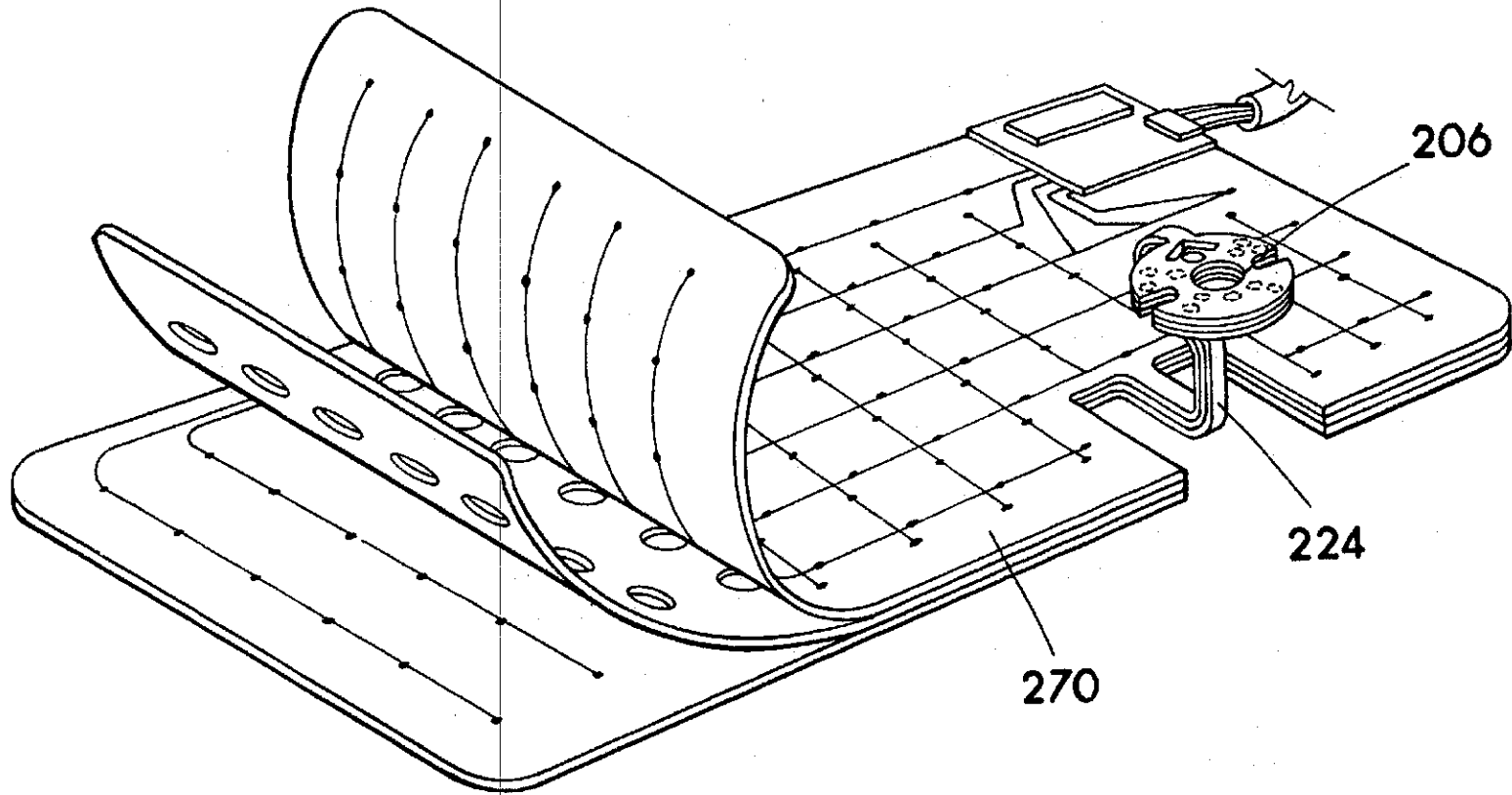


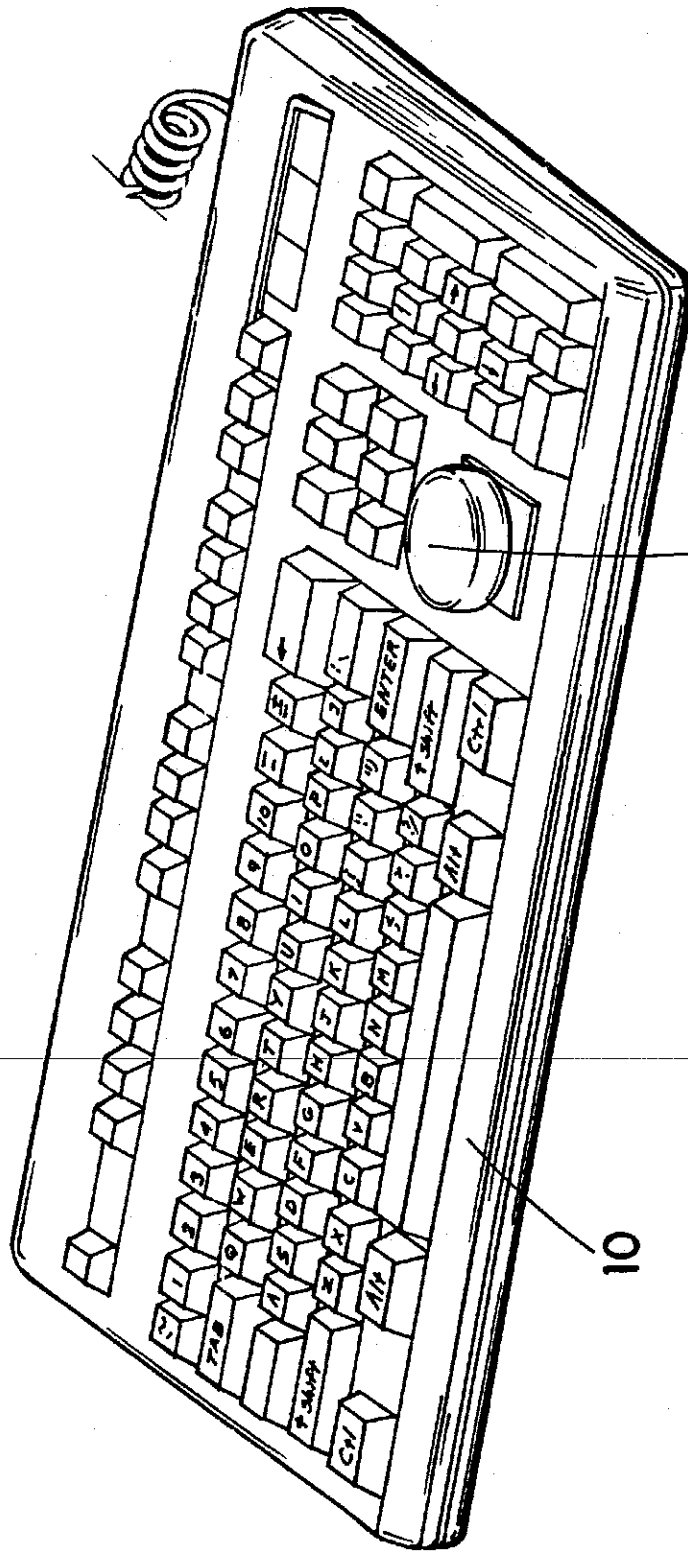
FIG. 18

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FIG. 19

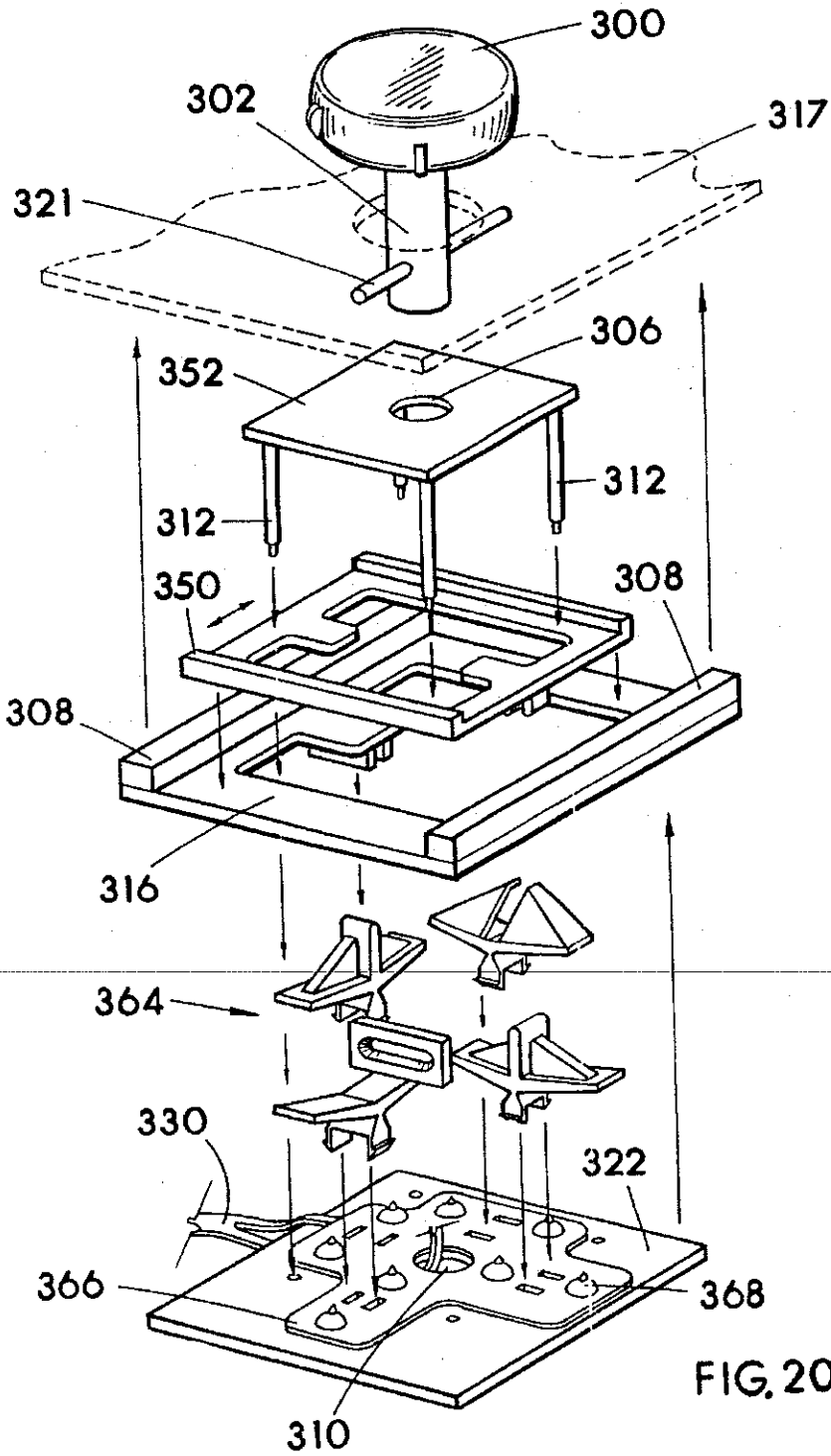


FIG. 20

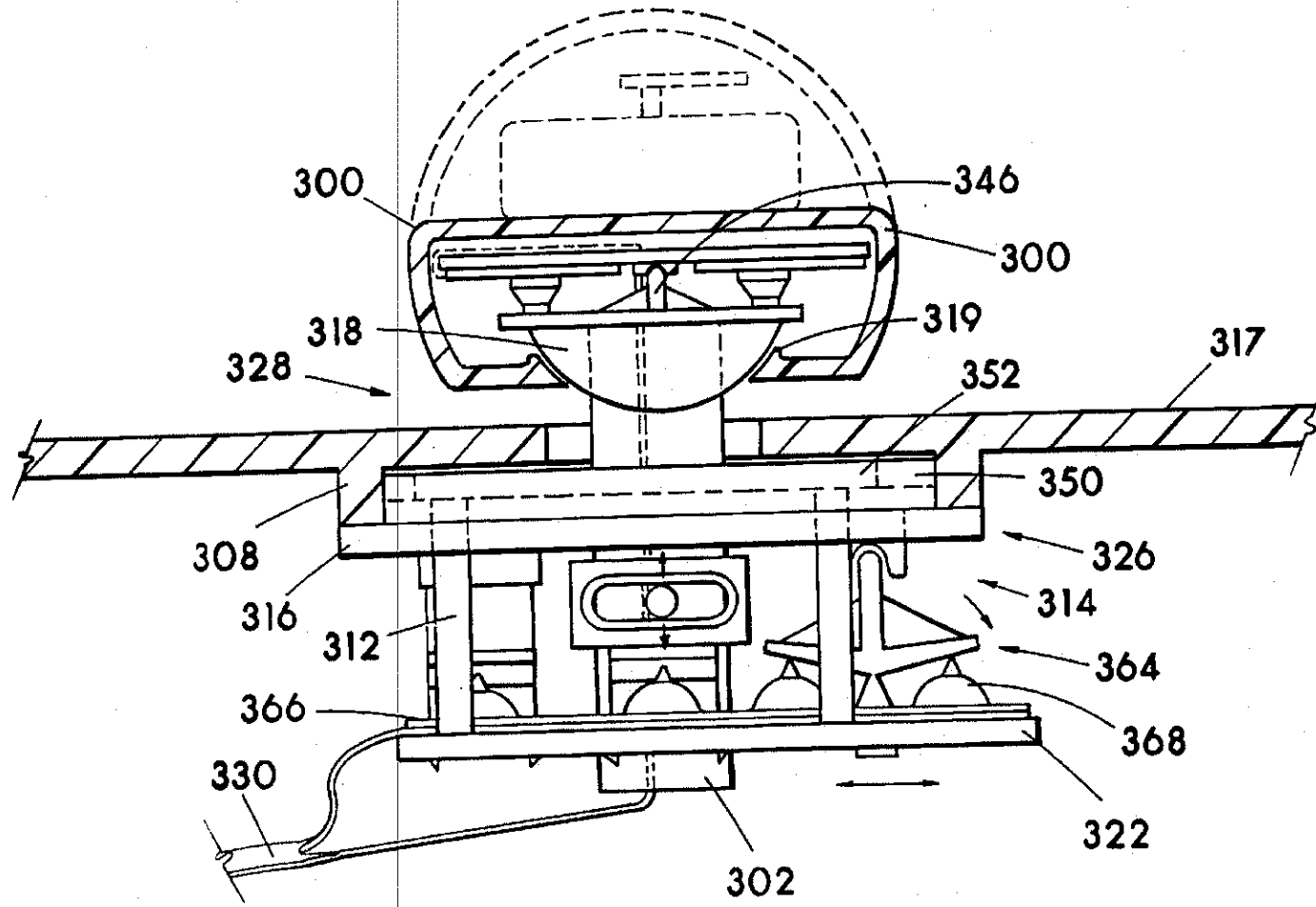


FIG. 21

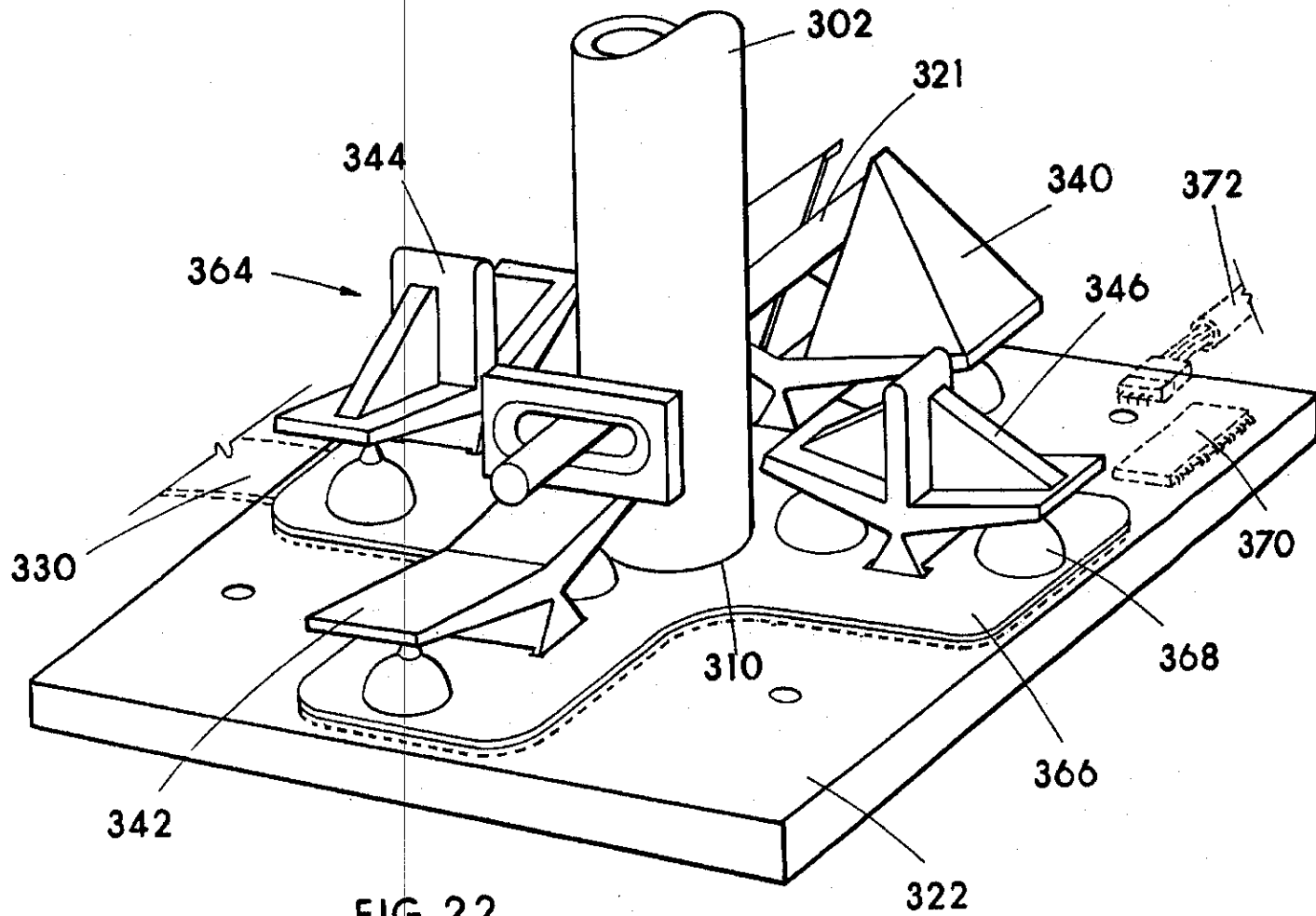


FIG. 22

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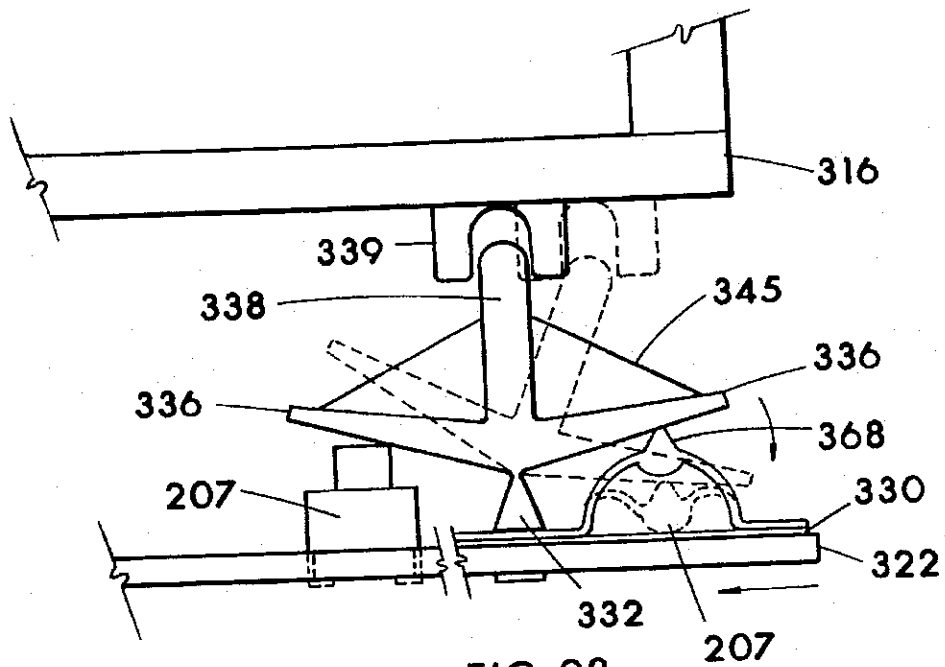


FIG. 23

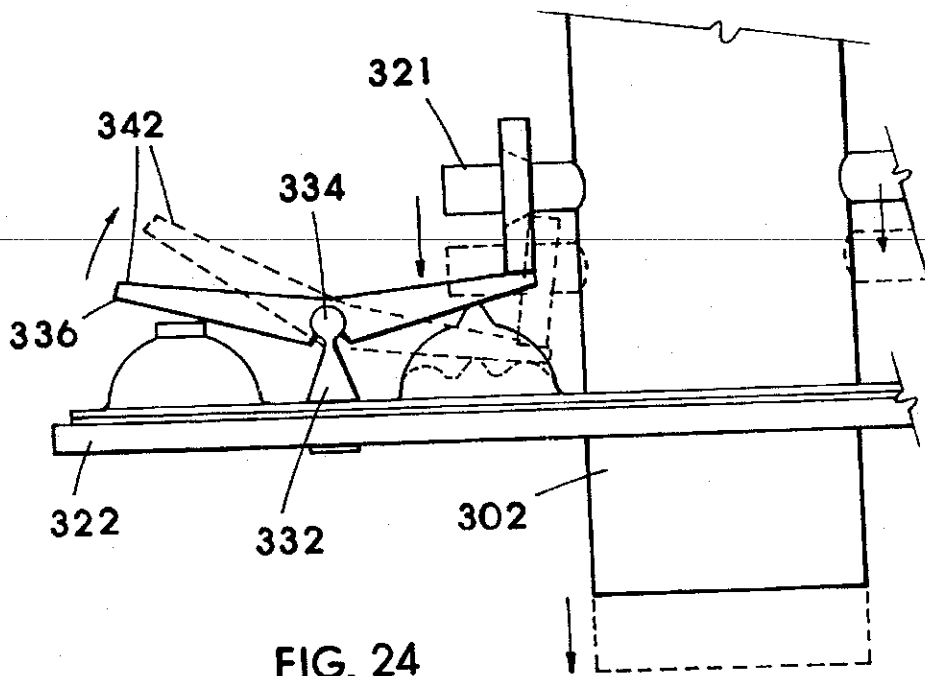


FIG. 24

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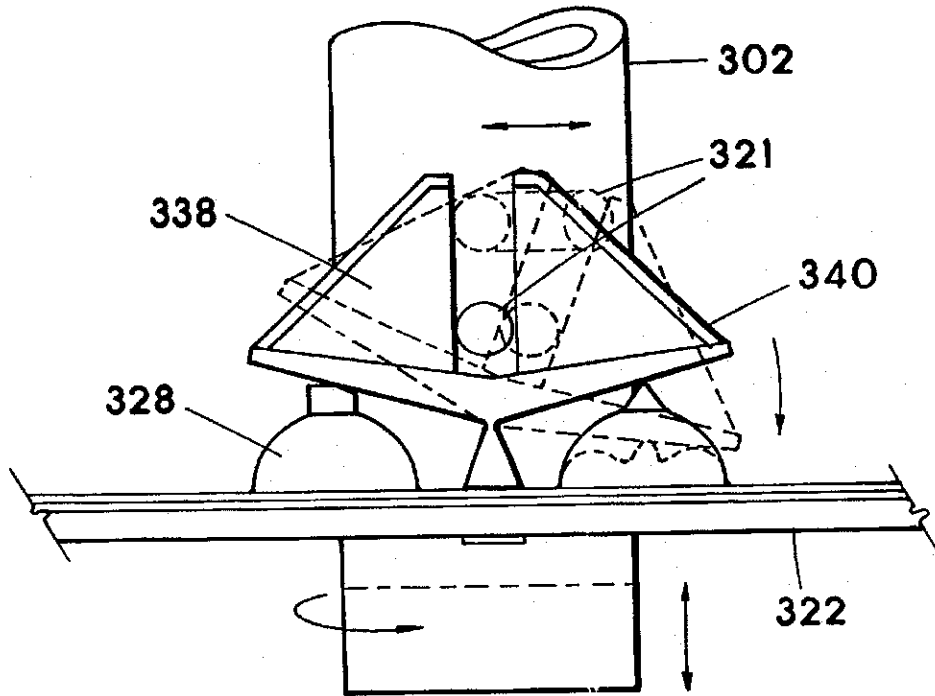


FIG. 25

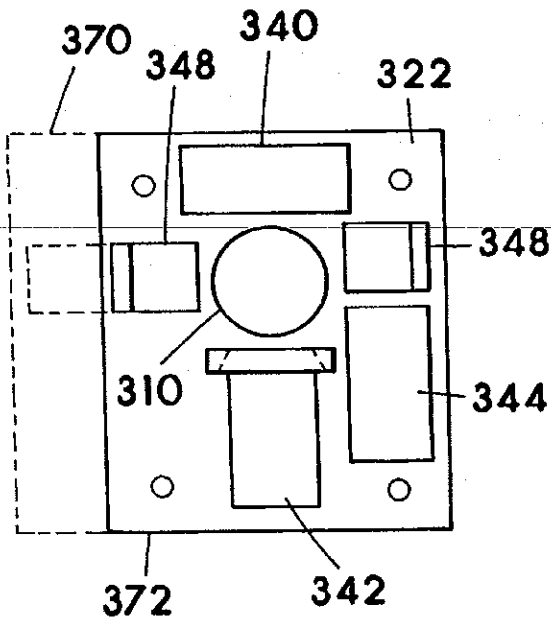


FIG. 26

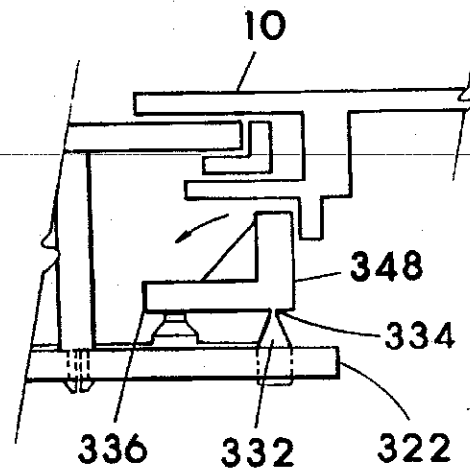


FIG. 27

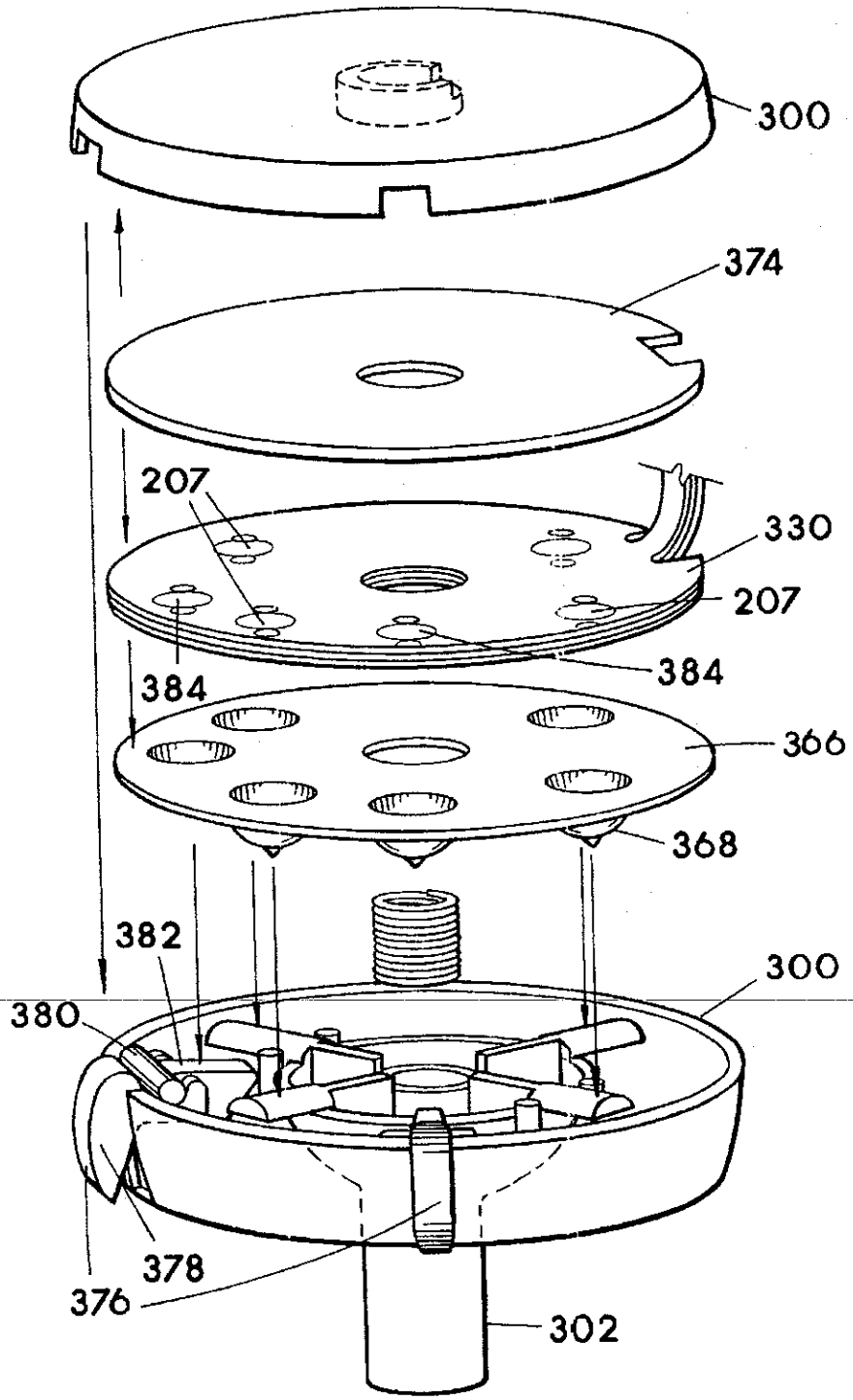


FIG. 28

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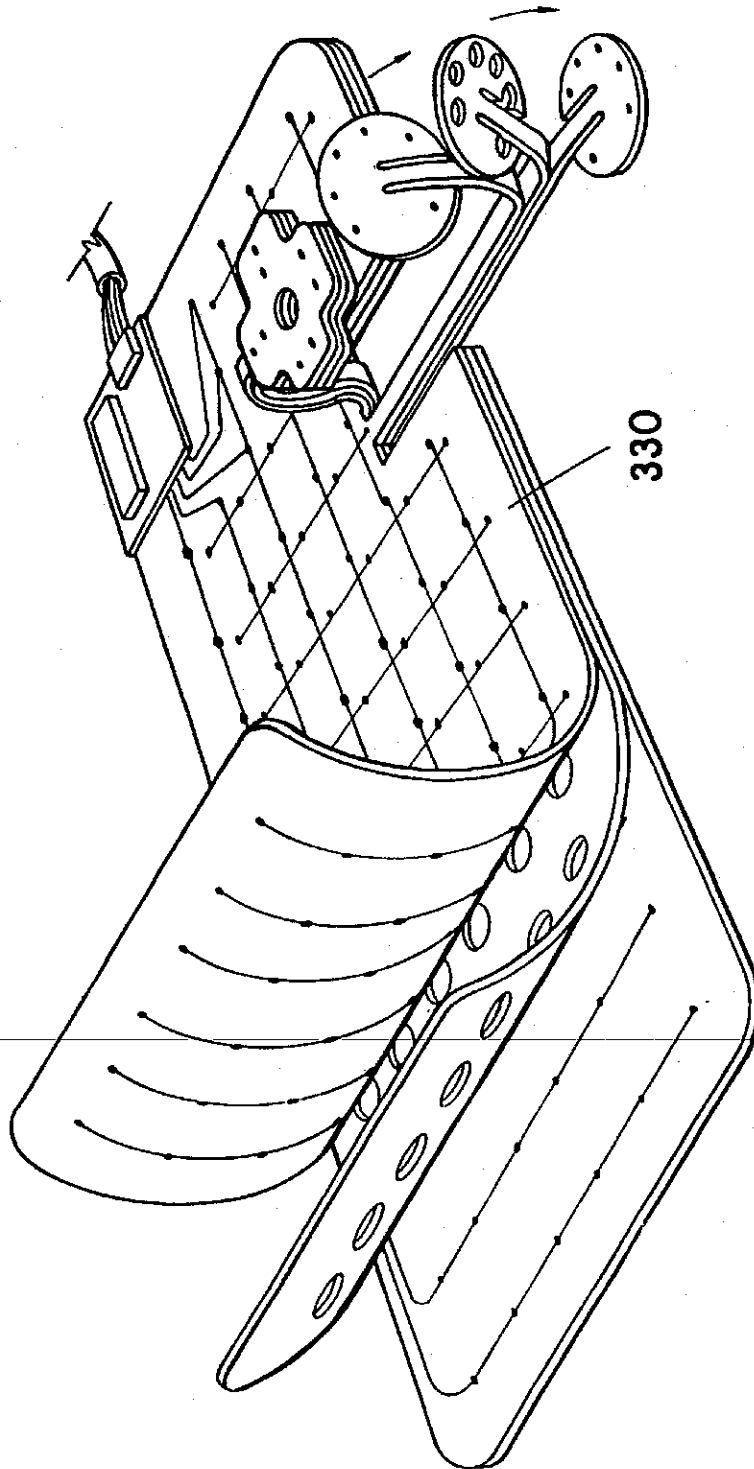


FIG. 29

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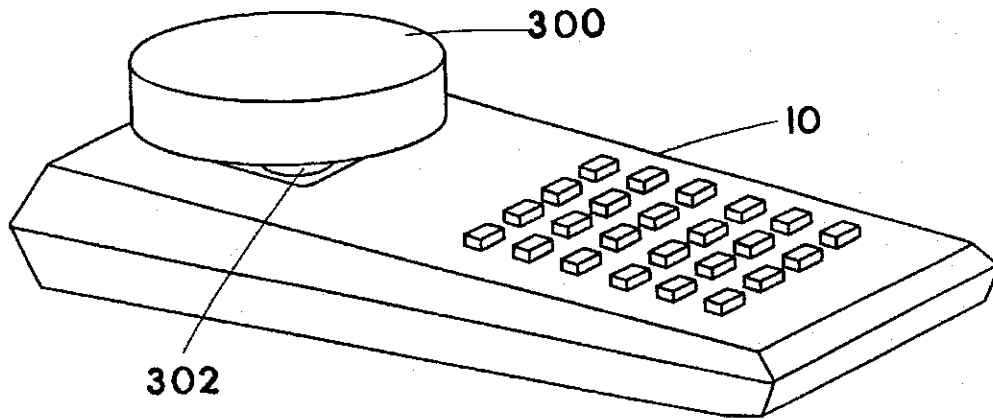


FIG. 30

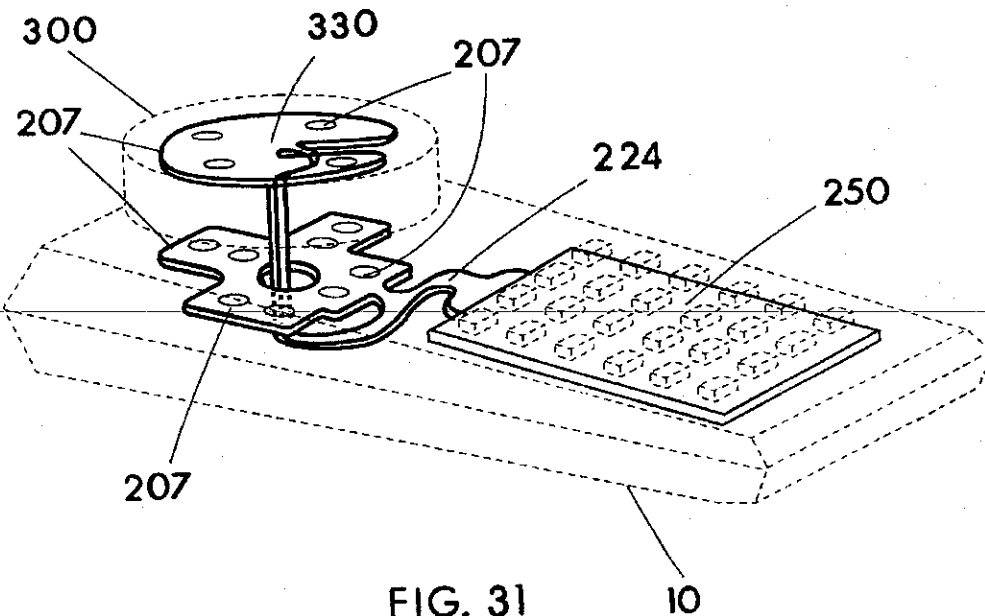


FIG. 31

