960,879

PATENT SPECIFICATION 960,879

DRAWINGS ATTACHED.

Date of Application and filing Complete Specification :
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Application made in Germany (No. V17447 VIIIb/21d¹) on Oct. 22, 1959.
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Index at Acceptance :—**H2** A(1C7B, 1C7D, 1C8, 8C, 16A, 16B, 16L, 16U, 16X).
International Classification :—H 02 k.

COMPLETE SPECIFICATION.

Improvements in or relating to Electric Motors.

I, ERNST VOELK, of 5-11 Dammstrasse, Nürnberg, Germany, a German Citizen, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electric motors and is intended to provide improved electric motors which may be economically manufactured.

According to the invention an electric motor comprising a stator and a rotor is characterised by the rotor comprising at least one permanent magnet wheel, the stator comprising stator windings and at least one carried body with a tubular main part and at least one disc-like flange of a diameter exceeding the diameter of the rotor and having *n* locating means (for example slots or incisions) at a spacing of 360°/n for locating *n* pole plates or pole plate packs, the pole plates or pole plate packs being mounted on the carrier body or bodies and each having a portion extending adjacent to the periphery of a magnet wheel and a portion within one of the stator windings, and the latter being beside the magnet wheel or wheels.

Further and optional features of the invention appear from the following description and are set forth in the appended claims.

The invention is illustrated by way of example in the accompanying drawings, in which:—

Figures 1 to 7 illustrate a first form of embodiment of an electric motor constructed in accordance with the invention;

Figure 1 being a central section through the assembled motor, only the end covers and the cylindrical sleeve being omitted;

Figures 2 and 3 showing a carrier body in side view and end elevation respectively;

Figures 4 and 5 representing a pack of pole plates in side view and end elevation respectively; and

Figures 6 and 7 showing a coil body in side view and end elevation respectively;

Figures 8 to 16 represent a second form of embodiment of an electric motor constructed in accordance with the invention;

Figures 8 and 9 showing the entire motor in central section and end elevation respectively (the end closing cover being omitted);

Figures 10 and 11 representing the carrier body in section and end elevation respectively;

Figure 12 being a side view of a pole plate;

Figure 13 an end elevation of a coil body;

Figures 14 and 15 representing a pole shoe in side view and end elevation respectively; and

Figure 16 being a view of an end cover.

Figures 17 and 18 show, in elevation, two further modified forms of embodiment of a carrier body for an electric motor constructed in accordance with the invention.

In the case of the example of embodiment of a motor constructed in accordance with the invention, as illustrated in Figures 1 to 7, the rotor comprises two magnet wheels 1 and 1^{11} and a stator winding 7 arranged between these two. The stator windings 7 and the laminated pole plate packs 21 of the stator are retained by a carrier body 17, which is pushed with its tubular central part 18 over the shaft 4. At both ends of each carrier body 17 there are flanges 19 with six radial incisions 20 in each. Each of the pole plate packs 21 is surrounded in its middle part 22 by a coil, and cranked outwards at its two ends at 23, the cranked portions being received by the incisions 20. The coil body 24 pushed over

[*Price* 4*s.* 6*d.*]

the middle part 22 of each pole plate pack 21 is provided at 25 (Figure 7) with a lateral slot, which is somewhat narrower than the radial thickness of the middle part 22 of the pole plate pack 21. Each coil body 24 is provided with two end flanges 26, which are also laterally slotted and are in segment form as shown in Figure 7. The coil bodies 24 are pushed on to the pole plate packs 21, the slots 25 springing apart and returning to their original position again after complete passage of the pole plate pack. Then the stator windings 7 are wound over these coil bodies 24.

The individual parts can be held together by sleeve-shaped half-shells (not shown) which have end covers and which are pushed on, or by a cylindrical sleeve consisting of a single piece, which is pushed on axially after assembling the motor and which is closed at the ends by two covers.

The force lines of the magnetic field issue radially from the peripheries of the magnet wheels, and the magnetic flux path closed by the pole plate packs 21.

Obviously it is possible to provide three or more magnet wheels instead of only two, when the pole plate packs must be cranked correspondingly often to provide an additional stator part for each additional magnet wheel. The use of laminated pole plates is not absolutely necessary in every case.

The form of embodiment according to Figures 8 to 16 differs from that according to Figures 1 to 7 in that only one single magnet wheel 1 is provided, but with stator windings 7 at both ends. One may conceive this form of embodiment as derived from the first embodiment if one of the two magnet wheels is omitted and at the opposite end of the remaining magnet wheel a further stator winding is arranged. This idea admittedly necessitates a somewhat different construction, and also a provision for the correct closing of the magnetic flux path.

In this second form of embodiment only one single magnet wheel 1 is mounted on the shaft 4, namely in the middle thereof, and it is further assumed that this magnet wheel 1 has three North and three South poles on its periphery. After pushing on and securing the magnet wheel 1 on the shaft 4, a carrier body 17 is pushed over each of the two shaft ends, this body here however having only one single flange 19, namely on its end facing the magnet wheel 1. The carrier body 17 again consists of insulating material, for example synthetic thermoplastic material or synthetic resin, and can be extruded or pressed in a simple manner. The tabular part 18 of the carrier body 17 may have in cross-section an external shape as an n-sided figure, n being the number of the poles on the magnet wheel 1 and consequently being equal to the number of the coil bodies 24 mentioned further below. In the present case $n=6$.

The flange 19 again comprises $n=6$ radial incisions 20, which are arranged at intervals of $360/n=60°$ in each case. The inner end of each radial incision 20 is adjoined on the side allocated to the tubular part 18 by a recess 29 of equal width, which however extends only approximately to midway of the thickness of the flange 19. In the centre between each two radial incisions 20 there is provided on the end of the flange 19 remote from the tubular part 18 a channel-shaped recess 27, which is of the same width, and in the radial direcion approximately of the same length, as the recesses 29. Each of these recesses 27 is adjoined by a slot 28 of equal width, extending through the entire width of the flange 19. In place of pole plates assembled from plate packs, in the present form of embodiment there are used pole plates 21 consisting of soft iron rods of suitably selected permeability, with rectangular cross-section. They are cranked twice, so that their end portions, further remote from the shaft 4, are arranged in cage fashion around the magnet wheel 1, while on their other portions they carry the stator windings 7. The stator windings 7 are again wound on coil bodies 24 with end flanges 26. In contrast with the first embodiment however here the coil bodies 24 and flanges 26 are not slotted, since they can be pushed on to the pole plates 21 in the axial direction. For closing the magnetic flux path on the outer ends of the carrier bodies 17 here a pole yoke 30 is necessary for each pole pair, this yoke being illustrated in Figures 14 and 15.

In assembling the electric motor according to this embodiment the pole plates 21 are pushed through the slots 28 and grasp the opposite flange 19, lying in the radial incisions 20 thereof, with their cranked ends, while with their angled middle pieces they lie in the channel-shaped recesses 27 and through the slots 28. The two carrier bodies 17 thus are fixed in their mutual spacing, after insertion of the pole plates 21. The cranked ends of the pole plates 21 are arranged around the magnet wheel 1 in cage fashion. The pole plates 21 are here offset, on one side of the magnet wheel 1, by 30° in relation to those on the other side. On to the freely projecting ends of the pole plates 21 there are now fitted the coil bodies 24, with the attached stator windings 7. Into the opening of each coil body 24 there also fits one arm of a pole yoke 30, which consists of soft iron. It is pushed with another arm into the opening of a coil body 24 of an opposite polarity.

The coil bodies 24 now are seated on the carrier body 17. Since they also contact

the flange 19 at the front, after the application of the coil bodies 24 and pushing in of the pole yokes 30, a firm combination is produced, thus the coil bodies 24 are fixed on both sides and form a uniform entity with the coils. The opening in each coil body 24 must here be of such dimensions that the freely projecting part of the pole plate 21 and the arm of the pole yoke 30 pertaining thereto fill this opening, sitting closely.

Obviously the coil windings must be connected with one another according to the predetermined circuit plan, the arrangement of the individual parts in relation to one another is determined in accordance with the winding pitch, in a manner known *per se*.

A cylindrical sleeve 8 (Figure 8) is pushed over the unit thus produced, which sleeve in the present case, however, does not have to be made in the form of two half-shells as in the former forms of embodiment, but can form one single piece. End covers 9 can again be pushed on to the ends of the sleeve 8. These covers 9 can be connected with the sleeve 8 in any suitable fashion, for example by turning over the edges of the sleeve 8 as indicated in Figure 8.

The form of embodiment according to Figure 17 differs from that according to Figures 8 to 16 merely in that the two carrier bodies therein are interconnected by means of cross-pieces 31 secured to the flanges 19 to form a uniform entity. The production of such a shaped body is not difficult, but it must be cut along a radial plane, namely both for reasons of production and also in order that it may be placed around the magnet wheel and the shaft, so that it forms two half-shells. Here the sleeve 8 can be cast or pressed on at the same time. The holding together of the two half-shells can be effected by rings or bands, but the use of end covers 9 which possess annular grooves 10 into which the edges of the sleeve 8 engage as shown in Figure 18 is especially expedient.

In Figure 17 it is shown that it is also possible to go still further, and in the production of this shaped body by pressing, extension or otherwise to secure the pole plates 21 simultaneously, according to the style of production of the shaped body by pressing or extruding the shaped body around the pole plates 21.

A further example of embodiment of such a shaped body is shown in Figure 18, and here the sleeve 8 is extruded at the same time. The two shells of the shaped body are held together by lateral covers 9, each of which possesses an annular groove 10, in which the pertinent end of the sleeve 8 engages.

Machines constructed in accordance with the invention can naturally also be constructed in a manner known *per se* as motor generators. In this case one side of the coils is wound as motor, the opposite side as generator. Machines thus wound also deliver voltages shifted in phase by 90°, and currents which, according to the nature of the phase angle on the generator side, possess defined ratios in relation to the primary phase.

The number of the pole plates provided can be increased or reduced, in a manner known *per se*. However according to known principles it must always amount to an even number. The arrangement of $2n$ pole plates as provided in the examples of embodiment according to Figures 8 to 18 has proved expedient. It increases the efficiency and the housing of an appropriate number of poles is possible without difficulty.

The motor constructed in accordance with the invention is extraordinarily simple to produce, its simple and few individual parts can be produced by mass production. The motor works very economically, for it avoids the remagnetisation losses which occur in the iron cores of the stator windings. Furtheremore by the avoidance of the remanence phenomena (mutual force influences between stator and rotor) a smooth, uniform running is achieved. The force flux of the magnet fields, achieved by the style of construction in accordance with the invention, renders it possible in a simple manner to combine a plurality of drive systems with the corresponding stator windings on one shaft into one unit, and thus to bring about a desired increase of output.

A further advantage for synchronous motors is obtained as regards starting up. Motors constructed in accordance with the invention, especially those with a plurality of magnet wheels, can be constructed in a simple manner so that starting difficulties are avoided. For this purpose it is merely necessary to rotate one magnet wheel a fraction out of its alignment with the other magnet wheels. Then as a result of the field asymmetry a torque necessarily occurs on starting up of the motor.

WHAT I CLAIM IS:—

1. An electric motor comprising a stator and a rotor, the rotor comprising at least one permanent magnet wheel, the stator comprising stator windings and at least one carrier body with a tubular main part and at least one disc-like flange of a diameter exceeding the diameter of the rotor and having n locating means (for example slots or incisions) at a spacing of $360°/n$ for locating n pole plates or pole plate packs, the pole plates or pole plate packs being mounted on the carrier body or bodies and each having a portion extending adjacent to the periphery of a magnet wheel and a portion within one of the stator windings,

and the latter being beside the magnet wheel or wheels.

2. An electric motor according to Claim 1, comprising two or more magnet wheels and having the stator windings disposed each between two magnet wheels, the pole plates or pole plate packs being cranked, coil bodies of resiliently deformable material being provided each with a lateral slot having a width somewhat less than that of a ploe plate or pole plate pack which is pushed through the said lateral slot during assembling of the motor, and the stator windings being wound on the coil bodies.

3. An electric motor according to Claim 1, the said locating means being in the form of slots to each of which at a side of a flange facing towards a magnet wheel joins a radially outwardly-extending channel-shaped incision, each flange also having in its side facing away from a magnet wheel a radially-extending recess joining a radial incision in the periphery of the flange, the pole plates being cranked, coil bodies each with a stator winding thereon being axially pushed one on to each of said pole plates, and pole yokes each having two arms and being arranged to close the magnetic flux path between two stator windings, each arm of a pole yoke being pushed into a coil body to lie in contact with one of the pole plates.

4. An electric motor according to Claim 1, comprising stator windings and a carrier body at each side of each magnet wheel, the carrier bodies being interconnected one to another by means of cross-pieces secured to the flanges of the carrier bodies and the carrier bodies consisting of two or more parts fitting together along radial planes.

5. An electric motor according to Claim 4, wherein the pole plates are secured in the carrier bodies during the production of the carrier bodies by pressing or extrusion or the like.

6. An electric motor constructed and arranged substantially as hereinbefore described with reference to and as illustrated by Figs. 1 to 7, or Figs. 8 to 16, or Fig. 17, or Fig. 18 of the accompanying drawings.

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from which copies may be obtained.

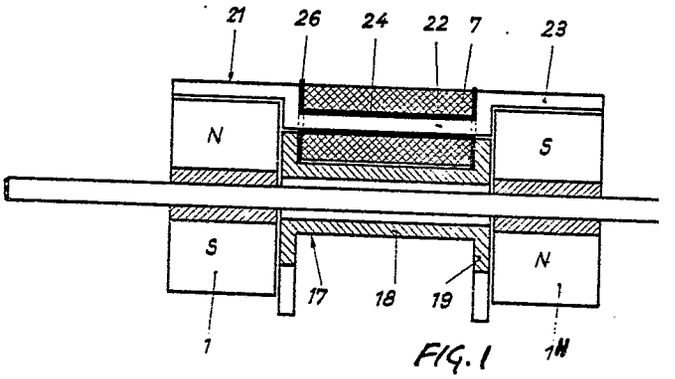

FIG. 1

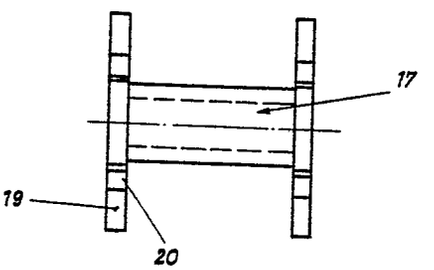

FIG. 2

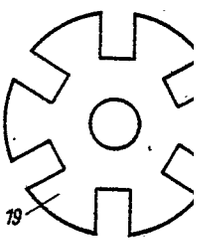

FIG.

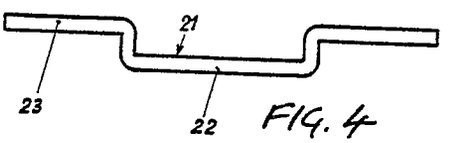

FIG. 4

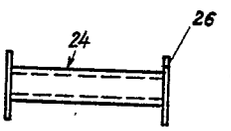

FIG. 6

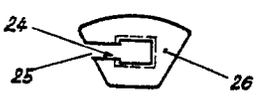

FIG. 7

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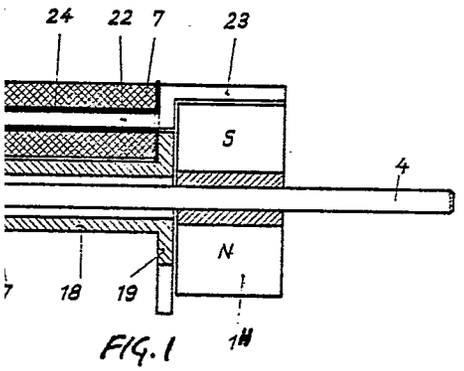

FIG. 1

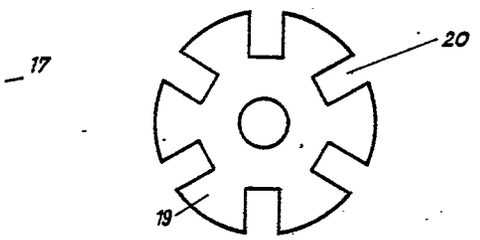

FIG. 3

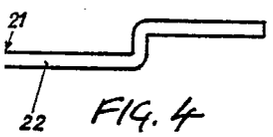

FIG. 4

FIG. 5

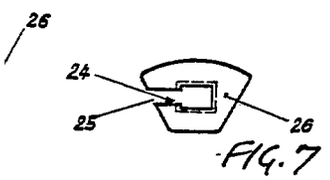

FIG. 7

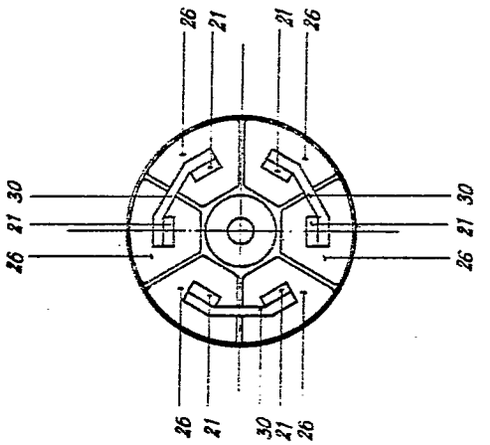

FIG. 9

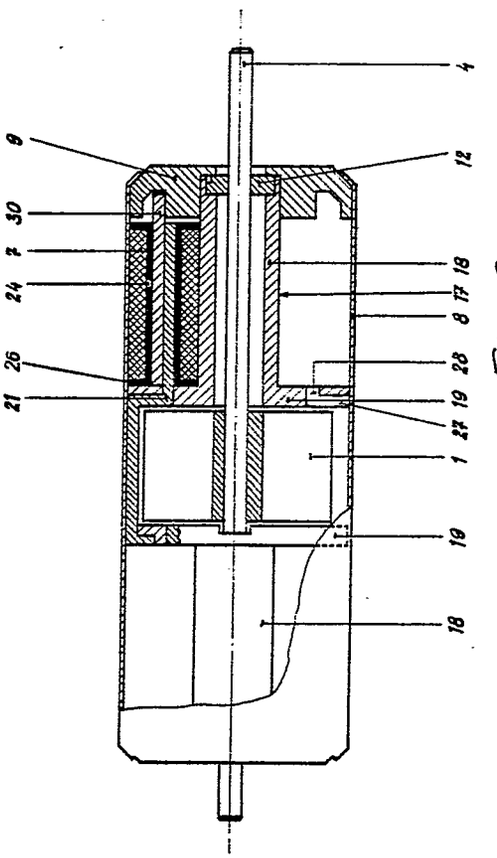

FIG. 8

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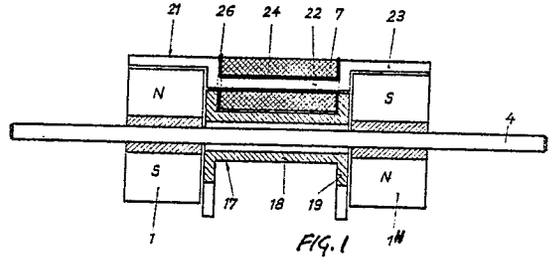

FIG. 1

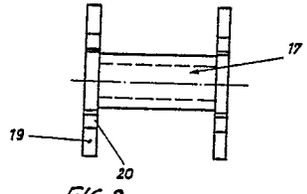

FIG. 2

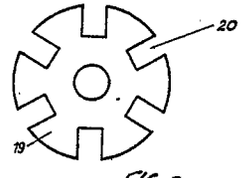

FIG. 3

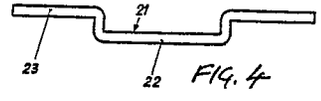

FIG. 4

FIG. 5

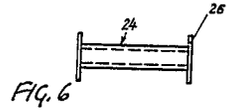

FIG. 6

FIG. 7

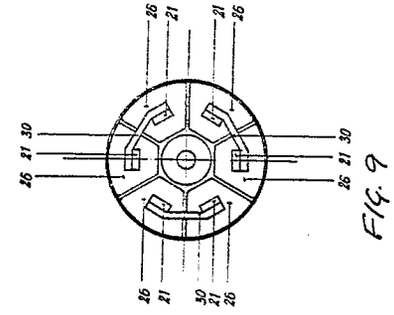

FIG. 9

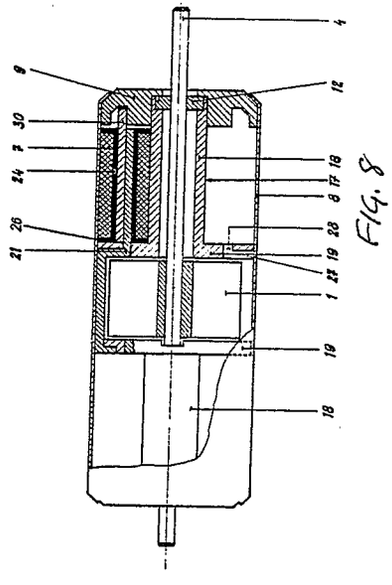

FIG. 8

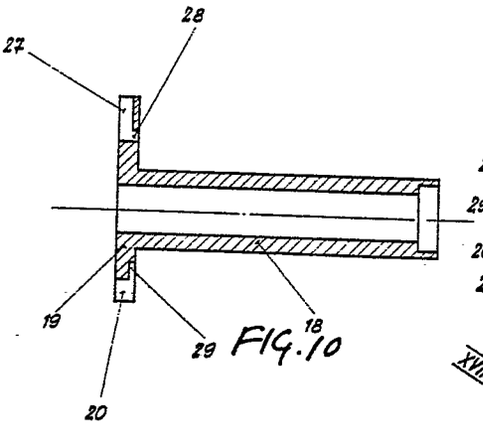

FIG. 10

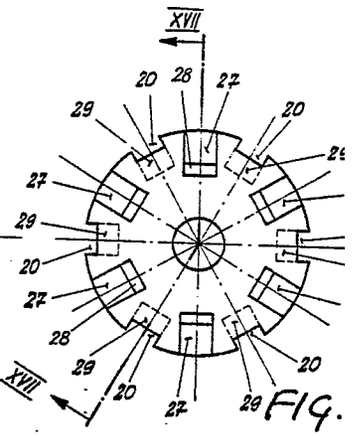

FIG.

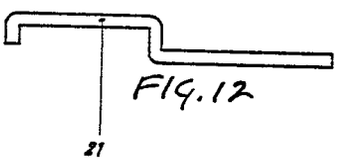

FIG. 12

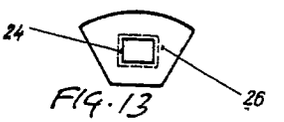

FIG. 13

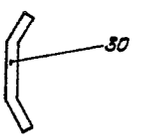

FIG. 15

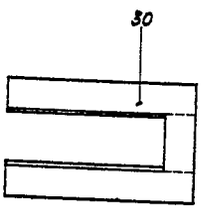

FIG. 14

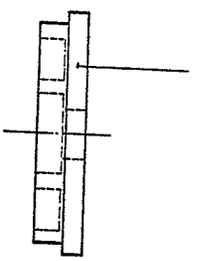

FIG. 16

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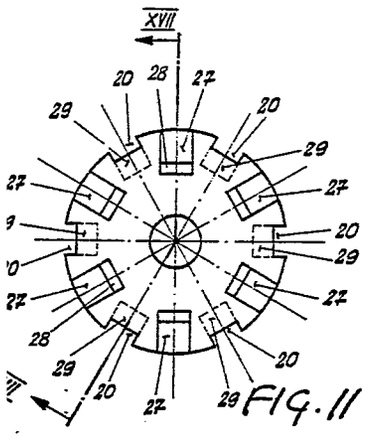

FIG. 11

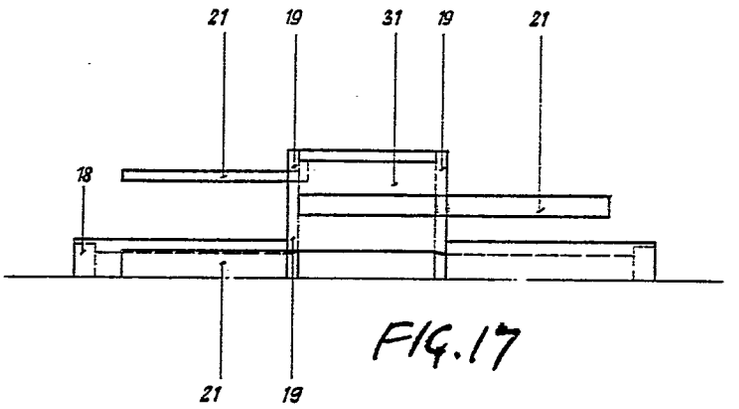

FIG. 17

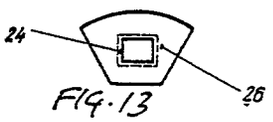

FIG. 13

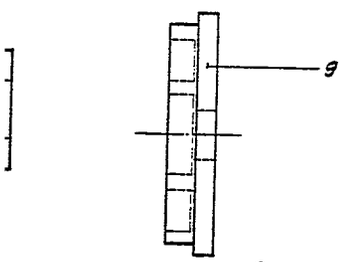

FIG. 16

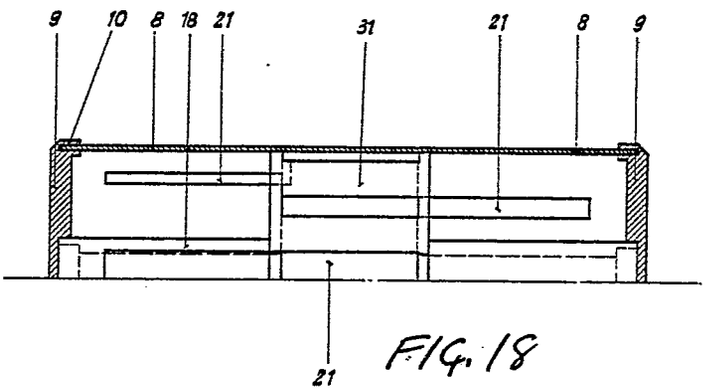

FIG. 18

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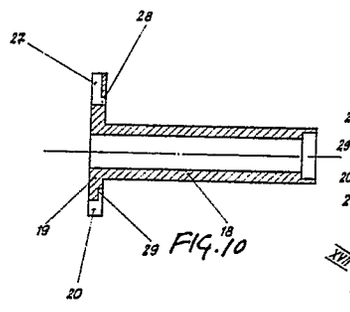

FIG. 10

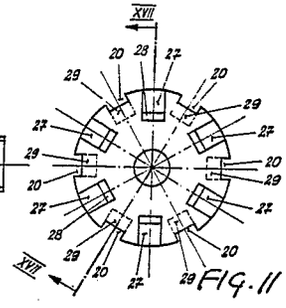

FIG. 11

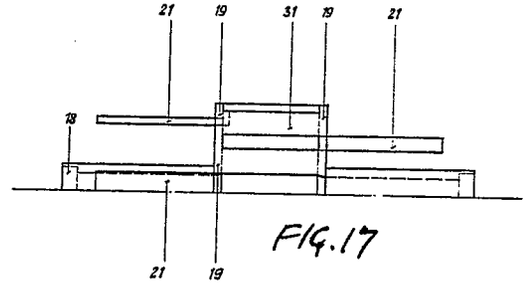

FIG. 17

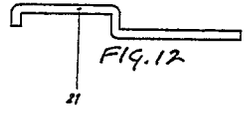

FIG. 12

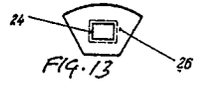

FIG. 13

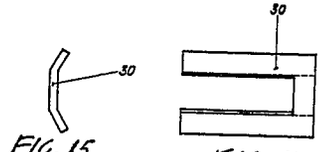

FIG. 15

FIG. 14

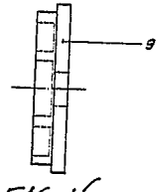

FIG. 16

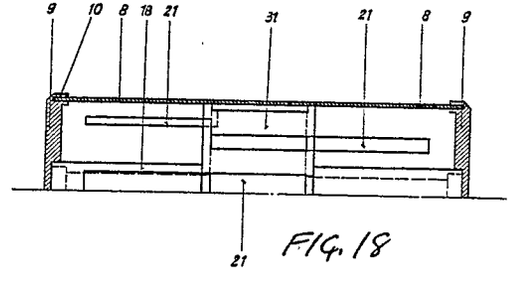

FIG. 18