Nov. 17, 1953

H. R. NILSSON ET AL

2,659,239

INDEPENDENT SYNCHRONIZATION

Filed Sept. 27, 1950

3 Sheets-Sheet 1

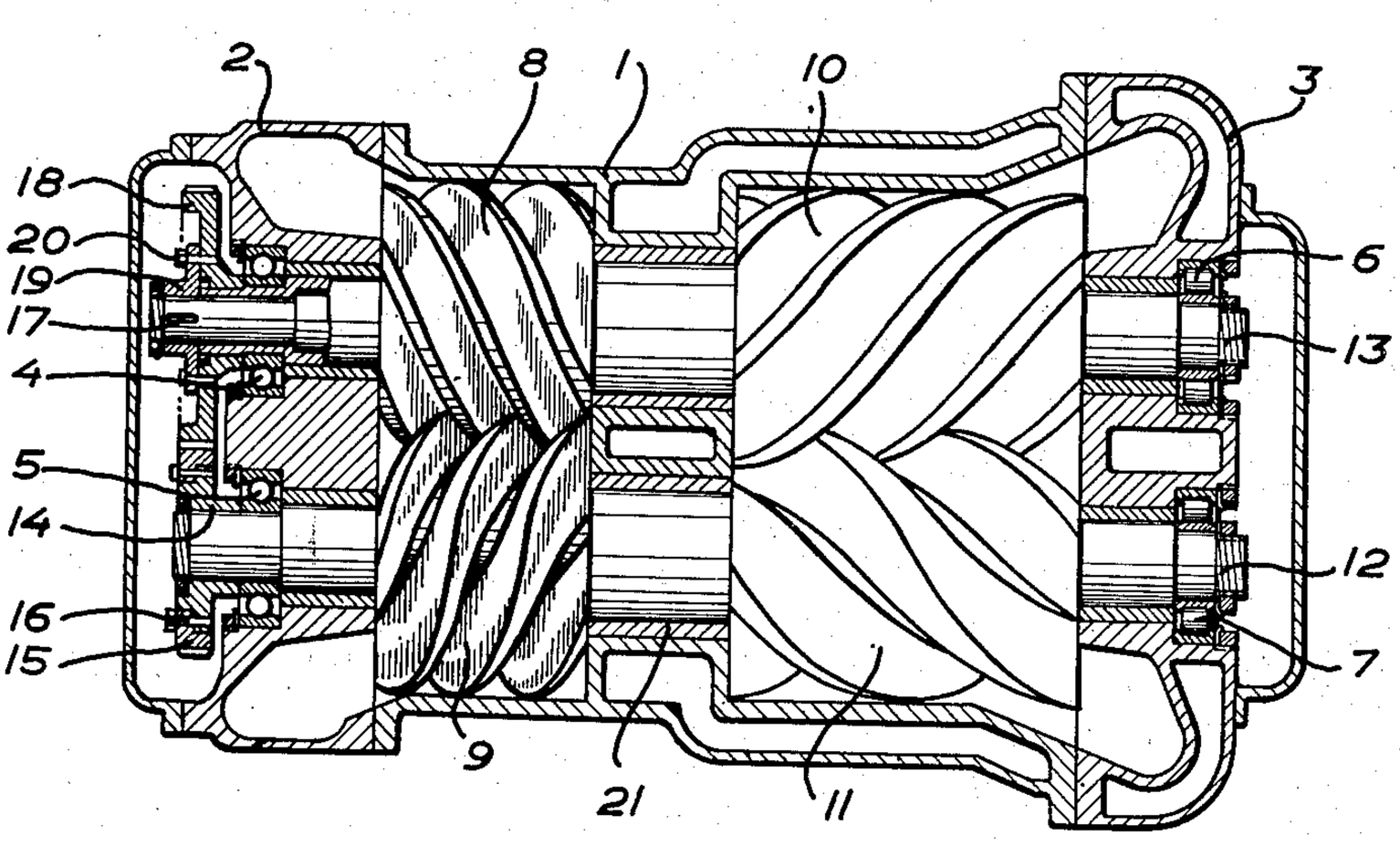

FIG. 1

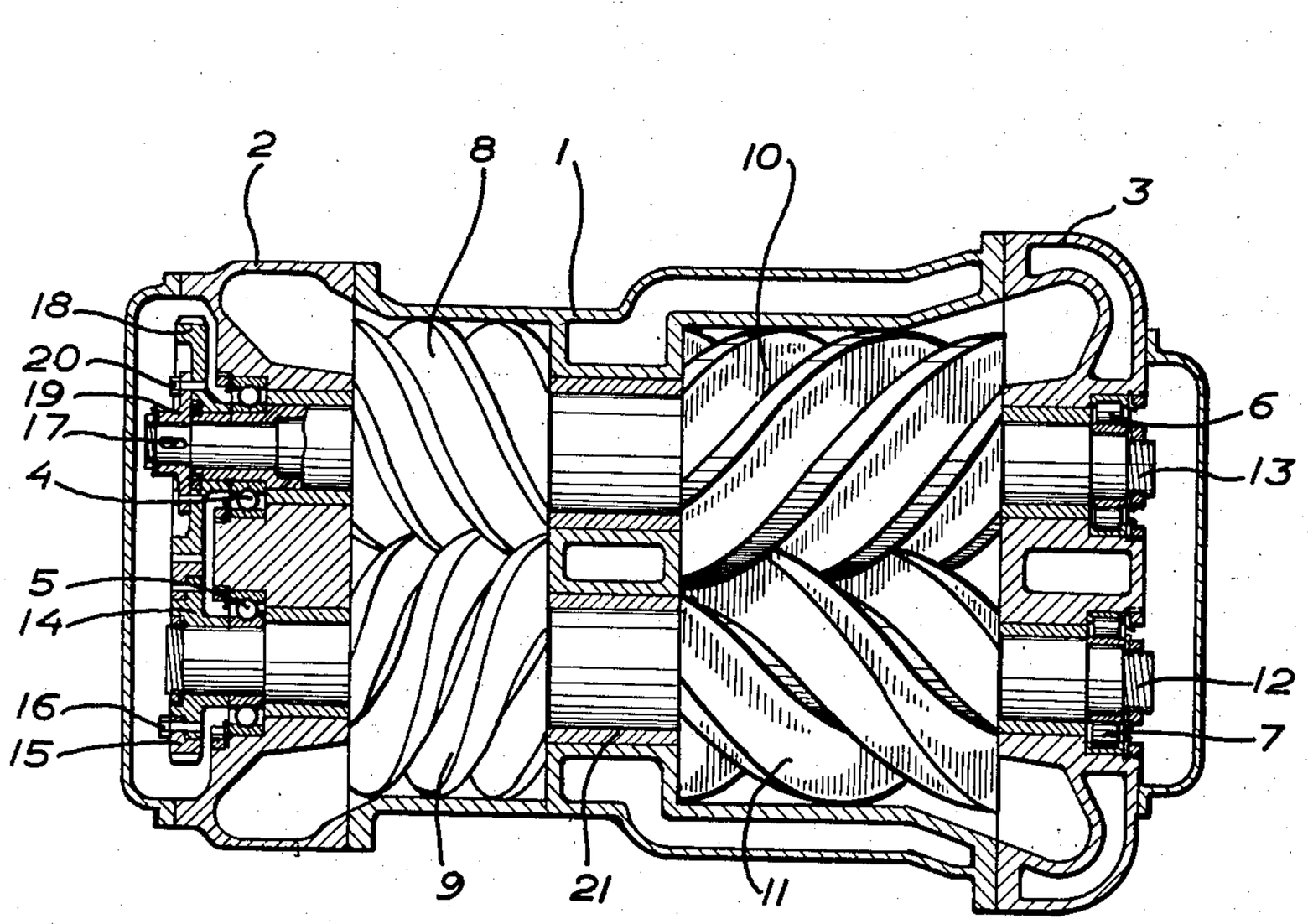

FIG. 2

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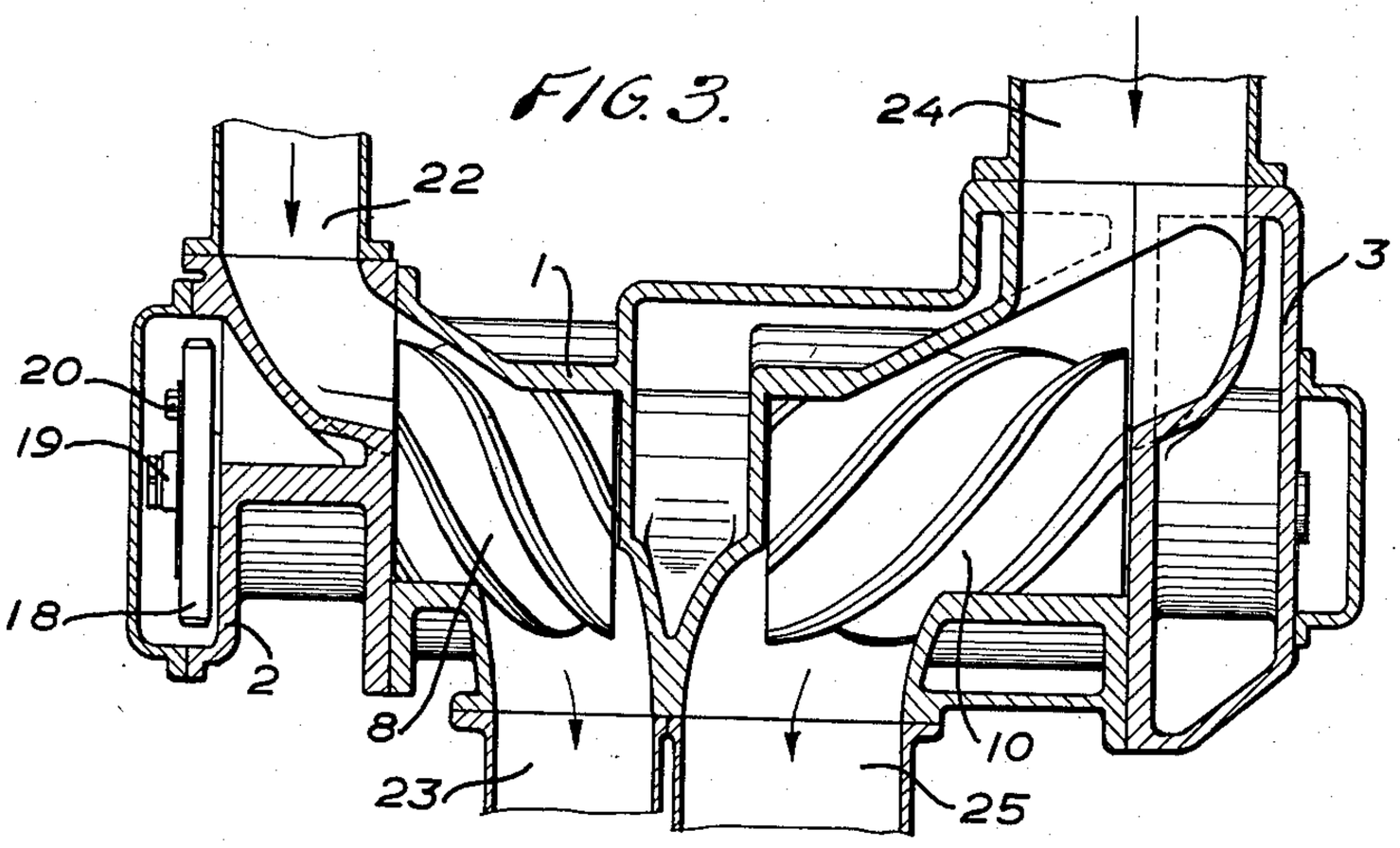
FIG. 3.



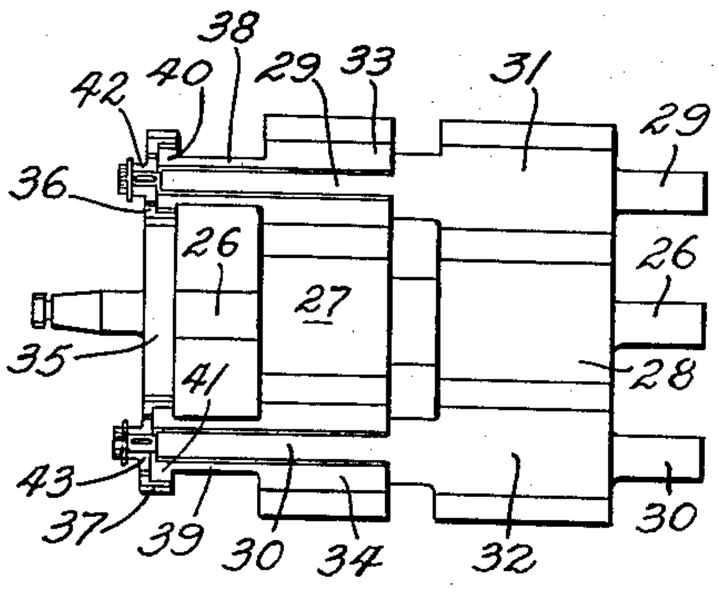
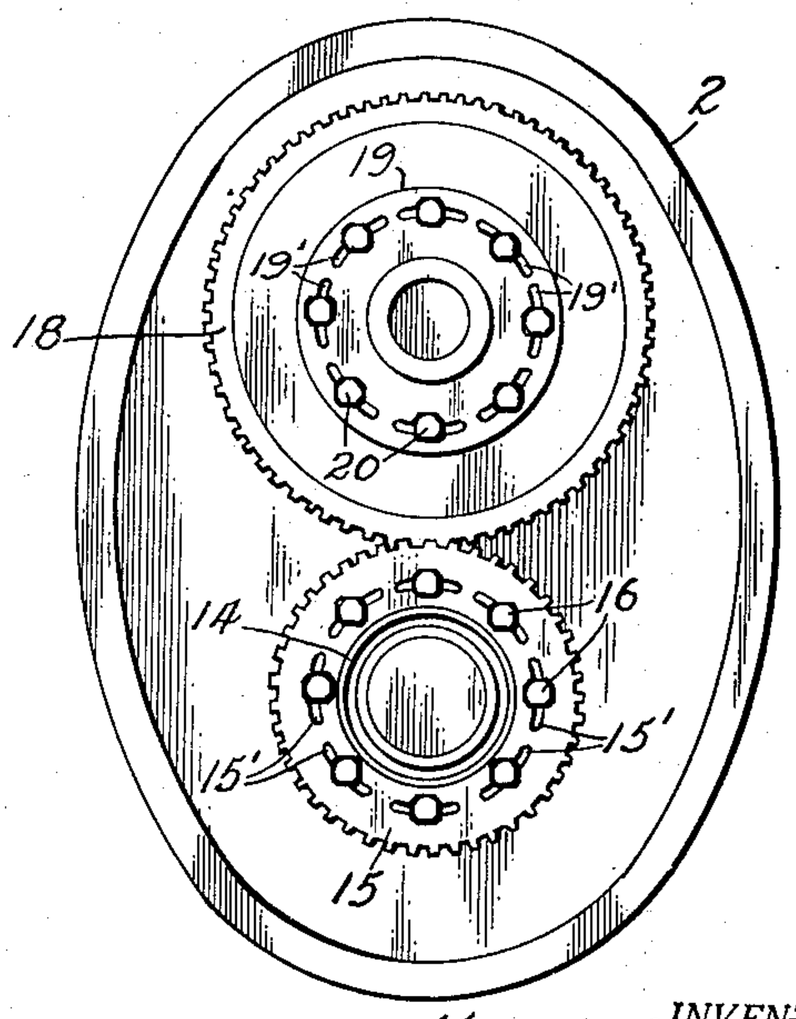


FIG. 4.

FIG. 7.



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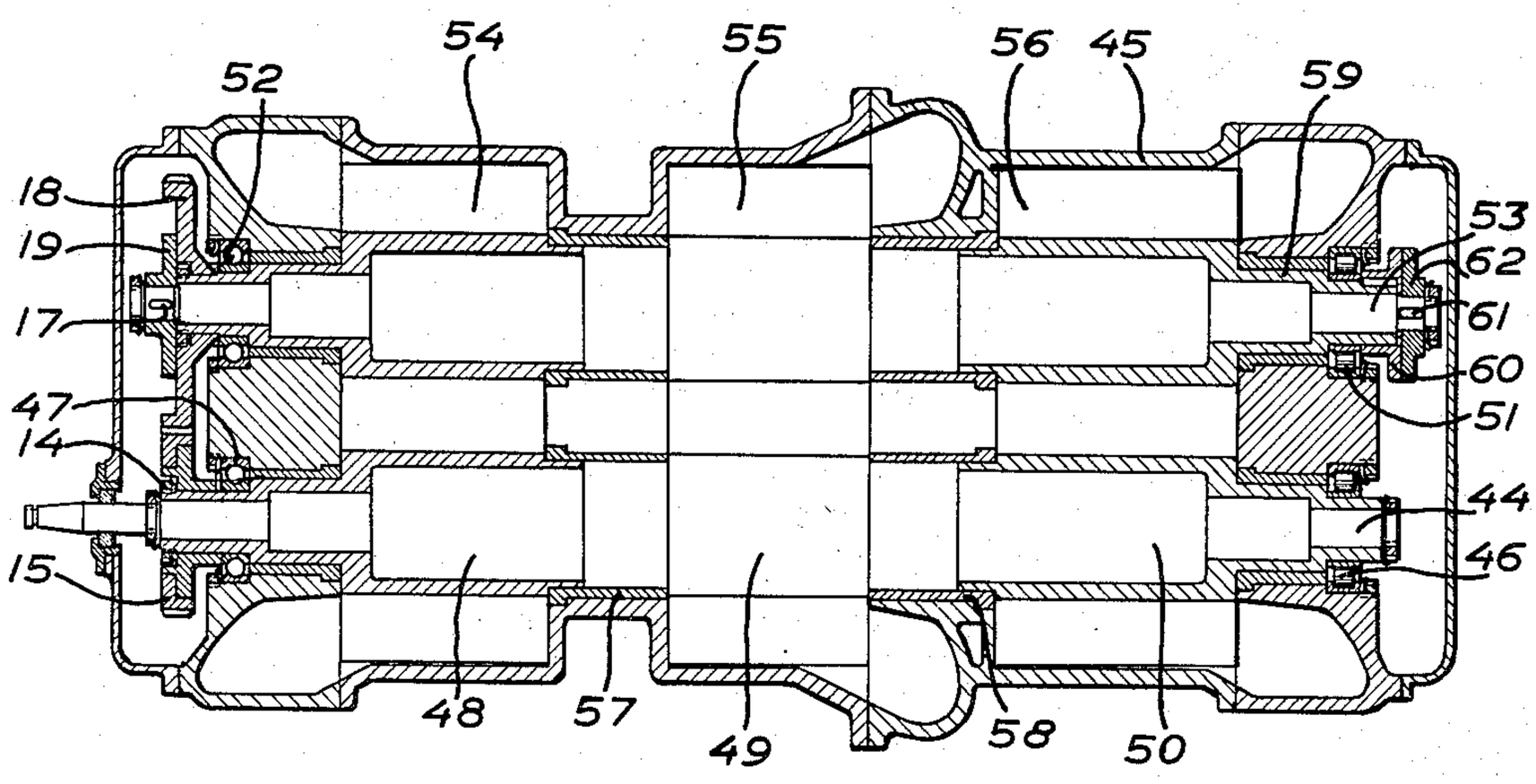

FIG. 5

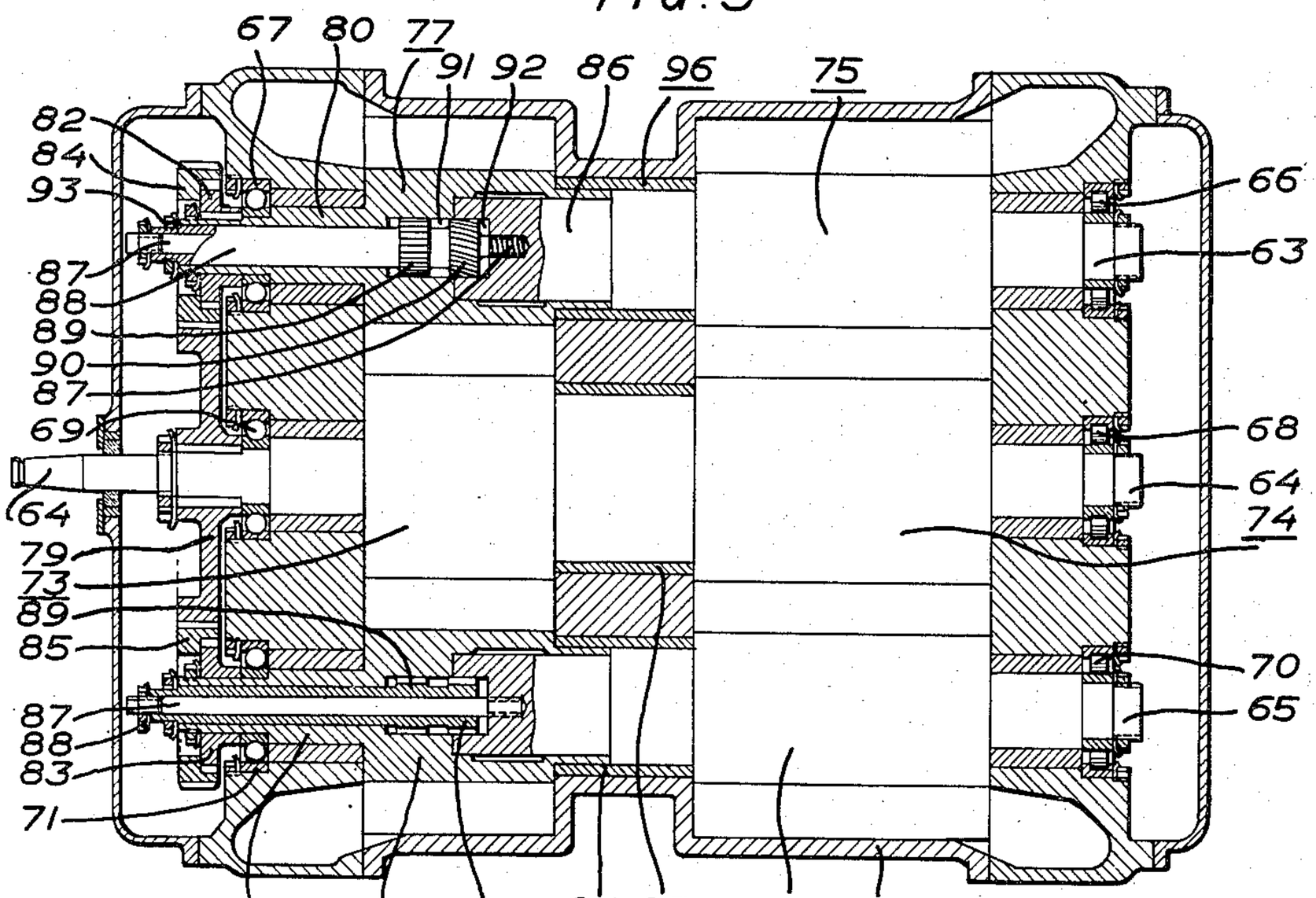

FIG. 6

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INDEPENDENT SYNCHRONIZATION

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Application September 27, 1950, Serial No. 186,946

Claims priority, application Sweden October 7, 1949

13 Claims. (Cl. 74—395)

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The present invention relates to rotary devices of the kind having a plurality of shafts carrying cooperating rotor bodies and requiring synchronized operation between the cooperating parts. More particularly the invention relates to such devices of the kind in which the rotor bodies are provided with helical lands and grooves which intermesh in cooperative relation to provide chambers of variable volume used to compress or expand elastic fluid, and still more particularly the invention relates to such devices in which the pairs of intermeshing rotor bodies each comprise a male rotor the lands of which lie substantially outside the pitch circle of the rotor and a female rotor the grooves of which lie substantially within the pitch circle of the rotor.

Devices of the kind under consideration may be constructed with rotors comprising a plurality of aligned rotor bodies mounted to rotate about the same axis, with the different rotor bodies intermshing respectively with different aligned bodies of a cooperating rotor. Such constructions, however, have presented serious difficulties from the standpoint of obtaining the required synchronized relationship of all of the intermeshing parts, and it is the general object of the present invention to provide new and improved rotor constructions of the kind under consideration which enable the various rotor bodies of multiple rotor devices comprising multiple bodied rotors to be readily adjusted in desired relation to each other.

To this end the invention contemplates the provision of rotors comprising shaft parts carrying rotor bodies, some of which are in fixed relation to the shaft parts and others of which are angularly adjustable relative to the shaft parts, combined with angularly adjustable synchronizing means connecting the shaft parts and also connecting the adjustable rotor bodies. The manner in which the invention may advantageously be carried into effect will best be understood from a consideration of the ensuing portion of this specification, taken in conjunction with the accompanying drawings, which discloses by way of example but without limitation different embodiments of apparatus for carrying the invention into effect.

In the drawings:

Fig. 1 illustrates in horizontal section an embodiment of the device applied to a compressor. Said figure shows in heavier lines those cooperating rotors provided with helical lands and grooves which are first to be synchronized with each other, while Fig. 2 shows in heavier lines those cooperating rotors which are then to be synchronized with each other. Fig. 3 is a vertical section of the compressor shown in Figs. 1 and 2 taken on the center line of the compressor.

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Fig. 4 is a diagrammatic view of another embodiment of the device used in an engine provided wtih three shafts, two rotors being arranged on each shaft.

Fig. 5 is a longitudinal section of a further embodiment of the device used in an engine provided with two shafts, three rotors being arranged on each shaft.

Fig. 6 shows a modification of the device illustrated in Fig. 4, in which another synchronizing device is used for synchronizing the rotors fixed on the two lateral shafts.

Fig. 7 shows an end elevational view of the apparatus of Fig. 1 with the cover plate removed and particularly showing the structure permitting relative adjustment of the two synchronizing gears.

In the embodiment of the compressor illustrated in Figs. 1, 2 and 3, numeral 1 designates the housing of the compressor, said housing having partially double walls for cooling with a liquid or with a gaseous medium. In the two end walls 2, 3 of the housing are arranged bearings 4, 5 and 6, 7 respectively, for carrying two sets of rotors 8, 9 and 10, 11 respectively. Of these rotors, those designated by 9, 11 are fixed on a shaft 12 and the rotor 10 is likewise fixed on a shaft 13, whereas the rotor 8 is adjustable in different angular positions on the shaft 13. To the end portion of the shaft 12 is fixed a hub 14 of a gear wheel, the gear rim 15 of which is adjustable in the desired angular position in relation to the hub 14 by means of stud bolts 16. As shown in Fig. 7, the bolts 16 are slidably received in arcuate slots 15' in the gear 15, thus permitting relative adjustment between the gear 15 and the hub 14. To the end portion of the other shaft 13 is, by means of a key 17, fixed a flange 19 serving as a support hub for a second gear wheel 18 rigidly connected with the rotor 8. Said flange is arranged to be connected with the gear wheel 18 by means of stud bolts 20 by which it will be possible to adjust the gear wheel 18 in different angular positions with respect to the shaft 13 and in connection therewith the angular position of the rotor 8 with respect to said shaft 13. With further reference to Fig. 7 the bolts 20 are slidably received in arcuate slots 19' in the flange 19, this arrangement permitting relative adjustment between the gear 18 and such flange. Numeral 21 denotes a seal between the two sections of the compressor.

In the vertical section of the compressor shown

in Fig. 3, numeral 1 designates the housing of the compressor, 2 and 3 the two end walls, 8 and 10 the two rotors arranged in a row, 18 the gear wheel connected with the rotor 8, and 19 the flange connected with the shaft 13. Numeral 22 designates the air inlet and 23 the air outlet in the one section of the compressor, while 24 and 25 denote the corresponding inlet and outlet in the other section of the compressor.

In those 2-shaft compressors or motors in which the one shaft carries rotors the lands of which are located substantially outside the pitch circle of said rotors (so-called male rotors) and the other shaft carries rotors the grooves of which are located substantially inside the pitch circle of the respective rotor (so-called female rotors), the rotor or rotors adjustable in different angular positions preferably being female rotors.

When synchronizing the rotors shown in Figs. 1, 2 and 3 the cooperating rotors 8, 9 which are arranged in that end portion of the housing 1 which faces the synchronizing gear 15, 18, are first set by adjusting the gear rim 15 on the gear wheel hub 14 which is rigidly connected with the one shaft 12 whereby these rotors are synchronized, the one rotor 11 of the second set of rotors arranged on said shaft being at the same time fixed in relation to the synchronization. The other rotor 10 of this set is then adjusted with a predetermined clearance between the lands of this rotor and the lands of the rotor 11 cooperating with the rotor 10, and is fixed in this position in relation to the synchronizing gear by the flange 19 rigidly connected with the end of the shaft 13. This can preferably be accomplished with the aid of stud bolts 20 which are inserted in arcuate slots in the flange 19 and threadedly received in the gear wheel 18 arranged on said shaft. By these two operations the two rotor sets can thus be synchronized quickly and very accurately.

In the embodiment illustrated diagrammatically in Fig. 4 two rotors 27, 28 are fixed on a shaft 26. On both sides of this shaft 26 are arranged two other shafts 29, 30 which carry rotors cooperating with the rotors on the intermediate shaft 26. On each of these shafts is fixed a rotor 31 and 32 respectively, and a rotor 33 and 34 respectively is turnably mounted on each of said shafts. On the one end portion of the intermediate shaft 26 is mounted a gear wheel 35 in mesh with gear rims 36, 37. Said gear rims are adjustable to different angular positions in relation to wheels 40, 41 rigidly connected with the rotors 33, 34 by means of the hollow shafts 38, 39 of said rotors, said wheels 40, 41 being in turn, by means of flanges fixed on the shafts 29, 30, adapted to be locked in different angular positions in relation to said shafts in the same manner as described above in connection with Fig. 1.

In this embodiment each of the rotors 33, 34 is first synchronized with the intermediate rotor 27 by means of the gear rims 36, 37 intermeshing the gear wheel 35 and lockable in different angular positions in relation to the gear wheels 40, 41, and then the rotors 31 and 32 are synchronized with the intermediate rotor 28 by locking in desired angular positions the flanges 42, 43 fixed to the shafts 29, 30 of said rotors with the gear wheels 40, 41.

In the embodiment shown in Fig. 5, numeral 44 denotes a shaft carried by two bearings 46, 47 arranged in a rotor housing 45. Three rotors 48, 49, 50 are fixed on said shaft. Another shaft

53 carried by two bearings 51, 52 in said rotor housing 45, is provided with three rotors 54, 55, 56 cooperating with the rotors 48, 49, 50 arranged on the first mentioned shaft, the intermediate rotor 55 being fixed on the shaft 53, while the other two rotors 54 and 56 are adjustable in different angular positions in relation to the shaft 53. In this embodiment a synchronizing device similar to that described in connection with Figs. 1 and 2 is used for synchronizing the rotor sets 48, 54 and 49, 55, and therefore the corresponding reference numerals have been used in Fig. 5. In order to prevent leakage between the different sections seals 57, 58 are arranged between the different rotor sets. At the opposite end of the engine the rotor 56 turnably arranged on the shaft 53 is provided with a flange 60 formed on a hollow shaft 59 of said rotor, said flange being lockable in different angular positions in relation to the shaft 53 by means of a flange 62 fixed on said shaft by means of a key 61.

In the embodiment illustrated in Fig. 6 are arranged three parallel shafts 63, 64, 65, one end portion of each of which is journalled in a rotor housing 72 by means of bearings 66, 68, 70. In the opposite end of said housing are arranged three bearings 67, 69, 71 carrying extension parts of said shafts. The intermediate shaft is provided with two fixed rotors 73, 74, while on each of the other two shafts is fixed a rotor 75, 76 and a rotor 77, 78 turnably arranged in relation to the shafts 63 and 65, respectively. On the one end portion of the intermediate shaft 64 there is fixed a gear wheel 79 intermeshing with adjustable gear rims 84, 85 on the gear wheels 82, 83 fixed on the hollow shafts 80, 81 of the rotors 77, 78 which are adjustable in different angular positions in relation to the shafts 63, 65. The two rotors 77, 78 are synchronized with the rotor 73 fixed on the intermediate shaft 64 according to the same principle as in the embodiment shown in Fig. 4, while the rotors 75, 76 are synchronized with the rotor 74 fixed on the intermediate shaft 64 with the aid of a device described hereinafter.

The other rotor 77 is turnably arranged on an extension shaft 86 of the rotor 75. Into the end portion of this elongation shaft is screwed a bolt 87, which at its outer end is provided with a square head for turning the bolt with a key. The outer end of the bolt 87 is also provided with threads. On this bolt there is displaceably mounted a sleeve 88 which at its inner end is provided with external straight splines 89 and with helical splines 90, the straight splines 89 engaging corresponding splines or grooves in a bore 91 made in the turnable rotor 77, while the helical splines 90 engage corresponding splines or grooves in a bore 92 in the end portion of the extension shaft 86. Numeral 93 denotes lock nuts for the sleeve 88 relative to the hollow shaft 80 and relative to the bolt 87 respectively. When the sleeve 88 is displaced on the bolt 87 in one direction or another, the rotor 77 will, with the aid of the straight and the helical splines, be turned in either direction in relation to the rotor 75, whereafter they are locked in the desired angular position in relation to each other by the lock nuts 93 arranged on the sleeve and on the bolt respectively. After the rotor 75 has been synchronized in relation to the rotor 74, the other rotor 76 can be synchronized with this rotor 74 in a similar manner. Seals 94, 95, 96 are provided between the rotor sets as in the other embodiments.

By the above described arrangement of two different types of splines for synchronizing, the advantage obtained at the same time is that the torque will be transmitted between the two coaxial rotors at a considerably shorter axial distance than by long power-transmitting shafts extending through hollow shafts and for this reason being weak, whereby the risk of incorrect synchronizing arising in the latter case due to distortion of the long weak shaft is eliminated.

Naturally, the invention is not limited to the embodiments now described and disclosed for synchronizing rotors mounted on different shafts, but the same may be varied in a great many different ways within the scope of the invention. Furthermore, this invention may also be used with advantage for synchronizing rotors in motors of the positive displacement type.

We claim:

1. A rotary device having at least two cooperating rotors, each comprising a shaft part and at least two rotor bodies carried by the shaft part, each of said rotors including at least one rotor body fixed relative to the shaft part of the rotor, one of said rotors including a rotor body angularly adjustable relative to the shaft part of the rotor, synchronizing means connecting said shaft parts to turn the rotors in timed relation to each other and adjustable means for holding said adjustable rotor body in selected angular relation to the shaft part of the rotor of which said adjustable rotor body comprises a part.

2. A device as defined in claim 1 in which said synchronizing means is angularly adjustable to change the relation between the shaft parts connected thereby.

3. A device as defined in claim 2 comprising an integral rotor having rotor bodies fixed relative to the shaft part of the rotor, and in which said synchronizing means comprises a gear angularly adjustable with respect to said integral rotor.

4. A device as defined in claim 3 in which said angularly adjustable gear meshes with a gear connected to the adjustable rotor body and cooperating rotor.

5. A device as defined in claim 4 in which an angularly adjustable connection is provided between the gear connecting to said adjustable rotor body and the shaft part of the rotor of which said adjustable rotor body comprises a part.

6. A device as defined in claim 5 in which said integral rotor comprises two rotor bodies and the cooperating rotor comprises one rotor body fixed relative to the shaft part of the rotor and one rotor body angularly adjustable relative to the shaft part of the rotor.

7. A device as defined in claim 5 in which the integral rotor comprises three rotor bodies and the cooperating rotor comprises one rotor body fixed relative to the shaft part of the rotor and two rotor bodies independently adjustable angularly with respect to the shaft part of the rotor.

8. A device as defined in claim 2 comprising an integral rotor having rotor bodies fixed relative to the shaft part of the rotor, and in which said synchronizing means comprises a gear angularly fixed relative to said integral rotor.

9. A device as defined in claim 8 in which said gear meshes with a gear connected in angularly adjustable relation to the adjustable rotor body of the cooperating rotor.

10. A device as defined in claim 9 in which the shaft part of said cooperating rotor is connected in angularly adjustable relation with the last mentioned gear.

11. A device as defined in claim 9 in which an axially adjustable part having different sets of splines of different angularity is provided for adjusting the angular relation between different rotor bodies of the cooperating rotor.

12. A device as defined in claim 8 in which two rotors each having at least one adjustable rotor body cooperate in intermeshing relation with said integral rotor, and in which the gear angularly fixed relation to the integral rotor meshes with different gears each angularly adjustable relative to the adjustable rotor body of one of the cooperating rotors.

13. A device as defined in claim 1 in which the male rotor bodies on one rotor intermesh with female rotor bodies on a cooperating rotor and said cooperating rotor constituting the rotor including a rotor body angularly adjustable relative to the shaft part of the rotor.

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