(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 August 2001 (23.08.2001)

PCT

(10) International Publication Number
**WO 01/61151 A1**

(51) International Patent Classification[7]: **F01C 1/16**, 3/08

(21) International Application Number: PCT/CZ01/00007

(22) International Filing Date: 15 February 2001 (15.02.2001)

(25) Filing Language: Czech

(26) Publication Language: English

(30) Priority Data:
PV 581-2000 18 February 2000 (18.02.2000) CZ

(71) Applicant *(for all designated States except US)*: **MULTUŠ, Radek** [CZ/CZ]; Zakřany 253, 664 11 Zbýšov (CZ).

(71) Applicant and
(72) Inventor: **PERNA, Vratislav** [CZ/CZ]; Tučkova 40, 602 00 Brno (CZ).

(74) Agent: **KORISTKA, Martin**; Karpatská 3, P.O. Box 8, 625 00 Brno 25 (CZ).

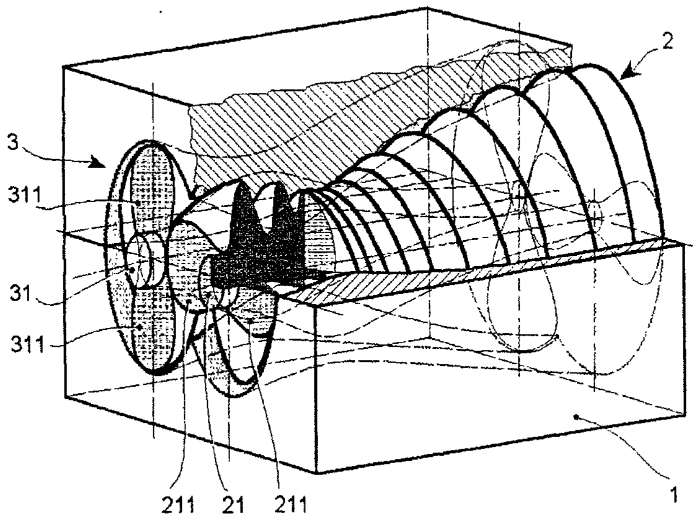
(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: EQUIPMENT WITH MUTUALLY INTERACTING SPIRAL TEETH




(57) **Abstract:** There is designed an equipment with mutually interacting spiral teeth, comprising at least one rotor and one stator with a working surface limited by at least two sprial teeth, which are in mutual interaction by their wrappers and the spiral teeth, being wound-up on shaft surfaces, thus creating rotors, or simultaneously on a surface of at least one shaft, thus creating a rotor, and also on an inner stator surface, provided the spiral teeth have the same or opposite sense of thread lead with, a constant or variable lead angle while the axes of rotations of mutually interacting spiral teeth are parallel or concurrent or skewed, where at least a part of a rotation wrapper of the first-rotor shaft (21) of at least one of the first rotor (2) is created by a rotation of a curve around the axis of the first-rotor shaft (21), the curve being concave or convex to the rotating axe of the first-rotor shaft (21) and at least part of the surface is concave or convex with respect to the rotating axis of the said stator (1) inner space and is represented by a shape of a rotation wrapper of the first rotor (2).

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# EQUIPMENT WITH MUTUALLY INTERACTING SPIRAL TEETH

## Technical Field

The invention relates to an equipment with mutually interacting spiral teeth, comprising at least one rotor and one stator with a working surface limited by at least two spiral teeth, which are in mutual interaction by their wrappers and the spiral teeth being wound-up on shaft surfaces, thus creating rotors, or simultaneously on a surface of at least one shaft, thus creating a rotor, and also on a inner stator surface, provided the spiral teeth have the same or opposite sense of thread lead, a constant or variable lead angle and the spiral teeth wrapper is determined by sum of profiles of all sections through the spiral tooth by rotation planes intersecting the axis of rotation and at the same time being co-axial with the axis of the spiral tooth rotation, while the axes of rotations of mutually interacting spiral teeth are parallel or concurrent or skewed.

## Background of the Invention

The basic requirement on equipment with mutually interacting spiral teeth is either a change of a medium volume without or with a simultaneous increase of its pressure, or a change of pressure and/or flow rate at the output while maintaining the medium volume or utilisation of a medium pressure energy without a change of the medium volume and conversion of the energy upon a rotary motion or utilisation of the pressure energy by simultaneous medium expansion and conversion of the energy on a rotary motion or expansion of a burning mixture of fuel and compressed medium volume and conversion of the pressure energy on a rotary motion by simultaneous medium volume expansion.

There exist a plenty of well-known equipment operating on a principle of mutual interaction of spiral teeth wound-up on at least two rotors seating in a stator, or, as the case may be, wound-up on one rotor and on inner stator surface Spiral teeth surface can be by parts described by functions given in any point by three parameters, i. e. by a diameter of a creating helix, by an angle of angular displacement and by an angle of a helix lead. Every rotor can be represented by a determined sum of profile sections running through co-axial rotating areas, usually defined as surfaces of second degree, namely a spherical surface, a conical surface and in limited values by a surface perpendicular to the axis of rotation. The solutions known at present have spiral teeth which are wound-up on a cylindrical or a conical shaft wrapper. These solutions are known for different type of profiles of spiral teeth, nevertheless they do not enable a variability and especially steepness of profile changes of the same spiral tooth along its axis. At rotors with cylindrical shaft wrapper it is possible to change the thread intermediate space only by a change of spiral teeth steepness. At rotors with a spiral conical wrapper it is possible to change the thread intermediate spaces by a change of spiral teeth lead and by a change of a vertex angle of the conical shaft wrapper. The change of volume of space between the threads is in both cases limited by the length and by rotors diameters. It is impossible to extremely increase the size of rotors because the demands on built-in space do not increase proportionally. Large masses can cause unbalances and oscillation of rotors and problems with their sealing.

Known equipment for media compressing, such as rotational spiral compressors, work on a principle of rotors with cylindrical rotational wrapper and with spiral teeth having a constant lead and a constant teeth profile. The function of rotors is exclusively the medium transport in thread intermediate spaces in the direction from input to output. The pressure is produced at the equipment output. The disadvantage comprise a limitation of a compression rate caused by equipment dimensions and by the construction as described above as well. The efficiency is limited by constant shape and size of labyrinth of the thread intermediate spaces of the present equipment.

The equipment with a constant volume of a thread intermediate space is also used as generators and in reversed arrangement as motors, e. g. pneumatic motors, hydro-motors, when the pressure medium is fed to the input and moves the spiral rotors. The disadvantage comprise again an invariable and steep characteristics of a pressure change performed between the medium input and output.

By a serial combination of the equipment there is acquired a staggered increase of compression, while a parallel combination of a larger number of the equipment provides for an increase of the volume compression rate.

In principle there can be as unsuccessful depicted known constructions of internal combustion engines with spiral teeth. The arrangement of these types of motors has been so far restricted to combinations of two and more mutually interconnected individual equipment, like that of a compression and an expander. The disadvantage of these solutions consist mainly in restricted possibilities of adaptation of a shape of a working space and arrangement of individual parts of equipment for suction, compression, expansion and exhaust, to particular required procedure of an internal combustion process. All known equipment manifest large dimensions. The types with shafts and housing of a cylindrical shape have mainly large overall length and at the types with conical shafts and housing have large diameters. Such parameters negatively influence even a dynamic balancing of rotors.

Known equipment comprise for example a technical solution according to CZ utility model No. 8308, where spiral teeth are wound-up on a conical body and a rotating wrapper of rotors is also conical. In this type of equipment a change of a medium volume occurs already in the thread intermediate space, nevertheless the process and degree of compression and expansion of a medium is limited by vertex angles of conical rotors. Such an embodiment cannot be modified to change a working characteristic of the equipment as required.

There is also known a solution of a combustion motor with a rotating disc as presented in CZ patent application PV 558-91, describing rotating compressor discs with thread surfaces which are used to split a working space of a rotating working disc. However this thread surfaces are not in a mutual interaction and the rotating compressor discs serve only as rotating slide valves of the working disc and do not transfer a pressure force in a torque. The disadvantages of this solution include a periodic charge cycle and maximum pressure impacts applied on rotating sliders. The equipment requires perfect sealing. A wear of parts resulting from combined effects of the mutual sliding movement and simultaneously acting impact forces will be high and therefore the service life of the equipment probably low.

Another similar solution of a rotating motor, included in a PCT patent application WO 93/14299, is an equipment utilising a rotating disc for splitting a working space of a rotor with a spiral tooth, the rotating disc being fitted with a notch allowing for a passage of the spiral tooth. The rotating disc and spiral tooth create two movable partitions of the working space. Outer convex surface of the working rotor is given by an outer shape of the rotating disc and do not determine working characteristics of the equipment. The rotating disc spiral tooth is not in interaction with any other spiral tooth.

Another known solution, as described in a paper DE 19738132 A1 is based on a principle of counter-rotating rotors with mutually adapted teeth profiles, with cylindrical or tapered rotation wrappers of rotors and with changing lead of spiral teeth of rotors. The compression happens already in the thread intermediate spaces, nevertheless the degree of compression is limited by the equipment dimensions. A transfer of a medium happens by a rotation of the rotors in mutually opposite directions, the medium being compressed only in an intermediate space of these rotors, not in a space between the rotor and the equipment housing. The construction allows only for a certain maximum possible length of the spiral teeth and to make it work a certain minimum number of threads of the spiral teeth is necessary.

Another known solution according to US patent 5.533.887 has two interacting rotors running in mutually opposite directions. The two rotors seating in a common housing, have tapered shafts on which there are wound-up spiral teeth with a constant lead and rotational wrappers of the spiral teeth form have a shape of cones with an orientation opposite to that of the shafts. These rotation wrappers of the rotors define tapered inner spaces of the housing with which they are also in a mutual interaction. This construction provides for a surface sealing of the rotor spiral teeth against the housing and therefore the spiral teeth have identical lead depending on vertex angles of the tapered shafts and the housing, the angles determining a waveform of working characteristics of the equipment. By the same input parameters it is possible to obtain only corresponding output parameters. Thus an application variability of the equipment is significantly limited.

All so far known solutions allow for changes of profiles of spiral teeth and for changes of spiral teeth lead only at a restricted range. No particular exact requirements on working characteristics of the equipment can be applied.

Disclosure and Object of the Invention

The foregoing problems are solved by an equipment with mutually interacting spiral teeth, comprising at least one rotor and one stator with a working surface limited by at least two spiral teeth, which are in mutual interaction by their wrappers and the spiral teeth being wound-up on shaft surfaces, thus creating rotors, or simultaneously on a surface of at least one shaft, thus creating a rotor, and also on a inner stator surface, provided the spiral teeth have the same or opposite sense of thread lead, a constant or variable lead angle and the spiral teeth wrapper is determined by sum of profiles of all sections through the spiral tooth by rotation planes intersecting the axis of rotation and at the same time being co-axial with the axis of the spiral tooth rotation, while the axes of rotations of mutually interacting spiral teeth are parallel or concurrent or skewed, the equipment in accordance with the present invention comprising at least a part of a rotation wrapper of the first-rotor shaft of at least one of the first rotor, the rotation wrapper being created by rotation of a curve around an axis of the first-rotor shaft, the curve being concave or convex to the rotating axe of the first-rotor shaft and at least a part of the surface being concave or convex with respect to the rotating axis of the said stator inner space and being represented by a shape of a rotational wrapper of the first rotor, provided all profiles of sections through the spiral first-rotor teeth correspond to a concave and/or convex shape of the stator inner wrapper and to a wrapper of the first-rotor shaft of at least of one first rotor. Further in accordance with the present invention at least two rotors, the first rotor and the second rotor are through their rotation wrappers in a mutual interaction with the stator inner surface and each pair of rotors, the first rotor and the second rotor, are in a mutual engagement through spiral surfaces of their spiral first-rotor teeth and second-rotor teeth, the mutual engagement being carried out along the contact curves comprising points of the smallest mutual distance of each profile of the spiral first-rotor teeth of the first rotor and the spiral second-rotor teeth of the second rotor.

## Brief Description of the Drawings

By way of examples the invention will be now described with reference to the following drawings :

Fig. 1a shows a sectional view of a stator housing furnished with one rotor with two teeth and three teeth at an inner stator surface,

Fig. 1b shows a lateral view of a stator housing in a section along the line A-A according to Fig. 1a, the housing being furnished with one rotor with two teeth and three teeth at the inner stator surface,

Fig. 1c shows a sectional view of a stator housing furnished with one rotor with one tooth and two teeth at an inner stator surface,

Fig.1d shows a lateral view of a stator housing in a section along the plane A-A according to Fig. 1c, the housing being furnished with one rotor with one tooth and having a stator with two teeth at its inner surface,

Fig. 2a shows an axonometric view of a housing without rotors in a partial section,

Fig. 2b shows an axonometric view of a stator housing, the housing constituting substantially a wrapper of rotors,

Fig. 2c shows an axonometric view of a rotor with two spiral teeth wound on a rotor surface, the rotor combining concave and convex shapes.

Fig. 3 shows a stator housing furnished with two rotors in an axonometric view, one of the rotors being in a partial section through spiral teeth on the rotor surface,

Fig. 4a shows a pair of rotors with convex surface in a partial section, the rotors being located in a common housing of a compressor application

Fig. 4b shows a pair of rotors in a partial section along the plane A-A according to Fig. 4a, the rotors being located in a common housing

Fig. 4c shows a pair of rotors with a convex surface in a partial sectional view, the rotors being located in a common housing. The direction of the rotor motion and the direction of a media flow are opposite to the situation illustrated in Figs. 3a, 4b, thus providing for an expander application of the equipment

Fig. 4d shows a pair of rotors in a sectional view along the plane A-A according to Fig. 4c, the rotors being located in a common housing

Fig. 5a shows a pair of rotors with a concave surface in a partial sectional view, the rotors being located in a common housing of a compressor application,

Fig. 5b shows a pair of rotors in a partial section along the plane A-A according Fig. 4a, the rotors being located in a common housing,

Fig. 5c shows a pair of rotors located in a common housing, in a partial sectional view, one of the rotors having convex surface and the other one a concave surface, the arrangement being designed for an application as a compressor,

Fig. 5d shows a pair of rotors in a common housing, in a sectional along lthe plane A-A according to Fig. 5c,

Fig. 5e shows a pair of rotors located in a common housing, in a partial sectional view, the rotors shafts having partially convex and partially concave surfaces, the said arrangement being designed for a compressor application.

Fig. 5f shows a pair of rotors located in a common housing in a sectional along the plane A-A according to Fig. 5e,

Fig. 6a shows a pair of rotors running in the same direction of motion, in a partial sectional view, the rotor shafts having a concave surface and the rotors being located in a common housing of a compressor application,

Fig. 6b shows a pair of rotors in a partial section along the line A-A according to Fig. 6a, the rotors being located in a common housing,

Fig. 6c shows a pair of rotors running in an opposite direction of motion, in a partial sectional view, the rotor shafts having one spiral tooth,

Fig. 5d shows a pair o rotors located in a common housing in a sectional along the plane A-A according to Fig. 6c, the tooth profile being illustrated,

Fig. 7a shows an equipment with three rotors in a common housing, the middle rotor having a shaft with a convex surface, both side rotors having cylindrical shafts,

Fig. 7b shows the three rotors located in a common housing in a sectional along the plane A-A according to Fig. 7b,

Fig. 8a shows a pair of rotors located in a common housing in a sectional along the plane A-A according to Fig. 8d,

Fig. 8b shows a pair of rotors located in a common housing in a sectional along the plane B-B according to Fig. 8d, the tooth profile and a shape of a working space being illustrated,

Fig. 8c shows a pair of rotors located in a common housing in a sectional along the plane C-C according to Fig. 8d, the tooth profile and a shape of a working space being illustrated,

Fig. 8d shows a pair of rotors running in an opposite direction of motion, in a partial sectional view, the rotors being located in a common housing and the rotor shafts being partially convex and partially concave and having two spiral teeth,

Fig. 8e graphically illustrates a waveform of pressure (P) and volume (V) within the thread intermediate space according Fig. 8d, the parts “X, Y and Z” being a compression, injection and combustion and expansion sections resp.,

Fig. 9a shows an equipment with three rotors in a common housing, the middle rotor having a shaft with a partially convex and partially concave surfaces and both side rotors cylindrical shafts, the equipment being designed for a motor application,

Fig. 9b shows three rotors located in a common housing in a sectional along the plane B-B according to Fig. 9a,

Fig. 10a shows rotational wrapper of rotors with spiral teeth wound on shafts with convex surfaces, the rotors having skewed axes, stator is not shown,

Fig. 10b shows rotational wrapper of rotors with spiral teeth wound on shafts with convex surfaces, the rotors having skewed axes, as shown in a plane perpendicular to the view of Fig. 10a and parallel to a plane of rotor axes,

Fig. 11a shows a sectional view of a combination of four rotors arranged side by side in a common housing,

Fig. 11b shows a sectional view of a combination of five rotors arranged side by side in a common housing,

Fig. 11c shows a sectional view of a combination of five rotors in a star-shape arrangement in a common housing,

Fig. 11d shows a sectional view of a combination of three rotors in a mutual engagement, the rotors being arranged in a common housing,

Fig. 11e shows a sectional view of a combination of four rotors in a mutual engagement, the rotors being arranged in a common housing,

Fig. 12 shows a sectional view of a stator with two spiral rotors each of them provided with spiral teeth wound on shaft surfaces having convex shape, the shafts having concurrent axes. The embodiment is designed for application as a drive for ships.

Description of Preferred Embodiments

On Figs. 1a, 1b displaying a specific embodiment of the equipment according to the invention, there is shown a stator 1 with three spiral teeth, first stator tooth 111, second stator tooth 111 and third stator tooth 111 and a rotor 2 with two spiral teeth, a first first-rotor tooth 211 and a second first-rotor tooth 211. Fig 1b shows the stator 1, representing a housing, accommodating a first rotor 2, consisting of a first-rotor shaft 21 with a concave surface, on which there are wound-up two spiral teeth, a first first-rotor tooth 211 and a second first-rotor tooth 211, the teeth mutually shifted by an angle of 180°. On an inner surface of the stator 1 there are wound-up three spiral stator teeth 111, the teeth being mutually shifted by an angle of 120°. The axis of the stator 1 and the axis of the first rotor 2 are mutually parallel and profiles of their spiral teeth, the stator teeth 111 and the first-rotor teeth 211, have the same lead which in all three case runs in the same sense. Both the first-rotor teeth 211 enter gradually into intermediate spaces of threads of the stator teeth 111, thus mutually engaging along contact curves, while always one of the first-rotor teeth 211 enters into the intermediate space of the threads of the stator teeth 111 and the other one of the first-rotor teeth 211 passes along the opposite stator tooth 111. The first-rotor teeth 211 are dividing the intermediate spaces of the threads of the stator teeth 111, thus closing them as partition walls.

For a purpose of a clarity of the description and the patent claims the following basic terms are defined.

A concave curve is such a curve, for all points of which it applies, that the curve at its any section can be expressed by a parameter function, defining a distance of a curve point from the parameter axis, the second derivative of the function to this parameter at this point being always negative or equalling zero.

A convex curve is such curve, for all points of which it applies, that the curve at its any section can be expressed by a parameter function, defining a distance of a curve point from the parameter axis, the second derivative of the function to this parameter at this point being always positive or equalling zero.

A contact curve is a set of points at which there occurs a maximum approach or a mutual contact of surfaces of spiral teeth of interacting rotors or contact of surfaces of spiral teeth of interacting rotors with a stator inner wrapper.

A rotation wrapper is a limiting rotation surface defining a space of a rotating body in such a way, that all points of this body are always only on one side of this surface and at the same time every point of this surface is a point through which there passes a rotation track of at least one point of the rotating body.

The equipment according to the specific embodiment of Figs.1a, b operates in such a way that by a simultaneous rotation and rolling of the first rotor 2 in the stator 1 a medium entering through an inlet into intermediate spaces of threads of the spiral stator teeth 111 and the first-rotor teeth 211 is pushed towards the outlet. By mutual interaction of the stator 1 and the first rotor 2 there is performed a mutual partition of the intermediate space of the threads of the stator 1 by the first rotor 2 and the other way round. Because of a concave shape of a wrapper of the first-rotor shaft 21 and a concave shape of the inner wrapper of the stator 1, the intermediate space of the threads of the spiral stator teeth 111 and the first-rotor teeth 211, is decreasing from thread to thread and within the thread intermediate space the medium is compressed. Such an embodiment is designed to operate as a medium compressor..

In an alternative case, the spiral first-rotor teeth 211 may be wound in an opposite sense than the spiral stator teeth 111 and as a consequence the first rotor 2 will perform a complex rotation movement. The function of the equipment will be substantially the same. The sense of lead and mutual engagement of the first-rotor teeth 211 and the stator teeth 111 limits possible profile shapes of the first-rotor teeth 211 and the stator teeth 111 and present a limiting factor for a practical application of the equipment.

In a case of parallel axes of the first rotor 2 and the stator 1, their mutual interaction is determined by the condition, that either the first rotor 2 with a concave first-rotor shaft 21 is located in a stator 1 with a concave inner wrapper or the first rotor 2 with a convex first-rotor shaft 21 is situated in a stator 1 with a convex inner wrapper. By a concurrent arrangement of the axes of the first rotor 2 and the stator 1, their mutual interaction is possible also for other combinations of convexity and concavity of the first rotor 2 and the inner wrapper of the stator 1.

Fig. 1c displays another particular equipment which is equivalent to the embodiment shown in Figs 1a, b. In this case the stator 1 is on its inner surface furnished with two spiral stator teeth 111 and the first rotor 2 is on the first-rotor shaft 21 fitted with one spiral first-rotor tooth 211. In the stator 1, which in this embodiment represents also a housing of the equipment, there is accommodated the first rotor 2, consisting of the first-rotor shaft 21 having a concave surface, on which there is wound one spiral first-rotor tooth 211. On the stator 1 inner surface there are wound the first spiral stator tooth 111 and the second spiral stator tooth 111, both teeth 111 being mutually shifted by an angle of 180°. The stator 1 and first rotor 2 have parallel axes and profiles of their stator teeth 111 and first-rotor teeth 211 have the same shape and the same sense of lead.

The spiral first-rotor tooth 211 enters gradually into the intermediate space of threads of the stator teeth 111 and is in a mutual engagement with them along the contact curves. The first-rotor tooth 211 intersect the intermediate space of the threads of the stator teeth 111 thus practically closing them as a partition wall.

The equipment according to the specific embodiment of Figs. 1c,d operates in such a way, that by rotation and simultaneous rolling of the first rotor 2 within the stator 1 a medium entering through an input into the intermediate space of threads of the spiral stator teeth 111 and the first-rotor teeth 211 is moved in the direction towards the output. By mutual interaction of the stator 1 and the first rotor 2 there is performed a partition of the of the stator 1 thread intermediate space by the first rotor 2 and vice versa. Due to the concave shape of the surface of the first-rotor shaft 21 and the concave shape of the inner surface of the stator 1, the intermediate space of the threads of the spiral first-rotor teeth 211 decreases with each subsequent thread and the medium within the thread intermediate spaces is compressed. The equipment is designed for compression of a medium.

Both varieties, as displayed on Figs. 1a, b, c, d, when operated in an opposite sense of rotation of the first rotor 2 in the stator 1, may perform a reverse function. In such a case a medium within the thread intermediate space is expanding and the equipment utilises the medium expansion.

Figs. 2a, 2b and 2c display further specific embodiments in axonometric views. On Fig. 2a there is shown a stator 1, representing a housing of the equipment. The stator 1 is designed to accommodate two rotors, the first rotor 2 and the second rotor 3 in parallel arrangement. Fig. 2b shows an inner wrapper of the stator 1, the shape of which is identical with the joint wrapper of rotation wrappers of the first rotor 2 and the second rotor 3, which are in an interaction with the inner wrapper of the stator 1. Fig. 2c shows a view upon a separate first rotor 2.

Another specific embodiment of the technical solution according to the invention is displayed on Fig. 3. In a partial section there is shown the stator 1, here also representing the equipment housing, which accommodates two rotors. The first rotor 2, consists of a first-rotor shaft 21 with a combined concave and convex surfaces, on which spiral teeth are wound, the first first-rotor tooth 211 and the second first-rotor tooth 211, the teeth being mutually turned by an angle of 180°. The second rotor 3, consists of a second-rotor shaft 31 with a combined concave and convex wrappers, on which spiral teeth are wound, namely the first second-rotor tooth 311 and the second second-rotor tooth 311, both teeth being mutually turned by an angle of 180°. Both rotors 2,3 have parallel axes, identical profiles of the first-rotor teeth 211 and the second-rotor teeth 311 and identical lead, nevertheless thel first-rotor teeth 211 have the opposite sense of lead than the second-rotor teeth 311. Both the first-rotor teeth 211 enter into the intermediate space of threads of both second-rotor teeth 311, and therefore the first rotor 2 and the second rotor 3 are in a mutual interaction, engaging especially along contact curves. Rotation tracks of the first-rotor teeth 211 and the second-rotor teeth 311 overlap each other..The first-rotor teeth 211 divide the opposing intermediate spaces of the threads of the second-rotor teeth 311 and in this way they are covering them as partition walls and at the same time also the second-rotor teeth 311 divide the opposing intermediate spaces of the threads of the first-rotor teeth 211 thus covering them as partition walls. An inner space of the stator 1 is limited by a wrapper of a system of circles; which are at one hand co-axial with the axis of rotation of the first rotor 2 and simultaneously circumscribed to the sum of profiles of all sections through the first-rotor teeth 211 and at the other hand co-axial with the axis of rotation of the second rotor 3 and at the same time circumscribed to the sum of profiles of all sections through the second-rotor teeth 311. As a consequence of the mutual interaction of the first rotor 2, the second rotor 3 and the stator 1, thread intermediate spaces are created between the first-rotor teeth 211, the second-rotor teeth 311 and the stator 1.

The equipment according to the specific embodiment of Fig. 3 operates in such a way, that by counter rotation of the first rotor 2 and the second rotor 3 within the stator 1 the medium entering through an input into the intermediate space of threads of the first rotor 2 and the second rotor 3 is moved towards the output. By mutual interaction of the first rotor 2 and the second rotor 3 there is performed a mutual partition of the first rotor 2 thread intermediate space by the second rotor 2 and vice versa. Due to the combination of a concave and convex shape of the surfaces of the first-rotor shaft 21 and the second-rotor shaft 31, the intermediate space of the threads of the spiral first-rotor teeth 211 and the second-rotor teeth 311 decreases with each subsequent thread and the medium within the thread intermediate space is compressed and subsequently with increasing thread intermediate spaces the medium is expanding.

In an alternative case, the first-rotor teeth 211 may have the same sense of lead as the second-rotor teeth 311 and as a consequence the sense of rotation of both rotors shall be the same. The function of the equipment in this case will be substantially the same. The sense of the thread lead and mutual engagement of the first-rotor teeth 211 and the second-rotor teeth 311 impose limitations on possible shapes of their profiles and thus on choice of a preferred application of the equipment in a praxis..

Another particular specific embodiment of the technical solution according to the invention is schematically displayed in a sectional view on Figs. 4a and 4b, In the stator 1, which is the housing of the equipment, there are in a push fit seated the first rotor 2 and the second rotor 3. The first rotor 2 consists of the first-rotor shaft 21 having a surface of a convex shape, at which the first spiral first-rotor tooth 211 and the second spiral first-rotor tooth 211 are wound, both first-rotor teeth being mutually turned by angle of 180°. The second rotor 3 consists of the second-rotor shaft 31 having a surface of a convex shape, at which the first spiral second-rotor tooth 311 and the second spiral second-rotor tooth 311 are wound, both second-rotor teeth being mutually turned by an angle of 180°. The first rotor 2 and the second rotor 3 have mutually parallel axes, and both the spiral first-rotor teeth 211 and the second-rotor teeth 311 have identical profiles and decreasing lead angle, nevertheless the first-rotor teeth 211 have the opposite lead sense than the second-rotor teeth 311. Both the first-rotor teeth 211 inter into the intermediate spaces of threads of both second-rotor teeth 311, so that the first rotor 2 and the second rotor 3 are in a mutual interaction, engaging substantially along contact curves. Rotation tracks of the first-rotor teeth 211 and the second-rotor teeth 311 overlap each other, as displayed by the section A-A of Fig. 4b The first-rotor teeth 211 divide opposing intermediate spaces of the threads of the second-rotor teeth 311 thus covering them as partition walls. Simultaneously also the second-rotor teeth 311 divide opposing intermediate spaces of the threads of the first-rotor teeth 211, thus also covering them as partition walls. The inner space of the stator 1 is limited by a rotation wrapper of the first rotor 2 and at the same time by a rotation wrapper of the second rotor 3. In this particular embodiment the inlet is on the side of the maximum mutual overlapping of the first rotor 2 and the second rotor 3, while the equipment outlet is on the opposite side, manifesting miniuml mutual overlapping of both rotors 2, 3. Fig. 4b displays the first rotor 2 and the second rotor 3 with preferred profiles of the spiral first-rotor teeth 211 and the second-rotor teeth 311, both engaging rotors being shown as viewed in a plane perpendicular to the axes of rotation of the rotors 2, 3.

The equipment according to the specific embodiment of Figs. 4a and 4b operates in such a way, that by counter rotation of the first rotor 2 and the second rotor 3 within the stator 1 the medium entering through an input into the intermediate space of threads of the first rotor 2 and the second rotor 3 is moved towards the output. By mutual interaction of the first rotor 2 and the second rotor 3 there is performed a mutual partition of the first rotor 2 thread intermediate space by the second rotor 2 and vice versa. Due to the convex shape of the surfaces of the first-rotor shaft 21 and the second-rotor shaft 31, the intermediate space of the threads of the first-rotor teeth 211 and the second-rotor teeth 311 decreases with each subsequent thread and the medium within the thread intermediate space is compressed.

The equipment according to the specific embodiment of Fig. 4c has the same arrangement as the embodiment according to Figs. 4a, 4b, only the first rotor 2 rotates in a direction opposite and the sense of rotation of the second rotor 3. The medium inlet is on the side of the equipment with the minimum mutual overlapping of the first rotor 2 and the second rotor 3 and the equipment outlet of is on the opposite side, manifesting maximum mutual overlapping of the first and second rotors 2, 3. As a consequence of the convex shape of the surfaces of both the first-rotor shaft 21 and the second-rotor shaft 31, the thread intermediate spaces of the first rotor 2 and the second rotor 3 increase with each subsequent thread and the medium within the thread intermediate spaces is expanding. This allows for an expansion function of this specific embodiment of the equipment.

Another particular specific embodiment of the technical solution according to the invention is schematically displayed in a sectional view on Figs. 5a and 5b, the latter one showing a sectional view A-A according to Fig. 5a. In the stator 1, which is the housing of the equipment, there are in a push fit seated the first rotor 2 and the_second rotor 3. The first rotor 2 consists of the first-rotor shaft 21 having a surface of a concave shape, at which the first spiral first-rotor tooth 211 and the second spiral first-rotor tooth 211 are wound, both first-rotor teeth 211 being mutually turned by an angle of 180°. The second rotor 3 consists of the second-rotor shaft 31 having a surface of a concave shape, at which the first spiral second-rotor tooth 311 and the second spiral second-rotor tooth 311 are wound, both second-rotor teeth 311 being mutually turned by an angle of 180°. The first rotor 2 and the second rotor 3 have axes arranged in parallel, and both the spiral first-rotor teeth 211 and the second-rotor teeth 311 have identical profiles and decreasing lead angle, but the spiral first-rotor teeth 211 have the opposite lead sense than the spiral second-rotor teeth 311. Both first-rotor teeth 211 inter into the intermediate spaces of threads of both spiral second-rotor teeth 311, so that the first rotor 2 and the second rotor 3 are in a mutual interaction, engaging substantially along contact curves. Rotation tracks of the spiral first-rotor teeth 211 and the second-rotor teeth 311 overlap each other, as displayed on the section A-A of Fig. 5b The first-rotor teeth 211 divide opposing intermediate spaces of the threads of the second-rotor teeth 311 thus covering them as partition walls. Simultaneously also the second-rotor teeth 311 divide opposing intermediate spaces of the threads of the first-rotor teeth 211, thus also covering them as partition walls. The inner space of the stator 1 is limited by a rotation wrapper of the first rotor 2 and at the same time by a rotation wrapper of the second rotor 3. In this particular embodiment the inlet is on the side of the maximum mutual overlapping of the first rotor 2 and the second rotor 3, while the equipment outlet is on the opposite side, manifesting minimum mutual overlapping of both rotors 2, 3. Fig. 5b displays the first rotor 2 and the second rotor 3 with preferred profiles of the first-rotor teeth 211 and the second-rotor teeth 311, both engaging rotors being shown as viewed in a plane perpendicular to the axes of the rotor rotation. From the point of view of its function the embodiment of Figs. 5a and 5b offers a working characteristics of a media compression having a steeper waveform than applies for the embodiment of Figs. 4a, 4b.

Another particular specific embodiment of the technical solution according to the invention as schematically displayed in a sectional view on Figs. 5c and 5d, is equivalent to the embodiment of Figs. 5a and 5b. It differentiates from the previous one by the shape of shaft surfaces as the first-rotor shaft 21 surface has a convex shape while the second-rotor shaft 31 surface is concave. This shapes result in rather different shapes of the first rotor 2 and the second rotor 3 and their rotation wrappers, defining an inner space of the stator 1. Other parameters, arrangement and mutual interactions of elements of the specific embodiment displayed at Figs. 5c, 5d correspond to the embodiment of Figs. 5a, 5b. Its function is analogous to the previous specific embodiments of Figs. 4a, 4b and 5a, 5b. The difference is to be seen in the fact that the equipment according to this specific embodiment, combining the first-rotor shaft 21 with a concave surface and the second-rotor shaft 31 with a convex surface within the stator 1, has unequal thread intermediate spaces of the first-rotor teeth 211 and the second-rotor teeth 311, the difference resulting from the different rotor rotation wrappers. As a consequence of this arrangement a change of the thread intermediate space has steeper characteristic than it is by the equipment with the first-rotor shaft 21 and the second-rotor shaft 31 having convex surfaces, as displayed on Figs. 4a, 4b, but not such a steep characteristic as the equipment with the first-rotor shaft 21 and the second-rotor shaft 31 having concave surfaces, as displayed on Figs. 5a, 5b. This applies only when provided that profiles, lead and numbers of spiral teeth are substantially identical.

Another particular specific embodiment of the technical solution according to the invention as schematically displayed in a sectional view on Figs. 5e and 5f, is equivalent to the embodiment of Figs. 5a and 5b. It differentiates from the previous one by the shape of shaft surfaces as both the first-rotor shaft 21 surface and the second-rotor shaft 31 surface have partially convex and partially concave shape, both surfaces being mutually identical. This shapes result in rather different shapes of the first rotor 2 and the second rotor 3 and their rotation wrappers, defining an inner space of the stator 1. Other parameters, arrangement and mutual interactions of elements of the specific embodiment displayed on Figs. 5e, 5f correspond to the embodiment of Figs. 5a, 5b. This embodiment combines features of the solution according Figs. 4a and 4b, with features of the embodiment according Figs. 5a, 5b and allows for more favourable waveform of the operation characteristic of media compression. In the inlet part of the equipment, within thread intermediate spaces, due to the high profile of spiral teeth of the first and second rotors 2, 3, there is transported high, constant volume of the medium. In the middle part the medium is continuously compressed and in the outlet part, due to the higher number of teeth with a low profile of the spiral teeth, a closure of an outlet opening is improved, and a return flow of the medium within the equipment is prevented.

A change of a shape of the convex or concave wrappers of the first-rotor shaft 21 and the second-rotor shaft 31 and/or a change of lead of the first-rotor teeth 211 and the second-rotor teeth 311, results in a decrease and/or increase of the volume of intermediate spaces of threads of the first rotor 2 and the second rotor 3. This applies for any part of the first rotor 2 and the second rotor 3.

Other particular embodiment of the technical solution according to the invention is displayed at Figs. 6a, 6b. The spiral first-rotor teeth 211 have the same sense of lead as the spiral second-rotor teeth 311. As a consequence, the sense of rotation of both rotors 2, 3 is the same. The sense of lead and the mutual engagement of the first-rotor teeth 211 and the second-rotor teeth 311, are limiting factors for available shapes of profiles of the spiral first-rotor teeth 211 and the second-rotor teeth 311, as displayed at Fig. 6b and thus also for a particular application the equipment function. The equipment function is substantially the same as applies for the equipment of Figs 4a, 4b, but different profiles of the spiral rotating teeth allow for a different waveform of working characteristics of the equipment and different practical application. By opposite sense of rotation of both the first rotor 2 and the second rotor 3, the equipment will work as an expander.

Another particular solution is the embodiment displayed on Figs. 6c, 6d having a first rotor 2 with one spiral first-rotor tooth 211 wound on the first-rotor shaft 21 and a second rotor 3 with one spiral second-rotor tooth 311 wound on a second-rotor shaft 31. This embodiment allows for a choice from a wider variety of profiles of the spiral first-rotor tooth 211 and the second-rotor tooth 311 and for further alternative process of the medium compression in thread intermediate spaces. According to the sense of rotation of both rotors 2, 3 the equipment operates either as a compressor or as an expander.

Another alternative solution is an equipment having the first rotor 2 with one spiral first-rotor tooth 211 wound on a first-rotor shaft 21 and further having a second rotor 3 with several spiral second-rotor teeth 311 wound on a second-rotor shaft 31. This embodiment limits the profile spectrum of spiral rotors teeth and the equipment function is subjected to unequal revolutions of the first rotor 2 and the second rotor 3, which could be favourable for special procedures of medium compression. The first rotor 2 with one first-rotor tooth 211 can for example function as a partition wall, like a spiral slide valve and the second rotor 3 with several spiral second-rotor teeth 311 does the working function, or the other way round.

All the above presented particular solutions and alternatives could be modified by different diameters of the rotation wrappers of rotors. This can advantageously allow for different mode of operation of the equipment according to the invention.

Each of the mentioned specific embodiments can be also operated in a reverse mode, with reversed direction of rotation of the rotors. In cases when the thread intermediate space moves from an inlet to an outlet, its volume increasing simultaneously, as is the case with embodiment according to Figs. 4c, 4d, the equipment functions as an expander. Such a function may be utilised for a transfer of the medium power in a rotation movement of rotors. Another application is suitable for an equipment utilising a decrease of pressure acting upon a medium during pumping process, e. g. in a case when media must not be pumped under pressure.

Another preferred specific embodiment is displayed in a sectional views on Figs. 7a and 7b. In the stator 1 there are seated the first rotor 2, the second rotor 3 and a fourth rotor 4, all rotors 2,3,4 being in a mutual interaction. The first rotor 2 comprise a first-rotor shaft 21 having a surface of a convex shape, at which two spiral first-rotor teeth 211 are wound, both first-rotor teeth 211 being mutually turned by an angle of 180°. The second rotor 3 consists of a second-rotor shaft 31 having a surface of a cylindrical shape, at which two spiral second-rotor teeth 311 are wound, both second-rotor teeth 311 being mutually turned by an angle of 180°. The third rotor 4 has a third-rotor shaft 41 with a surface of a cylindrical shape, at which two spiral third-rotor teeth 411 are wound, both third-rotor teeth 411 being mutually turned by an angle of 180°. Axes of all three rotors 2, 3, 4 are arranged in parallel and in the same plane. The first rotor 2 is located between the third rotor 3 and the fourth rotor 4 and has its spiral first-rotor teeth 211 wound with the opposite sense than both the third rotor 3 and the fourth rotor 4 and profiles of his first-rotor teeth 211 define not only the second-rotor teeth 311 and the third-rotor teeth 411 but also a shape of the stator 1 inner surface.

Both the second rotor 3 and the third rotor 4 are identical. They have identical profiles of all their second-rotor teeth 311 and the third-rotor teeth 411, the said teeth 311,411 having also identical sense of lead and lead angles, the angle decreasing in the direction from inlet to outlet of the equipment. The inlet side of the equipment is the side with the smallest diameter of the convex wrapper of the first-rotor shaft 21, while the outlet side manifests the same diameter being the largest one. The first-rotor teeth 211 enter the intermediate spaces of threads of both the second-rotor teeth 311 and third-rotor teeth 411, in an interaction with them, the said mutual engagement being performed substantially along contact curves. Rotation tracks of the spiral first-rotor teeth 11 and the second-rotor teeth 311 overlap each other and the same applies for the first-rotor teeth 211 and the third-rotor teeth 411, as shown on Fig. 7a. The first-rotor teeth 211 divide opposing intermediate spaces of the threads of both the second-rotor teeth 311 thus covering them as partition walls. Simultaneously the second-rotor teeth 311 and the third-rotor teeth 411 divide opposing intermediate spaces of the threads of the first-rotor teeth 211, thus also covering them as partition walls. The inner space of the stator 1 is defined by rotation wrappers of all three rotors 2, 3, 4. Fig. 7b illustrates mutual interaction of the three rotors 2, 3, 4 with the first-rotor teeth 211, the second-rotor teeth 311 and the third-rotor teeth 411, as seen in a sectional plane perpendicular to axes of rotation of the said rotors2, 3, 4, the said teeth 211, 311, 411 having preferred profiles. The equipment according to the specific embodiment of Figs. 7a and 7b operates in such a way, that by counter rotation of the first rotor 2 with respect to the second rotor 3 and the third rotor 4 a medium entering through an input into the intermediate space of threads of all three rotors 2, 3, 4 is moved towards the output. By mutual interaction of the three rotors 2, 3, 4 there is performed a mutual partition of the first rotor 2 thread intermediate space by the second rotor 3 and vice versa and simultaneously there occurs a mutual partition of the first rotor 2 thread intermediate space by the third rotor 4 and vice versa. Due to the convex shape of the surfaces of the first-rotor shaft 21, the thread intermediate decreases with each subsequent thread and the medium within the thread intermediate spaces is compressed. In this embodiment the equipment operates as a compressor. In an alternative case, with a sense of rotation of the rotors 2, 3, 4 being opposite to the one described above, the equipment shall operate as an expander.. In all the specific embodiments of the equipment designed for operation either as a compressor or as an expander, the stator may be alternatively furnished with rotors having concurrent axes. This arrangement shall result in a steeper waveform of operation characteristics of such an equipment. Another preferred specific embodiment is displayed on Figs. 8a, 8b, 8c and 8d. Fig. 8e shows waveforms of pressure and volume in thread intermediate space relating to this embodiment. In the stator 1, which representing also a housing of the equipment, the are seated the first rotor 2 and the second rotor 3. The first rotor 2 comprises the first-rotor shaft 21, the surface of which within sections X and Z, as seen on Fig. 8d, has a convex shape, while within a section Y it has a concave shape. On the first-rotor shaft 21 two spiral first-rotor teeth 211 are wound, both first-rotor teeth 211 being mutually turned by an angle of 180°. The second rotor 3 consists of a second-rotor shaft 31, the surface of which within the sections X and Z, see Fig. 8d, has a convex shape, while within the section Y it has a concave shape. On this surface two spiral second-rotor teeth 311 are wound, both second-rotor teeth 311 being mutually turned by an angle of 180°. Both rotors 2, 3, have parallel axes and substantially identical profiles of all the first-rotor and second-rotor teeth 211, 311. The teeth 211, 311 lead angle is decreasing within the section X, while remaining constant within the section Y and increasing within the section Y. Diameter of a rotation wrapper of the first rotor 2 and the second rotor 3, is increasing within the section X in the direction inwards from the inlet, while having substantially minimum value within the section Y and increasing within the section Z along the direction towards the outlet, where it reaches its maximum value. The first-rotor teeth 211 have lead with a sense opposite to the one of the second-rotor teeth 311. Both first-rotor teeth 211 enter into the intermediate spaces of threads of both second-rotor teeth 311, providing for an interaction of both rotors 2,3, their mutual engagement being performed substantially along contact curves. Rotation tracks of the spiral first-rotor teeth 211 and the second-rotor teeth 311 overlap each. The spiral first-rotor teeth 211 divide opposing intermediate spaces of the threads of the second-rotor teeth 311 thus covering them as partition walls. Simultaneously the second-rotor teeth 311 divide opposing intermediate spaces of the threads of the first-rotor teeth 211, thus also covering them as partition walls. The inner space of the stator 1 is limited by rotation wrappers of both rotors 2, 3. In this embodiment the equipment may work as an internal combustion engine. A medium enters through inlet in the section X, which operates as a compression chamber of the engine. The section Y operates as an injection and ignition area and the section Z represents an expansion space of the motor completed with the outlet.

The combustion engine according to the specific embodiment of Figs. 8a, 8b, 8c, 8d operates in such a way, that by a counter rotation of the first rotor 2 and the second rotor 3 within the stator 1 air is sucked through an input and moved into the intermediate space of threads of the first-rotor teeth 211 and the second-rotor teeth 311. In the section X, due to the convex shape of surfaces of both the first-rotor shaft 21 and the second-rotor shaft 31 and the respective shape of the stator 1 inside surface the air is compressed. In the section Y fuel is injected into the compressed air and ignited. In the section Z the burning fuel expands and its pressure energy acts within thread intermediate spaces of the rotors 2,3 upon surfaces of the first-rotor teeth 211 and the second-rotor teeth 311 and the action results in a torque of the rotors 2,3. The outlet is the motor exhaust.

On Fig. 8e a curve depicted as “V-curve” represents changes of volume, while the other curve, the “P-curve”, represents changes of pressure within the individual sections X, Y, Z of the motor.

In an alternative case of the combustion engine, the first-rotor teeth 211 may have the same sense of lead as the spiral second-rotor teeth 311 and in consequence of this both rotors 2,3 must the same sense of rotation. The function of such combustion engine is substantially the same. The lead sense and mutual engagement of the first-rotor teeth 211 and the second-rotor teeth 311 is a limiting factor for shapes of profiles of the spiral teeth 211, 311 and therefor also for practical applications of such a combustion engine.

In further alternative embodiments of the combustion engine, the convex surfaces of first-rotor shaft 21 and second-rotor shaft 31 in section X,Z may be changed into a concave one while the surface of the shafts 21, 31 within the section Y has a convex shape. The surface of the shafts 21, 31 may even be of a cylindrical or a tapered shape.

Still further specific embodiment of the equipment according to the invention is schematically shown on Figs. 9a and 9b. In stator 1 there are seated three rotors, a first rotor 2, a second rotor 3 and a third rotor 4, all three rotors being in a mutual interaction, their axes being located in one and the same plane. The arrangement of the rotors 2, 3, 4 correspond substantially to the embodiment shown on Figs. 7a, 7b. A part of the equipment, which on Fig. 9a is depicted as an „M-section“, corresponds to the construction of Fig.7a, designed for compressor application. The adjacent part of the equipment following the “M-section”, on Fig. 9 depicted as an „N-section“, corresponds to the construction of Fig.7a, but in an alternative, expander application.

The function is similar to the one applying for the specific embodiment of Figs 8a, 8b, 8c, 8d. The equipment therefore operates also as a combustion engine. The injection and ignition area corresponds to the area of transition of the “M-section” into the “N-section”.

Further specific embodiment of the equipment according to the invention is schematically presented on Figs. 10a, 10b, which for sake of clarity and understandability show only the first rotor 2 and the second rotor 3, without the stator 1. Displayed there are also only rotation wrappers of the first-rotor teeth 211 and the second-rotor teeth 311. This equipment being equivalent to the one shown on Figs. 8a, 8b, 8c and 8d, is also a combustion engine. The only difference is, that the axis of the first rotor 2 and the axis of the second rotor 3 are skew lines. This particular embodiment allows for steep working characteristic of the engine. In alternative cases of skew rotor axis arrangement the equipment could be operated also as a compressor and/or expander, again with the advantage of very steep working characteristics.

Figs. 11a, 11b, 11c, 11d and 11e schematically display several examples of mutual arrangement of the first rotors 2, the second rotors 3 and the stators 1 of the equipment described above. There exists a variety of other combinations, which could be applied according to the particular requirements on the equipment functions. Fig. 11a presents a side-by-side arrangement of the first rotors 2 and the second rotor 3, their axes being parallel.. Figs. 11b, 11c show a star-shape arrangement of one first rotor 2 and multiple second rotors 3 seating in the stator 1. Fig. 11d illustrates an alternative arrangement of three first rotors 2 in the stator 1, where all three first rotors 2 are in a mutually engagement and therefore must have the same sense of rotation. Fig. 11e represents another alternative arrangement of two first rotors 2 and two second rotors 3 in the stator 1, where each rotor engages with two adjacent rotors 2, 3.

The last but not least preferred embodiment of the technical solution according to the invention is schematically shown on Fig. 12.. In the stator 1, which is also a housing of the equipment, there are seated the first rotor 2 and the second rotor 3. The first rotor 2 consists of the first-rotor shaft 21 with a convex surface, on which there are wound-up the first spiral first-rotor tooth 211 and the spiral second first-rotor tooth 211, both teeth 211 being mutually shifted by the angle of 180°. The second rotor 3 consists of the second-rotor shaft 31 with a convex surface, on which there are wound-up the first spiral second-rotor tooth 311 and the second spiral second-rotor tooth 311, both teeth 311 being mutually shifted by angle of 180°. Both the first rotor 2 and the second rotor 3, have concurrent axis, mutually identical profiles of all first-rotor teeth 211 and second-rotor teeth 311, with lead angle increasing from the inlet side towards the outlet side, provided the volume of thread intermediate spaces is constant. The first-rotor teeth 211, have the opposite sense of lead than the second-rotor teeth 311. Both first-rotor teeth 211 enter into the intermediate spaces of the threads of both second-rotor teeth 311, the rotors engaging substantially along the contact curves. The rotation tracks of the first-rotor teeth 211 and the second-rotor teeth 311 overlap each other. The first-rotor teeth 211 divide the opposite intermediate spaces of the threads of the second-rotor teeth 311 thus substantially closing them as partition walls. At the same time the second-rotor teeth 311 divide the opposite intermediate spaces of the threads of the first-rotor teeth 211 thus substantially closing them as partition walls. The inner space of stator 1 is limited by a rotating wrapper of the first rotor 2 and also by a rotating wrapper of the second rotor 3. In this embodiment the inlet of the equipment on the side with maximum mutual overlapping of the first rotor 2 and the second rotor 3 and the distance between their rotation axis being the largest one. The outlet of the equipment is at the opposite side, with minimum mutual overlapping of the rotors and smallest distance of their rotation axis.

The equipment according to the specific embodiment of Fig. 12 operates in such a way, that by counter rotation of the first rotor 2 and the second rotor 3 within the stator 1 the medium enters through an input into the intermediate space of threads of the first rotor 2 and the second rotor 3 and is moved towards the output. By mutual interaction of the first rotor 2 and the second rotor 3 there is performed a mutual partition of the first rotor 2 thread intermediate space by the second rotor 2 and vice versa. Due to the convex shape of the surfaces of the first-rotor shaft 21 and the second-rotor shaft 31 and increasing angle of lead of both the first-rotor teeth 211 and the second-rotor teeth 311, their thread intermediate spaces are changing in shape but remain constant in volume. Speed of the medium transfer through the thread intermediate space accelerates along the direction from the inlet towards the outlet. Such an embodiment is suitable for application as a driving gear for ships.

By all the above mentioned preferred embodiments, except the equipment with only one spiral tooth or only one rotor, it is possible to wind up the spiral teeth alternatively on surface of shafts with a mutual irregular angle shift. It shall require a change of profiles of the spiral teeth, designed by known methods, to achieve mutual interaction between the rotors themselves and the rotors with respect to the stator.

It is also possible to wind up a higher number of spiral teeth on a shaft surface Nevertheless it shall also require a change of profiles of the spiral teeth, designed by known methods, to achieve mutual interaction between the rotors themselves and the rotors with respect to the stator. It can be advantageous for an effective action of a medium within thread intermediate spaces, for a strength of the material of spiral teeth and for efficiency of the equipment. It is also possible to manufacture variants with different number of spiral teeth wound-up on individual parts of the surface of the same shaft.

Another variation of all above mentioned equipment may comprise embodiments with rotors divided in a plane perpendicular to the axis of their rotation, the rotors being mutually interconnected by gears. The advantage of such variations would include a possibility of a change of working characteristics of particular equipment and a continuous and smooth control of the operation.

From the above mentioned examples of specific embodiments, their alternatives and variations it is evident, that the basic invention idea and the invention step comprise the solution enabling to combine at the same time changes of all parameters of spiral teeth in mutual interaction, concavity and/or convexity of the rotor shaft surfaces and the inner stator surfaces.

Each section of the thread intermediate space of the equipment according to the invention could be really different and in any place of the rotor it is possible to change at the same time all three parameters, namely the diameter, the sense of lead and the angle of lead of the spiral teeth.

Industrial applications

The present invention is designed for many industrial branches and fields. It can be applied especially everywhere, where compressors and turbo-compressors, expanders, exhausters, combustion engines, steam or gas engines and turbines, hydro-motors, hydro-generators, pump, mixing equipment and spiral drives of ships are used.

The list of reference characters

| | |
|---|---|
| 1 | - stator |
| 111 | - stator tooth |
| 2 | - first rotor |
| 21 | - first-rotor shaft |
| 211 | - first-rotor tooth |
| 3 | - second rotor |
| 31 | - second-rotor shaft |
| 311 | - second-rotor tooth |
| 4 | - third rotor |
| 41 | - third-rotor shaft |
| 411 | - third-rotor tooth |

## CLAIMS

1. An equipment with mutually interacting spiral teeth, comprising at least one rotor and one stator with a working surface limited by at least two spiral teeth, which are in mutual interaction by their wrappers and the spiral teeth being wound-up on shaft surfaces, thus creating rotors, or simultaneously on a surface of at least one shaft, thus creating a rotor, and also on a inner stator surface, provided the spiral teeth have the same or opposite sense of thread lead, a constant or variable lead angle and the spiral teeth wrapper is determined by sum of profiles of all sections through the spiral tooth by rotation planes intersecting the axis of rotation and at the same time being co-axial with the axis of the spiral tooth rotation, while the axes of rotations of mutually interacting spiral teeth are parallel or concurrent or skewed, **characterised in**, **that** at least a part of a rotation wrapper of the first-rotor shaft (21) of at least one of the first rotor (2) is created by a rotation of a curve around the axis of the first-rotor shaft (21), the curve being concave or convex to the rotating axe of the first-rotor shaft (21) and at least a part of the surface is concave or convex with respect to the rotating axis of the said stator (1) inner space and is represented by a shape of a rotation wrapper of the first rotor (2), provided all profiles of sections through the spiral first-rotor teeth (211) correspond to a concave and/or convex shape of the stator (1) inner wrapper and to a wrapper of the first-rotor shaft (21) of at least of one first rotor (2).

2. The equipment according to claim 1, characterised in, that at least two rotors, the first rotor (2) and the second rotor (3) are through their rotation wrappers in a mutual engagement with the stator (1) inner surface and each pair of rotors, the first rotor (2) and the second rotor (3), are in a mutual engagement through spiral surfaces of their first-rotor teeth (211) and the second-rotor teeth (311) and the mutual engagement is carried out along the contact curves comprising points of the smallest mutual distance of each profile of the first-rotor teeth (211) and second-rotor teeth (311).

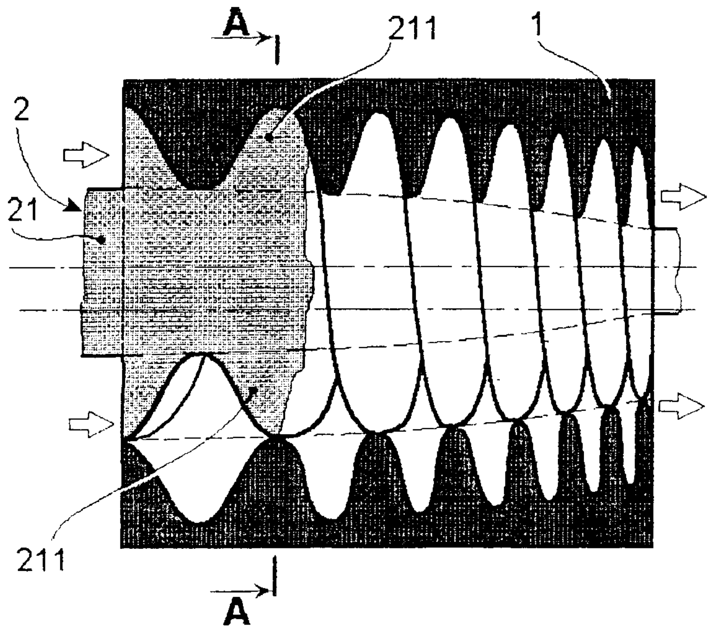


Fig. 1a

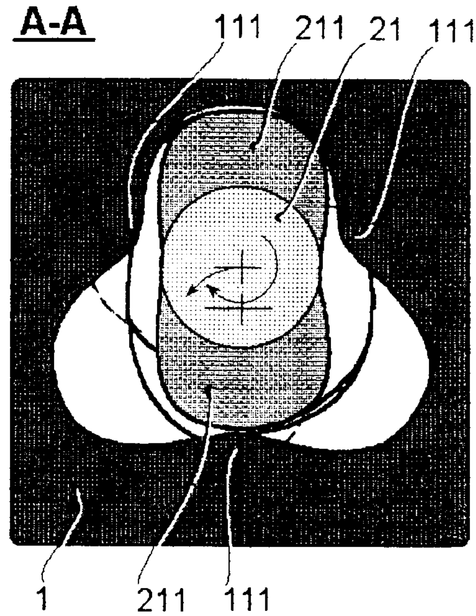


Fig. 1b

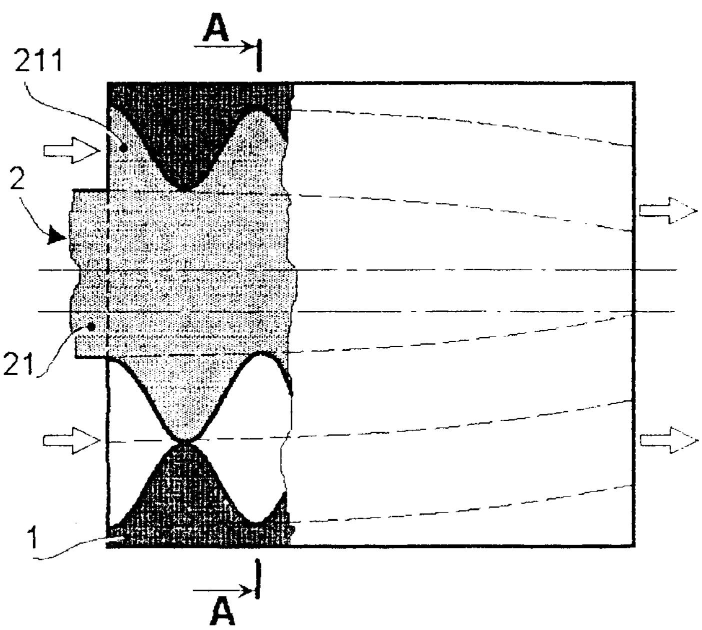


Fig. 1c

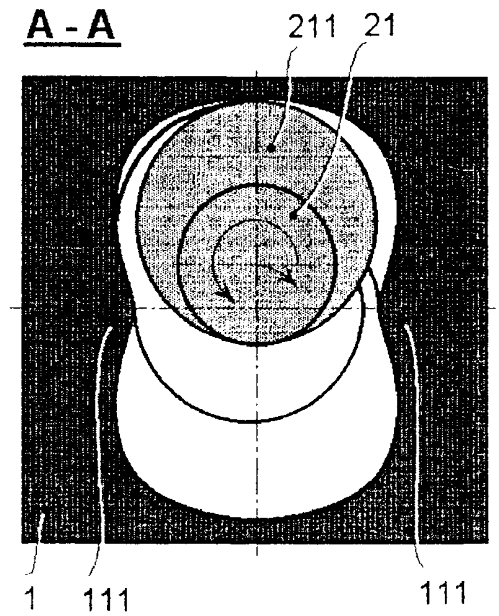


Fig. 1d

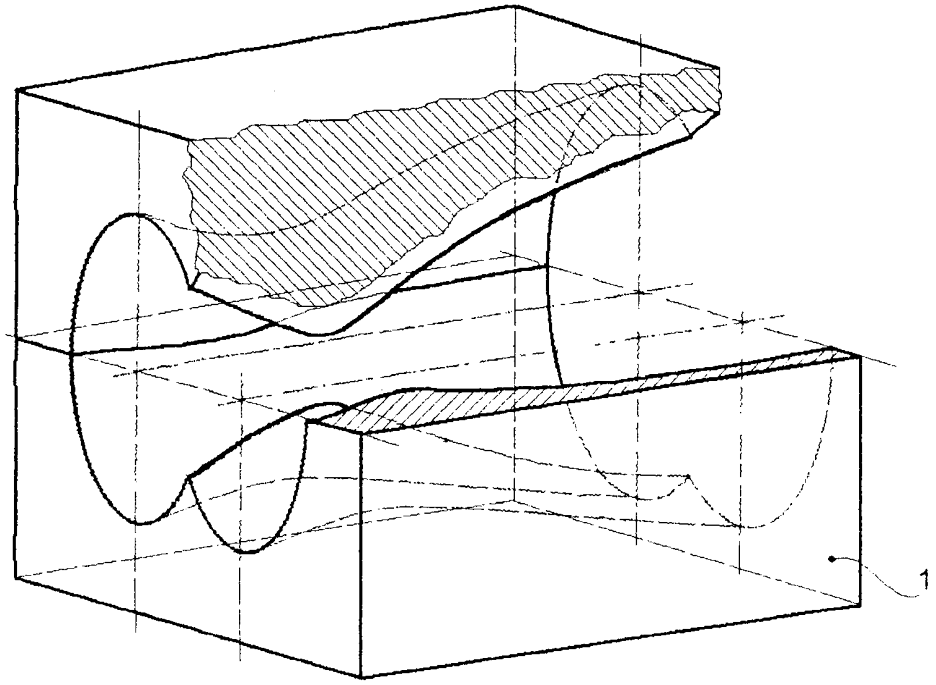


Fig. 2a

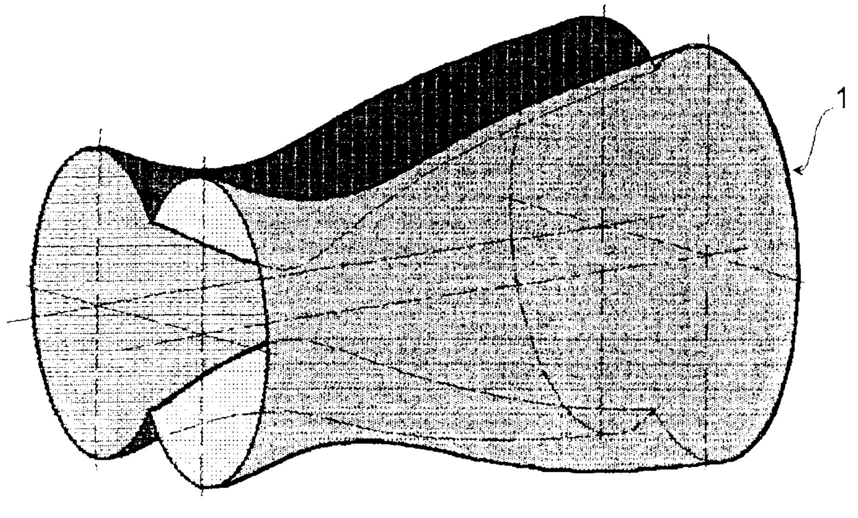


Fig. 2b

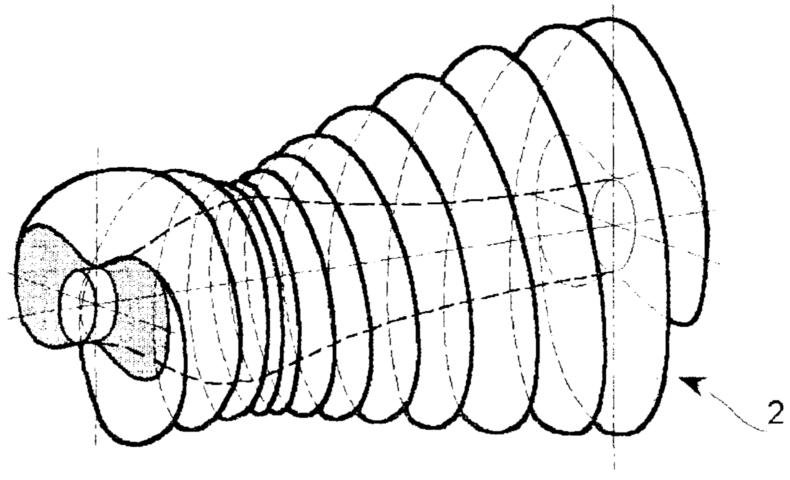


Fig. 2c

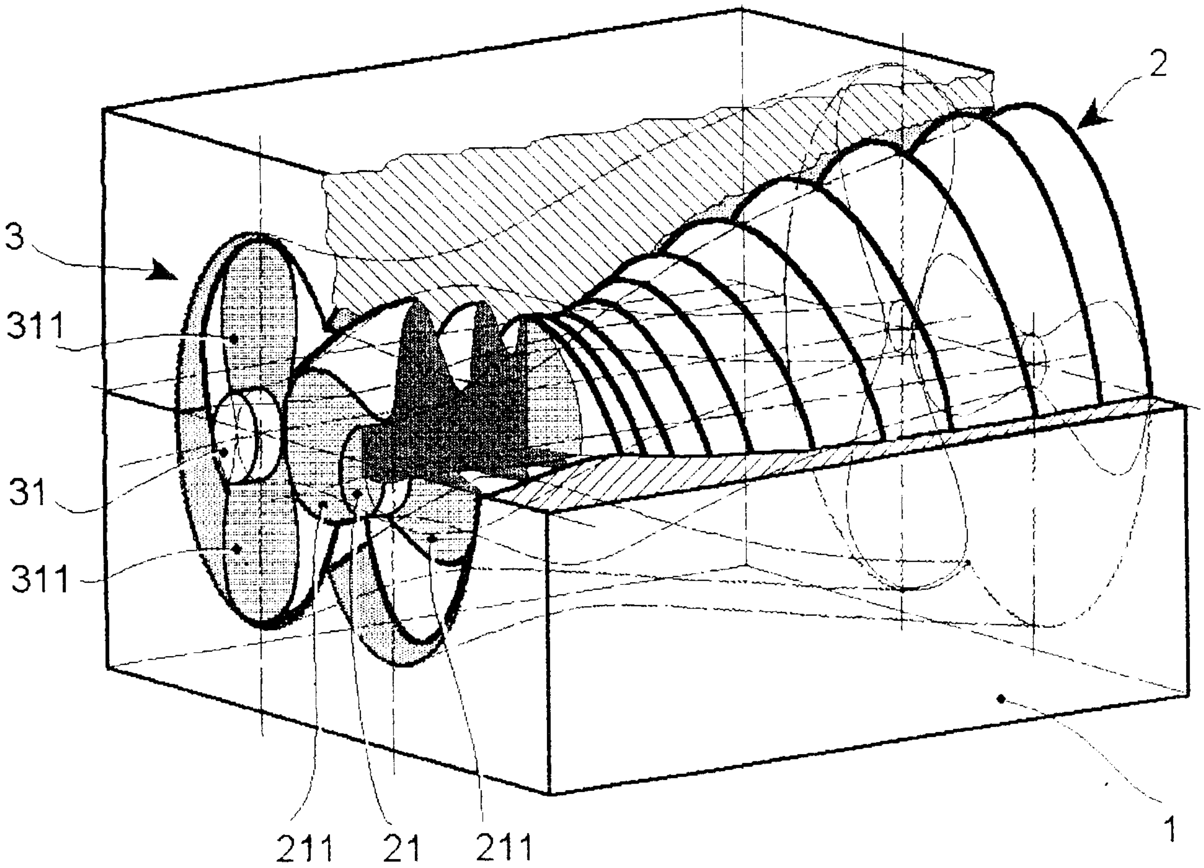


Fig. 3

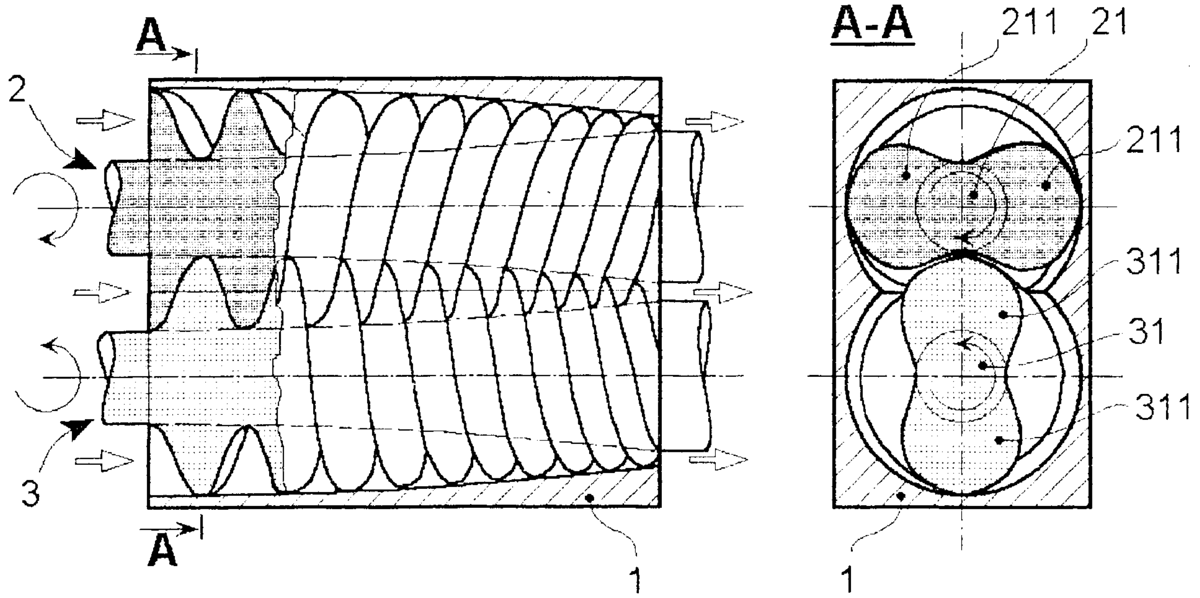


Fig. 4a Fig. 4b

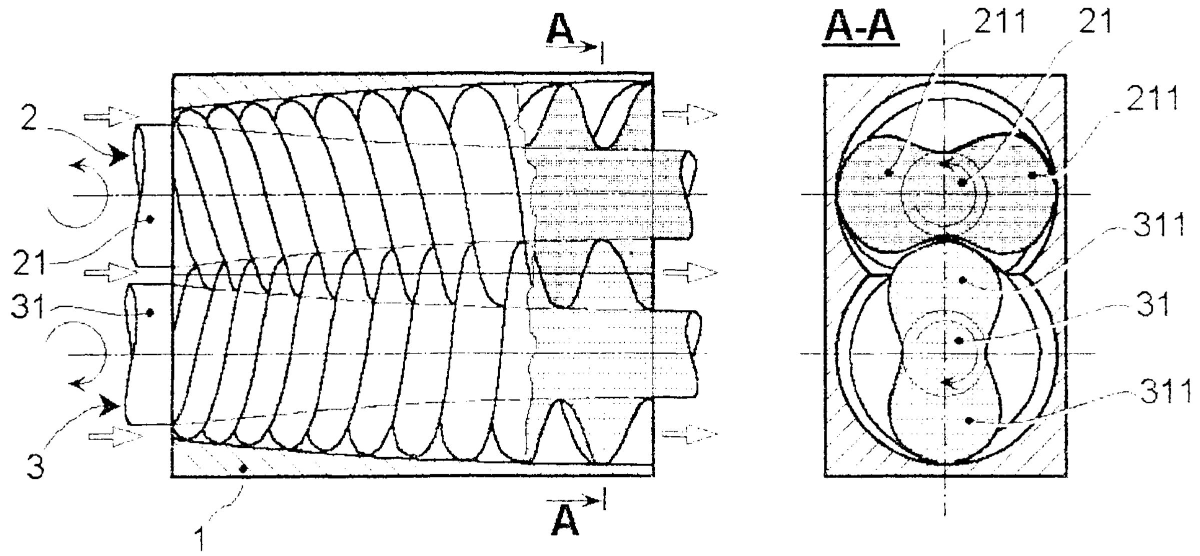


Fig. 4c Fig. 4d

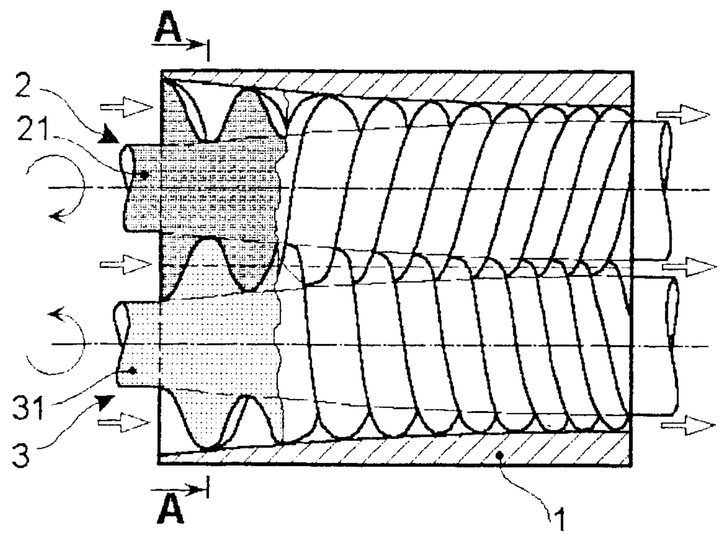


Fig. 5a

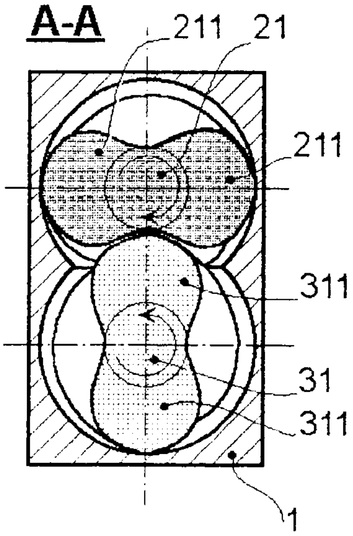


Fig. 5b

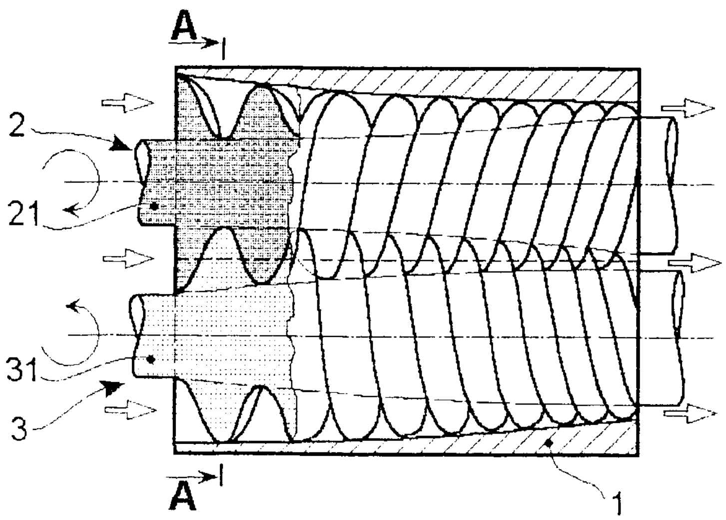


Fig. 5c

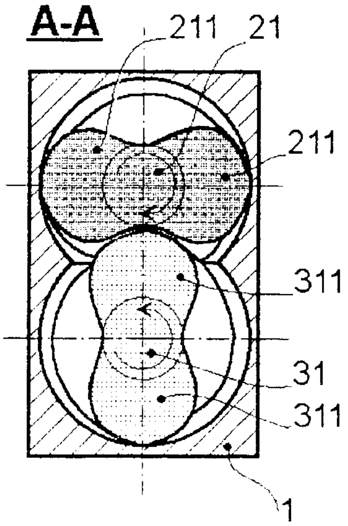


Fig. 5d

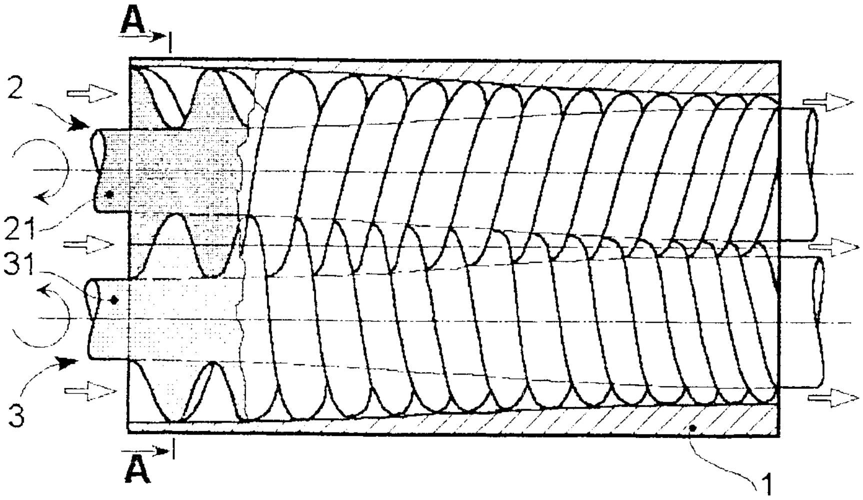


Fig. 5e

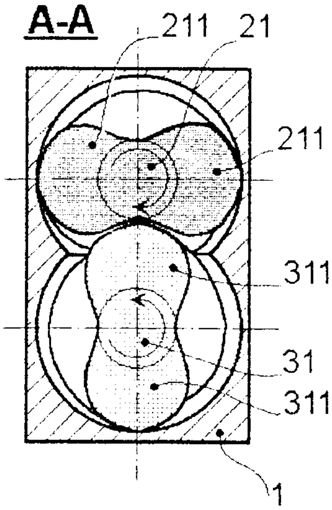


Fig. 5f

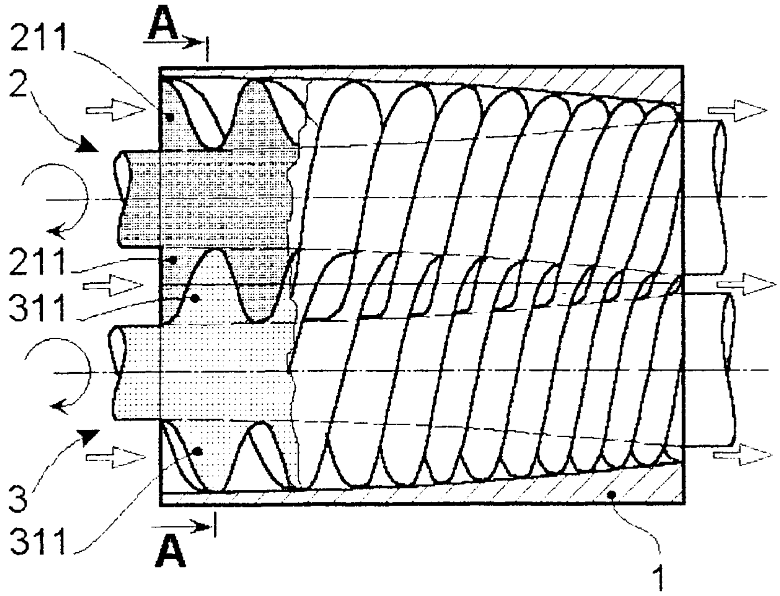


Fig. 6a

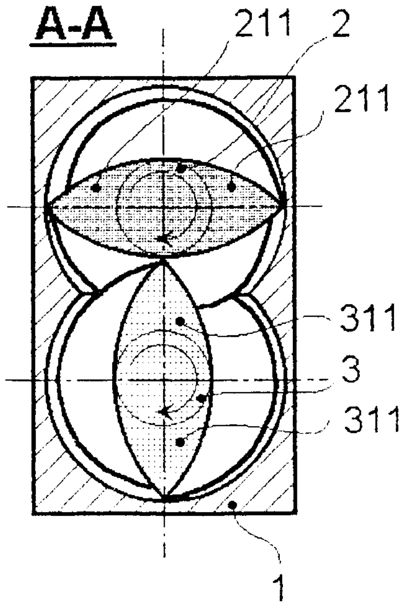


Fig. 6b

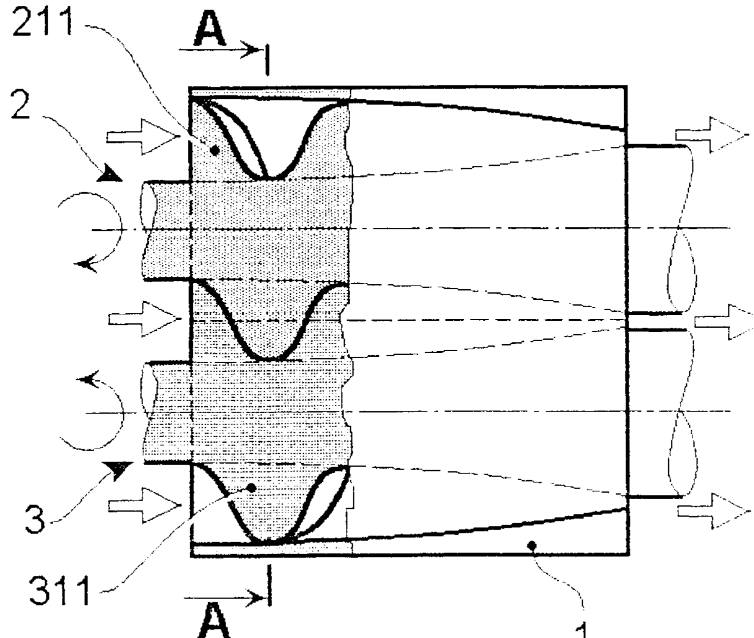


Fig. 6c

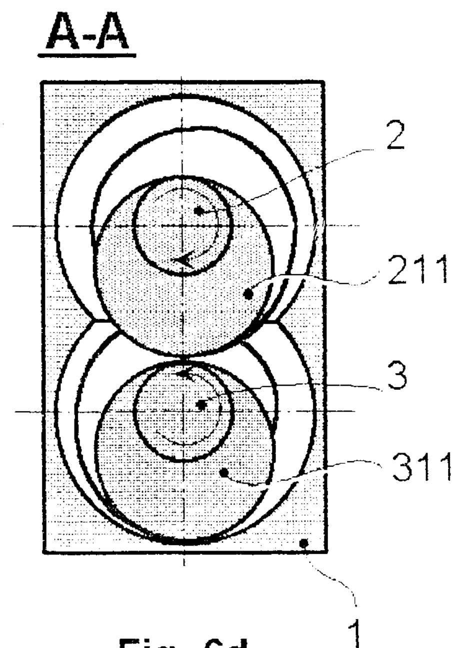


Fig. 6d

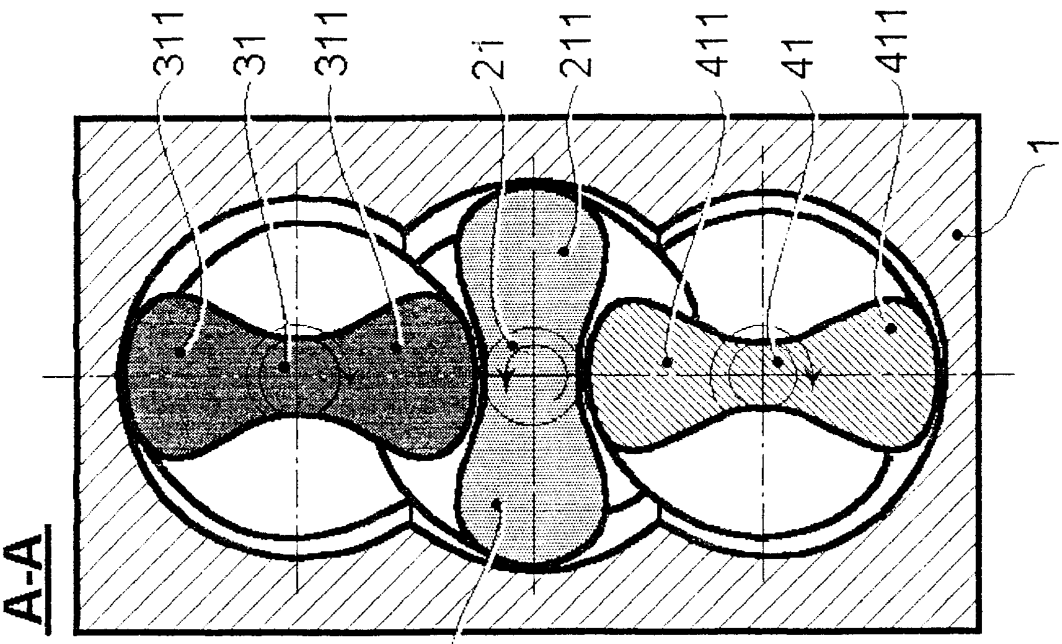


Fig. 7b

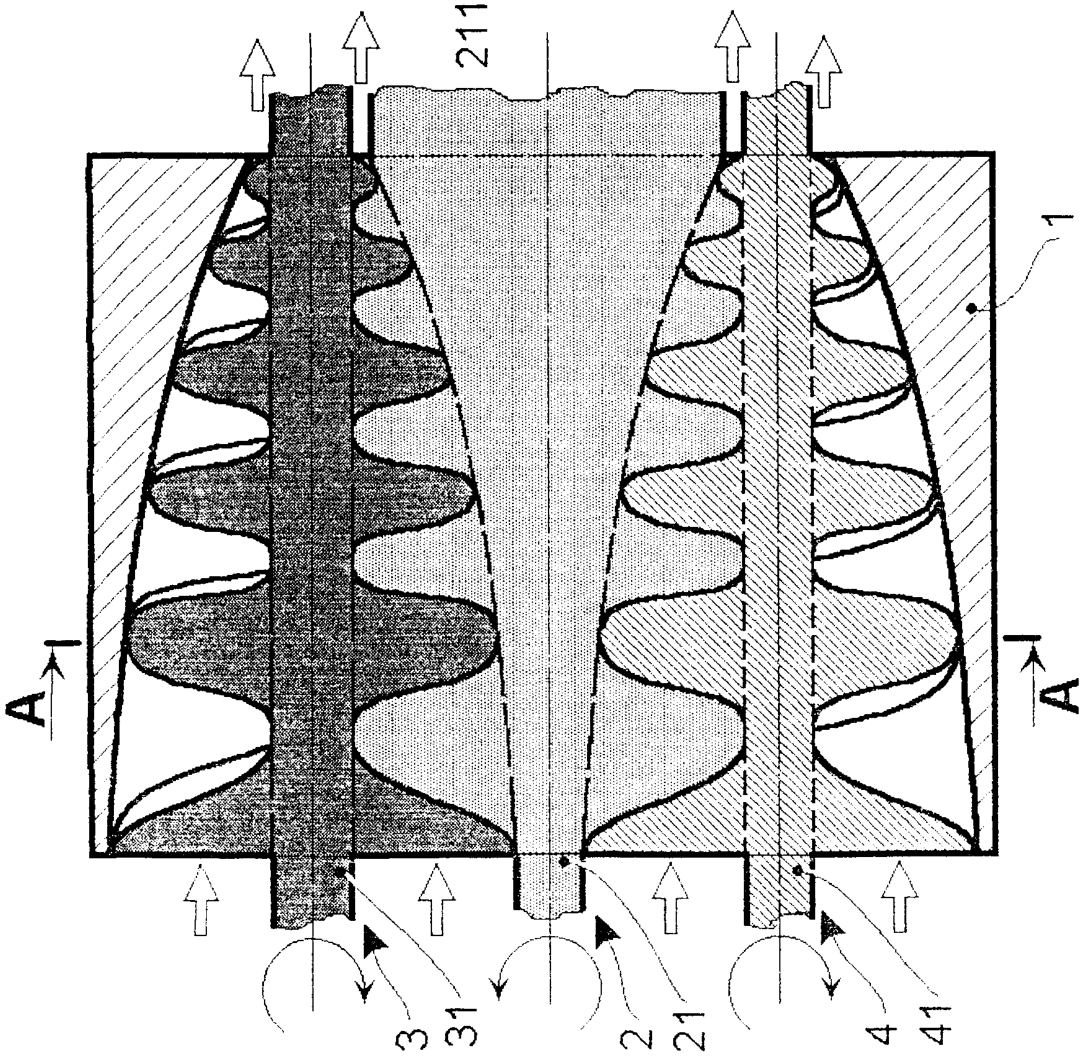


Fig. 7a

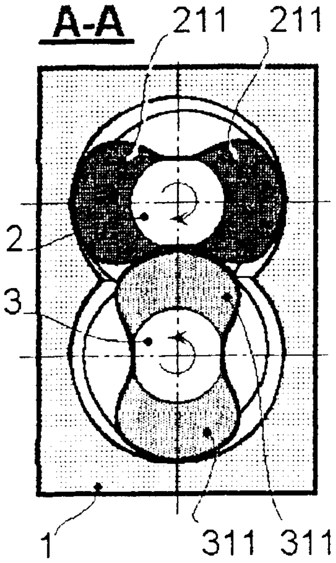

Fig. 8a

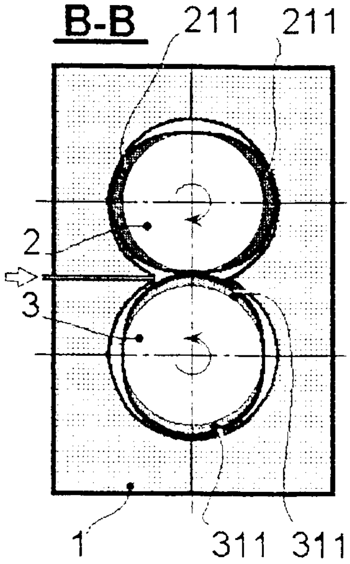

Fig. 8b

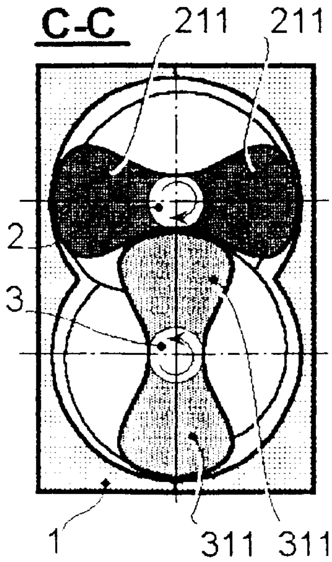

Fig. 8c

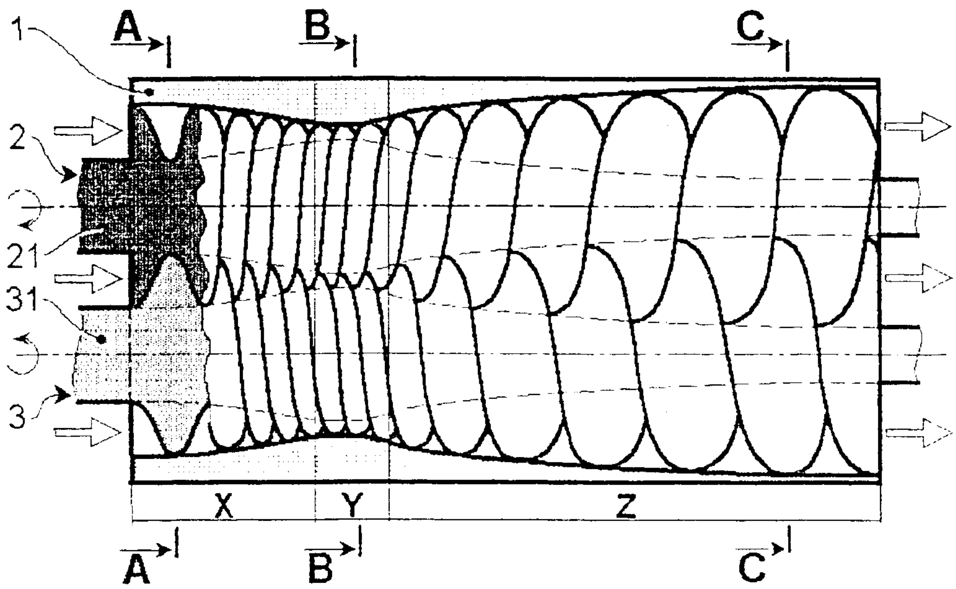

Fig. 8d

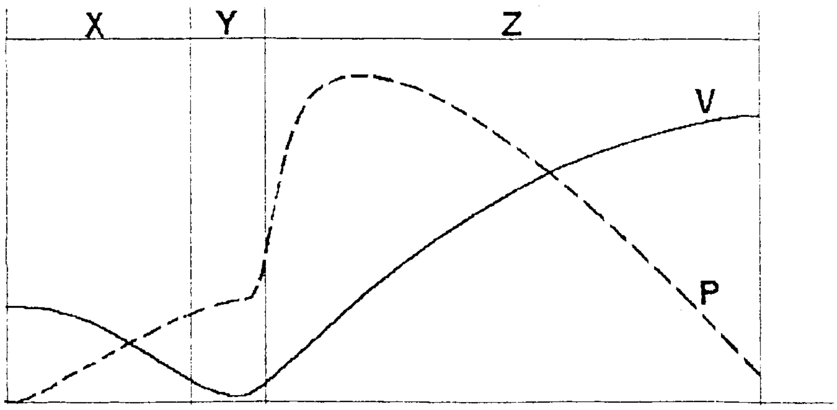

Fig. 8e

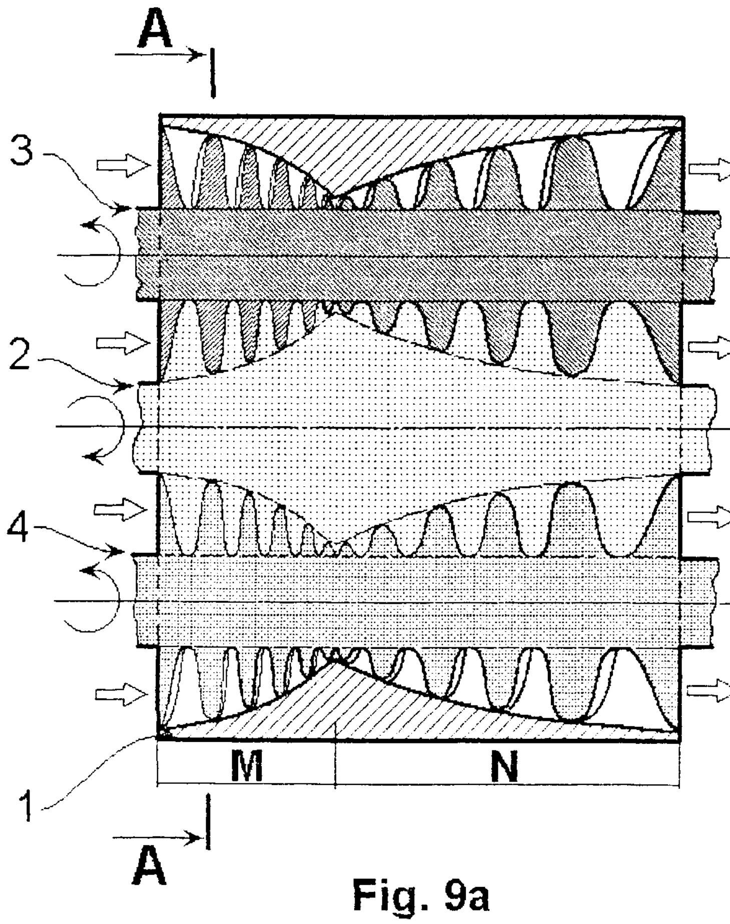


Fig. 9a

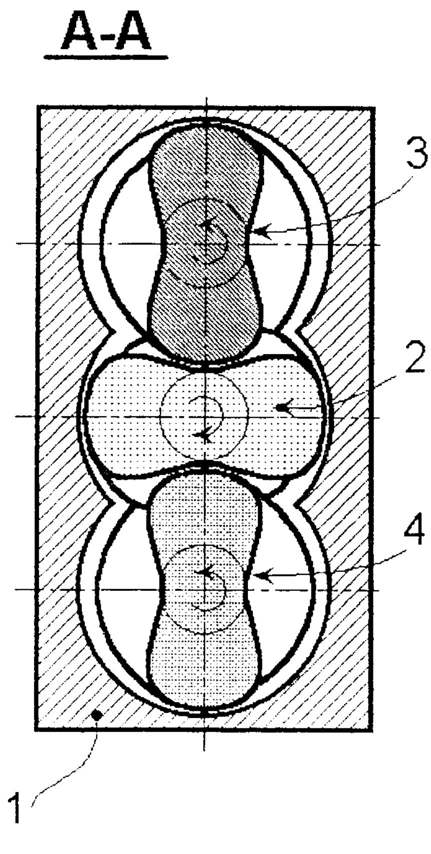


Fig. 9b

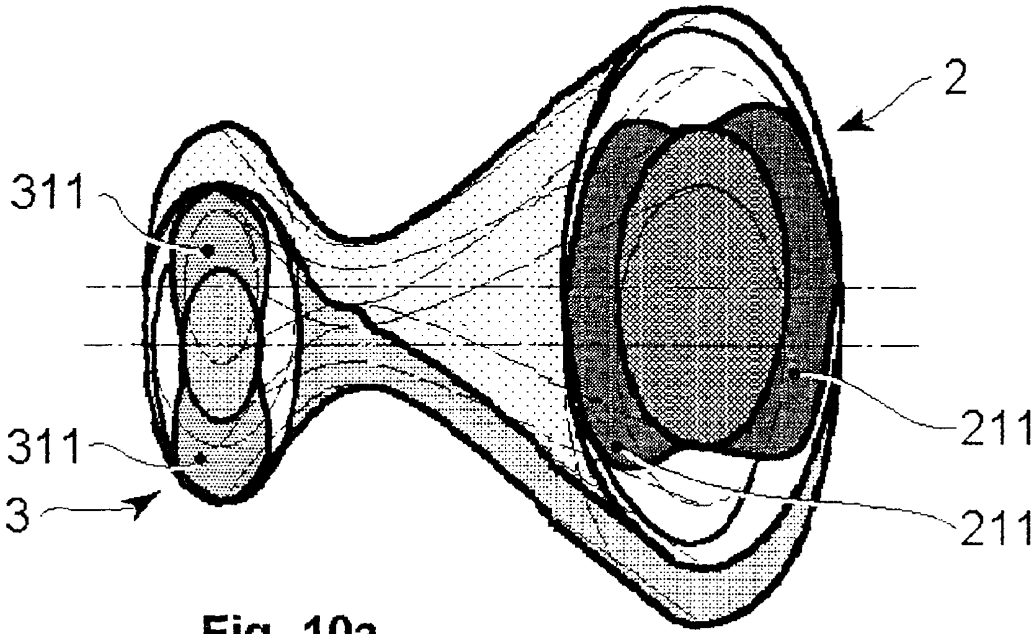


Fig. 10a

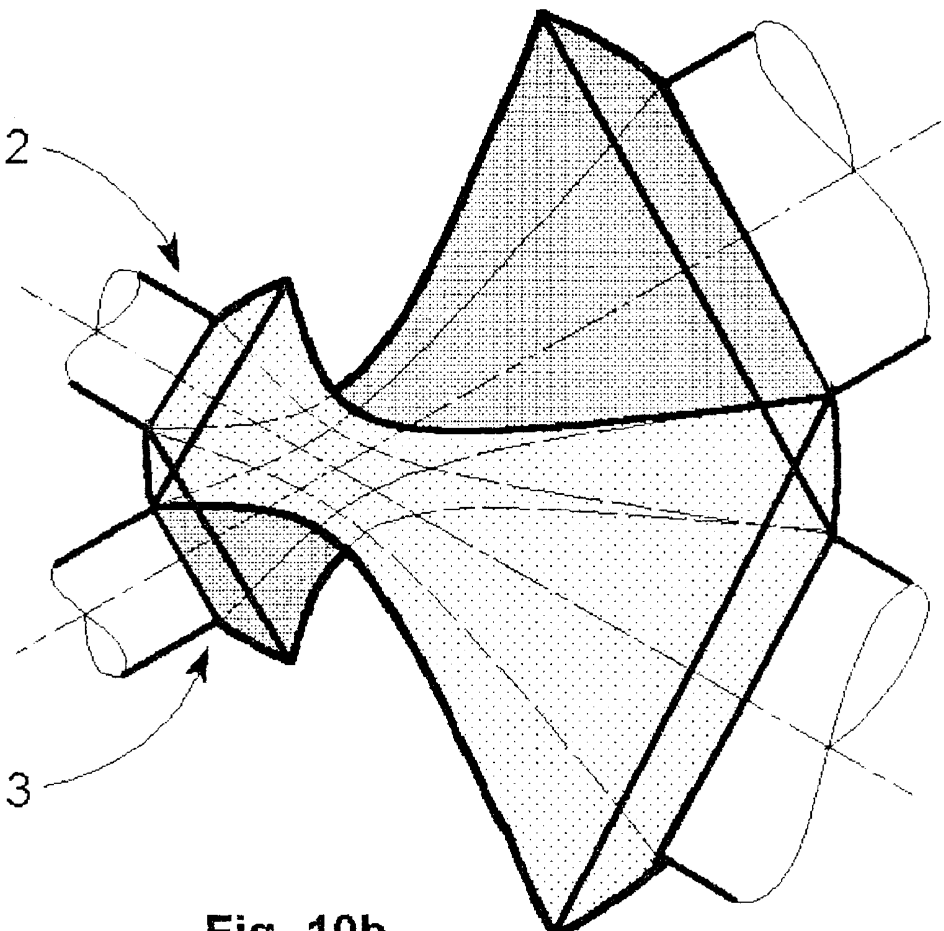


Fig. 10b

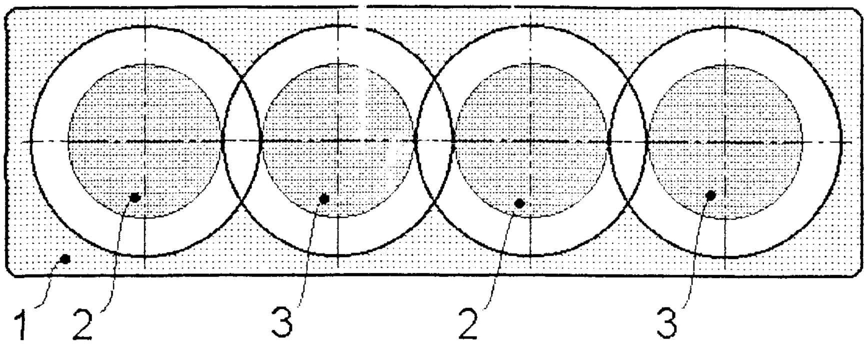


Fig. 11a

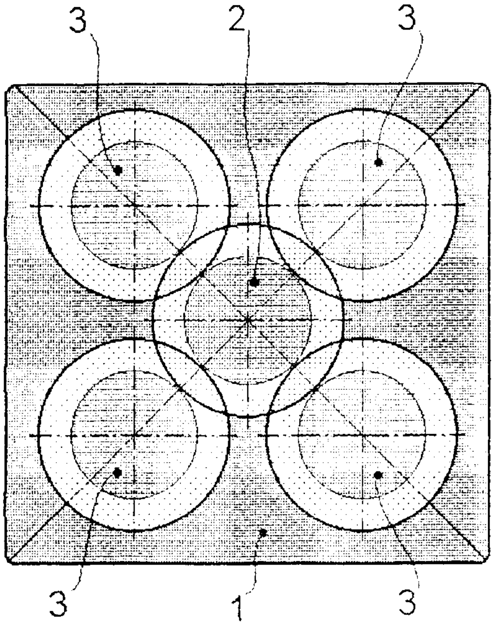


Fig. 11b

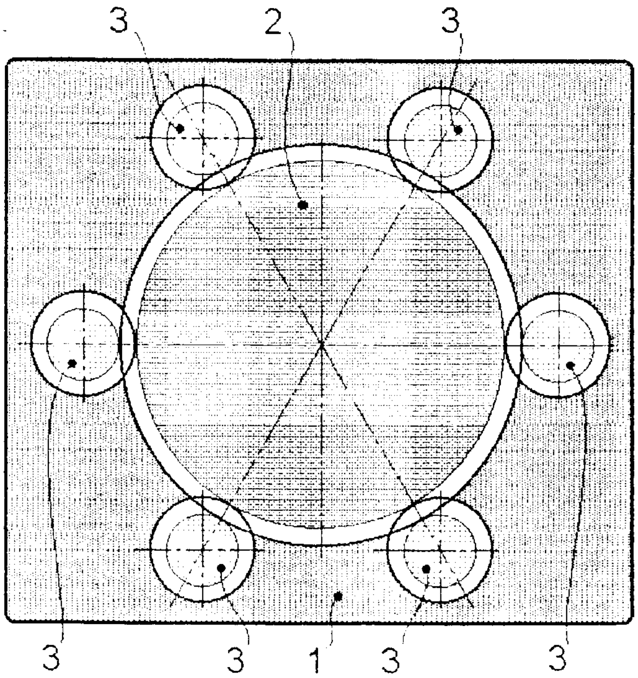


Fig. 11c

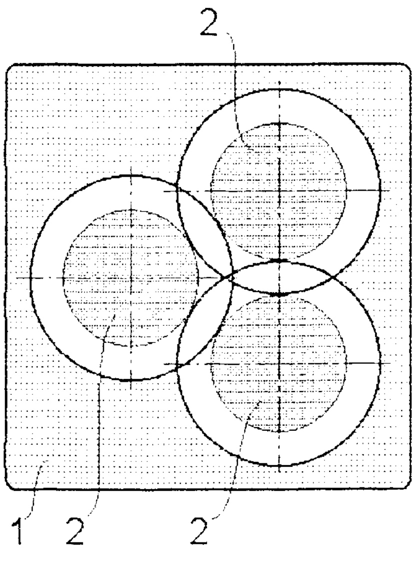


Fig. 11d

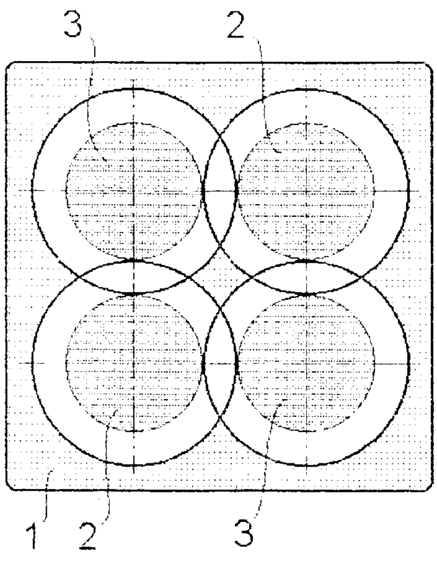


Fig. 11e

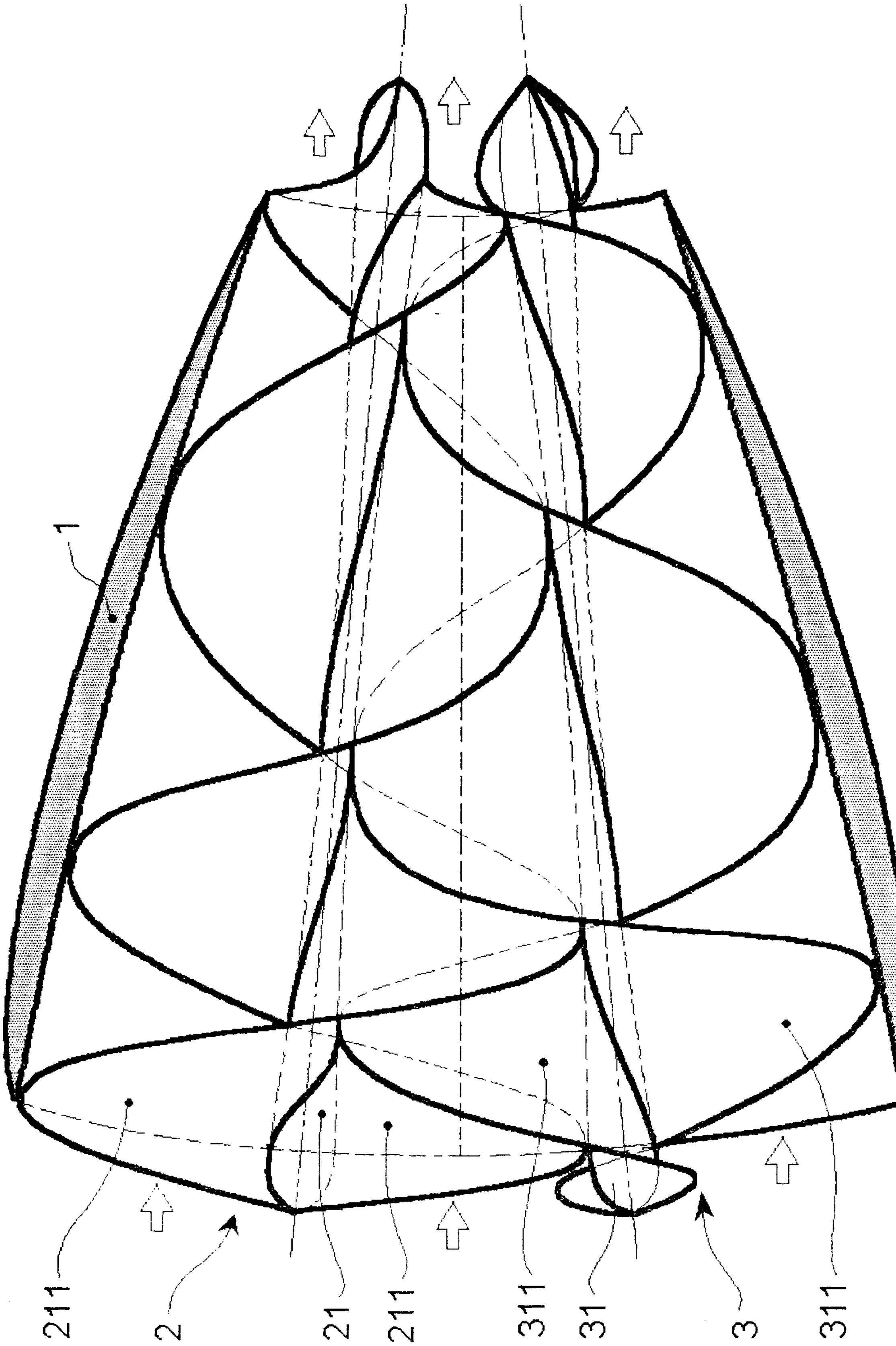


Fig. 12

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/CZ 01/00007

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 F01C1/16 F01C3/08

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F01C F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| Y | column 2, line 6 -column 3, line 26 column 4, line 64 -column 5, line 10 column 6, line 11 -column 7, line 9; figure --- | 1,2 |
| X | US 2 908 226 A (RICH) 13 October 1959 (1959-10-13) column 1, line 67 -column 2, line 26 column 3, line 1 -column 4, line 11; figures 1-3 column 7, line 11 - line 47; figures 19-22 --- -/-- | 1,2 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 6 July 2001 | 18/07/2001 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016 | Kapoulas, T |

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# INTERNATIONAL SEARCH REPORT

International Application No
PCT/CZ 01/00007

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
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| X | GB 419 338 A (BRITISH THOMSON-HOUSTON CO.) 9 November 1934 (1934-11-09) page 3, line 44 - line 82; figures 8,9 | 1,2 |
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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