Aug. 3, 1943. A. LYSHOLM ET AL 2,325,617

ROTOR

Filed Jan. 12, 1939 3 Sheets-Sheet 1

Fig. 1.

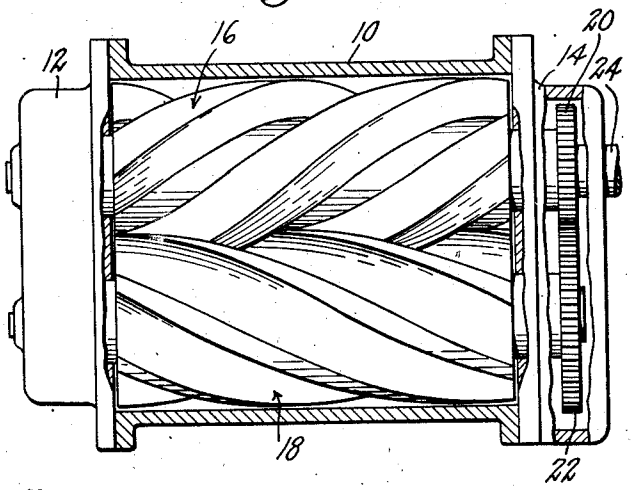
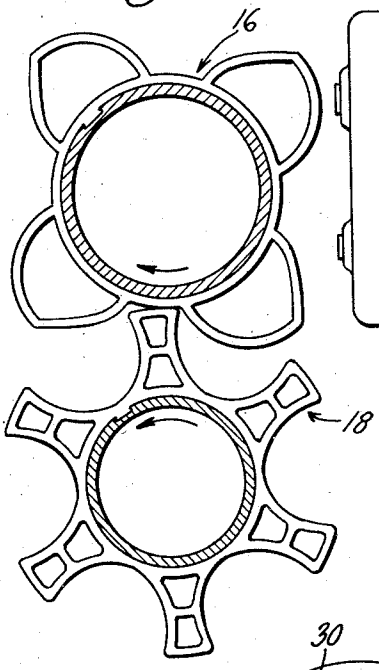



Fig. 2.



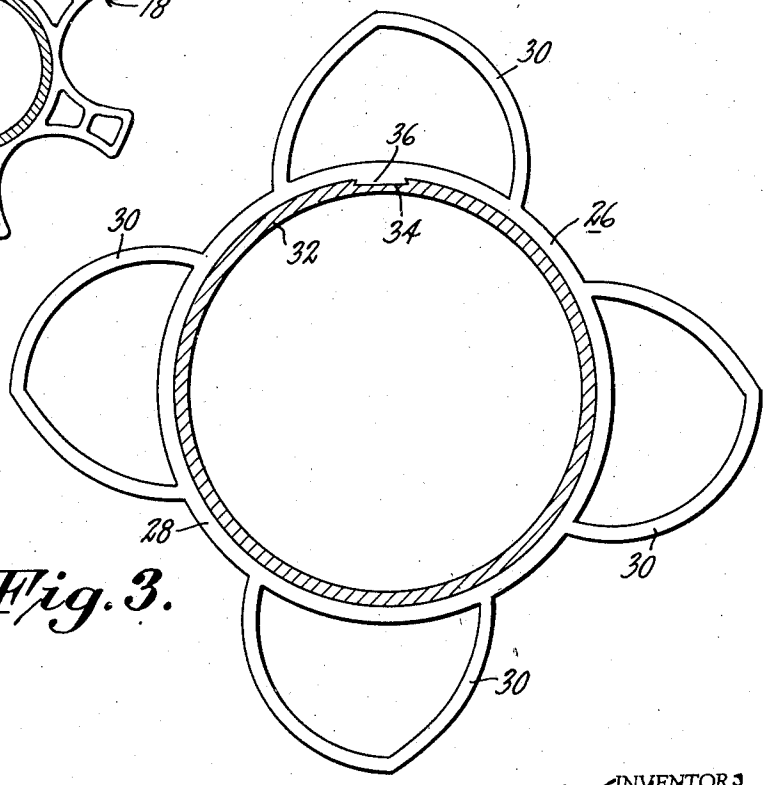




Fig. 3.

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Aug. 3, 1943. A. LYSHOLM ET AL 2,325,617

ROTOR

Filed Jan. 12, 1939 3 Sheets-Sheet 2

Fig. 4.

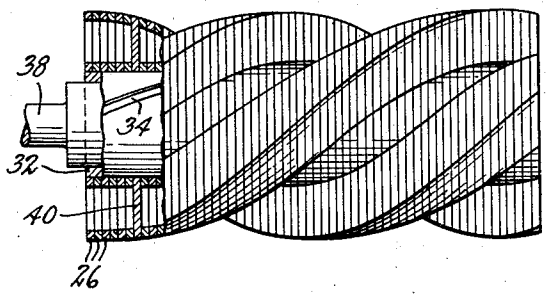



Fig. 5.

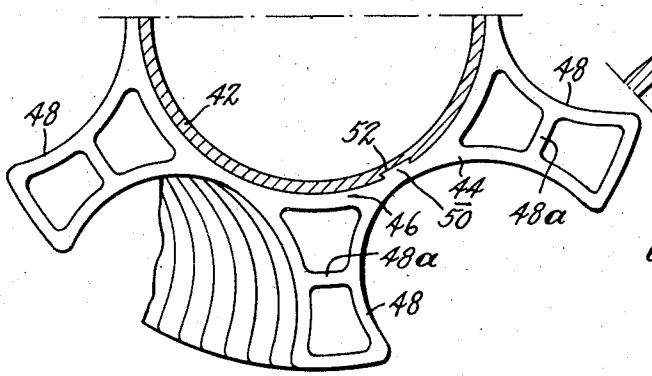



Fig. 6.

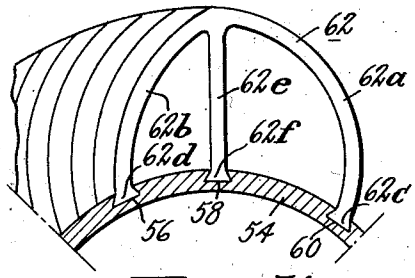



Fig. 7.

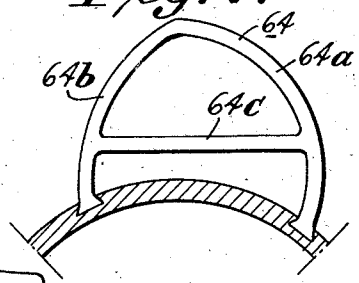



Fig. 8.

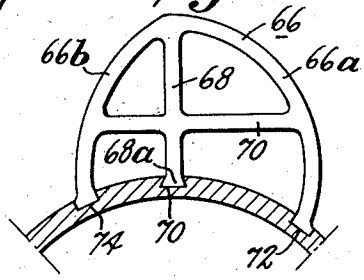
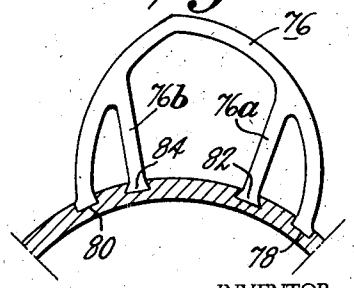



Fig. 9.




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Aug. 3, 1943. A. LYSHOLM ET AL 2,325,617

ROTOR

Filed Jan. 12, 1939 3 Sheets-Sheet 3

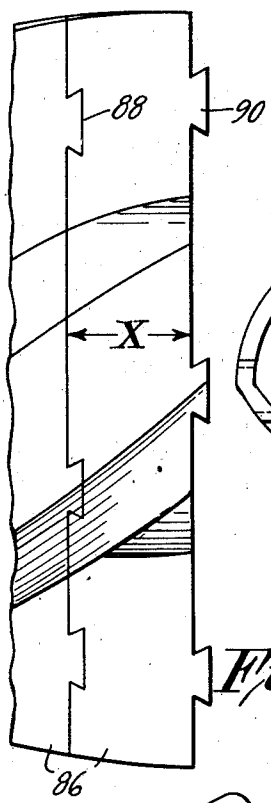



Fig. 11.

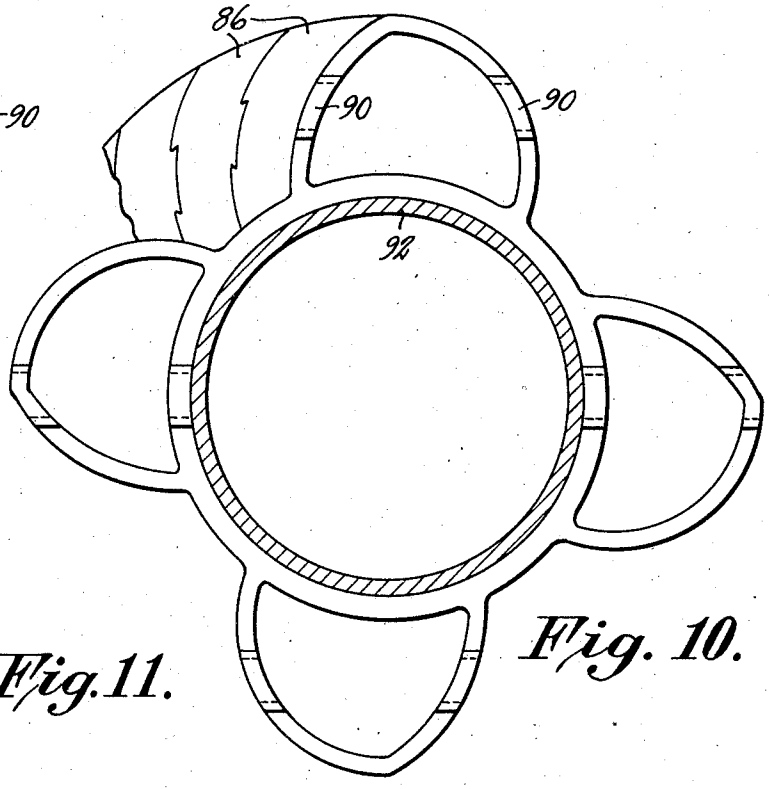



Fig. 10.

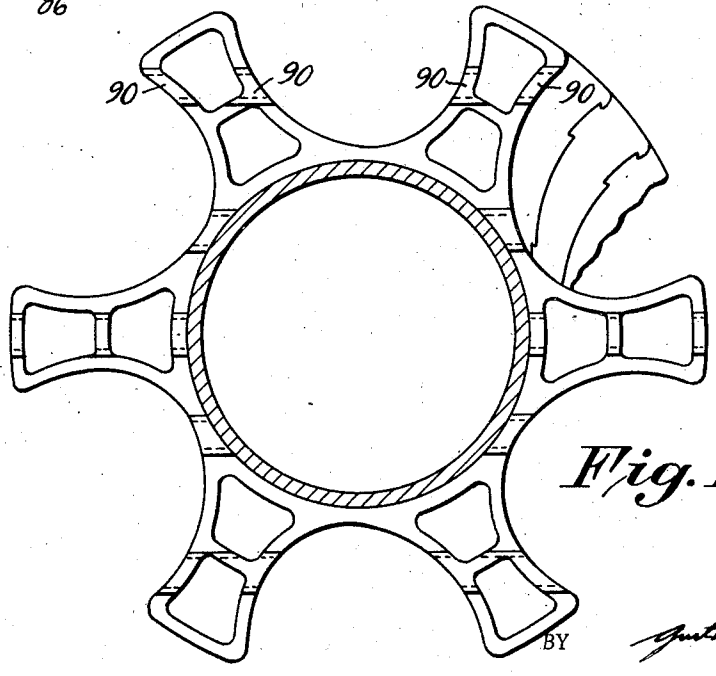



Fig. 12.

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Patented Aug. 3, 1943

2,325,617

# UNITED STATES PATENT OFFICE

2,325,617

## ROTOR

Alf Lysholm, Stockholm, and Gustav Karl William Boestad, Lidingo, Sweden, assignors, by mesne assignments, to Jarvis C. Marble, Leslie M. Merrill, and Percy H. Batten, as trustees

Application January 12, 1939, Serial No. 250,626
In Germany January 13, 1938

11 Claims. (Cl. 74—466)

The present invention relates to rotors for rotary engines and has particular reference to the profiled rotors with spiral threads or lobes for use in rotary compressors, and the manufacture thereof.

Heretofore rotors of this kind usually have been either die cast or milled from a solid piece of material, and the materials heretofore used have usually been ordinary iron, bronze, or brass or, in case light rotors are desired, aluminum or like light metal and the alloys thereof.

The procedure heretofore followed for forming rotors of this kind is satisfactory, however, only for rotors of comparatively small diameter. For large rotors, die casting is not sufficiently exact while the manufacture of rotors of large diameter by milling from solid pieces of material is uneconomical because of the very expensive machines required to perform the work and also the great amount of time and waste of material involved in this procedure.

In accordance with the present invention, the rotors are of built up construction formed by a plurality of parts which preferably are of like shape and of simple form, which are readily and cheaply made and which may be assembled in a simple and inexpensive manner to secure the desired screw threaded rotor form.

A further object of the invention is the fabrication of rotors of built up construction from parts which readily enable the rotor lobes or teeth as well as the central portion of the rotor to be made hollow, thus effecting a considerable saving in weight, which is of importance not only from the standpoint of weight having per se, but also from the standpoint of the operation of high speed compressors in which the weight of the rotating masses is an important dynamic factor.

The invention is capable of being carried into effect in many different specific ways and in order best to understand the principles of the invention and the manner in which the above stated and other and more detailed objects of the invention are carried into effect, reference may be had to the ensuing portion of this specification, taken in conjunction with the accompanying drawings, descriptive of various forms of apparatus constructed in accordance with such principles.

In the accompanying drawings:

Fig. 1 is a more or less diagrammatic view, partly in section, of compressor apparatus to which the present invention is applicable;

Fig. 2 is a transverse section showing the rotors of Fig. 1;

Fig. 3 is a section showing on enlarged scale one of the rotors of Fig. 2;

Fig. 4 is a side elevation, partly in section, further illustrating the rotor construction;

Fig. 5 is a partial section on enlarged scale showing the second of the rotors of Fig. 2;

Figs. 6 to 9, inclusive, are fragmentary sections showing various modified forms of tooth construction;

Fig. 10 is a transverse section of a rotor showing still another form of construction;

Fig. 11 is a plan view of a portion of the rotor shown in section in Fig. 10; and

Fig. 12 is a transverse section showing the form of construction of Fig. 10 applied to a different rotor shape.

Referring now more particularly to Figs. 1 and 2, the apparatus illustrated comprises a main casing part 10 having end covers 12 and 14 in which are located suitable bearings for rotatably mounting the rotors 16 and 18, which are preferably geared to rotate together by means of the gears 20 and 22.

The apparatus illustrated is capable of being operated either as a blower or compressor, or as a power delivering engine and since the porting required to secure the desired character of operation is not germane to the present invention, this has not been shown. The shaft 24 extending from one of the rotors is utilized either as a power input or as a power output shaft depending upon how the apparatus is used, and it will be understood that if desired, in this type of apparatus, one rotor may be driven by the other and the connecting gears omitted, although the use of gearing to connect the rotors is much preferable in the type of apparatus for which the present invention is particularly applicable and which usually contemplates the employment of relatively high peripheral rotor speeds.

Fig. 2 illustrates in section the rotors of Fig. 1 comprising the male rotor 16 and the female rotor 18.

In accordance with the present embodiment, the tooth portions of the rotors are formed by a series of laminations of relatively thin plate material. Advantageously, these laminations are stamped from such material in suitable dies although it will be evident of course that they may be cast.

Fig. 3 illustrates the form of the laminations for the rotors 16, each lamination 26 consisting of a relatively thin base ring portion 28 and a series of peripherally spaced hollow tooth sections 30 projecting from the base ring. These tooth sec-

tions are preferably formed as shown, with relatively thin walls, and the outer surfaces of these sections are shaped to conform to the desired tooth profile.

These laminations are mounted on a hollow tubular shaft portion 32, and adjacent laminations are peripherally offset with respect to each other so that the several tooth sections, when assembled, provide spirally extending teeth on the rotor.

Various ways of securing the laminations to the shaft portion may be employed. In the present embodiment the tubular shaft part is provided with a dove tail slot or keyway 34 of spiral form, the pitch of which corresponds to the pitch desired for the threads and the several laminations are formed with inwardly projecting dove tail teeth 36 shaped to fit in the slot 34. The several laminations are suitably threaded or pressed onto the shaft part axially from one end thereof to form the rotor assembly.

It will be evident that these laminations may be suitably keyed in other ways as, for example, by welding onto the surface of the shaft part 32 a spiral key and providing laminations with suitable keyway recesses enabling them to be threaded over the key.

A rotor thus formed may be mounted in any suitable manner, by means of bearings mounted within the hollow shaft part or, as in the embodiment illustrated, by means of the end parts 38 (Fig. 4) inserted in and suitably secured to the central shaft part or sleeve 32. The laminations may be retained in place in any suitable desired manner as by welding or brazing them together, or by making them a tight press fit on the central sleeve. If desired, the rotor structure may be strengthened by forming certain of the laminations with solid rather than hollow tooth webs, as indicated at 40 in Fig. 4.

It will be understood that when the rotor is assembled in this manner, the flanks of the teeth will present a series of steps rather than the smooth surface which is desired for the finally finished rotor. The machining required, however, to form the finished surface from these stepped surfaces, which are, to begin with, shaped to the desired profile and pitch, requires relatively little work and the removal of very little material. It will further be evident that the amount of machining (that is, cutting, grinding, or the like), required to bring the rotor teeth to final form, will depend on the thickness of the plates used. If plates of very thin material are used, the amount of finishing required may be reduced to very little.

Fig. 5 illustrates the construction employed in making the rotor which cooperates with the rotor shown in Fig. 4. In this construction a hollow sleeve 42 is provided which forms the central shaft portion of the rotor and upon which a series of peripherally offset laminations 44 are assembled. These laminations, as in the rotor previously described, are formed with a base ring portion 46 and a series of projecting teeth or lobes 48 shaped to provide intermeshing cooperation between the teeth and spaces of the two rotors. Because of the form of the teeth of this rotor, they may advantageously, when made of hollow form, be reinforced by means of circumferentially extending webs 48*a*.

The plates 44 in this instance are also provided with inwardly projecting teeth 50 adapted to be received in a spiral slot 52 in the sleeve 42.

The manner of assembling this rotor will be evident from the description of the rotor shown in Figs. 3 and 4.

In the embodiment just described, the rotor arrangement employs a male rotor 16 having four teeth, cooperating with a female rotor having six. It will be evident, however, that in so far as the present invention is concerned, the number of teeth employed and the combination of the numbers of teeth of cooperating rotors is immaterial, these factors as well as the factor of the specific tooth profile not affecting the principles of rotor construction contemplated by the invention.

In a further embodiment of the invention, the rotor teeth are built up of a series of laminations, each for a single tooth, and the several laminations being secured directly to a central shaft sleeve.

Referring now to Fig. 6, this form of construction is illustrated, comprising a central shaft sleeve 54 provided with a series of spirally directed dove tail slots 56, 58, and 60. A series of plate sections or laminations 62 are provided, each corresponding in profile to the desired tooth section and having side walls 62*a* and 62*b* terminating respectively in feet 62*c* and 62*d* shaped to fit in the slots. Central radial reinforcing webs 62*e* may also advantageously be provided, these webs having feet 62*f* adapted to be received in the slot 60. It is believed that the manner of construction of the tooth will be evident from the above description and, all of the teeth being of like construction, it is sufficient to describe but one.

Fig. 7 illustrates a modification of the general form of construction shown in Fig. 6, the tooth sections 64 being provided with side walls 64*a* and 64*b* each having feet adapted to be received respectively in suitable spiral slots in the central sleeve. In this form the stiffening of the tooth sections is provided by means of a transverse web 64*c* which enables one of the dove tail slots to be eliminated.

Fig. 8 shows still another embodiment in which the sections 66 are provided with crossed reinforcing webs 68 and 70. In this embodiment the web 68 is provided with a dove tail foot 68*a*, received in a corresponding dove tail spiral slot 70 in the central sleeve. This dove tail foot serves to retain the lamination against radial displacement and the side walls 66*a* and 66*b* are in this instance provided with feet which are received in open grooves or slots 72 and 74 of spiral form.

Still another form of tooth section is shown in Fig. 9 in which the side walls of the laminations 76 are received in open spiral slots 78 and 80 in the sleeve and the sections are retained against radial displacement by means of dove tail feet 82 and 84 formed at the inner ends of radially extending reinforcing webs 76*a* and 76*b*, and retained in suitable dove tail slots in the spiral sleeve. From the above it will be evident that in accordance with the principles of the invention the tooth laminations may be formed spirally of substantially any desired specific section and separately assembled, and it will be apparent that for manufacturing reasons the dove tailing may be limited to only a part of the groove structure.

Figs. 10 to 12 illustrate another form of construction particularly suited for making rotors of simple cast sections suitable for production by die casting methods. In this form of construction a series of cast sections 86 are provided, each having an axial length X and provided on their axially opposite ends with dove

tail slots and projections 88 and 86 respectively. These sections, which constitute relatively thick laminations, are formed with the sides of the teeth corresponding substantially to the desired finished surfaces of the teeth and are assembled in circumferentially offset relation on a central hollow shaft sleeve 92. The extent of the circumferential offset of the sections relative to each other is determined by suitable location of the slots and projections which, as will be observed from Fig. 10, are formed so that the sections may be assembled by movement of the several sections laterally with respect to each other into engaging relation. After the sections are assembled in this manner, the central sleeve is inserted, this member acting as a locking member preventing lateral displacement of the several sections relative to each other in the direction of the slots.

In rotary apparatus of the kind embodying intermeshing screw threaded rotors operating at high peripheral speeds, clearance between the rotors is required in order to avoid unacceptably high frictional losses and almost inevitable overheating. Since when clearance is employed the volumetric efficiency is affected by the amount of clearance, it is obviously desirable to maintain such clearance as constant as possible under all operating conditions. Heat of compression will tend to make rotors of the kind under consideration expand and in order to avoid adversely affecting the efficiency of operation of the apparatus it is desirable to use materials having low or negligible coefficients of expansion. One very suitable material having substantially negligible expansion coefficient is the variety of nickel-iron alloy in which the nickel content is of the order of from 32% to 40% and the iron content is of the order of from 68% to 60%. This material is commonly known as "Invar." This material and other special materials are, however, relatively expensive as compared with the ordinary metals and the present invention is particularly advantageous in connection with the use of such special materials since the amount of material required to be used is relatively little as compared with that required for conventional forms of rotor construction.

From the foregoing it will be apparent that th invention may be embodied in numerous different specific forms of apparatus and the invention is accordingly not to be considered as restricted to the forms shown herein by way of example but is to be understood as embracing all rotor forms falling within the scope of the appended claims.

What is claimed is:

1. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, said tooth portions being formed by a plurality of sections of like profile arranged in axially abutting relation and peripherally displaced with respect to each other to provide continuous tooth portions of helical form.

2. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, said tooth portions being formed by a plurality of thin laminations of like profile arranged in axially abutting relation and peripherally displaced with respect to each other to provide continuous tooth portions of helical form.

3. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of helical tooth portions carried by said body portion, said tooth portions being formed by a plurality of thin laminations of like profile arranged in axially abutting relation and peripherally displaced with respect to each other to provide continuous tooth portions of helical form, the major portion of said laminations providing hollow tooth sections and certain of said laminations providing solid tooth sections, the laminations having the solid tooth sections being spaced axially from each other along the length of the rotor to stiffen the several teeth of the rotor.

4. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, said tooth portions being formed by a plurality of sections of like profile arranged in axially abutting relation and peripherally displaced with respect to each other to provide continuous tooth portions of helical form, each of said sections having a plurality of hollow tooth profile portions peripherally spaced upon and connected by a peripherally continuous base ring portion fixed to said body portion.

5. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, said tooth portions being formed by a plurality of thin laminations of like profile arranged in axially abutting relation and peripherally displaced with respect to each other to provide continuous tooth portions of helical form, each of said thin laminations having a plurality of hollow tooth profile portions peripherally spaced upon and connected by a peripherally continuous base ring portion fixed to said body portion.

6. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, said tooth prtions being formed by a plurality of sections of like profile arranged in axially abutting relation and peripherally displaced with respect to each other to provide continuous tooth portions of helical form, each of said sections having a plurality of hollow tooth profile portions peripherally spaced upon and connected by a peripherally continuous base ring portion fixed to said body portion, the end walls of adjacent sections being provided with mutually interengaging transversely extending grooves and projections for locating the several sections peripherally with respect to each other, said projections and grooves permitting assembly and disassembly of the sections laterally of each other in the absence of said body portion and said body portion acting to prevent lateral displacement of the sections relative to each other when the rotor is assembled.

7. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, each of said tooth portions being formed by a plurality of axially adjacent apertured sections peripherally dis-

placed with respect to each other and fixed directly to the wall of said body portion to provide continuous tooth portions of helical form.

8. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, each of said tooth portions being formed by a plurality of axially adjacent apertured sections having side walls formed to substantially coincide with the desired profile, said side walls being of substantially uniform thickness and fixed respectively directly to the wall of said body portion to provide continuous tooth portions of helical form.

9. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, each of said tooth portions being formed by a plurality of axially adjacent apertured thin laminations having side walls formed to substantially coincide with the desired profile, said side walls being of substantially uniform thickness and fixed respectively directly to the wall of said body portion to provide continuous tooth portions of helical form.

10. A rotor for compressors and the like comprising a hollow body portion of generally cylindrical form having a peripherally continuous wall and a plurality of hollow helical tooth portions carried by said body portion, each of said tooth portions being formed by a plurality of axially adjacent apertured sections having said walls formed to substantially coincide with the desired profile, said side walls being of substantially uniform thickness and being connected by a transversely extending stiffening web, the base of each of said side walls being fixed directly to said body portion to provide continuous tooth portions of helical form.

11. A rotor for compressors and the like comprising a hollow body portion consisting of a cylindrical tubular member having a plurality of spiral grooves formed on its exterior surface and a plurality of helical teeth formed on said member, each of said teeth consisting of a plurality of relatively thin laminations having relatively thin side walls curved to substantially desired tooth profile, the base portions of said side walls being located in said spiral grooves and fixed to said body member, whereby to form a plurality of substantially hollow helical teeth on said body member.

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