United States Patent [19]

Ferchland

[11] B **3,924,314**

[45] **Dec. 9, 1975**

[54] **ASSEMBLY METHOD FOR ROTARY ENGINE**

[75] Inventor: **Harold W. Ferchland,** Troy, Mich.

[73] Assignee: **General Motors Corporation,** Detroit, Mich.

[22] Filed: **Nov. 7, 1973**

[21] Appl. No.: **413,546**

[44] Published under the Trial Voluntary Protest Program on January 28, 1975 as document no. B 413,546.

[52] **U.S. Cl.** ..... **29/156.4 R;** 29/423; 29/446; 277/9.5; 29/469

[51] **Int. Cl.**[2] **B23P 15/00**

[58] **Field of Search** ..... 29/156.4 R, 423, 434, 446, 29/469; 418/178, 120–122, 113; 277/9.5, 81 P

[56] **References Cited**

UNITED STATES PATENTS

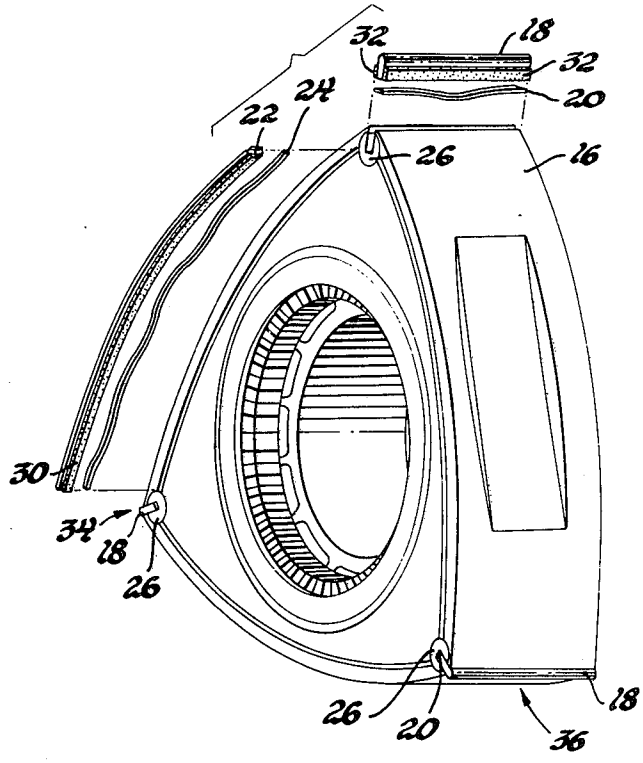
3,353,830	11/1967	Bell	277/9.5
3,356,375	12/1967	Harris	277/9.5
3,492,710	2/1970	Pitner	29/434
3,745,630	7/1973	Bensinger	29/156.4 R

Primary Examiner—Richard J. Herbst
Assistant Examiner—Dan C. Crane
Attorney, Agent, or Firm—George A. Grove

[57] **ABSTRACT**

The assembly of the rotor and the spring-biased seals carried by the rotor into the housing of a rotary engine is facilitated by applying an adherent, waxy film to the seals and inserting them in the rotor grooves. This film composition adheres to the side of the groove and temporarily holds the spring-biased seals in a recessed position during an assembly operation. However, the properties of the composition are such that the seals self-return after a short time to their normal operating positions for engine starting. Upon brief engine operation the wax composition evaporates and is consumed without residue.

3 Claims, 3 Drawing Figures



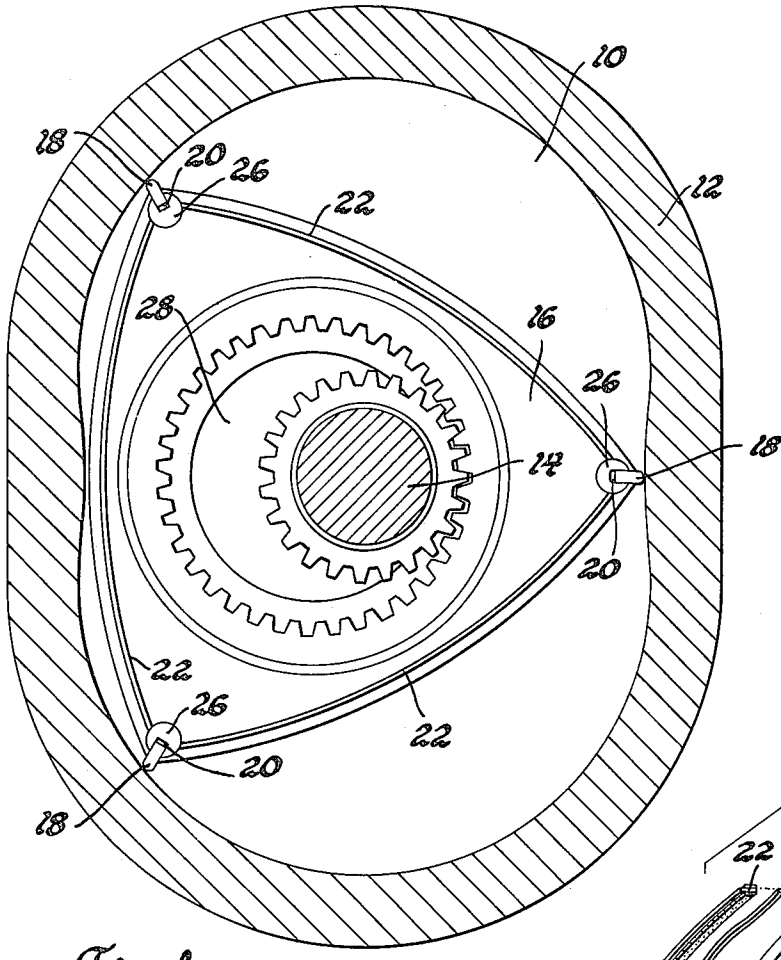


Fig. 1

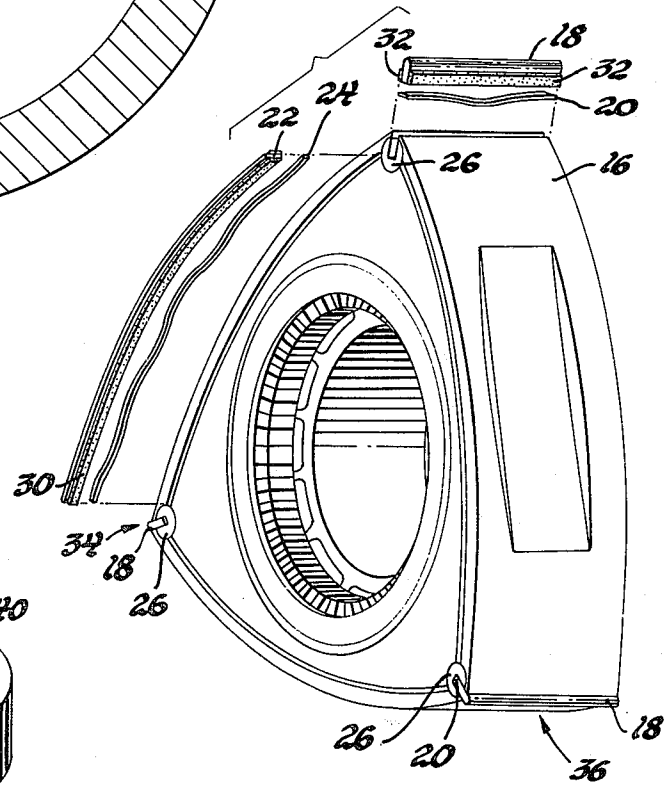


Fig. 2

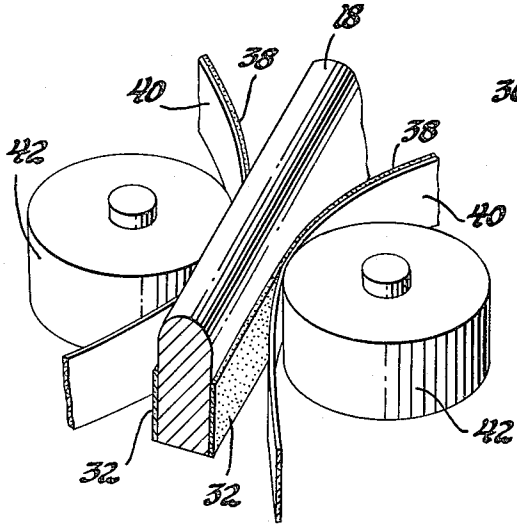


Fig. 3

ASSEMBLY METHOD FOR ROTARY ENGINE

This invention relates to the assembly of components of a rotary internal combustion engine, particularly of the Wankel type engine. More particularly, it relates to a method of retaining the many spring-biased seals, some in a recessed position, in the rotor grooves when the rotor is being positioned in the housing of the rotary engine.

Rotary engines of the Wankel type are now well known. In the operation of such devices a generally triangular-shaped rotor or piston rotates inside an epitrochoid-shaped housing. Seals carried by the rotor engage surfaces of the housing so that a number (frequently three) of separate spaces or cavities of varying volume are established. The various seals carried by the rotor are usually spring-biased so that they are always urged into sealing engagement with the adjacent housing surface despite a change in relative position or attitude of the rotor with respect to portions of the housing. When the many individual parts of the rotary mechanism have been manufactured it is necessary to assemble the seals and their associated springs in grooves in the rotor and position the rotor in the housing of the engine. In the case of a rotary engine having a three lobed rotor, three apex seals, six corner seals and 12 side seals may be carried by each rotor. Most, if not all, of these seals are spring-biased. Heretofore mechanical clamps or bands, or even tape have been employed to retain the spring-biased seals in their grooves when the rotor is being transported to an assembly area and/or when the rotor is being positioned in a housing. After the rotor has been positioned in the housing it is necessary to remove the holding devices so that the engine may function properly.

It is an object of the present invention to provide a method of assembling a rotor and its associated spring-biased seals in the housing of a rotary mechanism wherein a waxy, adherent, lubricant composition is employed to temporarily retain the seals in the rotor grooves and, if desired, in a recessed position against a spring force during engine assembly.

It is a more specific object of my invention to provide a method of assembling the rotor and associated spring-biased seals in the housing of a rotary mechanism wherein a petroleum wax based composition is applied to some or all of the seals before they are inserted in the grooves of the rotor. The waxy composition then holds the seals positioned within the grooves and in a recessed position, if desired, against the force of its associated spring during engine assembly. However, after a few minutes the holding power of the waxy material is overcome and the seal is urged to its normal operating position by the spring so that the engine can be started. Upon engine operation the waxy composition is consumed leaving no residue.

In accordance with the preferred embodiment of my invention, these and other objects and advantages are accomplished by providing individual manufactured components of the rotary engine, including the various sections of the housing, the crankshaft, the rotor, and the seals and springs in a clean condition. A thin film of a petroleum wax based composition, 2 or 3 mils in thickness, is applied to the side surfaces of the apex seals, the side seals, and if desired to the cylindrical surfaces of the corner seals. These seals and their associated springs are then placed in the intended grooves of the rotor. During the assembly of the seals in the rotor,

the film on the sides of the seals rubs against the adjacent walls of the grooves, adhereing thereto and holding the respective seals in place. Typically the apex seals will be pushed down into a recessed position in their grooves against the spring force of their associated springs. The rotor is then placed in the housing of the mechanism and the engine is fully assembled. Over a period of minutes a seal urged by its spring will assume its normal operating position, and thereafter when desired the engine may be started. As the engine warms up, the wax composition employed in the assembly of the seals will first act as a lubricant for the sliding seals but will ultimately evaporate and be consumed and removed with exhaust products of the engine. No residue is left in the engine to corrode its parts or impede its operation. There is no need to remove any mechanical device which might otherwise have been employed in connection with the assembly of the seals and the rotor in the engine housing.

A better understandind of my invention will be obtained from a detailed description thereof which follows. In connection with the description, reference will be made to the drawings in which:

FIG. 1 is a sectional view of a partially assembled rotary engine;

FIG. 2 is a perspective view of a rotor and its associated seals; and

FIG. 3 is a schematic drawing depicting one means of applying the adherent lubricant composition to the side surfaces of an apex seal.

The waxy, adherent, lubricant composition employed in accordance with my rotary engine assembly process preferably incorporates a microcrystalline petroleum wax. Petroleum wax contributes adherency and body to the composition used during the assembly of the spring-biased seals. After the engine has been started the waxy composition briefly serves as a lubricant until it is vaporized and burned from the engine without residue. Other suitable vaporizable and combustible hydrocarbon-like materials may be mixed with the wax to modify its properties in this application. For example, liquid polybutenes having a number average molecular weight of about 2,500 to 3,000 can be mixed with a microcrystalline petroleum wax to increase its tack and desirable release properties. A composition consisting of about 70 percent by weight of a microcrystalline petroleum wax having a specific gravity of about 0.85 and a melting range of about 150° to 160° F. and about 30 percent by weight of a liquid polybutene is particularly useful in the practice of my process. The mixture is prepared by melting a measured quantity of the wax and stirring in the polybutene and then cooling.

Other waxy compositions are suitable for use in the practice of my process. A mixture consisting, by weight, of 40 percent liquid polybutene, 30 percent amorphous polypropylene of relatively high molecular weight, 20 percent microcrystalline petroleum wax and 10 percent hydrogenated wood rosin has been used. This composition is likewise prepared by heating and mixing the components together.

The above-described tacky lubricant formulations are to be deemed only as illustrative of the waxy compositions which may be employed in the practice of my process. A thin film of such a material of the order of two to three mils thickness is applied by any suitable method to surfaces of apex seals, side seals and/or corner seals of the rotary mechanism which will lie adjacent to the walls of a groove in the rotor when the seal

is inserted therein. The grooves are normally machined to provide a small clearance for the seal, and the lubricant film is smeared upon and adheres to the side wall of the groove when the seal and its spring is inserted therein. The tacky lubricant temporarily holds the seal in place even in a recessed position against the force (upwards of 7½ lbs or so) of its spring tending to urge the seal out of the groove.

The assembly of a rotary engine employing my method will now be more fully described. Typically, a first end housing, indicated at **10** in FIG. **1,** is placed on a bench or in a suitable fixture. The rotor housing **12** is placed on top of the end housing **10.** The crankshaft **14** is inserted into the end housing **10.** A rotor **16,** with its apex seals **18** and apex seal springs **20,** side seals **22** and side seal springs **24,** and corner seals **26** all previously assembled in the proper grooves, and the eccentric **28** are threaded over the crankshaft **14** and positioned in the proper location or orientation for proper engine timing.

In accordance with my invention the side seals and corner seals may simply be held in place by the lubricant composition so that they do not fall out as the rotor is handled, shipped and placed in the rotor housing. The lubricant film **30** applied to the surfaces of the side seal **22** and the corner seal, as indicated in FIG. **2,** is very effective in holding the seals in place. However, it is usually preferred to depress at least the apex seals **18** for insertion of the rotor in the rotor housing. Referring to FIG. **2,** it is seen that my lubricant composition is suitably applied to both side surfaces of an apex seal as indicated at **32.** Each seal and its spring are then pushed into the groove in a recessed position as indicated at **34** of FIG. **2.** The lubricant film holds the apex seal in a recessed position until the rotor can be placed in the rotor housing. In the case of a typical two-rotor mechanism, the intermediate housing is then placed over the first rotor and the second rotor housing is placed over the intermediate housing. The procedure described above with respect to the first rotor and its associated seals is repeated with respect to the second rotor. The last end housing is then placed over the second rotor and the engine is bolted together, and the assembly completed by attaching the spark plugs, distributor, carburetor and the like. By the time the engine is ready to be given its trial run those seals which were initially in a recessed position will have been slowly urged out to their operating position, as illustrated for example with respect to an apex seal **18** at **36** in FIG. **2.** With the seals in their proper positions the engine can be started. As the engine is started and reaches operating temperature the waxy composition first decreases in viscosity to better serve as a lubricant for the seals. The composition is eventually evaporated and burned out of the engine leaving no residue which might corrode the engine or otherwise adversely affect its operation.

The composition employed in accordance with this assembly process may be applied to appropriate surfaces of rotor seals in accordance with any of a number of suitable techniques. The composition can initially be cast from a hot melt in the form of a crayon and rubbed onto one or more sides of a seal to form a film coating thereon. In another procedure a film of the composition can be applied by a hot melt gun which heats and extrudes the composition onto the side of a seal. A method which has been found to be particularly suitable is to initially apply a thin layer of the composition, about 2 to 3 mils in thickness, to a strip of release paper. Preferably the release paper is about 7/16 inch wide and of indefinite length. A layer **38** of lubricant composition 3/16 inch in width can be applied to the paper **40** and then readily transferred by pressure, such as by a roll **42** as depicted in FIG. **3,** at ambient temperature to an apex seal **18** or other seal. The strip of layer lubricant formulation **38** releases from the sized release paper **40** and is transferred by pressure to form a film **32** on the apex seal **18.**

Normally it is preferable to coat apex seals on both sides so that they can be suitably held in a recessed position. Side seals may suitably be coated on only one side since it may not be necessary to hold them in a recessed position but only to maintain them in the rotor groove. The corner seals are keyed with the apex seals and the adherent lubricant on the apex seal is frequently sufficient to hold the corner seal.

The described adherent, lubricant compositon may be employed in accordance with the subject assembly method although the composition of the seals and rotor may vary from application to application. Typically the rotor is formed of a ferrous base material such as steel or cast iron and may also be formed of aluminum in accordance with my assembly method. The seals may be formed of any suitable metal, carbon-metal composite or other suitable material and still be compatible with the practice of my assembly method.

While my invention has been described in terms of a preferred embodiment thereof, it will be appreciated that other forms may readily be adopted by one skilled in the art. Accordingly, the scope of my invention is to be considered limited only by the following claims.

What is claimed is:

1. A method of assembling components of a rotary engine of the type having an outer housing body including a cavity, a rotor disposed in said cavity for relative rotation with said outer body, said rotor having a plurality of grooves with at least one groove containing a spring-biased seal member such that in the operation of said mechanism said seal member is urged into sealing engagement with a surface of said housing body, said method comprising

providing a said rotor, and a said seal member and spring in substantially finished manufactured condition ready for assembly,

applying a film of adherent lubricant composition to a surface of said seal which lies adjacent a wall of a said rotor groove in the operation of said engine,

inserting said spring and seal in said groove and pushing said seal against said spring so that said seal is depressed in said groove below the normal operating position of said seal, said composition adhering to said groove wall and holding said seal in said depressed position while said rotor is placed in said housing,

and then placing said rotor including said spring-biased seal in said housing, said seal subsequently being returned to its operating position by said spring, said composition being removable from said engine by vaporization and combustion during the operation of said engine.

2. A method of assembling components of a rotary engine of the type having an outer housing body including a cavity for a rotor, a rotor disposed in said cavity for relative rotation with said outer body, said rotor having a plurality of grooves each adapted to receive a spring and a seal member such that in the operation of said engine a said seal member moves in a said groove

and is urged by a said spring into sealing engagement with a surface of said housing body, said method comprising

providing a said rotor and said seal members and springs in substantially finished manufactured condition for assembly,

applying a film of adherent waxy composition to a surface of each said seals which surface will in the operation of said engine slide against a wall of a said rotor groove,

placing each of said springs and its associated seal in appropriate grooves of said rotor,

pushing in at least one of said seals against its spring so that said seal is depressed in its groove below the normal operating position of said seal, said waxy composition adhering to said groove wall to temporarily hold said seal in said depressed position while said rotor is placed in said housing,

and then assembling said rotor in said housing, said seal being returned to its operating position after said assembly by the force of said spring overcoming the adherence of said composition, said composition being removable from said engine by vaporization and combustion during the operation of said engine.

3. A method of assembling components of a rotary engine of the type having an outer housing body including a rotor cavity, a rotor disposed in said cavity for relative rotation with said outer body, said rotor having a plurality of grooves each adapted to receive a spring-biased apex seal member such that in the operation of said engine each of said apex seal members is urged into sealing engagement with a surface of said housing body, said method comprising

providing a said rotor and said apex seal members and associated springs in substantially finished manufactured condition ready for assembly,

applying a film of an adherent waxy composition to the side surfaces of said apex seals,

inserting each of said apex seals and associated springs in a groove of said rotor,

pushing each of said apex seals against its associated spring so that said apex seals are depressed in their grooves below their normal operating position, said composition adhering to the surfaces of said seals and said grooves so as to temporarily hold said seals in said depressed position while said rotor is placed in said housing,

and then assembling said rotor and its spring-biased apex seals in said housing, each of said apex seals being returned to their normal operating position after said rotor has been assembled in said housing by the force of its spring overcoming the adherence of said composition, said compositon then being removable from said engine by vaporization and combustion during the operation of said engine.

* * * * *