March 5, 1968 D. W. HAMM ET AL 3,371,938

PISTON RINGS

Filed Aug. 16, 1965 3 Sheets-Sheet 1

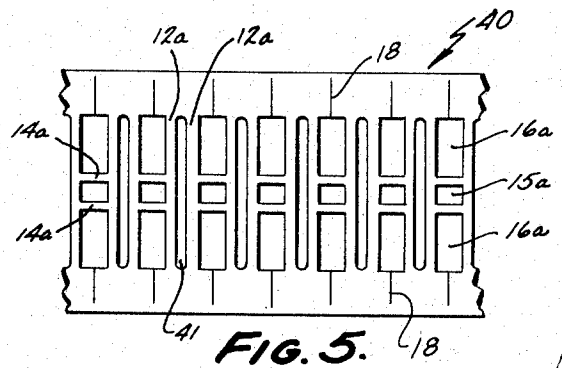


FIG. 5.

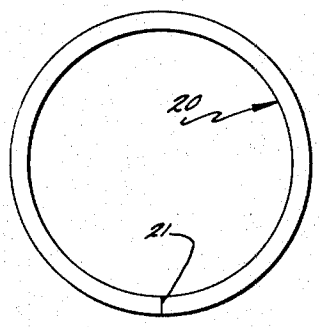


FIG. 4.

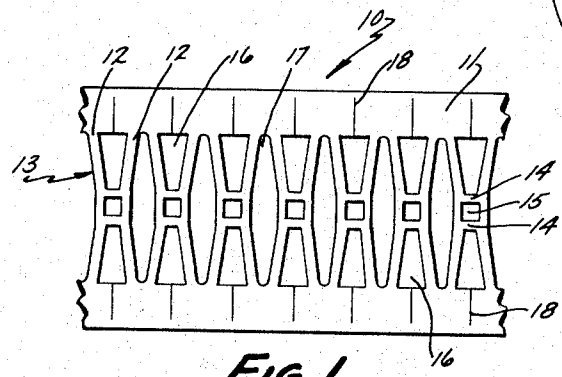


FIG. 1.

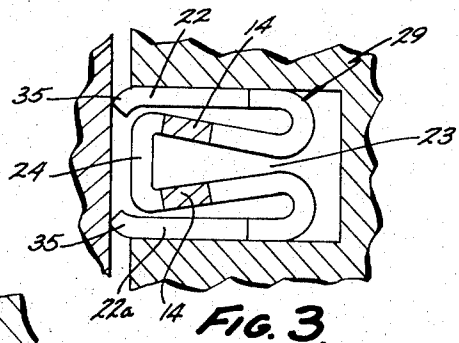


FIG. 3.

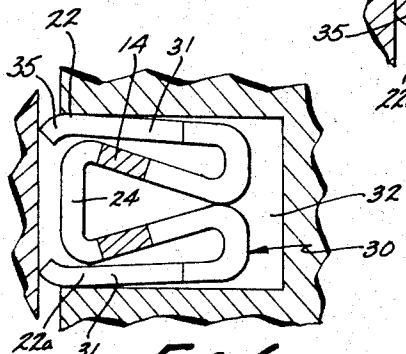


FIG. 6.

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PISTON RINGS

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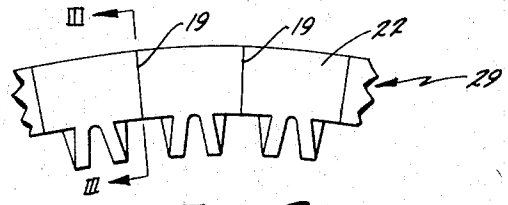


FIG. 2.

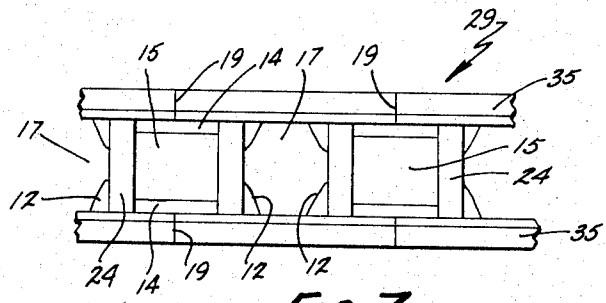


FIG. 7.

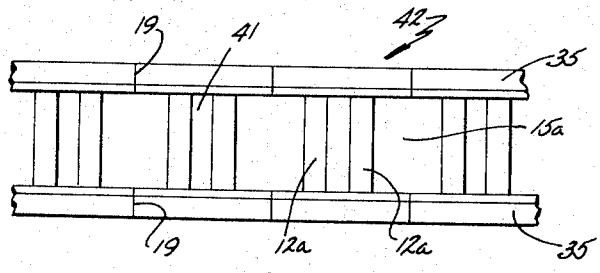


FIG. 8.

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PISTON RINGS

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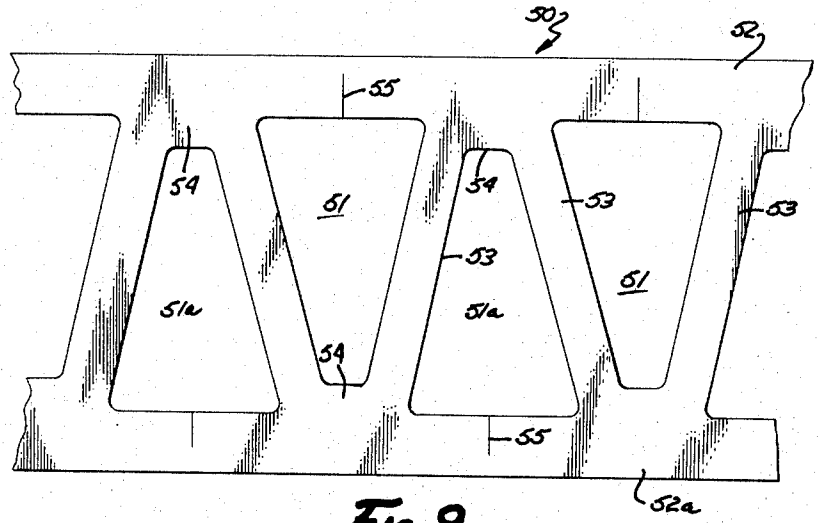


FIG. 9

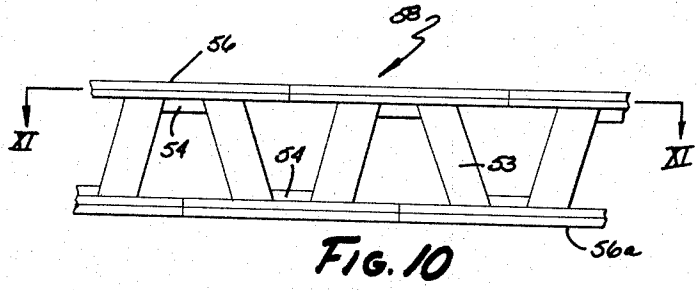


FIG. 10

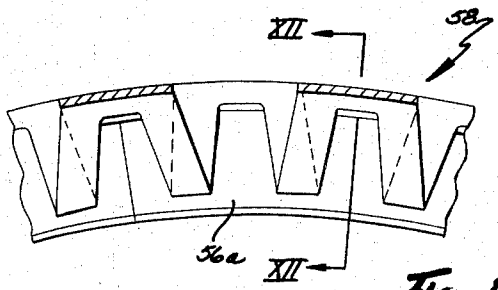


FIG. 11

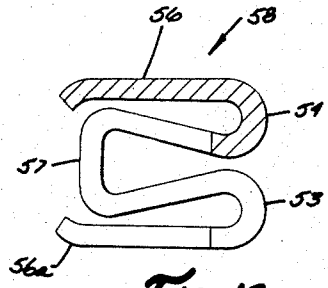


FIG. 12

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PISTON RINGS

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Continuation-in-part of application Ser. No. 426,573, Jan. 19, 1965. This application Aug. 16, 1965, Ser. No. 482,028

8 Claims. (Cl. 277—200)

ABSTRACT OF THE DISCLOSURE

A one-piece piston ring having sides consisting of a plurality of independent segments joined to each other only through the central body portion of the ring. The central body portion consists of struts, each of which has a pair of straps integral with a different segment. The struts are bent into an outwardly extending loop projecting generally to the outer face of the ring with the sides of the loop generally parallel to the plane of the segments. The two straps forming each strut are joined by a circumferentially extending tie bar which is arranged with the greater of its cross-sectional dimensions lying in the plane of the sides of the loop. The preceding description is not to be construed as a limitation upon the scope of the invention.

Related applications

This invention is a continuation-in-part of our co-pending application, Ser. No. 426,573, entitled Piston Rings, filed Jan. 19, 1965, now abandoned, which application is a continuation-in-part of our co-pending application Ser. No. 317,674, entitled Oil Ring, filed Jan. 13, 1964, now abandoned.

This invention relates to piston rings, and more particularly to an oil ring in which the structure of the ring is such that by simple changes in the blank, rings of a wide range of functional characteristics can be produced. Both the stiffness and the radial tension value of the ring can be materially varied to meet operating requirements.

This ring represents an improvement over the ring disclosed in co-pending application, Ser. No. 265,777 entitled Piston Ring, filed Mar. 18, 1963, now Patent No. 3,206,219, and rings of this general class which are formed by perforating a blank at regularly spaced intervals with transverse slots, and at the ends of the slots providing score marks by which the margins of the blank, after the ring has been formed, can be ruptured to form a plurality of individual segments.

In previously known constructions of rings of this general type, the only way the flexibility of the ring could be varied was either by making the ring of stock of a different thickness or increasing the radial depth of the ring or a combination of both. This, of course, required the selection of initial stocks of many different widths and thicknesses. This invention, for the first time, makes it possible to use a blank of uniform width and a stock of uniform thickness while accurately controlling the flexibility of the ring by minor changes in the configuration of the blank.

In the past, it has been considered essential in rings of all sizes that the separation between the segments on one side of the ring be offset from the separations on the other side of the ring to create a more tortuous path for the gases and lubricants attempting to escape past the ring. While this did have the desired effect, it also created problems. When these rings are circumferentially compressed, the contraction of the ring takes place only at the separations. When the separations are circumferentially offset, the contractions on one side of the ring are circumferentially offset from those on the other side. In other words, the circumferential dimension of the ring is shortened on one side in an area where, on the other side of the ring, the dimension is fixed. In the larger diameter rings, this tends to warp the ring axially, producing slight waves in the ring impairing its flatness. Slight as this deflection is, cumulatively, it significantly impairs the side sealing efficiency of the ring.

This invention overcomes this problem in the larger diameter rings by making it possible to align the separations on each side of the ring. Therefore, circumferential compression of the ring occurs uniformly on both sides of the ring, eliminating the tendency of the ring to warp.

This invention has another important facet which relates to the ring's durability. It has been standard practice to connect the segments or spring sections circumferentially along either the inner or outer bight portions of the ring. This arrangement causes the bending stresses arising out of both radial flexing of the ring and circumferential compression applied to generate tension to act normal to the thickness of the material from which the ring is fabricated. This is the weakest possible arrangement because it places the metal at the greatest disadvantage to resist these stresses. This invention permits these connections to be rotated approximately 90°. Thus, these stresses act parallel to the width of the connecting web rather than at right angles to it.

The rotation of the connecting web so that its width dimension is parallel to the stresses has other advantages. It permits the flexibility of the ring to be controlled by the width of the connecting web rather than the radial depth of the ring or the thickness of the initial stock. Thus, a ring having the desired degree of radial tension may be fabricated from substantially thinner stock. This is important in modern engine construction. Present engine designs are reducing the width of the ring groove. To produce satisfactory rings for these grooves, the radii over which the stock is bent must be held to a minimum. While the over-all height of the ring is reduced, the proportion of axial height actually occupied by metal must be kept substantially the same as that of rings of greater height in order to maintain a sufficient degree of openness. Further, as engine speeds and compression ratios increase and the stroke is decreased, it is increasingly important to hold the weight of the ring to a minimum. This is essential to minimize the effects of momentum and inertia.

In small diameter rings, the problems of axial warpage of the ring due to offset of the segment separations becomes subordinate to the problem of producing a ring having sufficient radial flexibility or "spring softness" to make the ring conformable to the cylinder wall. It is though that this condition arises because the length of the smaller diameter rings is significantly less and thus, per ring, there are fewer individual springs to produce the radial reaction. Also, the ring length being less, there are fewer segments and fewer separations requiring each segment to service a greater proportion of the total length

of the ring. Therefore, it is essential that each segment have greater freedom of movement.

The only way to impart this "softness" to the ring is to increase the effective length of the springs formed by the struts. Since the over-all width of the blank is limited by the height of the ring groove, the only practical way to do this is to utilize a greater proportion of the total strut length as the effective spring length. The second form of this invention does this and thus, makes this invention practical for small diameter rings. Ser. No. 426,573 provided a solution satisfactory for rings of larger diameter. However, it was found to create an edge margin structure which was to stiff to coil into a smoothly curved ring when utilized for small diameter rings. The stock had a tendency to kink. This application discloses a design solving this problem.

The invention also braces the segments against axial buckling due to a circumferential compression. This is done by placing the connections between the struts and the segments close together adjacent the midpoint of the segment. This shortens the span of the material between the struts and thus reduces the effective beam lengths resisting the buckling.

This invention provides a ring in which these important advantages can be obtained without sacrifice of the dependablility or durability of the ring. Further, the ring's radial tension values can be varied over a significant range without changing either the thickness or width of the stock.

These and other objects and purposes of this invention will be more clearly understood by those acquainted with the design and use of piston rings upon reading the following specification and studying the accompanying drawings.

In the drawings:

FIG. 1 is a fragmentary plan view of a blank suitable for manufacturing the ring of this invention;

FIG. 2 is a fragmentary plan view of the completed ring;

FIG. 3 is a sectional elevation view of the ring taken along the plane III—III of FIG. 2;

FIG. 4 is a schematic plan view of a ring incorporating this invention;

FIG. 5 is a fragmentary plan view of a blank for a modified form of this invention;

FIG. 6 is a sectional view similar to FIG. 3 but showing a ring embodying this invention constructed to produce side sealing effect;

FIG. 7 is a fragmentary front elevation view of a ring fabricated from the blank illustrated in FIG. 1;

FIG. 8 is a fragmentary front elevation view of a ring fabricated from the blank illustrated in FIG. 5;

FIG. 9 is a fragmentary plan view of a modified blank for this invention;

FIG. 10 is a fragmentary elevational view of a ring fabricated from the blank illustrated in FIG. 9;

FIG. 11 is a sectional view taken along the plane XI—XI of FIG. 10; and

FIG. 12 is a sectional elevation view of the ring taken along the plane XII—XII of FIG. 11.

To execute the objects and purposes of this invention, the ring has segments with the segments on one side of the ring aligned with the segments on the other side of the ring. The segments on one side are joined to the segments on the other side by struts. Structural continuity of the ring is effected by webs extending between adjacent struts acting as bridges at the partings between segments. The ring has a cross section in which the central portion has a radially inwardly opening loop. The webs or the bridges are in the loop portion and are located in planes substantially parallel to the sides of the ring with the openings or gaps between the webs arranged along the front face of the ring.

Referring to the drawings and specifically to FIG. 1, the numeral **10** refers to a blank having a pair of continuous side strips **11** joined at equally spaced intervals by straps **12** arranged in pairs with each pair forming a strut **13**. The straps of each strut converge toward the center of the blank and on each side of the centerline of the blank are joined by a pair of laterally spaced tie bars or bridging webs **14**. This gives the struts a configuration having a limited similarity to an hourglass. The straps of each strut are separated at the center by an opening **15** and on each side of the bridging webs **14** by generally wedge-shaped openings **16**.

Between each strut **13** and the next adjacent strut is a laterally elongated slot **17**, preferably rounded on each end. The sides of the slots **17** converge on each side of the blank's centerline. The entire blank is symmetrical about its centerline.

Centered at each end of each of the slots **16**, a shallow score mark **18** extends across each of the side strips **11** from the end of the slots either to or almost to the edge margin of the blank. These score marks may be provided on one or both faces.

To form a ring from the blank illustrated in FIG. 1, any one of several methods may be employed. An example of a suitable method is described in Patent 2,668,-131. In accordance with the teachings of this patent, the blank as illustrated in FIG. 1, is formed to the desired cross-sectional shape, coiled and is then heat treated and quenched to render it brittle. Following this, it is cracked or ruptured at the score lines at the ends of the slots **16** to form separations **19** (FIG. 2). The cracked ring is then stretched and heat treated to the desired hardness and cut off to length. It will be recognized that while this is a desirable way of forming this ring, the separations formed by rupturing of the score marks at the ends of the slots **16** may be formed by a cutting or shearing operation rather than by the specific method disclosed in the patent referred to above. The completed ring **20** has a part or gap at **21** (FIG. 4). When the ring is installed in a cylinder, the gap **21** is closed as shown in FIG. 4, and in this condition the ring forms a true circle.

The ring formed from this blank is illustrated in FIGS. 2 and 7. In forming this ring, the side strips **11** of the blank become the sides of the ring, with the marginal edges of the blank becoming the outer radial portions of the ring. These side strips **11** by reason of the rupture of the score lines **18** at the ends of the slots **16** are divided into a plurality of arcuate segments **22** (FIG. 2). It will be noted that since the score lines at opposite ends of each of the slots **16** are ruptured, the segments **22** on one side of the ring are aligned with the segments **22*a*** on the opposite side of the ring. The segments **22** on one side of the ring are joined to the corresponding segments **22*a*** on the other side of the ring by the struts **13**. Thus, one of the segments **22** on one side of the ring, together with the axially corresponding segment **22*a*** on the other side of the ring form a segment unit.

In forming the blank to the final cross-sectional shape of the ring **29** (FIGS. 2 and 3), the struts are first bent to extend down a portion of the inner bight portion and then are reversely bent to extend radially outwardly to form an enlarged loop portion **23** opening through the radially inner face of the ring.

The radially outer end of the loop **23** forms a straight post or pillar **24** extending between the segments **22** and **22*a*** adjacent the radial outer edge of the segments. As such, it forms a rigid post or brace extending between the segments, positively supporting them against axial convergence due to the various forces imposed upon the ring. These forces arise from the drag incident to the scraping action of the ring as it reciprocates against the cylinder walls, from the compressive forces of the gases which tend to travel downwardly between the cylinder wall and the piston, the vacuum conditions formed under certain operating conditions, and from the forces incident to momentum and inertia at each end of the piston's stroke. The post or pillar also prevents the ring from being

permanently distorted or warped by the forces applied in the installation of the ring. A ring constructed in this fashion is braced so that the side sealing effect of the ring is positively maintained.

In the forming of the ring to its cross-sectional configuration, the central opening **15** of the blank is positioned at the radially outer portion of the struts and provides the outer face of the ring with a high degree of openness (FIGS. 3 and 7). It is such a size that it extends the full height of the pillars **24**. The bridging webs or tie bars **14** are in those portions of the struts which extend radially and preferably closely adjacent the radii at the top and bottom of the pillar portion **24**. Thus, they are adjacent the outer radial face of the ring and lie with their greater or width dimension substantially parallel to the radius of the ring rather than parallel to the axis of the ring.

Each segment **22** and **22*a*** is integral with one strap of each strut. Thus, each segment is integral with two adjacent struts and the bridging webs **14** are the only structural continuity joining adjacent segments. The width of the bridging webs materially affects the amount of radial tension produced. The spacing along the straps between the segments and the bridging webs **14** is a second significant factor since it controls the effective length of the spring. This is important because the amount of radial tension developed materially affects the efficiency of the ring.

In ring constructions in which the width of the connecting or bridging web lies generally parallel to the axis of the ring, the radial tension of the ring varies with the first power of the width of the strap and the third power of the thickness of the stock. Thus, to have any really significant effect upon the radial tension value of the ring, it is necessary to vary the stock thickness. Since modern engine design has reduced the width of the ring groove, and made the mass-weight ratio a critical factor, without lessening the necessity for openness in ring design, effecting variations in radial tension by changing stock thickness is impractical.

This invention, by orienting the bridging webs in planes substantially parallel to the sides of the ring groove, permits the ring tension to be varied with the first power of thickness of the stock and the third power of the width of the bridging webs. Thus, a small increase in web width can significantly change the radial tension characteristics of the ring. Thin stock of uniform width producing a ring having a low mass-weight ratio can be used for a wide variety of rings. Further, since the bridging webs lie generally parallel to the sides of the ring, increases in their width do not materially affect the openness of the ring. The radially extending front to back openings remain almost the same size. It also permits the radial tension to be varied without varying the radial depth of the ring. This is important in keeping the weight of the ring to a minimum.

The orientation of the bridging webs materially contributes to the durability of the ring. The stress applied to the bridging webs is reduced for a given ring tension. This produces greater fatigue life. Further, use of a pair of bridging webs provides a safety factor. Should one fail, the other will serve the ring for a sufficient period to materially extend the service life of the ring, even though the ring's efficiency will, in all probability, be somewhat impaired.

The outer radial ends of the segments **22** and **22*a*** are bent toward each other at a small angle (FIGS. 3 and 8). This produces a flange **35** which materially stiffens and reinforces the segments against deflection. This deflection arises both from the compression incident to closing the ring for generating radial tension and from the drag incident to the ring's engagement with the cylinder walls. The flange resists both axially deflection due to cylinder wall engagement and buckling due to circumferential compression. This is particularly important since the invention permits the use of significantly thinner stock having less resistance to bending and deflection.

It will be noted that the straps **12** converge as they approach their point of juncture. The straps are integral with the segments immediately adjacent the segments's midpoint. This is important in reducing buckling of the segment. Tests have established that the circumferential compressive forces applied to the segments by the straps when the ring is closed create significant buckling forces. The tendency to buckle increases rapidly as the spacing between the straps increases. By reducing this space to a minimum, this effect is significantly reduced. This coupled with the flange **35** provides effective control of the deflection and buckling problems which have heretofore rendered thin stock piston rings unacceptable. At the same time, by shaping the straps of a single strut to converge toward the center of the blank, the openness of the face of the ring is preserved.

FIG. 6 illustrates the fact that the ring **30** can be made with outwardly radially diverging sides **31** so that the ring may have a certain degree of wedging action when it is seated in the ring groove **32**. This wedging action assures a more positive side sealing effect for the ring when it is seated in the groove without materially affecting the ability of the ring to flex radially, and thus conform to the contour of the cylinder wall. Except for the slight divergence of the sides, the ring structure remains identical to that of the ring **29**.

FIG. 5 illustrates a modification of this invention. The blank **40** is basically similar to blank **10** illustrated in FIG. 1. However, the straps **12*a*** are straight and the straps of each pair integral with a single segment are separated by a narrow elongated slot **41**. The openings **15*a*** and **16*a*** in each strut are rectangular. The straps **12*a*** of each strut are joined by tie bars or bridging webs **14*a*** similar to the bridging webs **14** except that they are somewhat longer.

When the blank **40** is folded, the resulting ring **42** is very similar to the ring **29** having a central loop portion and an open front face (FIG. 8). The bridging webs **14*a*** assume the same position as the bridging webs **14** in FIG. 3. The same flanges **35** are utilized.

Referring to FIGS. 9 through 12, the blank **50** is formed from a continuous ribbon of material similar to that used for the blanks **10** and **40**. It is blanked to provide a plurality of generally triangular apertures **51** and **51*a*** which remove much of the material of the central portion of the blank. The apices of the apertures **51** are directed oppositely to the apices of the apertures **51*a***.

The apertures **51** and **51*a*** create a pair of continuous side strips or bands **52** and **52*a*** connected by struts **53** arranged in pairs. At one end the two struts of each pair are integral with one of the bands **52** or **52*a*** and are arranged in closely spaced relationship. The struts of their diverge from each other as they extend across the blank with one strut of each pair becoming one strut of another pair on the opposite side of the blank. At the end of the struts where they define the apex of the aperture **51** or **51*a***, the struts are joined by a short web **54** forming an inward extension of the edge band.

Each of the bands is scored at **55** at equally spaced intervals lengthwise of the blank. These scores are identical to the scores **18** of blanks **10** and **40** and serve the same purpose. The scores **55** are arranged midway between the pairs of struts thus centering the webs **54** between the ends of the individual segments **56** subsequently formed by the scores.

The blank **50** is formed to the cross-sectional shape illustrated in FIG. 12 to form a ring having segments **56** on one side and segments **56*a*** on the other side. These segments are connected by the struts **53** which first form the inner radial face or bight of the ring and then project radially outwardly in a substantially closed loop **57** occupying the greater part of the cross-sectional central portion of the ring **58**. It will be observed in FIG. 12 that the web **54** extends into the loop **57** and in effect pro-

vides a bracing flange along the central part of each segment. Tests indicate that in rings of small diameter the length of this bracing flange should not exceed 50% of the length of the segment. This proportion has been found important in coiling the blank. If it is exceeded the resistance to coiling becomes so great that the flanged portion of each segment will not form a smooth curve and the curvature will be concentrated in the narrower portions of the edge bands formed by the biases of the apertures **51** and **51***a*. Such a ring will have a kinked edge consisting of substantially straight edge sections connected by rounded humps where the curvature is concentrated. In the larger diameter rings where the curvature is more gradual, this effect is either minimized to the point that it can be ignored or doesn't occur at all.

Since the struts **53** extend from the segments on one side to the segments on the other side without tie bars or other connecting means, the effective length of the springs formed by the struts is the entire strut length. Thus, each strut will yield under a less loading producing a "softer" spring action and greater ring flexibility. This becomes quite significant as the ring diameter decreases because of the reduction in the number of springs and the fact that each spring is required to serve a greater proportion of the over-all circumferential length of the ring.

It will be understood from the preceding discussion that this invention provides a simple way of varying the flexibility and radial tension capability of the ring. The range through which these characteristics can be varied is substantial. Further, the degree of flexibility can be accurately controlled. This is accomplished without changing the width or gauge of the stock. This constitutes a new method by which the flexibility of rings may be varied and accurately controlled. This method of making rings has not been practiced before. Thus, the ring can be readily varied to meet a wide range of operating conditions.

In a ring design of given cross-sectional configuration, stock of a single width and gauge may be used to create a wide variety of rings. This is an important economy. Also, the same basic die may be used for each of the rings. To fabricate any of the many possible variations of the ring, it is only necessary to remove or add certain segments of the die. By the simple expedient of changing that punch of the die forming the bridging webs **14** or **14***a*, the radial tension of the resulting ring can be widely varied. This is a simple change which can be made quickly and easily. The cost of the individual punches is relatively small. They are comparatively simple. Their cost is minor compared with that of a complete die assembly.

This invention eliminates the necessity for providing numerous die assemblies, each usable only for one particular ring. Not only is the initial die cost materially curtailed, but the problem of die storage is reduced. Die storage can become a serious and costly problem in many cases. By changing only the punch and die which forms the opening **16**, the width of the bridging webs **14** can be varied. Even small variations of this die can materially alter the spring characteristics of the ring. Thus, significant variations in the ring's characteristics can be effected at comparatively low cost.

By aligning the segments on each side of the larger diameter rings, the contraction of the rings, when placed under circumferential compression, is made uniform throughout the ring. This greatly improves the flatness characteristics of the ring because it permits the contraction at the separation to occur simultaneously on both sides of the ring, thereby making it uniform. The substantial spacing of the bridging webs **14** or **14***a* from the segments along the straps permits this to be done without interfering with the spring action of the ring. The structure also gives the ring a substantial degree of openness, as well as deep spring action without necessitating an increase in the radial depth of the ring. Because of its cross-sectional configuration, the ring can be fabricated from thin gauged materials without adverse affect on the strength of the segments. This reduces both the cost and the weight of the ring.

While preferred embodiments of this ring have been illustrated, together with a number of modifications of the ring, it will be obvious that many other modifications may be made each embodying the principles of this invention. Such of these modifications as do embody the principles of this invention are to be considered as included within the hereinafter appended claims, unless these claims, by their language, expressly state otherwise.

We claim:

1. A piston ring having a body formed from a single piece of material, said body having a pair of axially spaced side members each divided into a plurality of individual segments along the radial outer portion thereof, each segment being severed from each adjacent segment by a radially extending separation line; the separation lines of the segments of one side member being axially aligned with the separation lines of the segments of the other of said side members and said two separation lines together defining the terminus of a segment unit of said body; a plurality of circumferentially spaced struts connecting each segment of each side member to the axially corresponding segment of the other side member; each of said struts having a pair of straps, the straps on one side of each strut being integral with one segment on each side of the ring and the other strap with an adjacent segment on each side of the ring; said struts each being bent into a loop closed at one end, said closed end of said loop being at the radially outer face of said ring and said straps at said closed end forming axial pillars supporting said segments; a pair of axially spaced circumferentially extending tie bars joining one strap of each strut to the other strap of the same strut and bridging the separation between said segments; said tie bars and straps collectively defining a central aperture; said tie bars being in the loop portion of said struts and spaced from the radially inner face of said ring lying with their width dimension generally parallel to the planes of said segments; said segments providing the only structural continuity between the struts connected to each segment and the tie bars providing the only structural continuity between adjacent segments.

2. A piston ring as described in claim **1** wherein said tie bars are positioned at the ends of said pillars.

3. A piston ring as described in claim **1** wherein the radially outer edges of said segments on each side of said ring are bent to incline toward each other for forming a reinforcing flange for said segments.

4. A piston ring as described in claim **1** wherein the straps of adjacent struts are joined to each segment immediately adjacent the midpoint of the segment.

5. A piston ring as described in claim **4** wherein the straps of each strut converge from the segments on each side of the ring to their point of juncture with said tie bars.

6. A piston ring as described in claim **4** wherein the straps of each strut are straight and are separated by a narrow elongated slot extending from the segments on one side of the ring to the segments on the other side of the ring.

7. A piston ring as described in claim **2** wherein the straps of adjacent struts are joined to each segment immediately adjacent the midpoint of the segment; the radially outer edges of said segments on each side of said ring being bent to incline toward each other for forming a reinforcing flange for said segments.

8. A piston ring having a body formed from a single piece of material, said body having a pair of axially spaced side members each divided into a plurality of individual segments along the radial outer portion thereof, the segments of said side members being axially aligned; a plurality of circumferentially spaced struts connecting each segment of each side member to the axially corresponding segment of the other side member; each of said struts having a pair of straps, the straps on one side of each strut being integral with one segment on each side of the

ring and the other strap with an adjacent segment on each side of the ring; said struts each being bent into a loop closed at one end, said closed end of said loop being at the radially outer face of said ring and said straps at said closed end forming axial pillars supporting said segments; a circumferentially extending tie bar joining one strap of each strut to the other strap of the same strut and bridging the separation between said segments; said tie bar being in the loop portion of said struts and spaced from the radially inner face of said ring and lying with their width dimension generally parallel to the planes of said segments; said segments providing the only structural continuity between the struts connected to each segment

and the tie bar providing the only structural continuity between adjacent segments.

References Cited

UNITED STATES PATENTS

1,741,436	12/1929	Raule	277—214
2,346,896	4/1944	Bowers.	
2,569,778	10/1951	Phillips.	
2,631,908	3/1953	Teetor	277—200
2,764,458	9/1956	Ward et al.	277—200

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