Sept. 22, 1942. T. A. BOWERS 2,296,332

CLOSED PISTON RING

Filed Aug. 7, 1941 3 Sheets-Sheet 1

Fig. 1.

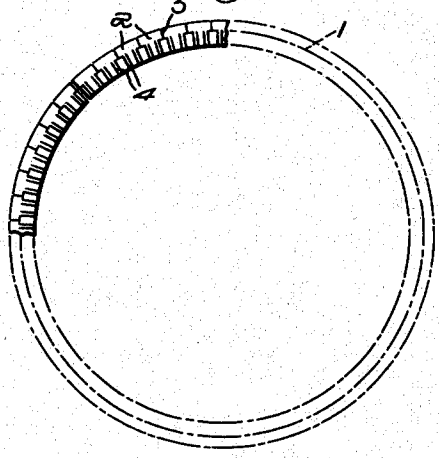


Fig. 2.

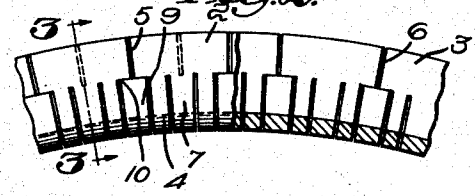


Fig. 3.

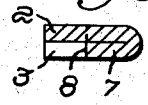


Fig. 4.

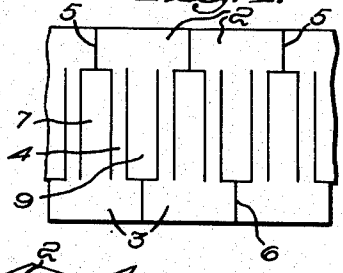


Fig. 6.

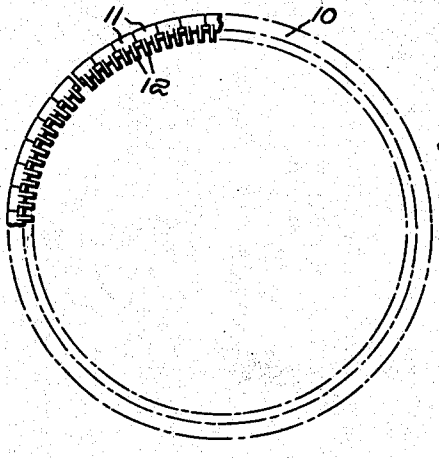


Fig. 5.

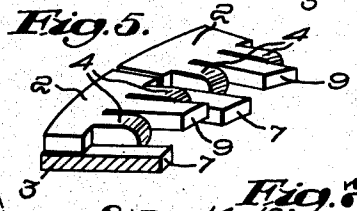


Fig. 7.

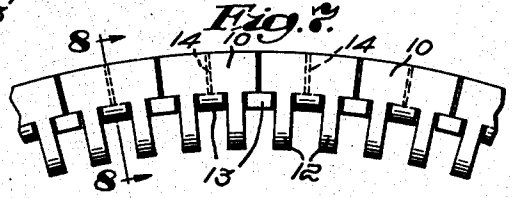


Fig. 8.

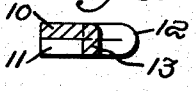


Fig. 9.

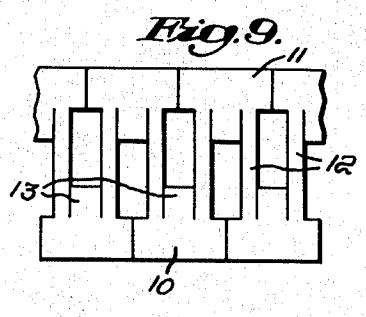
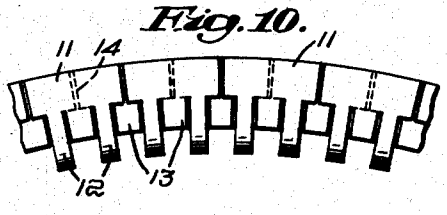


Fig. 10.



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Fig. 11.

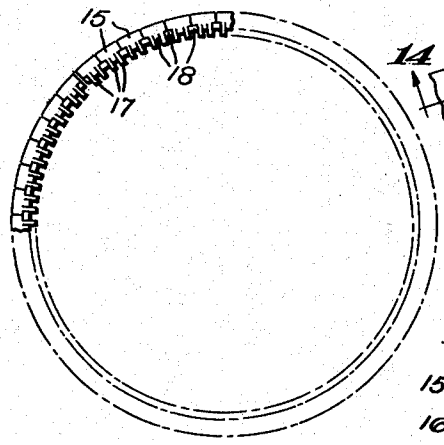


Fig. 12.

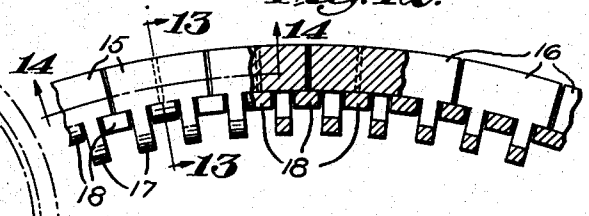


Fig. 13.

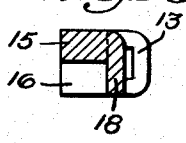


Fig. 14.

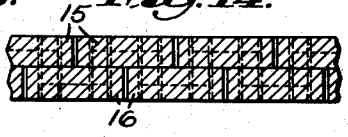


Fig. 15.

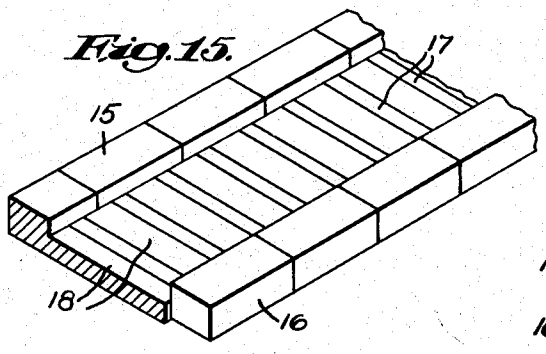


Fig. 16.

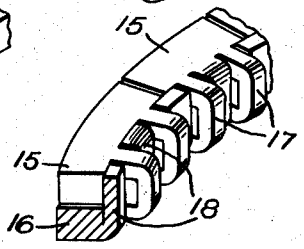
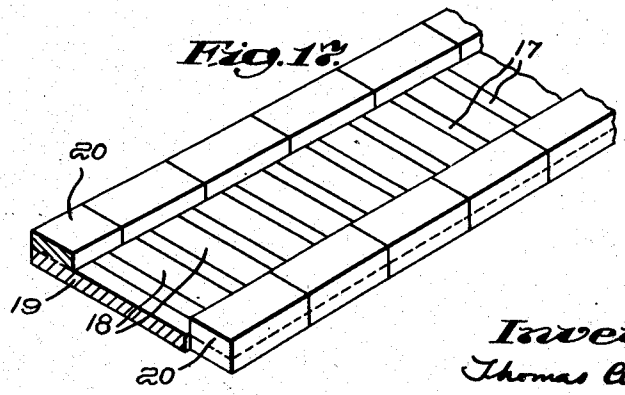


Fig. 17.



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Fig. 18.

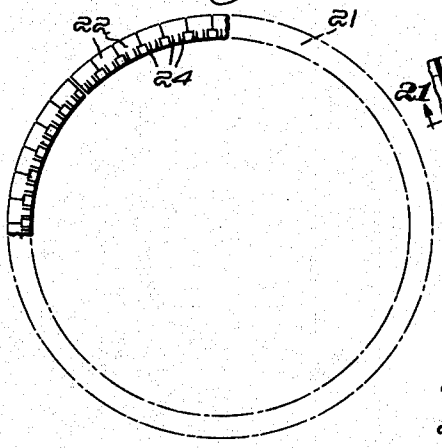


Fig. 19.

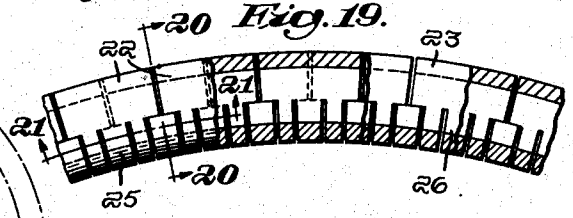


Fig. 20.

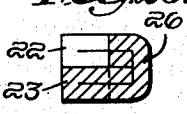


Fig. 21.

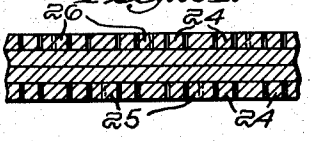


Fig. 22.

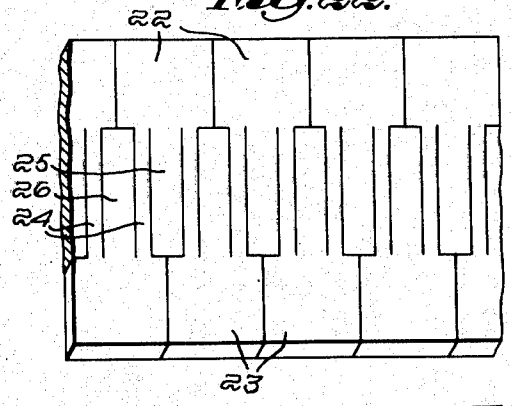


Fig. 23.

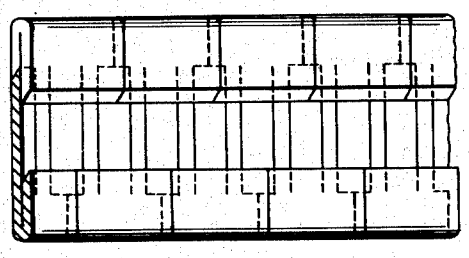
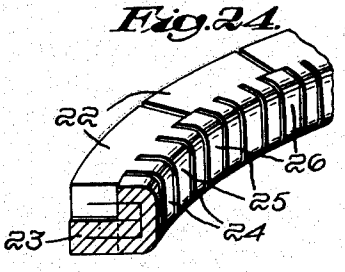


Fig. 24.



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Patented Sept. 22, 1942

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UNITED STATES PATENT OFFICE

2,296,332

CLOSED PISTON RING

Thomas A. Bowers, Mattapoisett, Mass., assignor to Power Research Corporation, Boston, Mass., a corporation of Massachusetts

Application August 7, 1941, Serial No. 405,807

15 Claims. (Cl. 309—44)

This invention relates to piston rings and more especially to flexible piston rings formed of resilient sheet materials.

An object of the invention is to improve piston rings and to devise substantially gas-tight ring structures made up of a plurality of segments of piston ring material connected together in minutely spaced-apart relation. Another object of the invention is to provide means for preventing passage of gases or other fluids radially between the spaces or gaps between the segments. Another object is to provide a means of varying the axial height of rings of the type noted, while maintaining the rings substantially gas-tight both radially and axially. The invention also aims to set forth improved methods of making piston rings from a strip of piston ring material, and to provide piston ring structures of novel flexible and extensible character which operate with their ends in abutting relation and which are cheap, efficient and durable.

The nature of the invention, and its objects, will be more fully understood from the following description of the drawings, and discussion relating thereto.

In the accompanying drawings:

Fig. 1 is a plan view of a piston ring of the invention;

Fig. 2 is a fragmentary enlarged plan view, partially broken away to illustrate a lower portion of the ring;

Fig. 3 is a cross section taken on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary plan view illustrating a step in a method of making a ring similar to that illustrated in Figs. 1–3 inclusive;

Fig. 5 is a fragmentary perspective view illustrating another step in the method referred to;

Fig. 6 is a plan view of a modification of piston ring;

Fig. 7 is an enlarged fragmentary plan view of a ring similar to that illustrated in Fig. 6;

Fig. 8 is a cross section taken on the line 8—8 of Fig. 7;

Fig. 9 is a fragmentary plan view illustrating a step in a method of making a ring similar to that illustrated in Figs. 6–8 inclusive;

Fig. 10 is an enlarged fragmentary plan view illustrating a further step in the method shown in Fig. 9;

Fig. 11 is a plan view of another modification of piston ring;

Fig. 12 is an enlarged fragmentary plan view of a ring similar to that shown in Fig. 11;

Fig. 13 is a cross section taken on the line 13—13 of Fig. 12;

Fig. 14 is a cross section taken on the line 14—14 of Fig. 12;

Fig. 15 is an enlarged fragmentary perspective view illustrating a step in a method of making a ring similar to that illustrated in Figs. 11–14, inclusive;

Fig. 16 is an enlarged fragmentary perspective view of another step in the method referred to;

Fig. 17 is an enlarged fragmentary perspective view illustrating another modification of method of making a piston ring; and

Figs. 18–24 inclusive illustrate still another modification of piston ring and a method of manufacture therefor.

In an earlier Patent, No. 2,224,338, issued to me December 10, 1940, I have described and claimed an improved oil control piston ring formed from a strip of resilient piston ring material such as a resilient steel or other suitable material. In making the ring of the patent referred to, portions of the strip are punched out to provide openings extending transversely within the edges of the strip. The edges of the strip are sheared to form slits or gaps which connect with the first formed openings. The gaps along one edge of the strip are staggered with relation to the gaps along an opposite edge, with the result that there are provided segments or crown portions occurring in staggered relation at opposite edges of the strip. The strip thus formed is folded longitudinally to provide a straight length of piston ring material of generally U-shaped cross section presenting spaced-apart oil scraping edges. The U-shaped strip is thereafter bent into an annular shape to constitute a piston ring.

The gaps provide for the segments being circumferentially spaced apart. When the ends of the ring are brought into abutting relation, the segments may be compacted against one another, thus decreasing the circumference of the ring. The resilient nature of the piston ring material tends to urge the segments back into their normal spaced-apart position, thus providing circumferential and radial extensibility in the ring. In practice a ring is employed slightly greater in circumference than the cylinder in which it reciprocates. The ring constantly operates in a slightly compacted position in which it develops a desirable wall pressure, which is exerted uniformly at all points in and around the cylinder irrespective of worn or irregular areas therein.

In accordance with the present invention, I provide a piston ring of somewhat the same gen-

eral segment construction in which means are incorporated for rendering the ring substantially gas-tight with respect to passage of gases both radially and axially of the ring. Sealing members or tongues, preferably forming a part of the segments, are provided and the annular layers or rows of segments are superimposed upon one another, thus allowing the sealing members to be bent over against inner edges of the segments and overlie the gaps between them. The superimposed relation of the rows of segments also provides for the segments sealing staggered gaps in the ring with respect to passage of gases axially of the ring.

Referring more in detail to the drawings, numeral 1 denotes a flexible piston ring of the type described in the above noted patent. The ring 1 is made up of an inner circular row of segments 2 and a lower annular row of segments 3 connected together by connecting portions 4.

Each of the segments 2 and 3 has at least two connecting portions extending radially inward therefrom, and each of the two connecting portions of a respective segment is secured to separate segments at an opposite side of the ring. Other arrangements of connecting portions may also be resorted to. Numeral 5 indicates gaps or interstices occurring between the upper row of segments 2, and numeral 6 refers to gaps or interstices occurring between the lower row of segments in staggered relation with respect to the gaps 5.

The upper annular row of segments 2 is superimposed upon the lower row of segments 3, and the connecting portions 4 are doubled over upon themselves in circumferentially spaced-apart relation at the inner periphery of the ring. By the staggered arrangement of the gaps, the segments 2 are made to overlie the gaps and the segments 3 underlie the gaps 5. This prevents passage of gases axially through the ring between the interstices or gaps of both rows of segments.

Numeral 7 refers to tongue members or sealing members integral with the crowns 2 and 3 at points between the connecting portions 4 of each of the crowns. The tongues 7 are of the same length as the connecting portions and are doubled upon themselves to extend substantially throughout the space between the connecting portions 4. If desired, a slight space between the tongues and connecting portions may be provided to facilitate the flexing of the ring. In this doubled over position of the tongue members, the ends are arranged in abutting relation with respect to the gaps of the segments. The ends 8 of tongues 7 are bent downwardly to overlie the gaps 6 and the ends 10 of tongues 9 are bent upwardly to overlie the gaps 5. The tongue members are preferably of the same thickness as the segments and connecting portions so that the ends of the tongues are of the same axial height as the gaps, and are thus adapted to prevent passage of gases radially through the gaps in both rows of segments.

An important feature of the invention is the provision of tongue or sealing members with a ring made up of segments. It is pointed out that in an internal combustion engine, there is a space between a cylinder and its piston, and a piston ring, when seated in a piston ring groove of the piston, extends across this space. The gaps 6 at the under side of the ring of the invention therefore provide a passageway for combustion gases to pass radially through the ring, and escape downwardly between the cylinder and piston, with resultant loss of compression and other disadvantages. By the tongue construction described above, the gaps 6 are efficiently closed, preventing passage of gas radially therethrough. The under side of the ring made up of segments 3 is forced against the piston groove by combustion gas pressure, preventing gas from escaping under the ring, and the upper gaps 5 are closed by the cylinder wall so that a substantially solid gas-tight ring is thus obtained.

In addition to preventing leakage of combustion gases, it is desirable to prevent oil from being sucked upwardly around the ring during the suction stroke of the piston. Oil may be sucked through the ring by means of the upper interstices 5 when the ring is seated against the upper side of a piston ring groove. It should be observed, therefore, that the tongues 9, while not being necessary to seal the ring to combustion gases, close the interstices 5 and effect a desirable oil sealing action during the suction stroke of the piston.

The tongues further serve to fill in the spaces between the connecting portions which gives the ring increased body and reduces the deposit of carbon, and provide various other improvements.

A preferred method of making the ring of the invention consists in cutting and bending a strip of piston ring material as illustrated in Figs. 4 and 5. The segments 2 and 3 are formed in the usual manner by transversely cutting the strip with slits or interstices 5 and 6. Instead of punching out portions of the strip intermediate the edges to form connecting portions 4, these portions are left integral with the segments on one side. By alternating this cutting operation, spaced-apart connecting portions of usual character are formed, and tongues along opposite sides of the strip are obtained. This method of cutting insures the tongues being of the same thickness as the segments and therefore being adapted to efficiently seal the openings or interstices 5 and 6 between these segments when the strip is folded over and bent into a ring body. It is pointed out that only one bending operation for bending both the connecting portions and the tongues is necessary in this method.

It is intended that other types of tongues, as for example separately attached pieces of piston ring material, may be resorted to, and various changes in the tongues themselves may be made. In Figs. 6–10 inclusive, I have shown a ring 10 made up of segments 11, connecting portions 12, and tongues 13. The segments in this ring modification have shortened tongue portions which do not extend throughout the spaces between the connecting portions 12 but are bent over so that their sides overlie the gaps 13 and 14 and effect a sealing action in the manner already described.

A ring such as that illustrated in Figs. 6, 7 and 8 may readily be made by punching and shearing a strip of sheet metal in the manner illustrated in Figs. 9 and 10, in which the segments 11 and connecting portions 12 are formed in the usual manner, but the tongue portions 13 are cut away for a part of their length to provide shortened tongues of a length equivalent to the axial height of the ring when the strip is folded over upon itself. Fig. 10 shows the shortened tongues bent over into a sealing position.

In Figs. 11–16 inclusive, I have illustrated another modification of piston ring having relatively thick segments 15 and 16, connecting por-

tions 17 and tongue members 18. In this form of ring, the segments 15 and 16 are of increased thickness which is adapted to provide added axial height to the ring. This is effected with the same sealing effect by tongue members integral with the segments which are alternately bent over into axially disposed positions, as is more clearly illustrated in Fig. 13. This type of construction affords desirable variation in the axial height which may be obtained in a ring made from a strip of piston ring material.

One method of making a ring with thick segments as noted consists in rolling a strip of piston ring material with relatively thick edges and relatively thin intermediate portions, as illustrated in Fig. 15. This modified type of piston ring material is cut and folded in the manner already described, and further illustrated in Fig. 16 of the drawings.

If desired, a ring having relatively thick segment construction may be obtained by welding, on a strip of piston ring material 19, other pieces of piston ring material 20, as illustrated in Fig. 17 of the drawings. The same cutting and folding operations may then be resorted to, to form a piston ring. It is pointed out that the welding of strips may be carried out for only a part of the width of the strips to facilitate formation of gaps.

Still other modifications of piston ring constructions having sealing tongues may be resorted to, as for example that shown in Figs. 18–22 inclusive. Numeral 21 denotes a piston ring, having relatively thick segments or crowns 22 and 23, connected together by connecting portions 24 and sealed by tongues 25 and 26. The thickened segment construction in this case is obtained by folding the edges of a strip of piston ring material upon itself, superimposing the folded edges upon one another, then bending the tongues 25 and 26 in the manner illustrated in Figs. 22–24 inclusive. The ring thus obtained operates in the same general fashion and provides a solid member which may be made of any desired height. Various other modifications may be resorted to.

It will be seen that I have disclosed a means of sealing flexible piston rings made up of connected segments, and variation in the body and axial height is provided for. Several methods of quickly and cheaply forming the rings from sheet metal have been set forth, and an efficient, durable compression ring adapted to exert a uniform wall pressure has been provided.

While I have shown a preferred embodiment of the invention, it should be understood that various other changes and modifications may be resorted to, in keeping with the spirit of the invention as defined by the appended claims.

I claim:

1. A piston ring comprising a plurality of layers of piston ring material, each of said layers being separated by overlapping openings which form circumferentially movable segments and connecting portions for the segments, sealing members mounted between the connecting portions and being integral with the said layers, said sealing members adapted to overlie openings between the circumferentially movable segments at the inside of the ring.

2. A piston ring comprising upper and lower sides of piston ring material, connecting portions for the sides, each of said sides being severed by openings radially disposed therein, sealing elements mounted between the connecting portions, said sealing elements extending from one of the sides axially of the ring to overlie openings in another of the sides.

3. A piston ring comprising annular rows of separated segments of piston ring material, connecting portions for connecting the segments of one of the rows to segments of another of the rows, the said segments presenting tongue members doubled over upon themselves between the connecting portions, the extremities of said tongues arranged in abutting relation with respect to other segments at their points of separation.

4. A piston ring comprising annular rows of separated segments of pison ring material, connecting portions for connecting the segments of one of the rows to segments of another of the rows, the segments having sealing portions which extend radially inward and then radially outward throughout the space between the connecting portions.

5. A piston ring comprising annular rows of separated segments of piston ring material, connecting portions for connecting the segments of one of the rows of segments to another of the rows, the segments having sealing portions doubled over upon themselves and extending throughout the space between the said connecting portions said sealing portions being of a thickness corresponding to the thickness of the segments and having their ends overlying gaps between segments at one side of the ring thereby to seal the said gaps to the passage of gases radially therethrough.

6. A piston ring comprising annular rows of segments of piston ring material superimposed one upon another and having radially extending gaps, spaced-apart connecting portions for connecting the segments of one of the rows of segments to another of the rows the segments having formed integrally therewith sealing portions of an axial height corresponding to the axial height of the radially extending gap the sealing portions being doubled over upon themselves and having ends thereof overlying the said gaps at one side of the ring for the purpose of sealing the gaps.

7. A circumferentially and radially flexible piston ring comprising upper and lower layers of piston ring material superimposed one against another, each of said layers being circumferentially separated by overlapping openings which form circumferentially movable segments and connecting portions for the segments, the openings of one of the layers occurring in staggered relation with respect to openings of another of the layers, said circumferentially movable segments presenting tongue members doubled over upon themselves and extending between the connecting portions, the free ends of the tongue members overlying openings of the said lower layer along an inner peripheral side of the ring.

8. A circumferentially and radially flexible piston ring comprising a plurality of layers of piston ring material superimposed one against another, each of said layers being circumferentially separated by overlapping openings which form circumferentially movable segments and connecting portions for the segments, said segments having axially disposed sealing strips integral therewith, said sealing strips being of a length corresponding to the axial height of the ring and overlying the said openings of one of the layers.

9. A piston ring comprising a plurality of layers of piston ring material superimposed one against

another, each of said layers being separated by overlapping openings which form circumferentially movable segments and connecting portions for the segments, said segments having tongue portions of a lesser length than the connecting portions, said tongue portions being bent over into overlapping relation with respect to openings of one of the layers.

10. A piston ring comprising a plurality of layers of piston ring material, each of said layers being separated by overlapping openings which form circumferentially movable segments and connecting portions for the segments, the connecting portions being of an axial thickness less than the axial thickness of the segments, said segments presenting tongue members extending axially of the ring between the connecting portions and said tongue members overlying openings of one of the layers along an inner peripheral side of the ring.

11. A circumferentially and radially flexible piston ring comprising a plurality of layers of piston ring material superimposed one against another, each of said layers being separated by overlapping openings which form circumferentially movable crowns and connecting portions for the crowns, the circumferentially movable crowns being of an axial thickness greater than the axial thickness of the connecting portions, said connecting portions being located against the inner peripheral edges of the crowns, sealing portions extending axially of the ring between the connecting portions, said sealing portions overlying openings in one of the said layers.

12. A piston ring comprising a strip of resilient piston ring material folded longitudinally of itself and bent into an annular body, said strip having overlapped openings formed transversely therein, portions of the strip intermediate the edges being partially severed to form tongue members, each of the edges of the strip being doubled over, the said doubled over edges being superimposed one upon another, and said tongue members extending axially of the ring into overlapping relation with respect to the said transversely formed openings in the strip.

13. A piston ring comprising a strip of piston ring material formed with transverse overlapping openings which define crowns and connecting web portions, said strip being folded longitudinally of itself along lines of folding which intersect the said crowns and along other lines of folding which intersect the said web portions.

14. A piston ring comprising a strip of piston ring material formed with transverse overlapping cuts which define crowns and connecting web portions, said strip being folded longitudinally of itself along lines of folding which intersect the crown portions along the outer periphery of the ring and which intersect the web portions along the inner periphery of the ring.

15. A piston ring comprising a strip of piston ring material formed with transverse overlapping cuts which define crowns and connecting web portions, said strip being folded longitudinally of itself along lines of folding which intersect the crown portions along the outer periphery of the ring and which intersect the web portions along the inner periphery of the ring, and sealing members extending between the web portions into abutting relation with the crowns.

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