July 19, 1955 HSIA-SI PIEN 2,713,527

PISTON RING

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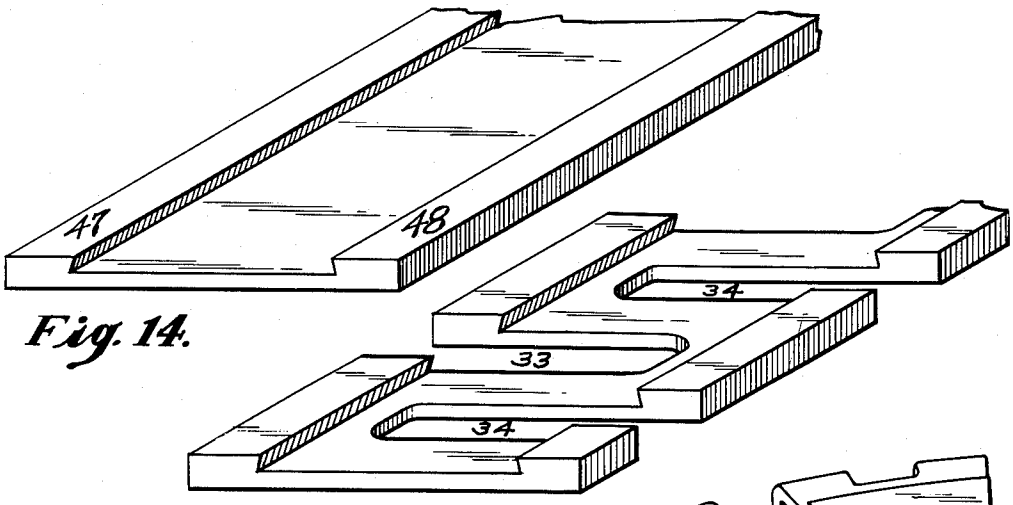


Fig. 14.

Fig. 15.

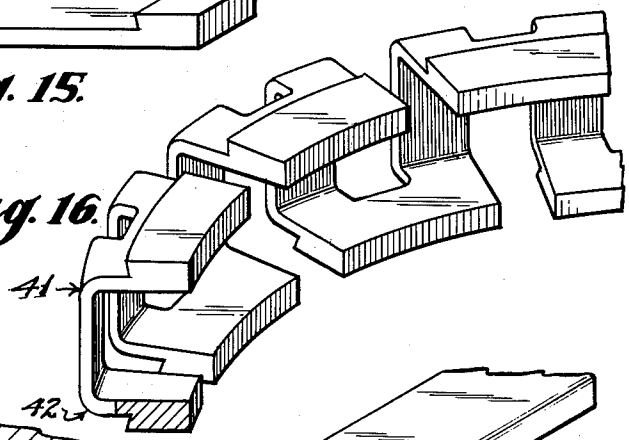
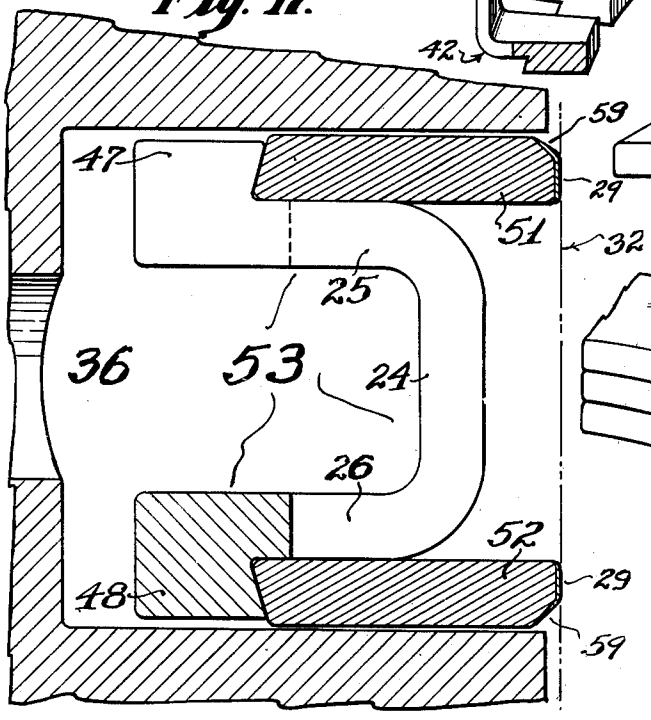


Fig. 16.

Fig. 17.



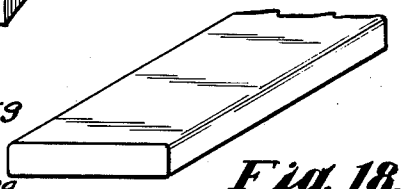
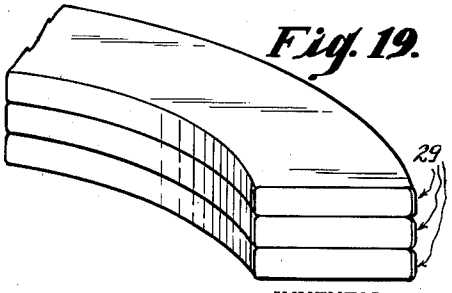


Fig. 18.

Fig. 19.



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July 19, 1955 HSIA-SI PIEN 2,713,527

PISTON RING

Filed Nov. 1, 1951 4 Sheets-Sheet 2

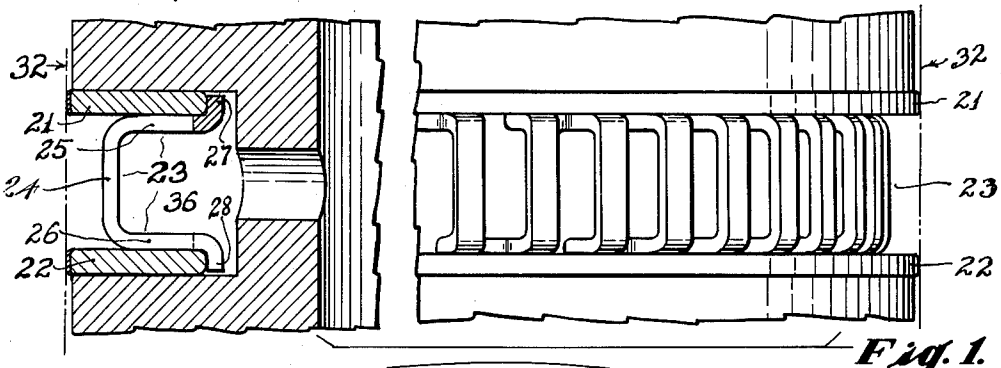

Fig. 1.

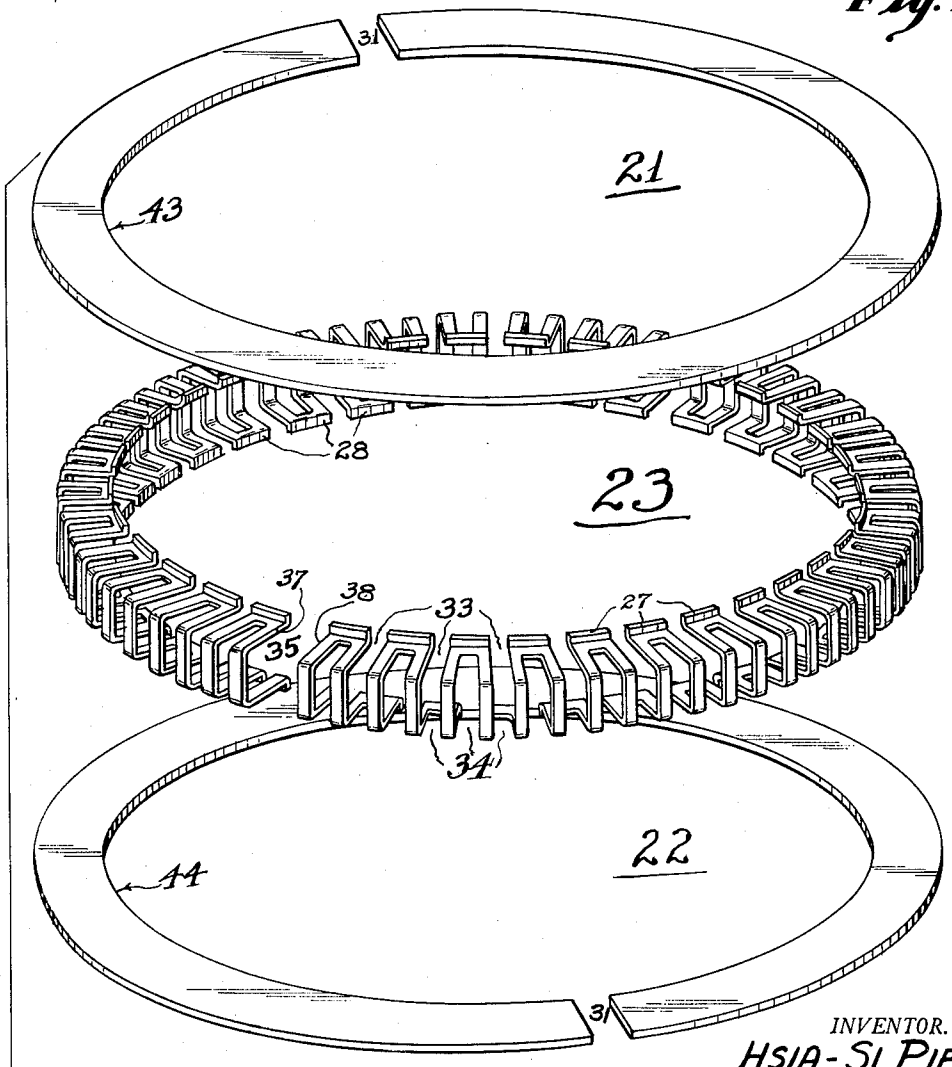

Fig. 2.

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July 19, 1955 HSIA-SI PIEN 2,713,527

PISTON RING

Filed Nov. 1, 1951 4 Sheets-Sheet 3

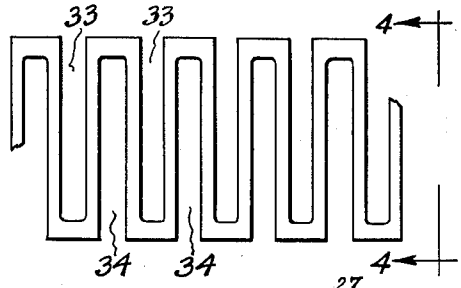


Fig. 3.

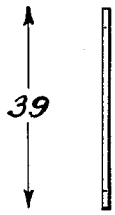


Fig. 4

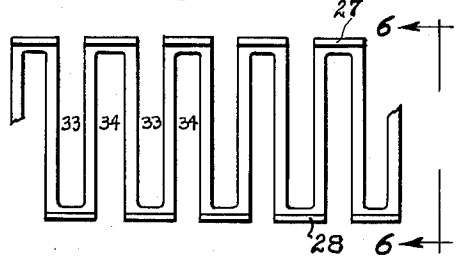


Fig. 5.

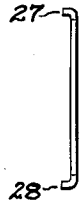


Fig. 6.

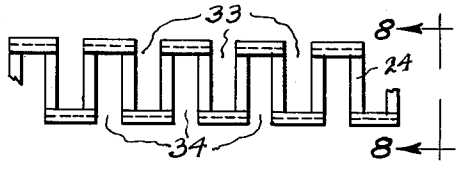


Fig. 7.

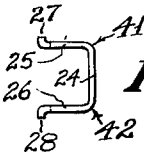
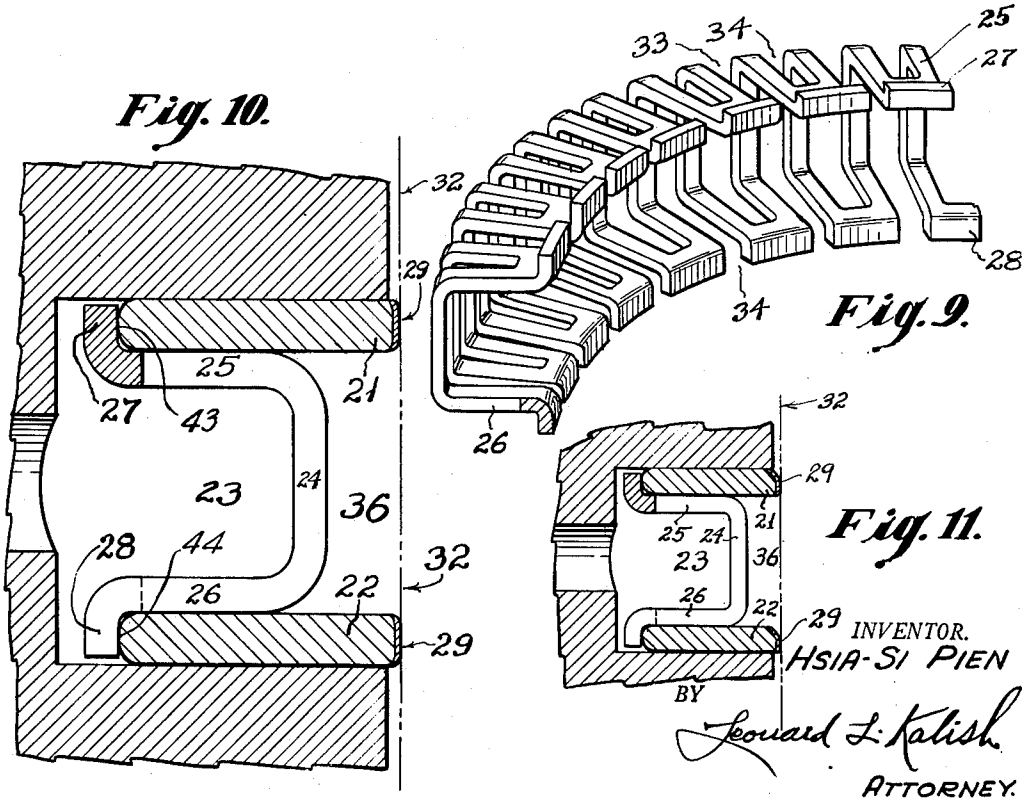


Fig. 8.

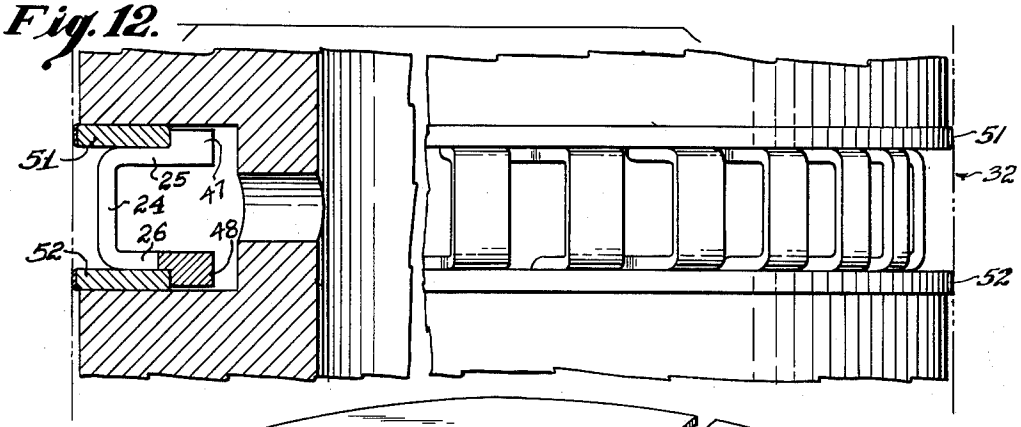


July 19, 1955 HSIA-SI PIEN 2,713,527

PISTON RING

Filed Nov. 1, 1951 4 Sheets-Sheet 4

Fig. 12.



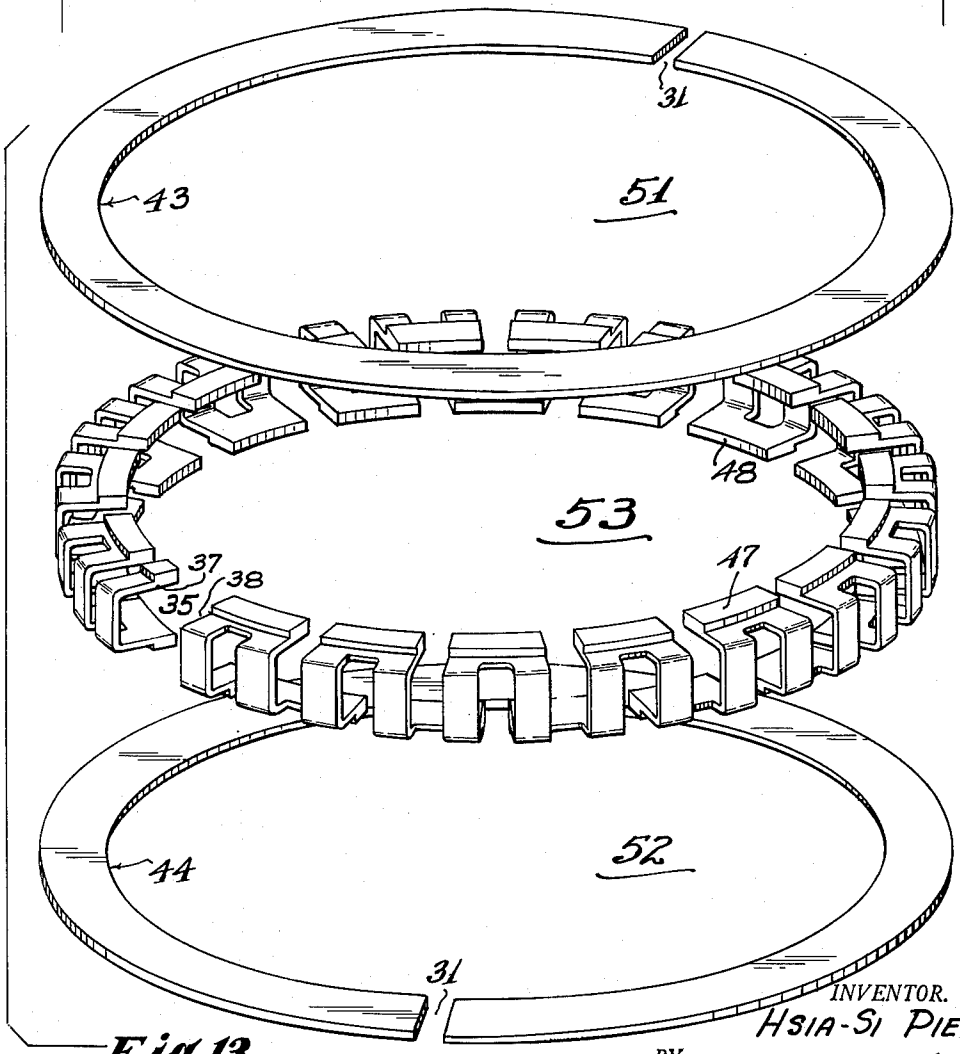


Fig. 13.

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PISTON RING

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Application November 1, 1951, Serial No. 254,344

3 Claims. (Cl. 309—45)

The present invention relates to certain new and useful piston-rings for internal combustion engines and the like and more particularly to oil-control piston-rings for internal combustion engines and the like.

An object of the present invention is a piston-ring which will conform to the cylinder-wall notwithstanding any slight out-of-roundness or out-of-cylindrical shape of the cylinder-wall due either to distortion of the cylinder-wall or due to wear, and one which will "break in" readily.

Another object of the present invention is a piston-ring which will bear against the cylinder-wall with uniform or equalized outward radial pressure and which will effectviely seal against the cylinder-wall and which may have a relatively high unit of contact-pressure per unit of contact-area with cylinder-wall, and which will provide adequate lubrication and will not score or scuff the cylinder-wall.

With the above and other objects in view, the present invention contemplates a 3-piece or multi-piece composite piston-ring including two (or more) thin flat annulus-shaped cylinder-contacting sealing elements or "rails" of generally uniform cross-section having a small axial dimension so as to present narrow cylinder-contacting surfaces and having an axial width substantially less than the depth of the ring-receiving groove and being sufficiently small in radial dimension and in cross-sectional area as to conform to the cylinder-wall when pressed thereagainst with uniformly distributed outward radial pressure, and an intervening circumferentially compressible non-bottoming seal-spacing resilient expander having seal-supporting side-lands and oppositely extending seal-engaging projections extending axially therefrom at the inner periphery thereof beyond the planes of said seal-lands and adapted to engage the inner peripheries of said sealing elements resiliently to urge them outwardly with uniformly distributed outward radial pressure when the ends of the seal-spacing expander abut each other and when said expander is circumferentially compressed by the sealing elements when the composite piston-ring is mounted in the ring-receiving groove of the piston within the cylinder.

The present invention further contemplates 3-piece oil-control rings comprising a pair of thin and generally flat cylinder-contacting oil-scraper sealing rings (or what, for brevity, may also be called "seals") and an intervening spacer and expander; the pair of seals having generally continuous inner and outer peripheries and each having but a single gap in the circularity thereof to permit it to be spread open sufficiently so that it can be mounted in the ring-receiving groove of the piston (and so as to permit the sealing members to be expanded against the cylinder-wall by the expander), while the spacer and expander, which is preferably set slightly inwardly from the cylinder-diameter, is segmented or slotted and given outward resilient pressure, so as to cause it to support the pair of oil-scrapers (or "seals") in an outward pressed condition against the cylinder wall.

The piston-ring of the present invention may include still other features or combinations of elements and may be embodied in still other forms, all as will appear more fully from the following description and accompanying drawings.

For the purpose of illustrating the invention, there are shown in the accompanying drawings forms thereof which are at present preferred, although it is to be understood that the various instrumentalities of which the invention consists can be variously arranged and organized and that the invention is not limited to the precise arrangements and organizations of the instrumentalities as herein shown and described.

In the accompanying drawings in which like reference characters indicate like parts:

Figure 1 represents a side-elevational view, partly in section, of a 3-piece oil-control ring representing one embodiment of the present invention, shown mounted in one of the ring-receiving grooves of a piston.

Figure 2 represents an "exploded" perspective view of the 3-piece oil-control ring of the present invention.

Figure 3 represents a plan view of a fragmentary portion of the punched or cut strip of band or ribbon of flat spring-metal, as, for instance, spring-steel, of which the spacer and expander is formed, showing the first stage in the formation of said spacer and expander member.

Figure 4 represents a section on line 4—4 of Figure 3.

Figure 5 represents a view, similar to that shown in Figure 3, of a fragmentary portion of the spacer and expander element, shown in its second or later stage of development or manufacture, namely, the stage in which the radially-acting seal-engaging lugs or ears have been bent generally at right angle to the main body of the spring-strip.

Figure 6 represents a section on line 6—6 of Figure 5.

Figure 7 represents a view similar to that shown in Figures 3 and 5, of the next or a later development stage of the spacer and expander, but prior to its being coiled into a generally circular shape, namely, wherein the entire spring-strip is bent longitudinally along two generally parallel lines, to form the generally U-shaped cross-section, with the seal-engaging ears projecting outwardly from the free ends of the U-shape.

Figure 8 represents a section on lines 8—8 of Figure 7.

Figure 9 represents a fragmentary portion of the completed spacer and expander element shown in Figures 7 and 8, but curved into a generally circular shape.

Figure 10 represents a cross-section of the completed piston-ring, shown disposed in the ring-receiving groove, but on a somewhat larger scale, better to show the details thereof.

Figure 11 represents a modified form of the construction shown in Figures 1 and 10.

Figure 12 represents an elevational view of a piston-ring representing another embodiment of the present invention, partly in section, shown disposed in the ring-receiving groove of a piston.

Figure 13 represents an "exploded" perspective view of the piston-ring shown in Figure 12.

Figure 14 represents a perspective view of a strip of flanged drawn metal of which the spacer and expander of Figures 12 and 13 is formed.

Figure 15 represents a smaller fragmentary perspective view of the same strip of metal (of Figure 14) with slots punched or cut thereinto, alternately from opposite edges.

Figure 16 represents a fragmentary perspective view of the spacer and expander (of Figures 12 to 15) after it has been bent into a U shape in cross-section and curved into a generally circular formation.

Figure 17 represents a cross-sectional view of the oil-control ring of the embodiment shown in Figures 12 and

13, on a somewhat larger scale, and showing another embodiment.

Figure 18 represents a fragmentary perspective view of the metal strip of which the cylinder-contacting elements, "seals" or "rails" of the piston-ring of the present invention are formed.

Figure 19 represents a fragmentary perspective view of a coil formed of the strip of Figure 18, with the outer cylinder-contacting surfaces chromium plated.

The 3-piece oil-control ring of the present invention is formed of an upper thin flat oil-scraper or oil-control ring-element **21** and a similar lower oil-scraper or oil-control ring-element **22**, and an intervening spacer and expander **23** of generally U-shaped cross-section, including the base portion **24** and the sides or legs **25** and **26** of the U, and the laterally projecting ears **27** and **28**.

Each oil-scraper **21** and **22**, or what for brevity may be called each "seal" or "rail," is preferably made of a flat band of steel although it may be formed of suitably hard drawn-metal band. The seals **21** and **22** are made by coiling the band into a coil of suitable diameter (Figure 19) and then cutting the individual convolutions to form the oil-scrapers or "seals" from such coil or by coiling such band and cutting off each convolution as it is formed (one at a time).

The outer cylinder-contacting edges or faces **29** of the seals **21** and **22** may plate with chromium, as indicated by the contrasting shading of the marginal zone **30** in Figures 1, 10 and 11. The seals or rails **21** and **22** are each "split" or provided with a gap at one point, as at **31**, but are of such diameter that when the gap **31** is approximately closed, the oil-scraper (**21** and **22**) will be at the diameter of the cylinder indicated by the line **32**. This gap **31** is formed when the oil-scraper is cut from the coil, as indicated above.

The spacer and expander **23** is slitted or slotted by means of the alternating slits or slots **33** and **34**; the slots **33** intersecting and extending through the entire U-cross-section of the spacer and expander excepting only the extreme inner end of the lower leg **26** of the U and the lower ear **28**, while the slots **34** intersect and extend through the entire U-cross-section of the spacer and expander excepting only the inner end of the upper leg **25** of the U and the upper ear **27**, as indicated particularly in Figures 2 and 9 (and Figures 15 and 16). The spacer and expander is also provided with a complete gap or break at one point in its circumference, as at **35**, so that it too may be spread open to permit it to be mounted within the ring-receiving groove **36**. The free ends **37** and **38** of the spacer and expander **23** abut each other when operatively installed within the ring-receiving groove. The uncompressed spacer and expander **23** is made suitably oversize in circumference, so that when the seals or rails **21** and **22** are mounted thereon in the manner indicated in Figures 1, 10, 11, 12 and 17, and the seals or rails **21** and **22** are collapsed to their gap-closing or cylinder-diameter, the spacer and expander **23** will be compressed suitably (with the ends **37** and **38** thereof abutting); this compression taking place through the slight resilient deformation of the successive base and leg portions **24**, **25** and **26** of the U-cross-sectioned spacer and expander **23** (Figures 9 and 10).

The spacer and expander **23** is preferably made of suitably tempered spring-steel or other suitable spring-metal. A flat strip, band or ribbon of annealed spring steel of the width **39** is alternately slotted inwardly from its opposite edges, by means of the slots **33** and **34**, respectively, as shown in Figures 2, 3 and 9. This may be done on a punch-press by suitable dies. This leaves behind the intervening narrow portions which later form the base portions **24** and leg portions **25** and **26** and the ear portions **27** and **28** of the generally U-cross-sectioned spacer and expander. Thereafter, the extreme marginal zones of the strip are bent, as indicated in Figures 5 and 6, at generally right angles, to form the ear portions **27** and **28**. Thereafter, the strip is further bent along parallel lines **41** and **42**, with a slight curvature or fillet at the bends, to form the generally U-shaped cross-section as indicated in Figures 7 and 8. The bends along lines **41** and **42** may be made first and the terminal ear portions **27** and **28** bent thereafter, or both sets of bends may be formed simultaneously. These bends may be formed by passing the slotted strip through suitable forming rolls. The so-formed U-shaped strip may then be coiled to suitable diameter, and successive turns or convolutions of the coils then cut off to form individual spacer and expander members, of one complete circle, as indicated in Figures 2 and 9, with the gap **35** therein at the point of the severing cut. The formed spacer and expander **23** is hardened and drawn or tempered to a suitable spring temper or spring hardness.

The outer side-surfaces of the legs **25** and **26** of the spacer and expander **23** form side-supporting surfaces or "lands" for axially supporting the oil-scrapers, "seals" or "rails" **21** and **22**. The ears or lugs **27** and **28** abut and bear against the inner peripheries **43** and **44**, respectively, of the seals **21** and **22**, and exert an outward radial force thereagainst, thereby to expand the seals **21** and **22**, with a uniformly distributed outward radial pressure, against the cylinder-wall **32**, as indicated in Figures 1, 10 and 11; without the expander **23** contacting or "bottoming" against the inner wall of the ring-receiving groove **36**.

The distance between the two outer seal-supporting side-surfaces or lands of the legs **25** and **26** of the spacer and expander **23** may be just equal to or very slightly less than the difference between the width of the ring-receiving groove **36** and the combined axial widths of the two seals or rails **21** and **22**, so that the legs **25** and **26** will either space the seals or rails snugly or loosely between the side-walls of the ring-receiving groove **36**. As the U may also be slightly resilient in an axial direction, slight resilient axially-outward force may be exerted upon the seals **21** and **22**, if desired.

By varying the circumferential length and/or the thickness of the base portion **24** and legs **25** and **26** of the U, the amount of outward radial pressure exerted upon the seals **21** and **22** may also be varied and set to the amount most effective for the desired oil-control.

The cross-section of the rails **21** and **22** is preferably symmetrical about each of two right-angular axes, as indicated in Figures 1, 10, 12, 18 and 19, with the corners slightly rounded or the cross-section may be as shown in Figures 11 and 17.

In the modified embodiment of the present invention shown in Figures 12 to 17, inclusive, the spacer and expander **53** is formed of a strip or band of spring metal such as spring-steel, a fragmentary portion of which is shown in Figure 14, which is formed by rolling or drawing, with the thickened marginal or flange portions **47** and **48**. The inner edges of the thickened marginal portions **47** and **48** may be more or less at a right angle to the plane of the strip as indicated in Figure 12 or they may be slightly undercut as indicated in Figure 17. The strip or band is slotted by punching or milling or otherwise cutting the slots **33** and **34**, alternately intersecting opposite edges of the strip and being short of the opposite flanged portion as indicated in Figures 15 and 16. The so-slotted band is then bent along two lines designated generally by the numerals **41** and **42**, to form the generally U-cross-sectioned band alternately slotted through opposite sides, which is then curved into a circular formation indicated in Figures 13 and 16, as indicated above, by coiling the slotted U-cross-sectioned band into a coil of suitable diameter; from which the individual convolutions of the coil are then cut to form the individual expanders **53** shown in Figure 13.

The inner peripheries **43** and **44** of the scraper-rings or seals **51** and **52** may, as indicated in Figures 1, 10, 11, 12, 18 and 19, be also slightly beveled to match the

undercut contact-faces of the seal-engaging lugs **47** and **48** (Figure 17) so that the outward radial force exerted by the expander **53** against the inner peripheries of the seals **51** and **52** will also tend to draw the rings **51** and **52** closely against the outer sides of the legs **25** and **26** of the U-cross-sectioned expander **53**.

A similar gap **35** is provided in the general circularity of the expander **53**, with the free ends **37** and **38** thereof abutting each other when mounted and operatively compressed within the ring-receiving groove **36** of the piston.

The expander **53** is likewise preferably made of spring-steel tempered to suitable spring temper, but other resilient spring metal may be used.

The sealing rings **51** and **52** are likewise preferably made of steel of suitable hardness or other suitable metal, namely, a hardness which will not score the cylinder wall.

A slight bevel **59** may be provided along the outer periphery of the sealing and oil-control elements **21**, **22**, **51** and **52**, as indicated in Figure 17. These bevels may both face outwardly as indicated in Figure 17 or they may both face upwardly, i. e. in the direction of the closed end of the piston as indicated in Figure 11. The amount of beveling may be increased so as to reduce the width of the cylinder-contacting cylindrical surface and thereby increase the contact pressure per unit of area.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

Having thus described my invention, the following is hereby claimed:

1. A 3-piece oil-control piston ring comprising a resilient and circumferentially compressible seal supporter and expander of generally U-shaped cross-section with the base of the U spaced inwardly slightly from the cylinder diameter and with the legs of the U extending inwardly from the base of the U and having the innermost ends thereof substantially thicker than the main portion of the legs of the U, said thickened leg-terminals of the U forming seal-engaging shoulders extending axially outwardly from the legs of the U and having an undercut radially-outward seal-engaging face, said supporter and expander being slotted through the base and sides of the U, at frequent intervals, with alternate slots extending through opposed thickened terminal leg portions of the U, the outer sides of the legs of the U forming seal-supporting lands, and a pair of flat and generally continuous seals, each seal having a beveled inner periphery adapted to be received in said undercut seal-engaging face of its seal-supporting land, said seals being disposed on opposite sides of said supporter and expander along said seal-lands thereof, with the undercut seal-engaging shoulders of said thickened terminal leg portions being in operative juxtaposition to and in contact with the inner beveled peripheries of said seals, thereby to exert an outward radial force upon said seals and to draw said seals against the outer surface of the legs of the U when the oil-control ring is compressed to cylinder diameter with the ends of said supporter expander in abutting relation to each other.

2. A spacer and expander for multi-seal piston-rings comprising a generally circular U-cross-sectioned resilient spring metal band with the base of the U outermost and with the legs of the U extending inwardly therefrom, the inner ends of the legs of the U being substantially thicker than the rest of the leg portions, with the thickened terminal portions extending radially outwardly in opposite directions and forming seal-engaging shoulders extending outwardly from the sides of the legs of the U and having an undercut radially-outward seal-engaging face, said U-cross sectioned spacer and expander having spaced slots therethrough at frequent intervals, each slot extending through one of the thickened end zones while leaving the opposite thickened end zone intact, and alternate slots extending through opposite thickened end zones, thereby to form a circumferentially compressible spacer and expander.

3. A 3-piece oil-control piston-ring comprising a resilient and circumferentially compressible seal supporter and expander of generally U-shaped cross-section with the base of the U spaced inwardly slightly from the cylinder diameter and with the legs of the U extending inwardly from the base of the U and having the innermost ends thereof substantially thicker than the main portion of the legs of the U, said thickened leg-terminals of the U forming seal-engaging shoulders extending axially outwardly from the legs of the U and having an undercut radially-outward seal-engaging face, said supporter and expander being slotted through the base and sides of the U, at frequent intervals, with alternate slots extending through opposed thickened terminal leg portions of the U, the outer sides of the legs of the U forming seal-supporting lands, and a pair of flat and generally continuous seals having chromium-plated outer peripheral edges, each seal having a beveled inner periphery adapted to be received on said undercut seal-engaging face of its seal-supporting land, said seals being disposed on opposite sides of said supporter and expander along said seal-lands thereof, with the undercut seal-engaging shoulders of said thickened terminal leg portions being in operative juxtaposition to and in contact with the inner beveled peripheries of said seals and to draw said seals against the outer surface of the legs of the U, thereby to exert an outward radial force upon said seals when the oil-control ring is compressed to cylinder diameter with the ends of said supporter expander in abutting relation to each other.

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