METHOD OF FORMING PISTON RINGS
Thomas A. Bowers, Boston, Mass., assignor to Power Research Corporation, Boston, Mass., a corporation of Massachusetts

Application March 28, 1940, Serial No. 326,340

1 Claim. (Cl. 25—156.6)

This invention relates to piston rings and more especially to methods of making piston rings of sheet materials.

It is a chief object of the invention to improve methods of making piston rings and to devise methods of fabricating from sheet materials composite structures generally adapted to comprising piston rings, and in particular oil control piston rings. A further object of the invention is to present methods of making novel ring portions and ring surfaces, and of imparting novel characteristics to piston rings. The invention also aims to indicate generally methods of making piston rings which may be carried out with conventional tool machinery such as punches, dies, and the like, whereby the expense of designing and making special machinery is avoided and the cost of manufacture of piston rings is reduced.

The nature of the invention and its objects will more fully appear in the following description of the drawings and discussion relating thereto.

In the accompanying drawings:

Fig. 1 is a fragmentary plan view of sheet material which may be employed in manufacturing piston rings.

Fig. 2 is a fragmentary plan view of the material illustrating a forming step in the method of making piston rings.

Fig. 3 is another plan view illustrating a further forming step.

Fig. 4 is a plan view illustrating a modified forming operation effected on sheet material.

Fig. 5 is a fragmentary perspective view illustrating a further step in the method relating to folding the formed material indicated in Fig. 3.

Fig. 6 is a fragmentary view of a finished ring as viewed from the outside thereof.

Fig. 7 is a symmetrical cross section of the finished ring assembled in a piston groove.

Fig. 8 is a fragmentary plan view of the ring.

Fig. 9 is a symmetrical cross sectional view of a ring similar to that shown in Figs. 5–8, inclusive, illustrating a further forming step.

Fig. 10 is an assembly view illustrating a preferred arrangement of rings of the type indicated in Fig. 9.

Figs. 11 and 12 illustrate modifications in the method of making piston rings indicated in Figs. 1–6, inclusive.

Figs. 13–16, inclusive, illustrate another general type of method for making a piston ring construction from sheet metal material.

Figs. 17–21, inclusive, illustrate modifications in the method indicated in Figs. 13–16, inclusive.

Fig. 22 is a perspective view illustrating a modification of the method indicated in Figs. 1–6, inclusive.

Figs. 23, 24 and 25 illustrate still further modifications in the method indicated in Figs. 13–16, inclusive.

Figs. 26–32, inclusive, illustrate another general type of method of making sheet metal piston rings; and

Figs. 33 to 35 illustrate a modification of the method indicated in Figs. 26–32, inclusive.

Referring in detail to the drawings, there have been illustrated a number of methods of treating sheet material which are directed to improving piston rings generally and in particular oil metering piston rings. Of the methods disclosed, Figs. 1–12, inclusive, relate to one general type of method and its modifications; Figs. 13–35, inclusive, indicate another type of method and its modifications; and Figs. 26–35, inclusive, illustrate still another type of method and modifications thereto.

Having reference to the construction included in Figs. 1–8, inclusive, numeral 1 denotes a length of sheet material employed in constructing the rings of the invention. The sheet material is of a resilient character and may consist of a spring steel, alloy, or other metal or suitable substance. According to the invention, a strip or sheet of the resilient material is formed in some desired manner to provide ring-forming portions and the material is folded in relation to these portions to provide desirable ring surfaces. As illustrated in Figs. 3 and 4, the strip 1 is punched to provide openings 2 occurring transversely within the strip and to form web portions 3. At the edges of the strip are additional cuts or slits 4 and 5 which, along either edge, connect with every other opening 2. It will be noted that the cuts 4 along one edge are staggered with relation to the cuts 5 along the opposite edge, with the result that there are provided segments or crown portions 6 and 7 occurring also in staggered relationship at opposite edges of the strip. The formed material is folded upon itself longitudinally of the strip as illustrated in Fig. 5. This provides a straight length of material which is formed into an annular body as illustrated in Figs. 6 and 8. Thereafter a length of the material suitable for effecting a desired piston ring size is cut off and various grinding or other conventional finishing operations may be resorted to, to provide a completed ring well suited to constituting an oil metering member.

The operations described in connection with treating the sheet material may be effected by
apparatus commonly referred to as "tool machinery." For example, the punching of opening 2 may readily be effected with conventional punch press mechanism. Similarly, the cutting of slits or openings 4 and 5 can be effected by conventional cutting or shearing dies, and folding of the material achieved with the aid of conventional press mechanism or rolling means. Forming a straight length of folded material into a circular body can be effected in several ways. An example of which is to force a length of the material through an annular channel or die.

In the construction indicated there is provided an annular supporting structure made up of the web portions 3 doubled over upon themselves with their points of folding constituting the inner periphery of the supporting structure. In the folded position of the sheet material, the openings 2 extend radially of the ring and provide for the doubled-over webs 3 being spaced apart in compressible relation to one another.

The openings 4 of the supporting structure, and constituting an outer periphery therefor, are upper and lower circumferential surfaces made up of the segments or crowns 6 and 7 disposed in contiguous relation to one another to comprise upper and lower layers of the sheet material. The openings 2, in the folded position of the strip, extend radially inward and provide for adjacent segments in each of the above mentioned layers, being spaced apart in compressible relation to one another.

The openings 4 of the top circumferential surface occur in staggered relation with respect to the openings 5 of the bottom circumferential surface indicated, and each opening is thus sealed, relative to flow of fluids vertically of the ring, by adjacent segments. Also, the openings 4 and 5 connect with openings 2 to form continuous passages, extending radially of the ring.

In the construction of a piston ring it is usually necessary to provide at the top and bottom of the ring "land surfaces," also referred to as "sealing surfaces," at which preliminary sealing surfaces occur in the radial width of the ring. Such surfaces allow a ring to properly "seat" or "seal" in its groove during reciprocation of the piston and thereby prevent flow of fluids past the ring.

A feature of the above indicated method of making rings is the provision of novel "land surfaces" or "sealing surfaces" which provide for satisfactory seating or sealing of the ring in its groove and effect other advantages. In the ring of the invention, such surfaces are comprised by a plurality of ring-forming portions as embodied by the segments 6 and 7. It has been found that by arranging the segments in contiguous relation to one another, they may comprise circumferential areas well adapted to constitute surfaces by which the ring may seal in its groove and prevent passage of oil therethrough. It also is found that the size of the segments may be such that they constitute only a part of the radial width of the ring, thus allowing the seating or sealing surfaces to occur at one side of a supporting structure at other points. Such a sealing surface makes possible the construction of a light, efficient ring, which at its supporting portions may be of an open construction highly adapted to facilitating passage of oil therethrough and comprising an oil metering member. Also, by making possible the construction of a suitable sealing surface from separate ring-forming por-

...tions, various arrangements and ring constructions of sheet metal are possible. The relatively smaller sealing surface of the ring effected by the ring-forming portions or segments also presents a further advantage by reason of the fact that there is reduction in extrusion of oil on to a cylinder wall such as occurs when an oil ring slips in its piston groove. This is so for the reason that less oil can collect at the top and bottom sides of the ring.

Another feature of the method consists in providing cuts or openings arranged in overlapping relation whereby intervening sections or portions of the cut material may be bent or flexed toward one another. By this means there is effected an extensible and compressible element. This element is adapted to being formed in the annular body and thereafter to present a circumferentially extensible and contractible character as has been illustrated. In developing extensibility in this way in an annular body, a preferable result may be obtained by making those cuts or openings which face toward the periphery of the body larger than openings which are to occur at the outer periphery of the body, as for example has been done with respect to openings 2 on the one hand and 4 and 5 on the other. This improves the range of extensibility which is effected by bending the operation of the structure as a piston ring.

It will be observed that the ring construction described presents relatively thin peripheral edges which are well suited to acting as oil metering portions and approximating the thin edges of separate steel rings heretofore used. From the relatively small bearing surface of the ring, and its highly developed circumferentially extensible and contractible character described, a very desirable range of wall pressure may be obtained which is particularly suited the ring to use with worn cylinders without there developing greatly increased cylinder wear.

Still another feature of the invention consists in a ring construction which is not affected by carbonization. It is pointed out that in substantially all oil rings, special passages are provided to pass oil to the crankcase. Such openings of any appreciable size, occurring in a ring body, tend to become clogged with carbon and fall. Carbonization takes place in two ways: first, in a thick soft body which develops by heat; and second, in a hard sealy mass which is formed after longer periods of ring operation. The ring of the invention presents no relatively large oil passageways in which carbon can form, and is sufficiently thin that it may depend upon passing oil over and under itself and through its interstices to provide efficient operation. The interstices are of a minute character and are continuously flexing which further prevents any substantial carbon formation at these points.

In operation, the ring functions as a gapless ring with its end adapted to abut one another. By its circumferential extensibility, the ring completely engages the wall of a cylinder, conforming to any non-uniformity or worn areas in the cylinder, and exerting a substantially uniform pressure at such a sealing surface. It should be noted that the extensible character of the ring is attained without the use of expander members disposed between the back of a ring and its ring groove. As a result there is less transfer of piston slap, and a reduction of the wear ordinarily developing from such piston slap.
With reference to specific operation of the ring structure as an oil metering member, it is pointed out that the segments 6 and 7 are contiguously arranged to constitute substantially continuous circumferential surfaces by which the ring may form a satisfactory seal against a top or bottom side of a piston groove for preventing passed over by the ring when in the sheet metal may be varied to form a ring presenting suitably thin oil scraping edges. By the location of the relatively large openings 2 extending well out toward the segments 6 and 7, oil collected by the segments may rapidly be passed over the ring into the ring groove and then down into the crankcase.

Various advantages are present in connection with the method of making piston rings illustrated in Figs. 1-8 inclusive. There is provided a one-piece ring which is adapted to be easily handled and assembled about a piston. The ring is provided with a novel extensible and compressible character, rendering it particularly adapted to conforming to worn or irregular cylinder surfaces. The procedures indicated may be suitably adapted for rings of a character closely simulating the thin edges of separate C-type rings heretofore employed. The entire structure is adapted to be formed of a tough thin material as steel of which only relatively small amounts are required, to provide a light durable ring. In addition to the materials of the character indicated, and the composite construction developed in connection therewith, are highly adapted to cheap manufacturing processes which make use of conventional "tool" machinery such as punches, forming and shearing dies, etc., in the manufacture of various parts, whereby relatively smaller amounts of money are required to be invested in "tooling up" to make the rings, and relatively smaller investments are required to be maintained at any one time. By the construction shown, almost any desired wall pressure may be arrived at without reducing the uniformly extensible character of the ring, and in addition it is possible to provide an improved and increased range of expansibility at any point in which the wall pressure of the ring is satisfactorily operative. The rings are further characterized by efficient oil metering and suitable repassing of oil to the crankcase, and provides such functions with substantial elimination of cylinder wear.

While the particular forming steps illustrated have been shown in connection with a length or strip of material, it is intended that such operations may be effected upon materials of varying cross section occurring in varying forms as in sheet form or in a web or roll and of one or more thicknesses. The cutting or forming operations may be modified for instance in the manner indicated in Fig. 4, in which alternately disposed slits or cuts 8 are employed in place of the openings shown in Figs. 2 and 3. Still other changes in the arrangement of the openings or cuts may be resorted to, as for example, openings may be deflected off center or angularly disposed of the material or in other ways. Also, the cutting or forming operations may be desired to be effected at other stages in the method of making the ring, as for instance after a sheet or strip of piston ring material has been folded or formed into either an intermediate or finished position, or at some other point. In addition, it may even be desired, in accordance with the invention, to utilize the cutting or forming operations to provide ring-forming portions which are completely severed and adapted to be separately brought together piece by piece on some form of annular supporting structure. The various advantages obtained by any one or all of the operations described may be resorted to in different ways and for different purposes in the modification of the ring other than the control type referred to above as for example compression rings or expander rings or other special types of sealing members.

A development in oil control ring construction is a ring assembly made up of a plurality of thin C-type rings mounted one upon another and provided with an expander member engaged at the inner side of each of the rings. Such a construction has been found to function due to a hydraulic pressure set up at the outer periphery thereof when the ring assembly reciprocates against the wall of a cylinder and collects oil between its sections. The hydraulic pressure opens the rings up upon one another and thereby provides passageways for the oil to move inwardly of the ring. A general objection to such rings is that they require a relatively strong expander, which underruns the ring seat to wall. Also, in order that the hydraulic pressure may be effective in spacing the rings apart, it must first overcome the friction of the rings on the expander member and a part of its value is lost thereby.

In accordance with the present invention, there is provided a ring assembly as illustrated in Fig. 10, in which the desirable hydraulic pressure of the conventional ring above described, is retained and the objections present from the use of an expander are eliminated. In addition, further improved friction loss is obtained by modification of the structure.

The assembly shown in Fig. 10 consists of a cylinder 9 and piston 10 in which are mounted two ring sections 11 and 12 disposed loosely one upon the other. These ring sections constitute circumferentially extensible and compressible annular bodies of the same general character as the rings described in Figs. 1-8, inclusive. However, the method of forming the ring sections is modified to provide beveled edges 13 and 14, occurring circumferentially of the rings when located above one another comprise oil chambers 15 as illustrated in Fig. 10. The action of the chambers 15 is to retain oil collected by the edges of the ring sections until a pressure is built up therein, at which time the ring sections are forced apart to form openings for oil to move radially inward of the ring and thence out through oil passages 16 in the piston 10.

It is pointed out that the present assembly, while functioning in the same manner as the "hydraulic" rings above referred to, is an improvement thereupon by reason of there being no separate expander member present; also by reason of the fact that there are radial interstices extending between the inner and outer peripheries of each ring section; and also due to each ring section being made up of upper and lower layers secured together along a strip of the material or in other ways. In use, the ring assembly possesses the advantage of being very easily mounted in a piston, independently of any expander member. Also, by the elimination of the expander member, their ability to be forced apart by oil pressure during reciprocation against the wall of a cylinder is greatly increased, repassing of oil is facilitated, and cylinder wear avoided.

Fig. 11 illustrates a modified method of mak-
ing a ring in which specific changes in the folding operation above described are carried out. A strip of the sheet metal, formed in some suitable manner as has for example been illustrated in Figs. 12 and 13, is folded longitudinally as before but in this instance reversely upon itself to form an increased amount of layers of material, plied one upon another to make up the ring 12a. Several changes are effected in the character of the ring by the modified folded construction. The height of the ring is increased, the effective size of the interstices becomes greater, the wall pressure of the ring is increased, and other advantages as above are effected.

The method of reversely folding sheet metal into a number of layers as shown in Fig. 11 may be further modified as illustrated in Fig. 12 in which two of the folds are left in a spaced apart position to comprise the ring 12b. By this construction, there is effected vertical resiliency or "take up" in the ring, enabling it to enauge with opposite sides of a piston ring groove and thereby eliminate slapping of the ring in the groove.

In Figs. 13-16, inclusive, there has been illustrated another general type of method for making piston rings which is further exemplary of changes in presentation and which particularly relates to the forming of circumferential oil scraping edges integral with and extending beyond a supporting structure therefor. In the figures referred to, a sheet metal material is again employed and subjected to some desirable forming operation, such as has been indicated in Figs. 2 and 3, to provide segments or ring-forming portions 17 and 18, interstices 17a and 18a, openings 18, and webs 18a. In this case the formed material is folded into an open annular body as for instance of the U-shaped formation as shown in Figs. 4 and 5. By this procedure there is effected a circumferentially extensible and contractible annular supporting structure at the outer periphery of which extend spaced-apart upper and lower circumferential oil scraping edges made up of the segments or ring-forming portions 17 and 18.

It will be seen that this ring construction has all of the advantages heretofore noted with respect to punched or folded sheet metal ring constructions, and in addition it presents radially extended contractible edges which are integral with a supporting structure and are an improvement upon separate edges as effected by separate C-type rings heretofore described. In addition, the structure is of a highly open reticulated character, admirably suited to allowing passage of oil therethrough, either radially or vertically, with there being maintained ample circumferential sealing surface at the top and bottom sides of the ring and with the web portions 18a presenting a minimum surface area upon which carbon can form in a detrimental manner.

Figs. 17-21, inclusive, relate to another modified method of treating sheet material in which the sequence of operation heretofore described is modified. In accordance therewith a strip 20 is directly formed into a longitudinally folded member 21 as illustrated in Fig. 18. Thereafter one or the other of the cutting steps previously required may be omitted, as for example been carried out in Fig. 19 to form a reticulated supporting structure of spaced-apart webs 22. Fig. 20 illustrates a further cutting operation of effecting segments 23 from interstices 23a. This procedure provides a ring as shown in Fig. 21 which is similar to the ring previously indicated in Figs. 15 and 16.

The method of Figs. 17-21, inclusive, is intended to be generally illustrative of various other methods in which sheet material is first folded and then formed by cutting or other operations. As an example another there may be pointed out the method of similarly treating sheet metal folded in the manner indicated in Figs. 5 and 6. Fig. 22 is intended to specifically illustrate folding sheet metal upon itself in a longitudinal manner to form a member as 24 and thereafter cutting at points such as those indicated in dotted lines. The method of forming a ring structure with circumferential edges which extend from their supporting structure to constitute oil scraping portions may be further modified to include the reverse folding operations indicated in Figs. 11 and 12. Fig. 23 is illustrative of such a modified procedure which results in a ring 25. Still further modification in the method referred to may be practiced as illustrated in Figs. 24 and 25 in which openings 26 and 27 are formed of different proportions. For example, as shown the openings 26 do not extend into the top or bottom sides of the finished ring.

In the methods described and illustrated, the cutting or other type of forming operations carried out on the sheet metal have in all cases effected the extensible character of the resulting ring. The cutting operations referred to may be employed for other purposes not limited to the imparting of the flexibility described. In Figs. 26-33, inclusive, another general type of method of making piston rings is illustrated which is particularly exemplary of cutting ring portions in sheet material independently of creating flexible character, and of forming piston rings in which flexibility is entirely derived from folding operations.

Having reference to Figs. 26-33, inclusive, numeral 29 denotes a strip of material which is cut in some suitable manner as by punching to provide segments 30 and cuts 31 extended inwardly of the segments. This formed strip is then folded transversely of the strip in the manner illustrated in Fig. 28 to comprise a supporting structure made up of web portions 32, at the outer side of which and at the top and bottom thereof, are disposed the segments 30 with the web portions being folded away from the segments in accordance with the slits 31. Figs. 29 and 30 illustrate a continuance of the reversely folding operation to form piston rings in which the webs are arranged in varying position, as for instance the vertical position assumed in Fig. 29 or the angular position as indicated in Fig. 30. The webs are in substantially spaced relation as illustrated in Figs. 31 and 32 in which finished rings are illustrated.

It will be seen that there are thus effected upper and lower circumferential edges, made up of a plurality of ring-forming portions or segments arranged in contiguous relation to one another and supported in a circumferentially extensible and contractible manner. As described in the previous ring constructions, ring-forming portions 30 are arranged to make up circumferential sealing surface at the ring and there is effected an open supporting structure for receiving the segments, at one side thereof. It should be observed that there is thus illustrated still another modification of a cut and folded sheet metal piston ring, in which the results obtained by the
cutting and folding operations are interchanged and the cutting is further helpful in determining the points along which folding occurs in relation to the ring-forming portions or segments.

A modification in the method of transversely folding a strip of material is illustrated in Figs. 33 and 34, in which a strip 33 is formed, at opposite sides thereof, with segments 34 and 35 disposed in staggered relation with respect to one another. The strip at this point may also be provided with oil passages 36, if so desired. The formed member is then reversely folded upon itself, as before into an annular body of extensible and contractible character, made up of webs 37. However, the method of forming the folded strip into an annular body is such as to arrange the lines of folding so that they extend in a direction vertically of the annular body. In this form, the segments 36 and 35 project from the top and bottom of the annular structure and the final step in the method is to bend the segments 36 downwardly and away from the supporting structure and the segments 35 upwardly and away from the supporting structure, in the manner illustrated in Fig. 36.

There is thus provided still another method of effecting circumferential edges in a reversely folded strip of piston ring construction and it is pointed out that this modification embodies still a further modified folding step in that the segments are bent away from the folded supporting structure and out of the plane of these portions. This procedure is intended to be illustrative of steps in which folding may occur in various planes with respect to the sheet material.

It will be observed that there have been disclosed and described ring members broadly illustrative of methods of forming composite piston ring structures from sheet material in which separate ring-forming portions are devised and brought together. It is also pointed out that a novel combination of cutting operations and folding operations has been described to produce novel ring structures, ring surfaces, and ring functions. Each of the several forming and assembling procedures are subject to modification in various ways and for various purposes, and are intended to be practical in connection with making various types of piston rings. The improvements disclosed provide novel, cheap, light, efficient and durable ring structures. It is pointed out that there is made available a method of making piston rings highly adapted to being carried out with tool machinery, which greatly lowers the cost of manufacturing piston rings generally and makes for more efficient production of such rings.

While I have shown preferred embodiments of the invention, it should be understood that various changes and modifications may be resorted to in connection therewith, as for example procedures for forming and assembling any type of composite ring structures may be resorted to in keeping with the spirit of the invention as defined by the appended claim.

Having described my invention, I claim:

That improvement in methods of making oil control piston rings which comprises cutting spaced openings elongated transversely in a flat strip of piston ring material at points intermediate the edges thereof and forming transverse cuts through the opposite edges of the strip to connect with said openings, said transverse cuts being of less width than said openings to provide sealing portions occurring alternately at opposite edges of the strip and intermediate supporting portions for the sealing portions, bending said supporting portions along a line of bending which extends longitudinally of the strip to arrange the sealing portions and supporting portions in superimposed relation such that the supporting portions are doubled over upon themselves and the sealing portions at one edge of the strip are located above points of separation of two of the sealing portions at the other edge of the said strip, and bending the supporting portions toward one another to provide a split ring body in which the supporting portions extend radially inward at the inner periphery thereof.

THOMAS A. BOWERS.