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ATTORNEYS
METHOD OF MAKING RESILIENT JOINTS

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1. This invention relates to a method for manufacturing flexible joints or supports for oscillating parts. In particular, it relates to the manufacture of joints or supports comprising two rigid concentric members separated by a ring or insert of a resilient elastic material maintained by said concentric members in a state of substantial radial compression and axial elongation.

2. In accordance with the process of manufacture hereinafter proposed, the ring or annulus of molded elastic rubberlike material is first disposed in the external member and then is pressed, preferably at high speed, in a telescopic manner through the central opening in the elastic annulus into coaxial position within the outer member. The positioning of the inner coaxial member causes the elastic annulus to be compressed radially and expanded laterally by very substantial amounts.

3. During this assembly process the resilient annulus has a strong tendency to roll or expand unevenly with the result that adjustment is required or an inferior joint is produced. To decrease this tendency it has been proposed to movably support one or more of the faces of the annulus with a spring or cam actuated piston that moves just sufficiently to permit equal movement of both faces of the resilient annulus so that the median transverse plane of the annulus remains stationary. While such a movable piston may by proper adjustment be made to operate satisfactorily, it has a tendency to complicate the apparatus and requires quite exacting adjustment.

4. It is an object of the present invention to provide an improved method of assembly of joints with rigid coaxial members separated by an annulus of resilient elastic material wherein the positioning of the annulus with respect to the coaxial members in the finished joint is readily controlled, wherein stable and reproducible results are readily obtained.

5. It is another object of the present invention to provide an improved method of manufacture of joints of the type described wherein the positioning of the resilient elastic annulus is closely controlled during the assembly operation.

6. It is a still further object of the present invention to provide an improved or more simplified apparatus for the manufacture of joints of the type described.

7. Other objects and advantages will be apparent on examination of the accompanying drawing in which like numerals refer to like parts and from the following description.

8. In the drawing:

Figure 1 is a front elevational view of apparatus suitable for assembling joints or mounting in accordance with the present invention showing separate presses, one for forming the annulus into the outer member or sleeve and another for injecting the inner sleeve into the annulus to radially compress and elongate it;

Figure 2 is a side sectional view of a portion of the apparatus taken on the line 2—2 in Fig. 1;

Figure 3 is a sectional view taken at 3—3 in Fig. 1, particularly showing a convenient outer sleeve restraining and aligning member that may be used and suitable means by which it may be raised and lowered;

Figure 4 is a sectional view of a portion of the apparatus of Figs. 1 to 3 showing the annulus positioned on one of the rigid joint members as preferably had in the first step of the assembly operation;

Figure 5 is a sectional view of a portion of the apparatus of Figs. 1 to 3 showing the positions of the joint members while the annulus is located on one of the rigid members or sleeves ready for injection of the other rigid member into coaxial position;

Figure 6 is a sectional view of a portion of the apparatus of Figs. 1 to 3 showing the components of the joint while the annulus is being compressed and elongated by the tapered leader member as it is forced into the opening of the annulus and illustrating the amount of movement of the outer rigid member and median transverse plane of the annulus caused by the initial elongation;

Figure 7 is a sectional view of the same portion of the apparatus illustrated in Figs. 5 and 6 but showing the inner sleeve in place at the completion of the injection operation and illustrating by comparison with Figs. 5 and 6 the change in position of the outer joint member and annulus;

Figure 8 is a view partially in section of an alternate type of annulus that may be used in preparing an improved joint or mounting by my process;

Figure 9 is a sectional detail showing a portion of a modified form of apparatus having a slightly different stop or positioning member from that shown in Fig. 1 and showing the annulus of Fig. 8 positioned in the outer sleeve;

Figure 10 is a detail partially in section of my especially desirable joint or support having relaxed protruding ends and assembled by the apparatus of Fig. 9;

Figure 11 is an elevational view partially in section of a portion of a modified form of apparatus for assembling a resilient connection or joint according to a modified process wherein the resilient annulus is first centrally disposed on the inner member and showing the joint members in position at the start of the final step of the assembly; and

Figure 12 is a similar view showing the position of the joint members at the completion of the assembly operation.
In the assembly of the joints, in accordance with the present invention, as well as by prior methods, the annulus of resilient rubberlike material is ordinarily disposed or carried in a relatively unstressed state on a generally cylindrical portion of one of the rigid members of the joint and is caused to axially elongate during the telescopic assembly of the other rigid members into coaxial relation. The present invention, however, deals largely with the controlling of the position of the resilient annulus during elongation into a portion of the time it is being elongated between the inner and outer rigid concentric members. In accordance with the present invention (1) the trailing face, i.e., the last face of the resilient member to be enclosed between the two inner and outer rigid concentric members or sleeves of the joint, is rigidly supported against axial movement during all or a substantial proportion (preferably at least the last 20 or 30% of the elongation thereof) caused by telescopic movement of the other rigid members into the final concentric position had in the finished joint or mounting; and (2) the rigid member first carrying the annulus or, if a single step assembly is used, the rigid member closest the supported portion of the face of the annulus has a flexible or without restraint in a direction opposite to the direction of the force impressed on the other rigid member during the telescopic assembly operation. This movement is also a direction opposite the direction of movement of second rigid member relative to the annulus during the telescopic assembly.

This invention is particularly adapted to the making of joints having end portions of the annulus in the non-radially compressed state. The annuli used in such joints have a nonuniform section with an offset as shown in the drawing and therefore only a portion of the trailing face of the resilient annulus as molded is conveniently supported. This annular portion has a thickness much less than the thickness of the annular space between the rigid concentric members. When the end portions of the annuli are substantially the maximum thickness of the annulus the size and area supported may correspond substantially to the area between the concentric members.

In my preferred process of assembly of the joint members the resilient annulus is first radially compressed by passing it through a zone of decreasing diameter into a central portion of the outer sleeve where it is positioned against an annular rigid supporting surface having a central opening of minimum diameter greater than the diameter of the inner member. The inner member is then telescoped through the openings of these members while the axes of all are in substantial alignment. During the elongation of the annulus by this telescopic movement the trailing face of the annulus is rigidly supported about an annular area having a maximum diameter about equal to the inner diameter of the outer member and having a thickness less than the difference between the outer radius of the inner member and the inner radius of the outer member.

Referring more particularly to the drawings (especially Figures 1–7 inclusive) wherein like numerals of reference are used throughout the several views, the essential parts of the joints of which the present invention is concerned are a resilient annulus of a soft vulcanized rubber or rubber-like compound or similar resilient deformable material, an outer rigid member having a generally tubular portion or sleeve which preferably has an inner surface 2a of generally cylindrical shape and an inner rigid member 18 with an outer surface 17 that preferably has a generally cylindrical shape. The annulus is generally molded and cured in a shape having a thickness greater than the thickness of the space between the rigid members of the joint, and preferably having a diameter greater than the inner diameter of the tubular portion of the outer rigid member.

In the assembly of the joints the elastic annulus may be first positioned on one of the rigid members as was usual practice heretofore. When it is first positioned in the tubular portion of the outer member or sleeve 3 of less diameter than the diameter of the annulus it may be forced along a path of gradually diminishing or tapered cross-section, as defined by the funnel-shaped or upper surface of the outer sleeve 2, 2a, so that the guide block 6 carrying a suitable piston or ram 4 which may be actuated by suitable means such as the fluid operated press 35. The outer grid member 3 of the joint may be placed for assembly about on the axis of the piston or the funnel-shaped guide 2. Support such as the block 6 carrying a suitable holder for the rigid member is provided to support the rigid member against thrust caused by downward movement of the piston or ram 4. The holder may be a tubular stop 5 that extends into the outer member and has an upper supporting surface 2a adapted to contact a portion of the axial face of the resilient annulus 1. The surface 2a is so positioned that it locates the transverse median plane of the annulus about centrally of the joint member (generally the sleeve 3) first carrying the annulus 1. The guide 2 may have a seat 2a adapted to fit the top of the outer member 3. It may be slidably carried by the two vertical posts 14 and is normally supported by the spring 13 so that the seat 2a is a substantial distance above the upper edge of the outer member 3. The block 6 may be slidably carried on the base plate 7 and a suitable handle 8 may be provided for sliding it. Adjusting means such as the set screws 8 may be provided at the outer end of the base plate 7 to limit the amount of movement of the block 6.

In the assembly of the annulus within the outer member it is placed within the funnel-shaped guide 2 as shown and is forced by downward movement of the piston 4 through a path of gradually diminishing cross-section into the outer member. The friction of the annulus passing through the tapered guide is sufficient to compress a spring 13 so that the seat 2a rests upon the upper surface of the outer sleeve 3. The outer sleeve 3 itself rigidly supported, provides rigid support for the guide 2 and annulus 1 is thus compressed in the guide 2 and forced or shot into the outer sleeve 3 as illustrated. The ram 4 then rises and the guide 2 is returned to its normal raised position by the compressed spring 13.

In the positioning of the annulus 1, the ram 4 or piston 4 initially engages the annulus 1 but as it moves downward a collar 10 which may be provided, engages the funnel-shaped guide 2 and maintains the guide spring 13 in compression so that the guide 2 remains flush with the top of the outer sleeve 3 during the positioning of the annulus 1 within the outer sleeve 3. When
the piston 4 is withdrawn the spring 5 raises the guide 2 from the outer sleeve 3 and allows the sliding block 6 to be moved under the axis of the press 31 for the next operation, namely the injection of the inner sleeve 18 within the central opening of the annulus 1 into coaxial position within the outer member while the annulus is disposed into the outer sleeve.

In accordance with this invention (as illustrated particularly by reference to Fig. 5) portions of the trailing face 16 of the thin face 15 to be concentrically disposed between inner member 18 and outer member 3 are rigidly supported against cocking and against movement by the rigid face 5a of a suitable stop (generally tubular) 5 which preferably projects sufficiently into the outer member to maintain the median transverse plane (perpendicular to the axis) i.e., substantially centrally within the portions of the outer member that are adapted to contact the resilient material in the completed joint.

The annular surface 5a of the support 5 has a thickness less than the difference in the aforementioned radii of the inner and outer member and the surface 5a is disposed closely adjacent the inner surface of the outer member 3. A sliding or loose fit is thus provided between portions of the outer cylindrical surface 5b of the support 5 and adjacent portions 5a of the inner surface of the outer member 3 so that upon axial expansion of the resilient annulus by telescoping movement of the inner member into the concentric or coaxial position in the completed joint (which telescopic movement is illustrated by Figs. 5 to 7 inclusive) both the outer sleeve and the median plane of the resilient annulus may slide in a direction directly opposite to the direction of the force applied to the inner member (indicated by arrow 40) to cause the telescoping movement.

The outer sleeve 3 may be free to move or may be restrained by a resilient restraining member 19 which may be maintained against the outer sleeve due to the slight pressure of the spring 24. The member 19 allows the outer sleeve to rise against spring pressure as the injection of the inner member is completed.

In the insertion of the inner sleeve 18 a removable taper 20 is provided to gradually open the opening into the resilient annulus in the manner shown in Fig. 6. The inner sleeve 18 is moved telescopically by the movement of the piston rod 31 of the fluid operated press 31.

The restraining member 19 is supported by a frame or mount 27 which can be raised or lowered as desired. The frame 27 slides vertically on two posts or studs 28 and is controlled by a crank rod 29 pinned to the frame 27 and to a crank arm 30. A handle 31 raises or lowers the crank arm 30 and in turn the frame 27. A gear segment 32 is attached to the handle 31 and interfits with a gear segment 33 attached to the crank arm 30. The frame 27 may be lowered at the beginning of each operation and then raised or lowered by engaging both ends of the outer sleeve. A horizontal arm 22 of the restraining member 19 may move vertically in slot 23 against spring 24. The maximum rise of the restraining member 19 is limited by suitable means such as the bolt 25 and the strength of the spring is controlled by the adjustable stop 26.

In accordance with the present invention, an annular portion of the trailing face of the annulus 1, which annular portion has an area and size when carried on one of the rigid members that fits within the annular space between the rigid members, and preferably the joint element first carrying the annulus with its median transverse plane in position (generally the outer sleeve 3) are positively and rigidly supported during the injection of the inner sleeve or member 18 from movement in the direction of the injecting thrust on the cooperating rigid member being telescoped therein. The outer sleeve 3 may be supported by the sliding block 6 and the trailing face and body of the annulus is supported and positioned within the outer sleeve 3 by the tubular stop or bushing 5.

The completion of the first step of an assembly operation of the present invention, that is, forcing the annulus into the outer sleeve, is particularly illustrated by reference to Fig. 4. In it the piston 4 is shown pressing the annulus flush against the stop 5. At the same time, the collar 10 on the piston rod 14 presses against the guide 2 and holds it flush against the outer sleeve 3. The outer sleeve 3 rests on the sliding block 6 and as shown the stop 5 is adjustably screwed into the sliding block 6. The height of the stop 5 may be adjusted to position the annulus as desired within the outer sleeve 3.

Figs. 5, 6, and 7 illustrate stages in the progress of the second step in a suitable two-step assembly operation in which step the inner sleeve is shot or inserted into the central opening in the annulus. In Fig. 5, the outer sleeve 3 is in position for shooting, solidly resting on the sliding block 6 and aligned between the stop 5 and the upper restraining piece 19. The lower edge or trailing edge of the annulus 1 is flush with the top of the stop 5. In Fig. 6 the shooting operation is partially completed. The annulus has started to elongate upwards because the rigid stop 5 prevents any downward elongation and the outer sleeve 3, working against the restraining member 19, which may or may not be present has been lifted up from the sliding block 6 along with the annulus. This figure also shows the tapered leader member 20 in the act of compressing and elongating the annulus.

Fig. 7 shows the operation nearing completion with the inner sleeve 18 in place, the annulus elongated and compressed to such extent that portions extend at either end, and the outer sleeve lifted clear of the sliding block 6 and almost above the stop 5 by the upward elongation of the annulus. When this joint is removed from the apparatus the extended portions 1b of the annulus contract back to normal thickness.

An alternate form of joint and stop is shown in Figs. 8, 9 and 10.

The annulus 35 shown in Fig. 8 in its molded state has relatively thin opposite extended or end portions of a thickness and diameter to correspond with the thicknesses and diameters of the annular space between the inner and outer rigid coaxial members of the joint. Intermediate these end portions is a thicker portion 42 preferably having an outwardly bulging (generally convexly curved) outer surface and preferably a hollowed or depressed inner surface 44. The outer surface of the annulus is preferably devoid of a shoulder or abrupt protrusion in order that when the annulus is incorporated into the outer member 3 the ends 41 will be located near the inner surface thereof and will be relatively smooth in the completed joint. The modified form of stop 34 is preferably made thicker or wider than that
In Figs. 1 to 7 inclusive to support more of the relatively thin extended portions of the trailing face of the annulus and to control accurately its expansion and position in the outer sleeve. The upper surface 24 of the stop 34 is made cruciform that is sloped downwardly from the inner edge to more securely control the location of the ends of the annulus. Because rubber slightly elongated deteriorates more rapidly than in its natural state when exposed to ozone, etc., the opening in the ends of the curved annulus 48 (Fig. 9) is in its molded and cured state almost as large in diameter as the outer diameter of the inner sleeve 18. This reduces to a minimum the stress in the ends exposed to the atmosphere and consequently reduces the deterioration by oxidation. At the same time the intermediate portion is made bulkier to provide for sufficient compression and elongation of the rubber in the completed joint and thus obtain the desired characteristics. Fig. 10 shows the finished joint when the alternate curved or rounded type of annulus has been used. In Figs. 11 and 12 a slightly modified method and apparatus are illustrated. The annulus 8 is disposed generally centrally on the inner rigid member which may be maintained in freely floating or sliding relation on the axis of the suitably actuated piston 30 by the support 51 and the annular rigid supporting surface 32 thereof that bears against the portion 53 of the trailing face of the resilient annulus or bushing 1. The rigidly supported portions of the annulus as in previous instances are those portions having, when the annulus is first positioned on one of the rigid members, a projected area and contour (projected on an axial plane) that fits within the projected area and contour of the space between the coaxial rigid members 8 and 18. The portions 53 lie in this instance closely against the outer surface of the inner member 18 which is the member first having the median transverse plane of the annulus centrally thereof. The maximum diameter of the stop is less than the diameter of the end portions of the outer member 3, which is telescopically moved in the direction of the arrow 55 to concentric coaxial position with respect to the annulus and rigid member. A tapered guide member 56 may be carried by the outer member during the telescope movement to facilitate radial compression of the annulus during the telescopic movement into coaxial position. The movement of the annulus 8 and of the free floating inner member 18 in the direction opposed to the movement of the outer member 3 is illustrated by comparison of the positions of the inner member with respect to the surface 52 in Figs. 11 and 12.

The advantages of the present method and apparatus are the simplicity and easy adjustment of the machines involved, particularly the annulus and outer sleeve supporting means, and at the same time the accurate control which is possible of the position of the annulus within the two coaxial sleeves. Although numerous joints or mountings have been manufactured, it has been found that the positioning of the resilient annulus during the assembling operations is achieved with considerable difficulty because the annulus may move in a lateral direction from the desired position. In some cases of portions of the annulus may elongate unequally in others. This necessitates the expenditure of considerable time and expense in correcting and repositioning the annulus or compensating by other means to obtain mountings with uniform properties. In addition after readjusting the axial position of the sleeves and annulus, axial stresses from the readjustment remain and show themselves in later operation.

The invention is particularly adapted to the assembly of joints in which the annulus has annular portions less thickness than the main body thereof extending beyond the ends thereof, in an axial direction as shown. These end portions are slightly or wholly radially uncompressed.

It is to be understood that the particular form of apparatus shown and described and the particular procedure set forth are presented for purposes of explanation and illustration and that modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. A method of assembling joints having an annulus of resilient material radially compressed and axially elongated between concentric portions of inner and outer rigid members, the steps which comprise the positioning of the annulus on one of the members in a relatively axially unelongated condition, and with a median transverse plane thereof located generally centrally of the portion of said rigid member adapted to bear against the annulus in the completed joint, rigidly and immovably supporting the trailing face of said annulus against cocking and while so immovably supporting the trailing face of said annulus axially elongating said annulus by telescopically forcing portions of the second rigid member into concentric relation with portions of said first rigid member, said first rigid member being movable in the direction opposite from the direction of thrust of said second rigid member when the members are being telescoped into concentric relation, whereby during said telescopic assembly said first rigid member moves in said opposite direction.

2. The method of claim 1 wherein said annulus is first positioned in the outer rigid member in a relatively axially unelongated condition.

3. The method of claim 1 wherein said annulus is first positioned on the inner rigid member in the axially unelongated condition.

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