RAM AIR FLAP SYSTEM

An assembly for increasing air flow to a vehicle cooling system includes a portion of a cooling fan shroud, the portion having a face defining an opening therethrough, and a plurality of support members extending from the face. A flap includes a plurality of apertures proximal to an edge. Each aperture of the plurality of apertures is formed to receive one of the plurality of support members for coupling the flap thereto. A clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the face to a second position in response to a flow of air.
RAM AIR FLAP SYSTEM

BACKGROUND

[0001] The present invention relates to ram air flap systems for vehicles, and specifically to a ram air flap system for increasing air flow to portions of a vehicle cooling system at increased vehicle speeds.

SUMMARY

[0002] In one embodiment of an assembly for increasing air flow to a vehicle cooling system, the assembly includes a portion of a cooling fan shroud, the portion having a face defining an opening therethrough, and a plurality of support members extending from the face. A flap includes a plurality of apertures proximal to an edge. Each aperture of the plurality of apertures is formed to receive one of the plurality of support members for coupling the flap thereto. A clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the face to a second position in response to a flow of air.

[0003] In one embodiment of a cooling fan shroud for a vehicle, the cooling fan shroud includes a cooling fan shroud face having a primary opening therethrough for a cooling fan, a plurality of secondary openings therethrough, and a plurality of support members extending from the face adjacent each secondary opening. A flap includes a plurality of apertures proximal to an edge, each aperture of the plurality of apertures formed to receive one of the plurality of support members for coupling the flap thereto. A clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the shroud face to a second position in response to a flow of air.

[0004] In one embodiment of a method of producing a cooling fan shroud, the method includes injection molding a shroud portion having a face defining an opening therethrough, a plurality of support members extending from the face, and a guide member adjacent the opening and extending from the face. The method further includes coupling a flap to the plurality of support members. The coupling includes flexing the flap to engage the support members of the plurality of support members.

[0005] In one embodiment of an assembly for increasing air flow to a vehicle cooling system, the assembly includes a portion of a cooling fan shroud. The portion has a face defining an opening therethrough and a plurality of support members extending from the face. A flap includes a plurality of apertures proximal to an edge, each aperture of the plurality of apertures formed to receive one of the plurality of support members for coupling the flap thereto. A clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the face to a second position in response to a flow of air. The flap is retained on the shroud portion at least partially by one or more elastic members attached to the shroud portion or formed as an integral part of the shroud portion. The elastic members are flexed during engagement of the apertures with the support members.

[0006] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a front view of a radiator cooling fan shroud incorporating a ram air flap system.
[0008] FIG. 2 is a partial perspective view of a portion of the fan shroud of FIG. 1.
[0009] FIG. 3 is a perspective view of a ram air flap for use with the shroud portion of FIG. 2.
[0010] FIG. 4 is a partial perspective view of the shroud portion of FIG. 2 with the flap of FIG. 3.
[0011] FIGS. 5a-5c are cross sectional views illustrating assembly of the flap of FIG. 3 onto the shroud portion of FIG. 2.
[0012] FIG. 5d is a cross sectional view of the flap of FIG. 4 closed.
[0013] FIG. 5e is a cross sectional view of the flap of FIG. 4 open.
[0014] FIG. 6 is a partial perspective view of a portion of another fan shroud.
[0015] FIG. 7 is a partial perspective view of a portion of another fan shroud.
[0016] FIG. 8 is a partial perspective view of a portion of another fan shroud.
[0017] FIG. 9 is a partial perspective view of a portion of another fan shroud.
[0018] FIG. 10 is an exploded view of a portion of another fan shroud and a flap.
[0019] FIG. 11 is a perspective view of the flap of FIG. 10 during assembly.
[0020] FIG. 12 is a perspective view of the assembled shroud portion and flap of FIG. 10.
[0021] FIG. 13 is an exploded view of a portion of another fan shroud and a flap.
[0022] FIG. 14 is a perspective view of the assembled shroud portion and flap of FIG. 13.
[0023] FIGS. 15a-15d are cross sectional views illustrating assembly of another flap onto a portion of another fan shroud.
[0024] FIG. 16 is a partial perspective view of a portion of another fan shroud.
[0025] FIG. 17 is a perspective view of the shroud portion of FIG. 16 assembled with a flap.
[0026] FIG. 18 is a perspective view of the shroud portion of FIG. 16 assembled with another flap.
[0027] FIG. 19 is a perspective view of the shroud portion of FIG. 16 assembled with the flaps of FIGS. 17 and 18.
[0028] FIG. 20 is a partial perspective view of a portion of another fan shroud.
[0029] FIG. 21 is a perspective view of the shroud portion of FIG. 20 assembled with a flap.
[0030] FIG. 22 is a side view of the shroud portion and flap of FIG. 21.
[0031] FIG. 23 is a partial perspective view of a portion of another fan shroud assembled with a flap.
[0032] FIG. 24 is a side view of the shroud portion and flap of FIG. 23.
[0033] FIG. 25 is a front view of the shroud portion of FIG. 23 without a flap.

DETAILED DESCRIPTION

[0034] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The
invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. And as used herein and in the appended claims, the terms “upper,” “lower,” “top,” “bottom,” “front,” “back,” and other directional terms are not intended to require any particular orientation, but are instead used for purposes of description only.

[0035] FIG. 1 illustrates a vehicle radiator cooling fan 10 contained within a cooling fan shroud 20. The shroud 20 presents a rear surface 30 directed toward the engine block of the vehicle, and the fan 10 is generally centrally located within the shroud. The fan 10, assisted by the shroud geometry, operates to draw and direct air across the radiator coils (not shown) to transfer internal engine heat from the cooling medium to the passing air in a manner known to those of skill in the art. In some embodiments, the cooling fan shroud 20 is positioned behind the radiator to guide air to the fan 10, and in other embodiments the cooling fan shroud 20 is positioned in front of the radiator, in which case the shroud 20 directs air passing through the fan 10 over the radiator coils. A plurality of ram air flap assemblies 100 are integrated with the rear surface 30 to form a ram air flap system to provide increased air flow across the radiator coils, as described herein.

[0036] The fan shroud 20 is preferably an injection-molded uniform component, of which separate portions include features of each individual flap assembly 100. The portions represent sections of the fan shroud 20 and are preferably integrally formed concurrently with the molding of the shroud 20, but in some applications may be separate injection-molded sections added to a fan shroud (with necessary modifications). FIGS. 2-3 illustrate a particular portion 110 of the fan shroud 20 and a flap 120. The portion 110 includes a rear face 128 defining one or more openings 132. The portion 110 is approximately 120 mm to 140 mm wide (length “W”) and approximately 40 mm to 50 mm high (length “H”), though the size may be dependent on the particular application. Referring to FIG. 2, the openings 132 may be considered as two distinct openings or one opening separated by a support member or rib 136. The support rib 136 can be continuous or non-continuous and exhibit a variety of linear or non-linear shapes.

[0037] The portion 110 further includes a plurality of support members 144 extending from the rear face 128. The support members 144 are generally hook-shaped and define a contoured supporting surface 148 for securing the flap 120, further described below. The support members 144 can be evenly spaced laterally across the rear face 128, or may be offset toward one of the portion edges 142, or may alternatively be mirrored about an approximate centerline bisecting the width W of the portion 110.

[0038] In some embodiments, the support members 144 adjoin a lateral arcuate recess 152 that permits operational deflection of the flap 120 to an open position, as will be further described. The recess 152 is preferably molded with the fan shroud 20 but can optionally be machined or otherwise formed subsequent to the molding process. As shown most clearly in FIG. 2, a portion of the recess 152 may be removed in the vicinity of each support member 144. A guide member or rib 160 projecting from the rear face 128 extends along a substantial portion of the portion 110 adjacent to the recess 152. The guide rib 160 presents an underside surface 164 cooperative with the recess 152 to seat the flap 120, as will be further described below. Though preferably molded with the fan shroud 20, the support members 144 and guiding rib 160 may be separate components secured to the fan shroud 20, such as through a subsequent molding step.

[0039] As shown in FIG. 3, the flap 120 is a generally planar member with a rear face 170 and is preferably punched from a relatively thick-walled, extruded or rolled film, for example, a thermoplastic. Suitable thermoplastics may include, but are not limited to, stabilized polypropylene, polyamide, or polybutylene terephthalate, as well as high-temperature polyetherimide and polyphenylene sulfide, any of which can be extruded into films and subsequently punched or cut, and which may include radiating cross-linking. In some applications, elastomers, silicones, or other extraducible plastics may be suitable, and the flap material may additionally be integrated with fibrous fillers or a fabric during the extrusion process. A composite of any of the aforementioned films may also be used in certain applications. A metal foil, preferably of a corrosion-proof alloy or painted or otherwise coated for corrosion protection may also be used. The flap thickness can range from about 0.05 to about 0.8 mm.

[0040] The flap 120 is sized to cover the opening(s) 132 when in a closed position, which can be considered substantially parallel to the rear face 128. A plurality of apertures 174, the edges of which are generally rounded to reduce stress concentration, are similarly punched or cut from the flap 120 near a top edge 178 and spaced to receive the plurality of support members 144.

[0041] Because the width of the assembly 100 can vary from application to application, a continuous film can be punched or cut to length to form a flap corresponding to a particular width and having a predetermined aperture separation. In such a situation, not all apertures 174 need to correlate with a support member 144. The flap itself may include areas of differing thickness for reinforcement purposes, for example, an additional supporting rib or ribs 180 formed during the extrusion process.

[0042] Referring to FIG. 4, the flap 120 is shown mounted to the support members 144. Each support member 144 extends through a corresponding aperture 174, retaining the flap 120.

[0043] Referring to FIGS. 5a-5e, in assembly the top edge 178 of the flap 120 is guided along the underside surface 164 of the guide rib 160. As the top edge 178 contacts the junction of portion 110 or recess 152 with the underside surface 164, continued insertion flexes, or elastically deforms, the relatively rigid flap 120 as it proceeds further into the recess 152 (FIG. 5c) or along portion 110. Once the top edge 178 passes across the end of the respective support members 144, the support members pass through the apertures 174, seating the flap 120 (FIGS. 5c-5d). The guide rib underside surface 164 is positioned to limit the travel of the flap 120 and thereby hinder removal of the flap 120 without affirmatively flexing the flap 120 to pass the aperture(s) 174 back over the ends of the respective support members 144 (see, e.g., FIGS. 5e and 5f).

[0044] In operation, as the vehicle speed increases, the velocity of the air relative to the vehicle increases. The position of the assembly 100 within the cooling fan shroud 20 exposes the openings 132 frontally to this air. The interaction of air with the flap 120 (due to dynamic pressure effects) deflects the flap 120 from a first position rearward to a second
position, shown in FIG. 5e, and allows the ram air to pass through the opening(s) 132 to or from the radiator coils (not shown). The flap 120 is allowed to move to the second position at least in part by a clearance fit, which allows the apertures to move relative to the support members. Therefore, the apertures in the flaps show a bigger area than the cross section of the support members. The amount of movement of the flap 120 is related to the velocity of the air, with the guide rib 160 providing an operational travel stop for the flap 120 during manufacture to position, as best seen in FIG. 5c. A typical opening angle is about 70°, which permits good airflow and additionally lowers packing depth. Further, self-closing by gravity and suction flow is promoted by such an arrangement. As the vehicle velocity decreases, diminishing dynamic pressure from the air permits the flap 120 to move back by gravity, to the first position (FIG. 5d). In the first position, the flap 120 additionally prevents short circuiting of air, i.e., in the absence of a flap 120, operation of the cooling fan 10 when the vehicle is not moving would permit portions of air passing through the cooling fan 10 to flow back in a reverse direction through the opening(s) 132, as indicated by the arrows of FIG. 5d. Such a situation lessens the amount of heat transferred from the radiator.

[0045] Referring to FIGS. 6-9, the features of each portion 110 of the fan shroud 20 can be varied to accommodate different applications. For example, FIG. 6 illustrates openings 132 further defined by a skirt portion 182 extending from the rear face 128 and presenting a contact surface 184 for contact with a front surface of the flap 120. As such, the flap 120 need not lie flush with the rear face 128 when in the first or closed position but rather rests against or is generally parallel to the skirt portion 182. FIG. 7 shows a single opening 132 having a skirt portion 182 and a support tab 190 to provide additional contact area for the flap 120 without substantially blocking the opening 132 for ram air flow. As shown, three support members 144 may be formed in the portion 110, with a center support member 144 generally aligned with the support tab 190. Referring to FIGS. 10 and 9, three or more openings 132 can be utilized with a significantly wider portion 110.

[0046] Referring to FIGS. 10-12, another flap assembly 200 includes a shroud portion 210 with a rear face 214 defining an opening 218. An optional support rib (not shown) can be molded therein for additional support. Thus, the portion 210 may have a plurality of openings 218.

[0047] As shown in FIG. 10, the portion 210 includes two mirrored support members 224 extending from the rear face 214 and presenting an undercut surface 228. A generally planar flap 240 with a rear face 244 and first and second edges 248 is punched or cut from a suitable extruded or rolled thermoplastic, as previously described. The flap 240 includes apertures 250 sized and spaced near a top edge 254 to correspond with the support members 224.

[0048] As illustrated, when the flap 240 is in a non-flexed condition, the apertures 250 are spaced wider than what would permit a simple passing of the apertures 250 over the support members 224. To secure the flap 240 to the shroud body 210, a user must force the first and second edges 248 toward each other, flexing the flap 240, as shown in FIG. 11. Flexing the flap 240 brings the apertures 250 to a position in which they can be passed over the support members 224. Once so positioned, upon release of the first and second edges 248, the flap 240 retains its natural unflexed state such that undercut surfaces 228 hinder separation of the flap 240 during operational conditions, as shown in FIG. 12.

[0049] FIGS. 13 and 14 illustrate an alternative embodiment with a flap assembly 260 including a shroud portion 262 with a rear face 268 defining an opening 272, which may or may not include a support rib, as previously described.

[0050] The shroud portion 262 includes two support members 276 extending from the front face and generally shaped as ‘mushrooms’ or buttons with an undercut surface 280. A flap 284 is a generally planar member with two apertures 288 geometrically configured for elastic expansion. For example, the primary oval shape of each aperture 288 in the flap 284 as shown in FIG. 13 is bisected by a laterally extending notch 292 that permits the expansion of the entirety of each aperture 288 when applied over the support members 276. The undercut surface 280 of each support member 276 retains the flap 284 during operation.

[0051] Additional support structure and flap aperture configurations permit simplified assembly while preventing separation of the flap from the fan shroud during operation. For example, FIGS. 15a-15c show a portion 310 of the fan shroud 20 with two support members 314 similar to the support member 224 of FIGS. 10-12 and a flap 320 with generally rectangular apertures 324 offset to one side of the flap 320 and sized to pass over the support members 314. The portion 310 also includes an elastic element 330 configured to partially deflect into a formed recess 334 and present an abutment surface 340.

[0052] During assembly, passing the flap apertures 324 over the respective support members 314 concurrently deflects the elastic element 330 forward toward the recess 334. The deflection permits the flap 320 to pass fully over the support members 314. Once in position, the flap 320 is moved laterally (leftward in FIG. 15a), which allows the elastic element 330 to spring back into its natural position (FIG. 15c), disposing of the abutment surface 340 adjacent an end 344 of the flap 320 to hinder movement of the flap 320 that might inadvertently align the apertures 324 with the support members 314, facilitating possible removal of the flap 320 during operation. In one alternative illustrated in FIG. 15d, the shroud body material forming the recess is replaced with an aperture 348 permitting the same amount of deflection of the elastic element during assembly.

[0053] The shroud and flap features of the aforementioned embodiments are in no way limiting and, for example, the support members may include one or three or more support members, which could embody differing shapes having the characteristic of retaining the flap to the shroud during operation. The shroud and flap may include additional surface finishes and treatments (e.g., stretching, coating, printing, or tempering) or other work subsequent to molding, e.g., rounding or bending of corners and edges, or the addition of further cutouts, notches, grooves, or indentations in an effort to improve aerodynamics and acoustics, and to minimize air leaks. In some applications, a sealing lip can be formed on a bottom edge of the flap for such a purpose. In other applications, the outer contour of the flap may contain recesses or other features to facilitate packaging and overcome space restraints.

[0054] Referring to FIGS. 16-19, a shroud portion 110 of the fan shroud 20 is similar to that shown in FIGS. 6 and 7, and like features are referenced with like numbers. The support members 144 of FIGS. 16 and 17 accommodate the flap 120 previously described. A catch member 400 integrally molded
with or subsequently fixed to fan shroud portion 110 at a first end 404 includes a second end 408 configured to block further movement of the flap 120 to a fully open position, as shown in FIG. 17. Specifically, the catch member 400 acts to limit the amount of deflection of the flap 120 to, for example, approximately 60° from the first position. Limited deflection decreases the amount of space necessary for operation and promotes more rapid self-closing of the flap assembly. The portion 110 of FIGS. 16-18 further includes first and second opposing pivot members 420 extending laterally into at least a portion of the opening 132 and defining a pivot axis 424. A separate flap 430 of a molded construction sized to cover the opening 132 is pivotally coupled to the pivot members 420 and thereby rotatable about the pivot axis 424 as illustrated in FIG. 18. Specifically, the flap 430 is configured such that it is mounted offset to the pivot axis 424, for example, at an approximate 1/3 to 2/3 ratio, i.e., for a uniform construction, approximately 2/3 of the surface area is on one side of the pivot axis 424. The ram air affects the greater surface area to a greater degree and thereby rotates the flap 430 about the pivot axis 424. As with the flap 120, decreasing the velocity of the vehicle lessens the rotative effect on the flap 430 and the flap 430 returns by gravity to its natural closed position covering the opening 132. Referring to FIG. 19, the flap 120 and the flap 430 can, in some applications, be included together to cover the same opening 132.

[0055] Referring to FIGS. 20-22, another flap assembly 500 includes a shroud portion 510 having a rear face 514 with a skirt 520 defining openings 524. A plurality of support members 530 similar to support members 144 of FIGS. 2-4 extend laterally across the shroud body 510 to support a flap 534 in a manner previously described. A pronounced guide rib 540 across the top of the shroud body 510 includes an underside surface 544 that cooperates with recessed area 548 of the shroud body 510 to seal the flap 534, as previously described with respect to FIGS. 5a-5c.

[0056] FIGS. 23-25 illustrate another embodiment of a flap assembly 600 in which a shroud portion 610 having a skirt 620 defines openings 624, and further includes support members 630, all of which are constructed and function similarly to previously described embodiments. As with the other embodiments herein, the support members 630 can be formed as mirrored about or offset from the approximate center of the portion 610 separating the openings 624. An integrally formed cantilevered deflection-limiting portion 640 extends rearward and includes a plurality of downwardly-protruding stops 644. A flap 650 is retained by the support members as previously described.

[0057] In operation, the deflection of the flap 650 due to interaction with the oncoming ram air deflects the flap 650 upward from a first position to a second position, as shown most readily in FIG. 24. The second position is limited by the position of the downwardly protruding stops 644 irrespective of the relative air velocity. For example, the stops 644 may limit the deflection of the flap 650 to approximately 60° from the first position.

[0058] The ram air flap assemblies and systems herein described are relatively easy to manufacture and, because the flaps are punched or cut from a thick-walled, extruded or rolled film, reduce material and manufacturing costs. Because deformation is not necessary during operational opening and closing of the flap(s), the greater wall thickness provides a more robust design with which to withstand engine compartment operating or maintenance conditions, including moisture, heat, vehicle fuel, steam jet cleaning, gravel or particulate impact, and splash water. In addition, the straightforward linear movement of the flap onto the support members effects comparatively quicker and easier assembly.

[0059] Various features and advantages of the invention are set forth in the following claims.

1. An assembly for increasing air flow to a vehicle cooling system, the assembly comprising:
   a portion of a cooling fan shroud, the portion having a face defining an opening therethrough, and
   a plurality of support members extending from the face;
   and
   a flap including a plurality of apertures proximal to an edge, each aperture of the plurality of apertures formed to receive one of the plurality of support members for coupling the flap thereto, wherein a clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the face to a second position in response to a flow of air.

2. The assembly of claim 1, wherein the cooling fan shroud includes a recess integrally formed in the face adjacent the plurality of support members, wherein the recess accommodates movement of the edge as the flap moves from the first position to the second position.

3. The apparatus of claim 1, wherein the shroud portion further includes at least one guide member adjacent to the recess and extending from the face, the guide member cooperatively at least one support of the plurality of supports to limit movement of the flap to the second position.

4. The apparatus of claim 3, wherein the second position is approximately 60° from the first position.

5. The apparatus of claim 1, wherein the flap blocks the opening in the first position.

6. The apparatus of claim 1, wherein the flap is punched from one of an extruded and a rolled film.

7. The apparatus of claim 1, wherein the flap is cut from one of an extruded and a rolled film.

8. The apparatus of claim 1, wherein the flap is constructed of a thermoplastic, elastomer, or metal.

9. The apparatus of claim 1, wherein the opening is a first opening and wherein the face further defines a second opening therethrough, the second opening separated from the first opening by a support member.

10. The apparatus of claim 1, wherein the flap further includes a reinforcement member generally orthogonal to the edge.

11. The apparatus of claim 1, wherein the recess is arcuate in cross-section.

12. The apparatus of claim 1, wherein the shroud portion further includes opposing pivot supports projecting across a portion of the opening and defining a pivot axis operable to support a rotatable flap.

13. The method of claim 1, wherein the thickness of the flap is between 0.05 to 0.8 mm.

14. A cooling fan shroud for a vehicle, the cooling fan shroud comprising:
   a cooling fan shroud face having
   a primary opening therethrough for a cooling fan,
   a plurality of secondary openings therethrough, and
   a plurality of support members extending from the face adjacent each secondary opening; and
   a flap including a plurality of apertures proximal to an edge, each aperture of the plurality of apertures formed
to receive one of the plurality of support members for coupling the flap thereto, wherein a clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the shroud face to a second position in response to a flow of air.

15. A method of producing a cooling fan shroud, the method comprising:
   injection molding a shroud portion having
   a face defining an opening therethrough,
   a plurality of support members extending from the face, and
   a guide member adjacent the opening and extending from the face; and
   coupling a flap to the plurality of support members,
   wherein the coupling includes flexing the flap to engage
   the support members of the plurality of support members.

16. The method of claim 15, wherein coupling a flap to the plurality of support members means coupling a flap having a plurality of apertures along a first edge, the apertures spaced to each receive one of the plurality of support members.

17. The method of claim 15 wherein coupling a flap to the plurality of support members means coupling a flap having a thickness of between 0.05 to 0.8 mm.

18. The method of claim 16, wherein coupling the flap to the plurality of support members includes elastically deforming the flap to position each of the plurality of apertures over each of the plurality of support members.

19. The method of claim 16, wherein coupling the flap to the plurality of support members includes elastically deforming the flap between the guide member and the plurality of support members such that an end of each support member of the plurality of support members extends through a respective aperture of the flap.

20. The method of claim 18, further including guiding the flap along the guide member into a recess.

21. The method of claim 15, wherein injection molding the shroud portion means injection molding the guide member to be disposed cooperatively with at least one support of the plurality of supports to limit operable movement of the flap.

22. An assembly for increasing air flow to a vehicle cooling system, the assembly comprising:
   a portion of a cooling fan shroud, the portion having
   a face defining an opening therethrough, and
   a plurality of support members extending from the face; and
   a flap including a plurality of apertures proximal to an edge, each aperture of the plurality of apertures formed to receive one of the plurality of support members for coupling the flap thereto, wherein a clearance fit formed between the apertures and the support members permits movement of the flap from a first position generally parallel to the face to a second position in response to a flow of air, and wherein the flap is retained on the shroud portion at least partially by one or more elastic members attached to the shroud portion or formed as an integral part of the shroud portion, the elastic members being flexed during engagement of the apertures with the support members.

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