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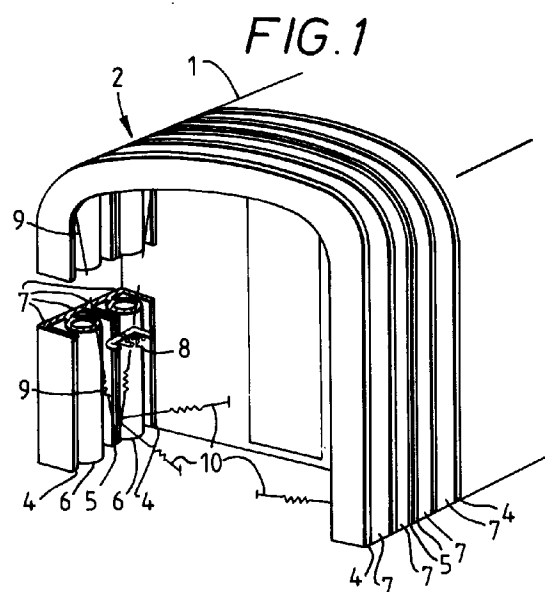
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(54) **Fairing constructions and vehicles comprising fairing constructions.**

(57) A fairing construction for fairing between adjacent cars (1) of a vehicle, particularly a railway train, forms a flush connection between end peripheries of adjacent cars (1). To accommodate changes in relative orientation of the cars (1), the fairing construction (2) has resiliently compressible elements (6) connected in series with freely extensible guides (8) between the cars (1). The compressible elements (6) cushion movements of the car peripheries towards one another, and carry an outer fairing face (7) of the construction (2). When the car peripheries become widely spaced, the compression elements (6) separate and are kept in longitudinal alignment by the freely extensible guides (8). A resilience adjuster may be provided to adjust the resilience of the compression elements (6) according to the vehicle speed and track curvature.



This invention relates to fairing constructions for connection between adjacent cars of a vehicle having plural cars, and to vehicles having such fairing constructions. In particular, although not exclusively, it relates to constructions for fairing between the cars of railway vehicles and most particularly high-speed trains.

Conventionally, railway trains have longitudinal spaces between the end walls of adjacent coupled cars. At high speeds, this inter-car spacing at the peripheries of the car ends causes problems of noise and drag. It is difficult to overcome these problems in a way consistent with all types of speed and track. But, improvements are urgently needed as faster trains become available.

In the prior art, EP-A-67944 describes means for fairing, i.e. reducing aerodynamic drag and noise, between adjacent cars. The periphery of each car end is provided with a longitudinally-projecting elastomeric lip, touching the corresponding lip on the other car when the train runs straight. Each lip has internal pressurizable cavities, whose pressure is controlled according to the train speed to adjust the lip stiffness. This can eliminate the gap and achieve fairing at high speeds, while permitting easy deformation of the lips for tight, low-speed curves.

However, cars are not always aligned with one another even on straight or slightly-curved track. When the cars are not aligned, the prior art construction develops a lateral stagger of the opposed lips that leads to noise.

The object of this invention is to provide a novel form of fairing construction for use between the end peripheries of coupled cars. In a particular aspect, it would be preferable to meet the requirements of a high-speed train fairing, in which noise and drag could be kept low at high-speed running, on straight or slightly curved track, with a construction which can nevertheless cope with tight curves on low-speed sections of track.

The present inventors have appreciated that, while it is very important to avoid lateral staggering and longitudinal spacing at high speeds, spaces and staggering may nevertheless be no problem at low speeds.

Accordingly, in a first aspect of the invention we provide a fairing construction for connection between a longitudinally-spaced opposed end peripheries of coupled cars of a vehicle, the fairing construction being longitudinally extensible and contractible to accommodate changes in the relative orientation of the cars, and comprising

peripherally-extending, longitudinally resiliently compressible compression means, to accommodate longitudinal deformations of the construction in a resilient manner in a contracted condition of the construction, the compression means being connected in longitudinal series with

longitudinally freely extensible guide means, which maintains the compression means in longitudinal alignment while allowing easy longitudinal deformation of the construction in its extended condition.

An outer fairing face, preferably a longitudinally smooth face, is provided on the compression means to achieve the necessary fairing effect. In the installed condition of the construction, the fairing face is preferably substantially flush with the outer periphery of each car.

The compression means may be provided by one or more individual compression elements. For example, an intermediate compression element may be connected to both car ends by separate sections of the guide means on either longitudinal side thereof. In a more preferred version, an individual compression element is disposed along the end periphery of each of the cars, and the guide means connects between these two separable compression elements.

In this way, it is envisaged that when the vehicle travels a small-radius curve, the fairing construction will compress its compression means on the inside of the curve and separate the compression means, with the separation traversed by the guide means, on the outside of the curve. Because such tight curves are travelled slowly, the separation causes no aerodynamic problem.

The elements of the fairing construction are connected between the car end peripheries in a series, so that at high speed they can maintain a general longitudinal alignment and a smooth surface transition without sharp surface discontinuities, even though the cars themselves may become mutually staggered.

The preferred construction for a compression element has a resiliently compressible member, which may be made of elastomer, and may have a tubular or hollow form, attached to a longitudinally-facing seating element. The seating element can provide a mechanically controllable boundary of the compression element, and thus suitably is at a separable side thereof. Typically it is, or comprises, a stiff lateral plate.

The compression element may have the resiliently compressible member sandwiched between two such longitudinally-facing seating elements.

Such seating elements may provide convenient fixing locations for the guide means in the series connection.

If the resilient response of the compression means is substantially elastic (linear), there may be a problem of excessive forces arising on the inside of very tight curves. Resilience adjuster means may therefore be provided, to enable controlled change of the resilient response of the compression means. Such control may be achieved e.g. by adjusting gas pressure in a hollow resiliently compressible member of the compression means. The pressure may be

regulated by a mechanical compression device, or by means of an auxiliary pressure chamber or accumulator chamber connected to the interior of the compressible member.

The resilience adjustment may be manually-controlled, or automatically speed-dependent or track-curve-dependent. Low resilience is preferred at low speeds, where tight curves are likely, while higher resilience is preferred at higher speeds so that the fairing face is well extended and supported.

Advantageous effects can be achieved by a careful mounting of the fairing face. In a simple embodiment, the fairing face may simply be a smooth (longitudinally straight) outer face of a compressible member of the compression means. More preferably, however, the fairing face is provided by a longitudinally deformable (and preferably resilient e.g. elastomeric) fairing layer which is divided into two or more longitudinally distributed, independently deformable regions. This can be achieved by attaching the fairing layer (which may be in one or plural sections) to the compression means locally, at multiple longitudinally-spaced fixing locations. For example, and most preferably, a resiliently compressible member of the compression means may have a longitudinally intermediate outward projection, at which the fairing layer is fixed to define independently deformable regions on either longitudinal side of the fixing.

This longitudinal sub-division of the fairing face has an advantage in reducing noise, since a longitudinal compression (e.g. on the inside of a fast, long curve) results in plural small lateral bulges rather than one large lateral bulge of the fairing face.

The fairing layer may be fixed at its fixing locations by plural longitudinally expansible joints, so that for modest longitudinal extension of the construction (e.g. on the outside of a fast, long curve) no single substantial separation occurs.

The guide means preferably comprises a plurality of individual peripherally-spaced guide assemblies. Each assembly preferably has an extensible portion whose extensional movement is constrained to be in the longitudinal direction, and is preferably substantially linear. This assures alignment of the compression means, and hence of the fairing face, between the car peripheries even when those peripheries are mutually staggered. It also assists separated fairing face sections to reunite in alignment, when recovering from substantial extensions of the construction.

The guide means should be freely extensible, that is, should offer little resistance to extension and subsequent contraction, preferably with little or no resilience.

Because space between car ends may be limited, the guide means also desirably has an extensible portion whose fully-extended length is much larger than its fully-contracted length. A telescopic or sliding connection is therefore less preferable, although a

multi-stage telescopic connection may be used. More preferred is a mechanism having plural transverse elements pivotably connected, such as a lazy-tongs mechanism.

Individual guide assemblies of the guide means may be connected on a peripherally-extending guide frame, to help hold the entire guide construction in lateral alignment.

When installed on the vehicle, the weight of the construction may be partly supported by one or more suspension members which connect between longitudinally intermediate portions of the construction and the car ends. Elongate sprung members may be used for this. Similarly, lateral stabilizing members may be connected between intermediate portions of the fairing construction and the car ends to inhibit bodily lateral movements of those portions. Again, long sprung members may be used.

Another aspect of this invention provides a vehicle, and preferably a railway vehicle, in which adjacent cars are faired together by a fairing construction as described above.

The fairing construction preferably extends at least up both sides and across the top of the opposed end peripheries of the cars. However, it may be useful even only at the sides.

Recently, there has been concern with the noise created on high-speed electric trains by the upstanding collectors used to contact overhead power cables providing current for the train drive. It has been proposed to reduce the number of these collectors, as well as to streamline their design. With fewer than one collector per car, it is necessary to run a high-voltage cable between cars. We envisage that such a cable may conveniently traverse between the cars inside the fairing construction proposed here, to minimize a potential noise problem caused by the crossing cable.

Embodiments of the invention are now described by way of example, with reference to the accompanying drawings in which

Figure 1 is a perspective view of a train car end with a fairing construction in a first embodiment; Figure 2 is a longitudinally-sectioned detail of part of the fairing construction of the first embodiment;

Figure 3 is a longitudinally-sectioned plan of the fairing construction of the first embodiment, in a straight, high-speed condition;

Figure 4 is a corresponding plan in a laterally deformed high-speed condition;

Figure 5 is a corresponding plan for a high-speed, large radius curve;

Figure 6 is a corresponding plan for a low-speed, small radius curve;

Figure 7 shows, in longitudinal cross-section, detail of a compression element and guide assembly of the first embodiment;

Figure 8 is an end elevation of the first embodiment on a train carriage end;

Figure 9 is a schematic side view showing the fairing construction between two train cars;

Figure 10 is a sectioned side elevation showing suspension and stabilizing members;

Figure 11 is a longitudinally-sectioned plan of a second embodiment of fairing construction, in a high-speed straight condition;

Figure 12 is a corresponding plan of a third embodiment of fairing construction;

Figure 13(a) is a corresponding plan of a fourth embodiment of fairing construction, while

Figure 13(b) shows sectional details of a fairing layer;

Figure 14(a) is a corresponding plan of a fifth embodiment of fairing construction, while

Figure 14(b) shows sectional details of a fairing layer;

Figure 15 is a corresponding plan of a sixth embodiment of fairing construction;

Figure 16 is a sectioned plan of a seventh embodiment of fairing construction;

Figure 17 is a sectioned plan of an eighth embodiment of fairing construction;

Figure 18 is a sectioned plan of a ninth embodiment of fairing construction;

Figure 19 is a sectioned plan of a tenth embodiment of fairing construction;

Figure 20 is a sectioned plan of an eleventh embodiment of fairing construction;

Figure 21 is a corresponding plan of the eleventh embodiment, for a low-speed, small radius curve;

Figure 22 is an end elevation of the eleventh embodiment on the end of a train car;

Figure 23 is an end elevation showing details of connection of a guide assembly to a seating element in the eleventh embodiment;

Figure 24 is a sectioned side elevation of the eleventh embodiment;

Figure 25 is an end elevation showing a twelfth embodiment of fairing construction on a train car;

Figure 26 illustrates schematically a gas pressure accumulator used in the twelfth embodiment;

Figure 27(a) is a longitudinally-sectioned plan of a fairing construction of a thirteenth embodiment, on the outside of a small-radius curve, while

Figure 27(b) shows details of a mechanical pressure regulator thereof;

Figures 28(a) and (b) show corresponding features on the inside of the small radius curve with the thirteenth embodiment;

Figure 29 shows schematically a gas pressure control system for a fourteenth embodiment of fairing construction;

Figure 30 shows schematically a gas pressure control system for a fifteenth embodiment of fair-

ing construction;

Figure 31 shows schematically a gas pressure control system for a sixteenth embodiment of fairing construction;

Figure 32 is a sectioned side elevation of a seventeenth embodiment, showing a fairing construction between two cars with a high-voltage cable connection;

Figure 33 is a plan view of the seventeenth embodiment;

Figure 34 is an end elevation of one car in the seventeenth embodiment;

Figure 35 is a sectioned side elevation of an eighteenth embodiment, showing an alternative mode of crossing a high-voltage cable;

Figure 36 is a sectioned plan view of the eighteenth embodiment, and

Figure 37 is an end elevation of the eighteenth embodiment showing one car.

The embodiments described below relate to the application of the invention in a high speed railway train. Railway cars are coupled together firmly at the chassis level. However, the body of a car is supported on the chassis through air springs. It is thus possible for the bodies of adjacent cars to move out of line, even on a straight track. Before describing the first embodiment of fairing construction, these potential misalignments are now explained with reference to Figures 4, 5 and 6.

These figures are plan sections at both sides of the fairing connection between two train cars 1, greatly laterally contracted to show both sides in detail. The longitudinal spacing of the cars 1 is typically about 500 mm.

Fig.4 relates to fast, straight travel. Dynamic changes of alignment and relative vibrations occur continuously between the cars 1. Relative lateral displacements of e.g. about 30mm may occur. There is a concomitant small change in longitudinal spacing: perhaps about 1mm. The fairing construction must accommodate these changes.

Fig.5 shows a condition for high-speed travel on a large radius (at least 2500 m) curve. On the outer side of the curve (top of the figure) expansion may be 20 mm, with a corresponding contraction of not more than 20 mm on the inner side.

Finally, Fig.6 illustrates the condition for a slow, small radius curve such as might be negotiated by a high-speed train near to a station or near to its operating base. With a curve radius of about 200 m the extension on the outside of the curve and the contraction on the inside of the curve may be as much as about 320 mm; a large proportion of the basic 500 mm spacing. Train speed is typically low, for example 50 km/h.

The first embodiment of fairing construction is shown in Figs.1 to 10. Fig. 9 shows schematically the opposed ends of two cars 1, with a fairing construc-

tion 2 connected between their end peripheries. The fairing construction extends entirely flush with those peripheries, effectively as a continuation of the side walls of the cars 1. Figs. 1 and 8 show the end of a single car with the fairing construction 2, showing the inverted-U shape of the construction extending continuously up the side walls and across the top of the car's end periphery.

Referring also to Fig. 2, the fairing construction 2 comprises a number of components connected in longitudinal series. At each end of the construction, a securing plate 4 forms a fixing location for the construction, being bolted to the end wall 1a of the car 1. Connected in series between the end plates 4 are two compression elements 3 and a plurality of guide assemblies 8, details of these appearing in Fig. 2.

Each compression element 3 comprises an elongate elastomeric tube 6 extending peripherally, sandwiched longitudinally between the fixing, or inner, end plate 4 and an outer end plate 5. The end plates 4,5 have opposed receiving grooves 40,50 which lock around end projections 64,65 of the compressible tube to form an integrated assembly in which the end plates act as opposed seating elements. The inner seating elements 5 of the two compression elements 3 are parallel, opposed, and butt together in the straight rest condition of the train. They may be of metal, or of suitable high-strength engineering plastics material.

At its laterally outer side, each of the compressible tubes 6 has an integral projecting rib 61 extending around the entire periphery. This projecting rib 61 forms a longitudinally intermediate fixing location for portions 7 of an elastomeric fairing layer which defines the exterior of the fairing construction. Each fairing layer portion 7 comprises a main, longitudinally smooth portion 70 (see Fig. 7), a perpendicular fixing flange 71 lying along the flat side of the projecting rib 61, and a thin securing lip 72 resting flush in a corresponding recess at the edge of the receiving element 4,5. The fairing layer portion 7 is secured in the compression element only at the lip 72 and at an inmost fixing extremity 73 of the fixing flange 71. This fixing may be by high-strength adhesive, or by bolting through thin metal plates (not shown). The greater part of the fixing flange 71 is not fixed against the projecting rib 61, although it lies against it in the rest condition of the construction.

The fairing layer portions 7 are desirably of an elastomer such as rubber.

The guide assemblies 8 are now described. Fig. 8 shows how a plurality e.g. four guide assemblies 8 are peripherally distributed around the construction. The details of each assembly are best seen in Figs. 2 and 7. Mounting brackets 81,82 are secured rigidly to the inner edges of the inner receiving elements 5, and an extensible mechanism 83 is connected between these mounting brackets. A control guide 84 ensures

that the extension of the extensible mechanism 83 is perpendicular to the brackets 81,82 and seating elements 5. In this embodiment the extensible portion 83 has a lazy-tongs or "pantograph" construction, with a series of inter-pivoted lever elements. Such constructions are well-known. They have the advantage that they may expand substantially linearly, with little flexing. The control guide 84 comprises a rigid lateral arm on which runs a slide 85 fixed to the last free lever of the lazy-tongs.

Other forms of guide assembly may be used, but this construction has the advantage that its contracted length is a very small proportion of its expanded length, and is hence appropriate for connection between two elements 5 which may abut in the contracted condition. For other types of guide assembly, it may be necessary to extend the mounting brackets 81,82 longitudinally.

Figs. 1, 8 and 10 also indicate the disposition of suspension members 9, comprising elongate metal rods connected by coil springs, which are connected between the fixing locations 4 at the tops of the sides and the seating elements 5 at the bottoms of the sides, to help support the weight of the fairing construction across the inter-car gap. Further details are not given, since such suspension members are in themselves known for supporting inter-car constructions. Similarly, lateral stabilizing members 10 connect between the seating elements 5 and inwardly-spaced parts of the car end walls 1a, to inhibit bodily lateral displacements of the middle of the fairing construction relative to the car end peripheries. Again, these may be spring-connected rods of generally known type.

The suspension members 9 also assist the longitudinally intermediate seating elements 5 to take up a vertically intermediate position between the car ends, in the event that one car end becomes higher than the other.

Fig. 8 also shows an inner vestibule diaphragm 11 of conventional type, used to surround a passenger communication passage and keep the vehicle interior airtight.

Finally, as regards the general arrangement, it should be mentioned that the entire fairing construction is pre-compressed in the straight condition of the train. That is, the resilient tubes 6 exert some appreciable longitudinal expansion force in the straight condition, corresponding to pre-compression of e.g. about 25 mm. This is to prevent transient longitudinal clearances from arising when minor longitudinal vibrations occur.

The behaviour of the fairing construction is now described, for varying conditions of the train.

Fig. 3 shows the high-speed straight condition, with no lateral stagger of the cars 1. Within each compression element 3, the outer fairing face 7 is held straight and smooth by the slight expansional urge of

the pre-compressed tubular member 6, while the contracted guide assembly 8 holds the abutting seat elements 5 of the two compression elements 3 in exact superimposition so that no stagger or step causes aerodynamic noise. The entire assembly is flush with the car sides. Minor longitudinal vibrations are taken up by the pre-compression, as mentioned above.

Fig. 4 illustrates the condition halfway up the side walls, when a transient lateral relative displacement of the cars 1 occurs during fast straight running. Typical dimensions have been described above. The seating elements 5 rotate very slightly clockwise, and the distance between the car end peripheries is slightly increased e.g. by about 1 mm. The slight rotation of the seating elements 5, through the tubes 6, slightly expands the outside of the compression elements at diagonally-opposed positions, and slightly contracts the outsides of the compression elements at the other diagonally-opposed positions. The expansion is taken up by forming a tiny clearance x, of about 1 mm, between the flange 71 of a fairing portion 7 and the outward projection 61 of the tube 6. The compression is taken up by a slight outward lateral bulging y of the fairing layer portions 7. The bulging is only a few mm, so little aerodynamic noise is caused.

Along the top of the fairing construction, similar considerations apply since the size of vertical displacements tend to be similar to that of lateral displacements.

Fig. 5 shows the condition on a large-radius high-speed curve. The increased distance on the outside of the curve is taken up by the pre-compression of the tubular members 6, so that the abutting seating elements 5 do not separate. Easy flexible expansion at the L-flanges 71 of the fairing layers, takes up the expansion by forming four very small clearances, but no single large clearance which could cause serious noise. On the inside of the curve, the four fairing layer portions 7 each bulge laterally, but the degree of bulging is small - perhaps about 15 mm - and noise is not serious. Bulging occurs easily and smoothly because of the flexible lip 72 connecting each fairing portion 7 to the adjacent end plate 4,5. The bulging is small because it is shared among plural fairing layer portions, secured at plural longitudinally-spaced fixing locations. A single long fairing element would bulge to a much greater distance.

Fig. 6 shows the low-speed, small radius curve condition. The extension on the outside of the curve far exceeds the pre-compression of the compression elements 3. As the extension increases from the straight condition, the compression elements 3 first relax and then separate, forming a space between their opposed seating elements 5. This separation occurs without generating large tensile forces, because the guide assembly 8 extends freely and non-resiliently to create and span the space between the compression elements 3 at the outside of the curve. There

is no noise problem, since such tight curves are negotiated only at low speeds.

On the inside of the curve, both compression elements 3 are substantially longitudinally squashed. As at the outside of the curve, there is some canting of the two seating elements 5, determined by the stiffness of the guide assemblies 8 compared with the mounting of the seating elements 5 through the compressible tubes 6. The fairing face regions 7 bulge outwards substantially, perhaps 40 mm. As mentioned, however, there is no aerodynamic problem at the low speed.

After the train passes the small-radius curve, the inside compression elements 3 re-expand to the straight condition, while the outside compression elements 3 are brought together by the vehicle end peripheries, with free contraction of the guide assembly 8. The controlled linear movement of the guide assembly 8 brings the compression elements 3 back together with exact lateral superimposition, avoiding any stagger. The extensible construction has just sufficient flexibility to accommodate the angling of the longitudinal axes of the two cars 1.

The guide assemblies deal easily with a large maintained expansion of the fairing construction, and return the compression elements to a smooth conformation after expansion. Conversely, the tubular compression members 6 can handle a large maintained compression of the structure without suffering any damage, since they are shaped to withstand compression stably, unlike the thin lips suggested in the prior art. That is, the compressible members of the present fairing construction preferably compress linearly with a regular outward expansion of their longitudinally-extending walls.

Fig. 11 shows a second embodiment which is the same as the first except for the conformation of the fairing layer elements 107. These differ from the corresponding elements in the first embodiment in that the L-section fixing flange 171 carries a longitudinally-projecting support element 175 which extends along behind the front layer of the fairing layer 107, spaced at a small distance. These supports 175 helped prevent any significant inward deformation of the layers e.g. by a strong side wind, improving the flatness and hence the fairing effect.

Fig. 12 shows a third embodiment which again is the same as before excepting the structure of the fairing layers 207. The rear surface of the main portion of each layer 207 is ribbed in the peripheral direction. Longitudinal bending is therefore facilitated, because the minimum thickness in the peripheral direction is reduced. Other, undesirable bending modes are not encouraged because the thickness as seen in non-longitudinal directions is maintained. The easier longitudinal bending improves the performance on the inside of tight curves.

Fig. 13(a) shows a fourth embodiment which

again is different as regards the fairing layers 307. As in the previous embodiment, the aim is to reduce the minimum bent thickness for longitudinal deformations. In this embodiment this is achieved by an outwardly opening, peripherally extending slit 375, positioned half-way along each fairing piece 307, to facilitate bending.

Fig. 13(b) shows the slit 375 in detail.

Fig. 14(a) shows a fifth embodiment with a still further varied construction of the fairing layer 407, again with a view to achieving easier extreme deformation on the inside of a tight curve.

Fig. 14(b) shows detail of the fairing layer 407. A single elastomeric piece 407 extends from one end plate 4 to the other 5. At the projection 61, the fairing piece has a rear recess 471 which receives the edge of the outward projection 61, but is attached to it only at a thin front web 472 of the recess. This allows easy flexion about the edges of the web. At its mid-point, each fairing layer region 470 has a peripherally-extending slit 475, as in the previous embodiment. At its longitudinal extremities, the fairing piece 407 is secured to the respective end plates 4,5 by L-section flanges 473 connected to the region 470 by a further peripherally-extending slit 476, inwardly directed, and to the end plate 4,5 only at a fixing terminal 477 of the flange 473. In this embodiment, the small clearances corresponding to clearances x of Fig. 4 occur adjacent the end plates 4,5.

Fig. 15 shows a sixth embodiment which corresponds to the first embodiment except for the cross-sectional shape of the tubular compressible members 106. In this embodiment the inner portion of each member 106 has a longer, more elliptical extension than the outer portion. It also has a layer thickness smaller than that of the outer portion. We find that this facilitates the very large compression which can be needed on the inside of a small-radius curve.

Fig. 16 shows a seventh embodiment with another construction of the compressible members 206, designed to reduce still further the lateral bulging of the fairing faces on high speed curves. This is done by forming the compressible member 206 into two longitudinal sections 206', each having a respective outward rib projection 261. Each section of the compressible member 206 is a convex tube, and they are connected together through communication apertures 262. By having two projections 261, the fairing layer of each compression element is divided into three independent longitudinal regions 507 instead of two as previously. For a given compression, therefore, the lateral bulging distance is less.

Fig. 17 shows an eighth embodiment which differs radically from the previous embodiments in the construction of the compressible members 306 and fairing faces 607. Each compression element 103 comprises end plates 104,105 with laterally intermediate attachment recesses 141,151. The compressible member 306 is a rectangular-section elastomeric tube having elongate end ribs which seat in the securing recesses 141,151 of the end plates and are secured therein by e.g. bolts 160. The laterally outer surface of each compressible element 306 is longitudinally flat and flush with the other outer edges, forming the fairing layer 607 of this fairing construction. This embodiment does not cope with large expansions and contractions as well as the other embodiments, but it has a reduced number of parts and hence good reliability.

Fig. 18 shows a ninth embodiment which is the same as the first embodiment except for the resiliently compressible members 406. The members 406 are not tubular, but form an open hemicylinder with the outward projecting rib 461 provided as before. These compressible members 406 are easier and cheaper to make than the tubular ones, although their maximum compressive force is less and cannot be adjusted easily.

Fig. 19 shows, in the condition encountered on a small-radius curve, a tenth embodiment of the invention in which the general disposition of elements in series is different. The fairing construction comprises a single peripherally-extending compression element 203. The guide means is divided longitudinally into two sections, each having plural peripherally-spaced guide assemblies 108 connecting between a respective bracket 181 on each separable end plate 205 of the compression element 203, and a respective fixing plate 12 screwed to the end wall 1a of the car 1. Each guide assembly 108 comprises a lazy-tongs construction as before, but of lesser maximum length.

The compression element 203 comprises a resiliently compressible section between the two longitudinally spaced end plates 205. In this version, the compressible section is formed from two elastomeric tubes 6 as in the first embodiment, but linked by a common central seating element 212 which also forms the median fixing location for the outer fairing layers 7.

In this embodiment, two longitudinal clearances are created, instead of one, on tight curves. This can give a safety improvement, in that flying objects are less likely to penetrate the construction. However, it is more difficult to stabilise and suspend the floating compression element 203.

Figs. 20-24 show an eleventh embodiment in which the guide assemblies 208 differ from the first embodiment. A lazy-tongs construction is used for the extensible portion, as above, but is connected to a simple bracket 281 on both the seating element plates 5. The longitudinal linear guide control is done by a separate unified assembly comprises a guide assembly frame 285 (Fig. 22) common to all the guide assemblies 208, carrying laterally-extending control slides 284 on which central joints of the extensible lazy-tongs are mounted to slide. In this embodiment,

the guide slides 284 can move bodily in the lateral/vertical direction while governing the sliding direction of the lazy-tongs. The lazy-tongs 283 can therefore pivot freely at its end brackets 281 and need not flex at all. It therefore becomes possible to make the lazy-tongs from very strong, rigid material without creating intolerable strains. It also becomes easier to use other guide assembly constructions not using lazy-tongs e.g. a stem and cylinder slider which might only be contractible to about half of its extended length.

In many cases, it may be desirable to be able to adjust the degree of resilience of the compressible part of the fairing construction, according to the condition of the train. In a construction such as that of the first embodiment as so far described, large forces would be generated in the compression elements 3 on the inside of a tight curve if those elements have closed tubes and are greatly compressed. For that reason alone, it might be desirable to have soft compressible elements 6. But, at high speeds on straight track, it is of great importance to keep the fairing face 7 properly located and supported. For that purpose, a large resilience of the compressible members 6 is desired. The following embodiment concerns means which may be incorporated into any of the embodiments described above using tubular compressible members, for adjusting the resilience thereof. Figs. 25 and 26 show a twelfth embodiment in which an accumulator 13 is connected to the hollow members 6, to provide a pressurised gas supply thereto. The accumulator 13 has an outer cylinder 131, an inner cylinder 132, and a diaphragm 133 urged by a spring 134. A minimum gas pressure of e.g. about 0.1 kgf/cm is desirably maintained. In high-speed travel, the spring 134 urges the diaphragm 132 to the left, to maintain the members 6 in their fully extended condition. On a sharp bend, however, the increase in pressure of the severely squashed member 6 (which might otherwise be nearly four times that in the normal condition) is relieved by pushing the diaphragm 132 to the right against the spring 134. This makes it easier to compress the hollow members 6 greatly.

Figs. 27 and 28 show a thirteenth embodiment, also with a self-governing adjustment but this time performed by mechanical action on the compressible members 506. The inward side of each compressible member 506 has a large area, so as potentially to project greatly inwardly. This inward portion is indented by a pressure adjusting mechanism 114 having a peripherally-extending compressing member 142, e.g. of hard rubber, urged outwardly by peripherally distributed springs 143 acting against a reaction seat 144 secured by support springs 145 to the end plates 4, 5. The pressure member 142 is guided by a lazy-tongs linearly extensible guide 146.

In the high-speed condition, or the open condition as shown in Fig. 27, the inner portion of the compressible member 506 is spread wide and is thus easily

deformed by the pressure regulator 114 to maintain its internal pressure. In the severely compressed condition (Fig. 28) the increased pressure in the compressible members 506 squeezes the pressure members 142 back against their springs 143, to prevent an inordinate pressure increase.

This embodiment is convenient to install, because the pressure regulator is integral with the fairing construction itself.

Fig. 29 shows a fourteenth embodiment in which the gas pressurised hollow members 6 are connected to a regulator 15 having a branched tube with one branch 151 leading to a discharge valve 152 which opens at a predetermined excess pressure e.g. 1.5 times a predetermined standard pressure P_0 and a second branch 153 leading to a feed valve 154 connected to an air source 155 and set to open when the pressure in this tube branch 153 falls below P_0 . The operation of the device to maintain a pressure approximately P_0 , irrespective of the degree of compression of the members 6, is self-explanatory.

Fig. 30 shows a fifteenth embodiment in which the compressible tube 6 is connected to a pressure regulating device 16, having a bifurcated tube and air source similar to the fourteenth embodiment, but with the feed valve 162 and discharge valve 163 interconnected to operate together, and solenoid operable. A reducing valve 164 moderates the source air pressure to the predetermined pressure P_0 . The hollow members 6 are monitored by a displacement sensor 165 whose output is fed to a comparator 166. The valves 162, 163 are operated in dependence on the measured longitudinal dimension of the members 6. When the members 6 are greatly compressed, and their length falls below a preset minimum, the discharge valve 163 opens to eliminate excess pressure. The feed valve is closed. When the hollow member 6 recovers after the curve, the feed valve 162 opens, the discharge valve 163 closes and air is supplied at the standard pressure P_0 . This operation may be programmed to occur when travel speed does not exceed a certain limit. Thus, deformation of the member 6 is detected directly, and its inner pressure is then regulated accordingly.

Fig. 31 shows a sixteenth embodiment which is different in that the operation of the feed valve 162, 163 is dependent on the vehicle travel speed, as determined by a tachometer generator 167 and compared with a preset value in a comparator 168. On the assumption that the travel speed will be low on any sharply-curved track, the discharge valve opens when the travel speed falls below the preset value and the possibility of great compression arises. Above that preset speed value, the feed valve 162 opens and the supply at P_0 is maintained. This embodiment is more reliable than Fig. 30.

Figs. 32 to 34 show a seventeenth embodiment. High voltage is collected from an overhead line 18 by

a current collector 19, and conducted along the train as shown by the arrows. The high voltage (e.g. 25kV) cable 20 runs on the car roof to a cable head 202 and crosses the gap between the cars to a cable head 202 on the next car. A branch cable 201 extends from the cable head 202 to a transformer 22 and then to a converter 24 and motor 25 for driving the train wheels 26. Streamlined covers 27 enclose the cable heads above the main roof 21 of each car, and these streamlined covers 27 define the upper end peripheries of the cars along which the top part of the fairing construction 2 is secured. The crossover portion of the high voltage cable 20 passes in the shrouded space between the top of the vestibule 11 and the underside of the upper fairing construction 2. By thus extending the fairing construction to align with the covers 27, turbulence and noise can be substantially reduced.

Figs. 35 to 37 show an eighteenth embodiment in which the cable heads 302 are provided not on the roof of each car but recessed in the end wall 1a. The high voltage cable 20 passes through each car roof 21 just behind the end wall 1a of the car and descends to the cable head 302 which is positioned in a recess 303 of the end wall 1a outside the vestibule 11 but inside the fairing construction 2, adjacent the bottom of the car. A short section 220 of the high-voltage cable crosses over from one cable head 302 to the other at a low level. Noise potentially caused by the cable heads and protruding cable portions is thus kept to a small level.

Claims

1. A fairing construction for connection between longitudinally-spaced opposed end peripheries of coupled cars (1) of a vehicle, the fairing construction (2) being longitudinally deformable to accommodate changes in the relative orientation of the cars (1) and comprising peripherally-extending, longitudinally resiliently compressible compression means (3) which accommodates longitudinal deformations of the fairing construction (2) in a longitudinally contracted condition thereof, and has an outer fairing face (7),
characterised by
longitudinally freely extensible guide means (8) connected in longitudinal series with the compression means (3), to align the compression means (3) longitudinally and accommodate longitudinal deformations of the fairing construction in a longitudinally extended condition thereof.
2. A fairing construction according to claim 1 in which the compression means comprises at least one peripherally-extending compression element (3) having a resiliently compressible member (6)

fixed to a longitudinally-facing seating element (5).

3. A fairing construction according to claim 2 in which the resiliently compressible member (6) is tubular.
4. A fairing construction according to claim 3, further comprising means (13,14,15,16) for adjusting the resilience of the resiliently compressible member (6).
5. A fairing construction according to any one of claims 2 to 4 in which the resiliently compressible member (6) is of elastomer.
6. A fairing construction according to any one of the preceding claims in which the outer fairing face (7) is fixed on the compression means (3) at plural longitudinally-spaced fixing locations, and has independently deformable regions between said fixing locations.
7. A fairing construction according to any one of claims 2 to 5 in which the outer fairing face (7) is fixed at a longitudinally intermediate outward projection (61) of the resiliently compressible member (6), and has independently deformable regions to either longitudinal side of said projection (61).
8. A fairing construction according to any one of claims 2 to 7 in which the outer fairing face (607) is integral with the resiliently compressible member (306).
9. A fairing construction according to any one of the preceding claims in which the guide means comprises plural peripherally-spaced guide assemblies (8).
10. A fairing construction according to claim 9 in which each guide assembly (8) comprises an extensible portion (83) having extensional movement constrained to the longitudinal direction.
11. A fairing construction according to claim 10 in which the extensible portion (83) has a lazy-tongs construction.
12. A fairing construction according to any one of the preceding claims in which the compression means comprises first and second longitudinally separable compression elements (8) connected by the guide means (8).
13. A fairing construction according to any one of claims 1 to 11 in which the guide means compris-

es first and second longitudinally separate guide sections (108) connected by the compression means (203).

- 14.** A vehicle having plural cars (1) coupled together in a longitudinal direction, and a fairing construction (2) according to any one of claims 1 to 13 connected between the opposed end peripheries of adjacent cars.
- 15.** A vehicle according to claim 14 which is a railway vehicle.
- 16.** A vehicle according to claim 14 or claim 15 in which part of the weight of the fairing construction (2) is supported by suspension members (9) connected between end walls (1a) of the cars (1) and longitudinally intermediate portions (5) of the fairing construction (2).
- 17.** A vehicle according to any one of claims 14 to 16 in which the outer fairing face (7) of the fairing construction (2) is flush with the outer periphery of the cars (1).
- 18.** A vehicle according to any one of claims 14 to 17 in which a high-voltage cable (20) extends between adjacent cars (1) inwardly of the fairing construction (2).
- 19.** A vehicle according to any one of claims 14 to 18 in which the fairing construction (2) extends around at least the sides and top of the end peripheries of the cars (1).

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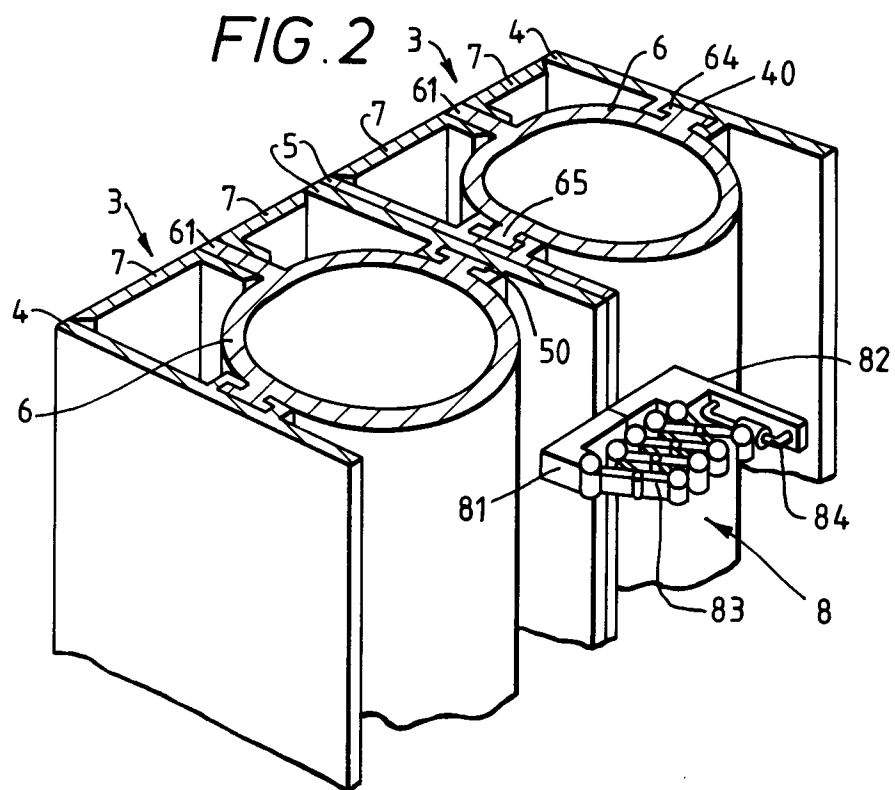
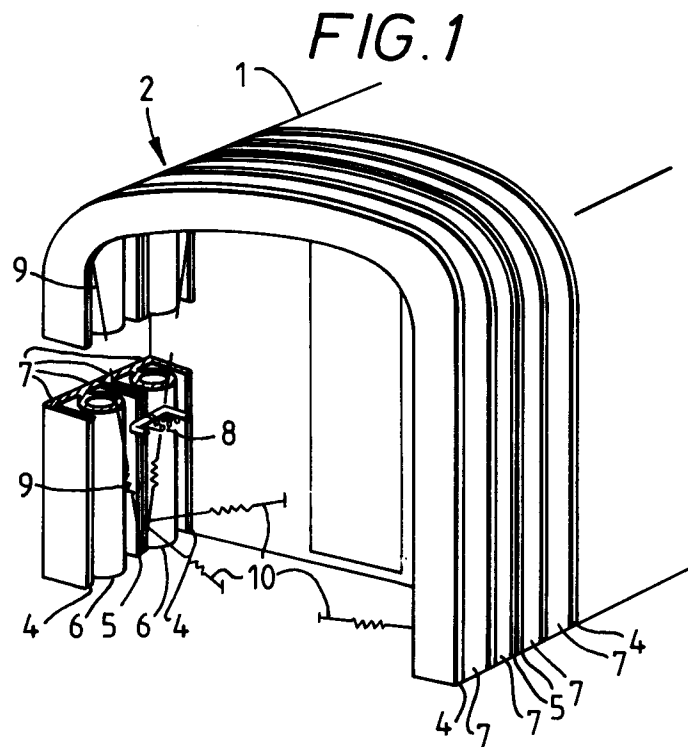
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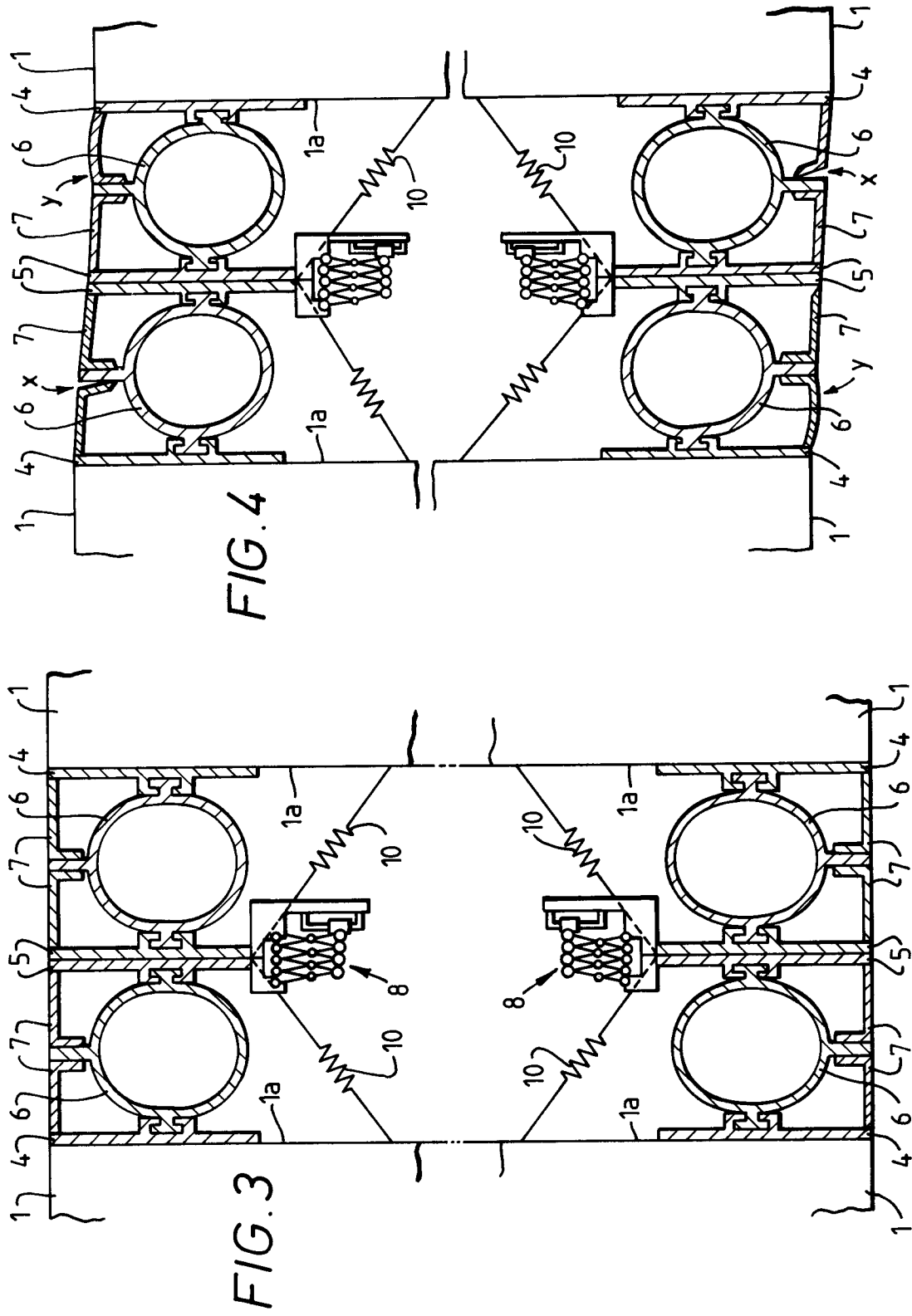
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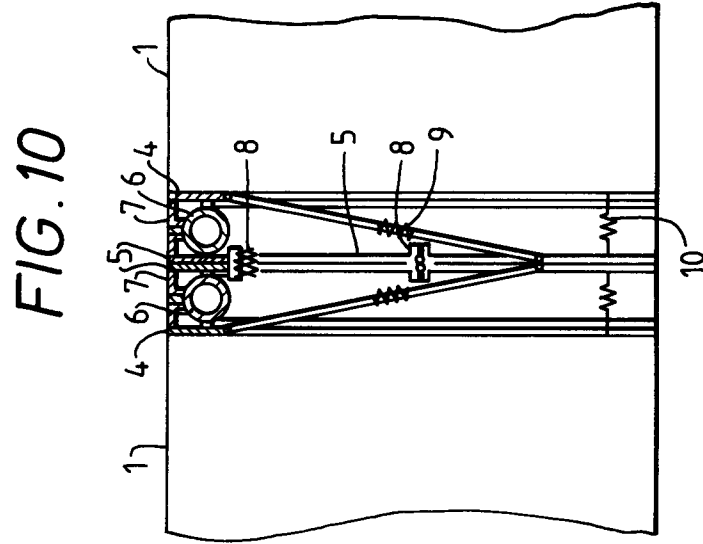
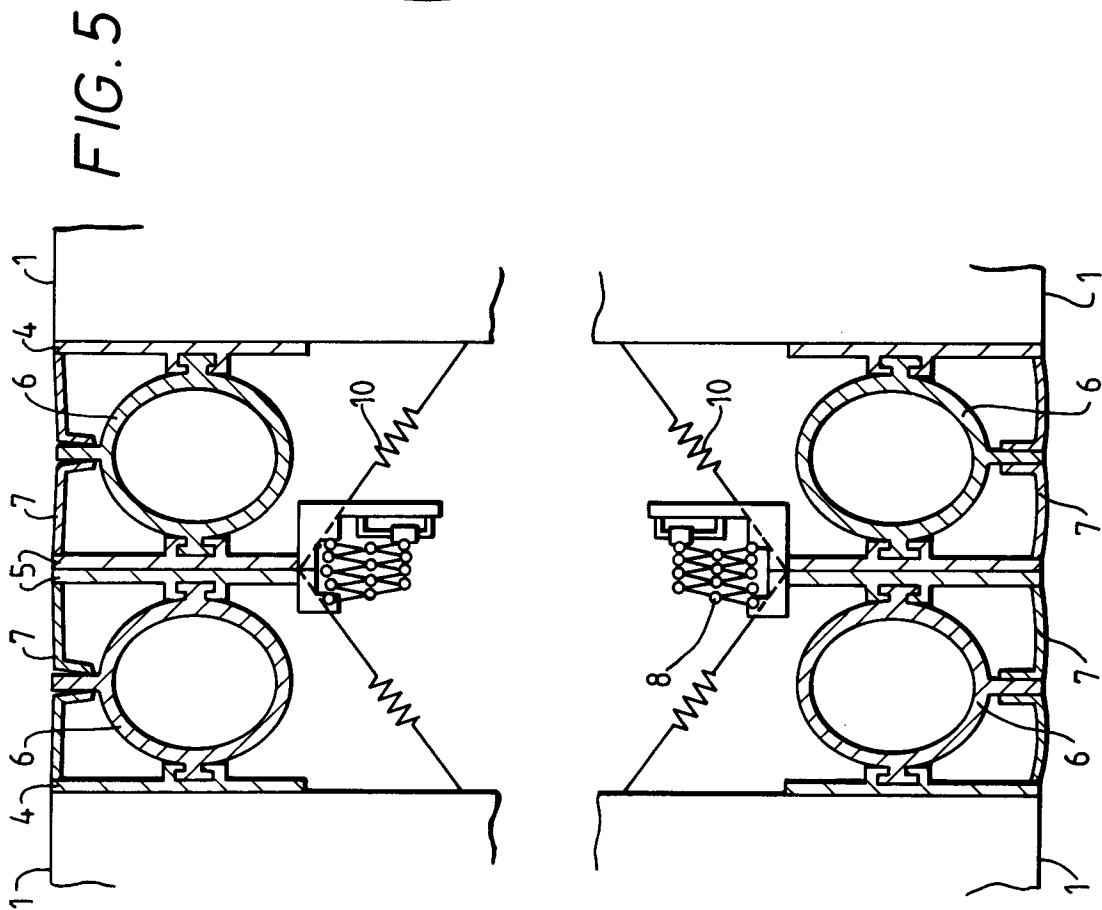
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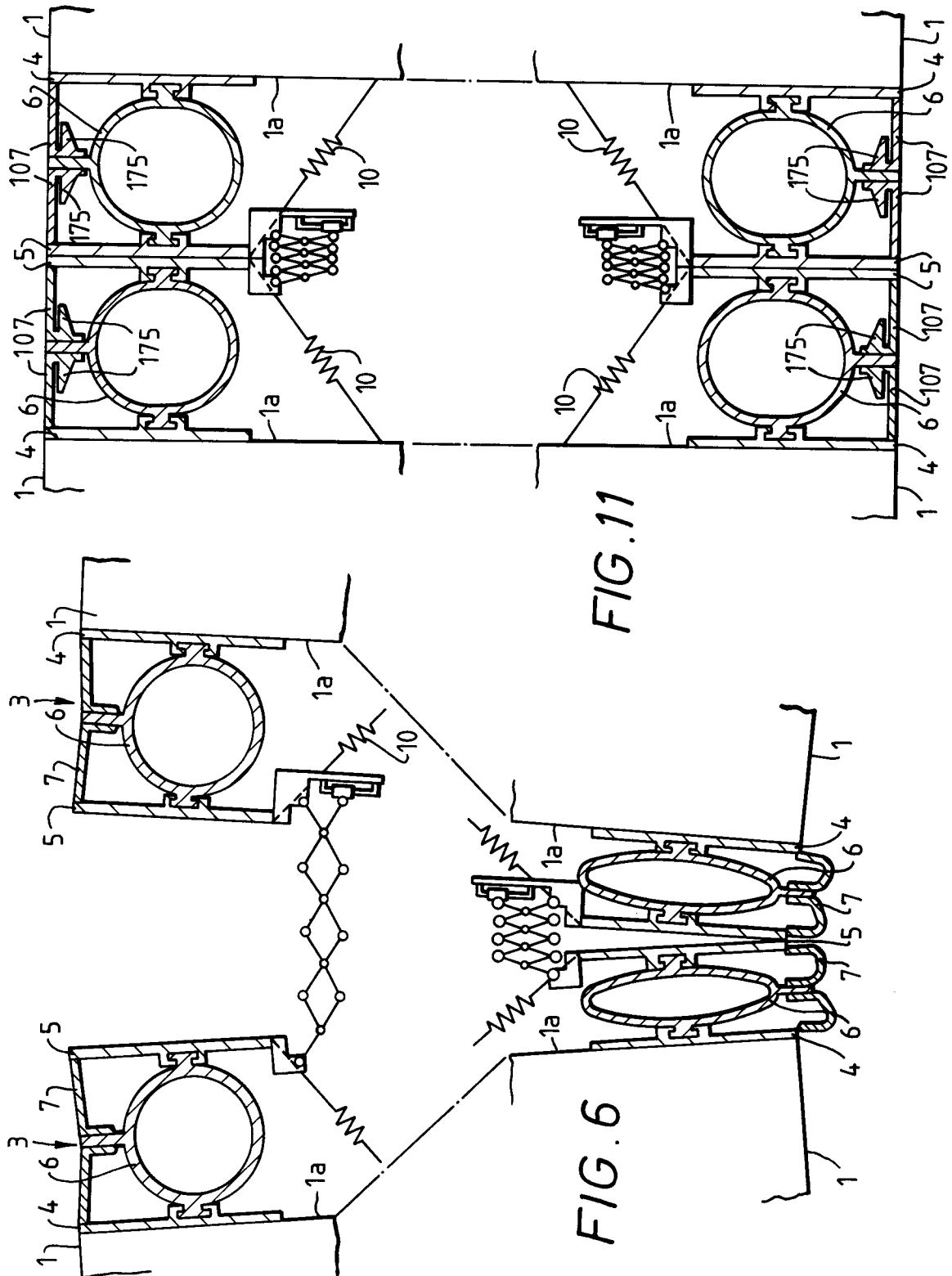
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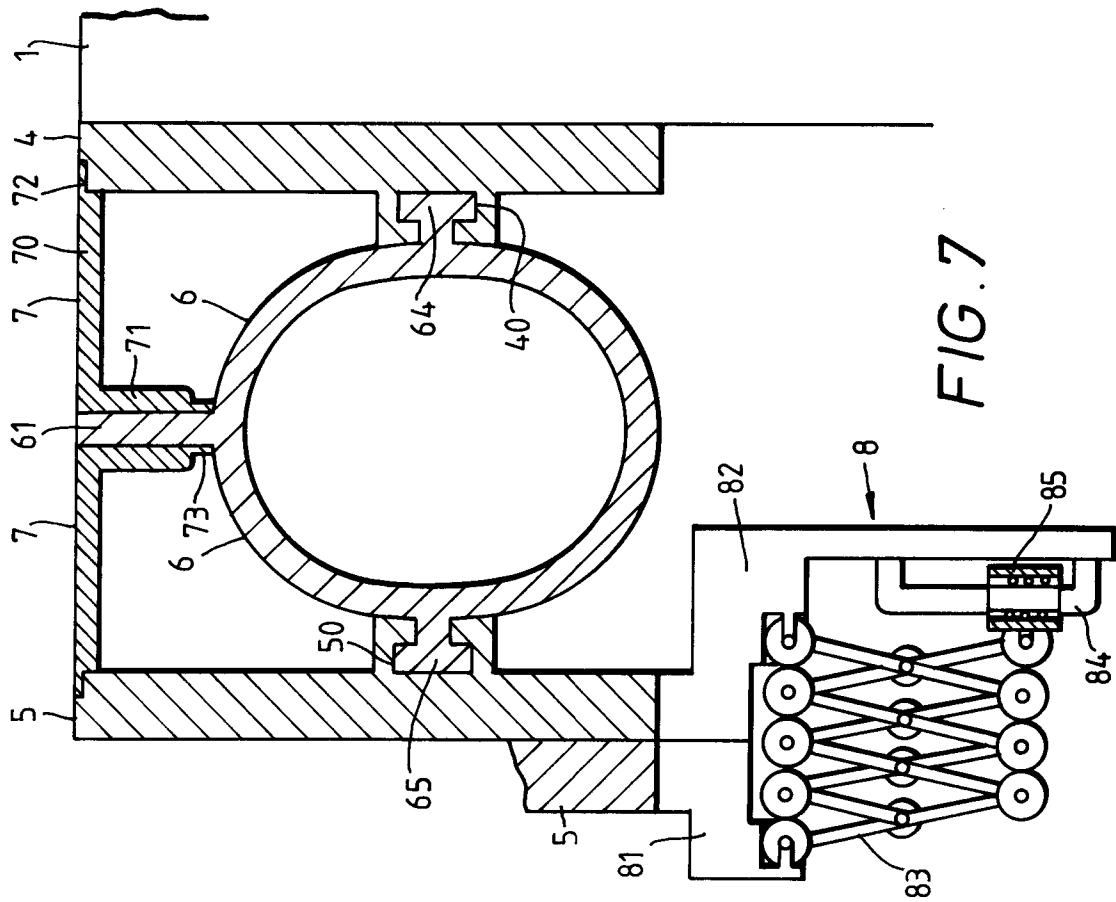


FIG. 8

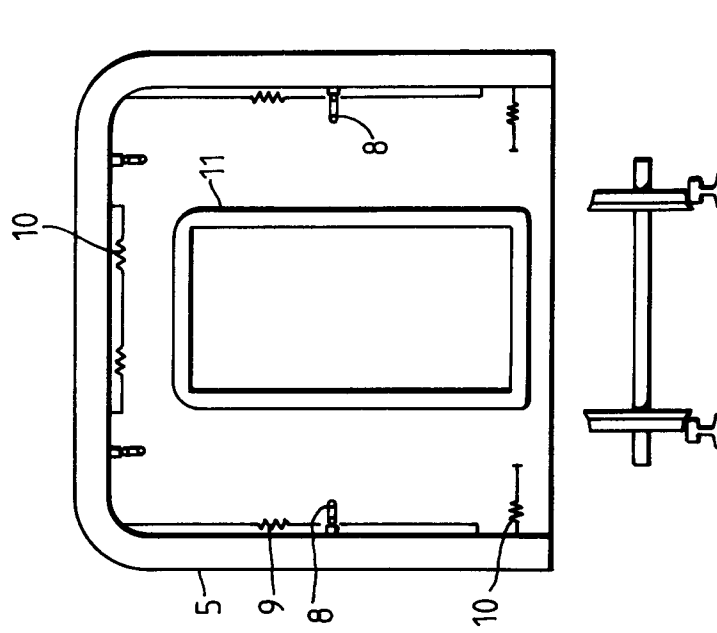


FIG. 9

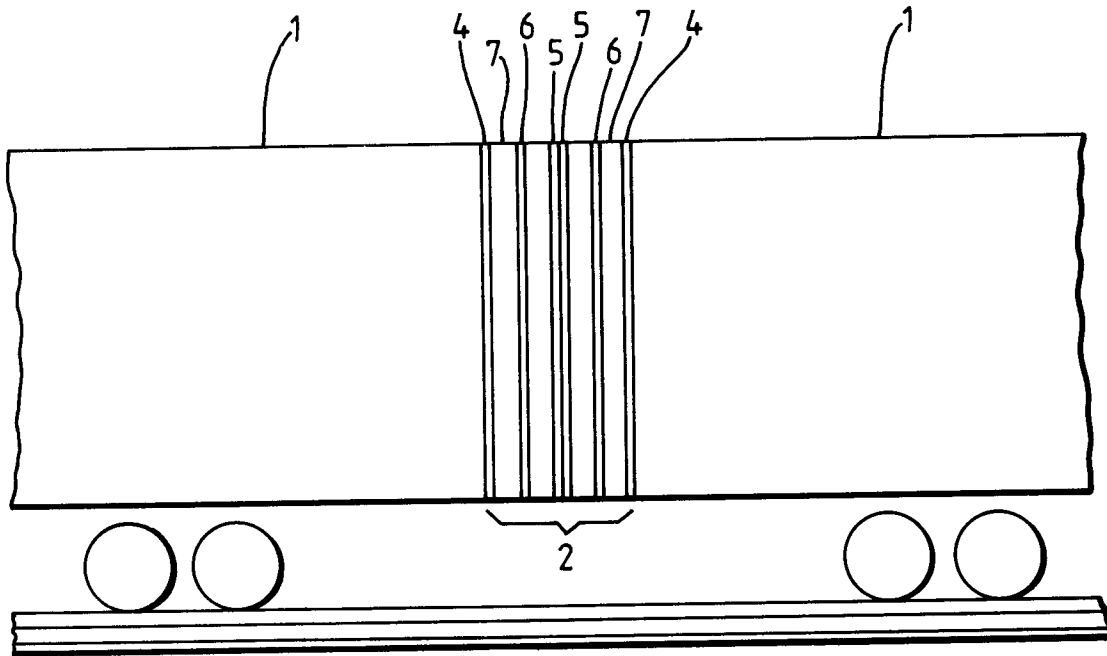
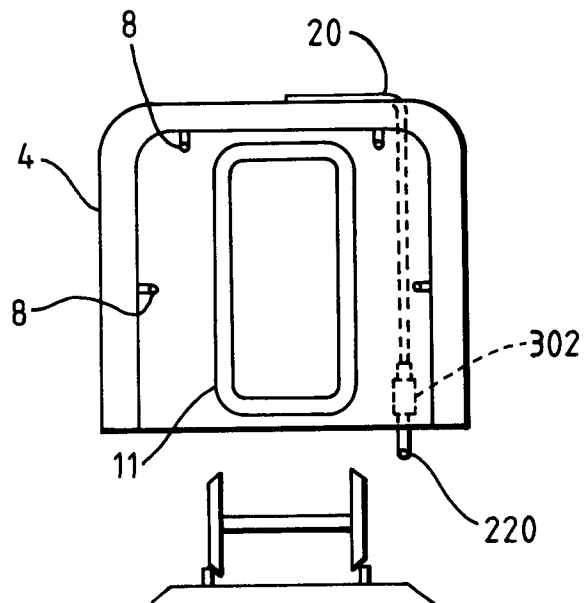


FIG. 37



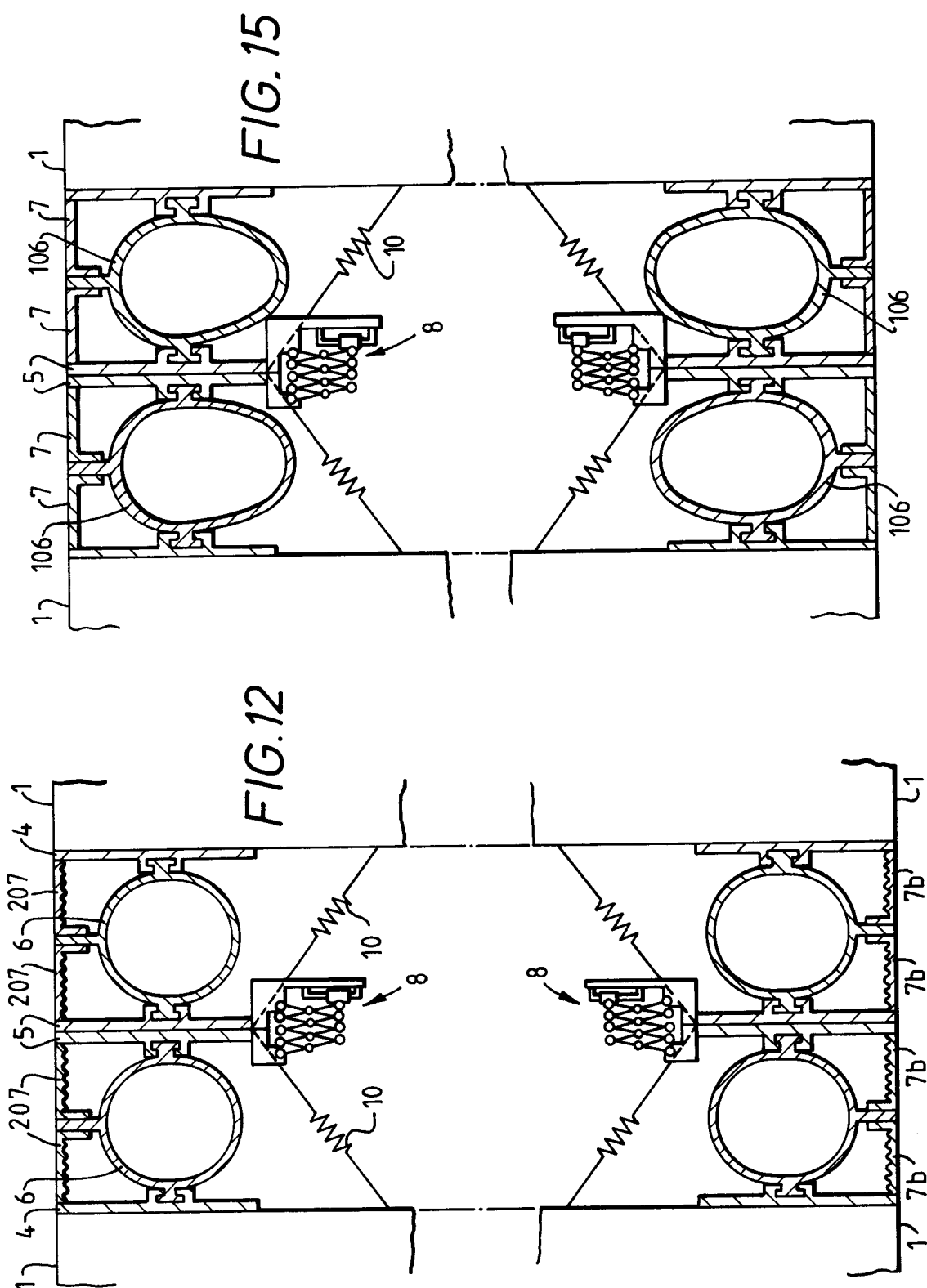


FIG.13(a)

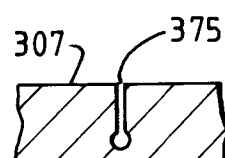
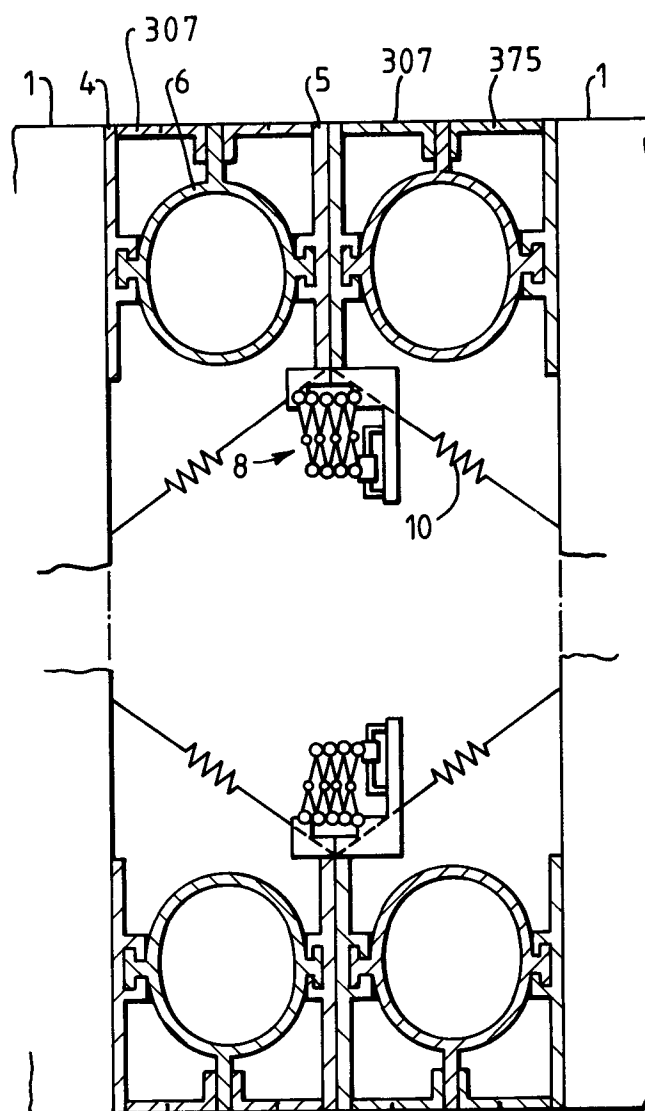


FIG.13(b)

FIG.14(a)

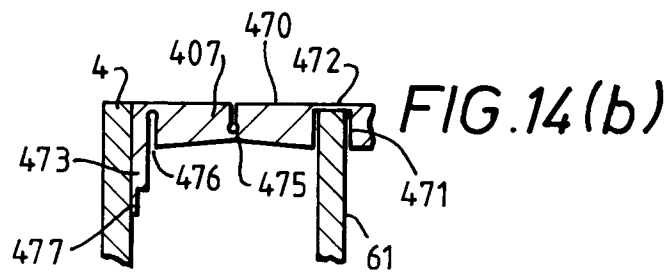
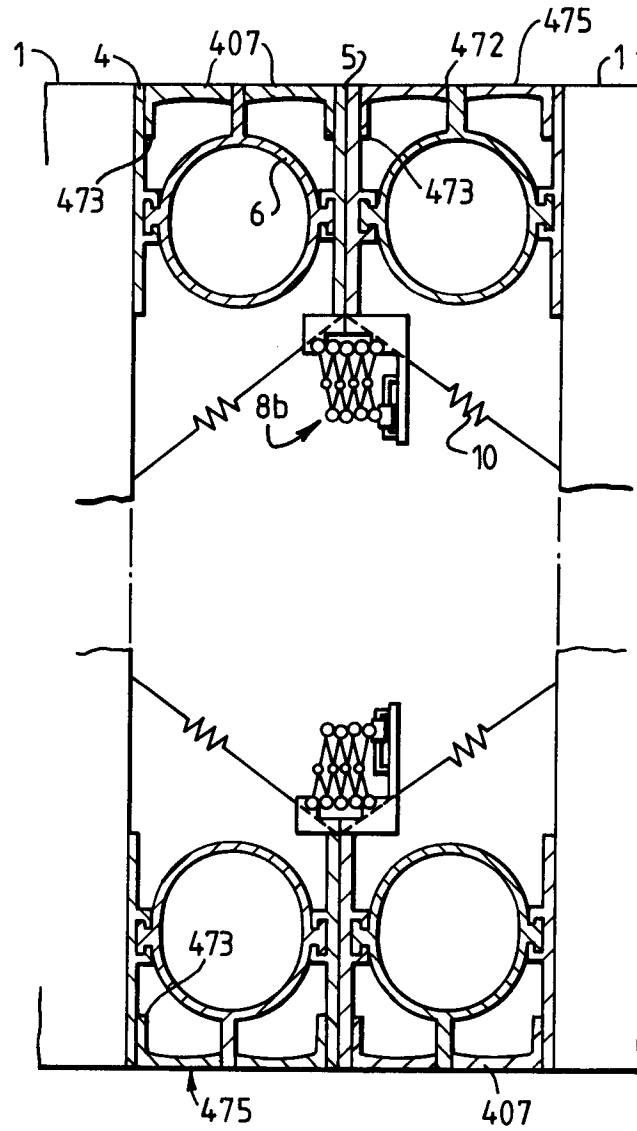


FIG. 16

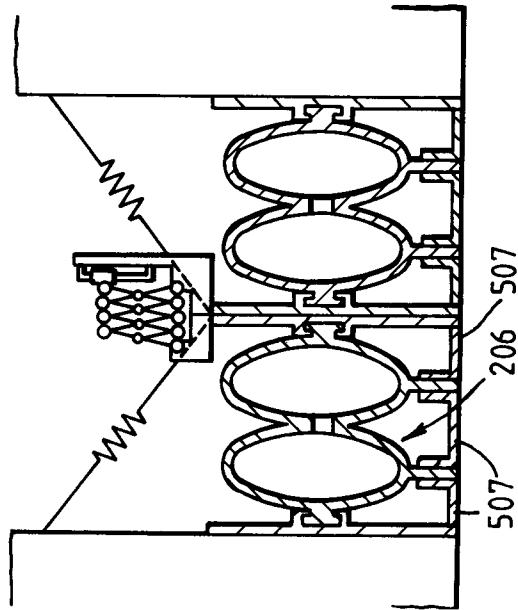
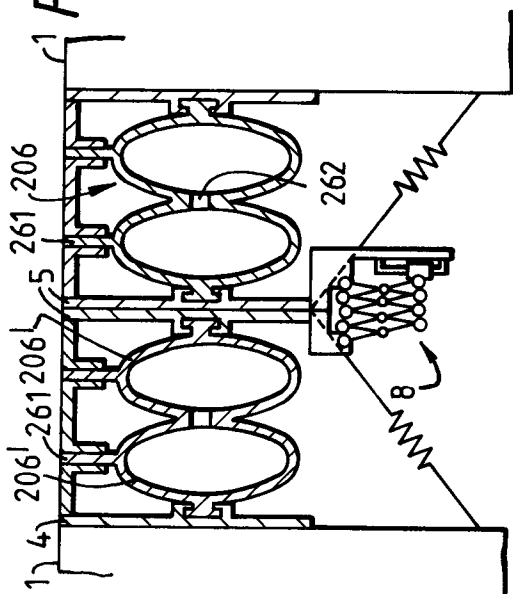
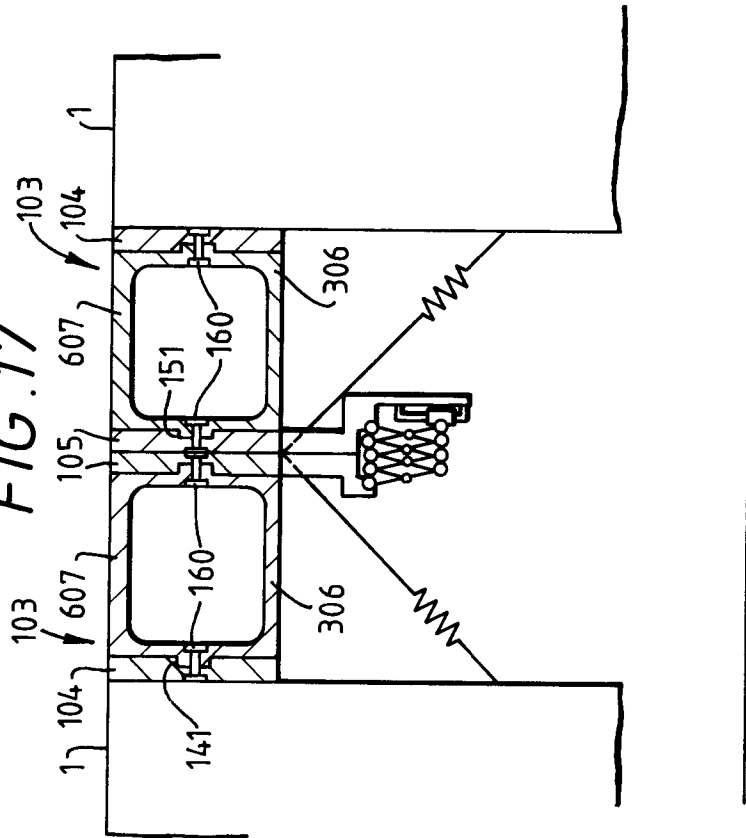


FIG. 17



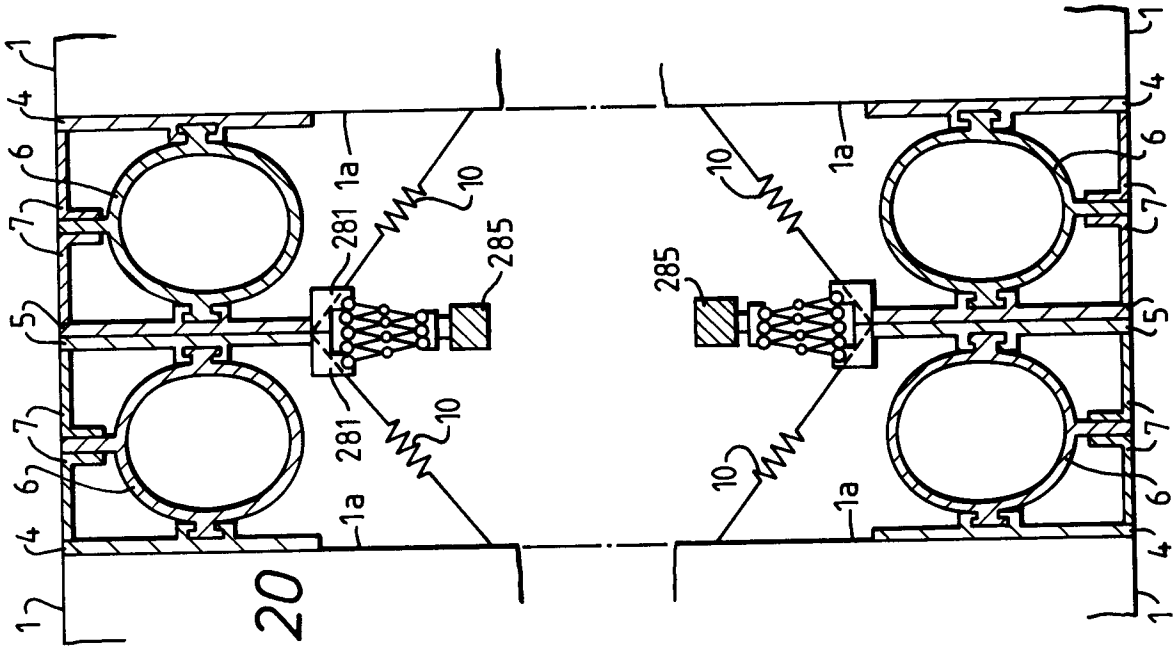


FIG. 20

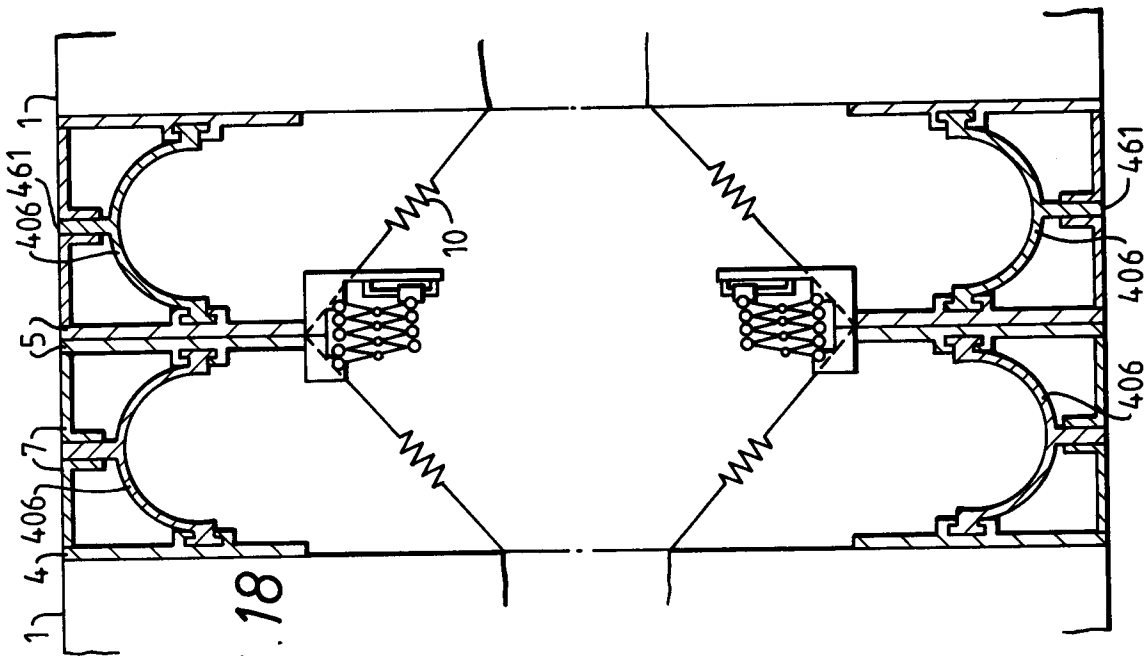


FIG. 18

FIG. 19

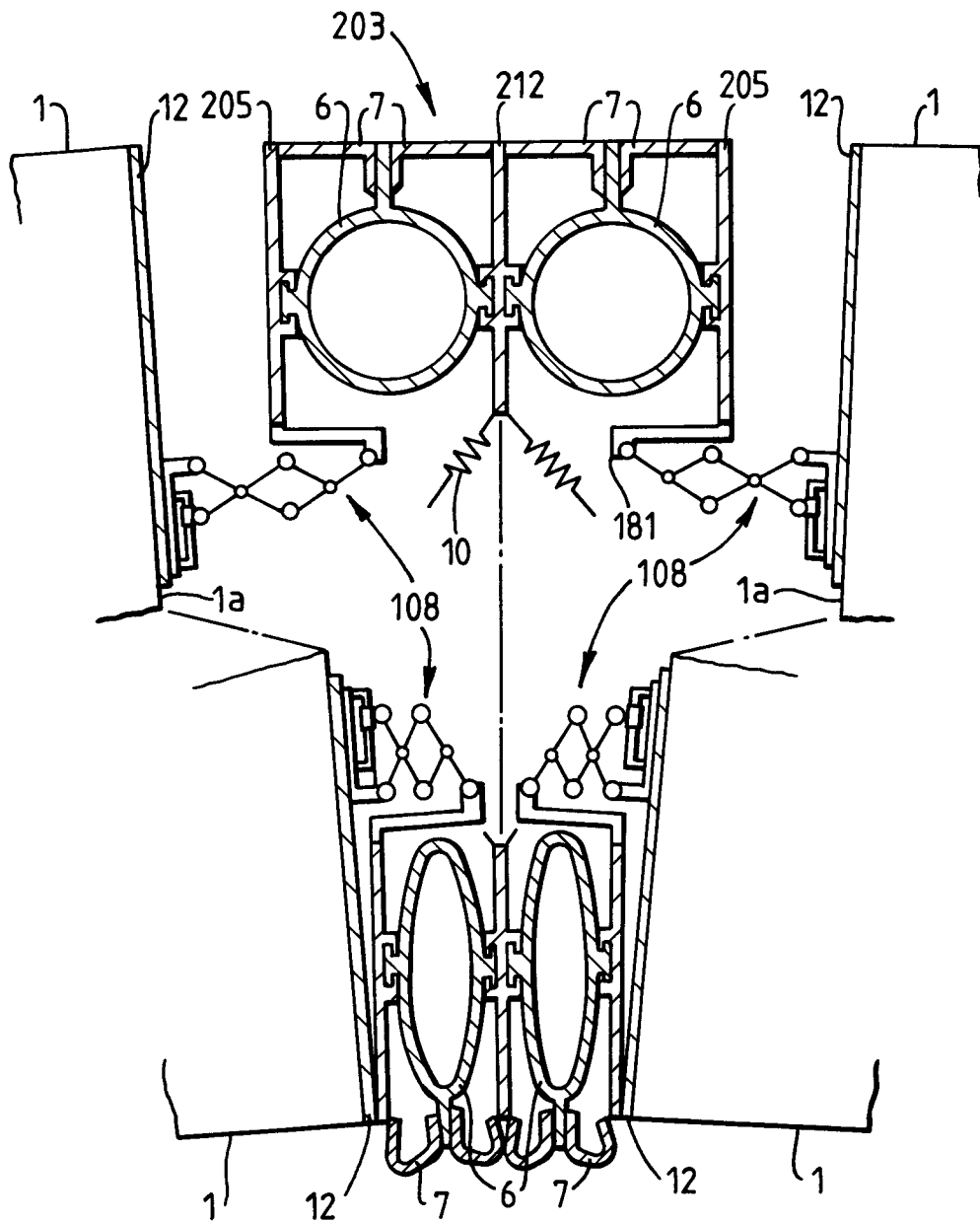


FIG. 21

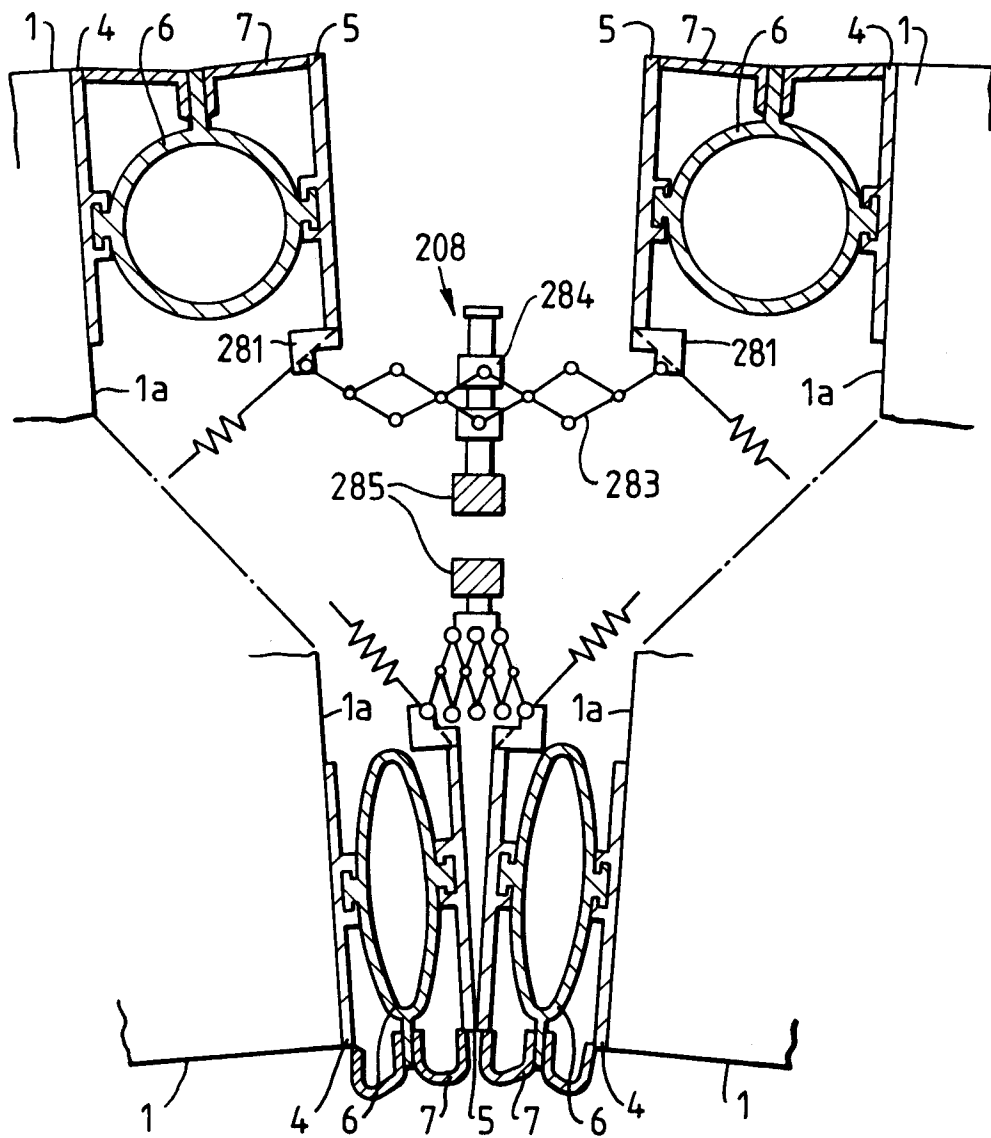


FIG. 22

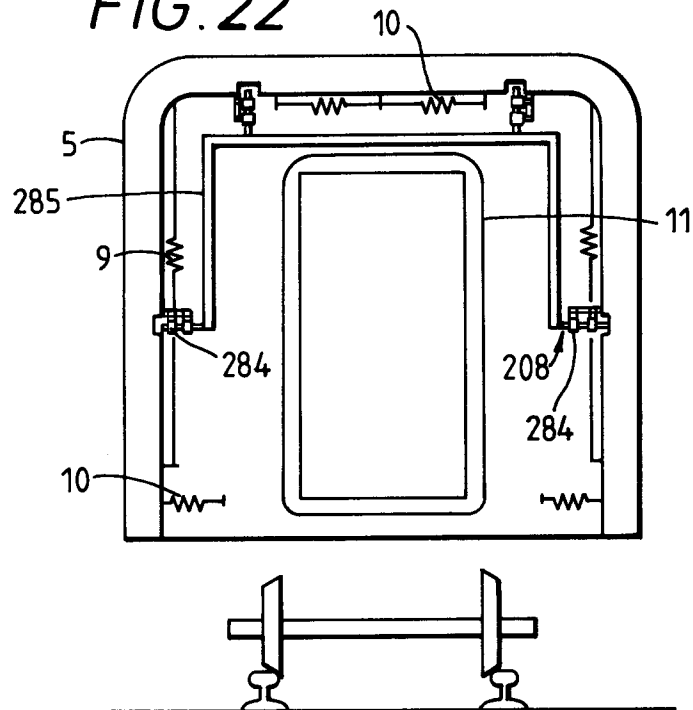


FIG. 23

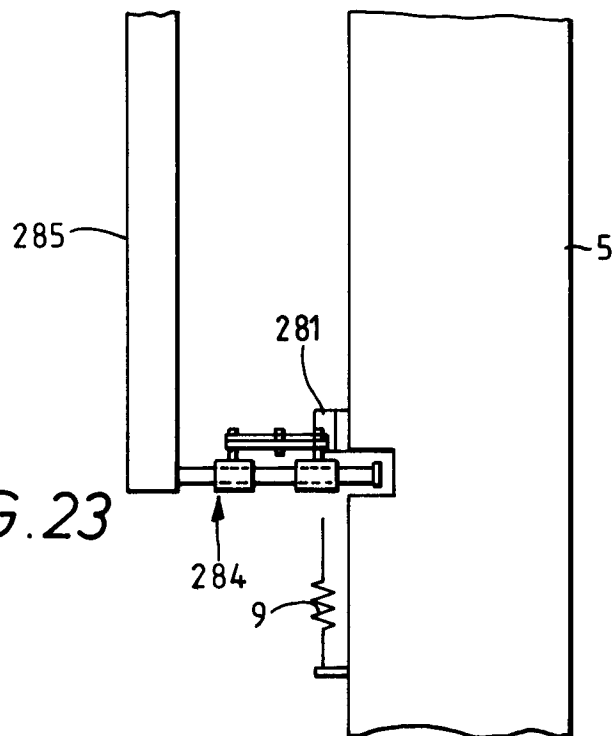


FIG. 24

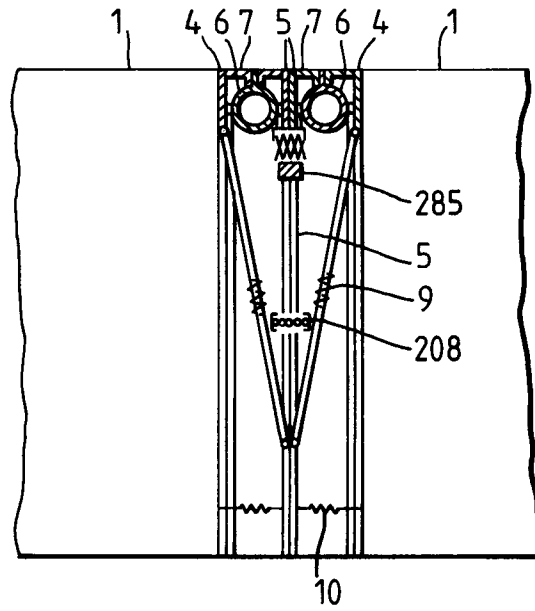
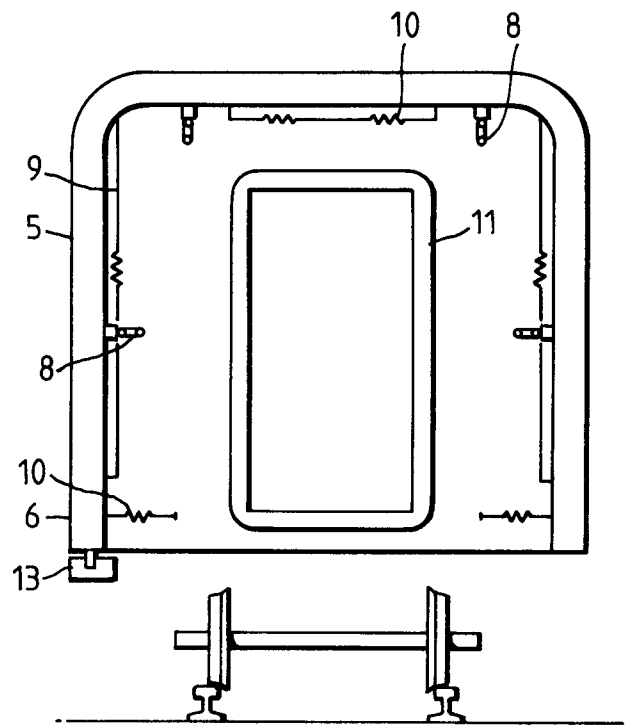


FIG. 25



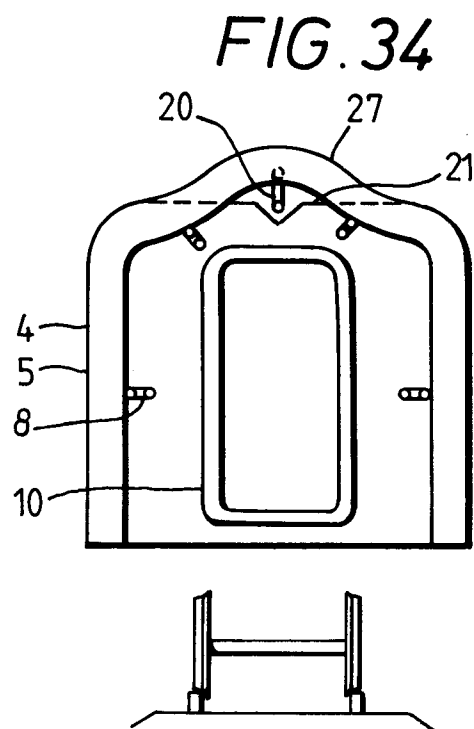
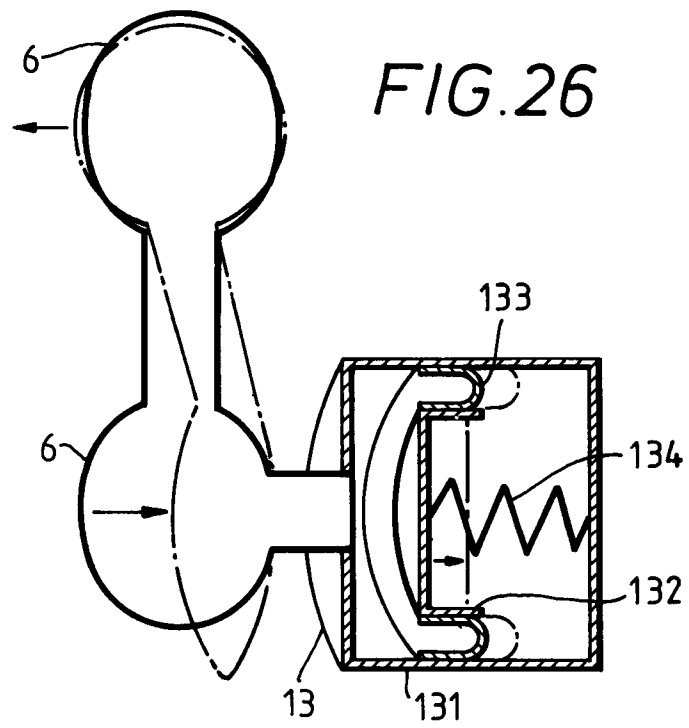


FIG. 27(a)

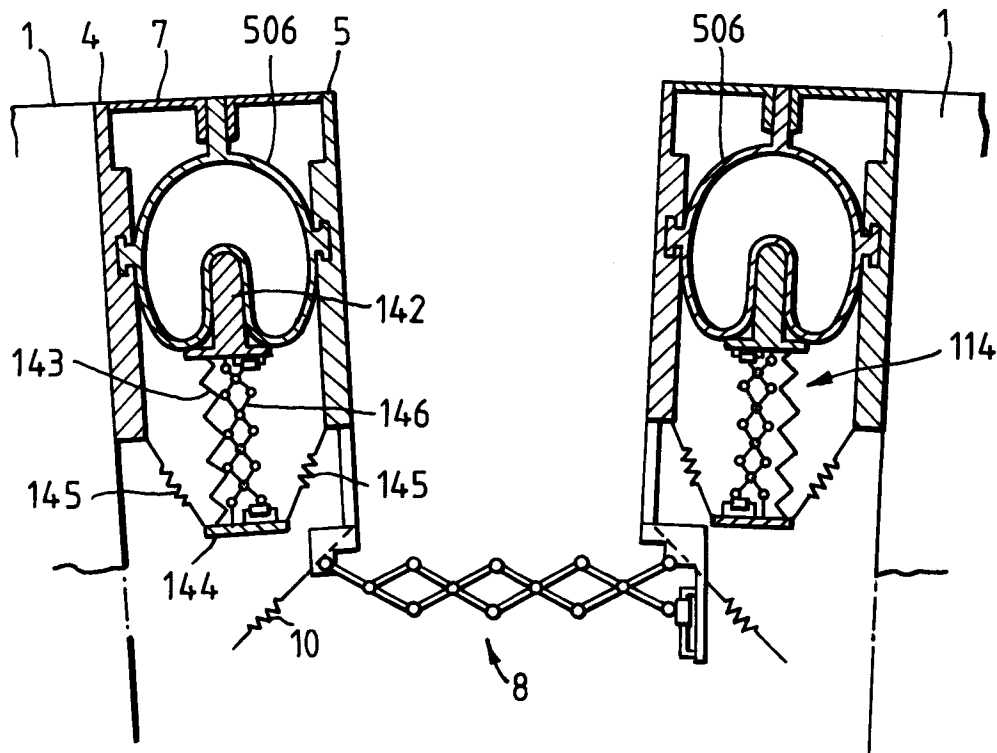


FIG. 27(b)

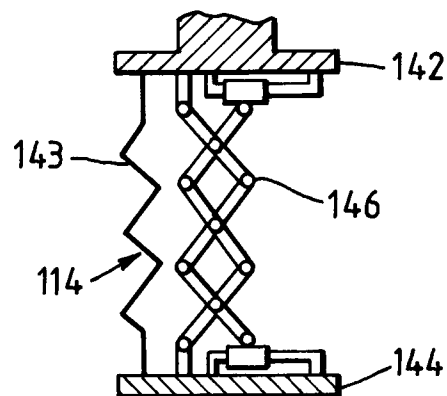


FIG. 28(a)

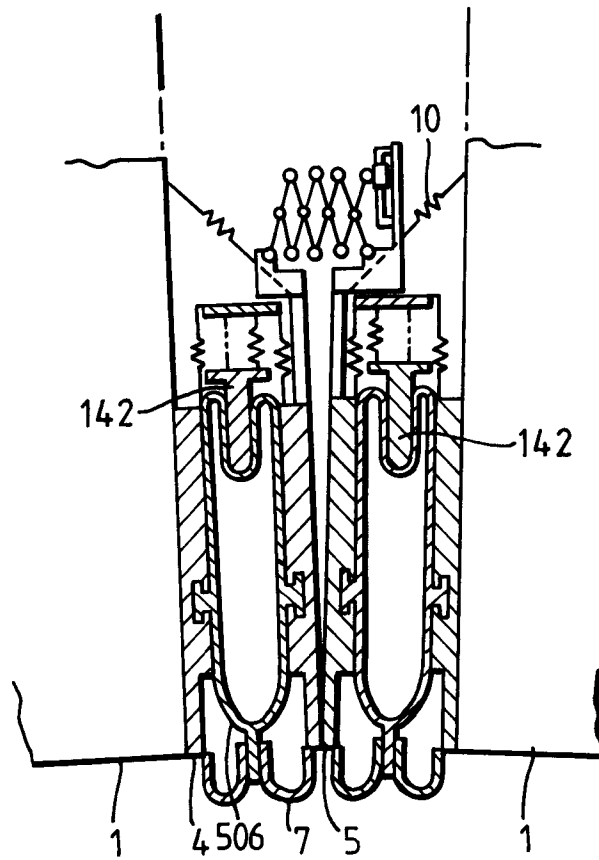
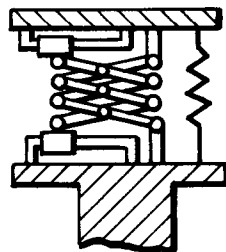


FIG. 28(b)



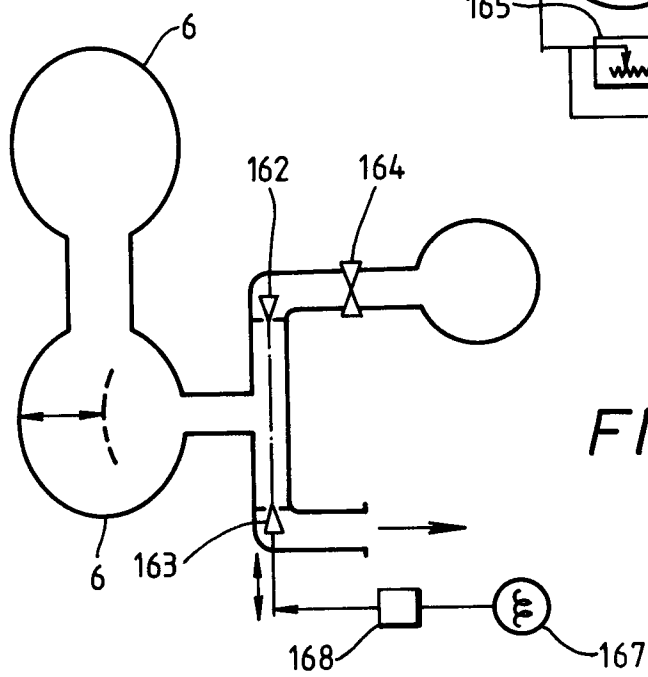
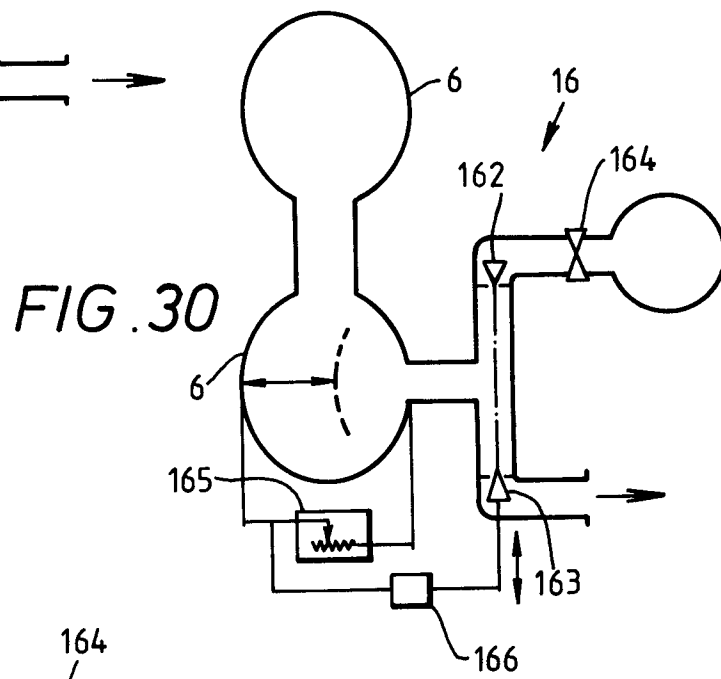
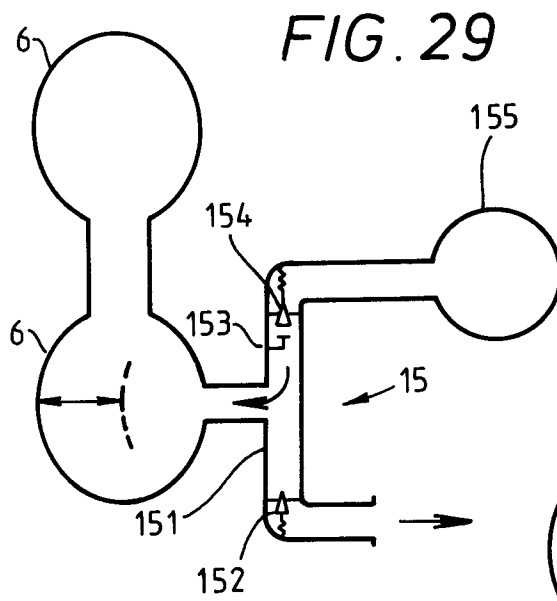


FIG. 32

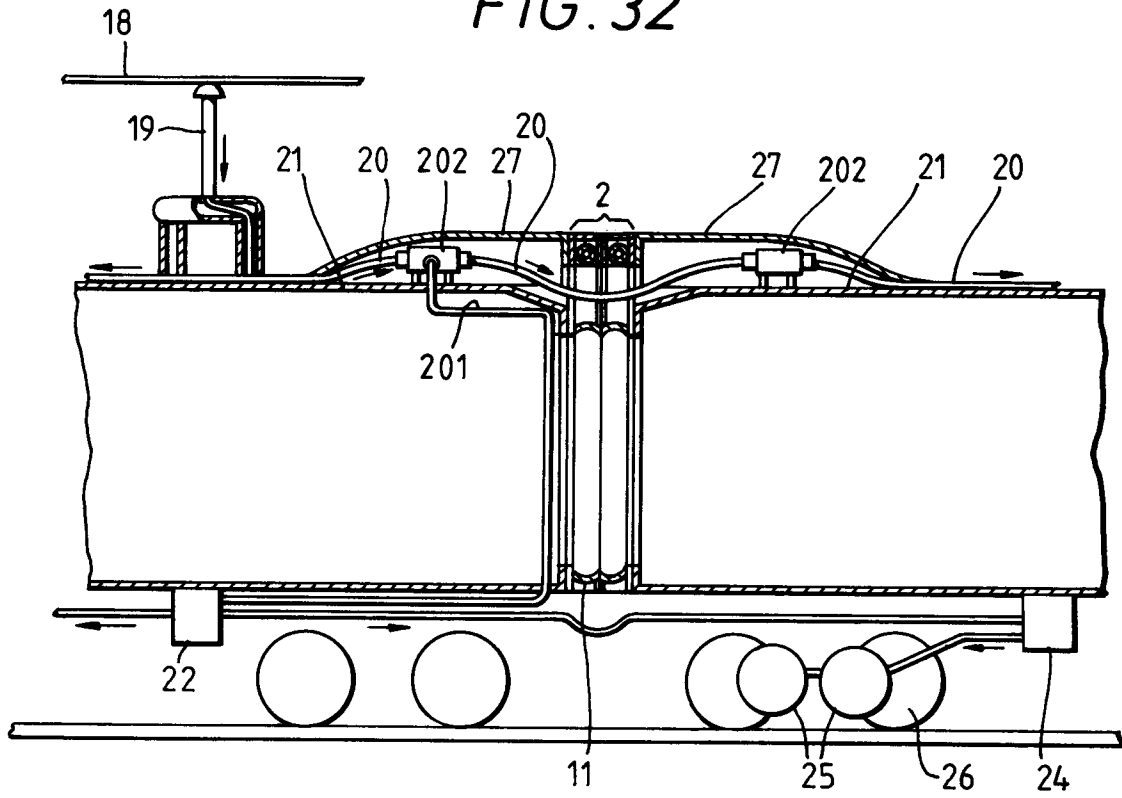


FIG. 33

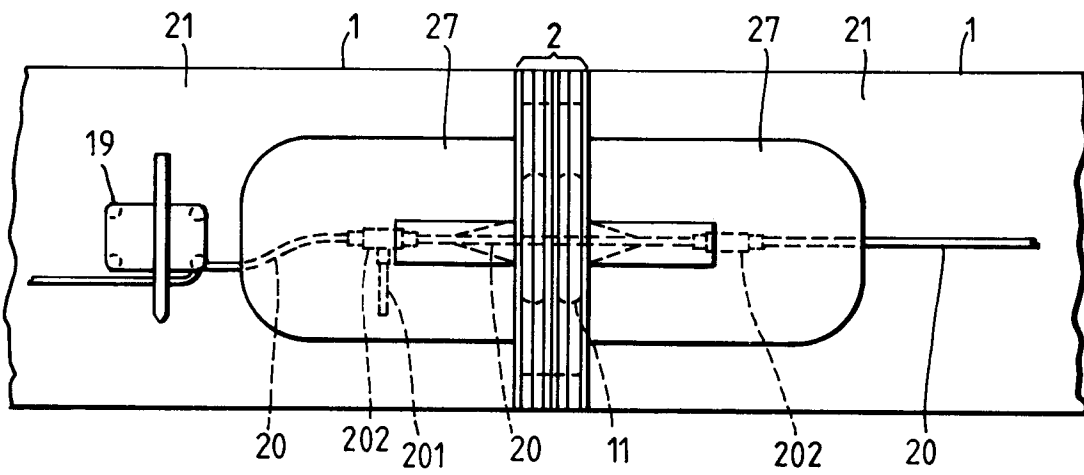


FIG. 35

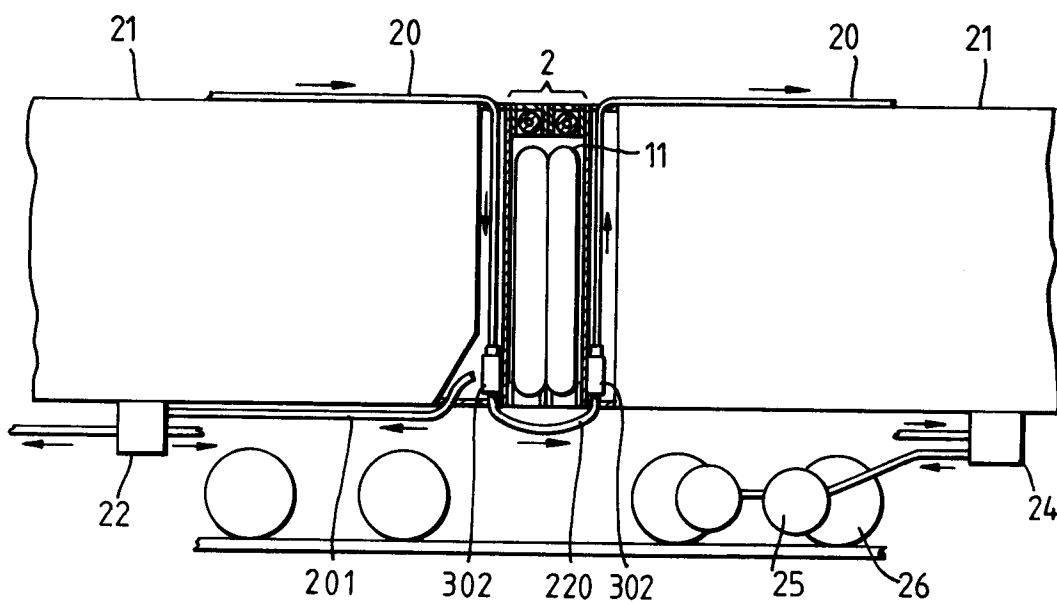
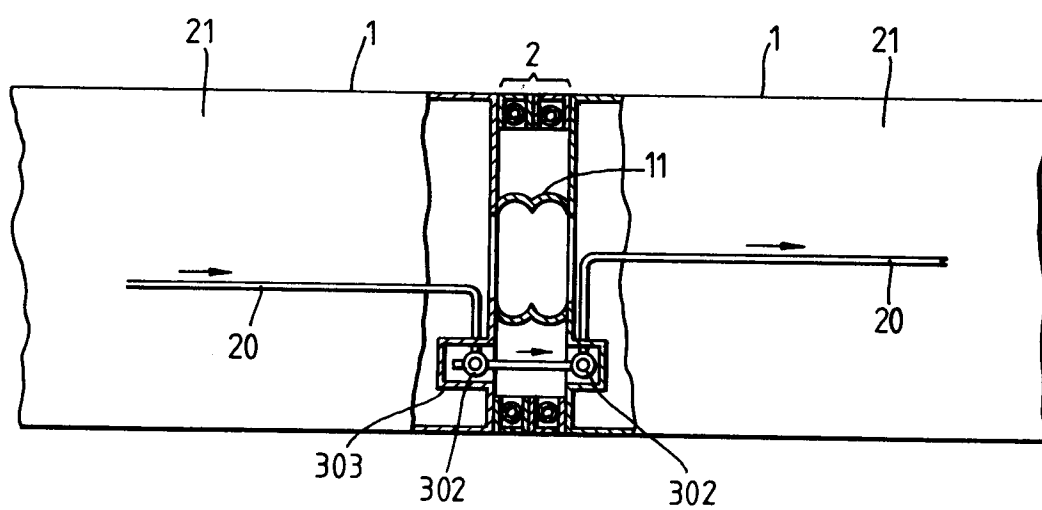


FIG. 36





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 30 1365

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE-A-1 455 082 (VEB WAGGONBAU AMMENDORF) * page 4, line 10 - page 5, line 9; figures 1-3 *	1,14	B61D17/22

A	DE-A-2 817 739 (WALTER VETTER GMBH) * page 6, line 1 - page 7, paragraph 2; figures 1-4 *	1,14	

A	DE-A-3 032 759 (D. HAFFER) * page 14, paragraph 5 - page 17, paragraph 3; figures 1-10,14 *	1,14	

A	FR-A-2 573 714 (FAIVELEY ENTREPRISES) * page 4, line 28 - page 5, line 26; figures 1-4 *	1,14	

			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B61D B60D B62D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 01 JUNE 1993	Examiner P. CHLOSTA
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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