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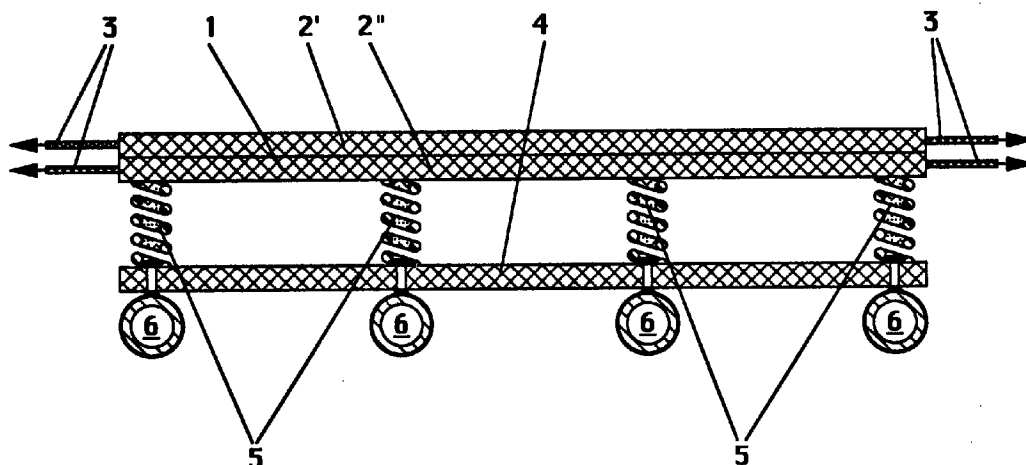
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(54) Guard-rail fitted with elastic structures

(57) A guard-rail consisting of elastic structures comprises an elastic rail (1) consisting of two superimposed layers (2',2'') of rubber and steel; the superimposed layers (2',2'') are tensile stressed by steel tie-rods (3); the rail (1) is connected to a supporting structure (4) by compression springs (5) located at suitable distances; the supporting structure (4) is elastic and sup-

ported by piers (6) of steel or reinforced concrete driven into the soil at the sides of the road edges; the piers (6) are connected to the supporting structure (4) by elastic connections; each pier (6) is associated with one compression spring (5).

Fig.1



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Description

PRESENTATION OF THE INVENTION

The present invention relates to a guard-rail consisting of elastic structures; essentially, this guard-rail comprises a plurality of elastic rails of rubber and steel which can be disposed at the sides of the road edges to hold and straighten the trajectory of the vehicles coming out of the carriageway accidentally.

STAND OF THE TECHNIQUE

The guard-rails of known type consist of fixed rails or rigid palings of steel or cement. The rails are supported by supporting piers or basements connected to the rails by connections or plates; the rails consisting of one or more shaped plates of cement, reinforced concrete or metal. The supporting piers or basements, disposed at regular distances, are of treated wood, shaped steel or reinforced concrete.

The connections consist of bolts; the axes of the rails are disposed at the same height of the centre of gravity of the more common auto-vehicles, therefore, the height of the supporting piers must be adequate to the height of the axe of the rails.

Along a road the guard-rails must be disposed always at the same distance from the edge of the road pavement and the rail must be located at a constant height.

Substantially, the known guard-rails present the following drawbacks:

1- The rigid rail takes up the thrust of a small part of the kinetic energy of the vehicle which impacts against the rail; for this reason, the rigid rail repels the vehicle towards the carriageway centre. The main danger due to the rebound of the vehicle is that other vehicles running in the same carriageway can collide with the re-bounded vehicle.

2- The part of the kinetic energy of the vehicle taken up by the rail is dissipated in a very small fraction of second; therefore, the vehicle and the passengers are stressed by a deceleration which is a very high multiple of the acceleration of gravity; the consequences of this deceleration are fractures and often deadly wounds and huge damages for the vehicle.

3- The rigid rail stressed by the impact of the vehicle takes up the thrust of a part of the kinetic energy or transmits it to the supporting piers or connections; therefore, an impact against a traditional guard-rail can be the cause for the breaking of the rail, the supporting piers or the connections; the most serious consequence of the breaking of the rail is that, after the impact, the vehicle is not controlled by the same rail and continues its run out of

the carriageway or in the opposite carriageway.

AIM OF THE INVENTION

The main purpose of this invention is to remedy these disadvantages. The invention, as claimed, solves the problem of creating a guard-rail fitted with elastic structures; the guard-rail actually taking up the thrust of all the kinetic energy of the vehicle; therefore, the impact against this guard-rail is not the cause for the rebound of the vehicle towards the carriageway, in addition, the impact does not set the vehicle in motion with a deceleration the value of which is a very high multiple of the acceleration of gravity.

The advantages offered by the invention mainly consist of the fact that the rail stressed by the impact of the vehicle transmits the energy to the supporting piers by elastically yielding connections avoiding the breaking of the rail, the supporting piers or connections; after the impact, the vehicle is controlled by the rail, it stops in a non infinitesimal time and, therefore, it does not continue its run out of the carriageway.

The guard-rail according to the present invention comprises a rail, supporting piers or basements and connecting elements to connect the supporting piers or basements to the rail, so that the rail is maintained in a vertical lying; the rail consist of one or more superimposed layers of an elastic material; the layers are tensile stressed by steel tie-rods housed inside the layers; the free ends of the steel tie-rods are fixed to the connecting elements and the steel tie-rods slide inside the layers; the connecting elements consist of elastically yielding structures cooperating with the tie-rods in order to reestablish the vertical lying of the guard-rail at the end of a pre-established time beginning with the impact of a vehicle against the rail.

In addition, guiding means are provided in the layers to obtain the sliding of the tie-rods inside the relevant layer; the sliding is due to the contraction or expansion of the tie-rods owing to temperature changes or forces induced on guard-rail by an impact of a vehicle; the sliding allows the tie-rods to be maintained parallel one another during the temperature changes or during and after an impact.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages, details and salient features will be outlined in the following description of preferred embodiments of the guard-rail, with reference to the accompanying drawings which demonstrate:

Fig.1 represents a top view of a first embodiment of the guard-rail;

Fig.2 represents a top view of a constructive detail of the guard-rail of Fig.1;

Fig.3 represents front view of the constructive detail of Fig.2 in enlarged scale;

Fig.4 represents a top view of a second embodiment of the guard-rail;

Fig.5 is a front view of a pier connected to the tie-rods of the elastic rail by extension springs;

Fig.6 represents a top view of a road layout controlled by guard-rails according to the present invention;

Fig.7 is a schematic representation of an elastic rail of the guard-rail according to the present invention;

Fig.8 is a schematic view of the rail of Fig.7;

Fig.9 is a side view of a constructive detail of the rail of Fig.7;

Fig.10 represents a schematic top view of a third embodiment of the guard-rail;

Fig.11 represents a top view of a fourth embodiment of the guard-rail;

Fig.12 represents a side sectional view of the guard-rail of Fig.11;

Fig.13 is an example of the curve of the variation of the speed in function of the time during an impact of a vehicle against a guard-rail according to the present invention;

Fig.14 is an example of the curve of the variation of the position of the vehicle in function of the time after the impact of a vehicle against the guard-rail.

Fig.15 represents a top view of a fifth embodiment of the guard-rail;

Fig.16 represents a side sectional view of the guard-rail of Fig.15.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

The guard-rail represented in Fig.1 essentially comprises an elastic rail 1 consisting of two superimposed layers 2', 2" of rubber and steel; the superimposed layers 2', 2" are tensile stressed by steel tie-rods 3; the rail 1 is connected to a supporting structure 4 by compression springs 5 located at suitable distances; the supporting structure 4 is elastic and supported by piers 6 of steel or reinforced concrete, driven into the soil at the sides of the road course. The piers 6 are connected to the supporting structure 4 by the elastic connections

represented in Fig.2. Each pier 6 is associated with one compression spring 5.

Fig.2 represents an elastic connection between the piers 6 and the supporting structure 4; essentially, this elastic connection consists of a band of rubber 7; a first part 8' of the band 7 embraces the pier 6; a second part 8" crosses a hollow 9 in the supporting structure 4; the second part 8" being fixed and tensile stressed by a wedge 10. A covering 11 is used for protection of the wedge 10 and the second part 8".

As shown in Fig.3, the second part 8" of the band 7, which forms a loop inserted into the hollow 9, presents a hole 12 into which the wedge 10 is introduced.

The guard-rail of Fig.4 is particularly suitable for constituting the traffic divider between the two opposite carriageways of a freeway or motorway. In practice, the guard-rail according to this embodiment is identical to the guard-rail of the embodiment shown in Fig.1, with the exception that it presents two supporting structures 4', 4", two series of compression springs 5', 5", and two elastic rails 1', 1". The first supporting structure 4' is symmetric to the second supporting structure 4" with respect to the piers 6; an identical symmetry is provided for both series of compression springs 5', 5" and both elastic rails 1', 1".

The pier 16 of Fig.5 is connected to the tie-rods 3 of the elastic rails 1', 1" by the extension springs 17 which act on the steel tie-rods 3 in order to maintain tensile stressed the rails 1', 1" for supporting the same loaded by the dead load. The abutments connecting the steel tie-rods 3 to the extension springs 17 are of known type, therefore, they are not of interest for this description. The number of the steel tie-rods 3 is chosen in order to maintain the elastic rails 1', 1" stressed with uniform tension in their vertical and horizontal dimensions.

A not shown analogue embodiment is used for connecting the rail 1 to the tie-rods 3 of Fig.1 by the piers 6.

The road layout of Fig.6 is a hairpin of a race-track; the carriageway 13 of the road is divided to three lanes; a first rail 1' is located at the sides of the external edges of the carriageway 13; near the hairpin a second rail 1" is provided to avoid the opposite carriageway 15 from being invaded by the vehicles 14, if the same side-skid; the shapes of the rails 1', 1" used for protection of the vehicles 14 are the same as those shown in Figs 1 and 4 together with those described hereafter.

In general, the guard-rails employed in the road layout of Fig.6 are supported by the piers 6 connected to the rails 1', 1" by the compression springs 5 and by the supporting structures 4, 4'; piers 16 are also provided connected to the rails 1', 1" by extension springs 17; the extension springs 17 act on the steel tie-rods 3 to maintain the rails 1', 1" tensile stressed for supporting the same loaded by the dead load, and maintain the guard-rail in the vertical lying.

The steel tie-rods 3 consist of cables or ropes tensile stressed by the springs 17; the right positioning of the rails 1', 1" as regards their height and distance from

the sides of the road edges depends on a right extension of the springs 17; an insufficient tension is not capable of maintaining the rails 1', 1" in the right position, since this tension does not prevent the displacement of the rails owing to the dead load, wind and other atmospheric or casual agents; an excessive tension maintains the rails 1', 1" in the right position, but it makes the same excessively rigid and, therefore, dangerous for the vehicles which impact against the guard-rail

The piers 16 with the extension springs 17 are used for maintaining the sections of the rails 1, 1', 1" in the vertical lying, said sections being located at the ends of the guard-rail; in Fig.6 these ends begin or terminate with the piers 16 and the springs 17, while the piers 6 are used for supporting the sections of the rails 1, 1', 1" located between two ends of the guard-rail supported by the piers 16. Near a curve a number of piers 6 is located allowing the guard-rail to be capable of radiusing the same curve.

Fig.7 schematically shows an elastic rail 1 of the guard-rail according to the present invention; as written with reference to Fig.1, the rail 1 consists of two superimposed layers 2', 2" of rubber and steel tie-rods 3^I, 3^{II}, 3^{III}, 3^{IV}, 3^V, 3^{VI}; the tie-rods are housed inside each layer 2', 2"; the two opposite ends of each tie-rod protrude from the relevant layer 2', 2" for connecting the same tie-rods 3^I, 3^{II}, 3^{III}, 3^{IV}, 3^V, 3^{VI} to the springs 17.

As illustrated in Figs 7, 8 and 9, guiding sleeves 18^I, 18^{II}, 18^{III} are provided to obtain sliding of the tie-rods 3^I, 3^{II}, 3^{III}, 3^{IV}, 3^V, 3^{VI} inside the relevant layers 2', 2"; the sliding is due to the contraction or expansion of the tie-rods owing to temperature changes or forces induced in the guard-rail by an impact of a vehicle with the aim of maintaining the tie-rods parallel to one another during the temperature changes or during and after an impact. In this way the layers 2', 2" are not subject to the permanent deformations which may compromise the structural stability of the guard-rail.

The guiding sleeves 18^I, 18^{II}, 18^{III} are essentially shaped as a tube and are crossed by the tie-rods 3^I, 3^{II}, 3^{III}, 3^{IV}, 3^V, 3^{VI}; in addition, they are fixed to the relevant layer 2', 2" by elastic bands 19^I, 19^{II}, 19^{III}, 19^{IV}, 19^V, 19^{VI}; each of these elastic bands crosses a hollow 20 made in the layer 2', 2"; the hollow 20 is perpendicular to the tie-rod 3 housed in the layer 2', 2"; the tie-rod 3 embraces the guiding sleeve 18 which it crosses as consequence of the extension due to two wedges 21^I, 21^{II} inserted into two opposite holes provided at the two ends of each elastic band 19. The holes have the same shape as the hole 12 of Fig.3.

Fig.10 schematically represents a third embodiment of the guard-rail which presents a rail 22 consisting of one or more layers 23 of an elastic material, the layers 23 being tensile stressed by steel tie-rods 24. The shapes and the positions of the tie-rods 24 are similar, with respect to the layers which house them, to the tie-rods 3 of the previous Figures; the free ends of the

tie-rods 24 are fixed to two basements 25', 25" driven into the soil. A supporting structure 26 driven into the soil supports a plurality of hydraulic jacks 27; each jack 27 is fitted with a piston 28 connected to a push-rod 29 which presents a free end rotating around a first pivot 30 integral with the rail 22. Therefore, each jack 27 is located between the first pivot 30 and a second pivot 31 supported by the supporting structure 26 in order to maintain the guard-rail in the vertical lying.

Each jack 27 is connected to a pressure source 32 by a canalisation 33 to maintain the pressure of the working fluid at a constant value; the source 32 is connected to a central control unit 34 fitted with a timer, the central control unit 34 being capable of restoring the working of the jack 27 at the end of a pre-established period of time beginning with an impact in order to allow the guard-rail to return to the vertical lying. The structures of the guard-rail of Fig.10 are elastic, since they retake their original position at the end of said period of time.

In Fig.10 the above elements are schematically shown and without a precise reference to the true structuration of the guard-rail.

The guard-rail of Figs 11 and 12 is used for the particularly sharp curves for protection of the vehicles; this embodiment also allows a single use of this guard-rail which can be disposed as an old shoe along the road edges.

The guard-rail consists of a pier 35 driven into the soil and connected to an elastic cylindrical rail 36 located around to the pier 35; the connection between the pier 35 and the rail 36 is obtained by compression springs 37 located between the pier 35 and the rail 36; the springs 37 are also used for maintaining the shape of the rail 36 cylindrical.

The length of the springs 37 is so chosen that the vehicle is protected by this guard-rail, since, after the impact, the rail 36 deforms elastically in a time sufficiently slow as to avoid decelerations much higher than the acceleration of gravity.

Fig.13 indicates the variation of the speed as a function of the time during the impact of a vehicle against a guard-rail; the curve was obtained by elaborating experimental data verified by means of tests of impact.

The speed of the vehicle at the instant of the impact is "V₀"; the stopping time is "τ₁"; the stopping space is "Σ". The curve is expressed by the following exponential function:

$$V = V_0 \times e^{-K_1 t}$$

wherein "V₀" is the speed at the instant of the impact, "e" the basis of the Euler's logarithms, "K₁" a constant depending on the constructive features of the guard-rail (material, shape, length of the section in which the impact occurs, etc.) and on the mass of the vehicle,

while "t" is the time considered as an independent variable.

In the case of an impact slowed by a constant deceleration equal to the deceleration at the initial instant of a vehicle impacting against a guard-rail according to the present invention, supposing the stopping space is again " Σ " and the initial speed " V_0 ", the stopping time is about three times shorter than the time " τ_1 ", as it was found after experimental tests.

Fig.14 shows the variation of the position of the vehicle in function of the time after its impact against the guard-rail. Considering the initial space negative, since the stopping space was " Σ_0 ", the curve is expressed by the following exponential function:

$$\Sigma = \Sigma_0 (1 - e^{-K_2 t})$$

wherein " Σ_0 " is the space at the beginning of the recovery towards the normal position of the guard-rail (in theory immediately after the impact), " K_2 " a constant depending on structural features of the guard-rail and mass of the vehicle.

The curve demonstrates that the vehicle is recovered into the position of the instant of impact in a time T, but it is prevented from an elastic rebound which can push it towards the carriageway. In addition, the time T is sufficiently slow to allow the passengers to abandon the vehicle with the necessary caution. Naturally, the time T depends on the structural features of the guard-rail and mass of the vehicle.

The measurement unit of the time, the space and the speed of the curves of Figs 13 and 14 are arbitrary and the elaboration of the data to obtain the curve was performed by means of statistical algorithms.

These tests were performed to determine the elastic characteristic of the guard-rail and define the response time of the guard-rail to the impacts.

Figs.15 and 16 show a fifth embodiment of the guard-rail which can be located as an old shoe at the beginning of a section of guard-rail with the second rail 1" of Fig.6. An elastic rail 38 is connected to a pier 39 by compression springs 40; the pier 39 is driven into the soil; the elastic rail 38 presents an opening 41 for connecting the extension springs 42 to a not represented rail of a guard-rail which, for example, may be the second rail 1" of Fig.6.

In this case the tie-rods 3 are tensile stressed by the springs 40 acting on the tie-rods 3, for example, as the air acts on a balloon or a shoe.

In this a way a guard-rail is obtained which protects the vehicles in a dangerous part of the road layout such as a very sharp curve and supports rectilinear sections of guard-rail or with a very roomy radius of curvature by the extension springs 42.

Also the elastic rails shown in Figs 11, 12, 15, 16 consist of superimposed layers of rubber tensile stressed by steel tie-rods.

The vehicle is protected by means of these guard-rails the rails of which deforms elastically owing to an impact in a time sufficiently slow as to avoid decelerations much higher than the acceleration of gravity.

Claims

1. A guard-rail fitted with elastic structures, comprising a rail (1,1',1''), supporting piers or basements (6) and connecting elements (5,27) connecting the supporting piers or basements to the rail in order to maintain the rail (1,1',1'') in a vertical lying, characterised by the fact that the rail (1,1',1'') consists of one or more superimposed layers (2',2'') of elastic material; the layers (2',2'') being tensile stressed by steel tie-rods (3) housed inside the layers (2',2''); the free ends of the steel tie-rods (3) being fixed to the connecting elements (5,27) and the steel tie-rods (3) sliding inside the layers (2',2''); the connecting elements consisting of elastically yielding structures (5,27) which cooperate with the tie-rods (3) to re-establish the vertical lying of the guard-rail at the end of a pre-established time which begins with the impact of a vehicle against the rail (1,1',1'').
2. A guard-rail as in claim 1, wherein guiding means (18^I,18^{II},18^{III}) are further provided in the layers (2',2'') to obtain the sliding of the tie-rods (3^I,3^{II},3^{III},3^{IV},3^V,3^{VI}) inside the relevant layer (2',2''); the sliding being due to the contraction or expansion of the tie-rods owing to temperature changes or forces induced into the guard-rail by an impact of a vehicle; the sliding allowing the tie-rods to be maintained parallel one another during the temperature changes or during and after an impact.
3. A guard-rail as in claim 1, wherein the connecting elements consist of compression springs (5',5'') mechanically connecting the piers (6) to the rail (1,1',1'').
4. A guard-rail as in claim 3, wherein a supporting structure (4) is provided connected to the rail (1) by compression springs (5) located at suitable distances one another; the supporting structure (4) being elastic and supported by the piers (6); each pier (6) being associated with one compression spring (5).
5. A guard-rail as in claim 4, wherein the piers (6) are connected to the supporting structure (4) by elastic connections consisting of bands of rubber (7); a first part (8') of each band (7) embracing the pier (6) and a second part (8'') crossing a hollow (9) provided in the supporting structure (4); the second part (8'') being fixed and tensile stressed by a wedge (10); the second part (8'') forming a loop inserted into the hollows (9) and presenting a hole (12) into which

the wedge (10) is introduced.

6. A guard-rail as in claim 1, wherein the connecting elements consist of extension springs (17) which mechanically connect the piers (16) to the rail (1',1'') to maintain the rail (1',1'') tensile stressed for supporting the same which is loaded by the dead load. 5

7. A guard-rail as in claim 1, wherein it consists of a pier (35) connected to a cylindrical elastic rail (36) located around to the pier (35); the connection between the pier (35) and the rail (36) being obtained by compression springs (37) located between the pier (35) and the rail (36); the springs (37) being also used for maintaining the shape of the rail (36) cylindrical; the length of the springs (37) being so chosen that the vehicle is protected by this guard-rail, since, after the impact, the rail (36) deforms elastically in a time sufficiently slow as to avoid decelerations much higher than the acceleration of gravity. 10 15 20

8. A guard-rail as in claim 7, characterised by the fact that the elastic rail (38) presents an opening (41) to connect the extension springs (42) to the rail (1'') of another guard-rail. 25

9. A guard-rail as in claim 1, characterised by the fact that the elastic structures are so shaped that the stopping time (τ_1) of the vehicle after the impact is sufficiently slow in order to avoid decelerations much higher than the acceleration of gravity; in addition, the vehicle is recovered into the position of the instant of impact in a time (T) sufficiently slow as to avoid the elastic rebound of the vehicle. 30 35

10. A guard-rail as in claim 1, characterised by the fact that the rail (22) is tensile stressed by steel tie-rods (24); the free ends of the tie-rods (24) are fixed to two basements (25',25'') driven into the soil; a supporting structure (26) driven into the soil supports a plurality of hydraulic jacks (27); each jack (27) being fitted with a piston (28) connected to a push-rod (29) which presents a free end rotating around a first pivot (30) integral with the rail (22); each jack (27) being located between the first pivot (30) and a second pivot (31) supported by the supporting structure (26) in order to maintain the guard-rail in the vertical lying; each jack (27) being connected to a pressure source (32) by a canalisation (33) to maintain the pressure of the working fluid constant; the source (32) being connected to a central control unit (34) fitted with a timer to restore the working of the jack (27) at the end of a pre-established period of time beginning with the impact in order to re-establish the vertical lying of the guard-rail. 40 45 50 55

Fig.1

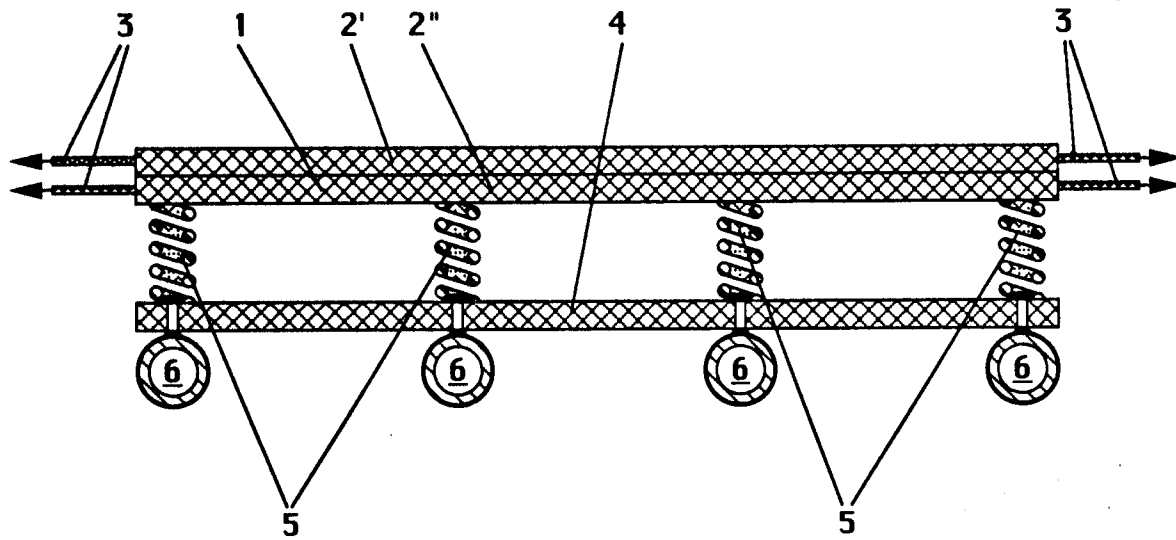


Fig.2

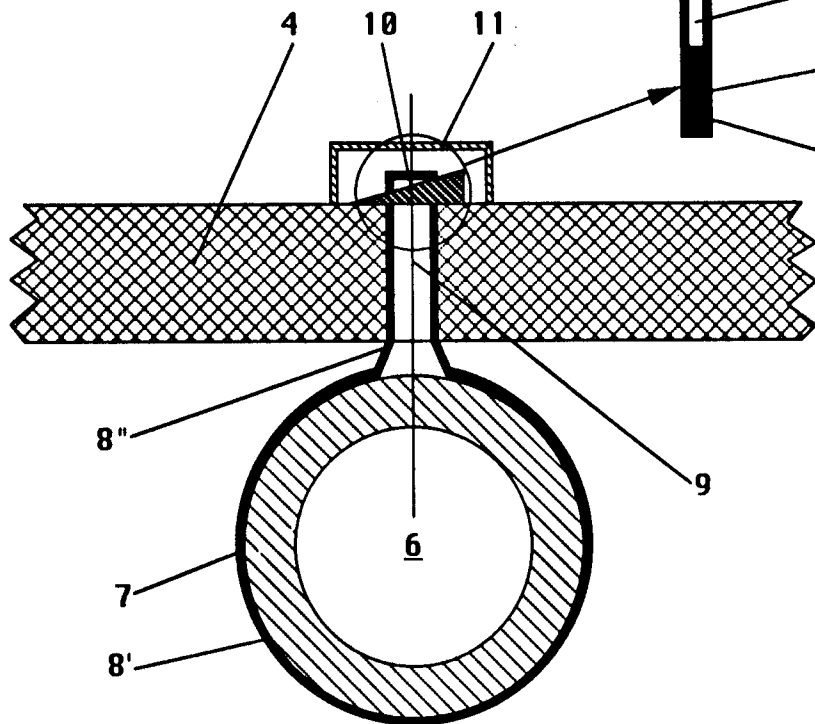


Fig.3

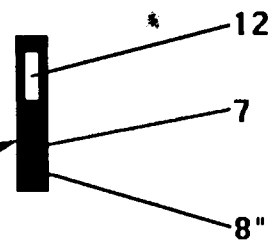


Fig.4

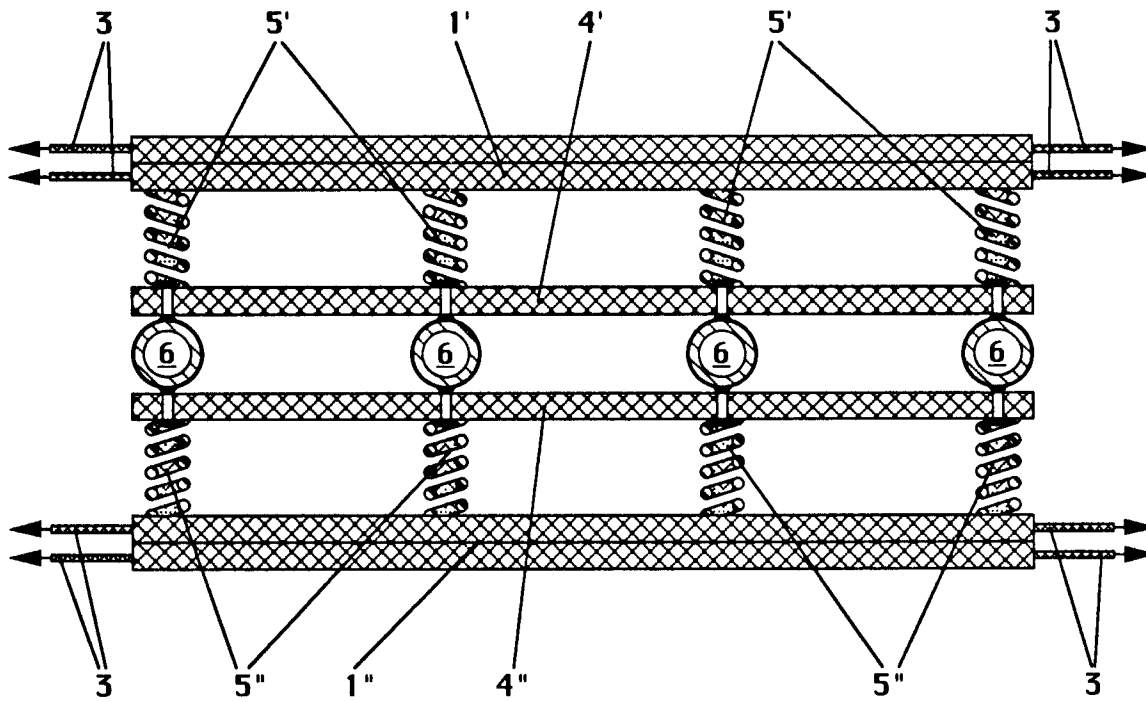


Fig 5

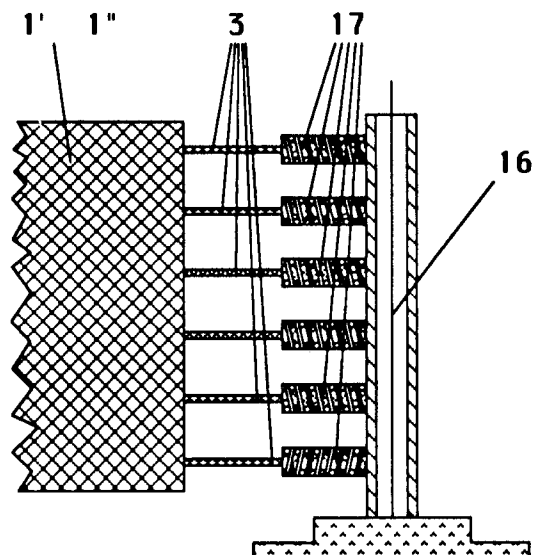


Fig.6

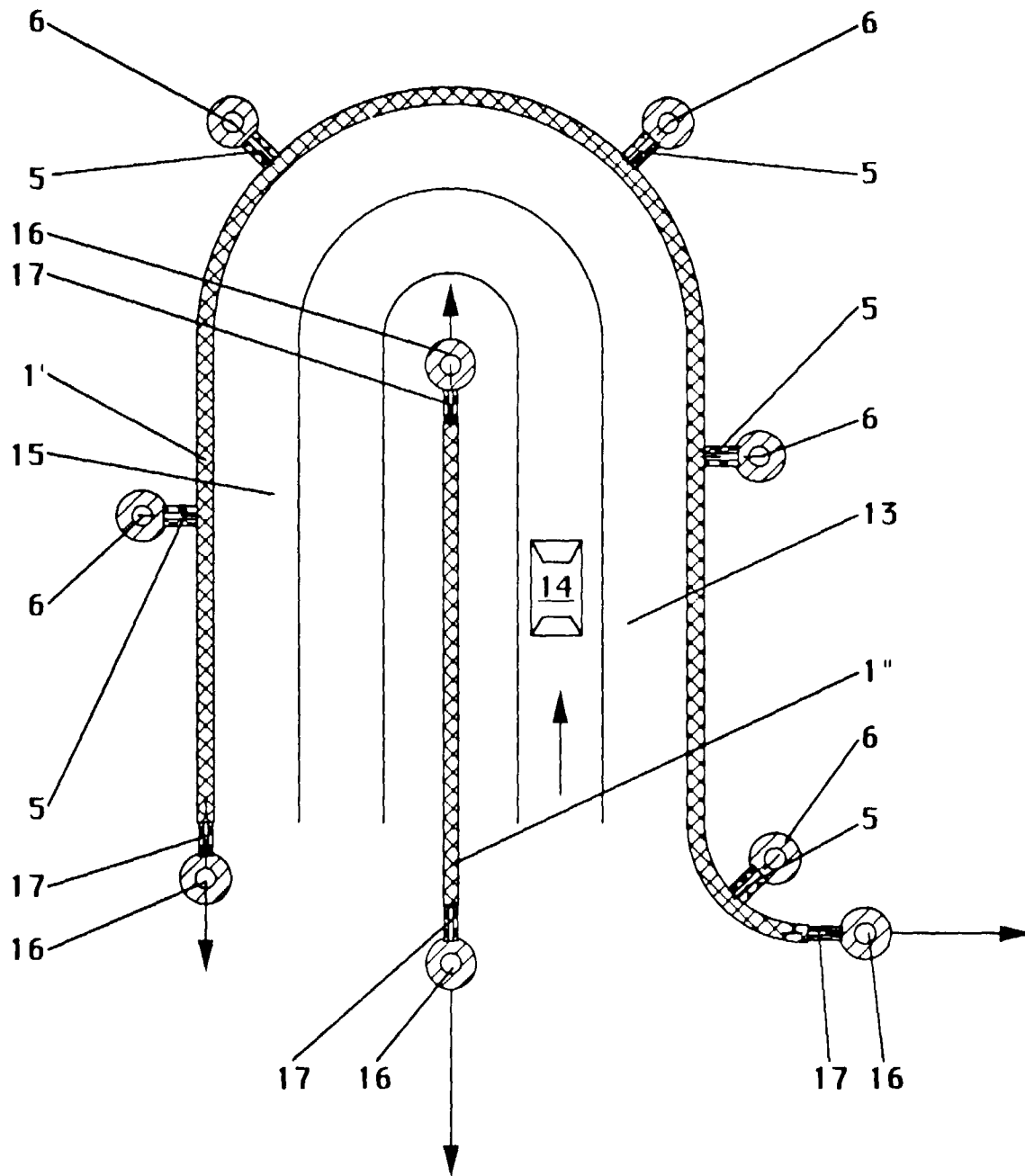


Fig.7

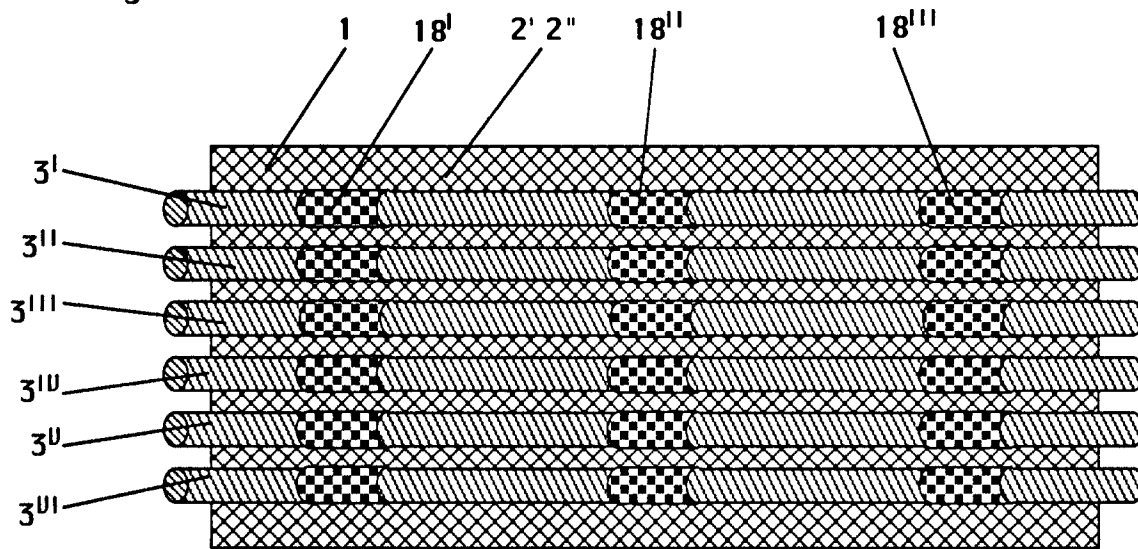


Fig.8

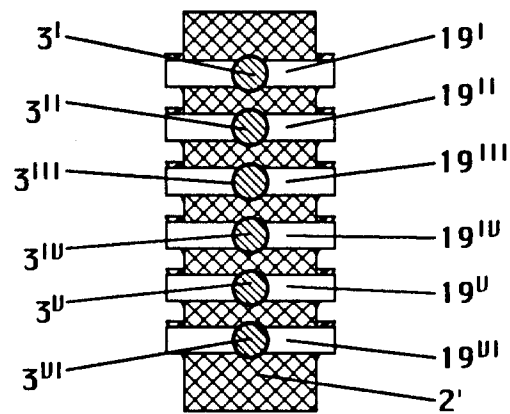


Fig.9

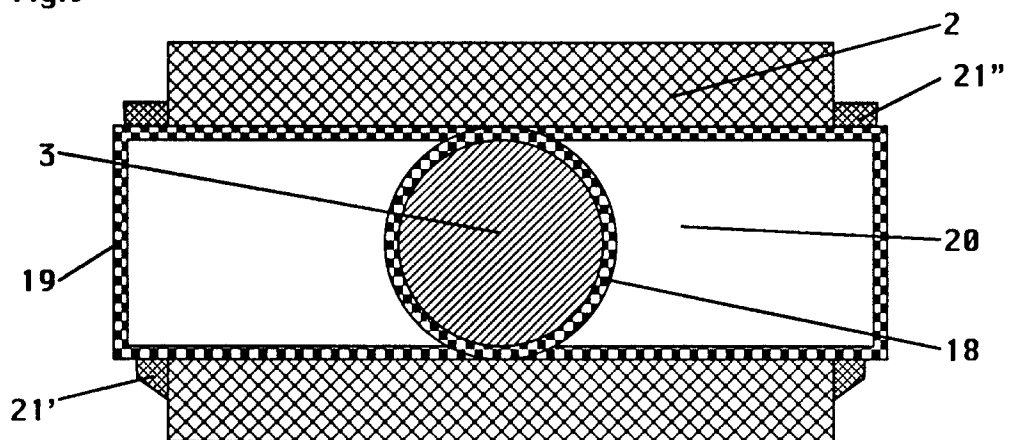


Fig.10

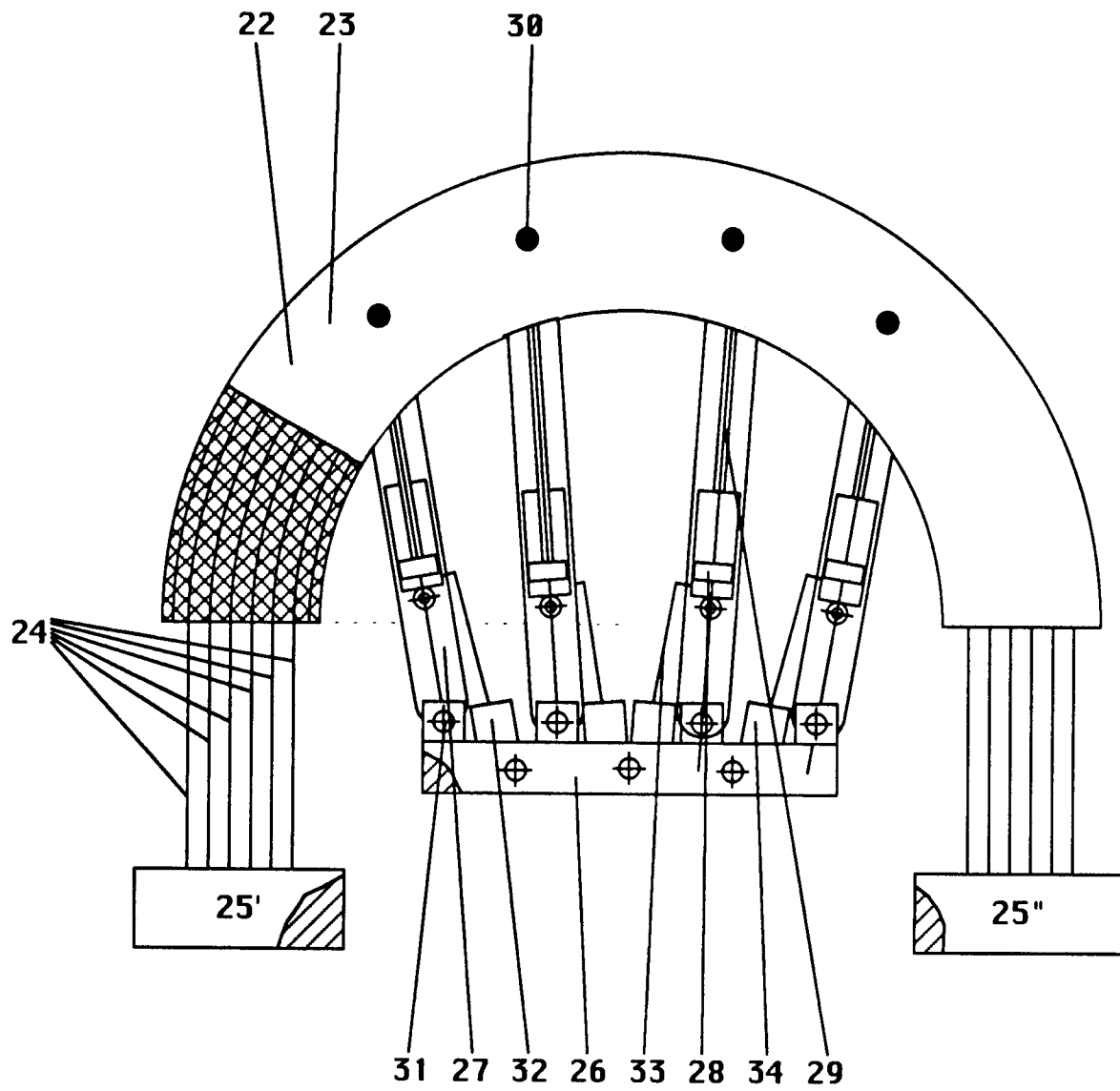


Fig.11

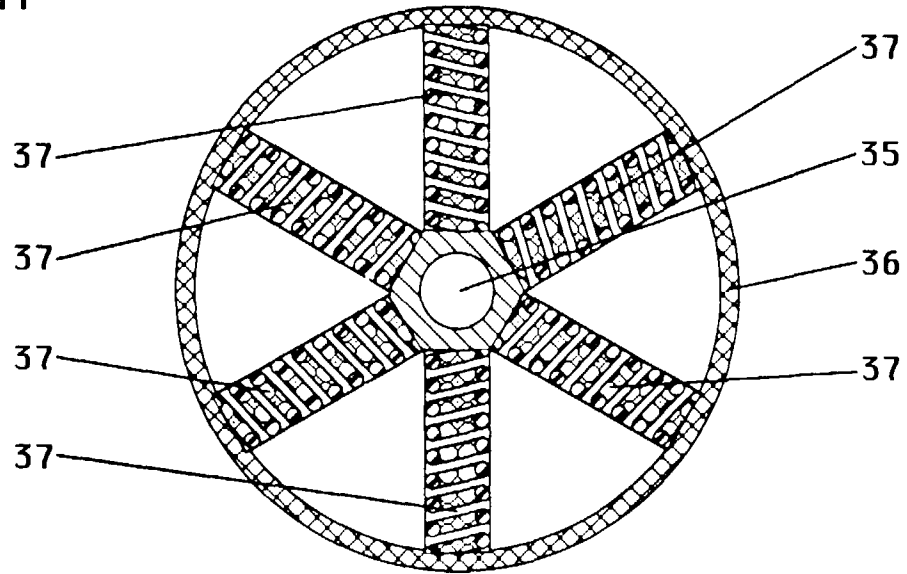
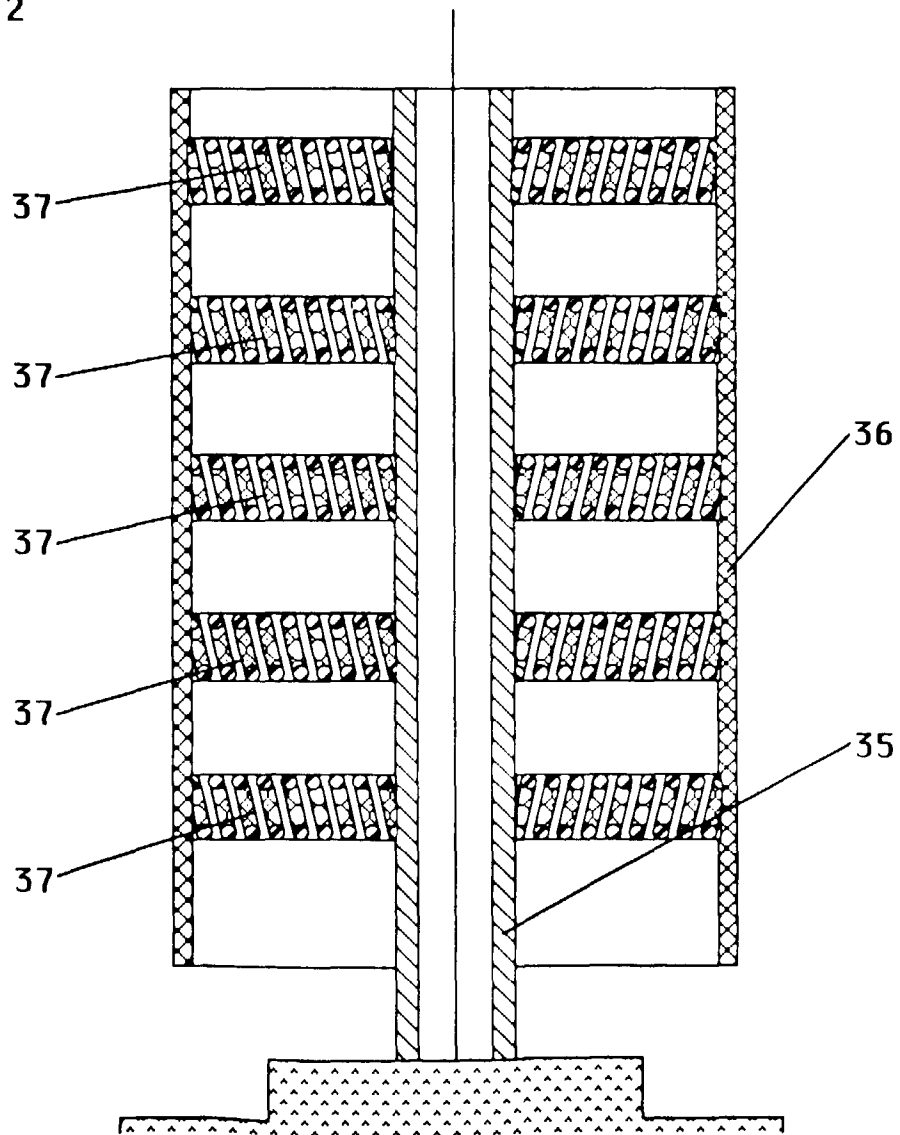


Fig.12



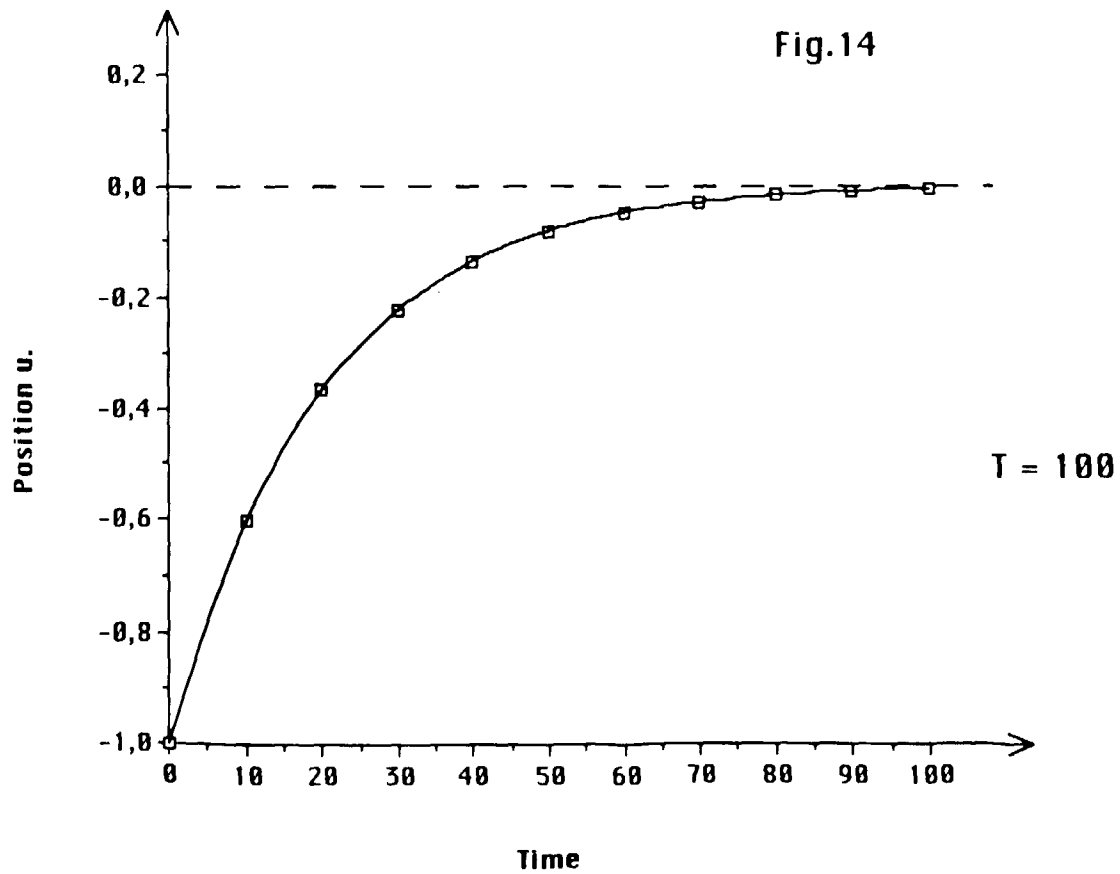
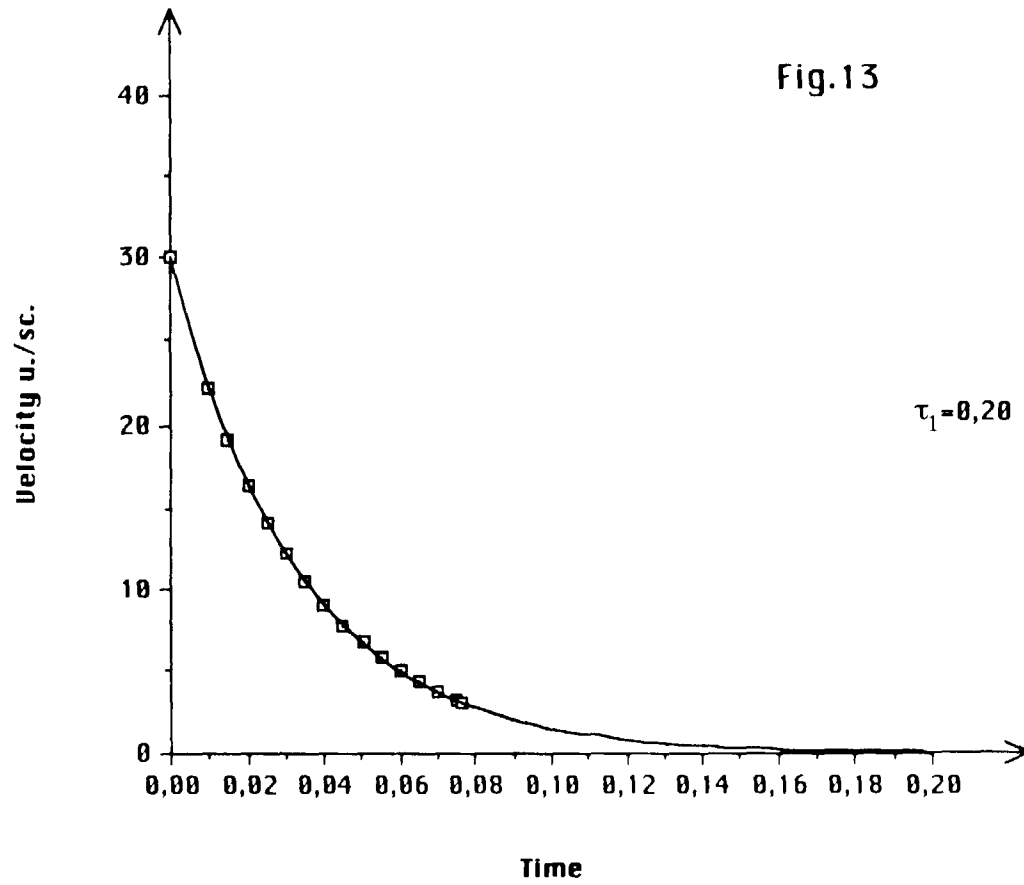


Fig.15

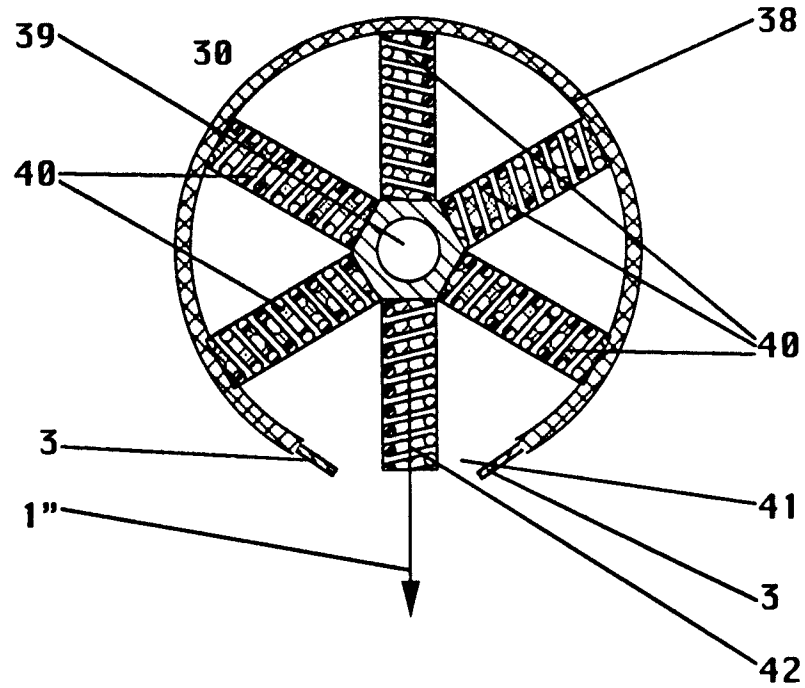
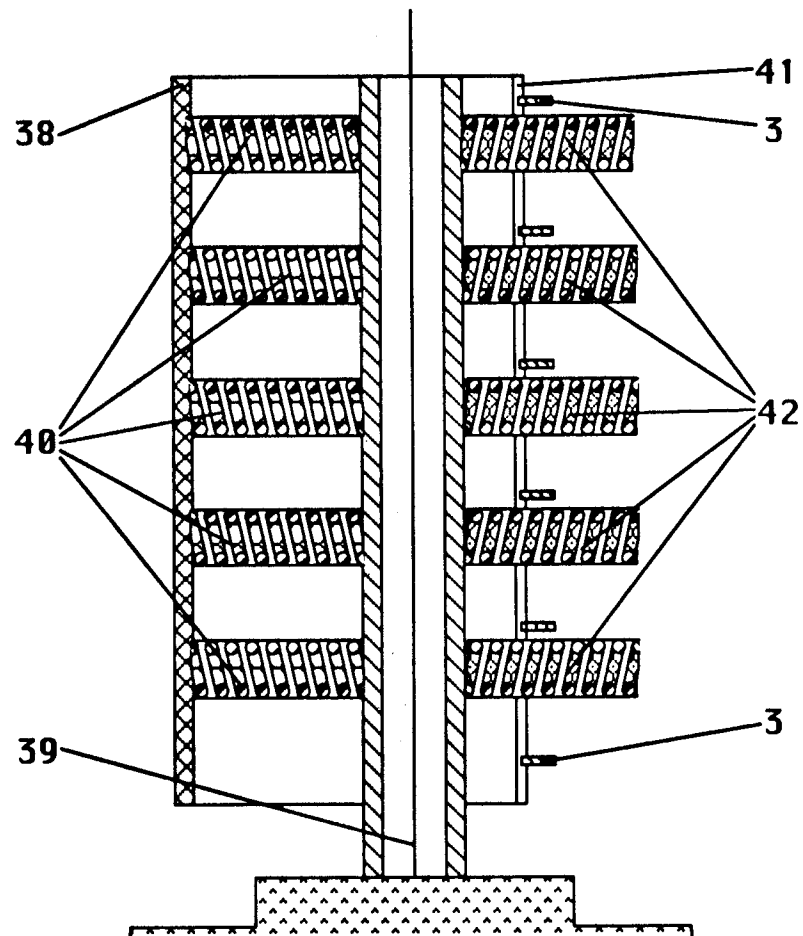


Fig.16





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 11 9919

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.6)
A	DE 16 58 664 A (G. GUBELA) * page 9, paragraph 4 - page 10, paragraph 1; figures *	1	E01F1/00 E01F15/02 E01F15/04
A	GB 312 960 A (A.J. HUNTING) * page 2, line 101 - line 106; figures *	1	
A	BE 826 790 A (GECOL SA.) * page 3, paragraph 7 - page 4, paragraph 1; figures *	10	
A	GB 981 756 A (G. WOLDEMAR)		
A	GB 1 272 588 A (BRITISH ROPES)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6) E01F
Place of search THE HAGUE		Date of completion of the search 21 May 1997	Examiner Verveer, D
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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