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(54) **Controlled-deformation spacer for anchoring road metal sheet strips or guardrails.**

(57) A spacer arm (12) for anchoring a road metal sheet strip or guardrail to support stakes is disclosed, which arm absorbs and dissipates the energy produced by the impact of a car against the guardrail due to its own structure, and keeps the guardrail generally in an operative position even in case of collision of heavy cars. To this purpose the arm is weakened by providing weaker zones (14,16) which are so designed as to be deformed in a differential way and cause their adjoining portions to rotate and/or to lengthwise slide after, the collision according to the stress to which the spacer is subjected.

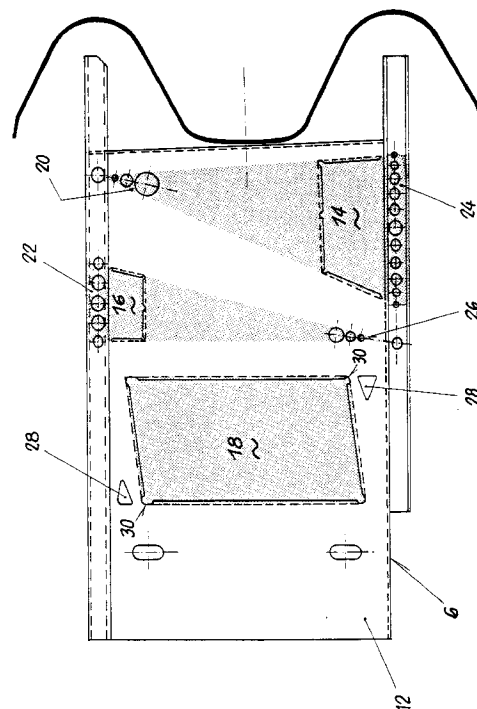


Fig. 3

The present invention relates to road safety barriers or guardrails and more specifically to an improved system for anchoring the road metal sheet strip or guardrail to the support stakes so as to absorb and dissipate the energy produced by the impact of a vehicle and to keep the strip in an operative position even in case of collision with heavy vehicles. According to the invention, spacing cantilevers which are weakened by less withstanding zones designed to deform in a differential way so as to cause the adjoining portions to reciprocally rotate and/or to longitudinally slide upon collision according to the stress to which the spacer is subjected. i.e. according to the impact strength.

Road safety barriers must contain within the road limits always heavier, taller and relatively faster vehicles, while minimizing the damages to passengers of small vehicles due to impact against such barriers. The problem involves the components of forces and deformations perpendicular to the road axis and is usually dealt with and solved in different ways, which also take into account available space, so that the range of proposed constructions is extremely wide.

In some applications a rope system with weak supports has been used un which the colliding vehicle causes the ropes to lengthen both upstream and downstream from the impact point; this allows the system to absorb a considerable amount of energy with low (i.e. elastic) lengthwise deformations but with high cross-deflections and therefore limited impact strain but at the same time having extensive space requirements.

In other cases, the ropes are replaced with metal sheet strips supported by members having poor transversal rigidity so that the strip sections are subjected to tensile strength, thus giving rise to a rope effect.

At the other end, extremely rigid structures (building barriers shaped in various ways) are used in which almost no deformation occurs and with which it is attempted with more or less satisfying results to lead the vehicle back to the road by means of the particular shape of the wall so as to transform the kinetic energy of the vehicle into potential energy by raising the vehicle itself.

Some of the proposed solutions address the problem of containing heavy vehicles having a high center of gravity, while protecting the environment using constructions of reduced height; all this taking into account whether such constructions are to be used as lateral barriers or traffic island barriers to be installed at the central island between two tracks.

A typical example of a barrier formed of metal sheets according to the present state of art is illustrated in Figures 1a and 1b of the annexed drawings: in particular Fig. 1a shows a side view of a barrier before an impact, and Fig. 1b shows the same barrier after an impact from the right hand to the left hand side of

the observer.

As can be seen the barrier is formed by a strip 1, stakes 2, and a connection arm or spacer 3, and can be used as a lateral guardrail or as traffic island guardrail (in which case the spacer is of the double type and includes also portion 3' supporting strips 1'.

It is known to use in these barriers a much more rigid spacer than the support stake and to dimension the spacer so that upon impact the strip is raised with respect to its rest position due to the deformation of the whole assembly, as shown in Fig. 1b, thus allowing vehicles with high centre of gravity to be kept back.

It is also known to use traffic island metal sheet barriers, in which the spacer is dimensioned so that (see Fig. 1c) upon maximum deformation the impact side is raised as shown in Fig. 1b while the opposite side comes in contact with the ground, so as to form an arch together with the stakes, and thus from that moment g to increasing the capability of containing the colliding vehicles.

It should also be noted that the behaviour of the system described immediately above is peculiar. In fact, the resistance to strain of the whole assembly increases greatly upon contact of strip 1' with the ground. This allows the guardrail to have a more elastic behaviour in case of low-energy impacts and a more rigid behaviour in case of impacts with energy higher than a given level.

Different yet analogous considerations lead to the design of constructions which are capable of undergoing relatively high deformations under limited strains (such as those produced from the impact of cars) while the more resistant components come into play only upon a given threshold of stress.

One application of such a principle is found in Italian Utility Model No. 204060, where a safety barrier having an increasing rigidity is disclosed, the strip of such barrier being connected to the support stakes by spacers formed of a diametrically disposed tubular member or ring in which a second ring of a smaller diameter is inserted, while another ring is secured to a longitudinal member which connects the support stakes at the middle thereof. This ring which has a diameter equal to that of the inner rings is not in contact with the guardrail strip and comes into play only when the resistance to strain of the outer rings is exhausted. Such a system is capable of absorbing an amount of energy derived from the sum of the energy absorption capability of each of the several structural members. This however, at the expense of lower cost and practicality and furthermore without the strip rising upon bending of the support stake.

Italian Patent Application No. 8912482 discloses a device of the above-mentioned type in which the strip of the guardrail is connected to the spacer, which secures it to the support stake, by means of an energy-recovery damping system. A similar system is

used for connecting spacer to support stake so as to form a controlled four-bar-linkage with the preceding system. In case of a collision of particular intensity the strip is raised and takes on a position transversal to the original orientation. The spacer is in turn shaped so that it is bent upwards in case of a particularly strong collision to cause such strip to further raise so as to assure heavy vehicles such as trailer-trucks having a high centre of gravity to be kept back from the guardrail. Also in this case as in the preceding case the system is rather complex both as far as construction and assembly is concerned since each support stake requires the combination of a spacer and two separate energy dissipators.

The present invention seeks to provide simplified supports for safety barriers or guardrails of the above-mentioned type and to reduce the cost and the assembly time thereof by utilizing the spacer itself as a damping system for absorbing energy, and at the same time taking advantage of the deformation of such assembly to ensure that the strip assumes an operative position under any circumstance.

Another goal of the present invention is to provide a spacer for connecting the strip of a safety barrier or guardrail of the above-mentioned type so that such spacer can undergo a controlled deformation, absorb energy as a function of the intensity of impact, and raise the strip upwards according to such intensity.

This has been achieved according to the invention by a spacer arm capable of absorbing and dissipating impact energy of a vehicle as a result solely of its conformation and without the addition of auxiliary dissipation devices or special measures for securing it to the support stakes.

The inventive step of the present invention is that of weakening the spacer by means of a combination of weaker controlled-deformation zones, each of which, upon being crushed, results in the adjoining parts to reciprocally rotate or slide. By dimensioning, combining and spacing such weaker zones in a suitable manner both the amount of energy to be progressively absorbed and the position assumed by the strip as a consequence of the deformation of the spacer can be controlled, while at the same time it is possible to obtain a lifting of a guardrail to a predetermined height thus compensating also for the deformations undergone by the support stake.

The present invention will be more readily apparent from the following description which refers to the accompanying drawings in which, besides Figs. 1a, 1b and 1c, which as already mentioned show the behaviour of a guardrail formed of metal members according to known techniques, Figs. 2a, 2b, 2c, 2d, 2e and 2f, selected only by way of example, shown schematically the deformations upon collision of the weaker zones as a function of design;

Figs. 3 and 4 show a side and a front view of a pre-

ferred embodiment of the support arm for a conventional double-corrugation strip, respectively; Figs. 5 and 6 show a side and a front view of the same embodiment as above but for a triple-corrugation strip, respectively;

Figs. 7a, 7b, 7c and 7d show the spacer arm with the triple-corrugation strip of Figs. 5 and 6 in a sequence of deformations which occur as a consequence of impacts of increasing intensity;

Figs. 8a, 8b and 8c show still a side view of the sequence of deformations of a modified arm having an L-shaped form and adapted to support a pair of staggered strips.

With reference to Figure 2a a rigid arm 6 is weakened at a certain zone by a slot 8. In the drawing the slot, shown by a shading, has the form of a right triangle with the vertex pointing downwards. Upon impact of a vehicle the impact force shown by the arrow "p" moves portion 10 of the arm upwards from position GABC to position G'A'BC as side FG of slot 8 is deliberately weaker than sides FC and CG. In other words it is a matter of a rotation with fulcrum at C.

In Figure 2b the still triangular weakening slot is turned upside-down, i.e. with the vertex pointing upwards and the horizontal side below. By an impact force "p" zone 10 is deflected in this case downwards passing from the position GABD to the position GA'B'C', i.e. a rotation with fulcrum at G in the opposite direction. By forming the two slots in two different zones of the same arm, i.e. at the opposite positions shown in Fig. 2c, zone 10 will pass from the initial position LABC to the lower position L'A'B'C' because of the combined rotations mentioned above, thus remaining parallel to its original position. A rotation to the opposite direction will occur in case of the mirror image embodiment of Fig. 2d, where the zone will pass from the position LABC to the upper position L'A'B'C' upon collision. The final result will be in any case a translation together with a rotation, the direction and amplitude of which will depend on the amplitude of the two single rotations and on the reciprocal positions of the squeezed zones. In particular, when the two rotations have the same amplitude as in the present case, a raising of the ar, and then of the strip will occur without any rotation.

It is self-evident that by spacing apart the two triangular slots the height to which the arm is lifted depends on the spacing between the slots, as can be seen by comparing Fig. 2e with Fig. 2d. By providing between such slots a four-sided slot having weakened corners as shown in Fig. 2f, the sliding of the strip can occur earlier or later and, in any case, at a predetermined time with respect to the two previously-mentioned deformations. The order in which the three deformations occur depends on the strain required to cause each single deformation. The deformation resulting from the least strain will of course occur before the others. In this way, the succession or

simultaneity of the deformations can be controlled.

Similar remarks may be made in relation to a number of slots of different shapes and to their combination, whereby a raising of the arm corresponding to a rotation about a virtual fulcrum can be achieved. It should be further appreciated that the term "slot" has been used for ease of understanding of the concept of weaker zones and that in the above examples, the slots correspond to the entire weaker zone. However, the slots can be restricted only to a portion of the zones intended to be deformed.

As the deformations used to achieve the predetermined purpose occur in an ideal plane perpendicular to the road axis, it is preferable that the weakening be effected in such a way as to minimize the risk of a deflection of the spacers in the plane parallel to the road (rotations about the axes of the stakes). To this end, the weakest zone (intended to cause great deformations at low strain) will occur preferably at the end of the spacer near the strip, while the relative strength of the weak zones increases as they near the stakes. In addition the weakening will be preferably made near the vertical neutral axis; to this end it is preferable that the spacer be designed so that such neutral axis corresponds to or is near the surface to be weakened (for example: the core of a I or Z -section).

As shown by the shading in Fig. 3, the combination of the shaped slots 14, 16 with holes 20, 22 and 24, 26 forms two weakened zones the effects of which are equivalent to those caused by a pair of triangular slots as shown in Fig. 2d. The succession of deformations shown in Figs. 7a, 7b, 7c, and 7d is as follows: the crushing of slot 14 causes the end of the arm where the barrier strip is bolted to rotate about a virtual fulcrum I, while the crushing of slot 16 causes portion 34 to rotate about a second virtual fulcrum II so as to partially compensate for the rotation about I. Finally, the crushing of slot 18 causes an upward displacement of the section of the arm at the right thereof and a further lifting of the barrier strip.

Figs. 7b and 7d show that the deformations never occur consecutively at each controlled zone but may be caused simultaneously according to a predetermined strain resistance.

The preceding description relates to a preferred embodiment of the invention. However, it is evident that a number of construction modifications and changes can be made to the spacer arm in order to render it capable of supporting strips of any shape or a combination of several strips as in the case illustrated by way of example in Figs. 8a-8c.

In such Figures spacer arm 36 has the shape of an inclined L, which allows the two strips 38, 40 to be secured independently at different heights and in staggered positions. Arm 36 has a plurality of weakening slots 42, 44, 46, 48 distributed both along the horizontal flange and the vertical flange of the L-section.

In particular, the lower strip is intended to take up alone the impact of a light vehicle with poor rigidity, while both strips are intended together to take up the impact of heavy vehicles: first the lower strip 38 and then also the upper strip 40 after lower strip 38 is raised and aligned with strip 40. The sequences is apparent in Figs. 8a, 8b and 8c.

It is evident that the weaker zones can be formed not only by weakening the construction in such areas but alternatively by strengthening other zones.

Claims

1. A safety device for anchoring road metal sheet strips or guardrails to support stakes, comprising a spacer arm joining the support stake and the strip, which arm is so designed as to undergo upon collision one or more impact strength dependent deformations while maintaining the road metal sheet strip or guard rail in an operative position.
2. A safety device for anchoring road metal sheet strips or guardrails to support stakes, comprising a spacer arm joining the support stake and the strip, which arm is so designed as to undergo upon collision differential deformations in order to absorb and dissipate energy increasing progressively in relation to impact intensity and to always keep the strip in operative position raising it upwards to the desired extent after the collision.
3. The safety device for anchoring road metal sheet strips or guardrails to support stakes of claim 1 or 2 characterized in that said deformations are provided by weakening said spacer arm with a combination of weaker zones, each of which can be subjected to a controlled squeezing causing the adjoining zones to reciprocally rotate and slide.
4. The safety device for anchoring road metal sheet strips or guardrails to support stakes of the preceding claims, characterized in that the deformations caused by rotations are also due to rotations about virtual fulcra.
5. The safety device for anchoring road metal sheet strips or guardrails to support stakes of the preceding claims, characterized in that the weakened zones are produced by providing the body of the spacer arm with a plurality of weakening slots and/or holes so as to form less withstanding zones in several sections of the arm.
6. The safety device for anchoring road metal sheet strips or guardrails to support stakes of the preceding claims, characterized in that both the

amount of energy to be progressively taken up and the position assumed by the arm as a consequence of a deformation can be controlled by shaping, dimensioning and distributing the weakening slots and/or the lightening zones along said spacer arm. 5

7. The safety device for anchoring road metal sheet strips or guardrails to support stakes of the preceding claims, characterized in that the deformation of the support stake is compensated by controlling the energy taken up because of the deformation of the spacer arm. 10
8. The safety device for anchoring road metal sheet strips or guardrails to support stakes of the preceding claims, characterized in that said spacer arm is secured to a rigid construction such as a wall or the like which replaces the support stake. 15
20
9. The safety device for anchoring road metal sheet strips or guardrails to support stakes of the preceding claims, characterized in that the longitudinal extension of the spacer arm is perpendicular to the road axis. 25
10. The safety device of claims 1 to 8, characterized in that the spacer arm is L-shaped so as to support two strips at different heights and in staggered positions. 30
11. The safety device of claims 1 to 8, characterized in that the spacer arm is shaped so as to support two or more strips, or longitudinal members formed of two strips coupled to each other and having possible different shapes, or members of any shape. 35
12. The safety device of claim 11, characterized in that the spacer arm is so shaped that the displacements of the strips or supported longitudinal members are independent of one another during the deformation due to the collision. 40
13. The safety device of the preceding claims, characterized in that the spacer arm is of metal. 45
14. The safety device of claim 13, characterized in that the spacer is one-piece member. 50
15. The safety device of the preceding claims, characterized in that there is only one weaker zone. 55

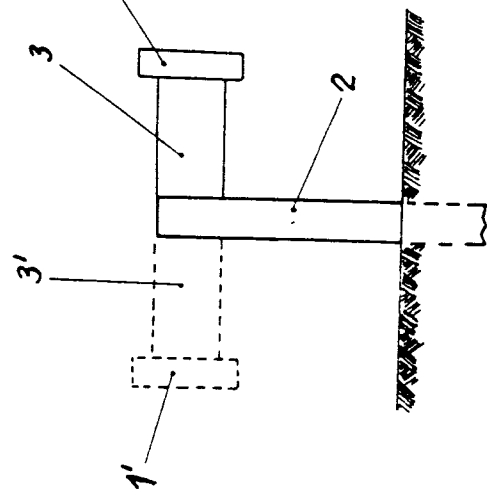


Fig. 1a

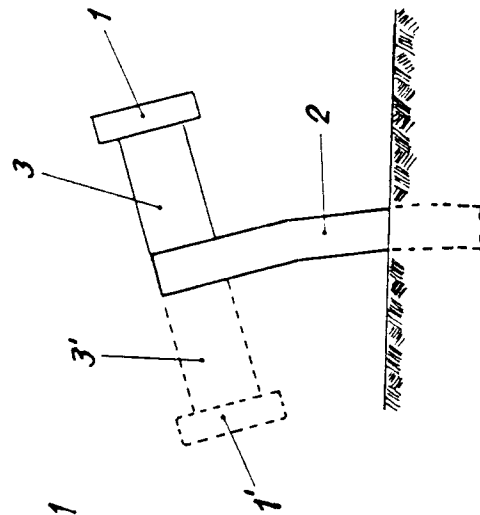


Fig. 1b

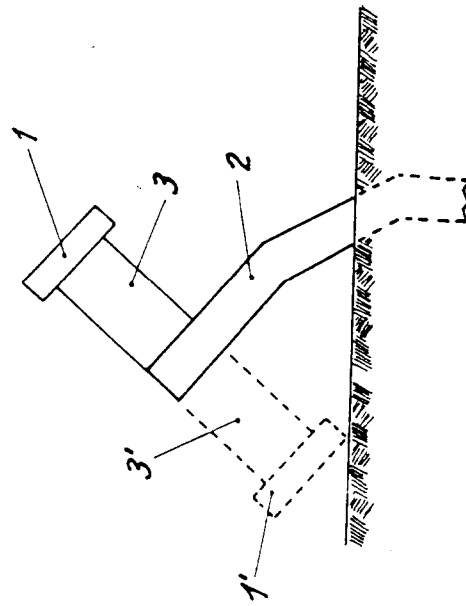
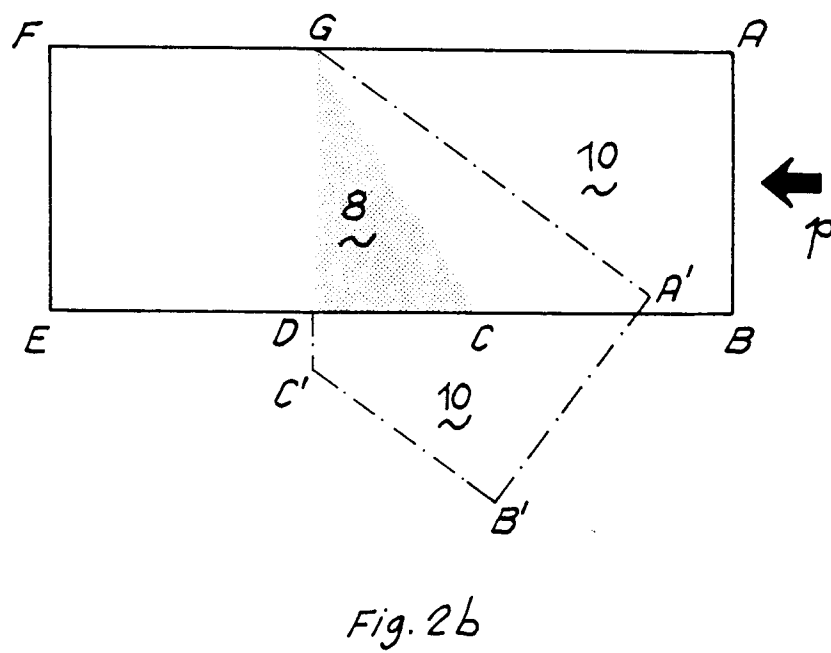
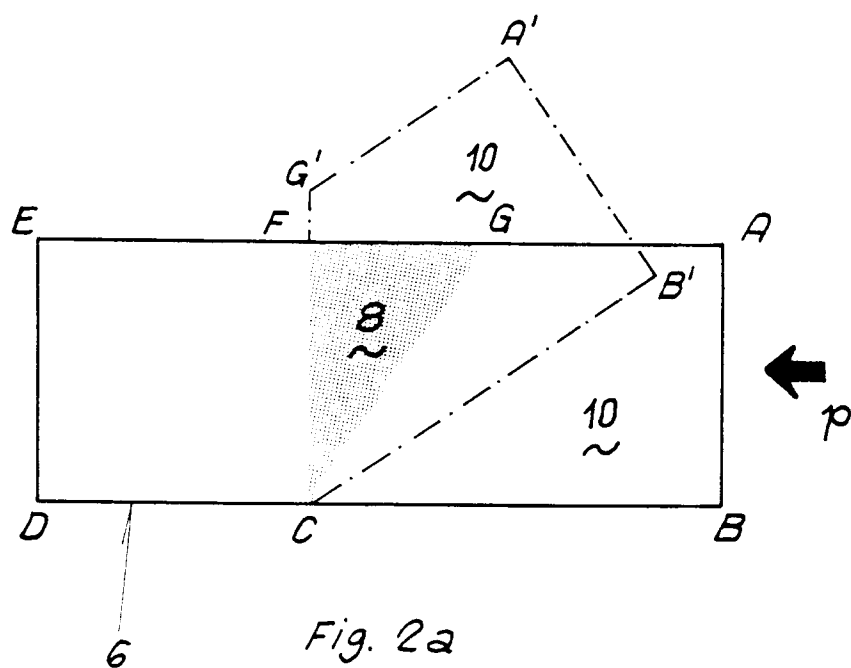


Fig. 1c



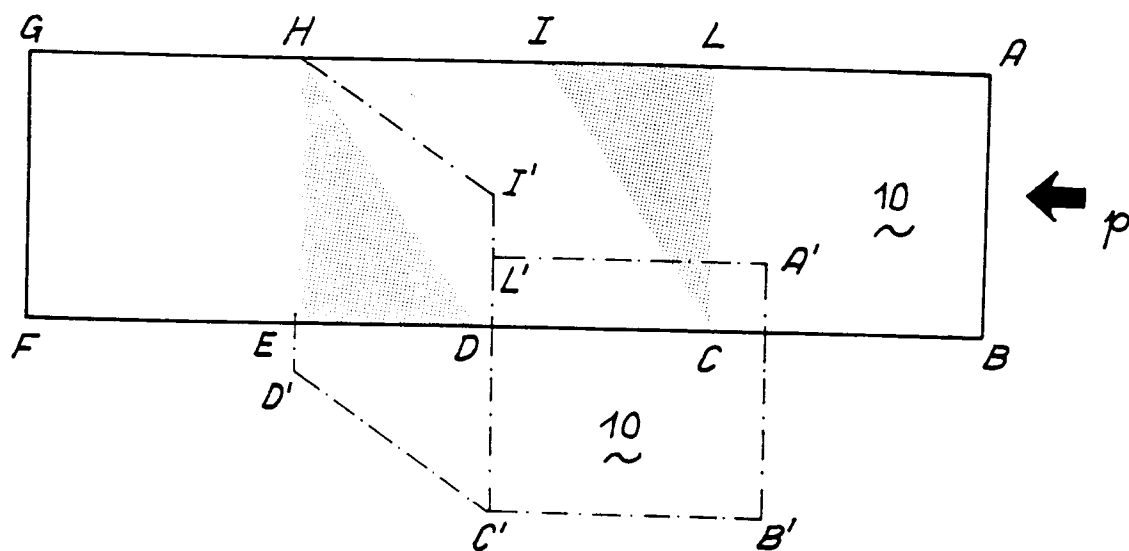


Fig. 2c

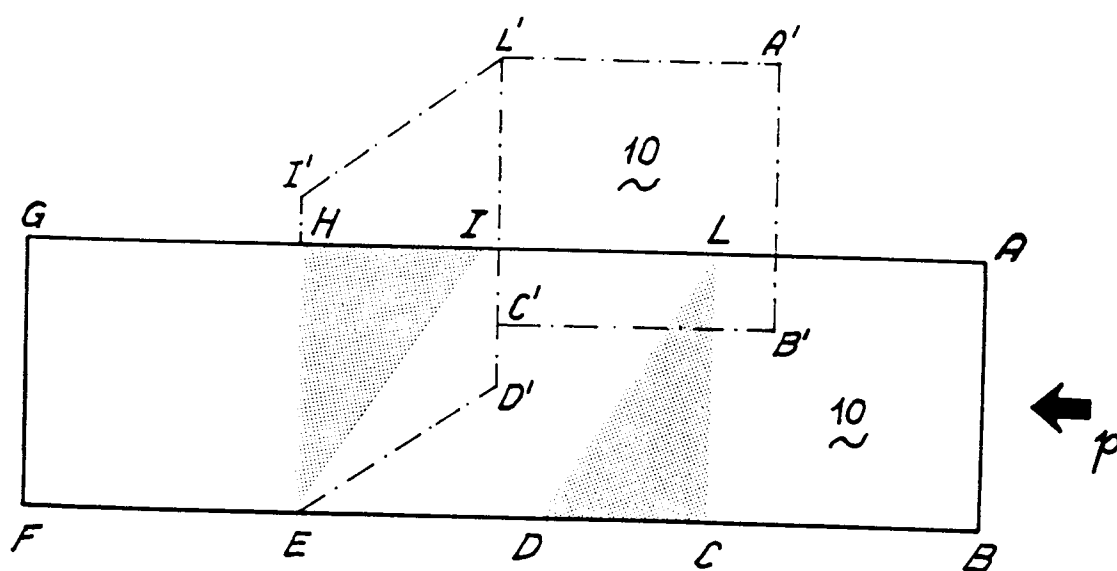


Fig. 2 d

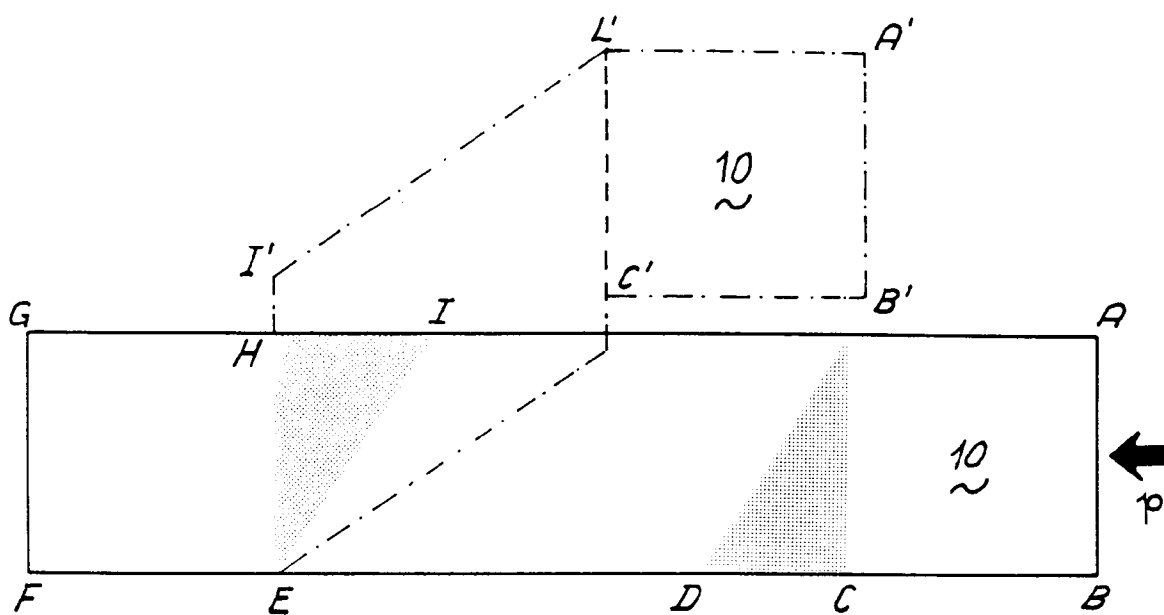


Fig. 2e

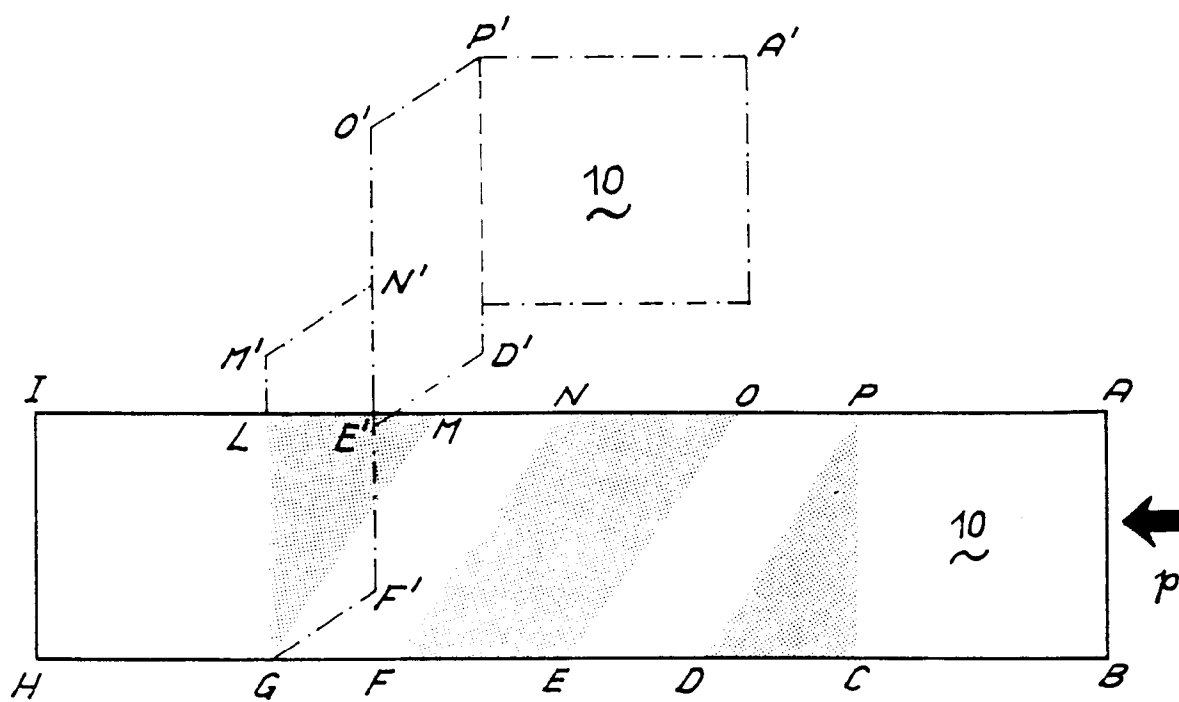


Fig. 2f

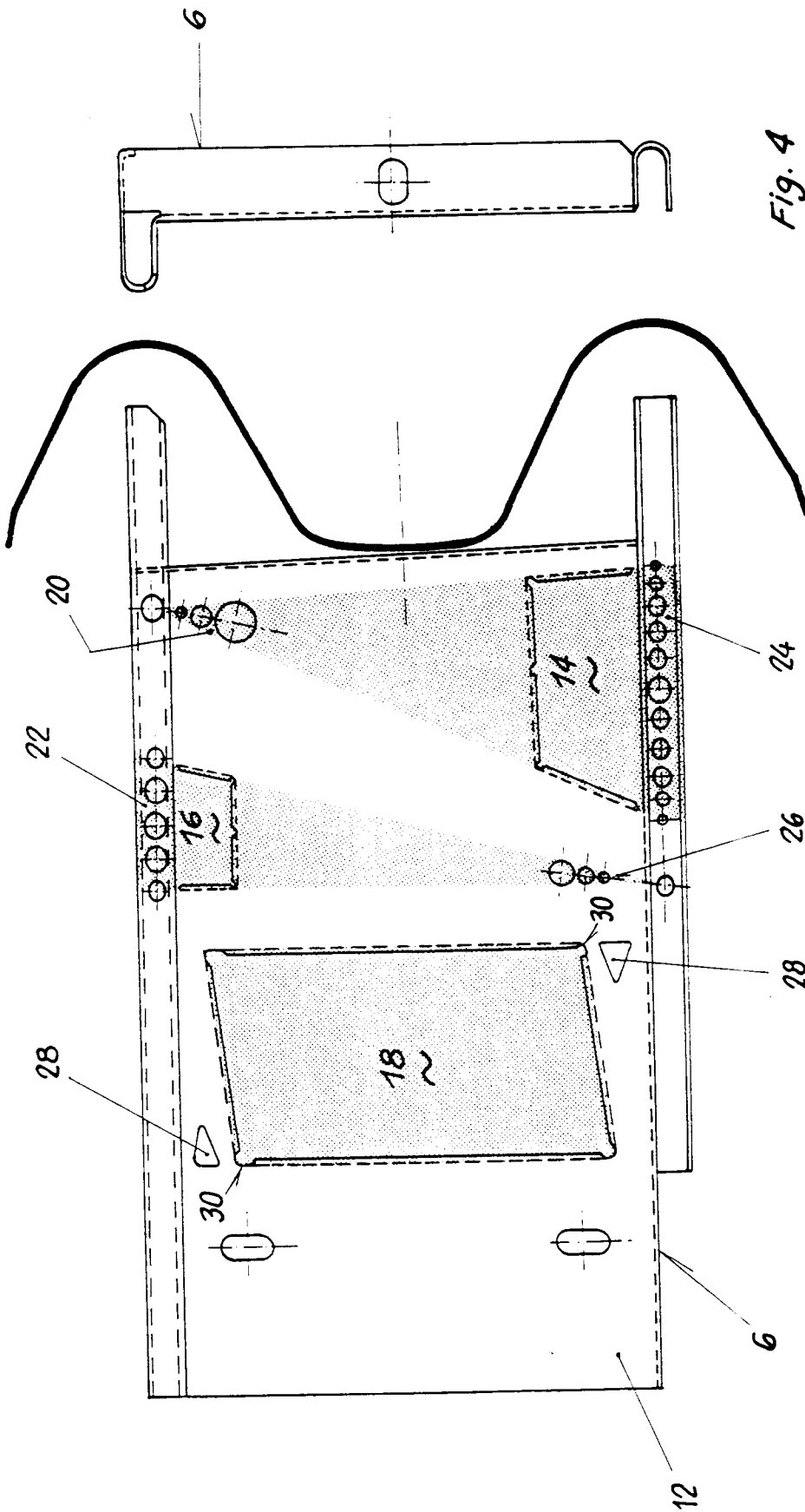


Fig. 3

Fig. 4

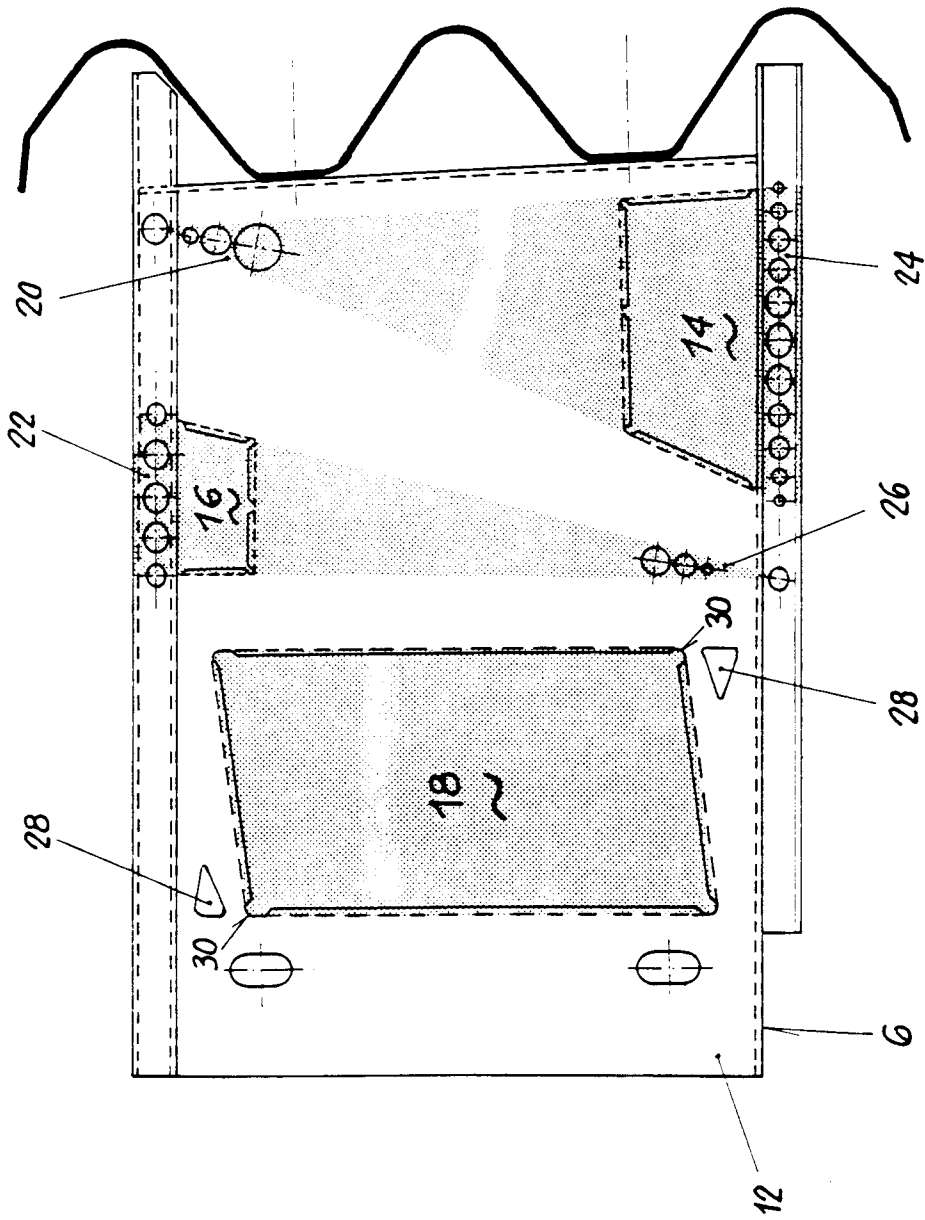


Fig. 5

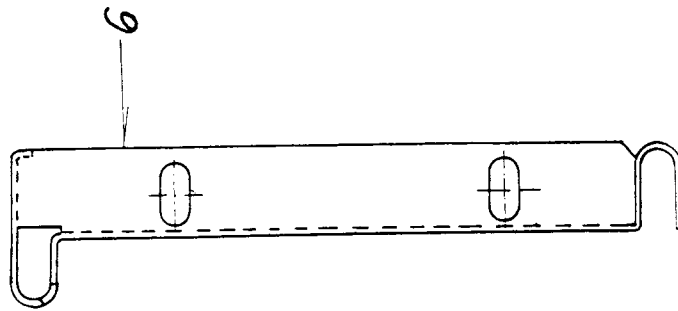


Fig. 6

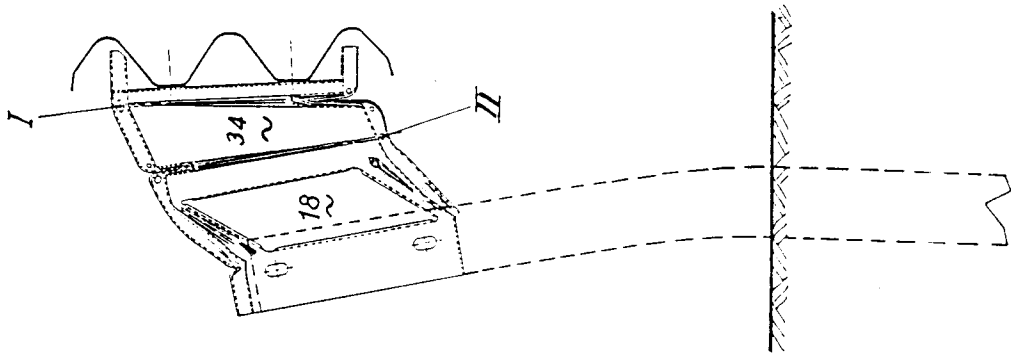


Fig. 7d

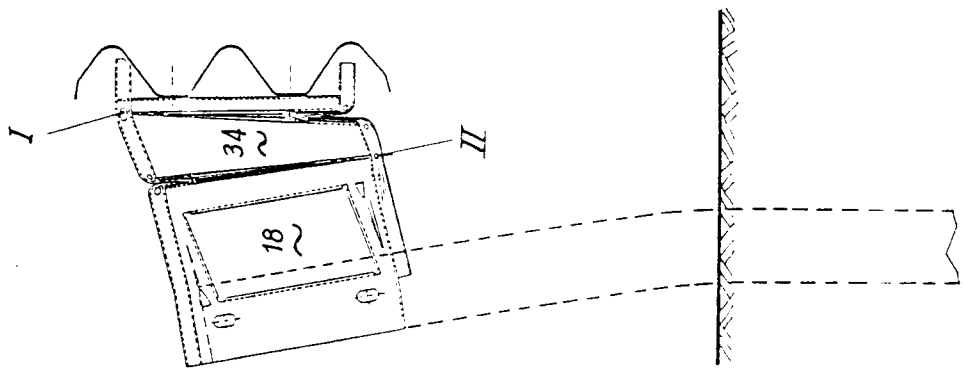


Fig. 7c

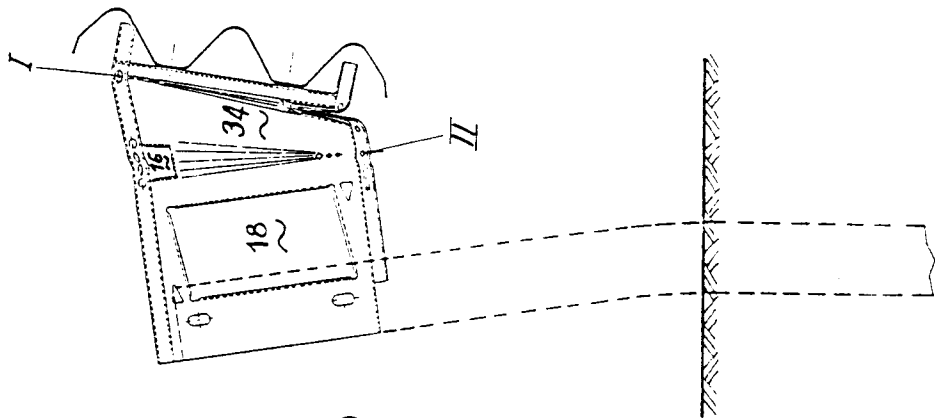


Fig. 7b

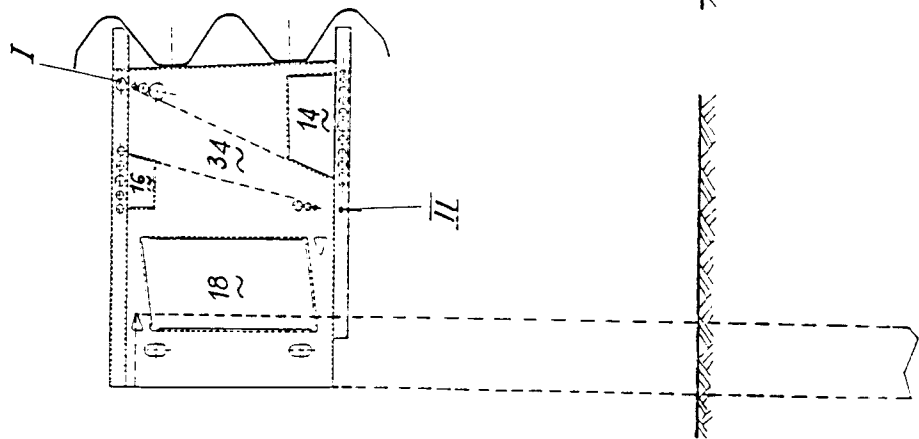
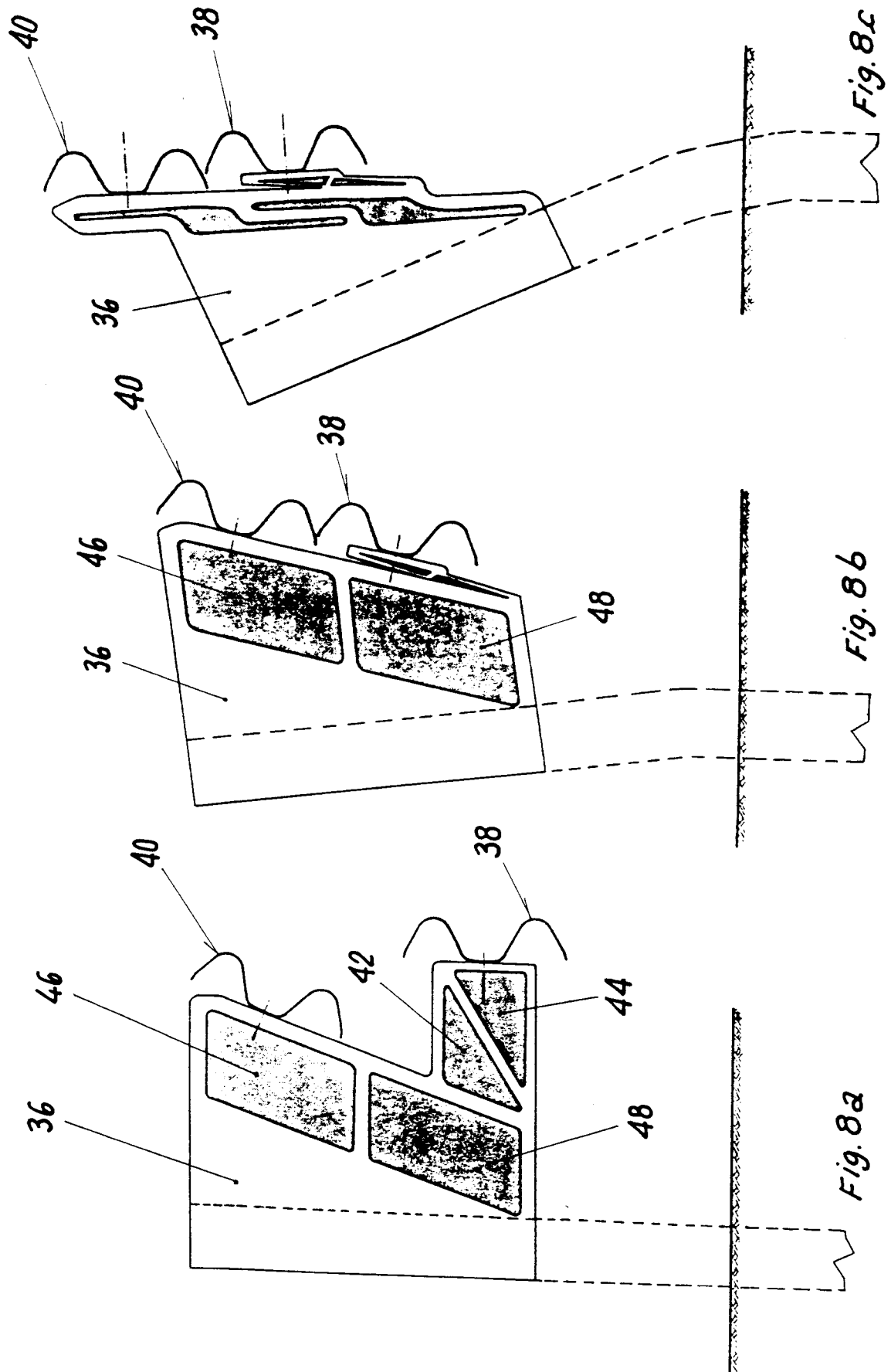


Fig. 7a





European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 93 83 0097

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)
X	EP-A-0 356 686 (METALMECCANICA FRACASSO) * the whole document *	1-3,5-7,9,13,17	E01F15/00
X A	DE-A-2 642 475 (ALPINE-MONTAN) * page 6, line 30 - page 7, line 18; figure 1 *	1,2,13 3-5	
X A	FR-A-1 584 411 (RANSHOFEN-BERNDORF) * the whole document *	1,4-6,9,13-15 3	
X A	FR-A-2 401 274 (UT-VASUTTERVEZO VALLALAT) * page 7, line 28 - line 38; figures 13,14 *	1,5,13 2	
X A	US-A-4 138 093 (L.N.MEINZER) * column 1, line 49 - column 2, line 6; figure 3 *	1,9,14,15 2	
X A	US-A-3 981 486 (E. BAUMANN) * column 3, line 59 - column 4, line 12; figures 10-13 *	1,13 2	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	LU-A-41 713 (J. FEIDERT) * page 2, paragraph 3 -paragraph 4; figures 2,3 *	1,2,6,11	E01F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 JUNE 1993	Examiner VERVEER D.
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