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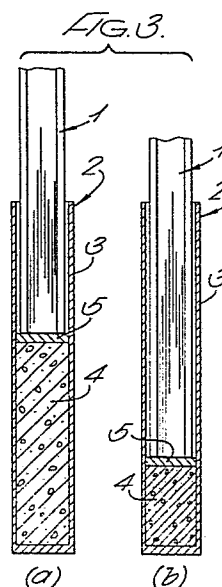
71 Applicant: **AMCO FINANZ AG**
Baarerstrasse 98 Postfach 2094
CH-6300 Zug(CH)

72 Inventor: **Dawson, Gordon Bertram**
1 The Orchards Stainton
Nr. Rotherham South Yorkshire, S66 7QH(GB)

74 Representative: **Carpmael, John William Maurice**
CARPMAELS & RANSFORD 43 Bloomsbury Square
London, WC1A 2RA(GB)

54 **Yieldable support element.**

57 A yieldable support element particularly for supporting the ends of mine roof support girders. The support element (2) allowing controlled movement of the support girder when the load reaches a level above which damage could occur, and comprising a hollow tubular housing (3) surrounding the end of the girder and containing a block (4) of foamed concrete or similar material which supports the girder. The compressive strength of the foam concrete determines the yield pressure for the support element.



"Yieldable Support Element"

The present invention relates to yieldable support elements, particularly for use in tunnel roof supports.

5 In deep underground workings such as coal mines roadway tunnels are provided for the passage of men and materials as well as for ventilation purposes. These roadways are generally supported by steel arches at regular intervals along them with a covering between the arches to make the roadway stable and safe. However, particularly where a
10 coal seam is being extracted, the strata are liable to move and reduce the tunnel height by at least half the thickness of the seam extracted. Due to the great pressures involved it is not practical to resist this movement and the arch supports become buckled and distorted so that it is necessary
15 to replace them completely at a substantial cost and inconvenience.

An attempt to deal with this problem has been to make the arch support from several sections clamped together, these being capable of sliding against one another when the
20 load pressure approaches that at which the arch would permanently deform. However, the load at which the arch sections slide depends on the friction between them and since this depends on the tightness of the clamping it is difficult to set exactly. It also varies while the sections are sliding
25 against one another due to the coarse stick-slip characteristics of the rough steel surfaces.

A more controlled construction of the supports can be achieved by incorporating hydraulic props, but this is extremely expensive.

30 It has also been proposed to use a yieldable support element positionable between a surface and one end of a support girder supporting said surface, the support element comprising a hollow tubular housing closed at one end and capable of surrounding the support girder with its axis
35 parallel to that of the girder, and material disposed in the housing and positioned against the one end so as to resist relative axial movement of the girder and housing towards one

another. However, such elements have not given a sufficiently controlled level of load on the arch at which yielding occurs, due mainly to the types of material used to resist the movement.

5 According to the present invention the material is a block of composite material comprising a first component material having a high resistance to compression and small regions of a second component material of substantially lower resistance to compression distributed throughout the
10 volume of the first material and being compressible by the relative axial movement of the girder and housing. This material gives a controlled yield in a single and inexpensive manner.

A yieldable support element constructed in accordance
15 with the present invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 shows an arched roadway support incorporating yieldable support elements according to the present
20 invention;

Fig. 2 is an enlarged section taken on the line II-II in Fig.1;

Fig. 3 shows an enlarged sectional elevation of part of Fig. 1 before and after a load is applied;

25 Fig. 4 is a corresponding view to that to Fig. 3 showing a second embodiment of the invention.

Referring to Figs. 1 and 2, an arched roadway support for use in underground workings such as coal mines comprises two or more lengths of H-section steel girder bolted
30 together to form an arch 1. The top of the arch fits snugly against the roof of the roadway and its legs are each supported by a yieldable support element 2.

Each yieldable support element 2, as seen in Fig. 3, consists of a hollow steel tube 3 into which the bottom
35 part of the corresponding arch leg can fit. The tube is closed at the bottom and contains a block 4 of solid material supporting a square steel plate 5 which is a close

sliding fit inside the tube 3 and carries the lower end of the arch leg.

The material of the block 4 is a foamed material known as autoclaved aerated concrete which consists of concrete with small air pockets distributed throughout its volume. This material has the property of progressively collapsing under a compressive load and it is possible by careful control of the size, distribution and frequency of the air pockets to obtain a particular section value for the compressive strength.

The block 4 is selected to have a compressive strength or yield pressure just below the pressure that would be exerted on it by the plate 5 if the load on the arch were sufficient to cause permanent buckling or deformation. This causes the block to start to collapse before the critical load is reached, and it will continue to collapse until the strata movement is finished and the pressure drops again. As the block 4 collapses it is compressed by the moving plate 5 and a limit to the strata movement which can be accommodated is set by the amount of compression which the block will allow. Figure 3 shows the block before compression (3a) and at its maximum compression (3b) where all the air pockets have been eliminated. Between these two positions the compressive strength remains substantially constant at its predetermined value, giving a steady reduction in the arch height as the strata closes. When the arch has eventually contracted to the position shown in Figure 3b a new block must be put into the yieldable support element, and either the arch lowered or the tunnel heightened.

In an alternative construction shown in Fig. 4 the lower end of the arch leg rests directly on the block 4, without any intervening plate. Since the leg has an H-shaped cross section this reduces the area of contact so that the compressive strength of the block must be increased if it is to collapse at the same load on the arch, but it also allows the debris 6 from the block, as it collapses, to occupy the space between the leg and the tube 3. The

volume occupied by the debris is less than that of the corresponding piece of the block since the air pockets have been eliminated and the proportion of air pockets is selected so that the volume of debris can be accommodated in the gap surrounding the leg, without packing. This gives a greater length of travel for the leg than in the embodiment shown in Figure 3 and so can cope with a greater strata movement before requiring replacement.

The preferred material for the block 4 is autoclaved aerated concrete whose free compressive strength varies from $3.5 \times 10^6 \text{ Nm}^{-2}$ for a density of 750 kg m^{-3} to $1.8 \times 10^6 \text{ Nm}^{-2}$ for a density of 400 kg m^{-3} , the density being determined by the proportion of air pockets in the material. This is a minimum strength since it is usually greater when confined in a tube and acted on uni-axially. The arch leg section can vary in size usually between 0.075 m and 0.12 m square, giving the construction in Figure 3 a selectable load of between approximately $50 \times 10^3 \text{ N}$ and $10 \times 10^3 \text{ N}$ at which the yieldable element will collapse. These load values are of the same order as the loads which can caused bending and distortion of the arches and the required value can thus be selected from the particular arch and particular situation envisaged.

The block must accommodate a maximum movement of approximately 0.3m to 1.2m in coal mines where the strata contraction is usually approximately half the width of the seam extracted. In the construction of Fig. 3 this movement is determined by the initial height of the block and the proportion of air present, which latter factor also determines the compressive strength.

It is possible to reduce the load at which the yieldable element collapses or to make the load change with the amount of collapse without altering the proportion of air pockets, by using a block of a reduced cross-sectional area e.g. an H-section block, or one whose cross-sectional area changes along its length. In a preferred arrangement slots of predetermined width and length are machined into the sides of the block to establish the required yield characteristics.

The above described material for the block may be replaced by any other foamed material having the required compressive strength and degree of collapse. Possible materials are foamed plastics and foamed cements or concretes having pockets of either gas or soft material such as polystyrene.

The support element may be used whenever a surface is supported by one end of a support girder and there is liable to be movement of the surface and support girder towards one another. In particular it could be used in an inverted position compared to that shown in the drawings, for example between a vertical roof support girder and either the tunnel roof itself or a further support girder.

Claims:-

1. A yieldable support element positionable between a surface and one end of a support girder supporting said surface, the support element comprising a hollow tubular housing (3) closed at one end and capable of surrounding the support girder with its axis parallel to that of the girder, and material (4) disposed in the housing (3) and positioned against the one end so as to resist relative axial movement of the girder and housing towards one another, characterised in that the material is a block of composite material comprising a first component material having a high resistance to compression and small regions of a second component material of substantially lower resistance to compression distributed throughout the volumes of the first material and being compressible by the relative axial movement of the girder and housing.
2. A yieldable support element according to claim 1, wherein the block of composite material (4) is positioned between the said one end of the housing and a piston means (5) which is a close sliding fit within the tubular housing and is capable of receiving the end of the support girder.
3. A yieldable support element according to claim 1, wherein the bore of the housing has a substantially greater cross-sectional area than that of the girder, the end of the girder is received directly by the block of composite material, and the proportion of the second component material in the composite material is sufficient to allow the composite material, after compression by the relative movement of the girder and housing, to pass into the space surrounding the girder.
4. A yieldable support element according to any preceding claim, wherein the composite material is a foamed concrete in which the first component material is concrete and the second component material is a gas distributed throughout the concrete in small pockets.
5. A yieldable support element according to any preceding claim wherein the block of composite material has a cross-sectional area which changes along its length.

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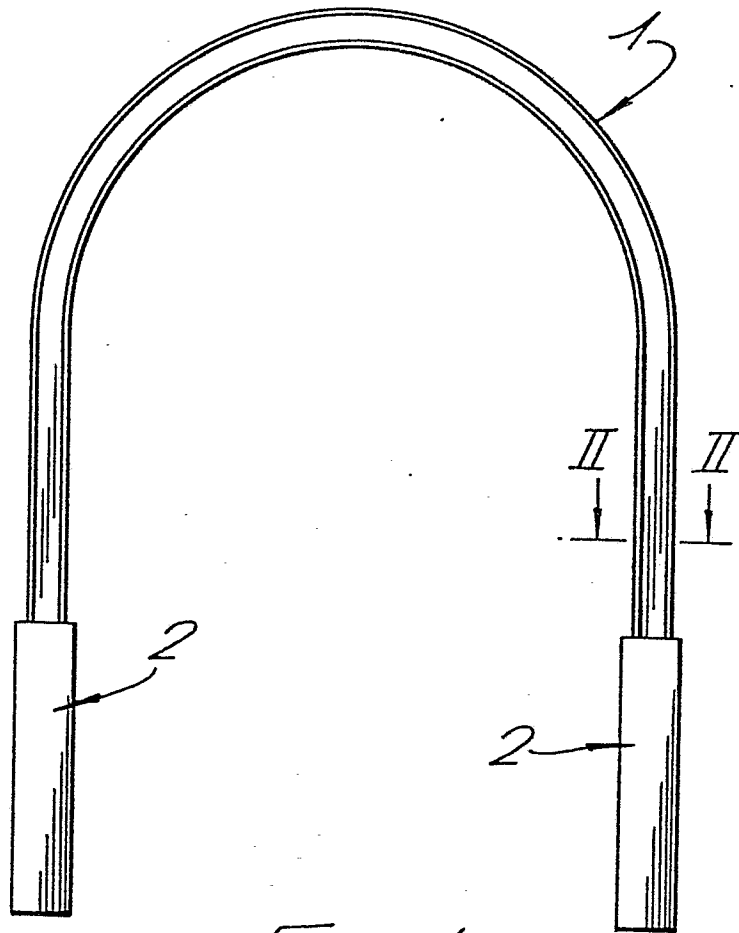


FIG. 1.

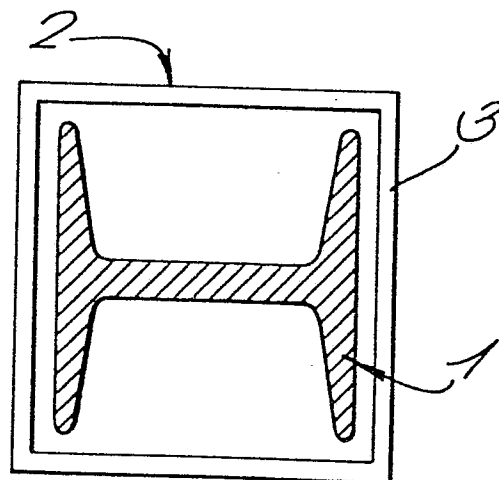


FIG. 2.

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FIG. 3.

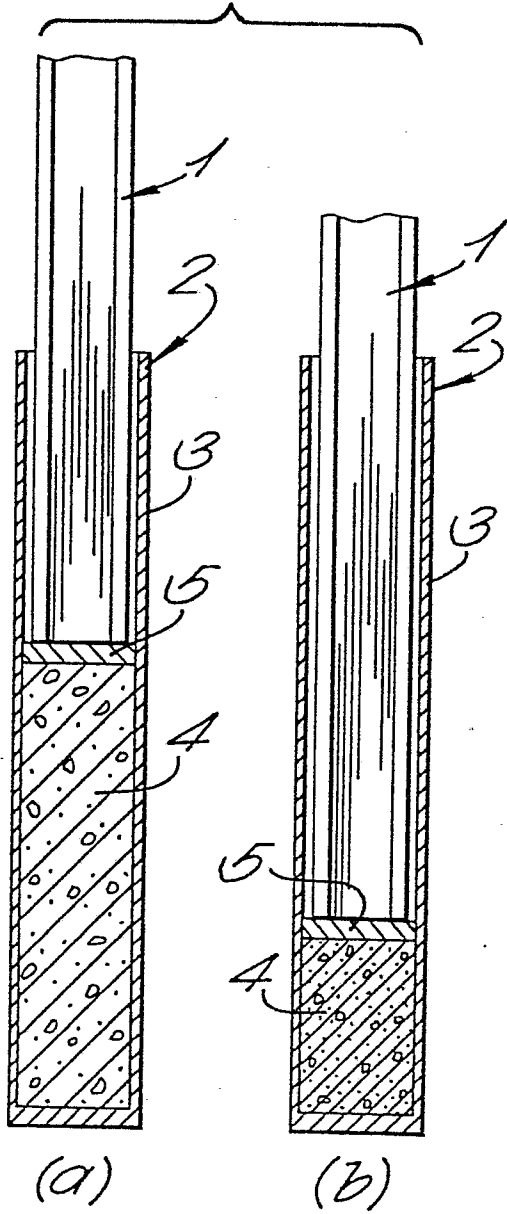
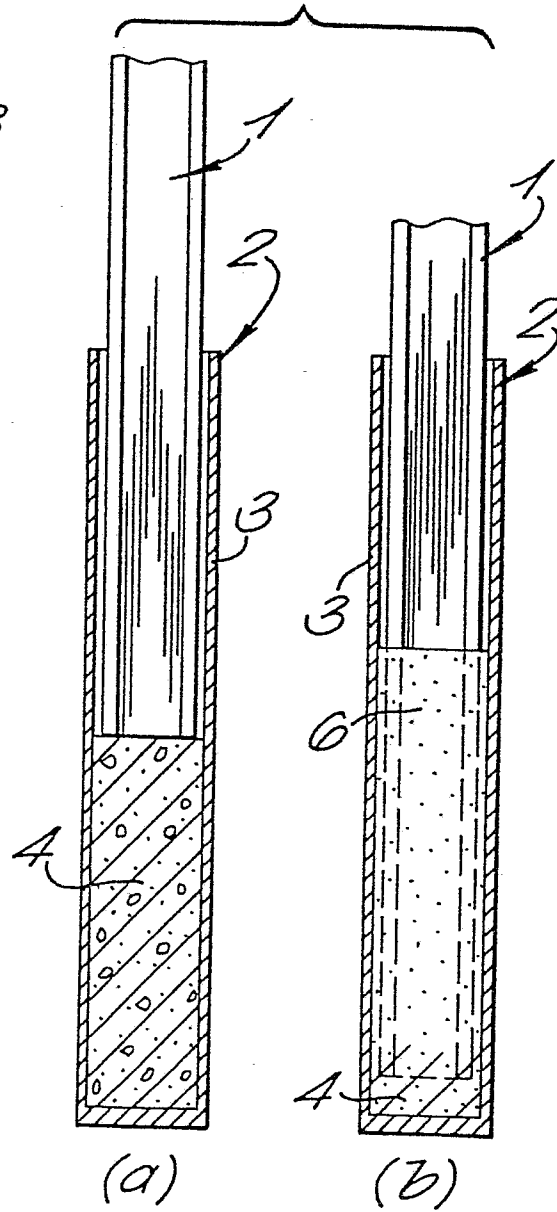


FIG. 4.





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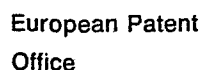
EUROPEAN SEARCH REPORT

0040096

Application number

EP 81 30 2103

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	<u>DE - B - 1 049 813</u> (ESSENER STEIN- KOHLEN) * Column 2, line 28 to column 4, line 2; figures 1,2 * --	1-3,5	E 21 D 11/30 11/18 15/18
X	<u>DE - B - 1 047 146</u> (ESSENER STEIN- KOHLEN) * Whole document * --	1,3-5	
X	<u>FR - A - 2 220 665</u> (MINE SUPPORT SYSTEMS) * Page 1, lines 1-28; page 2, line 10 to page 3, line 9; claims 1,2,4,8,9,11-14 * --	1,2,4	TECHNICAL FIELDS SEARCHED (Int. Cl.)
X	<u>FR - A - 944 055</u> (EBRARD) * Page 1, lines 1-18, 35-40; page 2, lines 44-51; figures 1,2 * --	1,2,4	E 21 D
	<u>FR - A - 376 032</u> (NELLEN) * Whole document * --	1-3	
A	<u>DE - B - 1 030 800</u> (ESSENER STEINKOHLN)		
A	<u>GB - A - 373 351</u> (KNAGGS)		
A	<u>GB - A - 1 016 292</u> (STEWARTS)		
A	<u>FR - A - 2 284 024</u> (MINE SUPPORT SYSTEMS)	./.	
X The present search report has been drawn up for all claims			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
Place of search The Hague			&: member of the same patent family, corresponding document
Date of completion of the search 29-07-1981		Examiner HAKIN	



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