March 31, 1964 KARL-THEODOR JASPER 3,126,708

COMPOUND SUPPORTING STRUCTURE FOR UNDERGROUND ROADS IN MINES

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FIG. 1

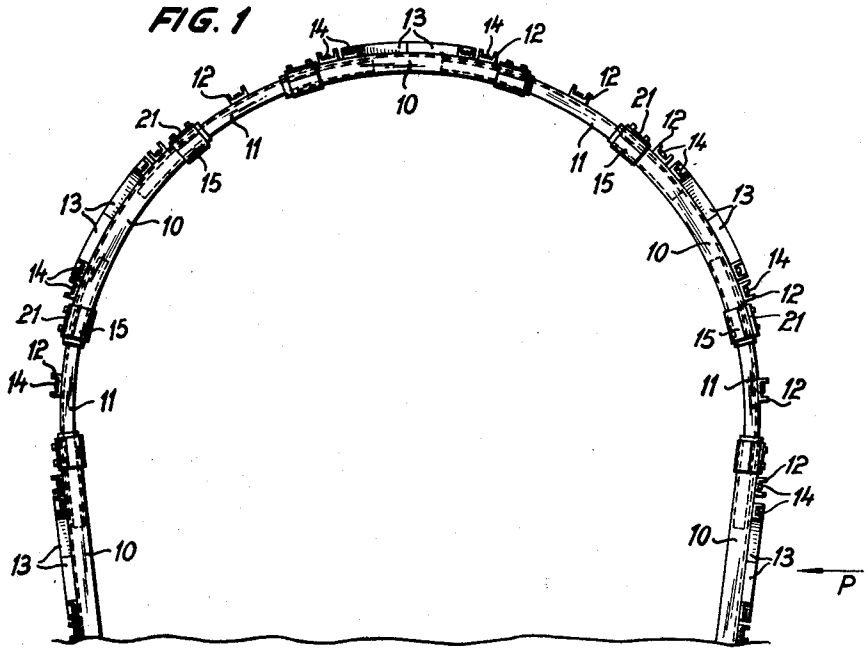
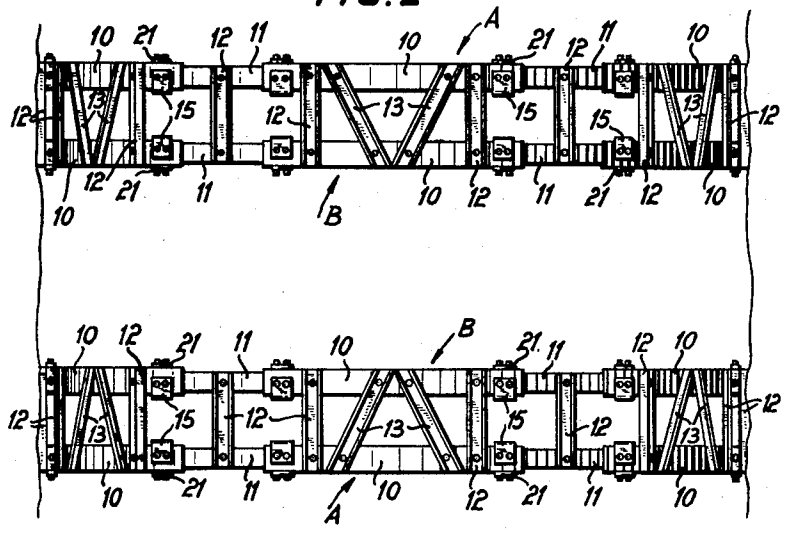


FIG. 2



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FIG. 4

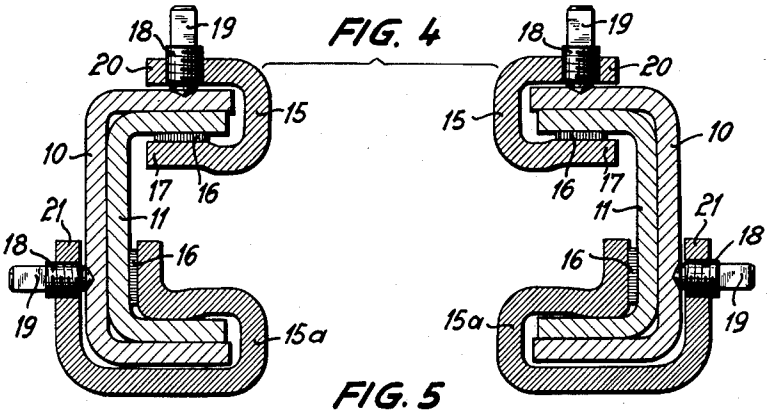
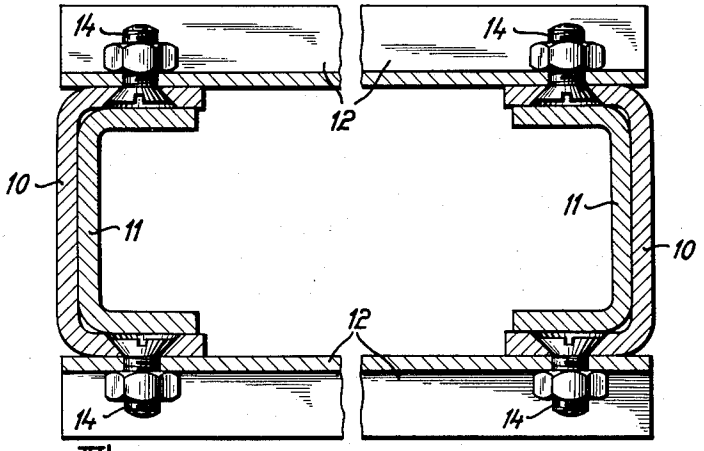


FIG. 5



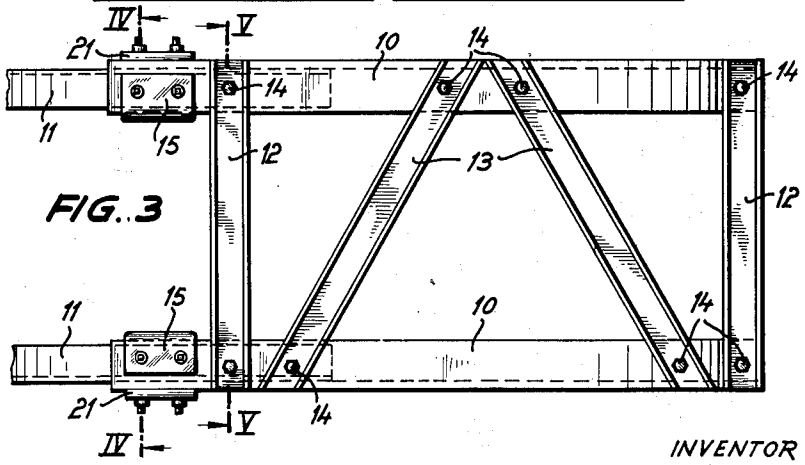


FIG. 3

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FIG. 6

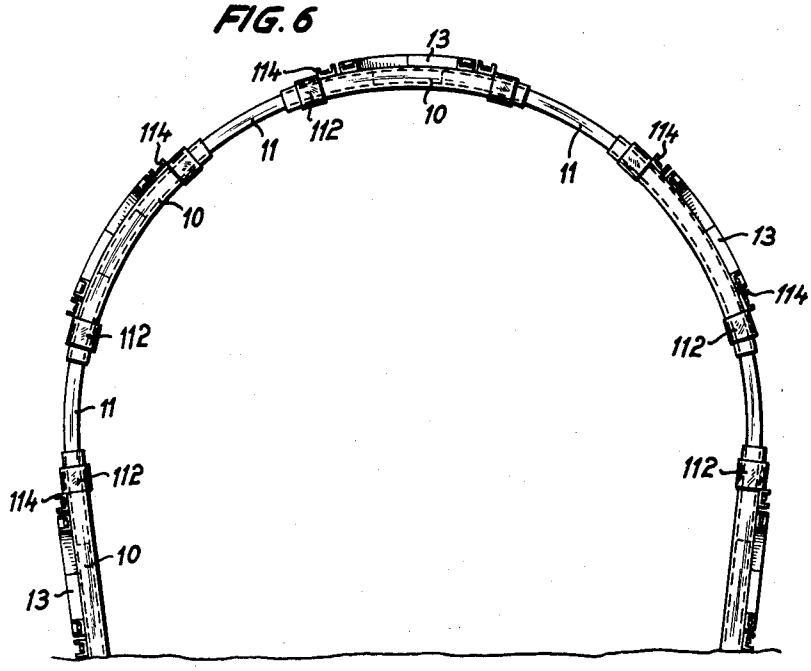
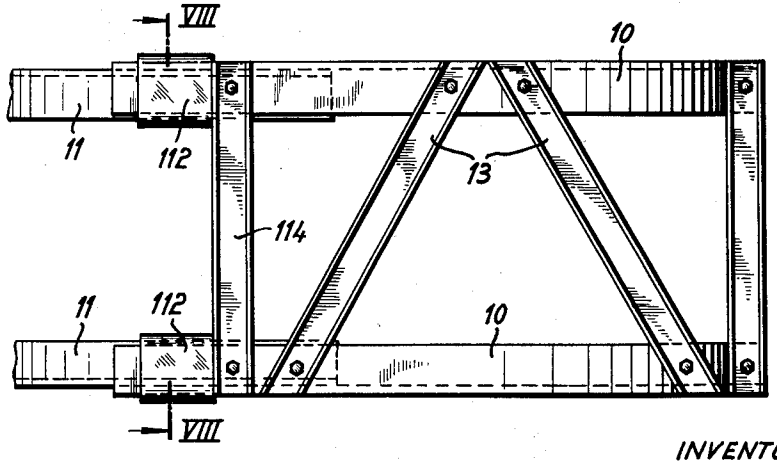


FIG. 7



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FIG. 8

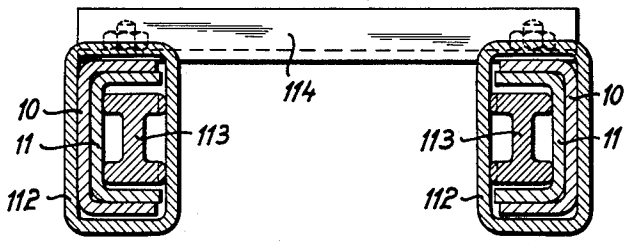


FIG. 9

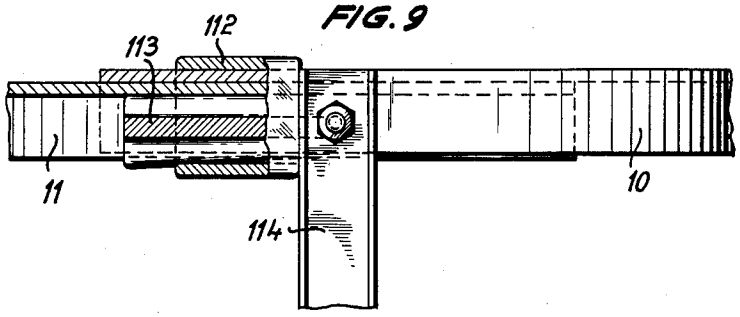


FIG. 10

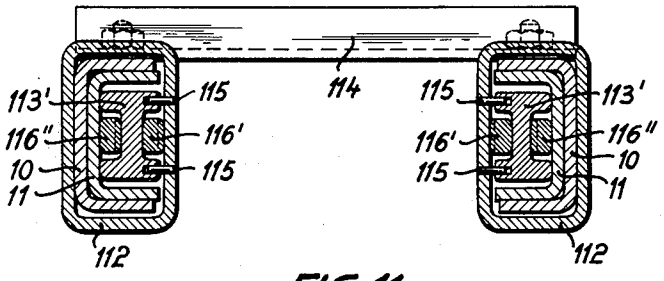
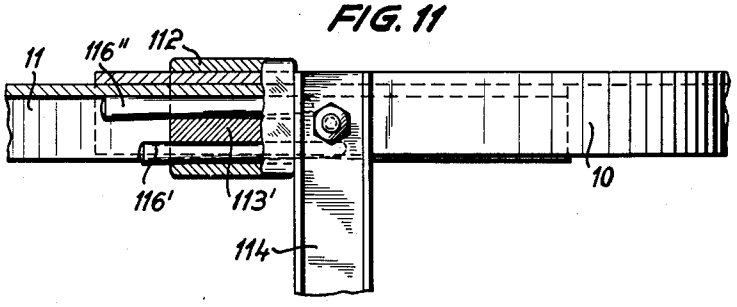


FIG. 11



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FIG. 12

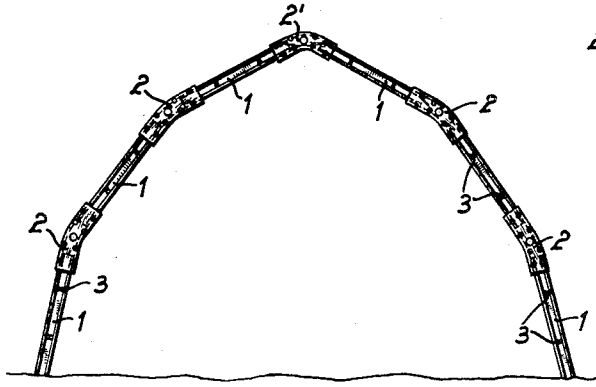


FIG. 13

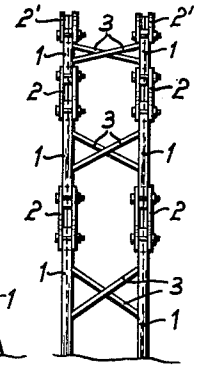


FIG. 14

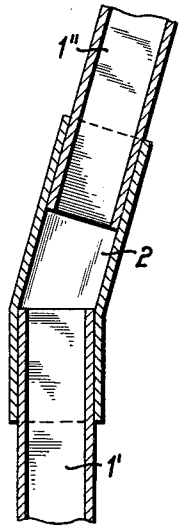


FIG. 15

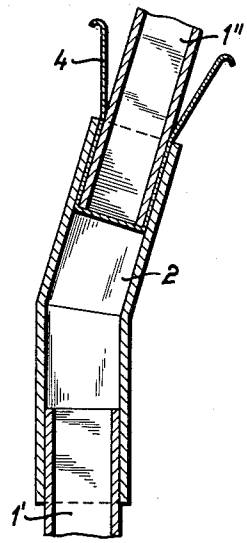
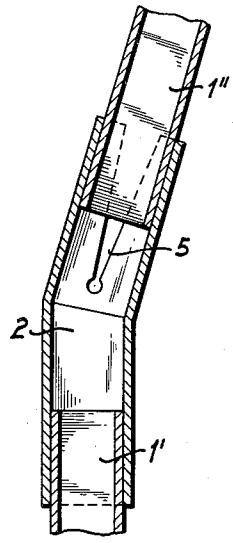


FIG. 16



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COMPOUND SUPPORTING STRUCTURE FOR UNDERGROUND ROADS IN MINES

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FIG. 17

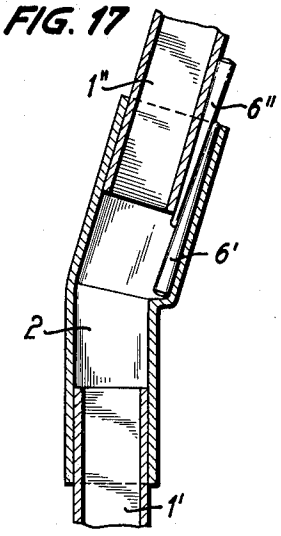


FIG. 18

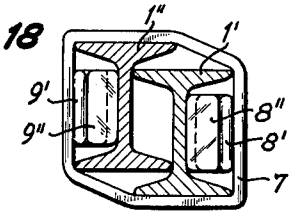


FIG. 19

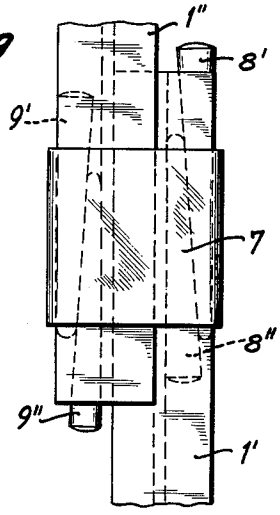


FIG. 20

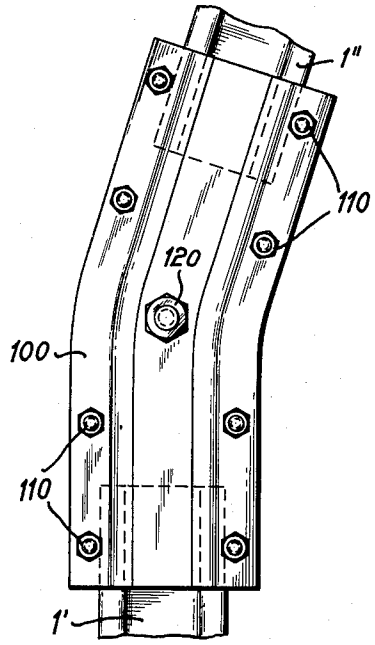
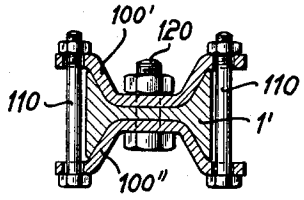


FIG. 21



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United States Patent Office 3,126,708 Patented Mar. 31, 1964

3,126,708

COMPOUND SUPPORTING STRUCTURE FOR UNDERGROUND ROADS IN MINES

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Filed Nov. 18, 1959, Ser. No. 853,751
Claims priority, application Germany Dec. 27, 1958
7 Claims. (Cl. 61—45)

The present invention relates to a compound supporting structure for underground roads in mines.

The proposed supporting structure represents a departure from the traditional principle of constructing single arches from a plurality of strong, relatively long, profiled sections clamped together so that they can slidably yield when the pressure exceeds a predeterminable limit.

The fundamental drawbacks of these known and conventional supporting structures are the great weight and bulk of the individual constituent sections, their resultant high cost, and their relative lack of adaptability to varying tunnel cross sections. The low stability of the single arch necessitates the provision of connections by bolted tension and compression members between consecutive arches along the length of the road. The presence of these connections entails the additional drawback that displacements lengthwise of the road, for instance as a result of movements in the overlying strata, do not have a merely local effect but are transmitted to neighbouring arches along the road.

The basic principle which underlies a roof supporting structure according to the present invention consists in distributing over a wider area the loads to which the supporting structures are subjected, that is to say in reducing local stresses in the supporting elements so that the supporting structure can be built up of correspondingly weaker component parts, such as relatively short individual elements in the form of sheet metal sections.

According to the invention, each of the built-up structures which is intended to replace a conventional single frame comprises a compound structure for supporting the inner surfaces of mine galleries consisting of a plurality of compound elements, each of the elements composed of a pair of relatively closely spaced elongate sections, transverse members interconnecting opposed sections of each of the elements to form an open lattice construction, the transverse members having portions extending outwardly of the sections, the end of the sections of each of the compound elements being nestably interconnected with adjacent ends of the sections of at least one adjacent compound element and forming an arched support, and means clamping the ends in yieldable relation to one another to form a support over a transverse area of the inner surface of a mine gallery.

The relatively short sections which build up an individual component arch may be slidably insertable or nestably interconnected the one into the other, preferably in the form of sheet metal U-sections of from 1.20 to 2 metres in length, the joints between the sections being established in the regions of overlap of adjacent sections. Such sheet metal sections can be easily produced by cold or hot pressing. The yieldable clamp connections which join the profiled sections together and yield when a given load is exceeded, and which are located at corresponding peripheral points of the two arches forming the compound supporting structure, may be of substantially lighter and simpler construction than the clamping straps required in conventional supporting systems.

In a first embodiment of the invention the yielding joints are secured by stirrup members which embrace flanges of the interposed sections, one shank of said stirrup-shaped member being fixedly located on the outer section, and the two interposed sections being clamped together between the locating means of said shank and the shank which bears against the corresponding inside face of the inner section.

In another embodiment which commends itself from the point of view of simplicity and convenience as well as on account of its adaptability to local conditions and the ready adjustability of its load-yield characteristics, each slidably yielding friction joint is established by a sleeve which embraces the point of overlap betwene adjacent sheet metal U-sections, the interposed U-sections being pressed against the inside wall of the sleeve by a wedge driven into the space between the opposite inside sleeve wall and the floor of the inner sheet metal U-section. This sleeve is simply pushed over adjacent sections when the structure is in course of assembly and may then rest on one of the cross members which connect the juxtaposed component arches together.

In a modified form of construction of a friction joint based on the afore-mentioned principle, which permits an even better distribution of the frictional forces, a special wedge member, for instance of H-section and secured to the sleeve, may be inserted into the space between the inside wall of the sleeve and the inner arch section, said wedge member being engageable with satisfactorily controllable wedging effect by two cooperating wedge members of opposite taper driven into the recesses formed on either side of the H-section.

The alternately outer and inner interposed sections which are therefore of two different sizes have the same static properties and like weight per unit length. This result can be achieved by appropriately designing the gauges of their respective flanges and webs.

In view of their short length and their lightness, dislocation of the sections is less likely to occur, and it is therefore unnecessary to provide two adjacent friction locks for each joint as is the case in the construction of conventional arches.

The principle which underlies the constructions which have been described above in general terms permits of slight modification inasmuch as the "lattice-like" compound supporting structure may naturally be built up of sheet metal sections other than U-sections. These may be either open sections, such as Z- and H-sections, or more particularly closed tubular round or box sections, and the component arches may be built up of like or of different types of section.

A particular type of slidable joint according to the invention permits this to be done. This consists in that peripherally adjacent straight sections of a compartment arch are yieldably connected together by intermediate elements of corresponding profile which bridge the gaps between peripherally adjacent arch sections, said intermediate elements embodying the angle required to hold adjacent arch sections in appropriate relative positions for forming the component arch. In a manner which is in principle already known these intermediate elements are elbow-shaped. The angle formed by the two shanks on each side of the elbow may be the same in all the intermediate elements which connect adjacent arch sections together but intermediate elements with different elbow angles may likewise be used. Generally speaking, the angle at the apex of the component arch is required to be more acute than the preferably similar elbow angles of the intermediate elements which form the joints down the sides.

If in the last-mentioned and preferred form of construction of the invention the component arch sections are tubular, then the intermediate elements may be in the form of sleeve-like elbow-shaped socket members

for the reception and yieldably frictional engagement of the interconnected arch sections.

According to yet another advantageous alternative embodiment, in which the profile of the intermediate elements is not so positively controlled by the profile of the interconnected arch sections, the intermediate elements are of divided two-part construction and consist of shell-like components of suitable shape which are pressed together so as to form a tapering gap of controllable width for the reception of the ends of the arch sections which are to be connected thereby.

This latter embodiment of the joint between adjacent arch forming sections also permits a more convenient arrangement for interconnecting the two component arches to form a compound structure consisting of individual elements of the utmost simplicity and like shape, and especially of sheet metal sections of equal length, interconnected by intermediate elements forming bridge members between adjacent ends of the arch sections, in a manner that is readily adaptable to tunnel cross sections of any size.

Various embodiments of compound supporting structure according to the invention will now be described, by way of example, with reference to the accompanying drawings, in which

FIG. 1 is a side view of a first embodiment of a complete built-up compound supporting structure,

FIG. 2 is a plan of two consecutive compound structures according to FIG. 1 in the underground road,

FIG. 3 shows, on an enlarged scale, a joined section of the structure of FIG. 1 as this would appear when seen in the direction of arrow P in FIG. 1,

FIG. 4 is a section, on an enlarged scale, taken on the line III—III of FIG. 3, and illustrating the formation of joints between cooperating sheet metal sections in the two component arches, this figure showing two embodiments of clamping means employed for forming the joint,

FIG. 5 is a section, on an enlarged scale, taken on the line IV—IV of FIG. 3, illustrating the manner in which the component arches are cross-connected to form a structural assembly,

FIG. 6 is a view of a compound supporting structure, similar to that shown in FIG. 1, in which sleeve-like clamping means are used to establish the joints,

FIG. 7 shows, on an enlarged scale, part of the structure according to FIG. 6, viewed in the direction towards the side face of the road,

FIG. 8 is a section, on an enlarged scale, taken on the line VII—VII of FIG. 7,

FIG. 9 is a detail, on an enlarged scale, of the compound supporting structure according to FIG. 7,

FIGS. 10 and 11 are sections, similar to FIGS. 8 and 9, of an alternative embodiment of the joint between arch sections,

FIG. 12 is a side view of a second embodiment of a compound supporting structure employing intermediate elements for joining together the component arch sections,

FIG. 13 is an end view corresponding to FIG. 12 showing the lattice-type cross bracing between the two component arches of the structure,

FIGS. 14, 15, 16 and 17 show, on an enlarged scale, various embodiments of elbow-shaped intermediate elements for use in the supporting structure of FIG. 12 to provide the yieldable connection with one of the two component arch sections which are joined together thereby.

FIGS. 18 and 19 are a cross section and side view, respectively, of a simple yieldable connection between two relatively staggered overlapping H-sections, and

FIGS. 20 and 21 are a side view and cross section, respectively, of an embodiment of an intermediate connecting member comprising two shell-section halves bolted together for clamping the ends of the component arch sections between them.

Referring to FIGS. 1 and 2, the compound supporting structure shown comprises two component arches A and B, each comprising alternate outer and inner sheet metal sections **10** and **11**. Each component arch in the example shown comprises a total of nine such sections, considerably more sections than are used in conventional underground road roof-supporting arches. Corresponding sections of the two component arches are arranged so that their open sides face each other. The sheet metal sections **10**, **11** in the illustrated embodiment are pressed U-sections clamped together in a manner described hereinafter so that their lapped joints can slidably yield.

Corresponding sections **10** and **11** in the two component arches A and B are connected together by transverse members **12** and/or **13** located outside the region of overlap between adjacent sections, so as to form rigid rectangular structures which are joined in the peripheral direction of the compound arch by clamping elements which connect adjacent sections **10** and **11** in such a way that they can yield when the load exceeds a predetermened maximum limit.

The transverse members **12**, **13**, which may also be U-section elements, are bolted to the sections **10**, **11** by bolts **14** with countersunk heads (see FIGS. 1 and 5) so that the bolts will not interfere with the sliding of an inner section **11** in an outer section **10**.

In a first illustrative example of clamping means shown in the upper part of FIG. 4 for connecting adjacent U-sections **10**, **11** together, one shank **20** of a stirrup member **15** which is bent through an angle of 180° is located in the region of overlap on the outer flange of the outer U-section **10**, whereas the other shank **17** extends into the interior of the inner U-section **11** and carries a friction pad **16** on that side which faces the flange of the inner U-section.

In an alternative form of construction, shown in the lower part of FIG. 4, the stirrup-member **15***a* of the clamping means is located on the web of the outer U-section **10** and embraces the flanges of the two overlapped sections **10** and **11** so as to extend into the interior thereof, the inside face of the stirrup member being likewise provided with a friction pad **16** which bears against the inside of the web of the inner U-section **11**.

The location of the stirrup members **15**, **15***a* on the outer section **10** may be effected by screws **18** which engage a threaded hole in the outer stirrup shank **20**, **21**, respectively, and which have pointed ends which are adapted to engage a depression in the outer section **10**. When the screws **18**, which are formed for instance with square ends **19**, are tightened, the stirrup members are thereby positively located on the outer section **10** and at the same time the shank of the stirrup member which carries the friction pad **16** is pulled into tight slidable contact with the inner section **11**.

The compound supporting structure shown in FIGS. 6 and 7 differs from that illustrated in FIGS. 1 and 3 merely in that use is made of a different type of clamping means which is shown in greater detail in FIGS. 8 and 9. In principle this form of clamping means consists of a closed sleeve **112** which, in the region of overlap of two sections **10**, **11**, completely embraces the two sections which are wedged between opposite walls of the sleeve by the interposition of a wedge means **113** to form a yielding connection. As shown in FIGS. 8 and 9 the wedge means **113** may be a generally H-section key element which is pushed from above into the interior of the overlapping U-sections **10**, **11**.

The sleeve **112** is held on the outer section and supported by a transverse member in the form of a U-section strut **114** which connects together the two component arches of the compound supporting structure. It will be readily understood that the wedge means **113** is sufficiently long to project from each end of the sleeve

112, so that it can be easily knocked into place or knocked out when the assembly is to be dismantled.

The embodiment of clamping means shown in FIGS. 10 and 11 differs from that shown in FIGS. 8 and 9 merely by the insertion into the interior of the inner section **10** of the frame of a wedge-shaped filler **113'** of H-section which is held in the sleeve **112** by locating pins **115** or other oppropriate means, the two sections **10** and **11** being clamped together by driving wedges **116'**, **116''** of opposite taper to that of the filler member **113'** into the recesses formed by the latter. The surfaces of the wedges **116'**, **116''** will therefore bear along their entire length on the cooperating surfaces of sleeve **112**, inner U-section **10** and filler member **113'** upon which the wedges act.

FIGS. 12 to 21 illustrate an embodiment of a compound supporting structure built up from straight sections of arbitrary profile and equal length, which sections are yieldably connected together by intermediate elements which bridge gaps between the ends of adjacent sections, and which have cross sections that appropriately correspond with the profiles of the joined sections, each intermediate member being formed with an elbow to produce the required overall shape of the compound structure.

With reference to FIGS. 12 and 13, the structure illustrated consists of six sections **1** interconnected in yieldable manner by intermediate elbow-shaped shoe elements **2**. The numeral **3** designates cross members and struts which connect and brace the two component arches of the compound supporting structure.

Generally speaking, the assembly of a structure of the type illustrated in FIGS. 12 and 13 will call for the provision of only two different kinds of intermediate elements **2** which differ in the angle formed by the elbow. One of these, as indicated at **2**, will then be suitable for forming the corners against the side walls of the road, whereas the other, indicated at **2'**, has a somewhat more acute elbow angle and may be used to join the sections of the structure at the apex.

This form of the supporting srtucture is suitable not only for use in roads driven through rocks but also for gate roads driven into the seam, because it permits the apex of the arch to be displaced according to the incidence of the seam. The fact may thus be utilised with advantage that the resultant skew structure formed by the component arches will be able largely to make good the deficiency in strength of conventional profiles in the Y-axis.

The elbow-shaped connecting elements **2** and **2'** which themselves form the angle between consecutive sections **1** can be embodied in various ways, examples of which are shown in FIGS. 14 to 17. In FIG. 14 an element **2** is shown permanently fixed to one (**1'**) of the sections **1**, preferably by being shrunk on to the same, and the possibility may be envisaged of contriving the shrunk-on joint so as to yield when a certain load is exceeded, this naturally being a much higher load than that at which the connection as such is calculated to yield. For instance, the shrunk joint may be designed to support a load of say 30 tons.

On the other hand, the connection with the adjacent section **1''** of the component arch is so contrived that this section will slide into the socket-formed element **2** when the load exceeds a much lower given maximum limit. The distance between the ends of adjacent sections **1'**, **1''** which is bridged by an element **2** is suitably designed to take into account the desired maximum yield. It will be readily understood that the arrangement may be optionally such that either the lower section **1'** or the upper section **1''** will yield by sliding into the element **2** at the lower maximum load. The important feature is that the joints between the component arch sections and the elbow-shaped element **2** which bridges the interval between the ends of the sections will have different load-yield points.

The length of the straight sections **1** which build up the component arches is uniform and may be adapted to the overall cross section of the supported road. For instance, for a small road cross-section of say 5 sq. m. the sections may be 1 metre long, whereas in a road cross-section of 20 sq. metres they may be up to 2 metres long. In other words, even in the largest roads the sections will still be conveniently portable, especially as their sheet metal construction ensures a light weight.

FIGS. 15 to 17 illustrate possible alternative forms of elbow-shaped socket-formed intermediate elements permitting a yielding connection between one of the supporting structure sections and the element.

In FIG. 15 the end face of section **1''** which is to be yieldably secured is provided with a binding **4** which is entrained and pushed into the elbow-shaped socket-formed element **2** when section **1''** is inserted therein, frictional resistance rising as the depth of insertion increases, so that the load-carrying capacity is thereby controlled.

In FIG. 16 the elbow-shaped element **2** is formed at one end with a tapering slot which produces the desired wedging effect.

FIG. 17 illustrates an embodiment in which section **1''** is wedged in the elbow-shaped element **2** by the cooperation of two oppositely acting wedges **6'** and **6''** inserted longitudinally of the section into a pocket-like enlargement of the element **2**.

A similar clamping effect may be obtained by the provision of two oppositely acting transverse wedge members.

A suitable wedge connection for directly joining two H-profile sections is illustrated in FIGS. 18 and 19. The two sections, placed together in such manner that one flange of one section bears against the web of the other in staggered juxtaposition are wedged inside a sleeve **7**, wedge-shaped keys **8'**, **8''** and **9'**, **9''** being driven into the inter-spaces between the webs of the sections and the insides of the sleeve for tightly joining the sections together.

Other forms of construction of elbow-shaped socket-formed intermediate elements and clamping means which can be used for profiled sections other than tubular sections (FIGS. 14 to 17) can be readily devised.

A particularly convenient arrangement for forming a yielding joint for instance between H-sections is illustrated in FIGS. 20 and 21.

In this embodiment the connecting elements are in the form of two shell-shaped members **100'** and **100''** which project into the corresponding profile of the component arch sections and are bolted together with an appropriate number of nuts and bolts **110**. Moreover, in order to produce, or adjust to, a desired load-yield characteristic by tightening the gap between the two shell-shaped elements, a further bolt **120** is located about midway between the opposed ends **1'** and **1''** of the connected sections and adapted to be more or less tightened to pull the centres of the shell-shaped sections together.

The bolts **110**, as well as bolt **120** which controls the width of the gap between the cooperating shell-shaped members, may, if desired, be replaced by bolts which can be tightened by wedges.

If the bolts are tightened sufficiently, the described connection can be made so rigid as to be practically incapable of yielding under increasing loads.

Even if the component arches should be built up of a lesser number of sections than herein described, for instance of five sections only, the sections are nevertheless all areanged to be of like length. In the case of an odd number of sections, the section at the apex of the component arch is of curved shape. The form of the elbow-shaped intermediate elements will not be affected, all said elements being of equal length, and incorporating the

same elbow angle. Moreover, this angle remains unchanged for roads of any cross-section.

In one embodiment of the supporting structure, using straight sections of limited length yieldably connected together by elbow-shaped intermediate elements which bridge the gaps between the ends of said sections, an especially advantageous arrangement consists in interconnecting the two component arches by means of crossed tie-rods secured by thread and nut to the centre part of the sections to form a rigid lattice-type structure.

It will be readily understood that the invention is not confined in scope to the illustrative examples which have been described by reference to the accompanying drawings. Numerous other modifications can be devised so as to embody the principles that underlie the invention.

For instance, clamped joints of the kind illustrated in FIGS. 18 and 19 or 20 and 21 could be applied to conventional roof supporting arches for forming the yielding connections between the customary stilts and the adjacent upwardly extending member of the arch. In such an application the joints according to the invention permit the yield and load resistance to be regulated and controlled in a particularly useful manner and, if desired, the joints could even be tightened until the resultant connection was rigid.

Moreover, by embodying the stilts or a yielding support in the form of two shell-like elements to establish a yielding connection by suitably tightening an appropriate number of tie bolts and nuts 110 with the simultaneous adjustment of the gap between the two members—which would then naturally differ from FIG. 20 by being straight instead of bent—any desired load-yield characteristic could be obtained without the need of specially preparing or machining the pair of shell-like elements or the arch sections which the elements grip.

I claim:

1. A compound structure for supporting the inner surfaces of mine galleries comprising a plurality of compound elements, each of said elements composed of a pair of relatively closely spaced elongate sections, transverse members interconnecting opposed sections of each of said elements to form an open lattice construction, said transverse members having portions extending outwardly of said sections, the ends of said spaced sections of each of said compound elements being nestably interconnected with adjacent ends of the sections of at least one adjacent compound element and forming an arched support, and means clamping said ends in yieldable relation to one another to form a support over a transverse area of the inner surface of a mine gallery.

2. A compound structure as defined in claim 1 wherein said sections and said transverse members are formed of sheet metal of substantially U-shaped cross-section.

3. A compound structure as defined in claim 2 wherein the open sides of said sections face one another.

4. A compound structure as defined in claim 1 wherein said clamping means comprises a stirrup-shaped member embracing said sections in the zone of nestably interconnected ends, said stirrup-shaped member including at least two shank portions, one of said shank portions fixedly engaged on the outer surface of one of said sections and the other of said shank portions bearing against the corresponding inside surface of the other of said sections.

5. A compound structure as defined in claim 4 wherein a friction pad is interposed between the other of said shank portions and the inside surface of the other of said sections.

6. A compound structure as defined in claim 1 wherein said clamping means comprises a sleeve embracing said sections in the zone of the nestably interconnected ends, and a wedge means interposed between the inner surface of said sleeve and the inner surface of the innermost of said sections.

7. A compound structure as defined in claim 6 wherein said wedge means comprises an H-section wedge member secured to the inside of said sleeve in the space between the inside surface of the innermost of said sections, and additional wedge members of an opposite taper disposed within the recesses formed on either side of said H-section and the inner surface of the innermost of said section and said sleeve, respectively.

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