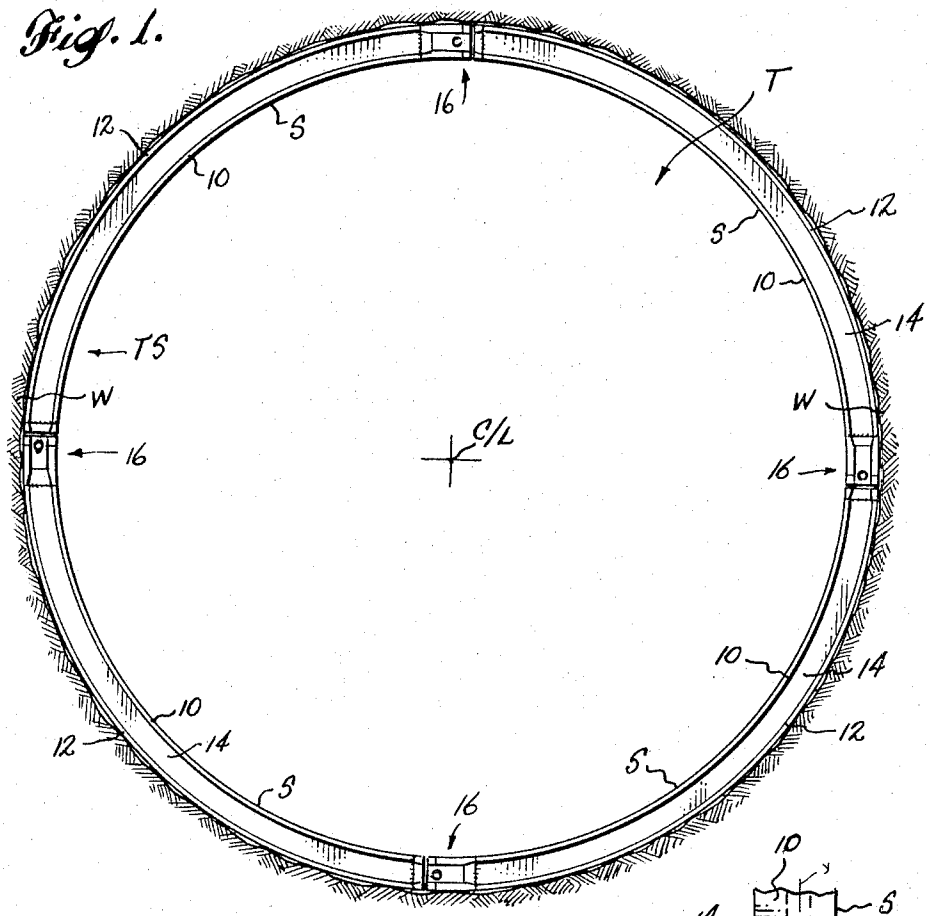
May 9, 1967 D. B. SUGDEN 3,318,099

ADJUSTABLE TUNNEL SETS

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Fig. 1.



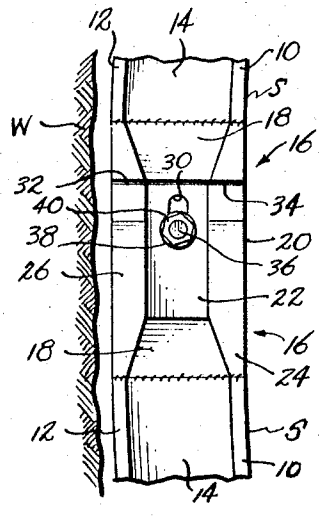


Fig. 2.

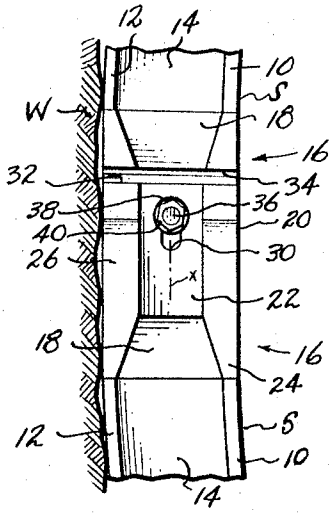


Fig. 3.

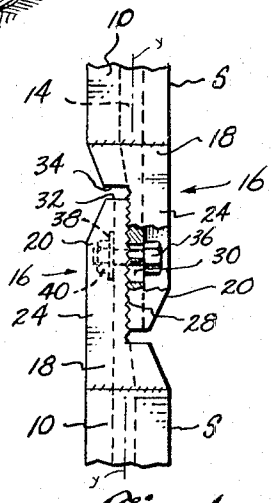


Fig. 4.

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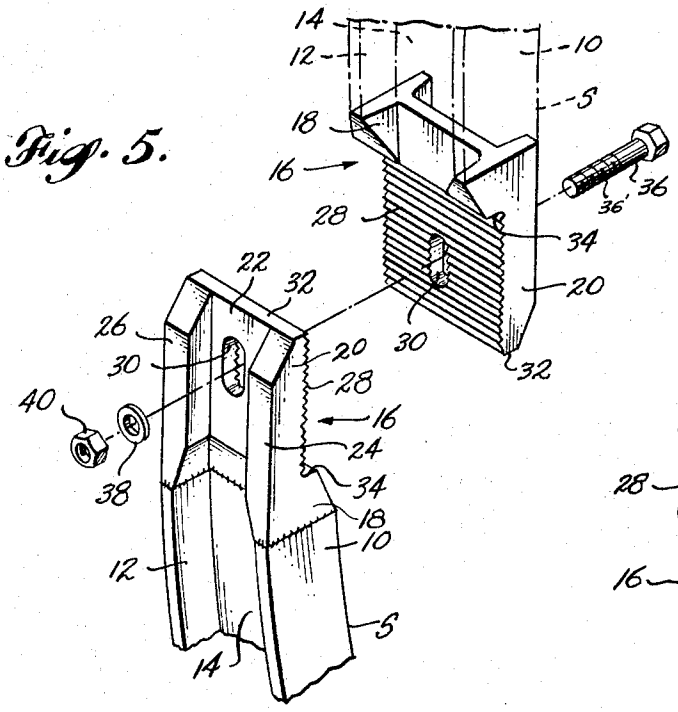
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ADJUSTABLE TUNNEL SETS

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Fig. 5.



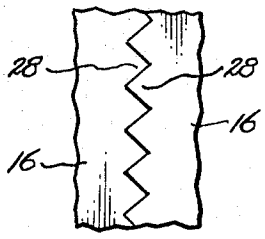


Fig. 6.

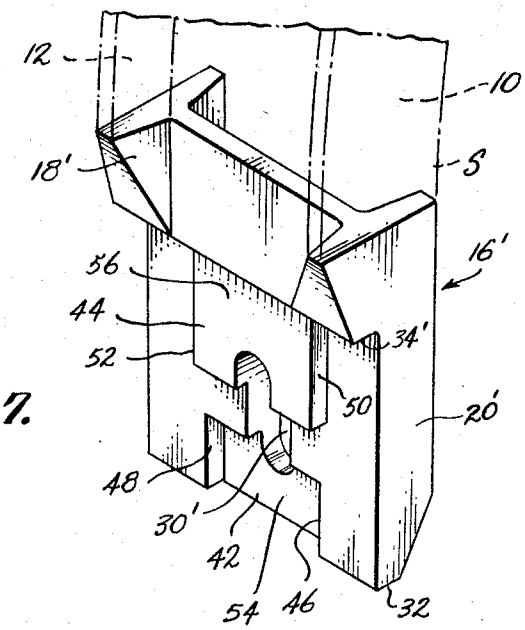


Fig. 7.

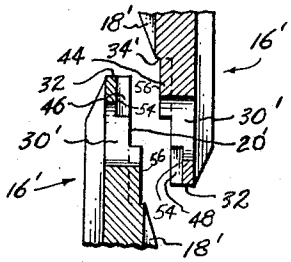


Fig. 8.

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ADJUSTABLE TUNNEL SETS

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Fig. 9.

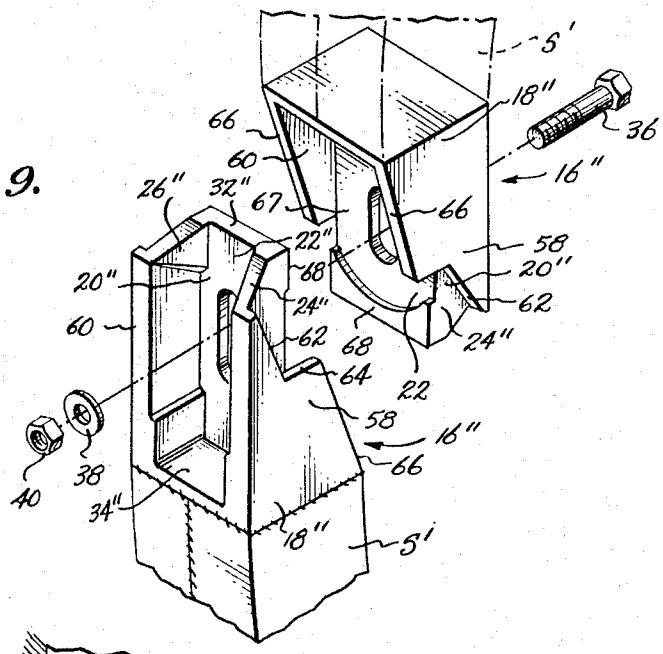
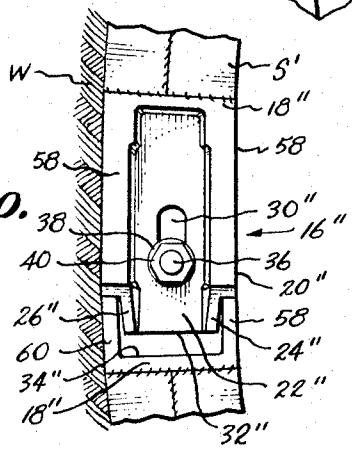


Fig. 10.



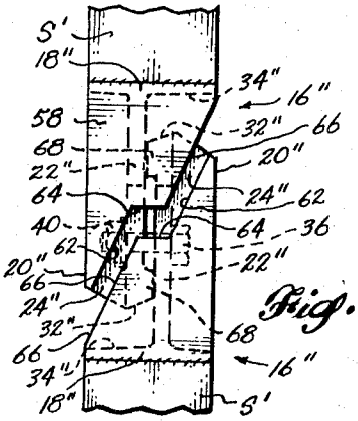


Fig. 11.

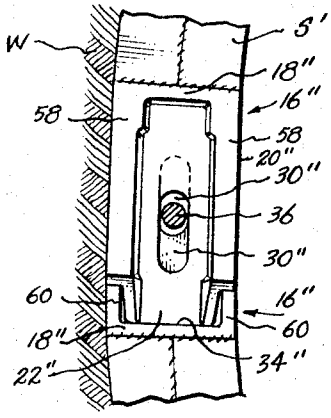


Fig. 12.

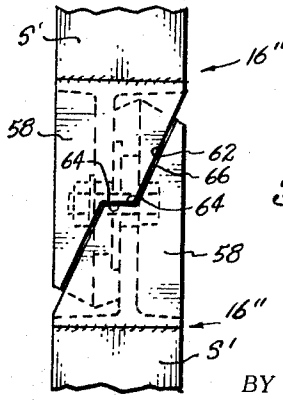


Fig. 13.

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United States Patent Office 3,318,099
Patented May 9, 1967

3,318,099

ADJUSTABLE TUNNEL SETS

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Filed July 6, 1964, Ser. No. 380,370
14 Claims. (Cl. 61—45)

The present invention relates to tunnel sets or ribs, and more particularly to the provision of an adjustable, structural steel tunnel set, especially adapted to be simply and quickly assembled at the desired location in a tunnel, and then adjusted as to size so that it fits closely against the tunnel wall at such location, and to yieldable tunnel sets.

When a tunnel is excavated, it is generally necessary to install some sort of support structure for the overhanging portion of the tunnel wall so as to prevent a cave-in. This support structure most commonly comprises "tunnel sets" or "ribs," consisting of a framework or structural figure of timber or steel extending across the tunnel section at regular intervals, and "lagging" consisting of wood or steel beams, steel plates, etc., bridging the spaces between sets and transmitting the rock load in such spaces to the sets.

Conventional tunnel sets of structural steel, such as those disclosed in the text "Rock Tunneling With Steel Supports," by R. V. Proctor and T. L. White, published 1946 by the Commercial Shearing and Stamping Company, Youngstown, Ohio (noting pages 120–122 in particular), for example, are of sectional construction and comprise "butt joint" connections between sections. These connections, specific examples of which are illustrated on pages 241–243 of the above-identified text, consist of a flat metal plate welded to the end of each section and disposed so as to abut the plate on the end of the next section, and a plurality of bolt fasteners or the like securing such plates together. This provides a strong and rigid joint, which is desirable, but results in a "fixed size" tunnel set. Since the tunnel set must be designed to have an outside dimension that is slightly smaller than the tunnel bore, so that it can be readily assembled in the tunnel, a space exists between the assembled conventional set and the tunnel wall. This space must be filled by wooden wedges or similar devices in order for the weight of the rock to be transmitted to the sets to be carried thereby.

Tunnel sets according to the present invention are characterized by adjustable joints or connections between sections, enabling such sets to be initially assembled in a slightly undersized condition, and then expanded until it fits closely against the rock well, thereby obviating the need for wooden wedges or other types of "blocking."

Generally speaking, tunnel sets according to the present invention are characterized by a plurality of rolled steel sections successively joined together at their ends by adjustable joint means, each such joint means comprising a pair of mutually side lapping joint elements having mating joint surfaces formed on the inboard sides thereof, which joint surfaces are disposed generally perpendicularly of the center line of the tunnel. The joint elements each are formed to include a bolt receiving slot opening extending transversely therethrough, generally axially of the tunnel, with each said bolt receiving slot opening being at least partly in register with the other such opening, and being elongated generally axially of its joint element. A transverse bolt extends through both of the slot openings and serves to detachably and adjustably secure the joint elements and hence the tunnel set sections together. The slot openings permit a limited amount of longitudinal movement of the joint elements

relative to each other so that once assembled the tunnel set can be expanded until it fits closely against the tunnel wall at its particular location in the tunnel. According to the invention, bolt means, preferably a single bolt, is used at each joint and the joint faces of the joint elements are formed to include interfitting projections and recesses, serving to prevent relative rotation of said joint elements about said bolt means. In tunnel sets to be used in tunnels formed in relatively hard rock, wherein the tunnel set must support "rock loads," the interfitting projections and recesses may take the form of serrations, all of which are perpendicularly related to the slots in the joint elements, and serve to prevent relative sliding movement of the joint elements when the transverse bolt is tightened. In tunnel sets to be used in "squeezing ground" the projections and recesses are preferably in parallelism with the said elongated slot, so that the joint will permit a predetermined amount of controlled contraction of the tunnel set in response to the pressure exerted thereon by the "squeezing ground."

Other objects, features, characteristics and advantages of the present invention include the provision of an improved form of structural steel tunnel set, comprising at least two I-beam sections or the like related end-to-end. Intermediate their ends the sections possess a generally uniform I-shaped cross-section formed by inner and outer flange portions and an interconnecting web portion. A joint component having a generally [-shaped cross-section formed by inner and outer flange half-portions and an interconnecting web half-portion is provided at the ends of each section. The inboard side of the web half-portion is generally coextensive with the major axis of the adjacent web portion. At each joint a pair of said joint components sidelap each other and together possess a generally I-shaped cross-section, substantially corresponding in shape to the cross-section of the beam sections between joint components. Each said joint component includes a bolt receiving opening in its web half-portion which is at least partly in register with the bolt receiving opening in the web half-portion of the next beam section. A bolt is inserted through the two openings and a nut is threaded onto its end and tightened so as to clamp and secure the two joint components together.

These and other objects, features, advantages and characteristics of the present invention will be apparent from the following description of certain typical and therefore non-limitive embodiments thereof, wherein like numerals and letters refer to like parts, and wherein:

FIG. 1 is a transverse sectional view of a tunnel incorporating tunnel sets according to the present invention, said view presenting in the foreground an elevational view of one of said tunnel sets in place and adjusted so as to be in contact with the tunnel wall;

FIG. 2 is a fragmentary side elevational view, on an enlarged scale, of the tunnel set in the vicinity of one of the expansible joints which interconnect the several segments of the tunnel set and make it possible to adjust the tunnel set to fit the girth of the tunnel at its particular location in the tunnel, such view showing the two joint members clamped together intermediate the limits of adjustment provided by the bolt receiving slots, and showing the outer surface of the tunnel sets spaced slightly inwardly from the tunnel wall;

FIG. 3 is a view similar to FIG. 2, but showing the joint members clamped together substantially at the point of maximum adjustment, and show the outer surface of the tunnel set in contact with the tunnel wall;

FIG. 4 is a fragmentary elevational view of the joint construction of FIG. 3, taken at a right angle to the view of FIG. 1, and looking toward the inner flange portions of the beam sections;

FIG. 5 is an exploded perspective view of the joint detail shown in FIGS. 2–4, such view showing the serrations at the joint face, and such view also showing the perpendicular relationship of said serrations to the elongated bolt receiving adjustment slot;

FIG. 6 is a fragmentary elevational view of the central portion of FIG. 4, but on a larger scale, such view showing the ridges of the serrations on each joint member interfitting into the valleys of the serrations on the other joint member;

FIG. 7 is a perspective view of a modified form of joint member according to the present invention, such form being especially adapted for use in squeezing ground, said joint member constituting one of a complementary pair of said joint elements, and involving axially aligned boss and channel portions; situated generally at opposite ends of the bolt receiving adjustment slot;

FIG. 8 is an elevational view, with parts in section, of a pair of said modified joint members interrelated as they are at a joint;

FIG. 9 discloses still another modified form of joint member according to the present invention, such form also being adapted for use in squeezing ground, the view of FIG. 9 being an exploded perspective view of a pair of said modified joint members interrelated as they are at a joint, but in spaced relationship;

FIG. 10 is a fragmentary side elevational view, similar to FIG. 3, but involving the form of joint member shown by FIG. 9, such view showing the joint members clamped together substantially at the point of maximum adjustment, and showing the outer surface of the tunnel set in contact with the tunnel wall of squeezing ground;

FIG. 11 is a fragmentary elevational view of the joint construction of FIGS. 9 and 10, taken at a right angle to the view of FIG. 10, and looking toward the inner flange portions of the beam sections;

FIG. 12 is a view similar to FIG. 10, but showing the joint members moved together in end abutting relationship, with the squeezing ground still in contact with the outer flange portions of the beam sections, such view presenting the clamping bolt in section and showing that when the two joint members are in end abutting relationship the compression forces are not carried at the joint by the clamping bolt, but rather are transmitted between abutting surfaces of the joint members; and

FIG. 13 is a fragmentary elevational view of the joint condition shown in FIG. 12, taken at a right angle to the view of FIG. 12.

Referring now to the details of the illustrated embodiments of the invention, in FIG. 1 a full circle tunnel set or rib TS, constructed according to the present invention, is shown assembled in a tunnel T which has been excavated by a rotary cutterhead tunneling machine, such as that disclosed in the James S. Robbins U.S. Patent No. 2,988,348, issued June 13, 1961, and entitled "Rotary Tunneling Machines." By use of such a machine, a relatively clean, substantially circular bore results. Owing to the adjustable joint construction, shortly to be described, the tunnel sets TS of the present invention can be initially assembled in an undersize condition and then expanded so that its outer periphery fits closely against the tunnel wall W.

The tunnel set illustrated in FIG. 1 comprises a plurality of rolled steel sections or segments S, each being an arcuate I-beam, H-beam, wide flange beam, etc. The inner and outer flange portions **10**, **12** of the sections S are concentrically related to and of the same curvature as the tunnel wall W. The web portion **14** of the sections S is disposed in a plane related perpendicularly to the center line C/L of the tunnel T.

Referring now to FIGS. 2–5, the terminal portions **16** of the sections S constitute joint components or members **16**. The joint components **16** are of identical construction and each comprise a mounting portion **18** and a clamping portion **20**. As clearly shown in FIG. 5, the mounting portion **18** has a cross-sectional shape matching that of the span portion of the tunnel set section S to which it is connected, as by welding, for example, i.e. it has an I-shape cross-section. The clamping section **20** is preferably about one-half as thick as the mounting portion **18**. Its inboard side constitutes the joint face, and such joint face is situated generally in the same transverse plane as the major axis *y* of web portion **14** (FIG. 4). As shown in FIG. 5, the clamping portion **20** has a generally [-shaped cross-section formed by a web half-portion **22** and inner and outer flange half-portions **24**, **26**.

In the embodiment illustrated by FIGS. 2–6, the joint face comprises a plurality of serrations **28**, related perpendicularly to an elongated bolt receiving opening **30** formed in the web half-portion **22**. The side boundaries of the opening **30** are in parallelism with the center axis *x* of web half-portion **22**.

When the tunnel set S is to be initially assembled the two joint components at each joint are brought together into sidelapping relationship and are moved lengthwise until the end surface **32** of each substantially abuts against the shoulder **34** of the other, as shown by FIG. 2. This puts the inboard portions of the respective slots **30** into alignment. A bolt **36** is inserted through the two slot openings **30**, and then a washer **38** is inserted over, and a nut **40** is threaded onto its threaded end portion **36'**. At the first joints to be assembled the nut **40** is at first loosely tightened to hold the joint component **16** together while the remaining connections are being made. When the tunnel set S is first assembled its outside diameter is slightly smaller than the bore diameter of the tunnel T. This is illustrated in FIG. 2 wherein the outer flange portions **12** of the sections S, and the outer flange half-sections **26** of the joint components **16**, are shown spaced radially inwardly from the tunnel wall W.

After the tunnel set has been assembled, at each joint the nuts **40** are backed off on their respective bolts **36** an amount sufficient to enable the serrations **28** to clear each other. By use of mechanical jacks or the like the sections S are then urged radially outwardly until they are in tight contact with the tunnel wall W, after which the nuts **40** are again threaded onto their respective bolts **36**, this time tightly so as to secure the joints (FIGS. 3 and 4). When two joint components **16** are assembled, the peaks of the serrations **28** on each one extend into the valleys of the serrations on the other (FIG. 4). The serrations prevent the joint components **16** from sliding endwise relatively together and also prevent relative rotation of the joint components **16** about the bolts **36**. This latter feature makes possible the achievement of a rigid connect while using but a single bolt.

The serrations may be of a symmetrical construction, as illustrated, i.e. each side is inclined the same amount, or may be of a saw tooth construction, wherein the outboard side of each serration is inclined at a steeper angle than the inboard side. Also, the peaks and valleys may be "rounded" somewhat.

FIGS. 7 and 8 disclose a modified form of joint member or component **16'** adapted for use in squeezing ground. Joint member **16'** is identical in all respects to the joint component **16** of FIGS. 2–6 except at the joint face. In this form the serrations **28** are replaced by a channel or recess **42** disposed outboardly of the center of slot opening **30** and a boss or projection **44** situated inboardly of such center. Preferably both the channel **42** and the boss **44** are of rectangular form and have identical width and depth characteristics. As best shown by FIG. 8, the boss **44** of each joint component **16'** fits into the recess **42** of the other such component **16'**. As shown by FIG. 7, side surface **46** of channel **42** is in a common plane with side surface **50** of boss **44**, and side surface **48** of channel **42** is in a common plane with side surface **52** of boss **44**. The side surfaces **46**, **50** parallel

the side surfaces **48**, **52** and the longitudinal center of opening **30'**. Also, the floor **54** of channel **42** is in parallelism with the face **56** of boss **44**. By virtue of this arrangement relative axial movement of the two joint components **16'** is possible, but relative angular movement is not.

The side of joint member **16'** opposite the side illustrated in FIG. 7 is preferably identical in construction to the corresponding side of joint member **16** (see FIG. 5).

The tunnel set S is initially assembled in an undersize condition as before, and then, also as before, it is adjusted outwardly to fit closely against the tunnel wall W. There is frictional resistance to sliding at the joint faces **54**, **56**, and the amount of this resistance is determined by the degree of tightening of the nut and bolt assembly. As will be evident, when the frictional resistance is overcome by the pressure of squeezing ground the joint members **16'** will slide relatively together and a portion of the load on the tunnel set **5'** is relieved.

FIGS. 9–13 illustrate another modified form of joint component or member **16''**, which is also intended for use in squeezing ground. Such form is huskier in construction than the joint members **16**, **16'** shown by FIGS. 1–8. It is especially to be used in conjunction with tunnel sets sections or beams S' which are fabricated from a pair of channel lengths welded together at the flanges, but may also be used with other beam forms, such as H-beams or wide flange beams, for example.

Like in the earlier forms, joint member **16''** comprises a mounting portion **18''** and a clamping portion **20''** asymmetrically related to the mounting portion (FIGS. 11 and 13). At and near the base of member **16''** the mounting portion **18''** possesses a generally I-shaped cross-section, and the upper part of the clamping portion **20''** has a generally [-shaped cross-section.

A pair of half-flange portions **24''**, **26''** and a web half-portion **22''** together form the clamping portion **20''**. As before, an elongated bolt receiving opening **30''** is formed in the web half-portion **22''**.

Generally triangular reinforcing portions **58**, **60** are provided outboardly of the flange half-portions **24''**, **26''**. These portions **58**, **60** include compression transmission surfaces **62**, **64**, **66**.

As shown by FIG. 13, for example, when the two joint members **16''** at a joint are moved endwise relatively together until they can move no more, the surfaces **64** of each member **16''** abuts the surfaces **64** of the other member **16''**, and the surfaces **62** of each member **16''** engages the surfaces **66** of the other member **16''**. Also, the terminal surfaces **32''** abut the shoulder surfaces **34''** (FIGS. 12 and 13). In conjunction with this feature, the slot openings **30''** are formed and arranged such that when the joint members **16''** are in the position shown by FIGS. 12 and 13 the end surfaces of such openings **30''** do not both bear against the bolt **36**. Consequently, the compression forces are not carried by the bolt **36** at the joints, but rather are transmitted across the joints by the surface-to-surface contact between surfaces **62**, **64**, **66**, and surfaces **32''**, **34''**.

Referring now to FIGS. 9, 11 and 13, the part (projection or boss) of each clamping portion **20''** which projects away from the plane in which surfaces **62** are situated interfits into the recess or channel formed on the other member **16''** at the joint by the parts of reinforcing portions **58**, **60**, and the part of the joint face side of web half-portion **22''**, which are inset from the plane in which surfaces **66** of said other member **16''** are situated. These projections and recesses prevent relative rotation of the joint members **16''** about the single bolt **16''**.

On each member **16''** a raised portion or boss **68** is provided at the outboard end of the joint face side of the web half-portion **22''**. As will be evident, the area of frictional contact at the joint face is equal to the combined area of the faces of the raised portions **68** present at each joint.

Each of the above described forms of joint members are preferably but not necessarily of cast construction.

It is an important advantage of the joint member **16** (or **16'** or **16''**) that each is identical with its complemental member. Only one casting form is thus required in each instance. Also, and possibly more importantly, the identity of the joint parts prevents any possibility of mixup of components in the tunnel, as might otherwise be the case if the joint members are similar but not identical.

Tunnel supports in rock tunnels are said to be acted upon by a rock load, whereas the tunnel supports in earth tunnels are acted upon by earth pressure. The term rock load indicates the height of the mass of rock which tends to drop out of the roof. If no support is constructed this mass of rock drops into the tunnel by increments whereby the roof assumes in the course of time the character of an irregular vault. On the other hand, the term earth pressure indicates the pressure exerted by a cohesionless or plastic material onto the tunnel support. If no support is installed, this material evades the tunnel either rapidly or slowly and the process continues until the tunnel has disappeared. "Squeezing ground" is rock or earth which contains a considerable amount of clay. One of the characteristics of this type of material is that it tends to swell when pressure is taken off of it. The process of excavating a tunnel in clay is associated with a decrease of the pressure in the clay adjoining and surrounding the tunnel. As is explained in the aforementioned text "Rock Tunneling With Steel Supports" (pages 80–85 in particular), the rapid change in stress in the clay due to the excavation of the tunnel is followed by slow movements associated with a gradual increase of the water content of the clay adjoining the tunnel walls. All these movements take place in the direction of least resistance, all of which are directed towards the tunnel supports. As soon as a tunnel support is placed and wedged (which is necessary with conventional supports, as previously explained), the squeeze is practically stopped, although the clay has not yet adjusted itself to the changes produced by the tunnel excavation. As a consequence the clay pressure on the support increases. Over a period of time the clay pressure on the support may increase until it exceeds the load carrying capacity of first the lagging and then the tunnel sets at which time the lagging and sets will become deformed and/or crushed. Tunnel sets according to the present invention embodying the joint construction illustrated in FIGS. 7–13 will yield when the frictional resistance of the joint forces is overcome, permitting the clay to squeeze into the tunnel a predetermined distance determined by the length of slot openings **30**. As a consequence, there is a very substantial reduction in the ultimate load on the tunnel support.

Tunnel sets according to the present invention which have incorporated therein the joint construction illustrated in FIGS. 2–6 have their greatest utility in connection with rock tunnels wherein the tunnel supports are subjected to rock loads.

From the foregoing, further variations, adaptations, modifications and characteristic features can be evolved by those skilled in the art to which the invention is addressed within the scope of the following claims.

What is claimed is:

1. In a tunnel set, a pair of rolled steel beam sections related end-to-end and joined together by expansible joint means, said joint means comprising: a pair of mutually sidelapping joint elements having mating joint faces formed on the inner sides thereof, said joint faces being directed generally perpendicular to the center line of the tunnel, and being formed to include mating projections and recesses, each said joint element being formed to include a bolt receiving slot opening, extending therethrough axially of the tunnel, with each said bolt receiv-

ing slot opening being at least partly in register with the other, and being elongated generally axially of its joint element; and a transverse bolt extending through both of the slot openings, and axially of the tunnel and perpendicular to said joint faces, said bolt serving to detachably and adjustably secure said joint elements and hence said tunnel set sections together, said slot openings permitting longitudinal movement of said joint elements relative to each other for the purpose of adjusting the tunnel set to fit the girth of the tunnel at its location in the tunnel, and said mating projections and recesses serving to prevent relative rotation of said joint elements about the transverse bolt.

2. A tunnel set according to claim 1, wherein said projections and recesses comprise complementary serrations, related perpendicularly to said slots, said serrations preventing relative sliding movement of the joint plates when the transverse bolt is tightened.

3. A tunnel set according to claim 1, wherein the projections and recesses and the bolt receiving slots are in mutual parallelism, such arrangement permitting the joint elements to slide axially relative to each other, within the limits of said slot openings, in response to the pressure exerted on the tunnel set by squeezing ground.

4. A tunnel set according to claim 3, wherein said projections and recesses comprise a channel formed in each joint surface longitudinally outwardly of the center of the slot therein and a boss standing out from each joint surface longitudinally inwardly of the center of the slot therein, with the boss of each joint element being slidably received in the channel of the other joint element.

5. A tunnel set according to claim 1, wherein the projections and recesses comprise a recess in each joint element located longitudinally inwardly of the center of the slot therein, and a protuberance located longitudinally outwardly of the center of the slot therein, with the protuberance of each joint element being slidably received in the recess of the other joint element.

6. A tunnel set according to claim 5, wherein said joint element further includes flange means directed generally perpendicularly to the joint face, said flange means each having a transverse stop surface located generally at the transition between the recess and protuberance, with each stop surface of each joint element being abuttable with a stop surface of the other joint element, and with the bolt slots being elongated to such an extent that when the stop surfaces of the two joint elements are in contact, the bolt is not contacted by an end surface of both slots, so that any compression forces are transmitted across the joints by the contact at the stop surfaces, and not through the bolt.

7. In a tunnel set, a pair of rolled steel sections related end-to-end, each said section having a generally I-shaped cross-sectional configuration extending generally uniformly throughout the greater part of its length, formed by a radially directed web portion and inner and outer flange portions, and a joint forming portion at its end, said joint forming portion sidelapping the joint forming portion of the other section, each joint forming portion having a substantially radially directed inner joint face and a generally channel-shaped cross-sectional configuration formed by a radially directed web half-portion and inner and outer flange half-portion, said joint forming portions together having a generally I-shaped cross-sectional configuration substantially conforming to the cross-sectional configuration of the said greater portion of the length of each section, said joint forming portions each also being formed to include a bolt receiving opening extending through its web half-portion axially of the tunnel, each said bolt receiving opening being at least partly in register with the other bolt receiving opening, and a bolt extending through both of said openings, and axially of the tunnel, and serving to detachably secure said joint portions and hence said sections together.

8. In a tunnel which is substantially circular in cross-section, a tunnel set of the full circle rib type comprising a plurality of sections successively joined together at their ends by expansible joint means, each such joint means comprising: a pair of mutually sidelapping joint elements having mating joint faces formed on the inner sides thereof, said joint faces being directed generally perpendicularly to the center line of the tunnel, and being formed to include mating projections and recesses, said joint elements each also being formed to include a bolt receiving slot opening extending transversely therethrough, generally axially of the tunnel, each said bolt receiving slot opening being at least partly in register with the other bolt receiving slot opening, and being elongated generally axially of its joint element; and a transverse bolt extending through both said bolt slot openings, and axially of the tunnel, and serving to detachably and adjustably secure said joint elements and hence said tunnel set sections together, said slot openings permitting longitudinal movement of said joint elements relative to each other for the purpose of adjusting the perimetrical shape and dimension of the tunnel set to fit the girth of the tunnel at the particular location of said tunnel set in the tunnel, and said mating projections and recesses serving to prevent relative rotation of said joint elements about the transverse bolt.

9. A tunnel set according to claim 8, wherein said projections and recesses comprise complementary serrations, related perpendicularly to said slots, said serrations preventing relative sliding movement of the joint plates when the transverse bolt is tightened.

10. A tunnel set according to claim 8, wherein the projections and recesses and the bolt receiving slots are in mutual parallelism, such arrangement permitting the joint elements to slide axially relative to each other, within the limits of said slot openings, in response to the pressure exerted on the tunnel set by squeezing ground.

11. A tunnel set according to claim 10, wherein said projections and recesses comprise a channel formed in each joint surface longitudinally outwardly of the center of the slot therein and a boss standing out from each joint surface longitudinally inwardly of the center of the slot therein, with the boss of each joint element being slidably received in the channel of the other joint element.

12. A tunnel set according to claim 8, wherein the projections and recesses comprise a recess in each joint element located longitudinally inwardly of the center of the slot therein, and a protuberance located longitudinally outwardly of the center of the slot therein, with the protuberance of each joint element being slidably received in the recess of the other joint element.

13. A tunnel set according to claim 12, wherein each joint element further includes flange means directed generally perpendicularly to the joint face, said flange means each having a transverse stop surface located generally at the transition between the recess and protuberance, with each stop surface of each joint element being abuttable with a stop surface of the other joint element, and with the bolt slots being elongated to such an extent that when the stop surfaces of the two joint elements are in contact, the bolt is not contacted by an end surface of both slots, so that any compression forces are transmitted across the joints by the contact at the stop surfaces, and not through the bolt.

14. A metallic joint component for an adjustable tunnel set, said joint component comprising a mounting portion and a clamping portion of rectangular proportions asymmetrically related to said mounting portion, said clamping portion having two edges and two sides, with a joint face formed on one of said sides, which joint face is coactable with the joint face of the clamping portion of a complementary joint component, and said clamping portion also being formed to include an elongated bolt receiving slot extending therethrough between the two

sides, generally parallel to the two edges, said joint face being formed to include a recess located longitudinally inwardly of the center of the slot therein, and a protuberance located longitudinally outwardly of the center of the slot therein, and with the two edges including means forming at least one transverse stop surface located generally at the transition between the recess and protuberance, and with the slot being elongated to such an extent that when the stop surface of such joint component is in contact with an associated stop surface of a complementary joint component, a bolt extending through said slot and through the slot of the complementary joint component is not in contact with both an end of said slot and an end of the slot in the complementary joint component, so that any compression forces are transmitted

by a surface-to-surface contact of stop surfaces, and not through the bolt.

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