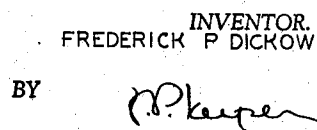


F. P. DICKOW
EXPANSION SHELL

Filed Oct. 17, 1963

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ATTORNEY

Aug. 17, 1965

F. P. DICKOW
EXPANSION SHELL

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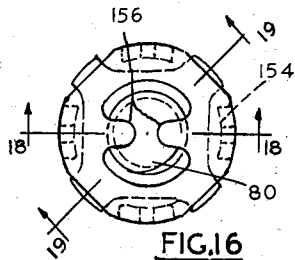


FIG. 16

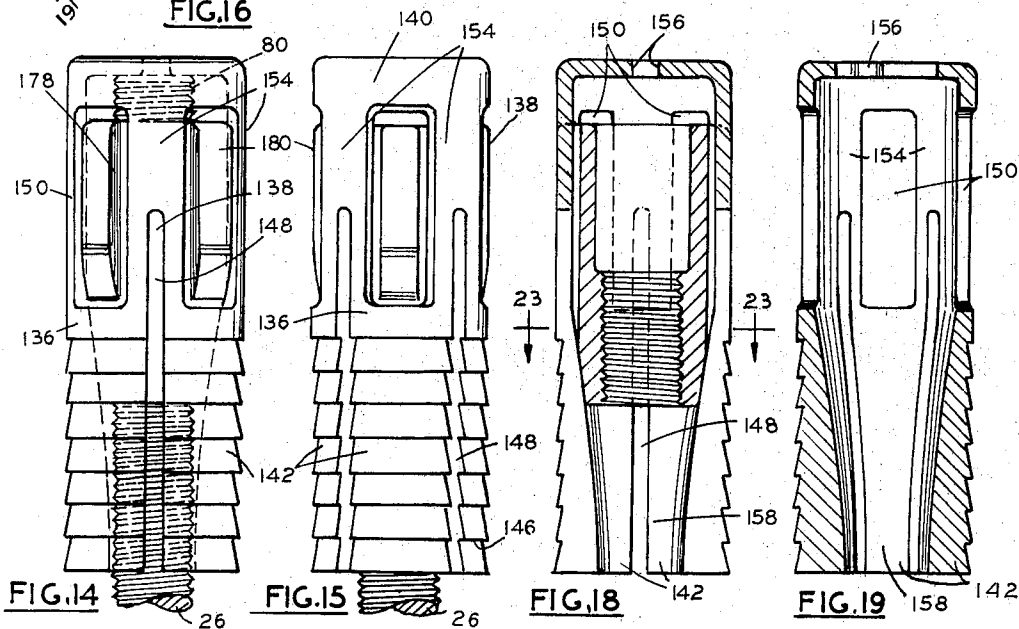


FIG. 14

FIG. 15

FIG. 18

FIG. 19

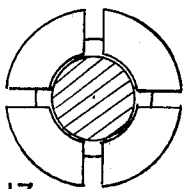


FIG. 17

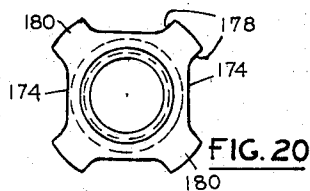


FIG. 20

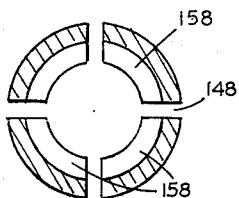


FIG. 23

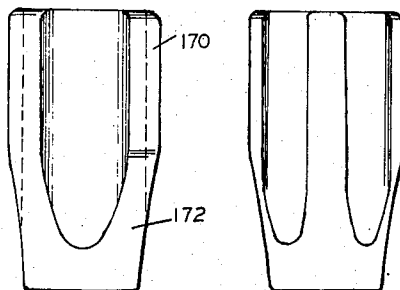


FIG. 21

FIG. 22

INVENTOR.
FREDERICK P DICKOW

BY

F.P. Keener
ATTORNEY

Aug. 17, 1965

F. P. DICKOW
EXPANSION SHELL

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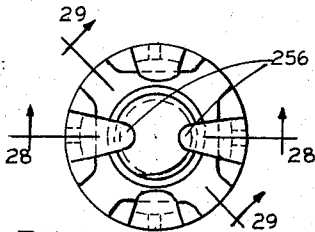


FIG. 26

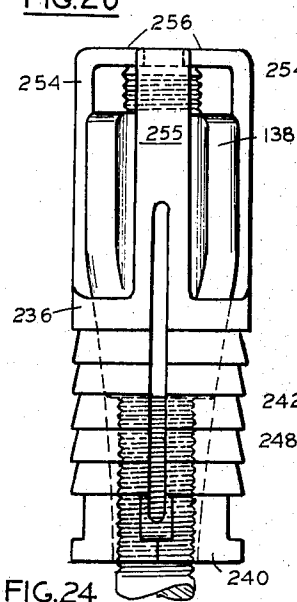


FIG. 24

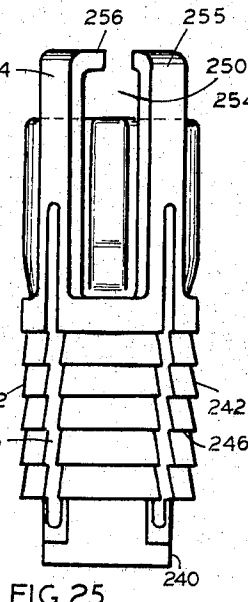


FIG. 25

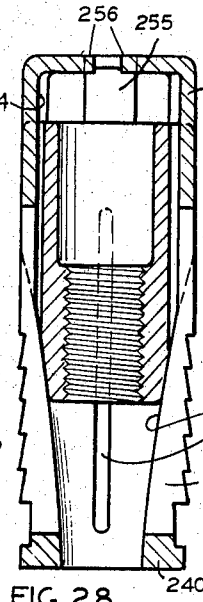


FIG. 28

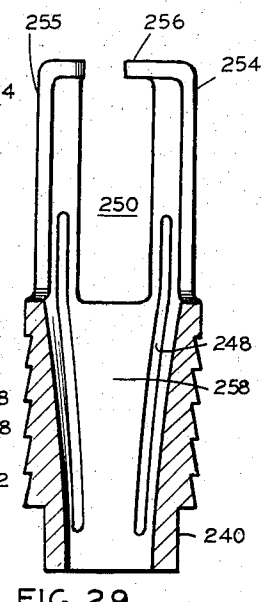


FIG. 29

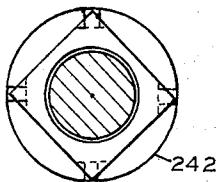


FIG. 27

INVENTOR.
FREDERICK P DICKOW

BY

F. P. Kuper
ATTORNEY

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3,200,693

EXPANSION SHELL

Frederick P. Dickow, Auburn, N.Y., assignor to The Eastern Company, Naugatuck, Conn., a corporation of Connecticut

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10 Claims. (Cl. 85-75)

This invention relates to mine roof bolt expansion shell assemblies, and more particularly to an assembly consisting solely of a unitary shell and a wedge confined therewithin.

The support of mine roofs from the rock strata above by drilling holes in the mine roof, and inserting bolts anchored by an expansion shell assembly in the rock strata above the roof is common practice. Depending on the nature of the rock strata above the roof and other consideration, the number, and spacing and length of the bolts employed may vary considerably. In drilling each hole for the reception of a bolt and expansion shell, it is desirable that the bore be of sufficient depth to reach hard rock. However the nature of the overlying rock may vary considerably. An expansion shell having a provision for a certain degree of expansion may provide adequate holding power in hard rock, and be inadequate in softer rock. Adequate holding power in softer rock may result from providing an adequate degree of expansion, and in providing uniform circumferential expansion of the shell.

Expansion shells comprising a pair of opposed gripping members, and a relatively long wedge to enhance the expansion is disclosed in Patent No. 2,753,750, wherein expansion of the shell members is limited to two opposed directions. A proposal to enhance the degree of expansion of such a shell is disclosed in Patent No. 3,022,700. In each of these disclosures, the shell members are separate segments, and are tied together by a separate inverted U shaped spring steel strap, sometime referred to as a bail, that is engaged by the bolt end to initially provide the necessary end thrust to cause the wedge to descend initially into expanding relation of the shell. In this manner there is provided initial gripping of the shell, after which tension on the bolt from its head end bearing against the mine roof acts to enhance the wedge expansion of the shell. Shells of the bail type referred to, composed of separate elements or segments, tied together by a strap, necessarily incur an assembly operation in the attachment of the strap to the shell segments. Such assemblies, comprising separate segments joined at one end, by a spring steel strap, which do not confine the wedge in place, permit the shell and wedge to become separated during transport, unless provided with a sleeve to hold the segments contracted about the wedge. Such sleeves are an item of expense, and require removal from the assembly before put to use.

Expansion shell assemblies, where the shell portion comprises a collar and integral expansion fingers, with a cooperating wedge threaded on the end of a bolt projected through the collar have been commonly employed.

In order to maintain the shell in assembled relation about the wedge when the assembly is mounted on the end of a bolt, ready for insertion into a bore, and to prevent the shell from sliding down the bolt when inserting the bolt and assembly up into a bore, resort has been had to providing ears pinched from the bolt, immediately below the shell collar. Resort has also been had to providing a thin nut threaded on the bolt, and disposed below the collar, the nut being threaded to the end of the threaded section of the bolt which thus provides a shoulder for the nut. In either case, the ears, or the thin nut bear against and support the shell collar when pushing the assembly into a mine roof bore. When

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the shell is suitably located in the bore, friction between the shell and bore causes the wedge to descend into the shell, upon threading the bolt into the wedge, with the bolt head against the mine roof plate. As further expansion takes place, and the bolt threads upward into the shell assembly, while drawing the wedge downward within the shell, the ears may bear with increasing pressure against the shell collar, and the ears tend to be sheared off by, or chew away at, the collar as they pass through or into the collar of the shell. Where the thin nut is employed, as expansion of the shell takes place, the wedge descending into the shell is resisted, and the bolt tends to thread upward into the assembly, and upward pressure on the thin nut against the shell collar increases so as to strip the threads therefrom, thereafter permitting the thin nut to slide down the bolt. The providing of ears on the bolt to back up the shell as it is pushed up into the bore, or the application of a thin nut to the bolt for the same purpose are both time consuming operations, and the nut is an additional expense.

Since the number of roof support bolts, and shell assemblies required is relatively great over a given roof area, the added cost of the items referred to is considerable. The threading of a thin nut to the end of or the proper position on the threaded portion of the bolt takes time, and the length of the thread on the bolt may be unduly limited to permit hastening of the operation. While the collar type of assembly, when applied to a bolt does not permit the shell being lost, the shell made of segments connected by a strap may readily be lost from the assembly in the field, after application of the wedge to the bolt end. Loss of a shell renders the bolt and remaining wedge useless.

The present invention comprises an assembly consisting solely of an integral one piece shell in the form of a malleable casting, and an expanding wedge. The assembly is applied to a bolt requiring no ears or thin nut. The wedge is confined within the shell, and the shell confined to the wedge, whether or not the wedge is threaded on the end of a bolt. The shell of the assembly is subdivided into four segments so that expansion in four directions is effected. In addition the wedging surface of the wedge is concave lengthwise thereof and cooperates with internal surfaces of the segments which are correspondingly convex lengthwise thereof, to provide ready initial expansion. In addition the shell assembly is provided with integral deformable fingers or tabs adapted to project over the bolt end to provide the initial thrust. On substantial increase in thrust, the tabs are adapted to deform and yield to permit the end of the bolt to pass on during further expansion of the shell.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description when taken in conjunction with the accompanying drawings. It is expressly understood that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein like reference characters indicate like parts:

FIGURE 1 is a front elevational view of an expansion shell disposed in a mine roof bore ready for initial expansion;

FIGURE 2 is a side elevational view of the assembly;

FIGURE 3 is a top plan view of the assembly;

FIGURE 4 is a bottom plan view of the assembly;

FIGURE 5 is a longitudinal section of the shell and wedge taken on the line 5-5 of FIGURE 3;

FIGURE 6 is a longitudinal section of the shell taken on the line 6-6 of FIGURE 3;

FIGURE 7 is a top plan view of the wedge;

FIGURE 8 is a front elevational view of the wedge;
FIGURE 9 is a side elevational view of the wedge;
FIGURE 10 is a sectional view through the assembly showing the same partly expanded;

FIGURES 11, 12 and 13 are sectional views taken on the lines 11—11, 12—12, and 13—13 of FIGURE 6;

FIGURE 14 is a front elevational view of a modified form of expansion shell assembly;

FIGURE 15 is a side elevational view of the assembly;

FIGURE 16 is a top plan view of the assembly;

FIGURE 17 is a bottom plan view of the assembly;

FIGURE 18 is a sectional view taken on the line 18—18 of FIGURE 16;

FIGURE 19 is a sectional view taken on the line 19—19 of FIGURE 16;

FIGURES 20, 21 and 22 are top, front and side views of the wedge;

FIGURE 23 is a sectional view taken on the line 23—23 of FIGURE 19;

FIGURE 24 is a front elevational view of a further modified form of the invention;

FIGURE 25 is a side elevational view of FIGURE 24;

FIGURE 26 is a top plan view of the assembly;

FIGURE 27 is a bottom plan view of the assembly;

FIGURE 28 is a sectional view taken on the line 28—28 of FIGURE 26, and

FIGURE 29 is a sectional view taken on the line 29—29 of FIGURE 26.

Referring to the drawings and FIGURE 1, there is shown a bore 20 extending upwardly into the rock strata 22, from the roof level 24 of a mine, for example, in which there has been inserted a mine roof bolt 26, having a hexagon head 28, bearing against a washer 30 and support plate 32. On the threaded end 34 of the bolt, and preferably in a region of hard rock strata there is positioned an expansion shell assembly comprising a shell 36, and expanding wedge 38. As shown the shell is unexpanded, and the wedge is ready to be drawn down and descend into the shell for initial expansion.

The shell comprises a collar 40 having four upstanding fingers or segments, 42, 42 and 44, 44, opposite segments being alike. The segments have a series of external arcuate gripping teeth 46. As shown in FIGURE 1 the segments 42 and 44 are separated by a lengthwise slot 48 extending to the collar 40, whereas shown in FIGURE 2, the segments 44 and 42 are separated by a similar lengthwise slot 50, the slot however having an angular offset at its upper end as at 52 so that upwardly extending arms 54 may extend from the segments 42 substantially in alignment with the longitudinal portion of the respective slots 50. The upper ends of each of the arms 54 are provided with inwardly extending integral taps or projections 56, which project toward the center. The spacing between the taps is substantially less than the diameter of the bolt 26.

The internal surfaces of each of the four fingers or segments 44 and 42 have camming surfaces 58 that are concave and arcuate transversely of the shell, the arcuate sections being concentric with the axis of the shell, when unexpanded. The camming surfaces 58, as they extend lengthwise of the shell are convex, and follow a curvature having a radius of about fifteen inches, the center of which lies in a plane extending transverse of the shell axis, and disposed about one and seven-eighths inches below the plane of the lower end of the collar 40. The circular aperture 60 at the lower end of the collar, formed by the curvature set forth, is of such size as to accommodate the bolt 26. In practice a shell having an overall diameter of one and eleven thirty-seconds of an inch and adapted for insertion into a bore of an inch and three-eighths, will normally have an opening in the lower end of the collar of five-eighths of an inch, to freely clear and receive a bolt of five-eighths of an inch diameter. The camming surfaces are in ef-

fect portions of a toroidal surface, as would be generated by an arc of about fifteen inches radius.

The lower end of the collar is squared off as at 62 to reduce the metal at the base of each of the fingers or segments 42 and 44, so that deformation, or hinging of the fingers outwardly during expansion will be facilitated. The shell is preferably made of a somewhat ductile material and may be a malleable iron casting, which is suitable for the purpose.

Expansion of the shell is effected by a circular wedge 38, having a lower internally threaded section 66 to receive the threaded bolt end, and an upper bore 68 providing clearance for the threaded bolt end. Exteriously, the wedge has a cylindrical upper portion 70 merging with a tapered portion 72, which is a frustum of a toroid, the curvature lengthwise being concave, and struck on an arc of about fifteen inches radius. All transverse sections through the wedge are circular concentric with the wedge axis. The tapered portion and its lengthwise concave curvature form in effect a wedging surface complementary to the internal surfaces of the fingers or segments, when the wedge is in the position shown in FIGURES 1 and 2, before expansion takes place.

The wedge is provided with exterior opposed parallel grooves 74 extending lengthwise of the cylindrical portion 70 thereof, and such grooves extend partly into the wedging portion 72 thereof, as is indicated at 76. The side walls 78 of the grooves cooperate with and embrace the arms 54 of the shell so that rotation of the wedge relative to the shell is positively prevented initially as well as for a considerable length of travel of the wedge as it is drawn downwardly and descends into the shell.

The shell assembly, when placed in a bore, may be caused to frictionally engage the bore, by placing a slight bend in the bolt, or the irregularities of the bore may be sufficient to hold the shell against rotation, as the bolt is turned, without resorting to such expedient. Rotation of the bolt, causes the upper end 80 of the bolt to be brought to bear against the tabs 56, whereupon further rotation of the bolt relative to the shell, causes the wedge to descend into the shell, expanding the shell segments into initial and firm gripping relation to the bore wall. As further rotation of the bolt is effected, the wedge is driven downwardly to effect further expansion, against the thrust resistance of the tabs 56. When the upward thrust of the bolt overcomes the resistance of the tabs 56, the bolt end 80 deforms the tabs 56, bending them aside. Thereafter further rotation of the bolt to create further shell expansion increases the tension in the bolt between the mine roof and the shell, and any degree of compression of the rock strata between the mine roof and shell or support of the roof may thereafter be effected, within the holding power of the expanded shell, upon the bore wall, it being understood that with increased bolt tension, the wedge tends to further expand the shell to enhance its holding power.

Assembly of the wedge within the shell and, between the arms 54 is effected by spreading the outer ends of the arms, sufficiently to insert the wedge into the position shown in FIGURES 1 and 2 for example, after which the arms are restored to their parallel relation, it being understood that the malleable casting readily permits such temporary deformation.

In FIGURES 14—23 there is shown a modified form of the expansion shell wherein the wedge is provided with four grooves equally spaced around its upper cylindrical portion, which cooperate with four arms extending upwardly from the gripping portions of the segments. As shown, the assembly comprises a generally cylindrical member or shell 136, and expanding wedge 138. As shown the shell is unexpanded and the wedge is in position to be drawn down in the shell for initial expansion. The shell comprises a collar 140, and four like gripping segments 142 formed by slots 148. The segments each have a series of arcuate gripping teeth 146, and adjacent segments are hung from the collar by four spaced arms

154, into each of which the slots 148 extend part way. The arms define windows 150.

The collar 140 is provided with inwardly projecting tab means 156, in the form of a projection or projections adapted to overlie, a substantial portion of the threaded end 80 of the bolt 26. Each of the segments have internal camming surfaces 158 that are concave transversely of the shell, and convex lengthwise, the surfaces being segments of a toroid generated by an arc of approximately fifteen inches radius and struck from a center on a transverse plane about one and seven-eighths of an inch below the lower end of the shell. The wedge is the same as the wedge shown in FIGURES 7, 8 and 9, except, as modified in FIGURES 20, 21 and 22, four grooves 174 being provided equally spaced about the cylindrical portion 170 of the wedge, which grooves extend partly into the wedging portion 172 thereof, as indicated at 176. The side walls 178 of the grooves define broad shoulders or wings 180 which extend outwardly into the windows 150, and the grooves 174 clear the arms 154. The lower portion of the wedge 172 is tapered and has lengthwise concave curvature, and the transverse sections thereof are circular. The wedging surface is complementary to the camming surfaces 158, and constitutes a frustum of a toroid generated by an arc of about 15 inch radius, and the wedge surfaces and the segment camming surfaces are complementary, when the wedge is in the position indicated in FIGURE 14.

The wedge is inserted into the shell, by slightly spreading the lower ends of the segments, by deformation to the extent necessary and the segments are thereafter bent back to their original position. Thus the wedge is confined to the shell, and the shell cannot become dislodged from the wedge in the field.

The operation of the assembly of FIGURES 14-23 is similar to that of FIGURES 1-13. The assembly is threaded on the end off a bolt of suitable length, with the end projecting through the end of wedge, ready for contact with the malleable iron tabs. The assembly is thrust into the bore to the depth necessary. If desired the bolt may be bent slightly to cant the assembly to cause it to frictionally engage the bore wall. On the other hand, one or more, or all of the segments may be spread apart slightly at their lower ends before insertion into the bore, so that a slight initial frictional grip on the bore will be had. Such spreading however does not approach that necessary for the insertion of the wedge, heretofore referred to so that the shell is still confined to the wedge. When the assembly is properly located in the bore, initial expansion is had by rotation of the bolt, to cause the wedge to descend and spread the segments, the end of the bolt being held by the tabs 156. When initial expansion has been effected, the thrust increases, and the tabs are caused to deform or bend outwardly to allow the bolt end to pass therebeyond, on further expansion.

In the further modified form shown in FIGURES 24-29, the lower end of the shell has a collar as in the form of FIGURE 1, and the upper end is provided with four arms as in the modification of FIGURE 14, the upper collar however being eliminated. As shown the assembly comprises a generally cylindrical member or shell 236, and an expanding wedge 138, corresponding to that shown in FIGURES 20, 21 and 22. The shell has a collar 240 at its lower end, and four like fingers or segments 242, each having arcuate gripping teeth 246. The segments are separated by lengthwise slots 248. Adjacent segments are provided with upstanding arms 254 and 255, which define windows 250, open at the upper end. Two of the arms have inwardly extending integral tabs 256 overlying the bolt end 80. The internal camming surfaces 258 of the segments have the same curvature as the camming surfaces of the segments of the previous modification, each surface being a segment of a toroid generated by an arc of about fifteen inches radius, the center of which

lies in a plane disposed about one and seven-eighths inches below the lower end of the shell.

Operation of the assembly is similar to the form shown in FIGURE 1. It will be understood that the overall diameter of the shells of all modifications, before expansion, will be somewhat smaller than the bore into which the assemblies will be used. For example, the assemblies herein described have an overall diameter of about one and eleven thirty-seconds of an inch, and are adapted for use in a bore of a diameter of one and three-eighths inches. When the assemblies of FIGURES 1, 14 and 24 are located in the mine roof bores, the arms 54, 154 and 254 and 255, as expansion of the shell takes place, tend to bear against the bore wall and may not enlarge to any substantial degree, and continue to ride within the grooves of the wedge to positively prevent rotation of the wedge during a considerable portion of the descent of the wedge into the shell. It will also be seen, particularly in the modifications of FIGURES 14 and 24, that as the shoulders of the wedge descend into the concave camming surfaces of the segments, the camming surfaces are driven outwardly as expansion takes place. Thus the concavity of the surfaces, which were circular about the center axis before expansion, become keying grooves around the shoulder of the wedge as the camming surfaces become eccentric of the axis and move away from the center, since the radius of curvature of the grooves tends to remain the same as the surfaces expand and move away from the center axis.

While preferred forms of the invention have been illustrated, it will appear that the length of the cylindrical portion of the wedge may be shortened if desired, in which case the length of the arms of the corresponding shell may be shortened. It will also be apparent that the three modifications of the shell shown have common features such that by minor modifications of the mold and core, any one of the forms may be cast. While malleable cast iron has been referred to as a preferred material, any sufficiently ductile material having the characteristics of malleable iron may be employed.

While several modifications of the invention have been illustrated and described, it is to be understood that the invention is not limited thereto. As various changes in the construction and arrangement may be made without departing from the spirit of the invention, as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. An expansion shell assembly for mine roof support and the like consisting of an expansion shell and wedge, said expansion shell comprising a one piece malleable iron casting in the form of a generally hollow cylindrical member, said member having a plurality of slits extending lengthwise thereof subdividing the shell into four substantially equal arcuate segments, said segments each having a series of uniformly lengthwise spaced arcuate gripping teeth on their external faces over a substantial portion of the lower half of the length of the shell, and having transversely concave and longitudinally convex camming surfaces behind said teeth on their inside faces, said camming surfaces extending upwardly and flaring outwardly, said shell having a pair of spaced parallel upwardly extending arms integral with and extending upwardly from at least two of said segments that are oppositely disposed, and said arms being in alignment with two of said slits that are oppositely disposed, and integral deformable tab means extending inwardly toward the axis of the shell at the upper end thereof in the plane of said arms, said expanding wedge having an upper cylindrical portion having lengthwise extending grooves on its exterior embracing said arms to confine the wedge within the shell and resist relative rotation therebetween, and a tapered wedge portion extending upwardly and tapering outwardly from its lower end and complementary to a

portion of said camming surfaces of said segments, said wedge member having an axial threaded bore to receive the threaded end of an expansion bolt, and said tab means extending at least partially across the threaded bore, and adapted to engage the end of an expansion bolt when threaded through the wedge bore to provide initial downward thrust of said wedge to spread said segments.

2. An expansion shell assembly for mine roof support and the like consisting of an expansion shell and wedge, said expansion shell comprising a one piece malleable iron casting in the form of a generally hollow cylindrical member, said member having a plurality of slits extending lengthwise thereof subdividing the shell into four substantially equal arcuate segments, said segments each having a series of uniformly lengthwise spaced arcuate gripping teeth on their external faces over a substantial portion of the lower half of the length of the shell and having transversely concave and longitudinally convex toroidal camming surfaces behind said teeth on their inside faces, said camming surfaces extending upwardly and flaring outwardly, said shell having a pair of spaced parallel upwardly extending arms integral with and extending upwardly from at least two of said segments that are oppositely disposed, and said arms being in alignment with two of said slits that are oppositely disposed, and integral deformable tab means extending inwardly toward the axis of the shell at the upper end thereof in the plane of said arms, said expanding wedge having an upper cylindrical portion having lengthwise extending grooves on its exterior embracing said arms to confine the wedge within the shell, and a tapered wedge portion having toroidal camming surfaces extending upwardly and tapering outwardly from its lower end and complementary to the toroidal camming surfaces of said segments, said wedge member having an axial threaded bore to receive the threaded end of an expansion bolt, said tab means extending at least partially across the threaded bore, and adapted to engage the end of an expansion bolt when threaded through the wedge bore to provide initial downward thrust of said wedge to spread said segments.

3. An expansion shell assembly for mine roof support and the like consisting of an expansion shell and wedge, said expansion shell comprising a one piece malleable iron casting in the form of a generally hollow cylindrical member having a plurality of slits extending lengthwise thereof subdividing the shell into four substantially equal arcuate segments, said segments each having a series of uniformly lengthwise spaced arcuate gripping teeth on their external faces, over a substantial portion of the lower half of the length of the shell and having transversely concave and longitudinally convex camming surfaces behind said teeth on their inside faces, said camming surfaces extending upwardly and flaring outwardly, said shell having a pair of spaced parallel upwardly extending arms integral with and extending upwardly from

at least two of said segments that are oppositely disposed, said arms being in alignment with two of said slits that are oppositely disposed, and integral deformable tab means extending inwardly toward the center of the shell at the upper end thereof in the plane of said arms, said expanding wedge having a tapered wedge portion extending upwardly and flaring outwardly from its lower end complementary to the camming surfaces of said segments and having lengthwise extending grooves in its upper portion embracing said arms, said wedge member having an axial threaded bore to receive the threaded end of an expansion bolt, and said tab means extending at least partially across the threaded bore, and adapted to engage the end of an expansion bolt when threaded through the wedge bore to provide initial downward thrust of said wedge to spread said segments.

4. An expansion shell in accordance with claim 1 wherein the lower ends of said segments merge into an annular integral collar.

5. An expansion shell in accordance with claim 1 wherein the upper ends of said arms merge into an annular collar, and in which the tab means extend radially inward from said collar.

6. An expansion shell in accordance with claim 2 wherein the toroidal surfaces of the segments and cam are segments of a toroid generated by an arc of approximately fifteen inches radius.

7. An expansion shell in accordance with claim 2 wherein the lower ends of said segments merge into an annular integral collar.

8. An expansion shell in accordance with claim 3 wherein the lower ends of said segments merge into an annular integral collar.

9. An expansion shell in accordance with claim 2 wherein the upper ends of said arms merge into an annular collar, and in which the tab means extend radially inward from said collar.

10. An expansion shell in accordance with claim 3 wherein the upper ends of said arms merge into an annular collar, and in which the tab means extend radially inward from said collar.

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EDWARD C. ALLEN, *Primary Examiner.*