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(54) SUPPORT ELEMENT FOR UNDERGROUND UNDERWORKINGS

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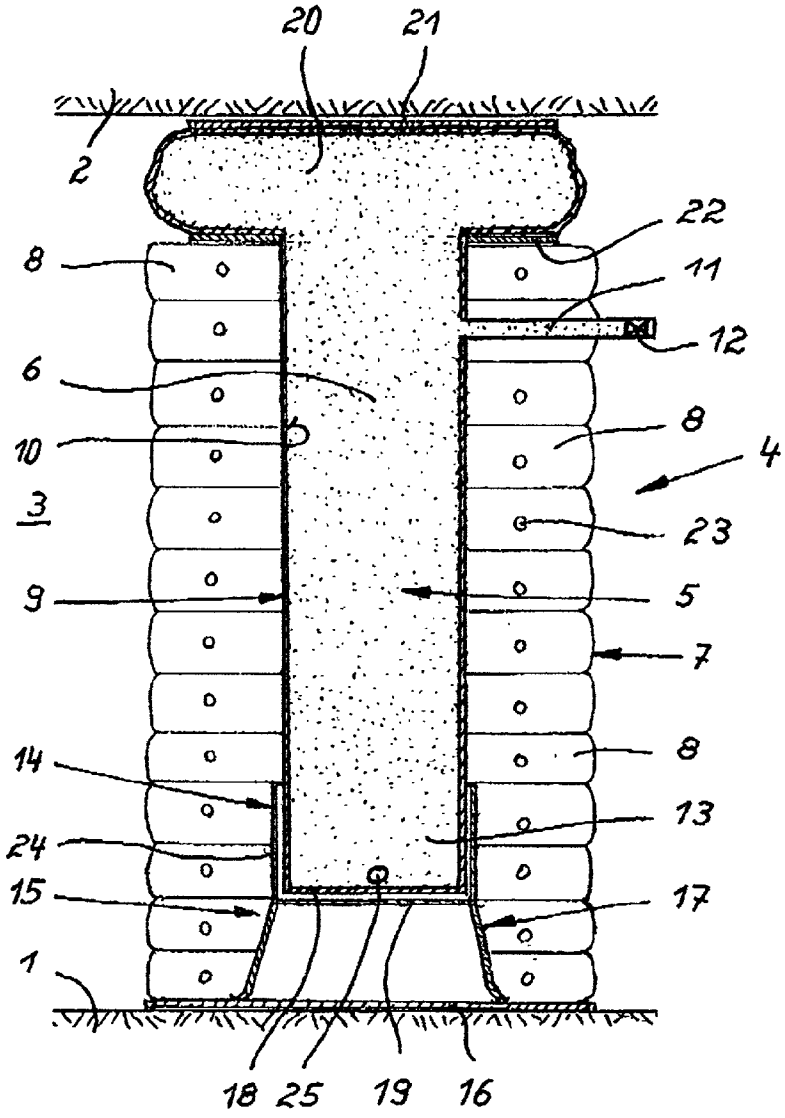
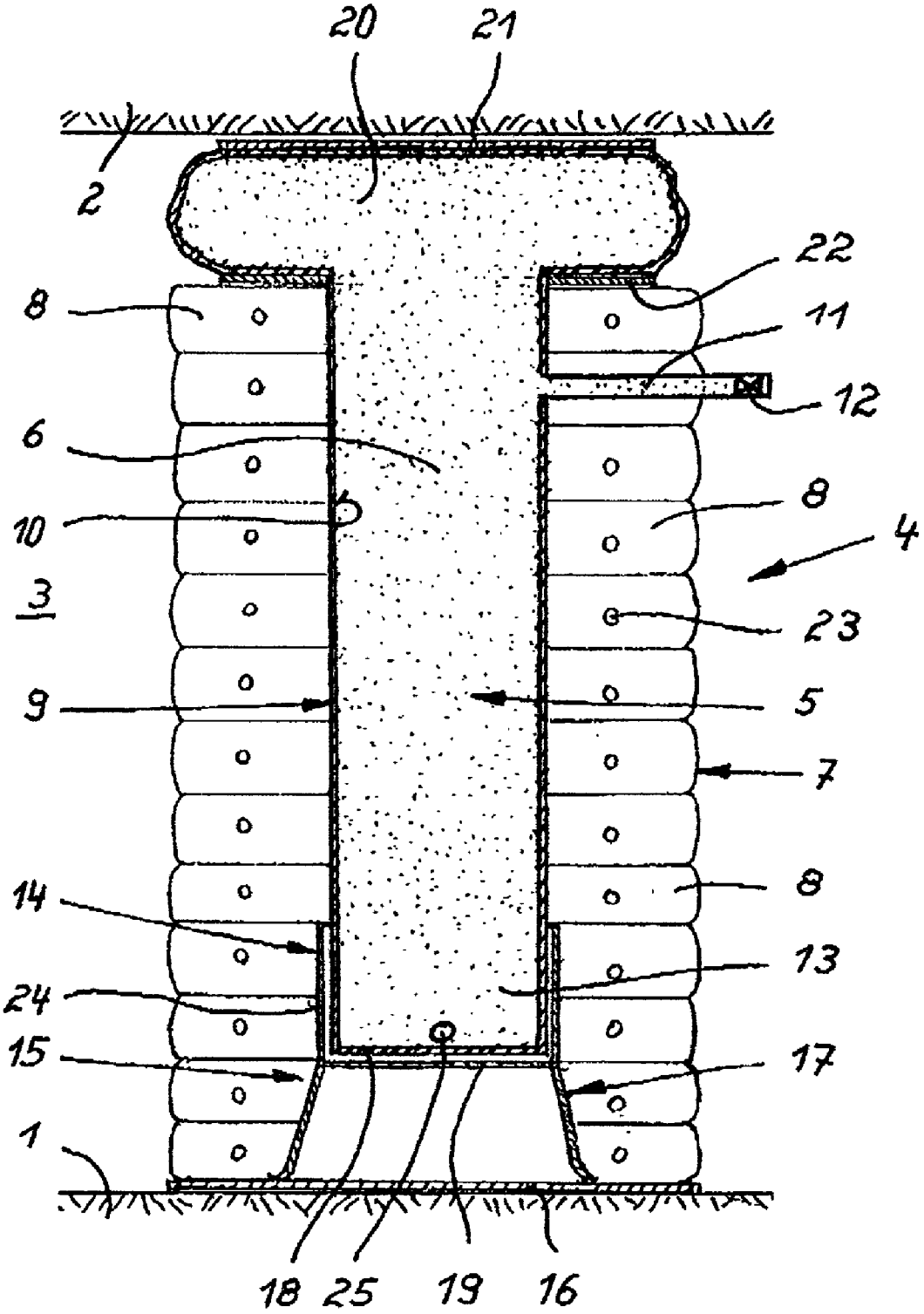
(57) **ABSTRACT**

A support element for underground underworkings has a sleeve of a flexible fabric permeable to water and air. A central column having a T-shaped vertical cross-section, comprised of a column shaft and a disk-shaped column head, is arranged in the sleeve and made of a hydraulically binding and expandable material introduced under pressure into the sleeve and solidifying in the sleeve to form the central column. A jacket surrounds the column shaft and consists of stacked, empty, fire-retardant automobile tires having openings allowing water, contained in the hydraulically binding and expandable material, and air to exit.

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SUPPORT ELEMENT FOR UNDERGROUND UNDERWORKINGS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to support elements for use particularly in connection with mining operations, in particular, for underground underworkings.

[0003] 2. Description of the Related Art

[0004] It is known from U.S. Pat. No. 5,143,484 to fill automobile tires, in particular, used automobile tires, with concrete in a circular ring shape and to stack the automobile tires filled with hardened concrete as a support element between the footwall and the top wall of underground underworkings. Because of the weight of the automobile tires filled with concrete, stacking is possible only with great force expenditure. Since no precise adjustment of a automobile tire stack to the respective local distance between the footwall and the top wall is possible, the spacing between the topmost automobile tire and the top wall must be filled by fillers such as wedges, preferably wooden wedges, requiring complex manual labor. A further property of such a support element is that it cannot be braced with a predetermined bracing load between the footwall and the top wall. The lack of the bracing load however favors convergence, even convergence of the footwall.

[0005] Further variants of a support element are known from German patent document DE 37 32 894 A1 and U.S. Pat. No. 4,277,204. The support elements have a rigid jacket casing which, after hardening, of the filled-in building material can be removed. The disadvantage of such supports resides in that a significant part of the support force is removed as soon as the jacket casing is removed. A further disadvantage resides in the use of the many metal parts which makes the use of support elements in large numbers very cost-intensive.

[0006] In the documents DE 196 08 940 A1 and DE 297 22 995 A1 further alternatives are described. For erecting these supports, empty bags of fabric are suspended from the top wall and then filled. In practice, it was found that a rapid filling of the bags is not possible because the holders of the bags on the top wall will tear off as a result of the weight of the still liquid building material so that the building material will then flow into the mine section.

SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to provide a support element for underground underworkings which are comprised of automobile tires and can be braced with a bracing load between the top wall and the footwall without additional manual force expenditure.

[0008] In accordance with the present invention, this is achieved in that the support element has a sleeve of a flexible fabric permeable to water and air; a central column having a T-shaped vertical cross-section, comprised of a column shaft and a disk-shaped column head, and comprised of a hydraulically binding and expandable material introduced under pressure into the sleeve and solidifying in the sleeve to form the central column; and a jacket surrounding the column shaft, comprised of stacked, empty, fire-retardant automobile tires having openings allowing water, contained in the hydraulically binding and expandable material, and air to exit.

[0009] According to the present invention, such a support element comprises a central column which, in vertical cross-section, is T-shaped as well as a jacket surrounding the shaft of the column and comprised of empty automobile tires. The automobile tires are stacked and in this way form a jacket in which a vertically extending inner shaft is defined. Into the shaft a sleeve is inserted which has the desired T-shaped configuration the column to be formed with rotational symmetry. Subsequently, a hydraulically binding as well as expandable material is filled under pressure into the sleeve. This can be realized preferably by means of a pump. The material spreads within the sleeve and, as a result of the air-permeable and water-permeable flexible fabric of the sleeve, substantially only solid components of the introduced material remain in the sleeve; the material will expand and harden. As a result of the T-shaped, rotationally symmetrical sleeve, between the top side of the jacket and the top wall a disc-shaped column head is formed which has a horizontal cross-section that is greater than that of the column shaft. This column head bridges the distance between the top side of the jacket and the top wall. The outer diameter of the column head substantially has the same outer diameter as the jacket. As a result of this configuration, between the footwall and the top wall a substantially cylindrical support element is built which, because of the hydraulically binding and expandable material, can be braced with a bracing load.

[0010] The fabric or woven cloth which is employed for the sleeve is comprised, in particular, of a flexible water-resistant woven material, for example, a glass fiber material or synthetic fiber material. Natural fibers are also conceivable which are impregnated with agents which increase the durability of the fabric.

[0011] The material for forming the central T-shaped column is a mixture, in particular, of fly-ash of fossil fuels, lime, aluminum powder, and water. Such a material cannot be charged electrostatically, is non-combustible, and moreover inexpensive. Expansion of the material is realized as a result of the reaction of the aluminum powder with the lime. If needed, the strength can be improved by addition of Portland cement as a stabilizer.

[0012] In regard to the automobile tires, care must be taken that they are fire-retardant. Automobile tires of the newest generation are fire-retardant as a result of their chemical composition. Tires of older generations can be made fire-retardant before their installation, for example, by foaming a protective layer thereon or by spraying an adhesive or cohesive emulsion thereon. Also, it is conceivable to provide a subsequent protection against combustibility on site when the tires are in the mounted state. This can be an individual measure or can be carried out in the context of the overall building measure, for example, by blowing thereon residual materials or cut-and-fill material.

[0013] As has been discussed above, the column head is configured such that it can take on a support action across a large surface area of the top wall upon finishing the bracing process. As soon as the filled-in material presses the column head against the top wall, the areas of the column head extending circumferentially about the column shaft are

pushed, when filling in more material, from above against the jacket of automobile tires in the direction toward the footwall so that the flexible jacket between the footwall and the top wall is tensioned or braced.

[0014] By means of the features according to the invention, it is therefore possible to provide a support element for the underground underworkings, for example, in mining operations and for tunnel construction, for securing the top wall against falling rock and convergence as well as to protect against footwall convergence. The bracing of the support element with the bracing load between the footwall and the top wall results because of the material employed for the central column in that at least one part of the bracing load is maintained even over an extended period of time.

[0015] Since the automobile tires have air outlet openings which are provided particularly in the running surfaces of the automobile tires, when the maximum load of the support element is surpassed causing the hardened column to burst, air can be suddenly released from the jacket so that the energy of the released parts can be relieved into the hollow spaces. At the same time, the hollow spaces can also receive the fragments of the burst material of the column. The miners are not endangered by the bursting parts of the column.

[0016] An improved adjustment of the column, on the one hand, to the top wall and, on the other hand, to the jacket comprised of automobile tires is achieved according to another embodiment of the invention in that between the disk-shaped column head and the top wall a head plate, in particular, a head plate which has a closed surface, is provided and between the column head and the jacket an circular ring-shaped pressure plate is arranged. The material of the head plate and of the pressure plate can be steel. However, a corresponding plastic material is also conceivable. Moreover, it is possible that the head plate is profiled in order to receive optionally additional construction elements, for example, rails on the top wall.

[0017] A substantially positive-locking adjustment of the head plate to the top wall is achieved when the head plate is configured to be flexible to a limited extent.

[0018] According to the features of another embodiment, the column has no direct contact with the footwall. Instead, the end section of the column shaft facing the footwall is positioned in a receptacle with a bottom plate, wherein the receptacle is open in a direction to the top wall. The bottom plate forms in this connection the counter abutment to the head plate and axially receives the braced flexible jacket of automobile tires.

[0019] The invention can be further improved in that the receptacle has a sleeve-like receiving section for the column shaft with support bottom and a foot section which widens conically in the direction toward the footwall. The receiving section centers accordingly the lower end of the column shaft facing the footwall such that it partially radially surrounds the column shaft. The conical foot section, upon surpassing a defined load, can buckle yieldingly and accordingly forms an additional safety part of the support element.

[0020] Advantageously, the receiving section can have at least one transverse opening. The transverse opening, for example, in the form of a bore, is expediently provided in the wall of the receiving section. This transverse opening serves for removing excess water of the material filled into the sleeve.

[0021] Moreover, the support bottom of the receiving section can be flexible, at least to a certain extent, in order to be able to receive a prestress.

[0022] With respect to a problem-free filling process of the sleeve, it is advantageous to provide the section of the sleeve surrounding the column shaft with a filling conduit having an integrated filling valve and extending the filling conduit through the jacket.

BRIEF DESCRIPTION OF THE DRAWING

[0023] In the drawing, the only FIGURE shows a support element according to the invention comprised of a central column and a stack of automobile tires surrounding the central column.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] The support element **4** which is braced between the footwall **1** and the top wall **2** of underground underworkings **3** with a bracing load comprises basically a central column **5**, which is T-shaped in vertical cross-section and has rotational symmetry, as well as a jacket **7** surrounding the shaft **6** of the column and comprised of empty, stacked automobile tires **8** which are fire-retardant.

[0025] The column **5** is formed of a hydraulically binding as well as expandable material which is introduced under pressure into a sleeve **9** which corresponds to the shape of the desired T-shaped configuration of the column **5** to be formed. This sleeve **9** extends, on the one hand, vertically through the stack of automobile tires **8** forming a central inner shaft **10** and, on the other hand, between the uppermost automobile tire **8** and the top wall **2**. The material is introduced via a filling conduit **11** into the sleeve **9**. The filling conduit **11** is arranged in the upper area of the sleeve **9** delimiting the column shaft **6** and extends radially through an automobile tire **8**. A suitable filling valve **12** is integrated into the filling conduit **11**.

[0026] The end section **13** of the column shaft **6** neighboring the footwall **1** is positioned in a sleeve-like receiving section **14** which is a unitary part of the receptacle **15** with bottom plate **16**. Between the bottom plate **16** and the receiving section **14**, a bottom section **17** is provided that extends conically widening toward the footwall **1**. The bottom **18** of the column shaft **6** contacts a support bottom **19** of the receiving section **14**.

[0027] Moreover, it is shown that a head plate **21** extends between a disk-shaped column head **20** and the top wall **2** and that a pressure plate **22** of an annular ring shape is provided between the column head **20** and the uppermost automobile tire **8** of the jacket **7**. The pressure plate **22** surrounds the column shaft **6**.

[0028] The sleeve **9** is comprised of a fabric which is flexible and allows passage of air as well as water so that substantially only the solid components of the material remain within the sleeve **9** when the sleeve is filled with the hydraulically binding and expandable material. Water and air can exit between and through the automobile tires **8**. The

automobile tires **8** are provided with openings **23** to allow water and air to pass through. Moreover, in the wall **24** of the sleeve-like receiving section **14** at least one opening **25** is provided through which excess water can also exit during filling of the sleeve **9**.

[**0029**] The materials employed for forming the column can be, aside from fly-ash cement, other hydraulically binding building materials such as anhydrite, gypsum or ready-mix concrete. For the purpose of volume expansion of the multi-component mixtures, in addition to pore-generating chemical materials, it is also possible to admix pore-generating converted natural materials such as a resin acids and materials such as fatty alcohol diglycol ether sulfate (C_{12}-C_{14}).

[**0030**] The cohesion of the multi-component mixture is realized by stabilizers. These are organic or inorganic, water-soluble components, such as water glass, glycerin, lime solutions, and, in addition, heavy-metal salts for forming insoluble hydroxides.

[**0031**] While specific embodiments of the invention have been shown and described in detail to illustrate the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A support element for underground underworkings, the support element comprising:

a sleeve of a flexible fabric permeable to water and air;

a central column having a T-shaped vertical cross-section, comprised of a column shaft and a disk-shaped column head, and comprised of a hydraulically binding and expandable material introduced under pressure into the sleeve and solidifying in the sleeve to form the central column; and

a jacket surrounding the column shaft, comprised of stacked, empty, fire-retardant automobile tires having openings allowing water, contained in the hydraulically binding and expandable material, and air to exit.

2. Support element according to claim 1, wherein between the disk-shaped column head and a top wall of the underworkings a head plate is provided and between the column head and the jacket a circular ring-shaped pressure plate is arranged.

3. The support element according to claim 2, wherein the head plate is flexible at least to a limited extent.

4. The support element according to claim 1, further comprising a receptacle with a bottom plate, wherein the receptacle is open in the direction toward the top wall, wherein the receptacle is configured to receive a lower end section of the column shaft facing the footwall.

5. The support element according to claim 4, wherein the receptacle has a sleeve-shaped receiving section for the end section of the column shaft, wherein the receiving section is comprised of a support bottom and a conical bottom section conically widening in the direction toward the footwall.

6. The support element according to claim 5, wherein the receiving section has at least one opening allowing water contained in the hydraulically binding and expandable material to exit.

7. The support element according to claim 5, wherein the support bottom of the receiving section is flexible at least to a limited extent.

8. The support element according to claim 1, wherein a section of the sleeve surrounding the column shaft comprises a filling conduit having an integrated filling valve, wherein the filling conduit extends through the jacket.

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