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(71) Applicant: **SMET-TUNNELLING N.V.**
2480 Dessel (BE)

(72) Inventor: **Kips, Paul**
2470 Retie (BE)

(74) Representative: **Luys, Marie-José A.H. et al**
Gevers & Vander Haeghen,
Livornostraat 7
1060 Brussel (BE)

(54) Eccentric pipe for constructing an underground pipe ceiling and method for the production of an underground pipe ceiling by using a plurality of such pipes

(57) This invention relates to a pipe for spanning a room, which pipe (1) comprises an essentially cylindrical outer wall (2) and an essentially cylindrical inner wall (3), the inner wall (3) being excentrically mounted with respect to the outer wall (2). A method for the production of an underground pipe ceiling by using a plurality of such pipes is also disclosed.

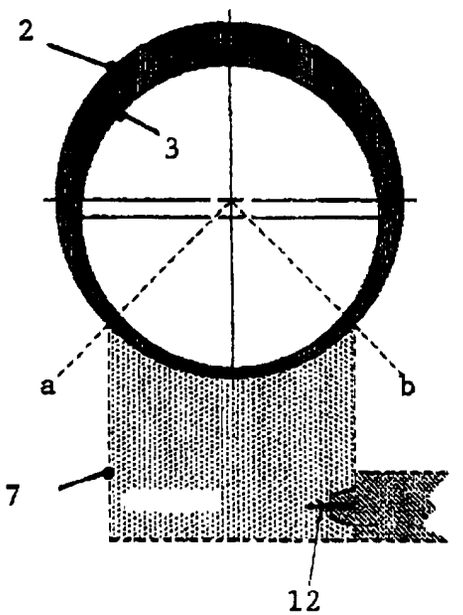

FIG. 4

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Description

[0001] The present invention relates to a tube for constructing a span of a room as described in the preamble of the first claim.

[0002] It is known to make use of tube ceilings when spanning large rooms, in particular large underground rooms. An underground tube ceiling is constructed by placing a first underground pipe parallel to the plane of the span to be constructed, by means of drilling. After a reinforcement has been applied in the pipes and the pipes have been filled with concrete, the ground below the pipes is removed so that a large underground room is created, the ceiling of which is formed by the pipes filled with reinforced concrete.

[0003] The span that can be effectuated with such a pipe ceiling is however limited due to the relatively high strain to which the pipe ceiling is subjected, by the ground laying on top of the pipe ceiling. De span that can be offered by a pipe ceiling is further limited in that the diameter of the pipes that may be used, and thus the beam height that can be provided, is limited. The pipes are namely supplied through smaller galleries located in the vicinity of the pipe ceiling. Besides this, relaxation of a.o. constructions located above the pipe ceiling, relaxation of the ground below the surface level where the pipe ceiling is located, as well as the affected area formed as a consequence of constructing the pipe ceiling, should be limited as far as possible.

[0004] Up to now, the problem of the limited span that can be provided by the known pipe ceiling has been solved by supporting the pipes at several positions as is shown in figure 1. However, this is time consuming, expensive and can often in practise not be effectuated because of the nature of the construction.

[0005] It is the aim of the present invention to provide a pipe with which a larger span can be provided, which does not involve the necessity of additional support.

[0006] This is achieved in the present invention with the technical features of the characterising part of the first claim. The excentric positioning of the inner wall with respect to the outer wall of the pipe permits the span that can be provided by the pipe to be increased, without adversely affecting the structural stability and without necessitating the presence of additional supports.

[0007] The span that may be provided by a pipe is determined by the beam height formed by the pipe. The beam height formed by the pipe can be increased by removing a segment from the bottom side of the pipe, in longitudinal direction thereof, and to remove the ground below this segment to such a depth that the beam height can be increased with the necessary height. Thereafter, pipe and recess are filled with concrete, reinforced or not, to provide the required span.

[0008] However when removing a segment from the pipe known from the state of the art to increase the beam height, the structural stability of the pipe is broken. As a consequence the pipe needs to be supported in cross direction at one or more positions, to repair its structural stability as good as possible and to ensure that the pipe is capable of withstanding downward and sideways applied forces of the surrounding ground layers. However, underground supports constitute unwanted obstacles.

[0009] This invention provides another attempt to the solution of the problem of the decreased structural stability that occurs when part of the bottom of the pipe is removed. The starting point of this invention is not the fact that a pipe of sleeve used to construct a span, is adapted to provide sufficient stability and allow deepening of the ground. On the contrary, with this invention a pipe is provided the construction of which, in particular the variation of the wall thickness, may be adapted to the span to be provided by the pipe later on.

[0010] By the excentric arrangement of the inner wall in the outer wall namely a pipe is provided with a varying wall thickness, which is adapted to the variable flexural moment to which the underground pipe is exposed. The wall thickness is lower at a position where the inner wall is closer to the outer wall, the wall thickness is larger at a position where the inner wall is located further away from the outer wall. The pipe is inserted in the ground in such a manner that the part with the larger wall thickness lays on top, parallel to the surface or parallel to the spanned surface. An analysis of the problem has shown that this part is subject to the largest pressure of ground layers laying on top of it, namely the vertical pressure exerted by the ground layers on top of it. The wall thickness decreases from the upper part to the bottom part of the pipe. The forces exerted sideways to the pipe apply under an angle and are thus smaller. The part with the smallest wall thickness onto which almost no forces are exerted, is located at the bottom. The largest pressure, and thus the largest flexural moment is exerted to the part of the pipe having the largest wall thickness. The smallest pressure and smallest flexural moment are exerted to the part with the smallest wall thickness. The flexural moment thus decreases with the wall thickness.

[0011] From such a pipe a segment may be removed from the wall of the pipe at the position where the wall thickness is the smallest, and a recess may be formed in the underlaying ground without thereby adversely affecting the structural stability of the pipe and without the necessity of using obstructive supports.

[0012] This invention also relates to a method for producing the above described pipe. The pipe is preferably produced by mounting an inner formwork in an outer formwork in such a manner that the inner formwork is excentrically positioned within the outer formwork. An outer wall is applied against the outer formwork, an inner wall is applied against the inner formwork and the outer and inner wall are connected to each other. In case the pipe is made of concrete, this is effectuated in practise by inserting concrete between the outer and inner casing. The reinforcement can be made as known from the state of the art and may for example be formed by a cylindrical cage placed parallel with the outer wall and

a cylindrical cage placed parallel to the inner wall of the pipe.

[0013] In case the maximal wall thickness would be insufficient for a given situation and a chosen type of pipe, use can be made of an inner formwork with a diameter that is smaller than the one originally planned, so as to allow the maximal wall thickness to be increased when producing the pipe. Possible beam height that may get lost may be compensated by increasing the recess below the pipe so that the desired span can be provided after all. In that way it becomes possible to adapt the type of pipe to a specific situation.

[0014] This invention also relates to a method for producing a pipe ceiling using the above described pipes, a plurality of pipes of this invention being positioned adjacent to each other. In case it is necessary to increase the beam height provided by the pipe, ground may be removed in longitudinal direction below the pipes, after which the pipes and the removed ground volume are filled with concrete, reinforced or not.

[0015] The invention is further elucidated in the attached figures and description of the figures.

[0016] Figure 1 is a view to a span known from the state of the art.

[0017] Figure 2a and 2b show a cross section of a pipe known from the state of the art, from which a wall segment has been removed.

[0018] Figure 3 shows a cross section of the pipe of this invention and the pattern of forces to which the pipe is subjected.

[0019] Figure 4 shows a cross section of the pipe of this invention below which a recess has been formed.

[0020] Figure 1 is a view to the known pipe ceiling 4 comprising a plurality of parallel, adjacent pipes 1, located below a surface 10. The pipes are mounted underground in a gallery 5, by inserting a plurality of short pipe lengths 6 one after the other. The diameter of the pipes 1 is adapted to the span that needs to be provided. Thereafter the ground below the pipes is removed, over a distance which is smaller than or equal to the maximum possible span that may be realised. The recess 7 and pipes 1 are filled with concrete, reinforced or not to create the desired beam height. The thus obtained beam 7 is supported by a support 8 to allow that the pipes 1 can span the length 11.

[0021] In the state of the art pipe 1 shown in figure 2, a segment (dotted line a-b) has been removed from the bottom of the pipe to allow the beam height h to be increased. To prevent collapsing of the pipe 1 when removing the wall segment a-b, a horizontal floor 9 is mounted between the thus formed extremities 13 and 14 of the pipe 1.

[0022] The preferred embodiment of this invention shown in figure 3, comprises a pipe wall or tube wall with an outer wall 2 and an inner wall 3. The inner wall 3 is positioned excentrically within the outer wall 2 so that a pipe with a varying wall thickness is obtained.

[0023] When constructing the span, a segment indicated between the dotted line a-b, is removed from the bottom of the pipe. The size or edge of the segment may be varied within reasonable ranges, but is preferably smaller than 90°, thus maximum ¼ of the circumference of the pipe. The size of the segment that is removed from the pipe will in general vary with the beam width aimed at, thereby taking into account that a support face is provided for the pipe 1 which is sufficiently large to avoid that the structural stability of the pipe is effected to a too large extent. If it is desirable to provide a larger beam height, in longitudinal direction of the pipe, at parts of the length of the pipe, but preferably the entire length of the pipe, a sleeve is formed below the segment by removing ground. Thereafter, a reinforcement and concrete are applied in the thus formed sleeve and pipe 1. In a similar way a plurality of adjacent pipes 1 are applied underground. Below the thus constructed pipe ceiling 4, the ground can be removed to form an open underground room.

[0024] The pipes 1 may be places parallel to or under an angle with respect to the surface 10.

[0025] The wall thickness of the pipe 1 may be varied within wide ranges. The maximum wall thickness is preferably maximum 10 times, more preferably 2 to 5 times the minimal wall thickness. The wall thickness decreases gradually from a point with the largest wall thickness which is preferably located on top of the pipe 1, towards a point with the smallest wall thickness, preferably at the bottom of the pipe 1. In that way a uniform evolution of the strength of the pipe wall can be obtained.

[0026] The pipe of this invention can be made of any material known to the man skilled in the art of making pipes, for example concrete, steel, plastic material etc. In case the pipe is made of steel, preferably a plurality of reinforcement means are introduced between the inner wall 3 and outer wall 2 to improve the stiffness of the pipe and to obtain a pipe with a resistance that is large at the position where the bending or flexural moment is the largest, and a smaller resistance at the position where the bending moment is smaller.

[0027] The pipe and method of this invention present the advantage that a water sealed, pipe ceiling may be constructed in a simplified and cheaper manner. It is namely virtually impossible to fit adjacent pipes together in a water tight manner. To prevent seeping of water between adjacent pipes, the space between those pipes is filled. This is preferably achieved by inserting a reinforcement 12 between the pipes, which is than imbedded in concrete or the material the pipes are made of. The reinforcement may for example also be applied in the recess below the pipes, or transversal to the longitudinal direction of the pipes, and may extend throughout adjacent recesses.

Claims

1. Pipe for spanning a room, which pipe (1) comprises

an essentially cylindrical outer wall (2) and an essentially cylindrical inner wall (3), characterised in that the inner wall (3) is excentrically mounted with respect to the outer wall (2).

2. Pipe as claimed in claim 1, characterised in that the pipe (1) has a wall with a wall thickness which gradually decreases from a position with maximum wall thickness to a position with minimum wall thickness.

3. Method for the production of an underground pipe ceiling in which a plurality of pipes of claims 1 or 2 are applied adjacent underground, each pipe having a top side with a larger wall thickness and a bottom side with a smaller wall thickness, the top side of each pipe being oriented towards a side of the pipe ceiling which is subjected to the largest pressure and the bottom side of each pipe being oriented towards the side of the pipe ceiling subjected to the smallest pressure, after which in longitudinal direction of the pipe a segment is removed from the bottom side of the pipe and in longitudinal direction below the removed segment of the pipe an amount of ground is removed after which the pipe and the removed volume are filled with reinforced concrete.

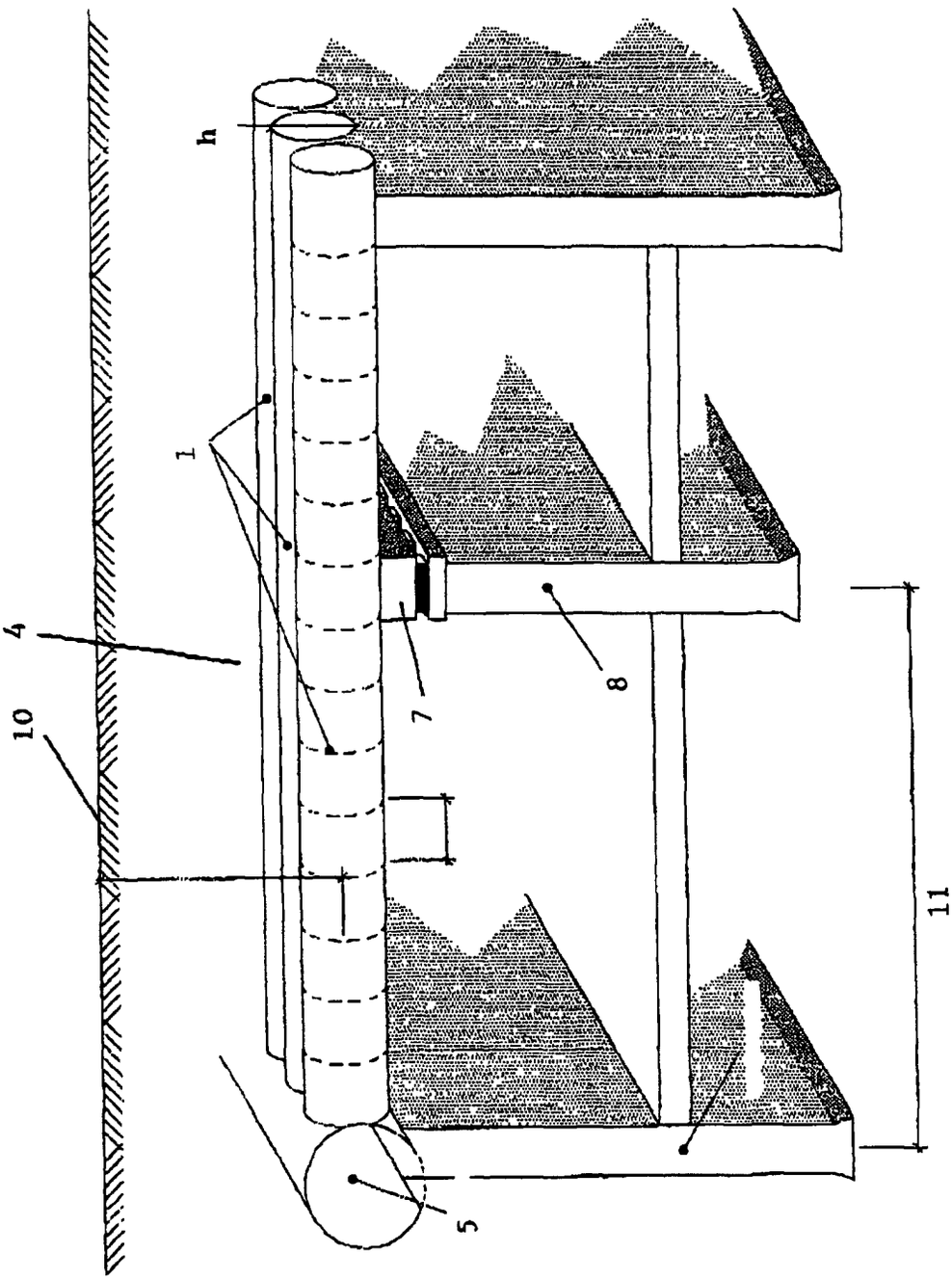


FIG. 1

FIG. 2a

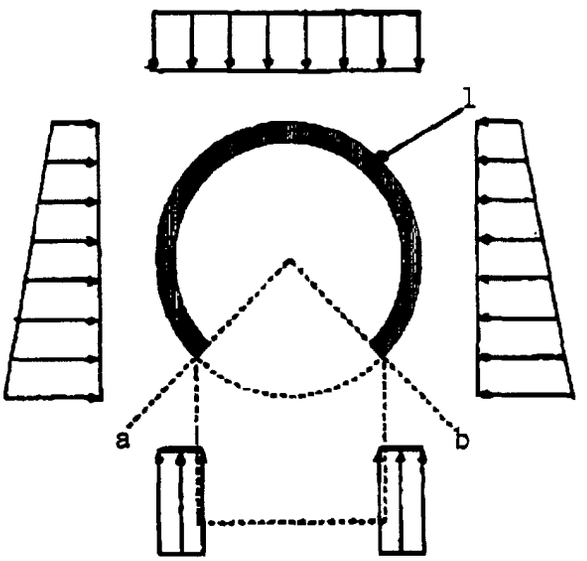
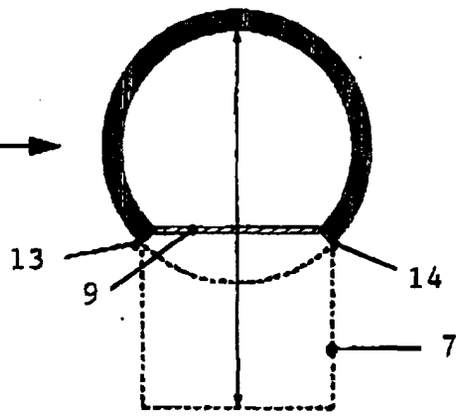


FIG. 2b



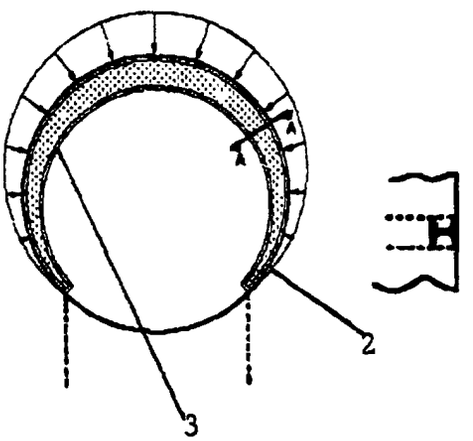


FIG. 3

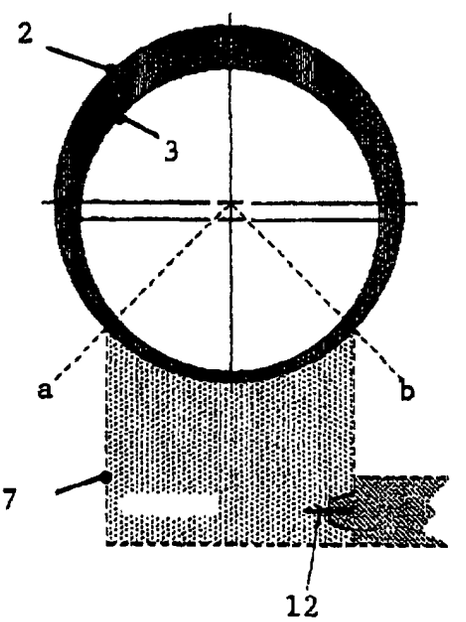


FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 00 87 0212

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B21C
E04B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 December 2000	Vinci, V

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