(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 323 084 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88311939.8**

(51) Int. Cl.4: **E21D 11/08**

(22) Date of filing: **16.12.88**

(30) Priority: **29.12.87 GB 8730218**
19.09.88 GB 8821923

(43) Date of publication of application:
05.07.89 Bulletin 89/27

(84) Designated Contracting States:
BE DE ES FR GB GR IT LU NL

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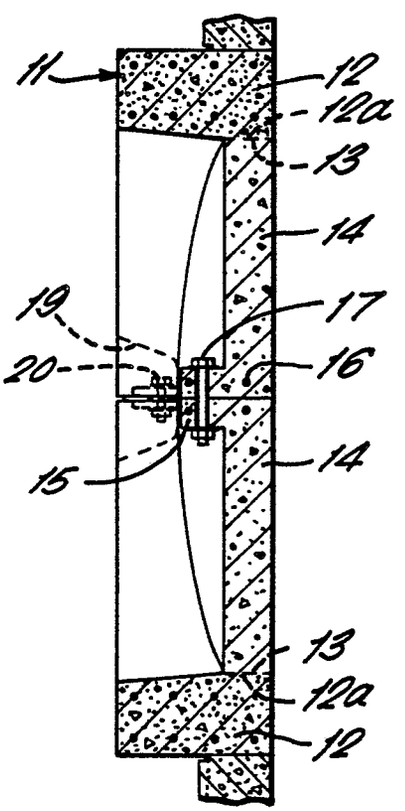
(54) Improvements in or relating to lining elements for tunnels or shafts.

(57) The disclosure relates to a shaft lining comprising precast concrete arcuate lining elements including a pair of special lining elements (11) to provide an access point for a horizontal tunnel. Each element (11) comprises an outer section (12) cast in high compression strength high impact strength steel reinforced concrete with a semi-circular shaped recess (13) in which a lightweight concrete wall section (14) is cast with an integral flange (15) along the diametrically extending edge thereof to abut with the corresponding flange (15) of the adjacent segment when erected. The two elements (11) are secured together by a fixing bolts (17) and (20). The lightweight concrete circular wall formed by the two semi-circular sections (14) within the elements (11) supports the wall of the encircling shaft during erection of the shaft but can readilly be broken out when connecting the shaft to a tunnel leading from the shaft.

FIG. 3



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IMPROVEMENTS IN OR RELATING TO LINING ELEMENTS FOR TUNNELS OR SHAFTS

This invention relates to lining elements for tunnels or shafts.

Use of precast concrete arcuate segments is well known both for tunnel and shaft lining but special forms of construction invariably have to be resorted to where a tunnel is required to connect to a shaft or, likewise, where a shaft is required to be connected to a tunnel. To enable a tunnel to be connected to or from a shaft in water bearing ground, it is necessary to stabilise the soil surrounding the opening. One method of achieving this is to form low strength piles around that section of the shaft, or alternatively, when forming an opening it is necessary to support the shaft internally to prevent collapse until the connecting tunnel has been completed.

This invention provides a lining element for a tunnel or shaft, the element having a main wall formed in reinforced, concrete and a removable wall portion cast in and supported by the main wall to be broken out of the main wall to provide an opening through the element for a branch shaft or tunnel where required.

The main wall of the lining element is preferably formed from a high compression, high impact resistance concrete and the removable wall portion is formed in a low impact resistance concrete with no reinforcement bridging the removable wall and the main wall so that the removable wall can readily be broken out of the main wall.

The removable wall portion of the lining element may have a reduced wall thickness compared with the wall thickness of the main wall to facilitate the breaking out of the further section.

Preferably the removable wall is formed from a lightweight concrete. For example the removable wall may be formed from "Lytag" concrete.

In any of the above arrangements the lining element may be of arcuate form and the removable wall portion may be formed part way along one circumferentially extending edge of the element whereby two such elements may be assembled side-by-side with said removable wall portions of the elements aligned to provide an enlarged opening when the wall portions have been removed.

More specifically the removable portion of the element may have a semi-circular profile to provide a circular opening with the similar adjacent element.

In a further arrangement the main wall of the lining element may be case in situ in the tunnel lining or shaft with the removable wall also cast in situ in the main wall.

The following is a description of some specific embodiments of the invention, reference being made to the accompanying drawings in which:

Figure 1 is a plan view of a shaft embodying lining elements in accordance with the invention

Figure 2 is a elevation from inside the shaft lining of Figure 1;

Figure 3 is a section of the line 3-3 on Figure 2; and

Figures 4 to 6 illustrate three further embodiments.

Figure 1 of the drawings shows one ring of a lining for a shaft comprising a purality of conventional reinforced precast concrete arcuate lining elements connected together both end to end and to the corresponding elements of the rings above and below. Over an arc of the lining spanning four rings, a pair of special lining elements 11 is provided to complete the rings of elements 10 and to provide an access point for a horizontal tunnel. The elements 11 will now be described in greater detail with reference to Figures 2 and 3.

Each element 11 is of twice the normal axial length of a conventional lining element 10 to span two rings of elements 10 and has a circumferential length of approximately twice that of the normal lining elements 10. The elements 11 each comprise a main section 12 cast in high compression strength high impact strength steel reinforced concrete with a semi-circular shaped recess 13 formed in one circumferential edge 12a of the element. The region of the main section 12 around the recess is formed with an increased thickness by a ram formed on the inner side of the element as indicated at 12b.

Initially the recess has a lightweight (e.g. "Lytag") semi-circular concrete wall section 14 cast therein with an integral flange 15 extending along the diametrically extending edge of the wall. The flange 15 and the adjacent part of the edge of the section 14 may be reinforced with cast-in reinforcement rods 16 as shown in Figure 3. Such rods 16 do not extend into the main section 12 of the element.

The two elements 11 are connected together with the semi-circular sections 14 in alignment and the respective flanges 15 in abutment. The edge portions of each main section 12 to either side of the semi-circular sections 14 have cast in anchor plates 18 with shallow recesses 19 behind the plates. The pairs of plates of opposing elements 11 are secured together by bolts 20 to provide a permanent lining between the elements 11. In addition the abutting flanges 15 of the elements may be secured together by a bolt or bolts 17.

Once the shaft has been erected and the ground surrounding the shaft stablilised, the sections 14 of the elements 11 can be broken out from the elements to reveal a circular aperture through the wall of the shaft for connection to a tunnel extending horizontally of the lining. It will be understood that the main sections 12 of the lining elements 11 are cast to dimensions and provided with reinforcement to enable them to withstand the full loads imposed on the shaft lining with the sections 14 removed.

The lining elements 11 may be formed with cast-in sockets 21 in the inside of the recess around the removable section 14 to receive attachments for securing a gaiter around the recess to cooperate with a tunnelling machine as it drives through the wall of the shaft. This arrangement is of particular value when entering unstable ground.

It will be appreciated that many modifications may be made to the above descripted embodiment without departing the scope of the invention. For example, the removal section of the tunnel lining element may be shaped otherwise than semi-circular according to the cross-section of the tunnel to be driven from the shaft lining. For example the removable section may be part oval, elliptical, rectangular or square to connect with an oval, elliptical, rectangular or square tunnel connected to the shaft lining. The arrangement can also be used in the wall of a tunnel to provide a connection with a subsidiary tunnel or a shaft connected to the tunnel. In addition the removable section may be formed wholly within the lining element thereby providing a continuous wall encircling the removable section. In the latter case the removable section may be of circular or any other shape to suit the cross-section of the shaft or lining to be connected to it.

In the above described embodiment, the circular removable section in the wall of the shaft lining spans two lining elements 11. It is however envisaged that it may be necessary to span three or more elements according to the size of the tunnel required to extend from the shaft. The shaft lining elements 11 described above are divided horizontally but they could, equally be divided vertically into two or more elements.

It will be appreciated that the invention is applicable also to shaft a tunnel linings other than circular in cross-section. For example the lining may be square, rectangular, oval or ellipical in cross-section.

Referring now to Figure 4 of the drawings, there is shown a further embodiment of the invention in which a single special lining element 11 has a main wall portion 12 cast in situ to complete a tunnel or shaft lining formed from precast annular segments. The removable section 14 of the special lining element is also cast in situ.

In Figure 5 of the drawings the special lining element 11 is a complete annular element which is cast in situ in the excavated tunnel or shaft with the removable portion of the lining also cast in situ in the main wall of the lining element. Such an arrangement may form part of a tunnel lining which si completely cast in situ or may form part of a lining the remainder of which comprises precast annular segments as shown in Figure 6. The details of the special lining elements are otherwise as described with references to Figure 1 above.

Claims

1. A lining element for a tunnel or shaft, the element having main wall in reinforced, concrete and a removable wall portion cast in and supported by the main wall to be broken out of the main wall to provide an opening through the lining element for a branch shaft or tunnel where required.

2. A lining element as claimed in Claim 1, wherein the main wall of the element is formed from a high compression, high impact strength concrete and the removable wall is formed from a low inpact resistance concrete with no reinforcement bridging the removable wall and the main wall so that the removable wall can readily be broken out of the main wall.

3. A lining element as claimed in Claim 1 or Claim 2, wherein the removable wall of the element has a reduced wall thickness compared with the main wall thickness to facilitate the breaking out of the removable wall.

4. A lining element as claimed in any of Claims 1 to 3 wherein the removable wall is formed from a lightweight concrete.

5. A lining element as claimed in Claim 4 wherein the removable wall is formed from "Lytag" concrete.

6. A lining element as claimed in any of the preceeding claims wherein the removable wall is formed part way along one edge of the element whereby two such elements may be assembled side-by-side with said removable wall portions of the elements aligned to provide an enlarged opening when the portions have been removed.

7. A lining element as claimed in Claim 6 wherein the removable portion of the element has a semi-circular profile to provide a circular opening with the similar adjacent element.

8. A lining element as claimed in any of the preceding claims for a circular, oval, elliptical, square or rectangular section lining.

9. A lining element as claimed in any of the preceding claims, wherein removable wall portion has a circular, elliptical, oval, rectangular or part thereof periphery according to the cross-section of the tunnel or shaft lining to extend therefrom.

10. A lining element as claimed in any of Claims 1 to 5, wherein the element is cast "in situ" in a lining formed of precast annular segments, the removable wall portion being cast in situ in the lining element to be removable therefrom when required.

11. A lining element as claimed in any of Claims 1 to 5, wherein the main wall of the element comprises a complete annular form cast "in situ" with the removable wall portion cast in situ in the main wall.

12. A lining element as claimed in Claim 11, wherein the main wall of the element is adapted to be connected to rings of precast segments on either side of the element.

FIG. 1.

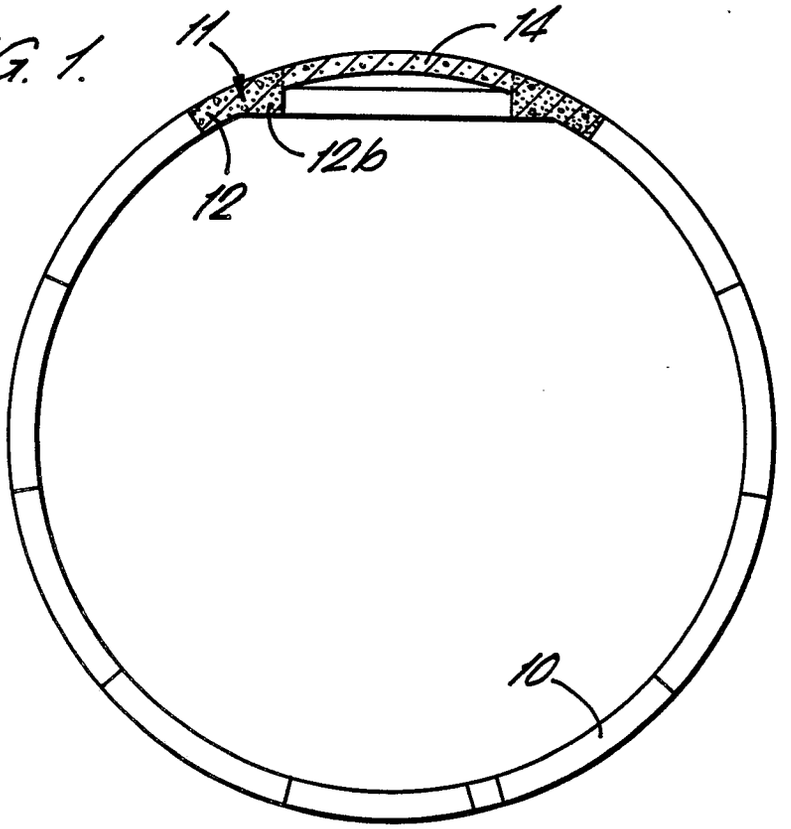
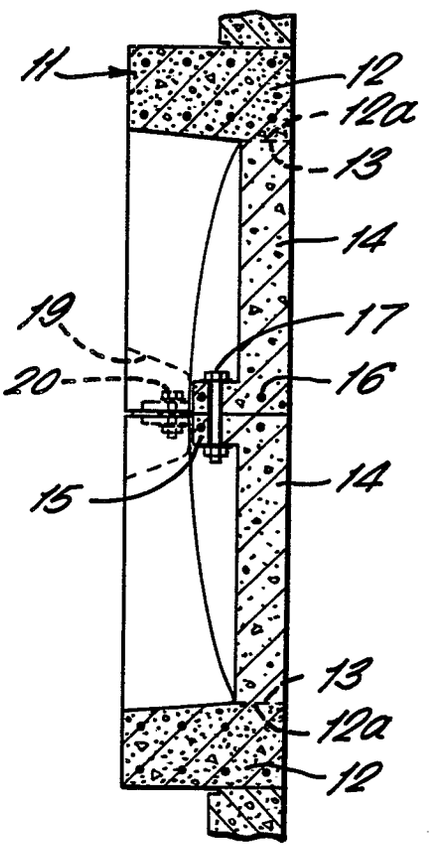


FIG. 3.



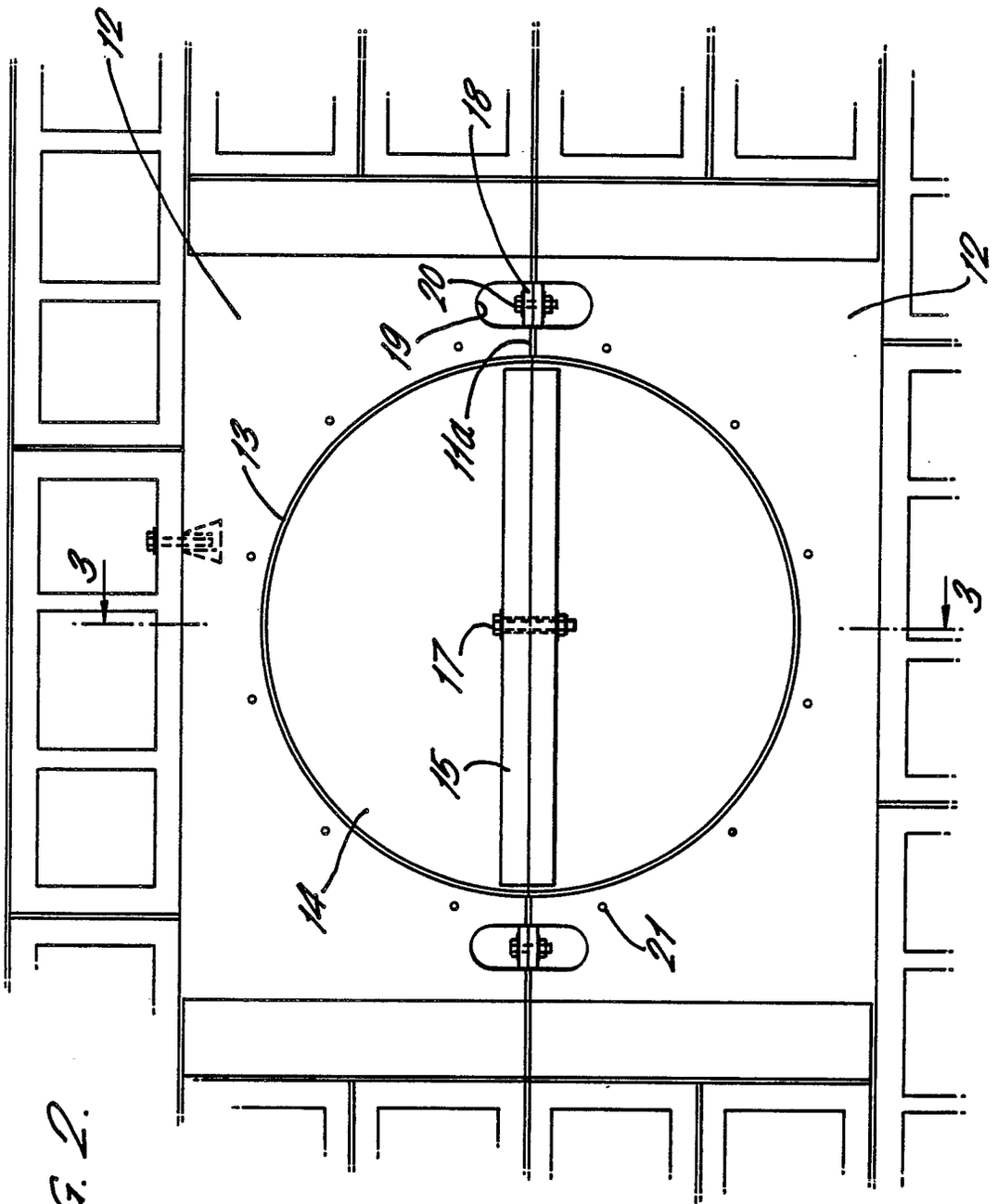


FIG. 2.

FIG. 4.

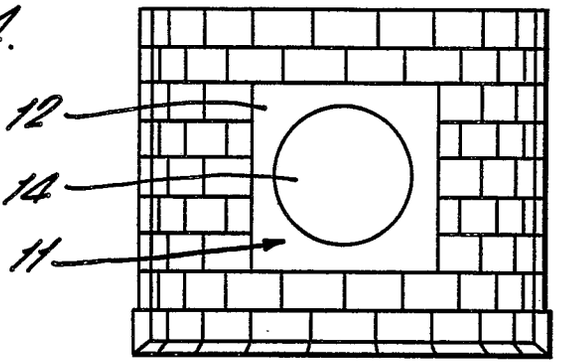


FIG. 5.

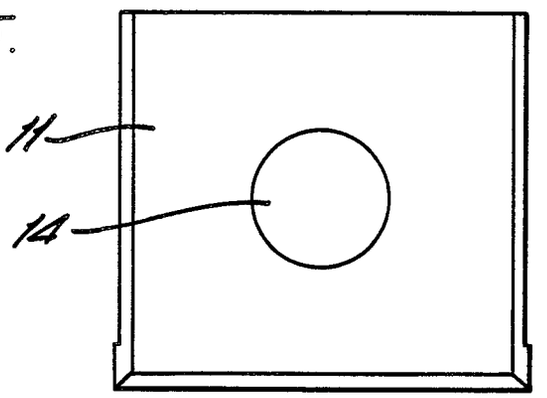
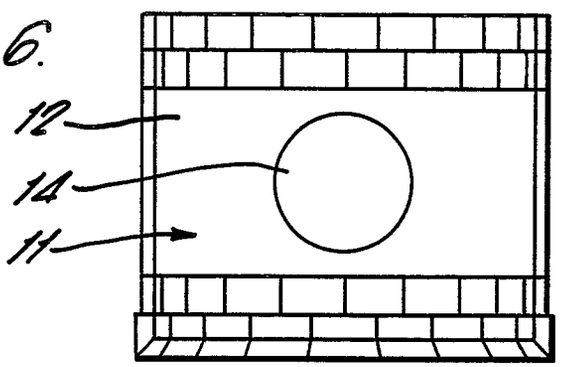


FIG. 6.



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 31 1939

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A-2 525 519 (MORIN) * Page 6, line 35 - page 7, line 9; figures 2,3 *	1,3,8-10	E 21 D 11/08
X	CH-A- 466 170 (BÜSCHER) * Column 3, lines 10-22; figures *	1,8-10, 12	
A	CH-A- 348 421 (MORGAN) * Page 3, lines 10-24; figure 4 *	1	
A	FR-A-1 005 519 (SOCIETE AUXILIAIRE DES DISTRIBUTIONS D'EAU) * Whole document *	11	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

E 21 D
E 03 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	05-04-1989	RAMPELMANN J.

CATEGORY OF CITED DOCUMENTS

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