United States Patent [19]

Lobbe et al.

[11] **3,834,170**

[45] **Sept. 10, 1974**

[54] **PROCESS OF, AND A PLANT FOR, CONSTRUCTING TUNNELS**

[75] Inventors: **Armin Lobbe,** Oberaden; **Wolf-Rudiger Von Schenck Zu Schweinsberg,** Borstel Bei Winson/Luhe, both of Germany

[73] Assignee: **Gewerkschaft Eisenhutte Westfalia,** Wethmar near Lunen, Westfalia Germany

[22] Filed: **Sept. 26, 1972**

[21] Appl. No.: **292,470**

[30] **Foreign Application Priority Data**

Sept. 27, 1971 Spain 395457
Nov. 12, 1971 Spain 396949

[52] **U.S. Cl.** **61/84,** 61/85, 61/42, 52/310

[51] **Int. Cl.** **E01g 5/08,** E01g 5/16

[58] **Field of Search** 61/85, 84, 63, 42, 45; 52/310

[56] **References Cited**

UNITED STATES PATENTS

1,867,837	7/1932	Jackson	61/45 R X
2,438,528	3/1948	Wilhelm et al.	52/310 X
2,698,560	1/1955	Heltzel	52/310 X
2,879,662	3/1959	Spinelli	52/310 X
3,350,889	11/1967	Sturm	61/85
3,561,223	2/1971	Tabor	61/85

Primary Examiner—Dennis L. Taylor
Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

A plant for use in tunnel constructions and having a drive shield with a cutting head for driving into a working face to advance the tunnel. A plurality of rams which act upon an abutment member are used to drive the shield forwards. The abutment member transmits the forces from the rams to a mass of fluid concrete introduced under pressure and supported on support means such as a tubular shell or series of rings spaced inwardly from the tunnel wall. The concrete when hardened forms a continuous lining for the tunnel wall. Water is removed from the fluid concrete with the aid of filters provided on the abutment member or the support means.

15 Claims, 4 Drawing Figures

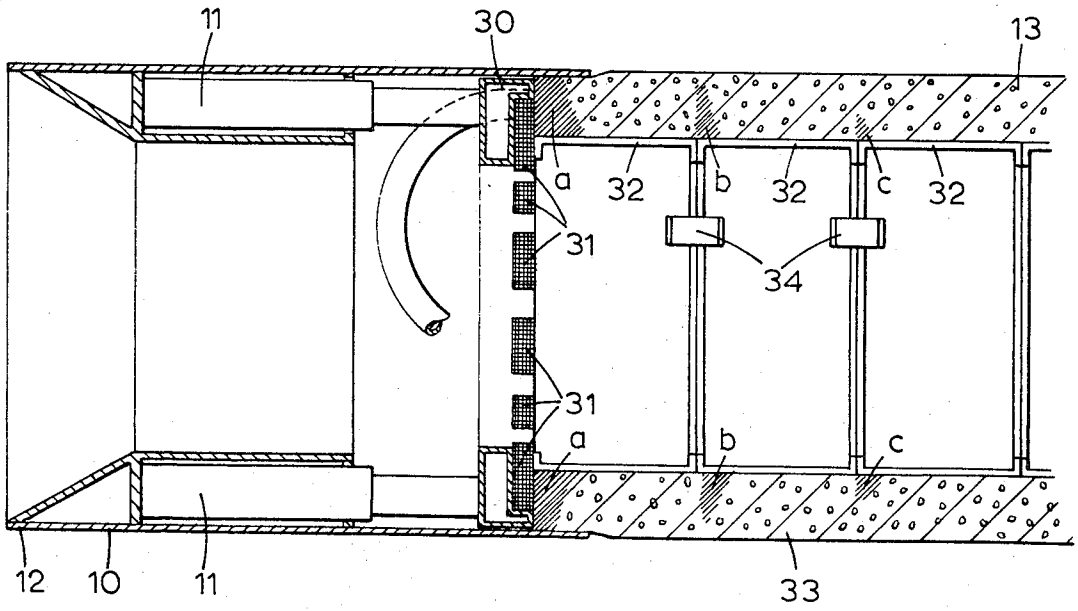


Fig.1.

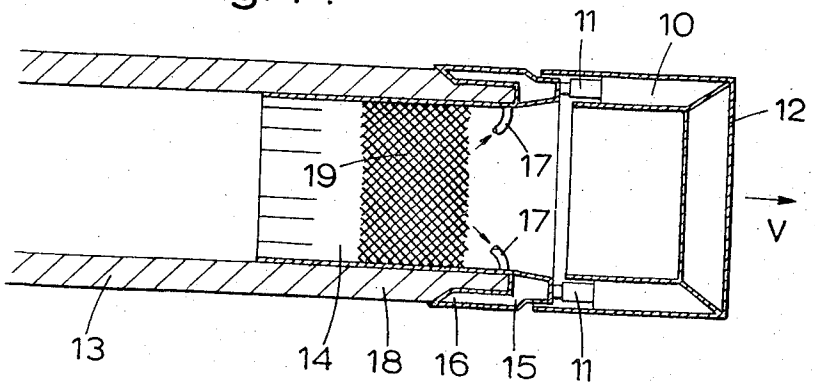

11
10
12
19
17
17
V
13
14
18
16
15
11

Fig.2.

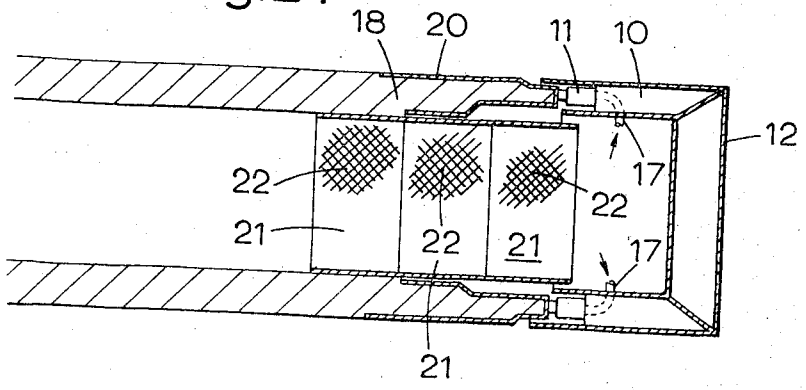

18
20
11
10
12
22
17
22
21
22
21
17
21

Fig. 3.

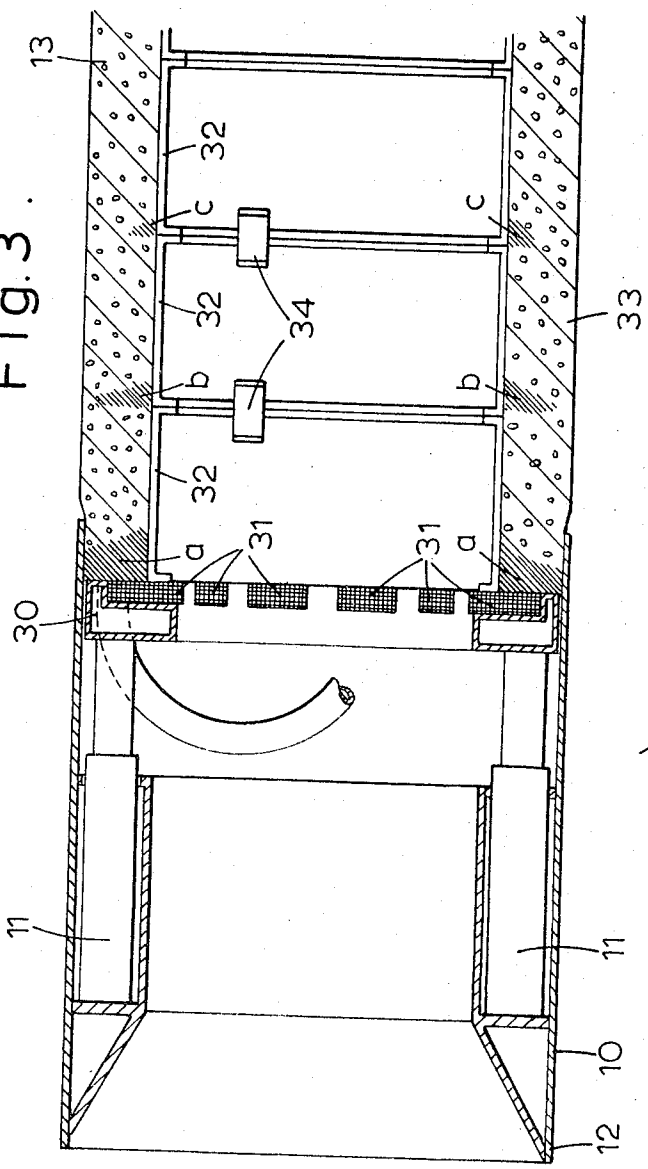
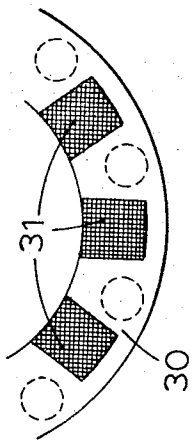


Fig. 4.



PROCESS OF, AND A PLANT FOR, CONSTRUCTING TUNNELS

BACKGROUND TO THE INVENTION

The present invention relates to a process of, and plants for, constructing a tunnel.

In tunnel construction it is known to support the wall of the tunnel behind the excavating or driving work with a concrete lining. It is desirable to introduce fluid concrete to form such a lining as near as possible to the working face and to introduce the fluid concrete as soon as possible after a fresh advance. Hitherto the time required for the concrete to harden has slowed down the rate at which the tunnel can be advanced.

A general object of the present invention is to provide an improved process of and plants for constructing tunnels.

SUMMARY OF THE INVENTION

In a process of constructing a tunnel by advancing a drive shield into a working face and by forming a concrete lining for supporting the tunnel wall produced by the drive shield; the invention comprises, in one aspect, removing water from the fluid concrete used to form the lining via at least one filter. In this way the concrete can be hardened more rapidly and preferably the fluid concrete is introduced under pressure to ensure an adequate quantity of water is removed.

However, the invention also comprises supporting a mass of fluid concrete used to form the lining and using said mass of concrete as an abutment for driving the shield forward before said concrete has hardened. More particularly, the rams used for advancing the shield may act against the concrete. In this way the advance of the tunnel can be virtually continuous since there is no necessity to wait for the concrete to harden before advancing the shield. The advance of the shield serves to compress the concrete to expell more water therefrom and this results in a concrete lining of good quality and density being produced.

The invention also provides a plant for constructing tunnels which plant includes means for supporting fluid concrete used to form a lining for the tunnel, and one or more filters allowing water to be removed from said fluid concrete.

The plant thus enables the tunnel to be constructed more quickly and economically than hitherto. In general the driving operation and the introduction of fresh fluid concrete can take place in succession to one another.

Preferably an abutment member is disposed between the rams used to advance the drive shield and the concrete. The support means can take the form of a tubular shell spaced inwardly from the tunnel wall and attached to the abutment member. Alternatively the support means can be slidable in relation to the abutment member or merely engageable therewith. The support means can also in these latter alternatives, be in the form of a series of rings. The shell or rings may have the filters therein but it is also possible for the abutment member to be provided with these components. The abutment member may also define or partly define a chamber for initially receiving the concrete.

In the case where the abutment member has the filters this causes the concrete to harden more quickly in a zone which is adjacent the filters. Although this does

have some advantage in preventing flowing of the concrete and transmitting the thrust forces of the rams the presence of the zones of pre-hardened concrete is disadvantageous in the lining and hence it is desirable to use a vibrating device or similar to destroy these zones and disperse the agglomerations of hardened concrete into the more fluid concrete.

The invention may be understood more readily and various other features of the invention may become more apparent from consideration of the following description.

BRIEF DESCRIPTION OF DRAWING

Embodiments of the invention will now be described by way of example only, with reference to, and as illustrated in, the accompanying drawings, wherein

FIG. **1** is a schematic longitudinal sectional view of a tunnelling plant made in accordance with the invention;

FIG. **2** is a schematic longitudinal sectional view of a further tunnelling plant made in accordance with the invention;

FIG. **3** is a schematic longitudinal sectional view of another tunnelling plant made in accordance with the invention; and

FIG. **4** is an end view of part of the abutment member used in the plant depicted in FIG. **3.**

DESCRIPTION OF PREFERRED EMBODIMENT

Referring initially to FIG. **1,** the plant has a drive shield **10** formed at its forward end with a cutting head **12.** A plurality of hydraulic rams **11** are used to drive the shield **10** in the direction of arrow V to cause the head **12** to penetrate a working face. Material is removed from the face and conveyed rearwardly through the shield **10** and the tunnel previously constructed. This is well known per se. As the tunnel progresses the wall of the tunnel is supported by a concrete lining **13** formed in situ. To this end, a tubular shell **14** having an abutment member **15** at its forward end is provided. The member **15** engages the rams **11** and absorbs the thrust forces when the shield **10** is driven forwards. The member **15** is a double-walled structure, having a rearwardly projecting extension **16** which, with the main body of the shell **14,** defines a chamber for receiving fluid concrete from pipes **17** for forming the lining **13.** The portion of the concrete lining denoted **18** is supported by the shell **14** during its setting process. The shell **14** is provided with one or more filters **19** which enable water to pass from the fluid concrete into the interior of the shell **14.**

During operation the shield **10** is advanced and the shell **14** is then drawn up towards the shield **10.** Fluid concrete is pumped under pressure, preferably in the order of 2–5 atmospheres, into the chamber between the extension **16** and the main body of the shell **14** via the pipes **17.** This fluid concrete tends to move rearwardly, over the portion **18** supported by the shell **14.** Since the fluid concrete is under pressure water is urged through the or each of the filters **19.** The fluid concrete is supported radially between the shell **14** and the tunnel wall and axially by the existing hardened lining **13** and the member **15.** Hence although the introduced concrete has not set it can still form a rear support for the abutment member **15** when the rams **11** next drive the shield **10** forwards. The concrete is in fact compressed by the operation of the rams **11** so that

water is again forced out of the concrete and through the or each of the filters **19.** The cycle is then repeated and the overall tunnel driving process can thus take place continuously without waiting for the newly-introduced concrete to harden.

The plants depicted in FIGS. **2–4** are similar to that shown in FIG. **1** and like reference numerals are used to denote like components. As shown in FIG. **2** the FIG. **1** arrangement is modified so that a series of rings **21** provided with filters **22** replaces the shell **14** as a support to the fluid concrete mass. A double-walled abutment member **20** defines a chamber for receiving fluid concrete and again takes the thrust forces from the rams **11.** The inner wall of the member **20** slidably engages the exterior periphery of the rings **21.** By adding more rings **21** the radial support for the concrete can be lengthened. The plant is operated in the same manner as described above with the member **20** sliding over the rings **21** as the rams **11** draw up the member **20** prior to the introduction of the fluid concrete.

In the plant shown in FIGS. **3** and **4** the rams **11** are again supported rearwardly by an abutment member, here denoted **30.** As shown in FIG. **4** the member **30** is of double-walled hollow structure with an annular configuration. Filters **31** are provided on the rear annular surface of the member **30.** A series of rings **32** are connected together to form a support for the fluid concrete. In a similar manner to the other embodiments, fluid concrete is pumped into the space **33** between the tunnel wall and the periphery of the rings **32.** Water from this concrete passes through the filters **31** and as a result the concrete located in a zone a adjacent the member **30** tends to harden more rapidly than the remaining concrete. When the shield **10** is driven forward by the rams **11** the concrete is compressed by the abutment member **30** to augment this zonal pre-hardening of the concrete. After advance of the shield **10** a further ring **32** would be installed and the concrete again fed in as before. The zonal pre-hardened concrete a prevents the more fluid concrete from flowing forwardly and possibly running between the member **30** and the foremost rings **32** when the former is drawn up by the rams **11** and the fresh ring **32** is installed. However, as a result of the zonal pre-hardening, sections or rings of hardened concrete in the mass of generally still fluid concrete form at the junctures between the rings **32,** i.e., at the zones denoted *a, b* and *c* in FIG. **3.** It is desirable to destory these isolated sections of pre-hardened concrete after they have served their useful function to cause the hardened concrete to be dispersed in the still fluid concrete. In this way discontinuities which could cause cracking and fracture of the lining can be prevented. To destroy the pre-hardened concrete sections it is preferable to use some form of vibrating device to break up or crush the sections. Such a device may act at the juncture between two adjacent rings **33** to vibrate the latter as indicated diagrammatically by numeral **34** in FIG. **3.**

We claim:

1. In a plant for use in constructing a tunnel, said plant comprising a movable drive shield, a plurality of rams for advancing said drive shield into a working face to form said tunnel, means for forming an abutment against which the rams can bear during advancement of the shield and means for defining at least part of a chamber which serves to receive fluid concrete used to form a lining for the tunnel, the improvement wherein the abutment-forming means faces said chamber whereby the fluid concrete in said chamber is compressed by said abutment means when the rams advance the shield, and filter means which allows water to pass out from the chamber to accelerate the setting of the fluid concrete.

2. A plant according to claim **1** and further comprising means for supporting part of said lining.

3. A plant according to claim **2,** wherein the support means is in the form of a tubular shell spaced inwardly from the tunnel wall and having the abutment forming means attached to its foremost end.

4. A plant according to claim **3,** wherein the shell has several filters therein allowing water to pass radially inwards of the tunnel.

5. A plant according to claim **3,** wherein the abutment forming means has an extension which combines with part of the shell to form said chamber for receiving the fluid concrete, the chamber being open towards the existing concrete lining.

6. A plant according to claim **2,** wherein the support means is slidable in relation to the abutment forming means.

7. A plant according to claim **6,** wherein the support means is composed of a series of rings arranged end to end, the rings having filters therein allowing water to pass radially inwards of the tunnel.

8. A plant according to claim **7,** wherein said chamber for receiving the fluid concrete is formed within the abutment-forming means, the chamber being open towards the existing concrete lining.

9. A plant according to claim **2** wherein the abutment-forming means is provided with filters and wherein the support means is in the form of a series of rings.

10. A plant according to claim **9,** wherein there is provided at least one device for vibrating the rings to cause zones of pre-hardened concrete in the fluid concrete and caused by the disposition of the filters to be broken up.

11. A plant according to claim **1,** wherein the abutment forming means is provided with filters.

12. A plant according to claim **1,** and further comprising means for introducing said fluid concrete at pressure.

13. A plant according to claim **1,** wherein the water is driven out from the fluid concrete in the chamber by a pressure differential established across the filter means.

14. A plant according to claim **1,** wherein the abutment-forming means is of hollow annular configuration.

15. A plant according to claim **14** wherein the filter means is provided in the abutment-forming means.

* * * * *