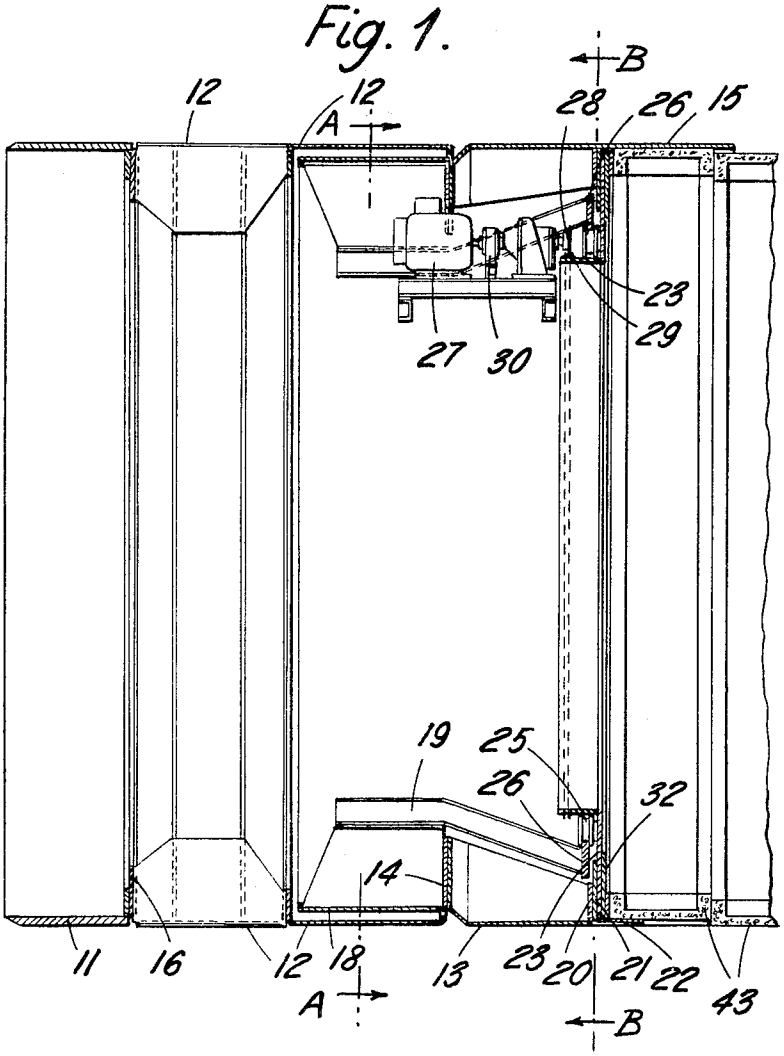
Feb. 1, 1966 J. BLAND 3,232,062

TUNNEL-LINING MACHINES

Filed Sept. 14, 1962 5 Sheets-Sheet 1

Fig. 1.

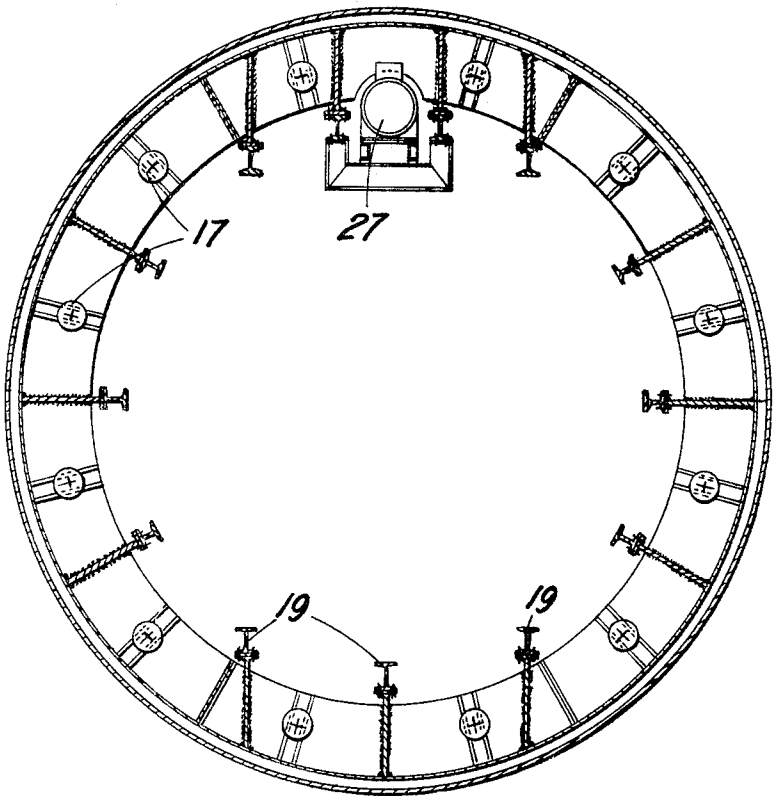


Feb. 1, 1966 J. BLAND 3,232,062

TUNNEL-LINING MACHINES

Filed Sept. 14, 1962 5 Sheets-Sheet 2

Fig. 2.

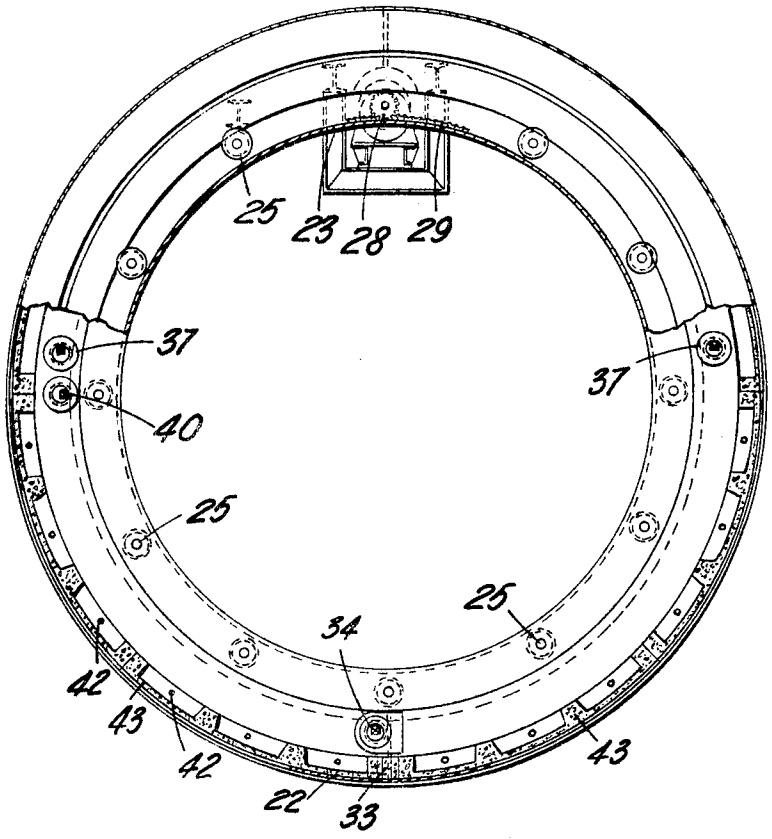


Feb. 1, 1966 J. BLAND 3,232,062

TUNNEL-LINING MACHINES

Filed Sept. 14, 1962 5 Sheets-Sheet 3

Fig. 3.

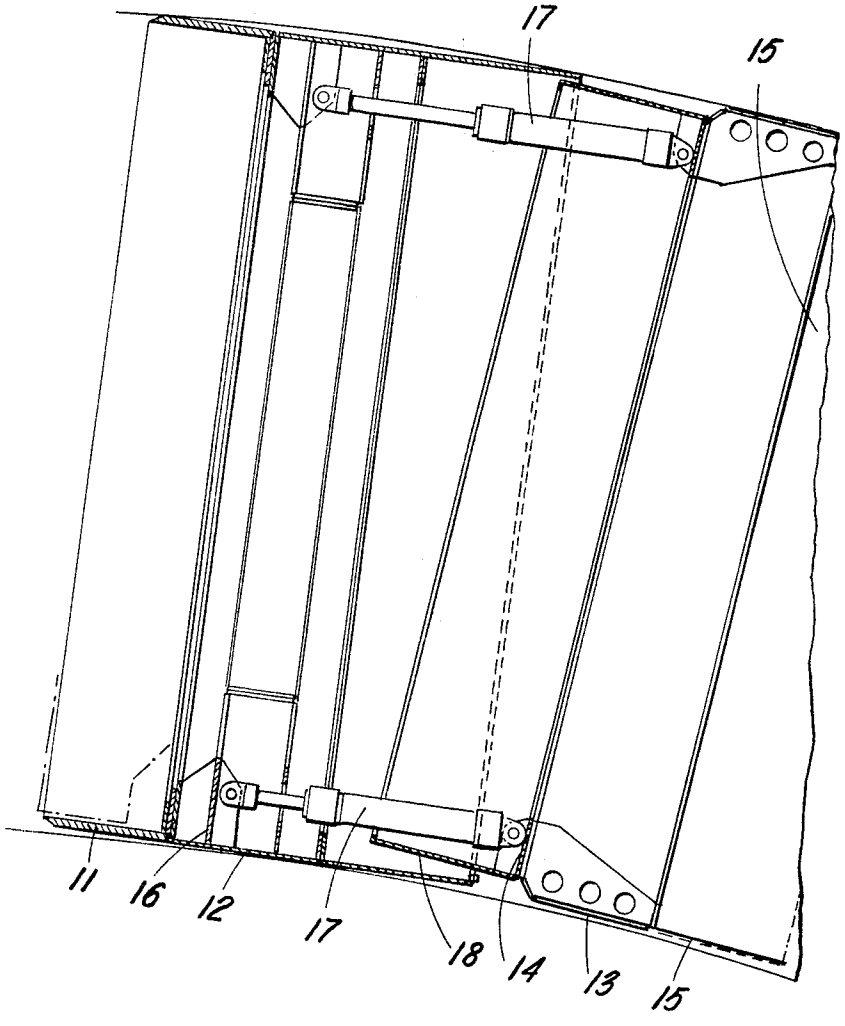


Feb. 1, 1966 J. BLAND 3,232,062

TUNNEL-LINING MACHINES

Filed Sept. 14, 1962 5 Sheets-Sheet 4

Fig. 4.



Feb. 1, 1966 J. BLAND 3,232,062

TUNNEL-LINING MACHINES

Filed Sept. 14, 1962 5 Sheets-Sheet 5

FIG.5

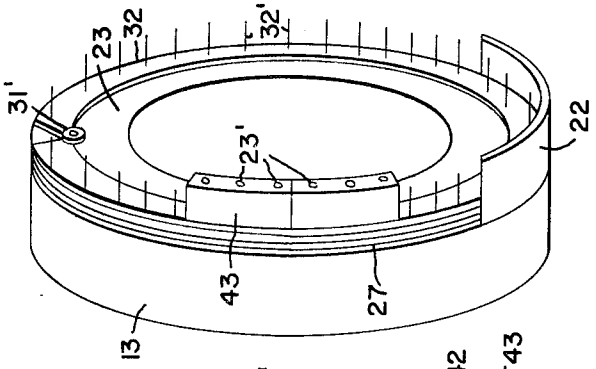


FIG.8

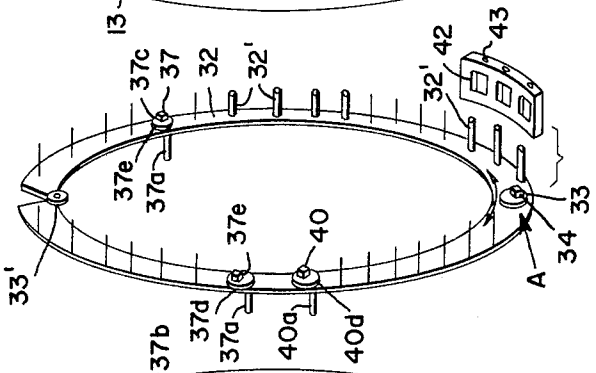


FIG.7

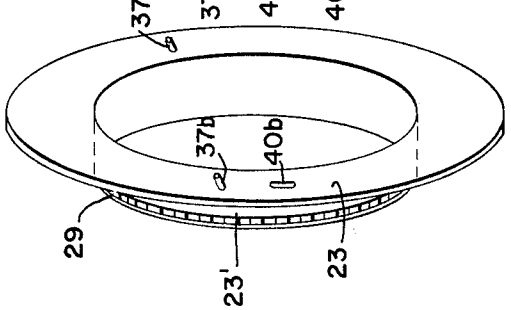


FIG.6

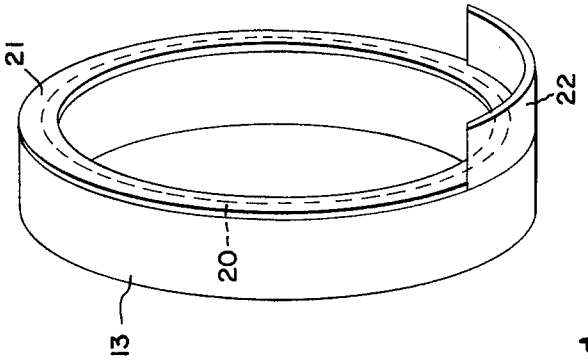


FIG.11

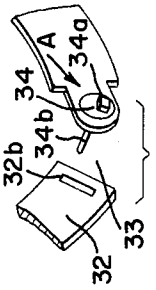


FIG.10

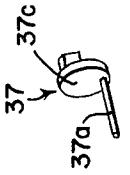
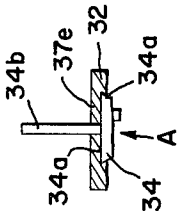


FIG.9



INVENTOR

John BLAND

BY Mawhinney & Mawhinney

ATTORNEYS

United States Patent Office 3,232,062 Patented Feb. 1, 1966

3,232,062

TUNNEL-LINING MACHINES

John Bland, London, England, assignor to Economic Foundations Limited, London, England, a British company

Filed Sept. 14, 1962, Ser. No. 223,750
Claims priority, application Great Britain, Sept. 18, 1961, 33,423/61
4 Claims. (Cl. 61—84)

This invention relates to tunnel lining machines, for use in a tunnel to assemble pre-formed elements to form a lining therefor. The invention has for an object to improve the ease of use and speed of operation of such a machine.

The invention provides a tunnel lining machine comprising an annular carrier having an outer periphery of diameter comparable to but smaller than that of the tunnel for which the machine is intended, said carrier being mounted at or near its periphery on supporting means which permit the carrier to rotate in said tunnel, means mounted at or near the periphery of the carrier for so rotating it, and releasable means for releasably holding at least one preformed tunnel-lining element on said carrier for rotation therewith.

Preferably at least the said releasable holding means is adjustable in a plane transverse of the tunnel, so that the or each element may be aligned with previously positioned elements.

The carrier may be mounted for movement axially of the tunnel so that the or each element may be moved into abutment with previously positioned elements.

Said releasable means may be spigots engageable in holes in an element and may be arranged so that the said axial movement in one sense tends to withdraw the spigots from the element.

Said rotating means may be an electric motor mounted on said supporting means.

Said supporting means may carry a ram for effecting the axial movement of the carrier.

The releasable means may be capable of holding a ring of segments built up there on.

The tunnel lining machine may be formed as an integral part of a tunnel boring machine similar to that described and claimed in British specification No. 894,446.

One specific form of tunnel-lining machine according to the invention is shown in the accompanying drawings in which:

FIGURE 1 shows a side section through a tunnel-lining machine made as an integral part of a tunnel boring machine,

FIGURE 2 is a section on the line A—A of FIGURE 1,

FIGURE 3 is a part section on the line B—B of FIGURE 1,

FIGURE 4 is a horizontal section through the machine of FIGURE 1 showing it in action on a 75 ft. radius curve.

FIGURE 5 is a perspective view of an assembly of the reaction ring and associated parts partially loaded with segments,

FIGURE 6 shows the reaction plate in perspective,

FIGURE 7 shows the drive ring assembly in perspective,

FIGURE 8 shows the holding ring in perspective,

FIGURE 9 is a detail cross-section showing the adjustment device of the holding ring,

FIGURE 10 is a perspective view of said holding device,

FIGURE 11 shows in perspective the end portions

of the holding ring at the split in association with one of the adjustment devices.

The tunnel boring machine is formed similarly to that described and claimed in British specification No. 894,446 and has an annular cutting head 11 carried for rotation relative to a non-rotating cylindrical shield 12. Behind the shield is a reaction plate 13 arranged for expanding into gripping contact with the tunnel bore by means as described in British specification No. 894,446. The top half of the plate 13 is extended rearwardly to form a hood 15. The reaction plate and the shield have flanges 14, 16 respectively which act hydraulic rams 17 (FIGURE 4) which operate to advance the cutting head relative to the reaction plate when the reaction plate is gripping the tunnel walls, and to pull the reaction plate forward in the tunnel when the reaction plate is released.

The reaction plate has freedom to lie with its axis at a limited angle to the axis of the cutting head and shield, to accommodate bends in the tunnel as shown in FIGURE 4.

A cylindrical forward extension 18 of the reaction plate lies inside the shield and is arranged about an axis which is aligned with that of the reaction plate. The forward extension however does not expand or contract with the gripping and releasing movements of the reaction plate.

The rear end of the reaction plate has a radial flange 20 carrying a ring 21 which has at the base of the machine a shoe 22 (FIGURES 1, 3, 5 and 6) on which an element 43 (FIGURES 3 and 5) of the tunnel lining material may be placed.

Adjacent said ring 21 and rotatable relative thereto is a carrier comprising a drive element having a flat vertically disposed ring 23 marginally from the opening of which an axial tubular ring portion 23′ extends and is disposed within the reaction plate 13 on a circle of rollers 25 mounted on a track ring 26 supported as in FIGURE 1 from the forward extension 18 of reactor plate 13 by arms 19.

An electric motor 27 is mounted on said forward extension 18 and is connected to drive a pinion 28 which operates a chain 29 attached to and driving the tubular ring portion 23′ (FIGURES 1 and 3). A brake 30 is fitted in the drive.

Mounted on said drive element 23 (FIGURE 5) is an angular element or segment-holding ring 32. The holding ring 32 is split on a diameter at 33 (FIGURES 3, 8 and 11) and hinged at 33′ at the other end of the diameter, and has an adjustment device A such as a cam 34 (FIGURES 8, 9, 10 and 11) operable to open or close the ring at the split. Cam 34 occupies a hole 34^a of ring 32 and has a peg member 34^b which extends through one part of the ring 32 and into the slot 32^b in the adjacent end of the ring at split 33.

The holding ring 32 is mounted on the drive ring by adjustable means similar to devices A comprising a pair of pegs 37^a located in holes 37^e at opposite sides of the ring, as in FIGURES 8 and 10, and are slidable in axially aligned slots 37^b (FIGURE 7) in the flat portion of the drive ring 23. The pegs are mounted off center of circular cams 37^c movable in holes 37^d in the holding ring and arrangd so that rotation thereof moves the holding ring parts in unison bodily at right angles to said slots while rotation of one or the other tilts the holding ring relative to the said slots. A further peg 40 identical to devices A has a peg member 40^a slidable in a slot 40^b (FIGURE 7) in the tubular drive ring portion 23 disposed at right angles to the said aligned slots 37^b and has its cam 40^c arranged in hole 40^d of ring 32 for rotation to move the holding ring parts

correspondingly. Hydraulic means (not shown) are provided for rotating the cams.

The holding ring 32 also has spigots 32' which in use engage as in holes 42 of the concrete elements 43.

In use a single element (in this case, segment 43 having ⅛ of the total circumference of the lining) is placed on the shoe 22 while in the position of FIGURE 1 and engaged by means of holes 42 (FIGURE 8) on the adjacent spigots 32'. If desired a clamp may be used to maintain the segment in position. The motor 27 is then started and the drive ring 23 rotates taking the holding ring 32 with it. According to one method of operation the holding ring is rotated until segment 43 is positioned next to the last-positioned segment, and then adjusted in position by rotation of the cams until the segment may be bolted or otherwise attached to the last-positioned segment. The segment may then be released by withdrawing the carrier 23 forwardly, by means of the hydraulic rams, so that the spigots are withdrawn from the segment. A further segment is then placed on the shoe and the process repeated.

In a preferred method of operation, the holding ring is rotated sufficiently for the shoe 22 to be freed of the segment 43 and a further segment 43 is placed on the shoe and attached to the first segment. This process is repeated until a complete ring is formed. When the complete key segment is to be inserted it is usually found necessary to expand the diameter of the holding ring and segment ring by use of the cam 34. The holding ring 32 is then rotated until the segment ring is in its correct position relative to the preceding ring. The carrier is then moved rearwardly and horizontally by means of the hydraulic rams 17 until the segment ring abuts the preceding ring. The segment holding ring 32 is, if necessary, adjusted by the cams 37 and 40 so that the segment ring may be bolted to the preceding ring. The carrier is then withdrawn from the segments by the hydraulic rams and is ready in position for another segment ring to be formed.

As can be seen from FIGURE 4 the machine can readily line tunnels having bends therein, since the tunnel-lining part can follow the contours of the bore substantially independently of the tunnel-boring part.

Where cast iron tunnel-lining segments are used it is possible to dispense with the reaction plate. The hydraulic rams may act directly on the free end of the tunnel-lining and the segments and carrier may be positioned at the rear end of the shield 12.

The tunnel-lining machine may, of course, be formed independently of the tunnel-boring machine.

The machine has the advantages of leaving the centre part of the tunnel free for access, soil removal etc., and also of enabling the lining to be rapidly placed in position without undue physical effort.

If desired the ring 21 may be omitted from the machine described above, in which case the shoe 22 is constructed as an extension of the reaction plate 13.

I claim:

1. A tunnel-lining machine having a generally upright annular carrier, structure to mount the carrier both for rotation about a generally horizontal axis and for axial movement, means extending approximately peripherally and axially of the carrier to support a preformed tunnel-lining segment to be loaded onto the carrier, means closer to the periphery of the carrier than said axis for rotating the carrier, and apparatus on the carrier for releasably holding segments in an annular line for movement rotatably and axially therewith.

2. A machine as claimed in claim 1 in which the said apparatus comprises axially extending spigots for engagement with the segments so as to permit axial movement of the carrier in one direction to tend to withdraw the spigots from the segments.

3. A machine as claimed in claim 1 in which the carrier is split on a diameter to form carrier parts, the parts being connected together by hinge means, and there is means to effect relative movement of the parts towards and away from each other by pivotal movement at the hinge means.

4. A machine as claimed in claim 1 wherein the said structure includes ram mechanism operable to impart travel thereto and the apparatus on the carrier is a segment-holding ring adjustable inwardly and/or outwardly with respect to the axis of axial movement of the carrier, and said holding ring is sectional and has spigot-positioning segments disposed approximately parallel to the line of axial movement of the carrier.

References Cited by the Examiner

UNITED STATES PATENTS

1,351,137	8/1920	Sheen	61—84
1,505,060	8/1924	Quayle	61—84
1,843,334	2/1932	McGrath	61—84 X
2,128,172	8/1938	Warner et al.	61—84
2,764,872	10/1956	Budd	61—84
2,804,754	9/1957	Bridge	61—84
2,898,742	8/1959	Robbins	61—84
2,919,121	12/1959	Ruth	61—84

FOREIGN PATENTS

1,163,356	4/1958	France.
114,443	1918	Great Britain.
858,559	1/1961	Great Britain.
894,446	4/1962	Great Britain.

CHARLES E. O'CONNELL, *Primary Examiner.*

EARL J. WITMER, *Examiner.*

R. A. STENZEL, *Assistant Examiner.*