United States Patent

Markewitz et al.

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[45] **July 25, 1972**

[54] TUNNEL FORMWORK

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[52] **U.S. Cl.** ..... **61/45 C**

[51] **Int. Cl.** **E21d 15/14**

[58] **Field of Search** ..... 61/45 C, 45 R; 299/31, 33, 299/11; 248/351, 354, 357

[56] **References Cited**

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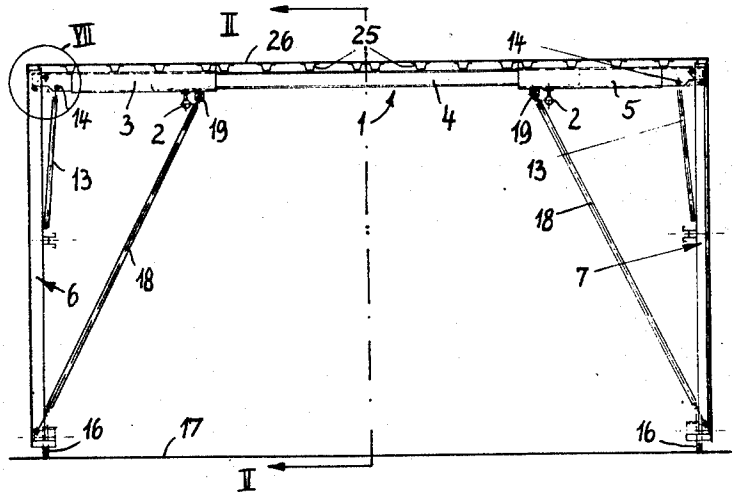
Primary Examiner—Dennis L. Taylor

Attorney—Craig, Antonelli & Hill

[57] **ABSTRACT**

A tunnel formwork of the type comprising a horizontal formwork portion and two vertical formwork portions both of which are resistant to bending. The vertical formwork portions are movable relative to the horizontal formwork portion. Each vertical formwork portion is connected to the horizontal portion by guides. At least two guides are arranged in the area of the junction points between adjacent formwork portions, and at least two guides connect the lower region of the vertical formwork portions with the central area of the horizontal portion. The formwork portions are so designed as to be secured in at least one position.

14 Claims, 8 Drawing Figures



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6 Sheets-Sheet 1

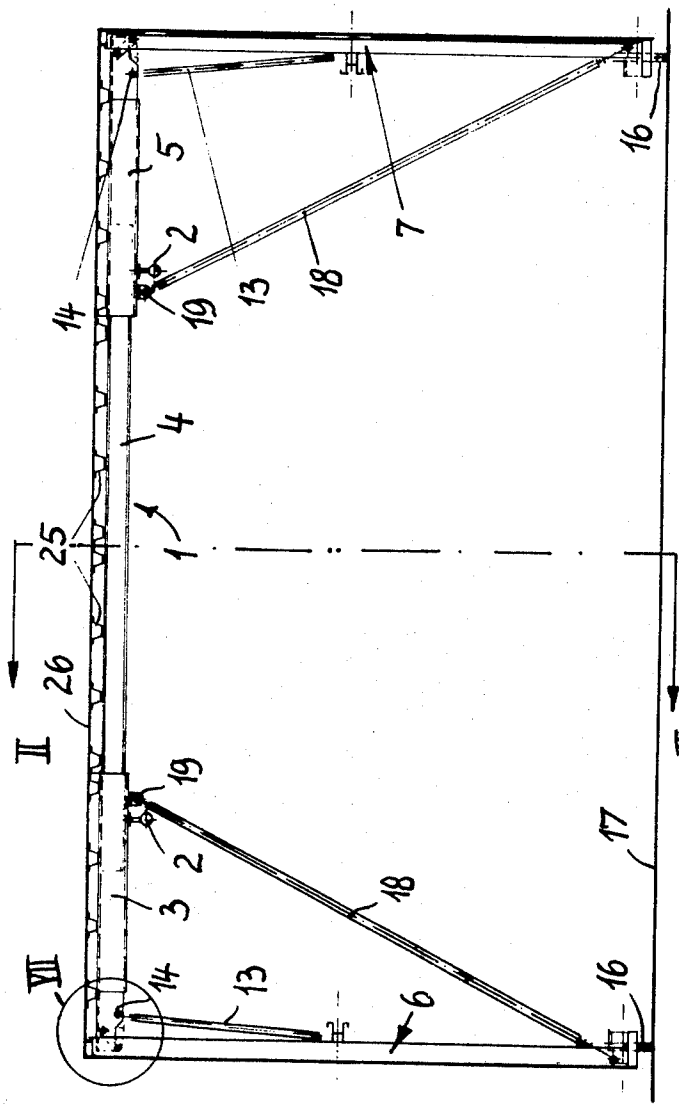

FIG. 1

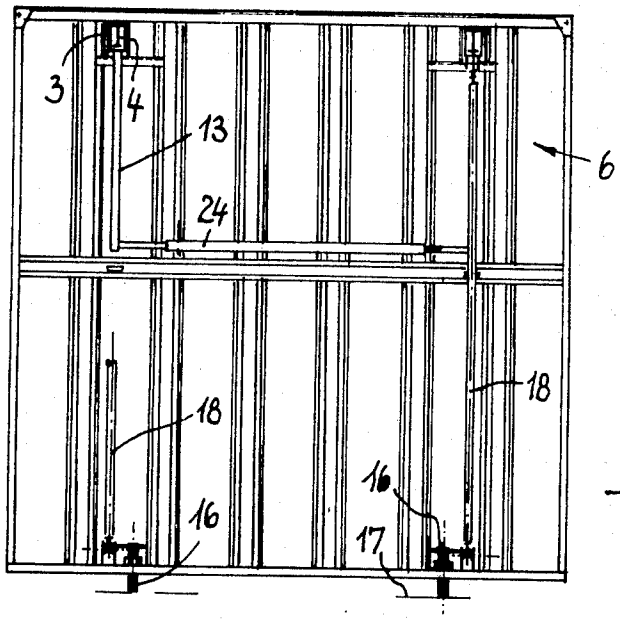
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FIG. 2

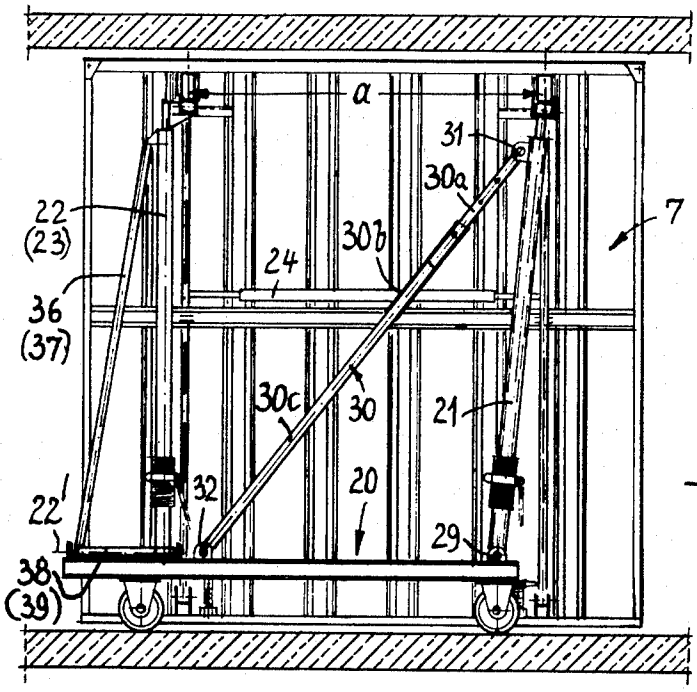
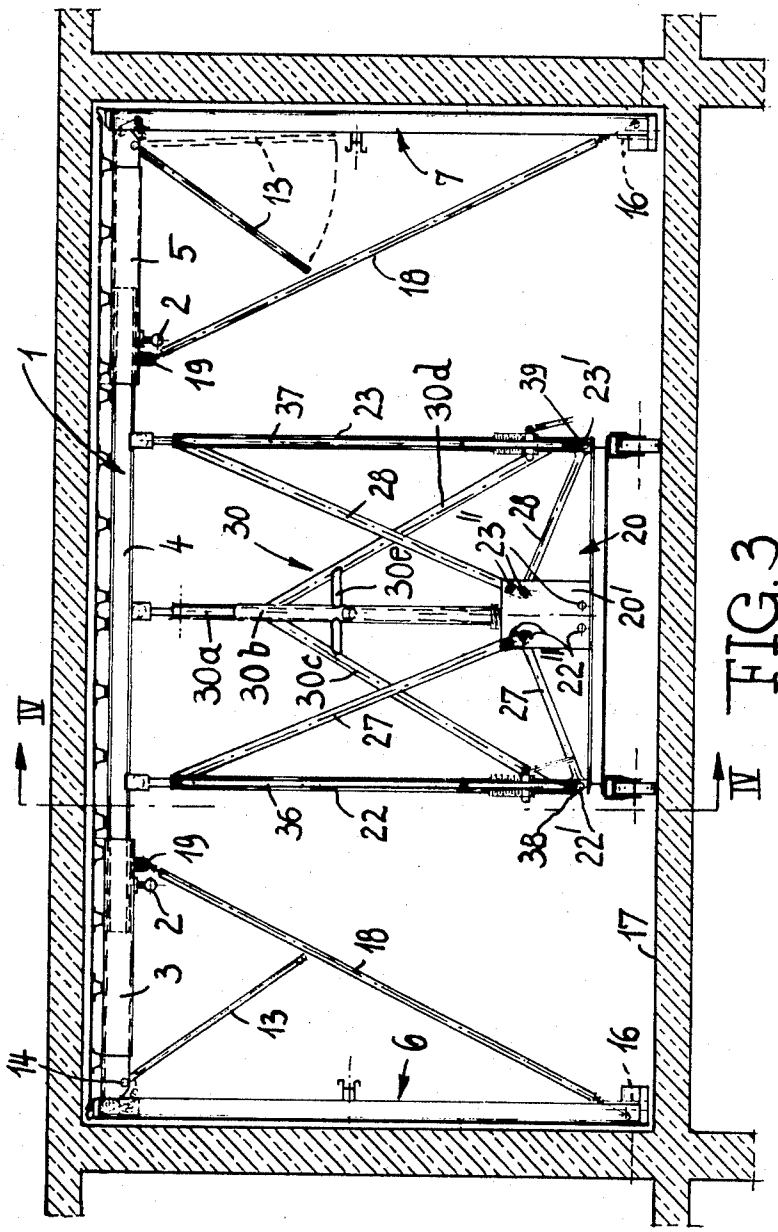

a
31
30a
22
(23)
30b
7
24
36
(37)
30c
30
21
32
20
22'
29
38
(39)

FIG. 4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28
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30a
30b
30c
30d
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36
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IV
IV

FIG. 3

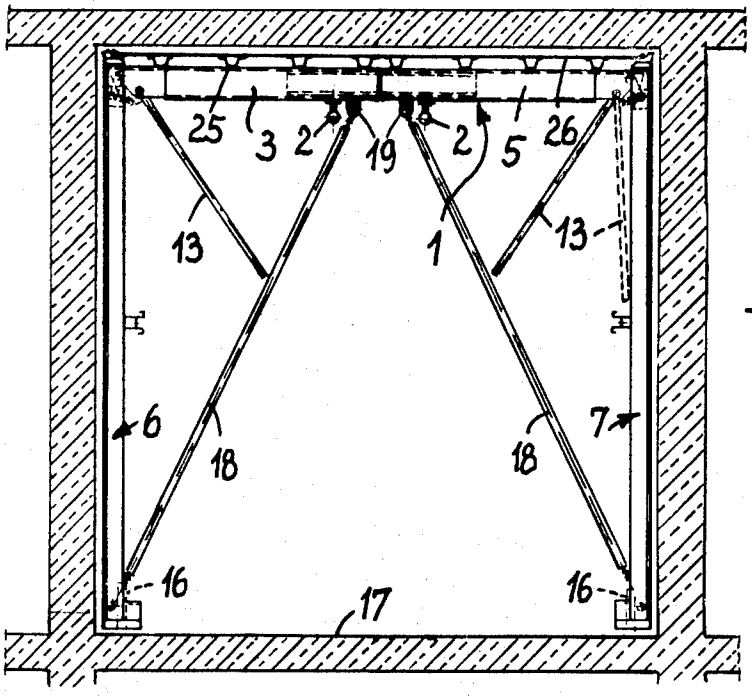
25
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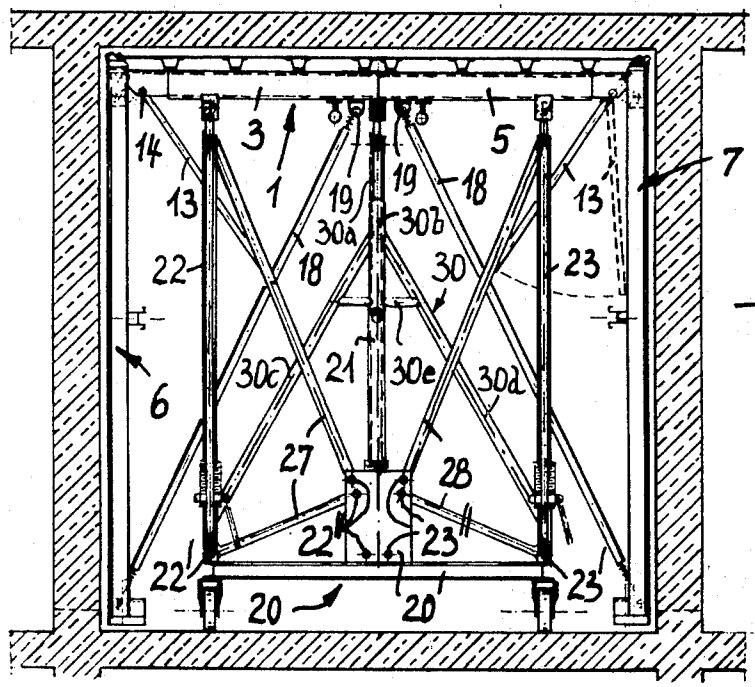
FIG. 5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30c
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30e
30d
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FIG. 6

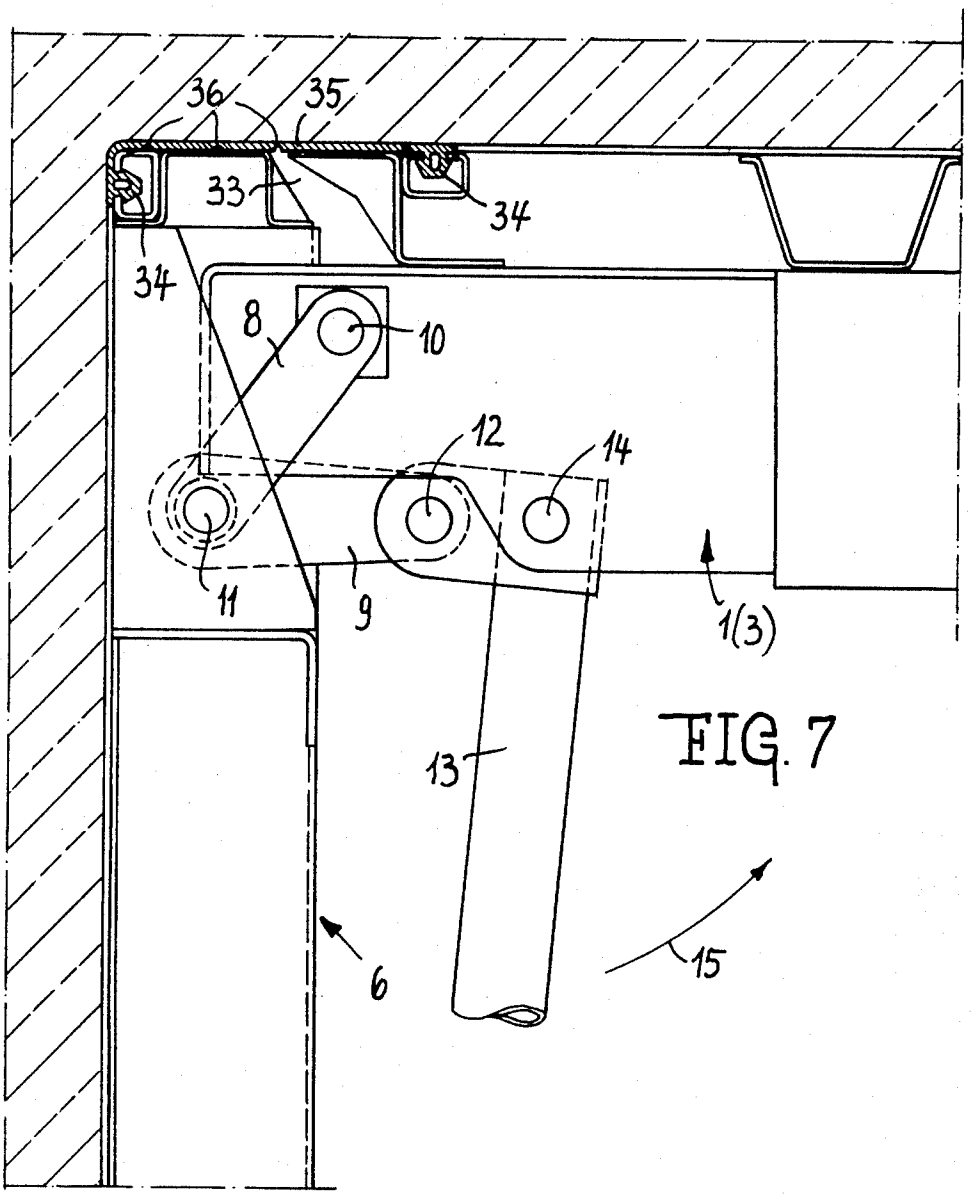

FIG. 7

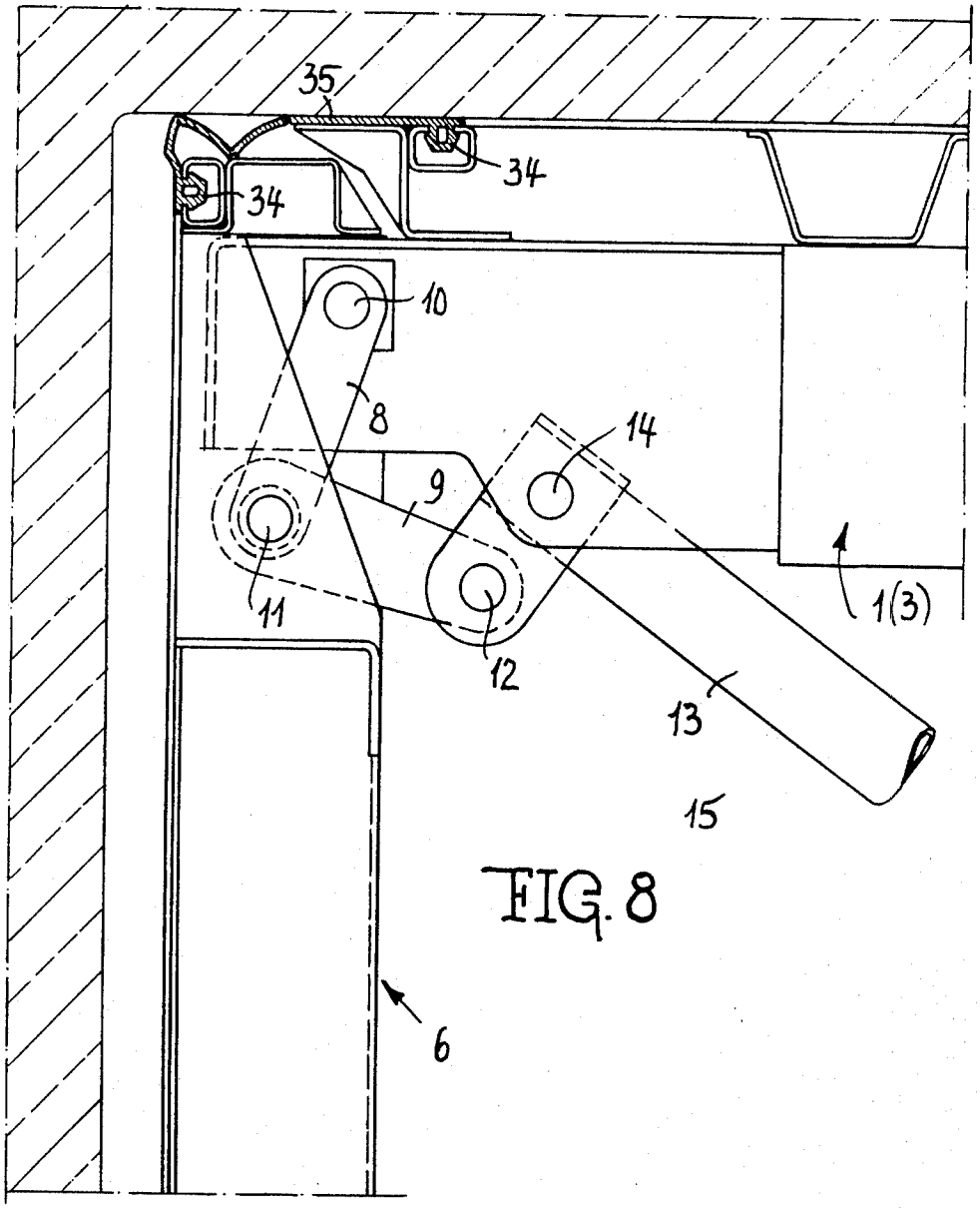

FIG. 8

TUNNEL FORMWORK

This invention relates to a tunnel formwork of the kind comprising a horizontal formwork portion and two vertical formwork portions both of which are resistant to bending, the vertical formwork portions being movable relative to the horizontal formwork portion.

Most tunnel formworks are designed in such a way that the removal of the forms must start with the lowering of the formwork member arranged in the horizontal plane, or in the case of an arrangement of a plurality of formwork members in this plane with the lowering of one of these members. Tunnel formworks are also known where the formwork members arranged in parallel, vertical planes upon dismantling are firstly raised from the erected concrete walls and only then are the formwork member(s) which are in a horizontal plane, removed. In both cases the encased area is so filled with supports, struts, etc that it is difficult to reach the points at which the means are arranged which need to be operated for erecting or removing the forms of such a formwork. The formwork members and the supports associated therewith were provided with rollers, or the like in order to make such a formwork mobile.

The invention is based on the consideration that access to the means to be operated becomes proportionately more difficult as the areas to be encased become narrower, as a result of which erection times are also increased even if for installing and removing the forms only relatively few means have to be operated. In order to avoid these difficulties it is proposed according to the invention that each vertical formwork portion is connected by guides to the horizontal formwork portion, there being at least two guides arranged in the area of the junction points between adjacent formwork portions and at least two guides connecting the lower region of a vertical formwork portion with the central area of the horizontal formwork portion, means also being provided which permit the formwork portions to be secured in at least one position. In spite of the presence of a central gangway each formwork is sufficiently rigid to be able to absorb and remove stresses which occur. The encased area is accessible at all times, moving parts can be operated without difficulty and can be simply installed and removed again with the formwork portions. In the central gangway which is formed it is even possible to introduce a formwork transporting vehicle, so that in this case it is unnecessary to place rollers on the vertical formwork portions.

It is preferred that the guides which are associated with the formwork portions adjacent their junction points shall be pairs of double guides made similar to bell crank levers. These guides are made pivotable relative to each other by an actuating lever mounted in bearings on the horizontal formwork portion, and with the lower ends of the vertical formwork portions, foot jacks are associated.

It is further preferred that the horizontal formwork portion comprises at least three telescopically interconnected supporting beams carrying a formwork plate reinforced with ribs and that the bearings of the said actuating lever and the lower guide shall be on the outer support portions of the horizontal formwork portion.

Due to the fact that the formwork portions are permanently connected with one another, they can be transported together both before and after the removal of the forms. A formwork transporting vehicle introduced for this purpose should therefore have three supports, supported by their free ends relative to the vehicle and which are variable in length, whereof two are arranged in a plane at right angles to the direction of movement of the vehicle and the third is arranged at one of the angles of an isosceles triangle, at the other angles of which the two other supports are mounted. These other two pivotable supports are about axes parallel to the direction of movement of the transporting vehicle and can be fixable in several positions, and the third support and its steadying struts are articulated to one another and to the vehicle, said steadying struts being designed in such a way that their length can be varied. It is thus possible with formworks whose formwork portions arranged in vertical parallel planes are at a relatively small spacing from one another, to introduce the formwork transporting vehicle under the formwork because the third support can still be inserted without difficulty, whilst the other two supports can be moved almost up to the diagonal struts which brace the formwork members relative to one another.

If the transporting vehicle were to have four supports it could not in such a case be introduced beneath the formwork. Some preferred embodiments of the invention by way of example only will now be described with reference to the accompanying drawings in which:

FIG. 1 shows a cross-section through a formwork constructed according to the invention in the encased condition and where the spacing between the vertical formwork members is relatively large,

FIG. 2 is a cross-section on the line II—II of FIG. 1,

FIG. 3 is a cross-section, corresponding to that of FIG. 1, through a formwork constructed according to the invention in the encased condition, carried by a formwork transporting vehicle,

FIG. 4 is a cross-section on the line IV—IV of FIG. 3;

FIG. 5 is a cross-section through a formwork corresponding to FIG. 3 in the encased condition, with the formwork members arranged in vertical planes at a relatively small spacing from one another;

FIG. 6 shows the arrangement according to FIG. 5 with a transporting vehicle;

FIG. 7 is an enlarged view of the upper left corner VII shown in FIG. 1 and

FIG. 8 shows the view of FIG. 7 with the double guide in a different position.

The formwork shown in FIGS. 1 to 4 comprises a horizontal formwork portion I formed from supporting beams 3, 4 and 5 which are resistant to bending, telescopically insertable into one another and fixable in a selected position relative to one another by fixing means such as screws 2, etc., as well as two formwork portions 6 and 7 arranged parallel to one another in vertical planes and also consisting of plates resistant to bending. The upper ends of the formwork portions 6 and 7 are connected at each end by bell crank like pairs of double guides 8, 9 to the outer supporting beams 3 and 5 respectively of formwork portion 1. Each guide 8 connects the formwork portion 1 or its supporting beams 3 and 5 with an upper end of the vertically mounted formwork portion 6 or 7 in that it is on the one hand movable about a pin 10 fixed on the formwork portion 1 and on the other hand movable about a pin 11 fixed to a vertical formwork portion e.g. 6 (FIGS. 7 and 8). The guide 9 is pivoted on the same pivot 11 and also on a pivot 12 of a two-armed actuating lever 13, which is in turn pivotable about a pivot 14, which is fixed to the formwork portion 1 or part of this formwork portion e.g. the supporting beam 3. As can be seen from FIGS. 7 and 8, it is thus possible to vary the spacing of the upper end of a vertical formwork portion, e.g. the formwork portion 6, from one side of the formwork portion 1, e.g. the supporting beam 3 and in fact merely by manually changing the position of the actuating lever 13. If, for example, the formwork portion 6 is in an encased position (FIG. 7) and this formwork portion requires to be removed, it is only necessary to pivot each actuating lever 13 in the direction of the arrow 15, so that each lever 13, for example, assumes the position indicated in FIG. 8. So that it is unnecessary to fix the actuating lever 13 in the encased position of the formwork, the pivots 11, 12 and 14 and the lever 13 are so arranged that in the encased position of the formwork the axis of each pivot 12 will be above the line connecting the axes of the pivots 11 and 14. Thus, a so-called dead center must be passed, in order to be able to remove the forms.

At the lower ends of each vertical formwork portion 6 and 7 are provided two or more foot jacks 16, which support each formwork portion relative to a base support, for example a flooring 17, when the formwork is encased. Also in the region of the lower ends of the formwork portions 6 and 7 are pivoted guides 18, the other ends of which are pivoted on the form-

work portion 1 or the supporting beams 3 or 5 of the formwork portion 1 at 19. Due to the provision of pairs of double guides 8 and 9 the guides 18 need not be made variable in length, they pivot with the formwork portions 6 and 7 when the actuating levers 13 are pivoted from their positions shown in FIGS. 1 and 7 into the positions according to FIGS. 3, 5 and 8. Obviously the formwork portion 1 must be supported e.g. by a transporting vehicle 20 (FIGS. 3 and 4) before the jacks 16 are retracted by rotation and the levers 13 are pivoted. Then after lowering the formwork can be moved from the finished area to another point by means of the transporting vehicle 20.

FIG. 5 shows that the three members 3, 4 and 5 of formwork portion 1 can also be telescoped together to such an extent that relatively narrow spaces can be encased. The central member 4 of formwork portion 1 is thus pushed fully into the two outer formwork members 3 and 5. It can be seen from FIG. 6 that between the pivot points 19 of the guides 18 there is still enough space for a support 21 on a transporting vehicle 20 to be introduced between guides located in the same horizontal plane, whilst the two other supports 22 and 23 of the transporting vehicle can be moved into close proximity with the outer guides 18. Here again the actuating lever 13 can still be pivoted without difficulty. It is preferred to connect adjacent levers 13 pivotable about the same axes 14 to one another by a bar or the like 24, because then, apart from the operation of the jacks 16, it is only necessary to carry out one operation to remove each formwork portion 6 or 7 from a concrete wall. The same naturally applies during the encasement process.

A formwork shell 26 is placed on the formwork portion 1, supported by sections 25.

As already explained the formwork transporting vehicle 20 (FIGS. 3 and 4) carries three variable length supports 21, 22 and 23, braced relative to the vehicle by steadying struts. The supports 22 and 23 are rigidly fixed to the vehicle 20 by the struts 27 and 28 and their free ends can be raised and lowered. Each support 22 and 23 is rigidly connected with its two struts 27 and 28 and is pivotable about axes 22' and 23' parallel to the direction of movement of the transporting vehicle 20 and capable of being held relative to holes 22'' and 23'' by bolts on a plate 20' fixed to the vehicle 20. In this way the spacing between the two heads of the supports 22 and 23 can be varied. To reinforce the supports 22 and 23 further struts 36 and 37 (FIG. 4) are fixed to the tops thereof, the lower ends of which are rigidly connected via crosspieces 38 and 39 with the lower ends of the supports 22 and 23. The crosspieces 38 and 39 are also therefore pivotable about the axes 22' and 23'. The lower end of the third support 21 is pivoted on the vehicle 20 at 29. The upper end of the support 21 is pivoted at 31 to a variable length fork shaped strut 30. The strut portion 30 hingedly connected at 31 is inserted into a strut portion 30*b* and is fixed to it in a variable length manner. Two strut portions 30*c* and 30*d*, connected with one another via a strut portion 30*e*, are each connected at an acute angle to strut portion 30*b*. The ends of the strut portions 30*c* and 30*d* which form the ends of the fork-like strut 30 are pivoted at two points 32 on the side of the vehicle 20, so that the spacing *a* (FIG. 4) between the top of support 21 and tops of supports 22 and 23 can be varied, by changing the length of the fork-like strut 30.

Obviously parts of the embodiments shown can be replaced by others, consequently it is for example possible to make the formwork portion 1 in one part if such a formwork is always to be used for producing uniformly sized areas. The other parts of the formwork or the formwork transporting vehicle can also be constructed differently, provided that only the same effect is obtained. It is important that the formwork portions 6 and 7 arranged in vertical planes are not pivoted on the supports but on the horizontally arranged formwork 1 or its members 3 and 5 as a result of which the free central passageway is formed and the insertion and removal of the forms can take place very simply.

It is advisable to cover the gaps 33 between adjacent formwork portions 1 and 6 or 7 by a plastic strip 35 fixed thereto by beading 34. This strip is adapted to deform upon removing the forms (FIGS. 7 and 8), this deformation being assisted by means of grooves 36 formed in the said strip 35.

What is claimed is:

1. A tunnel formwork comprising a horizontal formwork portion and two vertical formwork portions, which portions are resistant to bending, the vertical portions being movable with respect to the horizontal portion, each vertical formwork portion being connected to the horizontal portion by guides, there being at least two guides arranged in the area of the junction points between adjacent formwork portions and at least two guides connecting the lower region of the vertical formwork portions with the central area of the horizontal portion, means being provided which permit the formwork portions to be secured in at least one position.

2. A tunnel formwork as claimed in claim 1 wherein the guides provided at the junction points of the formwork portions are pairs of double guides similar to bell crank levers, which are each arranged to be pivotable by means of an actuating lever pivotally mounted on the horizontal formwork portion, the lower ends of the vertical formwork portions being provided with jacks.

3. A tunnel formwork as claimed in claim 2 wherein the horizontal formwork portion comprises at least three telescopically interconnected supporting beams the pivot bearings of the actuating lever and of the lower guide being provided on the outer supporting beams of said horizontal formwork portion.

4. A tunnel formwork as claimed in any of claim 1 including a formwork transporting vehicle serving to move the complete formwork, said vehicle having three variable length supports, the arrangement of which in cross-sectional shape corresponds to an isosceles triangle, the base of which is at right angles to the direction of movement of the vehicle.

5. A tunnel formwork as claimed in claim 4 wherein the supports are pivotally connected with the transporting vehicle by means of joints and are arranged to be held in their pivotal plane by variable length or adjustable diagonal struts.

6. A tunnel formwork arrangement for use in forming tunnels, especially concrete lined tunnels; said arrangement comprising a horizontal bend resistant formwork portion having an upwardly facing forming surface, two vertical bend-resistant formwork portions having respective outwardly facing forming surfaces, said vertical portions being arranged to extend substantially perpendicularly downwardly from opposite ends of the horizontal portion, two similar first guide means for connecting respective upper ends of said vertical portions to respective opposite ends of said horizontal portion, and two similar second guide means extending from respective lower ends of said vertical portions to respective central portions on said horizontal portion for assisting in bracing the horizontal portion and the vertical portions in position with respect to one another, the first and second guide means including means for selectively maintaining the framework portions in at least one position with respect to one another such that a self supporting formwork having three forming surfaces is obtained.

7. A tunnel formwork as claimed in claim 6, wherein the first guide means includes manually operable lever means operable to selectively lock and unlock the horizontal and vertical portions in a fixed self-supporting position with respect to one another, said lever means including a lever coupling member for coupling levers arranged at both ends of the horizontal portion together such that both vertical portions are releasable simultaneously.

8. A tunnel formwork as claimed in claim 6, wherein the first guide means includes three pivotal guide bars connected to one another, a first of said three bars being pivotal at one end thereof about a first pivot pin fixed to the vertical portion and being pivotal at the other end thereof about a second pivot pin fixed to the horizontal portion, a second of said three

bars being pivotal at one end thereof about said first pivot pin and being pivotal at the other end thereof about a third pivot pin fixed to a third of said three bars, the third of said three bars being pivotal at one end thereof about said third pivot pin and being pivotal at the other end thereof about a fourth pivot pin fixed to the horizontal portion, said third bar being rigidly attached to a manually operable lever such that the third bar can be pivoted about the fourth pivot pin by manual forces to consequently move the ends of said vertical and horizontal portions over a predetermined path with respect to one another during form locking and unlocking operations.

9. A tunnel formwork as claimed in claim **8**, wherein the axis of the third pivot pin is positioned vertically above a line between the axes of the first and fourth pivot pins when the first guide means is in a form locking position, whereby a so-called dead center must be passed to release the forms from the form locking position.

10. A tunnel formwork as claimed in claim **6**, wherein sealing means are provided for sealing the junction between respective vertical and horizontal portions.

11. A tunnel formwork as claimed in claim **10**, wherein said sealing means includes plastic strips fitted to the vertical and horizontal portions by beading, said strips having grooves for permitting deformation upon removal of the forms and the consequent change in position of the respective horizontal and vertical portions with one another.

12. A tunnel formwork as claimed in claim **6**, wherein the second guide means include struts attached at one end adjacent the bottom ends of the vertical portions and attached at the other end to attachment points on the horizontal portion, the attachment points being spaced close to the respective ends of the horizontal portion in order to leave sufficient room under the horizontal portion and between the struts for assembly, disassembly and transportation of the formwork.

13. A tunnel formwork as claimed in claim **11**, wherein the first guide means includes three pivotal guide bars connected to one another, a first of said three bars being pivotal at one end thereof about a first pivot pin fixed to the vertical portion and being pivotal at the other end thereof about a second pivot pin fixed to the horizontal portion, a second of said three bars being pivotal at one end thereof about said first pivot pin and being pivotal at the other end thereof about a third pivot pin fixed to a third of said three bars, the third of said three bars being pivotal at one end thereof about said third pivot pin and being pivotal at the other end thereof about a fourth pivot pin fixed to the horizontal portion, said third bar being rigidly attached to a manually operable lever such that the third bar can be pivoted about the fourth pivot pin by manual forces to consequently move the ends of said vertical and horizontal portions over a predetermined path with respect to one another during form locking and unlocking operations.

14. A tunnel formwork as claimed in claim **6**, wherein said first guide means includes means to lock the ends of said vertical and horizontal portions together to form a right-angle corner form by the intersection of their respective upper and outward surfaces.

* * * * *