# United States Patent

[11] 3,590,590


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[45] Patented **July 6, 1971**
**Continuation of application Ser. No. 692,597, Dec. 21, 1967, now abandoned.**


[54] **TUNNEL BUILDING**
**11 Claims, 25 Drawing Figs.**


[52] **U.S. Cl.** ..... **61/84,** 61/45, 61/85, 25/38
[51] **Int. Cl.** ..... **E01g 5/08,** E01g 5/16
[50] **Field of Search** ..... 61/85, 84, 45, 33; 25/38; 299/31



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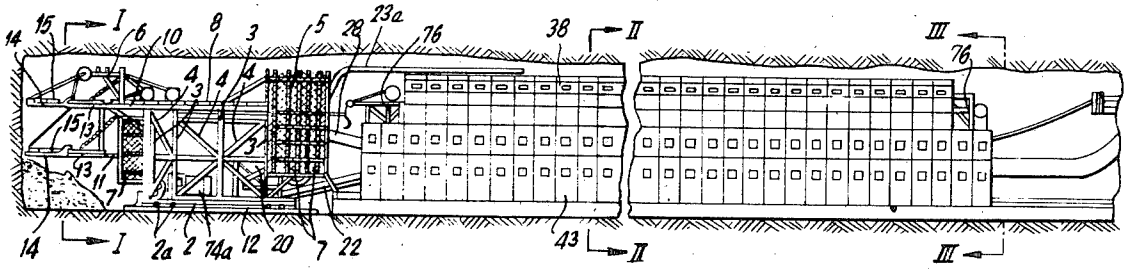
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*Primary Examiner*—Jacob Shapiro
*Attorney*—McGlew and Toren



**ABSTRACT:** A device for excavating a tunnel and lining it with concrete is formed of a scaffolding member located at the working face and followed in series by a support structure and a concrete form assembly. The scaffolding member has collapsible working platforms which can be arranged vertically across its front end to provide protection during the blasting operation. The support structure includes means for conveying excavated material to a plurality of temporary storage hoppers located within the form assembly and a conveying system for supplying concrete into the forms. Portions of the form panels can be extended laterally outwardly to assist in the removal of any temporary support required for the tunnel.

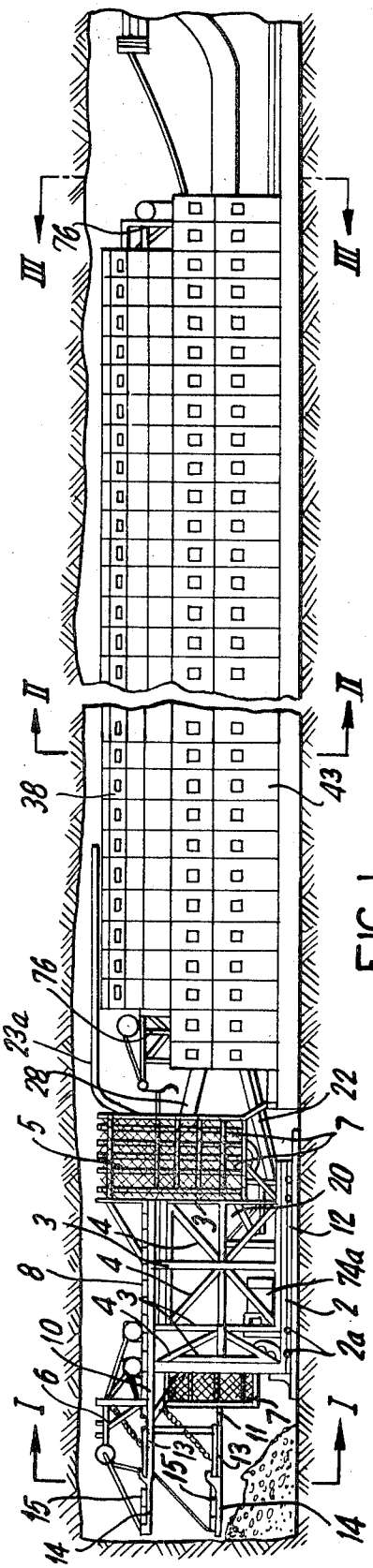


FIG. 1

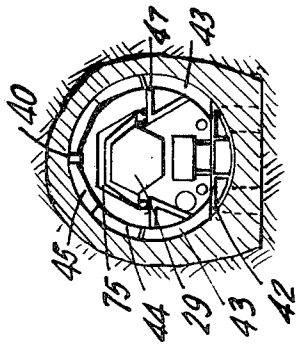


FIG. 4

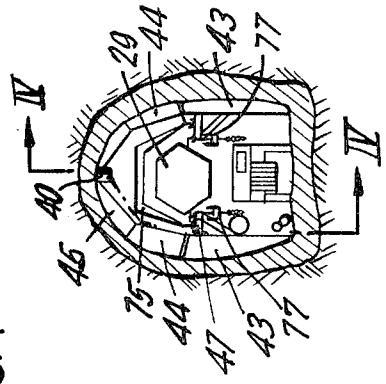


FIG. 3

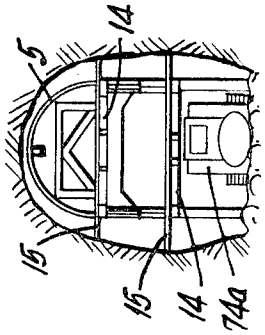


FIG. 2

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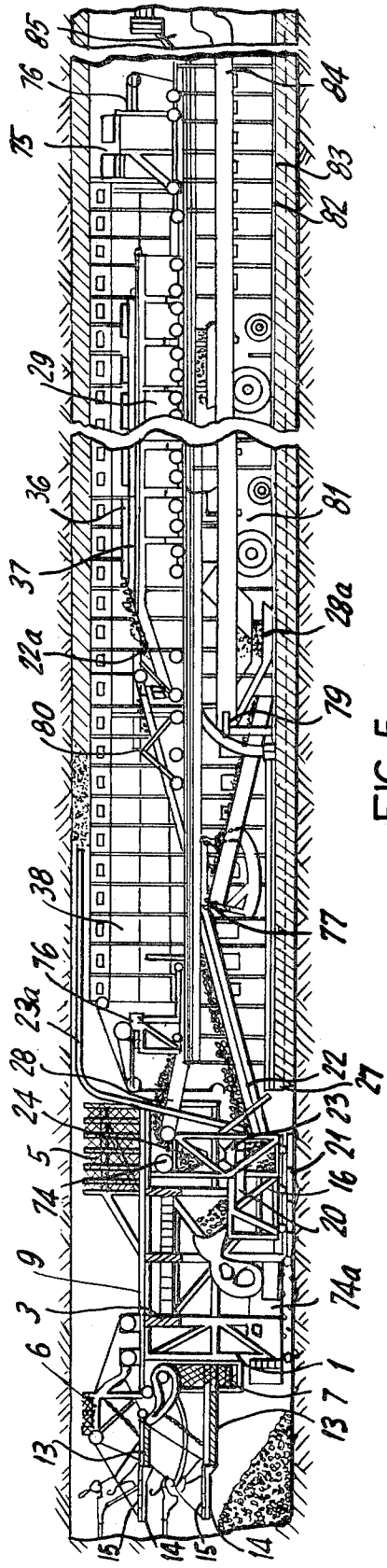


FIG. 5

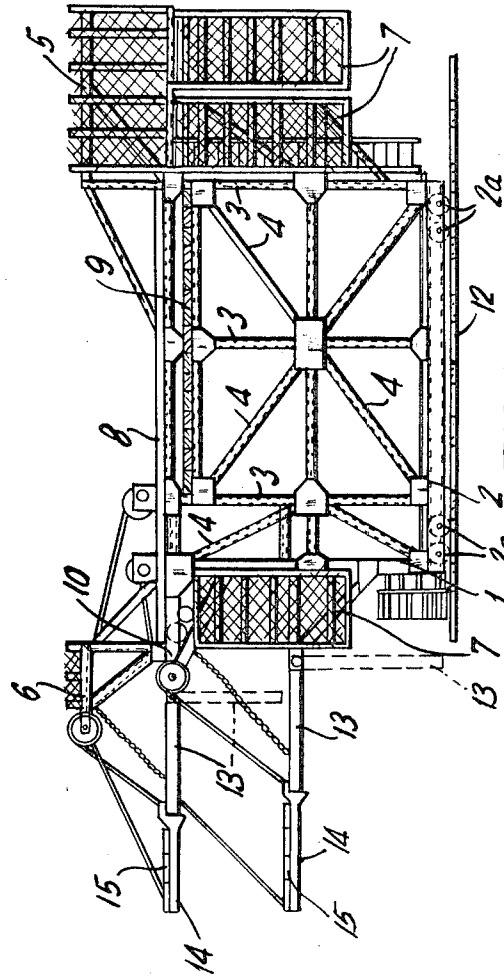


FIG. 6

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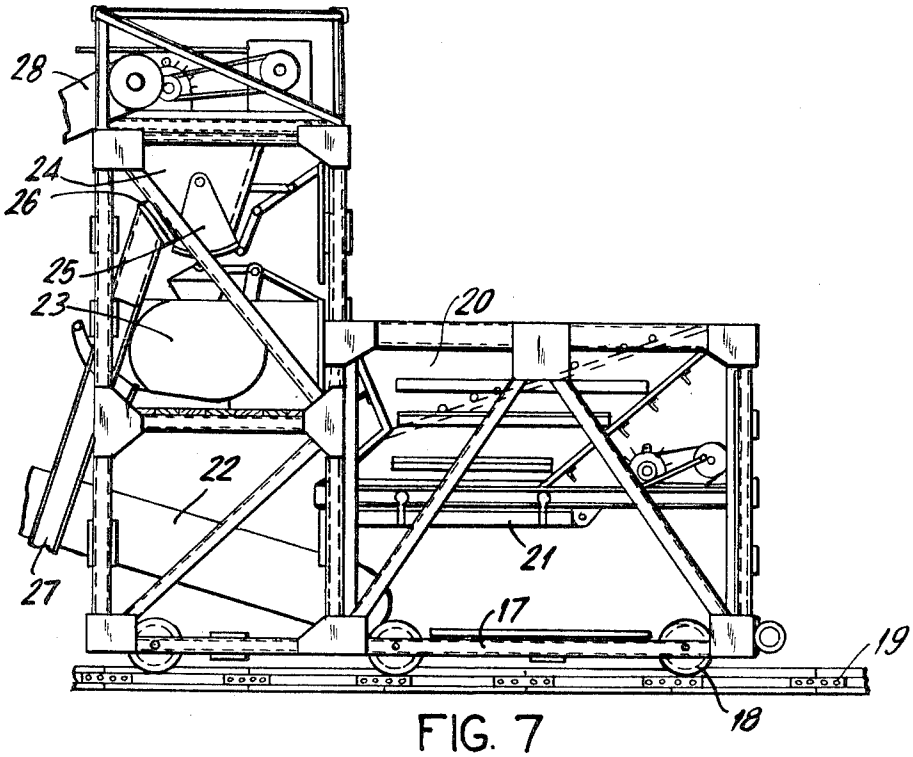



FIG. 7

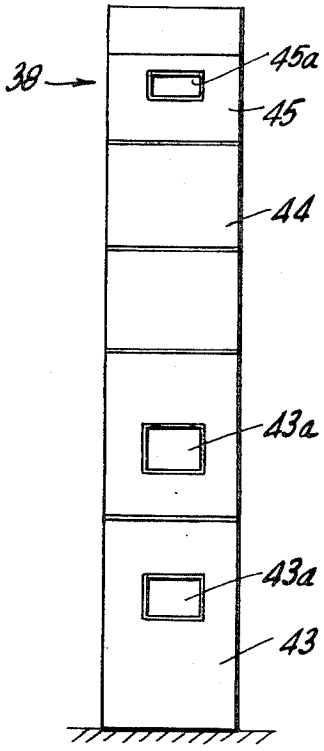



FIG. 9

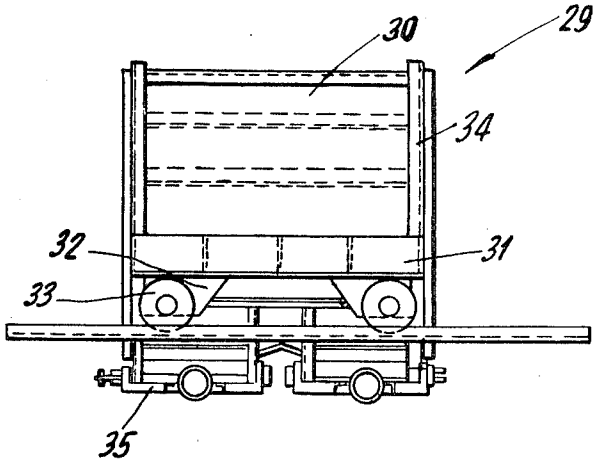



FIG. 8

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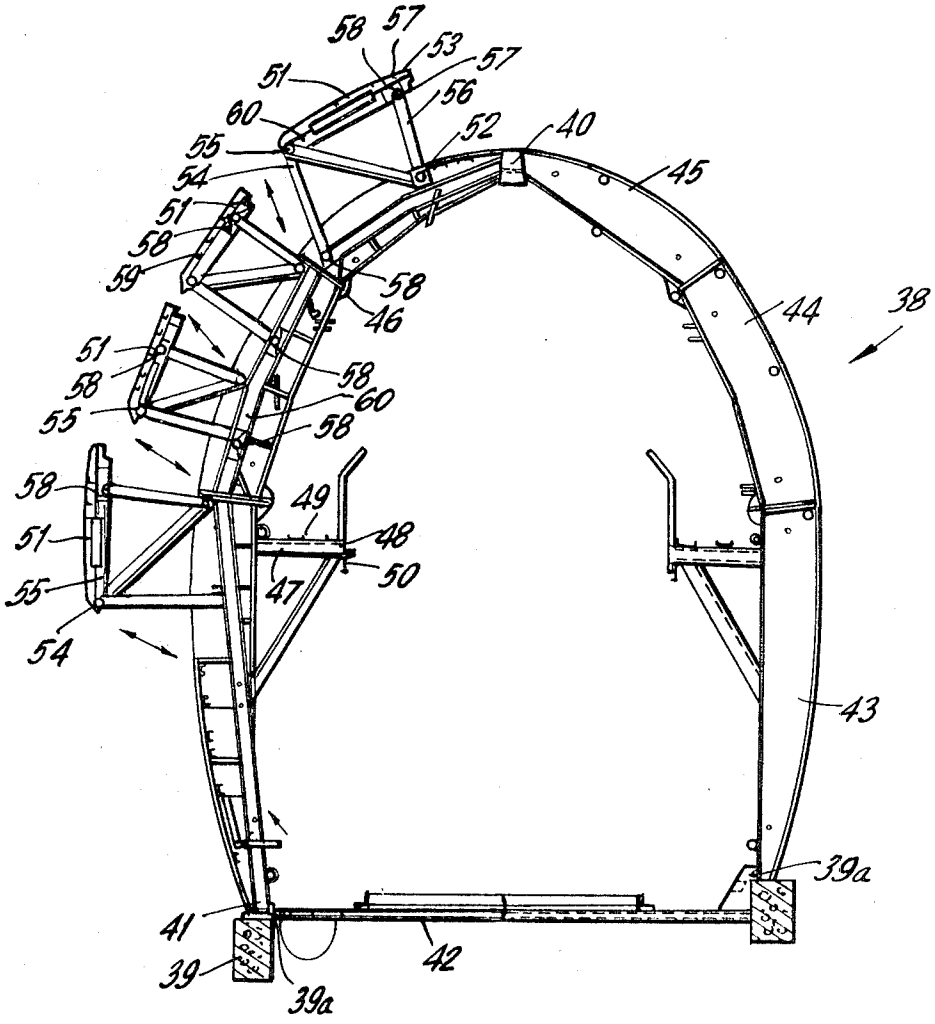



FIG. 10

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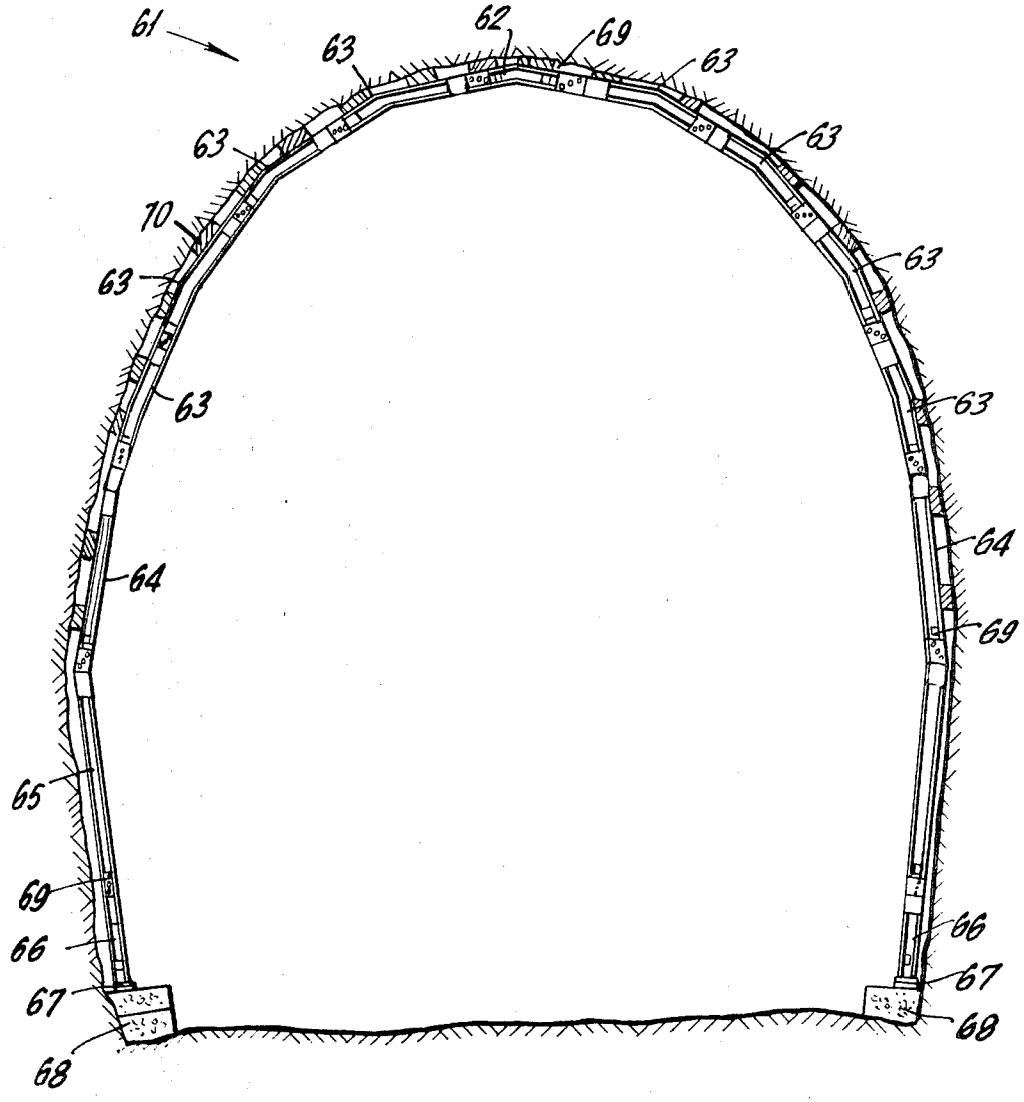



FIG. 11

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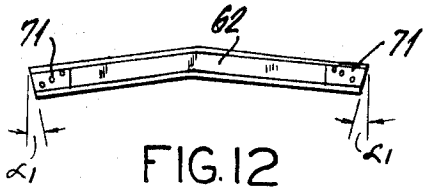



FIG. 12

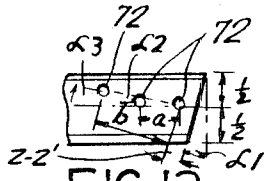



FIG. 13

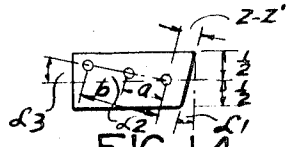



FIG. 14

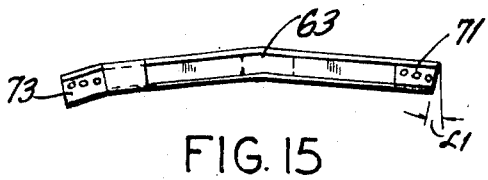



FIG. 15

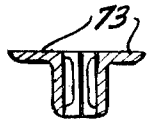



FIG. 16

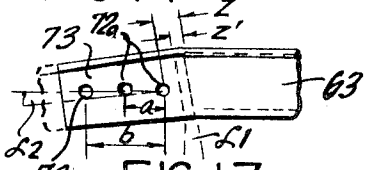



FIG. 17

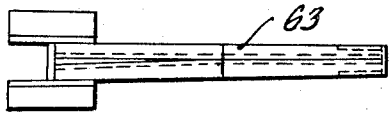



FIG. 18

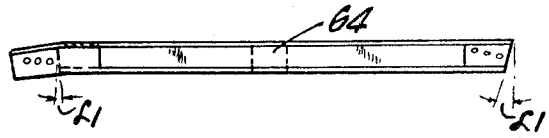



FIG. 19

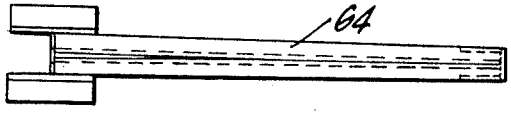



FIG. 20

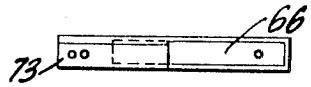



FIG. 23

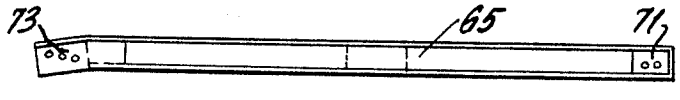



FIG. 21

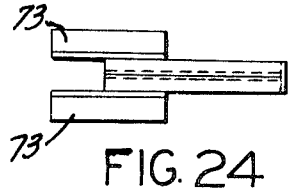



FIG. 24

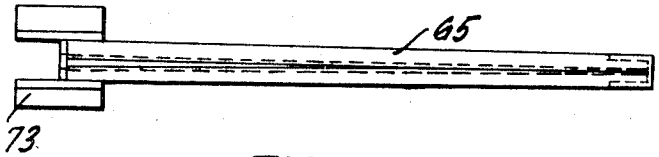



FIG. 22

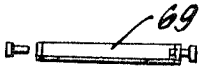



FIG. 25

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# TUNNEL BUILDING

This application is a continuation of application Ser. No. 692,597 filed Dec. 21, 1967 and now abandoned.

## SUMMARY OF THE INVENTION

The present invention relates to a tunnel-building device having as its objects to speed up tunnel building, to cut the building costs and to increase the safety at work. The building speed is increased approximately 1.5 to 3 times and the costs are cut by 10 to 30 percent as compared with conventional tunnel-building methods.

The invention may be used both in civil engineering and in mining.

The novelty of this invention as compared with other known equipment for the building of tunnels consists in the following:

This tunnel building device makes possible the building of tunnels in hard and soft rock and ground, with the exception of fluid sandy muds, and by using the same means, the same structure and the same labor force, by applying the same building method, and without any downtime and particular preparatory work for a change from hard to soft rock or ground and vice versa can be accommodated.

The excavation of rock, or earth, and the removal of the spoil are carried out on the full designed profile both in hard rock and in soft ground, with the exception of loose rock, sand, mud and similar ground, without retracting the device from the working face when blasting. The device moving forward only and at the same rate at which the work is progressing, this being achieved by a determined design of the front scaffolding which protects the whole device against any blasting operations.

In this way it is possible to start immediately behind the working face and at a determined distance, but not more than 35 linear meters from the working face, pouring the concrete for the permanent supporting concrete lining in its final form, or to start pouring within 3 to 8 days after the start of the excavation works so that pressure in the rock can not build up to its final and full measure, but may attain approximately 25 percent of their ultimate value. It is, therefore, possible to use lighter temporary supports and these can be stripped before pouring the concrete, a thinner final lining of concrete is made possible and the work itself is more safe.

Due to a specific design of the front part of the scaffolding it is possible to bore the holes for the blasting operation, to the working face and the loading of the previously excavated spoil all at the same time so that time, labor and digging equipment are saved. The design of the scaffolding is such that, if necessary, specific temporary steel supports and lagging can be erected during the loading and drilling operations and spoil removal, respectively, these steel supports being put in place from top to the bottom.

The temporary steel supports are of such design that they can be adjusted to fit different shapes of the excavation and can be stripped before pouring the concrete, just by disassembling them from the bottom to the top.

The spoil is hauled by belt conveyors, independently of the loading of the excavated material at the working face, and by specific bunkers for the provisional storage of the spoil, speeding up the loading of the excavated material and at the same time reducing the number of transport vehicles with the total haulage time being extended.

Pouring of the permanent concrete supporting lining is carried out at the same time as the excavation work and at a distance of 4 to 30 linear meters from the face, or 3 to 8 days after the respective section has been excavated. Pouring of the permanent concrete lining is continuous and executed along the whole designed section so that there are no horizontal joints, and, at a distance of 8 to 30 linear meters from the face, a completely finished tunnel is obtained.

The device is laid out so that the temporary steel supports can be removed partly or completely before pouring the concrete, and the same provisional lagging and steel supports



can be used over and over, thus expecting considerable savings in cost.

Various phases of the work can be carried out simultaneously but are not directly connected with each other. During the drilling, charging and shooting of the blastholes, or the spoil digging operation respectively, all other phases of the work as necessary—propping and installation of the temporary sheeting, erecting of the form panels, loading of the spoil, haulage of the material out of the tunnel, shifting of the form panels, removal of the temporary steel supports, pouring of the concrete—are carried out and completed.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of an embodiment of the tunnel-building device of the present invention;

FIG. 2 is a transverse view taken along line I–I of FIG. 1;

FIG. 3 is a transverse view taken along line II–II of FIG. 1;

FIG. 4 is a view similar to FIG. 3 for a circular tunnel;

FIG. 5 is a side view, partly in section, taken along line IV–IV of FIG. 3 and includes a diagrammatic illustration of the building method and the functional connection of all parts of the device in accordance with the present invention;

FIG. 6 is a side view of a part of the device, from which the blast holes are drilled, the excavation executed and the provisional steel supports placed;

FIG. 7 is a side view of another part of the device;

FIG. 8 is a side view of a hopper for the provisional storage of spoil;

FIG. 9 is a side view of a form panel section for the retaining of the poured concrete;

FIG. 10 is a transverse view taken along line II–II in FIG. 1 and shows on the left-hand side of the centerline and illustrates a form section in its working position ready to take the temporary steel supports, while on the right-hand side of the centerline it shows the form section in its position for retaining the poured concrete;

FIG. 11 is an elevational view of a steel arch for temporary lagging;

FIG. 12 is a side view of the central section of the steel arch;

FIG. 13 is an enlarged detail view of the end part of the main beam shown in FIG. 12;

FIG. 14 is a side view of a side plate fitted to the end of the main beam shown in FIG. 13;

FIG. 15 is a side view of steel arch sections fitted to the right and to the left of the central main beam of the arch as shown in FIG. 12;

FIG. 16 is a cross-sectional view of one end of the main beam illustrated in FIG. 15;

FIG. 17 is a partial side view of the section shown in FIG. 16;

FIG. 18 is a top view of the section shown in FIG. 15;

FIG. 19 is a side view of the section which is attached to the section shown in FIG. 15;

FIG. 20 is a top view of the section shown in FIG. 19;

FIG. 21 shows a side view of the section to be fitted to the section shown in FIG. 19;

FIG. 22 is a top view of the section shown in FIG. 21;

FIG. 23 is a side view of the bottom section of the arch shown in FIG. 11;

FIG. 24 is a top view of the section shown in FIG. 22; and

FIG. 25 is a side view of a tie between adjacent arches as shown in FIG. 11.

## DETAILED DESCRIPTION OF THE INVENTION

As viewed from the left or front in FIGS. 1 and 5 the tunnel-building device consists of: a scaffolding 1 at the front of the device, a structure 16 which supports the following: a bunker 20 for excavated material, a loader 21, the front end of an inclined belt conveyor 22, a pneumatic concrete gun 23, a hopper 24 for concrete, the top part of a belt conveyor 28 for concrete, chutes 27 for pouring concrete into the foundations, the footing arch and the floor slab, a pneumatic tube 23–*a* for

placing concrete, an auxiliary tank for compressed air; and a mechanical winch 74 for hauling the truck for transporting form panels. The structure 16 is situated under the rear part of the scaffolding. To the right of the structure 16, and connected to it for purposes of movement, the tunnel-building device includes a longitudinally extending concrete form panel structure which forms an open passageway along the line of the tunnel. The passageway contains a belt conveyor 22 for the transportation of the spoil, a truck 22–*a* carrying the upper end of the belt conveyor 22, a belt conveyor 37 and a switch 36 for loading the spoil into hoppers 29 for the temporary storage of the spoil material with those elements being supported by the form panel structure, note FIGS. 1—5. Form panels 38 to support the poured concrete and to support, if necessary, temporary steel supports 61 are a part of the form panel structure and include a truck 75 for the stripping, transferring and erecting of the form panel top sections; two working platforms 76 for disassembling and erecting the lower sections of the form panels; two crane trucks 77 each fitted with one hand hoist for lifting, transferring and lowering the lower sections of the form panels; the structure 28–*a* to take the concrete dumped from the truck and including a mechanical shovel 79 to load the concrete onto the lower end of the belt conveyor 28; and a working truck 80 from which the concrete is compacted by vibrating.

In addition to the parts, as listed above, the tunnel-building device includes rail trucks 81, a duct 82 for air under pressure, a water pipe 83, a conduit 84 for supplying fresh air to the working site, electric power conduits 85 for supplying power to electric motors mounted in different places of the device, and finally the rock drills.

The scaffolding 1 is a steel structure of determined shape and dimensions. The cross section of the scaffolding has the form of a gantry to let free passage for the rail trucks 74 and the structure 16. The scaffolding 1 consists of two longitudinal beams 2 of such design that at their front and rear ends two grooved wheels 2*a* can be mounted. The longitudinal beams 2 carry four upright frames 3 which are in their vertical planes stiffened by diagonals 4. The rear part of this structure is protected by the protective structure 5. Mounted on the front end of the scaffolding 1 are two brackets 10, one on each side, and at a predetermined distance below these brackets are two brackets 11 one on each side of the scaffolding and a protective structure 6 is mounted about the brackets 10. At the front and rear end of the scaffolding 1 protective aprons 7 are suspended along the sides of the scaffolding 1, which aprons can be swung out or drawn in to suit the width of the excavated profile. On the top of the structure and along its longitudinal axis is an oak timber floor 8, and below this another transversal oak timber floor 9. The scaffolding 1 moves on rail tracks 12 of determined length. Hinged at the forward ends of the brackets 10 and 11 are a pair of vertically spaced working platforms 13, arranged to be positioned about the hinge between a horizontal working positioning and a vertical shielding position, see FIG. 6, one upper and one lower. These working platforms are of a specific design and consist of box section side beams into which steel members of determined section are fitted. These members are tied together by ribs. At the front end and on the sides of the working platforms are rectangular openings into which fit the ends of the removable beams 14. The removable beams 14 consist of two steel members at one end fitted with steel plates of determined shape fixed to the sides and the center of the beam, the plates being clamped on their inner and outer side by other steel plates. Supported on the beams 14 are removable working platforms 15 consisting of three longitudinal beams of determined length, the beams being tied together by steel members. Around these members and the beams steel sections of determined thickness are latticed into a latticework forming a unit with the supporting beams. The bottom side of the supporting beams is fitted with stop plates.

With reference to FIG. 7, the structure 16 which supports the bunker 20 for the spoil, the loader 21 and other parts of the tunneling device, consists of two horizontal beams 17 of such design that each of them carries three grooved wheels 18. These wheels move on rails of determined length. Mounted at the front end that is the right-hand end in FIG. 7, of the structure is the bunker 20 and at its discharge opening is fitted a plate of the loader 21. The rear end of the structure 16 supports the belt conveyor 22. Located on a lower platform of the structure 16 is the pneumatic concrete gun 23 for concrete placing. On an upper platform the concrete hopper 24 is positioned above the filler opening of the concrete gun 23. The hopper 24 has on its bottom a gate 25 to control the discharge of concrete into the concrete gun, and on the front side of the hopper are two gates 26 to control the discharge of concrete into the chutes 27.

Supported on the upper platform is the top end of the belt conveyor 28. The hopper 29, see FIGS. 3, 4, 5 and 8, is supported from the form panel structure, described below, and is used for the temporary storing of the spoil with the hopper having a specific design with recessed bottom, and consists of side panels 30 joined under a determined angle. To the sides are fitted two triangular supports 31, and to these supports 31 are fitted bearings 32 for the wheels 33. At its front end the hopper is closed by the front panel 34. The bottom of the hopper is stiffened by two steel sections which separate the discharge opening into four parts, these openings being closed by gates 35.

The form panel structure is made up of the concrete form panels 38 each of which consists of two halves of determined shape and dimensions to take the load of the rock and of the poured concrete. Both halves rest on base plates 39*a* supported by concrete footings 39. At the top the two halves are tied together by an oakwood wedge and two bolts, the bottom ends of the form panel halves being tied together by means of joints 41 and a brace 42 so that a three-jointed arch is obtained. Each half of the form panel consists of a lower section 43, a central section 44 and a top section 45. The lower, central and top sections are built up of lateral panels, the two lateral panels being tied together by stiffeners.

The lateral sides of the form panels both on section 43 and on section 45 are covered with sheet metal. To the top end of the section 43 two steel plates are fitted, and two equal plates are fitted to the bottom end of section 44. These plates have a determined number of holes into which corresponding bolts fit so that the sections 43 and 44 can be securely bolted together into a rigid structure.

The top end of section 44 is fitted with two steel plates and equal plates are fitted to the bottom end of section 45. These plates have holes and a corresponding number of bolts so that also these two sections can be securely bolted into a structure. At the ends of these sections and to their inner side, pins and sockets respectively are fitted to form a joint 46 so that these sections 44 and 45 are permanently bolted together, but can swivel on the joint 46.

To the inner side of the section 43 two brackets 47 are fitted. The brackets 47 form a structure for supporting elements located within the passageway through the form structure. These brackets support a steel plate 48 and guides 49. To the bottom side of the brackets a guide 50 of specific shape is fitted. In this way on the inner side of the form panels a crane track with three rails provides supporting member for elements in the form structure and a gangway for the workers is obtained.

Both the lower section 43 and the top section 45 of the form panel is fitted with one collapsible structure 51, while the central section 44 is fitted with two such structures. In certain of the sections of the form panel openings with lids 43*a*, 45*a* for the compacting of concrete with vibrating needles, see FIG. 9.

The left-hand half of FIG. 10 shows these collapsible structures 51 in the extended position. The structure 51 consists of the following main parts: The shaft 52 which with one end of the collapsible structure is supported in an opening in the side plate of the form panel, and at a certain distance therefrom is supported by a support acting as a sort of bearing, the end of

the shaft projecting from this bearing. A strut 53 of a special L-section turns on this shaft. The other end of this strut 53 is fitted with the shaft 54 one end of which is mounted in the vertical flange of the strut 53, the other end of the shaft which is supported by a bracket projecting from this bracket. On the part of the shaft 103 between the flange of the strut 53 and the supporting bracket swivels a U-shaped beam. An equal system of struts and beams is fitted to the other side panel of the form panel, and the two parallel beams 55, covered with sheet metal, in their retracted position form part of the skin of the panel sections 43, 44 and 45. The system of struts 53 and beams 55 turning on the shafts 52 and 54 can take any desired position. To lock the strut 53 in a desired position a brace 56 swivels on the projecting end of the shaft 54, the other end of the brace being fitted with a stub shaft 57 supporting a sliding shoe 58. This sliding shoe 58 can move in a channel 60 provided with guides on its edges. After the brace 56 and the sliding shoe have been brought into position corresponding to the desired position of the strut 53 the sliding shoe is secured in place by means of two oak timber wedges 59 so that the shoe cannot move, thus fixing the position of the diagonal struts 53.

The same system of the brace 56 swiveling on its lower end on the projecting part of the shaft 52 is used to fix the beam 55 in a desired position. The shoe 58 sliding in the channel 60 of the beam 55 is locked into position by wooden wedges 59 when it becomes necessary. The collapsible part of the form panel has to be brought firmly against the arches of the temporary retaining lagging. If the collapsible structure of the form panel has to be retracted into the form panel to become a part of its surface for obtaining a continuous sheeting for the pouring of the concrete, first the wedges 59 are removed from the channel 60 on beam 55 and the beam 55 lowered onto the diagonal strut 53 after which the wedges in the lower channel 60 are removed and the strut 53 folded into the body of the form panel.

As shown in FIG. 11, the steel arch for supporting the temporary lagging consists of a central section 62 at the crown of the arch, four sections 63 on each side of the central section of the arch, and then extending downwardly each side of the arch has, in serial arrangement, a section 64, a part 65 and a terminal part 66. The arch rests on two oak wood wedges 67 which in turn are set on the ground or on concrete footings 68. The arches are connected by ties 69 and lagging 70 supported against the arch is pressed firmly against the rock. The sections of the arch are of such design that the arch can be widened or narrowed by approximately 50 cm. so that it can better fit the profile of the excavation and it is, therefore, not necessary to adjust the excavation to the arch.

The central section or headpiece 62 is a steel beam of determined design, and to its ends are fitted plates 71 of determined design having their ends cut of an angle $\alpha_1$ as are cut the ends of the central section 62. Holes are drilled in the plates 71 and the central section 62 forming an angle $\alpha_2$ with the centerline of the section, and another hole is at an angle $\alpha_3$ to the centerline of the section, while the spacing of the holes is "$a$" and "$b$" respectively. The beam 63 is a steel section of determined shape and bent at a certain radius or at a determined angle. One end of the beam is cut at the angle "$z$'" and to the sides of the beam at the end are attached the plates 71 with the same features as for the section 62. Fixed to its sides at the other end of the beam, are two L-sections 73 bent under a determined angle and projecting from the beam. The projecting part of the section 73 has three holes 72$a$ disposed at an angle $\alpha_2$ to the centerline and at distances "$a$" and "$b$." The first hole is at a distance "$z$" from the section while the plate 71 has holes drilled so that the first hole is at a distance "$z$–$z$'" from the end of the section. Due to the holes drilled at the angles $\alpha_2$ and $\alpha_3$ it is possible to assemble the beams 62 and 63 by inserting one section into the other and securing them by bolts or wedges. If one bolt is removed and the other loosened, and a bolt is to be fitted into the third hole, the complete part has first to be turned on the loosened bolt until the third hole on one section aligns with the third hole in the plate of the second section so that the bolt can be fitted. In this way a certain swinging of the section 63 with respect to section 62 is made possible, this being the case for all other sections, members of the arch, so that the arch can be opened or closed within determined limits. All other sections of the arch are of determined shape and tied together in the same way as already described.

The tunnel-building device operates in the following way:

Blasting and/or digging of the face is carried out at the full designed profile. The swiveling platforms 13 on the scaffolding 1 are in the suspended or hanging position, shown dotted in FIG. 6, during the blasting operation for protecting the scaffolding and all other parts of the device against the blast so that the scaffolding remains all the time at the working face. Loading of the spoil and excavated material is via the loader 21, the hopper 20 and the conveyor belt 22 into the travelling hoppers 29 and from these into the rail trucks. During the loading operation the working platforms 13 are lifted to their horizontal position and the removable supporting beams 14 with the working decks 15 are attached to them from which the drilling of the blastholes and, according to requirements, erecting of the steel arches 61 for the temporary sheeting is carried out simultaneously. After clearing the spoil from the working face drilling of the blastholes in the lower part of the working face can start.

At the same time that the drilling, loading and spoil haulage operations are being performed concrete can be poured for lining the complete tunnel section. Concrete is discharged into the trough 28–$a$ from where it is loaded by a scraper shovel 79 onto the belt conveyor 28 which carries the concrete to the hopper 24. From this hopper the concrete is discharged for lining the tunnel as excavated by conveying it into the concrete gun 23 which places the concrete between the forms and the rock wall above the tunnel invert. From the same hopper 24 concrete for the base slab in the invert and for foundations is fed through the chutes 27 so that a continuous pour is obtained along the whole profile of the tunnel.

The temporary sheeting—the supporting arches 61 and the lagging, is removed as the pouring of concrete progresses, this having been made possible by the collapsible structures 51 mounted on the form panels.

Dismantling and stripping of the form panels is done in sections during the pouring of the concrete and during the haulage of the excavated material. The sections 44 and 45 of the form panels are removed, transported and erected from the working platforms 75, while the sections 43 are stripped and erected again from the working platform 76, the form panel sections being transported by the cranes 77 traveling on the tracks fitted to the inner structure of the form panels. This tunnel-building device makes possible the pouring of concrete for the final supporting lining of the tunnel at a distance of 30 linear meters from the working face in hard rocks and at the working face if the working is in soft rocks and earth.

What I claim as new and desire to secure by Letters Patent is:

1. A device for excavating a tunnel removing the excavated tunnel material and lining the tunnel with concrete comprises a scaffolding arranged to be positioned adjacent the working face of the tunnel and to extend longitudinally rearwardly therefrom, means for movably positioning said scaffolding within said tunnel, platform means mounted on the forward end of said scaffolding, said platform means positionable between a horizontally disposed working position, and a vertically disposed shielding position whereby the device is protected from damage during any blasting operations, means mounted on the sides of said scaffolding for affording protection therealong, a longitudinally extending structure arranged adjacent the rearward end of said scaffolding and extending longitudinally rearwardly therefrom, a portion of said scaffolding extending rearwardly over the forward portion of said structure, means arranged for movably positioning said structure along the tunnel, said scaffolding constructed to form a longitudinally extending passageway therethrough adapted to

permit the movement of a tunnel loader between the working face and the forward end of said structure, a bunker mounted on said structure and arranged to receive excavated material removed from the working face of the tunnel, a longitudinally extending concrete form structure assembly spaced rearwardly from the rearward end of said structure and forming a central open space therethrough, said form structure assembly comprising a bracket support assembly extending along each side thereof, hoppers for excavated material movably mounted on said bracket support assembly means extending between said bunker and said hoppers for conveying excavated material from said bunker to said hoppers, a member located within said form structure assembly and spaced from said structure and arranged to receive a supply of concrete to be placed in the forms, a concrete distributing hopper located on said structure, means for conveying concrete from said member in said form structure assembly to said distributing hopper, said form assembly comprising a plurality of side panels for supporting the concrete poured behind the form, and at least certain parts of said side panels being displaceable laterally outwardly from the position for supporting concrete to provide support for temporary support members supporting the unlined portion of the tunnel in advance of the concrete lining.

2. A device, as set forth in claim 1, wherein said form assembly comprising a plurality of said side panels is composed of a plurality of form sections and each form section comprises three upwardly extending side panels located on each side of the centerline of the tunnel, said side panels on each side of the centerline are arranged one above the other and are bolted together forming one-half of one said form section, a wooden insert separates the upper halves of each of said form sections and bolts in combination with said wooden insert joins said half sections together, a hinge secured to the lower end of each said half section, and a horizontally arranged brace extending between said hinges.

3. A device, as set forth in claim 1, wherein said means for movably positioning said scaffolding comprising a pair of longitudinally extending rails arranged to be positioned on the invert of the tunnel, and wheels secured to said scaffolding and in rolling engagement with said rails for positioning said scaffolding member longitudinally along the tunnel

4. A device, as set forth in claim 1, wherein said platform means comprises a pair of first brackets secured to the upper part of said scaffolding at the forward end thereof, a second pair of brackets spaced vertically below said first pair of brackets and located on the forward end of said scaffolding member, a working platform hinged to each pair of said brackets and positionable between a horizontally arranged working position and a vertically disposed shielding position, removable beams supported in the forward end of said working platforms and extending therefrom toward the working face of the tunnel, and a removable working platform mounted on said removable beams.

5. A device, as set forth in claim 1, wherein said means mounted on the sides of said scaffolding comprising protective aprons mounted on the forward and rearward ends of the sides of said scaffolding and said protective aprons being arranged to be moved laterally transverse to the longitudinal direction of the tunnel to suit the width of the excavated profile of the tunnel.

6. A device, as set forth in claim 1, wherein said structure comprises a pair of longitudinally extending transversely spaced horizontal beams, a plurality of flanged wheels carried by each of said horizontal beams, a plurality of interconnected structural members extending upwardly from said horizontal beams and forming a plurality of support surfaces, and said means arranged for movably positioning said structure comprising a pair of longitudinally extending transversely spaced rails arranged to support said flange wheels in rolling engagement for movably positioning said structure.

7. A device, as set forth in claim 1, wherein said means for conveying concrete from said member to said distributing hopper comprises an inclined conveyor extending upwardly from said movable member to said distributor hopper.

8. A device, as set forth in claim 7, wherein a pneumatic concrete gun is mounted on said structure and is arranged to receive concrete from said distributing hopper for placing the concrete between said form panels and the wall of said tunnel, and chutes connected to said distributor hopper for pouring concrete in the invert of the tunnel.

9. A device, as set forth in claim 1, wherein each of said hoppers for excavated material comprises a pair of end panels, a pair of downwardly and inwardly converging side panels secured at their opposite ends to said end panels, a pair of beams secured to the bottoms of said panels and extending perpendicular to one another for dividing the bottom of said hopper into four discharge openings, a separate gate for each said discharge opening, a pair of wheel bearings secured to each side of said hopper, a wheel movably mounted in each said bearings and being supported by said support frame within said form assembly.

10. A device, as set forth in claim 2, wherein each of said side panels in half of one of said form sections having at least one subpanel articulated to said side panel and being displaceable outwardly from a position forming a part of the surface of the form for pouring concrete to a variable second position whereat said subpanel is arranged to be positioned against a temporary tunnel support in the unlined section of the tunnel for supporting the temporary support as it is being removed in advance of the concreting operations.

11. A device, as set forth in claim 10, wherein each of said laterally displaceable subpanels comprises a strut member pin connected to the frame of said form panels, a beam supporting the outer surface of said side panels, the opposite end of said strut from the one pin connected to said frame being movably secured to said beam, and a pair of braces pin connected to said frame with one of said braces secured at its end opposite the end pin connected to said frame to said strut at the point said strut is connected to said beam and the other end of said brace being slidably positionable within the frame of said form panels, the other said brace being pin connected to said strut at the point of articulation of said strut to said frame of said form panel and the opposite end of said brace being movably positionable within said beam, and means for locking the movably positionable ends of said braces in position for holding an extended subpanel in position against a temporary support.