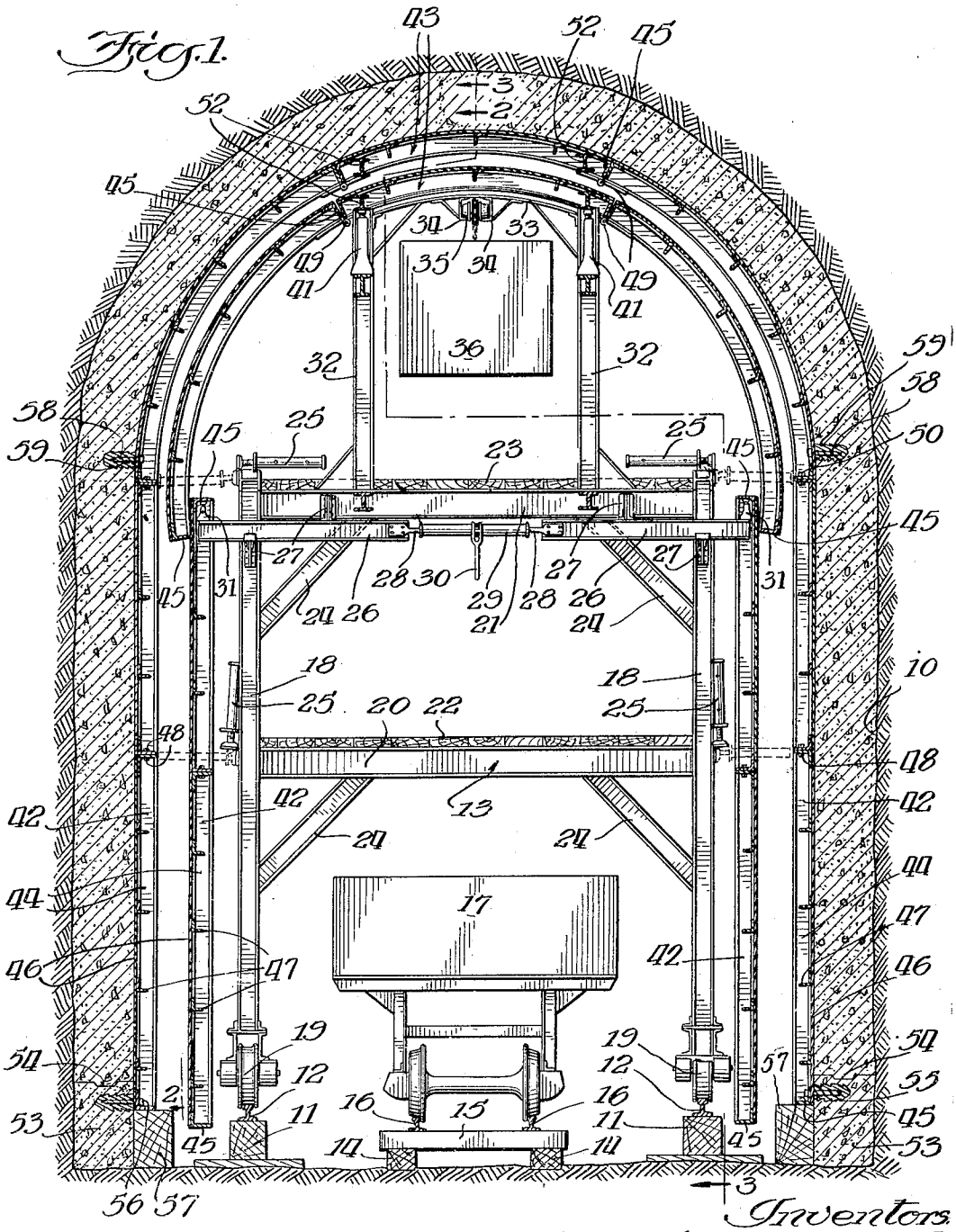
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TUNNEL CONSTRUCTION APPARATUS

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Fig. 1.



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TUNNEL CONSTRUCTION APPARATUS

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Fig. 2.

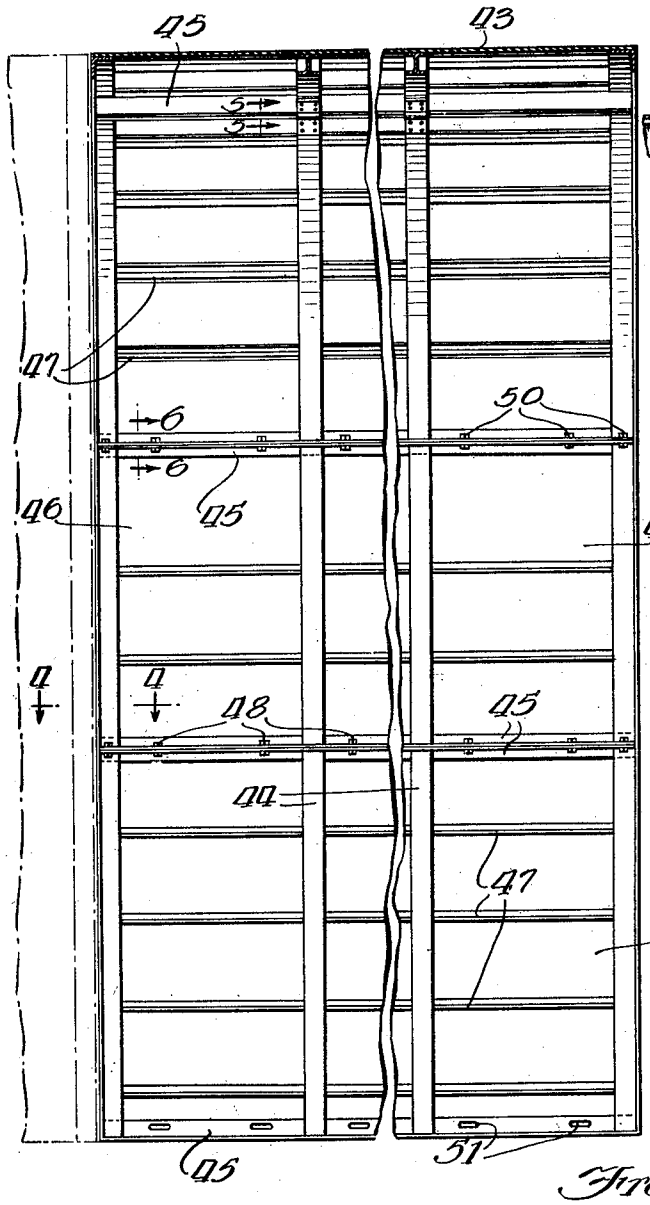
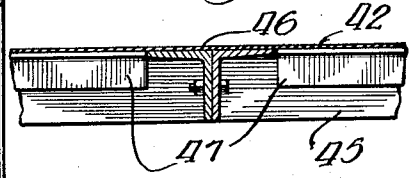


Fig. 4.



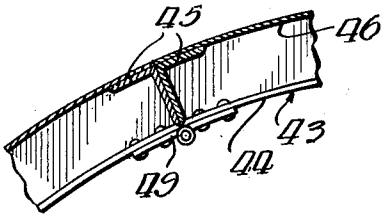


Fig. 5.

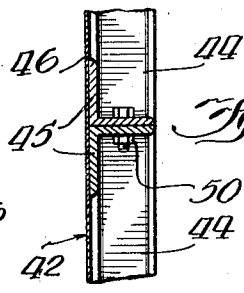


Fig. 6.

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TUNNEL CONSTRUCTION APPARATUS

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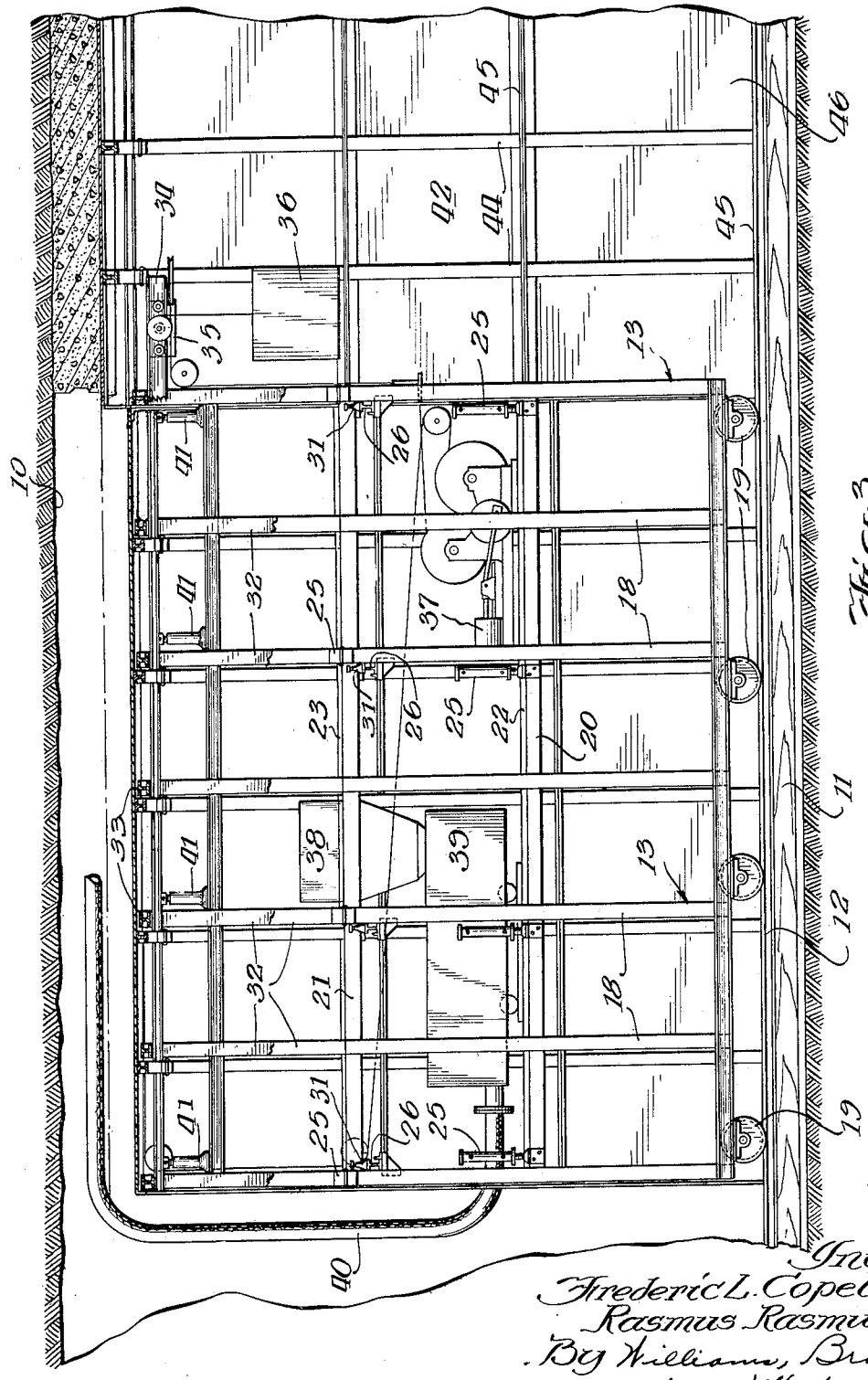


Fig. 3.

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UNITED STATES PATENT OFFICE

1,927,256

TUNNEL CONSTRUCTION APPARATUS

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Application May 31, 1932. Serial No. 614,587

4 Claims. (Cl. 25—131.6)

This invention relates to tunnel construction apparatus and methods, and particularly to apparatus for, and method of lining tunnels with concrete. The apparatus comprises an improved tunnel form and improved mechanism cooperating therewith adapted for use in holding the form in position during pouring and the period of initial set, and adapted to transport the form from one position to another along the tunnel.

One of the objects of the invention is to provide an improved collapsible form for this purpose.

A further object of the invention is to provide an improved carriage for transporting the form.

A further object of the invention is to provide an improved collapsible form and carriage therefor adapted to transport the collapsed form through an erected form.

A further object of the invention is to provide an improved method of lining tunnels.

Further objects, advantages and capabilities of the invention will appear from the following description of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, in which

Figure 1 is a transverse section through a tunnel showing an improved form embodying our invention in erected position and a similar form in collapsed position, the latter form being shown supported by the carriage or jumbo;

Fig. 2 is a sectional view showing the erected form, the section being taken on the line 2—2 of Fig. 1;

Fig. 3 is a longitudinal sectional view of a tunnel during lining, the section being taken on the line 3—3 of Fig. 1;

Fig. 4 is a sectional detail view taken on the horizontal line 4—4 of Fig. 2;

Fig. 5 is a sectional detail view taken on the line 5—5 of Fig. 2, and

Fig. 6 is a sectional detail view taken on the line 6—6 of Fig. 2.

Referring to the drawings, the excavated tunnel which it is desired to line is designated by the reference numeral 10. This tunnel possesses substantially vertical sides and an arched roof. On the flat bottom of the tunnel are laid longitudinal timbers 11 which serve as a support for rails 12 upon which the carriage or jumbo 13 is mounted. Between the timbers 11 are laid longitudinal timbers 14 which serve as a support for ties 15. Upon the ties are laid rails 16 for muck trucks 17 which are adapted to pass below the jumbo 13. The rails 16 may also be used for supplying concrete to the work.

The jumbo 13 comprises vertical side frames 18 which carry at their lower ends wheels 19 adapted to run on the rails 12. The frames 18 are connected by horizontal frames 20 and 21 upon which are supported decks 22 and 23. The whole carriage or jumbo is trussed by suitable elements, certain of which are shown and designated 24. As shown in Fig. 1 the frame 20, and associated parts are elevated sufficiently to provide free passage for the trucks 17.

On its outer sides the jumbo carries a plurality of jacks 25 which are pivotally mounted so they can be moved outwardly into horizontal operative position and, when desired, turned inwardly about their pivots into the position shown in full lines in Fig. 1. The purpose of these jacks will hereinafter be described.

Below the frame 21, there are mounted on the jumbo a plurality of sliding bars 26 which are guided and supported by suitable brackets 27. These bars are arranged in opposite pairs and carry at their innermost ends threaded rods 28 which are received in a common complementary jack element 29 which may be rotated by any suitable means, for example the handle 30 which has a ratchet connection therewith. At their outermost ends the bars 26 have rigidly mounted thereon jacks 31 which are located so as to operate in a vertical direction.

Above the frame 21 the jumbo is provided with two longitudinal vertical frames 32 which are inter-connected by arcuate arch members 33. The members 33 have secured thereto oppositely directed channels 34 which are arranged longitudinally so as to serve as runners for the carriage 35 for the concrete bucket 36. The carriage 35 may be actuated in any suitable way, for example, by the donkey engine 37 so as to transport the bucket into operative relation with a hopper 38 of a cement gun 39, from which it may be discharged into the inner side of the forms by means of a flexible conduit 40.

The frames 32 have rigidly mounted thereon jacks 41 which are adapted to project upwardly clear of the frames 32 and elements mounted thereon so as to provide support for the arched forms, in the manner hereinafter described.

The forms comprise vertical side forms 42 and arched forms 43. The side forms 42 may suitably comprise frames of steel shapes, for example vertical H-beams 44 and horizontal angle irons 45. To this frame is secured, for example by welding, steel plates 46. Between the H-beams 44 the plates 46 are reinforced by angle irons 47. The

side forms may suitably be made in two parts bolted together as shown at 48.

The arched forms may be of the same material and construction and comprise three sections hingedly connected together by means of hinges 49 located at the inner ends of the abutting flanges of the angle irons 45 of the arched sections. The angle irons 45 at the top of the side wall forms 42 and the angle irons 45 at the extremities of the arched forms 43 are provided with complementary openings whereby the same may be bolted together by the bolts 50. The angle irons 45 at the lower ends of the side wall forms 42 are provided, in their vertical webs, with openings 51 for the purpose hereinafter described. I-beams 52 are secured to the inner side of the center section of the arched form adjacent their ends and spaced so as to enable these beams to be engaged by the jacks 41 for the transportation of the arched form.

The operation of the device is as follows. A footing of concrete 53 is first poured to serve as a support for the lining on each side. The upper face of the footing 53 may be provided with a recess or keyway 54 to enable the lining to bond more effectively thereto. At the appropriate height in the footing 53 a series of screw anchor sockets 55 are cast into the footing, said sockets being spaced apart at the same distance as the openings 51 in the side wall form 42.

After footings 53 have set, the forms are applied thereto in the following manner. The forms are located on the jumbo in the manner shown in Fig. 1. The jumbo being moved into appropriate position along the rails 12, the jacks 41 are elevated so as to bring the arched sections clear of the side sections 42. The jacks 31 are then elevated so as to bring the side wall forms 42 into their appropriate elevation, that is with the openings 51 in alignment with the anchor sockets 55 of the footings 53. The jack element 29 is then rotated by means of the handle 30 so as to extend the arms or bars 26 which carry the jacks 31 so that the side wall forms 42, which are carried by the jacks 31, are moved upward into position so as to serve as forms for the lining to be poured above the footings 53. Anchor screws 56 are then passed through the openings 51 and threaded into the anchor sockets 55. The lower ends of the forms 42 are supported by means of blocks 57 which are inserted along the side of footings 53 as shown in Fig. 1. The extreme sections of the arched form 43 are pushed outwardly and the jacks 41 are lowered so as to cause the arched form to rest upon the side forms.

The arched form is bolted to the side wall forms by means of the bolts 50. The jacks 25 are swung outwardly, that is into the position shown in dotted lines in Fig. 1, and are expanded so as to engage the forms and hold them rigidly in position until the concrete is poured. The concrete may be supplied by the bucket 36 to the hopper 38 of the gun 39 and may be injected behind the forms by means of the flexible conduit 40, with or without use of bulkheads to prevent escape of the concrete at the ends of the forms. It will be noted that the complete form must be held in exact position by means of the jumbo until the concrete has been poured, and preferably until initial set has occurred. After the concrete has been poured the mass prevents any substantial movement of the form even when the support provided by the jumbo is withdrawn. Accordingly, after the concrete has been poured, and preferably after initial set has occurred, the jacks 25 may be elevated, the jacks 41 may be lowered and the arms 26 and jacks 31 may be retracted to their initial positions. The jumbo is now free and can be moved along the rails 12 for the purpose of removing the forms from a point where the concrete has adequately set to the new end of the work, which normally necessitates a collapsed form to be passed through an erected form. This state of things is illustrated in Fig. 1.

In dismounting an erected form the jacks 41 are expanded until they contact with the I-beams 52 of the arched form. The arms 26 are projected and the jacks 31 are elevated so as to contact with the upper flanges of the side wall forms 42. The anchor screws 56 are then withdrawn and the blocks 57 are removed. The bolts 50 are removed and the jacks 31, which now take the weight of the side wall forms 42, are lowered and the arms 26 are drawn inwardly. During these movements hinged sections of the arched form are held outwardly. The jacks 41 are now lowered and the hinged sections of the arched form are allowed to fall inwardly to a position to the outside of the dismounted side wall forms 42. The movements of these sections about their pivots bring their lower ends inwardly away from the walls so that adequate clearance is provided for the dismounted forms, thus loaded upon the jumbo to move through the adjacent erected forms. If it should be desired to leave the arched form in position after removing the side wall forms 42 the hinged sections of the arched forms may carry anchor screws 58 and anchor screw sockets 59 adjacent their lower edges. When, subsequently, it is desired to move the arched section, the jumbo is placed in position beneath it and the jacks 41 are elevated so as to engage the I-beams 52. Support having thus been provided for the arched form, the anchor screws 58 are withdrawn, the jacks 41 are lowered and the arched form is transported into desired position.

Although the invention has been described in connection with the specific details of a preferred embodiment thereof, it must be understood that such details are not intended to be limitative of the invention except in so far as set forth in the accompanying claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a carriage adapted to move through a tunnel, side wall forms and an arched form adapted to be erected for the lining of said tunnel with concrete, said forms including vertical side wall forms and superior arched form comprising hinged sections, arms on said carriage adapted to be projected outwardly towards the side walls, jacks on the outer ends of said arms adapted to engage and support said side wall forms, jacks on said carriage adapted to engage and support the center section of the arched form, and extensible means pivotally mounted on said carriage adapted to hold said forms in desired position until the concrete is poured, said extensible means being adapted to be moved inwardly to permit the forms to be collapsed upon the carriage to a degree to permit them to be moved on the carriage through an erected form.

2. In a tunnel construction apparatus, in combination, side wall forms and a hinged arched form adapted to be secured thereto, said arched

form comprising sections hinged together so that the extremities of said hinged form may be moved inwardly, a carriage adapted to support and transport said forms, said carriage being provided with upwardly extensible jacks adapted to receive and support the arched form, outwardly extensible bars carrying jacks adapted to receive and support the vertical side wall forms at their upper ends, and jacks pivotally mounted on said carriage adapted to be extended outwardly to engage said forms to support same against inward displacement during the pouring of a lining behind said forms.

3. In combination, a carriage adapted to move through a tunnel, side wall forms and an arched form adapted to be erected for the lining of said tunnel with concrete, said forms including vertical side wall forms and a superior arch form comprising hinged sections, arms on said carriage adapted to be projected outwardly towards the side walls, jacks on the outer ends of said arms adapted to engage and support said side wall forms, jacks on said carriage adapted to engage and support the center section of the arched form, the side wall forms being adapted to be carried inwardly by said arms, whereafter the arched form is adapted to be lowered by the last said jacks, the outer hinged sections being moved inwardly over the upper ends of the side wall forms to enable the carriage and forms to pass through other forms installed in concrete pouring relation to the tunnel.

4. A carriage for use in supporting and transporting forms for tunnel lining comprising arms adapted to be projected laterally from the carriage, jacks on the outer ends of the arms adapted to engage and support side wall forms, upwardly directed jacks adapted to raise and support an arch form comprising sections, to enable the arch form to be moved downwardly with its lower sections swung inwardly over the upper ends of the side wall forms in their retracted position.

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