Nov. 5, 1929. S. E. MURRAY 1,734,773

COLLAPSIBLE STEEL FORM

Filed March 5, 1928

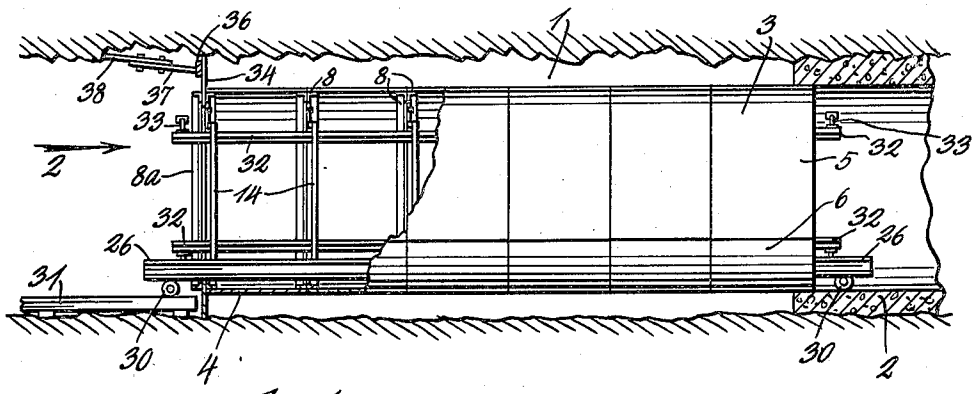


Fig. 1.

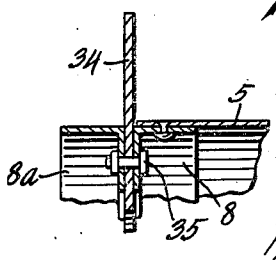


Fig. 3.

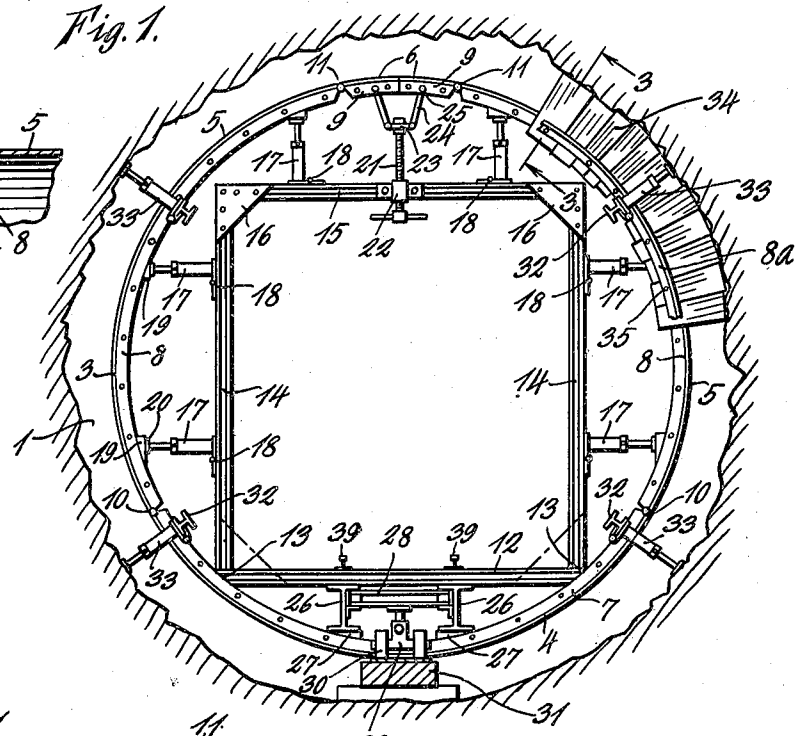


Fig. 2.

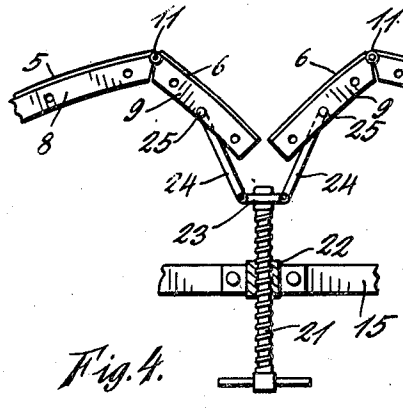


Fig. 4.



Fig. 5.

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UNITED STATES PATENT OFFICE

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COLLAPSIBLE STEEL FORM

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This invention relates to improvements in collapsible steel forms of the type employed in connection with the lining of tunnels.

After a tunnel has been cut, it is necessary to line the interior thereof with concrete so as to prevent the crumbling of the walls and to maintain the tunnel in operative condition. Where the tunnel is small, as for example, when it is used for conveyance of water, the interior is nearly always cylindrical. This is often true also with larger tunnels, but the latter may sometimes be made of horseshoe cross section. The form to which this invention relates is adapted more particularly for use where a circular tunnel is under consideration, although the construction employed can also be adapted to other shapes.

In the lining of tunnels with concrete, it is necessary to provide a steel form of cylindrical shape whose outside diameter, when expanded, is the same as that of the inside diameter of the completed lining. This form must be of rigid construction and means must be provided for centering it within the bore and for moving it forwardly as the work of lining proceeds. It is also necessary that this form shall be provided with means which enables the workmen to collapse the form so as to release it after the concrete has set, in order that the form can be advanced and put in place for the forming of another section of the lining. It is also necessary that these forms shall have means for centering them within the tunnel and for conveniently expanding the form after it has been collapsed.

It is the object of this invention to produce a collapsible form which shall be so constructed that it can be formed in sections which can be readily transported and which can be readily assembled so as to produce a form of any desired length and at the same time to provide convenient means for collapsing and expanding the form and for holding it in expanded position against the pressure of the wet concrete and which can readily be moved ahead as the work of lining proceeds.

The above and other objects which may become apparent as this description proceeds are attained by means of a construction and an arrangement of parts which will now be described in detail, and reference for this purpose will be had to the accompanying drawing in which the preferred embodiment has been illustrated and in which:

Fig. 1 is a longitudinal section through a tunnel showing the form in place and ready to receive a section of lining;

Fig. 2 is an end view looking in the direction of arrow 2 in Fig. 1 with parts of the bulkheads removed so as to disclose the construction;

Fig. 3 is a section taken on line 3—3, Fig. 2, and illustrates the manner in which the bulkheads are held in place;

Fig. 4 is a view to a somewhat enlarged scale showing the means employed for collapsing the forms and for expanding the same; and

Fig. 5 is a top plan view of an extensible brace member which is employed for holding the bulkheads against the pressure of the concrete.

In the drawing numeral 1 represents the interior walls of the tunnel and 2 a section of lining. The form to which this invention relates consists of a plurality of sections which are substantially identical in construction and which have been indicated as a whole by numeral 3. Each section consists of four curved plates which have been indicated by reference numerals 4, 5 and 6. There are two plates numbered 5 and two plates numbered 6 and as these are identical in shape and size they have been indicated by the same reference numeral. Secured to the ends of these plates are angles 7, 8 and 9 respectively. The ends of angle irons 4 are hinged at 10 to the lower ends of the angle irons 8, while the upper ends of angle irons 8 are hinged at 11 to the angles 6. Secured to the angles 7 is a transverse I-beam 12, whose ends are preferably welded to the flange of angle 7 at 13. Vertical I-beams 14 extend upwardly from the ends of I-beam 12 and are secured at their upper ends to the ends of the horizontal I-beam 15. Beams 12, 14 and 15 form a rectangle and the ends of these beams are preferably welded

together and in addition to this the corners are reenforced by means of triangular braces 16. Secured to the vertical beams 14 are two spaced jacks 17, which are hinged at 18. These jacks are the ordinary screw jacks and their construction will therefore not be described in detail. Welded to the angles 8 are abutments 19, against which the heads 20 of the jacks abut. Other jacks 17 are secured to the upper horizontal beam 15, by means of hinges 18 and serve to support the upper ends of the plates 5 in the manner shown in Fig. 2. Plates 6 which are secured to the angles 9 are hinged at 11 to the upper ends of angles 5 and can be moved from the position shown in Fig. 2 to that shown in Fig. 4. When plates 6 are in the position shown in Fig. 2, the form assumes a circular cross section and is held rigidly in this shape by means of the jacks 17. After the concrete has been set and the forms are to be moved, the jacks 17 are all released and permitted to rotate about their hinges so as to get into a position in which they will not obstruct the operation after which the plates 6 are moved downwardly into the position shown in Fig. 4. For the purpose of controlling the hinged plates 6, I have provided a screw 21 which cooperates with a nut 22 secured to the transverse beam 15. Secured to the upper end of this screw by means which permits it to rotate is a transverse bar 23 to the outer ends of which the connecting bars 24 are hinged. The upper ends of these bars are pivotally connected at 25 to the angles 9. By rotating screw 21 so as to move part 23 upwardly, plates 6 may be moved into the position shown in Fig. 2 and by a reverse rotation of this screw they will be moved to the position shown in Fig. 4. For the purpose of supporting the form, large I-beams 26 are placed beneath the transverse beams 12 and are welded to the angles 7 at 27. Extending between the outer ends of I-beams 26 are transverse beams 28 to the under side of which jug jack dollies 29 are secured. These dollies are properly braced and the one located at the rear of the form is so positioned that the wheels 30 will be supported on the lower surface of the concrete lining, while the wheels of the dolly at the front end of the form rest upon a timber 31 which forms a track and which is adjusted to the proper height. In order to give rigidity to the form in a longitudinal direction, I-beams 32 have been secured to the inside at spaced points in the manner shown in Fig. 2. Hingedly connected to the outer ends of I-beams 32, are jacks 33, which may be of similar construction to the jack 17, to which reference has already been made. After the form has been moved to the proper position and expanded, the jacks 33 are put into place and adjusted so as to properly center the form within the bore and to hold it rigidly in the centered position.

For the purpose of this explanation we will assume that one section of the lining has been put in place in the manner shown in Fig. 1 and that the form has been moved forwardly so as to be properly positioned for the reception of another section of lining. The forward end of the form must be provided with bulkheads 34, so as to prevent the concrete from flowing forwardly and these bulkheads are constructed in the following manner. The inwardly flanges of angles 7, 8 and 9 are provided with openings 35 and similar sections of angle irons which have been designated as 8^a in Fig. 3 are provided with corresponding openings. The bulkheads 34 which are formed from a number of boards or planks are clamped between angles 8 and 8^a and are adjusted so that their outer ends extend into close contact with the inner surface of the bore in the manner shown in Fig. 2, where a section of this bulkhead has been illustrated. Whalers 36 are secured to the outside of the bulkheads and braces comprising extensible sections 37 and 38 are put into place between these whalers and some suitable projection on the inner surface of the bore and these braces resist the strains to which the bulkheads are subjected as the concrete is put into place. The concrete is introduced in the usual manner by means of a long pipe through which the moist concrete is forced to flow by the action of compressed air. After the form has been put into place as shown in Figs. 1 and 2, the concrete is then introduced so as to fill the space between the form and the inner surface of the bore. After the concrete has been put into place, it is left for a sufficient time to permit it to set and after it has hardened to the required extent the jacks 17 and 33 are loosened, after which the screw 21 is rotated so as to bring plates 6 into the position shown in Fig. 4. This collapses to form so as to decrease its diameter about four inches. The jug jack dollies are then rotated so as to raise the lower surface of the form about two inches and the form can then be pulled fowardly by means of a hoisting engine or a winch until it assumes the position with respect to the last lining section shown in Fig. 1, when it is again adjusted and another section of lining introduced.

Rails 39 are put into place on and supported by the transverse beams 12 and these rails are used for the cars by means of which the concrete is transported to the front end of the form.

Particular attention is called to the construction shown in Fig. 4, as this construction greatly facilitates the contraction and expansion of the form. The hinged plates 6, together with the screw mechanism for moving them produce uniform operation that provide a toggle mechanism for producing

the necessary force to move the form outwardly and in this manner the placing of the form is greatly simplified, the use of jacks 17, which are supported from the interior frame comprising beams 12, 14 and 15 serve to hold the forms rigidly so that their shape will not be distorted due to the pressure of the moist concrete and jacks 33 are conveniently placed for the purpose of centering the form within the bore.

The construction of this form as above described has been outlined in its most important details, but no attempt has been made to show the bracing of the jug jack dollies and some other minor features which are believed to be clearly within the field of mechanical skill and have for this purpose not been illustrated in detail.

Having described the invention what is claimed as new is:

1. A collapsible core for concrete construction comprising a plurality of arcuate sections, each of which forms a segment of a circle, said sections being adapted to be placed edge to edge so as to form a cylindrical section, two of said segments being narrower than the other segments, said narrow segments being placed adjacent to each other, each of said narrow segments being hinged to the adjacent wider segment, a rectangular frame located within each section in a plane perpendicular to the axis of the section, the lower corners of said frame being secured to the section, a screw operatively connected with the upper transverse member of the frame, and means operated by the rotation of the screw for moving the narrow segments about their hinges.

2. A collapsible core for concrete construction comprising a cylindrical section whose outer surface is formed from a plurality of curved plates, each of which has the same radius of curvature, one of said plates being located below the axis of the section so as to be bisected by a vertical plane passing through the axis, a curved side plate hingedly connected with each upper edge of the bottom section, a narrow curved top section hingedly connected with the upper edge of the side sections, said bottom, side and top sections forming a cylinder when in normal position, a rectangular frame having its bottom member horizontal and secured at its ends to the bottom plate, the upper corners of said frame being spaced from the side plates, a screw operatively connected with the top member of said frame, and means for connecting said screw with each of the narrow top plates so that the latter will be rotated about their axis when the screw is rotated.

3. A collapsible core for concrete construction comprising a cylindrical section whose outer surface is formed from a plurality of curved plates, each of which has the same radius of curvature, one of said plates being located below the axis of the section so as to be bisected by a vertical plane passing through the axis, a curved side plate hingedly connected with each upper edge of the bottom section, a narrow curved top section hingedly connected with the upper edge of the side sections, said bottom, side and top sections forming a cylinder when in normal position, a rectangular frame having its bottom member horizontal and secured at its ends to the bottom plate, the upper corners of said frame being spaced from the side plates, a screw operatively connected with the top member of said frame, means for connecting said screw with each of the narrow top plates so that the latter will be rotated about their axes when the screw is rotated, and means for bracing the plates to the frame.

In testimony whereof I affix my signature.

SCOTT E. MURRAY.