G. W. JACKSON.

ART OF CONSTRUCTING LINING WALLS FOR SHAFTS EXCAVATED
IN THE EARTH.

APPLICATION FILED JUNE 12, 1906.

Inventor:
George W. Jackson.

Witnesses:
William Hyde
McKee.

Attorneys

G. W. JACKSON.
ART OF CONSTRUCTING LINING WALLS FOR SHAFTS EXCAVATED IN THE EARTH.
APPLICATION FILED JUNE 12, 1906.
To all whom it may concern:

Be it known that I, GEORGE W. JACKSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Art of Constructing Lining-Walls for Shafts Excavated in the Earth; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in the art of constructing lining-walls for shafts excavated in the earth—such, for instance, as shafts designed to afford access to and egress from underground tunnels and subways.

The invention refers both to the structure of such walls and to the method of constructing the same.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

Among the primary objects of my invention is to simplify and improve the construction of such walls and to cheapen the cost thereof.

A shaft-wall embodying my improvements is composed of a layer or thickness of concrete or other substance which is given form when in a plastic state and subsequently dries or sets and constitutes the body of the wall and a plurality of vertically-separated transversely trussed or braced reinforcing-rings which are embedded in said concrete body.

In constructing a shaft-wall in accordance with my novel method or process I proceed generally as follows: The excavation in the earth is dug in successively-lower sections, and said excavation is lined with successively-lower sections of lagging supported by vertically-separated rings, each section being lined before the next lower section is commenced.

After the excavation has been completed and lined to the bottom an inner lining or shell, located a distance inside the outer lining, is built upwardly from the bottom in successively-higher sections, and as each section of the inner shell is completed the annular space between said linings is filled with concrete or the like, which hardens to support the lagging constituting the outer lining of the excavation. The lagging-supporting rings of the outer lining are retained in the spaces between said lining and the inner shell and constitute the reinforcing-rings of the completed shaft-wall. The said inner shell is built upwardly from the bottom of the excavation in successively-higher sections in the same general manner as is the outer lining constructed downwardly in successively-lower sections—that is to say, each section of said inner shell is constructed of lagging of suitable length supported on said lagging-rings, the said lagging being supported on the outer sides of the rings.

As shown in said drawings, Figure 1 is a 75 vertical section taken through a shaft having a wall made in accordance with my invention and illustrating the communication of the lower end of the shaft with a tunnel. Fig. 2 is a transverse section taken through the shaft and its wall. Fig. 3 is a similar transverse section taken through the shaft during the process of forming the wall. Fig. 4 is a partial vertical section of the shaft, illustrating the process of constructing the wall. Fig. 5 is a detail illustrating the manner of hanging the lagging constituting the inner shell to the inner lagging-supporting rings. Fig. 6 is a transverse section taken through one form of the reinforcing-ring. Fig. 7 is a 90 similar section of modified form of ring.

As shown in the drawings and referring more particularly to Figs. 1 and 2, A designates the layer of concrete body of the shaft-wall, and B the reinforcing-rings embedded in said concrete. The cross-section of the shaft herein shown is oval; but its cross-section may vary as desired.

The reinforcing-rings B are preferably made of standard or commercial shapes of rolled bars. The inner and outer members of said rings may comprise channel-bars 6, as shown in Fig. 6, or angle-bars 7, as shown in Fig. 7. The said rings consist of the inner and outer members 6 or 7, joined by transverse brace or truss bars 8, attached at their ends to the flanges of the inner and outer members, preferably in oblique or laced arrangement. This form of ring is advantageous, inasmuch as it may be constructed of ordinary concrete.
commercial bars, and therefore at a low cost, and further, because the trussed construction thereof affords great strength against lateral stress, while capable of being made comparatively light.

Another advantage of the skeleton form of ring is that it is more closely united to the concrete body of the wall when embedded therein than if made solid.

In order to facilitate the placing of the rings in the excavation, they are divided, being made of two parts joined at their meeting ends by bolts \( b' \), extending through lugs \( b' \), attached to or formed on the adjacent ends of the parts of the two-part rings. Preferably filling-blocks \( b' \), of wood or like material, are interposed between the ends of the parts of the two-part rings, thereby enabling the rings to be expanded or contracted as necessary to properly fit the same in the shaft-excitation.

C C designate the lagging-straips of the outer lining, which are supported by said rings and between the same and the earthen sides of the excavation. The said lagging-straips are supported on the rings by means of bolts \( c \), extending through the lagging and projecting inwardly over the rings, as shown in Fig. 4. The inner shell, between which and said outer lining or the sides of the excavation is formed the space to receive the plastic material constituting the body of the wall, comprises inner rings \( D \), smaller in diameter than the reinforcing-rings \( B \), and lagging-straips \( E \), supported on the outer sides of said rings \( D \). Said latter rings are shown as made of a number of parts joined by bolts \( d' \), extending through overlapping lugs \( d' \) on the ends of the ring parts. Between certain of the parts of the inner rings are interposed filler-blocks \( d' \), which perform the same function as the filler-blocks \( b' \) of the reinforcing-rings.

The manner of placing the outer lining of the excavation, comprising the lagging \( E \) and the rings \( B \), during the excavation of the shaft is as follows: The said lagging-straips \( C \), usually made of wood, are made of a length to correspond with an approximate depth of excavation of the successive vertical sections of the shaft. After the first section of the excavation has been made of the depth determined upon one of the rings \( B \) is suspended at the mouth of the shaft in any suitable manner, as by means of timbers \( F \), laid across the mouth of the shaft, and suspension-bolts \( F' \), extending through said timbers and connected with the first or upper ring. Thereafter a second ring is placed in the excavation at the bottom thereof and is suspended from the first or upper ring by means of other suspension-straips \( F' \), Fig. 4. Thereafter the lagging \( C \), constituting the lining of the first section, is inserted between the upper and lower rings of the earthen wall of the excavation and supported on the lower ring by means of the bolts \( c \). After one section or course of lagging has been thus placed another section of the shaft of like depth is excavated, and when said section is completed another ring is fitted in the excavation at the bottom thereof and supported from the ring next above by the suspension-straips \( F' \) in the manner before described. Thereafter the second course of lagging is inserted between the ring last placed and the ring above the same and supported on the lower ring. The lagging of adjacent courses or sections about end to end outside the rings \( B \), near the vertical centers thereof, as shown in Fig. 4. The successively lower sections or courses of lagging and the rings \( B \), constituting the outer lining, are in a like manner placed in the excavation until the full depth of the excavation is reached. At this time all the earth has been removed from the shaft-excavation, and the sides of the excavation are lined from top to bottom with the successively-lower sections or courses of the lagging. In case the sides of the excavation be irregular and pockets or voids are formed behind the outer lagging \( C \) such voids may be filled by driving wedges or shingles behind the lagging at the time the same are placed. If desired, the rings \( B \) may be supported from stress tending to crush the same inwardly by means of braces placed across the shorter diameters of the rings. The necessity for such braces will depend upon the character of the earth being excavated. A convenient form of the suspension-straips \( F' \) comprises straight rods screw-threaded at their upper and lower ends and extended through the skeleton rings and provided at their upper and lower ends with washers \( f' \), which fit above and below the rings, and nuts \( f' \), engaging the screw-threaded ends of the rods. After the excavation has thus been completed and its sides lined the inner shell, composed of the lagging \( E \) and lagging-supporting rings \( D \), is placed in position, beginning from the bottom of sections \( E \), in commencing to construct the said sectional inner shell the first or lower ring \( D \) is placed upon the bottom of the excavation, and thereafter the next upper ring is located at a suitable level above the same and is supported at such level, preferably by three or more of the lagging-straips \( E \), that constitute the inner shell. This manner of supporting an upper ring from the next lower ring will be made clear by examination of the construction of the lagging and supporting-ring, as shown in Fig. 5. Said lagging is therein shown as made of thin metal plates reinforced at their side margins by angle-bars \( e \), which terminate short of the ends of the plates. The said lagging-plates meet at the vertical centers of the rings \( D \), which latter are shown in Fig. 5 as made of channel-bar cross-section.
to the ends of said plates are short transverse angle-bars e', which are adapted to fit between the parallel flanges of the channel-bar of the rings D. It will be observed, therefore, that an upper ring may be preliminarily supported from a lower ring by three or more of said lagging-plates by properly engaging lower and upper ends of the lagging-plates with the lower and upper rings. Therefore after the lower course of lagging is completely finished by placing said lagging on the outer side of the channel-bar ring. It will be noted that sufficient space is left between the supporting-rings of the inner shell and the outer or reinforcing rings to admit the lagging-plates readily in place. When the lower course of lagging is thus completed, it constitutes one section of the inner shell, which supports the plastic material of the wall while the same sets or hardens. After the first section of the inner lining has been thus placed the plastic material is placed in the space between the inner lining and the said wall of the excavation. The inner shell is thus built up section by section, and as each section or course is finished the space between the same and the side of the excavation is filled with a plastic material, these steps being continued until the inner lining has been completed to the top of the excavation and the successively-higher spaces between the same and the side wall of the excavation completely filled. If desired, the outer laggings C may be removed prior to the time the said space is filled with the plastic material. In some instances, however, as where the earth being excavated is of a nature to readily shift laterally, it may be deemed advisable to retain the outer lagging in place. The inner shell remains in place until the plastic material is hardened or sets and is thereafter removed, leaving a smooth face of the concrete wall exposed inside the shaft.

The resultant wall is composed of the body or layer of concrete and the embedded reinforcing-rings B, together with the suspension-rods F', which latter for the purpose of reinforcement are preferably left in place. This construction produces a wall-shaft of great strength and capable of withstanding the lateral pressure brought thereon by the earthen walls of the excavation. By reason of the skeleton form of the reinforcing-rings the said rings and concrete layer are firmly bound together, so that the strength of the metal rings is utilized to its maximum in resisting lateral pressure tending to crush the wall. Moreover, by reason of the trussed or braced construction of the rings said rings may be made comparatively light, while of ample strength to resist the pressure brought thereon.

The mode of constructing the shaft-wall as above described is economical and enables the excavation to be made and the wall constructed therein with a minimum danger of the walls collapsing, and therefore minimum danger to the operatives.

I claim as my invention—
1. The improved wall described for shafts excavated in the earth, comprising a body or layer of concrete extending continuously around the shaft, and vertically-separated, closely-spaced, reinforcing-rings embedded in said wall-body.

2. The improved wall described for shafts constructed in the earth, comprising a body or layer of concrete extending continuously around the shaft, and vertically-separated, closely-spaced, laterally-trussed reinforcing-rings embedded in said wall-body.

3. The improved wall described for shafts excavated in the earth comprising a body or layer of concrete extending continuously around the shaft, and vertically-separated, closely-spaced, reinforcing-rings embedded in said wall-body, said rings each comprising inner and outer members of angular cross-section and short bars joining said members in trussed relation.

4. The improved wall described for shafts constructed in the earth, comprising a body or layer of concrete extending continuously around the shaft, vertically-separated, closely-spaced, laterally-trussed reinforcing-rings embedded in said wall-body, and vertical suspension-rods extending between and joining said rings.

5. The process of constructing the wall of a shaft excavated in the earth, which consists in lining the sides of the excavation with successively-lower sections or courses of lagging supported on vertically-separated lagging-rings as the work of excavation progresses, constructing an inner shell composed of successively-higher, vertically-divided courses or sections of lagging and supporting rings therefor, filling the space between said inner shell and the side of the excavation with the plastic material and thereafter removing the said inner shell.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 8th day of June, A. D. 1906.

GEORGE W. JACKSON.

Witnesses:
HOWARD VANSCOIK,
ALORNE MCDUOO.