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REINFORCED CONCRETE LINING FOR MINE SHAFTS AND METHOD OF THE MANUFACTURE THEREOF.
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[Diagram of reinforced concrete lining for mine shafts and method of manufacture]
UNITED STATES PATENT OFFICE.

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REINFORCED-CONCRETE LINING FOR MINE-SHAFTS AND METHOD OF THE MANUFACTURE THEREOF.


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To all whom it may concern:

Be it known that I, CARL SCHOLZ, a citizen of the United States, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Reinforced-Concrete Linings for Mine-Shafts and Methods of Manufacture Thereof, of which the following is a full, clear, and exact description.

The invention relates to the construction and lining of mine shafts and seeks to provide an improved method of constructing and lining the shaft and an improved fireproof construction of reinforced concrete lining which is suited to the needs of any emergency that may arise in sinking the shaft, which is of sufficient strength at all points to withstand the pressure thereon, and by which safety, rapidity and economy in sinking and lining the shaft is effected.

The invention consists in the features of novelty hereinafter set forth, illustrated in their preferred embodiment in the accompanying drawings and more particularly pointed out in the appended claims.

A concrete lining for mine shafts has many advantages particularly in coal mines. It is strong and prevents the shaft from caving in, and it is durable and fire-proof, but heretofore such linings have only been constructed with difficulty and at large expense. A concrete lining for mine shafts is now usually constructed by molding successive ring portions at the surface and sinking the lining by excavating beneath it. This method is slow and expensive and difficult to carry out. For example, if solid rock is penetrated, the blasting is apt to shatter the lower portion of the lining. It is also difficult to keep the heavy shaft lining plumb as it is sunk through different strata and for this reason there is a limit to the depth of such a shaft lining. It is also difficult to place the cage guides in position, since these must be put in after the shaft is sunk and, with this method, it is not possible to secure good contact between the lining and the sides of the shaft. A concrete lining has also been formed in a continuous body about the shaft, the same being molded in permanent position as the shaft is sunk. This method necessitates the construction of large off sustaining molds within the mine shafts, and a large amount of lumber is required for the molds and for the false-work for sustaining the molds in position during the construction of the shaft and its lining.

In accordance with the present invention, a skeleton frame is placed within the shaft as it is sunk. This frame comprises a number of vertical structural metal beams (preferably I-beams) each of which is formed of convenient lengths connected together and which are arranged within the shaft with the webs thereof substantially perpendicular to the sides of the shafts. The vertical beams are connected at intervals by horizontal curved space bars which are secured to the outer flanges of the I-beams. The skeleton frame is supported from the sides of the shaft as it is sunk by a head frame or anchor of concrete at the upper end of the shaft and by projecting plates secured to the vertical beams. If necessary, the sides of the shaft are prevented from caving as the shaft is sunk in by wooden lagging held in place between the connecting space bars and the shaft sides. This frame also carries the cage guides which are placed in position with the frame work.

When the shaft is sunk to the desired depth, the concrete lining is molded upon the skeleton frame commencing at the bottom and working toward the top. The process of molding the concrete lining is effected by using a series of wooden panels which are held in position against the inner flanges of the vertical beams and the space between the panels and the sides of the shaft is filled with concrete. In this way, the concrete lining is formed in a series of arches or sections which extend between the vertical beams and which embed the horizontal connecting space bars. By molding the concrete in position progressively from the bottom up, the process of plumbing and lining the shaft is much simplified and rendered most economical.

In the drawings, Figure 1 is a cross-section of the improved construction taken on the line 1—1 of Fig. 2. Fig. 2 is a vertical section on the line 2—2 of Fig. 1 and Fig. 3 is a detail section on the line 3—3 of Fig. 1. Fig. 4 is a plan view of the supporting head frame at the upper end of the shaft. Fig. 5 is a section on the line 5—5 of Fig. 4.
The shaft is preferably four-sided, as shown, but the sides are of curved or arch form. This form combines the advantages of both the rectangular and the circular or elliptical shaft. That is to say, the economy in space and in excavating of the rectangular shaft is maintained while the arch form of the concrete lining is well adapted to resist the pressure thereon as in a circular or elliptical shaft. This shape also provides ample clearance for the cages and leaves spaces in addition for pipes, cables and a ladder-way.

In the preferred construction set forth, eight vertical I-beams \(a\) and \(a\)' are employed. These beams are arranged adjacent to the walls of the shaft with the webs thereof substantially perpendicular thereto. The four other I-beams \(a\) are located at the centers of the shaft sides. These beams are formed in convenient lengths of say fifteen feet each and these lengths are progressively installed with the shaft as the material is excavated therethrough. The separate sections of each I-beam are connected together, as by means of suitable fish-plates \(a\) and the separate beams are connected together at intervals by horizontal space bars \(b\) which are connected to the outer flanges of the I-beams \(a\) and \(a\)' by gusset plates \(b\)'. The beams \(a\) and \(a\)' and the connecting space bars \(b\) are bolted together and the skeleton frame is further supported in position by projecting brackets or angle pieces \(a\) which are bolted or riveted to the outer flanges of the I-beams \(a\) and \(a\)' and rest upon the rock strata surrounding the excavation. If necessary, the walls of the shaft are prevented from caving in as is sunk by a wooden lagging consisting of boards \(b\) placed in vertical position between the horizontal angle bars \(b\) and the sides of the shaft. The boards of this lagging are preferably spaced apart, as shown.

The framework is also supported by a head frame or anchor comprising connected channel bars \(c\) and \(c\)' mounted upon a foundation \(c\) preferably formed of concrete. The concrete foundation is molded in position about the upper end of the shaft and the channel bars placed thereon with their flanges outturned. The bars \(c\) form a rectangle and the bars \(c\)' extend diagonally across the corners of the rectangle. These bars are connected by gusset plates \(c\) and the I-beams \(a\) and \(a\)' are connected at their upper ends to the inner flanges of these bars as shown.

In the preferred form above, two of the sides of the shaft are somewhat longer than the other two sides and the vertical center beams \(a\) of the longer sides are connected by a series of horizontal battens \(a\) preferably in the form of I-beams. These horizontal I-beams are connected at their ends to the beams \(a\) by angle clips \(a\) which are bolted to the lower flanges of the I-beams \(a\) and to the outer flanges of the vertical beams \(a\). The I-beams \(a\) are arranged with their webs in vertical planes. To increase the strength of each alternate bunting, a smaller I-beam \(a\) is secured to its upper flange, the web of the smaller I-beam being arranged in horizontal position. At the upper central portions of the other beams \(a\), short I-beam sections \(a\) are secured and the inner guides for the cages, which are preferably in the form of T-rafts \(a\), are fastened to the flanges of the I-beams \(a\) and \(a\)'s. The outer guide rails \(f\), for the cages are secured to the inner flanges of a series of short I-beam sections \(f\), these I-beam sections being in turn secured to the inner flanges of the center vertical beams \(a\) of the shorter sides of the shaft. The parts of this skeleton frame are cut to proper lengths and the holes for the rivets and bolts formed therein before they are placed in the mine shaft, so that the frame can be quickly placed within the shaft by unskilled labor, and the sides of the shaft \(a\) are prevented from caving in by the wooden lagging which is held in place by the skeleton frame.

Ordinarily, the shaft will be sunk to the desired depth before the concrete is placed in position. This is done commencing at the bottom and working toward the top of the shaft by the use of a set of molding panels which extend between the vertical beams \(a\) and \(a\)' of the skeleton frame and are held against the outer flanges of the I-beams \(a\) and \(a\)' by turnbuckles or adjusting screws. The panels, of course, are curved to conform to the curvature of the lining sections between the vertical beams \(a\) and \(a\)' and when the panels are placed in position, the concrete is poured into place between the panels and the side walls of the shaft, thus forming arches which extend between the I-beams \(a\) and \(a\) and in which the horizontal cross-bars \(b\) are embedded. The wood lagging may be removed or left in position, as desired, and if left in position, will also be embedded in the concrete. If it is further necessary to strengthen the concrete, the horizontal connecting bars \(b\) are provided with holes for receiving reinforcing rods \(b\). The size and spacing of these rods and the size of the angle bars will depend upon the material which is penetrated by the shaft.

The arched concrete lining is molded in horizontal portions one above the other, but it will only be necessary to employ three or four sets of the sectional molds or panels, since by the time the third or fourth portion of the lining is completed, the panels of the first portion formed can be removed and used again. The amount of false work and lumber necessary in constructing the lining is therefore small. Moreover, the section
molds or panels which are held in place can be readily set in position against the inner flanges of the vertical beams $a$ and $a'$ and the use of large self-sustaining molds is avoided. Furthermore, the skeleton frame can be shifted to some extent as the concrete lining is built up in successive portions from the bottom of the shaft and the proper plumbing of the shaft lining can be readily effected. The buntings and guide rails for the cages $g$ are rigidly sustained from the skeleton frame-work and space is left at the side of the cage ways for pipes, cables and for a ladder $h$ which is secured to the cross buntings.

3. While the shaft is ordinarily sunk to the desired depth before the concrete lining is formed, parts of the lining can be placed in position as the shaft is sunk in case the shaft passes through quick sand or water, or in case the sides of the shaft are subject to great pressure. In such cases, the concrete lining can be placed in position in individual rings or portions, as required. Preferably, also, the upper faces of the horizontal I-beams $c$ and $c'$ are filled with concrete so that water will drain therefrom. The short $I$-beam spacers $f$ are also preferably embedded in concrete to insure rigidity.

The improved method and construction affords safety, rapidity and economy in sinking and lining the shaft and perfect contact can be secured between the lining and the sides of the shaft. Furthermore, the use of self-sustaining forms for molding the concrete lining is avoided and the combination of the skeleton steel frame works and the sectional concrete arches between the vertical beams of the frame work provides a lining of great strength and which is absolutely fire-proof. It should be noted that the vertical beams $a$ and $a'$ form the bases for the series of arch sections of the lining and each concrete arch section is self-sustained. This arrangement overcomes the objection of cracking which is apt to take place in a continuous lining extending entirely about the shaft.

It is obvious that changes may be made in the details set forth without departure from the essentials of the invention as defined in the claims.

I claim as my invention:

1. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical I-beams having their webs substantially, perpendicular to the sides of the shaft and curved, horizontal space bars connecting said vertical beams, projecting supporting brackets and transverse buntings connected to said frame and a concrete lining formed about the sides of the shaft in arch-sections that extend between said vertical beams and embed said horizontal space bars, substantially as described.

2. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical I-beams having their webs substantially, perpendicular to the sides of the shaft and curved, horizontal space bars connecting said vertical beams, projecting supporting brackets and transverse buntings connected to said frame and a concrete lining formed about the sides of the shaft in arch-sections that extend between said vertical beams and embed said horizontal space bars, substantially as described.

3. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical, structural metal beams having their webs substantially perpendicular to the sides of the shaft and outwardly curved, horizontal space bars connecting to the outer flanges of said vertical beams and adapted to hold lagging in place against the sides of the shaft, and a concrete lining formed about the sides of the shaft in arch-sections that extend between said vertical beams and embed said horizontal space bars, substantially as described.

4. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical I-beams having their webs substantially perpendicular to the sides of the shaft, and outwardly curved, horizontal space bars connecting said vertical beams, projecting supporting brackets and cross buntings secured to said vertical beams, cage guide rails secured to said buntings and to certain of said beams, vertical reinforcing rods extending through said horizontal space bars, and a concrete lining formed about the sides of the shaft in arch-sections that extend between said vertical beams and embed said connecting space bars and said reinforcing rods, substantially as described.

5. A reinforced concrete lining for mine shafts comprising a head frame a skeleton frame supported therefrom and of vertical, structural metal beams having their webs substantially perpendicular to the sides of the shaft, and horizontal space bars connecting said vertical beams, projecting supporting brackets and cross buntings secured to said beams and a concrete lining formed about the sides of the shaft in sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

6. A reinforcing concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical I-beams having their webs substantially perpendicular to the sides of the shaft and horizontal space bars connected to the outer flanges of said vertical beams and adapted to hold lagging in place against the sides of the shaft, projecting supporting brackets and cross buntings secured to said beams, cage guide rails secured to said beams, substantially as described.
to said buntions and certain of said beams, and a concrete lining formed about the sides of the shaft in sections that extend between said vertical beams and embed said horizontal space bars, substantially as described.

7. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical, structural metal beams having their webs arranged in planes extending inwardly toward the central portion of the shaft and space bars connecting said vertical beams and adapted to hold lagging in place against the sides of the shaft, and a concrete lining formed against the sides of the shaft in arch-like sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

8. A reinforced concrete lining for mine shafts comprising vertical I-beams arranged at the corners and at the centers of the sides of the mine shaft and outwardly curved, horizontal space bars connected to the outer flanges of said I-beams, outwardly projecting supporting brackets secured to said frame, cross buntions secured to the central I-beams at two opposite sides of the shaft, and to the central I-beams at the other sides of the shaft, and a concrete lining formed about the sides of the shaft in arch-sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

9. The method of forming reinforced concrete linings for mine shafts which consists in erecting within the shaft as it is excavated a skeleton frame formed of vertical beams and curved horizontal space bars, interposing lagging between said frame and the sides of the shaft and building up a concrete lining against the sides of the shaft and in arch-sections between said vertical beams and about said space bars, substantially as described.

10. A reinforced concrete column for mine shafts comprising a head frame, a skeleton frame supported therefrom and formed of vertical, structural metal beams having their webs arranged in planes extending inwardly toward the central portion of the shaft and space bars connecting said vertical beams, and a concrete lining formed against the sides of the shaft in sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

11. A reinforced concrete lining for mine shafts comprising a skeleton frame, formed of a series of vertical, structural metal beams having their webs arranged in planes extending inwardly toward the central portion of the shaft and space bars connecting said vertical beams, and adapted to hold lagging in place against the sides of the shaft, and a concrete lining formed against the sides of the shaft in arch-like sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

12. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical, structural metal beams having their webs arranged in planes extending inwardly toward the central portion of the shaft and space bars connecting said vertical beams, outwardly projecting supporting brackets secured to said frame, and a concrete lining formed against the sides of the shaft in arch-like sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

13. A reinforced concrete lining for mine shafts comprising a skeleton frame formed of a series of vertical, structural metal beams having their webs arranged in planes extending inwardly toward the central portion of the shaft and space bars connecting said vertical beams, transverse buntions connected to certain of said vertical beams, and a concrete lining formed against the sides of the shaft in sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

14. The method of forming reinforced concrete linings for mine shafts which consists in erecting and supporting within the shaft as it is excavated a skeleton frame formed of vertical beams and connecting space bars, interposing lagging as required between said frame and the sides of the shaft, and building up a concrete lining against the sides of the shaft in sections that extend between said vertical beams and embed said connecting space bars, substantially as described.

Witnesses:

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