April 15, 1941. G. PERRINE 2,238,566

TUNNEL LINING

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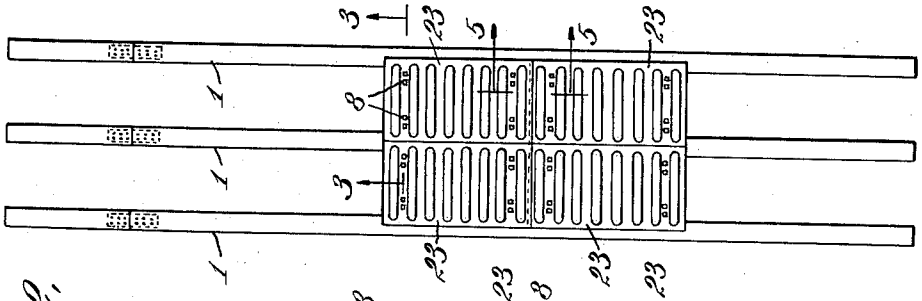


Fig. 2.

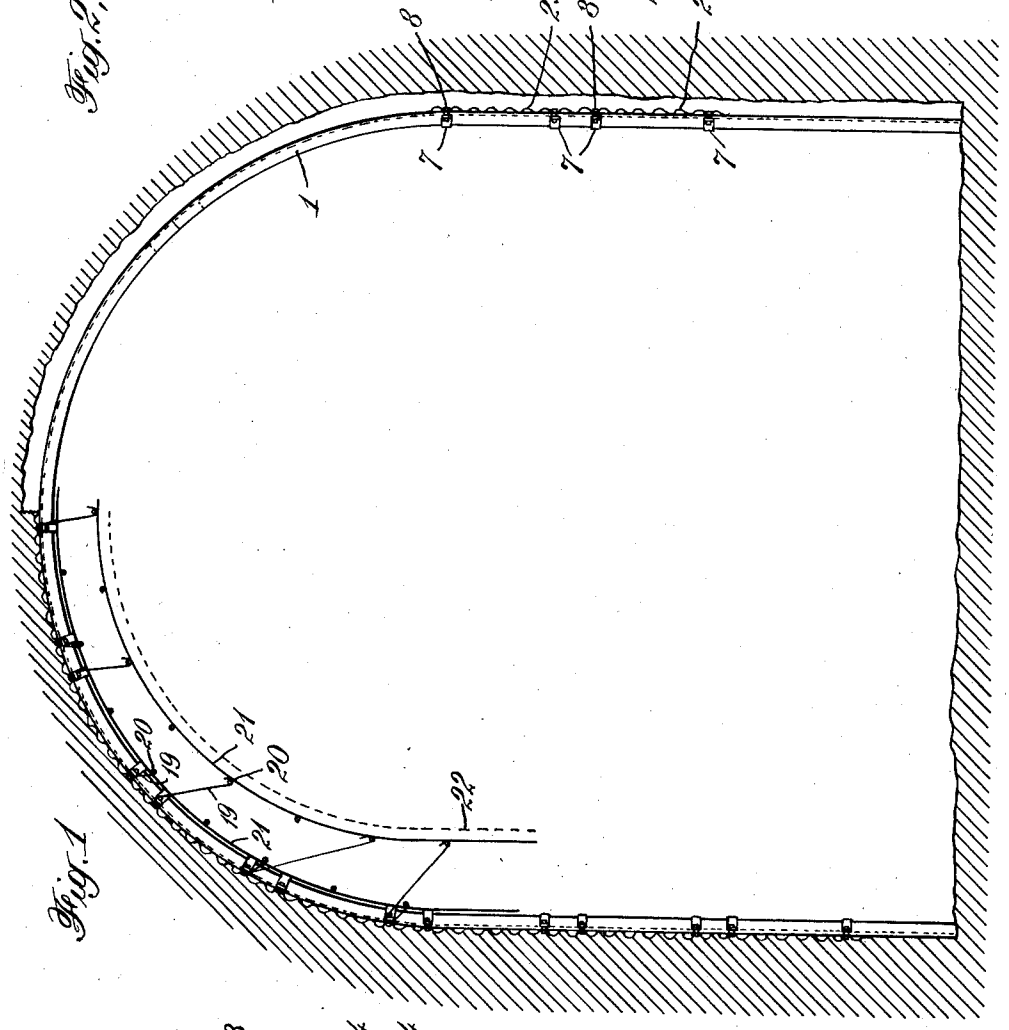


Fig. 1.

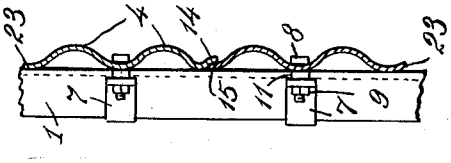


Fig. 5.

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Fig. 3

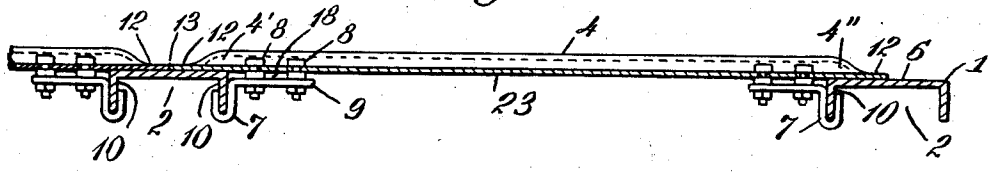


Fig. 4

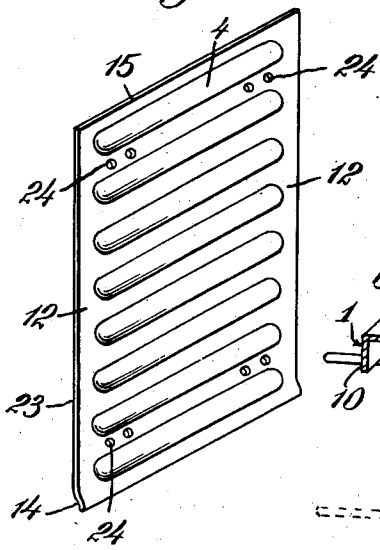


Fig. 10

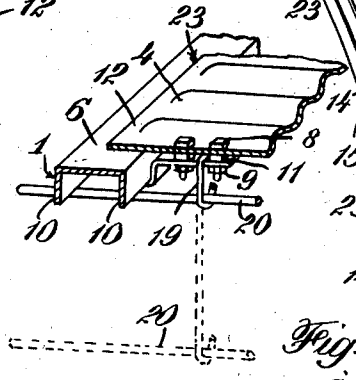


Fig. 6

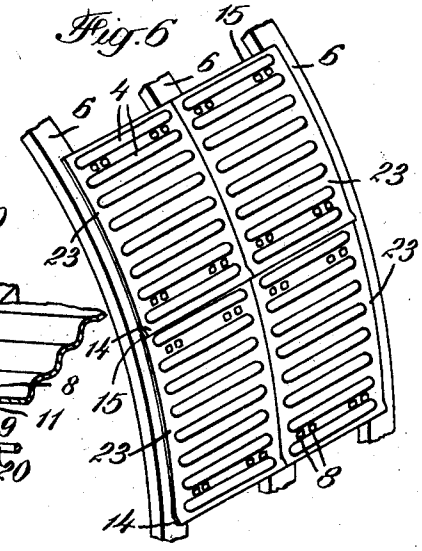


Fig. 7

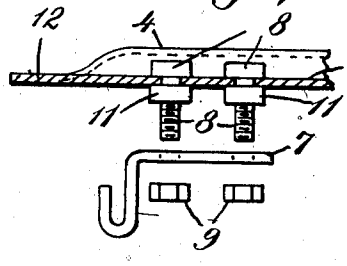


Fig. 9

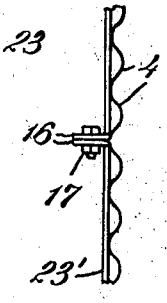
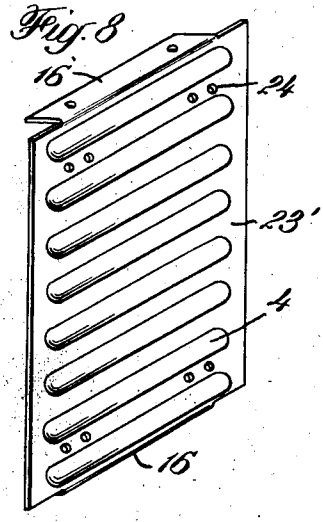


Fig. 8



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TUNNEL LINING

George Perrine, New York, N. Y.

Application March 15, 1939, Serial No. 261,895

3 Claims. (Cl. 61—45)

This invention relates to tunnel linings and particularly to that type in which metal liner plates are supported by a series of parallel metal flanged ribs each of which extends circumferentially of the tunnel.

Heretofore it has been customary to bolt the liner plates to the ribs but this makes it necessary to provide bolt holes in the ribs as well as in the plates. It is difficult to pass a bolt through both the hole in a rib and the hole in a plate unless they fit exactly. This makes extreme care necessary in manufacturing and also in erection in the tunnel. If any error in manufacturing or erection occurs, drilling or reaming on the job is necessary to correct it. Even if the plates and ribs are properly drilled to match holes when in place they may not be properly curved with respect to one another and for that reason the holes will have sprung apart and it is impossible to pass a bolt through them. Some means is necessary for bending the plate into place before the bolts can be inserted. All this is expensive and in many instances delays the whole tunnel work.

In accordance with my invention no holes are drilled in the ribs but the liner plates are secured thereto by means of clips which are bolted to the plates and merely hook over the flanges of the ribs. Preferably the ribs are channel-shaped in cross section with the channel facing the interior of the tunnel, thus minimizing excess excavation and concrete.

With this construction it is unnecessary to match holes in plates and ribs and the manufacturing requirements are not so exacting or expensive, sprung plates can be pulled into place by the clip itself which will adjust itself during the operation and a slight error in size or positioning one plate will not make increased work with every other plate because there is no predetermined spot for a plate to rest. All these features save time and expense. Additionally, this construction makes possible other advantages, such as providing hangers for reinforcing rods, as will be more particularly pointed out hereinafter.

In previous constructions which used liner plates the plates were most frequently corrugated for added strength but the corrugations either ran circumferentially of the tunnel and parallel with the supporting ribs, or, if they extended transversely of the ribs, they did not overlap the ribs. In either form the corrugations did not have the full strengthening effect of my construction. Instead of using the corrugations merely to stiffen the plates I propose to make transverse beams of them. To do this it is necessary to extend them so that they overlap the ribs. The ends of the corrugations will then rest on the flat surface of the ribs and each corrugation will act as a small beam. This makes it possible to use lighter and less expensive plates. Although the corrugations extend far enough to rest on the flat surface of the ribs it will in most cases be desirable to have straight flat edges of plates abut one another throughout their length and therefore I propose to terminate the corrugations short of the edges and leave the remaining portion of the sides of the plate flat. The ends of the plate may be flat so as to abut one another, or bent so as to overlay one another, or flanged, as will be described hereinafter.

Additional features and advantages of the invention will be referred to hereinafter.

Several embodiments of the invention are illustrated in the accompanying drawings, in which:

Figure 1 is a transverse section through a tunnel illustrating structure of the improved lining;

Fig. 2 is a side elevation of a portion of the lining shown in Figure 1;

Fig. 3 is a partial longitudinal section taken on the line 3—3 of Fig. 2;

Fig. 4 is a perspective view of one type of liner plate which may be employed;

Fig. 5 is a partial transverse section taken on the line 5—5 of Fig. 2 illustrating the manner in which the plates may be formed to cause one edge portion of each plate to overlap the edge portion of an adjoining plate of the same course;

Fig. 6 is a perspective view of a portion of the lining illustrating the manner in which the liner plates fit over the ribs;

Fig. 7 is a detail view, partly in section, illustrating the clip assembly;

Fig. 8 is a perspective view of another type of liner plate;

Fig. 9 is an end view illustrating the manner in which the end flanges of the type of liner plate shown in Figure 8 may be bolted together; and

Fig. 10 is a broken perspective view of a portion of one of the liner plates illustrating the manner in which the clips may be made use of to support rods of the reinforcing structure for the concrete masonry.

Referring first to Figs. 1 and 2, the improved lining comprises a series of parallel ribs 1 each of which is supported upon subgrade in any suitable manner and extends circumferentially of the tunnel. The ribs are arched or otherwise shaped to conform with the desired cross section of the tunnel. Each rib is preferably channel-

shaped in cross section as best shown in Fig. 3, the channels 2 of the ribs facing the interior of the tunnel.

One type of liner plate that may be employed is shown in Fig. 4, and designated in general by the reference numeral 23. It is provided with corrugations 4 which extend nearly to the edge of the plate and are so formed on the plate that when the plates are applied to the supporting ribs the corrugations will extend lengthwise of the tunnel and at right angles to the supporting ribs, as best shown in Fig. 6. The plate is provided near each corner with a pair of perforations, as shown at 24 to receive the bolts of a clip hereinafter referred to. The perforations 24 preferably lie in the valleys between the corrugations.

The plates 23 are preferably positioned on the supporting ribs as shown in Fig. 6, so that the joints between the plates of one course will be in line with the joints between the plates of the next course. Each plate spans a pair of the ribs and is supported on the outer faces 6 of them. Near each corner of each plate there is a clip 7 which is secured to the plate by means of bolts 8, passing through the bolt holes 24, and by nuts 9. Each clip embraces the edge portion of the adjacent lateral flange 10 of one of the ribs (Fig. 3 and Fig. 10).

The bolts 8 are preferably inserted in the perforations 24 of the plates and secured to the plates by lock-nuts 11 (Fig. 7) before the plates are taken into the tunnel. This saves time for the workmen in the tunnel because after the plate is positioned on the ribs it can be secured by merely slipping the clip 7 over the bolts 8 and applying the nuts 9, at the same time seeing to it that the clips 7 properly embrace the flanges of the ribs. When the nuts 9 are tightened the liner plates will be rigidly clamped to the supporting ribs.

It will be observed that it is unnecessary to take the time to find any corresponding hole on the rib, or to drill the plate to fit the hole on the rib if there is error, or to take time to insert the bolt through two holes which are slightly out of register. Also it will be observed that if the plate does not conform exactly to the curvature of the arch, it can be pulled into place by the clip and the clip can be adjusted laterally to its proper position by simultaneously tightening the nuts and tapping the clip laterally with a hammer.

To position the plates at the outer or ground side of the supporting ribs, they may be inserted edgewise from the interior of the tunnel through the space between a pair of ribs and then leveled and brought back against the supporting faces 6, provided there is space enough outside of the supporting ribs to do this. If not, the plates of the course under construction may be secured to the last rib of the completed portion of the lining and the free outer edges of the plates may be supported in any suitable way, as by cantilever bars attached to plate clips previously placed and bolted, while the next supporting rib (which will ultimately support these free edges of the plates) is moved laterally into position. However, the exact procedure followed in erecting the lining is immaterial as far as the invention is concerned.

It will be noted, particularly from Fig. 3, that the corrugations 4 are long enough so that the opposite ends 4' and 4'' of each corrugation partly overlie the supporting faces 6 of the pair of ribs, which support the plate. Thus, each corrugation acts as a small beam which completely spans a pair of ribs and is supported at its opposite ends upon them. However, the corrugations are not long enough to extend entirely across the width of the plate. This provides flat portions 12 at the extreme opposite edges of each plate which seat on the underlying supporting faces 6 of the pair of ribs whereby a close joint exists where the edges of the plate rest on the ribs and also at the meeting edges of adjoining plates as shown at 13 (Fig. 3 and Fig. 6).

When the type of plate shown in Fig. 4 is employed one end of it is preferably bent outwardly as shown at 14 so that it will overlap the adjacent end 15 of an adjoining plate of the same course, as best shown in Fig. 5 and Fig. 6. This prevents dirt or other matter from falling through the joints between the plates making up one of the courses and serves to direct moisture down the entire course thus preventing its seeping through between the plates.

If desired the plates may have the form shown in Fig. 8 in which end flanges 16 are bent downwardly at right angles to the body of the plate. These flanges are accommodated in the space between the two ribs which support the plate and the adjacent flanges of two adjoining plates of the same course may be bolted together as indicated at 17 in Fig. 9.

It will be understood that for the arched portion of the lining the plates are suitably curved whereas for the sidewalls of the lining the plates need not be curved. If desired, all of the plates may be kept in stock in flat form and when an order is received for plates to conform to an arch of a particular radius the plates may then be formed to the proper radius.

It will be noted that the lock-nuts 11 on the bolts 8 cause a space 18 (Fig. 3) to be formed between each clip 7 and the under face of the liner plate. As shown in Fig. 10 these spaces so formed under the plates afford a convenient location for hanger rods 19 for supporting the reinforcing rods 20 for the concrete. The clips serve to support the hangers 19 so that the rods 20 may be hung by them, and these in turn may support other rods of the reinforcing structure as indicated at 21 at the left of Fig. 1. The system of rods, exemplified by those shown at 19, 20 and 21, may be used to reinforce the concrete lining of the tunnel indicated by the dotted line 22.

The liner plates may be made of sheet metal stamped or rolled to give them the proper shape and to form the corrugations. The size and curvature of the corrugations should be such as to give the plates the necessary strength. Preferably the corrugations project above the plane of the plate and not below the plane thereof so that the edge portions of each plate may seat flatly against the supporting faces of a pair of ribs notwithstanding the fact that the corrugations are long enough to project over the supporting faces on the ribs, as previously described and as shown in Fig. 3. The plates have not only the strength which would be expected to result from ordinary corrugations but they have additional strength and great resistance to pressure exerted upon them by reason of the fact that each corrugation of the plate acts as a small beam supported at its ends on the ribs as hereinbefore described. The plates may be conveniently handled while placing them in the tunnel and may be readily stacked in piles for storage and for transportation, particu-

larly when the plate is formed as shown in Fig. 4.

I claim:

1. A tunnel lining comprising flanged circumferentially extending ribs disposed with the flanges projecting toward the interior of the tunnel, liner plates each of which spans a pair of adjacent ribs and is supported on the outer faces thereof, and clamping clips secured to each plate and embracing the edge portion of a flange on one of the ribs whereby the plates are clamped in position on the ribs.

2. A tunnel lining comprising channel-shaped ribs disposed with their channels facing the interior of the tunnel, liner plates each of which spans a pair of adjacent ribs and is supported on the outer faces thereof, and clips bolted to each plate and embracing the edge portion of one of the lateral flanges of one of the ribs.

3. A tunnel lining comprising circumferential ribs, liner plates each of which spans a pair of adjacent ribs and is supported on the outer faces thereof, a plurality of clamping clips movably associated with the under side of each plate, each of said clips having a portion adapted to engage and clamp against a portion of one of said ribs when the clip is retracted towards the plate, and means for so retracting each clip to clamp the plate to its supporting ribs.

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