Oct. 9, 1928. 1,686,910

H. F. FREASE

LEVER ARCH

Filed March 15, 1926

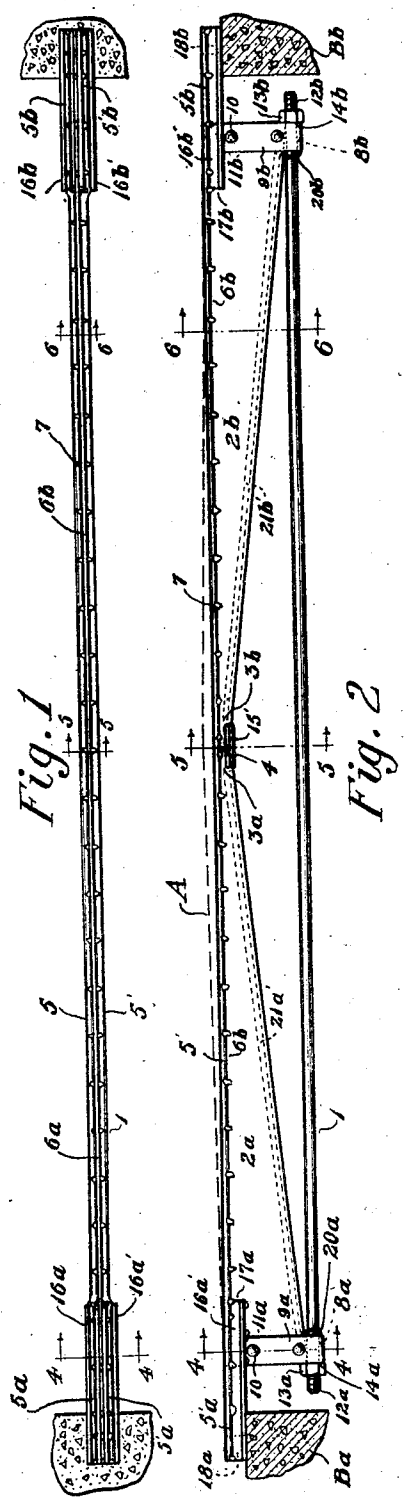


Fig. 1

Fig. 2

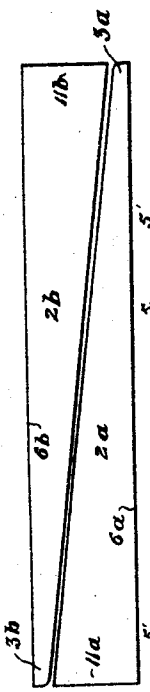


Fig. 3

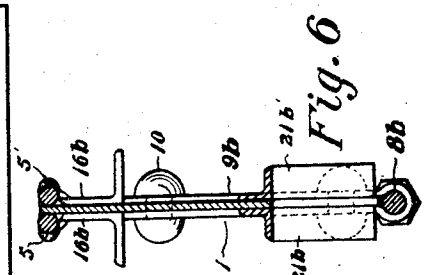


Fig. 6

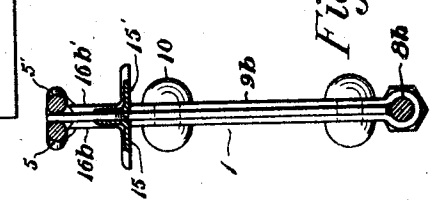


Fig. 5

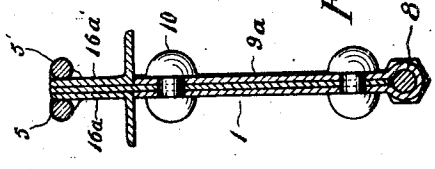


Fig. 4

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UNITED STATES PATENT OFFICE.

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LEVER ARCH.

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The invention relates to structures and structural members for supporting transverse loads; and the objects of the invention are to provide structures of the above character, more efficient than beams, trusses and the like, of usual construction, and more economically and easily manufactured.

These objects are attained in the present invention by combining in a single structure parts co-acting with each other to provide arch and lever action for the structure, and by so arranging the parts that the reactions at the bearings for the cantilever arch are normally vertical under normal conditions of transverse loading.

A preferred embodiment of the invention is illustrated in the accompanying drawing, forming part hereof, in which—

Figure 1 is a top plan view of an improved lever arch structure, embodying the present invention, supported at its ends for use for example as a floor joist in combination with other similar joists, metal lath and concrete, not shown, according to well known methods of joist floor construction;

Fig. 2, a side elevation thereof;

Fig. 3, an elevation illustrating the method of cutting triangular arch struts for the preferred structure from a rectangular plate;

Fig. 4, a transverse cross section of an improved lever arch, as on lines 4—4, Figs. 1 and 2;

Fig. 5, a transverse cross section, as on lines 5—5, Figs. 1 and 2; and

Fig. 6, a transverse cross section of the same on line 6—6, Figs. 1 and 2.

Similar numerals refer to similar parts throughout the drawing.

The improved lever arch, indicated generally at 1, includes triangular arch struts 2^a and 2^b, which may be cut from a rectangular plate, as illustrated in Fig. 3. The struts 2^a and 2^b are arranged with their apexes 3^a and 3^b preferably abutting each other, as at 4.

A pair of top arch bars 5 and 5′ are secured along the upper edges 6^a and 6^b of the struts 2^a and 2^b, as by arc welds 7; and the bars 5 and 5′, respectively, are preferably provided with terminals 5^a and 5^b and $5'^a$ and $5'^b$ extending beyond the ends of the struts 2^a and 2^b.

For providing tie-rod sleeves 8^a and 8^b, at the lower outer corners of the struts, U-straps 9^a and 9^b are secured, respectively as by rivets 10, to the bases 11^a and 11^b of the triangular struts 2^a and 2^b. A tie-rod 12 provided with threaded ends 12^a and 12^b extends through the sleeves 8^a and 8^b respectively, and nuts 13^a and 13^b are screwed upon the threaded ends 12^a and 12^b of the tie-rod and abut the U-straps as at 14^a and 14^b.

For resisting lateral displacement of the lower corners of the strut apexes 3^a and 3^b, a pair of guide angles 15 and 15′ may be secured as by arc welding to the apex 3^b of the strut 2^b, thus forming a U-notch guide for the apex 3^a of the strut 2^a.

For providing lever end supports for the arch structure, spaced angle end supports 16^a and $16^{a'}$ and 16^b and $16^{b'}$ may be secured, as by welding, on both sides, at the upper outer corners 17^a and 17^b of the struts 2^a and 2^b, respectively, and the angle end supports are transversely spaced from the tie-rod, that is to say under the normal use of the lever arch structure, the lever end supports are above the tie-rod, and the end supports may extend longitudinally beyond the ends of the struts any desired distance coextensive with the terminals 5^a and $5'^a$ and 5^b and $5'^b$ of the arch bars 5 and 5′; and the end angles and the arch bar terminals are preferably secured to each other as by arc welds. Spacer plates 18^a and 18^b may be secured between the outer ends of angles 5^a and $5'^a$ and the angles 5^b and $5'^b$, respectively.

In use the nuts 13^a and 13^b may be screwed up upon the tie-rod 12 distances sufficient to provide any desired arch, as indicated by the dotted line A, arch bars 5 and 5′.

Any desired adjustment of the tie-rod nuts may be locked as by hammering over the threads in the ends 12^a and 12^b and/or providing arc weld abutment collars 20^a and 20^b for securing the tie-rod to the U-straps opposite the nuts 13^a and 13^b, respectively.

The angle end supports 16^a and $16^{a'}$, and 16^b and $16^{b'}$ may rest upon bearings as concrete beams B^a and B^b, and the lever arch 1 is then in position to carry transverse loads applied between the bearings B^a and B^b.

It is a well known fact that an ordinary arch arranged between the bearings B^a and

B^b and subject to the usual vertical transverse loads will set up reactiones in the bearings B^a and B^b having horizontal, as well as vertical components; which horizontal components have heretofore been resisted by tie-rods directly connecting to bearings B^a and B^b.

By reason of the fact that the stresses set up in an arch by proper loading, are all of the same character, that is to say compression, an arch is a very desirable type of structure for supporting transverse loads. Arch floor constructions, however have not heretofore been in very general use because of the necessity for providing tie-rods connecting the bearings to take up the horizontal components of the reaction set up in the bearings by the arch.

The lever arch of the present invention, when subject to the usual vertical transverse loads, set up in the bearings B^a and B^b, reactions which are substantially vertical; since in the arch made up of the triangular struts 2^a and 2^b and the arch bars 5 and 5′, any horizontal thrusts set up therein by transverse loading, are resisted and absorbed by the tie-rod 12.

The lever portions of the improved structure 1 are the outwardly extending angle supports for each end of the structure in combination with the sleeve forming U-straps secured thereto; by which any desired upward arch may be given to the arch bars and the struts by the heretofore described manipulation of the nuts 13^a and 13^b screwed upon the threaded ends 12^a and 12^b of the tie-rod 12, the line of action of the tie-rod being transversely spaced from the point of contact of the lever end supports 16^a and $16^{a'}$, and 16^b and $16^{b'}$, respectively, with the bearings B^a and B^b.

It is obvious that a sufficient arch may be given to the arch bars and struts so that maximum transverse loading will not deflect the upper lever of the bars 5 and 5′ below the horizontal.

It is moreover obvious that the lower tie-rod 12 may remain substantially horizontal during normal conditions of loading; so that a plaster ceiling secured thereto will not be subject to any cracking deflection caused by transverse loads superimposed upon the upper arch bars. It is well known that ordinary beams and trusses for use in joist floor construction subject plaster ceilings secured to their lower portions to cracking deflection caused by transverse loads applied upon their upper portions.

It may be seen by inspection of Fig. 3, that the arch struts require only half the weight of material which would be required for the solid web plate of an ordinary plate girder of the same external dimensions, and the same quantitv of material in its flanges as is contained in the arch bars and tie rods.

In such a plate girder the web plate is usually depended upon to resist shear loads. Shear loads are normally a maximum at the ends of a girder; so that if the present structure is viewed solely as a modified form of plate girder without taking into account its arch characteristics, weight savings are apparent over ordinary types of plate girder construction.

On the other hand, the use of triangular arch struts provides a desirable form of strut member and enables the attainment of an arch action, at the same time presenting a substantially horizontal upper level for the structure, of particular advantage in light weight floor construction.

As illustrated in dotted lines in Fig. 2, and in full lines in Fig. 6, re-enforcing means such as angle bars 21^a and $21^{a'}$, and 21^b and $21^{b'}$ may be provided when desired for the lower edges of the struts 2^a and 2^b. Such re-enforcement will be found desirable when the strut triangles are made of relatively light gauge material.

It will be noted that structural members made with trianguar arch struts as heretofore desired are able to resist transverse loads even though the upper edges of the arch struts, normally substantially at or above the horizontal, should deflect below the horizontal.

It will also be noted, that while structural members made according to the present invention are substantially as easy to manufacture as ordinary plate girders, the improved cantilever arches herein set forth have a large open triangular space between the lower tie-rod and the upper arch struts, through which laterally extending pipes, wires and the like may be inserted with even more ease than in the case of the use trussed bar joists and the like.

I claim:

1. A structural member including triangular arch struts having apexes and bases opposite the apexes, means providing apex abutments between adjacent apexes, and means spaced from the adjacent apexes connecting the bases opposite the apexes, and an arch bar secured along the outer edges of the arch struts.

2. A structural member including triangular arch struts having apexes and bases opposite the apertures, means providing apex abutments between adjacent apexes, and means spaced from the adjacent apexes connecting the bases opposite the apexes, and lever end supports extending longitudinally beyond the bases, and an arch bar secured along the outer edge of the arch struts.

3. A structural member including triangular arch struts having apexes and bases opposite the apexes, means providing apex abutments between adjacent apexes, and means spaced from the adjacent apexes con-

necting the bases opposite the apexes, and a plurality of arch bars secured along the outer edges of the arch struts.

4. A structural member including triangular arch struts having apexes and bases opposite the apexes, means providing apex abutments between adjacent apexes, and means spaced from the adjacent apexes connecting the bases opposite the apexes, and lever end supports extending longitudinally beyond the bases, and a plurality of arch bars secured along the outer edges of the arch struts.

5. A structural member including triangular arch struts having apexes and bases opposite the apexes, means providing apex abutments between adjacent apexes, sleeves at the bases opposite the adjacent apexes and a tie-rod extending through the sleeve.

6. A structural member including triangular arch struts having apexes and bases opposite the apexes, means providing apex abutments between adjacent apexes, sleeves at the bases opposite the adjacent apexes, and a tie-rod extending through the sleeve, and lever end supports extending longitudinally beyond the bases.

7. A structural member including an arch having outer bases, tension means connecting the outer bases of the arch and adapted to resist the end thrust thereof, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced from the tension connecting means.

8. A structural member including a normally upper arch having outer bases, tension means below the arch connecting the outer bases thereof and adapted to resist the end thrust thereof, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced above the tension connecting means.

9. A structural member including an arch having outer bases, means for resisting the end thrust of the outer bases, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced from the thrust resisting means.

10. A structural member including a normally upper arch having outer bases, means below the arch for resisting the end thrust of the bases, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced above the thrust resisting means.

11. A structural member including an arch having outer bases, means for resisting the end thrust of the outer bases, and lever end supports on the arch longitudinally extending outwardly beyond the bases thereof and transversely spaced from the thrust resisting means.

12. A structural member including a normally upper arch having outer bases, means below the arch for resisting the end thrust of the bases, and lever end supports on the arch longitudinally extending outwardly beyond the bases thereof and transversely spaced above the thrust resisting means.

13. A structural member including an arch having outer bases, tension means connecting the outer bases of the arch and adapted to resist the end thrust thereof, and lever end supports on the arch longitudinally extending outwardly beyond the bases and transversely spaced from the tension connecting means.

14. A structural member including a normally upper arch having outer bases, tension means below the arch connecting the outer bases thereof and adapted to resist the end thrust thereof, and lever end supports on the arch longitudinally extending outwardly beyond the bases and transversely spaced above the tension connecting means.

15. A structural member including an arch having outer bases, tension means connecting the outer bases of the arch and adapted to resist the end thrust thereof, and vertically reacting end supports on the arch outwardly extending longitudinally beyond the bases.

16. A structural member including an arch having outer bases, means for resisting the end thrust of the outer bases, and vertically reacting end supports on the arch outwardly extending longitudinally beyond the bases.

17. A structural member including an arch having outer bases and a normally substantially level load supporting upper surface, tension means connecting the outer bases of the arch and adapted to resist the end thrust thereof, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced from the tension connecting means.

18. A structural member including an arch having outer bases and a normally substantially level load supporting upper surface, means for resisting the end thrust of the outer bases, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced from the thrust resisting means.

19. A structural member including an arch having outer bases, adjustable tension means connecting the outer bases of the arch and adapted to resist the end thrust thereof, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced from the tension connecting means.

20. A structural member including an arch having outer bases, adjustable means for resisting the end thrust of the outer bases, and end supports on the arch extending outwardly longitudinally therefrom and transversely spaced from the thrust resisting means.

21. A structural member including arch struts having apexes and bases opposite the apexes, means providing apex abutment between adjacent apexes, a tie-rod spaced from the adjacent apexes and connecting the bases,

and end supports on the struts extending outwardly longitudinally therefrom and transversely spaced from the tie-rod.

22. A structural member including arch struts having apexes and bases opposite the apexes, means providing apex abutment between adjacent apexes, a tie-rod spaced from the adjacent apexes and connecting the bases, and lever end supports on the struts longitudinally extending outwardly beyond the bases thereof and transversely spaced from the tie-rod.

In testimony that I claim the above, I have hereunto subscribed my name.

HURXTHAL F. FREASE.