May 23, 1961 M. SAPP 2,984,944

BUILDING ARCH CONSTRUCTION

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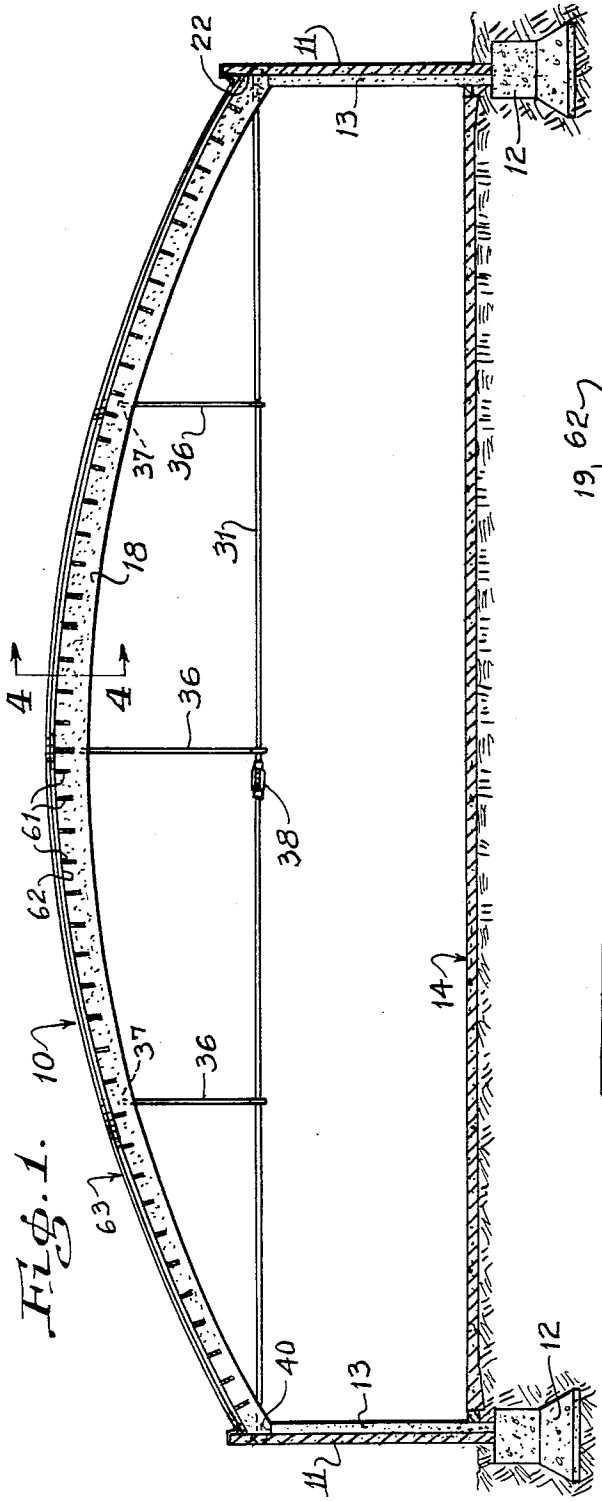

Fig. 1.

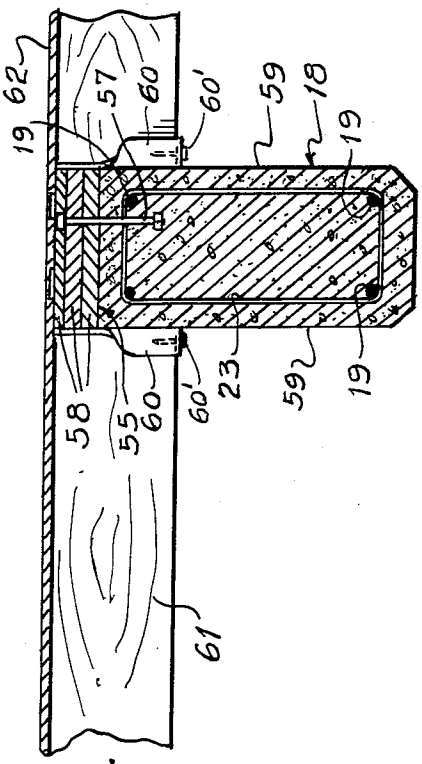

Fig. 4.

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BUILDING ARCH CONSTRUCTION

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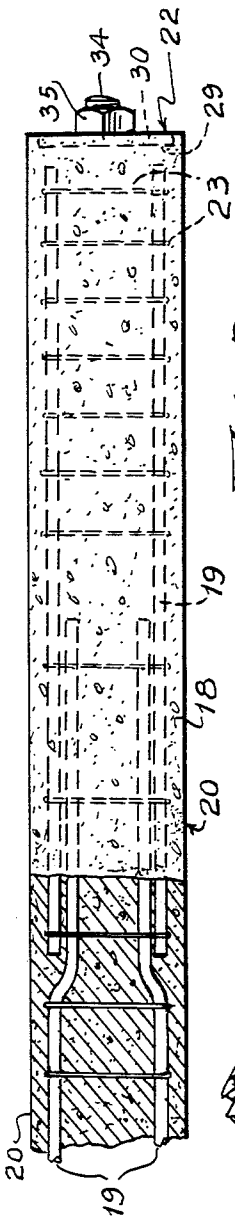

Fig. 2.

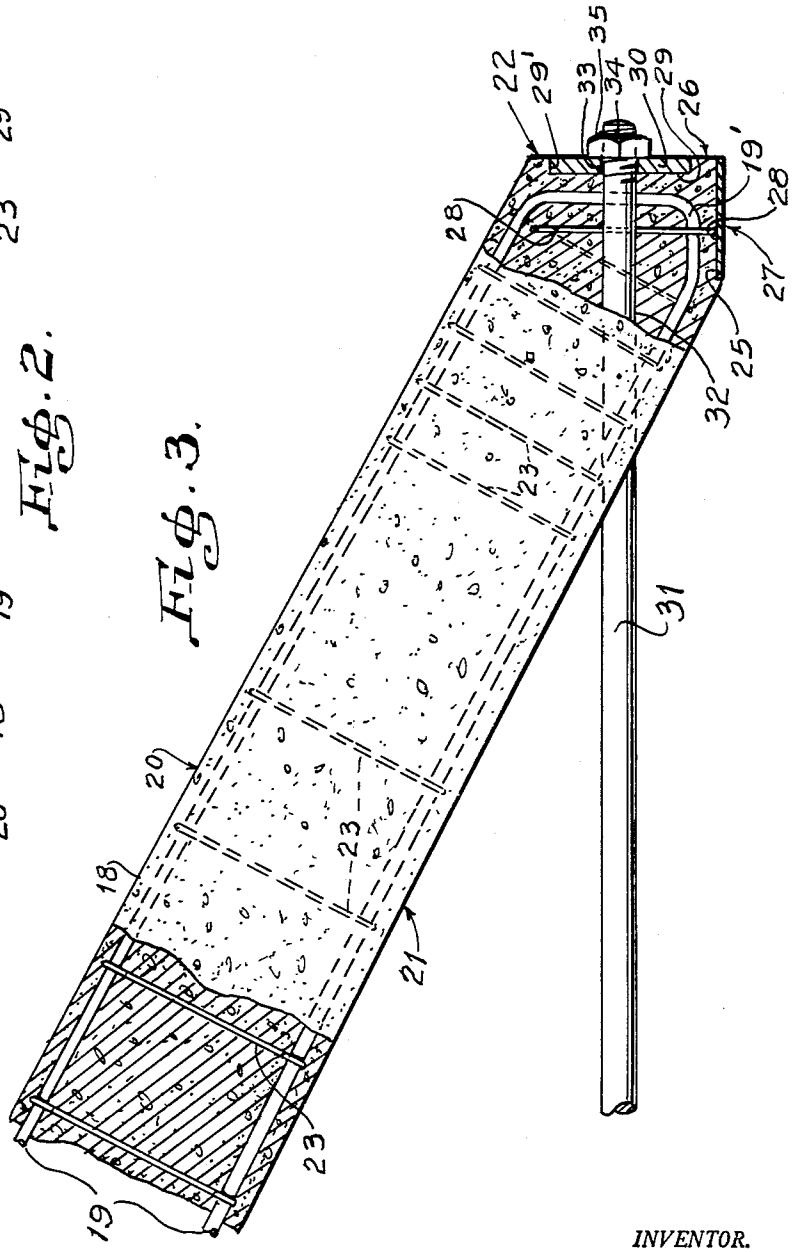

Fig. 3.

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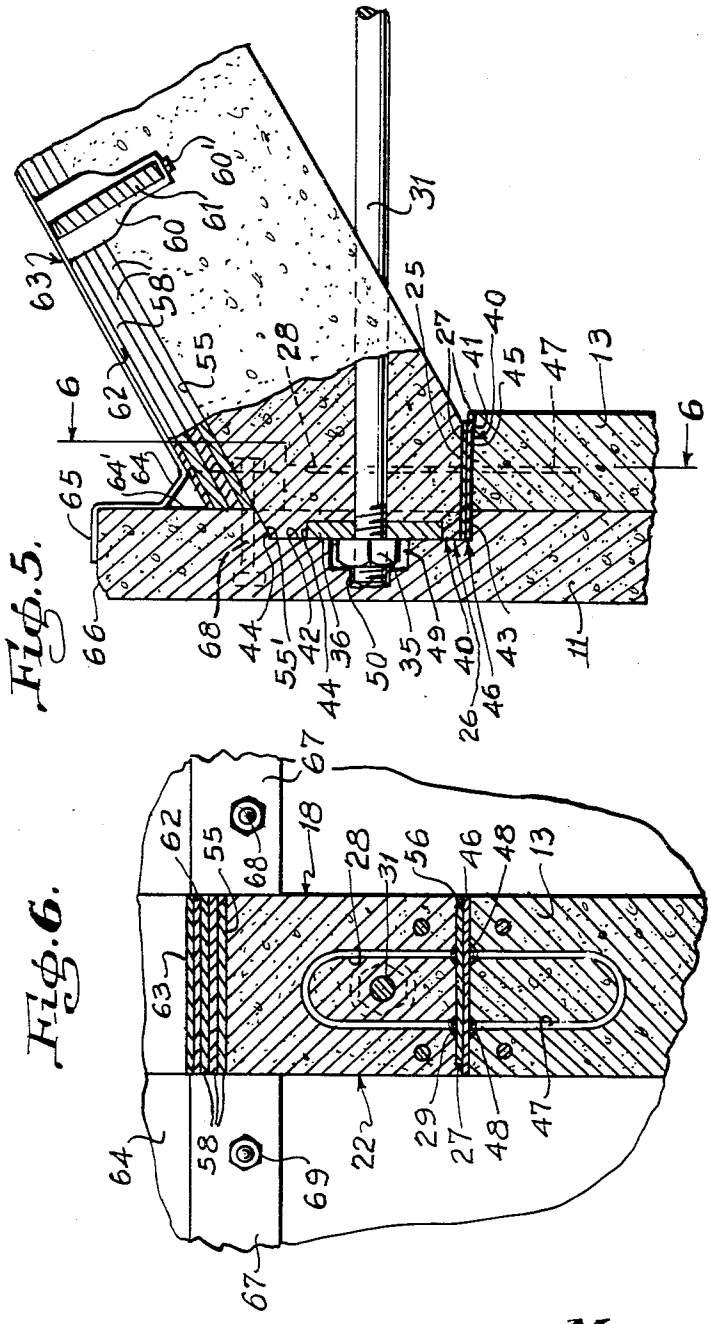

Fig. 5.

Fig. 6.

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BUILDING ARCH CONSTRUCTION

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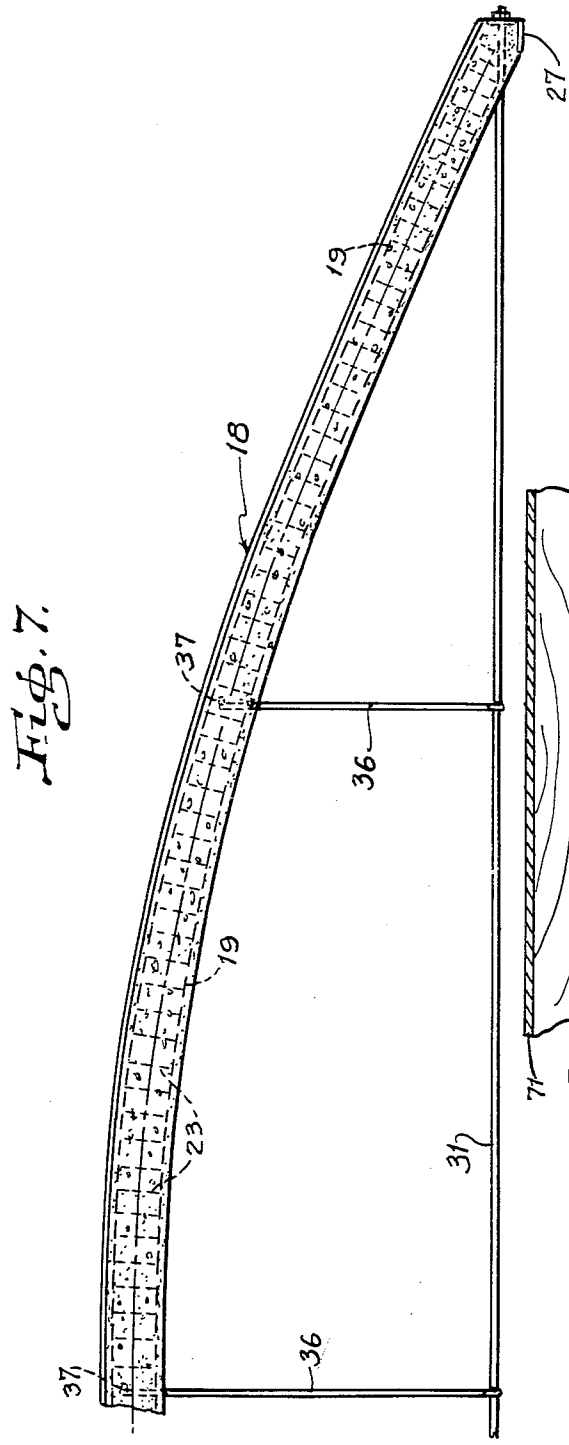

Fig. 7.

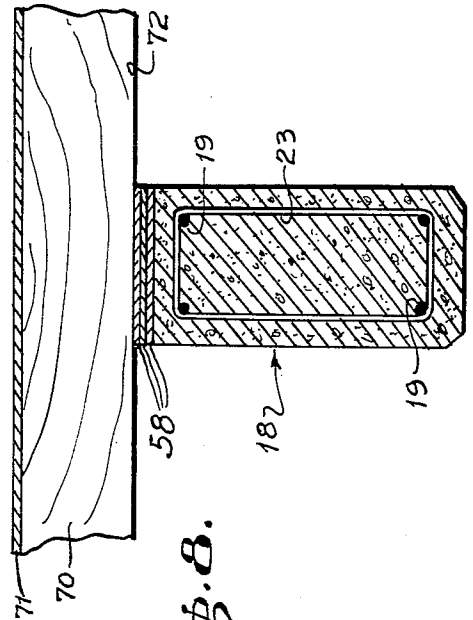

Fig. 8.

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2,984,944

BUILDING ARCH CONSTRUCTION

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3 Claims. (Cl. 50—55)

This invention relates to a building structure or construction, and particularly concerns a novel concrete arch construction for buildings, especially designed so that the arch is balanced, and so that the weight of the arch introduces a minimum of thrust load into the columns or other supports carrying the arch.

One of the difficulties encountered in the design of a concrete arch construction for buildings is that the arch often transmits an undersirable thrust load to the supporting members and walls on which the arch is positioned. This tends to weaken such supports or walls and may also impart an outward slant thereto due to the outward thrust of the arch. Avoidance of such a condition is most desirable. Also, it is desirable that the forces to which the arch is subjected be balanced in such a manner that the ends or the feet of the arch do not tend to creep or move in relation to the seat on the column or wall supporting the respective ends of the arch. In this respect, it is advantageous that the ends of the arch be immovably positioned with respect to the seats therefor. Further, another goal to be attained in the design of an arch construction of the foregoing type is the provision of additional and cooperating reinforcing structure in the walls or columns adjacent the seats supporting the ends of the arch and in the respective ends of the arch adjacent such seats, so as to properly support the weight of the arch and take the bending moments produced in the arch.

These and other objects and advantages are accomplished according to my invention. The invention provides a building arch construction employing a single means or tie rod which is in the axial plane of the reinforced concrete arch, so that the arch can be placed in uniform compression by adjusting the tension on the tie rod, e.g., by means of a turnbuckle. In this manner, the arch may be prestressed to some degree before erection, that is, before it is placed in position on the supporting columns or buttresses of a building. The outward thrust of the arch is thus taken up in the tension of the tie rod and turnbuckle, and does not introduce any substantial thrust load into the columns and footings for the ends of the arch.

My arch construction also includes a novel foot or end structure and a novel mating seat structure on the columns or supports for the arch, the combination of such foot and seat structure permitting the supports for the arch to properly take up the weight and any other forces transmitted to the supports by the arch. The foregoing structure also permits a connection between the arch footings and their mating seats on the supporting columns or walls to prevent any movement or turning of the footings on their seats. More specifically, each footing or end of the arch is shaped in the form of a pair of perpendicular intersecting horizontal and vertical chordal surfaces, an end plate being secured to each of the horizontal surfaces. A mating seat is provided on each of the supports to receive the ends of the arch, the seat also having intersecting horizontal and vertical surfaces, with a plate attached to the horizontal surface of

each such seat. The above plates on the footings of the arch can be welded to the plates attached to the seats supporting the arch to provide a positive connection between the arch and the supports therefor.

A reinforcing member, preferably in the form of a hairpin shaped rod, is positioned in each of the support members adjacent the seats thereof and a similar member is positioned in each of the arch footings adjacent the horizontally positioned end plates thereof. The vertical chordal surfaces at the ends of the arch also have a plate attached thereto, and the tie rod is securely anchored at its opposite ends to such plates.

The invention will be more readily understood from the description below of a preferred embodiment of the invention taken in connection with the accompanying drawings, wherein—

Fig. 1 is an elevational view of a building arch construction according to the invention;

Fig. 2 is a fragmentary plan view of an end of the arch of Fig. 1, shown partly in section;

Fig. 3 is a an elevation of the structure of Fig. 2, shown partly in section;

Fig. 4 is an enlarged section taken on line 4—4 of Fig. 1;

Fig. 5 is a fragmentary section of a column showing one end of the arch positioned in its mating seats on said column;

Fig. 6 is a section taken on line 6—6 of Fig. 5;

Fig. 7 is an enlarged view of one-half of the arch shown in Fig. 1; and

Fig. 8 is a modification of the structure shown in Fig. 4.

Referring to the drawings, the arch structure represented generally by the numeral **10** is supported by the side walls **11** on foundations **12**, and the buttresses **13** spaced at intervals along such walls of a building structure. The buttresses are in turn supported by the members **12** of the building structure.

The arch member or truss **18** of the arch structure **10** is of concrete construction reinforced by rods **19** extending in two spaced parallel planes within the arch and adjacent the top and bottom lateral edges **20** and **21**, respectively, of the arch. The rods **19** have curved portions **19'** positioned adjacent the ends **22** of the arch, the curved portions **19'** generally following the outer contour of such ends **22**. Rods **19** are laced or connected at intervals with crosswires or ties **23**.

The opposite ends or heels **22** of the arch **18** are formed by a pair of intersecting chordal surfaces **25** and **26** (see Fig. 3), one such surface **25** being in a horizontal plane and the other in a vertical plane. A metal plate **27** is secured to the surface **25** by means of a hairpin shaped rod **28**, embedded in the end **22** of the arch. Rod **28** is welded at **29** to plate **27** (see Fig. 6), and is located in a vertical plane normal to plate **27**. The hairpin rod **28** has a dual function in that it not only serves to anchor plate **27** to surface **25**, but also aids in reinforcing the heel or end **22** of the arch. The vertical chordal surface **26** has a recess **29'** therein for receiving a metal plate **30**, the outer surface of which is flush with chordal surface **26**.

A single tie rod **31** connects the opposite ends of the arch **18**, the tie rod being positioned in the axial plane of the arch. Rod **31** extends parallel to the horizontal chordal plates **27** and is rotatably received in an aperture **32** in the ends **22** of the arch and passes through an aperture **33** in about the center of the vertical chordal plates **30**. The outwardly extending ends of the rod **31** are threaded as at **34** to receive a nut **35** to secure the tie rod against longitudinal movement. Rod hangers **36** are suspended from the arch member **18** at spaced intervals

therealong, and are connected at their lower ends to the tie rod **31** for supporting same intermediate its ends. The hangers **36** are attached to the arch by any suitable means; for example, the hangers may be connected to eyes or other fasteners **37** connected to the arch. A turnhandle **38** is connected to tie rod **31** intermediate the ends thereof. The tie rod functions to prevent spreading of the arch, and the turnbuckle **38** and nuts **35** may be adjusted to vary the tension on the tie rod.

The columns or buttresses **13** each have in cooperation with their contiguous wall **11**, a seat **40**, the ends or footings **22** of each arch **18** resting in such seats on a pair of opposed buttresses, said seats being located at approximately the same height above the floor **14**. The seats **40** are each formed by a pair of intersecting horizontal and vertical surfaces **41** and **42**, respectively (see Fig. 5). Surface **42** constitutes the inner surface of a recess formed in wall **11** just above buttress **13**, the recess having a horizontally extending bottom **43** and an inclined upwardly extending top **44**. Surface **41** of the seat **40** consists of the top surface **45** of the buttress **13** and the bottom surface **43** of the recess in wall **11**, surfaces **43** and **45** being contiguous and in alignment with each other to form essentially a single surface **41**. A metal plate **46** is secured over surface **41** by means of a hairpin shaped rod **47** similar to rod **28**, and rod **47** is being welded at **48** to plate **46**, and embedded in the concrete buttress **13**. It is seen that hairpin rod **47** extends downwardly into column **13** along the same vertical plane as hairpin rod **28**, such plane being normal to plate **46**. As in the case of hairpin rod **28**, hairpin rod **47** functions both to anchor plate **46** to surface **41** and to reinforce the upper portion of the buttress **13** adjacent plate **46**. The vertical surface **42** of the seat **40** has a recess **49** disposed centrally therein, the inner surface of which is bored at **50**, recess **49** and bore **50** being provided for a purpose hereinafter pointed out.

Prior to the erection of the arch member **18** on the supports or seats **40** atop a pair of opposed buttresses **13**, nuts **35** and turnbuckle **38** on the tie rod **31** can be adjusted so that the arch is subjected to uniform compressive forces along the length of the arch balanced by the tension in the rod when the arch is in position. By use of a single tie rod positioned across the arch as described above, and by employing the vertical plates **30** imbedded in opposite ends of the arch for balancing of such compressive forces of the arch by the tension induced in the tie rod, the resultant forces at the ends **22** of the arch are thus balanced by the rod tension which is directed essentially inwardly, and substantially no outward thrust is exerted by the arch against the walls or columns **13** when the arch is seated thereon.

In positioning the arch in seats **22**, the vertical surfaces **26** at the ends of the arch are brought into abutting relation with the vertical surfaces **42** on opposing walls **11**. In so doing, the nuts **35** at the ends of the tie rod **31** are received in the opposed recesses **49** and the ends of the tie rod are disposed in the bores **50**. The ends **55'** of the upper surface **55** of arch **18** mate with the inclined upper surfaces **44** formed in opposite walls **11**, and plates **27** secured to the lower horizontal chordal surfaces **25** on the footings **22** of the arch, are welded at **56** to the respective plates **46** of the seats **40**. Thus, the footings **22** of the arch are securely positioned in such seats, and it is seen that these footings and the mating seats are so designed that the former are locked in the seats **40** so that the ends of the arch are unable to move or slide out of position, for example, inwardly, regardless as to the amount of inward compression to which the arch is subjected in response to the tension placed on the tie rod **31**.

Also, it will be observed that the provision of the vertical reinforcing hairpin rods **28** and **47** closely adjacent to each other in the footings **22** of the arch and the upper ends of the buttresses **13**, as shown in Fig. 5, enables the ends of the arch and the upper portions of the buttresses adjacent seats **40** to readily absorb the weight of the arch and any thrust or movement exerted on the ends of the arch and the buttresses by the compressive force to which the arch is subjected. Thus, practically the entire weight of the arch is carried by the colums **13** with essentially no outer thrust exerted against walls **11**. The positioning of the hairpin rods **28** and **47** in the same vertical plane tends to improve these strength characteristics.

Each arch **18** has anchored to the upper surface **55** thereof by means of bolts **57** a number of wooden curved top plates **58** overlying each other, and shown as three in number in Fig. 4. Spaced at intervals along opposite sides **59** of the arch are pairs of aligned joist hangers **60** anchored to the arch by suitable means, such as nails (not shown). Joists or rafters **61** extend transversely between adjacent arch members, the ends of such joists being secured on joist hangers **60** by means of nails **60'**. The joists serve as a support for a cover member **62**, over which a roofing **63** (see Fig. 5) of any suitable type may be laid, such roofing being bent at its end portions **64**, to overlie the inner upper surfaces **64'** of the walls **11**, and terminating in a horizontally bent portion **65** secured by suitable means (not shown) to the upper horizontal surfaces **66** of such walls. End rafters or ledgers **67** are secured to walls **11** between the ends of adjacent arches by means of bolts **68** and nuts **69**. The ends of cover member **62** are secured as by nailing to rafters **67**.

Fig. 8 shows a modification of the structure of Fig. 4. In this embodiment the hangers **60** of Fig. 4 are omitted and the joists **70** over which the covering **71** is placed, extend continuously across the tops of the respective arches, the lower edges **72** of the joists being in contact with the upper one of the wood plates **58** extending along the upper surface of each arch.

While as shown in Fig. 5 of the above described embodiment, seat **40** is formed in part in the wall **11** by providing a recess **42** therein, it is understood that the entire seat may be formed in the columns or buttresses **13** without recessing the walls, e.g. by providing thicker columns. In this case, actually the entire weight of the arch will be carried by the columns alone.

While I have described a particular embodiment of my invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. In a building structure, a concrete arch, columns supporting the ends of said arch, an adjustable tensioning member connected to the ends of said arch, each end of said arch having a horizontal lower surface, a horizontal seat on each of said columns, a first relatively flat metal bearing plate integral with each of said columns and providing a sliding bearing surface for each of said seats, a second relatively flat metal bearing plate integral with said arch at each said horizontal lower surface and providing a sliding bearing surface for each of said horizontal lower surfaces of said arch, said arch being supported by said columns with said second plates disposed in face to face contact with the respective first plates for facilitating relative sliding adjustment between the ends of said arch and said columns during erection of said building structure, and means fixedly securing the first plates to the respective second plates in adjusted relative position against further relative sliding movement.

2. In a building structure as set forth in claim 1, each end of said arch further having a vertical surface intersecting said horizontal lower surface, a third metal plate integral with each said vertical surface, said adjustable tensioning member passing through said third plates, and securing means on said tensioning member frictionally abutting said third plates.

3. In a building structure as set forth in claim 1, said means fixedly securing the first plates to the respective

second plates being a weld between the first and respective second plates.

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