No. 886,666. PATENTED MAY 5, 1908.

W. M. THOMAS.

AUTOMATIC ADJUSTABLE ARCH CONSTRUCTION.

APPLICATION FILED JULY 5, 1907.

3 SHEETS—SHEET 1.

Fig. I.

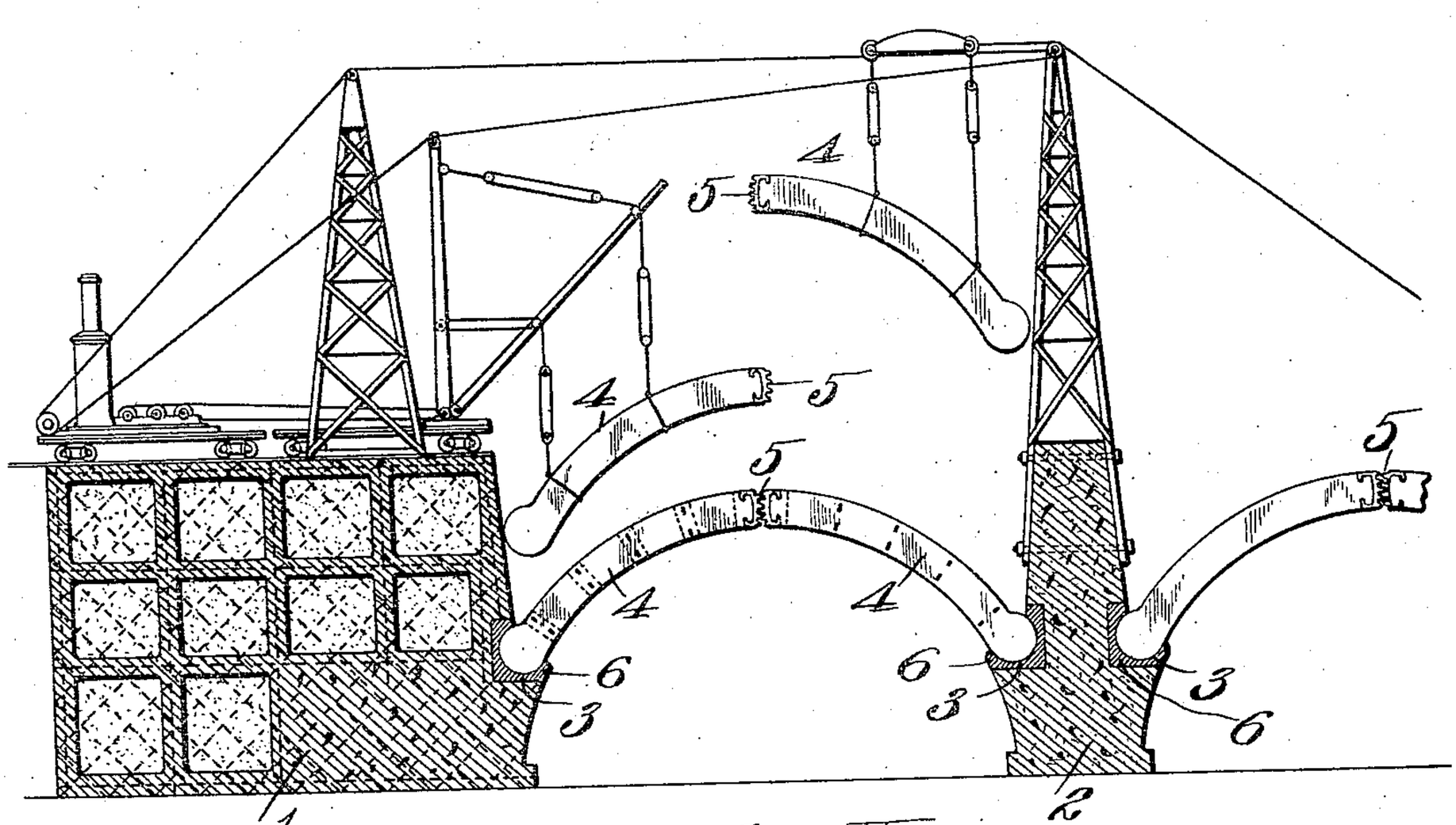

Fig. II.

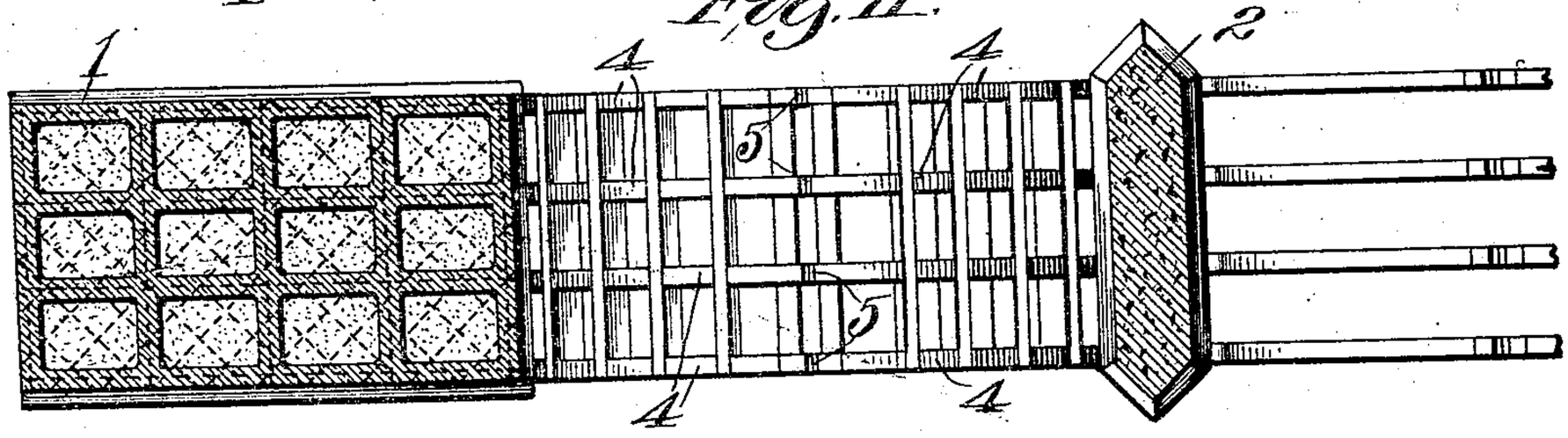

Fig. XIII.

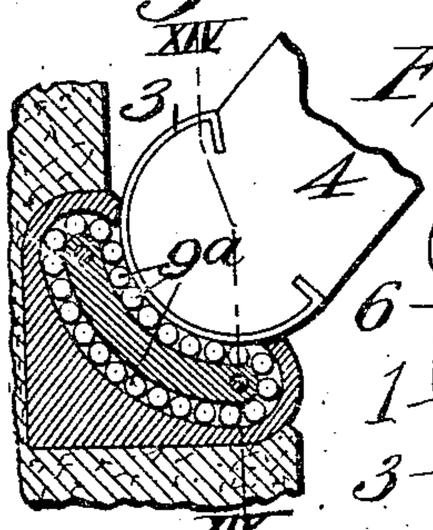

Fig. III.

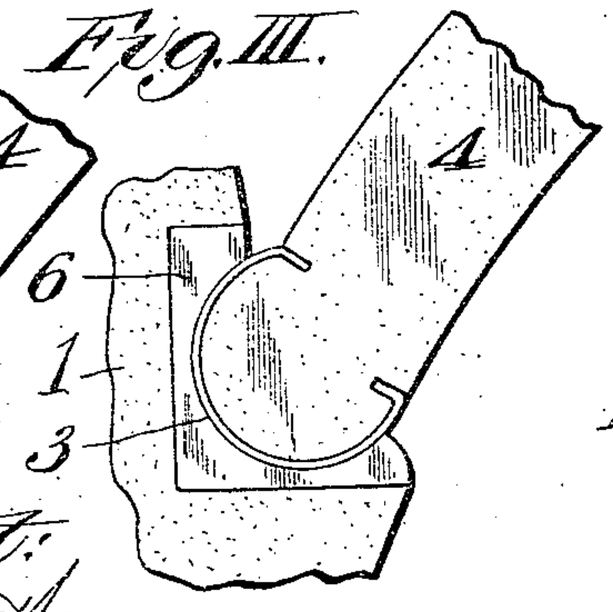

Fig. IV.

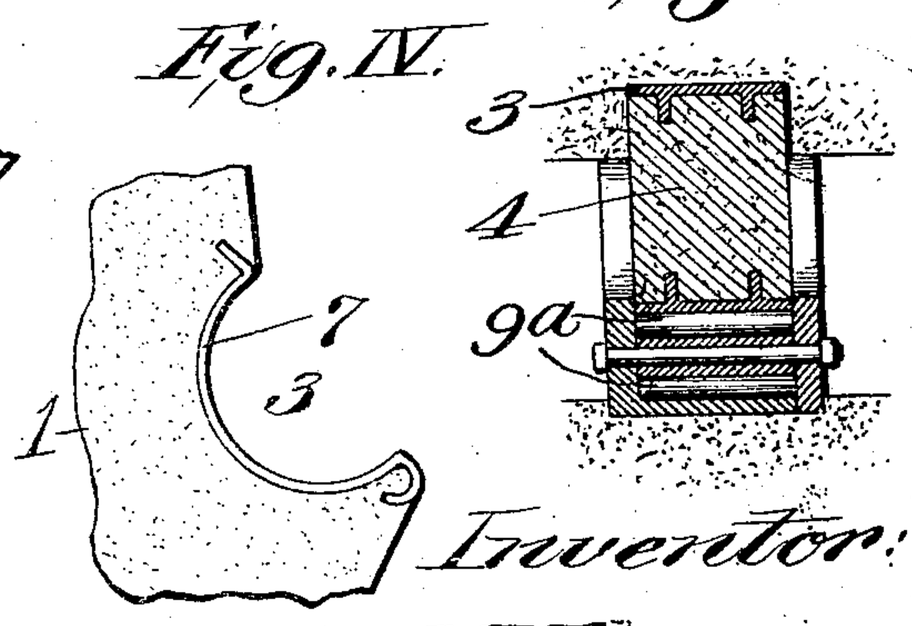

Fig. XIV.

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3 SHEETS—SHEET 2.

Fig. V.

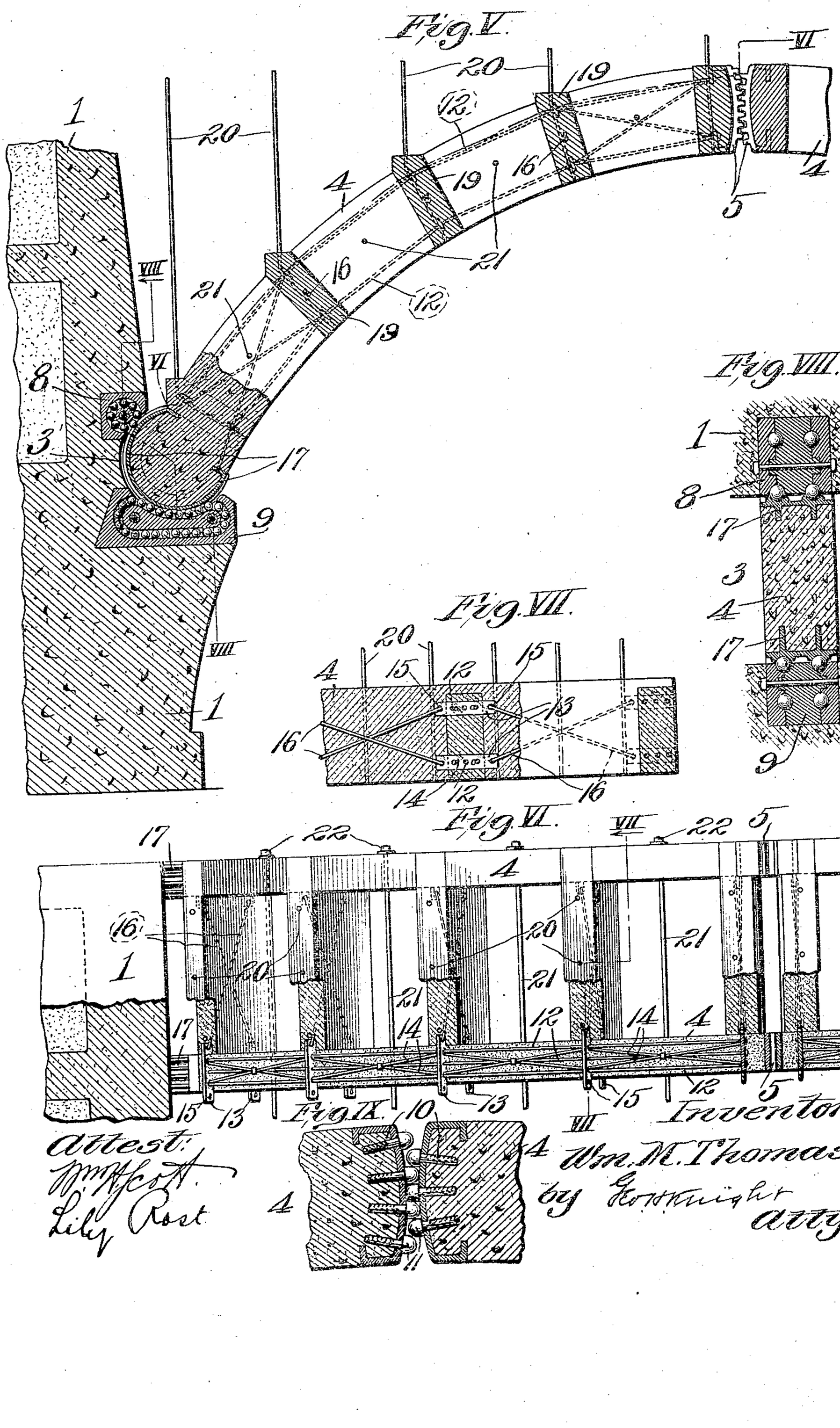

Fig. VIII.

Fig. VII.

Fig. VI.

Fig. IX.

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APPLICATION FILED JULY 5, 1907.

3 SHEETS—SHEET 3.

Fig. X.

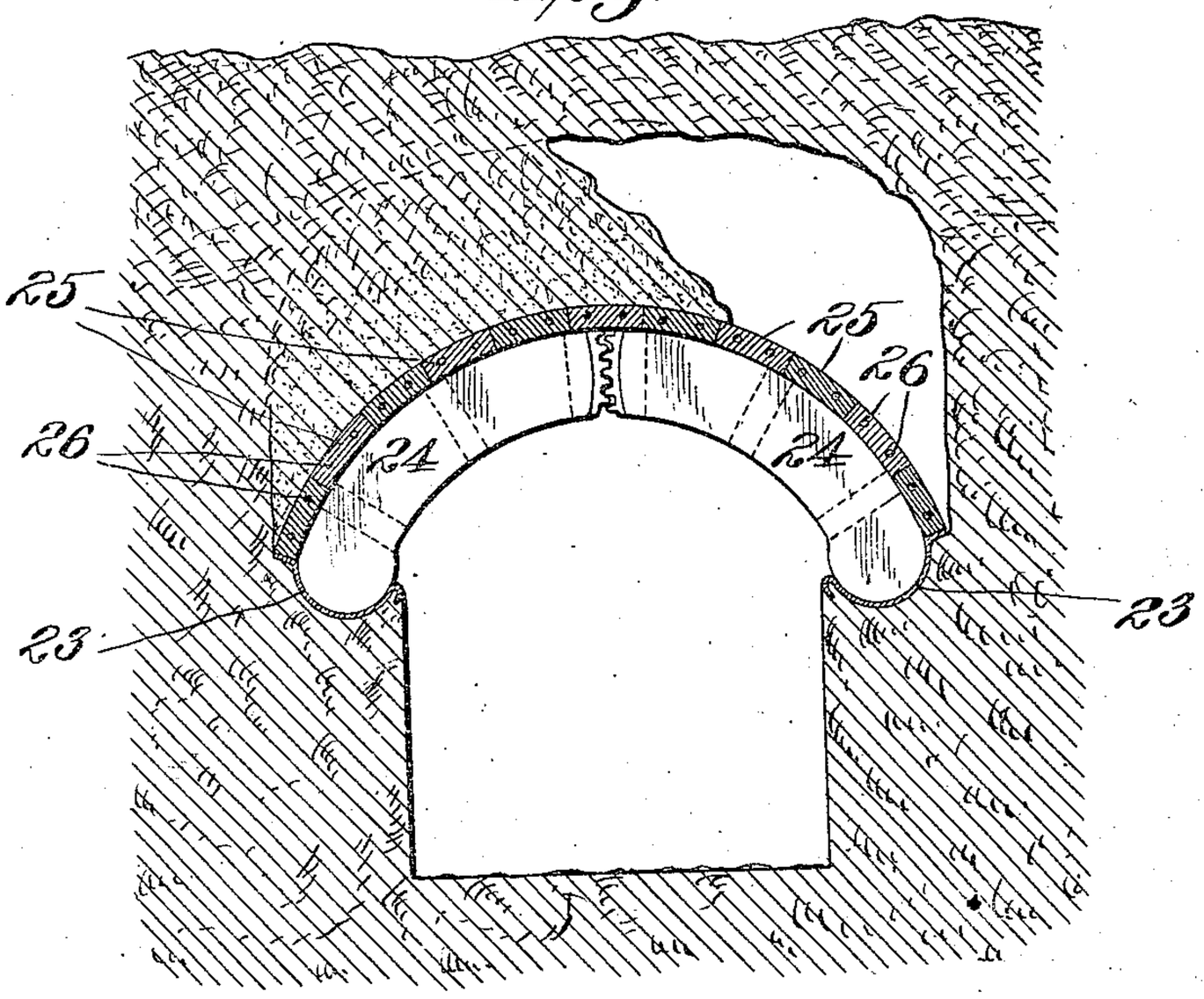


Fig. XI.

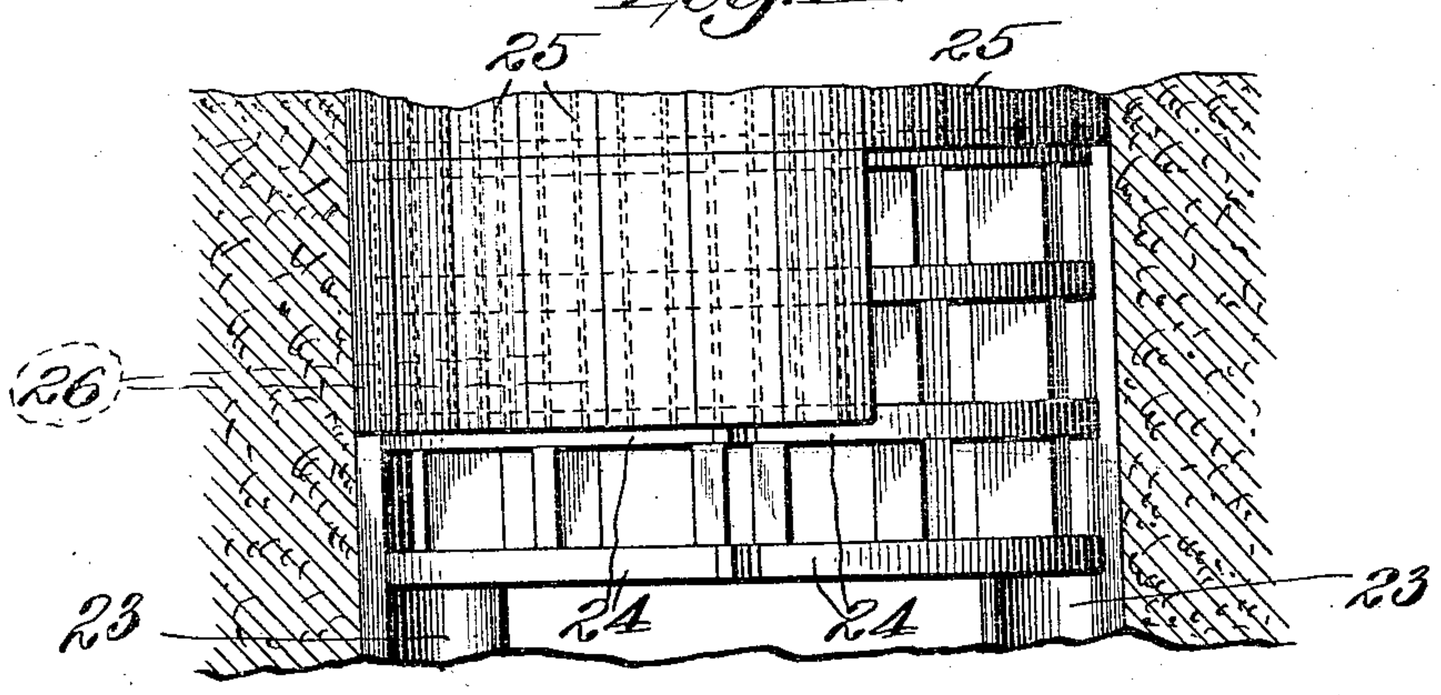
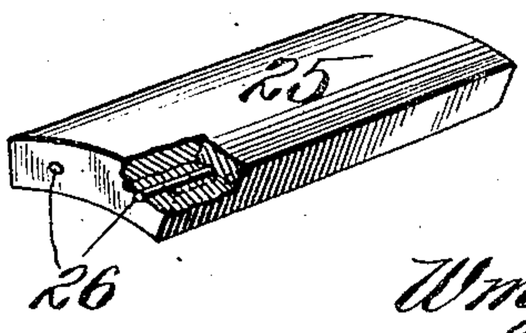


Fig. XII.



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UNITED STATES PATENT OFFICE.

WILLIAM M. THOMAS, OF SANTA CRUZ, CALIFORNIA.

AUTOMATIC ADJUSTABLE ARCH CONSTRUCTION.

No. 886,666. Specification of Letters Patent. Patented May 5, 1908.

Application filed July 5, 1907. Serial No. 382,280.

To all whom it may concern:

Be it known that I, WILLIAM M. THOMAS, a citizen of the United States of America, residing at city of Santa Cruz, in the county of Santa Cruz and State of California, have invented certain new and useful Improvements in Automatic Adjustable Arch Construction, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to a new and useful improvement in automatic adjustable arch construction for bridges, tunnels, etc., and has for its object primarily to produce an effective and inexpensive structure which will adequately support a super-structure and in addition thereto a pre-determined maximum load, and will permit of the crown of the arch rising or falling, due to expansion and contraction or to excessive loads or stresses, with no detrimental results to the arch.

Another object of my invention is to construct an arch or a number of arches of braced concrete, composed of two or more segments, preferably two, which can be manufactured at the site of the work or at any distant point and transported and set in place on the skewbacks by the use of a crane, hoists or the like, thus eliminating the very expensive and laborious work of erecting supporting forms, or molds for the arch rings, were they built up in the construction of the arch as an entirety. I propose to erect bridges and other structures by first building up the foundations to a proper height to form skewbacks, mount sockets therein, build up the balance of the skewbacks to a proper height, mount towers on said skewbacks, and support by said towers, cables, etc. for conveying segmental arch sections into such position that one of the partly cylindrical or segmental ends of each section may be placed in the segmental sockets in the skewbacks and their innermost or crown ends brought toward each other until they abut and form the crown of the arch, after which their segmental parallel arch sections are bound together by transverse partition walls as will hereinafter be more fully described. The super-structure is then placed upon and secured to the arch frame thus formed, in any suitable manner.

Figure I is a vertical longitudinal section of a portion of a bridge having an abutment arch and skewback, embodied in my invention, the view also illustrating the manner in which the arch is put in place. Fig. II is a plan view of the arch construction and a horizontal section of the abutment and skewback. Fig. III is a detail view of meeting portions of a skewback and one of the arches. Fig. IV is a detail view of a portion of the skewback, illustrating a slightly modified construction of arch receiving socket. Fig. V is an enlarged vertical longitudinal section through a portion of the skewback and one of the arch segments and a portion of a mating segment shown partly in side elevation and partly in section. Fig. VI is in part a plan view of the parts shown in Fig. V and in part a longitudinal section taken on the line VI—VI, Fig. V. Fig. VII is a vertical transverse section taken on line VII—VII; Fig. VI. Fig. VIII is an enlarged vertical section taken on line VIII—VIII, Fig. V. Fig. IX is a detail section of the crown of the arch, or the meeting point of the segments forming the arch, illustrating one method of construction of these parts. Fig. X is a vertical transverse section of a tunnel construction wherein my invention is employed. Fig. XI is a top plan view of the arch construction of the structure illustrated in Fig. X. Fig. XII is a detail perspective view partly broken away of one of the laggings or voussoirs employed in forming a roof for the arch construction. Fig. XIII is a vertical section of a modification of the bearing between the skewback and arch section. Fig. XIV is a section on line XIV—XIV Fig. XIII.

In the drawings, I represents a masonry pier or abutment which acts as a skewback for one side of the arch, and 2 another masonry pier which forms a skewback for the other side of the arch. Each of these skewbacks is provided with a segmental socket 3.

4 designates segmental arch sections, each of which is provided with a partly cylindrical or segmental end designed to fit in the segmental sockets 3 of the skewbacks to form a knuckle joint. The innermost end of each of these segmental arch sections is provided with a flanged segmental gear or rack 5 which is designed to mesh one with the

other in such manner as to support the segmental arch sections in proper position.

The segmental socket 3 heretofore referred to may be made in several different ways such for instance as being in the nature of a cast metal block 6 (see Fig. III) or for lighter constructions, this socket may be formed of sheet metal as is illustrated at 7 in Fig. IV. Another method of forming this socket is illustrated in Figs. V and VIII of the drawings wherein it will be noted that the same provides for an anti-frictional socket and consists of a casting or castings 8 and 9 of metal, having ball or roller races formed therein and in which balls or rollers are located, said balls or rollers coöperating with complementary ball or roller races formed on the partly cylindrical or segmental end of the segmental arch sections 4. The segmental gear or rack 5, which as before stated is secured to the innermost or crown end of the segmental arch section, may be formed of a casting as is illustrated in Fig. V or may be provided with a plurality of perforations through which bolts 10 pass, said bolts being provided with enlarged heads 11 which act as gear teeth as is clearly illustrated in Fig. IX of the drawing.

The arch sections 4 are formed principally of concrete, reinforced by longitudinal rods 12 transverse bars 13 and diagonal truss rods 14, the transverse bars 13 being provided with perforations for the passage of the rods 12 and 14, thereby causing them to act as distance pieces for the former and king posts for the latter. There are two assemblies of the rods 12 and 14 and the bars 13, one arranged close to the extrados and the other close to the intrados of the arch to stiffen the same laterally. The bars 13 being of sufficient length to extend some distance beyond the finished concrete sides of the arch segments. Said extensions are provided with perforations 15 which receive the ends of diagonal cross brace rods 16 which tie one segmental arch section to the segmental arch section next parallel thereto as is clearly illustrated in Figs. VI and VII of the drawings. These segmental arch sections, which as before stated are formed principally of concrete, have formed integral therewith the partly cylindrical outer end covering 17 formed of sheet or cast metal, and also the segmental gear teeth or cogs 5, said metal coverings 17 and said gear teeth 5 being preferably tied together by the reinforcing rods 12 and 14 whereby a skeleton framework is formed for preserving the integrity of the segmental arch sections.

After all of the segmental arch sections are placed in position in their sockets, the crown of the arch is formed by the abutment of the segmental gears, and the diagonal brace rods 16 are secured in place between the segments, concrete division or tie walls 19 are formed between the parallel segmental arch sections, and arranged to encompass or surround said rods 16. These walls 19 are formed by arranging suitable temporary molds or forms on, or around the arch rings and in juxtaposition to the rods 16 and filling the concrete thereinto. The partition walls 19 also have embedded therein upwardly extending rods 20, which are employed to tie the superstructure (not shown) of the bridge to the arch. Alining holes are formed transversely in all the segmental arch sections and through these holes through rods or bolts 21 are passed, said rods or bolts being provided upon their ends with washers and nuts 22 in order that the entire assembly of parallel segmental arch sections can be firmly drawn together.

By the construction of an arch as above described it will be apparent that the arch as an entirety is yielding at its crown so that when expansion and contraction of the arch takes place, or when the arch is depressed by an excessive load, the segmental arch sections are permitted to partly rotate in the sockets in the skewbacks due to the interlocking segmental gear construction of the arch sections at their crowns.

In constructing a bridge such as is illustrated in Figs. I and II of the drawings, the abutment at the end of a span of arches is preferably formed of reinforced concrete, and made as follows: I first lay a thick concrete foundation, reinforcing the upper and lower sides thereof preferably with diagonally arranged rods of metal so arranged as to form a sort of lattice work, then build upwards therefrom marginal and intermediate walls of concrete which may also be braced similarly to the foundation, fill in the compartments formed by these vertical walls with sand, rocks, etc. then thereover form a horizontal layer of concrete also braced with metal rods, and continue to build up the abutment to the required height by vertical and horizontal walls until a sufficiently heavy structure is produced to adequately support the loads or stresses to be imposed upon the bridge.

In Figs. X to XII inclusive, I have shown a modified form of the invention wherein the same principle of reinforced adjustable arches is employed to form the roof of a tunnel, and in the construction of the same, I proceed as follows: I first excavate the rock, dirt, etc. to form the tunnel proper, then set metal sockets 23 in place in the skew backs, then arrange the segmental arch sections 24 in place and then place over the assembled arches, lagging blocks 25 which form voussoirs of the arch, which lagging or voussoirs are preferably so arranged as to extend from the center of one arch ring to the center of

another arch ring as shown in Fig. XI of the drawing. The space between the voussoirs and top of the tunnel is then filled in with cement, etc.

I prefer to stiffen the lagging blocks or voussoirs which are preferably formed of concrete, with plain metal rods 25 and 26 that strengthen these blocks and prevent breakage of the same in handling.

In Figs. XIII and XIV I have shown a slightly modified form of anti frictional bearing between the skewback and the arch sections, wherein rollers 9^a are employed in lieu of the balls illustrated in Figs. V and VIII of the drawings.

Claims:

1. In a structure of the character described, the combination of a pair of skewbacks having segmental sockets and an automatically adjustable arch supported thereby comprising segmental sections having segmental ends fitting in the segmental sockets and flanged meshing segmental gears, substantially as set forth.

2. In a structure of the character described, the combination with a pair of skewbacks having segmental sockets therein, antifriction rollers in said segmental sockets, and an arch comprising segmental sections having segmental ends supported by said anti-friction rollers, and meshing segmental gears, whereby said arch is permitted to rise and fall under abnormal conditions, substantially as set forth.

3. In a structure of the character described, the combination with a pair of skewbacks having sockets therein, anti-frictional devices arranged in said sockets, an arch comprising segmental sections supported by said anti-frictional devices and flanged meshing segmental racks carried by said segmental arch sections and meshing with each other, whereby the arch is permitted to freely rise and fall under abnormal conditions, substantially as set forth.

4. In a structure of the character described, a segmental arch section of composition material, a metallic partly cylindrical body arranged at one end of the section and a metallic member provided with gear teeth arranged at the other end thereof, substantially as set forth.

5. In a structure of the character described, a segmental arch section of composition material, brace rods arranged longitudinally thereof, a metallic partly cylindrical body arranged at one end of the section and gear teeth arranged at the other end thereof, substantially as set forth.

6. In a structure of the character described, a segmental arch section of composition material, brace rods arranged longitudinally and near the extrados thereof, brace rods arranged longitudinally and near the intrados thereof, a partly cylindrical metallic body arranged on one end of said segmental arch section and gear teeth arranged on the other end of said segmental arch section, substantially as set forth.

7. In a structure of the character described, a segmental arch section of composition material, longitudinal brace rods arranged in said arch section, transverse bars arranged in said arch section and through which said longitudinal rods pass, a metallic partly cylindrical body located at one end of said arch section, and gear teeth located at the other end of said arch section, substantially as set forth.

8. In a structure of the character described, a segmental arch section of composition material, longitudinal brace rods and transverse bars, through which said longitudinal brace rods pass arranged near the extrados of said arch section, longitudinal brace rods and transverse bars, through which said longitudinal brace rods pass arranged near the intrados of said arch section, a partly cylindrical metallic body at one end of said arch section, and gear teeth formed at the other end of said arch section, substantially as set forth.

9. In an arch the combination with supports, of a plurality of segmental arch sections which rest upon said supports to form an arch proper, a plurality of these arches proper arranged parallel to each other, tie bars connecting these parallel arches proper, one end of each of these segmental arches being formed partly cylindrical and designed to rest upon said supports and gear teeth formed on the crown end of said segmental arch sections for the purpose specified, substantially as set forth.

10. In an arch the combination with supports, of a plurality of segmental arch sections which rest upon said supports to form one arch proper, a plurality of these arches proper arranged parallel to each other, tie bars connecting these parallel arches proper transverse composition partition walls connecting said parallel segmental arch sections, and surrounding said tie bars, and one end of each of these segmental arches being partly cylindrical and designed to rest upon said supports, and gear teeth at the crown end of said segmental arch sections for the purpose specified.

11. In an arch the combination with supports, of a plurality of segmental arch sections arranged to form an arch proper and designed to rest upon said supports, a plurality of parallel arch sections proper, each segmental arch section having longitudinally disposed brace rods and transversely arranged bars through which said longitudinal bars pass, said transverse bars extending laterally beyond the sides of the segmental

arch sections and provided with perforations to receive tie bars for connecting one segmental arch section to the next parallel segmental arch section partition or division walls between said parallel segmental arches and surrounding said tie bars, one end of each of these segmental arch sections being partly cylindrical and designed to rest upon said supports, and gear teeth at the crown end of said segmental arch sections for the purpose specified.

WILLIAM M. THOMAS.

In the presence of—
W. P. NETHERTON,
EVA M. WHINERY.