Feb. 11, 1947. R. G. SECHAUD ET AL 2,415,709

MAKING REINFORCED CONCRETE ARCHES

Filed Jan. 23, 1946 4 Sheets-Sheet 1

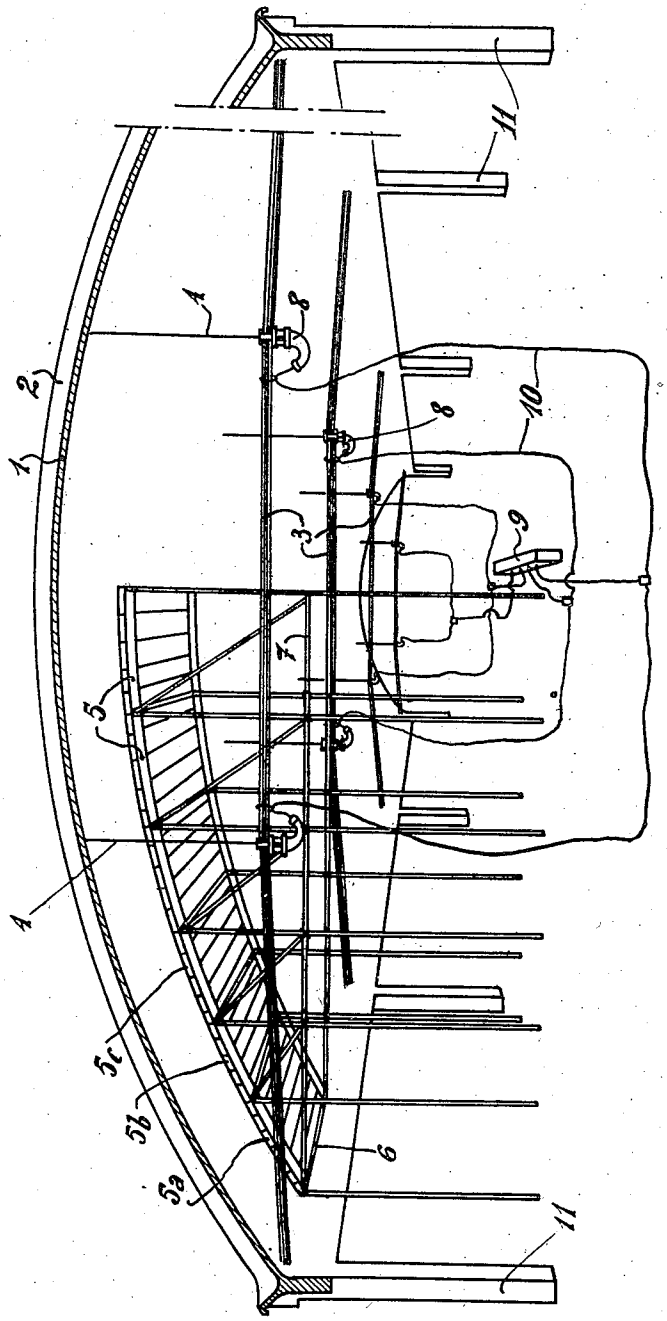


Fig. 1

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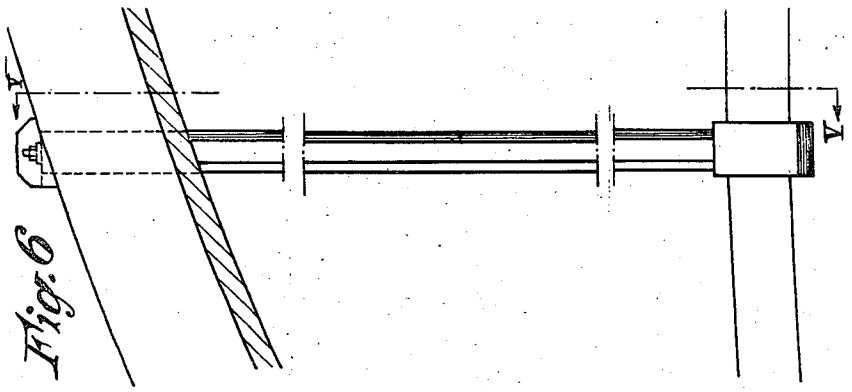


Fig. 6

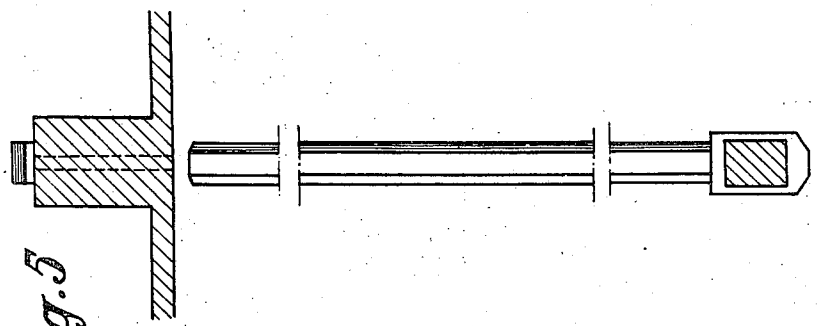


Fig. 5

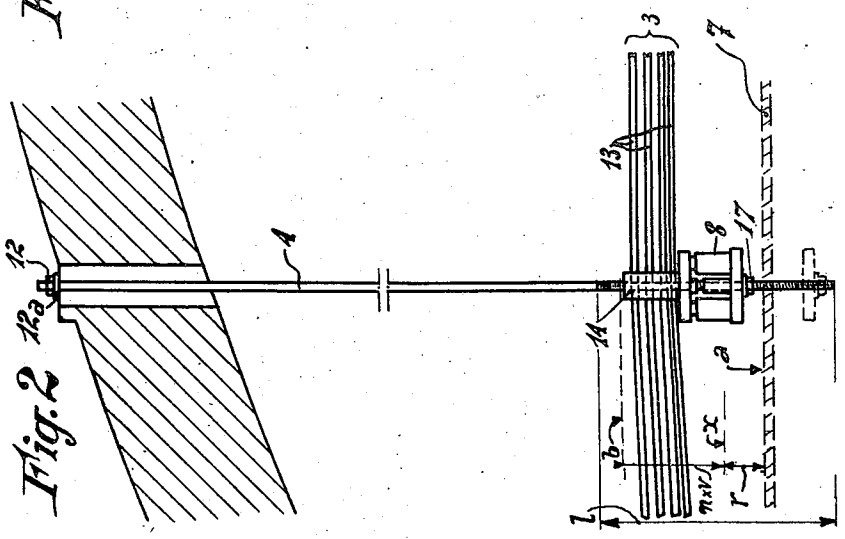


Fig. 2

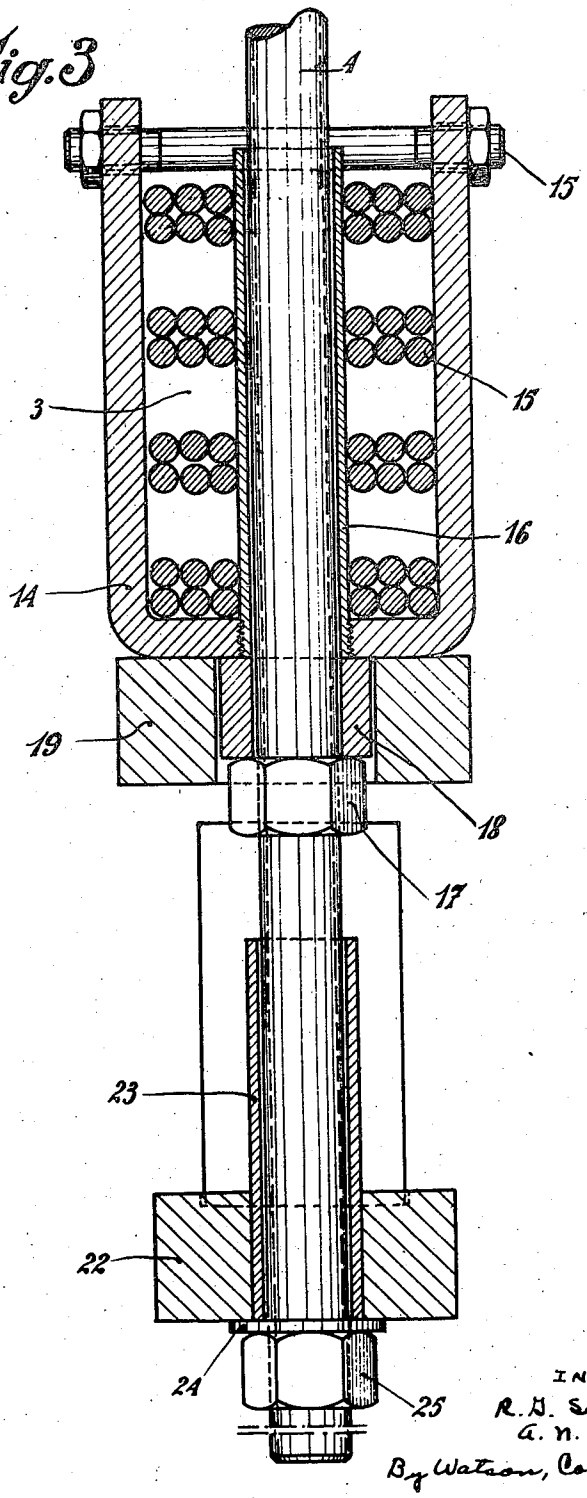
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MAKING REINFORCED CONCRETE ARCHES

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Fig. 3



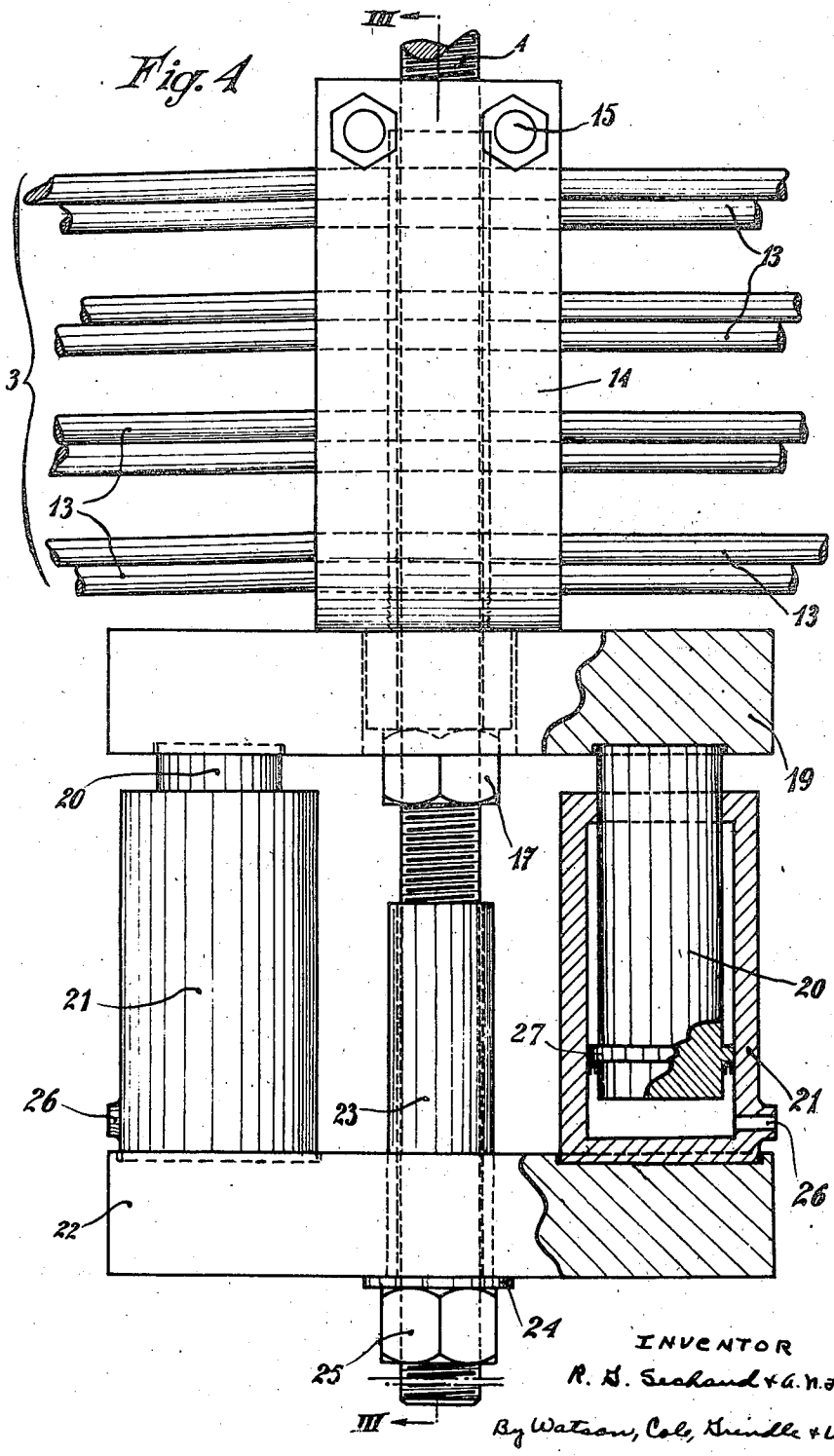
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MAKING REINFORCED CONCRETE ARCHES

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Fig. 4



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UNITED STATES PATENT OFFICE

2,415,709

MAKING REINFORCED CONCRETE ARCHES

Roger Gaston Séchaud and Adolphe Norbert Florent Metz, Paris, France

Application January 23, 1946, Serial No. 642,898
In France February 20, 1945

6 Claims. (Cl. 108—1)

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It is known that reinforced concrete roofs having a middle or large span, particularly types of penthouses, sheds and the like are generally subtended by ties or braces which may be covered with concrete and are supported at spaced-apart points by suspending rods attached to the roof itself.

It is further known that when centre-striking is effected without taking special precautions, the tie steel wires begin to be stressed only during said operation and their resilient stretch causes horizontal displacements of bearing or roof rest points with consequent considerable secondary stresses in the component parts of roof and posts.

Such secondary stresses are larger as the displacements of bearing points are greater, and with a view to limiting the effects thereof, one is led to providing special devices (rest apparatus, connecting rods and the like) or a low working load for steels. In order to remedy these limitations inconsistent with economy in construction, it is known to effect cambering of ties, i. e., to lift the ties at the meeting point with each suspending rod by a sufficient amount to make up for resilient stretch in horizontal direction or even to overtake said stretch.

Theoretically, this simple expedient should allow of avoiding spreading out of rest points and consequent secondary stresses. As a matter of fact, when one tie is cambered at a time, the same secondary stresses as before take place during centre striking operations, and cambering practically results only in lowering secondary stresses in posts to admissible amounts. It will be realized that cambering is efficient only in so far as tensile strengths of steel and concrete posts are not exceeded when centre-striking is effected. However, in a roof chiefly when it is made as a ribbed web, very large and indefinite secondary stresses as have arisen during centre-striking and cambering operations for each successive vault section, are still extant and may result in causing considerable cracks.

It is an object of this invention to provide a centre-striking process with simultaneous tie cambering, applicable to reinforced concrete vaults or roofs, whereby secondary stresses in vaults or roofs and supports therefor are prevented.

According to this invention, both centre-striking and cambering of all ties relating to a structure, as a rule a monolithic structure, i. e., distinct from adjacent structures or separated therefrom, e. g., by conventional expansion joints, are performed progressively.

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Furthermore the transfer of cambering stress to the vault or roof is also progressive since according to this invention, the very suspending rods for ties are employed for cambering said ties.

Progressive centre-striking is preferably started from the side edges towards the centre of the structure while cambering is effected in successive steps as centre-striking proceeds.

According to this invention, the mechanical apparatus for drawing ties upwardly are independent of the scaffolding, and are borne from the suspending rods. Moreover in order that the operation be progressive, they are controlled simultaneously so as to produce equivalent forces and lifts in the successive steps. For this purpose, jacks, preferably hydraulic jacks, supplied with pressure liquid from a common feeding device, are provided and operated in a series of successive steps.

The following description with reference to the appended drawings given solely by way of example will show how this invention may be carried out.

Fig. 1 is a diagrammatic perspective view of a shed with means for cambering ties according to this invention.

Fig. 2 is a diagrammatic elevation of a suspending rod.

Figs. 3 and 4 show a cambering jack, Fig. 3 being a section along III—III on Fig. 4.

Figs. 5 and 6 show the final suspending rod, Fig. 5 being a section along V—V on Fig. 6.

The shed shown as an example Fig. 1 has a roof which is a thin vault 1 made of reinforced concrete supported from arches 2 which are borne on posts 11. Arches 2 are subtended by ties 3 supported from suspending rods 4. For the sake of clarity, only a part of the scaffolding which supports template sections 5 adapted for lining the vault has been illustrated, the showing being diagrammatic. Any one of template sections 5 can be taken out independently of the other sections, starting from the vault springing plane 6, i. e., from the edges of the construction. The scaffolding further comprises a floor 7 for supporting ties 3 while the construction is being erected.

At the time of discentering or centre-striking, each suspending rod 4 is connected with the corresponding tie by means of a jack 8, e. g., a hydraulic jack, provided to lift the tie with transfer of load to the suspending rod firmly secured at its upper part. Each jack has a predetermined operative stroke, and by means of screw-threaded

rods or movable clamps, as many successive lifts through jacks as desired may be effected. All jacks (eight in the showing) are supplied from a main tank through pipes 10 so as to be operated at the same pressure.

In order to center-strike the vault, the ties 3 are lifted through jacks 8 by an amount which is a fraction of the final camber to be given to said ties; starting from the vault springing portions, a part of the template, for instance elements 5a, 5b thereof, is removed, then the tie is further lifted by a suitable amount then another portion of the template, e. g., elements 5c, is removed and so on. In the example of scaffolding shown on the drawings the centre-striking may be performed in six successive steps and thus the tie may be cambered after six lifts.

It will be realized that according to this method, any forces transferred to posts 11 can remain vertical and furthermore no secondary stress is developed in the vault itself.

In the example illustrated, each tie is supported from two suspending rods. It will be obvious that any number of such rods may be provided, and it is only necessary for imparting the desired camber to the tie, either to adjust the jacks differently (e. g., to cause them to impart different lifts) or to cut off for instance the jacks corresponding to side suspending rods, as soon as the lift obtained therefrom is sufficient, while proceeding with operation of the jacks associated with the middle suspending rods.

The assembly of a suspending rod and a tie as cambering is being effected is illustrated on Fig. 2. The suspending rod 4 comprises a steel rod (made of concrete steel, steel of any kind, or stainless steel where the rods shall not be covered) which is screw-threaded over an extent l at its lower part; at its upper part, it may be attached in any manner to the roof, for example by means of a nut 12 and a washer 12a. The steel wires 13 comprised by tie 3 may be plain steel wires which have been cold-drawn, or high resistance steel wires, or even cables. They are originally laid on horizontal floor 7 which is a part of the scaffolding diagrammatically shown on Fig. 1 and placed at level a. While the steel wires are held in a bundle by supporting stirrups 14, the ends thereof have been embedded in the springings of vault sustaining arches. While the roof is still on the template, the cambering device illustrated by Figs. 3 and 4 is placed in position. Referring to said Fig. 3, a tie 3 comprised by steel wires 13 is supported in a stirrup 14 the legs of which are connected by bolts 15. Suspending rod 4 loosely passes through tie 3 in stirrup 14, said rod engaging a tube 16 screwed into the stirrup. Screwed on a screw-threaded portion of suspending rod 4 is a nut 17 which supports stirrup 14 through a ring 18. The cambering device proper includes a first cross-bar 19 the upper face of which engages stirrup 14 while its lower face is engaged by the plungers 20 of a pair of jacks; the cylinders 21 of said jacks rest on a second cross-bar 22; feed inlets are shown at 26. Cross-bar 22 is fast with a guiding tube 23 and is supported from the suspending rod 4 by means of a washer 24 and a nut 25.

The various members being mounted on the screw-threaded portion of suspending rod 4, nut 25 is at first so adjusted that the jacks, completely retracted contact cross-bars 19, 22.

When the jacks are operated, upper cross-bar 19 and tie 3 are moved upwardly, and the corresponding stress will be transferred to the suspending rod. Nut 17 is then tightened as cross-bar 19 is moved up to follow the latter and upon pressure being released from the jacks, said nut will prevent the tie from resuming its original position.

The lower cross-bar 22 and the jacks may then be raised by screwing and tightening nut 22; the jacks may be operated again to lift the tie by a further amount.

Each suspending rod in the construction is equipped with like jacks. In order to make allowance for the fact that various suspending rods may not have to support the same stresses (side rods for instance), we may provide jacks having plungers with different diameters. However such a precaution is not sufficient because owing to accidental circumstances (defects, irregular centre-striking) theoretically identical suspending rods may react on the jacks differently. Furthermore, jacks are sometimes unreliably responsive, and it is not possible safely to complete an adjustment by relying both on identity of reaction of suspending rods and accuracy of jacks. According to this invention instead of adjusting the operative stroke of jacks by means of the pressure in the tank, the jacks are arranged to be locked after a predetermined stroke, for instance as defined by an abutment flange 27 (Fig. 4). The abutment may be adjustable where it is desired to employ jacks for very different cambering operations.

Referring to Fig. 2, another manner of using the device above described will be set forth:

A general adjustment is originally effected by lifting all ties by an amount r from level a to level x. This first adjustment enables of doing away with any slight inaccuracies of position in laying ties on the corresponding supporting floors. The force required for initially lifting the ties is very small, and the adjustment can be made without jacks, merely by screwing nuts 17 with a spanner.

Level x and adjustment lift r are so calculated that the vertical distance from intermediate level x to final level b is an integer number n of jack strokes.

After adjustment has been completed for all ties, the jacks are set in operation. All jacks being connected with common tank 9 (Fig. 1), the feed pump therefor is started, and it is stopped when all jacks have attained the end of their stroke. Nuts 17 are then tightened by hand, hydraulic pressure is released, lower cross-members are raised by screwing nuts 25, and the whole is ready for a further lift which will be effected after taking off a part of the template elements. It is only necessary to effect n similar operations accurately to camber all ties according to the predetermined design, i. e., to bring tie 3 from level a to level b.

When the tie has reached its final position, all jacks and cross-members are removed and the screw-threaded portion of each suspending rod which protrudes below the tie is cut off flush with nut 17.

The suspending rods, stirrups and tie may then be embedded in preservative concrete as illustrated on Figs. 5 and 6. For this purpose, it is advantageous to provide light reinforcements adapted to retain concrete in contact with suspending rods. In actual practice, the original adjustment and the first jack operation may be made without starting with centre-striking because very small camberings result in drawing

together only insensibly the roof rest points, specifically the tops of posts 11.

It will be realized that should small enough lifts be provided (e. g., one-fifth of the total camber) centre-striking may be effected without substantially altering the original span between rest points and consequently without subjecting the roof and posts to secondary stresses, even provisional ones.

It should further be understood that while we have described what we deem to be efficient and reliable embodiments of our invention, we do not wish to be limited thereto as alterations can be brought therein without departing from the spirit of this invention as defined in the following claims.

What we claim is:

1. In a process of centre-striking an arcuate structure built on a template and having a bow-string tie which spans, and is anchored to the arch springing portions of said structure, the steps of simultaneously applying tensioning forces substantially at right angles to said tie from said arcuate structure at a plurality of spaced-apart points along the tie, then taking off a portion of the structure lining template.

2. In a process of centre-striking an arcuate structure built on a template and having a plurality of parallel, spaced-apart ties distributed over its length, each of which spans, and is anchored to, the arch springing portions of said structure, the steps of simultaneously applying tensioning forces substantially at right angles to each tie from said arcuate structure at a plurality of spaced-apart points along said tie, and taking off a portion of the structure lining template.

3. In a process of centre-striking an arcuate structure built on a template and having a bow-string tie which spans, and is anchored to, the arch springing portions of said structure, the steps of simultaneously applying tensioning forces

substantially at right angles to said tie from said arcuate structure at a plurality of spaced-apart points along said tie, so as to produce a cambering of said tie; taking off a portion of the structure lining template while the tensioning forces are kept; then proceeding with a series of similar applications of tie cambering forces, at at least a part of said points along the tie and taking off of template portions, until the final camber is reached and the template removed; and fixing said tie in its final camber condition.

4. In a process of centre-striking an arcuate structure which has been built on a template and has a bow-string tie that spans, and is anchored to, the arch springing portions of said structure, and a plurality of suspending rods substantially at right angles to said tie, said suspending rods being anchored at spaced-apart points of the arcuate structure intermediate the arch springing portions thereof, the steps of drawing said tie from all suspending rods simultaneously to produce a camber of said tie; and taking off a portion of the structure lining template while said tie is in said camber condition.

5. In the process of claim 4, the additional steps of further drawing said tie from at least a part of said suspending rods simultaneously in successive stages, to produce a series of more and more intensive cambers, with taking off of portions of the template in each camber condition, until the final camber is attained and the template removed; and securing the suspending rods to the tie after said final camber has been reached.

6. The process of claim 4, the step of drawing said tie from the suspending rods being effected by means of a plurality of fluid pressure operated devices each of which is operatively interposed between a suspending rod and the tie, the fluid pressure being fed from a common source.

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