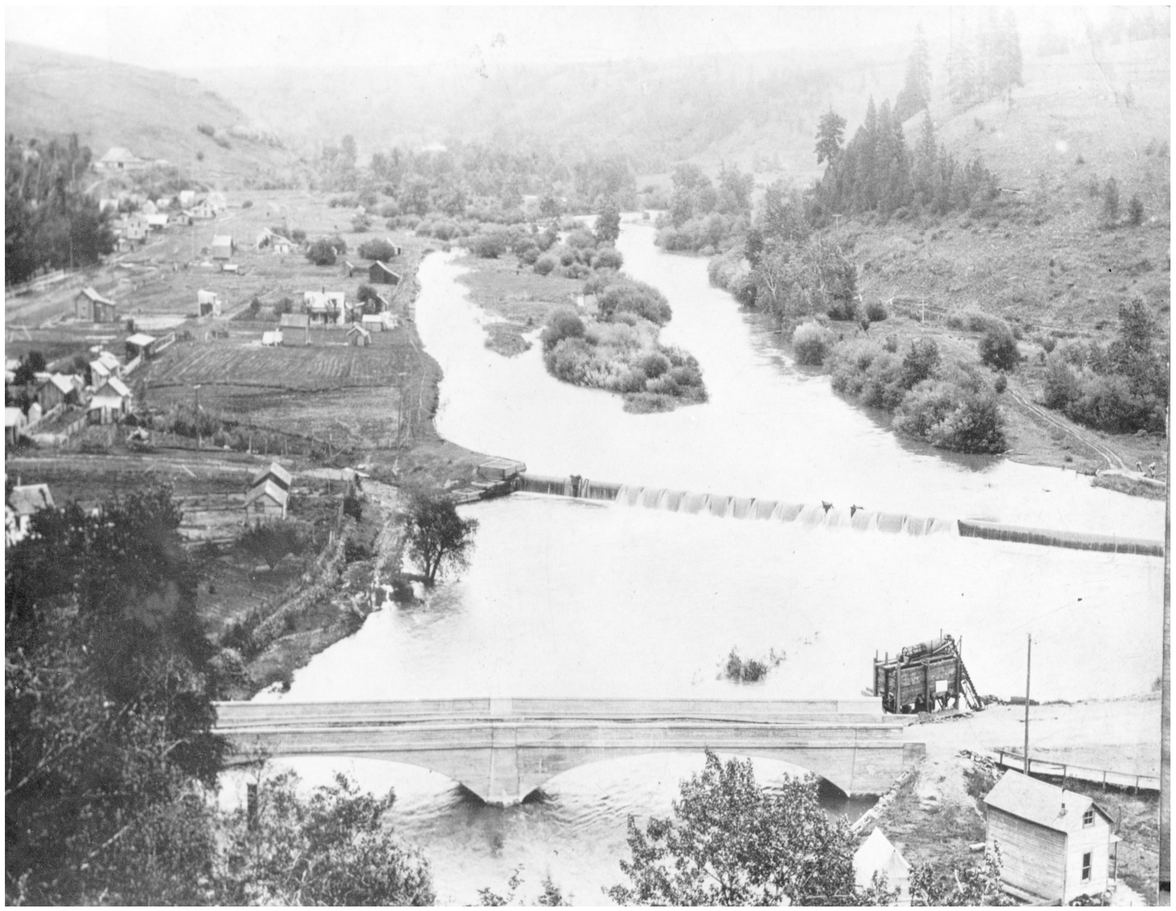
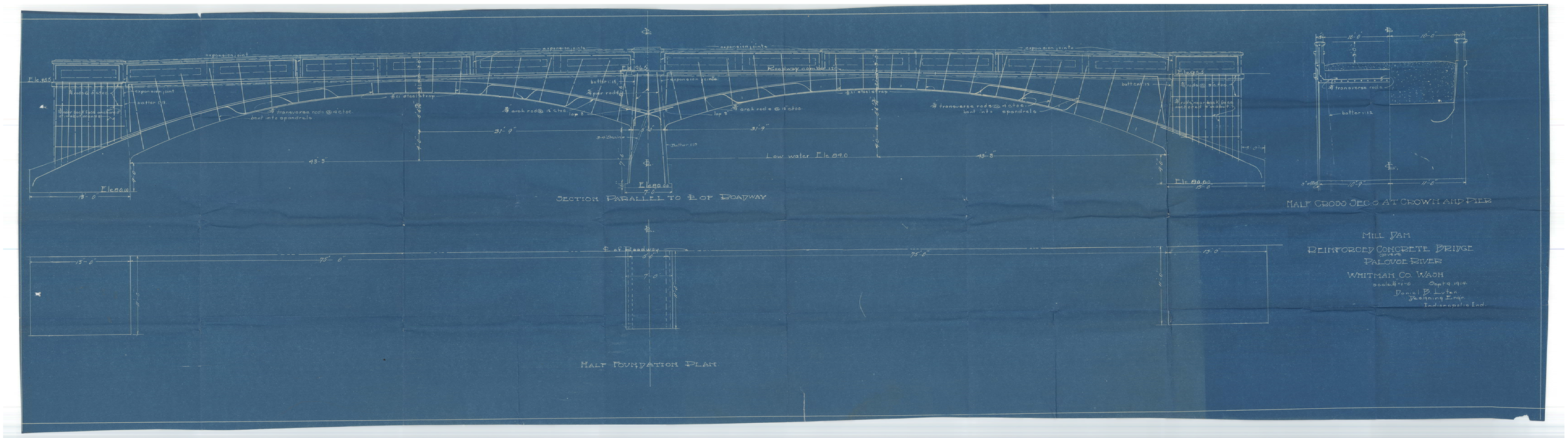


North Fork Palouse River and dam, Colfax, Washington, circa 1900 looking north. It was built to supply sufficient water to run the flour mill. In background to the left of the photo is the north flat area of Colfax. The bridge was referred to as the sixth street bridge. Sixth street currently divides Schmuck Park and Jennings Elementary School. The dam no longer exists

Reference: City of Colfax and Whitman County Library Rural Heritage collection, WCLCF365, http://www.washingtonruralheritage.org/cdm/singleitem/collection/whitman/ id/3541/rec/1). Note the left span, which was buried beneath fill during 1960s channelization of the Palouse River.

City of Colfax Sixth Street Bridge. Photo taken March 2018, courtesy of Whitman County looking northerly.

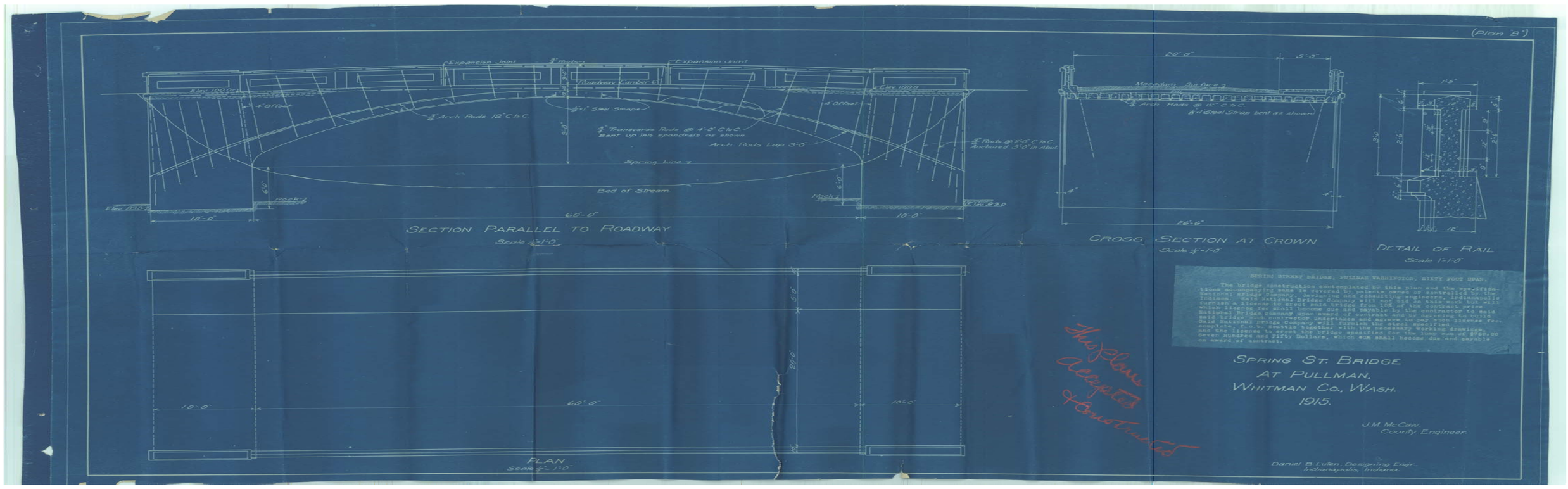


Plan sheet for City of Colfax Sixth Street Bridge. Plans courtesy of Whitman County records.

City of Colfax –Sixth Street Bridge

City of Pullman Spring Street Bridge. Photo taken March 2018 courtesy of Whitman County looking southerly.

Plaque on the City of Pullman Spring Street Bridge. Photo taken March 2018 courtesy of Whitman County.



Plan sheet for City of Pullman Spring Street Bridge. Plans courtesy of Whitman County records.

City of Pullman — Spring Street Bridge

Left: Aerial photo of Kenova Bridge No. 3310-02.49 looking easterly. Courtesy of Whitman County.

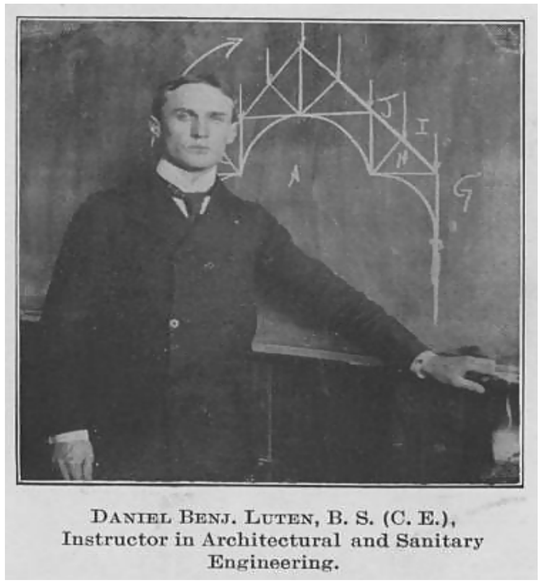
Right: McLead Bridge No. 1000-00.68 looking southwesterly. Courtesy of Whitman County.

Left: Photo of underneath of Kenova Bridge No. 3310-02.49 looking southerly. Courtesy of Whitman County.

Right: McLead Bridge No. 1000-00.68 looking southerly. Courtesy of Whitman County.

Left: Photo of Kenova Bridge No. 3310-02.49 looking westerly. Courtesy of Whitman County.

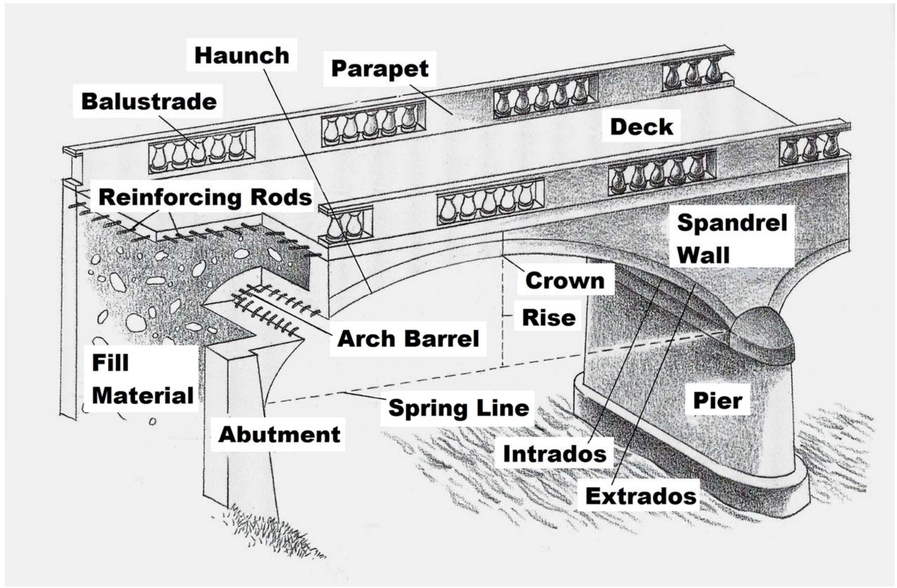
Right: McLead Bridge No. 1000-00.68 plaque. Courtesy of Whitman County.



DANIEL BENJ. LUTEN, B. S. (C. E.),
Instructor in Architectural and Sanitary Engineering.

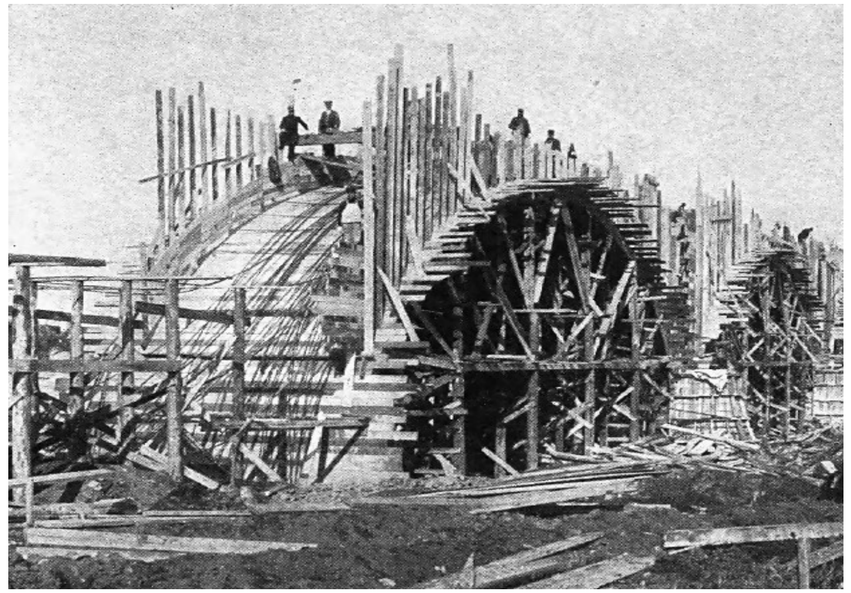
Daniel B. Luten, Purdue University professor, 1899 (Purdue University 1899:45)

Reference Cited:
1899 *Debris* [yearbook]. On file, Purdue University Libraries, Archives and Special Collections, Purdue University, Lafayette



Typical filled spandrel concrete arch bridge (adapted from California Department of Transportation 1990:74)

Reference Cited:
1990 *Historic Highway Bridges of California.* California Department of Transportation, Caltrans Publication Unit, Sacramento



Erecting centering, Maumee Bridge, Waterville, Ohio, before 1909 (National Bridge Company 1908:137)

Reference Cited:
National Bridge Company
1908 *Reinforced Concrete Bridges, Luten Patents.* National Bridge Company, Indianapolis.

No. 802,004. PATENTED OCT. 17, 1905.

D. B. LUTEN.

CENTERING FOR AND METHOD OF CONSTRUCTING ARCHES.

APPLICATION FILED FEB. 25, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

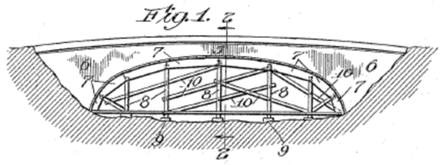


Fig. 2.

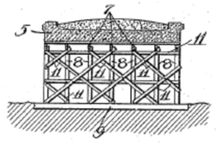
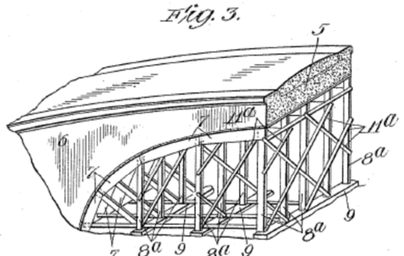


Fig. 3.



Witnesses:
Robert H. Weir
W. Perry Hahn

Inventor:
Daniel B. Luten
By Robert Lewis Ames
Attorney

No. 802,004. PATENTED OCT. 17, 1905.

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CENTERING FOR AND METHOD OF CONSTRUCTING ARCHES.

APPLICATION FILED FEB. 25, 1905.

2 SHEETS—SHEET 2.

Fig. 4.

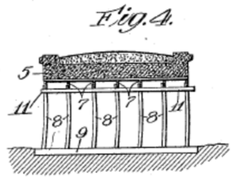


Fig. 5.

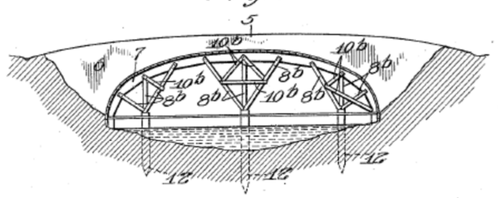
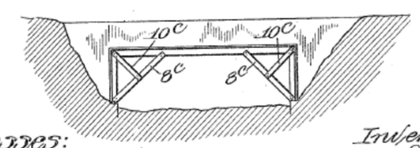


Fig. 6.



Witnesses:
Robert H. Weir
W. Perry Hahn

Inventor:
Daniel B. Luten
By Robert Lewis Ames
Attorney.

UNITED STATES PATENT OFFICE.

DANIEL B. LUTEN, OF INDIANAPOLIS, INDIANA.

CENTERING FOR AND METHOD OF CONSTRUCTING ARCHES.

No. 802,004. Specification of Letters Patent. Patented Oct. 17, 1905.

Application filed February 25, 1905. Serial No. 247,306.

To all whom it may concern:

Be it known that I, DANIEL B. LUTEN, a citizen of the United States, residing at Indianapolis, Indiana, have invented certain new and useful Improvements in Centering for and Methods of Constructing Arches, of which the following is a specification.

My invention relates to the art of masonry arch construction, and pertains more particularly to a new and improved construction of centering or false work for arches, involving also a novel method or process in the construction of the arch itself by reason of the novel character and manner of manipulating the centering or false work. In building arches of considerable span—say seventy-five feet and upward—engineers usually specify that the uprights of the wooden centers on which the arch is supported during construction shall be erected on wedges, which are removed gradually after the arch is completed, so as to let the stresses develop in the arch-ring gradually. Sand-boxes have also been used for this same purpose, the upright-supports resting in boxes of sand confined by means of removable plugs or the like, and when it is desired to lower the centers or "strike the centers," as it is called, the plugs are withdrawn so as to let the sand run out of the boxes and the uprights settle slowly.

My present invention comprises a novel method and construction in arch-centering whereby this same result of an easy and gradual settling of the arch-ring may be attained in a simpler and more economical manner than by the means and methods above described and which at the same time effects an economy in the cost of the centering itself. Generally describing the novel principle and feature of the present invention it may be stated that in the erection of arch-centering the uprights employed have heretofore, so far as I am aware, been required to be of such cross-sectional dimensions in proportion to their length or height as to be capable of sustaining the entire weight of the arch-ring without bending or buckling. I have discovered that much lighter uprights may be safely employed where used in conjunction with sway-bracing, affording the same strength and rigidity of vertical support to the arch-ring during construction as the heavier uprights and dispensing with the necessity of auxilliary devices for facilitating the gradual settlement of the arch-ring, my substitute for the latter residing in the expedient of gradually removing the sway-bracing after the arch-ring has been completed to the point at which the centering may be removed, whereby the light uprights gradually bend or buckle, affording sufficient resistance to support the ring against the sudden imposition of its own weight effect, but at the same time yielding sufficiently to permit the gradual settling to permanent form which every arch-ring undergoes upon the gradual withdrawal of the support afforded by the centering.

The principal of my invention is disclosed in the accompanying drawings, which show an arch-ring supported upon my improved centering and also illustrate the manner in which the stresses are allowed to develop gradually in the arch-ring upon the removal of the centering.

Referring to the drawings, Figure 1 is a side elevational view of an arch supported upon my improved centering. Fig. 2 is a cross-sectional view of the same on the line 2 2 of Fig. 1. Fig. 3 is a perspective fragmentary view in which the uprights are shown as having greater width than thickness with bracing required consequently only in the plane of the lesser dimension. Fig. 4 is a view similar to Fig. 2, illustrating the bending or buckling of the uprights during settling of the arch and upon removal of the bracing. Fig. 5 is an elevational view of another form of centering in which the weight of the arch is transmitted to piling by compression-pieces radiating from the tops of the piling, the aforesaid compression-pieces being designed as the flexible members in my improved form of construction and held to place by the transverse bracing members; and Fig. 6 is a similar elevational view of a flat arch or girder in which still another arrangement of the compression-pieces is shown.

Referring to the drawings, 5 may designate the ring of a concrete or other masonry arch—such, for instance, as occurs in an arch-bridge—6 designating the spandrel-walls thereof.

7 designates the usual centers, supported on uprights 8, resting on sills or other firm supports 9. The uprights 8, which are usually oak or other wooden timbers, are intentionally of such cross-sectional dimensions proportionately to their length as to be incapable of resisting the gravity thrust of the arch-ring without bending or buckling thereunder.

10 designates longitudinal, and 11 transverse, sway-bracing whereby said uprights are supported at various points between their

ends against bending or buckling either longitudinally or transversely of the arch. I have found in practice that in the construction of an arch requiring oak uprights six inches square in cross-section to carry the load unbraced uprights four inches square in cross-section may be safely substituted when used in conjunction with sway-bracing to afford the same rigid support to the arch-ring during construction. When in the building of the arch the work has progressed to the point where the centering is to be removed and the arch-ring allowed to settle, I gradually remove the sway-bracing, the effect of which is to cause the light uprights under the heavy load to slowly bend or buckle a few inches out of true vertical position, as illustrated in Fig. 4. Preferably the bracing is removed gradually from the several uprights or columns, so that the settling of the arch-ring thereupon takes places very gradually, the uprights acting as springs elastically supporting a large part of the weight, while at the same time permitting the arch to gradually assume its full loading. As the uprights bend their resistance to the imposed loading decreases, so that they act as springs supporting the arch, yet with diminishing resistance as the arch settles, thus requiring the arch to assume its full loading as the uprights buckle, a most desirable function. If there be any danger of the collapse of the arch as the support of the centering decreases, it may be guarded against by the previous introduction of auxiliary props to receive the arch in case the centering should suffer complete collapse. After removal of the bracing from the uprights the uprights themselves may be cut out one by one, removing first, preferably, the more unimportant members near the ends of the span.

A desirable modification for some cases is the use of compression members 8^a, Fig. 3, having a less diameter in one direction transverse to its length than in the other, so that buckling can occur in but one direction. The compression members are then braced against bending in this direction, as by the transverse braces 11^a, and the bracing in the other direction may be dispensed with.

Fig. 5 shows a form of centering embodying the principle of my invention, wherein the weight of the arch is transmitted to piling 12 by compression members or struts 8^b, radiating from the tops of the piling, said compression members being designed to be flexible and held against bending during erection of the arch-ring by bracing 10.

While I have described the device as applied particularly to the lowering of an arch, it is apparent that the principle of the invention is applicable to the construction of girders, floors, and other constructions where a superimposed structure is to assume the loading after erection on a temporary false work, as in Fig. 6, wherein 8^c represents the main compression-struts braced against buckling by the braces 10.

In view of the fact that the heavy uprights constitute the most expensive part of the centering, while the sway-bracing represents the least expensive part thereof, it is obvious that my invention effects a material economy in the total cost of centering material, aside from the important advantage of dispensing with the necessity for wedges, sand-boxes, and similar devices for effecting the gradual lowering of the uprights from the arch-ring in striking the centers.

I have used the term "uprights" not in the narrow sense of a vertical member, but in the broad sense of a vertical or inclined piece or any compression member or strut.

I claim—

1. The method of constructing an arch which consists in erecting the same on centering having braced uprights too light to carry the arch without bracing, and subsequently removing the bracing, allowing the uprights to bend or buckle as the arch settles and assumes its loading, substantially as described.

2. The method of constructing an arch which consists in erecting the same on centering having laterally-braced uprights too light to carry the arch without bracing, and subsequently removing the bracing from the uprights successively, allowing the latter to bend or buckle as the arch settles and assumes its loading, substantially as described.

3. In arch or analogous constructions, a false work or centering having flexible weight-resisting members held rigidly to place by removable bracing, substantially as described.

4. In arch or analogous constructions, a false work or centering having flexible members adapted to resist endwise compressive strains held rigidly to place by removable lateral bracing, substantially as described.

5. An arch or similar centering comprising uprights or columns too light to alone carry the weight of the arch without bending, and removable sway-bracing for said uprights, substantially as described.

6. An arch or similar centering comprising uprights or columns too light to alone carry the weight of the arch without bending, and removable sway-bracing serving to support said uprights against bending in all directions, substantially as described.

Signed by me at Indianapolis, county of Marion, State of Indiana, in the presence of two witnesses.

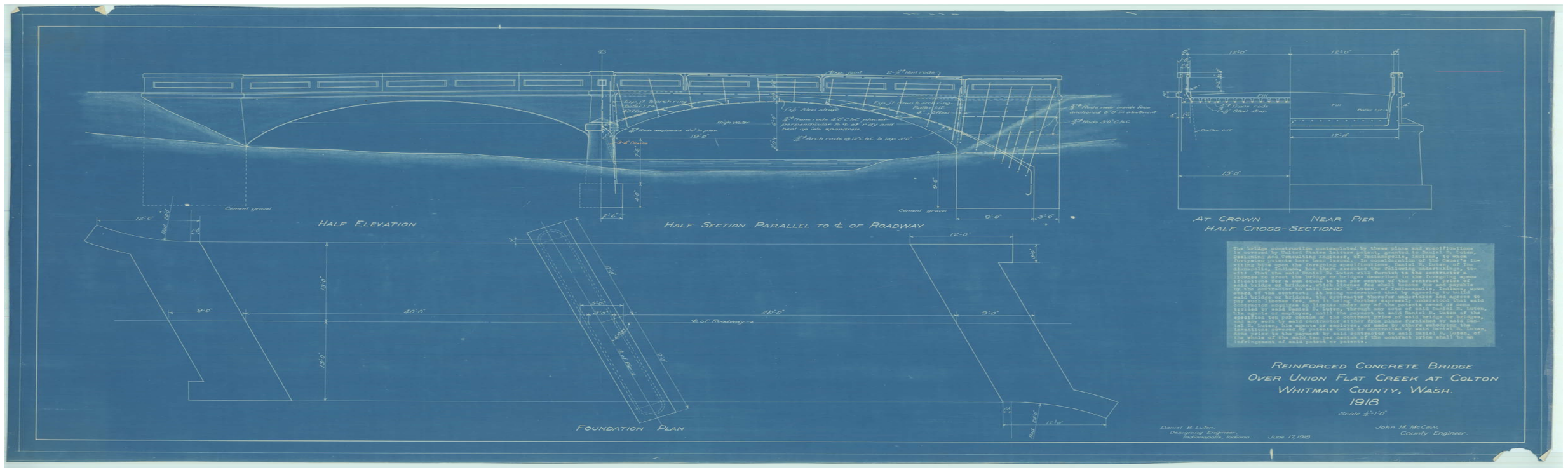
DANIEL B. LUTEN.

Witnesses:
A. C. BROWN,
J. C. STUCTSENBERG.

Sample Luten patent

Aerial photo of the Town of Colton, WA bridge looking southwesterly. Courtesy of Whitman County.

Aerial photo of Lower Seltice Bridge No. 1260-00.03 looking southwesterly. Courtesy of Whitman County.



Town of Colton, WA bridge plans. Courtesy of Whitman County.