(No Model.)

R. H. COUSINS.

BEAM OR GIRDER.

No. 417,706. Patented Dec. 24, 1889.

Fig. 1

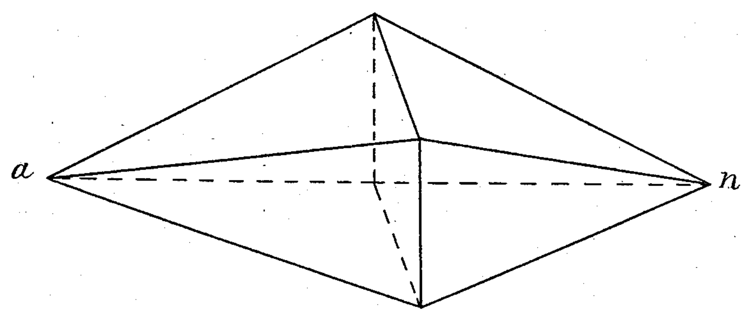
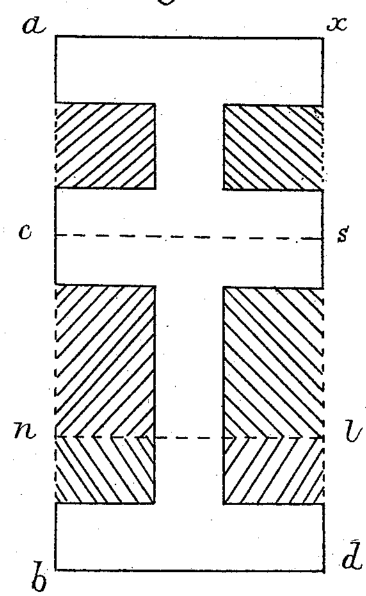


Fig. 2.



WITNESSES:

T. C. Tipton.

J. R. Lybrand.

INVENTOR

Robert Henry Cousins

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

ROBERT HENRY COUSINS, OF McKINNEY, TEXAS.

BEAM OR GIRDER.

SPECIFICATION forming part of Letters Patent No. 417,706, dated December 24, 1889.

Application filed December 17, 1888. Serial No. 293,928. (No model.)

To all whom it may concern:

Be it known that I, ROBERT HENRY COUSINS, a citizen of the United States of America, residing in the city of McKinney, in the county of Collin and State of Texas, have invented a certain new and useful Improvement in the Form or Shape of the Transverse Section of Beams, Girders, and Railroad-Rails, of which the following is a specification.

The object of my invention or improvement is to obtain the greatest transverse strength of beams, girders, and railroad-rails with the least amount of material, whereby the transverse strength is more effectually increased than by any method at present known, all of which will be apparent and understood from the following statement, taken in connection with the accompanying drawings, in which—

Figure 1 is a diagram graphically representing principles involved in my invention, and Fig. 2 is a view of a section of a beam made in accordance therewith.

The usual and only known method used by constructers of beams, girders, and railroad-rails to compute their strength and conversely that by which they are constructed to have a given transverse strength is that known as the "common theory of flexure," which theory assumes the existence of a neutral axis or fulcrum that passes through the center of gravity of the section of the beam and girder, with respect to which the moment of resistance of the section must be computed. The stress or strain in the bottom and the top fibers of the beam or girder is assumed to be an empirical quantity, called the "modulus of rupture," all of which assumptions of the common theory of flexure are erroneous and assume the existence of "mechanical conditions" that are physically impossible. I have discovered that the fulcrum or axis around which the load breaks the beam, girder, or railroad-rail, and with respect to which the moment of resistance of their transverse sections must be computed, is a line in the top or compressed side of the beam or girder, and that there is a neutral line or line of no strain within the section and parallel to the above-described axis, the compression and tensile strain increasing uniformly from this neutral line toward the top and bottom of the transverse section, respectively, and at the instant of rupture becomes the crushing and tensile strength of the material composing the beam, girder, or railroad-rail. The position of the above-described neutral line is determined from the condition that the moment of compressive resistance shall be equal to the moment of tensile resistance, both to be computed with respect to the above-described fulcrum.

Now every flanged beam, girder, and railroad-rail may be conceived to be cut from or constructed by the removal of certain portions of a rectangular beam, whose depth and breadth is the depth and breadth of the flanged beam, girder, or railroad-rail, respectively. The moment of compressive resistance of the rectangular beam may be graphically represented by two pyramids with rectangular bases placed base to base, as represented in Fig. 1. The sum of the heights or altitudes of these pyramids is the depth of the neutral line below the fulcrum or axis. The apex *a* of one pyramid represents the moment of resistance of the material of the rectangular beam at the fulcrum, and the apex *n* of the other that of the material at the neutral line, from which it is evident that the moment of compressive resistance of the compressed area of the section increases, respectively, from the fulcrum and neutral line, and that at one-half of the distance between these lines it becomes a maximum or greatest, and is represented by the bases of these pyramids. The height or altitude of each pyramid is one-half the distance between the fulcrum and the neutral line, and the base of each is one-half this height by the breadth of the rectangular beam. The volume of these two pyramids multiplied by the crushing strength is one-half the required moment of resistance of the rectangular section. From this graphic representation of the moment of compressive resistance it is evident that the material at and near one-half the depth between the neutral line and the fulcrum is the most effective in resisting the transverse load, and therefore should not be removed from the rectangular section in order to construct the flanged beam, girder, or railroad-rail of any desired shape of transverse section, as has been the practice.

In order to illustrate this process and its application, let *a b d x*, Fig. 2, represent a rectangular section from which is required to be formed a beam with flanges at the top and bottom. *n l* represent the neutral line, *a x* the axis or fulcrum, and *c s* a line at one-half the distance between *a x* and *n l*. The shaded or hatched portions of the figure represent the material that is the least effective and that should be removed to form the required section. The moment of resistance of the section that is not shaded above the line *n l* must be equal to one-half the required moment of resistance of the section. In order to preserve the required equilibrium between the moments of compressive and tensile resistance, sufficient metal must be removed from the tension or extended area immediately below the neutral line, where it is the least effective, to cause the moment of tensile resistance of the remainder to be equal to the other half of the required moment of resistance of the section.

The above-described method of constructing beams, girders, and railroad-rails of maximum strength and minimum amount of material is applicable to beams, girders, and railroad-rails when made of wood, cast-iron, wrought-iron, steel, and other metals. The converse method is equally true, that in building up a beam, girder, and railroad-rail composed of web and flanges only such material should be placed in them as is shown by the foregoing process of construction to be the most effective.

This discovery of the position of the fulcrum and of the neutral line and that the metal at one-half the distance between these lines in a transverse section is the most effective I believe to be new with me and to be of practical value in the arts and manufactures.

What I claim as my invention, and for which I desire to secure Letters Patent, is—

In a beam, girder, or railroad-rail composed of a vertical web and a flange or flanges, a mass of the metal in a flange or flanges projecting from the web at and near one-half the distance between the axis and the neutral line, for the purpose and substantially as described in the foregoing specification.

ROBERT HENRY COUSINS.

Witnesses:

THOMAS FLOURNOY MONTGOMERY,
FRANCIS HENRY WELCH.