June 28, 1927. 1,634,127

N. WAGNER

STRUCTURAL STEEL JOIST

Filed March 1, 1926 2 Sheets-Sheet 1

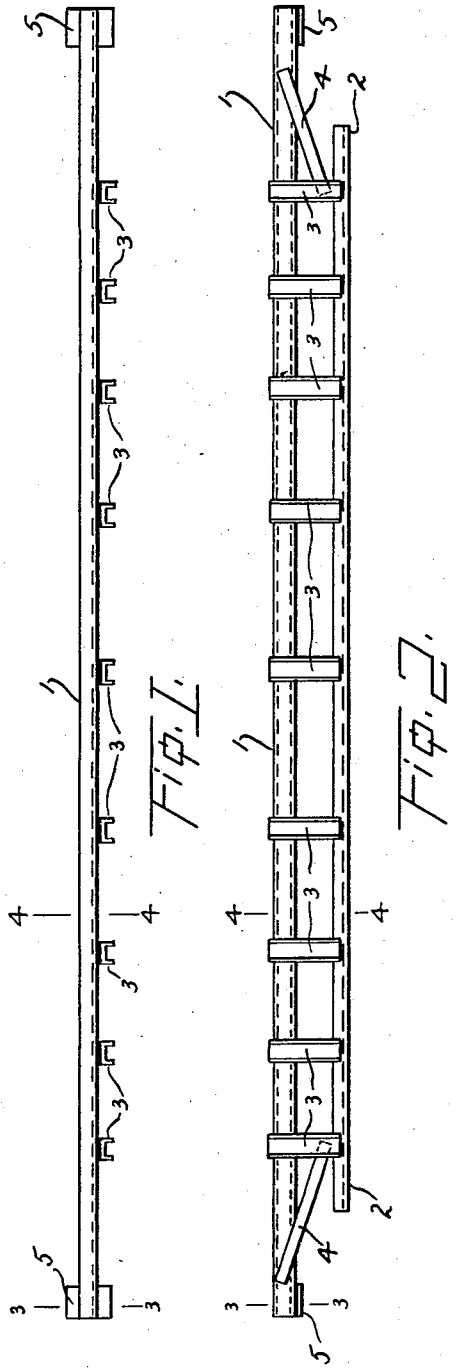


Fig. 1.

Fig. 2.

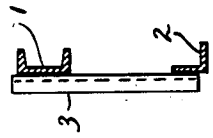


Fig. 4.

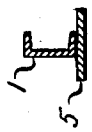


Fig. 3.

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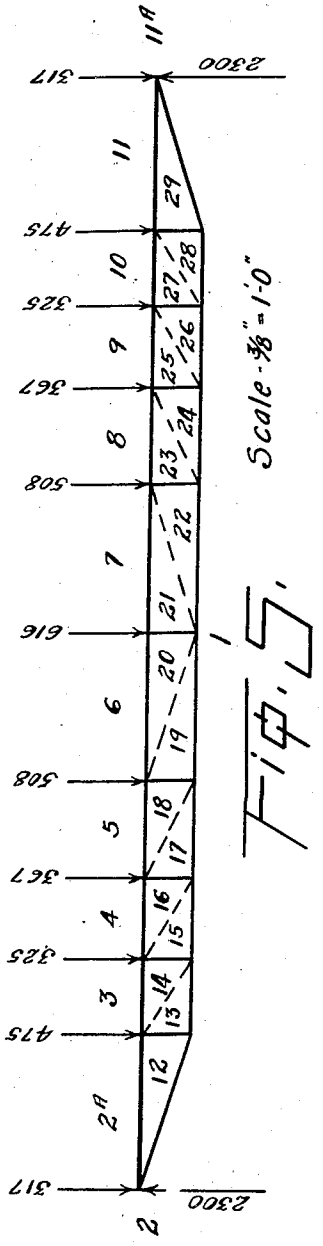


Fig. 5.

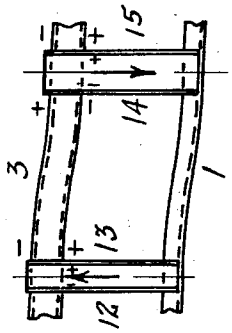


Fig. 6.

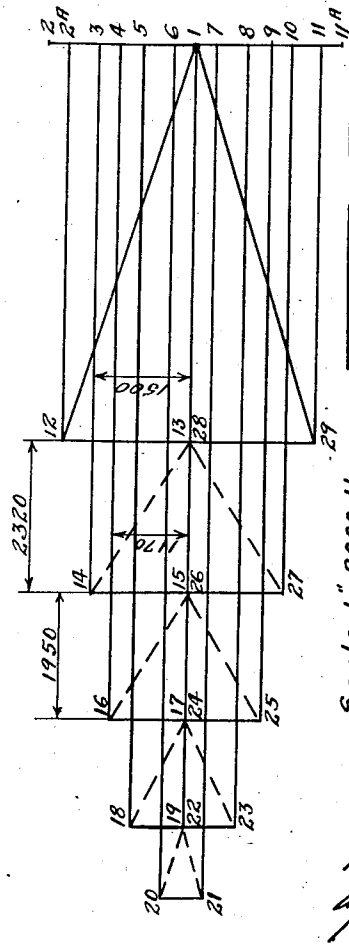


Fig. 6.

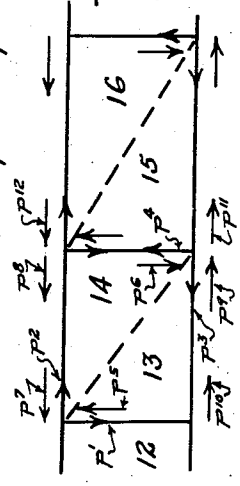


Fig. 7.

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UNITED STATES PATENT OFFICE.

NORMAN WAGNER, OF HAMILTON, ONTARIO, CANADA.

STRUCTURAL-STEEL JOIST.

Application filed March 1, 1926. Serial No. 91,583.

My invention relates to improvements in structural steel joists and the object of the invention is to provide a novel type of steel joist in which, by a novel disposition of the component members, for a given strength, the weight is reduced without the use of objectionably light material; a further object is to simplify the design to such an extent that it will affect the cost of fabrication and thus offset any extra cost of steel which it is necessary to use to insure a durable joist; a further object is to provide a joist which will lend itself readily to welding of the various connections between the component parts instead of the usual riveted connection; a further object is to provide a joist in which all members thereof are straight and do not require any other work before assembling other than shearing; a further object is to provide a joist which can be made in any structural steel shop without necessitating any additional outlay in the form of special tools or machinery; a further object is to provide a joist, all the parts of which are readily available stock material carried by all structural steel shops; a further object is to eliminate the use of the diagonal web members thus facilitating the subsequent work or erection by providing a maximum web clearance through which pipes or conduits may be threaded more readily and conveniently than where the usual sloping web members are used; a further object is to provide a joist which will lend itself readily to the application of a wood floor directly on top of the joist.

Other objects will appear in the course of the following specification.

My invention consists in the construction and arrangement of parts, all as hereinafter more particularly described and illustrated in the accompanying drawings in which:—

Fig. 1 is a top plan view of a joist constructed in accordance with my invention.

Fig. 2 is a side elevation thereof.

Fig. 3 is a section on the lines 3—3 of Figs. 1 and 2.

Fig. 4 is a section on the lines 4—4 of Figs. 1 and 2.

Fig. 5 consists of a single line diagram in which auxiliary diagonal members shown dotted have been inserted so that a stress diagram may be completed. The loads which are shown in this figure are the equivalent of an uniform load over the entire span.

Fig. 6 is the stress diagram referred to above.

Fig. 7 shows a system of stresses which are used in my joist as a substitute for the diagonal web members which have been eliminated and which I shall refer to in detail later.

Fig. 8 is a descriptive illustration of the effect of the stresses in my joist referred to in the preceding paragraph and shall be referred to in detail later.

In the drawings, like characters of reference indicate corresponding parts in the different views.

In the form illustrated, my improved joist consists of a horizontal top chord 1 of channel section and a horizontal bottom chord 2 of angle section spaced below the top chord.

The bottom chord 2 is shorter than the top chord.

Connecting the top and bottom chords 1 and 2 are a series of spaced apart substantially vertical posts 3 also of channel section.

The posts 3 are welded to the top and bottom chords.

Inclined chords 4 are welded to the top chord adjacent to its ends and to the end posts 3 at the bottom thereof so that these inclined chords 4 form end members for the joist.

Bearing plates 5 are secured to the bottom of the top chord 1 at the ends thereof.

It will be noted that, in my improved joist all members used are straight and require no work before assembling, other than shearing, so that the joist may be readily constructed in any structural steel shop without involving the use of special tools or machinery.

Another feature of my joist is that the top chord can be readily punched if desired for a mailing strip, so that a wood floor may be conveniently attached directly to the steel joist.

By the use of vertical posts 3 only, in place of the usual diagonal web members hitherto used, a maximum web clearance is provided which greatly facilitates the subsequent work of erection, as pipes and conduits may be much more conveniently threaded through the joist than is the case when diagonal web members are used, as these diagonal mem-

bers sometimes seriously interfere with the placement of pipes and conduits and considerable work is frequently involved in keeping clear of such diagonal members particularly where the pipe or conduit is not running perpendicular to the web of the joist.

A further feature of my construction is that pipes or conduits may be readily suspended from the top chord by a hanger, as the concrete floor does not prevent the use of a clip on the bottom of the top chord 1.

It will also be noted that the top chord, being a channel, will carry a substantial concentrated load at any point.

In order to describe the theory used in my novel joist Figures 5, 6, 7 and 8 will be referred to.

Referring now to Fig. 6 we have noted that the vertical component of stress in member 13—14 is 1500 pounds and the horizontal component of member 13—14 is 2320 pounds. If the member 13—14 is eliminated, as in my joist, these stresses must be accounted for.

Let us now refer to Fig. 7.

Since the diagonal member 13—14 is in tension, the vertical component of 13—14 at the upper end thereof must act downward as shown by force p^1 and the horizontal component must act to the right as shown by force p^2. At the lower end of diagonal 13—14, the vertical component of 13—14 must act upward as shown by force p^4 and the horizontal component must act to the left as shown by force p^3.

Consider now the forces p^1 and p^4 only.

To counteract these forces we must create a resisting couple of equal and opposite forces such as p^5 and p^6, p^5 acting in the line of action of p^1 and p^6 acting in the line of action of p^4. To accomplish this, my joist as illustrated uses a stiff top chord as shown in Fig. 8 and in this manner it is able to develop the resisting couple referred to.

The effect of these resisting internal forces on the top chord is to develop tension in the top flange and compression in the bottom flange adjoining the post 12—13 and compression in the top flange and tension in the bottom flange adjoining the post 14—15 as indicated by the plus (compression) and minus (tension) signs in Fig. 8. In other words half of the moment required to resist the moment of the couple p^1—p^4 is developed by the top chord adjoining post 12—13 and the remaining half of the moment is developed by the top chord adjoining the post 14—15.

In this discussion I have neglected to consider the resisting stresses developed by the bottom chord as their effect is so small as to be negligible.

At some point in the top chord between posts 12—13 and 14—15 lies the point of contraflexure where no bending moment occurs.

Having taken care of the vertical components of diagonal member 13—14 through the stiffness of the top chord, let us now turn our attention to the horizontal components of this diagonal member 13—14 namely p^2 and p^3.

To resist these we must again create a resisting couple of equal and opposite forces. This time we accomplish this by making our posts stiff enough to develop these forces.

Referring to Fig. 7 again, it might be noted that p^2 or p^3 represents the horizontal shear across the entire panel. We are therefore justified in making posts 12—13 and 14—15 each assume their share of this shear. To accomplish this we use two forces p^7 and p^8 to resist p^2, also p^9 and p^{10} to resist p^3.

The forces p^7 and p^8 each of which is equal to ½ of p^2 act in the line of action of p^2 but in opposite direction and also forces p^9 and p^{10} each of which is equal to ½ of p^3 act in the line of action of p^3 but in opposite direction. The forces p^7 plus p^8 form a couple with forces p^9 plus p^{10} which resist the couple p^2—p^3. We now make post 12—13 stiff enough to develop the resisting couple p^7—p^{10} and the post 14—15 is made strong enough to develop the resisting couple p^8—p^9 from panel 13—14, plus the resisting couple p^{11} and p^{12} which in turn is developed to resist the horizontal component of diagonal member 15—16 in panel 15—16.

In this way my joist eliminates all diagonal web members by using stiff vertical and horizontal members rigidly connected together to take care of the stresses which are ordinarily developed in the diagonal members commonly used in general construction work.

The axial stress in the top chord as shown in the stress diagram in Fig. 6 can not be neglected. It is therefore necessary to combine the axial stress and bending stress in each panel to find the maximum stress in the top chord.

The axial stress in the bottom chord is assumed to remain a simple tensile stress. No bending stress is figured in combination with it as stated previously.

Since the top chord develops the entire vertical components of the resisting stresses it relieves the interior posts of all axial stress.

Since the vertical component of the diagonal web member (which is eliminated in my joist) represents the vertical shear in the panel, it can be readily seen that the vertical shear controls the spacing of the posts, as the top chord must not be stressed beyond the allowable stress for the combination of stresses as previously stated.

The spacing for this type of joist is indicated in Fig. 5.

If the bottom chord is made stiff, as would be the case if this chord had top and

bottom flanges, the resisting moment developed by the bottom chord would share proportionately with the top chord in resisting the vertical shear and in this way the posts might be placed farther apart towards the ends of the joist. This design is not economical however in the shorter spans.

Various modifications may be made in my invention as stated above without departing from the spirit thereof or the scope of the claims and therefore the exact forms shown are to be taken as illustrative only and not in a limiting sense and I desire that only such limitations shall be placed thereon as are imposed by the prior art or are specifically set forth in the appended claims.

From the foregoing it will be noted that I have devised an improved form of structural steel joist which will provide a maximum strength with a minimum weight of suitable material and whereby the objects of my invention have been attained.

What I claim as my invention is:

1. A structural steel joist of the class described comprising, spaced apart top and bottom chords one of which has top and bottom flanges, and posts secured to said chords and constituting the entire web system over a portion of the joist, said posts rigidly secured to that chord having top and bottom flanges.

2. A structural steel joist of the class described comprising, spaced apart top and bottom chords and posts secured to said chords and constituting the entire web system for a portion of the joist, the top chord having top and bottom flanges and the posts rigidly secured to said top chord.

NORMAN WAGNER.