July 10, 1928.

1,676,538

C. B. FOSTER

FABRICATED STEEL TOWER OR DERRICK CONSTRUCTION

Filed July 17, 1926

3 Sheets-Sheet 1

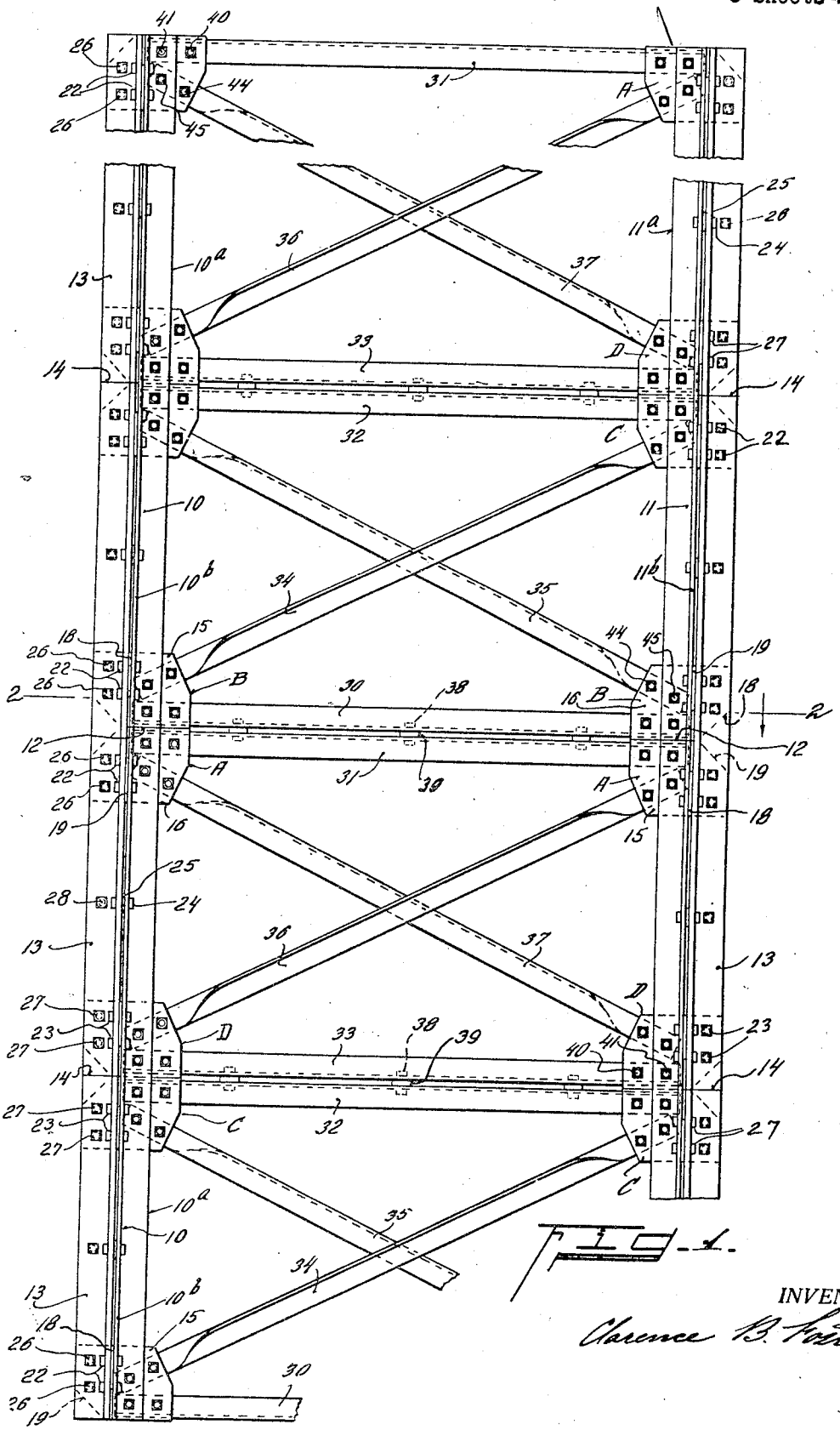


FIG. 1.

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FABRICATED STEEL TOWER OR DERRICK CONSTRUCTION

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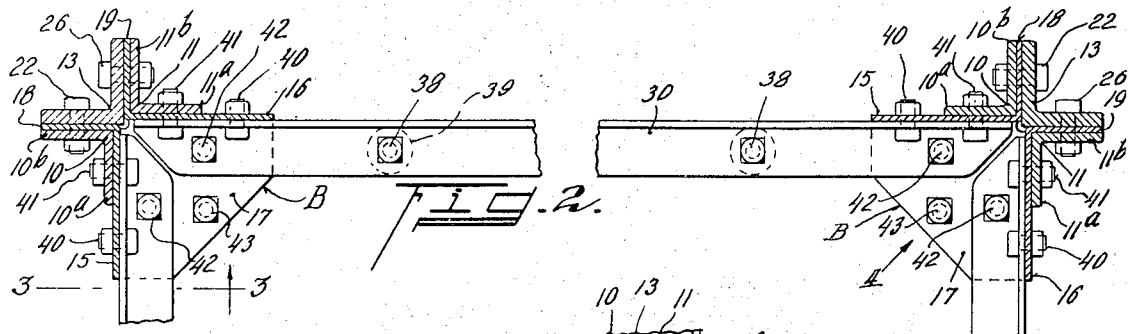


Fig. 2.

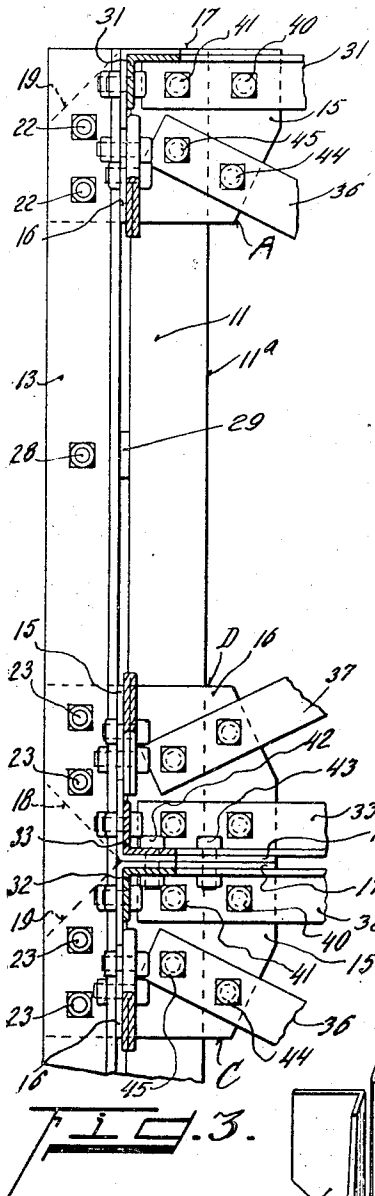


Fig. 3.

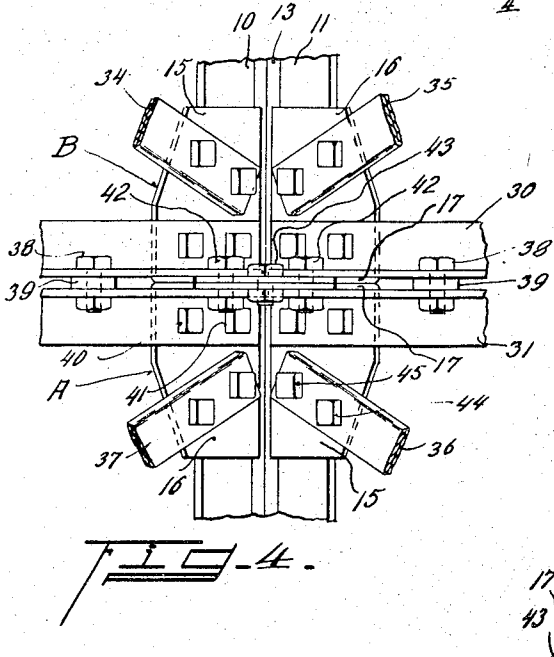


Fig. 4.

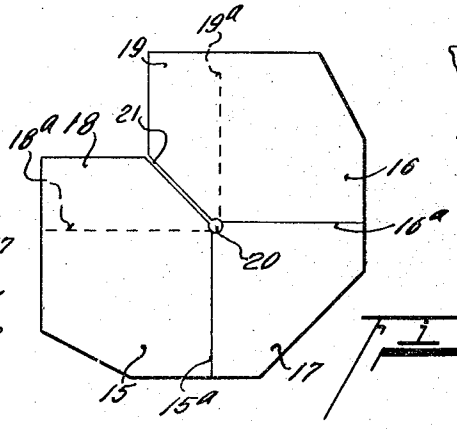


Fig. 5.

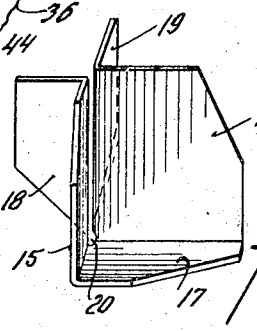


Fig. 6.

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FABRICATED STEEL TOWER OR DERRICK CONSTRUCTION

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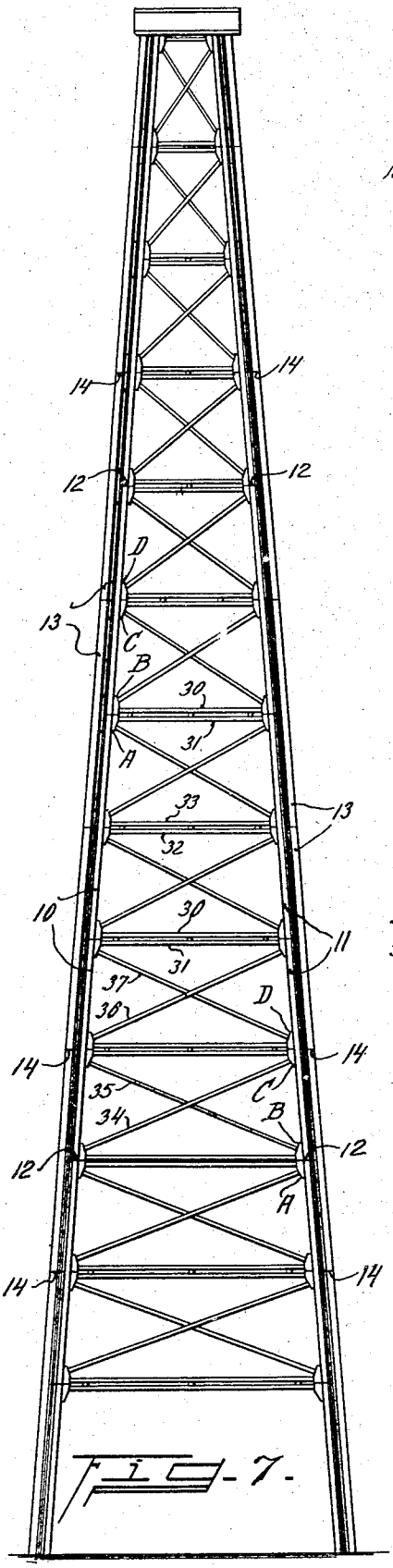


Fig. 7.

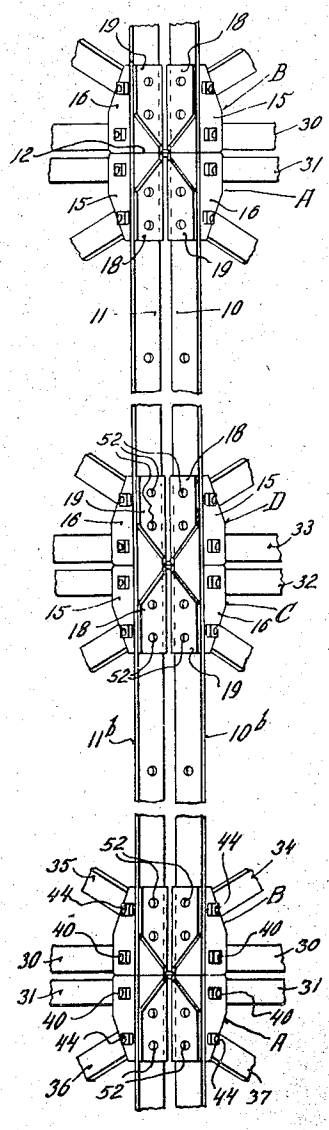


Fig. 8.

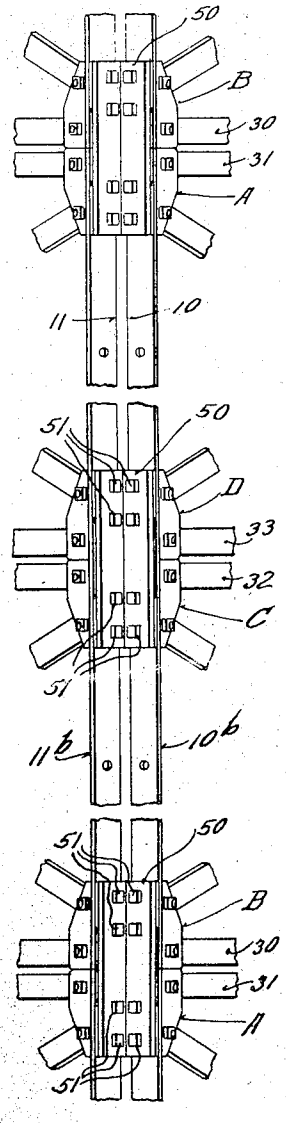


Fig. 9.

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Patented July 10, 1928. 1,676,538

UNITED STATES PATENT OFFICE.

CLARENCE B. FOSTER, OF GLENDALE, CALIFORNIA, ASSIGNOR OF ONE-SIXTH TO FREDERICK L. FEISTHAMEL, ONE-SIXTH TO ARTHUR J. CARR, AND ONE-SIXTH TO THOMAS A. COLLINS, ALL OF LOS ANGELES, CALIFORNIA.

FABRICATED-STEEL TOWER OR DERRICK CONSTRUCTION.

Application filed July 17, 1926. Serial No. 123,134.

This invention relates to an improved type of fabricated steel tower or derrick construction, and is particularly directed to that class of structure in which the corner leg columns and associated girts are formed of standard structural angles.

It is the major purpose of the present invention to produce an improved type of heavy duty corner construction formed of fabricated steel angles associated in a particular relationship to produce adjacent sides connected to a corner leg column, with said column comprised of two opposed inner leg angles and an outer intermediate leg angle arranged in back-to-back relationship to form a triple-angle leg column cross-shape in cross section, and with the transverse girts of each adjacent side connected to one of said inner leg angles and the outer leg angle connected only to said inner leg angles, whereby said outer leg angle may be independently removed to convert the heavy duty structure into a structure suitable for lighter duty; and to provide a novel type of compound gusset-bracket adapted for association with the leg angles and transverse girts to strengthen the structure at points of juncture of the side members with said corner column.

A further object resides in incorporating such a construction in a tower or derrick structure in a manner permitting the erection of such a structure progressively in stories or tiers each of which may be finished to a horizontal level, and in which the corner leg columns are each formed of three strings of angle leg sections vertically aligned to abut one upon the other with the sections of the outer intermediate string arranged in break-joint relationship with those of the two inner opposed strings of leg sections.

A still further object is to incorporate such a construction in a well derrick gradually tapering upwardly and arranged for conversion from a heavy duty drilling derrick to a lighter pumping derrick in an easy, quick, and economical manner.

In the drilling of wells, the derrick is subjected to very heavy loads and strains and must for this reason be of very sturdy construction, while a derrick used for operating a completed well is not subjected to such heavy loads or strains and can therefore be of much lighter construction.

A heavy derrick suitable for drilling is quite expensive and as a matter of economy some operators have established a practice of dismantling the heavy derrick used during drilling and of replacing it by a lighter derrick after the well is on production, the heavy derrick being assembled elsewhere for use in drilling another well. While this practice is cheaper than providing new derricks for every well, the dismantling and erection amounts to an item of great expense.

It is therefore of great economical importance to so design a well derrick that it may be of such strength as to be first used as a drilling derrick and can be subsequently converted, at a minimum of expense, into a lighter pumping derrick, without excessive dismantling of parts and so that such parts are fully available for replacement to quickly and easily reconvert the structure back to a drilling derrick, or may be completely salvaged for use in the building of another drilling derrick. It is of further importance that a well derrick be well braced and reinforced, especially at the corner legs, to withstand strains tending to bend or twist the structure, and for this reason it is desirable that the girts of each side of the structure be connected to the corresponding girts of the adjacent sides by horizontal gusset means, that the girts and braces be connected to the leg columns by vertical gusset means, and that such gusset means be of such character that their securance in place is not entirely dependent upon bolts or like means.

Therefore, among the further objects of this invention are; to provide an integral compound gusset bracket adapted for association with a corner leg column and the two adjacent sides of the structure, and providing a horizontal gusset plate forming an independent connecting means between the horizontal girts of said adjacent sides, and two vertical gusset plates each associated with one of said sides; to provide such gusset bracket with angled wings or anchor plates adapted to be clamped between the outer and inner leg angles of the corner column; and to provide a compound gusset bracket of the character, which may consist of a single sheet metal stamping.

Various other objects and advantages will

be more fully apparent from the following description of the accompanying drawings, which form a part of this disclosure, and which illustrate a preferred form of embodiment of the invention.

Of the drawings:

Fig. 1 is an elevation of a tower structure constructed in accordance with the present invention.

Fig. 2 is an enlarged plan section, partly broken, taken on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary vertical section taken on line 3—3 of Fig. 2.

Fig. 4 is a fragmentary elevation of a corner portion of the tower, looking outwardly in the direction indicated by the arrow 4 in Fig. 2.

Fig. 5 is a plan view of the gusset bracket blank before being bent to form.

Fig. 6 is a perspective view of one of the gusset brackets as it will appear before the bolt holes are punched therein.

Fig. 7 is an elevation of a drilling derrick constructed in accordance with the present invention.

Fig. 8 is an enlarged fragmentary elevation of one corner of the derrick as it will appear with the outer intermediate leg angles removed.

Fig. 9 is a similar elevation showing the angles' joint-plates which may be used to replace the removed intermediate leg angles.

In Figs. 1 to 6 there is illustrated a heavy duty type of structure in the form of a square tower having four corner leg columns connected together by transverse girts and diagonal sway braces which form the respective sides of the structure. The several leg columns are of duplicate construction and each is formed of three strings of angle sections disposed in back-to-back relationship to form a leg column substantially cross-shape in cross section, with the sections of each string vertically aligned to abut one upon the other.

The inner opposed angle leg sections 10 and 11 are disposed with their respective flanges 10^a and 11^a extended in the planes of the respective adjacent sides of the tower and with their other flanges 10^b and 11^b extending outwardly, and the respective leg sections 10 and 11 of the several corner leg columns are arranged in horizontal alignment so as to bring the several lines 12 of abutment at coincident vertically spaced intervals, whereby the tower may be assembled progressively in stories or tiers to a horizontal level. The outer intermediate angle leg sections 13 are disposed between the inner opposed leg sections 10 and 11 with their flanges in parallel relationship with the flanges 10^b and 11^b of said inner leg angles and said outer leg angles are disposed in brake-joint relationship with the inner leg angles 10 and 11 so that their lines 14 of abutment come half way between those of the inner leg angles, as shown in Fig. 1.

Disposed at each end of each pair of the inner leg angle sections 10 and 11 is a compound gusset bracket of novel construction, formed to provide two vertical gusset plates 15 and 16 disposed at right angles to each other, a horizontal gusset plate 17 connecting said vertical gusset plates, and two vertical anchor plates 18 and 19 extending outwardly from and at right angles to the respective vertical gusset plates. This gusset bracket is preferably formed of a single sheet metal stamping of the contour illustrated in Fig. 5, said stamping being formed with a central aperture 20 and a slit 21 extending inwardly to intersect said aperture. In the forming of the bracket from said stamping, the anchor plates 18 and 19 may be bent back along the dotted lines 18^a and 19^a and at right angles to the vertical gusset plates 15 and 16, and said vertical gusset plates 15 and 16 may then be bent upwardly along the lines 15^a and 16^a and at right angles to the horizontal gusset plate 17, thus forming a bracket of substantially the shape illustrated in Fig. 6, said bracket being, by preference, subsequently punched or bored to accommodate the several rivets or bolts by which it is secured into the tower structure.

At each level or tier of the tower structure, as defined by the lines 12 of abutment between the vertically adjacent inner leg angles, two of the above described gusset brackets are positioned in reverse relationship with their respective horizontal gusset plates 17 back-to-back and their respective vertical plates extended in opposite directions; and such gusset brackets are disposed so that their vertical gusset plates 15 and 16 closely engage the inner surfaces of the flanges 10^a and 11^a of the respective inner leg angles 10 and 11, and with their vertical anchor plates 18 and 19 disposed between the adjacent outer leg angle section 13, and the respective flanges 10^b and 11^b of the inner leg angles 10 and 11, as clearly shown in Fig. 2, these particular gusset brackets being indicated generally, by the reference characters A and B.

Certain other intermediate gusset brackets C and D, similar to those above described, are preferably located at approximately the middle of the respective pairs of inner leg angles 10 and 11 of each corner column and are disposed in the same relationship to the several leg angles as are the gusset brackets A and B, that is, each pair of said brackets C and D are in reverse relationship vertically with their verical anchor plates positioned between the leg angles and their horizontal gusset plates in back-to-back relationship.

In erecting the structure, the several leg

angles of each corner leg column are secured together by bolts 22, 23, and 24, the bolts 22 extending through the flange 10^b of the respective leg angles 10, the anchor flanges of the respective gusset brackets A and B, and the adjacent flange of the respective leg angle 13, the bolts 23 extending through the flange 10^b, the anchor flange of the respective gusset brackets C and D, and the adjacent flanges of the leg angles 13, and the bolts 24 extending through the flanges 10^b, through suitable spacers 25, and through the adjacent flange of the respective leg angle 13; and by bolts 26, 27, and 28 extending in like manner through the flange 11^b of the respective leg angles 11, the anchor plates of the respective gusset plates and the adjacent flanges of the respective leg angles 13, the bolts 28 extending through suitable spacers 29, in the same manner as do the bolts 24, it being understood that a greater number of the bolts 24 and 28, with their associated spacers, may be provided if desired.

The side structure connecting the adjacent corner leg column is illustrated as comprising a plurality of girts and braces, and as such girts and braces included in each story or tier are duplicates of those included in the other stories or tiers, only one set thereof will herein be described in detail. The sides of each story includes lower and upper transverse marginal girts 30 and 31, so called because they define the respective lower and upper margins of the respective story, a pair of intermediate transverse girts 32 and 33, a lower pair of diagonal sway or anti-vibration braces 34 and 35, and an upper pair of similar sway or anti-vibration braces 36 and 37.

The several transverse girts are of angle form and may be of identical size and shape, with the ends of their horizontal flanges cut angular as shown in Fig. 2, and the respective ends of each girt are disposed in nested relationship inside the cooperating gusset bracket with the horizontal flange of said girt engaging the horizontal gusset plate thereof and the vertical flange of said girt engaging the adjacent vertical gusset plate of said bracket. This relationship, will in the complated structure, dispose the several girts in pairs, which pairs are secured together at spaced intervals by bolts 38 extending through the horizontal flanges of the respective girts and through suitable intermediate spacers 39.

Each end of each girt is secured to the associated gusset bracket by a bolt 40, extending through its vertical flange and the adjacent vertical gusset plate portion of said bracket, and is secured to said bracket and the adjacent inner leg angle by a bolt 41 extending through the vertical flange of said girt, said vertical gusset plate portion of said bracket and through said inner leg angle, said vertical gusset plate portion of the bracket being thus clamped between said girt and said inner leg angle, as is plainly evident in Fig. 2. Bolts 42 extend through the horizontal flanges of the respective girts and through the horizontal gusset plate portions 17 of each pair of brackets A, B, and C, D, thus securing said pairs of brackets together independently of their connection with the corner legs, and said horizontal gusset plates are further secured together independently also of the girts, by a bolt 43.

The several diagonal sway braces are of angle form and their ends are swaged to bring both flanges thereof to vertical parallel contact thus providing securing ends of double thickness. These respective sway braces are each secured to the vertical gusset plate portions of the associated brackets by bolts 44 and 45, the bolts 44 extending through said braces and the vertical gusset plate portions of said brackets, and the bolts 45 extending through said braces, said bracket and the adjacent inner angle leg sections.

The above described construction provides a tower or similar structure in which the respective corner leg columns each consists of three strings of angle leg sections arranged in back-to-back relationship and secured together throughout their lengths at spaced intervals to form corner legs substantially cross-shape in cross section, and transverse girts and braces connected to said corner legs by compound horizontal and vertical gusset brackets, with such gusset brackets forming reinforcing connections joining the transverse girts and braces of one side of the tower to those of the adjacent side thereof. Such construction further provides corner leg columns consisting of two vertical strings of opposed inner corner leg angles and an intermediate string of outer corner leg angles connected together in a manner permitting a removal of said outer leg angles to convert the structure to one adaptable for use for lighter service.

In Fig. 7, the above described construction is shown incorporated in an oil well drilling derrick, and when such a derrick is to be converted to a lighter pumping derrick the outer leg angles 13 thereof will be removed, Fig. 8 showing a corner of the derrick with such leg angles removed. In certain instances the structure may be used in this condition, but it is believed to be desirable to substitute for the removed leg angles, short angle joint-plates 50, as shown in Fig. 9, these joint-plates being secured in place by bolts 51 which extend through the same bolt holes as did the respective bolts 22, 23, 26, and 27 previously used to secure the leg angles 18 in place. In case the joint-plates 50 are not used, suitable bolts may be provided to extend through the bolt holes

52 and secure the vertical anchor plates 18, 19 to the respective inner leg angles 10 and 11.

The several stories or tiers of the tower are herein described as being of like construction, but it is to be understood that this has more particular reference to the major portion thereof, for it will be evident, particularly to those skilled in the oil industry, that in a well derrick certain portions of the structure will necessarily be somewhat modified to accommodate the walking-beam, draw-works and other portions of the drilling or pumping equipment and also that suitable provisions will be made for the derrick ladder, platform, water table, crown-block, etc.

While the structure herein illustrated and described is fully capable of fulfilling all of the objects primarily stated it is to be understood that I do not wish to restrict the present invention to the specific embodiment herein disclosed, for it is susceptible of embodiment in various other forms, all coming within the scope of the claims, which follow.

I claim as my invention:

1. In a structure of the nature disclosed, the combination of: relatively spaced triple-angle corner leg columns, each comprised of only two opposed inner leg angles and one intermediate outer leg angle disposed in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shape in cross section; transverse girts forming the respective sides of the structure and connecting the adjacent corner leg columns, the girts of each side being secured at opposite ends to the adjacent inner leg angles of the associated leg columns; means connecting the inner leg angles of each corner column independently of the intermediate leg angles thereof; and independent removable means for securing the intermediate leg angle of each corner column to the inner leg angles thereof, whereby the intermediate leg angles may be independently removed.

2. In a structure of the nature disclosed, the combination of: relatively spaced triple-angle corner leg columns, each comprised of only two opposed inner leg angles and one intermediate outer leg angle disposed in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shape in cross section, with one flange of each inner leg angle disposed parallel to the adjacent side of the structure; transverse girts forming the respective sides of the structure and connecting the adjacent corner leg columns, the girts of each side being secured to the respective parallel flanges of the adjacent inner leg angles; means connecting said flanges of both inner leg angles of each corner leg column independently of the intermediate leg angle thereof; and removable means for securing the other flanges of both inner leg angles of each corner leg column to the intermediate leg angle thereof, whereby said intermediate leg angle may be independently removed.

3. In a structure of the nature disclosed, the combination of: relatively spaced triple-angle corner leg columns, each comprised of only two opposed inner leg angles and one intermediate outer leg angle disposed in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shape in cross section; transverse girts forming the respective sides of the structure and connecting the adjacent corner leg columns; means for securing the girts of each side to the adjacent inner leg angle of each associated corner column; and independent removable means for securing the intermediate leg angle only to the inner leg angles, whereby said intermediate leg angle may be separately removed.

4. In a structure of the nature disclosed, the combination of: relatively spaced triple-angle corner leg columns, each comprised of only two opposed strings of inner leg angles and one intermediate string of outer leg angles arranged in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shape in cross section, the leg angles of each string being vertically aligned to abut one upon another, the the inner leg angles of said two opposed strings being horizontally aligned so that the leg angles of both said opposed strings abut at coincident levels, and the intermediate leg angles being disposed to break-joint with the inner leg angles; transverse girts forming the respective sides of the structure and connecting the adjacent corner leg columns; means for securing the girts of each side to the adjacent inner leg angles of each associated corner column; and independent removable means for securing the intermediate leg angles only to the inner leg angles, whereby said intermediate leg angles may be separately removed.

5. In a structure of the nature disclosed, the combination of: relatively spaced triple-angle corner leg columns, each comprised of two opposed strings of inner leg angles and an intermediate string of outer leg angles arranged in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shape in cross section, the leg angles of each string being vertically aligned to abut one upon another, the inner leg angles of said two opposed strings being horizontally aligned so that the leg angles of both said opposed strings abut at coincident levels, and the intermediate leg angles being disposed to break-joint with the inner leg angles; transverse girts forming the respective sides of the structure and connecting the adjacent corner leg columns; means for se-

curing the girts of each side to the adjacent inner leg angles of each associated corner column; means connecting the inner leg angles of each corner leg column independently of the intermediate leg angles thereof; and independent means for securing the intermediate leg angles only to the inner leg angles, whereby said intermediate leg angles may be separately removed.

6. In a structure of the nature disclosed, the combination of: a triple-angle corner leg column formed of two opposed strings of vertically aligned inner leg angles with the angles of each string horizontally aligned with those of the other string and an intermediate string of vertically aligned outer leg angles disposed in break-joint relationship with said inner leg angles, the three strings of leg angles being arranged in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shape in cross section; reinforcing brackets positioned at opposite ends of said inner leg angles and secured thereto to form direct connections between both strings of inner leg angles; transverse girts forming adjacent sides of the structure, the girts of each side being secured to the adjacent inner leg angles and to said brackets and means for securing the intermediate leg angles only to the inner leg angles, whereby said intermediate leg angles may be separately removed.

7. In a structure of the nature disclosed, the combination of: a triple-angle corner leg column formed of two inner strings of vertically aligned leg angles with the angles of each string horizontally aligned with those of the other string, and an intermediate string of vertically aligned leg angles disposed in break-joint relationship with the inner leg angles, the three strings of leg angles being arranged in back-to-back relationship to form a corner leg column substantially cross-shape in cross section; compound gusset brackets reversely arranged in pairs and positioned at the abutting ends of the inner leg angles, each bracket having two vertical gusset plate portions connected by a horizontal gusset plate portion, with each vertical gusset plate secured to the adjacent inner leg angle and the horizontal gusset plate forming a direct connection between the two inner strings of leg angles; means securing the horizontal gusset plates of each pair of brackets together to connect the several leg angles of both inner strings; transverse girts and braces forming adjacent sides of the structure, the girts and braces of each side being secured to the adjacent inner leg angles and the adjacent brackets; and separate means for securing the intermediate leg angles to the inner leg angles independently of the girts, braces, and brackets.

8. In a structure of the nature disclosed, the combination of: relatively spaced corner leg columns each formed of two opposed strings of vertically aligned leg angles with the flanges of each string disposed at right angles to the adjacent flanges of the opposed string, and with the inner flange of each string disposed parallel to the adjacent side of the structure and the other flange thereof extended outwardly, the leg angles of both strings being horizontally aligned to bring their respective abutment joints at coincident levels; transverse girts forming the respective sides of the structure and connecting the adjacent leg columns; means for securing the girts of each side to the adjacent inner flanges of the associated leg columns; intermediate angle connecting elements associated with each corner leg column and disposed between the outer flanges of both strings of leg angles thereof in positions to span said respective abutment joints; and separate means for securing said connecting elements to said outer flanges of the leg angles of both opposed strings.

9. A compound gusset bracket for a fabricated steel structure, comprised of: two angularly disposed vertical gusset plate portions; a horizontal gusset plate portion connecting the lower edges of said vertical gusset plate portions; and two vertical anchor plate portions, each connected to an inner vertical edge of one of said vertical gusset plate portions and angularly disposed relative thereto.

10. A compound gusset bracket for a fabricated steel structure, comprised of: a single sheet metal stamping having a horizontal triangular gusset plate, two vertical gusset plates extending upwardly from the respective opposite edges of said horizontal gusset plate, and two vertical anchor plates each extending outwardly from the inner vertical edge of one of said vertical gusset plates and angularly disposed relative thereto.

11. In a structure of the nature disclosed, the combination of: relatively spaced triple-angle corner leg columns, each comprised of only two opposed strings of vertically aligned leg angles and one intermediate string of vertically aligned leg angles arranged in relatively spaced back-to-back relationship to form a corner leg column substantially cross-shaped in cross section, the leg angles of both opposed strings of all of said leg columns being respectively, of corresponding lengths so as to break joint at coincident levels, and the intermediate leg angles of each corner column being disposed in break-joint relationship with those of the companion opposed strings; and transverse girts forming the respective sides of the structure and connecting the adjacent corner leg columns, the girts of each side being se-

cured to the adjacent opposed strings of the associated corner leg columns independently of the intermediate leg angles thereof.

12. A combination as defined in claim 7, in which each compound gusset bracket has two vertical anchor plates each connected to one of the vertical gusset plate portions thereof and positioned between one inner leg angle and the adjacent intermediate leg angle.

13. A combination as defined in claim 7, in which each girt is of angle form and is nested in a horizontal corner of one of said gusset brackets with its horizontal flange connected to the horizontal gusset plate and its vertical flange connected to the adjacent vertical gusset plate of said bracket.

14. A combination as defined in claim 4, in which the girts of each side comprise upper girts secured to the upper ends of the inner leg angles of the associated corner leg columns and lower girts secured to the lower ends of said inner leg angles.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 8th day of July, 1926.

CLARENCE B. FOSTER.