

Nov. 21, 1950

E. A. CAMPBELL

2,530,807

JACKING STRUCTURE FOR TOWERS

Filed Oct. 31, 1949

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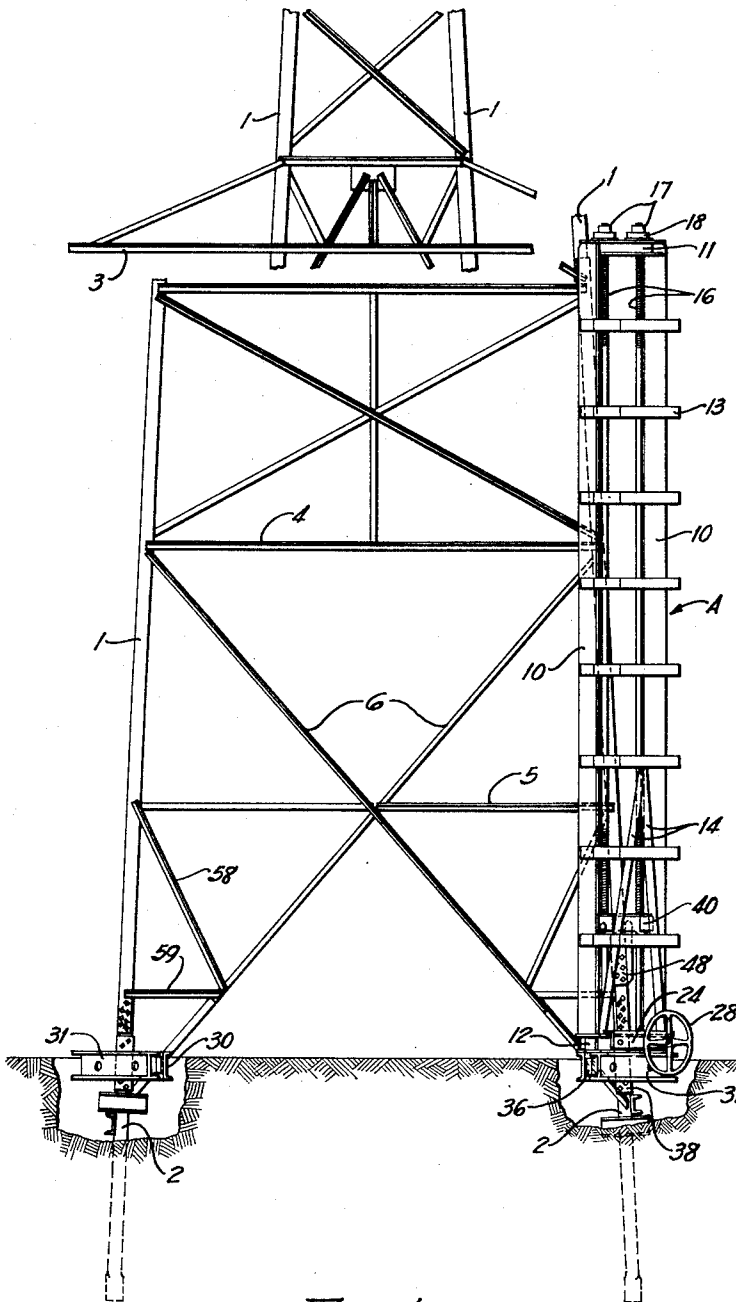


Fig. 1

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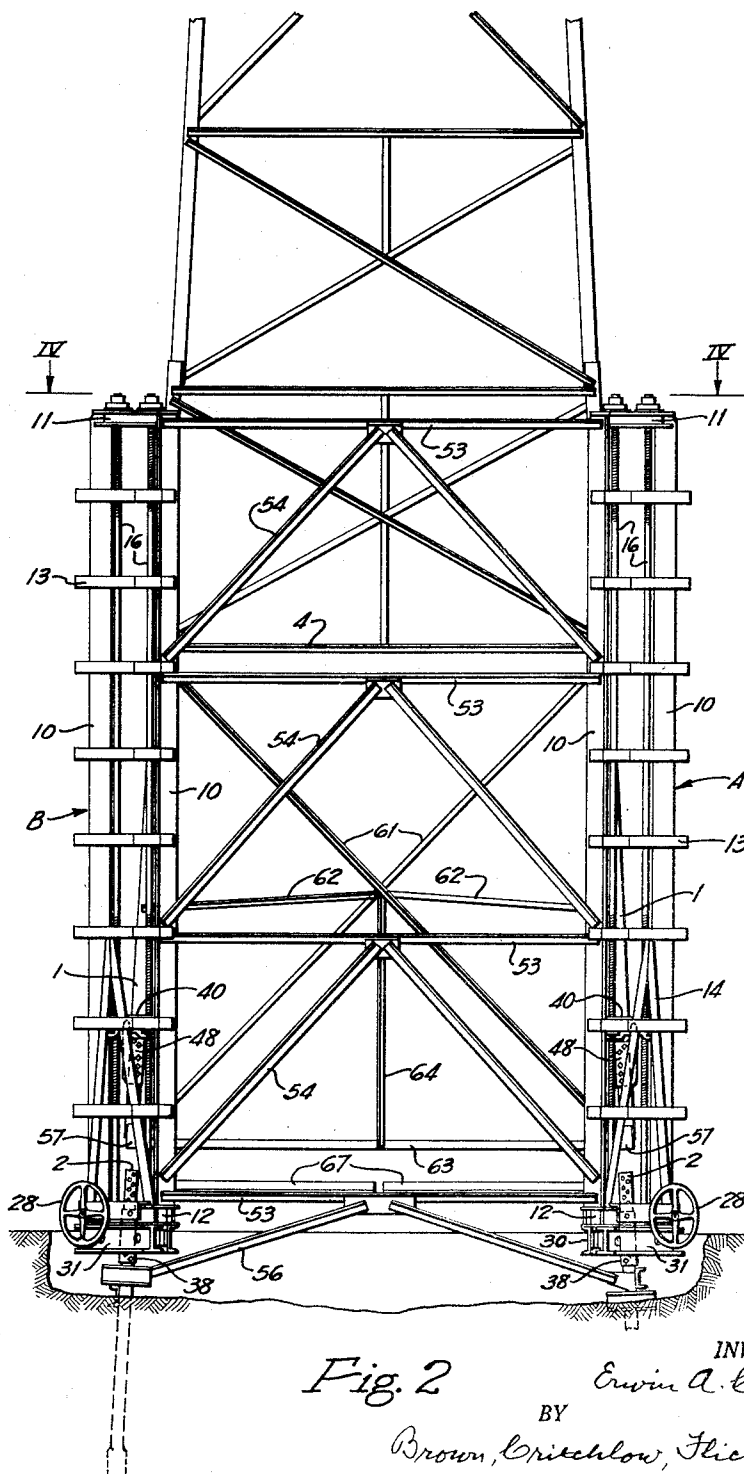
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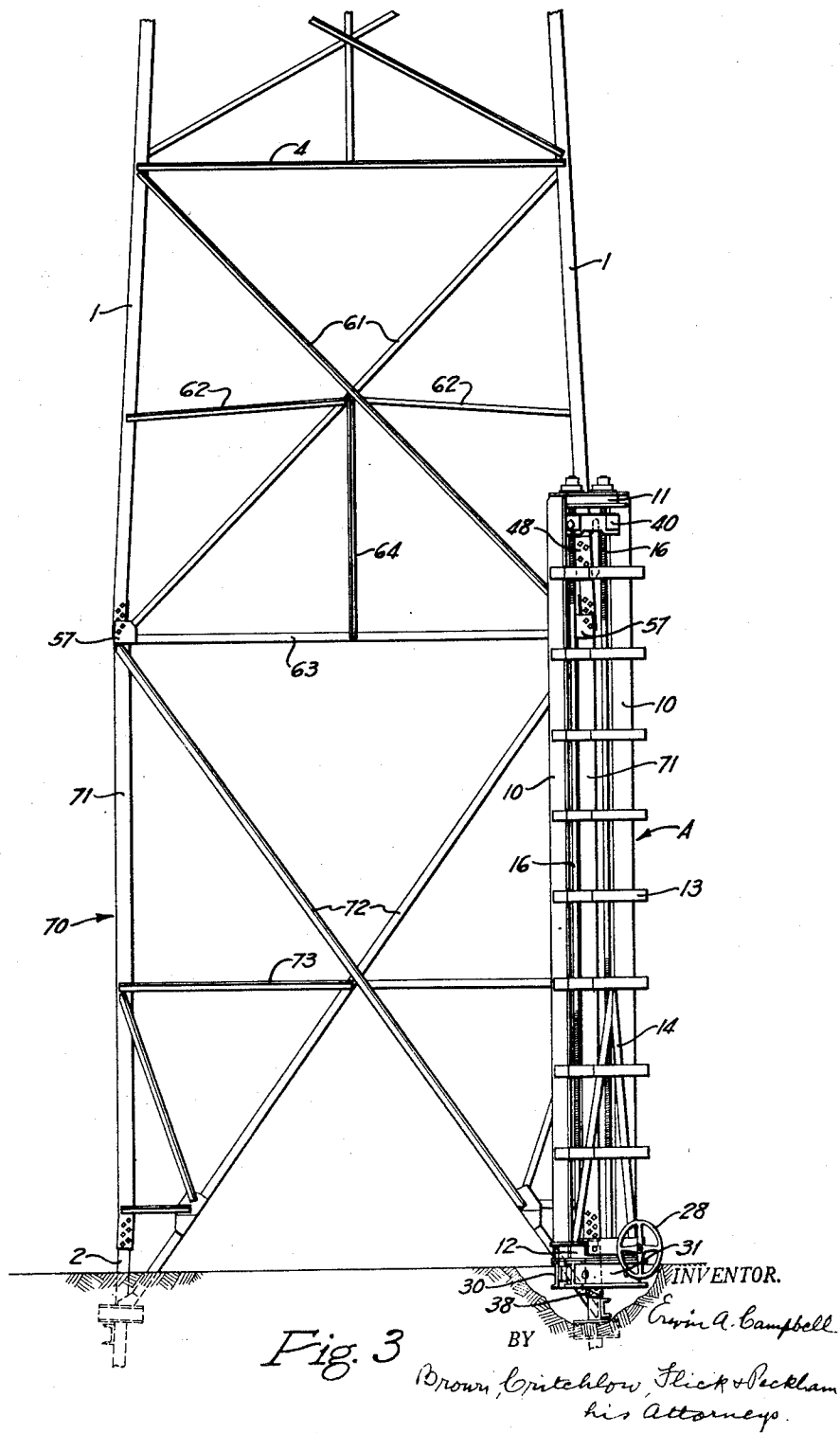
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Fig 4

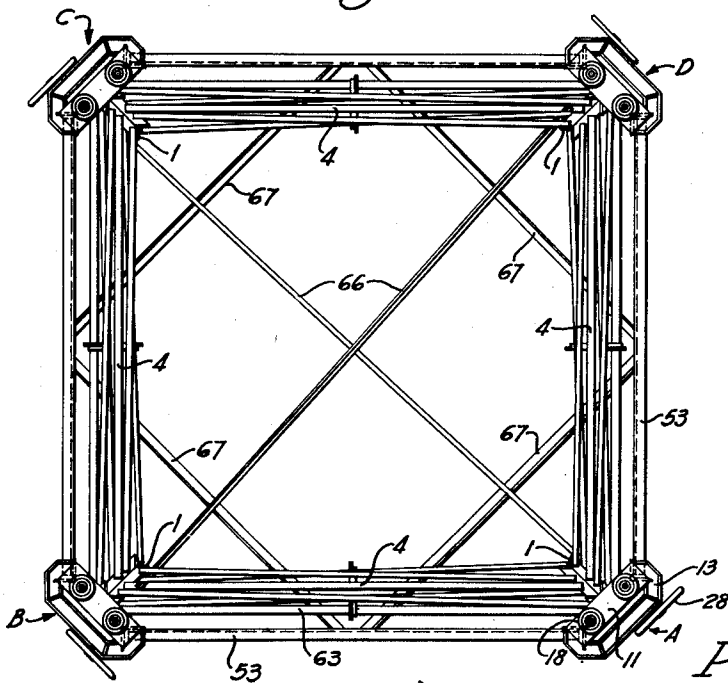


Fig 8

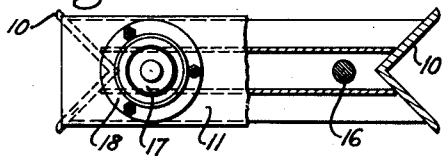


Fig 9

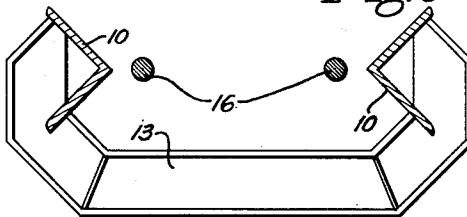


Fig 10

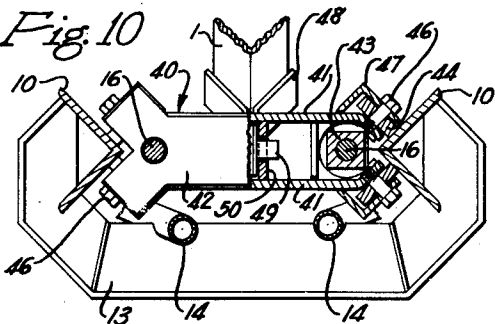
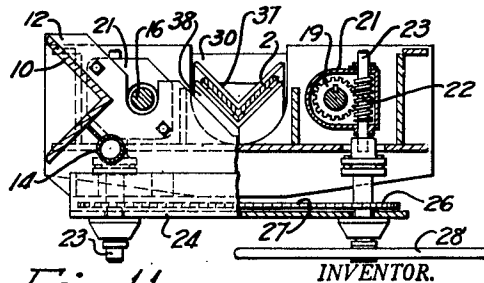


Fig. 11

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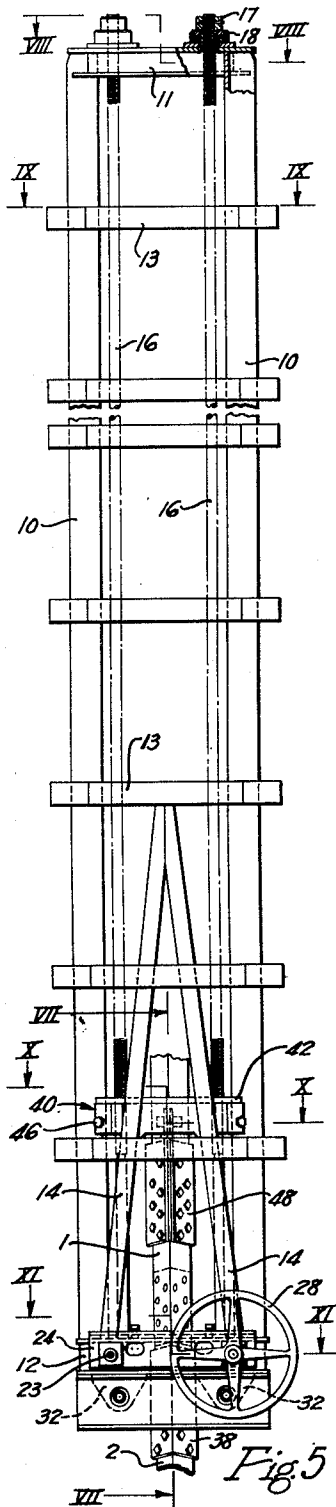
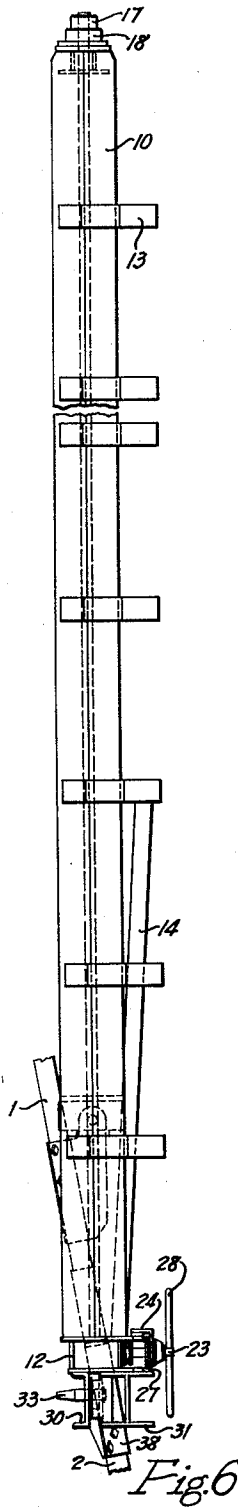
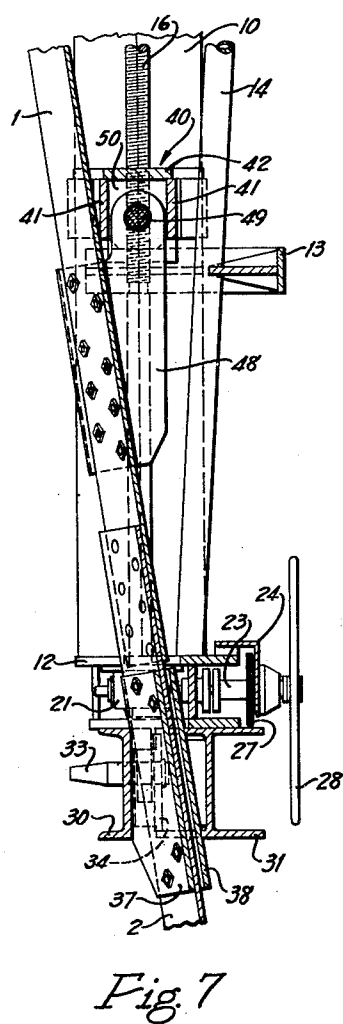


Fig. 7

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UNITED STATES PATENT OFFICE

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JACKING STRUCTURE FOR TOWERS

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11 Claims. (Cl. 254—92)

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This invention relates to screw jacks, and more particularly to a jacking structure for lifting a tower to permit an extension to be built under it.

Skeleton towers having legs, girts and braces formed from structural steel members, are used for supporting high tension electric power lines. In some locations it has been found that, due to the erection of houses and buildings, such transmission towers no longer support the power lines high enough in the air; and, due to this later construction near the towers, there is no room for relocated tower bases. To construct new and taller towers and transfer the transmission lines to them, without cutting off the supply of electric power, would be impracticable. Therefore, it has been proposed that the present towers be increased in height. For obvious reasons, it is not feasible to build additional sections on top of the towers, so the only alternative is to lift the towers and build additional sections beneath them. The problem then becomes one of providing means capable of safely lifting the towers.

It is among the objects of this invention to provide tower elevating apparatus, which is stable, which can be built around the lower part of a tower, which can readily raise the tower, which safely supports the tower without interfering with construction of a tower extension section beneath the raised tower, and which is relatively simple in construction and easy to operate.

In accordance with this invention, the elevating apparatus is in the form of a jacking structure having a separate jack for each leg of the tower with which the structure is to be used. The several jacks are rigidly connected by suitable bracing to form a strong and stable structure. Each of the jacks includes a vertical frame and has means for connecting the lower end of the frame to a tower leg near the surface of the ground so that the jack frame will be supported by the tower leg. The jack frames support vertical screws, preferably two in each frame. The screws are rotatably mounted at their upper ends in the top of the frame and are suspended therefrom so that they will be in tension when the jacks are in use. The screws are rotated in unison from their lower ends. Threaded on each pair of screws in a jack frame is a lifting member which travels up and down the screws when they are turned. Means is provided for connecting this lifting member to the tower leg near the lower end of the frame. The frame and lifting member are connected to the tower leg preferably by vertically spaced clamps. After the clamps have been secured to the legs of the tower each leg can be separated into two sections between the clamps attached to it, and then by turning all of the jack screws at once the tower can be slowly elevated in the jacking structure. A tower section of the desired height then is

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constructed inside of the jacking structure and is connected at its lower ends to the leg stubs that support the jacking structure. The upper end of the added tower section is connected to the lower end of the tower, now located near the top of the jacking structure. The jacking structure then can be removed from the tower, the height of which thus has been increased.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which Fig. 1 is a fragmentary side view of a transmission tower with one of my jacks mounted in operative position and with the support for another of the jack frames connected to another leg of the tower; Fig. 2 is a side view of the tower with the jacking structure complete and with the tower elevated a few inches; Fig. 3 is a side view of the tower with the tower extension in place and with all but one of the jacks removed; Fig. 4 is a horizontal section through the tower taken on the line IV—IV of Fig. 2, showing the jacking structure in plan; Fig. 5 is an enlarged side view of one of the jacks; Fig. 6 is an edge view of the jack; Fig. 7 is an enlarged vertical section taken on the line VII—VII of Fig. 5; and Figs. 8, 9, 10 and 11 are enlarged horizontal sections taken on the lines VIII—VIII, IX—IX, X—X and XI—XI of Fig. 5.

Referring to Fig. 1 of the drawings, a conventional electric transmission tower is shown which is constructed of structural steel angle members. The tower has four legs, each of which has an upper section spliced near the ground to a lower section 2. The lower section, sometimes called the stub, is anchored in the ground. The tower tapers upwardly and has one or more cross arms 3 near its top for supporting electric transmission lines. The legs are connected near the base of the tower by horizontal girts 4 and 5 and inclined braces 6. In order to elevate the tower the two sections 1 and 2 of each leg are disconnected at the splice, along with the inclined braces 6 that connect the upper section of one leg to the lower section of another leg, and then the tower above the stubs 2 is raised. This is done by means of a jacking structure that now will be described.

The jacking structure includes four jacks, A, B, C and D, one for each tower leg as shown in Fig. 4. The jacks are located outside of the tower and are connected rigidly together by braces so that the jacking structure surrounds the lower part of the tower. As shown best in Figs. 5 to 11, each jack includes a column or vertical frame having a pair of parallel vertical side rails 10 rigidly connected at their upper ends by a crossbeam 11, and rigidly connected at their lower ends by a hollow base member 12. The side rails are formed from angle bars pointing toward each other so that their side surfaces converge toward

the center of the frame. The rails are connected at vertically spaced intervals by horizontal braces 13 that curve outward away from the rails. The lower part of the frame is further braced by a pair of tubular braces 14 welded to the base member 12 and converging upward and outward to one of the horizontal braces 13.

Located between the side rails of the frame is a pair of long parallel screws 16, the upper ends of which extend up through the crossbeam at the top of the frame. Heads 17 are secured to the projecting upper ends of the screws, these heads being rotatably mounted in and supported by bearings 18 mounted on top of the beam. The screws are thus suspended in the frame from their upper ends. The lower end of each screw extends down into the hollow base member 12 where it is splined in a worm gear 19 (Fig. 11) journaled in a box 21 mounted in the base member. Each gear meshes with a worm 22 on a shaft 23 that extends out through the front of the base member and through a bracket 24 attached to the top of that member. Between the base member and bracket, each shaft supports a sprocket 25 around which a chain 27 extends. The outer end of one shaft carries a hand wheel 28, by which the shaft can be turned, whereupon the other shaft will be turned with it by means of the chain and sprockets, so that the two screws are rotated in unison.

The base of each frame is designed to rest on top of a frame support formed from spaced inner and outer horizontal supporting beams 30 and 31, as shown in Figs. 6 and 7. The frame is provided with a pair of depending lugs 32 that will project down between the two supporting beams, where they are locked in place by removable pins 33 inserted through openings in the lugs, inner channel beam 30, and a vertical plate 34 welded in the back of outer I beam 31. The two beams are detachably connected together at their ends by brackets 35 secured to plate 34. Supporting beams 30 and 31 are intended to be clamped to a leg stub 2 just below the splice. For this purpose the inner beam is secured to an inclined clamping member 37 adapted to fit inside of a leg stub. The outer beam is provided with a similar clamping member 38 adapted to fit over the outside of the stub. The two clamping members are bolted to the stub between them before the jack frame is set on the frame support.

The actual lifting of each tower leg is done by means of a lifting member 40 attached to the leg and to the screws 16 in the adjoining jack. As best shown in Figs. 5, 7 and 10, the lifting member has parallel side walls 41 connected along their upper edges by a top plate 42. The ends of this plate are provided with holes through which the jack screws extend. Rigidly mounted in opposite ends of the lifting member are nuts 43 which are threaded on the screws, so that when the screws are turned the lifting member will be moved vertically thereby. To guide the lifting member and to help relieve the screws of lateral strains, the opposite ends of the lifting member carry guide rollers 44 that engage the converging surfaces of the adjoining side rails 10 of the jack frame. Each roller is journaled on a bolt 46 screwed into an in-turned end of one of the side walls of the lifting member. The outer end of the bolt is supported by a bracket 47 welded to a side of the lifting member.

The lifting member is attached to leg section 1 above the splice by means of a clamp 48 which is shaped to fit over the outer surface of the leg.

The outer part of the clamp has a projection that extends upward into the lifting member, and the projection is provided with a transverse hole through which a pivot pin 49 extends. The ends of the pin also extend through holes in a pair of parallel vertical plates 50 welded to the opposite sides of the lifting member. This pivotal suspension of the clamp from the lifting member prevents the clamp from causing the lifting member to bind on the rails 10 and the screws in case there is any lateral movement of the leg relative to the jack.

When it is desired to raise a tower, such as shown in Fig. 1, an excavation first is made around each tower leg so that there will be room to attach the frame supports to the legs below the splices where the upper and lower leg sections 1 and 2 are joined. Bolt holes are then drilled in each leg stub below the splice, and additional bolt holes are drilled in each leg above the splice. These holes permit the clamps of the jacks to be attached to the legs. The next step is to bolt clamping members 37 and 38 to each leg stub 2 and to bolt clips 36 to inner frame-supporting beam 30. With the frame supports thus attached to the leg stubs, a jack column or frame is set on each frame support with its lugs 32 projecting down between the two beams of the support. Locking pins 33 are driven through the two beams and lugs to lock the frame on the support. Fig. 1 shows the frame supports attached to the legs, and a jack frame mounted on one of the supports. After all of the jacks have been placed in position, the lifting leg clamps 48 are bolted to legs 1 above the splices.

The next operation is to rigidly connect the four jack frames together around the tower by means of horizontal girts 53 and inclined braces 54, as shown in Fig. 2. Additional braces are added later, after certain interfering braces on the tower have been removed, as now will be described. First, the lower sections of inclined braces 6 of the tower must be removed, one of these being removed at a time and replaced immediately by an inclined brace 55 connecting the leg stub to the lowest girt of the jacking structure. The hand wheels 28 of the four jacks then are turned to apply a lifting force to the tower sufficient to relieve the load at the leg splices, whereupon the splice bolts can be removed. These bolts are removed from only one face of the tower at a time, and new gusset plates 57 are welded to the lower ends of the upper leg sections 1. Horizontal girts 5, inclined braces 6 and supplementary braces 58 and 59 then are removed from the same tower face and are replaced immediately by inclined braces 61 connected to the new gusset plates, and by substantially horizontal girts 62. Also, a lower girt 63 is added which has a vertical brace 64 extending from its center up to the point where the inclined braces 61 cross. Diagonal braces 56 (Fig. 4) also are added to connect the lower ends of leg sections 1. Braces 66 and girts 63 tie the lower ends of leg sections 1 together. The jacks are then operated again to raise the tower about one foot, as shown in Fig. 2. Diagonal braces 67 (Figs. 2 and 4) then can be installed in the lower part of the jacking structure to reinforce it.

The tower and jacking structure now are ready for the major elevating operation. This is accomplished by turning the hand wheels at the bottoms of the jacks in unison so that all four corners of the tower are raised simultaneously

until they have reached the desired height. A tower extension 70, as shown in Fig. 3, then is erected inside the jacking structure in the space between the leg stubs 2 and the bottom of the elevated tower. This extension includes vertical extension legs 71 connected to the upper ends of the leg stubs and to the lower ends of legs 1. The extension legs also are connected by inclined braces 72 to the leg stubs. Horizontal girts 73 help strengthen the extension. After the extension has been erected, the jacks are operated to lower the lifting members 40 just enough to take the strain off lifting clamps 48 so that they can be disconnected from leg sections 1. The jacking structure braces are removed next, and then the jack frames are removed from their supports. Following this, the frame supports are disconnected from the leg stubs and the excavations around the stubs are filled in. Fig. 3 shows extension 70 in place and all of the jacking structure, except one jack, removed from the tower. The height of the tower has been increased by the height of the extension.

When jack screws of the great length (twenty feet) necessary here are used, they must always remain under tension while the load is on them. Otherwise, they would buckle or would have to have a very great diameter to support a compression load. The screws 16 shown herein are always under tension because they are suspended from their upper ends, while their lower ends are splined in worm gears 19 so that no resistance will be offered to stretching of the screws when the load is on them.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, means adapted to connect the lower end of the frame to a tower leg near the surface of the ground to support the frame from said leg, a vertical screw rotatably mounted at its upper end in the top of the frame and suspended therefrom, means mounted in one end of the frame for rotating the screw, a lifting member threaded on the screw for vertical travel when the screw is turned, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and the lower end of the frame the upper section of the leg can be raised.

2. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, a support for the lower end of the frame adapted to be fastened to a tower leg near the surface of the ground, a pair of parallel vertical screws rotatably mounted at their upper ends in the top of the frame and suspended therefrom, means mounted in one end of the frame for rotating the two screws in unison, a lifting member threaded on both screws for vertical travel when they are turned, and means adapted

ed to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and said support the upper section of the leg can be raised.

3. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, means adapted to connect the lower end of the frame to a tower leg near the surface of the ground to support the frame from said leg, a vertical screw rotatably mounted at its upper end in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the screw, a lifting member threaded on the screw for vertical travel when the screw is turned, a clamp adapted to be fastened to said tower leg, and means for pivotally connecting said clamp to the lifting member on a horizontal axis extending across said leg, whereby after the leg has been separated into two sections at a point between the clamp and the lower end of the frame the upper section of the leg can be raised.

4. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame having parallel sides, means adapted to connect the lower end of the frame to a tower leg near the surface of the ground to support the frame from said leg, a vertical screw rotatably mounted at its upper end in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the screw, a lifting member threaded on the screw for vertical travel when the screw is turned, rollers carried by said member and engaging said sides of the frame for guiding the lifting member, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and the lower end of the frame the upper section of the leg can be raised.

5. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame having parallel side rails, each of said rails having a pair of side surfaces converging toward the center of the frame, means adapted to connect the lower end of the frame to a tower leg near the surface of the ground to support the frame from said leg, a pair of parallel vertical screws rotatably mounted in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the two screws in unison, a lifting member threaded on both screws for vertical travel when they are turned, a pair of rollers carried by each end of said member in engagement with said converging surfaces of the adjoining side rail for guiding the lifting member, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and the lower end of the frame the upper section of the leg can be raised.

6. A jacking structure for a tower provided with a plurality of legs, said structure compris-

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ing a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame having parallel side rails, each of said rails having a pair of side surfaces converging toward the center of the frame, a support for the lower end of the frame, a clamp adapted to be fastened to a tower leg near the surface of the ground to support said frame support, a pair of parallel vertical screws suspended and rotatably mounted in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the two screws in unison, a lifting member threaded on both screws for vertical travel when they are turned, a pair of rollers carried by each end of said member in engagement with said converging surfaces of the adjoining side rail for guiding the lifting member, and a clamp adapted to be fastened to said tower leg and suspended from said lifting member between said screws, whereby after the leg has been separated into two sections at a point between the two clamps the upper section of the leg can be raised.

7. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, a support for the lower end of the frame adapted to be fastened to a tower leg near the surface of the ground, a pair of parallel vertical screws rotatably mounted at their upper ends in the top of the frame and suspended therefrom, worm gears rigidly mounted on the lower ends of the screws, parallel worms meshing with said gears, means for turning one of the worms, sprockets rigidly connected to both worms, a chain connecting the sprockets so that both screws will be turned in unison, a lifting member threaded on both screws for vertical travel when they are turned, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and the lower end of the frame the upper section of the leg can be raised.

8. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, a support for the lower end of the frame, a clamp adapted to be fastened to a tower leg near the surface of the ground for supporting said frame support, means for detachably mounting the frame on said support, a vertical screw rotatably mounted at its upper end in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the screw, a lifting member threaded on the screw for vertical travel when the screw is turned, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and the clamp the upper section of the leg can be raised.

9. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, inner and outer clamping members adapted to be fastened to the inner and outer surfaces of a tower leg near the surface of the ground, inner

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and outer horizontal beams rigidly mounted on said clamping members, means detachably connecting said beams together in laterally spaced relation, the lower end of the frame being provided with a depending projection inserted between said beams with the frame resting on them, a fastening member extending through said beams and frame projection to detachably hold the frame on the beams, a pair of parallel vertical screws rotatably mounted at their upper ends in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the two screws in unison, a lifting member threaded on both screws for vertical travel when they are turned, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point between the lifting member and said clamping members the upper section of the leg can be raised.

10. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame having parallel side rails, inner and outer clamping members adapted to be fastened to the inner and outer surfaces of a tower leg near its lower end, inner and outer horizontal beams rigidly mounted on said clamping members, means detachably connecting said beams together in laterally spaced relation, the lower end of the frame being provided with a depending projection inserted between said beams with the frame resting on them, a fastening member extending through said beams and frame projection to detachably hold the frame on the beams, a pair of parallel vertical screws rotatably mounted at their upper ends in the top of the frame and suspended therefrom, means mounted in the lower end of the frame for rotating the two screws in unison, a lifting member threaded on both screws for vertical travel when they are turned, rollers carried by said member and engaging said side rails of the frame for guiding the lifting member, a clamp adapted to be fastened to said tower leg above said clamping members, and means for pivotally connecting said clamp to the lifting member on a horizontal axis extending across said leg, whereby after the leg has been separated into two sections at a point between said clamp and said clamping members the upper section of the leg can be raised.

11. A jacking structure for a tower provided with a plurality of legs, said structure comprising a separate jack for each tower leg and braces for rigidly connecting the jacks together around the tower; each jack including a vertical frame, means connected to the lower end of the frame for supporting it, a vertical screw rotatably mounted at its upper end in the top of the frame and suspended therefrom, means mounted in one end of the frame for rotating the screw, a lifting member threaded on the screw for vertical travel when the screw is turned, and means adapted to connect said lifting member to said tower leg, whereby after the leg has been separated into two sections at a point below the lifting member the upper section of the leg can be raised.

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No references cited.