US 20080092478A1

(19) United States
(12) Patent Application Publication
Min et al.
(10) Pub. No.: US 2008/0092478 A1
(43) Pub. Date: Apr. 24, 2008

(54) FRICTION TYPE RETROFITTING DEVICE FOR STEEL TOWER STRUCTURES

(76) Inventors: **Kyung Won Min**, Seoul (KR); **Ji Hun Park**, Gyeonggi-do (KR); **Byoung Wook Moon**, Gyeonggi-do (KR); **Sung Kyung Lee**, Seoul (KR)

Correspondence Address:
L.C. BEGIN & ASSOCIATES, PLLC
510 HIGHLAND AVENUE, PMB 403
MILFORD, MI 48381

(21) Appl. No.: **11/636,158**

(22) Filed: **Dec. 8, 2006**

(30) **Foreign Application Priority Data**

Oct. 24, 2006 (KR) 10-2006-0103282
Oct. 24, 2006 (KR) 10-2006-0103283

Publication Classification

(51) **Int. Cl.**
E04H 12/08 (2006.01)

(52) **U.S. Cl.** **52/651.01**

(57) **ABSTRACT**

Disclosed herein is a friction type retrofitting device for steel tower structures. The retrofitting device includes a coupling part which couples an outer column and an inner column of a post of a steel tower to each other using an angle bracket and a bolt. A slot is formed in a portion of the outer column to which the coupling part is coupled. A friction plate is provided to contact an outer circumferential surface of the slot. Thereby, wind energy transmitted to the steel tower is attenuated by friction between the outer circumferential surface of the slot of the coupling part and the friction plate.

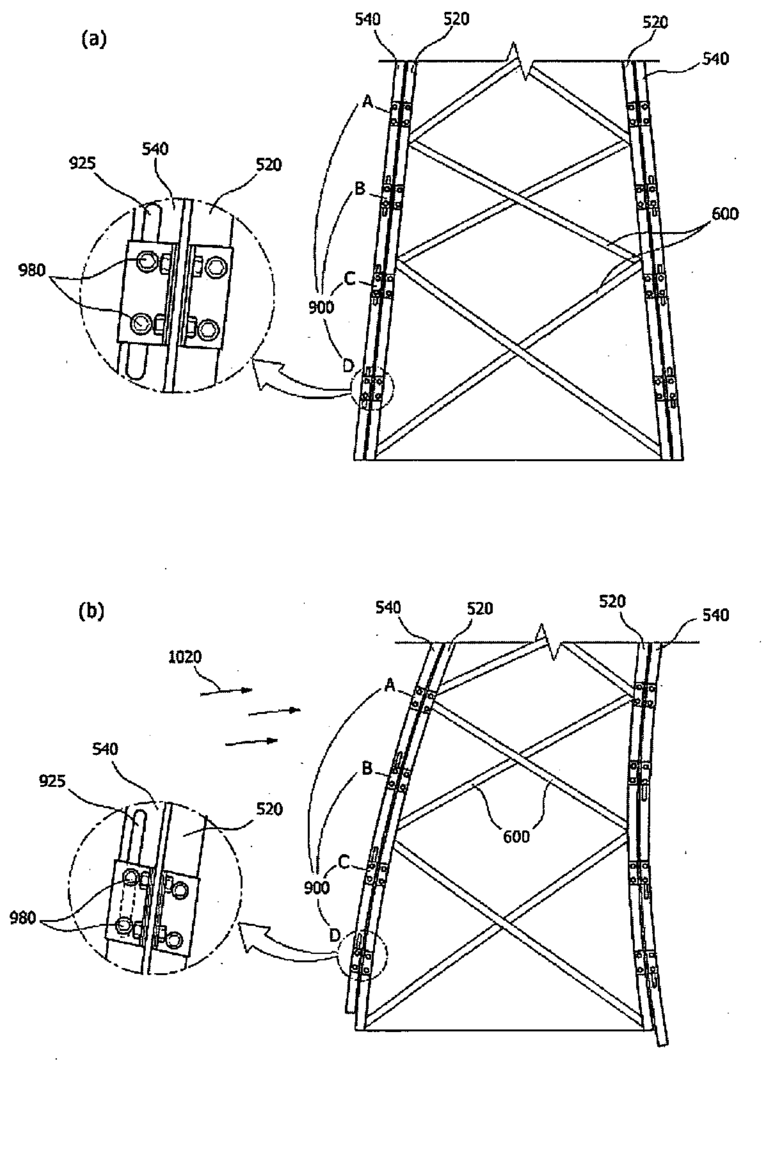


FIG. 1

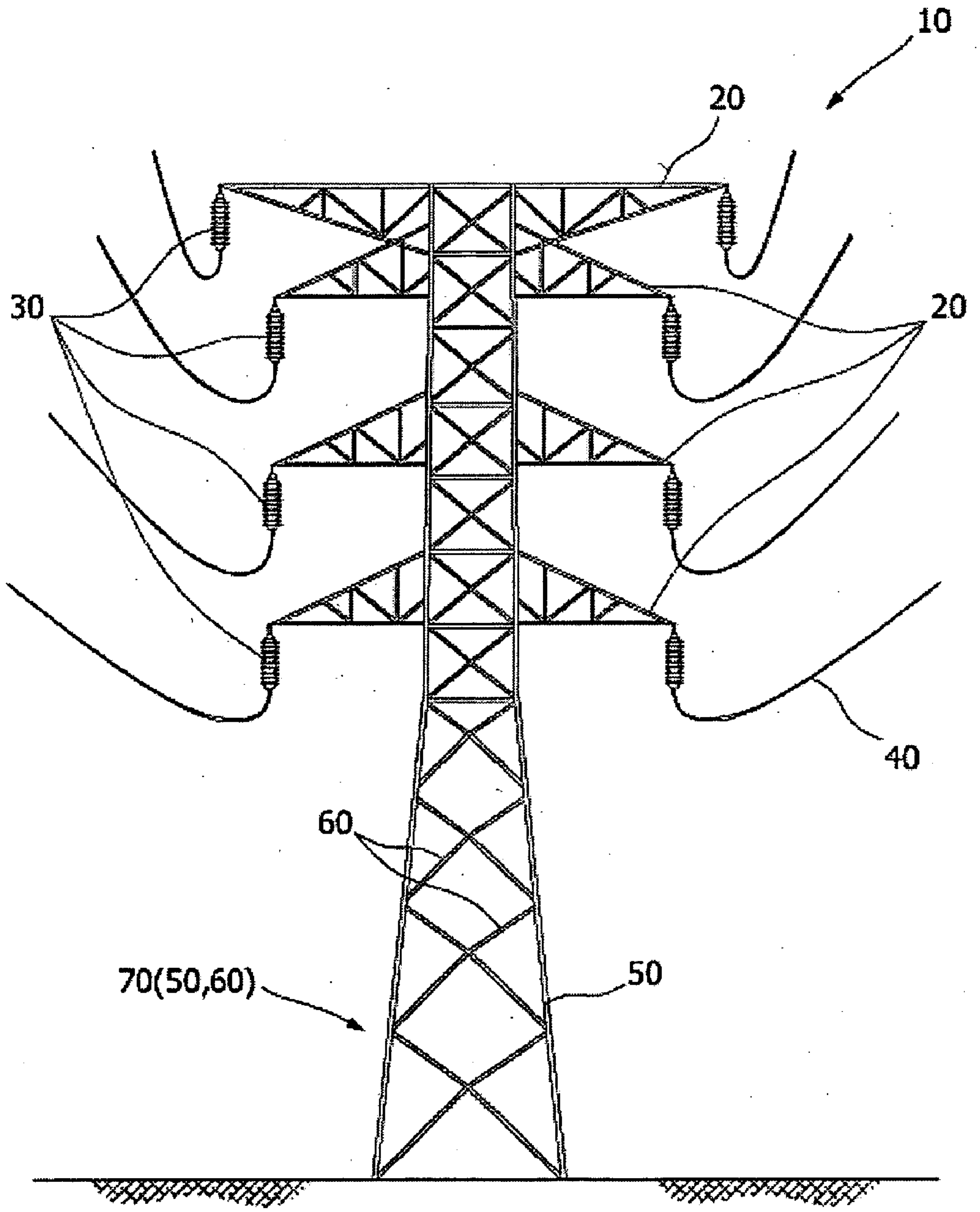


FIG. 2

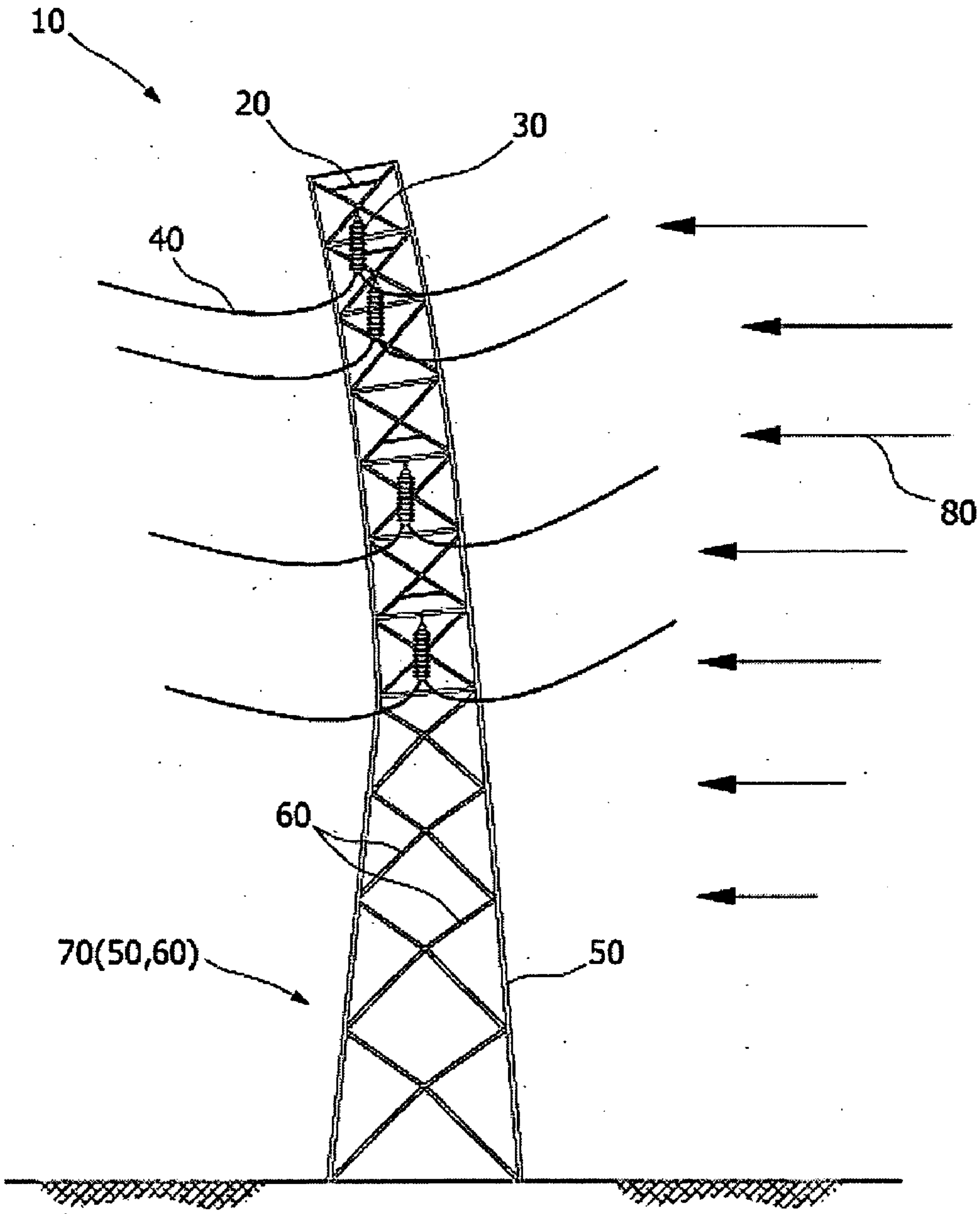


FIG. 3

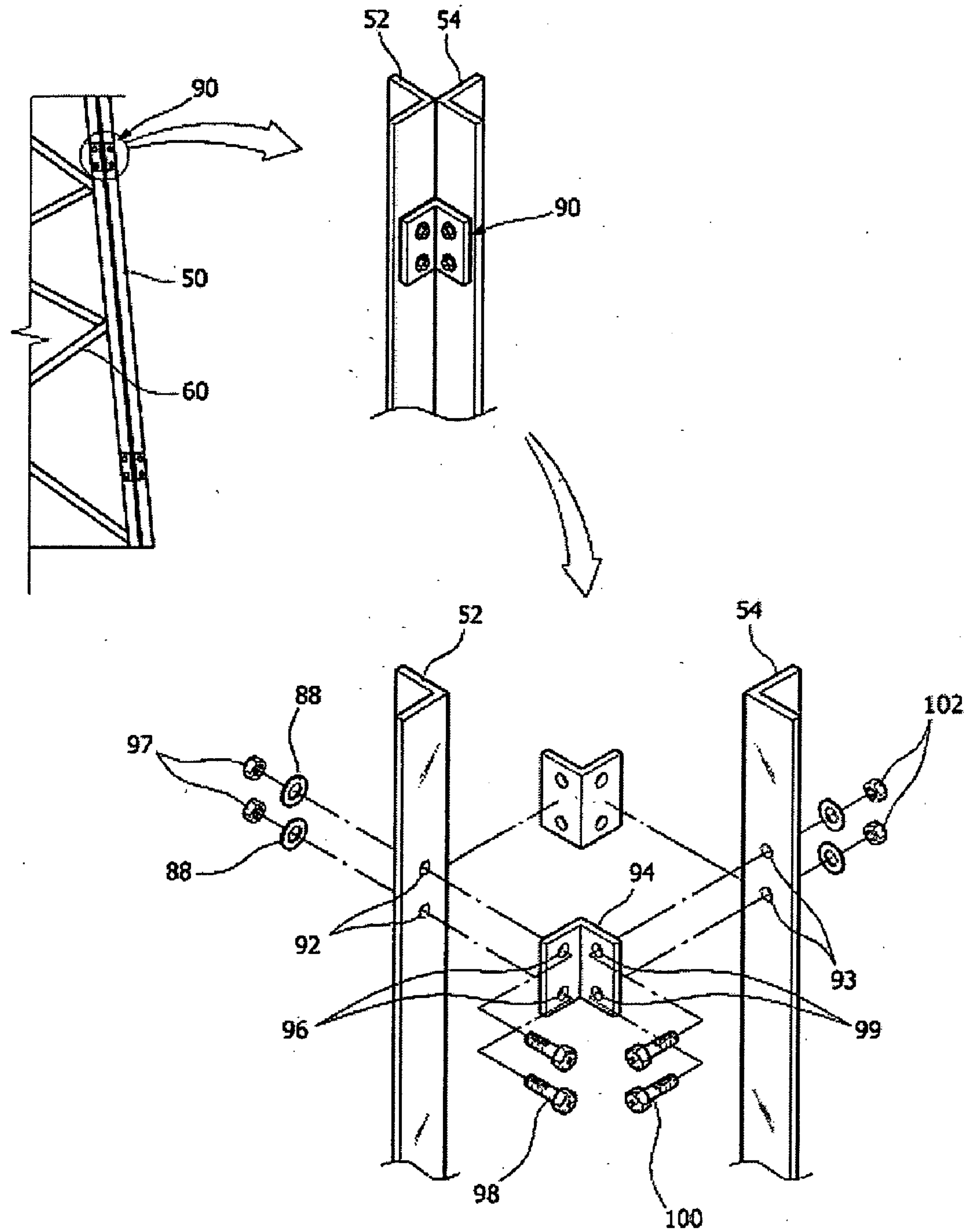


FIG. 4

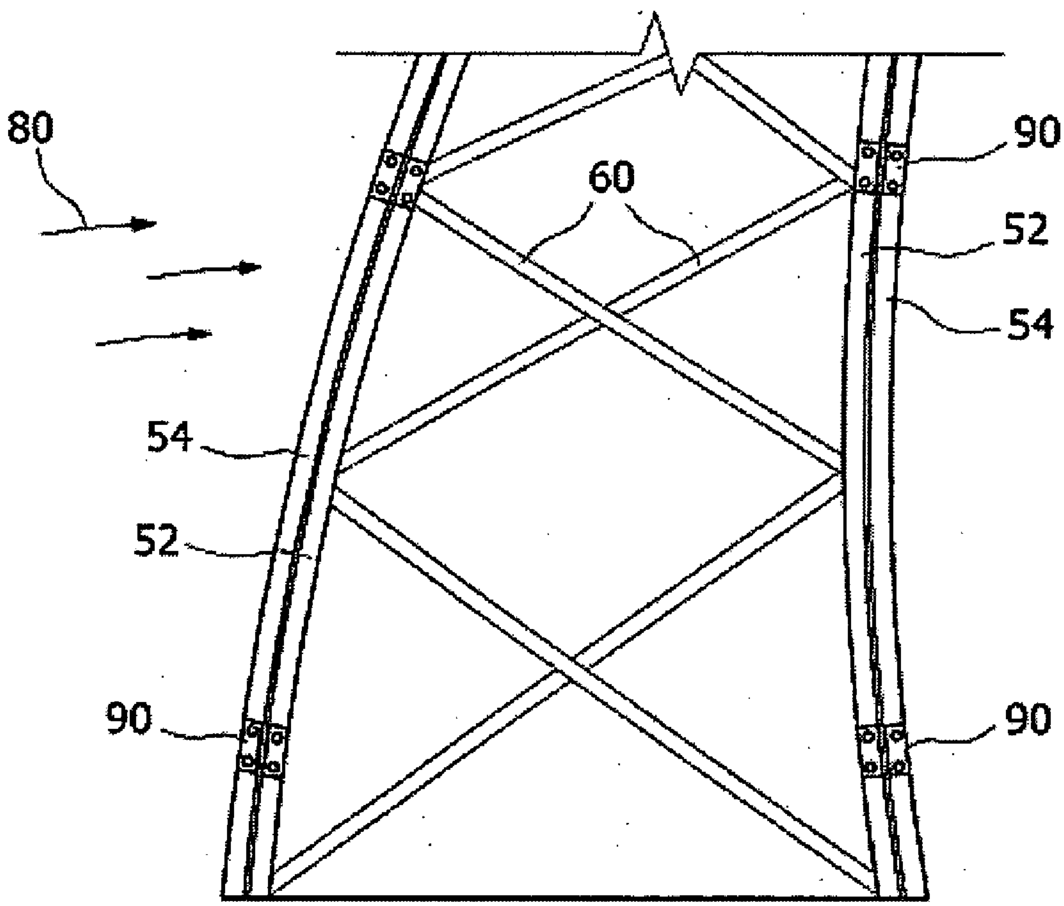


FIG. 5

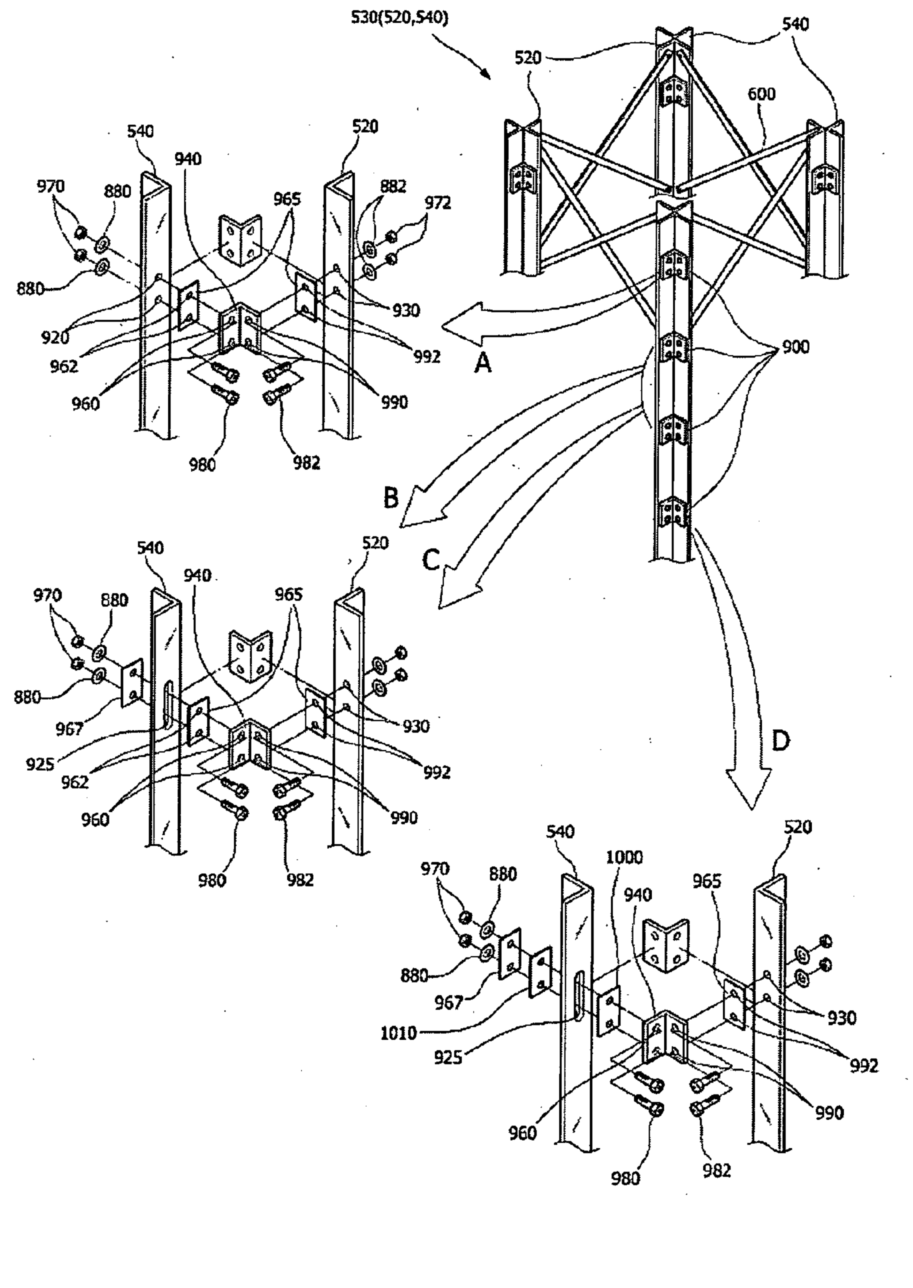
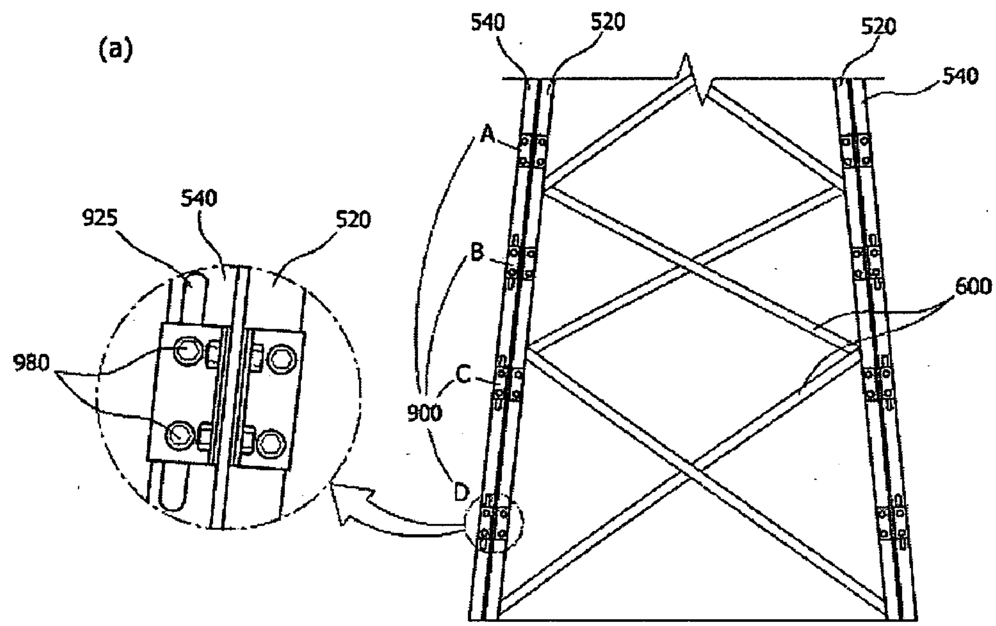

530(520,540)
520
540
600
900
A
B
C
D
970
880
882
972
940
965
920
930
962
992
960
990
980
982
967
925
1000
1010

FIG. 6


(a)
540
520
520
540
A
B
C
D
900
600
925
540
520
980

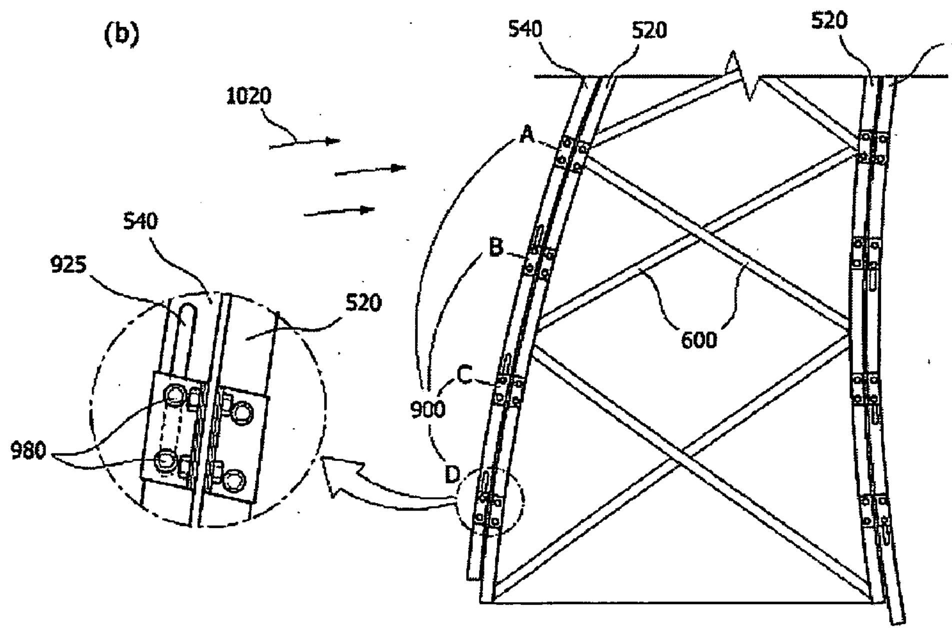

(b)
540
520
520
540
1020
A
B
C
D
900
600
925
540
520
980

FIG. 7

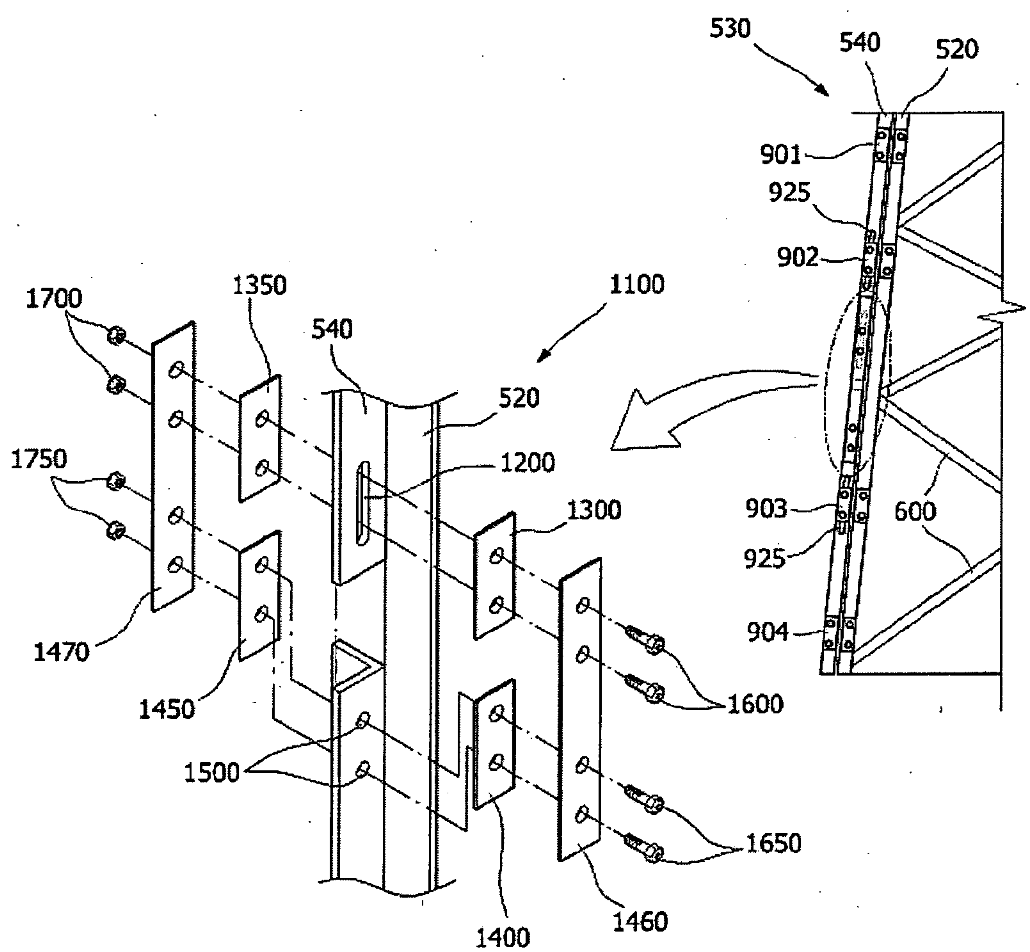
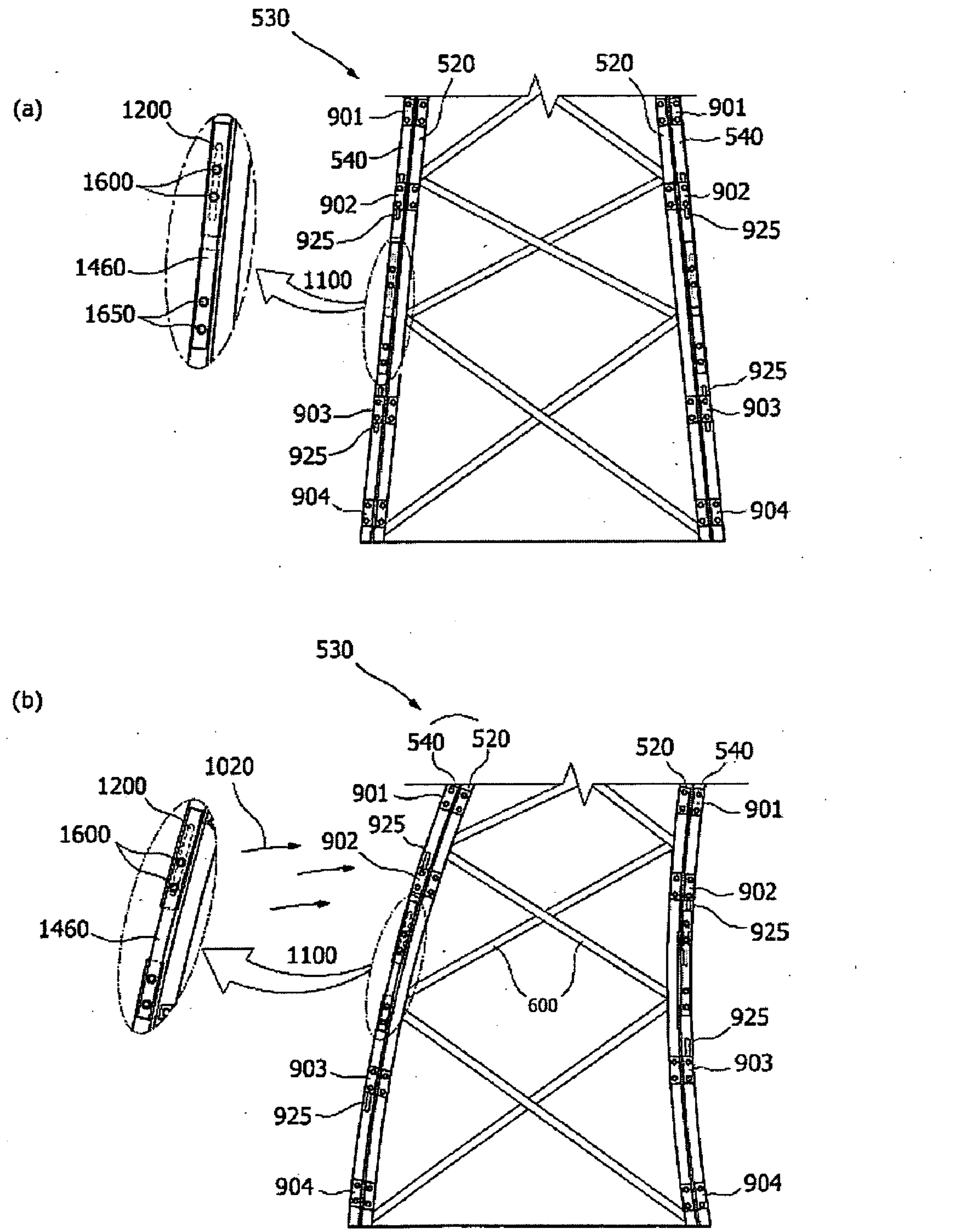

530
540
520
901
925
902
903
925
904
600
1100
1700
1350
540
520
1200
1750
1300
1470
1450
1600
1500
1650
1400
1460

FIG. 8


(a)
530
520
520
901
901
1200
540
540
1600
902
902
925
925
1460
1100
1650
925
903
903
925
904
904
(b)
530
540
520
520
540
1020
901
901
1200
925
1600
902
902
925
1460
1100
600
925
903
903
925
904
904

FRICTION TYPE RETROFITTING DEVICE FOR STEEL TOWER STRUCTURES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to a friction type retrofitting device for steel tower structures. More particularly, the present invention relates to a friction type retrofitting device for a steel tower, such as a power-transmission tower that transmits high voltage to a distant place, in which a slot and a friction plate are provided on a coupling part between columns constituting a post of the steel tower, thus attenuating vibrations generated by wind force acting on the steel tower.

[0003] 2. Description of the Related Art

[0004] FIG. **1** is a front view showing a general steel tower, FIG. **2** is a side view showing the steel tower of FIG. **1**, when wind acts on the front of the steel tower, FIG. **3** is a detailed view showing part of a post of the steel tower, and FIG. **4** is a view showing the structural change of the conventional post under the condition of FIG. **2**.

[0005] As shown in FIG. **1**, a general steel tower, especially a power-transmission tower **10** for transmitting high voltage, includes a frame **70** which is set up vertically, arms **20** which are horizontally provided on the upper portion of the frame **70**, insulators **30** which hang downwards from ends of the arms **20**, and electric wires **40** which are connected to the lower ends of the corresponding insulators **30**.

[0006] The frame **70** includes four vertical posts **50**, and cross members **60** which are crossed between the vertical posts **50** to be coupled to the vertical posts **50**.

[0007] As shown in FIG. **2**, when wind **80** blows in all directions, the power-transmission tower **10** is shaken. The part of the power-transmission tower **10** that is moved by the wind **80** is restored to its original position within a predetermined elastic range after the wind **80** dies down.

[0008] As shown in FIG. **3**, each post **50** of the power-transmission tower **10** has a cruciform section. The cruciform section is formed by contacting edges of L-shaped columns **52** and **54** with each other and positioning the remaining parts of the columns **52** and **54** to be opposite to each other. Among the two columns **52** and **54**, the inner column **52** faces the interior of the power-transmission tower **10**, while the outer column **54** faces the exterior of the power-transmission tower **10** and has on predetermined portions thereof coupling parts **90**.

[0009] Each coupling part **90** of the conventional power-transmission tower includes first holes **92** and second holes **93** which are formed in the inner column **52** and the outer column **54**, respectively, an angle bracket **94** which has an "L"-shaped section and is provided with third holes **96** and fourth holes **99**, first bolts **98** which pass through the first holes **92** and the third holes **96**, second bolts **100** which pass through the second holes **93** and the fourth holes **99**, first nuts **97** which are fastened to the first bolts **98**, second nuts **102** which are fastened to the second bolts **100**, and washers **88** which are provided in front of the first nuts **97**.

[0010] However, the outer column **54** is provided at an outer position relative to the inner column **52**. Thus, when the power-transmission tower **10** is moved by the wind, as shown in FIG. **4**, the outer column **54** provided at a position facing the wind **80** is extended further than the inner column **52**. The outer column **54** provided at the opposite side is compressed more than the inner column **52**.

[0011] Thereby, the force applied to the power-transmission tower **10** by the wind is transmitted to each coupling part **90** of FIG. **3**, so that a large amount of energy acts on the second bolts **100**, the second holes **93**, and the fourth holes **99**. Thus, the wind repeatedly acting on the power-transmission tower **10** greatly reduces the durability of the coupling part **90**.

[0012] Further, in the case where the interval between the coupling parts **90** mounted to each post **50** is large, so that the length of the post is larger than the cross-section thereof, the post is apt to buckle, that is, bend suddenly, when the compressive load acting on both ends of the post reaches a predetermined level.

SUMMARY OF THE INVENTION

[0013] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a steel tower structure, in which coupling parts are mounted to posts of a steel tower at proper intervals, thus preventing the posts from buckling, a slot is formed in a coupling part of an outer column, and a friction plate is coupled to the coupling part of the outer column, thus absorbing wind energy using friction energy, therefore enhancing durability.

[0014] In order to accomplish the above object, the present invention provides a friction type retrofitting device for steel tower structures, including a coupling part coupling an outer column and an inner column of a post of a steel tower to each other using an angle bracket and a bolt, a slot formed in a portion of the outer column to which the coupling part is coupled, and a friction plate provided to contact an outer circumferential surface of the slot. In this case, wind energy transmitted to the steel tower is attenuated by friction between the slot and the friction plate of the coupling part.

[0015] Further, a horizontal section of the post has a cross shape, and a horizontal section of each of the outer column and the inner column has an L shape. Further, a plurality of coupling parts having the slot in the outer column may be provided on the post, and the friction plate may be provided on one of the coupling parts. A reinforcing plate may be provided on a portion of the outer column to which the coupling part is coupled.

[0016] The present invention provides a friction type retrofitting device for steel tower structures, including an outer column which is arranged to be parallel to an inner column, thus providing a post of a steel tower, and is divided at a predetermined position into two portions, a slot which is formed in one of the divided portions, and a friction plate which is provided to contact an outer circumferential surface of the slot. In this case, wind energy transmitted to the steel tower is attenuated by friction between the slot and the friction plate.

[0017] Further, a horizontal section of the post has a cross shape, and a horizontal section of each of the outer column and the inner column has an L shape. Further, a plurality of coupling parts is provided to couple the outer column to the inner column using an angle bracket and a bolt, with a slot formed in a portion of the outer column to which the coupling part is coupled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The above and other objects, features and advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0019] FIG. **1** is a front view showing a general steel tower;

[0020] FIG. **2** is a side view showing the steel tower of FIG. **1**, when wind acts on the front of the steel tower;

[0021] FIG. **3** is a detailed view showing part of a post of the steel tower;

[0022] FIG. **4** is a view showing the structural change of the conventional post under the condition of FIG. **2**;

[0023] FIG. **5** is a detailed view showing a post of a steel tower, according to an embodiment of the present invention;

[0024] FIGS. **6***a* and **6***b* are views showing the operation of the post of the steel tower of FIG. **5**;

[0025] FIG. **7** is a detailed view showing a post of a steel tower, according to another embodiment the present invention; and

[0026] FIGS. **8***a* and **8***b* are views showing the operation of the post of the steel tower of FIG. **7**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Hereinafter, the preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. Reference now should be made to the drawings, in which the same reference numerals are used throughout the different drawings to designate the same or similar components. For clear description of the present invention, known constructions and functions will be omitted.

[0028] The first embodiment of the present invention is as follows.

[0029] FIG. **5** is a detailed view showing a steel tower, according to an embodiment of the present invention.

[0030] A friction type retrofitting device for steel tower structures, according to the present invention, includes coupling parts **900**, slots **925**, and friction plates **1000** (see portion D of FIG. **5**). The coupling parts **900** couple an outer column **540** and an inner column **520** of each post **530** of the steel tower to each other using angle brackets **940** and bolts **980** and **982**. Each slot **925** is formed in a portion of the outer column **540** to which the coupling part **900** is coupled. The friction plate **1000** is provided to contact the outer circumferential surface of the corresponding slot **925**.

[0031] Further, the horizontal section of each post **530** has a cross shape, and the horizontal section of each of the outer column **540** and the inner column **520** has an L shape.

[0032] When the length of each post **530** is larger than the sectional area, and compressive load applied to both ends of the post **530** reaches a predetermined level, buckling may occur, that is, the post **530** may suddenly bend. In order to prevent the buckling, a proper number of coupling parts **900** is provided in the longitudinal direction of each post **530**. As shown in FIG. **5**, when four coupling parts **900** are provided on one post **530**, the upper coupling part **900**, marked by A, has first holes **920** which are formed in the outer column **540**, and second holes **930** which are formed in the inner column **520**. Two first reinforcing plates **965** are provided to contact the first holes **920** and the second holes **930**. An angle bracket **940** is provided to contact the first reinforcing plates **965**.

[0033] Third holes **960** and fourth holes **990** are formed in the angle bracket **940**. Fifth holes **962** and sixth holes **992** are formed in the reinforcing plates **965**. The angle bracket **940** is provided to one side of the outer column **540**, and first washers **880** and first nuts **970** are provided to the side opposite the angle bracket **940**. The angle bracket **940** is provided to one side of the inner column **520**, and second washers **882** and second nuts **972** are provided to the side opposite the angle bracket **940**.

[0034] The coupling part **900** marked by A is provided with first bolts **980** which sequentially pass through the third holes **960**, the fifth holes **962**, the first holes **920**, and the first washers **880**, and are fastened to the first nuts **970**. The coupling part **900** marked by A is also provided with second bolts **982** which sequentially pass through the fourth holes **990**, the sixth holes **992**, the second holes **930**, and the second washers **882**, and are fastened to the second nuts **972**.

[0035] The coupling parts **900** that are marked by B and C and are provided at a middle position have the same structure as the coupling part **900** marked by A except that the slot **925** is formed in the outer column **540** in place of the first holes **920**, and a second reinforcing plate **967** is additionally provided in back of the slot **925**.

[0036] Meanwhile, the coupling part **900** marked by D and provided at a lower position has the same structure as the coupling parts **900** marked by B and C, except that the first friction plate **1000** is provided between the front of the slot **925** and the angle bracket **940** in place of the first reinforcing plate **965**, and a second friction plate **1010** is provided between the back of the slot **925** and the second reinforcing plate **967**.

[0037] Further, each of the first and second reinforcing plates **965** and **967** is made of steel having a low frictional coefficient. Each of the first and second friction plates **1000** and **1010** is made of brass having a high frictional coefficient.

[0038] Thus, in brief, a plurality of coupling parts **900** having the slots **925** in the outer column **540** is provided on each post **530**. The friction plate **1000** is provided on one of the coupling parts **900**, and the reinforcing plate **965** is provided on the outer column **540** of the coupling part **900**.

[0039] The operation of the steel tower structure according to the first embodiment of the present invention, which is constructed as described above, will be described below.

[0040] FIGS. **6***a* and **6***b* are views showing the operation of the posts of the steel tower of FIG. **5**.

[0041] In FIG. **6***a*, which shows part of the steel tower, the coupling part **900** marked by A is a locking coupling part, the coupling parts **900** marked by B and C are buckling-prevention coupling parts, and the coupling part **900** marked by D is a friction coupling part.

[0042] That is, the coupling part **900** marked by A is a firm locking coupling part which does not have the slot but has only the first holes **920** of FIG. **5**. The coupling parts **900** marked by B and C are buckling-prevention coupling parts which have slots **925** in the outer column **540** and are provided with first and second reinforcing plates **965** and **967** each having a low frictional coefficient, thus preventing buckling. The coupling part **900** marked by D is a friction coupling part which has a slot **925** in the outer column **540** and is provided with the first and second friction plates **1000** and **1010** each having a high frictional coefficient.

[0043] Thus, as shown in FIG. **6***b*, when wind force **1020** acts on the steel tower, the coupling part **900** marked by A is moved in the state where the outer column **540** and the inner column **520** are fixed. In the coupling parts **900** marked by B and C, the first bolts **980** passing through the slots **925** of the outer column **540** move slightly downwards in the slots **925**. At this time, a very small amount of frictional energy is generated between the first and second reinforcing plates **965** and **967** which contact the outer circumferential surface of each slot **925**.

[0044] Further, in the coupling part **900** marked by D, the first bolts **980** passing through the slot **925** of the outer column **540** move downwards in the slot **925**. The movement of the first bolts **980** of the coupling part **900**, marked by D, is the largest, because the coupling part **900** marked by D is the farthest from the fixed coupling part **900** marked by A. At this time, a large amount of frictional energy is generated between the first friction plate **1000** and the second friction plate **1010**, which are in close contact with the outer circumferential surface of the slot **925**, thus absorbing energy transmitted by the wind force **1020**.

[0045] That is, the energy generated by the wind force **1020** transmitted to the steel tower is attenuated by friction generated between the outer circumferential surface of the slot **925** of the outer column **540** of the coupling part **900** marked by D and the first and second friction plates **1000** and **1010** thereof.

[0046] The second embodiment of the present invention will be described below.

[0047] FIG. **7** is a detailed view showing a post of a steel tower, according to another embodiment of the present invention.

[0048] The steel tower structure of the present invention includes an outer column **540** constituting each post **530**. The outer column **540** is arranged to be parallel to the inner column **520**, and has a division part **1100** which is divided at a predetermined position into two portions.

[0049] The division part **1100** has on an upper portion thereof a slot **1200**, and third and fourth friction plates **1300** and **1350** which are provided to contact the front surface and the back surface of the slot **1200**, respectively.

[0050] Further, the division part **1100** has on a lower portion thereof seventh holes **1500**, and third and fourth reinforcing plates **1400** and **1450** which are provided to contact the outer circumferential surface of the seventh holes **1500**.

[0051] Further, a first coupling plate **1460** is provided to contact the third friction plate **1300** and the third reinforcing plate **1400**. A second coupling plate **1470** is provided to contact the fourth friction plate **1350** and the fourth reinforcing plate **1450**.

[0052] Third bolts **1600** sequentially pass through the first coupling plate **1460**, the third friction plate **1300**, the slot **1200**, the fourth friction plate **1350**, and the second coupling plate **1470**, and are fastened to third nuts **1700**. Fourth bolts **1650** sequentially pass through the first coupling plate **1460**, the third reinforcing plate **1400**, the seventh holes **1500**, the fourth reinforcing plate **1450**, and the second coupling plate **1470**, and are fastened to fourth nuts **1750**.

[0053] The position of the upper structure and the lower structure of the division part **1100** may be changed.

[0054] Meanwhile, the horizontal section of the post **530** has a cross shape, and the horizontal section of each of the outer column **540** and the inner column **520** has an "L" shape.

[0055] Further, a plurality of coupling parts **901**, **902**, **903**, and **904** is provided to couple the outer column **540** to the inner column **520** using angle brackets and bolts. A slot **925** which is equal to the slot **925** of FIG. **5** is formed in the outer column **540**, to which each of the coupling parts **902** and **903** is coupled.

[0056] The operation of the steel tower structure according to the second embodiment of the present invention, which is constructed as described above, will be described below.

[0057] FIGS. **8***a* and **8***b* are views showing the operation of the post of the steel tower of FIG. **7**.

[0058] Among the coupling parts **901**, **902**, **903**, and **904** shown in FIG. **8***a*, the coupling parts **901** and **904** are the locking coupling part, which is the same as the coupling part **900** marked by A in the first embodiment. The coupling parts **902** and **903** are the buckling-prevention coupling parts, which are the same as the coupling parts **900** marked by B or C in the first embodiment.

[0059] Further, the function of the friction coupling part, which is marked by D in the first embodiment, is achieved by the upper structure of the division part **1100**.

[0060] That is, as shown in FIG. **8***b*, when wind force **1020** acts on the steel tower, the posts **530** are moved. Thus, the distance between the coupling parts **901** and **904** which are the locking coupling part is slightly increased. The lower portion of the division part **1100** maintains a fixed state, while the slot **1200** of the upper portion of the division part **1100** moves upwards. At this time, a large amount of friction is generated between the outer circumferential surface of the slot **1200**, the third friction plate **1300**, and the fourth friction plate **1350**, thus attenuating energy transmitted by the wind force **1020**.

[0061] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims. The present embodiments are therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within bounds of the claims, or equivalents of such bounds, are therefore intended to be covered by the claims.

[0062] As described above, the present invention provides a friction type retrofitting device for steel tower structures, in which coupling parts are appropriately provided on posts of a steel tower, thus preventing the posts from buckling, and a slot and a friction plate are provided on the coupling parts, thus attenuating vibrations generated by wind force, therefore increasing the durability of the steel tower.

What is claimed is:

1. A friction type retrofitting device for steel tower structures, comprising:

a coupling part coupling an outer column and an inner column of a post of a steel tower to each other using an angle bracket and a bolt;

a slot formed in a portion of the outer column to which the coupling part is coupled; and a friction plate provided to contact an outer circumferential surface of the slot,

wherein wind energy transmitted to the steel tower is attenuated by friction between the outer circumferential surface of the slot and the friction plate of the coupling part.

2. The friction type retrofitting device as set forth in claim **1**, wherein a horizontal section of the post has a cross shape, and a horizontal section of each of the outer column and the inner column has an L shape.

3. The friction type retrofitting device as set forth in claim **1** wherein a plurality of coupling parts having the slot in the outer column is provided on the post, the friction plate being provided on one of the coupling parts.

4. The friction type retrofitting device as set forth in claim **2** wherein a plurality of coupling parts having the slot in the outer column is provided on the post, the friction plate being provided on one of the coupling parts.

5. The friction type retrofitting device as set forth in claim **3**, wherein a reinforcing plate is provided on a portion of the outer column to which the coupling part is coupled.

6. A friction type retrofitting device for steel tower structures, comprising:

an outer column arranged to be parallel to an inner column, thus providing a post of a steel tower, and divided at a predetermined position into two portions;

a slot formed in one of the divided portions; and

a friction plate provided to contact an outer circumferential surface of the slot,

wherein wind energy transmitted to the steel tower is attenuated by friction between the outer circumferential surface of the slot and the friction plate.

7. The friction type retrofitting device as set forth in claim **5**, wherein a horizontal section of the post has a cross shape, and a horizontal section of each of the outer column and the inner column has an L shape.

8. The friction type retrofitting device as set forth in claim **5** wherein a plurality of coupling parts is provided to couple the outer column to the inner column using an angle bracket and a bolt, with a slot formed in a portion of the outer column to which the coupling part is coupled.

9. The friction type retrofitting device as set forth in claim **6** wherein a plurality of coupling parts is provided to couple the outer column to the inner column using an angle bracket and a bolt, with a slot formed in a portion of the outer column to which the coupling part is coupled.

* * * * *