A boom point sheave mounting assembly for excavators, such as draglines, or shovels, which includes a sheave shaft mounted transversely of the boom in the boom side frames and carrying at least one ball at its center upon which a bearing carrier assembly is mounted for swivel movement. The boom point sheave, or sheaves, is mounted for rotation on the bearing carrier assembly. The shaft ends may project beyond the boom side frames and have the outboard ends of the boom pendants, or hoist ropes, connected to them. A torque rod, in some instances, is used to urge the sheave toward at rest position. This mounting assembly imposes sheave rotational loads, sheave swivel loads and boom suspension loads on a single transverse axis for direct application to the boom to put the boom in compression.

19 Claims, 16 Drawing Figures
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BOOM POINT SHEAVE ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to boom point sheave mounting assemblies and particularly to such assemblies which allow swivel motion to the sheave, or sheaves, located at the outer tip, or point, of the booms of excavating machines.

Sheave assemblies to allow swivel action to sheaves mounted at the boom point of excavating machines are not new. The assembly in present use has the sheaves mounted on a fixed shaft, and that shaft, in turn, is mounted in a swivel frame supported by the boom point structure. The swivel frame has front and rear trunnions having a pivot axis longitudinally of the boom, and spaced above and sheave shaft, and the trunnions are journaled in front and rear bearings supported upon beams extending transversely of the boom. The front bearing receives load from the swivel and carries it across the front beam, and from this beam down the sides of the boom. The rear bearing puts the thrust and shear load imposed upon it into the rear cross beam, so that it travels up the boom and resolves with the boom pendant loads. These loads then combine to make total boom compression. This results from the fact that the sheave loading is imposed at points spaced longitudinally of the boom, as well as longitudinally from the points of boom pendant attachment.

The present structure is very difficult to maintain, due to the fact that the front bearing, carrying the front swivel bearing, must be bolted to the boom, and its location makes access to the sheave assembly difficult. The thrust and shear loads from the rear bearing are applied to a deep beam, and, due to its structure, this beam deflects similar to a diaphragm, making design difficult and fatigue failure likely. The structure is complicated and heavy, which is extremely disadvantageous in a boom point assembly, for structural weight at the boom point in equivalent to five times that weight at ground level in large draglines, for example.

SUMMARY OF THE INVENTION

The general object of the present invention is to provide a boom point sheave assembly wherein the sheave has a swivel action to follow hoist line direction, which will permit resolution of the load of the hoist rope within a single internal component, which, in turn, applies the load directly to the sides of the boom in the correct direction for boom compression.

A more specific object is to provide an assembly of this nature which eliminates a conventional swivel frame, and utilizes a single mounting shaft for the sheave, or sheaves.

Another object is the provision of a boom point sheave assembly which is of much lighter weight than the one now used, and greatly reduces the weight ratio for the front end moment of the excavator.

A further object is to utilize a ball shaft as the sheave mounting member, to provide a combination mounting for sheave rotation and swivel in a single unit.

Yet another object of the invention is to provide a sheave mounting of the above described nature, wherein there are means to allow swivel motion to the sheave mounting member while restraining rotation of that member, and resisting the swivel motion force by means of a torque bar anchored at its end remote from the sheave shaft to the boom.

Still a further object is to provide a boom point sheave mounting which will apply sheave loadings in the most direct route possible to their supporting structures, with as little detour as possible.

It is also an object of the present invention to provide a boom point sheave assembly which can be manufactured and maintained much easier than is possible with previously known constructions.

Other objects of the invention will become apparent from the following description of practical embodiments thereof, when taken in conjunction with the drawings which accompany, and form part of, this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a somewhat diagrammatic side elevation of a dragline excavator, showing one embodiment of the improved sheave mounting at the boom tip;

FIG. 2 is an enlarged horizontal section through the boom tip and the sheave mounting, taken on the line 2—2 of FIG. 2;

FIG. 3 is a further enlarged longitudinal section through the center of the assembly, taken at right angles to the view shown in FIG. 2;

FIG. 4 is a vertical section taken on the line 4—4 of FIG. 3;

FIG. 5 is a detail section through the torque rod showing its locking arrangement, and is taken on the line 5—5 of FIG. 3;

FIG. 6 is a side elevation of a slightly modified form of the invention, wherein the sheave assembly includes a deadend for the hoist line;

FIG. 7 is a vertical section through the form of FIG. 6, shown on an enlarged scale and taken on the line 7—7 of FIG. 6;

FIG. 8 is a view, generally in side elevation, of another modified form of the invention;

FIG. 9 is a section taken on the line 9—9 of FIG. 8;

FIG. 10 is an exploded perspective view of the elements forming a torsion member to resist rocking movement of the sheave of the embodiment shown in FIGS. 8 and 9;

FIG. 11 is a side view of still another embodiment shown mounted on the point of a boom;

FIG. 12 is a vertical section taken on the line 12—12 of FIG. 11;

FIG. 13 is a section taken on the line 13—13 of FIG. 12;

FIG. 14 is an exploded perspective view of the shaft and sheave mounting elements of the embodiment shown in FIGS. 11, 12 and 13;

FIG. 15 is a side view of yet a further embodiment of the invention, wherein plural sheaves are mounted in the assembly on the boom and the boom pendants are not connected to the sheave assembly shaft; and

FIG. 16 is a section taken on the line 16—16 of FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in detail, and first to FIG. 1, a dragline excavator is shown in conventional form as an example of the equipment in which the invention can be used. No details are shown, as the dragline is not part of the invention.
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The dragline includes a base, or turb, having a top 3 upon which a live thrust roller ring is mounted. A main frame is rotatably supported on the ring and mounts an enclosure, or house, 6. A boom 7 has its foot pivoted to the front of the main frame, as at 8, and the boom is held in raised position by pendants 9, anchored to the boom tip and to an A-frame, or gantry, 10 fixed to the main frame. Hoist lines 11 run from drums within the house, over sheaves 12 at the boom point, and suspend a bucket 13 from the boom. Draglines are run from the bucket to other drums within the house. To this point, the construction is standard.

As the bucket is frequently offset laterally from the boom point during operation, the boom point sheaves are mounted to swivel laterally to compensate for hoist line angularity and maintain a fair-lead from the bucket to the hoist drums. The assemblies by which the sheaves are mounted form the subject of the present invention.

Referring now to FIGS. 2 through 5, the boom 7 is shown as comprising a pair of side frames 15, with the frames held in desired spaced relation by means of suitable transverse plates, or bulkheads, 16, extending between the side frames at predetermined spaced points along the boom length. The outermost bulkhead is spaced inwardly from the boom tip, or point, and the boom point sheave is mounted in this area.

In the forms shown in FIGS. 2 through 5, two sheaves 12, mounted to swivel as a single unit, are employed to accommodate double line rigging. The sheaves are mounted for rotation and swivel movement upon a shaft 17, which bridges the space between the boom side frames and rests in seats 18 in the side frames. Caps 19 encircle the upper part of the shaft and are bolted to the side frames to secure the shaft to the boom. The ends of the shaft project beyond the boom side frames, and the extreme ends of the shaft are reduced in diameter, as at 20. The boom pendants 9 (FIG. 1) are fitted with anchors, or eyes, 21 at their outboard ends, and the anchors fit over the reduced ends of shafts 17 to connect the pendants to the boom. There are annular grooves 22 adjacent the shaft ends which receive split collars 23 to hold the pendant anchors in place on the shaft. By this arrangement, sheaves 12 and pendants 9 are carried upon a single shaft supported at the boom point, so that boom weight and sheave loadings will be imposed along a single axis for transfer longitudinally to the boom. Although the pendants have been described as the boom-supporting means, hoist lines would be used if the excavator is of a type having a movable boom. In order to prevent endwise movement of shaft 17, the shaft is provided with peripheral flanges 24, spaced equidistant from the shaft center, to abut the inner faces of the boom side frame and position the shaft with respect to the boom.

At its center, shaft 17 is enlarged to provide swivel ball 25, and the sheaves 12 are mounted on this ball for both rotation and swivelling. This is done by means of a bearing carrier assembly 26 which is mounted for swivel movement upon the shaft ball, and upon which the sheaves are mounted for rotation. The carrier assembly consists of a generally cylindrical casting 27 and a bushing 28, carried within the casting. Centrally of the exterior of casting 27, there is a raised annular hub 29 which serves as a positioning and separating means for tapered anti-friction bearings 30 that are seated on the casting on either side of the hub. The bearings carry the sheaves 12 in spaced relation for free rotation. Plates 31 are bolted to the ends of casting 27 to hold the bearings against outward movement. Casting 27 is of increased diameter interiorly, as at 32, from one side of the center to the other end, to seat the bushing 28. The bushing will embrace a substantial area of the shaft ball 25, and is made in two parts 33, for ease of assembly, and each part has its inner face 34 of concave curvature to seat upon the ball 25. In mounting the bearing carrier assembly upon the shaft, one bushing member will be slipped into the larger end of the casting and seated against the shoulder 35 at the juncture of the sections of different diameter internally of the casting 27. The partial assembly will be slipped upon the shaft with the bushing member in place upon ball 25. The other bushing member will then be pushed into the casting into contact with the first member and into seating relation with the shaft ball. Finally, a sleeve 36 is slipped into the casting to hold the bushing in place. Sleeve 36 has an upwardly peripheral flange 37 at its end, and it is bolted, as at 38, to casting 27. Bushing 28 provides the swivel mounting on ball 25 required for proper swivel position.

While it is desirable for the bearing carrier assembly to be free to swivel on shaft 17, rotation on the ball is undesirable. In order to restrain rotative movement of the bearing carrier to carry side load, and define the center of swivel about the center line of the boom, the ball 25 is drilled diametrically, as at 39, the bushing has a similar opening 40, and casting 27 has diametrically opposed openings 41. A rod, or shaft, 42 is passed through these aligned openings to hold the parts against all movement except rotative movement of the bearing carrier about the shaft. The shaft has a cap 43, provided by a torsion rod to be described, at one end, and a cap member 44 is bolted to the other end to hold the shaft in position.

It is desirable to provide some means to bias the sheaves toward their normal, at rest position, which was achieved in previous assemblies by offsetting the weighed mass. To do this, a torsion rod 45 has one end connected to the bearing carrier casting 27 and projects longitudinally along the boom centerline. The first bulkhead 16 adjacent the boom point has an opening 46 through which the torsion bar extends, and the next adjacent bulkhead forms an anchor for the remote end of the rod, as at 47. The intermediate section of the torsion rod is rotatively mounted in the bulkhead adjacent the boom point by a suitable bushing 48. The anchor 47 includes a plate 49, fixed to the bulkhead, having a notch 50 in its base to seat upon a positioning stud 51 projecting from the bulkhead.

In order to seal the swivel area to eliminate dirt, flexible boots 52 may be used. They will surround the shaft 17 and be connected to the bearing carrier 26 and the shaft flanges 24.

The above-described assembly concentrates the boom loading on a single transverse axis adjacent the boom point for imposition longitudinally of the boom in substantially ideal manner. This is due to the fact that stresses of sheave rotation, sheave swivelling and boom suspension are all carried through shaft 17 directly to the boom, for the shaft is mounted in the boom side frames and the sheaves are mounted for rotation on bearing carrier 26 which, in turn, is mounted for swivel motion about the center of shaft ball 25, while the ends of shaft 17 serve as attachment points.
for the boom-supporting members 9. Thus, the divided circuitous paths of force application on the boom is eliminated, and a direct longitudinal force application is obtained. At the same time, the torque force of sheave swivel is taken by torsion rod 45, which serves to return the sheave to normal position when swivelling loads are released. Due to the fact that the sheaves are mounted upon a single shaft, the assembly is entirely open and accessible for repair, for the former cross beams for trunnion support are not needed. A further advantage of the present assembly in the elimination of bodily shifting of the sheaves during swivelling because of the separated axes of rotation and swivel of the previous arrangement.

In FIGS. 6 and 7, a slightly modified form of the invention is shown. The basic parts of the assembly are substantially the same as in the first-described form, but a dead-end connector for the hoist line is included to allow the entire depending hoist reaving to move as a unit and to apply all hoist line load through the sheave assembly to the boom along a single axis.

Referring to this form of the invention in detail, the sheave assembly 53 has a mounting shaft 54, carrying a ball 55 at its center. A bearing carrier assembly 56 is mounted for swivel movement on ball 55, as before, and a swivel rod 57 fixes the bearing carrier assembly on the ball for swivel movement about a single axis. A torsion rod 58, in axial alignment with the swivel axis, biases the carrier assembly toward an at rest position, as in the previous form. Sheaves 59 are rotatably mounted on bearings 60 of the bearing carrier assembly. To this point, there is no change from the first-disclosed form.

In the embodiment of FIGS. 6 and 7, the cylindrical casting 61 of the bearing carrier assembly is slightly longer than in the first embodiment, and the ends 62 of a dead-end yoke 63 are journalled upon it, outboard of the bearings 56. Yoke 63 is U-shaped and straddles the sheaves 59, and connecting eyes 64 for the hoist line dead-ends are carried by its closed end. Hoist lines 65 have their dead-ends connected to eyes 64, extend downwardly and around bucket sheaves 66 and then upwardly around the boom point sheaves 59.

By having the dead-end yoke mounted on the cylindrical casting 61 of the bearing carrier assembly, both flights of the trailing hoist line can remain in a single plane during swinging of the bucket and swivel movement of the boom point sheaves. At the same time, the entire hoist line loading on the boom is applied to shaft 54, and, therefore, along a single axis transversely of the boom.

A further modified form of the invention is shown in FIGS. 8, 9 and 10. In this form, the basic structural arrangement is the same, but the manner of attachment of the torsion rod to the assembly is different, to not only bias the bearing carrier toward rest position but also replace the swivel, or pivot, rod in defining the sheave plane and pivot axis.

Referring in detail to this form of the invention, a mounting shaft 67 is carried by the boom 68, the shaft having a ball 69 at its center. A bearing carrier assembly 70 is swivelly mounted on the ball 69, and consists of a cylindrical casting 71 which carries bushing 72 which seats on ball 69, and bearings 73 on which sheaves 74 rotate. Closure plates 75 abut the ends of cylindrical casting 71 and enclose bearings 73. This much of the structure is essentially the same as the base structure of the two forms previously described.

In order to bias the bearing carrier assembly towards rest position, and to provide a fixed axis about which the sheaves may swivel, a torsion rod 76 is connected at one end to a bulkhead 77 of the boom 68. Its opposite end is not connected directly to the bearing carrier assembly, as before, but it is bolted to a yoke 78. The yoke is a U-shaped member having legs 79 which straddle the bearing carrier assembly and terminate in accurate mounting plates 80. The mounting plates lie against, and are concentric with, portions of the closure plates 75 which overlie the ends of cylindrical castings 71. Bolts 81 attach the mounting plates 80 to the closure plates and cylindrical casting 71.

With the above-described construction, the bearing carrier assembly is free to move on the wall 79 of shaft 68, and so permit the sheaves to swivel, but the movement will be confined to rotative movement about the projected axis of torsion rod 76, for the yoke is fixed to the torsion rod and bearing carrier. Thus, the projected torsion rod axis becomes the pivot axis for the assembly, and the swivel axis for the sheaves. This arrangement eliminates the swivel pivot through the bearing carrier assembly and mounting shaft ball, yet the swivel action is the same.

Turning now to that form of the invention shown in FIGS. 11, 12, 13 and 14, there is shown another arrangement of boom point sheave which eliminates the torsion rod of the former embodiments, and utilizes gravity to return the sheaves to rest position. At the same time, the boom loading is applied along a single axis extending transversely of the boom.

In this embodiment of the invention, the mounting shaft 82 is a two-part member, consisting of a shaft proper 83 and a trunnion carrier 84 which slides onto the shaft and is fixed to it at the shaft center by means of a pin 85. Shaft 83 has its ends mounted in the boom 86, and also carries the boom pendant end eyes 87. Trunnion carrier 84 is a casting having a body 88 of appropriate shape and trunnions 89 projecting oppositely from the body, the trunnions having a common axis which is normal to the longitudinal axis of the shaft 83 and above that axis. In the particular form shown, the trunnion axis is tangent to the circumference of shaft 83.

The bearing carrier assembly 90 of this form of the invention consists of a pair of circular castings 91, each being cut out in its center, as at 92, to permit the assembly to be mounted about the trunnion carrier 84 for free swivel movement without contact with the trunnion carrier body. Each casting 91 has recesses 93 to receive bearings 94 mounted on the trunnions 89, so that when the castings 91 are bolted together they are swivelly mounted on the trunnions 89. Therefore, the bearing carrier assembly can swing freely on the trunnions at right angles to the axis of the mounting shaft 82. The bearing carrier assembly castings carry bearings 95 on their outer surfaces, and sheaves 96 are mounted on these bearings.

Although the swivel axis for the sheave 96 is the trunnion axis, and this axis is spaced vertically of the axis of the mounting shaft 82, the geometric center of the sheave and the bearing carrier assembly is coincident with the mounting shaft axis when the sheave and bearing carrier assembly are in the rest position. The center of gravity of the swivelling portions of the unit is at, or
below, the geometric center, so that gravity serves to bias the sheave toward its vertical, at rest, position. If hoist line forces on the sheave cause it to swivel and move from a vertical position, it will turn to vertical position as soon as these forces are relieved. Therefore, no torsion rod is needed in this construction, for gravity provides the necessary bias.

The last-disclosed form of the present invention is shown in FIGS. 15 and 16. This embodiment is more nearly like those forms first-described than the construction just described above, but it differs from all previous assemblies in some respects.

In this last form, a mounting shaft 97 is fixed transversely of the boom 98 at the boom tip. Shaft 97 has two ball-shaped enlargements 99 spaced apart equidistant on opposite sides of the shaft longitudinal center. Each ball 99 forms a swivel support for a bearing carrier assembly 100. These assemblies are substantially the same as those previously described, in that each consists of a cylindrical casting 101 having an internal bushing 102 in riding contact with the ball surface. The cylindrical castings each carry bearings 103 on which sheaves 104 are rotatably mounted. This arrangement provides two sets of double sheaves, each set being mounted upon a bush and independently movable for swivel action.

In order for each set of sheaves to have independent, controlled movement, each has its own pivot pin 105 extending through its bearing carrier assembly and the ball on which it is mounted. This provides separate swivel axes for the respective sheave sets. There is also a torsion rod 106 for each sheave set, the torsion rods being connected to the respective bearing carrier assemblies in axial alignment with the pivot rods. The opposite ends of the torsion rods are attached to a bulkhead 107 of the boom 98. Thus, the sheave sets will be independently biased toward vertical, rest position.

In this last form, the boom pendents 108 are not connected to the mounting shaft 97 of the swivel assembly, but, instead, are fastened directly to the boom by means of pins 109 through extensions 110 of the boom. It will be noted from FIG. 15 that the pendents are so connected to the boom that they extend parallel to, and at equal distances on opposite sides of, a projected radius of the mounting shaft 97. This permits the direction of pendant load force on the boom to remain the same.

Although several different forms of the invention have been disclosed, the basic construction features of the swivel assembly are the same in all. In all cases the hoist load is applied to the boom along a single transverse axis, which is the axis of the mounting shaft of the assembly. The shaft is positioned so that its axis intersects the longitudinal centerline of the boom for optimum thrust loading of the boom. In all cases, a bearing carrier assembly is swivelly mounted with respect to the boom on an axis which is normal to that of the mounting shaft. In all forms, there are means to bias the sheaves toward rest position, the biasing means being a torsion rod in all cases except the form shown in FIGS. 11, 12, 13 and 14, where the offset relation of the mounting shaft and trunnion axis provide for gravity bias.

While in the above practical embodiments of the invention have been disclosed, it will be obvious that the specific details of construction shown and described are merely for purposes of illustration, and the invention may take other forms within the scope of the appended claims.

What is claimed is:

1. A boom point sheave assembly for excavators having a boom pivotally supported at its foot to a main frame and suspended in raised position comprising, a shaft mounted in the boom at the point and extending transversely of the boom, means mounted for pivotal movement relative to the shaft for swivel movement about a pivot axis normal to the shaft, means for biasing said pivotally mounted means toward a predetermined rest position, and a sheave rotatably mounted on the pivotally mounted means and having an axis of rotation which is normal to the pivot axis of the pivotally mounted means whereby rotational and swivelling loads on the sheaves are imposed directly on the shaft and transferred directly to the boom.

2. A boom point sheave assembly as claimed in claim 1 wherein, the means to bias the pivotally mounted means includes the pivot axis spaced above the axis of the shaft, and the center of gravity of the pivotally mounted means and the sheave being below the pivot axis to weight the pivotally mounted means toward at rest position.

3. A boom point sheave assembly as claimed in claim 1 wherein, the means to bias the pivotally mounted means is a torsion rod positioned longitudinally of the boom having one end connected to the boom and a yoke connected to the other end of the torsion rod and to the pivotally mounted member, the projected longitudinal axis of the torsion rod intersecting the axis of the shaft and defining the pivot axis for the pivotally mounted means.

4. A boom point sheave as claimed in claim 1 wherein, the means to bias the pivotally mounted means includes a torsion rod positioned longitudinally of the boom and having one end connected to the boom and its other end connected to the pivotally mounted means in axial alignment with the pivot axis.

5. A boom point sheave assembly as claimed in claim 1 wherein, the shaft has a ball formation at its center, and the means pivotally mounted on the shaft includes a bearing carrier mounted for swivelling movement on the ball.

6. A boom point sheave assembly as claimed in claim 5 wherein, the bearing carrier includes a bushing having a spherically concave inner face in swivel contact with the shaft ball formation, and there is a pivot rod extending through the bearing carrier and ball formation diametrically of the ball formation with the axis of the pivot rod defining the pivot axis for the bearing carrier.

7. A boom point sheave assembly as claimed in claim 6 wherein, the bearing carrier includes a cylindrical member surrounding the bushing, and the sheave is rotatably mounted on the cylindrical member.

8. A boom point sheave assembly as claimed in claim 7 wherein, a torsion rod is positioned longitudinally of the boom and has one end connected to the boom and the other to the bearing carrier to bias the bearing carrier toward at rest position.

9. A boom point sheave assembly as claimed in claim 8 wherein, there is a second sheave on the cylindrical member, and the sheaves are spaced equidistant on opposite sides of the pivot rod.

10. A boom point sheave assembly as claimed in claim 9 wherein, there are means on the shaft to pre-
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9 vent endwise movement of the shaft relative to the boom.
11. A boom point sheave assembly as claimed in claim 10 wherein, the outboard ends of the boom pendants are connected to the shaft.
12. A boom point sheave assembly as claimed in claim 11 wherein, the ends of the shaft project beyond the sides of the boom, and the connection of the pendants to the shaft is to the projecting shaft ends.
13. A boom point sheave assembly as claimed in claim 1 wherein the shaft has a pair of ball formations, one ball formation on each side of the shaft center, and there is a pivotally mounted means including a bearing carrier mounted for swivelling movement on each ball formation.
14. A boom point sheave assembly as claimed in claim 13 wherein, each bearing carrier includes a bushing having a spherically concave inner face in contact with its respective shaft ball formation, and there is a pivot rod extending through each bearing carrier and ball formation with the axis of each pivot rod defining the pivot axis for its respective bearing carrier.
15. A boom point sheave assembly as claimed in claim 14 wherein, there are bearings on each bearing carrier and sheaves rotatively mounted on the bearing of each bearing carrier.
16. A boom point sheave assembly as claimed in claim 15 wherein, there is a torsion rod in axial alignment with each pivot rod, the torsion rods each having one end connected to the boom and the other end connected to its respective bearing carrier.
17. A boom point sheave assembly as claimed in claim 1 wherein, there is a hoist line hitch dead end connector pivotally mounted on the pivotally mounted means.
18. A boom point sheave assembly as claimed in claim 17 wherein, the dead end connector is a U-shaped yoke having its arm ends pivotally mounted on the pivotally mounted means and means on its closed end for coupling to the dead end of a hoist line hitch.
19. A boom point sheave assembly as claimed in claim 18 wherein, the pivotally mounted means includes a cylindrical bearing carrier upon which the sheave is mounted, and the dead end connector arm ends are mounted on the bearing carrier on opposite sides of the sheave.

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Disclaimer


Hereby enters this disclaimer to claim 2 of said patent.

[Official Gazette March 10, 1976.]