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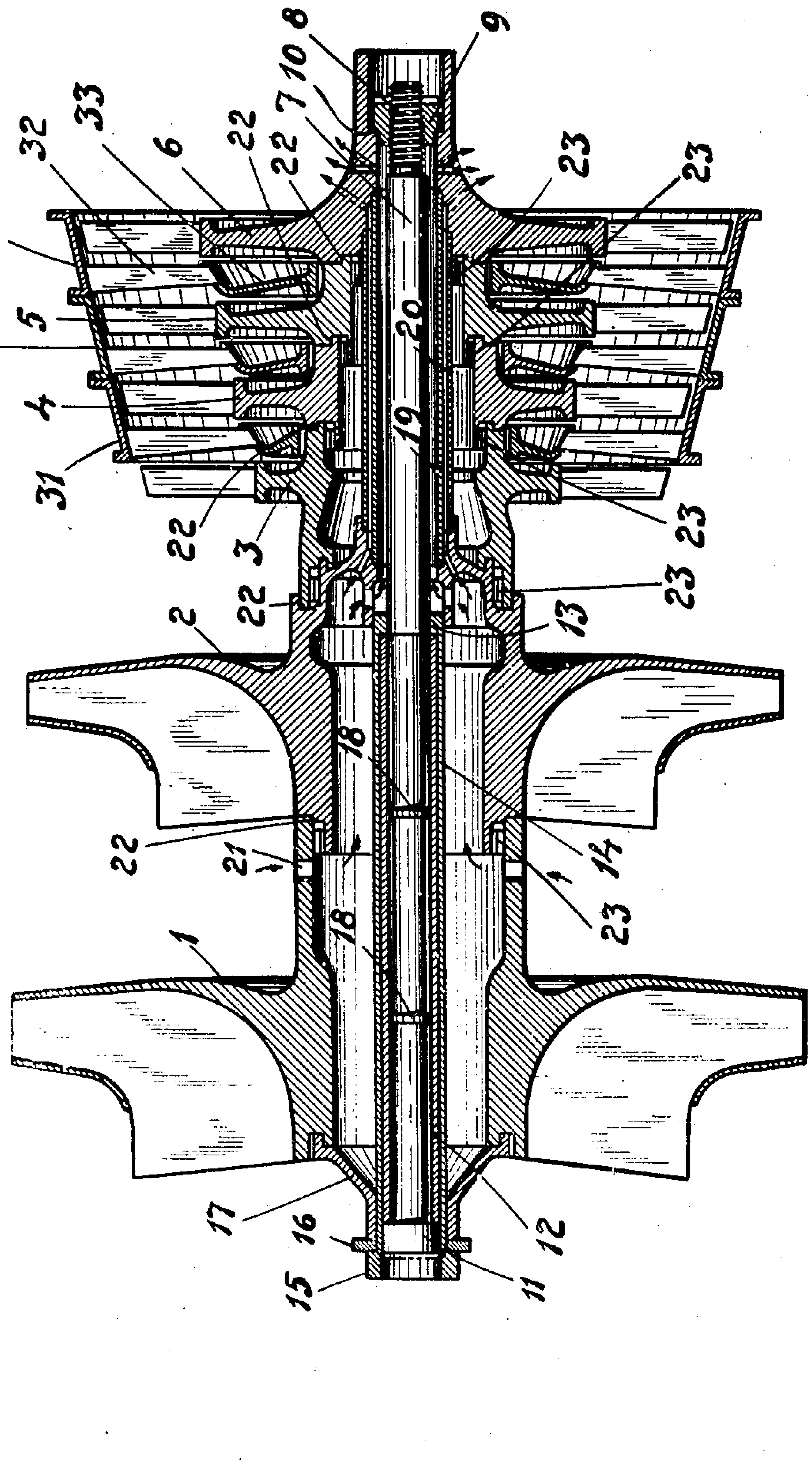

INVENTOR.
Karl A. Bergstedt
BY
Cushman Darby Cushman
Attys.

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ROTOR FOR MULTISTAGE TURBINES OR SIMILAR MACHINES

Karl Abdon Bergstedt, Langedrag, Sweden, assignor to Svenska Flygmotor Aktiebolaget, Goteborg, Sweden, a corporation of Sweden

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9 Claims. (Cl. 230—116)

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This invention relates to multistage turbines, dynamic compressors and similar engines having moving blades and particularly relates to a rotor for such engines. Particularly in gas turbines, attention has to be paid, in the construction of rotors, to the high temperatures occurring in operation and giving rise to very great thermal expansions, especially in view of the great coefficient of expansion of heat resistant materials.

In order to obtain sufficient strength with respect to stresses caused by centrifugal forces, the rotor is divided into a plurality of interconnected wheels. It has proved unsuitable to interconnect the wheels by means of bolts, since the stresses in the bolts gradually cease on account of the high temperatures. Further, it is not suitable to mount the wheels in the usual manner on a common shaft in view of difficulties arising from thermal expansion and alterations of the diameters due to the influence of centrifugal forces. On account thereof, the wheels have hitherto been welded together so as to constitute an undivided set of wheels. This results, however, in the inconvenience that it will be difficult and sometimes impossible to repair the rotor and that the assemblance of guide vanes between the moving blades is rendered rather complicated.

The present invention relates to a rotor in which the moving blades are mounted on wheels or the like arranged in coaxial alignment with each other and provided with central openings through which extends a tension rod adapted to keep the wheels together. In order that said tension rod upon axial expansion of the rotor due to variations in temperature shall be subject merely to elastic stretch, it would be necessary, in gas turbines, to give the tension rod a very great length. It is the principal object of the invention to provide a construction in which the stresses occurring in the tension rod are prevented from amounting above the flow limit of the material.

The invention will be more clearly described with reference to an embodiment illustrated in the annexed drawing. The drawing shows a longitudinal section of a rotor for a gas turbine power plant, said rotor being devised in accordance with the invention. In the diagrammatic representation only such parts have been illustrated as are relevant to the invention. The drawing illustrates a four-stage axial flow turbine and a two-stage centrifugal compressor driven by the turbine.

The rotor is composed of six wheels 1 to 6, the wheels 1 and 2 being compressor wheels, and the wheels 3, 4, 5 and 6 being turbine wheels.

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Each of the wheels has a central opening through which extends a tension rod 7. The end of the rod 7 located on the turbine side has a threaded portion 8 engaged by a nut 9 which abuts against a shoulder 10 provided in the hollow end portion of the turbine wheel 6.

The end of the tension rod located on the compressor side is provided with a collar 11 which abuts against one end of a sleeve 12 surrounding the tension rod. At the opposite end, the sleeve 12 abuts against a shoulder 13 on an outer sleeve 14 which extends to the end of the rotor and is provided with a collar 15 which through a washer 16 and a sleeve 17 abuts against the first compressor wheel 1. Due to the construction shown, the tensile stresses in the rod 7, which keep the wheels together are transferred to the wheels by means of the sleeves 12 and 14, the sleeve 12 being subject to compression, while the sleeve 14 is subject to tension.

When the rotor has been assembled, the nut 9 is tightened to such an extent that the wheels are firmly kept in engagement with each other. In operation, the rotor will be heated and its length will be considerably increased so that the tensile stresses in the rod 7 will also be increased. The various parts are dimensioned such that the increase of the length of the rotor will cause elastic deformation of the tension rod 7 and the sleeves 12 and 14. Consequently, the initial stresses in the rod 7 will remain when the turbine is put out of operation and the temperature decreases.

It will be obvious that the portion of the tension rod 7 located within the turbine wheels 3, 4, 5 and 6 will be relatively highly heated in operation with the result of a decrease of the mechanical strength. In order to compensate for said decrease, the portion of the rod located within the turbine wheels has a greater diameter than the remaining portion.

The resilient and telescopically mounted sleeves 12 and 14 are located at the cooler end of the rotor within the compressor wheels 1 and 2 and surround the thinner portion of the tension rod 7. The inner diameter of the sleeve 12 is larger than the diameter of the rod 7. In order to prevent the sleeve 12 from collapsing, the rod 7 is provided with supporting flanges 18.

To prevent as far as possible intensive heating of the rod portion located within the turbine wheels, said portion is surrounded by two protecting sleeves 19 and 20. Cooling air withdrawn from the compressor through apertures 21 passes between the protecting sleeves as well as between the inner sleeve 19 and the tension rod 7, as indicated by arrows in the drawing.

As will be seen from the drawing, the wheels are centered relative each other by means of cylindrical guide faces 22 so as to maintain all of the wheels in mutual coaxial positions. To transmit the torque between the wheels, they are provided with external and internal gear rims 23, each external gear rim engaging a corresponding internal gear rim on the adjacent wheel. It is of course not necessary to provide a gearing of the type used in gear wheels, since there occurs no relative movement or rolling, and it may be sufficient to provide projections and corresponding recesses which on account of the great torques and the high temperatures should be provided along the entire circumference and should have sufficient cross sectional areas.

It will be further seen from the drawing that the abutting cylindrical guide faces 22 on the compressor wheel 2 and turbine wheel 3 are arranged in a manner such that the highly heated wheel 3 has an external cylindrical face engaging an internal cylindrical face on the wheel 2 so as to obtain a tighter engagement and a more secure guiding action than in the reverse arrangement.

Due to the fact that the rotor is composed of separate wheels which are kept together by means of the tension rod 7, it is possible to provide undivided guide vane rims between the rotating wheels. In the drawing, three guide vane rims are illustrated. Said rims comprise undivided conical rings 31 suitably flanged and bolted to each other. The inner ends of the radial guide vanes 32 secured to the rings 31 are loosely introduced into recesses in discs 33 provided for preventing leakage between the wheels. Due to this arrangement, the guide vanes 32 may freely expand in radial direction without causing detrimental stresses.

It will be understood that the conical drum constituted by the rings 31 is mounted in the turbine casing by means of any suitable connection known per se and not illustrated in the drawing.

It will be understood that the invention is not limited to the specific embodiment described with reference to the drawing. For instance, it may be suitable to provide a plurality of compression sleeves and tension sleeves telescopically mounted on each other. Further, the invention is not limited to the combination of compressor wheels and turbine wheels, but may be applied to turbines alone, compressors and similar engines or machines which are heated in operation and subject to thermal expansion which may detrimentally affect the connections between the various parts of the rotor.

What I claim is:

1. In a multistage turbine, rotary compressor or the like, a rotor consisting of a set of separate wheels in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

2. In a gas turbine power plant, a rotor consisting of a set of wheels comprising separate turbine wheels and at least one compressor wheel in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

3. In a gas turbine power plant, a rotor consisting of a set of wheels comprising separate turbine wheels and at least one compressor wheel in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels, the rod portion located within said turbine wheels having a larger cross-sectional area than the rod portion located within said compressor wheel.

4. In a gas turbine power plant, a rotor consisting of a set of wheels comprising separate turbine wheels and at least one compressor wheel in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding the rod portion located within said compressor wheel, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

5. In a gas turbine power plant, a rotor consisting of a set of wheels comprising separate turbine wheels and at least one compressor wheel in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding the rod portion located within said compressor wheel, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a

shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels, the inner diameter of said first sleeve being greater than the diameter of said rod portion, said rod portion having radial guide members abutting against the inner cylindrical face of said first sleeve.

6. In a multistage turbine, rotary compressor or the like, a rotor consisting of a set of separate wheels having internal and external gear rims for torque transmission between the wheels, said wheels being arranged in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

7. In a multistage turbine, rotary compressor or the like, a rotor consisting of a set of separate wheels, guide vanes between at least some of said wheels, carriers for supporting said guide vanes, said wheels being arranged in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

8. In a multistage turbine, rotary compressor or the like, a rotor consisting of a set of separate wheels, guide vanes between at least two adjacent wheels, an undivided ring carrying said guide vanes, a sealing member between said two adjacent wheels, recesses in said sealing member, said guide vanes extending from said ring radially inwardly between said two adjacent wheels, the inner ends of said guide vanes being loosely inserted into said recesses, said wheels being arranged in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

9. In a multistage turbine, rotary compressor or the like, a rotor consisting of a set of separate wheels, a plurality of guide vane rims, said rims comprising rings and guide vanes secured to said rings, flange and bolt connections between said rings, said guide vanes extending radially inwardly from said rings between adjacent wheels, said wheels being arranged in coaxial alignment with each other, moving blades secured to said wheels, each of said wheels having a central opening, a rod extending axially through the openings in the wheels and having one of its ends secured to one end wheel of said set of wheels, a first sleeve surrounding said rod along at least part of the length of the rod, a second sleeve surrounding said first sleeve, the other end of said rod having a shoulder abutting against one end of said first sleeve, one end of said second sleeve having a shoulder abutting against the other end of said first sleeve, and a shoulder at the other end of said second sleeve, said last-named shoulder abutting against the other end wheel of said set of wheels.

KARL ABDON BERGSTEDT.

No references cited.