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ELASTIC FLUID TURBINE.

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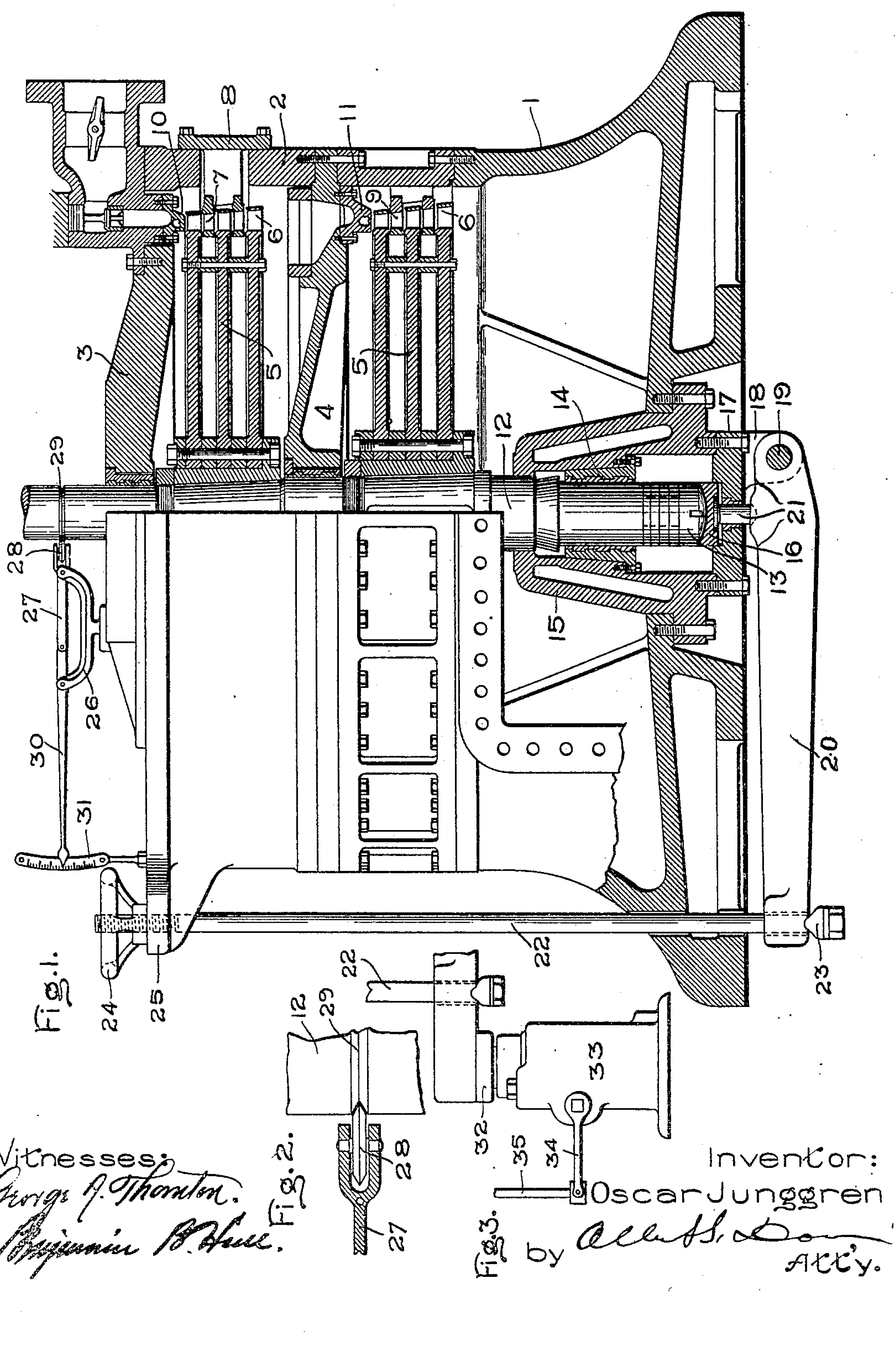

UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

No. 795,396. Specification of Letters Patent. Patented July 25, 1905.

Application filed April 29, 1903. Serial No. 154,886.

To all whom it may concern:

Be it known that I, OSCAR JUNGGREN, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Means for Compensating for Temperature Changes in Elastic-Fluid Turbines, of which the following is a specification.

In the practical operation of steam or other elastic-fluid turbines the expansion and contraction due to temperature changes affects different parts unequally. This is chiefly due to the fact that the shaft presents only a limited surface to the action of the steam, while having a relatively large cross-section. On the other hand, the casing presents a large surface to the steam and is relatively thin in cross-section. The expansion is also due in part to the fact that dissimilar metals are employed for the shaft and casing. For example, the shaft is made of steel, while the casing is made of cast-iron. Other things being equal, the longer the shaft and casing are the greater will be the difference in length between the parts when measured cold and hot. Actual tests on certain large turbines show that this expansion commonly amounts to one-sixteenth of an inch. For machines of greater height the increase is correspondingly greater. I do not mean to be understood by this that one part—such as the casing, for example—expands a sixteenth of an inch (to use the above illustration) before the shaft expands at all, for such is not the case, since the shaft begins to expand as soon as the casing, only it takes longer for it to do so. Variations in the temperature of the steam within the wheel compartment or shell, such as occur with changes in load, also cause unequal expansion of the parts. The difference in expansion is particularly noticeable when the turbine is first started into operation, because the surface of the casing exposed to the steam is greater than that of the shaft. After all of the parts are heated to their maximum for a given load the difference in expansion due to the use of dissimilar metals is not so noticeable. The unequal expansions cause the wheel-buckets that are carried by the shaft to rub on the stationary intermediate buckets or the nozzles which are carried by the casing, or both. When it is considered that the clearances between the moving and stationary buckets are sometimes as small as one one-hundredth of an inch, the liability of the parts rubbing is readily apparent. Part of the expansion can be compensated for by adjusting the intermediates, which requires the greatest care; but the nozzles, that are fixedly attached to the casing, will eventually engage with the wheel-buckets, as it is desired to run with a very small clearance at this point.

It is undesirable to keep changing the position of the intermediate buckets, because it is a more or less difficult task and requires a considerable amount of time. Again, it is impracticable in a staged turbine to adjust all of the intermediates simultaneously and to the same degree where they are divided into a large number of sets or groups.

Another reason why the parts in a turbine sometimes rub is the fact that the wheel-rim and parts attached thereto assume a slightly-different position when the centrifugal strains are great than when the wheel is stationary or revolving slowly. This may be due to uneven strains or stresses in the wheel-body or it may be due to some peculiarity in its structure. Whatever the cause may be the changing in relative positions between the moving and stationary parts is objectionable.

The present invention has for its object to provide a means whereby the clearances between the wheel-buckets and the intermediates and nozzles can be simultaneously and easily adjusted without in any way interfering with the action of the turbine.

For a consideration of what I consider to be novel and my invention attention is called to the following description and the claims appended thereto.

In the attached drawings, which represent one embodiment of my invention, Figure 1 is an elevation in quarter-section of a vertical turbine. Fig. 2 is a detail view showing the means for indicating the relative changes in length of the wheel-shaft and casing due to changes in temperature, and Fig. 3 shows a hydraulic jack for raising the outer end of the supporting-lever.

1 represents the base of the turbine, which supports the casing 2, that is made of cast-iron and divided into a number of pieces for simplifying its construction and rendering the machine as a whole easy to assemble. The upper part of the casing is provided with a cover 3 and is divided into stages or compartments by the diaphragm 4, and in each of the compartments thus formed is located a wheel 5. In the present instance the wheel is shown

as being composed of three disks bolted together and provided with peripheral buckets 6; but any other form of wheel construction can be employed, if desired. Between the rows of wheel-buckets are intermediate buckets 7, that are carried by a suitable support 8, that may be adjusted from the outside of the casing. The second-stage or low-pressure wheel is similar in construction to the high-pressure wheel, except that the passages formed between the buckets are somewhat larger to compensate for the increased volume of the motive fluid. Between the wheel-buckets are intermediate buckets 9, which may or may not be adjustable, as is desired. Fluid is delivered to the high-pressure wheel by one or more nozzles or devices 10, which deliver the steam or other elastic fluid at the proper angle to the wheel-buckets at such a temperature as will temporarily cause unequal expansion of the parts. Fluid to the second-stage wheel is delivered by one or more nozzles 11. The wheels are carried by a steel shaft 12 and are rigidly attached thereto. The lower end of the shaft is provided with a step-bearing 13 and a steady-bearing 14, both of which are inclosed by a casing 15, that is attached to the base of the machine. The lower end of the step-bearing is provided with a spherical surface, which is seated in an adjustable block 16, and the latter is provided with suitable means to prevent it from rotating. Situated directly underneath the bearing and attached to the casing 15 is a plate 17, that is provided with lugs 18, that support the pivot 19 for the adjusting-lever 20. The plate also acts as a guide for the block 16. Extending through the plate 17 and engaging with the lever is a cylindrical pin or support 21. Surrounding the support and seated on the plate is a suitable guide or bushing. The outer end of the lever is supported by a rod 22, located at one side of the casing, that is provided with a knife-edge 23, that engages the outer end of the lever. The said rod acts as a connecting device between the lever and the means for moving it. The upper end of the rod is screw-threaded and provided with a hand-wheel 24, by means of which the position of the shaft and wheels relative to the nozzles and intermediate buckets can be changed. The hand-wheel is supported by a projection 25, formed on the upper part of the casing. Mounted on the cover of the turbine is a support 26, which carries a device for indicating the relative position of the wheel-buckets within the casing. The indicating device comprises a lever 27, that is provided with a V-shaped roller 28, that engages with a corresponding groove 29, formed in the shaft. When the parts are in normal position, there is a slight clearance between the surfaces of the roller and the sides of the V-shaped groove; but as soon as the shaft expands or contracts by a certain predetermined amount relative to the casing the roller will be brought into engagement with one of the side walls of the groove and be raised or depressed, as the case may be. The opposite end of the lever 27 is connected to a pivoted pointer 30, which rises or falls as the shaft moves up or down. The pointer travels in front of a scale-plate 31, that is attached to the upper side of the casing, so that the operator can determine at a glance the relative position of the moving and stationary parts without opening the casing. When the pointer indicates that the casing or shaft has expanded a certain predetermined amount, so that the clearance between the nozzles and the upper set of wheel-buckets is different than it should be, the operator rotates the hand-wheel 24 forward or backward, as the case may be, which raises or lowers the outer end of the lever 20, and thus permits the shaft to move slightly in a longitudinal direction.

Owing to the arrangement of the lever 20 and support for the shaft a considerable movement is necessary at the outer end of the lever before the shaft is appreciably moved. This is desirable, because it decreases the liability of the operator overadjusting and thus bringing the wheel-buckets into engagement with the lower intermediate buckets, and it also decreases the labor of adjusting. When the pointer 30 returns to its normal position, the operator knows that the parts bear the proper relation. It will be noted that the adjustment of the parts is accomplished by means located at one side of the turbine, where the parts are readily accessible.

In Fig. 3 is shown a hydraulic jack of any suitable construction, such as may be bought on the open market, for moving the outer end of the lever 20. In this case the lever may be extended somewhat more than in Fig. 1 and arranged to rest on the movable head or piston 32 of the hydraulic jack 33 or other motive device. Motion to the head or piston is imparted by the lever 34 through a fluid medium and is itself actuated by a rod 35, that preferably extends to some point adjacent to the indicator. When the jack is used, the rod 22 and hand-wheel 24 are employed as a locking or supporting means for the parts.

By means of my invention a turbine can be run with smaller clearances than has heretofore been considered possible because the wheel-buckets and nozzle and intermediates as a whole can be moved relatively to each other, and this with ease and in a brief interval of time. With the structure shown the pitch distance between a given set of buckets is kept constant, and when the parts assume an abnormal position, due to unequal expansions, they can as a whole be simultaneously adjusted to compensate therefor. After the parts are fully heated the intermediate buckets may, with the relation unchanged, engage the under side of the wheel-buckets owing to the expansion of the casing, and this can be compensated for by raising the wheel-buckets.

According to the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it known that the apparatus shown is merely illustrative and that the invention can be carried out in other ways.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An elastic-fluid turbine comprising a wheel-casing, a shaft, wheel-buckets thereon, and a device supported by the casing for discharging a heated motive fluid against the buckets, the casing and shaft expanding unequally under the action of the motive fluid, in combination with a casing which is detachably secured to the turbine-casing and supports the shaft, a device carried by the bearing-casing for moving the shaft to adjust the clearances between the buckets, and a means extending toward the side of the turbine for moving the device.

2. An elastic-fluid turbine comprising a wheel-casing, a shaft, a bearing therefor, wheel-buckets carried by the shaft, intermediate buckets between the wheel-buckets, and a device for discharging a heated motive fluid against the buckets, the shaft and casing expanding unequally under the action of the motive fluid, in combination with a casing for the bearing, a device for adjusting the bearing supported by its casing, a means located outside of the wheel-casing and extending toward the side thereof for moving the device to adjust the bearing, shaft and casing longitudinally with respect to each other.

3. An elastic-fluid turbine comprising a casing, a shaft, a bearing therefor, a support for the bearing, a bucket-wheel carried by the shaft, a device for discharging motive fluid at a relatively high temperature to the buckets, which causes unequal expansion of the parts, in combination with a means attached to the bearing-support for moving the shaft and bearing longitudinally to change the clearances between the device and the buckets, and a controllable device for moving said means.

4. An elastic-fluid turbine comprising a casing, a shaft, a bearing therefor, a support for the bearing, a bucket-wheel carried by the shaft, a device for discharging motive fluid at a relatively high temperature to the buckets, which causes unequal expansion of the parts, in combination with a lever attached to the bearing-support for moving the shaft and bearing longitudinally to prevent the parts from engaging due to unequal expansion, and means for securing the lever in place.

5. An elastic-fluid turbine comprising a casing, a vertical shaft, a bucket-wheel mounted on the shaft, a device for discharging motive fluid at a temperature which causes unequal expansion of the parts, in combination with a step-bearing located within the casing, a support therefor, a device for adjusting the bearing to change the clearances, and a means extending through the casing from the bearing and engaging the adjusting device.

6. An elastic-fluid turbine comprising a wheel-casing, a wall for dividing it into compartments working at different temperatures, a bucket-wheel in each compartment, intermediate buckets between the wheel-buckets, and nozzles for discharging motive fluid to the buckets at such a temperature that it causes unequal expansion of the parts, in combination with a lever for moving the casing and wheels with respect to each other to maintain a given clearance between buckets, a bearing-casing which incloses the end of the shaft and carries the pivot for the lever, and means for adjusting the lever and holding it in position.

7. An elastic-fluid turbine comprising a wheel-casing, a shaft, bucket-wheels mounted thereon, one or more nozzles for discharging motive fluid to the wheels at a temperature which causes unequal expansion of the parts, in combination with a bearing engaging the end of the shaft, a casing for the bearing, a means carried by the casing for adjusting the bearing to vary the clearance between buckets, and an indicator which indicates the relative position of the parts.

8. An elastic-fluid turbine comprising a casing, a vertical shaft, wheel-buckets mounted thereon, a nozzle or device for discharging motive fluid to the buckets at a temperature which causes unequal expansion of the parts, in combination with a step-bearing for the shaft, a casing for the bearing, which is attached to the wheel-casing, an adjustable support for the bearing extending through its casing, and a means external to the wheel and bearing-casings for moving the adjustable support.

9. An elastic-fluid turbine comprising a casing, a vertical shaft, wheel-buckets mounted thereon, a nozzle or device for discharging motive fluid to the buckets at a temperature which causes unequal expansion of the parts, in combination with a step-bearing for the shaft, located within the wheel-casing, a support located under the bearing, which extends through the casing, a means located under the turbine, which engages the support for moving it, and a device for actuating the means, which extends longitudinally of the turbine and is accessible from a point near the top of the turbine.

10. An elastic-fluid turbine comprising a wheel-casing, a shaft, wheel-buckets carried by the shaft, intermediate buckets located between the wheel-buckets, and a device for discharging motive fluid against the buckets,

the shaft and casing expanding unequally under the action of the motive fluid, in combination with a step-bearing for the shaft, a steady-bearing for the shaft located above the step-bearing, a casing attached to the wheel-casing which carries the step and steady bearings, means extending through the bearing-casing for adjusting the step-bearing and shaft to change the clearances, and an actuator for the device which is also supported by the step-bearing casing.

In witness whereof I have hereunto set my hand this 28th day of April, 1903.

OSCAR JUNGGREN.

Witnesses:
ALEX. F. MACDONALD,
HELEN ORFORD.