No. 773,657. PATENTED NOV. 1, 1904.

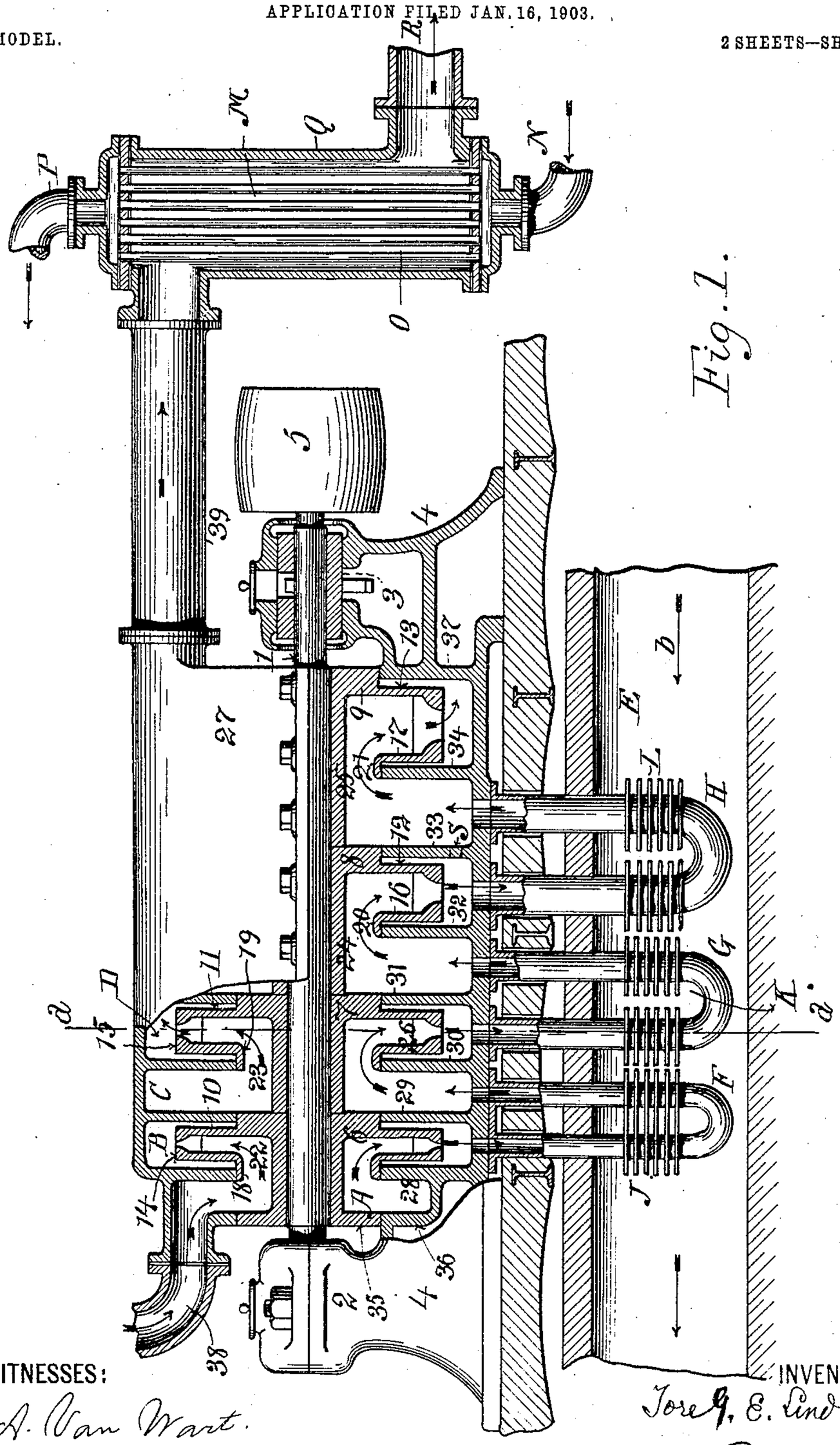
T. G. E. LINDMARK.

EXHAUST HEATER FOR COMPOUND MOTORS.

APPLICATION FILED JAN. 16, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

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A. Henderson.

INVENTOR

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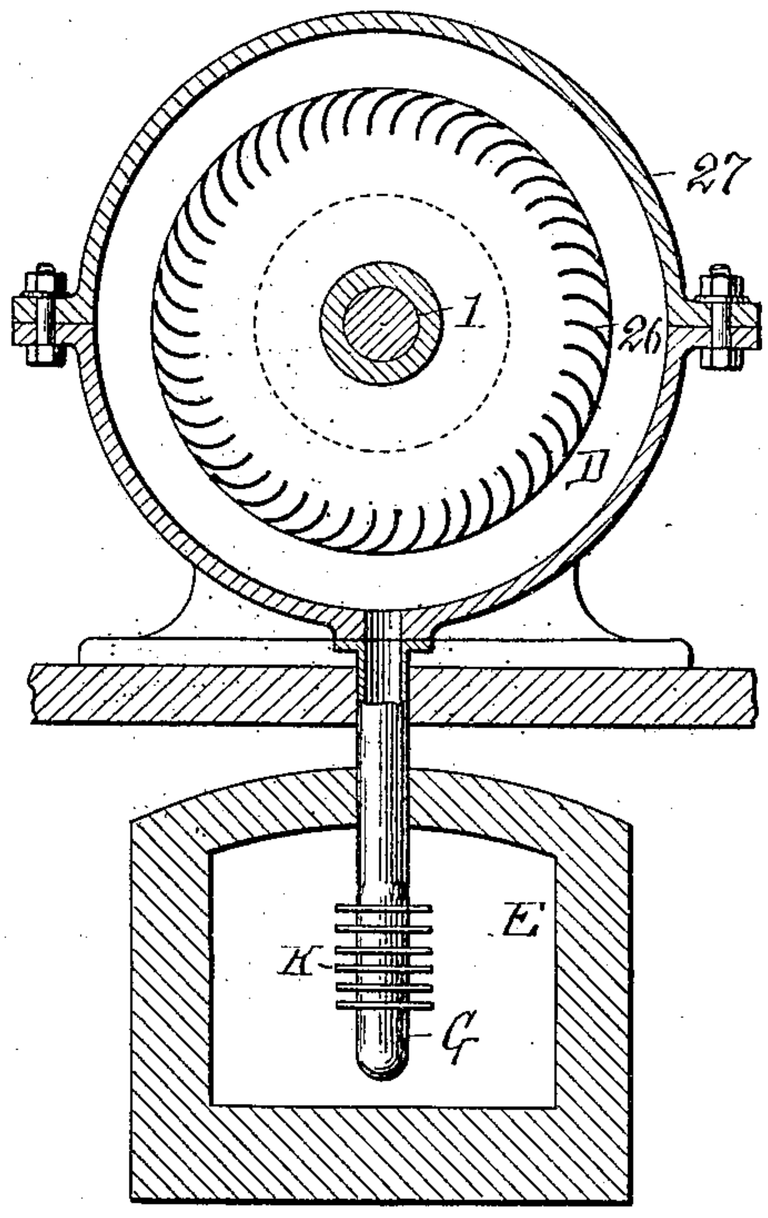

Fig. 2.

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No. 773,657. Patented November 1, 1904.

UNITED STATES PATENT OFFICE.

TORE GUSTAF EMANUEL LINDMARK, OF STOCKHOLM, SWEDEN.

EXHAUST-HEATER FOR COMPOUND MOTORS.

SPECIFICATION forming part of Letters Patent No. 773,657, dated November 1, 1904.

Application filed January 16, 1903. Serial No. 139,262. (No model.)

To all whom it may concern:

Be it known that I, TORE GUSTAF EMANUEL LINDMARK, a subject of the King of Sweden and Norway, and a resident of Stockholm, Sweden, have invented a new and useful Improvement in Exhaust-Heaters for Compound Elastic-Fluid Motors, of which the following is a specification.

The invention relates to elastic-fluid motors wherein the fluid undergoes progressive expansion, and more particularly to turbines.

The invention consists in the combination, with a plurality of said motors, of means for superheating the fluid, so as to increase the degree of superheating prior to each expansion or prior to certain number of expansions, and also in the construction hereinafter set forth, and more particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a longitudinal section of a multiple steam-turbine provided with my heating apparatus and feed-water heater. Fig. 2 is a partial cross-section on the line *a a* of Fig. 1.

Similar characters of reference indicate like parts.

The wheel-shaft 1 is supported in bearings 2 3 in standards 4 and provided with the pulley 5. On said shaft are the wheel-hubs 6 7 8 9, each hub being flanged, as shown at 10 11 12 13, so that said flanges each form a wheel-head. The opposite wheel-heads 14 15 16 17 are flanged, as shown at 18 19 20 21, to form annular steam-inlets 22 23 24 25 to the interior of the wheels. Between the heads of each wheel are the inclined buckets 26. The wheel-casing 27 incloses the wheels and has annular partitions 28 29 30 31 32 33 34, which extend radially upward to meet the flanges 18 19 20 21, and also shoulders formed upon the hub-flanges 10 11 12 13.

The wheel-hub 6 is flanged at 35 and is received in one head, 36, of the casing. The opposite casing-head, 37, receives the shouldered portion of hub 9. Communicating with head 36 is the steam-inlet 38 and with head 37 the exhaust-outlet 39. By reason of this construction there is formed within the casing a chamber A, into which the steam first enters, from which it passes through the inlet 22 to the first wheel of the series, thence it escapes between the buckets 26 to the surrounding chamber B. The arrangement of the succeeding wheels and chambers is the same—that is, in advance of the second wheel there is a chamber C, from which the steam passes by the inlet 23 to said second wheel and then escapes into the surrounding chamber D, and so on. The chambers and wheel-passages of the successive wheels are, however, progressively larger to allow for the expansion of the steam as it proceeds from wheel to wheel, the final chamber communicating with the exhaust-outlet 39. As the steam flows from the wheel-buckets the several wheels are set in rotation.

I find that with a compound steam-turbine of this type it is desirable to superheat the steam between expansions, so that the degree of superheating will increase from inlet to outlet. To effect this, I provide a duct or conduit E, through which hot gases are caused to pass in the direction of the arrows *b*. Into this conduit project the U-shaped pipes F G H, the pipe F connecting the inclosing chamber B of the first wheel with the receiving-chamber C of the second wheel, the pipe G connecting the inclosing chamber D of the second wheel with the surrounding chamber of the third wheel, and the pipe H connecting the inclosing chamber of the third wheel with the surrounding chamber of the fourth wheel. Therefore the steam from chamber B passes through pipe F before reaching chamber C, and so on, and in traversing each successive pipe the steam becomes superheated from the gases passing through the duct E. The pipes F G H are constructed of successively-larger diameter in proportion to the increased volume of the expanded fluid. In order to augment their heating-surface, they may be provided with projecting metal flanges J K L. As the exhaust-steam escapes in a highly-superheated state, it is desirable to utilize it, and therefore I connect the exhaust 39 with the feed-water heater shown at M. In this device the feed-water enters at N, passes upward through the tubes O, and escapes at P. The superheated steam passes through the casing Q, surrounding tubes O, and escapes at R.

While I have here shown an arrangement whereby the steam is superheated before every expansion, this is not essential, since between some of the wheels of the compound series I may omit the connecting-pipe. In that case the steam would be led directly from the inclosing chamber of one wheel to the receiving-chamber of the next wheel. Thus if the openings leading into pipe H were closed an opening at S (dotted lines) would be used to conduct the steam from one chamber to the other.

I claim—

1. In combination with a plurality of elastic-fluid motors wherein said fluid undergoes progressive expansions, means for augmenting the temperature of said fluid prior to each expansion by an amount progressively increasing from the first expansion to the last.

2. In combination with a plurality of elastic-fluid motors disposed in series, means for augmenting the temperature of said fluid prior to entrance to each motor by an amount progressively increasing from the first admission to the last.

3. In combination with a plurality of elastic-fluid turbines in which said fluid is progressively expanded disposed in series, means interposed between successive turbines for augmenting the temperature of the working fluid by amounts progressively increasing from the initial admission end of the series to the final exhaust.

4. In combination with a plurality of elastic-fluid motors wherein said fluid undergoes progressive expansions, means for maintaining uniform the temperature of said fluid at the inlets of the several motors, substantially as described.

5. The combination of a plurality of elastic-fluid turbine-wheels, a shaft supporting the same, a casing, partitions in said casing forming successive chambers, conduits exterior to said casing and connecting said chambers in series, and means for heating said conduits, substantially as described.

6. The combination of a plurality of elastic-fluid turbine-wheels, a shaft supporting the same, a casing, partitions in said casing forming successive wheel-chambers, conduits exterior to said casing and connecting said chambers in series, and a duct for conveying heated gas; the said connecting-conduits extending into said duct, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

TORE GUSTAF EMANUEL LINDMARK.

Witnesses:

WALDEMAR BOMAN,

F. EKEBOHM.