No. 859,553 PATENTED JULY 9, 1907.

S. Z. DE FERRANTI.

ELASTIC FLUID TURBINE.

APPLICATION FILED OCT. 10, 1905.

7 SHEETS—SHEET 1.

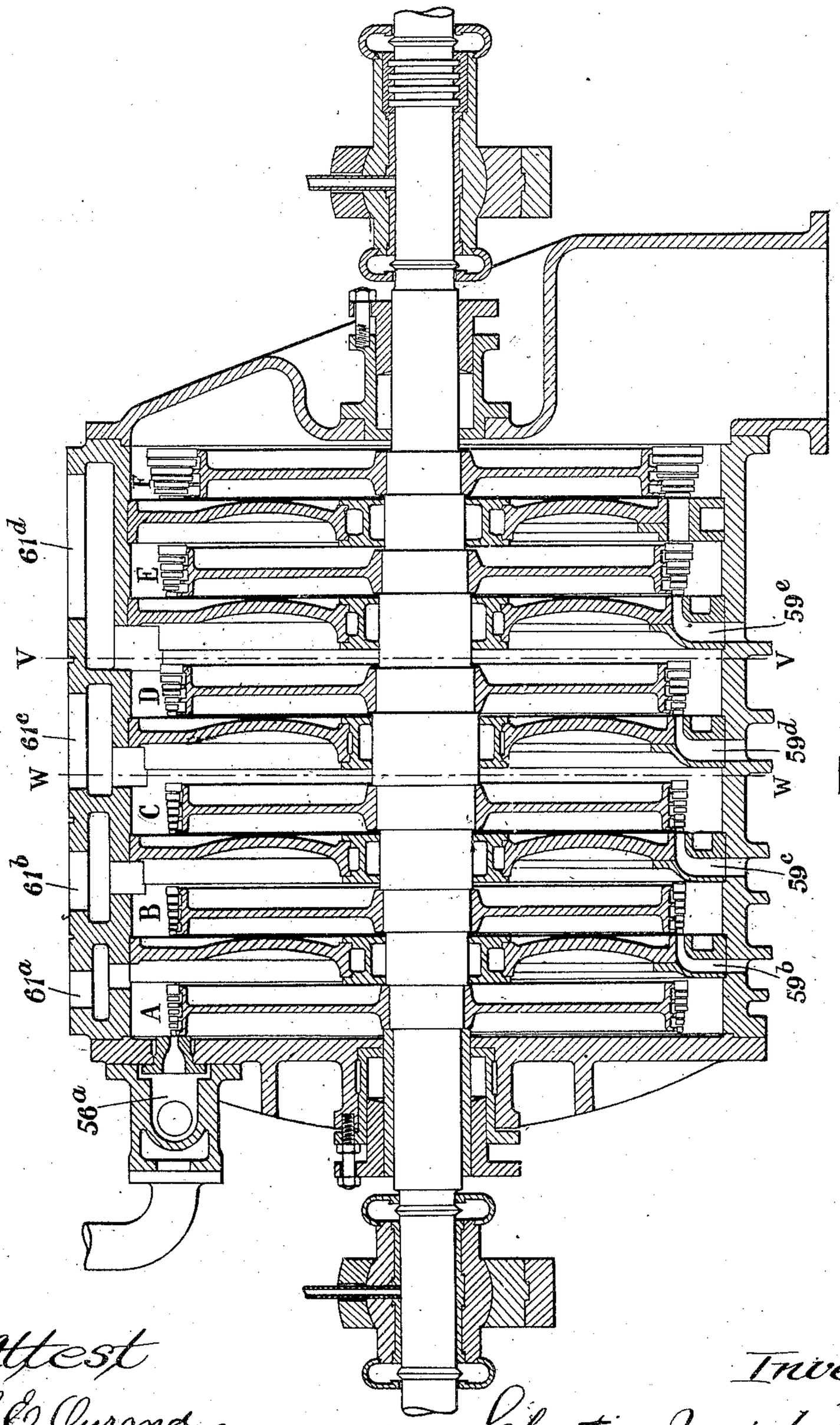

Fig. 1.

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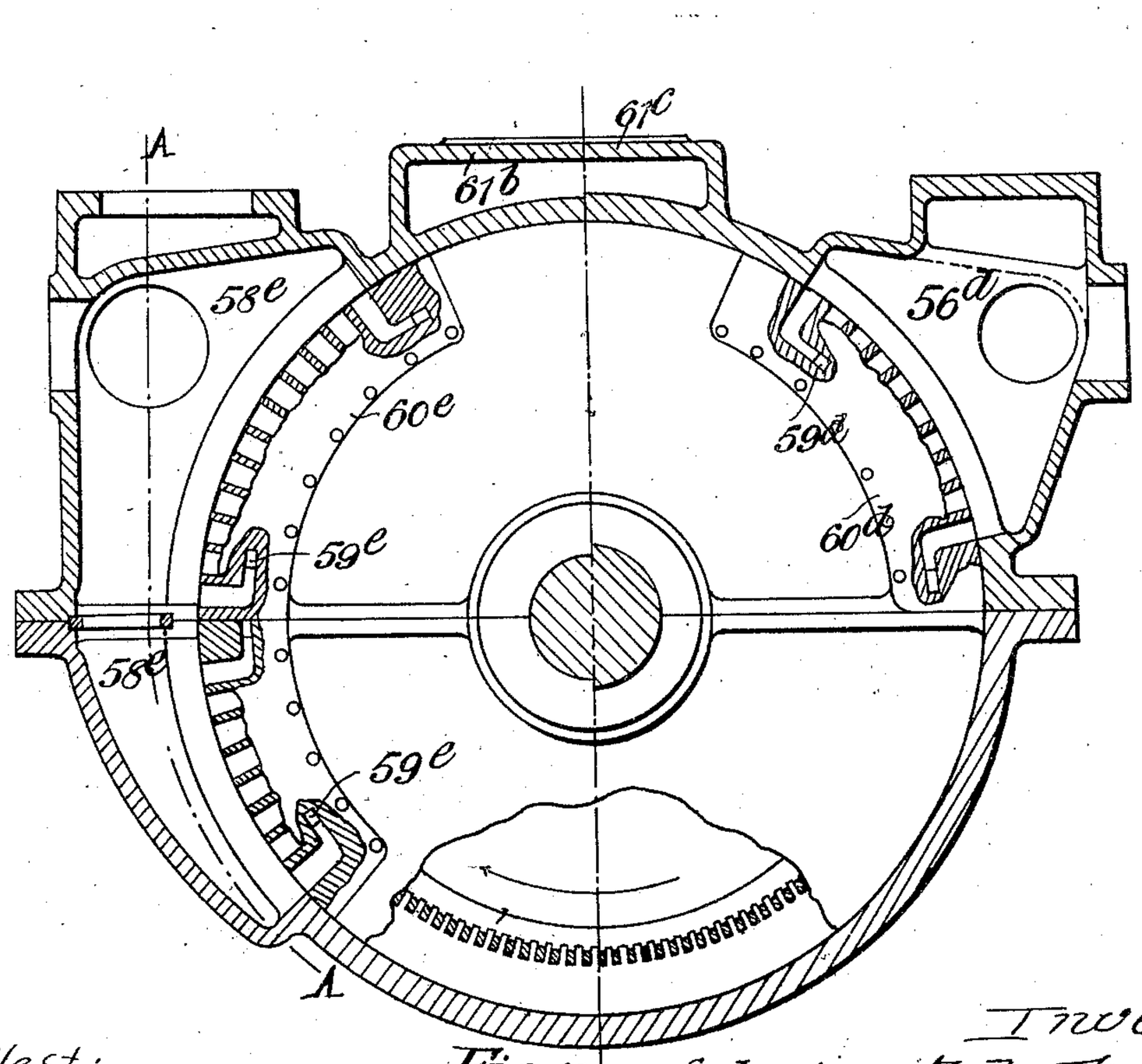

Fig. 1.

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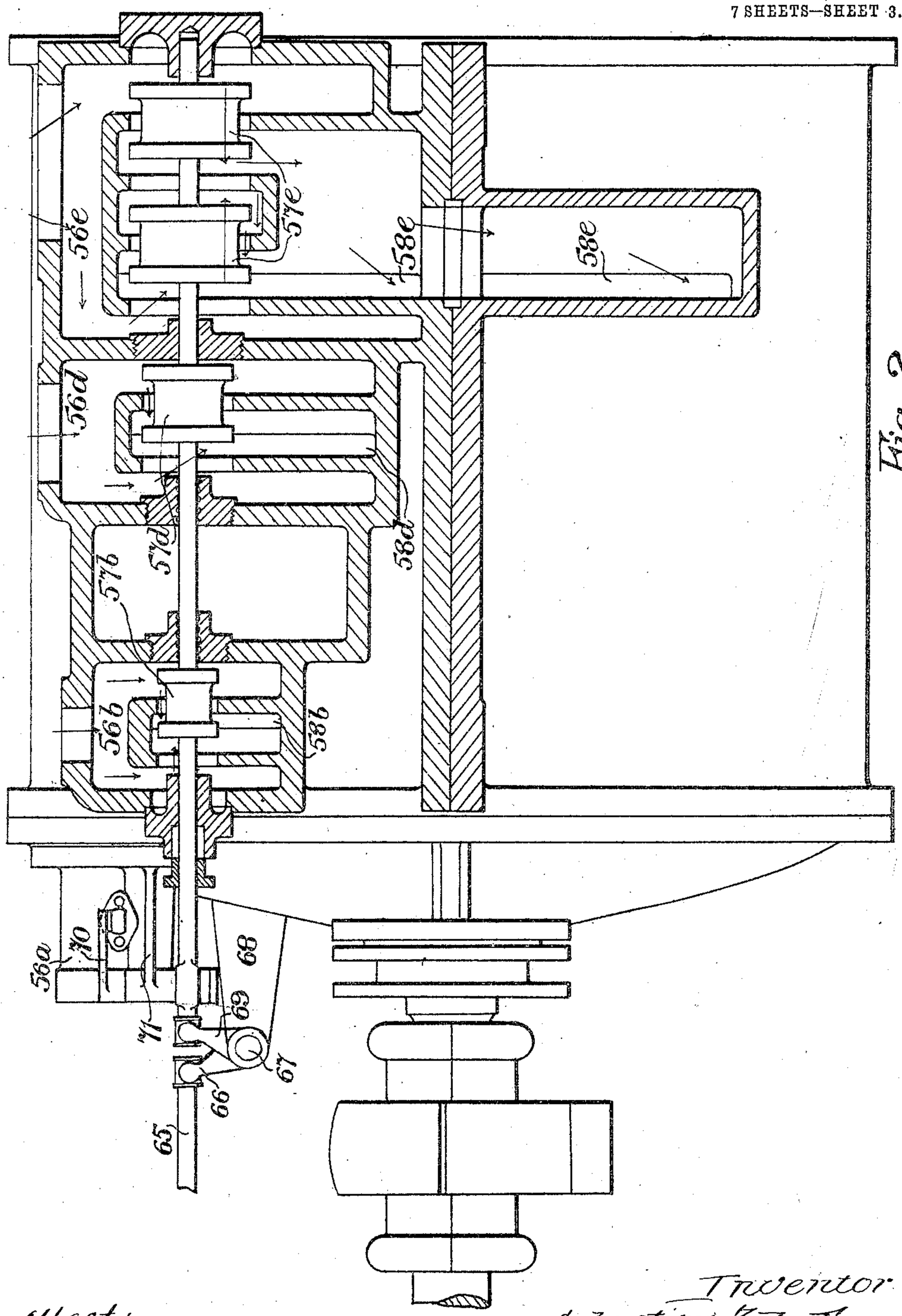

Fig. 2.

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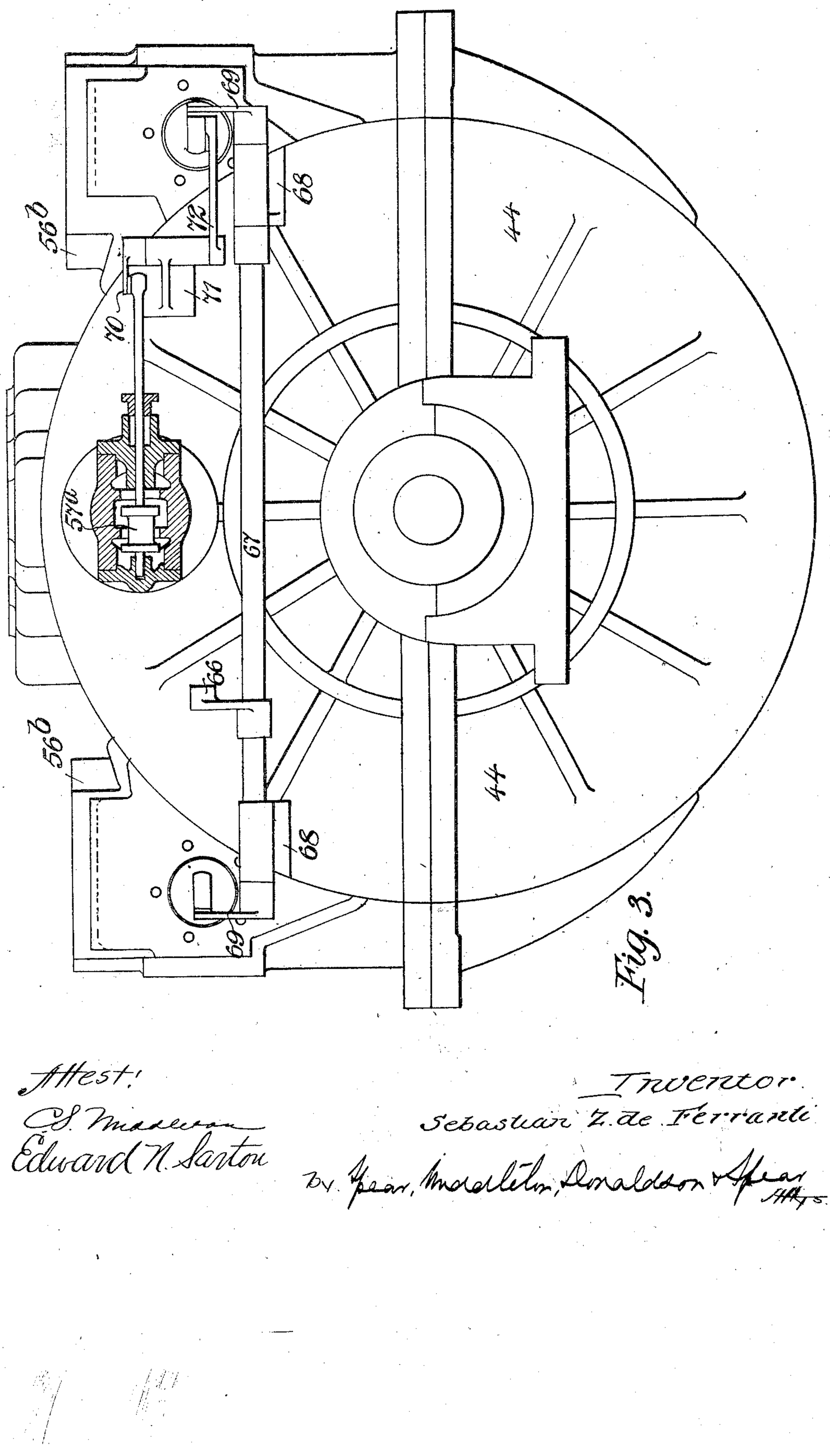

Fig. 3.

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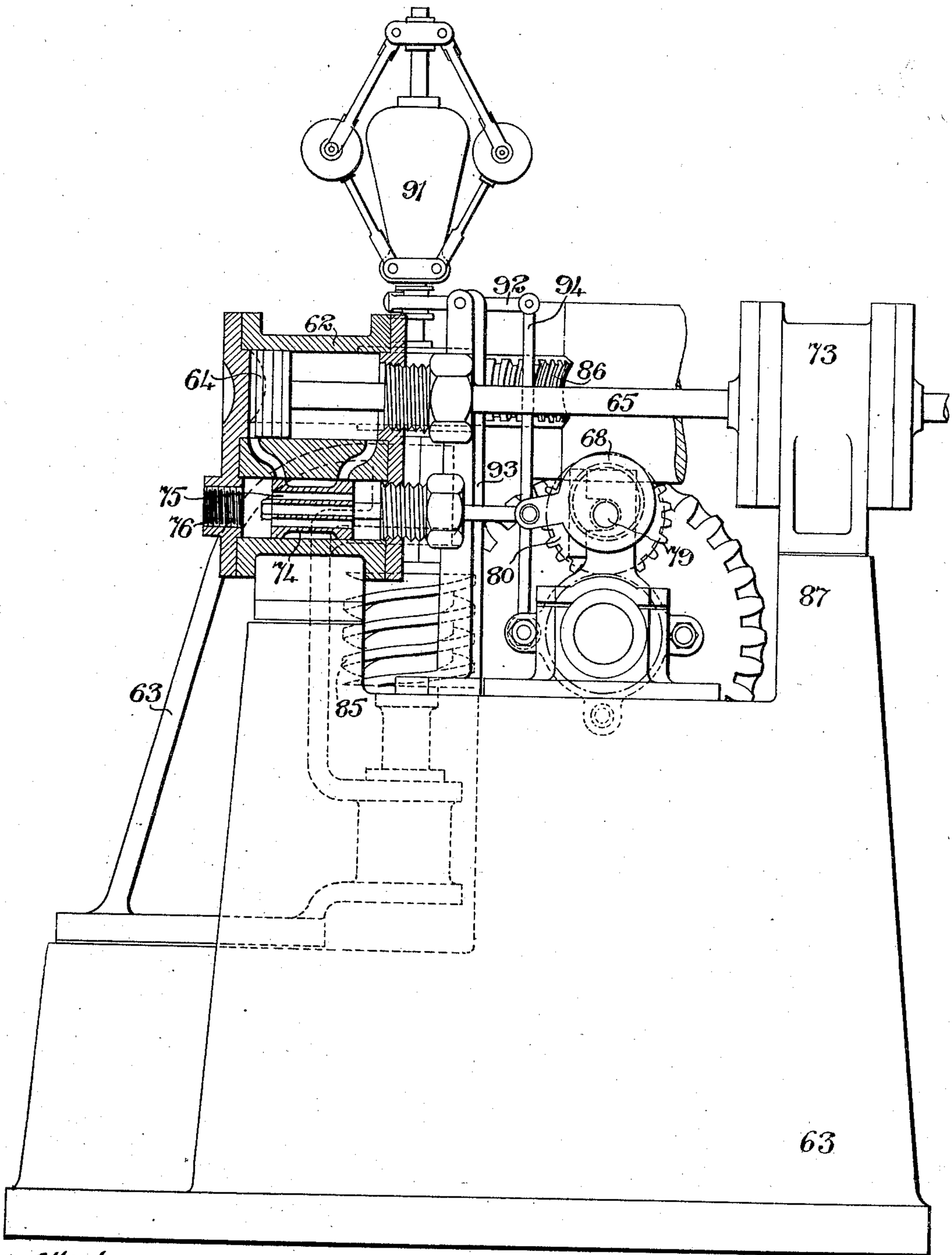

Fig. 4.

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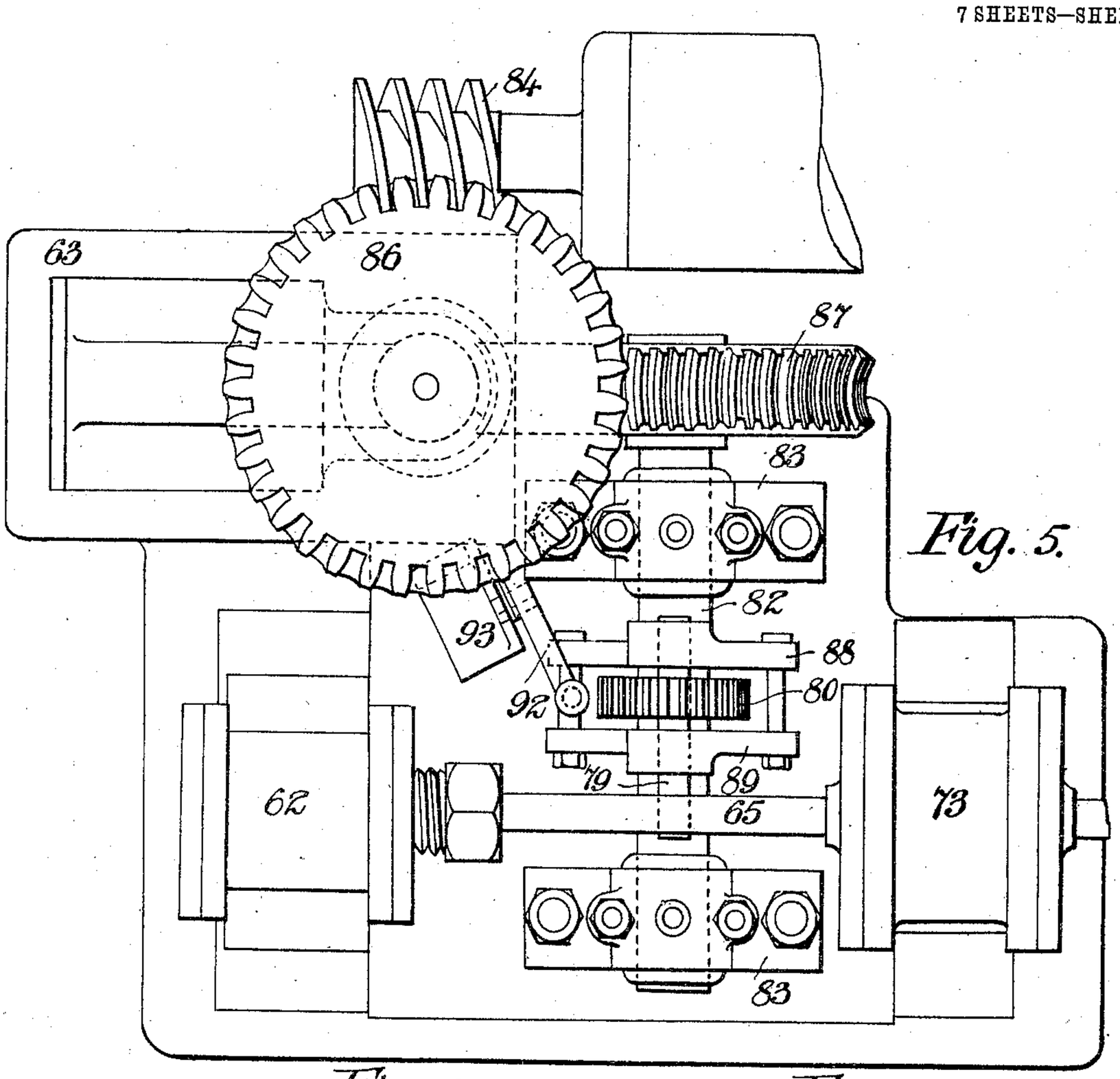


Fig. 5.

Fig. 9.

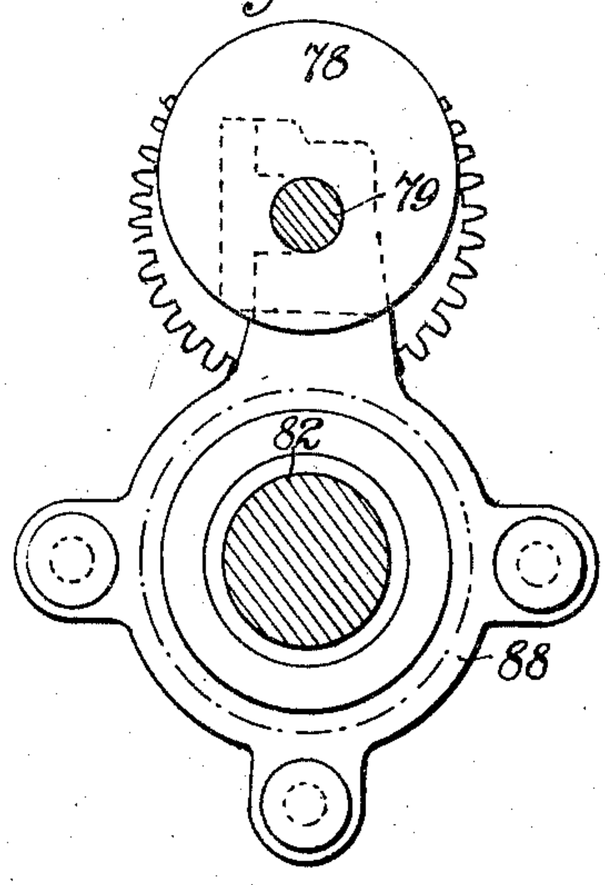
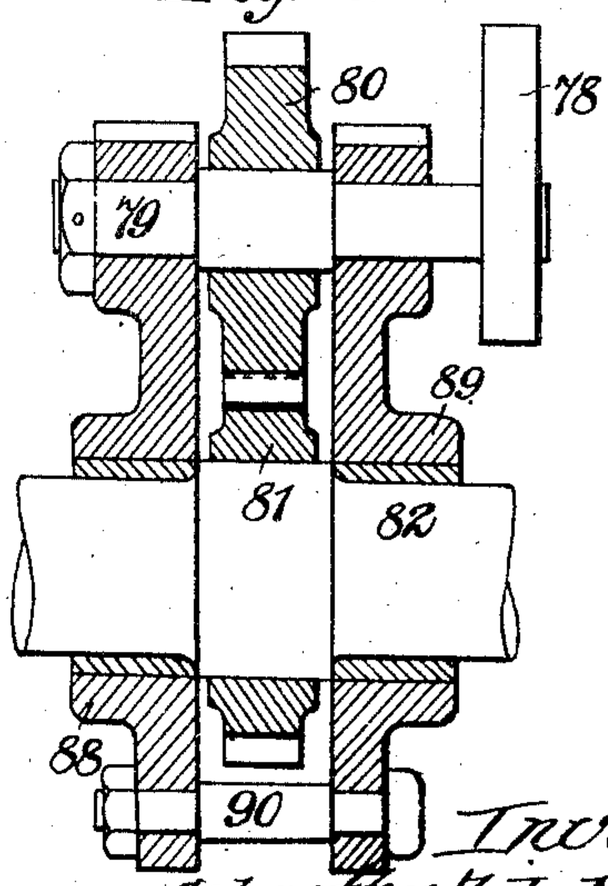


Fig. 10.



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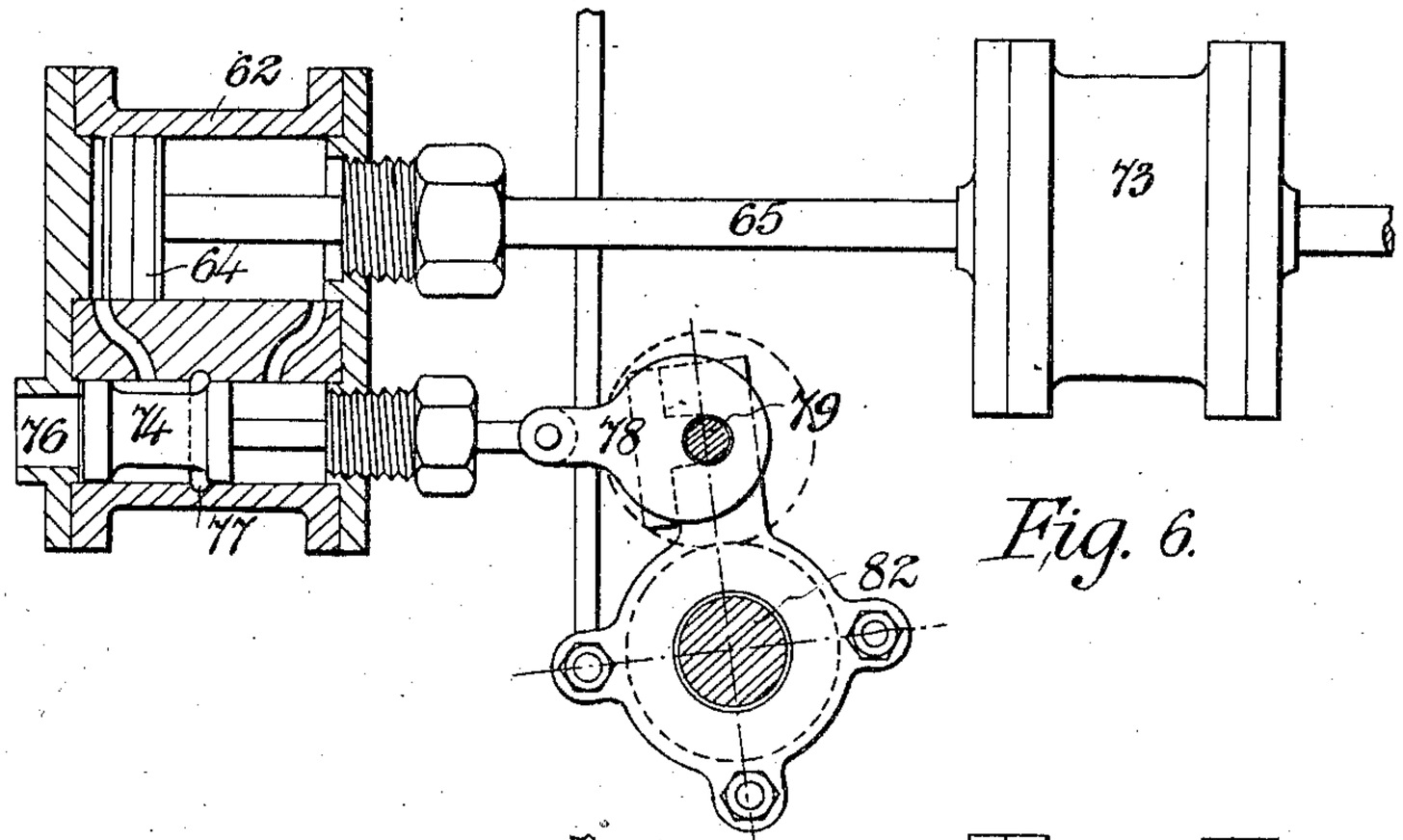

Fig. 6.

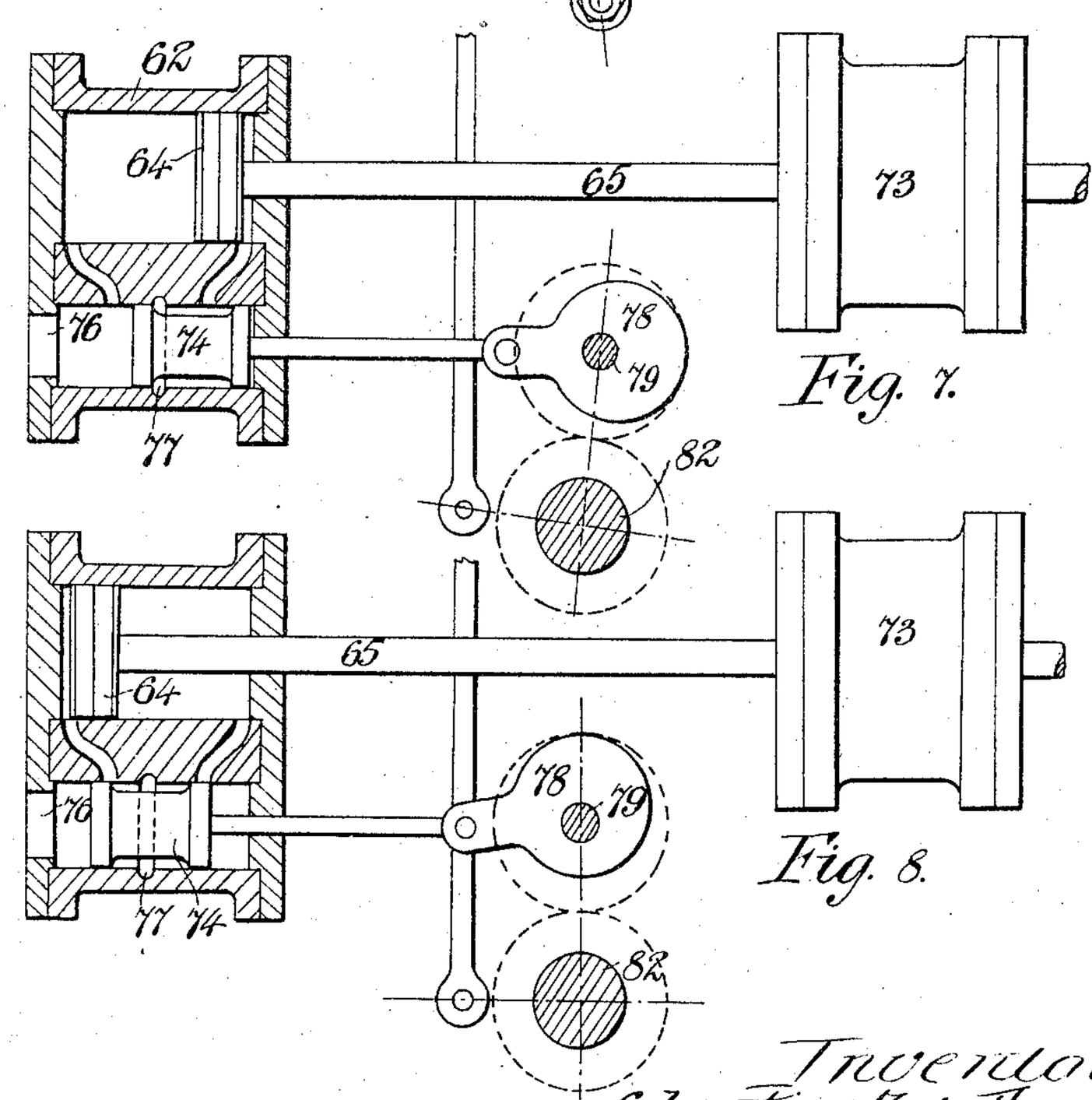

Fig. 7.

Fig. 8.

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UNITED STATES PATENT OFFICE.

SEBASTIAN ZIANI DE FERRANTI, OF LONDON, ENGLAND.

ELASTIC-FLUID TURBINE.

No. 859,553. Specification of Letters Patent. Patented July 9, 1907.

Original application filed October 31, 1903, Serial No. 179,407. Divided and this application filed October 10, 1905 Serial No. 282,187.

To all whom it may concern:

Be it known that I, SEBASTIAN ZIANI DE FERRANTI, a subject of the King of Great Britain and Ireland, and a resident of 31 Lyndhurst road, Hampstead, London, N. W., England, have invented certain new and useful Improvements in and Relating to the Governing of Elastic-Fluid Turbines, of which the following is a specification.

Such a turbine is described in my patent application, No. 179407, from which the present application is divided.

My invention relates to the governing of multiple stage elastic fluid turbines, and more particularly to the kind known as "isothermal" wherein the temperature of the turbine is maintained practically uniform from end to end by means of reheaters disposed between the turbine stages.

Difficulties arise in the governing of turbines of the hereinbefore described types, and to overcome these difficulties I apply the principle of puff governing or governing by blasts, that is to say I arrange quick opening valves to deliver steam to each section of the turbine in periodical blasts, similar valves of suitable area being provided for each stage of the expansion, and I further couple the mechanism operating all these valves so that they act preferably simultaneously under the control of a mechanical or electrical governor of any well known type. My invention differs from the puff governing or governing by blasts as used heretofore in providing puff governing at several stages or sections, at which stages or sections the steam pressure is kept practically constant irrespective of load.

Referring now to the accompanying drawings:—Figure 1 shows a longitudinal vertical section through a turbine of the multistage type. Fig. 1ª is, as to its left hand half, a section on the line V V of Fig. 1, and, as to its right hand half, a section on the line W W of the same figure. Fig. 2 is a section through the valve chests taken on the line A′ A′ of Fig. 1ª. Fig. 3 is an end view of the high pressure end of the turbine showing part of the governing gear. Figs. 4 and 5 are elevation and plan respectively of a general arrangement of puff-governing gear. Figs. 6, 7 and 8 are views showing the action of the gear, and Figs. 9 and 10 detail views of the levers on which the eccentric spindle is journaled.

In carrying the invention into effect according to one form, I have shown in Figs. 1, 1ª, and 2, a turbine of the multistage type. It will be seen (see Fig. 1) that six wheel chambers A, B, C, D, E, and F, are provided, the exhaust outlets, 61ª, 61ᵇ, etc, from which are arranged at the top of the turbine, the steam entering by way of the valve chambers 56ª, 56ᵇ, etc., disposed on opposite sides of the center line. These valve chambers increase in size from the high pressure to the low pressure end of the turbine as shown by the typical sections of Figs. 1ª, and 2, this latter figure also showing by the omission of the valve 57ᶜ of wheel chamber C that at the high pressure end of the turbine sufficient areas can sometimes be given to the steam passages by arranging a valve on one side of the center line only; thus the valves 57ᵇ and 57ᶜ to chambers B and C are arranged respectively on opposite sides of the center line and consequently only the valve 57ᵇ shows in the particular section shown. At the low pressure end of the turbine, valves on both sides are generally necessary; but I may adopt any suitable arrangement throughout in order to insure sufficient areas for the steam passages. Two sets of valves, as shown in Fig. 3, are arranged to run the whole length of the turbine, their action being under the control of the governor gear to be described hereinafter. It will be understood that reheaters are preferably arranged between adjacent stages, so that the steam from the stage or chamber A, for example, passes out by the exhaust outlet 61ª, through the reheater, and enters the valve chamber 56ᵇ of stage B as indicated by an arrow in Fig. 2. To meet the exigencies of design no provision is made for reheaters between chambers E and F. These reheaters, however, form no part of the present invention and are not shown in the accompanying drawings since no claims are directed to them. From the valve chests, passages 58ª, etc., lead to the nozzles 59ᵉ, etc., which are preferably formed in separate castings, such as 60ᵉ, Fig. 1ª, bolted on to their appropriate partitions; these nozzle castings, as will be evident, are constructed of different lengths, areas and so forth, so as to correspond with their respective valve chests. The true position of the nozzles is shown in Fig. 1ª, the nozzles in Fig. 1 being shown out of the true position for convenience of drawing in a manner well understood.

The valve 57ª, for distributing steam to the first stage is, for convenience, placed at right angles (see Fig. 3) to the two main lines of valves, its action, however, being in all respects essentially similar.

The course of the steam through the turbine will, in view of the above remarks and the arrows on the drawings, be readily followed without further description.

According to one form of governing gear in which the principle of puff governing or governing by blasts, is embodied, as applied to the turbine just described,

a cylinder 62, (see Figs. 4 to 8) supported on any convenient bed-plate 63, is arranged to operate a set of valves admitting steam to the different sections of the turbine. A piston 64 working in this cylinder, and piston-rod 65, are connected, in the arrangement shown, to the lever 66 keyed to the shaft 67. This shaft (see Fig. 3) passes across the end of the turbine, supported by suitable brackets 68, and carries other levers 69, each adapted to operate its respective line of valves.

The valve 57ª, which is placed for convenience at right angles to the main lines of valves, is operated by means of the lever 70 keyed to a vertical shaft journaled in the bracket 71, a second lever 72, also keyed to this shaft, being suitably connected to a point of one of the main valve spindles.

An air buffer 73 is preferably arranged on some suitable portion of the mechanism to avoid shock.

Admission of steam to the cylinder 62 is controlled by the piston-valve 74 having through passages 75; the steam enters the valve chest through the opening 76, and exhausts by the passage 77.

It will be obvious that other types of slide valve may be adopted.

The valve 74 is operated by an eccentric 78 keyed to the shaft 79, (see Figs. 9 and 10) a spur-wheel 80 being also mounted on the shaft. The wheel 80 gears with another spur-wheel 81 mounted on the shaft 82 carried in bearings 83. This shaft 82 is driven from the main turbine shaft by means of gearing such as the worms 84, 85 and the worm wheels 86 and 87.

The spur-wheel and eccentric shaft 79 is journaled on the levers 88, 89 secured together by the bolts 90 and turning loosely on the shaft 82. The position of these levers is controlled by a governor 91, acting through the lever 92 (fulcrumed on any convenient bracket 93) and link 94.

The operation of the mechanism is as follows:— Supposing, while running normally, that the load is removed. The speed of the turbine will increase and the outward movement of the governor balls will cause the gear to assume the position shown in Fig. 6. The valve 74 can then admit steam to the right-hand side of the piston only, the piston consequently being held in the extreme position shown at the left hand end of the cylinder and the line of valves closed. The opposite case to this is shown in Fig. 7; with full load the governor balls will approach each other as nearly as possible, throwing the gear into the position shown. The action of the valve 76 is then such as to admit steam to the left hand of the piston only, the piston being held at the extreme right hand end of the cylinder and the line of valves being fully open.

In some intermediate state of working the eccentric shaft will assume its mid-position as shown in Fig. 8; the valve 76 will then operate as in an ordinary engine, the piston and consequently the line of valves reciprocating bodily and causing the steam to be admitted the turbine in puffs or blasts.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:—

1. In combination a plurality of turbine chambers; together with means for keeping the pressure in said chambers substantially constant, said means including valves controlling the passage of working fluid from chamber to chamber together with means for causing certain of said valves standing in the same operative relation to different chambers to puff simultaneously.

2. In combination, a plurality of turbine chambers; together with means for keeping the pressure in said chambers substantially constant, said means including valves controlling the passage of the whole of the working fluid from chamber to chamber in a series of puffs.

3. In combination, a plurality of turbine chambers; together with means for keeping the pressure in said chambers substantially constant, said means including puffing valves controlling the passage of the whole of the working fluid from chamber to chamber, said valves acting simultaneously to admit to and exhaust from said chambers equal quantities of working fluid.

4. In combination a plurality of turbine chambers; a rotatable turbine element together with means for keeping the pressure in said chambers substantially constant, said means including valves controlling the passage of the whole of the working fluid from chamber to chamber and means operated from said turbine element for causing said valves to puff.

5. In combination a plurality of turbine chambers, together with means for keeping the pressure in said chambers substantially constant, said means including valves controlling the passage of working fluid from chamber to chamber in a series of puffs and including also a speed governor acting to proportion the duration of said puffs to the load.

6. In combination a plurality of turbine chambers; ducts between said chambers; means controlling the passage of the whole of the working fluid through said ducts from chamber to chamber in a series of puffs and including also speed-responsive means for varying the duration of said puffs.

7. In combination a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber in a series of rhythmic puffing cycles, each cycle comprising a puffing period and an idle period and means for varying the ratio between the lengths of said puffing and idle periods.

8. In combination, a plurality of turbine chambers, duct means between a certain pair of said chambers, and means controlling the passage of the whole of the working fluid through said duct means from one of said certain pair of chambers to the other in a series of puffs at all working loads.

9. In combination, a plurality of turbine chambers, ducts between said chambers, means for controlling the passage of the whole of the working fluid through said ducts from chamber to chamber in a series of puffs at all working loads below a certain load and means for coalescing said puffs into a continuous blast at said certain load.

10. In combination, a plurality of turbine chambers, ducts between said chambers, means controlling the passage of working fluid through said ducts in a series of puffs together with means for varying the duration of said puffs, said last mentioned means including a member having a reciprocatory rhythmic movement and including also means for shifting the center of travel of said member.

11. In combination, a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber in a series of puffs under certain working conditions and means for coalescing said puffs into a continuous blast under certain other working conditions.

12. In combination, a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber in a series of puffs under certain working conditions and means for reducing the length of said puffs to the vanishing point under certain changing conditions.

13. In combination, a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber and means for operating said controlling means, said operating means acting to hold said controlling means

opened or closed under certain limiting working conditions and to cause said controlling means to puff under certain intermediate conditions.

14. In combination, a plurality of turbine chambers; ducts between said chambers and means controlling the passage of working fluid through said ducts from chamber to chamber together with means for causing certain of said controlling means disposed in ducts between different chambers to puff simultaneously.

15. In combination a plurality of turbine chambers ducts between said chambers and means controlling the passage of the whole of the working fluid through said ducts from chamber to chamber in a series of puffs.

16. In combination, a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber in a series of puffs and a speed governor acting to proportion the duration of and puffs to the load.

17. In combination a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber in a series of puffs and means for mechanically connecting an operative set of said controlling means together.

18. In combination, a plurality of turbine chambers together with means for keeping the pressure in said chambers substantially constant said means including valves controlling the passage of working fluid from chamber to chamber in a series of puffs and means for mechanically connecting an operative set of said valves together.

19. In combination, a plurality of turbine chambers, valves controlling the passage of working fluid from chamber to chamber, a spindle on which said valves are mounted together with automatic means for reciprocating said spindle.

20. In combination, a plurality of turbine chambers; valves controlling the passage of working fluid from chamber to chamber; a spindle on which said valves are mounted together with means giving a reciprocatory movement to said spindle and means for causing a variable dwell at the ends of said movement.

21. In combination, a plurality of fluid chambers; valves controlling the passage of working fluid from chamber to chamber; a piston and cylinder for actuating certain of said valves; a valve controlling the movement of said piston together with means for automatically shifting the center of travel of said valve.

22. In combination, a plurality of fluid chambers; one or more lines of valves controlling the passage of working fluid from chamber to chamber; a piston actuating one of said lines of valves; a cylinder in which said piston works; a valve controlling the movement of said piston; means including an eccentric for reciprocating said valve together with means including a speed governor for automatically shifting the center of travel of said valve.

23. In combination, a plurality of turbine chambers, ducts between said chambers, means for controlling the passage of working fluid through said ducts from chamber to chamber in a series of puffs, together with a single governor to which certain of said controlling means standing in the same operative relation to different chambers are subject.

24. In combination; a plurality of turbine chambers; ducts between said chambers; means controlling the passage of working fluid through said ducts from chamber to chamber in a series of puffs and a centrifugal governor regulating said puffs.

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

SEBASTIAN ZIANI DE FERRANTI.

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