

No. 702,826.

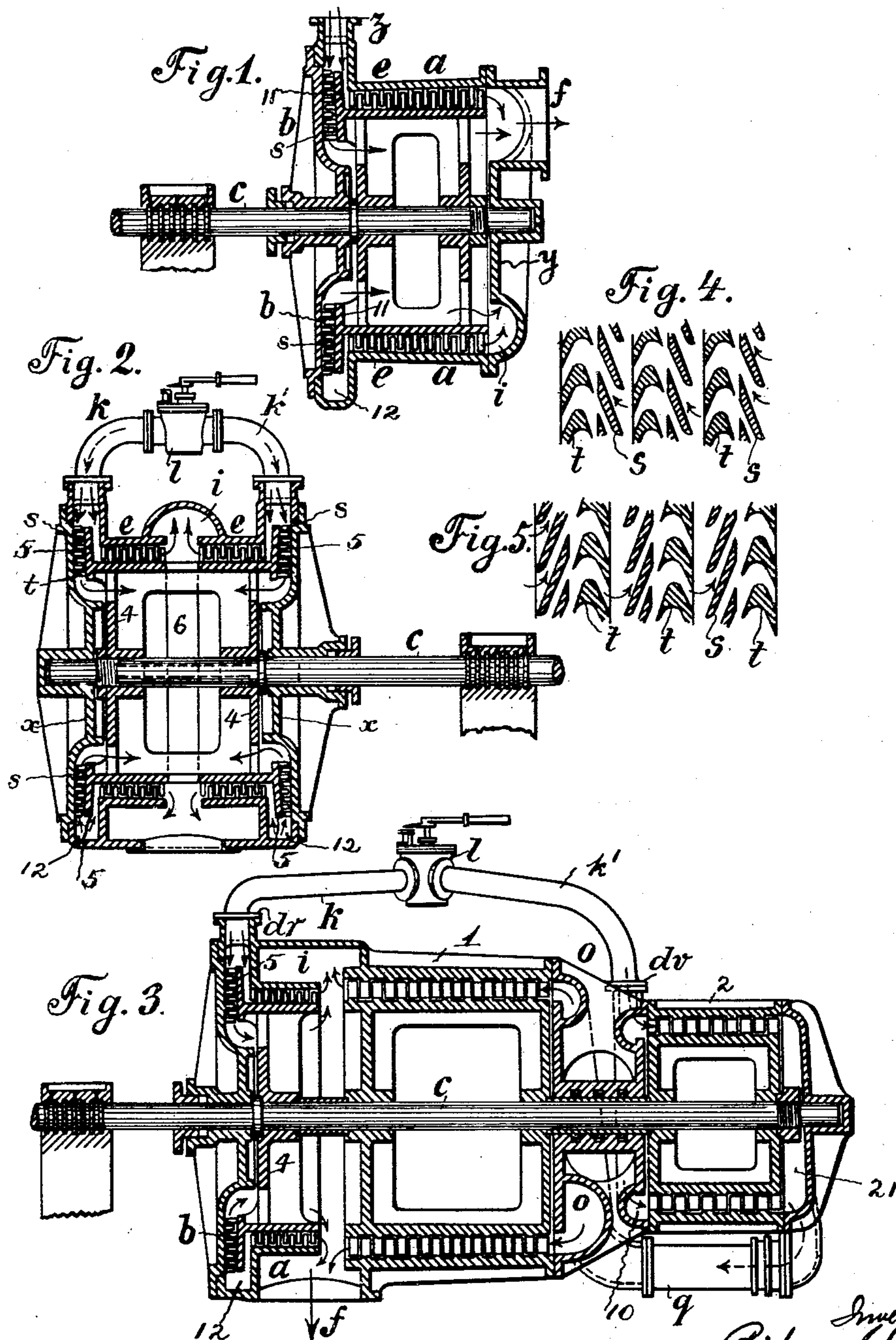
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R. SCHULZ.

COMBINED AXIAL AND RADIAL TURBINE.

(Application filed Sept. 20, 1901.)

(No Model.)



Witnesses:  
Attest  
B. H. Summers

Inventor:  
Richard Schulz  
by Neworth & Co.



# UNITED STATES PATENT OFFICE.

RICHARD SCHULZ, OF BERLIN, GERMANY.

## COMBINED AXIAL AND RADIAL TURBINE.

SPECIFICATION forming part of Letters Patent No. 702,826, dated June 17, 1902.

Application filed September 20, 1901. Serial No. 75,834. (No model.)

*To all whom it may concern:*

Be it known that I, RICHARD SCHULZ, a subject of the King of Prussia, German Emperor, residing at Berlin, Germany, have invented certain new and useful Improvements in a Combined Axial and Radial Turbine; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters and figures of reference marked thereon, which form a part of this specification.

The invention relates to combined axial and radial steam-turbines, and has for its object to produce an economical and more satisfactorily working turbine for the driving of propellers for ships, arranged to take up all or nearly all of the axial thrust on the shaft.

It has been the practice to arrange several turbines in tandem on a common shaft and to fasten to the shaft for each of said turbines a counter-disk to be acted upon by the working steam in opposite direction to the pressure upon the turbine for taking up wholly or nearly said axial thrust. These counter-disks required considerable space, and it was impossible to maintain them steam-tight, thereby causing considerable loss of steam.

The present invention is to provide a combined axial and radial turbine for reverse running, whereby the axial thrust is taken up within or by the turbine-body itself. Steam entering the working face to drive the radial turbine produces a thrust in one direction that is wholly or partially balanced by the action of steam on its rear or idle face before entering to drive the axial turbine.

Referring to the drawings, in which like parts are similarly designated, Figure 1 is a longitudinal section of a combined axial and radial turbine for positive running. Fig. 2 is a similar view, partly in elevation, showing two such combined axial and radial turbines symmetrically arranged, one of them for reverse running; Fig. 3, a similar view showing two axial turbines connected in tandem on the same shaft, with a combined axial and radial turbine for reverse running. Fig. 4 is a section through the development of the gates and buckets of the axial turbine,

the course of steam being from right to left. Fig. 5 is a similar view in which the course of steam is from left to right.

The axial turbine *a* and the radial turbine-body *b* are both secured on the same shaft *c*, the radial turbine being a plate 11, forming part of or in case of need separately secured to said shaft, extending toward the center and also radially outward from the axial turbine-body *a*. A suitable casing *e* incloses the combined turbine, having a head *x*, provided with gates *s*, which closes the end at the radial turbine and directs steam to the buckets of the radial turbine. An annular passage 12, formed in the casing *e*, conducts steam which enters the union *z* to the outer periphery of the radial turbine. A second head *y* closes the exhaust end of the turbine and is provided with an annular exhaust-chamber *i* and a union *f* for the exhaust-pipe. Steam will enter the union *z*, pass into the annular chamber 12, and pass through the radial turbine toward its center, when it will pass axially through the interior of axial turbine-drum to the annular exhaust-chamber *i*. At the same time some of the entering steam in the annular inlet-chamber will pass between the plate which carries the radial turbine *b* and the walls of the chamber 12—that is, to the back of the radial turbine—to counterbalance the axial thrust on the working face thereof and then enter the axial turbine *a*.

Referring to Fig. 2, the buckets *t* of the axial turbines are secured on a drum 4, whose rim extends somewhat beyond its ends, and to this rim is secured or formed integral therewith the plates 5, which extend radially somewhat beyond the drum 4 and carry the buckets *t* of the radial turbines. Each head *x* similarly constructed is provided with gates *s* for the radial turbines, and the casing is so formed as to provide annular inlet-chambers 12 at both ends, which allows steam to be fed to the periphery of the radial turbines, pass through them into the center of the drum carrying the axial turbines, and out through the middle of this drum, which is provided with a suitable exhaust-passage 6, leading to the annular exhaust-chamber *i*, formed in the casing *e*, between the ends thereof. At the same time some of the steam will pass to the back or along the rear wall of the radial turbine



on its way to the axial turbine, then through its gates and buckets directly into the exhaust-passage *i*.

Fig. 3 shows two axial turbines combined in tandem and a combined axial and radial turbine for reverse running. Steam is directed either to the positively-running or to the reverse-running turbines by means of the valve in union *l*. 2 represents the high-pressure and 1 the low-pressure turbine, both for direct running, arranged on a single shaft, so that steam will pass through them in opposite directions, whereby each will counterbalance the axial thrust of the other. Steam will pass through pipe *k'* to the annular inlet-chamber 10 of the high-pressure axial turbine, pass through its gates and buckets to its exhaust-chamber 21, thence by pipe *q* to the annular inlet-chamber *o* of the low-pressure turbine, through its gates and buckets to the annular exhaust-chamber *i*. The combined axial and radial turbine for reverse running projects somewhat into this annular exhaust-chamber *i*, which serves as an exhaust-chamber common to both the direct and the reverse running turbines. The combined turbine-body 4 is secured to the same shaft *c*, is provided with a ring 5, that carries the radial turbine within the annular inlet-chamber 12, the construction being similar to that described in Fig. 2. The valve in the union *l* is shifted to cut off steam from pipe *k'* and direct it through pipe *k*. Then it enters the union *d r* into the annular inlet-chamber 12, part of it passing through the gates and buckets on the working face of the radial turbine, the other part to the back or idle face of this radial turbine, and then through the gates and buckets of the axial turbine to the annular exhaust-chamber *i*.

Having thus described this invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In a turbine, the combination with a suitable casing, gates thereon and a shaft, of an axial turbine, buckets thereon cooperating with the gates and a radial turbine on one end of the axial turbine having buckets on one face thereof, and means to admit live steam to both faces of the radial turbine to balance the axial thrust on the turbine, substantially as described.

2. A combined axial and radial turbine, comprising a suitable casing provided with an annular inlet and an annular exhaust chamber, gates arranged on the casing, a drum carrying the buckets to form an axial turbine and a radial turbine formed on the end of the axial turbine and arranged in the annular inlet-chamber, substantially as described.

3. A combined axial and radial turbine, comprising a suitable casing provided with annular inlet and outlet chambers and suitable gates, a drum carrying the buckets to form an axial turbine, a radial turbine formed

on the end of said drum and projecting into the annular inlet-chamber, and a passage through the interior of said drum, whereby steam can be exhausted from the radial turbine through said drum to the annular exhaust-passage, substantially as described.

4. In a turbine, the combination with a casing, gates thereon and annular inlet and exhaust chambers formed thereon, and suitable heads one of which is provided with gates, of a turbine-drum intermediate the inlet and exhaust chambers, an annular plate projecting into the inlet-chamber, suitable buckets thereon cooperating with the gates on the head, and a passage between the radial turbine-body and a wall of the inlet-chamber along its face to admit steam to the turbine on said drum and thereby produce an axial pressure on the back of said radial turbine contrary to that produced on the working face, substantially as described.

5. The combination of a suitable casing, an annular inlet-chamber formed at each end, an annular chamber formed intermediate the ends, heads for the casing, gates thereon and on the casing, of a pair of turbine-drums provided with buckets cooperating with the gates on the drum, a passage between the drums in register with the exhaust-chamber, an annular plate on each drum projecting into an inlet-chamber and provided with buckets to cooperate with the gates on the casing-heads, and means for admitting steam to one or the other of said drums, substantially as described.

6. The combination of a suitable casing provided with annular inlet and exhaust chambers, of a combined axial and radial turbine, the latter arranged to neutralize its own axial thrust, and another turbine or turbines on the same shaft arranged to run in an opposite direction, substantially as described.

7. In a turbine, the combination with a suitable casing, gates thereon, an annular inlet-chamber formed at one end and a suitable exhaust-passage, of a shaft, an axial turbine thereon cooperating with gates on the casing and having a central passage therethrough, a radial turbine on an end of the axial turbine and projecting into the inlet-chamber, whereby steam will be admitted to both faces of the radial turbine to balance its thrust and be divided thereby, one part passing through the radial turbine to drive it, then through the interior of the axial turbine to the exhaust and the other passing through the axial turbine to drive it, substantially as described.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

RICHARD SCHULZ.

Witnesses:

JOHANNES HEIN,  
HENRY HASPER.