No. 788,006. PATENTED APR. 25, 1905.

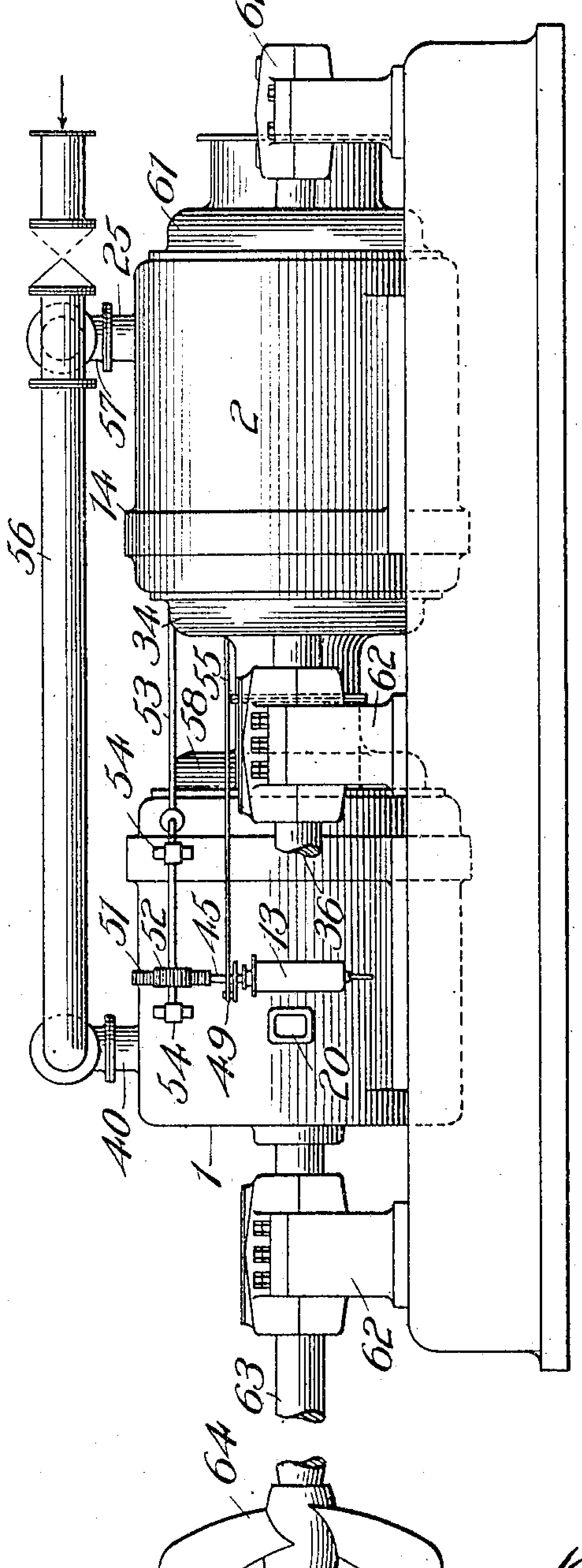
J. WILKINSON.

COMPOUND MARINE TURBINE.

APPLICATION FILED AUG. 24, 1904.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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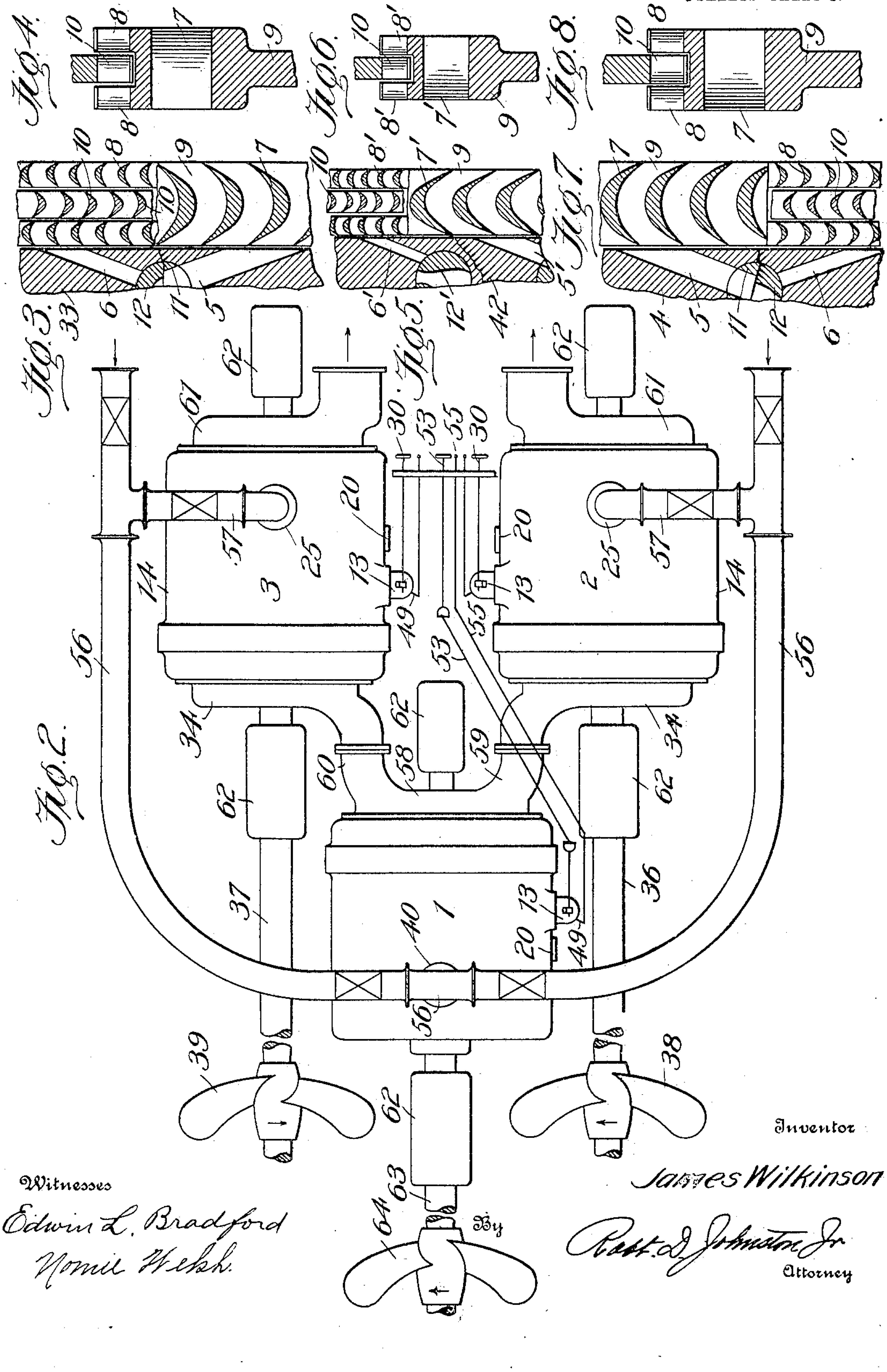

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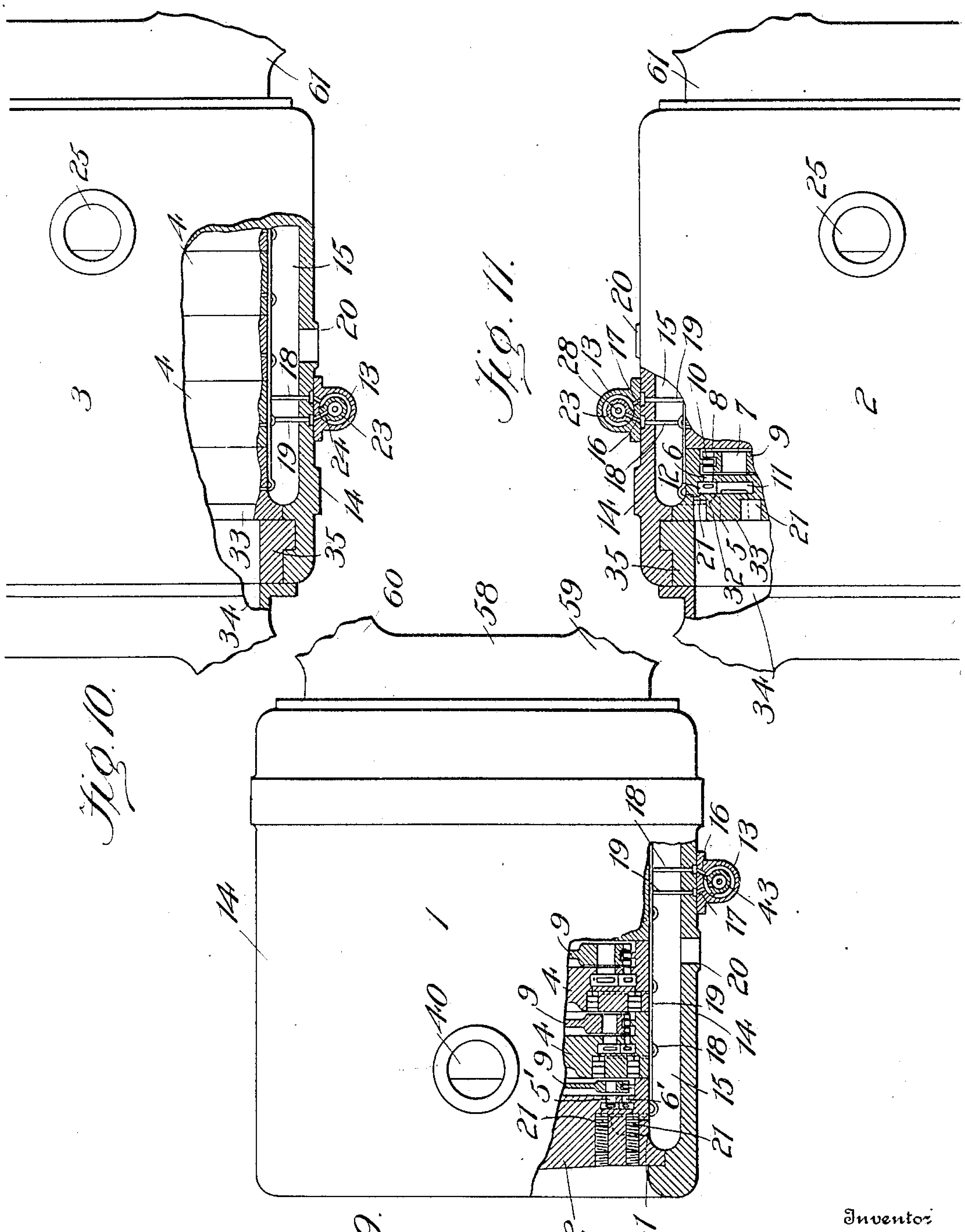

Fig. 10. Fig. 11. Fig. 9.

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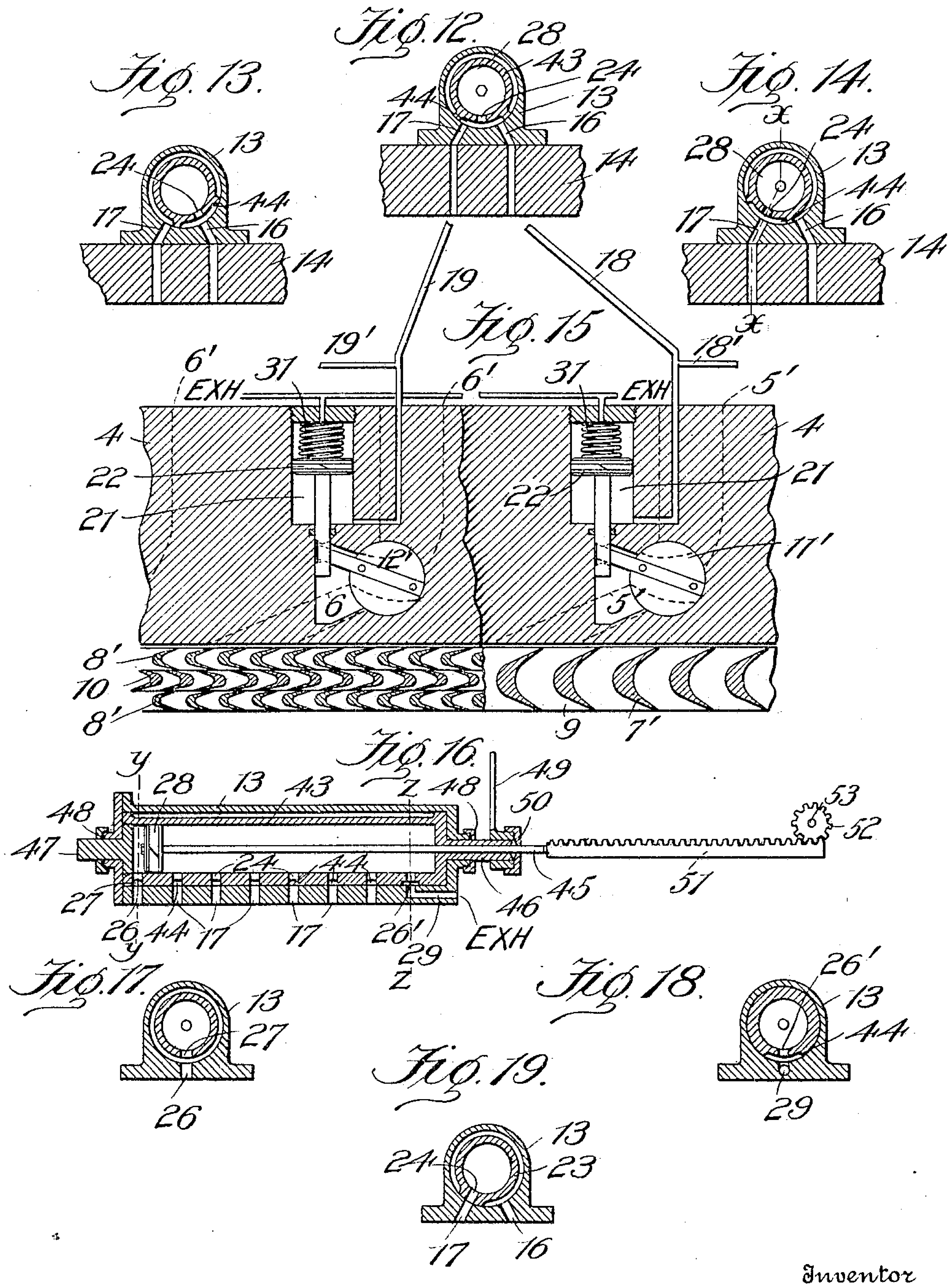

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UNITED STATES PATENT OFFICE.

JAMES WILKINSON, OF BIRMINGHAM, ALABAMA, ASSIGNOR TO WILKINSON TURBINE COMPANY, OF BIRMINGHAM, ALABAMA, A CORPORATION OF ALABAMA.

COMPOUND MARINE TURBINE.

SPECIFICATION forming part of Letters Patent No. 788,006, dated April 25, 1905.

Application filed August 24, 1904. Serial No. 221,986.

To all whom it may concern:

Be it known that I, JAMES WILKINSON, a citizen of the United States, residing at Birmingham, in the county of Jefferson and State of Alabama, have invented new and useful Improvements in Compound Marine Turbines, of which the following is a specification.

My invention relates to improvements in a compound marine turbine the several turbine units of which are so constructed and coupled up that I am enabled to secure in a comparatively simple manner and without loss in the efficient action of the motor fluid the requisite variations in speed and power as well as independent control of the several propeller-shafts necessary for the successful propulsion and steering of vessels. At the same time I adapt one or more of the turbine units to reverse with high torque.

Having in patents heretofore issued to me shown turbines provided with independent groups of working passages designed to drive the shaft at two speeds—one representing full and the other cruising speed—and having shown these turbines adapted to reverse the vessel at half speed or drive it forward at cruising speed in addition to their normal operation in driving forward at full speed, it is my purpose in my present invention to combine these novel types of turbine to provide a multiple or compound marine turbine of high efficiency and wide range of usefulness which is compact in form and capable of being readily controlled. With this object in view I provide a group of three two-speed turbines, each of which drives a separate propeller-shaft and is provided with an independent controller mechanism, so that they are capable of independent action. Motor fluid to drive the vessel forward is admitted to the initial or high-pressure two-speed non-reversible turbine, with which the secondary two-speed reversible turbines are coupled up by suitable conduits in what may be termed "multiple series"—*i. e.*, a separate conduit leads from the exhaust-head of the high-pressure turbine to the supply-head of each secondary turbine, from which the pressure has access to the full-speed forward-driving working passages of each of these latter turbines under the control of their respective controller mechanisms. When reversing the vessel, these secondary units become high-pressure turbines, the motor-fluid pressure being admitted directly to their high torque-reversing working passages, while their controller mechanisms close the forward-driving working passages. Thus being independent, one of these latter turbines may operate in series with the initial turbine while the other is reversing, or both may operate in multiple, driving the vessel forward, or both may reverse when the high-pressure turbine will be out of service, its only communication with the exhaust or condenser being through the full-speed working passages of the secondary turbines which are then maintained closed. For cruising motor fluid is admitted to the half-speed working passages of the initial turbine to drive its propeller-shaft slowly, and the fluid exhausting into one or both of the secondary turbines will be lower in pressure than when operating at full speed, so that the speed and power of these latter turbines will be reduced. This will effect a relatively slow speed of propulsion of the vessel without sacrificing any economy in operation. It will thus be evident that with a minimum number of turbines I am able to secure a highly-efficient action of the steam both to drive the vessel at full and cruising speeds and to reverse with high power, the several turbines being of such a character that they can be independently controlled to secure the necessary independent operation to utilize them in steering and maneuvering the vessel.

A further object of my present invention is to provide these several turbines with independent controller mechanisms capable of varying the volume and controlling the flow of motor fluid through the several groups of working passages of each turbine. The controller mechanisms for the reversing-turbines constitute the subject-matter of a pending application, upon which, however, the controller mechanism for the initial turbine is an improvement in that it is adapted to control the admission of motor fluid to either group of working passages therein or to both of them simultaneously. The purpose of this is to enable all the working passages to be thrown open to increase the volume of motor fluid flowing through the initial turbine to secure an overload power from the secondary turbines. The loss in efficiency in the action of the fluid in the initial turbine is compensated by the increased power and speed derived from the low-pressure turbines.

I simplify the control of the several turbines by providing operating means for their respective controller mechanisms, which can be manipulated from a common point of control.

My invention further comprises the details of construction and arrangement of parts hereinafter described, and illustrated in the accompanying drawings, which form a part hereof, and in which—

Figure 1 is a side elevation of my compound marine turbine. Fig. 2 is a top plan view of the same. Fig. 3 is a broken-away view through the supply-head and bucket-wheel of one of the reversible turbines, taken to show in section part of the inner and outer working passages. Fig. 4 is a detail sectional view of the bucket-wheel in Fig. 3. Fig. 5 is a view similar to Fig. 3, taken through the two-speed forward-driving turbine. Fig. 6 is a sectional view of the bucket-wheel in Fig. 5. Fig. 7 is a view similar to Fig. 3 of the other oppositely-acting reversing-turbine, taken, however, through one of the diaphragms to illustrate the similarity of the supply and stage valves of the several turbines. Fig. 8 is a sectional view of the bucket-wheel in Fig. 7. Fig. 9 is an enlarged view of the two-speed forward-driving turbine, partly broken away to illustrate internal construction. Figs. 10 and 11 are similar views of the two reversible turbines. Figs. 12, 13, and 14 show the controller mechanism for the non-reversible turbine in different operating positions, and Fig. 15 is a detail sectional view of the half and full speed nozzles and their valve-controller mechanism. Fig. 16 is a longitudinal sectional view of a controller mechanism along the line x x, Fig. 14. Figs. 17 and 18 are sections along the lines y y and z z of Fig. 16. Fig. 19 is a sectional view of a modified form of controller mechanism for the reversible turbines.

Similar reference-numerals refer to the same parts throughout the drawings.

The turbine units 1, 2, and 3 of the battery are preferably arranged as shown and mounted upon a common bed-plate.

The turbines 2 and 3 are of the multiple-stage reversible type more fully described in Letters Patent issued to me, Nos. 752,496 and 761,866, and here briefly described as comprising an inner casing formed by a plurality of abutting diaphragms 4, provided each with two rows of reversely-disposed nozzles 5 and 6, which discharge motor fluid against buckets 7 and 8, respectively, disposed in concentric rows on a bucket-wheel 9 and at different radial distances from the shaft to which the wheel is keyed. The succeeding nozzle-passages and interposed buckets form inner and outer working passages, which increase in area across stages in proportion with the expansion of the fluid and act with opposite driving effects upon the shaft.

Each wheel 9 carries two parallel rows of buckets 8, between which is interposed a stationary row of intermediates 10. I therefore fractionally abstract the velocity of the motor fluid a greater number of times in the outer than the inner working passages, thus securing, when fluid is admitted to the outer passages, a relatively slower rate of speed. I provide a rotary fluid-actuated valve 11 to govern the admission of fluid-pressure to each nozzle 5 and similar valves 12 for the nozzles 6. Any suitable controller mechanism, such as that described in the above-mentioned patents, may be used to operate the valves of these turbines 2 and 3, that shown in the drawings constituting the subject-matter of a pending application. I have, however, illustrated it in connection with the controller mechanism for turbine 1, both mechanisms comprising a casing 13, secured to the side of the outer turbine-shell 14, between which and the turbine-casing is formed an annular fluid-pressure-supply chamber 15. This casing 13 has two rows of openings 16 and 17, which register with openings in the shell leading to pipes 18 and 19, respectively. These pipes, which are connected through hand-holes 20 in the shell, are disposed around the inner casing and are adapted to communicate with reciprocating fluid-pressure motors 21, seated in the supply-head and diaphragms and having pistons 22, which move both the supply and stage valves 11 and 12 by means of suitable stems and cranks. The pipes 18 conduct fluid-pressure to operate the valves 11 in the outer working passages, while pipes 19 control the valves for the other working passages. Within casing 13 of the controller mechanism for turbines 2 and 3, which I am now describing, is a rotary shell 23, having a single row of openings 24, adapted to register with either 16 or 17. Motor-fluid pressure is admitted to chamber 15 through a port 25 and by a passage 26 from the chamber through an opening leading from a groove 27 into one end of shell 23, which constitutes a cylinder for the controller-piston 28. The shell communicates by an opening 26′ at its other end with port 29 in the casing, which leads to the atmosphere or other low or exhaust pressure. The shell acts as a valve to prevent the escape of the pressure in the casing through port 29 without interrupting the latter's communication with opening 26′ of the shell. The piston is actuated by a rod 30, with which it is suitably geared or connected, and by its position determines the number of openings 24 exposed to the pressure of the atmosphere. It will be observed that shell 23 is reduced, except where openings 24 lead through it, to leave a clearance between it and the casing 13, which constitutes a chamber practically surrounding the shell and exposed to the high pressure which is admitted to the casing through opening 26 from chamber 15. This pressure holds the shell 23 as a valve firmly against the casing 13 to prevent leakage into the openings 16 and 17 or 29. When pressure is not supplied to motors 21, springs 31, such as shown in the motors for the valves of turbine 1, may be used to open the turbine-valves. Hence in all the turbines the valves of the working passages controlled by the pipes exposed to the high pressure in the casing will all be held closed, as will also so many valves of the active working passages as have pressure admitted to their motors by the controller-piston 28. It may be here noted that each pipe 18 or 19 may by suitable branches, such as 18′ and 19′, control a plurality of motors 21 for the valves, admitting fluid to any one of the compartments or to all of the compartments or to a row or rows of motors in the line of the fluid's flow across compartments.

By reference to Fig. 11 it will be seen that the fluid-pressure in the supply-chamber 15 of turbines 2 and 3 is admitted by passages 32, leading through supply-heads 33, to only the nozzles 6 for the outer row of half-speed-reversing working passages. The inner row of supply-nozzles 5 open into the supply-chamber formed by a casing 34, secured to the end of shell 14 or to the annular retaining-ring 35, which interlocks with the shell and serves as an abutment to lock head 33 in place. This and all the preceding description applies equally to turbines 2 and 3, it being noted that their respective shafts 36 and 37 are provided with propellers 38 and 39, designed to rotate in reverse directions while driving the vessel forward. For this reason the corresponding buckets on their respective wheels 9 are reversed, as may be seen by comparing Figs. 3 and 7.

The turbine 1 is also provided with nozzles 5′ and 6′ and valves 11′ and 12′ of similar construction to the corresponding parts of turbines 2 and 3. These, together with buckets 7′ and 8′, constitute inner and outer working passages operating to drive the turbine at different speeds; but here all the passages are similarly disposed and act to drive the turbine in but one direction and that forward. The motor-fluid pressure, which is admitted to the supply-chamber 15 through port 40, enters passages 41, leading inwardly through supply-head 42 to the inlet ends of the supply-nozzles for all the working passages, its admission to the inner or the outer row of passages, or both, being controlled by a governing mechanism which differs from that already described for turbines 2 and 3 in that the rotary shell 43, which corresponds to 23, is provided on its under side with a plurality of circumferentially-elongated recesses 44, formed in the portion through which the openings 24 pass. Each opening 24 opens into one of these recesses, all of which are sufficiently wide to span both of a pair of oppositely-disposed openings 16 and 17 in the casing 13 when the shell is moved to an intermediate position. The opening 26′ in the shell enters one of these recesses, which registers with port 29, being in communication therewith throughout the operating positions of the shell. In this position the high pressure around the shell will not have access to either group of pipes, and consequently the piston 28 will simultaneously control the valves of all the working passages by opening their controller-pipes to the high or exhaust pressure in the shell.

The stem 45 of the piston projects through a hollow spindle 46, integral with an end of the shell 43, and this, with the said spindle 47, projects through suitably-packed openings 48 in the casing 13, which thus serves as a bearing for the shell. A crank or handle 49 is fixed to the spindle 46, and a packing-gland 50 prevents leakage around stem 45. A rack 51 is connected to the outer end of the stem and meshes with a pinion 52 on a rod 53, mounted in bearings 54 and provided with universal joints, so that it can be operated from the same point with rods 30, which shift the controller-pistons for turbines 2 and 3. With the same object in view I provide a jointed rod 55 to operate crank 49 from the point of common control to rotate shell 43 to open either or both of the rows of working passages in turbine 1, and similar means may be used to operate shells 23. When shell 43 is moved to either extreme position, it will act in the same manner as shell 23 to cut the inner or the outer working passages out of service, while the piston controls the flow of fluid through the active passages. This method of control for a two-speed non-reversible turbine I claim, broadly, herein without limitation to any specific mechanism for carrying it into effect. I also desire to protect hereby the detailed construction of the controller mechanism for turbine 1 as a modification of the controller mechanism constituting, broadly, the subject-matter of a pending application.

Having thus described the independent operation of each of the turbine units, I will now refer to the manner in which they coöperate in driving the vessel. Motor-fluid pressure is supplied to turbine 1 through pipes 56, which join and enter port 40. Branch pipes 57 admit pressure to ports 25 for turbines 2 and 3. The fluid-pressure flowing through the working passages in turbine 1 is only partly converted into velocity, so that it enters the exhaust-head 58 of that turbine under considerable pressure. From this head 58 lead two branch conduits 59 and 60 to the supply-chambers 34 of turbines 2 and 3, respectively. From chambers 34 it flows under the control of valves 11 through the inner working passages to the exhaust-heads 61 of these turbines, when it will have been expanded to the atmosphere or condenser pressure. I provide suitable bearings 62 for the shafts 36 and 37 and also for shaft 63 of turbine 1, which is provided with a propeller 64, designed to drive forward in the same direction as propeller 38.

The controller mechanisms for the several turbines being independent, either turbine 2 or 3 may be cut out of communication with turbine 1 by closing the inner row of working passages. Also by admitting initial pressure to the outer working passages of the turbine thus cut out it will reverse at high torque. All the turbines may be forced, at slight loss in efficiency in turbine 1, by opening all the working passages in turbine 1; also, by opening all the forward working passages in turbine 1 and varying the number open in turbines 2 and 3 pressure will bank up in turbine 1 until it practically constitutes a conduit to admit full pressure to turbines 2 and 3 to increase the speed of rotation. When desired, both turbines 2 and 3 may be caused to reverse when turbine 1 will be out of service, due to the fact that all exhaust of pressure therefrom is interrupted by valves 11. These and other combinations may be effected to secure a wide range and varied character of control for the group of turbines.

Though the motor fluid is expanded and the fluid-pressure thereof is fractionally abstracted a greater number of times in the high-torque reversing-passages of turbines 2 and 3 than in the forward-driving passages, yet since these latter working passages normally operate in series with turbine 1 the forward and reversing speeds of turbines 2 and 3 are substantially the same. This enables the proper proportioning of the propellers for most efficient action when driven in either direction.

The utilization of valve means to independently close the low-pressure working passages of the secondary turbines enables me to vary the supply of exhaust fluid thereto at highest economy and at the same time to control the flow of motor fluid through the initial turbine by regulating the exhaust therefrom. In view of the multiple series in which the turbines of the set are grouped this valve control enables me to regulate the coöperation of all the turbines to produce an efficient and very flexible control for any required speed or power.

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

1. In a set of turbines driving separate shafts, a high-pressure multicellular turbine having full and cruising speed working passages, and one or more turbines coupled up in series with said high-pressure turbine.

2. In a set of turbines driving separate shafts, a high-pressure multicellular turbine having full and cruising speed working passages, and a plurality of turbines coupled up in series with said high-pressure turbine.

3. In a set of turbines driving separate shafts, a high-pressure multicellular turbine having full and cruising speed, forward-driving, working passages, one or more low-pressure turbines having forward-driving working passages, and means to connect said latter working passages in series with the working ing passages of said high-pressure turbine.

4. In a set of turbines driving independent shafts and having independent working passages, a high-pressure turbine having an exhaust-head, a low-pressure turbine having a supply-head, a conduit between said heads, valve means to control the admission of motor fluid successively to the several supply-nozzles for the working passages of the low-pressure turbine and to control the exhaust from said high-pressure turbine.

5. In a set of marine turbines driving independent shafts, a plurality of turbines operating in series, the low-pressure turbine or turbines connected to an exhaust or condenser and having a plurality of valve-controlled, motor-fluid-supply passages, and means to open or close said passages to control both the supply to the low-pressure turbines and the exhaust from the high-pressure turbine.

6. In a set of marine turbines operating in series and driving independent shafts, a high-pressure turbine, one or more low-pressure turbines having a plurality of motor-fluid-admission passages, a motor-fluid-supply chamber or chambers for said passages into which said high-pressure turbine exhausts, and means to control the coöperation of the set of turbines by opening or closing said passages.

7. In a set of marine turbines driving different shafts, a high-pressure turbine, one or more two-speed, axial-flow, reversible turbines, and means to compound said turbines.

8. A plurality of turbines driving independent shafts, a two-speed, non-reversible, high-pressure turbine with substantially the same initial and exhaust pressure for both driving speeds, a low-pressure turbine, and means to exhaust the pressure from said high to said low pressure turbine.

9. In a set of marine turbines, a high-pressure turbine operating by the instrumentality of different working passages to drive forward at full and cruising speeds, and one or more turbines compounded with said high-pressure turbine and adapted to operate as

low-pressure forward-driving turbines and as independent high-pressure reversing-turbines, said latter turbines operating in either direction at substantially the same speed and efficiency.

10. In a set of multicellular marine turbines driving different shafts, a two-speed, forward-driving, high-pressure turbine, a low-pressure forward-driving turbine adapted to reverse at high torque, and means to connect said turbines so that they operate in series in driving forward.

11. In a set of marine turbines, a high-pressure turbine, one or more turbines having axially-disposed forward and reversing working passages, means to supply high pressure to said reversing working passages and to said high-pressure turbine, and means to exhaust the pressure from said latter turbine into the forward-driving working passages of said reversible turbines.

12. In a set of marine turbines driving different shafts, one or more multicellular reversible turbines having independent working passages, a high-pressure turbine, connections to direct the motor fluid in series from said high-pressure turbine through the low-pressure working passages of said reversible turbine or turbines, and means to admit a high pressure to the other working passages of said latter turbine or turbines.

13. In a set of marine turbines driving different shafts, a high-pressure two-speed nonreversible turbine, two or more axial-flow high-torque reversible turbines, conduits to connect said turbines with said high-pressure turbine so that they operate in series therewith in driving forward, and means to admit high pressure to the high-torque reversing-passages of said reversible turbines.

14. In a set of compound axial-flow turbines, an initial high-pressure, forward-driving, turbine having working passages for driving a propeller-shaft at full speed, and working passages for driving said propeller-shaft at a lower speed, a secondary turbine having low-pressure working passages connected up in series with said initial turbine, and high-pressure, high-torque, reversing-passages, and means to control the admission of motor fluid to the working passages of said turbines.

15. In a two-speed forward-driving turbine, high-speed working passages, low-speed working passages, means to close one set of passages while controlling the admission of pressure to the other set, said means being also adapted to control the admission simultaneously to both sets of working passages.

16. In a two-speed forward-driving turbine, one or more working passages operating efficiently to drive the turbine at full speed, one or more working passages operating efficiently to drive the turbine at a low speed, means to cut said working passages into or out of service, and a controller mechanism for said means adapted to control either the full or low speed passage or passages, while cutting the other passage or passages out of service, and to control the admission of motor fluid to the working passages for both driving speeds to compensate overload conditions.

17. In a set of marine turbines, an initial high-pressure turbine operating in series with one or more low-pressure turbines, said high-pressure turbine comprising independent working passages to drive its propeller-shaft at two speeds in the same direction, and a controller means which varies the admission of motor fluid to high or low speed working passages under normal-load conditions, and which admits motor fluid under control to all of the working passages under overload conditions.

18. In a set of marine turbines, an initial high-pressure turbine provided with independent groups of full and cruising speed working passages, means to control the admission of high pressure to either or both of said groups of passages, and one or more low-pressure turbines adapted to operate in series with said high-pressure turbine.

19. In a turbine adapted to drive a propeller-shaft efficiently at full and cruising speeds, working passages for effecting said driving speeds, and means to control the admission of pressure to said passages either independently or jointly, one or more secondary turbines having working passages coupled up in series with said two-speed turbine, and means to control the admission of pressure to the several working passages of said secondary turbine or turbines independently.

20. The combination of a compound turbine operating by stage expansion and having two independent working passages adapted to drive the turbine forward and comprising means to fractionally expand the motor fluid and abstract the velocity thereof a greater number of times in one than in the other of said passages, means to control the admission of motor fluid to either or both of said working passages, with one or more turbines operating in series with said first-mentioned turbine.

21. A turbine having two independent sets of working passages designed to drive the turbine at different speeds of rotation by the interposition of a greater number of rows of buckets in one than in the other of said sets of working passages, a controller mechanism adapted to control the admission of motor fluid to either set of working passages while closing the other, one or more secondary turbines operating in series with said first-mentioned turbine, and means to admit an overload supply of motor fluid to said set of tur-

bines by admitting motor fluid to both sets of working passages in said first-mentioned turbine.

22. In combination with a multicellular turbine having working passages at different distances from its shaft center, the working passages being adapted to drive the turbine forward at different speeds, one or more secondary turbines having working passages at different distances from its shaft center, one set of said working passages operating in series with either or both of the working passages of said first-mentioned turbine, and means to admit high pressure to the other working passages of said latter turbine or turbines for the purpose of reversing it or them at high torque.

23. In an elastic-fluid turbine, two sets of nozzle-passages at different distances from the shaft center, different sets of rotatable buckets coöperating with said sets of nozzles, independent valves for controlling the flow of motor fluid through said nozzles, in combination with a controller mechanism adapted to close one set of nozzle-passages, while controlling the flow of motor fluid through the other set, and to simultaneously control the volume of motor fluid flowing through both sets of nozzle-passages and discharged thereby against said rotatable buckets.

24. In an elastic-fluid turbine, two sets of nozzle-passages, two independent sets of rotatable buckets coöperating respectively with said sets of nozzles, one set of nozzles and coöperating buckets being adapted to drive the turbine efficiently at a lower rate of speed than the other set of nozzles and coöperating buckets, fluid-actuated valve means to cut the nozzle-passages of each set out of service, and a controller mechanism for said valve means which is adapted to simultaneously control the volume of motor fluid discharged through said nozzle-passages against both sets of buckets.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JAMES WILKINSON.

Witnesses:
NOMIE WELSH,
H. M. HARTON.