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Amiot

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[54] **PROPULSION INSTALLATIONS FOR BOATS, MORE PARTICULARLY FOR HIGH-SPEED LAUNCHES**

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[30] **Foreign Application Priority Data**

Jan. 13, 1972 France 72.01106

[52] **U.S. Cl.** **60/718,** 74/661
[51] **Int. Cl.** **F01b 21/00**
[58] **Field of Search** 60/718, 717, 716; 74/661; 115/37, 34

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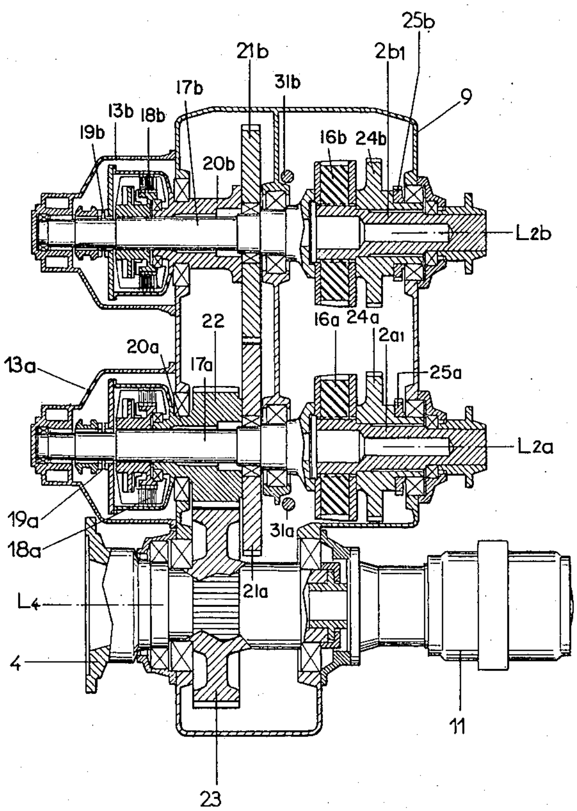
Attorney, Agent, or Firm—Larson, Taylor & Hinds

[57] **ABSTRACT**

The specification discloses a very compact installation for a high-speed launch, such installation comprising a main internal combustion power unit and an auxiliary power unit, each unit having a drive shaft extending into a reduction gear mechanism which also has an output shaft driving a screw, the reduction gear mechanism being arranged so that the auxiliary power unit can selectively either (a) drive water and oil pumps of the main power unit to preheat the unit, (b) drive the main power unit to start the same, or (c) drive the screw during low speed manoeuvres.

7 Claims, 19 Drawing Figures



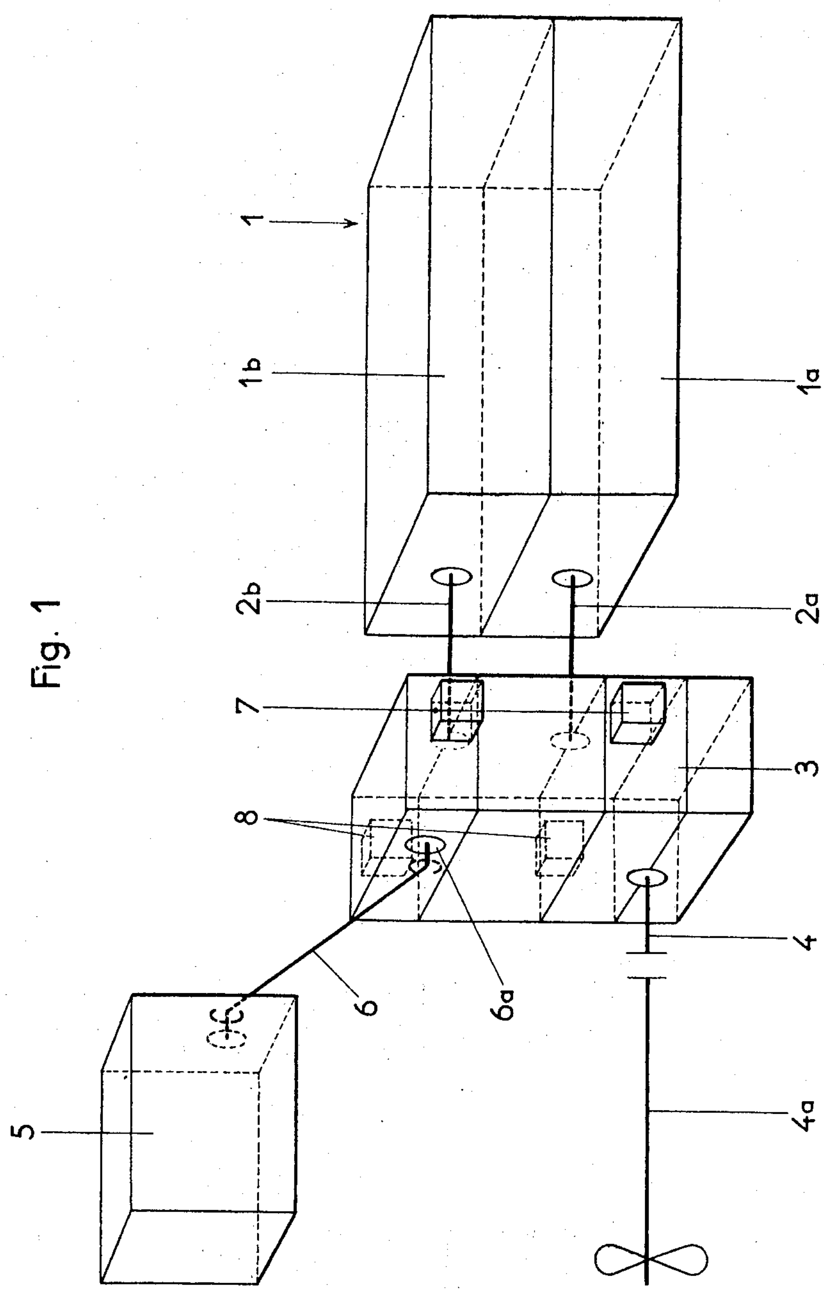


Fig. 1

Fig. 1a

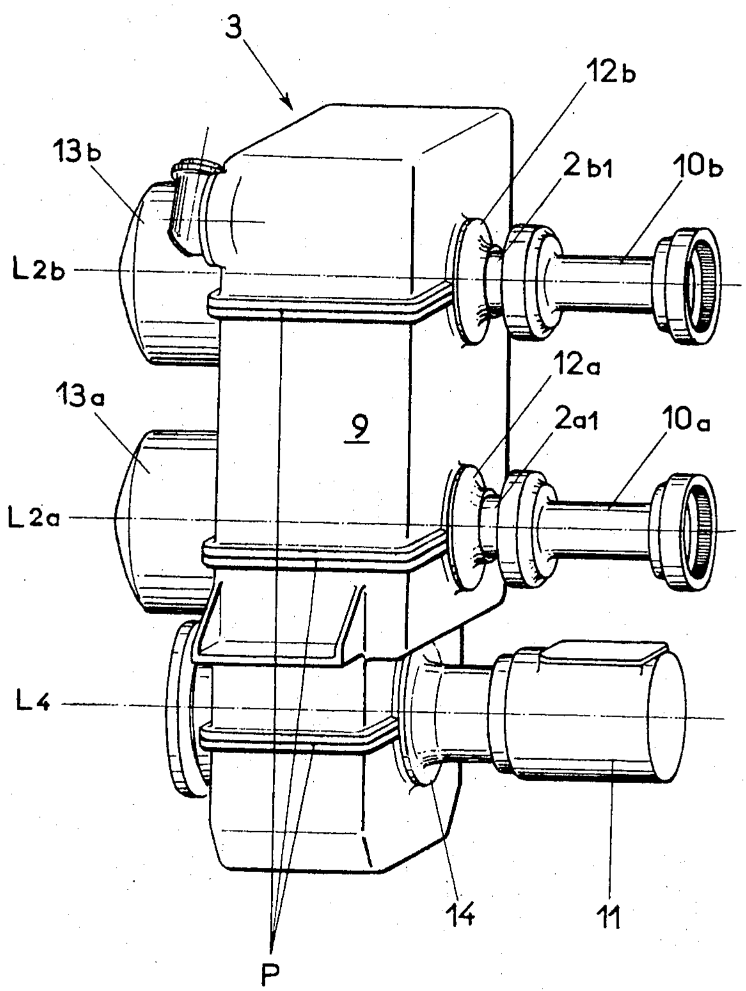
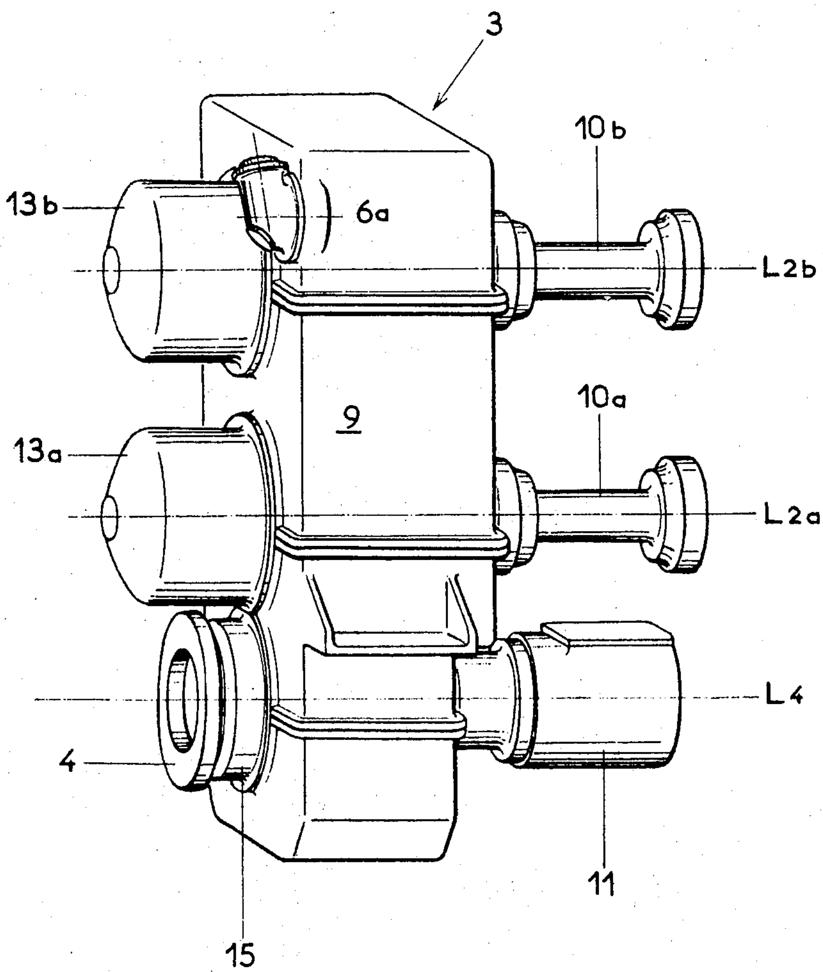


Fig. 1b



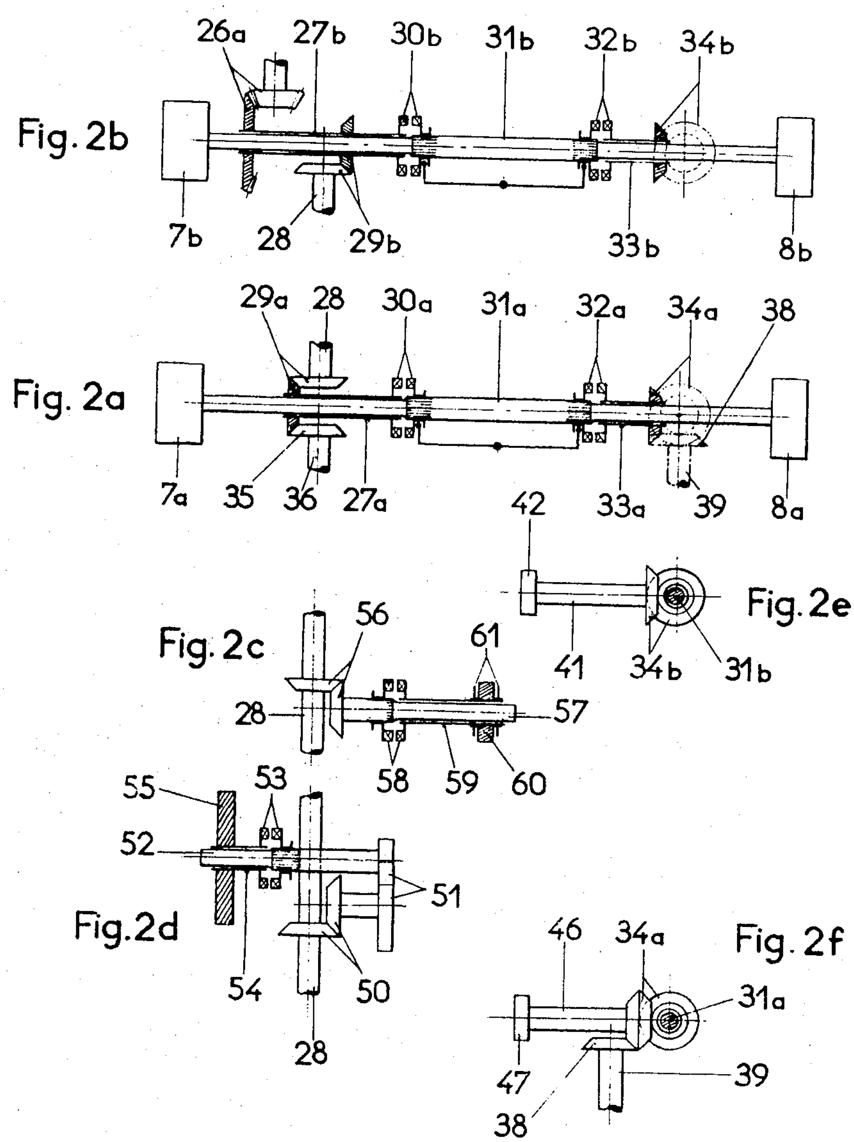

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Fig. 2e
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Fig. 2c
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Fig. 2d
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Fig. 2f
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Fig. 2g

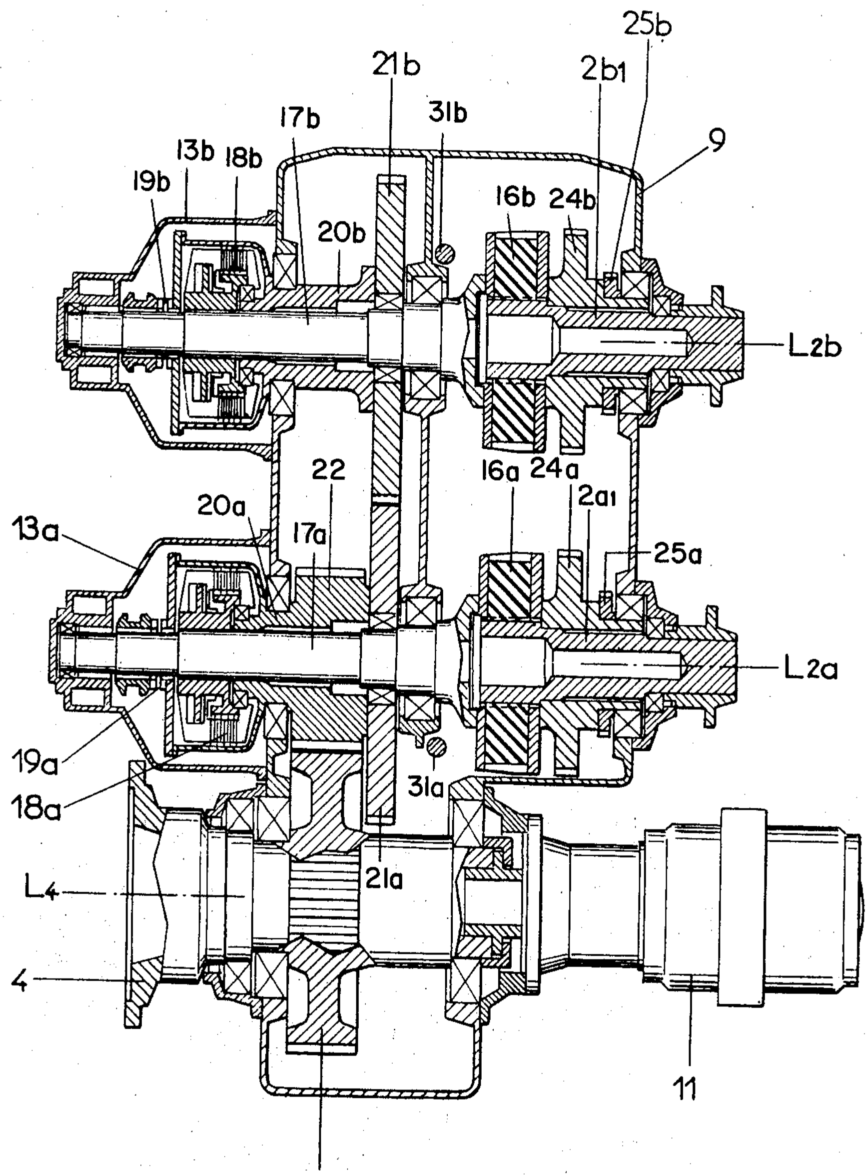
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Fig.3

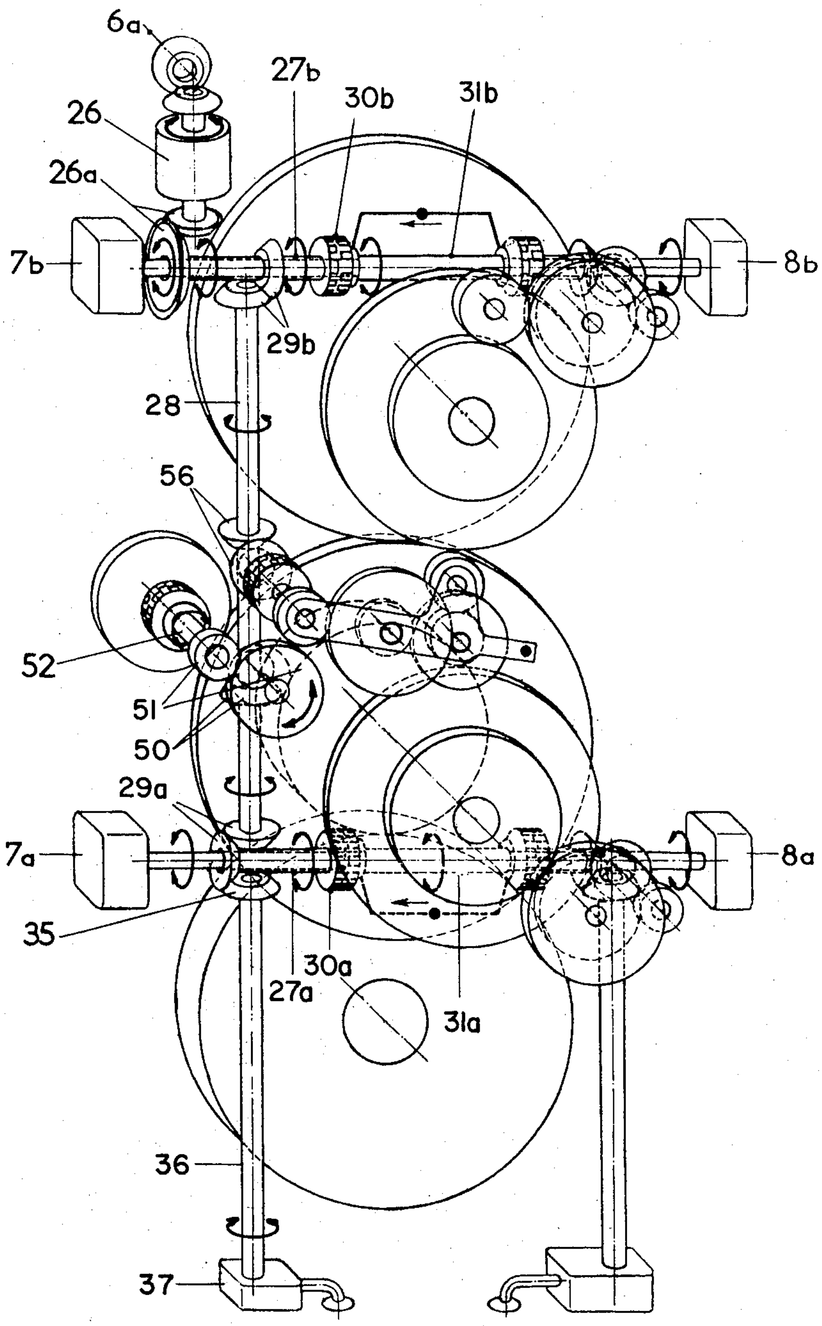
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Fig. 4

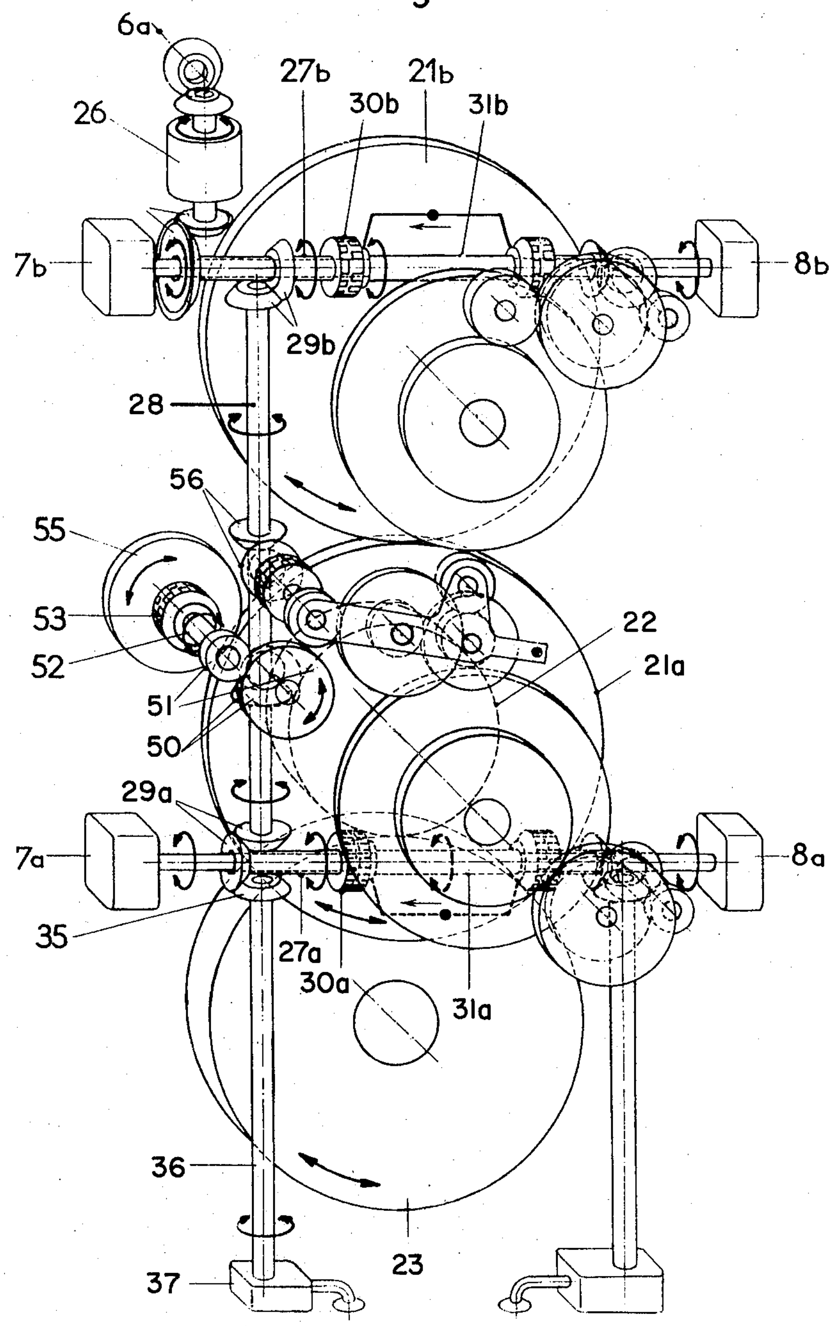
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Fig. 4a

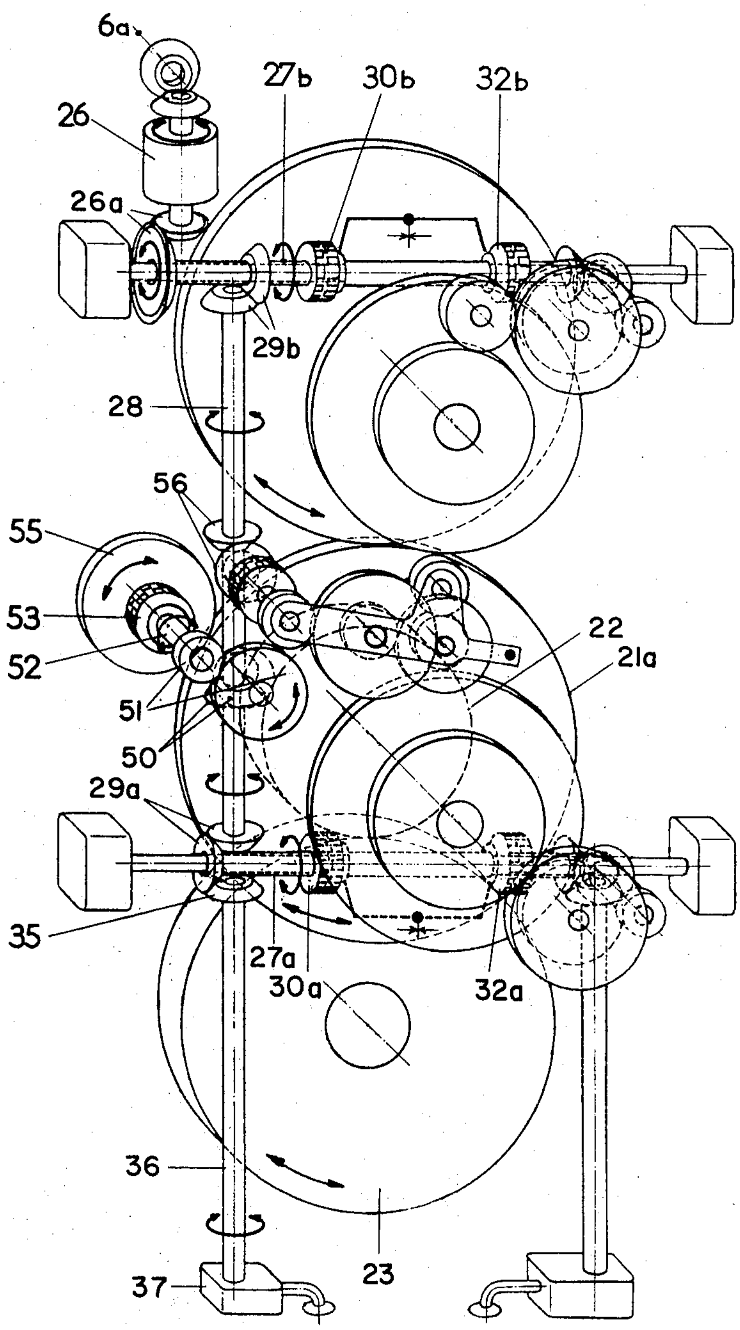
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Fig. 5

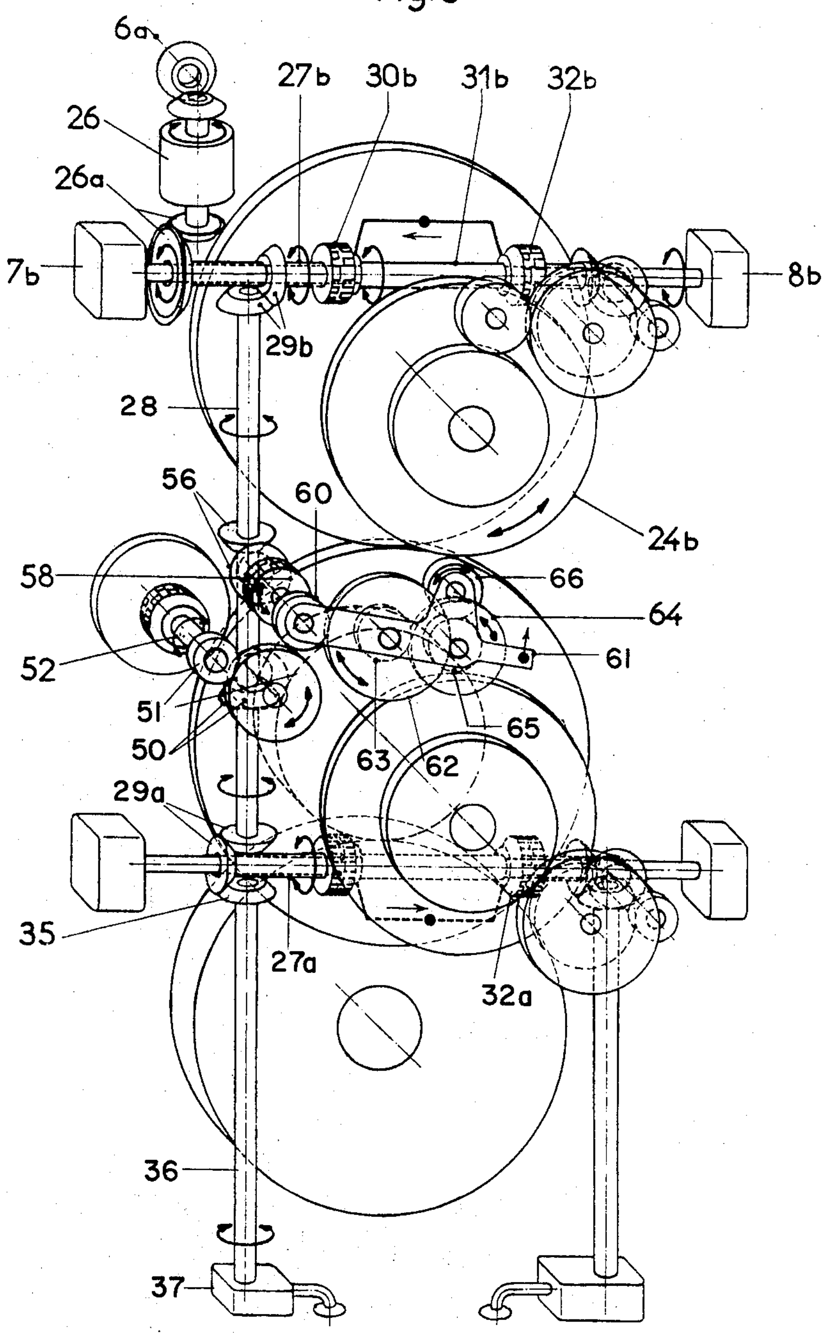
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Fig. 6

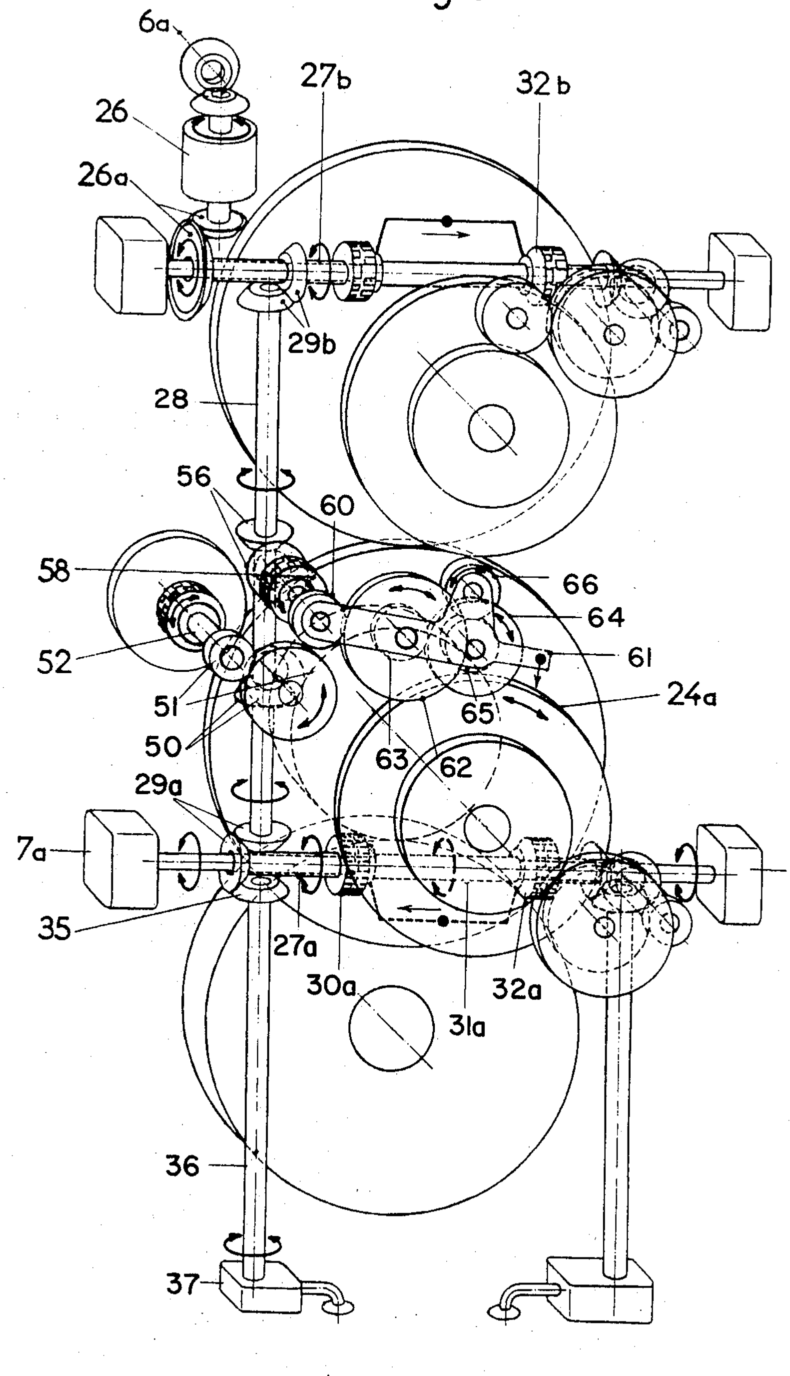
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Fig. 7

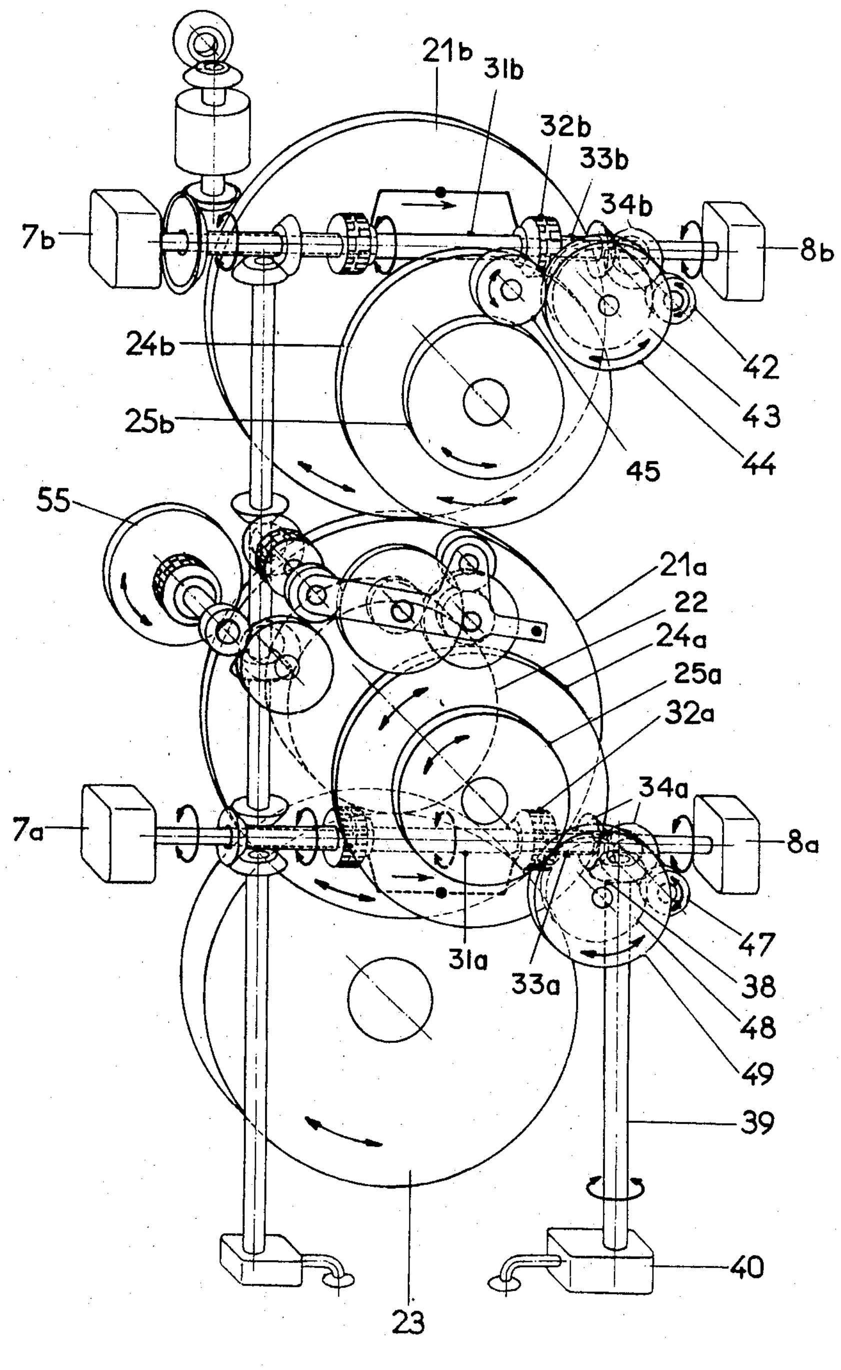
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Fig. 8

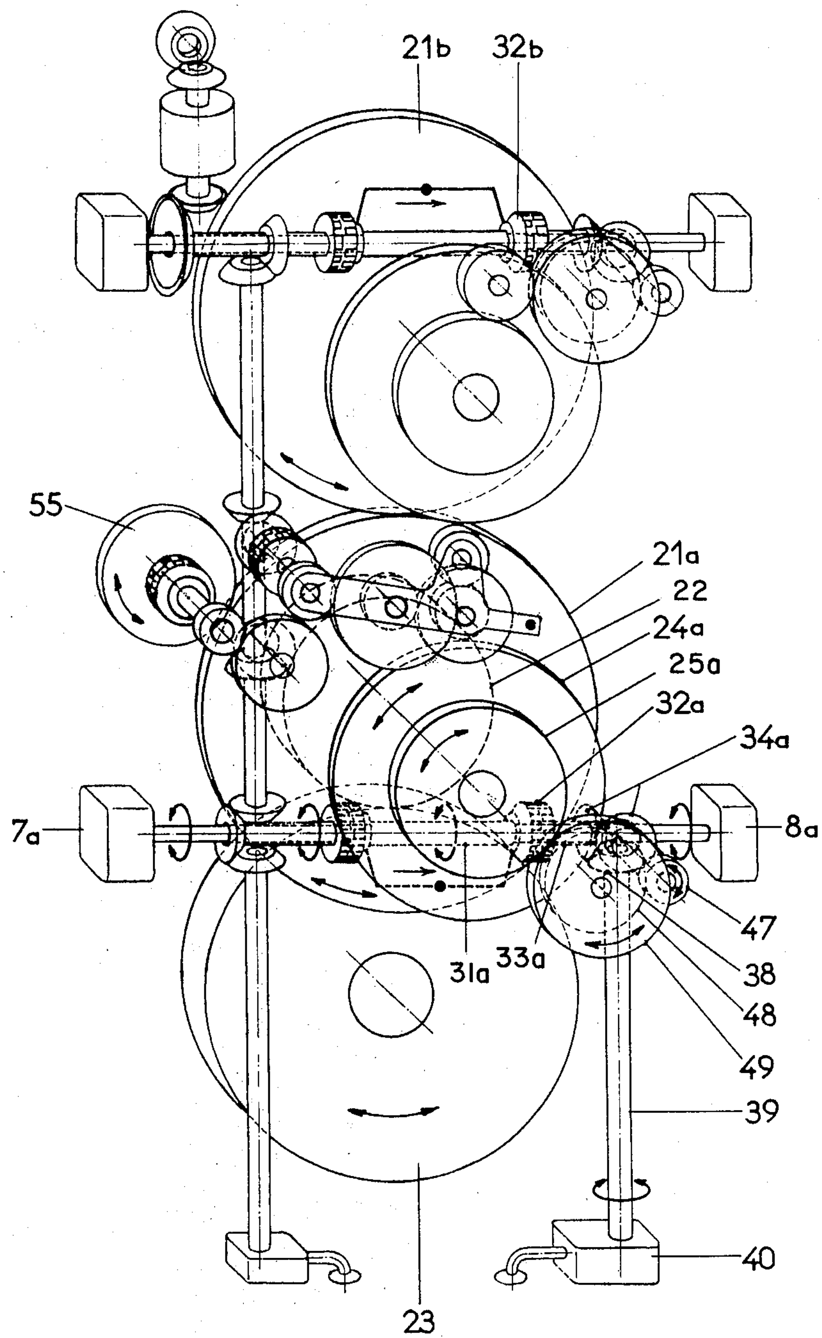

Fig. 9

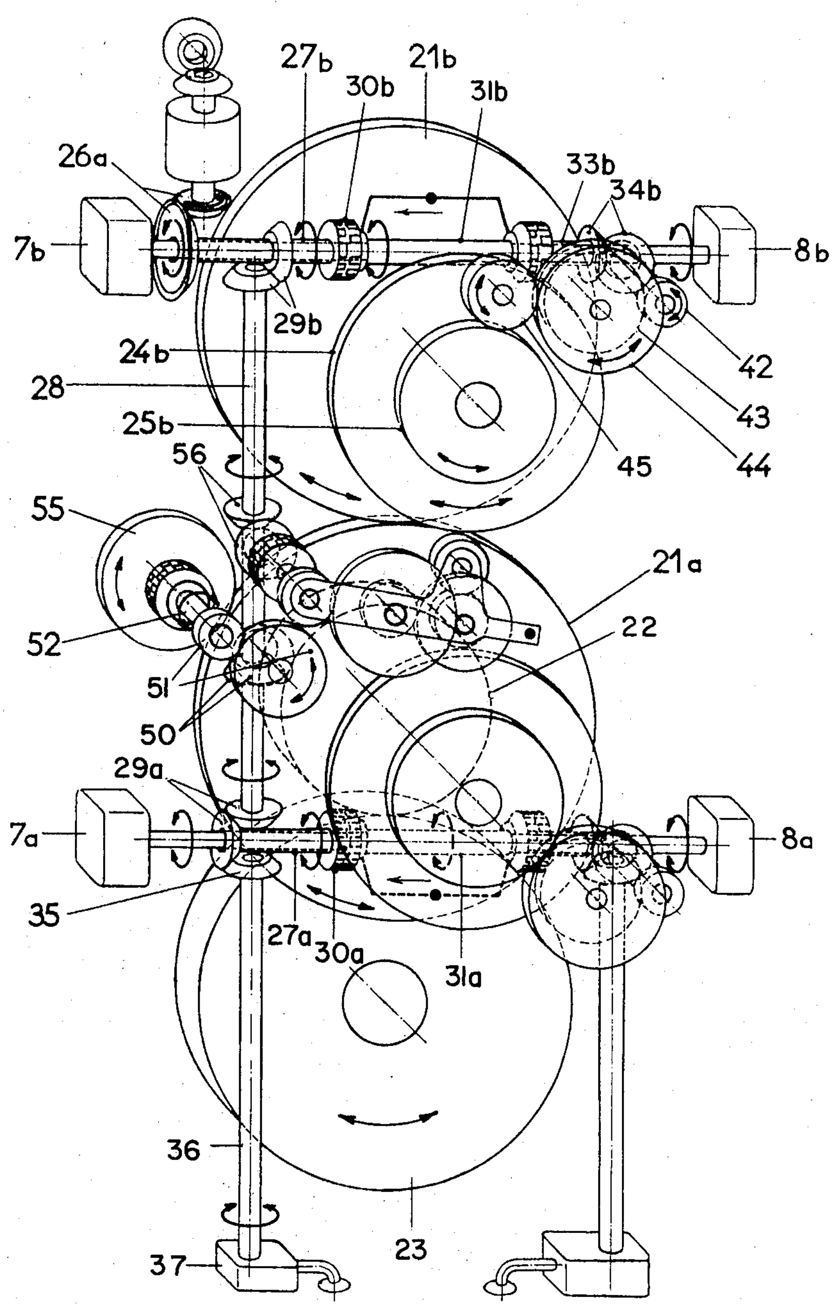
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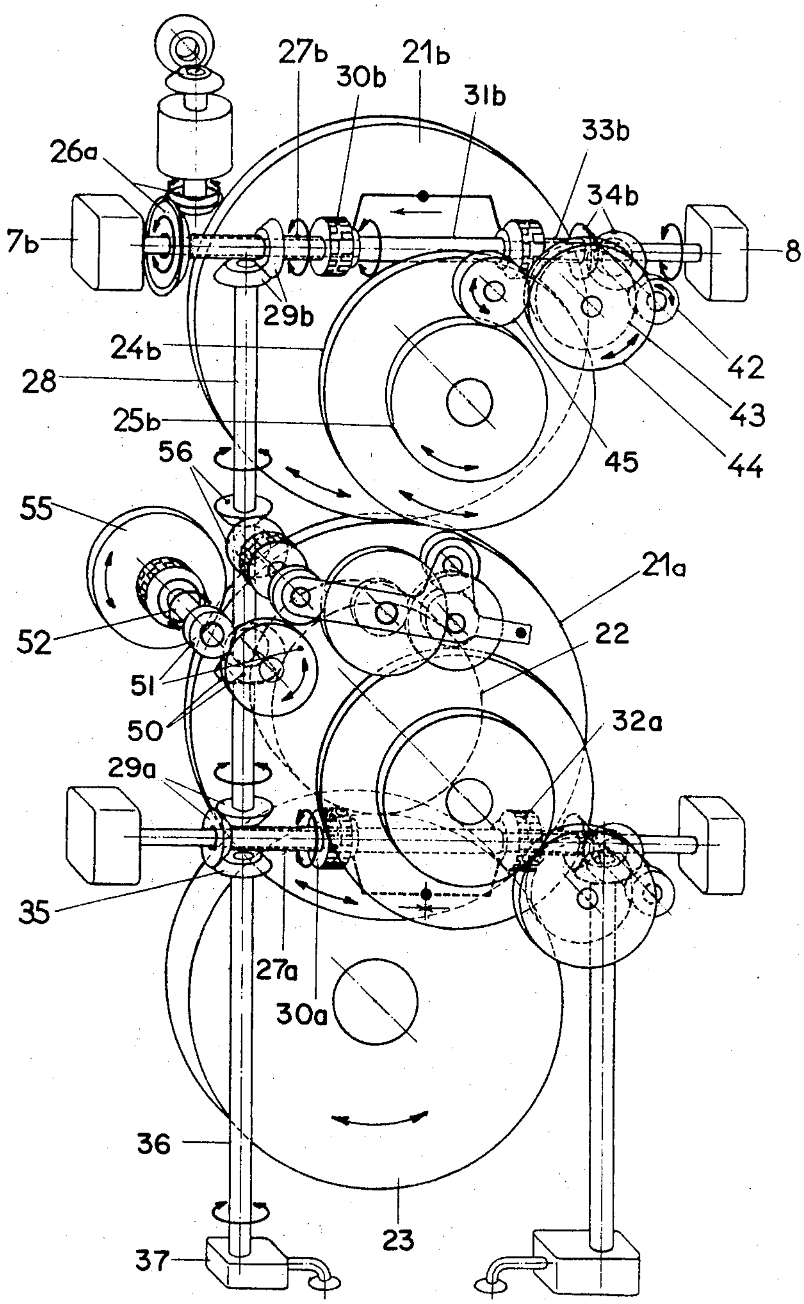
Fig. 10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PROPULSION INSTALLATIONS FOR BOATS, MORE PARTICULARLY FOR HIGH-SPEED LAUNCHES

BACKGROUND OF THE INVENTION

This invention relates to propulsion installations for boats, of the type which develop a relatively high power (above 1,000 H.P. and up to 10,000 H.P., and even several tens of thousands horse-power); the invention relates more particularly — because this would appear to be the most advantageous application — but not exclusively to propulsion installations of this type intended for high-speed launches or patrol-boats, i.e., boats requiring powerful propulsion installations with only limited space available for their accommodation.

Boat propulsion installations of this type generally comprise, inter alia, a power unit coupled to a reduction gear mechanism, the output shaft of which is coupled to a propulsion means such as a screw, the power unit being equipped with auxiliaries, some of which are pumps (cooling liquid pumps, lubricating pumps), which contribute more particularly by their operation to bringing the power unit up to the required operating temperature during the time from the start order until the operation of the main engines at the required temperature.

Propulsion installations of this kind should advantageously satisfy in the best possible way a number of criteria, some of which are mechanical, others of a marine nature while yet others are of an economic nature or tactical or strategic in the case of propulsion installations for naval vessels (i.e., particularly high-speed surveillance and attack launches).

Of these criteria, the following would appear to be the most important: the weight and size reduction of the means required for starting the power unit; preheating of the power unit before starting; the possibility of carrying out harbour manoeuvres, i.e., low-speed manoeuvres, under conditions which do not adversely affect the operation of the power unit, such harbour manoeuvres always being necessary between the quayside situation and the situation from which the boat can use a required speed without inconvenience; reduction of the time required for bringing the boat to the operational condition, i.e., the time between the moment at which the start order is given (boat at quayside with propulsion installation completely stopped) and the moment when preheating of the power unit is complete and the harbour manoeuvres have been carried out, and the boat is capable of using the required speed and undertaking the mission entrusted to it; at the end of the stage of bringing the boat to the operational condition, the stoppage of the maximum possible number of movable components of the installation which were involved in bringing the boat to the operational condition but which no longer have to play any function beyond that stage, i.e., within the normal range of operating speeds of the said installation; accessibility and convenience of inspection and removal of the main components of the reduction gear mechanism; and, in the (special and frequent) case in which the power unit of the installation comprises a plurality of engine elements coupled to a common reduction gear mechanism whose output shaft forms the single drive shaft of the installation, maximum independence of the said engine units as regards normal operating and starting.

It is precisely the main object of this invention simultaneously to satisfy the above criteria to a wide extent, since this was not the case with propulsion installations of the type hitherto proposed, i.e., those in which starting of the power unit is carried out by an installation for the injection of compressed air into the cylinders of the power unit, such installation comprising compressors, air cylinders, valves, control units, and so on, of appreciable weight and size; the same applies to installations of the kind equipped with a separate propulsion unit for harbour manoeuvres, this unit in no way contributing to the other stages of the procedure for bringing the installation to the operating condition (preheating and starting of the power unit in particular).

SUMMARY AND DESCRIPTION OF INVENTION

The invention provides a propulsion installation comprising:

a power unit; a reduction gear mechanism; a primary input shaft of the reduction gear mechanism drivingly connected with said power unit; an output shaft of the reduction gear mechanism arranged to drive propulsion means; wherein the improvement comprises the provision of:

an auxiliary engine; a secondary input shaft of the reduction gear mechanism arranged to be driven by the auxiliary engine; means to decouple the said output shaft from the primary input shaft; said reduction gear mechanism including means to drivingly connect the secondary power input shaft to the output shaft with such output shaft decoupled from the primary input shaft; and means including a freewheel device to drivingly connect the secondary power input shaft to the primary input shaft for starting of the power unit, said freewheel device permitting transmission of torque from the secondary power input shaft to the primary power input shaft to rotate a shaft of the power unit in the direction in which such shaft is rotated for starting of the power unit.

In the advantageous case in which the installation power unit comprises a plurality of engine units coupled respectively to as many input shafts provided for this purpose in the reduction gear mechanism, the gear train and the coupling means of the said reduction gear mechanism are so arranged for starting as to allow the user selectively to couple the power take-off shaft driven by the auxiliary engine to any of the input shafts associated with the said engine units so that the engine units in question can then be started successively.

When the installation power unit consists of only two engine units, the reduction gear mechanism comprises for the purposes of starting one or other of the said engine units, a transmission mechanism comprising gearwheels mounted on a rocking support which can be brought from a neutral position into one or other of two end positions in which one of two output gearwheels of the said transmission mechanism meshes with one or other of the starting means for the said engine units.

Irrespective of which embodiment is adopted, the main feature of the invention enables the auxiliary engine associated with the propulsion installation to perform a double role, i.e., enables the auxiliary engine to carry out the harbour manoeuvres on its own and carry out starting of the power unit of the propulsion installation at the required time.

The marine propulsion installation according to the invention may also have other advantages by applying to it, in addition to the main feature above, one or more of the following additional features which form part of the invention and which will now be discussed more explicitly.

According to a first additional feature, the gear train and transmission means of the reduction gear mechanism are also so arranged as to allow selective coupling of the power take-off shaft driven by the auxiliary engine to some or all of the accessories of the power unit (more particularly lubricant and cooling liquid pumps) which, by their operation, are adapted to assist the power unit in running up to temperature, this first additional arrangement allowing the auxiliary engine provided in the propulsion installation to perform a third beneficial role.

Preferably, the said auxiliaries are driven at a reduced speed in relation to their normal operating speed.

According to a second additional feature, some of the auxiliaries of the power unit, more particularly those assisting in running the power unit up to temperature, are borne by the reduction gear mechanism and driven by the latter, thus facilitating their inspection and maintenance, simplifying their drive system and making any repairs more convenient.

According to a third additional feature, the reduction gear mechanism of the installation comprises a casing having a joint plane at the level of each input or output shaft leading to the said reduction gear mechanism so that it is a simple matter to expose and repair at each of its levels the essential components of the power transmission at the level in question, inspection bell-housings or covers advantageously being provided in the walls of the said casing at the end of each line of shafting, said bell-housings or covers straddling the joint planes of the casing and, in the casing of bell-housings, also protecting some of the components of the reduction gear mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a highly diagrammatic perspective view of the essential elements of a propulsion installation according to the invention for a high-speed launch, said installation comprising a power unit consisting of two superposed engine units;

FIGS. *1a* and *1b* are more detailed perspective views respectively in right-hand and left-hand three-quarter view showing a reduction gear mechanism belonging to this installation;

FIG. **2** is a perspective view of the complete gear train and transmission and coupling elements housed in the casing of the said reduction gear mechanism;

FIGS. *2a* and *2b* are elevations of two transverse lines of shafting of the reduction gear mechanism corresponding respectively to the bottom engine unit and the top engine unit of the installation power unit;

FIGS. *2c* to *2f* illustrate details of FIG. **2** respectively in the direction of the arrows Fc to Ff;

FIG. *2g* is a section of the said reduction gear mechanism in elevation;

FIG. *2h* is a similar view to FIG. **2** and bears the reference of all the internal components of the reduction gear mechanism;

FIG. **3** shows in the same conditions the same elements of the reduction gear mechanism as FIG. **2,** but the in this FIG. **3** double arrows show those of the said elements which are in motion during the preheating procedure of the power unit;

FIG. **4** is a similar view to FIG. **3** except that double arrows show the elements which are in motion on a harbour manoeuvre accompanied by simultaneous preheating of the power unit;

FIG. *4a* is a similar view to FIG. **4** but differs from FIG. **4** in that further double arrows show the elements which are in movement in a harbour manoeuvre carried out without preheating of the power unit;

FIG. **5** is a similar view to FIG. **3** except that double arrows show the elements which are in movement during starting of the top engine unit of the power unit;

FIG. **6** a view similar to FIG. **5** but differs from FIG. **5** in that double arrows show the elements which are in movement on starting of the bottom engine unit of the power unit;

FIG. **7** a similar view to FIG. **3** but differs from FIG. **3** in that further double arrows show the elements shaded grey are those which are in motion when the two engine elements of the power unit are in operation;

FIGS. **8** and **9** are views similar to those above wherein double arrows indicate the components in motion illustrating, respectively, propulsion of the boat by the bottom engine unit on its own and by the top engine unit on its own, and

FIG. **10** differs from FIG. **9** only in that the bottom engine element is not only stopped but also under repair

The high-speed launch propulsion installation shown diagrammatically in FIG. **1** comprises essentially a drive unit **1** formed from two superposed engine units **1***a* and **1***b* each having their own output shaft **2***a* and **2***b* respectively; a reduction gear mechanism **3** to which the output shafts **2***a* and **2***b* of the engine units **1***a* and **1***b* are coupled, and a single output shaft **4** of which is coupled to the installation screw shaft **4***a*, preferably through a resilient coupling system; an auxiliary engine **5** coupled, for example via cardan shaft **6,** to a power input shaft or secondary power shaft **6***a* which extends to the interior of the reduction gear mechanism **3**; and a number of accessories, including accessories for bringing the power unit **1** to operating temperature, comprising, in the case of each engine unit, at least one cooling freshwater pump **7** and at least one circulating and lubricating oil pump **8,** all these pumps being carried and driven by the reduction gear mechanism **3.**

The engine unit **1** is preferably constructed in accordance with the French Pat. application filed by the same applicant on 23rd Aug., 1971 under the number 71-30,521 for "Improvements in and relating to propulsion installations for vehicles or vessels, more particularly for boats", now French Pat. No. 2,151,163 the said power unit then being formed from two superposed diesel engine units **1***a* and **1***b* with turbocompressors and each comprising ten pairs of horizontal opposed cylinders. In these conditions each engine unit can develop a power of the order of 4,000 to 5,000 H.P. and in this particular case this results in the complete power unit developing a total power of the order of 8,000 to 10,000 H.P., although this is of course only an example and without departing from the scope of the invention it would be possible to use power units developing a much higher total power.

The auxiliary engine **5** is preferably a diesel piston engine of a power of the order of 200 to 300 H.P., and this auxiliary engine may also be used if required to drive an electrical generator feeding the auxiliary equipment.

The reduction gear **3**, which is shown in perspective at two different angles in FIGS. **1***a* and **1***b*, comprises generally a casing **9** formed from four superposed elements which are connected detachably in three horizontal joint planes p (FIG. **1***a*), which from top to bottom are respectively situated at the level of the line of shafting L2*b* of the top element, L2*a* of the bottom engine unit and L4 of the reduction gear output.

The driving torque produced by the bottom engine unit **1***a* and collected at the output shaft **2***a* of the said engine unit is transmitted through a releasable coupling device **10***a* to a first input shaft **2***a***1** belonging to the line of shafting L2*a* and entering the reduction gear casing **9**.

The driving torque produced by the top engine unit **1***b* and collected from the output shaft **2***b* of said engine unit is transmitted via a double-toothing coupling **10***b* similar to coupling **10***a* to a second input shaft **2***b***1** belonging to the line of shafting L2*b* and entering the reduction gear casing **9**.

At the opposite end to the output shaft **4**, a control box **11** is provided at the end of the shafting line L4 for varying the pitch of the boat screw.

Detachable bell housings or covers co-axial with the shafting lines are also provided for ease of removal and installation on the lateral walls of the casing **9** through which the lines of shafting extend, and the following are examples of these:

on the line of shafting L2*a*: a cover **12***a* on the input shaft side **2***a***1** and a bell **13***a* on the opposite side;

on the line of shafting L2*b*: a cover **12***b* on the input shaft side **2***b***1** and a bell **13***b* on the opposite side; and on the line of shafting L4: a cover **14** which forms a fixing flange on the control box side **11** and a cover **15** on the opposite side.

A general structure of this kind for the reduction gear mechanism **3** makes inspection and any repaid of the internal elements of the mechanism very simple and rapid for the following reasons:

In the event of trouble with the elements housed in one of the bells **13***a* or **13***b* it is only necessary to remove the bell in question to gain access to the elements.

In the event of trouble on the top line of shafting L2*b*, coupling **10***b* is decoupled and bell **13***b* and cover **12***b* are removed, whereupon the fixing elements of the top element of the casing **9** are removed to release the said top element in the upward direction, access then being possible from the top to the interior of the reduction gear mechanism at the line of shafting L2*b*.

In the event of trouble on the bottom line of shafting L2*a*, the two couplings **10***a* and **10***b* are decoupled, bell **13***a* and cover **12***a* are removed, whereupon the fixing means of the casing elements connected in this joint plane are removed so that the two casing elements situated above the said joint plane can be released as a unit in the upward direction, then giving access from the top to the interior of the reduction gear mechanism at the level of the line of shafting L2*a*.

Finally, in the event of trouble at the level of the line of shafting L4, i.e., the screw shaft line, the covers **14** and **15** are removed and the screw pitch control box **11** is secured and the fixing means of the bottom casing element are removed so that the said bottom casing element can be released in the downward direction, thus giving access from above to the interior of the reduction gear mechanism at the level of the line of shafting L4.

The internal components of the reduction gear mechanisms **3** will now be described generally, whereupon the successive stages of the procedure for rendering the propulsion installation operative, and some specific phases of operation, will be explained.

In this connection, reference will be made to FIGS. **2** and **2***a* to **2***h* generally and, initially, more particularly to FIG. **2***g*.

On the line of shafting L2*b*, the top input shaft **2***b*$_1$drives a rotary coupling **16***b* and through this a shaft **17***b* extending into the bell **13***b* and bearing, inside said bell **13***b*, a clutch device **18***b* lockable in the engaged position by means of a dog clutch system **19***b* provided at the shaft end.

The driven, i.e. output part of the clutch **18***b* is connected to a tubular shaft **20***b* on which is secured a gearwheel **21***b* meshing with an identical gearwheel **21***a* which will be discussed hereinafter.

On the line of shafting L2*a*, the bottom input shaft **2***a*$_1$ drives a resilient angular coupling **16***a* and, through the agency thereof, a shaft **17***a* extending as far as the bell **13***a* and bearing inside the latter a clutch device **18***a* which can be locked in the engaged position by a dog clutch system **19***a* provided at the end of the shaft.

The driven, i.e., output part of the clutch **18***a* is connected to a tubular shaft **20***a* to which there are secured the gearwheel **21***a* mentioned above and a gearwheel **22** meshing with the gearwheel **23** ekeyed on the output shaft **4** of the reduction gear (screw shaft line L4).

This system is completed as follows: on the top line of shafting L2*b*: by a starting gear **24***b* and a power take-off gear **25***b*, these two elements being connected to the driven part of the resilient rotary coupling **16***b*,

and, on the bottom line of shafting L2*a*: by a starting gear **24***a* and a power take-off gear **25***a* identical to the above, these two elements being connected to the driven part of the resilient angular coupling **16***a*.

In addition to the above-described elements which concern the main function of the reduction gear, i.e., the transmission of power from the power unit to the screw shaft, the said reduction gear comprises a number of auxiliary elements which have been referred to hereinbefore, and which are used during preheating of the power unit, during starting of the power unit, and during manoeuvres of the craft as low speed at ports. These other elements are controlled by the auxiliary engine **5** through the agency of the secondary input shaft **6***a*.

By means of a clutch **26** (see FIG. **2***h*), for example an electromagnetic clutch, and a bevel gear **26***a*, the secondary input shaft **6***a* drives the following:

Two horizontal tubular transverse shafts **27***a* and **27***b* respectively associated with the bottom engine unit **1***a* and the top engine unit **1***b*,

and a vertical shaft **28** permanently coupled to the said tubular transverse shafts **27***a* and **27***b* respectively by two bevel gears **29***a* and **29***b*.

As will be apparent from FIG. **2***b*, the top transverse shaft **27***b* bears the driving part of a dog clutch **30***b*, the driven part of which is connected to a shaft **31***b* extending through the tubular shaft **27***b* and bearing the fresh-water pump **7***b* at one end and the oil pump **8***b* at its other end, these two pumps being associated with the top engine unit **1***b*.

A second dog clutch **32***b* is provided on the same transverse line of shafting and is combined with the dog clutch **30***b* so that when one of these two dog clutches is in the operative position the other dog clutch is in the disengaged position, a neutral position in which both dog clutches are disengaged being provided in the control system for such dog clutches. The driven part of the dog clutch **32***b* is connected to a tubular shaft **33***b* co-axial with shaft **31***b* and driving a bevel gear **34***b* which will be discussed hereinafter.

As will be apparent from FIG. 2*a*, the bottom transverse shaft **27***a* is associated with elements identical to those described in connection with the top transverse shaft **27***b*, i.e., a dog clutch **30***a*, shaft **31***a*, a freshwater pump **7***a*, an oil pump **8***a* (these two pumps being associated with the bottom engine unit **1***a*), a second dog clutch **32***a* combined with the dog clutch **30***a*, and a tubular shaft **33***a* driving a bevel gear **34***a* which will also be discussed hereinafter.

As will be apparent from FIG. 2*h*, the bottom transverse shaft **27***a* is also coupled by a bevel gearwheel **35** meshing with the bevel gearwheel arrangement **29***a* to a vertical shaft **36** driving a secondary pump **37** for recovery of oil from the bottom of the reduction gear casing when only the auxiliary engine **5** is in operation and, through a gearwheel **38**, to a vertical shaft **39** driving a main pump **40** for drawing oil from the bottom of the reduction gear casing if at least one of the engine units **1***a*and **1***b* is in operation.

The driven gearwheel of the bevel gear **34***b* (see more particularly FIGS. **2***e* and **2***h*) is secured on a shaft **41** connected to a gearwheel **42** meshing with a gearwheel **43** connected to another larger-diameter gearwheel **44** meshing with a gearwheel **45** meshing with the power take-off gearwheel **25***b* already mentioned and belonging to the line of shafting L2*b*, the shaft of the gearwheel **44** rotating a fuel circulating pump associated with the top engine unit.

Similarly, and as will be apparent from FIGS. **2***f* and **2***h*, the driven gearwheel of the bevel gear **34***a* is secured on a shaft **46** connected to a gearwheel **47** meshing with a gearwheel **48** connected to another larger-diameter gearwheel **49** meshing with the power take-off gearwheel **25***a* already mentioned and belonging to the line of shaftinf L2*a*, the shaft of the gearwheel **49** rotating a fuel circulating pump associated with the bottom engine unit.

For the purpose of operating on the auxiliary engine **5** alone, the reduction gear **3** also comprises (FIGS. **2***d* and **2***h*) a bevel gear **50** driven by the vertical shaft **28**, the driven gear wheel of this bevel gear being coupled by a gear train **51** to a shaft **52** bearing the driving part of a dog clutch **53**, the driven part of which is secured to a tubular shaft **54** surrounding the shaft **52** and bearing at its end a gearwheel **55**, the function of which will be described hereinafter in connection with the description of harbour manoeuvres.

To enable the reduction gear to be used for starting either of the engine units **1***a* and **1***b*, the gearing of the reduction gear is completed by a three-position transmission device or quadrant of the type which can pass from a neutral position to one or other of two end positions corresponding to coupling of the vertical shaft **28** (which is adapted to be driven by the auxiliary engine **5**) to respectively the starting gearwheel **24***a* or the starting gearwheel **24***b*.

This transmission device (FIGS. **2***c* and **2***h*) comprises a bevel gear **56**, the driving gearwheel of which is secured to the vertical shaft **28** and the driven gearwheel of which is secured to a shaft **57** on which the driving part of a dog clutch **58** is secured for rotation, the driven part of the dog clutch **58** being connected to a tubular shaft **59** surrounding the shaft **57** and bearing at its end a gearwheel **60**, the shaft of which forms the pivot for the support **61** of the quadrant of the gearing, of which the gearwheel **60** is the input gearwheel.

In addition to the gearwheel **60**, the gearing also comprises a gearwheel **62** meshing with gearwheel **60** and comprising a freewheel (the direction of which will be adapted to the starting problem to be solved), the driven part of which is connected to a gearwheel **63** meshing with a gearwheel **64** connected for rotation to a smaller-diameter gearwheel **65** meshing with an identical gearwheel **66.**

For starting the bottom engine unit **1***a*, the support **61** is moved downwardly and the output gearwheel of the three-position transmission is the gearwheel **65** which then engages with the starting gearwheel **24***b*.

The various clutches and dog clutches mentioned above are individually provided with control systems which have been omitted from the drawing for clarity, and these control systems may be of a conventional type, for example hydraulic.

Also, all the gear trains in the reduction gear allow for the direction of rotation of the engine units and the direction required for the screw, and of course the entire system can obviously be adapted to different initial conditions as to direction of rotation by the addition of suitably arranged reversing gearwheels.

The successive stages of operation of the above propulsion installation will now be described starting from the time when the boat is at the quayside with the power unit cold until the time when the boat is in the normal operating condition with its power unit in operation, and this description will also include certain specific cases of operation.

For this description, reference will be made to FIGS. **3** to **10**, which have been made identical as regards the relative positions of the elements (for simplification purposes), but in which those elements which are in motion have been indicated using double arrows and been given their reference numeral in order to distinguish the various stages of operation. The operations carried out on the dog clutches or clutches will also be indicated hereinafter in connection with each Figure.

1. Preheating (FIG. 3)

The boat is at the quayside with the power unit cold. A special heating installation (for example an electrical heating installation) is provided to heat the freshwater and oil involved in the propulsion installation. All the clutches and dog clutches of the reduction gear and of the three-position transmission are assumed to be in the neutral position.

Auxiliary engine **5** is started if it has not already been started for other purposes.

Dog clutches **30***a* and **30***b* are brought into the operative position.

Clutch **26** of auxiliary engine is brought into operative position.

In these conditions, the water pumps **7***a*, **7***b* and the oil pumps **8***a*, **8***b* and the secondary recovery pump **37**, are driven and the complete power unit heats up progressively.

2. Harbour Manoeuvre (FIG. 4)

When the preheating as described above has reached the required temperature, and before starting harbour manoeuvres or starting the propulsion engine, the previous manoeuvre must be interrupted for a moment to bring the various dog clutches concerned into the operative position without rotation.

Thus before starting the harbour manoeuvre procedure, clutch **26** is disengaged and when the gearhweels have stopped dog clutche **53** is engaged, and then clutch **26** is engaged so that while preheating is restored the gearwheel **21***a* coupled to the screw shaft is driven and thus receives all the power of the auxiliary engine but rotates at a reduced speed because of the internal step-down ratios of the reduction gear. In this stage of operation, the screw pitch is initially set to zero and is progressively brought to a suitable intermediate value.

In the specific case in which the harbour manoeuvre is not prior to a sea trip and is simply for a change of mooring position, there is no point in using the preheating stage, and in that case all that is necessary (FIG. **4***a*) is to leave the dog clutches **30***a* and **30***b* in the neutral position (the same applies to dog clutches **32***a* and **32***b*), and to bring clutch **26** into the operative position so that the boat moves at slow speed as before but without preheating.

3. Starting of top engine unit (FIG. 5)

It will be assumed that the top engine unit **1***b* is to be started first, preheating of the engine unit having been completed.

The screw is reset to zero pitch.

Clutch **26** is disengaged to stop the gearing.

Dog clutches **30***b* and **32***a* are brought into the operative position as is also dog clutch **58** which controls all the gearing in the three-position transmission **61.**

The three-position transmission **61** is swung up to couple gearwheel **66** to starting gearwheel **24***b*.

Clutch **26** is engaged gently by successive pulses.

When gearwheel **24***b* has started, dog clutch **30***b* is disengaged by engaging dog clutch **32***b*.

Clutch **18***b* is brought into the operative position to ensure effective starting of top engine unit, the freewheel of gearwheel **62** then coming into operation, and then the three-position transmission **61** is returned to the neutral position.

4. Starting of bottom engine unit (FIG. 6)

If it is preferred to start the bottom engine unit **1***a* first, after the power unit has been heated to the required temperature as before, the screw is reset to zero pitch clutch **26** is disengaged to stop the gearing controlled by the auxiliary engine, the dog clutches **30***a* and **32***b* are brought into the operative position as is also the dog clutch **58** controlling all the gearing of the three-position transmission device **61,** the device **61** is swung down to couple the gearwheel **65** to the starting gearwheel **24***a*, clutch **26** is engaged gently by successive pulses, when the gearwheel **24***a* has started the dog clutch **30***a* is disengaged by engaging the dog clutch **32***a*, the clutch **18***a* is brought into the operative position so as to ensure effective starting of the bottom engine unit, the freewheel of the gearwheel **62** then coming into operation, and then the transmission device **61** is returned to its neutral position.

5. Operation of complete power unit (FIG. 7)

After the engine units **1***a* and **1***b* have been successively started in the required sequence, clutch **26** is disengaged to disconnect the auxiliary engine **5,** dog clutches **19***a* and **19***b* are brought into the operative position, dog clutches **32***a* and **32***b* being engaged, and the screw pitch is progressively increased by means of pitch control box **11.**

In thses conditions, the total power of the two engine units **1***a* and **1***b* is transmitted positively to the screw shaft **4** and the auxiliaries associated with the said engine units (freshwater pumps **7***a*, **7***b*, oil pumps **8***a*, **8***b*, main oil recovery pump **40** and fuel circulation pumps) are effectively driven at normal speed.

6. Operation of botton engine unit alone (FIG. 8)

If it is proposed to propel the boat using only the bottom engine unit **1***a* (either because it is required to operate at half power or because the top engine unit **1***b* has broken down or may be undergoing repair), the dog clutch **19***b* is disengaged, and then the clutch **18***b*, the dog clutches **32***a* and **32***b* being engaged and the clutch **26** remaining disengaged.

In these conditions, only the power of the bottom engine unit **1***a* is transmitted positively to the screw shaft **4** and only the auxiliaries associated with the bottom engine unit are effectively driven at their normal speed (freshwater pump **7***a*, oil pump **8***a*, main oil recovery pump **40** and bottom engine unit fuel circulation pump). 7. Operation of top engine unit alone

It is it required to operate with just the top engine unit, three possibilities are available.

a. It is required to operate at half-power drive after preheating and starting the top engine unit alone by means of the auxiliary engine **5.** In this case, after the procedure described under heading **3** (FIG. **5**), dog clutch **19***b* is engaged and the screw pitch is progressively increased by means of the pitch control box **11.**

b. Starting from complete operation of the power unit described under heading **5** (FIG. **7**), the top engine unit **1***b* is required to operate alone, the bottom engine unit **1***a* being stopped just to use only half-power drive for the time being, the sequence of operations being as follows: the screw is reset to zero pitch, the two engine units are stopped after disengagement of the dog clutches **19***a* and **19***b* and then of the clutches **18***a* and **18***b*, starting of the top engine unit **1***b* alone is carried out by means of the auxiliary engine **5** as described under heading **3** (FIG. **5**), and clutch **26** is disengaged and then dog clutch **30***a* is engaged at standstill.

In these conditions (see FIG. **9**), only the power of the top engine unit **1***b* is transmitted positively to the screw shaft **4,** the driven accessories being as follows for the top engine unit **1***b*; freshwater pump **7***b*, oil pump **8***b*, secondary oil recovery pump **37** and top engine unit fuel circulation pump and, for the bottom engine unit **1***a*: the freshwater pump **7***a* and the oil pump **8***a*.

c. If, on the other hand, after a total operation of the power unit as described under heading **5** (FIG. **7**) it is necessary to carry out inspection, dismantling, or repair of the bottom engine unit (i.e., in a situation in which the operation of the bottom engine unit auxiliaries must be stopped the following procedure is carried out to obtain operation of just the top engine unit **1***b*.

As before, the procedure is as follows: the screw is reset to zero pitch, the two engine units are stopped after disengagement of the dog clutches **19***a* and **19***b* and then of the clutches **18***a* and **18***b*, starting of the top engine unit **1***b* alone is then carried out by means of the auxiliary engine **5** described under heading **3** (FIG. **5**), and the clutch **26** is disengaged whereupon the dog clutches **30***a* and **32***a* are set to neutral.

In these conditions (see FIG. **10**), only the power of the top engine unit **1***b* is transmitted positively to the screw shaft **4**, the only auxiliaries driven being the freshwater pump **7***b*, the oil pump **8***b* and the secondary oil recovery pump **37**.

The numerous advantages of such a propulsion installation, particularly in connection with its compactness, size, accessibility of the components of the reduction gear and the numerous combinations possible to allow for specific situations whether transient (preheating, harbour manoeuvres, and partial or total starting of the power unit) or permanent (operation with one or other of the engine units or with both engine units simultaneously) are sufficiently clear from the foregoing for it to be unnecessary to dwell on this point.

It will of course be apparent from the foregoing that the invention is in no way limited to those applications or embodiments of its various parts which have been more particularly discussed on the contrary, the invention covers all variants thereof.

I claim:

1. A propulsion installation, comprising:

a power unit; a reduction gear mechanism, a primary input shaft of the reduction gear mechanism drivingly connected with said power unit; an output shaft of the reduction gear mechanism arranged to drive propulsion means; wherein the improvement comprises the provision of:

an auxiliary engine; a secondary input shaft of the reduction gear mechanism arranged to be driven by the auxiliary engine; means to decouple the said output shaft from the primary input shaft; said reduction gear mechanism including means to drivingly connect the secondary power input shaft to the output shaft with such output shaft decoupled from the primary input shaft; and means including a freewheel device to drivingly connect the secondary power input shaft to the primary input shaft for starting of the power unit, said freewheel device permitting transmission of torque from the secondary power input shaft to the primary power input shaft to rotate a shaft of the power unit in the direction in which such shaft is rotated for starting of the power unit in which the power unit comprises only two engine units, and in which the said means within the reduction gear mechanism for drivingly connecting the said secondary power input shaft successively with each primary input shaft comprises a transmission mechanism comprising a rocking support; a pair of driving gearwheels mounted on the rocking support, means to rock the support between three positions; and a pair of starter gear wheels arranged to be driven to drive their respective primary input shafts during starting of respective engines units; the rocking support when in a first said position thereof having a first of said pair of driving gearwheels in driving engagement with a first of said starter gearwheels, when in a third said position thereof having a second of said pair of driving gearwheels in driving engagement with a second of said starter gearwheels, and when in a second and intermediate position thereof having both of said pair of driving gearwheels out of engagement with said starter gearwheels.

2. A propulsion mechanism as claimed in claim **1**, and including pump means arranged to pump fluid to preheat the power unit prior to starting the same; means within the reduction gear mechanism being provided which can be selectively drivingly coupled with the secondary power input shaft for driving said pumps; gear means being provided in said reduction gear mechanism for drivingly connecting the pump means with the primary input shaft.

3. A propulsion installation as claimed in claim **2**, in which the transmission ratios of the gears within the reduction gear mechanism are such that said pump means are arranged to be driven faster when being driven by said primary input shaft than when being driven by said secondary input shaft for the same rotational speed of said input shafts.

4. A propulsion installation as claimed in claim **1**, and including pump means operable during preheating of the power unit, said pump means being carried on and driven by the reduction gear mechanism.

5. A propulsion installation as claimed in claim **1**, in which the reduction gear mechanism comprises a casing having a joint plane at the level of each said input or output shaft of said reduction gear mechanism, whereby eventual power transmission components of said reduction gear mechanism may be simply exposed and repaired at each of its shaft levels.

6. A propulsion installation as claimed in claim **5**, and comprising covers provided in the walls of said casing at the end of each said input or output shaft, said covers straddling the joint planes of the casing.

7. A propulsion installation as claimed in claim **6**, wherein some of said covers comprise bell-housing which protect some of the components of the reduction gear mechanism.

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