

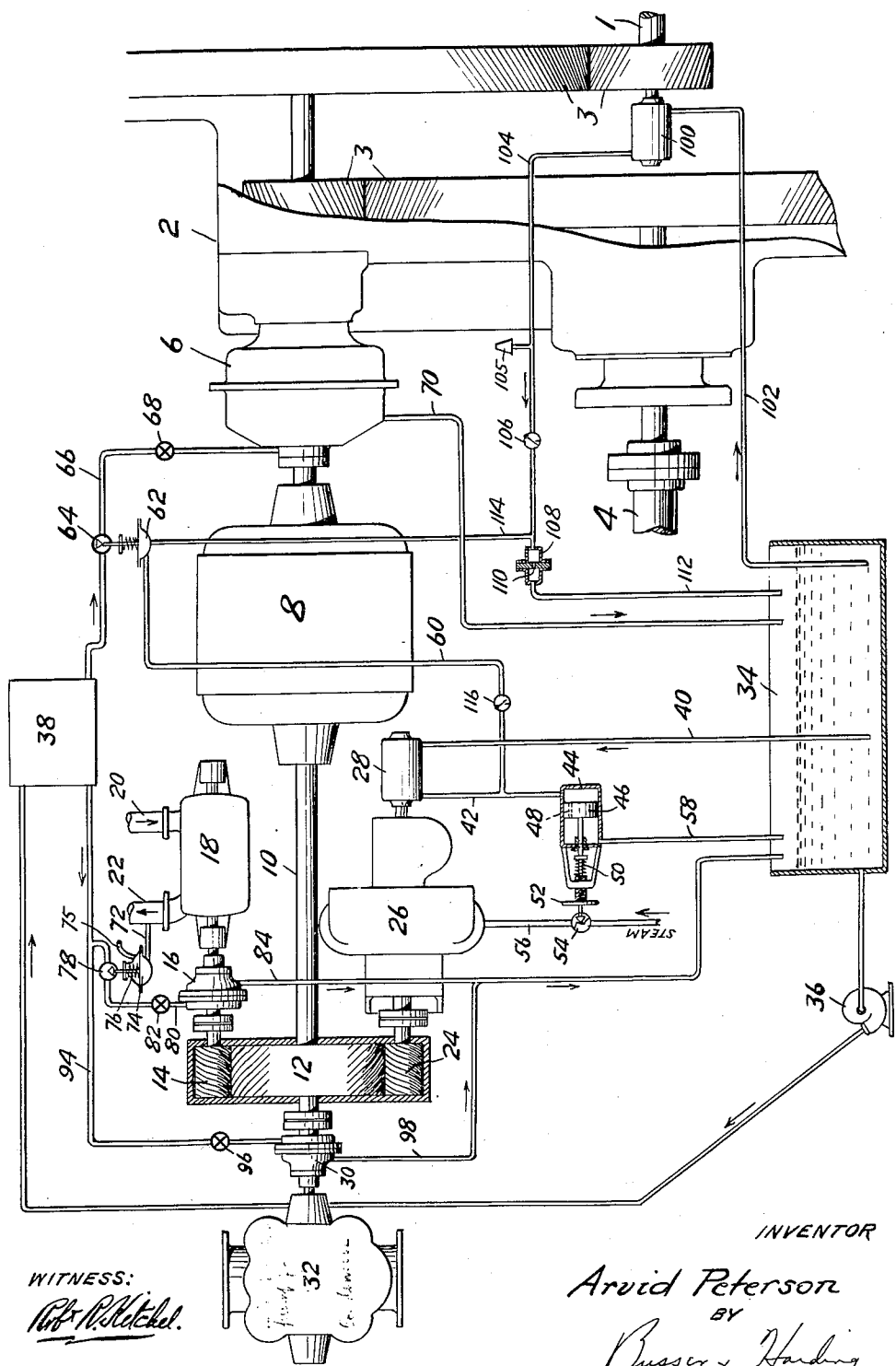
July 23, 1935.

A. PETERSON

2,009,001

DRIVING MEANS FOR SHIP AUXILIARIES OR THE LIKE

Filed March 3, 1934



UNITED STATES PATENT OFFICE

2,009,001

DRIVING MEANS FOR SHIP AUXILIARIES
OR THE LIKEArvid Peterson, Trenton, N. J., assignor to
De Laval Steam Turbine Company, Trenton,
N. J., a corporation of New Jersey

Application March 3, 1934, Serial No. 713,815

14 Claims. (Cl. 60-102)

This invention relates to means for driving auxiliaries, such as those included in a steam driven ship power plant from a main propelling or power unit.

5 From an economical standpoint it is highly desirable to drive as many of a ship's auxiliaries as possible from the main propelling unit. The reason for this is that the main propelling unit is very efficient and delivers its power with a
10 very low rate of fuel consumption. On account of the fact that the auxiliaries for a steam power plant such as that of a ship require comparatively little power, turbines or other devices for driving them are very inefficient and the steam
15 or fuel required for driving these auxiliaries by separate turbines or engines is considerably greater than would be the case if the auxiliaries could be driven directly from the main power unit.

20 However, there is one difficulty in connection with such an arrangement and that is that a ship, particularly a cargo ship, is seldom operated at constant speed and consequently the output from the auxiliaries is affected, sometimes in
25 a way which is quite objectionable.

Taking as a specific example a turbine-driven ship, there may be considered a boiler feed pump of centrifugal type which must supply feed water to the boilers at approximately constant pressure
30 somewhat higher than the boiler pressure. In the case of cargo ships it is often desirable to operate for long periods of time at a speed as much as 20% below maximum speed. Assuming,
35 for example, that the boiler pressure is 400 pounds per square inch, and the required boiler feed pump pressure is 500 pounds per square inch, and the feed pump is designed for 500 pounds per square inch pressure at maximum operating
40 speed, it would deliver only 320 pounds per square inch if the speed were reduced 20% and accordingly it could not feed boilers operating at 400 pounds per square inch pressure. It is not practical to reduce the boiler pressure enough to take
45 care of this reduction in pump pressure.

It would therefore be necessary to design the boiler feed pump in such a way that it will produce 500 pounds per square inch pressure when the ship is operating at 20% below its maximum speed. However, at maximum speed the boiler
50 feed pump would then deliver a pressure of about 785 pounds per square inch, which is very undesirable because of the piping and regulating equipment used between the boiler feed pump and the boilers. It is also very undesirable to
55 operate a pump designed for a pressure of 500

pounds per square inch at a pressure more than 50% greater than normal.

The example just referred to is typical not only of the boiler feed pump but of other auxiliaries which are sometimes used. To a somewhat lesser
5 degree the variation in speed is also objectionable in connection with the drive of electrical generators although in such cases electrical means are generally readily available to insure
10 a constant voltage output in spite of a reduction amounting to over 20%.

It is the object of the invention to provide a driving arrangement for auxiliaries which will operate them under proper conditions in spite of
15 speed fluctuations of a main power unit, while at the same time driving the auxiliaries the greater part of the time by such main unit. Inasmuch as the invention is particularly adaptable to use in connection with ship auxiliaries, the description
20 will be directed primarily thereto for specific examples. It will be understood, however, that the arrangement is equally applicable to other power plants in which, however, there are generally not involved the conditions indicated above
25 with respect to a cargo ship.

Specific objects of the invention particularly relating to details of arrangement will be apparent from the following description read in conjunction with the accompanying drawing, in
30 which the figure represents diagrammatically the layout of a typical unit.

There is indicated diagrammatically at 2 the housing of the speed reducing gears 3 between the main turbine whose shaft is indicated at 1 and a propeller driving shaft 4. In a typical arrange-
35 ment, a two-stage reduction would be provided, the propeller shaft being driven, for example, at a normal speed of 75 R. P. M. with an expected reduction for considerable periods of time to
40 60 R. P. M. The auxiliaries in such case could conveniently be driven from the pinion shaft of the second gear reduction which would typically operate at a normal speed of about 700 R. P. M.
45 with a speed of about 560 R. P. M. corresponding to a 20% reduction. The pinion shaft just referred to serves to drive the clutch 6 and through it the generator 8 and the other auxiliaries. Inasmuch as under certain conditions the propeller
50 shaft must be made to operate at very low speeds which would be insufficient for the driving of the auxiliaries, and at times reversed, there is necessarily provided a clutch such as indicated at 6
55 which may disconnect entirely the various auxiliaries from the main turbine. The auxiliaries

are then driven by an auxiliary turbine hereafter described.

The clutch 6 is preferably of a type controlled in its operation by oil pressure or oil flow. This clutch, for example, may be of the type indicated in the patent to Föttinger, 1,199,356, dated September 26, 1916, and is diagrammatically illustrated as of this character. A more complete indication of this type of clutch and its mode of control is given in my application Ser. No. 661,761, dated March 20, 1933, to which further reference may be made in connection with other clutches involved in the present system. The Föttinger type of clutch is characterized by the fact that it permits slip of a degree depending upon the quantity of liquid circulating in the impeller and turbine portions thereof. When the quantity of liquid introduced is reduced or cut off altogether, slippage of varying degrees or complete effective disengagement is attained. On the other hand, when the clutch passages are maintained filled with liquid a very slight slip occurs and the operation takes place at high efficiency. This type of clutch is well known in improved forms and need not be further discussed.

Instead of using the Föttinger type of clutch, another satisfactory type which may be used is the Metten clutch illustrated in the patent to J. F. Metten, 1,157,793, dated October 26, 1915. This clutch is operated by oil pressure and the clutch may be engaged or disengaged at will by controlling the oil pressure by means, for example, of a bypass. Inasmuch as slipping is not required at the location of the clutch 6 and the clutch is either engaged or disengaged, the Metten clutch at this point is somewhat more desirable than the Föttinger clutch, since by reason of the positive engagement under running conditions there is involved no loss of power such as occurs in the case of the Föttinger clutch even when the Föttinger clutch is operating with a minimum slip.

The clutch 6, whatever its nature may be, is controlled by a regulation of oil flow in a manner which will be hereafter described. In the illustrated embodiment of the invention, the driven member of the clutch is connected directly to a generator 8 which is used for supplying light and for driving auxiliaries other than those connected mechanically to the main turbine unit. This generator is provided with voltage control means of the usual fashion so that it will maintain substantially constant voltage for a speed reduction of about 20%. Such type of control is well known and forms no part of the present invention. It is merely mentioned to indicate that there is not required for the driving of the generator any such devices as are necessary for the driving of other auxiliaries.

The shaft 10 forming an extension of the generator shaft has connected thereto a gear 12 which meshes with pinions 14 and 24 whereby a speed increase is provided driving the pinions at full and low speeds respectively of about 5155 R. P. M. and 4120 R. P. M., continuing, by way of example, reference to speeds heretofore referred to as typical. The pinion 14 drives, through a clutch 16 of the Föttinger type, a boiler feed pump 18 which receives water through the passage indicated at 20 and discharges through the passage 22. This boiler feed pump in the present example is illustrated as of the multistage centrifugal type, since this type particularly has a pressure characteristic which falls rapidly with

decrease of speed as indicated in the introduction to this specification.

Pinion 24 is connected with the auxiliary turbine 26, which has a normal operating speed of about 5155 R. P. M. The shaft of this auxiliary turbine is directly connected to a pump 28 which may conveniently be of the positive screw type indicated in the patent to C. O. J. Montelius, 1,698,802, dated January 15, 1929. A pump of this character is highly efficient and capable of delivering fluid at high pressures. As will be pointed out hereafter, this pump forms part of a speed governing arrangement for the auxiliary turbine.

A water circulating pump 32 for the condensers may be driven from the gear 12 at a speed of the order of the minimum speed of the shaft 10 through a Föttinger coupling indicated at 30. Alternatively, this circulating pump may be directly connected to the gear 12, since the speed of operation of this pump is not so critical as that of the boiler feed pump and the circulating water requirements are generally approximately in direct proportion to the propeller speeds.

It is necessary, however, that this condenser water circulating pump should operate when the main turbine is running at very low speeds or running in reverse. Hence it must be connected to be driven by the auxiliary turbine.

To insure positive lubrication in a system of this type, there is generally provided a pressure lubricating system in which oil is delivered from a sump 34 by means of a pump 36 into an overhead oil supply tank 38. This tank 38 may be duplicated and a separate one may be provided to take care of the controls in accordance with the present invention. In any event, however, it is very important to provide a pressure oil supply in a system of the character disclosed involving the use of oil controlled clutches. This importance is due to the fact that if a failure of oil pressure should occur, the boiler feed pump might stop, with disastrous results. It will be understood, therefore, that 38 is intended to represent either the main pressure supply of lubricating oil or an auxiliary pressure supply designed solely for control purposes.

Besides forming the supply for the oil pump 36, the sump 34 provides a supply of oil through a conduit 40 to the pump 28 driven by the auxiliary turbine 26. This pump delivers oil under suitable pressure through a passage 42 to the right-hand end of a cylinder 44 in which there slides a piston 46 provided with an orifice 48. The piston 46 is urged to the right by a spring 50 the tension of which is adjustable by means of a hand wheel 52 whereby the axial position of a fixed spring abutment may be adjusted. The rod of the piston controls a valve 54 in the steam supply line 56 to the auxiliary turbine 26. When the piston moves to the left this valve is closed, cutting off the supply of steam to the auxiliary turbine. Conversely, when the piston moves to the right, the valve is opened. By reason of the provision of the fixed orifice 48, the oil pressure tending to move the piston to the left will vary approximately as the square of the speed of the pump 28 which is, as noted above, preferably of a positive nature as shown in the Montelius patent. The adjustment is such that as soon as the auxiliary turbine shaft is rotating at a speed above a certain value, the steam supply thereto will be cut off. On the other hand, when the speed drops, steam will be supplied until an equilibrium speed is attained depending upon the

adjustment of the spring 50. The arrangement thus acts as a speed governor. Oil is discharged from the cylinder 44 to the sump by the pipe 58.

A branch 60 from the pipe 42 serves to control a valve 64 by means of an expansible diaphragm or piston arrangement indicated at 62, the arrangement being such that the valve 64 is opened when the pressure in the line 60 increases, that is, when the speed of the pump increases so that the pressure within the cylinder 44 rises. A spring controls the valve 64 so as to cause it to close when the pressure in 62 drops. The valve 64 is interposed in the supply line 66 from the oil supply tank 38 to the coupling 6, from which coupling oil is drained through a pipe 70. A manually operable valve 68 may be interposed in the line 66 to furnish adjustment independently of the automatic valve 64.

The discharge pipe 22 of the boiler feed pump is connected by means of a pipe 72 with a diaphragm or piston type pressure control device 74 for a valve 78, the connection being below the diaphragm or piston. The space above the diaphragm or piston is connected by a pipe 75 to the boiler while a spring 76 tends to further oppose upward movement of the diaphragm or piston. The valve 78 is interposed in the oil feed line 80, which serves to supply oil to the Föttinger coupling 16. The arrangement is such that when the pressure in 22 increases to a suitable amount above boiler pressure the valve 78 is closed to an extent throttling the oil passing to the Föttinger coupling and thus regulating the amount of oil therein and consequently the slip. A manual valve 82 interposed in the line 80 provides adjustment of oil flow independent of the automatic valve 78. Discharge of oil from the coupling takes place through a conduit 84.

While, if desired, a similar automatic control may be associated with the condenser water circulating pump 32, this is generally unnecessary since the demands on this pump are usually about proportional to the speed of the main turbine. The pump 32 may be driven through the coupling 30 which receives oil through the pipe 94 under manual control by valve 96 and discharges through pipe 98. The manual control at 96 is desirable since through it the flow of oil may be reduced and slip of clutch 30 provided to reduce the power consumed by pump 32 when, for example, the ship is operating in very cold water.

The devices so far described are sufficient for operation, as will be brought out later, if, after the main turbine has been operating at abnormal low speeds or in reverse, it is not necessary or desirable to cause the main turbine to again automatically pick up the auxiliaries. There is in general a dislike on the part of marine engineers to have too many automatic devices on a ship and consequently it would, in general, not be objectionable to cause the main unit to again drive the auxiliaries by means of manual intervention. In case, however, totally automatic control is desired, there may be provided additional devices which will now be described.

A second pump 100 similar to that indicated at 28 is arranged to be driven from the main turbine by, for example, direct connection to its shaft 1. If this pump is to operate at lower speeds, it may be driven through suitable reduction gearing. The pumps of the type described, however, are capable of operating at high speeds. This pump 100 takes oil from the sump through the pipe 102 and delivers it under pressure to the pipe 104, in which there is interposed a check

valve 106 opening to permit flow from the pump but operating to prevent flow to the pump through the pipe 104. This check valve is provided because the pump will operate in a reverse direction if the main turbine is reversed. To prevent the pump from operating against a vacuum, a relief valve indicated at 105 may be provided which may open to the atmosphere or alternatively may be connected with the sump 34, so that the pump will never run dry. Lubricating oil may, however, be provided in any suitable fashion so that while the pump is not operating fully, it may be sufficiently lubricated during reversal of the main turbine.

The pipe 104 is connected through 114 to the valve 62 below the diaphragm thereof in the same fashion as the pipe 60. The pipe 104 is also connected to a chamber 108 across which there extends a diaphragm provided with a suitable orifice 110. Discharge of oil passing through the orifice takes place into the sump 34. In connection with the apparatus just described, there must be provided a check valve 116 in the pipe 60, which check valve may be omitted if manual pickup of the auxiliaries by the main turbine is to be used.

In the operation of the arrangement described, if it is assumed that the propeller is operating at full forward speed, the shaft 10 will be driven at its full speed and consequently the shaft of turbine 26 will be driven at full speed. Under such conditions the pump 28 will produce a pressure in the cylinder 44 such as to close the valve 54, with the result that the auxiliary turbine 26 will be driven without any supply of steam thereto. At the same time the pressure in the line 60 will be such that the valve 64 will be fully opened and the coupling 6 would be full of oil if it is of the Föttinger type. If it is of the Metten type, provision is made by the use of a bypass to insure that the pressure therein is sufficient to maintain engagement of the clutch.

The feed water supply pump 18 is so designed in the present system that it would deliver water at the necessary pressure and volume at, say, 80% of the speed at which it would operate if there were no slip in the clutch 16 and the propeller shaft was being operated at full forward speed. As a consequence of this design, if during full forward speed operation of the propeller there was no slip in the clutch 16, then the pressure and volume delivered by the pump 18 would be so great as to be objectionable and cause an undue absorption of power and wear on the pump. An equilibrium condition is provided such that when the pressure in the outlet 22 is normal (in the present case exceeding by the proper amount the boiler pressure) the valve 78 is controlled so as to throttle the oil supply of the Föttinger clutch 16 with the result that the clutch is not filled and slip occurs to an extent of approximately 20%, so that the pump 18 is operated at its normal speed. It may be noted that the maintenance of a substantially constant excess pressure over a substantially constant boiler pressure corresponds approximately to operation of the pump 18 at uniform speed. Obviously the control of valve 78 may be such as to insure any other uniform condition of operation that may be desirable.

If, now, the speed of operation of the propeller drops within the range down to 80% of full speed, the pressures actuating the valve 78 will initially fall off, opening these valves and admitting more oil to the Föttinger clutch 16.

As a consequence, the slip of the clutch decreases so that the discharge pressure or the excess pressure of the boiler feed pump remains constant. Due to the delays in the system which produce a damping effect, equilibrium conditions are attained, with the result that the slip of the clutch 16 is fixed to such extent that the pump 18 operates at its normal pressure. At the same time the automatic electrical controls, which are not shown, maintain the voltage output of the generator 8 at its full value in spite of the fluctuations in speed.

Down to about 80% of full propeller speed the pump 28 will maintain a pressure sufficient to keep the valve 54 closed so that no steam is admitted to the auxiliary turbine and will also keep the valve 64 fully open to maintain the clutch 6 full of oil if it is of the Föttinger type, or engaged if it is of the Metten or similar type. Under the abnormal conditions of operating speeds less than 80% of full speed, or reversal of the direction of operation of the propeller, the auxiliary turbine must be brought into operation to drive the auxiliaries. The adjustments are consequently such that when the speeds drop below 80% the pressure on the piston 46 will be no longer sufficient to hold it to the left and it will move to the right, opening the steam supply valve 54 to admit steam to the auxiliary turbine. At the same time the pressure in 62 drops so that the valve 64 will be at least partially closed, decreasing or interrupting entirely the flow of oil to the coupling 6 and thereby permitting a slip or even a reversal of direction of motion of the clutch elements. Due to the governor action of the pump 28 and the piston 46, the speed of operation of the auxiliary turbine 26 will correspond to 80% of full speed of the shaft 10 so that the auxiliaries will be satisfactorily driven.

If, now, after low speed or reverse operation of the main turbine unit, the speed of this main unit is increased above 80% of its full forward speed, then the auxiliaries may be again driven by the main unit and the steam to the auxiliary turbine cut off. There has been mentioned above the fact that the picking up of the auxiliaries by the main turbine under these conditions may be effected either manually or automatically.

If manual operation is to be effected, then the various connections to the pump 100 will be omitted along with the check valve in the pipe 60. Under such conditions all that is necessary in the way of manual operation to cause the main unit to again become effective to drive the auxiliaries is adjustment of the abutment of the spring 50 so as to increase its tension and thereby cause the auxiliary turbine 26 to speed up by reason of opening of the valve 54. When this occurs the pressure of the oil delivered by the pump 28 increases to such extent that the valve 64 is opened and flow of oil to the coupling 6 again provided. As soon as the clutch 6 again connects the main unit with the auxiliaries the tension on the spring 50 may be reduced to its normal amount, and as a result the valve 54 will be closed, cutting off the steam to the auxiliary turbine. The operation, in case of drop of speed of the main turbine, will then be the same as hereafter referred to. If, however, the main turbine is to pick up the auxiliaries automatically, then there may be provided all of the elements which have been described. In such case, the adjustments are made so that until the pump 100 attains a certain minimum speed in a forward direction, the valve 64 will not be opened. This end is attained by a

suitable adjustment of the valve 62 and the provision of a suitable orifice 110 which will obviously tend, by reason of its bleeding action, to prevent the rise of pressure in the line 104. Inasmuch as the resistance to flow through an orifice is approximately proportional to the square of the quantity of flow, it will be seen that a rather sensitive adjustment may be easily provided. Under conditions of rise of speed of the main unit to a proper amount, the pressure produced by the pump 100 will be sufficient to open the valve 64. The check valve 116 will, at the same time, prevent loss of oil through the pipe 60 and the valve arrangement 44. It will thus be seen that the auxiliaries may be picked up automatically. When the speed drops below the proper amount, the pressures at 62 created by both of the pumps will be insufficient to maintain the valves 64 open and consequently the clutch will be disengaged, as described above. Re-engagement, of course, will take place at a speed exceeding, by some predetermined amount, the speed at which control is taken away from the main turbine.

While there has been referred to throughout 80% of full speed as the critical speed where the operation changes it will be understood that this percentage is given only by way of consistent example, and that by proper adjustment and design the system may be made to operate under other conditions.

What I claim and desire to protect by Letters Patent is:

1. In combination, main driving means arranged to operate at varying speeds, a device arranged to be normally driven by said main driving means, an intermediate shaft, a clutch between the main driving means and said shaft, a second clutch between said shaft and the device, auxiliary driving means, governing means controlling said second clutch whereby during operation of said shaft within a predetermined speed range the device is operated under an approximately uniform condition, and means whereby the auxiliary driving means automatically becomes effective to drive said shaft and the first clutch is disconnected when the speed of the main driving means drops below a value sufficing to operate the shaft within said range.

2. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, means whereby when said device is driven by the main driving means it operates at controlled speed substantially independent of the speed of the main driving means while the main driving means is operating within a predetermined speed range, auxiliary driving means, and means whereby the auxiliary driving means is effective to drive said device at said controlled speed when the speed of the main driving means drops below said range.

3. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, means whereby when said device is driven by the main driving means it operates at controlled speed substantially independent of the speed of the main driving means while the main driving means is operating within a predetermined speed range, auxiliary driving means, and means whereby the auxiliary driving means automatically becomes effective to drive said device at said controlled speed when the speed of the main driving means drops below said range.

4. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, means whereby when said device is driven by the main driving means it operates at controlled speed substantially independent of the speed of the main driving means while the main driving means is operating within a predetermined speed range, auxiliary driving means, means whereby the auxiliary driving means automatically becomes effective to drive said device at said controlled speed when the speed of the main driving means drops below said range, and means whereby the main driving means again becomes automatically effective to drive said device as before when it is again operating within said range.

5. In combination, main driving means arranged to operate at varying speeds, a device arranged to be normally driven by said main driving means, an intermediate means between the main driving means and said device through which such normal driving is effected, auxiliary driving means, governing means controlling the connection between the intermediate means and said device whereby during operation of the main driving means within a predetermined speed range the device operates at controlled speed substantially independent of the speed of the main driving means, and means whereby the auxiliary driving means automatically becomes effective to drive the intermediate means and the main driving means becomes ineffective to drive the intermediate means when the speed of the main driving means drops below said range.

6. In combination, main driving means arranged to operate at varying speeds, a device arranged to be normally driven by said main driving means, an intermediate means between the main driving means and said device through which such normal driving is effected, auxiliary driving means, governing means controlling the connection between the intermediate means and said device whereby during operation of the main driving means within a predetermined speed range the device operates at controlled speed substantially independent of the speed of the main driving means, means whereby the auxiliary driving means automatically becomes effective to drive the intermediate means and the main driving means becomes ineffective to drive the intermediate means when the speed of the main driving means drops below said range, and means whereby the main driving means again becomes effective to drive said device as before when it is again operating within said range.

7. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, a variable slip clutch between said main driving means and said device, governing means for controlling the slip of the clutch whereby the speed of operation of the device is substantially independent of the main driving means while the main driving means is operating within a predetermined speed range, the lower limit of such range corresponding approximately to a minimum possible slip of said clutch to impart proper speed of operation to said device, auxiliary driving means, and means whereby the auxiliary driving means is effective to drive said device at desired speed of operation through said clutch when the speed of the main driving means drops below said range.

8. In combination, main driving means ar-

anged to operate at varying speeds, a device arranged to be driven by said main driving means, a variable slip clutch between said main driving means and said device, governing means for controlling the slip of the clutch whereby the speed of operation of the device is substantially independent of the main driving means while the main driving means is operating within a predetermined speed range, auxiliary driving means, and means whereby the auxiliary driving means is effective to drive said device at desired speed of operation through said clutch when the speed of the main driving means drops below said range.

9. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said driving means, a variable slip clutch between said main driving means and said device, governing means for controlling the slip of the clutch whereby the speed of operation of the device is substantially independent of the main driving means while the main driving means is operating within a predetermined speed range, auxiliary driving means, means whereby the auxiliary driving means is effective to drive said device at desired speed of operation through said clutch when the speed of the main driving means drops below said range, and means whereby the main driving means again becomes automatically effective to drive said device as before when it is again operating within said range.

10. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, auxiliary driving means, governing means for the auxiliary driving means arranged to insure at least a predetermined minimum speed of said auxiliary driving means, the governing means being adjustable to vary the value of such minimum speed, a clutch between the main driving means and said device, and means associated with said governing means whereby the clutch is disengaged and the auxiliary driving means is rendered effective to drive said device when the speed of the main driving means drops approximately to said minimum speed, and whereby, when the speed of the main driving means again rises, temporary adjustment of the governing means to raise the value of the minimum speed effects reengagement of the clutch.

11. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, auxiliary driving means, governing means for the auxiliary driving means arranged to insure at least a predetermined minimum speed of said auxiliary driving means, a clutch between the main driving means and said device, means whereby the clutch is disengaged and the auxiliary driving means is rendered effective to drive said device when the speed of the main driving means drops approximately to said minimum speed, and means whereby, when the speed of the main driving means again rises, the clutch may be reengaged by temporarily increasing the speed of the auxiliary driving means.

12. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, auxiliary driving means permanently connected to said device and arranged to be driven with the device by the main driving means when the latter is operating within a predetermined speed range, a clutch between the main

driving means and said device, means whereby the auxiliary driving means is rendered effective to drive said device when the speed of the main driving means drops to the lower limit of said range, and means permanently connected to the auxiliary driving means effective to disengage the clutch when the auxiliary driving means operates at a speed less than that corresponding to the minimum of said predetermined speed range and to effect reengagement of said clutch when the auxiliary driving means operates at a higher speed.

13. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, auxiliary driving means, means whereby the auxiliary driving means is rendered effective to drive said device when the speed of the main driving means abnormally decreases and the

main driving means is at the same time disconnected from the device, and means operated by increase of speed of the auxiliary driving means to reconnect the main driving means with the device.

14. In combination, main driving means arranged to operate at varying speeds, a device arranged to be driven by said main driving means, auxiliary driving means, means whereby the auxiliary driving means is rendered effective to drive said device when the speed of the main driving means abnormally decreases and the main driving means is at the same time disconnected from the device, and means operated either by increase of speed of the main driving means or by increase of speed of the auxiliary driving means to reconnect the main driving means with the device.

ARVID PETERSON.