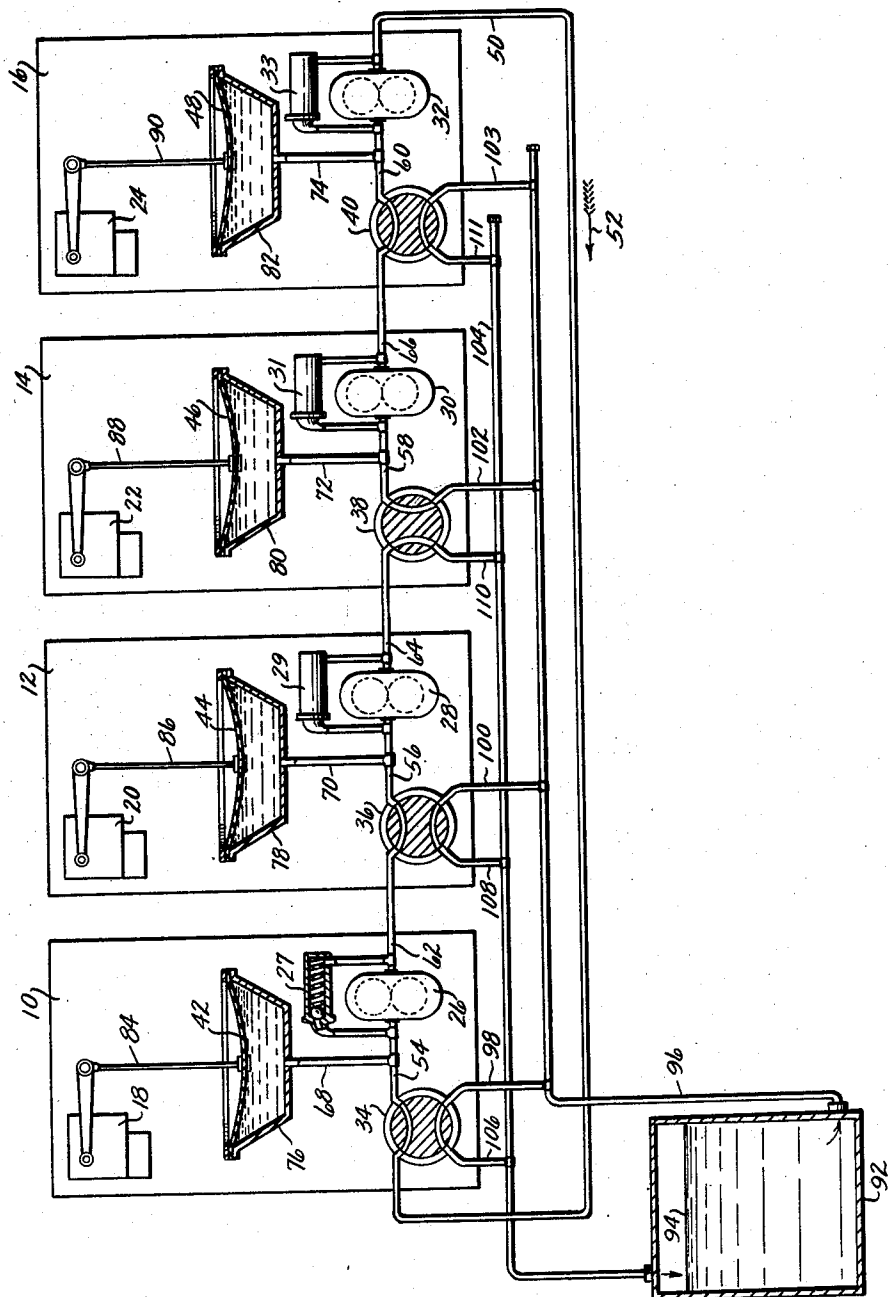


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J. A. SPANOGLE
MULTIPLE-UNIT SPEED CONTROL

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INVENTOR
JOHN A. SPANOGLE
BY *Joseph E. Hazel*
Charles R. Smith ATTORNEYS

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MULTIPLE-UNIT SPEED CONTROL

John A. Spanogle, Dayton, Ohio

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a multiple unit speed control and is especially useful for synchronizing the speeds of several mechanically disconnected power units, as for instance, by individual regulation of the several rheostats or other controls of a series of electric motors, or by individual throttling of the several carbureters of a series of internal combustion power units, or by individually changing the pitch of the several propellers of a multi-engined aircraft.

Broadly, the object of the invention is to provide a device of this character which is more simple in construction and therefore less costly and more reliable than devices of a similar nature now in use.

More specifically, an object of the invention is to provide each power unit of the series with a fluid pump connected thereto for rotation therewith, all of the pumps being of the same output capacity when rotating at the same speed, and connecting the pumps in a closed series circuit, whereby the pressure difference between adjacent pumps in the circuit is a function of the speed difference between the power units driving those pumps, then providing the control means of each power unit with a pressure sensitive device, and employing the said pressure difference to actuate the pressure sensitive device of the control means of the off-speed power unit to bring it back to speed.

The invention may advantageously be applied to a system in which one of a series of power units is selected and adapted for manual control of its speed, and the remainder synchronized to that speed.

In the drawing, the single figure is a schematic illustration of a system in which any one out of four internal combustion engines may be selected as a master power unit, and the synchronizing mechanism is so designed that the remaining power units will maintain the same speed as the master unit selected whether or not that unit varies in speed.

Like numerals refer to like parts throughout the drawing.

In the drawing, which shows one form in which the invention may be practiced, four internal combustion engines 10, 12, 14 and 16 are respectively provided with carbureters 18, 20, 22 and 24, engine driven gear pumps 26, 28, 30 and 32, hav-

ing relief valves 27, 29, 31 and 33, selector valves 34, 36, 38 and 40, and carbureter operating diaphragms 42, 44, 46 and 48.

A relatively long discharge pipe 50 connects the discharge side of the pump 32 to the intake side of the valve 34, the fluid moving in the direction of the arrow 52. Shorter lengths of pipe 54, 56, 58 and 60 respectively connect the valve and the suction side of the pump of each power unit, while other short lengths 62, 64 and 66 connect discharge sides of the pumps of one unit to valves of the next. Branch pipes 68, 70, 72 and 74 extend from the pipes 54, 56, 58 and 60 respectively to the diaphragm casings 76, 78, 80 and 82. Rods 84, 86, 88, 90 attach the several diaphragms to the operating arms of the carbureters 18, 20, 22 and 24 respectively.

A tank 92 holds a reserve supply 94 of fluid. A suction manifold 96 connects the bottom of the tank to the selector valves. Branches 98, 100, 102 and 103 of the manifold 96 extend to the valves 34, 36, 38 and 40 respectively. A discharge manifold 104 extends from the valves to the top of the tank 92, branches 106, 108, 110 and 111 of this manifold extending to the valves 34, 36, 38 and 40 respectively.

The plugs of the valves may be turned through ninety degrees of rotation so that the ports of the plugs may be horizontal as shown in valves 34, 36 and 40 or vertical as shown in valve 38. The operation of the apparatus shown is as follows:

Any one of the four power units may be selected as the master and the other three will automatically maintain the master speed, changing with it through the normal range of speeds of which the power units are capable. In the drawing, the power unit 14 has been selected as the master unit. Selection is made by turning the valve plug of unit 14 with the ports of the plugs vertical leaving the other three valves with their plugs having the ports horizontal. No other adjustment is required to cause the units 10, 12 and 16 to maintain speeds synchronous with unit 14.

The suction line of the pump 30 extends from the bottom of the tank 92 through members 86, 102, 38 and 58. Its discharge line is through members 66, 40, 60, 32, 50, 34, 54, 26, 62, 36, 56, 28, 64, 38, 110 and 104 back to the tank 92. It will be noted that the pump 30 on the master power unit 14 pumps through all the other pumps in series. If, for instance, the power unit 10 should momentarily overspeed, its overspeeded pump 26 would not only draw the normal volume

fed to it by the pump 32, but would draw additionally from the casing 76 which would actuate the diaphragm 42 and operate the carbureter 18 to thereby bring the unit 10 back down to speed. Conversely if the unit 10 should under-speed, the pressure in casing 76 would rise and operate the diaphragm 42 and carbureter 18 to bring the unit back up to speed. Thus, if any unit pumps faster or slower than the reference unit 14, the rise or fall in pressure in their diaphragm casings will bring the offspeed units back to the speed of the reference unit. Any unit may be made the reference unit by turning the valve plug of that unit with the ports vertical and the remaining valve plugs with their ports horizontal. All units will then maintain a speed synchronous with that of the reference unit selected. This is considered one of the valuable features of the invention, being particularly valuable when synchronizing multi-engined aircraft, for, should the engine 14, which had been selected as a reference unit become defective and require repairing in flight, any other engine could be selected as a reference unit by merely turning its selector valve with the plug ports from horizontal to vertical, and turning the plug ports of the selector valve 38 on the defective engine 14 from the vertical to the horizontal position. The relief valve 31 would then pass fluid around the pump 30 while the engine 14 was being repaired.

It will of course be understood that by varying the capacity of the several pumps and appropriately adjusting the several carbureters, a different normal speed may be selected and maintained in each power unit, all differing from each other and from the reference unit selected.

Having described my invention, I claim:

1. In an apparatus which includes two or more power units, a control means for synchronizing any or all of the power units with any selected one of said power units, said control means comprising, for each power unit, a fluid pump driven by said power unit, a suction conduit and a discharge conduit for each pump, a speed regulating device associated with said power unit, a speed sensitive device connected to the inlet side

of the pump and adapted by variation in pressure to operate said speed regulating device, and a selector valve for connecting the suction conduit of one pump to the discharge conduit of the pump next preceding, a fluid tank common to all power units, a suction manifold and a discharge manifold each having branches extending to the selector valves, and means included in each selector valve operative to one position to connect the suction and discharge conduits of succeeding pumps together and a branch of the suction manifold to a branch of the discharge manifold, and operative to another position to connect the suction conduit of one pump to a branch of the suction manifold, and the discharge conduit of the next preceding pump to a branch of the discharge manifold.

2. For use in connection with a plurality of prime movers, control apparatus comprising means for manually selecting any one of the prime movers as a master, and means for automatically maintaining the remaining prime movers at the speed of the selected master, said control apparatus comprising, a fluid supply reservoir common to all prime movers and having a supply and a return opening, a fluid pump for each prime mover driven by said prime mover and having a suction side and a discharge side, a speed control device for each prime mover, a fluid pressure sensitive device for each prime mover connected to the suction side of the pump of said prime mover and adapted upon variation in pressure in said suction side to actuate said speed control device, and selector valves, one for each prime mover, each having two passageways and each operable to two positions, and conduit means associated with said valves adapted in one position of a valve to connect the suction side of a pump to the discharge side of the pump next preceding and the supply and return opening together, and operative in the other position of the valve to connect the suction side of its pump to the supply opening of the reservoir and the discharge side of the pump next preceding to the return opening of the reservoir.

JOHN A. SPANOGLE.