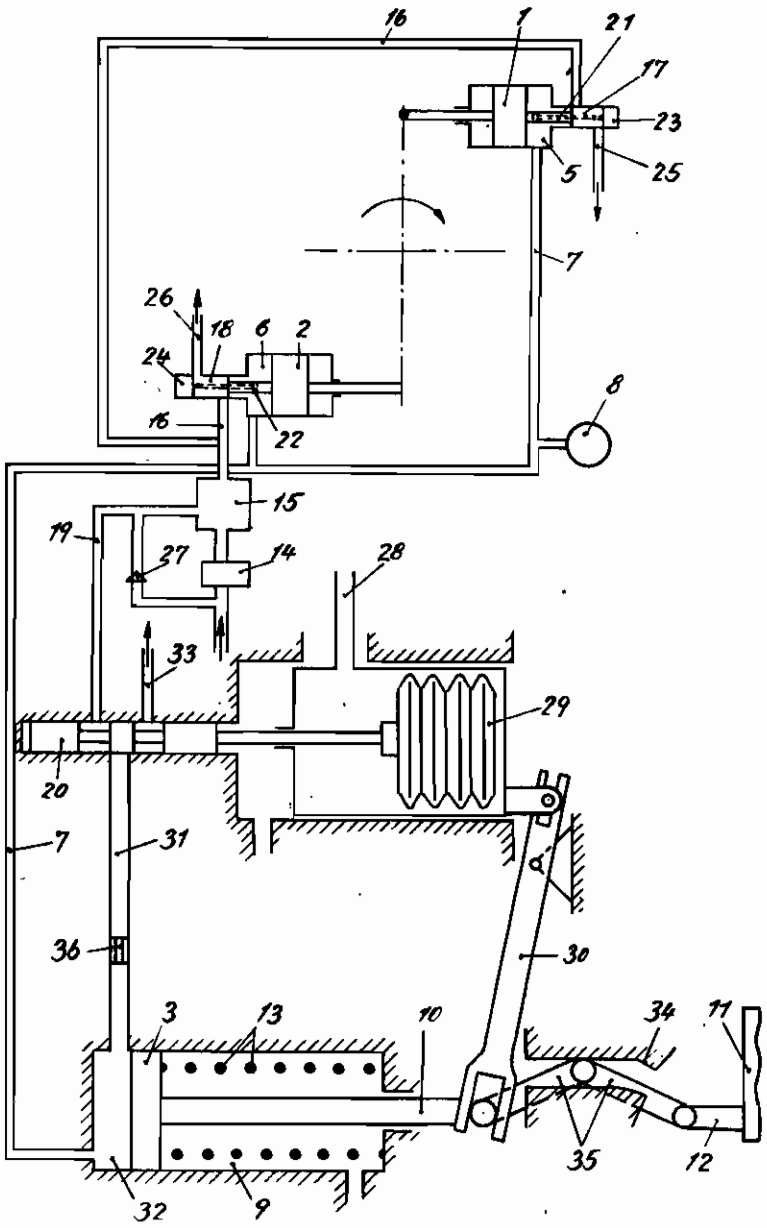
PUBLISHED
MAY 11, 1943.
BY A. P. C.

J. BIECHL
FUEL METERING DEVICES FOR INTERNAL COMBUSTION ENGINES
Filed Aug. 8, 1939

Serial No.
288,980



Inventor
Jos. Biechl

Published May 11, 1943

Serial No. 288,980

ALIEN PROPERTY CUSTODIAN

FUEL METERING DEVICES FOR INTERNAL COMBUSTION ENGINES

Josef Biechl, Munich, Germany; vested in the Alien Property Custodian

Application filed August 8, 1939

This invention relates to a method for determining the output of aircraft engines during flight. Hitherto this has been effected by using devices designed to take up the reaction of the torque delivered by the engine by means of a piston subjected to oil pressure which then can be measured with instruments exposed to this oil pressure. Thus the output can be ascertained with the help of the speed of the engine prevailing at every time.

This invention now proposes to utilize with this method the oil pressure being in dependent relation to the general torque in order to control the fuel supply for each working stroke by influencing through an appropriate regulating device the delivery quantity of the injection pump, in which case in the known manner the engine speed prevailing at every time will determine the quantity of fuel delivered in consequence of the driving connection between engine and injection pump. A further form of construction of the invention provides for the regulation the utilization of the influence of the condition of the precompressed air delivered from a blower. The regulation according to the invention will be effected in such a way that firstly, as usual, corresponding to the air passage through the engine, which depends upon the engine speed, the fuel will be delivered by the pump automatically in accordance with this engine speed. If for instance the output varies for the same engine speed, the variation of the torque thus involved will cause a different pressure in the pressure gauge system. Considering that the pressure according to the invention thus obtained influences through a piston the delivery quantity of the injection pump, the fuel supply is in direct proportion to the torque delivered by the engine. This arrangement will eliminate in contrast to all others hitherto known every possibility of errors, as the regulation is effected directly in dependence on the value which alone is determining the load to which the engine is subjected that is to say the effectively delivered torque.

As this method of regulation involves the possibility that the variation of the fuel supply is effected with a certain delay, the invention as a modification an additional adjustment consisting in that the pressure prevailing in the charging pipe actuates by means of a control device the adjusting piston which latter is directly influenced in dependence of the torque. The regulation process regarded as a whole will take place in such a way that for instance when adjusting the output throttle in order to obtain a high output this will immediately be followed by an increase of pressure in the charging pipe which, according to the invention, is utilized to influence with the assistance of a servomotor the same piston which is directly impinged by the oil pressure in dependence of the torque and actuates the adjustment rod of the injection pump. Thus the engine delivers a torque which is increased in accordance with the variation of the throttle valve position, which in turn brings about a variation in the pressure gauge system, effecting its influence directly on the adjusting piston, which controls the fuel delivery exactly according to the delivered torque. From the fact that the pressure of the measuring system without the intermittence of any control devices acts unrestrainedly upon the adjusting piston, which as counterforce is placed under spring pressure all influences that possibly could lead to errors in regulation will be eliminated from the beginning.

It must further be pointed out as a matter of importance in the regulating process according to the invention that the direct influence exerted on the adjusting piston in dependence on the delivered torque also correctly considers the air passage through the engine which increases inversely proportional with the exhaust back pressure and directly proportional with the height of flight and the increased fuel supply implied therewith, since the output and the torque serving as regulating value correspondingly increases. For this reason there is no necessity to arrange the additional devices as usual hitherto which in dependence upon the condition of the outer air took account of this circumstance. This simplified arrangement involves a further advantage that the invention secures an exact regulating effect as could not be obtained hitherto in regulating according to the condition of the outer air.

As already mentioned in the premise the realization according to the invention depends upon the measuring of the torque delivered by the engine with the assistance of an appropriate device. The invention provides for this purpose a pressure gauge system the construction and cooperation of which with regulating device according to the invention will be described in the following with reference to the accompanying drawing.

In the example of construction oil is used as pressure fluid, which might as well as be replaced by any other medium. Furthermore the regulation is effected under the additional influence of the charging pressure though, as mentioned in the premise, there is a possibility of regulation

only in direct dependence on the pressure being in dependent relation to the torque, taking into the bargain a certain lag.

The pressure gauge system for taking up and measuring the torque delivered by the engine consists in a known manner of two pistons 1 and 2 which take up the torque transmitted through lever arms, the back pressure will be taken up by the pressure fluid acting upon the pistons. This causes beyond the piston an oil pressure which is in dependent relation to the torque of the engine. Both the cylinder spaces 5 and 6 taking up the back pressure are connected with each other by a pipe conduit 7 in which the measuring instrument 8 for the torque is inserted and which is besides in communication with the cylinder 9 containing the adjusting piston.

The adjusting piston 3 actuates with its connecting rod 18 the rod 12 adjusting the delivery quantity of the fuel injection pump 11 and responses directly to the torque, which is in dependent relation to the oil pressure admitted through the conduit 7. The counterpressure working on the piston 3 is represented by the spring 13. In order to efficiently prevent the possibility of an undesired lag in regulation the air condition prevailing beyond the blower may be considered for this purpose. The charging pressure likewise influences the adjusting piston 3 through the medium of a servomotor.

For carrying out the servomotor effect in dependence upon the charging pressure implies the existence of a medium of constant pressure, for instance oil in contrast to the pressure in the conduit 7 varying dependently on the torque delivered at every time. To obtain this constant pressure the invention provides a pump 14 which delivers into an equalizing tank from which on the one hand through conduits 17 the pressure oil is led into the cylinder spaces 5 and 6 in which the pressure is adjustable in correspondence with the torque by controlling the inlet and outlet bores by control pistons 17 and 18 operatively connected to the pistons 1 and 2. On the other hand a constant pressure is obtained through the conduit 19 in the piston valve 20. The pressure in the equalizing tank 15 is given such a value by a relief valve 27 that it is above the maximum pressure prevailing in the spaces of the measuring cylinder.

The control pistons 17 and 18 connected with the pistons 1 and 2 taking up the torque work in such a manner that for instance an increase of torque will cause the pressure pistons 1 and 2 to be displaced outwardly. Thus the inner edges of the control pistons 17 and 18 will release the inlet openings from the pressure conduit 16 as long as the pressure is again equalized. The pressure prevailing in the spaces 5 and 6 and consequently in the conduit 7 is higher than before. Furthermore the cylinder spaces 5 and 6 are connected through bores 21 and 22 with the spaces 23 and 24 beyond the control piston 17 and 18 so that the same pressure is prevailing in the spaces 5 and 23 resp. 6 and 24. If for instance the torque diminishes the pistons 1 and 2 are moved inwardly and at the same time the outlet bores 25 and 26 are released from the outer edges of the control pistons 17 and 18 as long as again the same pressure—in this case lower than before—is obtained in the spaces 5 and 23 resp. 6 and 24 to compensate the pressure exerted from the torque.

The charging pressure influencing indirectly the regulating effect actuates through a conduit 28 upon a barometric capsule 29 which in its initial position can be displaced by means of a balance arm 30 to the other end of which the connecting rod 10 of the adjusting piston 3 is pivoted. The piston valve 20 is moved by the barometric capsule 29 in such a manner that with a diminishing charging pressure—corresponding to an expansion of the capsule—the piston valve is moved outwardly which permits the oil to leave the space 32 through the connection pipe 31 between the piston valve 20 and the cylinder space 32 in front of the adjusting piston and through the discharging pipe 33. With increasing charging pressure the piston valve 20 is moved inwardly thus providing a connection between the constant pressure pipe 19 and the conduit 31 leading to the regulating pressure space 32.

The invention will operate as follows: If for instance in consequence of an adjustment for higher output the charging pressure increases thus causing the piston valve 20 to permit the constant pressure contained in the conduit 19 to influence through the conduit 31 the adjusting piston 3 as long as the latter has been displaced under the pressure of the spring 13 so far that the balance arm 30 in consequence of the variation of the initial adjustment of the barometric capsule 29 will bring the piston valve 20 again into its neutral position. The displacement of the adjusting piston 3 against the spring pressure effects by the rod 12 an increased delivery of the injection pump 11. This will have as a further consequence the desired increased torque and an increasing pressure in conduit 7 so that the position of the adjusting piston 3 preliminarily adjusted by the variation of the charging pressure corrects exactly corresponding to the effective torque delivered by the engine that is to say the fuel supply to the engine is in correct relation to the real requirements. In other words the fuel supply which is primarily regulated indirectly according to the charging pressure will be adjusted directly according to the only competent value for the correct metering which means a regulation free of errors. This regulation is rendered possible by the fact as, according to the invention, the adjusting piston 3 is influenced as well by the charging pressure as by the torque.

A diminishing output will ensue a decrease of the charging pressure thus causing the piston valve 20 to release the way out from the intermediate pipe 31 into the discharging pipe. This will have the consequence that the adjusting piston 3 will be displaced under the pressure of the spring 13 to produce a diminished fuel supply. The movement of the adjusting piston 3 continues as long as after taking into consideration the piston of the balance arm 30 the initial position of the barometric capsule 29 corresponds to the neutral position of the piston valve 20. The diminished pressure in the conduit 7 caused by the decrease in torque acts directly upon the adjusting piston 3 which controls the preliminary adjustment exactly corresponding to the real fuel requirements for the torque effectively delivered by the engine.

In order to make the relation of the movements of the piston rod 10 and the rod 12 capable of being influenced, the invention provides between the connecting rod 10 of the adjusting piston 3 and the rod 12 adjusting the delivery quantity 11 a toggle lever 35 guided in a link 34.

A nozzle 36 is provided in the connection pipe

31 between the piston valve 20 and the regulating pressure space 32, the dimensions of which must be so as to obtain the necessary adjustment of the regulating rods notwithstanding a departure from the usual relation between charging pressure and torque. If for instance the charging pressure decreases compared with the torque this means that the piston valve 20 releases the outlet bore for the conduit 31 so that a pressure in the space 32 corresponding the high torque can expand and possibly take this way, without moving however the adjusting piston 3 against the spring pressure as would be necessary. By the arrangement according to the invention and an appropriate choice of the nozzles 36 this possible drawback is efficiently avoided, as in the case described the expansion of the pressure corresponding the torque is retarded or partly prevented owing to the existence of the nozzle 6.

Resuming it may be pointed out once more that by proceeding according to the regulating process being the object of the invention that an adjustment of the fuel supply in accordance with the only competent value that is to say the torque delivered by the engine, is effected in a way that eliminates every sort of errors thus representing a regulation as could not be obtained with anyone of the regulating devices known hitherto if it were for fundamental reasons. A further advantage will be that the device according to the invention can operate for carrying out this process without servomotor devices owing to the direct influence exerted on the adjusting piston by the pressure corresponding the torque as the forces produced are great enough to effect all regulating operations. This involves besides exactness—since all sources of errors are eliminated—a robust construction, which is especially desired a far reaching insensibility to oscillations is obtained therewith. Precisely the high sensibility of the regulating devices known hitherto to external influences and particularly to oscillations so that the invention represents a remarkable progress also in this respect. In conclusion attention is called to the fact that with the regulation according to the invention the additional regulation for taking into account the decreasing pressure of the outer air with increasing height of flight which was indispensable up to now in every case can be suppressed. Nevertheless this value is given a more correct consideration for the fuel supply than would be possible with all regulating devices known up to now, which means a further important simplification.

JOSEF BIECHL.