

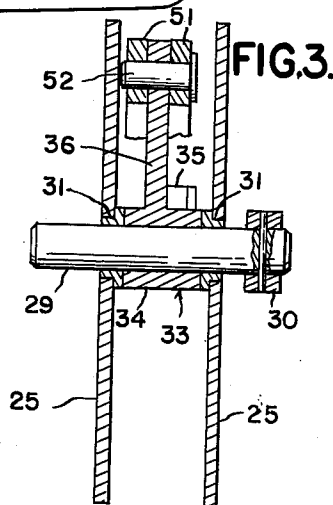
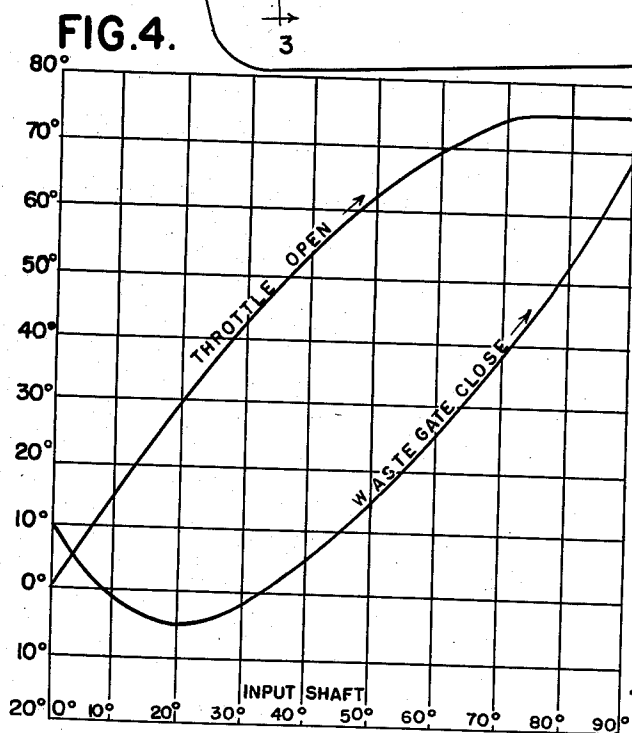
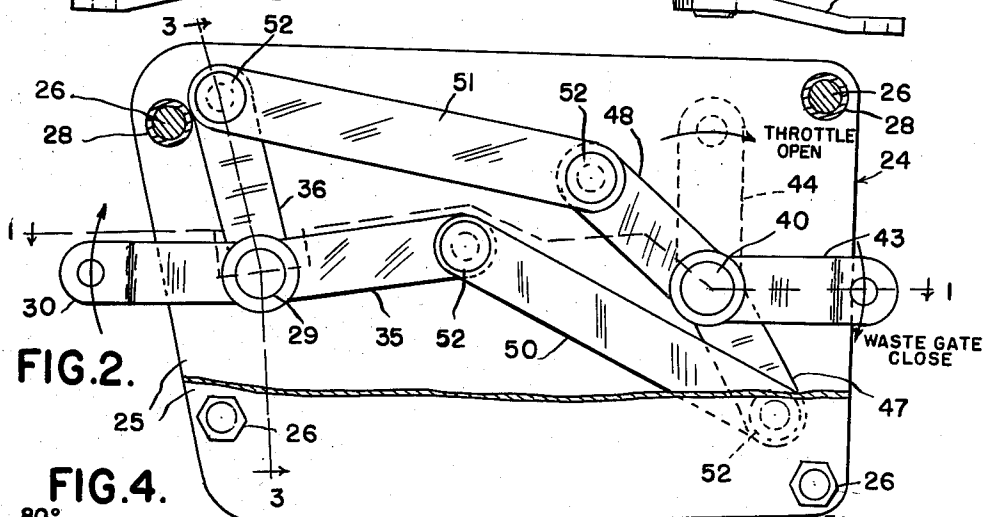
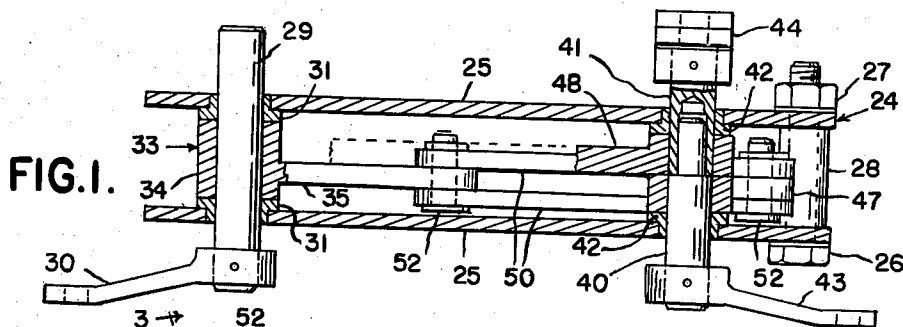
June 25, 1963

R. J. POWELL ETAL
ENGINE CONTROLS

3,094,836

Filed Feb. 20, 1961

2 Sheets-Sheet 1



INVENTORS
ROBERT J. POWELL
BY JAMES E. CHAMPION

Hauke & Hauke
ATTORNEYS

June 25, 1963

R. J. POWELL ETAL
ENGINE CONTROLS

3,094,836

Filed Feb. 20, 1961

2 Sheets-Sheet 2

FIG. 5.

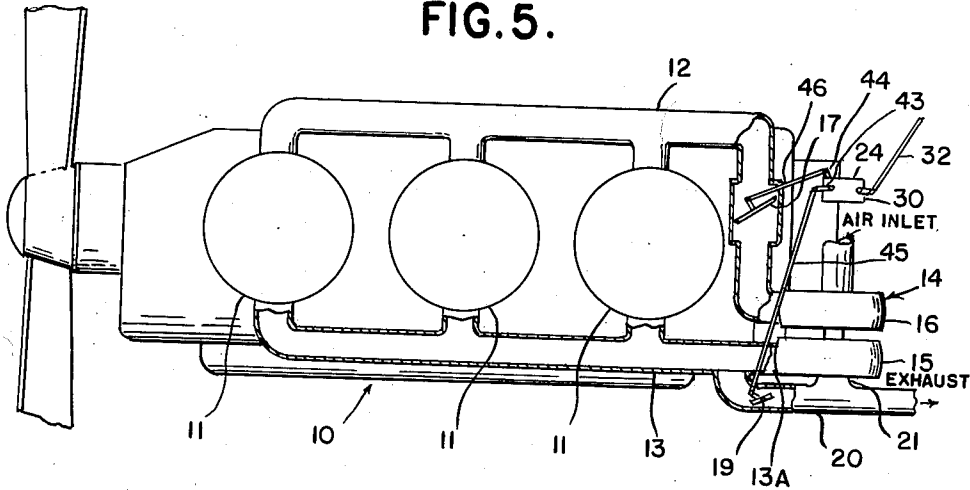
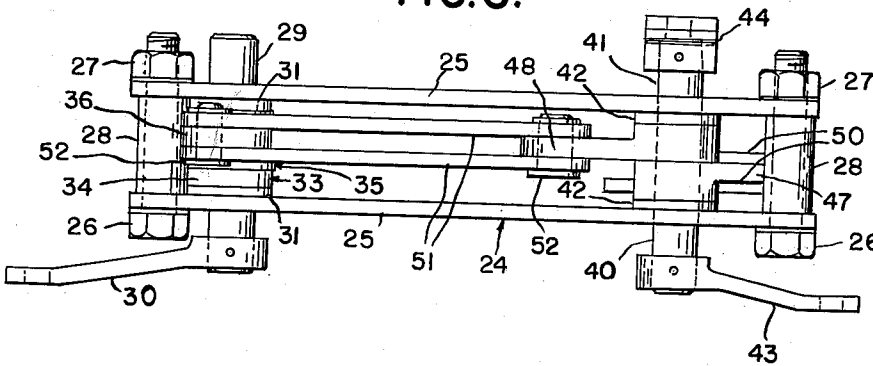


FIG. 6.



INVENTORS
ROBERT J. POWELL
BY JAMES E. CHAMPION
James E. Champion
ATTORNEYS

1

3,094,836

ENGINE CONTROLS

Robert J. Powell and James E. Champion, Muskegon, Mich., assignors to Continental Motors Corporation, Muskegon, Mich., a corporation of Virginia
Filed Feb. 20, 1961, Ser. No. 90,315
6 Claims. (Cl. 60—13)

Our invention relates to supercharged internal combustion engine control systems and more particularly to a means for coordinating a supercharger with throttle valve operation.

In internal combustion engines provided with exhaust driven turbine operated superchargers, it is apparent that the degree of turbo-supercharger air pressure depends on exhaust back pressure. A waste gate is generally provided to open and close the exhaust duct for varying turbo-supercharger speed.

Another factor in the operation of internal combustion engines that we have made use of in the present invention is that actuation of the air throttle valve toward the open position generally produces up to about 90% of the total engine power increase available through throttle control during about the first half of throttle motion. Further actuation produces relatively little change in power.

Heretofore turbo-superchargers either were made to operate continually during all engine ranges, or were arranged for manual cut-in, or rather complex control systems were used to achieve required power by varying the output of the supercharger as engine requirements dictate.

In the development of simplified control systems and engines, we have attempted to produce overall efficiency of engine operation without any sacrifice of simplicity or increase in manufacturing costs and maintenance.

An object of the present invention is to make use of the turbo-supercharger only during high power operation by directly coordinating the operations of the throttle and waste gate.

Another object of the invention is to improve efficiency of engine operation by providing a means for energizing the turbo-supercharger only during that range of throttle operation which produces little increase in engine power.

Other objects and advantages of the invention will become apparent in the following description, and reference may be had to the accompanying drawings in which like reference characters refer to like parts throughout the several views and in which:

FIG. 1 is a longitudinal cross-sectional view of a preferred mechanical coordinator control device taken substantially on the line 1—1 of FIG. 2.

FIG. 2 is a side view of the preferred coordinator.

FIG. 3 is a cross-sectional view taken substantially on the line 3—3 of FIG. 2.

FIG. 4 is a diagram illustrating one type of relationship available with the coordinator.

FIG. 5 is a diagrammatic view of a preferred engine utilizing the present coordinator.

FIG. 6 is a top view of the coordinator shown in FIG. 2.

Referring to FIG. 5, a preferred aircraft engine 10, shown diagrammatically, for which the present control system is applicable, has cylinders 11, an air intake manifold 12, and an exhaust manifold 13. A turbo-supercharger 14 is provided in which exhaust gas selectively directed through a branch duct 13A of the exhaust manifold 13 drives a turbine 15 which is drivingly connected to a supercharger 16 which, relative to the driving input, delivers compressed air to the air intake manifold 12. A throttle valve 17 is provided in the manifold 12.

Operation of the turbo-supercharger 14 is controlled

2

by means of a waste gate 19 provided in the exhaust outlet 20 which bypasses the turbine 15 and is connected with the outlet 21 of the turbine 15. With the waste gate 19 open, no exhaust pressure is available to run the turbine and hence no supercharging occurs. As the waste gate 19 is closed, exhaust back pressure builds and energizes the turbine 15 to operate the supercharger 16.

It will be apparent that degree of supercharging is directly related to the position of the waste gate 19. For all practical purposes, the waste gate 19 has little or no operative effect until it is about half closed, then back pressure builds up rapidly until maximum energy is directed to the turbine and full supercharging occurs when the waste gate is completely closed.

Since supercharging is used to increase power output of the engine, it is not really required as long as reserve power is still available with throttle operation. Generally, the first half of throttle travel can provide about 90% of unsupercharged engine power, and further opening is for all practical purposes just so much lost motion.

We have therefore conceived the idea of so coordinating waste gate and throttle operation that as effectiveness of the throttle decreases after half-throttle position, the effectiveness of the waste gate increases.

A practical, simplified approach to coordinating waste gate and throttle operation is the mechanical coordinator device 24, illustrated in FIGS. 1-3 and 5. In this arrangement, a pair of support plates 25 are mounted and spaced apart by any means such as bolts 26, nuts 27 and spacers 28. An input shaft 29 is rotatably carried by bearings 31 mounted in the plates 25, preferably extending therethrough as shown in FIGS. 1, 3 and 5, and provided with an end lever 30.

A control rod 32 or the like is connected to the lever 30 as in FIG. 5 and extends to the pilot's compartment (not shown).

A lever assembly 33 having a hub 34 and a pair of arms 35 and 36, is secured to the input shaft 29 and rotates therewith.

A pair of coaxially connected output shafts 40 and 41 are separately rotatably carried by bearings 42 mounted in the plates 25 and extend oppositely through the plates 25 as shown in FIGS. 1 and 6. The output shafts carry end levers 43 and 44 respectively connected by control rods 45 and 46 or the like to, respectively, the waste gate 19 and the throttle valve 17, as shown in FIG. 5.

A pair of arms 47 and 48 are secured respectively to the output shafts 40 and 41. The ends of a pair of links 50 are connected by any means such as pins 52 to the arms 35 and 47. The ends of another pair of links 51 are similarly connected to the ends of the arms 36 and 48.

It will be seen that rotation of the input shaft 29 will produce different rotations of the output shafts 40 and 41 depending on the angular relationships of the input lever arms 35 and 36, and the lengths of the links 50 and 51. Thus, pilot operation of the input shaft lever 30 can produce whatever operation of the output shaft levers, and consequently the waste gate and throttle, that may be desired to effect a predetermined coordination.

In the configuration shown, it will be seen that as the input shaft lever 30 is moved clockwise in the direction shown by the arrow in FIG. 2, the lever assembly arm 36 will rotate clockwise, rotating the output shaft arm 48 and hence the lever 44 clockwise also, opening the throttle which is connected to the lever 44. Operation is fairly close to a one-to-one ratio particularly in the lower and mid-range. It will be apparent that the angular relationships of the lever arms 36 and 48 and the length and position of the links 51 may be altered as needed to provide any desired operation.

Also, as the input shaft lever 30 is moved clockwise, the lever assembly arm 35, output shaft arm 47, and

3

hence the lever 43 will rotate clockwise, closing the waste gate which is connected to the lever 43. The initial motion of the arm 30 will have little effect, due to the over-center positioning of the links 50 in the relative angular relationship of the arms 35 and 47 with each other and with the arms 36 and 48 respectively. Waste gate closing can thus be delayed as desired to effect supercharger operation only after the throttle valve is about 50% open, yet only one control need be moved by the pilot. In fact, any desired relationship between throttle and waste gate actuation may be achieved by varying the construction relationships of the various levers, arms and links of the coordinator, and by adjusting the relative angular relationships of the arms and levers.

It is thus possible to produce a relationship such as that indicated by the graph of FIG. 4. As will be seen, throttle closing occurs on a fairly straight slope as the input shaft rotates up to about 70°. Meanwhile, the waste gate will first move slightly overcenter (represented by degrees below 0°), and then begin to close at an increasing rate relative to the input shaft angular rotation.

When the throttle is about 50% open (about 40° on the graph), about 90% of unsupercharged power has been attained. At this stage, the input shaft has been rotated about 30°, so the waste gate hasn't quite started to close. Thereafter, further rotation of the input shaft, although continuing to open the throttle, will not alone provide for much increase of power thereby. However, the waste gate will then close at a fairly rapid rate relative to input shaft rotation, thereby producing an increasingly great supercharging effect.

In sum total, as the pilot operates his control from closed to open, a continuous increase of power is achieved. Yet, supercharging is automatically delayed until needed by virtue of coordination between throttle and waste gate.

Although we have described only one preferred embodiment of the invention, it will be apparent to one skilled in the art to which the invention pertains that various changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. In an internal combustion engine having air induction means provided with a throttle valve and an exhaust driven turbo-supercharger provided with a waste gate op-

4

erable to vary exhaust back pressure for varying turbo-charger pressure, a means for coordinating operation of said waste gate and said throttle valve, said means comprising,

- (a) a support,
- (b) an input shaft rotatably carried by said support,
- (c) a pair of output shafts rotatably carried by said support and having means for operably connecting said output shafts respectively with said throttle valve and said waste gate, and
- (d) separate linkage mechanisms connecting said output shafts with the input shafts and being operable to transmit rotative motion from the input shaft individually to each output shaft, whereby waste gate operation may be coordinated with the throttle valve operation throughout the throttle valve motion.

2. The coordinator as defined in claim 1 and in which said linkage mechanisms are separately adjustable with respect to said shafts to individually vary rotations of said output shafts with respect to rotation of said input shaft.

3. The coordinator as defined in claim 1 and in which said input shaft has two lever arms fixed thereto, in which said output shafts each has a lever arm fixed thereto, and separate link elements connecting the input shaft lever arms respectively with the lever arms of the output shafts.

4. The coordinator as defined in claim 1 and in which said support comprises a pair of parallel spaced side plates and in which said shafts are parallel with each other and extend through said side plates normal thereto, and operating levers secured to the ends of said shafts.

5. The coordinator as defined in claim 1 and in which said output shafts are axially aligned.

6. The coordinator as defined in claim 4 and in which said input shafts are axially aligned, abut each other intermediate said side plates, and extend oppositely through said side plates.

References Cited in the file of this patent

UNITED STATES PATENTS

1,571,143	Royer	Jan. 26, 1926
1,589,789	Daimler	June 22, 1926
2,562,742	Rowe et al.	July 31, 1951
2,731,792	Nallinger	Jan. 24, 1956
2,933,942	Boylan et al.	Apr. 26, 1960
2,933,943	Buddo et al.	Apr. 26, 1960