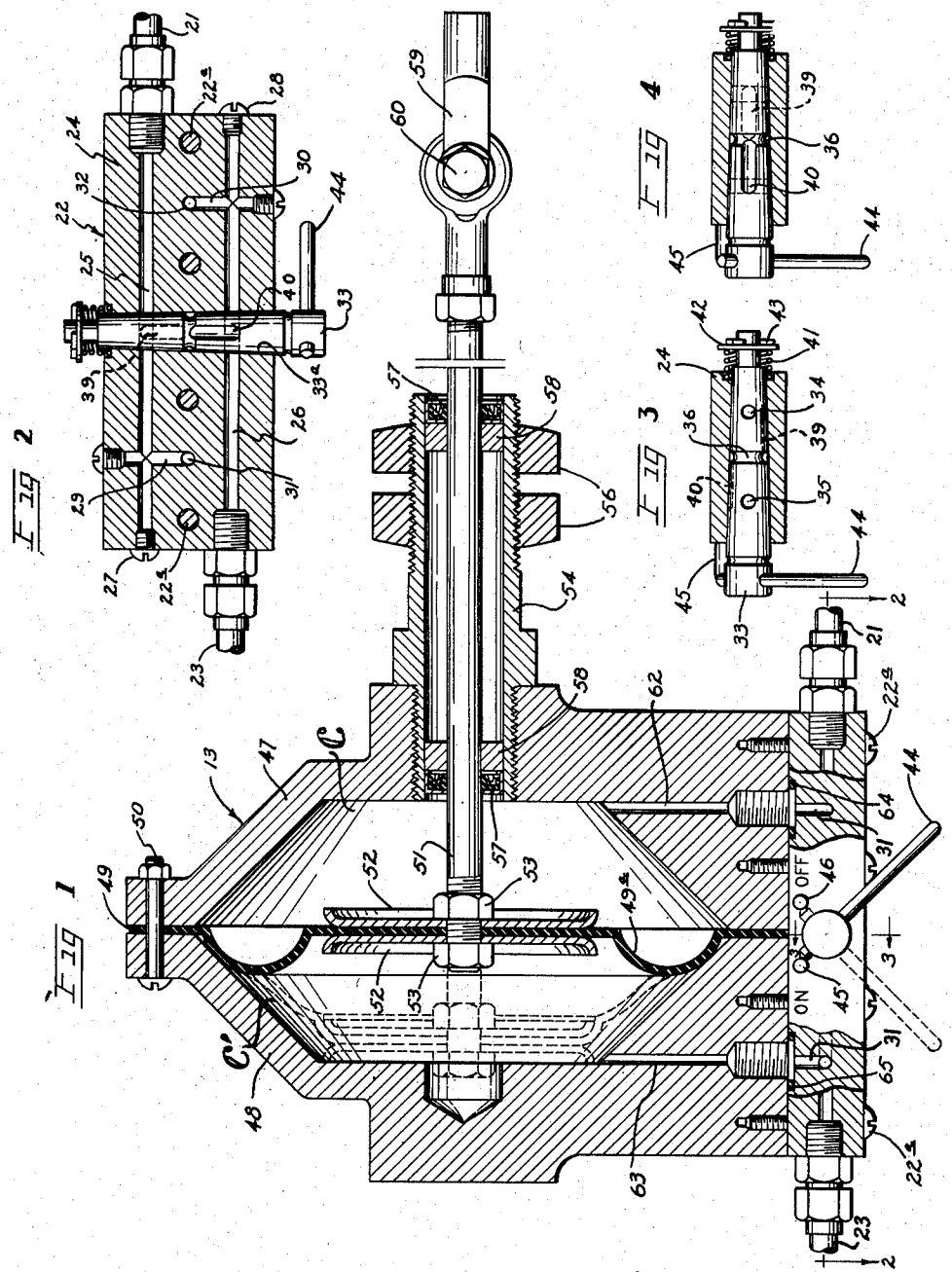
May 12, 1959 L. T. RADFORD 2,886,011

SYNCHRONIZING DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed July 13, 1953 2 Sheets-Sheet 1



Lawrence T. Radford
INVENTOR.

BY

Wayland D. Keith
HIS AGENT

May 12, 1959 L. T. RADFORD 2,886,011

SYNCHRONIZING DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed July 13, 1953 2 Sheets-Sheet 2

Fig 5

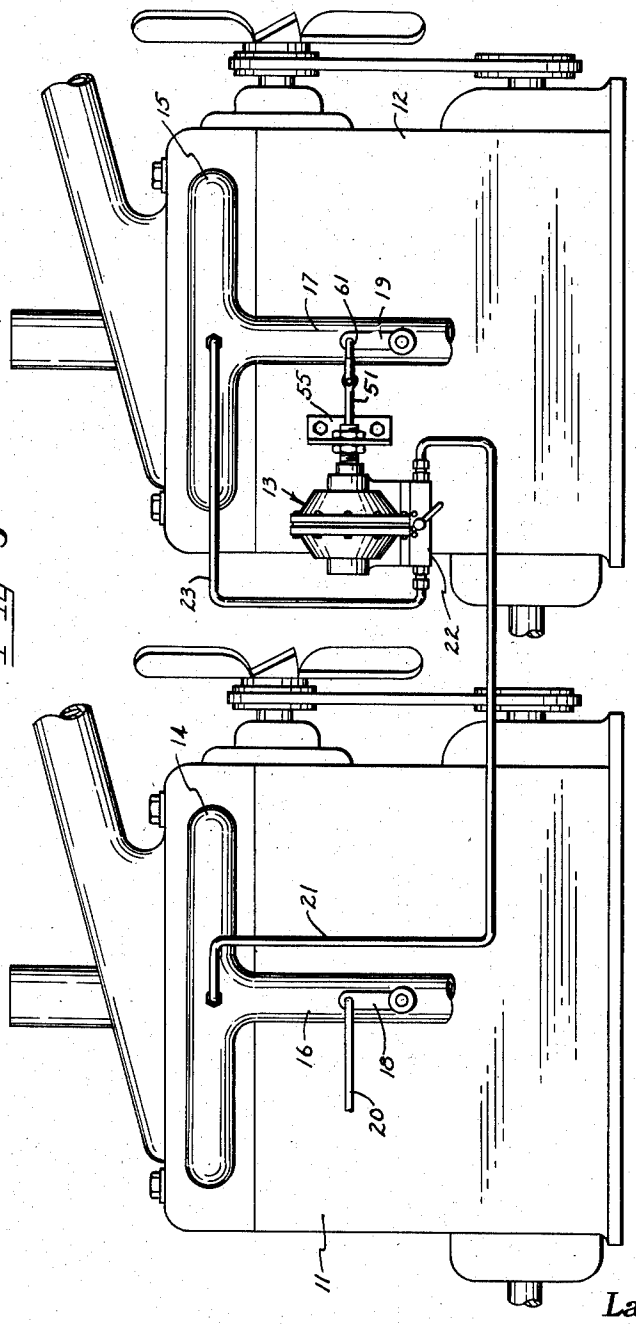
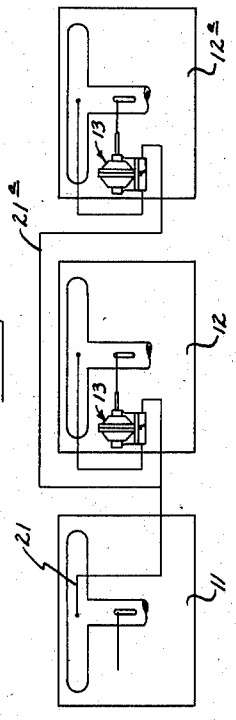


Fig 6



Lawrence T. Radford
INVENTOR.

BY

Wayland D. Keith
HIS AGENT

United States Patent Office 2,886,011 Patented May 12, 1959

2,886,011

SYNCHRONIZING DEVICE FOR INTERNAL COMBUSTION ENGINES

Lawrence T. Radford, Wichita Falls, Tex.

Application July 13, 1953, Serial No. 367,577

2 Claims. (Cl. 121—46.5)

This invention relates to improvements in synchronizing devices and more particularly to synchronizing devices wherein the vacuum in the manifolds of the auxiliary engines will balance with the vacuum in the manifold of a pilot engine.

The synchronization of engines by utilizing the vacuum of a manifold of a pilot engine to control apparatus to open and close carburetors in accordance with the vacuum of the first engine, is well known in the art, however various difficulties have been encountered with such arrangements, particularly when it is desirable to use the engines independently or to use one engine without using the other engine or engines.

Various valves have been proposed heretofore, for controlling the vacuum to an actuator member such as a diaphragm or piston but each of these required expert attention in order to be properly controlled, and frequently four to six valves had to be provided for opening and closing in a prearranged manner to control the respective engines.

In the present device, the auxiliary or drone engines are readily synchronized with the pilot engine, or a single valve may be turned in such manner as to release the engines individually from the pilot engine, with which they are synchronized.

An object of this invention is to provide a synchronizing device for two or more engines in which the output of two or more engines can be quickly and easily synchronized, or any one of the auxiliary engines may be released from the pilot engine.

Another object of this invention is to provide a vacuum controlled synchronizing device that may be installed to synchronize an auxiliary engine with a pilot engine, which synchronizing device may be readily controlled to synchronize the engines by the relation of the vacuum within the manifold of the pilot engine to that in the manifold of the auxiliary engine.

Another object of this invention is to provide a vacuum control for a plurality of engines that are connected together in driving relation so that the vacuum from the primary engine will regulate the speed of the secondary engines in synchronous relation.

A still further object of this invention is to provide a valve arrangement whereby a plurality of engines may be synchronized with a pilot engine, or each engine may be operated independently without one engine interfering with the operation of the other engines.

Yet another object of this invention is to provide an engine synchronizing device that functions with a minimum of parts, which is positive in operation and requires a minimum of maintenance.

An embodiment of this invention is illustrated in the accompanying drawings in which like reference characters designate like parts in the several views thereof, in which:

Fig. 1 is a longitudinal sectional view of the vacuum actuating device for synchronizing the engines, showing a dual three-way valve attached thereto, with parts

broken away and shown in elevation to show the details of construction;

Fig. 2 is a horizontal longitudinal sectional view taken on the line 2—2 of Fig. 1, looking in the direction indicated by the arrows;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1, looking in the direction indicated by the arrows;

Fig. 4 is a sectional view taken on the same line of Fig. 3, but with the valve stem moved into "off" position;

Fig. 5 is an elevational view of a pair of engines connected together in synchronized relation by means of the present device; and

Fig. 6 is a diagrammatic view of three engines connected together in synchronized relation by the utilization of the present device.

With more detailed reference to the drawing the numeral 11 designates the pilot engine and the numeral 12 a secondary or auxiliary engine that is maintained in synchronized relation by the diaphragm control unit generally designated by the numeral 13. Each of the engines 11 and 12 have manifolds 14 and 15 respectively to which pipes 16 and 17 connect, which pipes lead from a suitable source of fuel to the respective manifolds. Butterfly control valve levers 18 and 19 are mounted on the respective pipes 16 and 17 and control butterfly valves within the respective pipes in a manner well understood in the art of carburetion.

A rod 20 connects with the lever 18 and with a suitable throttle lever (not shown) so that the engine may be regulated so that the flow of gas to the manifold may be regulated.

A tubing 21 connects with the manifold 14 and is responsive to the suction within engine 11, which tubing also connects with an end of a valve generally designated by the numeral 22. A tubing 23 connects with the manifold 15 and with the opposite end of the valve 22. The body 24 of the valve 22 has longitudinal holes 25 and 26 drilled therethrough and to which the respective tubings 21 and 23, respectively, are connected. The holes 25 and 26 have the ends opposite to that to which the tubing connects plugged by screws 27 and 28 respectively. Transverse holes 29 and 30 intersect holes 25 and 26 respectively and further holes 31 and 32 are drilled vertically to intersect the respective transverse holes 29 and 30, as will best be seen in Figs. 1 and 2. The valve body 24 has a transverse tapered plug 33 therethrough fitted in fluid tight relation within tapered bore 33*a* of said body. The tapered plug 33 has passages 34 and 35 formed transversely therethrough that register with the respective holes 25 and 26 when said plug is in one position. The plug also has an annular groove 36 thereabout intermediate passages 34 and 35, which annular groove interconnects with longitudinal grooves 39 and 40 formed within the plug longitudinally thereof. The plug has a spring 41 surrounding the smaller end thereof and in contact relation with a side of said body 24 and with a washer 42 secured on the end of the plug by means of a pin 43, the spring always maintains the plug in tight fitting relation with the tapered bore 33*a*. The opposite end of the plug has a handle 44 thereon for manually turning the plug. A pair of pins 45 and 46 are positioned in close proximity to the outer end of the plug 33 and the handle 44 projects through the plug in such manner that the handle will form a limiting stop for the plug, so as to correctly position the plug either in "on" position when in contact relation with pin 45, and in "off" position when in contact relation with the pin 46. When the pin is in position as indicated in Figs. 1 and 2, that is, in "on" position, the holes 25 and 26 are aligned respectively with holes 34 and 35. However when in "off" position, the passages are closed with respect to fluid passing through the respective passages. The passages

25 and 26 are interconnected through passage 39 and annular groove 36 and passage 40 which serves a specific purpose as will be more fully described hereinafter.

When the handle 44 is positioned in a vertical position, neither holes 34—35 are aligned with passages 25—26, nor will the grooves 39—40 be in contact relation with passages 25—26, however the plug 33 will serve as a stop to close both the holes 25 and 26 which will prevent movement of fluid through the holes in either direction.

The housing of the diaphragm control unit 13 is composed of two halves 47 and 48, which are substantially identical in size and shape and represent the front and rear portions of said housing and have a diaphragm 49 therebetween that is held in secure relation by bolts 50 passing through the housings 47 and 48 and through the diaphragm 49 so as to form a fluid tight seal therearound. The diaphragm 49 is apertured near the center thereof and has a connecting rod 51 passing therethrough and through plates 52. The rod is threaded to receive nuts 53 on each side of the plates 52 so as to form a seal around the aperture formed in the diaphragm 49. The diaphragm 49 has an annular groove 49*a* formed therearound within the chamber formed by housings 47 and 48.

The connecting rod 51 extends outward through openings formed in the side of the housing 47 and passes into a threaded extension neck 54 which threadably engages the housing 47 and has a threaded end to engage a bracket 55. A pair of nuts 56 threadably engage neck 54 and the bracket 55, which nuts hold control unit 13 in adjusted position and in spaced relation with respect to lever 19.

The neck 54 is hollow and has a pair of packing seal elements 57 fitted therein near each end thereof so as to exclude air from entering chamber C in the diaphragm control unit 13. An oilless, sintered metal bearing 58 is positioned near each end of neck 54 so as to hold connecting rod 51 in central guided relation with respect thereto.

The outer end of connecting rod 51 has a clevis 59 connected thereto by means of a pin 60 so as to enable free arcuate movement of lever 19 that is connected thereto by rod 61.

The diaphragm 49 has sufficient travel so that the plates 52 will either seat on the forward side or the rearward side of the housings 47 and 48 respectively, as will best be seen in Fig. 1, so as to give full travel of lever 19. When the diaphragm is in the rearmost position, as shown in dashed outline, the connecting rod 51 will be retained in the rearmost position due to the distortion of the diaphragm which forms a toggle action to press the diaphragm rearward, if arranged in the position as shown in Fig. 1, however, by reversing the diaphragm so that the annular ridge 49*a* will protrude forward, the diaphragm may be retained in the forward position at the innermost end of the travel of the connecting rod 51.

The passages 62 and 63 extend upward from the base of housings 47 and 48 respectively and interconnect with passages 32 and 31 respectively so as to enable the vacuum to be exerted on each side of the diaphragm 49, as will best be seen in Fig. 1. Annular gaskets 64 and 65 are fitted within the recesses in the valve body 24 so as to form tight joints between the valve body 24 and the housings 27 and 28, thereby joining passages 32—62 and 31—63 in fluid tight relation.

Fig. 5 discloses the engine synchronizing device installed so as to be used in conjunction with two engines, however this is a representative installation, and if it is desired to install the device on more than two engines, as many additional engines as desired may be added, if connected substantially in the same manner and with the control line leading from the synchronizing device of the secondary or auxiliary engine or engines to a line that connects with the intake manifold of the pilot engine. A diagrammatic illustration is shown in Fig. 6 wherein the pilot engine is designated by the numeral 11 and the first secondary or drone engine is indicated by the numeral 12, and the second secondary engine is indicated at 12*a*. The engines 11 and 12 in Fig. 6, are arranged in substantially the same manner as the engines 11 and 12 in Fig. 5, however, engine 12*a* is adapted to have a line 21*a* leading to the line 21 that connects with the manifold of engine 11. In this manner, the same vacuum is applied to the vacuum control units 13 on each of the engines 12 and 12*a*. Therefore the engines will be synchronized to run in set relation with respect to engine 11 and the throttling of both the engines will react simultaneously to the throttling of engine 11.

Operation

In the operation of the device, the diaphragm control unit 13 is mounted on the auxiliary engine or engines, as indicated at 12 and 12*a* in Figs. 5 and 6, and the unit is adjustably spaced by nuts 56 threadably mounted on stem 54, which nuts bindingly engage a bracket 55. A tubing 21 of the pilot engine 11 leads from the manifold 14 thereof to an end of valve body 24 of the valve assembly, and the tubing 23 leads from the manifold of the engine 12 to the opposite end of the valve body and is connected thereto in fluid tight relation. With the valve in the "on" position, as shown in Figs. 1, 2, 3 and 5, the vacuum exerted in manifold 14 will be transmitted through tubing 21 through valve passage 25 to and through valve plug 33, passages 29, 31, and 63 into chamber C'. With the diaphragm in this position, the plate 52 is urged into engagement with the rear of the housing 48 by a toggle action exerted by the diaphragm 49, when the diaphragm approaches the extreme end of its travel, which insures the same manifold pressures being held in the "idle" or closed throttle position.

With reference to the arrangement as shown in Fig. 5, when both the engines 11 and 12 have been started and are ready to be synchronized, the valve handle 44 will be turned to the "on" position allowing equal manifold pressures on both sides of the diaphragm 49 which, when the engine is idling, that is, with the throttle in closed position, the diaphragm will be in the extreme rear position, as shown in dashed outline in Fig. 1.

When the pilot engine 11 is accelerated, an increased pressure on the side of diaphragm intermediate the diaphragm and the housing 48 will result, thus allowing the diaphragm 49 to move toward the housing 47 under the influence of the higher vacuum being exerted within the chamber C, this will cause an acceleration of the drone or auxiliary engines. When the auxiliary engine has attained the same speed as the pilot engine, the manifold pressures of the engines will become equal, whereupon, the diaphragm will be maintained in this position by the equalization of the vacuum in the respective compartments C and C', which compartments are interconnected with the drone engine 12 and the pilot engine 11 respectively.

When it is desired to accelerate the engines negatively, which is commonly referred to as "de-acceleration," the throttle of the pilot engine 11 is closed to the desired extent, or it may be completely closed or shut off, then a higher vacuum is immediately created in the chamber C', which will draw the diaphragm 49 toward housing 48, and in case the throttle is shut off, the diaphragm will occupy the position as indicated in dashed outline in Fig. 1, and when in this position, a toggle action will be accorded the diaphragm, as hereinbefore set out, and with the drone or auxiliary engine throttle in closed position, the pressure in the respective manifolds will become substantially equal. However, due to the toggle action exerted by the diaphragm 49 on the connecting rod 51, the throttle on the drone or auxiliary engine 12 will be maintained closed, thereby preventing creepage in the idling speed of the engines.

By moving the lever 44 from the position as indi-

cated as "on" in Fig. 1 to the "off" position as indicated in dashed outline in Fig. 1 and as indicated in full outline in Fig. 4, the passages **25** and **26** leading to the manifolds will be closed and the passages **29** and **30** that lead to the chambers C' and C are interconnected through grooves **39**, **36** and **40**, so that the throttle of the secondary or drone engine may be operated manually without the diaphragm **49** materially impeding the linear movement of connecting rod **51**, as the air displaced from one of the chambers on the opposite side of the diaphragm will be of equal volume, within the housings **47** and **48**.

When it is desired to hold the secondary engine or engines at a fixed speed, the valve lever **44** is moved into a substantially vertical position, that is, approximately half way between "on" and "off" positions, whereupon the passages **25—26** is blocked from contact with the chambers C' and C, also the passages **39**, **36** and **40**, therefore the diaphragm **49** will be held in a fixed relation thereby maintaining the engine throttle in a set position.

When the engine **11** is started, a vacuum is applied to the line **21** which will cause the diaphragm **49** in the vacuum control unit **13** of engine **12** or **12***a* to move into position as indicated in dashed outline, if these engines are not running, the control handle **44** is moved into "off" position as indicated in dashed outline in Fig. 1, which will enable the diaphragm **49** to be relieved of vacuum or pressure on either side and the throttle of the drone engine will be free to be opened to any desired degree. If the throttle is fully closed, a toggle or snap action will be exerted when the diaphragm moves past the mid or toggle action point. This will insure that the throttle of the drone or auxiliary engine will remain closed.

By having the valve lever **44** set in an intermediate or vertical position, the throttle of the drone engine may be maintained in a set position, due to the fact that the passages **25** and **26** are blocked by the stop **33**.

It will be readily apparent that the lower end of the passages **62** and **63** are tapped, and by the removal of screws **22***a*, the valve **22** may be removed and pipes **21** and **23** connected directly with pipes **62** and **63**, respectively. While this is not usually a desirable manner of operating the device, since the individual unit control is lost by the removal of the valve, it does give flexibility of use to the device, as the unit can be used while the valve is removed for repair or replacement.

While the invention has been described and claimed in one embodiment thereof, it is to be understood that

changes may be made in the minor details of construction and adaptations made to different installations, without departing from the spirit of the invention, or the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. A dual, three-way valve for use with a vacuum actuated speed synchronizing device for connection to a plurality of internal combustion engines, said device comprising a valve body having a pair of longitudinal passages formed therein, a plug passing transversely through said valve body and fitted therein in such manner as to intersect said longitudinal passages in said body, said plug having a pair of transverse holes formed therethrough, each of which holes is adapted to register with said respective longitudinal passages in said valve body when said plug is in one position, and which plug is adapted to close said longitudinal passages in said valve body when in another position, said plug having an annular groove formed therein mediate said pair of transverse holes, said plug having a pair of longitudinal grooves formed therein which grooves are diametrically opposite and which extend outward from said annular groove in opposite directions a sufficient distance so one of said longitudinal grooves will register with one of said longitudinal passages in said body on one side of said plug when said plug is in one position, and the other of said longitudinal grooves in said plug will simultaneously register with the other of said longitudinal passages in said body on the opposite side of said plug, and means for moving said plug into said respective positions.

2. A dual, three-way valve as defined in claim 1, wherein said plug is adapted to close said longitudinal passages in said valve body when in another position

References Cited in the file of this patent

UNITED STATES PATENTS

1,062,300	Pierce	May 20, 1913
1,784,671	Jehle	Dec. 9, 1930
2,062,824	Rockwell et al.	Dec. 1, 1936
2,148,305	Sanford	Feb. 21, 1939
2,177,301	Kyes	Oct. 24, 1939
2,381,429	Bell et al.	Aug. 7, 1945
2,427,690	Peterson	Sept. 23, 1947
2,520,591	Wilmarth	Aug. 29, 1950
2,545,458	Ginn	Mar. 20, 1951
2,584,872	Hart	Feb. 5, 1952
2,615,429	Jacques	Oct. 28, 1952