Sept. 23, 1941. J. A. KENNEDY 2,256,569

SYNCHRONIZING DEVICE

Filed June 3, 1940 2 Sheets-Sheet 1

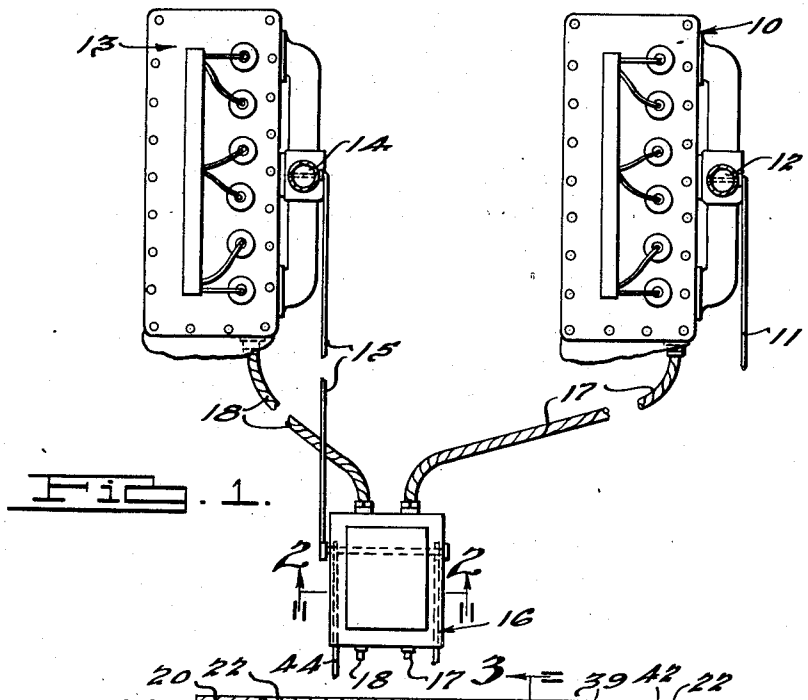


Fig. 1.

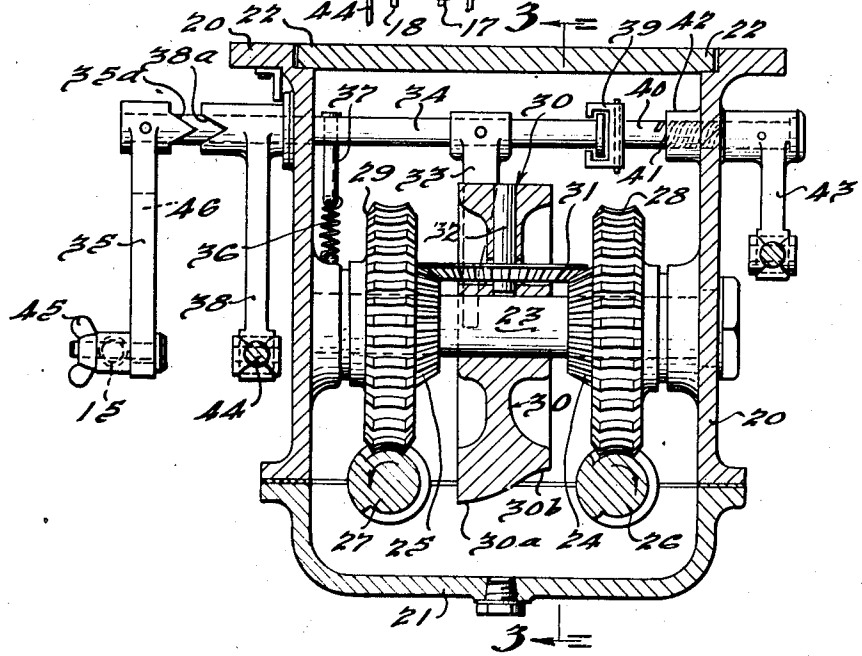


Fig. 2.

INVENTOR
James A. Kennedy.
BY
Gregory Dolgorukov
ATTORNEY

Sept. 23, 1941. J. A. KENNEDY 2,256,569

SYNCHRONIZING DEVICE

Filed June 3, 1940 2 Sheets-Sheet 2

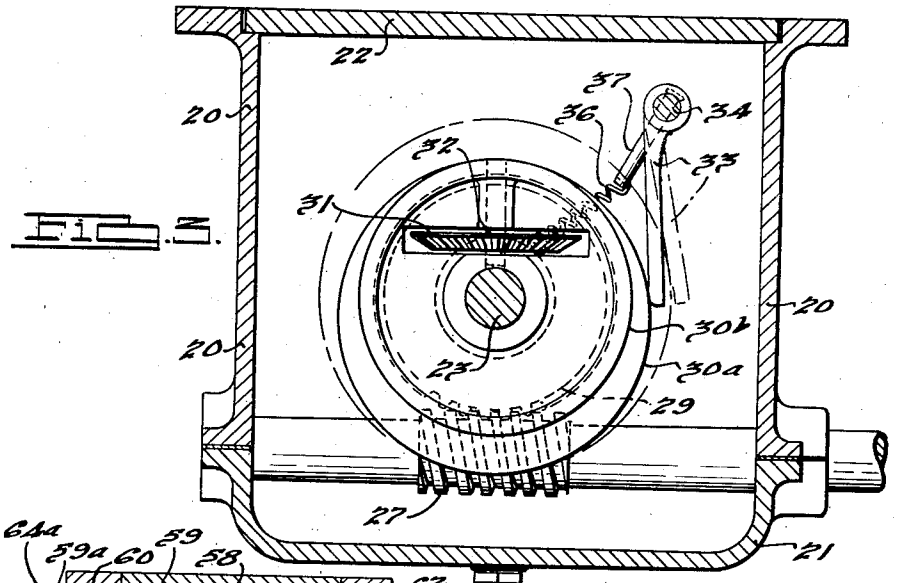


FIG. 3.

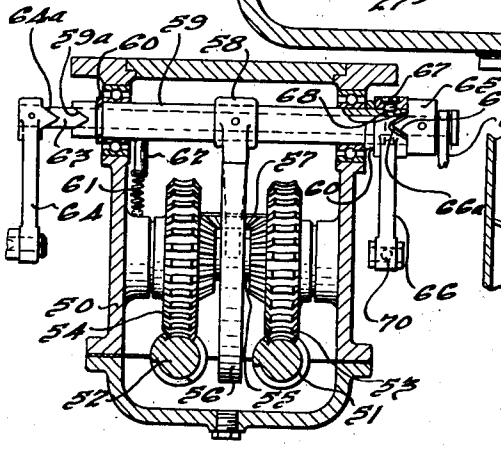


FIG. 4.

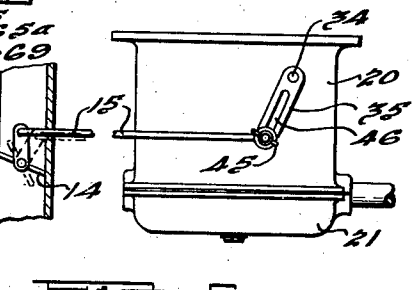


FIG. 5.

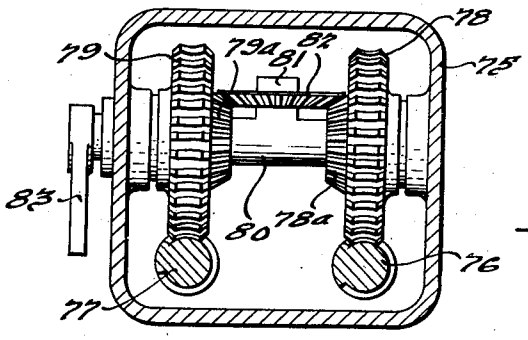


FIG. 6.

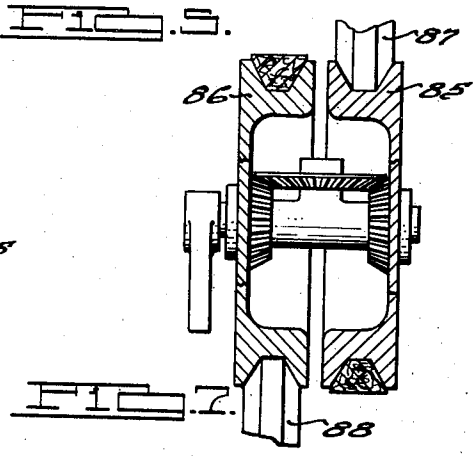


FIG. 7.

INVENTOR
James A. Kennedy.
BY Gregory Dalgorukov
ATTORNEY

Patented Sept. 23, 1941

2,256,569

UNITED STATES PATENT OFFICE

2,256,569

SYNCHRONIZING DEVICE

James A. Kennedy, Ann Arbor Township, Washtenaw County, Mich.

Application June 3, 1940, Serial No. 338,668

12 Claims. (Cl. 60—97)

This invention relates to synchronizing devices and more particularly to such devices adapted for synchronizing a plurality of rotating machines or mechanisms.

One of the objects of the present invention is to provide an improved synchronizing device including differential gearing and having a simplified mechanism for converting the movements of the differential gearing into the synchronizing movements of the speed controlling member of the following machine.

Another object of the invention is to provide a synchronizing device for engines, which device includes differential gearing and has an improved mechanism converting the movements of said gearing into the synchronizing movements of the throttle controlling mechanism.

A further object of the invention is to provide an improved synchronizing device which may be built in a standard size and used in connection with various engines irrespective of their throttle travel.

A still further object of the invention is to provide an improved synchronizing device for internal combustion engines, which device performs its synchronizing function without affecting the speed of the leading engine or producing sudden increases or decreases of the speed in the following engine or other irregularities in its operation.

A still further object of the invention is to provide an improved synchronizing device which may be connected and disconnected from the following engine without disorganizing or adversely affecting the speed and the smooth operation thereof.

It is an added object of the present invention to provide a synchronizing device of the foregoing character which is compact and simple in construction, dependable in operation, and is relatively inexpensive to manufacture.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a diagrammatic view illustrating the operative interconnection between the leading engine, the synchronizing device embodying the present invention, and the following engine.

Fig. 2 is a sectional view of the synchronizing device shown diagrammatically in Fig. 1, the view being taken in the direction of the arrows on the section plane passing through the line 2—2 of Fig. 1.

Fig. 3 is another sectional view of the synchronizing device, said view being taken in the direction of the arrows on the section plane passing through the line 3—3 of Fig. 2.

Fig. 4 is a sectional view illustrating a modified construction embodying the present invention.

Fig. 5 illustrates an operative connection between the crank of the synchronizing device and the throttle of the following engine, said figure also showing the adjustment means permitting connection of a standard synchronizing device to engines having throttles with different throttle travel.

Fig. 6 is a sectional view showing another modification of my improved synchronizing device.

Fig. 7 shows a still further modification of the synchronizing device.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In the drawings there are shown, by way of example, several structures embodying the present invention. My improved synchronizing device is illustrated in the drawings and hereinafter described as applied to two internal combustion engines having usual throttles. It will be understood, however, that my improved synchronizing device may be applied with equal success to synchronizing more than two engines and also to engines different than engines of the internal combustion type. For instance, my synchronizing device may be used in connection with steam engines and also with various rotating machines or mechanisms.

Referring to the drawings, Fig. 1 illustrates diagrammatically the operative connection of my improved synchronizing device to two internal combustion engines. Referring to said figure, the numeral 10 designates generally an engine manually controlled with the aid of a rod 11 suitably connected by its respective ends to the throttle 12 and to a manually actuated mechanism such for instance as a pedal (not shown). The numeral 13 designates generally a similar engine

which should, when desired, rotate at the same rotative speed with the engine 10. In other words, while the engine 10 may be termed a "leading engine," the engine 13 should follow the engine 10 as the same changes its rotative speed and for this reason the engine 13 may be termed a "following engine." The following engine 13 is provided with a throttle or speed controlling member 14 similar to the throttle 12 of the leading engine 10. The throttle 14 is operated with the aid of a rod 15.

The synchronizing device is indicated generally by the numeral 16. It is drivingly connected to the engine 10 with the aid of a flexible cable 17 and with the following engine 13 with a similar cable 18. It is preferable to utilize for such a connection the tachometer cables usually provided in engines. Thus the synchronizing device may be simply inserted in said cables such as illustrated in Fig. 1, wherein cables 17 and 18 are shown leading to the synchronizing device 16 and from said device to a tachometer (not shown).

The synchronizing device shown in Figs. 2 and 3 comprises generally a casing 20 having a removable bottom 21 and a cover 22. In said casing 20 there is operatively journalled a shaft 23 on which there are rotatively mounted two bevel gears 24 and 25. The bevel gears 24 and 25 are provided with means whereby they are connected for rotation with the flexible cables 17 and 18 respectively. In the present embodiment said connection is effected with the aid of worm-and-gear means. Worms 26 and 27 are suitably arranged in the casing and connected respectively to the flexible cables 17 and 18 and engage gears 28 and 29. By virtue of such a construction the gears 28 and 29 freely rotate on the shaft 23 in proportion to the rotative speed of the engines. In the present embodiment of the invention the engines 10 and 13 are presumed to rotate in opposite directions and therefore the gears 28 and 29 also rotate in opposite directions with respect to each other. Since there is no driving connection between the gears 28 and 29 and the shaft 23, said gears as well as gears 24 and 25 may rotate independently of the shaft 23 and also of each other. It should be clearly understood however that gears 28 and 24 are securely connected together as well as gears 29 and 25, and it is preferable to manufacture said connected gears as integral units.

On the shaft 23 there is mounted an eccentric generally indicated by the numeral 30, the left hand portion of which, termed "controlling" portion and indicated by the character 30*a*, is provided with a certain amount of eccentricity, while the right hand portion termed "non-controlling portion" indicated by the numeral 30*b* is concentric with the shaft 23. Portions 30*a* and 30*b* smoothly merge into each other. The eccentric 30 carries a connecting bevel gear 31 mounted therein for rotation on a shaft 32.

It will now be understood in view of the foregoing that the bevel gears 24 and 25 and the connecting bevel gear 32 form a differential mechanism. In operation, when the gears 24 and 25 secured respectively to the gears 28 and 29 rotate at equal rotative speeds in opposite directions, the connecting bevel gear 31 rotates on its shaft 32 but remains bodily stationary. If one of the gears, the gear 25 for instance, begins rotating slower than the gear 24 which may be caused by the engine 13 slowing down, the connecting bevel gear 31 in addition to its rotative movement begins to revolve around the shaft 23, said revolving continuing as long as there is a difference in rotative speeds of the gears 24 and 25. In the example given, the connecting gear 31 will bodily revolve around the shaft 23 in a clockwise direction, the observer presumed to be looking on the shaft 23 from the right hand side thereof. The above described movements of the eccentric 30 are utilized for changing the position of the speed controlling member or throttle 14 of the following engine 13 to increase the speed of the engine 13 until the rotative speed of the connected gears 29 and 25 is increased to a point when it becomes equal to the rotative speed of the connected gears 28 and 24, in which case bodily movement or revolving of the connecting bevel gear ceases and the throttle 14 remains stationary in the position to which it was brought by the controlling movements of the eccentric 30.

The operative connection between the throttle 14 of the following engine 13 and the eccentric 30 is provided by a follower finger 33 mounted on a countershaft 34 operatively journalled in the casing 20. On one end of the countershaft 34 there is provided a crank 35 connected with the aid of the rod 15 to the throttle 14 of the following engine 13. A spring 36 connected to the casing 20 and to a pin 37 secured to the shaft 34 insures constant and yielding engagement of the eccentric 30 by the follower finger 33. In operation as the eccentric 30 rotates, the follower finger 33 is moved, thus rotating the shaft 34 and, consequently, the crank 35 is actuated to operate the throttle 14 moving it in a desired direction.

Means are provided whereby the following engine 13 may be disconnected from the synchronizing device and be manually controlled. In the present embodiment of the invention said means are represented by a crank 38 rotatively mounted on the shaft 34 and provided with a slot or notch 38*a* adapted to be engaged by a tooth 35*a* of the crank 35. A slip joint 39 is provided on the shaft portion 40 and engages the opposite end of the shaft 34. The shaft portion 40 is threaded as indicated at 41, the threaded portion engaging an internally threaded portion provided in the boss 42 formed on the casing 20. As the shaft portion 40 is rotated with the aid of a lever or crank 43 from the position shown in Fig. 2, the screw thread operates to move the shaft portion 42 to the right. Because of this movement of the shaft portion 40 connected by the slip joint 39 with the shaft 34, the shaft 34 also moves to the right. Such movement of the shaft 34 produces movement of the follower finger 33 from the eccentric portion 30*a* to the concentric portion 30*b* of the eccentric 30, as well as an engagement of the cranks 35 and 38 through the tooth and slot 35*a* and 38*a* forming, in effect, a jaw clutch. Under such conditions rotation of the eccentric 30 does not produce any movement of the follower finger 33 and therefore said eccentric becomes inoperative for moving the crank 35 and consequently the throttle 14. However, the cranks 38 and 35 being positively connected together by the jaw clutch, the manual control lever 44 connected to the crank 38 may be used for operating the throttle 14 manually. The movements of the manual control lever 44 will cause movements of the follower finger 33 but the same will be of no consequence as far as the synchronizing operations are concerned. It should be understood at this point that the diameter of the concentric portion 30*b* of the eccentric 30 should be equal

or less than the smaller diameter of the eccentric.

My improved synchronizing device may be manufactured in one or several standard sizes and may be used with various engines having different throttle movements or strokes. Means are provided whereby adjustment can be made and movement of the crank **35** is brought to a proper relation to the movement of the following engine throttle **14**. In the present embodiment of the invention said means are in the form of a slot **46**, see Fig. 5, provided in the crank **35** and a wing nut means **45** connecting the rod **15** to the crank **35**. By moving the end of the rod **15** and tightening it in a proper position along the slot **46**, the stroke of the rod **15** may be adjusted to the stroke of the throttle in any given engine.

Fig. 4 illustrates an embodiment having a simplified eccentric. In this embodiment the general organization of the differential device is similar to that of the structure shown in Figs. 2 and 3. The device includes a casing **50**, worms **51** and **52**, driving gears **53** and **54** rotatively mounted on a shaft **55**. To the shaft **55** there is secured an eccentric **56** carrying a connecting bevel gear **57**. A follower finger **58** is secured to a hollow countershaft **59** journalled in suitable bearings in the casing **50** and provided with means preventing its longitudinal sliding in the casing. In the present embodiment said means are exemplified by the retainer washers **60**. A spring **61** connected to the pin **62** secured to the countershaft **59** tends to keep the follower finger **58** in constant operative engagement with the eccentric **56**. Within the hollow countershaft **59** there is rotatively and slidably fitted a second shaft **63** having on one of its ends a crank **64** substantially similar with the crank **35** of the structure shown in Fig. 2. The shaft **63** may be of solid construction as in the present instance. The crank **64** is rigidly secured to the shaft **63**. By means of a tooth **64***a* engaging a slot **59***a* and forming, in effect, a jaw clutch, the crank **64** and the shaft **59** may be operatively connected together for simultaneous rotation.

On the opposite end of the shaft **63** there is rigidly secured a head piece **65** having a tooth **65***a* adapted to engage a slot **66***a* of a manual control crank **66**. The crank **66** rotates freely on the hollow countershaft **59** but is prevented from sliding along said countershaft **59** by a screw **67** following a circular groove **68** provided on the end of the hollow shaft **59**. A shifting fork **69** is provided and it enables moving the shaft **63** longitudinally. The fork **69** is operated manually in any suitable way.

In operation in the position of the shaft **63** shown in Fig. 4 the automatic control in Fig. 4 the automatic control crank **64** is disconnected from the hollow countershaft **59**, and therefore rotation of said countershaft **59** produced by the follower finger **58** does not affect said crank **64**. Rotation of the countershaft **59** also does not affect the manual control crank **66**, as explained. On the other hand the manual control crank **66** operated with the aid of a rod **70** is connected with the shaft **63** through the head piece **65** and manual operation of the rod **70** produces corresponding movements of the crank **64** giving desired manual operation of the following engine. In other words, Fig. 4 illustrates the device arranged for manual control of the following engine. For automatic operation thereof, the shaft **63** is moved with the aid of the fork **69** to the right, thus disconnecting the end piece **65** from the crank **66** and connecting the shaft **59** with the crank **64**.

Fig. 6 illustrates a synchronizing device of a simplified construction which is intended for automatic control of the following engine but does not provide for manual control thereof. As shown in Fig. 6, said device comprises a casing **75**, worms **76** and **77** engaging gears **78** and **79** having bevel gear portions **78***a* and **79***a* and rotatably mounted on a shaft **80**. Shaft **80** has a projection **81** carrying a connecting bevel gear **82** engaging the bevel gear portions **78***a* and **79***a* of the gears **78** and **79**, respectively. To the shaft **80** there is secured an automatic control crank **83**. The operation of the device is similar to the automatic control operation of the structures described above.

Fig. 7 shows a device similar in part to the device of Fig. 6 but having, instead of worm-and-gear means, pulleys **85** and **86** operated with the aid of belts **87** and **88**, preferably of the V-type. The pulleys are of hollow construction and serve also as a housing for the differential device which is substantially similar to that of the structure shown in Fig. 6. The operation of this device is similar to that of the structure of Fig. 6.

It should be understood that the adjustment means illustrated in Fig. 5 may be used in any of the above described structures.

I claim:

1. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears, and a connecting gear carried by said eccentric and operatively engaging both of said first gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds.

2. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears, and a connecting gear carried by said eccentric and operatively engaging both of said gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds, a follower engaging said eccentric, and means operatively connecting said follower with the speed controlling member of the following engine.

3. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears, and a connecting gear carried by said eccentric and operatively engaging both of said bevel gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds, means operatively connecting said eccentric with the speed controlling member of the following engine, and adjustment means for changing the relationship between the movements of said connecting means and the speed controlling member of the following engine, said adjustment means adapted to effect selectively an infinitely large number of adjustment positions.

4. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears and having a controlling portion, and a connecting gear carried by said eccentric and operatively engaging both of said gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds, a follower engaging the controlling portion of said eccentric, means operatively connecting said follower with the speed controlling member of the following engine, and means for moving selectively said follower out of engagement with said controlling portion of the eccentric in order to render said eccentric inoperative for controlling purposes.

5. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears, a connecting gear carried by said eccentric and operatively engaging both of said bevel gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds, a follower engaging said eccentric, means operatively connecting said follower with the speed controlling member of the following engine, a portion concentric with said shaft and merging smoothly into said eccentric, and manually operated means moving said follower from said eccentric to said concentric portion for rendering said eccentric inoperative for automatic controlling operation.

6. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears, and a connecting gear carried by said eccentric and operatively engaging both of said bevel gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds, a countershaft operatively connected with the speed controlling member of the following engine, a follower finger secured to said countershaft and engaging said eccentric to transmit movements thereof to said shaft and, consequently, to the speed controlling member of the following engine.

7. In a device for synchronizing two engines having speed controlling members, said device including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly connecting said gears to said engines for rotation in opposite directions, an eccentric mounted on said shaft intermediate said gears, a connecting gear carried by said eccentric and operatively engaging both of said bevel gears and adapted to revolve bodily for rotating said eccentric when said gears rotate at different speeds, a countershaft operatively connected with the speed controlling member of the following engine, a follower finger secured to said countershaft and engaging said eccentric to transmit movements thereof to said shaft and, consequently, to the speed controlling member of the following engine, and resilient means insuring a yielding engagement of the eccentric by said followe finger.

8. In a device for synchronizing two engine having speed controlling members, said devic including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly con necting said gears to said engines for rotatio in opposite directions, an eccentric mounted o said shaft intermediate said gears, a connectin gear carried by said eccentric and operativel engaging both of said bevel gears and adapte to revolve bodily for rotating said eccentri when said gears rotate at different speeds, countershaft, a crank secured to said counter shaft and operatively connected to the spee controlling member of the following engine, follower secured to said countershaft and adapt ed to engage said eccentric for rotating th countershaft in response to the operative move ments of said eccentric, and means renderin said follower irresponsive to controlling move ments of said eccentric.

9. In a device for synchronizing two engine having speed controlling members, said devic including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly con necting said gears to said engines for rotatio in opposite directions, an eccentric mounted o said shaft intermediate said gears, a connectin gear carried by said eccentric and operativel engaging both of said bevel gears and adapte to revolve bodily for rotating said eccentri when said gears rotate at different speeds, countershaft, a crank secured to said counter shaft and operatively connected to the spee controlling member of the following engine, follower secured to said countershaft and adapt ed to engage said eccentric for rotating th countershaft in response to the operative move ments of said eccentric, and means for movin said countershaft longitudinally of its axis fo bringing the follower into and out of the op erative position with respect to the eccentric, loose crank on said countershaft connected to manual control means of the following moto and jaw clutch means on said cranks adapted t connect drivingly said cranks when said coun tershaft is moved longitudinally of its axis, an means for moving said countershaft longitudi nally within predetermined limits for connect ing and disconnecting said cranks for manua and for automatic control of the following en gine, respectively.

10. In a device for synchronizing two engine having speed controlling members, said devic including a shaft, two bevel gears rotatively mounted on said shaft, means drivingly connect ing said gears to said engines for rotation i opposite directions, an eccentric mounted on sai shaft intermediate said gears, and a connectin gear carried by said eccentric and operativel engaging both of said bevel gears and adapted t revolve bodily for rotating said eccentric whe said gears rotate at different speeds, a hollo countershaft, a follower secured to said coun tershaft and engaging said eccentric for rotat ing said countershaft in response to the op erative movements of said eccentric, a soli shaft rotatively and slidably arranged in sai hollow countershaft, one end of said solid shaf being operatively connected to the speed con trolling member of the following engine, an means for drivingly connecting and disconnect ing said shafts.

11. In a device for synchronizing two engine

having speed controlling throttle valves, one of said engines being leading and the other following, said device comprising a casing, a shaft mounted in said casing, two spaced bevel gears rotatively mounted on said shaft, worm-and-gear means drivingly connecting said bevel gears to said leading engine and said following engine, respectively, for rotation in opposite directions with respect to each other, an eccentric mounted on said shaft intermediate said gears, a connecting bevel gear carried by said eccentric and operatively engaging both of said bevel gears and adapted to move bodily with said eccentric when said bevel gears rotate at different speeds, a hollow countershaft rotatively journalled in said casing, a follower secured to said hollow countershaft and engaging said eccentric for rotating said countershaft in response to the rotative movements of said eccentric, a second shaft rotatively arranged within said hollow shaft and longitudinally slidable therein, a manual control crank rotatively arranged on said hollow shaft, means drivingly connecting one end of said second shaft with the throttle valve of the following engine, and means adapted in one sliding position of said second shaft to connect drivingly said manual control crank with said second shaft, and in the other sliding position of said second shaft to connect the same drivingly with said hollow shaft.

12. In a device for synchronizing two engines having speed controlling throttle valves, one of said engines being leading and the other following, said device comprising a casing, a shaft mounted in said casing, two spaced bevel gears rotatively mounted on said shaft, worm-and-gear means drivingly conecting said bevel gears to said leading engine and said following engine, respectively, for rotation in opposite directions with respect to each other, an eccentric mounted on said shaft intermediate said gears, a connecting bevel gear carried by said eccentric and operatively engaging both of said bevel gears and adapted to move bodily with said eccentric when said bevel gears rotate a different speeds, a hollow countershaft rotatively journalled in said casing, a follower secured to said hollow countershaft and engaging said eccentric for rotating said countershaft in response to the rotative movements of said eccentric, a second shaft rotatively arranged within said hollow shaft and longitudinally slidable therein, a manual control crank rotatively arranged on said hollow shaft, two jaw clutches adapted in one position of the second shaft to connect the same drivingly with said hollow shaft for automatic control of the following engine, and in the other position of the second shaft to disconnect the same from said hollow shaft and connect it drivingly with said manual control crank.

JAMES A. KENNEDY.