No. 878,747. PATENTED FEB. 11, 1908.

H. SAURER.

STARTING DEVICE FOR EXPLOSION ENGINES WITH FOUR CYLINDERS.

APPLICATION FILED OCT. 6, 1906.

3 SHEETS—SHEET 1.

Fig. 1.

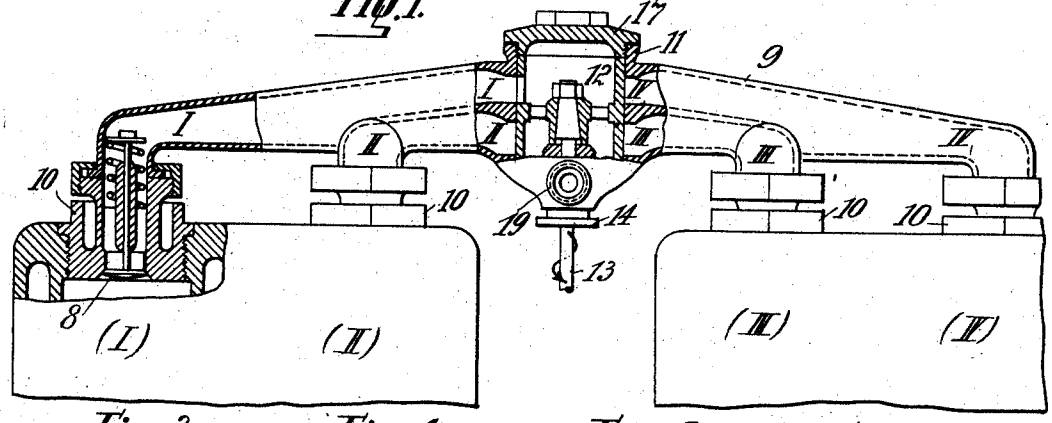


Fig. 3.

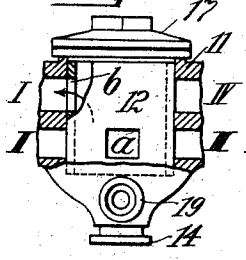


Fig. 4.

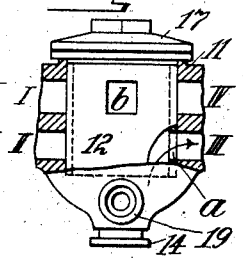


Fig. 5.

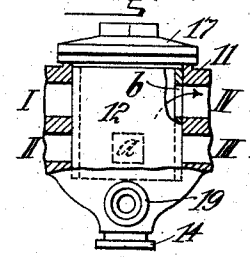


Fig. 6.

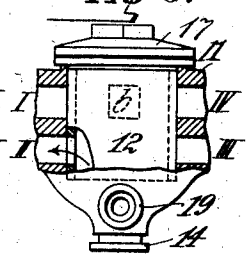


Fig. 3a.

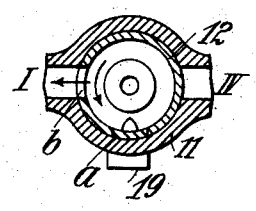


Fig. 4a.

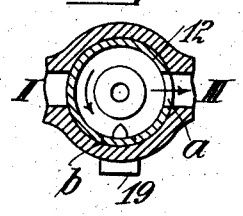


Fig. 5a.

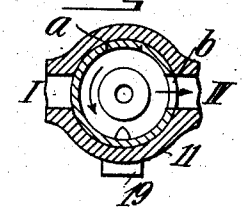


Fig. 6a.

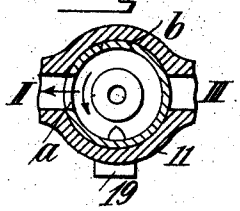


Fig. 2.

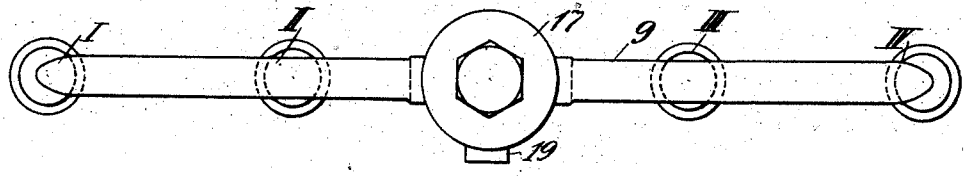
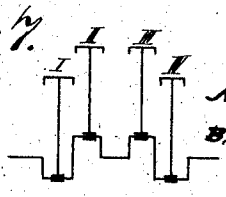


Fig. 7.



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3 SHEETS—SHEET 2.

Fig. 8.

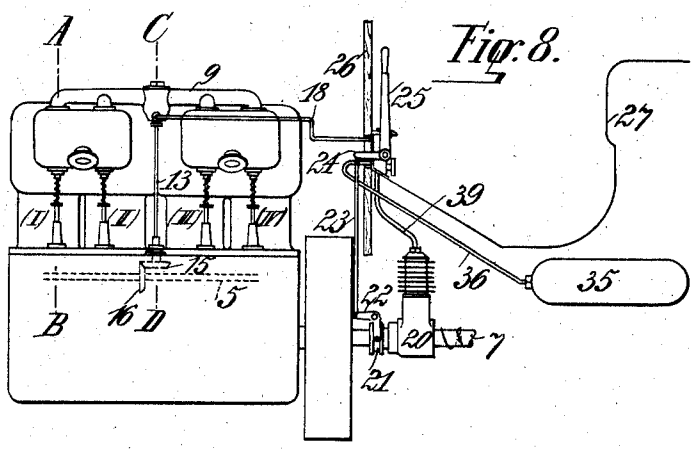


Fig. 9.

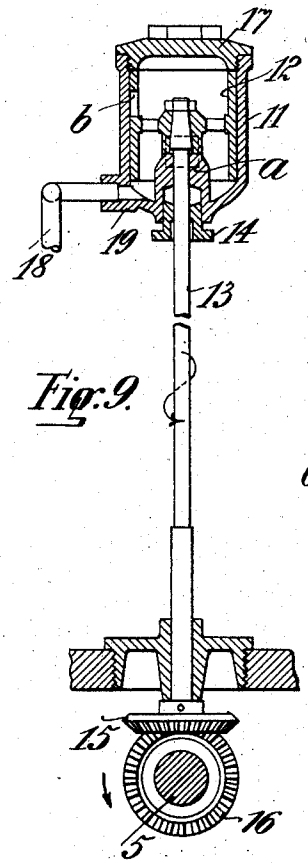


Fig. 10.

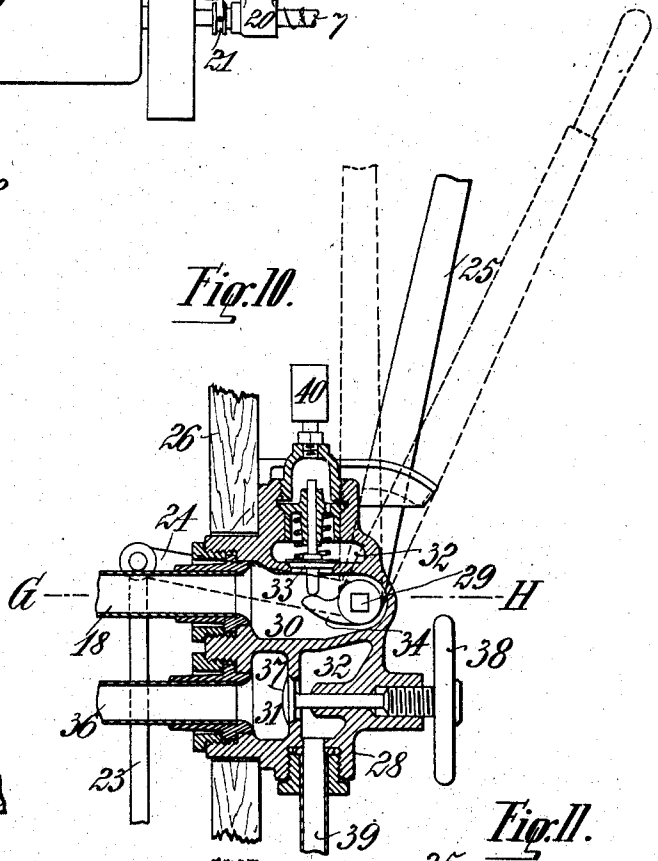
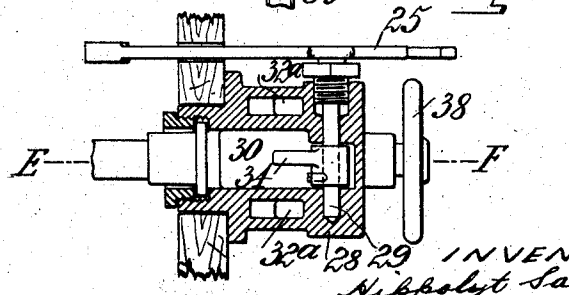


Fig. 11.



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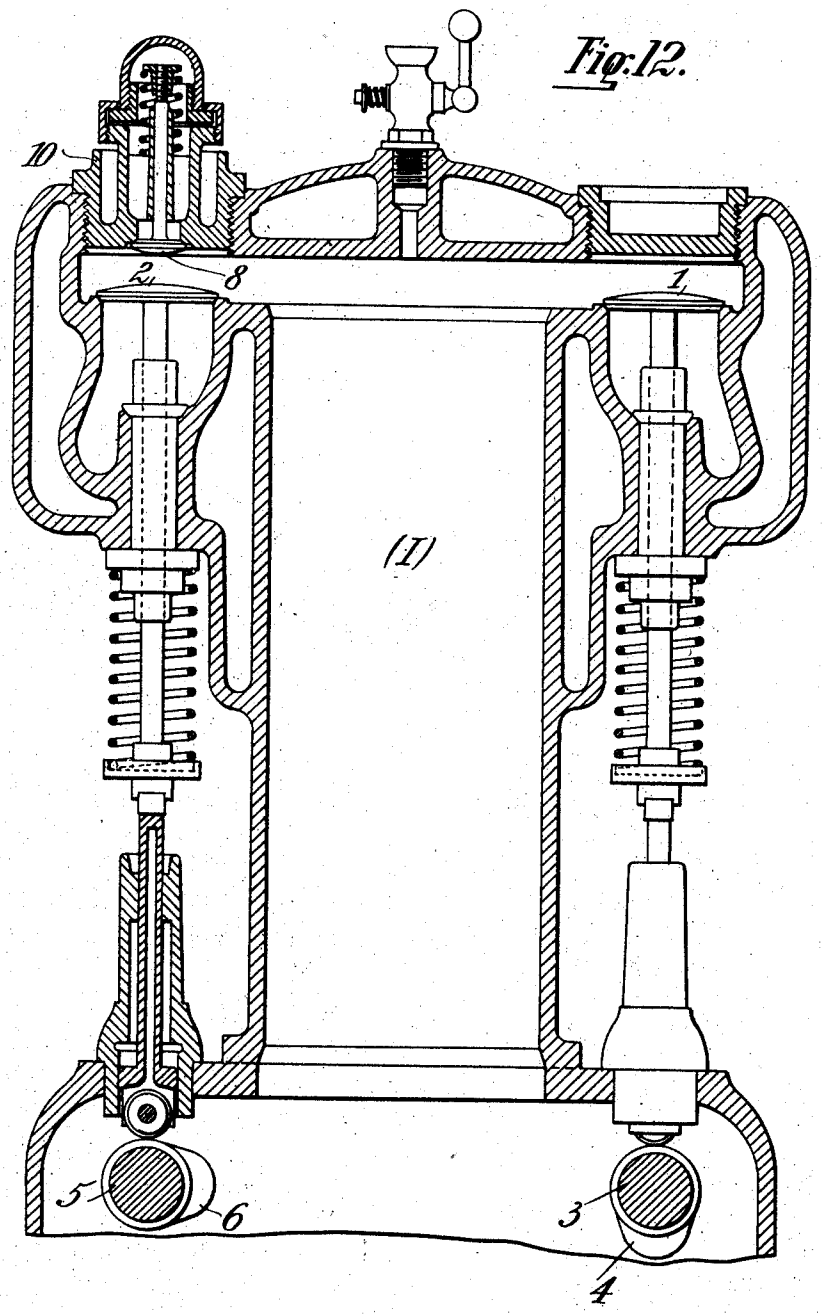
3 SHEETS—SHEET 3.

Fig. 12.



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UNITED STATES PATENT OFFICE.

HIPPOLYT SAURER, OF ARBON, SWITZERLAND.

STARTING DEVICE FOR EXPLOSION-ENGINES WITH FOUR CYLINDERS.

No. 878,747. Specification of Letters Patent. Patented Feb. 11, 1908.

Application filed October 6, 1906. Serial No. 337,707.

To all whom it may concern:

Be it known that I, HIPPOLYT SAURER, a citizen of the Confederation of Switzerland, residing at Arbon, Switzerland, have invented a new and useful Starting Device for Explosion-Engines with Four Cylinders, of which the following is a specification.

In my application for a U. S. patent of April 24, 1906, Serial No. 313,437 and bearing the same title as the present application, I have described a starting device for a four stroke cycle explosion-engine in an automobile, which device is arranged for admitting the compressed air invariably to that cylinder, in which the piston had stopped during the expansion of the exploded gases, since this piston usually occupies a position more or less in the middle of its stroke, that is to say a position so favorable, that the compressed air acting upon the piston will be able to at once overcome the resistance of the engine during the start of the latter. During the following stroke of the piston in the same cylinder the exhaust of the air (corresponding to that of the wasted gases during the usual work) can take place by means of the usual outlet valve, so that no additional outlet valve or device for turning the four stroke cycle into a two-stage cycle is necessary.

My invention relates to another starting device of a similar kind, whereby a greater simplicity, a reduction of the speed, an increased safety in the work, a better accessibility and a good appearance of the device are obtained. The new starting device is suitable for all explosion-engines with four cylinders, which are to be started by means of compressed air or gas. The new starting device is to be controlled from the driver's seat, the same as the engine.

I will now proceed to describe my invention with reference to the accompanying drawings, in which—

Figure 1 is an elevation of the starting device and the upper part of the engine, the rotary distributing valve with its box and the inlet valve with its box for the left cylinder being shown in section, Fig. 2 is a plan of the same, Figs. 3 to 6 show four different positions of the rotary distributing valve, the latter itself being shown substantially in elevation, Figs. 3^a to 6^a are horizontal cross sections through the same and its box and correspond to Figs. 3 to 6 respectively, Fig. 7 is a diagram, which will be referred to later on, Fig. 8 is an elevation on a reduced scale of the explosion engine provided with the new starting device, part of the automobile being indicated by an outline, Fig. 9 is a vertical cross section (on the same scale as Figs. 1 to 6) through the rotary distributing valve and its driving mechanism on the line C—D in Fig. 8, Fig. 10 is a vertical longitudinal section on a larger scale through the device controlling the supply of compressed air or gas to the engine on the line E—F in Fig. 11, Fig. 11 is a horizontal section through the same on the line G—H in Fig. 10, and Fig. 12 is a vertical cross section on an enlarged scale through the line A—B in Fig. 8 and shows one of the four cylinders with its ordinary inlet and outlet valves and the inlet valve of the new starting device.

Similar characters of reference refer to similar parts throughout the several views.

I have shown in Fig. 8 a known explosion-engine, the construction of which is immaterial to my invention. It comprises four cylinders marked with (I), (II), (III) and (IV) and having each a spring-pressed inlet-valve 1 (see Fig. 12) and a spring-pressed outlet-valve 2 as usual. The inlet-valves 1 of all the cylinders are controlled from a cam shaft 3 by means of cams 4 and all the outlet-valves 2 are controlled from another cam shaft 5 by means of cams 6 and the two cam shafts 3 and 5 are in any known manner so driven from the crank-shaft 7 as to make one revolution on every two revolutions of the latter as usual. I do not show any igniting device as it forms no part of my invention.

Besides the ordinary inlet-valve 1 each cylinder is according to my invention provided with an additional spring-pressed inlet-valve 8, see Figs. 1 and 12, of any known construction for the compressed air or gas. In Fig. 12 this inlet-valve 8 is shown as disposed above the outlet valve 2, but it may also be disposed somewhere else. A two-armed connection 9 is arranged to be connected with the boxes 10 of the four inlet-valves 8 in any known and approved manner and is cast in one piece with a cylindrical casing 11 (see Fig. 9), in which a rotary tubular distributing valve 12 is mounted to turn. This distributing valve 12 is fastened on a vertical shaft 13, which passes through a suitable stuffing box 14 on the casing 11 and is arranged to be driven in any suitable manner, for example from the cam shaft 5 for the

outlet-valves 2 by means of bevel wheels 15 and 16, as is shown at Fig. 9. The two arms of the connection 9 are each divided by a partition into two channels, so that there are in all four channels I to IV leading to the four cylinders (I) to (IV) respectively. The casing 11 is provided with a cover 17 of any construction, so that the rotary tubular distributing valve 12 is rendered easily accessible. This valve 12 is provided with two square apertures *a* and *b*, which are set at an angle of 90° from each other and are so disposed, that the one aperture *a* may periodically register with either of the two lower channels II and III and the other aperture *b* may periodically register with either of the two upper channels I and IV. The compressed air or gas is supplied to the casing 11 through a suitable tube 18 and a connection 19. The rotary distributing valve 12 is made open (see Figs. 1 and 9) to permit the compressed air or gas to pass upwards.

An air-compressor 20 (see Fig. 8) of any known and approved construction is provided and can be coupled at will with the crank-shaft 7 by means of a suitable clutch 21, a bent lever 22, a rod 23 and the arm 24 of an operating lever 25. On a convenient board 26 or the like in the automobile 27 is secured a casing 28 shown in Figs. 10 and 11, in which the shaft 29 of the operating lever 25 is mounted to rock. The casing 28 contains three chambers 30, 31 and 32, of which the chamber 32 is shown as divided into an upper and a lower portion that communicate with one another through two side passages 32^a, 32^a, see Fig. 11. The chamber 30 communicates with the casing 11 of the rotary distributing valve 12 through the already mentioned tube 18 and is normally closed with a spring-pressed stop valve 33. An arm 34 is fastened on the shaft 29 and is adapted to open the stop valve 33 on the operating lever 25 being turned from its middle position shown in full lines in Fig. 10 to its right extreme position indicated by dotted lines. When the operating lever 25 is turned from its middle position into its other (vertical) extreme position the air-compressor 20 will be coupled with the crank-shaft in the above mentioned manner and thus be set in motion. The second chamber 31 in the casing 28 communicates with a suitable reservoir 35 through a tube 36 and is normally closed with a stop valve 37, which may be operated in any known manner, for example from a hand-wheel 38. The third chamber 32 communicates with the air-compressor 20 through a tube 39. It will be obvious, that the operating lever 25 can be operated from the driver's seat.

As the explosion-engine works in the four stroke cycle, of course the compressed air or gas can be admitted to each of the four cylinders (I) to (IV) only once for every two revolutions of the crank-shaft 7. This means, that the rotary tubular distributing valve 12 requires to make one revolution on every two revolutions of the crank-shaft 7, the same as the cam shafts 3 and 5 for operating the inlet-valves 1 and outlet-valves 2 respectively. For this reason the two bevel wheels 15 and 16 are made alike. Thus the speed of the rotary tubular distributing valve 12 is kept moderate.

The crank-shaft 7 is assumed to be bent in the manner shown at Fig. 7 and the ignitions of the compressed mixtures in the several cylinders are assumed to take place in the following order: (I), (III), (IV) and (II). Now that the compressed air or gas for starting the explosion-engine is also invariably admitted to each cylinder during that stroke of its piston, during which in the usual work of the engine the expansion of the exploded gases would take place, it follows that the compressed air or gas must be admitted to the several cylinders in the same order, viz. (I), (III), (IV) and (II). Thereby it is also rendered possible to utilize the ordinary outlet-valves 2 for the exhaust of the spent air or gas and no special mechanism for turning the four stroke cycle into a two-stage cycle for the starting of the automobile will be necessary.

With the rotary tubular distributing valve 12 of the construction described above it is possible to admit the compressed air or gas to the several cylinders in the said order, as will be clear after an examination of Figs. 3 to 6 and 3^a to 6^a. For the position of the valve 12 shown in Figs. 3 and 3^a the compressed air or gas will be admitted through the upper aperture *b* and the channel I to the first cylinder (I). After the shaft 13 has been turned through an angle of 90° in the direction of the arrow, the compressed air or gas will be admitted through the lower aperture *a* and the channel III to the third cylinder (III), as is shown at Figs. 4 and 4^a. After the turn of the rotary tubular distributing valve 12 through another angle of 90° the compressed air or gas will be admitted through the upper aperture *b* and the channel IV to the fourth cylinder (IV), see Figs. 5 and 5^a. When the valve 12 has been turned through a further angle of 90°, the compressed air or gas will be admitted through the lower aperture *a* and the channel II to the second cylinder (II), as Figs. 6 and 6^a will prove. In this case no special mechanism for turning the four stroke cycle into a two-stage cycle and vice versa is required, which means, that the starting device is very simple and safe.

As already indicated above, on stopping the automobile in general in one of the four cylinders the piston will stop in about the middle of its stroke during the expansion of

the exploded gases in the same cylinder. From this the manner of operating the starting device will be obvious and it is as follows: The driver will take care to keep the reservoir 35 filled with compressed air or gas, he coupling during the drive the air-compressor 20 with the crank-shaft 7 by turning the operating lever 25 from its normal position into the vertical position and opening the stop valve 37 by means of the hand-wheel 38. When the pressure gage 40 shows, that the compressed air or gas in the reservoir 35 has attained the required pressure, the driver closes the stop valve 37 and disconnects the air-compressor 20 from the crank-shaft 7.

When the automobile is at rest and the driver wants to start it, he opens the stop valve 37 by means of the hand-wheel 38 to admit compressed air or gas from the reservoir 35 to the chamber 32 through the tube 36 and the chamber 31. Thereupon he turns the operating lever 25 from its normal position to the extreme position shown in dotted lines on the right in Fig. 10, so as to open the stop valve 33 by means of the arm 34 and to admit the compressed air or gas from the chamber 32 to the casing 11 of the rotary distributing valve 12 through the tube 18. The compressed air or gas will then pass through either of the two apertures *a* and *b* of the valve 12 and through the respective one of the four channels I to IV and open the spring-pressed inlet-valve 8 of that cylinder in which the piston had stopped during the expansion of the exploded gases. The compressed air or gas driving this piston will start the engine. The spent air will be discharged through the outlet-valve 2 during the following stroke, while the compressed air or gas will enter another cylinder and drive its piston, whereupon the compressed air or gas will enter a third cylinder and drive its piston, while the spent air in the second cylinder will be discharged through the corresponding outlet-valve 2. Afterwards the compressed air or gas will enter a fourth cylinder and drive its piston and so on. After the start the driver may close the stop valve 33 and may operate the four stroke cycle explosion-engine in the usual manner.

It is evident, that the order, in which the ignitions of the compressed mixtures in the several cylinders take place, may be altered, if so preferred. In this case it is easy to so alter the starting device, that is to say the rotary distributing valve 12 and the four channels I to IV, as to obtain the desired effect.

It is a special advantage of the new starting device, that the connection 9 contains itself the rotary distributing valve 12, occupies little space, can be made nice and need be tightened only on four places between it and the four cylinders, also that it can be fastened direct on the latter.

The starting device may be varied without departing from the spirit of my invention.

I claim:

1. In a four stroke cycle explosion-engine with four cylinders, the combination with four spring-pressed inlet-valves in the four cylinders, of a connection on the four cylinders above said four spring-pressed inlet-valves and comprising a cylindrical bore in its middle with four openings and four separate channels leading from the four openings to the spring-pressed inlet-valves, and a rotary tubular distributing valve mounted to turn in the cylindrical bore of said connection and provided with two apertures and so driven as to make one revolution on every two revolutions of the crank-shaft, its two apertures being so disposed as to severally and each supply compressed air or gas through the respective channel to either of two cylinders during that stroke of its piston, during which in the normal work of the engine the expansion of the exploded gases would take place.

2. In a four stroke cycle explosion-engine with four juxtaposed cylinders, the combination with four spring-pressed inlet-valves in the four cylinders, of a connection fastened on the four cylinders above said four spring-pressed inlet-valves and comprising a cylindrical bore in its middle with two opposite pairs of superposed openings and four separate channels leading from the four openings to the four spring-pressed inlet-valves, and a rotary tubular distributing valve mounted to turn in the cylindrical bore of said connection and provided with two apertures in two parallel planes at right angles to its axis and so driven as to make one revolution on every two revolutions of the crank-shaft, its two apertures being so disposed as to severally and each supply compressed air or gas through the respective channel to either of two cylinders during that stroke of its piston, during which in the normal work of the engine the expansion of the exploded gases would take place.

3. In a four stroke cycle explosion-engine with four cylinders, the combination with four spring-pressed inlet-valves in the four cylinders and adapted to severally open into the latter under the pressure of compressed air or gas, of a connection on the four cylinders above said four spring-pressed inlet-valves and comprising a cylindrical bore in its middle with a connection for the supply of compressed air or gas, also with four openings and four separate channels leading from the four openings to the spring-pressed inlet-valves, a rotary tubular distributing valve mounted to turn in the cylindrical bore of said connection and provided with two apertures which are so disposed as to severally

and each supply compressed air or gas through the respective channel to either of two cylinders during that stroke of its piston, during which in the normal work of the engine the expansion of the exploded gases would take place, and means for so driving said rotary tubular distributing valve that it makes one revolution on every two revolutions of the crank-shaft.

4. In a four stroke cycle explosion-engine with four juxtaposed cylinders, the combination with four spring-pressed inlet-valves in the four cylinders and adapted to severally open into the latter under the pressure of compressed air or gas, of a connection on the four cylinders above said four spring-pressed inlet-valves and comprising a cylindrical bore in its middle with a connection for the supply of compressed air or gas, also with two opposite pairs of superposed openings and four separate channels leading from the four openings to the four spring-pressed inlet-valves, a rotary tubular distributing valve mounted to turn in the cylindrical bore of said connection and provided with two apertures in two parallel planes at right angles to its axis, which apertures are so disposed as to severally and each supply compressed air or gas through the respective channel to either of two cylinders during that stroke of its piston, during which in the normal work of the engine the expansion of the exploded gases would take place, and means for so driving said rotary tubular distributing valve that it makes one revolution on every two revolutions of the crank-shaft.

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