No. 877,377. PATENTED JAN. 21, 1908.

H. SAURER.

STARTING DEVICE FOR EXPLOSION ENGINES WITH FOUR CYLINDERS.

APPLICATION FILED SEPT. 14, 1907.

3 SHEETS—SHEET 1.

Fig. 2.

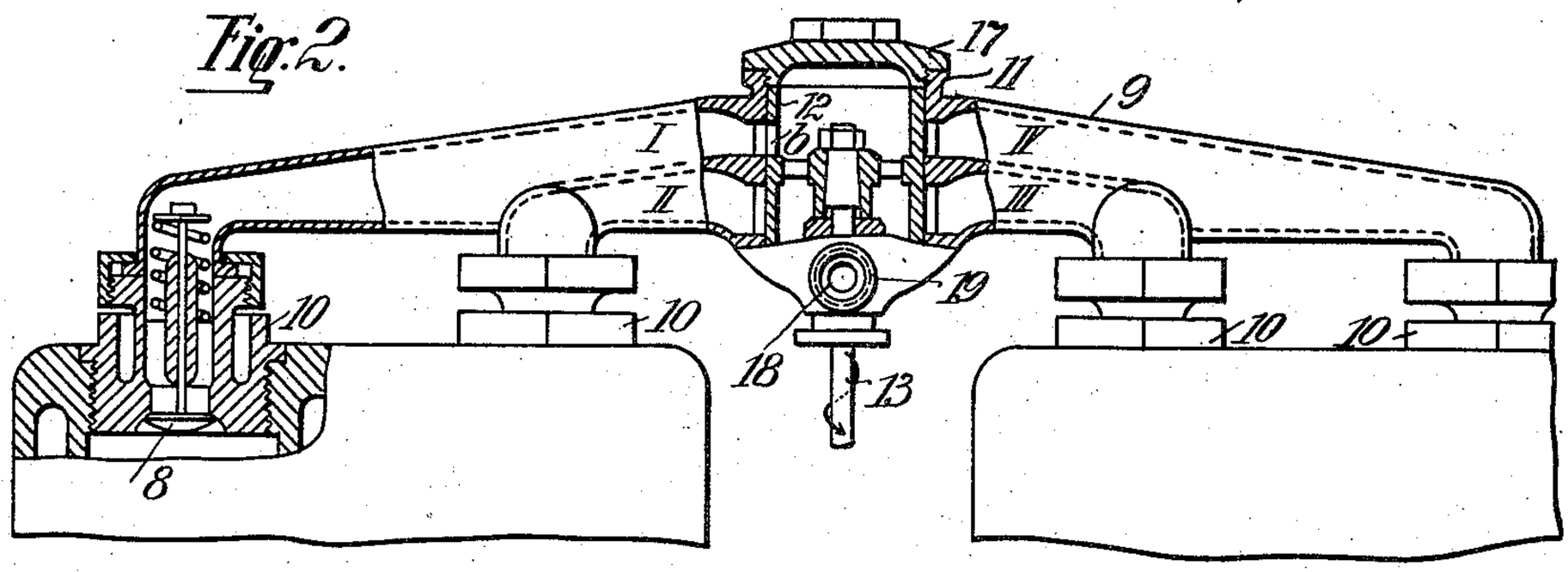


Fig. 4.

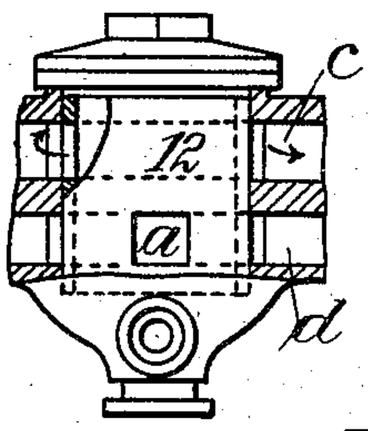


Fig. 5.

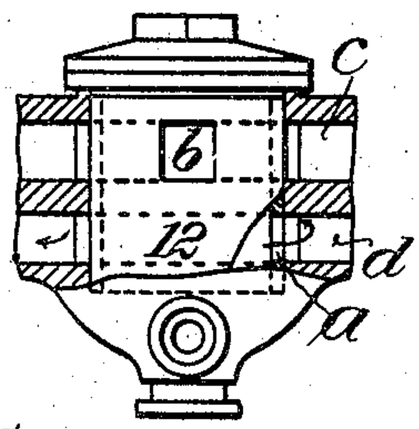


Fig. 6.

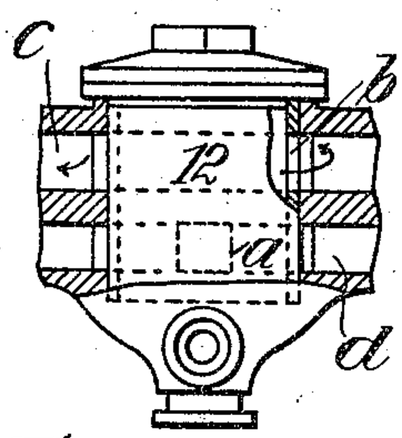


Fig. 7.

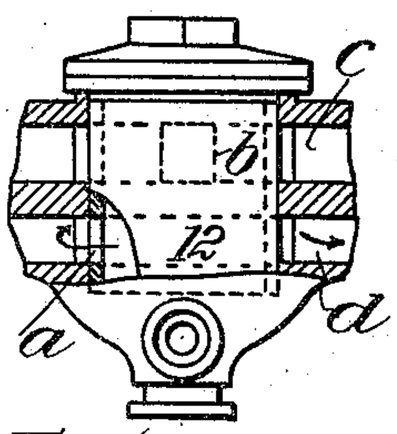


Fig. 4a

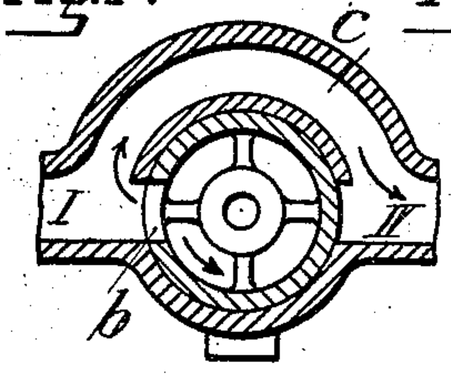


Fig. 5a

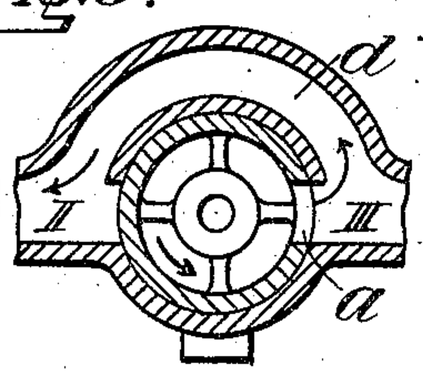


Fig. 6a

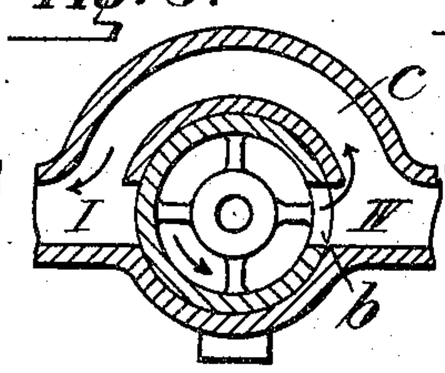
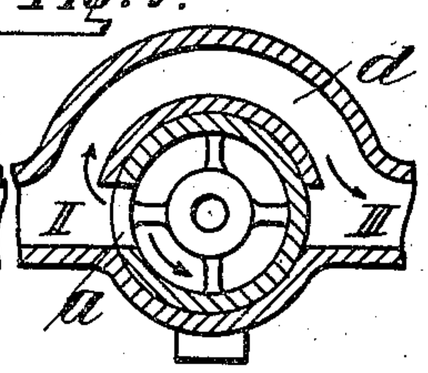


Fig. 7a



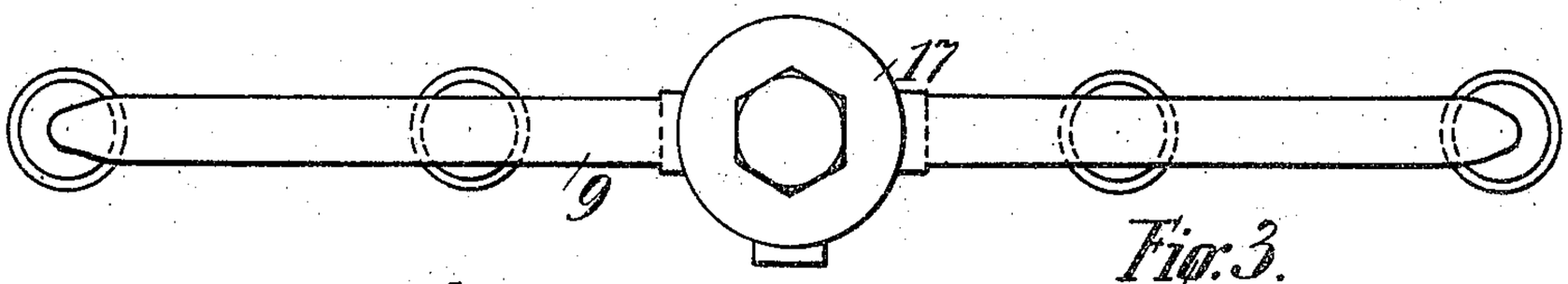
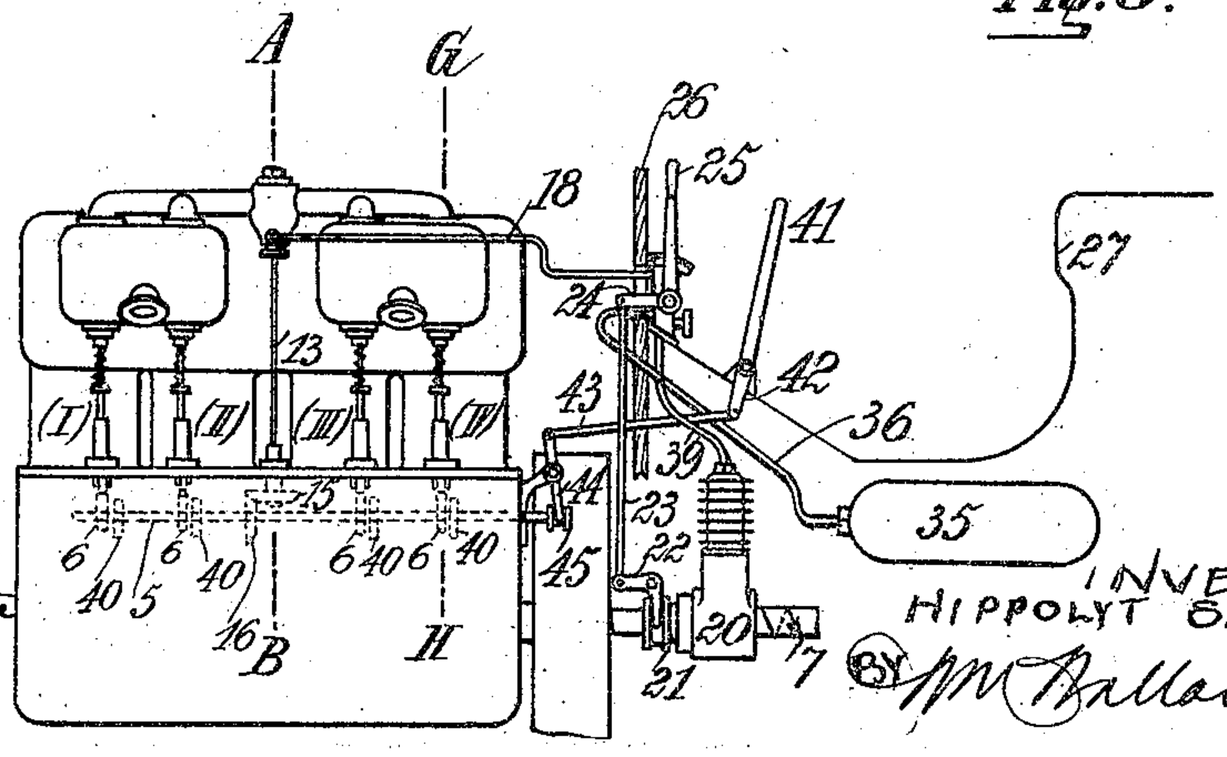


Fig. 3.

Fig. 1.



WITNESSES
Alvin G. White
W. P. Burke

INVENTOR.
HIPPOLYT SAURER.
BY Wm Ballard Bliss
ATTY

No. 877,377. PATENTED JAN. 21, 1908.

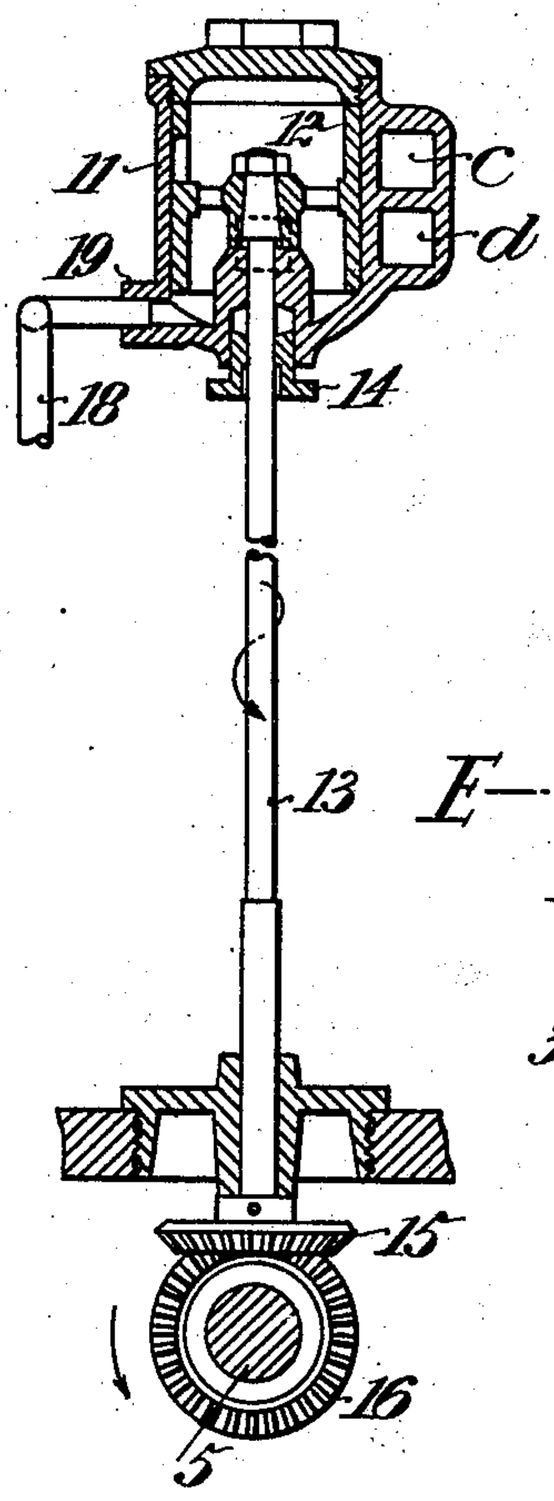
H. SAURER.

STARTING DEVICE FOR EXPLOSION ENGINES WITH FOUR CYLINDERS.

APPLICATION FILED SEPT. 14, 1907.

3 SHEETS—SHEET 2.

Fig. 9.



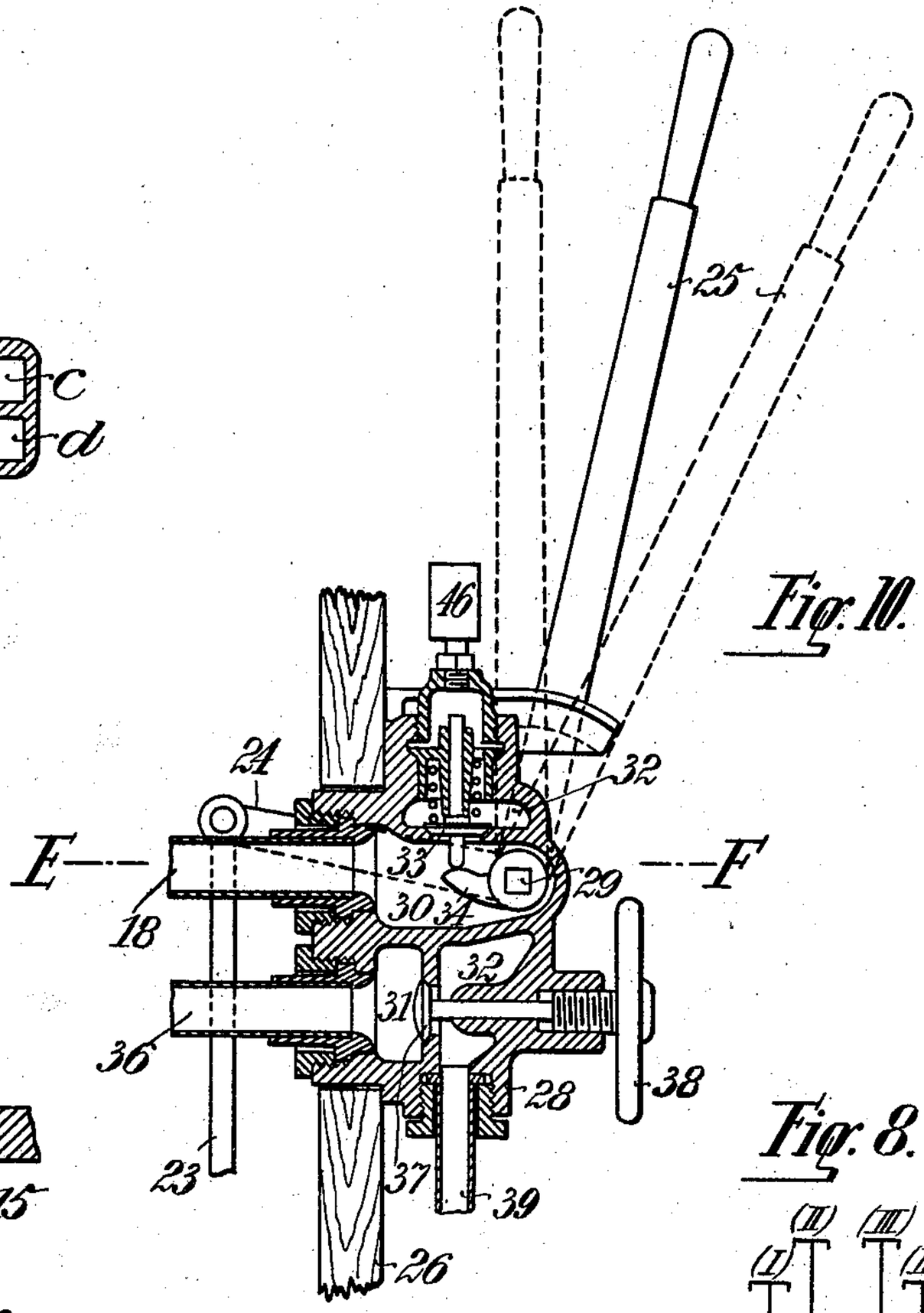


Fig. 10.

Fig. 8.

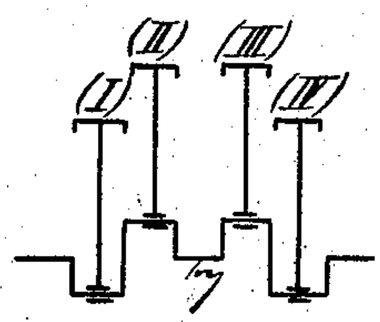
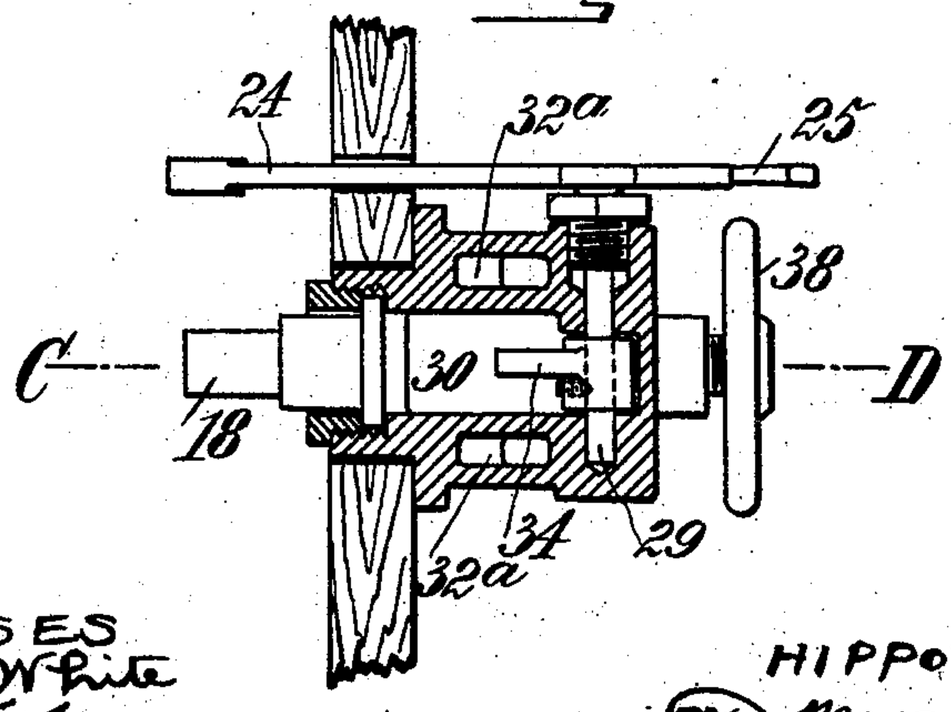


Fig. 11.



WITNESSES
Alvin S. White
W. P. Burke

INVENTOR
HIPPOLYT SAURER
BY
ATTY.

No. 877,377. PATENTED JAN. 21, 1908.

H. SAURER.

STARTING DEVICE FOR EXPLOSION ENGINES WITH FOUR CYLINDERS.

APPLICATION FILED SEPT. 14, 1907.

3 SHEETS—SHEET 3.

Fig. 12.

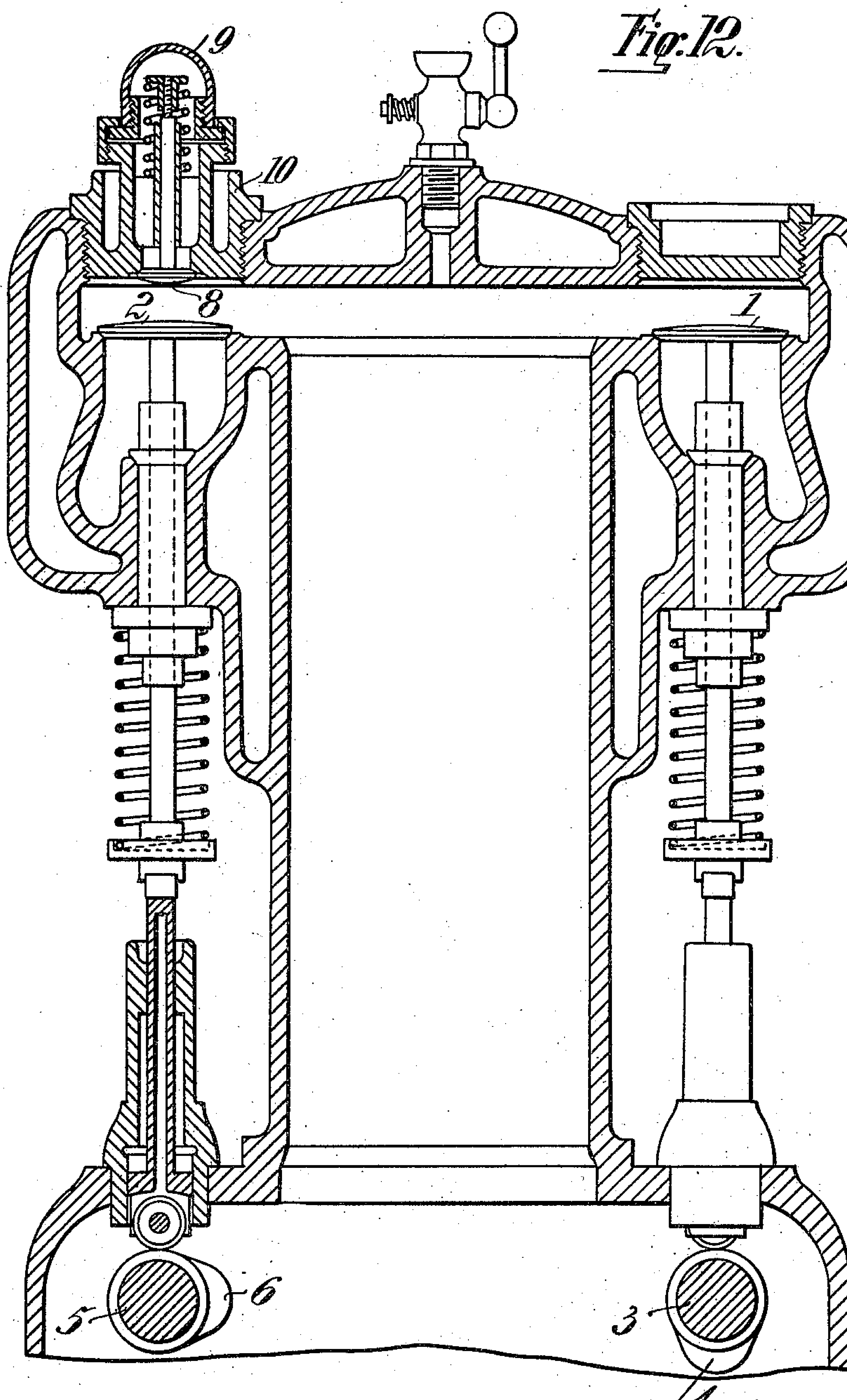
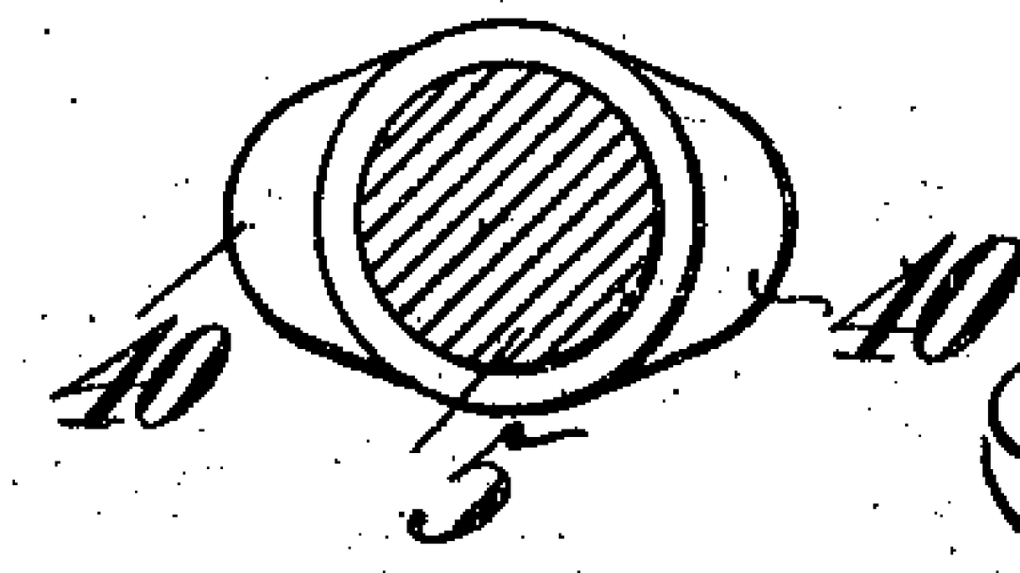


Fig. 13.



WITNESSES
Alvin G. White
W. P. Burke

INVENTOR
HIPPOLYT SAURER
BY H. M. ... ATTY

UNITED STATES PATENT OFFICE.

HIPPOLYT SAURER, OF ARBON, SWITZERLAND.

STARTING DEVICE FOR EXPLOSION-ENGINES WITH FOUR CYLINDERS.

No. 877,377. Specification of Letters Patent. Patented Jan. 21, 1908.

Original application filed October 6, 1906, Serial No. 337,707. Divided and this application filed September 14, 1907. Serial No. 392,913.

To all whom it may concern:

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

This application is a division of an application, Serial No. 337,707, filed by me October 6, 1906, in which I have described a starting device for a four stroke cycle explosion-engine with four cylinders in an automobile. By means of this device during the start of the automobile compressed air is supplied to every cylinder once on every two revolutions of the crank-shaft.

My invention relates to a modification of this starting device, whereby the compressed air is supplied to every cylinder once on every revolution of the crank-shaft.

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

Figure 1 is an elevation of an explosion-engine provided with the new starting device, part of the automobile being indicated by an outline, Fig. 2 is an elevation on an enlarged scale 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 extreme cylinder being shown in section, Fig. 3 is a plan of the same, Figs. 4 to 7 show on a reduced scale four different positions of the rotary distributing valve, the latter itself being shown substantially in elevation, Figs. 4ª to 7ª are horizontal cross sections through the same and its box and correspond to Figs. 4 to 7 respectively, Fig. 8 is a diagram, which will be referred to later on, Fig. 9 is a vertical cross section (on the same scale as Figs. 2 and 3) through the rotary distributing valve and its driving mechanism on the line A—B in Fig. 1, 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 C—D in Fig. 11, Fig. 11 is a horizontal section through the same on the line E—F in Fig. 10, Fig. 12 is a vertical cross section on an enlarged scale through the line G—H in Fig. 1 and shows one of the four cylinders with its ordinary inlet and outlet valves and the inlet valve of the new starting device, and Fig. 13 is a vertical cross section through the left cam shaft in Fig. 12 in another plane and shows two cams instead of the single one.

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

The new starting device to be described hereinafter is suitable for a four stroke cycle explosion-engine with four cylinders and a crank-shaft having its four cranks set in one and the same plane. I have discovered, that automobiles provided with vertical explosion-engines of this kind invariably so stop, that the crank-shaft occupies a horizontal position or nearly so and that the piston in one of the four cylinders is about in the middle of its stroke, it having stopped during the expansion of the exploded gases. This position of the said piston is most favorable for the start of the automobile, since compressed air or gas acting upon the piston will be able to at once overcome the resistance.

In Fig. 1 I have shown a known four stroke explosion-engine, the construction of which with the exception of that of the crank-shaft just mentioned, is immaterial to my invention. The engine comprises four cylinders marked (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. As Fig. 8 diagrammatically shows, the four cranks of the crank-shaft 7 are in one and the same plane. 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. 2 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 Figs. 2 and 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. 2 and 9) to permit the compressed air or gas to pass upwards.

An air-compressor 20 (see Fig. 1) 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 7 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 two bevel wheels 15 and 16 are made alike and the cam shaft 5 is driven at the rate of 2:1 as mentioned above, it follows that the rotary tubular distributing valve 12 makes one revolution of every two revolutions of the crank-shaft 7. Thus the speed of the rotary tubular distributing valve 12 is kept moderate, which is preferable for its satisfactory operation. In order to admit the compressed air or gas to every cylinder once on every revolution of the crank-shaft 7, the two upper channels I and IV are put in communication with one another by means of a passage *c* and in a similar manner the two lower channels II and III are connected by means of a passage *d*, as is shown. Then the compressed air or gas will be admitted to any two cylinders at a time, if either aperture *a* or *b* registers with either of the two channels II and III or I and IV respectively. This will be clear from an examination of Figs. 4 to 7 and 4^a to 7^a. Of course for the start the four stroke cycle requires to be turned into a two-stage cycle. For this purpose any known mechanism may be employed. For example the cam shaft 5 may be made longitudinally movable and may be provided with four pairs of opposite cams 40, 40 in addition to the four single cams 6, see Fig. 13. These pairs of cams 40, 40 are disposed at a certain uniform distance from the single cams 6, so that it is only necessary to shift the cam shaft 5 through the said distance in either direction for causing the outlet-valves 2 to be each opened once for every revolution or once for every two revolutions of the crank-shaft 7 respectively. The longitudinal motion of the cam shaft 5 may be effected from the driver's seat by means of a hand-lever 41, its arm 42, a rod 43 and a two-armed lever 44 shown in Fig. 1, the lower arm of the two-armed lever 44 being forked and engaging by means of two pins in a grooved disk 45 fastened on the cam shaft 5.

In order to render the following explanations intelligible, it is first assumed that the two passages *c* and *d* were omitted, so that the compressed air or gas is admitted to every cylinder only once for every two revolutions of the crank-shaft.

The crank-shaft 7 is assumed to be bent in the manner shown at Fig. 8 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. 4 to 7 and 4ª to 7ª. For the position of the valve 12 shown in Figs. 4 and 4ª 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 (II), as is shown at Figs. 5 and 5ª. 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. 6 and 6ª. 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. 7 and 7ª will prove.

From the above it will be seen, that the outlet-valves 2 are severally always opened at the correct moments for permitting the wasted air to escape, if there are no passages *c* and *d*. As the passages *c* and *d* are actually there and each cylinder receives the compressed air once for every revolution of the crank-shaft 7, of course the start of the automobile will be accelerated. The compressed air or gas will be admitted to any two cylinders at a time, if either aperture *a* or *b* registers with any of the four channels I to IV. This will be clear from an examination of Figs. 4 to 7 and 4ª to 7ª. For the position of the rotary tubular distributing valve 12 shown at Figs. 4 and 4ª the compressed air or gas will be admitted through the upper aperture *b* and the channel I to the first cylinder (I) and also through the passage *c* and the channel (IV) to the fourth cylinder (IV). After the turn of the valve 12 through 90° the compressed air or gas will be supplied through the lower aperture *a* and the channel III to the third cylinder (III) and also through the passage *d* and the channel II to the second cylinder (II), see Figs. 5 and 5ª, and so on. As the two cams 40, 40 of every pair on the cam shaft 5 are set at an angle of 180° from each other, it follows, that the corresponding outlet-valve 2 will be opened once for every revolution of the crank-shaft 7, and also that all the outlet-valves 2 are severally opened at the right moments, that is to say once during the exhaust stroke and once during the compression stroke of each piston.

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 46 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 shifts by means of the hand-lever 41 the cam shaft 5 into the other extreme position, so as to bring the pairs of cams 40, 40 into the planes of the outlet-valves 2. Next 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 two of the four channels I to IV and open the spring-pressed inlet-valves 8 of two cylinders. The compressed air or gas driving their pistons will start the engine. The spent air will be discharged through the outlet-valves 2 during the following stroke, while the compressed air or gas will enter the two other cylinders and drive their pistons. After the start the driver may close the stop valve 33 and return the hand-lever 41 to its initial position 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, the four channels I to IV and the passages *c* and *d*, 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 therefrom 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, said connection being provided with two passages for each connecting two of the four channels.

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 therefrom 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, said connection being provided with two passages for each connecting two of the four channels.

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 joint for the supply of compressed air or gas, also with four openings and four separate channels leading therefrom 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 which are so disposed as to severally and each supply compressed air or gas to two cylinders at a time, said connection being provided with two passages for each connecting two of the four channels.

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 joint for the supply of compressed air or gas, also with two opposite pairs of superposed openings and four separate channels leading therefrom 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 to two cylinders at a time, said connection being provided with two passages for each connecting two of the four channels, and means for so driving said rotary distributing valve that it makes one revolution on every two revolutions of the crank-shaft.

HIPPOLYT SAURER

Witnesses:
A. KELLER,
EUGENE NABEL.