J. MUCHKA.

PRODUCTION OF PROTECTIVE GAS.

APPLICATION FILED JAN. 6, 1921.

1,413,285. Patented Apr. 18, 1922.

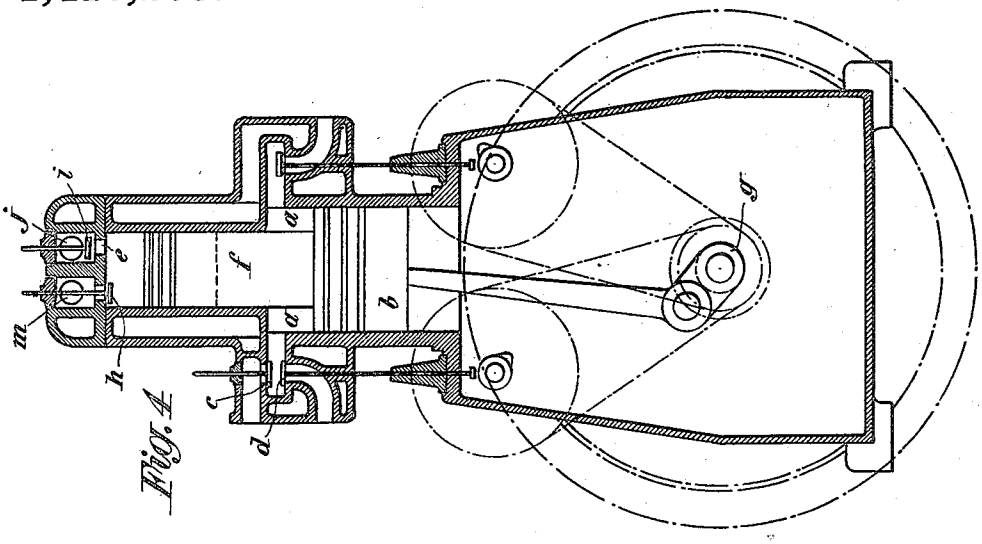

Fig. 4

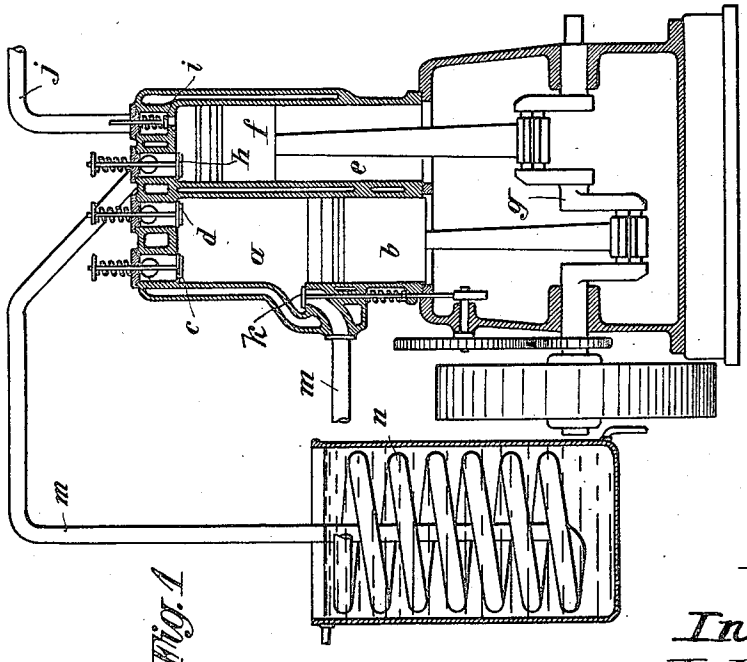

Fig. 1

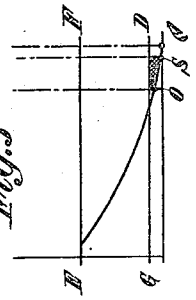

Fig. 3

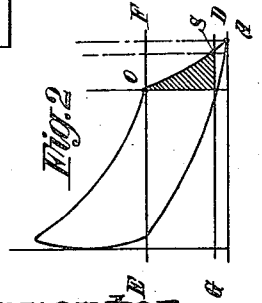

Fig. 2

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PRODUCTION OF PROTECTIVE GAS.

1,413,285. Specification of Letters Patent. Patented Apr. 18, 1922.

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To all whom it may concern:

Be it known that I, JOSEF MUCHKA, residing at 39 Wallgasse, Vienna VI, Austria, have invented certain new and useful Improvements in and Relating to the Production of Protective Gas, (for which I have filed applications in Austria Sept. 24, 1915, and in Germany Feb. 7, 1917,) of which the following is a specification.

In large installations for the storage of highly inflammable liquids, which naturally require considerable quantities of protective gas, it is usual to produce the latter with the aid of special machines on the premises. This has the advantage that a substitution for the protective gas of another gas kept in stock becomes impossible and the installation is independent of the delivery of the protective gas through other undertakings.

Such protective gas producers consist substantially of an internal combustion engine, the waste gases of which, consisting of carbondioxide, nitrogen and water vapor, provide the protective gas, which is sucked through a suitable arrangement over a cooling and purifying device and is transmitted to a collecting vessel. These purified waste gases consisting mainly only of carbondioxide and nitrogen are thereupon converted in a known manner by means of a compressor into pressure gas and are used for superposition on the inflammable liquid.

It is essential for the use of such protective gas producers, that they shall only deliver protective gas, which is free from unburnt components, that is, such as contain oxygen.

This problem is solved according to the present invention by only such a quantity of combustion gases being taken from the cylinder of the internal combustion engine as protective gas, as is capable of flowing away during the explosion stroke in consequence of the pressure being above the pressure obtaining in the protective gas pipe. The remaining portion of the combustion gases is allowed to escape into the atmosphere during the following exhaust stroke.

The pressure above atmospheric, which still obtains only in the case of normal ignition at the end of the explosion stroke within the cylinder, provides complete safety against the conducting away to the protective gas pipe of unburnt gas mixtures which are present in the cylinder in the case of misfires.

The drawing off of the quantity of gas taken away at the end of the explosion stroke for the purpose of collecting it is effected in the simplest manner by adding a specially controlled outlet or over-pressure member, to which is connected the protective gas pipe leading to the collector. This over-pressure member is opened towards the end of the explosion stroke and is again closed before the piston commences the exhaust.

If, in consequence of a misfire, there should not occur the great over-pressure in the cylinder due to the explosion alone, through lack of an over-pressure at the end of the idle stroke thus caused no gas can pass from the cylinder into the protective gas pipe. There will however be a backward flow of protective gas from the said pipe to the cylinder, as the pressure in the protective gas pipe in this case is higher than the end pressure in the cylinder.

In the accompanying drawing two constructional examples of protective gas producers working according to the described method are shown in Figures 1–4 diagrammatically in section. The diagrams shown in Figures 2 and 3 show the course of the pressure line during the compression stroke and explosion stroke, the former (Figure 2) when the engine is working normally, the latter (Figure 3) for the case of the ignition failing (misfire).

The apparatus consists, according to Figure 1, in a known manner, of an internal combustion engine which is preferably a four-stroke one, having the piston *b* working in the cylinder *a*, the controlled inlet valve *c* and the controlled exhaust valve *d*.

For transferring the combustion gases, which must be first freed from water vapor, into the protective gas collector, according to the constructional form shown, a compressor is provided consisting of the cylinder *e*, the piston *f* of which is driven by the shaft *g* of the internal combustion engine. The compressor is provided with the suction valve *h* and the pressure valve *i*, which latter controls the pressure pipe *j* leading to the protective gas collector (not shown).

According to the invention there opens into the cylinder *a* of the internal combustion engine a pipe *m* which is closed by a valve *k* operating at a pressure above atmospheric, which leads through a cooling device *n* and a purifier (not shown) to the suction valve *h* of the compressor.

The controlled valve *k* is opened with the last part of the working stroke of the piston *b*, shortly before it reaches its bottom dead centre, so that, in consequence of the relatively great pressure above atmospheric, still obtaining in the cylinder in this part of the stroke, combustion gases can pass from the cylinder to the pipe *m*.

This flowing away of the waste gases continues up to the positive closing of the valve *k*, occurring immediately before the end of the explosion stroke, which takes place before the piston commences the following exhaust stroke.

During this period, in consequence of the flowing away of gas through the pipe *m* to the cooler *n*, the pressure of the waste gases remaining in the cylinder *a* will have sunk to the small pressure above atmospheric obtaining in the pipe *m*. The gas still remaining in the cylinder at the end of the working stroke is thereupon forced out by the piston *b*, which is carrying out its exhaust stroke, through the exhaust valve *d*, which is in the open position.

In the diagram, Figure 2, which shows the course of the pressure for normal ignition, the horizontal line C—D represents the small pressure above atmospheric in the protective gas pipe *m*, i. e., before the compressor. The line E—F indicates the pressure obtaining in the last part of the explosion stroke at the moment of the opening of the controlled outlet member *k* in the interior of the cylinder *a* and amounting to approximately 5–7 atmospheres.

The point 0 of the expansion line corresponds to the moment of opening and the point S to the moment of closing of the valve *k*, while the point A gives the moment of the commencing of the exhaust.

Thus the diagram shows that within the abscissæ section from O—S, in consequence of the pressure above atmospheric obtaining in the cylinder, the quantity of gas corresponding to the shaded triangular surface can, on the valve *k* being opened, flow off from the cylinder *a* into the pipe *m*. Within the last abscissæ section S—A the further expansion in the cylinder takes place up to the preliminary flowing out of the gas just before the end of the stroke, which flowing out is followed immediately by the exhaust period, which takes place during the whole of the subsequent stroke. The preliminary flowing out and the forcing out of the remainder of the waste gas from the cylinder into the atmosphere takes place in a known manner through the exhaust valve *d*, which remains open during this whole period.

If, however, there is a misfire, the explosion period will also be omitted and in this case, as shown in Figure 3, the expansion line coincides with the compression line corresponding to the previous stroke. The ordinates of these lines do not extend within the interval of time limiting the period of opening of the valve *k* beyond the line C—D corresponding to the pressure in the pipe *m* before the compressor *e*. Hence, in this case, in spite of the opening of the valve *k*, no gas mixture can pass from the cylinder *a* to the protective gas pipe *m*, but from the latter, in consequence of the pressure above atmospheric obtaining continuously in the same, a small portion of the combustion gas, which has already flowed off, will flow back into the cylinder. During the following exhaust stroke, which commences at the point A the entire unburnt charge will be forced through the valve *d* out of the cylinder *a* into the atmosphere.

Thus unburnt gas, containing oxygen can never get into the protective gas pipe.

In Figure 4 a further constructional form of the arrangement described above, working according to the same method, is shown diagrammatically in section.

In this case, the cylinder *e* of the compressor is not located next to the cylinder *a* of the internal combustion engine, but on it. In this arrangement as well through the direct coupling of the two pistons *b* and *f* during the stroke of the explosion period the flowing off of the combustion gases from the cylinder *a* of the internal combustion engine takes place in the same manner through the pipe *m* by way of the valve *h* into the cylinder *e* of the compressor, as was described in connection with the arrangement shown in Figure 1.

In this case as well the unburnt gases will not flow off to the pipe *m* in the case of a misfire for the same reasons.

The small losses of protective gas, which occur in consequence of the backward flow of small quantities of the combustion gases from the pipe *m* to the interior of the cylinder *a* in the case of misfires and therefore occur only exceptionally, are fully compensated by the advantage of the complete reliability in working, which could hitherto be obtained only with more complicated apparatus and even then not completely.

For the rest, the arrangement, as is obvious, is not dependent on a compressor being used with it, which receives the waste gases directly from the internal combustion engine, but for conveying the waste gases away other suitable arrangements can be used.

The member *k* need not be fitted to the lower end of the cylinder *a* of the internal combustion engine, but can be connected at any point on the cylinder. In place of the valves, slides or any other cut-off means may be used with the same effect. It is only essential that the positive opening of the said member shall only take place at the moment,

when, in consequence of the piston being near the end of the stroke, in the case of misfires, the expansion in the interior of the cylinder has progressed so far that the pressure obtaining within the cylinder at this moment has already fallen below the pressure of the combustion gases in the pipe before the compressor.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A method for the production of protective gas by means of an internal combustion engine which consists in conducting that portion of the combustion gases which flows from the cylinder of the internal combustion engine into a protective gas pipe during part of the explosion stroke due to the pressure in the cylinder being above the pressure existing in the said protective gas-pipe, and allowing the remaining portion of the combustion gases to be conducted out of the cylinder of the internal combustion engine into the atmosphere during the following exhaust stroke.

2. A method for the production of protective gas by means of an internal combustion engine, which consists in conducting that portion of the combustion gases which flows from the cylinder of the internal combustion engine into a protective gas-pipe during part of the explosion stroke, due to the pressure in the cylinder being above the pressure existing in the said protective gas-pipe and being at a point of the explosion stroke at which the pressure for the corresponding position of the piston of the engine during the compression stroke is lower than the pressure existing in the protective gas-pipe, and allowing the remaining portion of the combustion gases to be conducted out of the cylinder of the internal combustion engine into the atmosphere during the following exhaust stroke.

3. An apparatus consisting of a four-stroke internal combustion engine for the production of protective gas according to the method as claimed in Claim 1, comprising in addition to the cylinder of the internal combustion engine and the usual exhaust member, a cut-off member operating at a pressure above atmospheric to which a protective gas pipe is connected and which is intended to be opened towards the end of the explosion stroke, but be closed again before the stroke is quite completed.

In testimony whereof I have signed my name to this specification.

JOSEF MUCHKA.

Witnesses:
HUGO KEIK,
ORNTON KUBIK.