

(No Model.)

N. A. OTTO.
Gas Motor Engine.

No. 241,706.

Patented May 17, 1881.

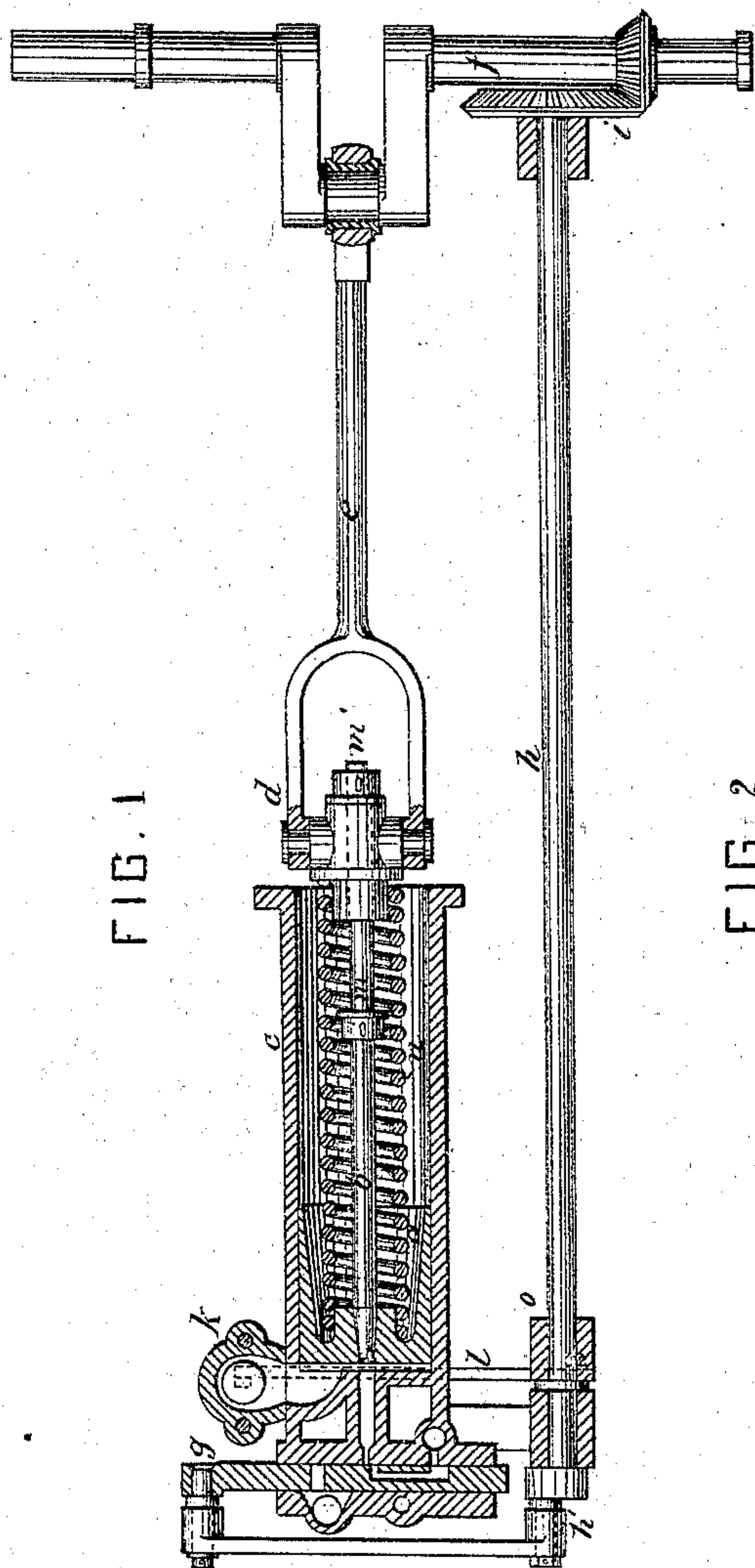


FIG. 1

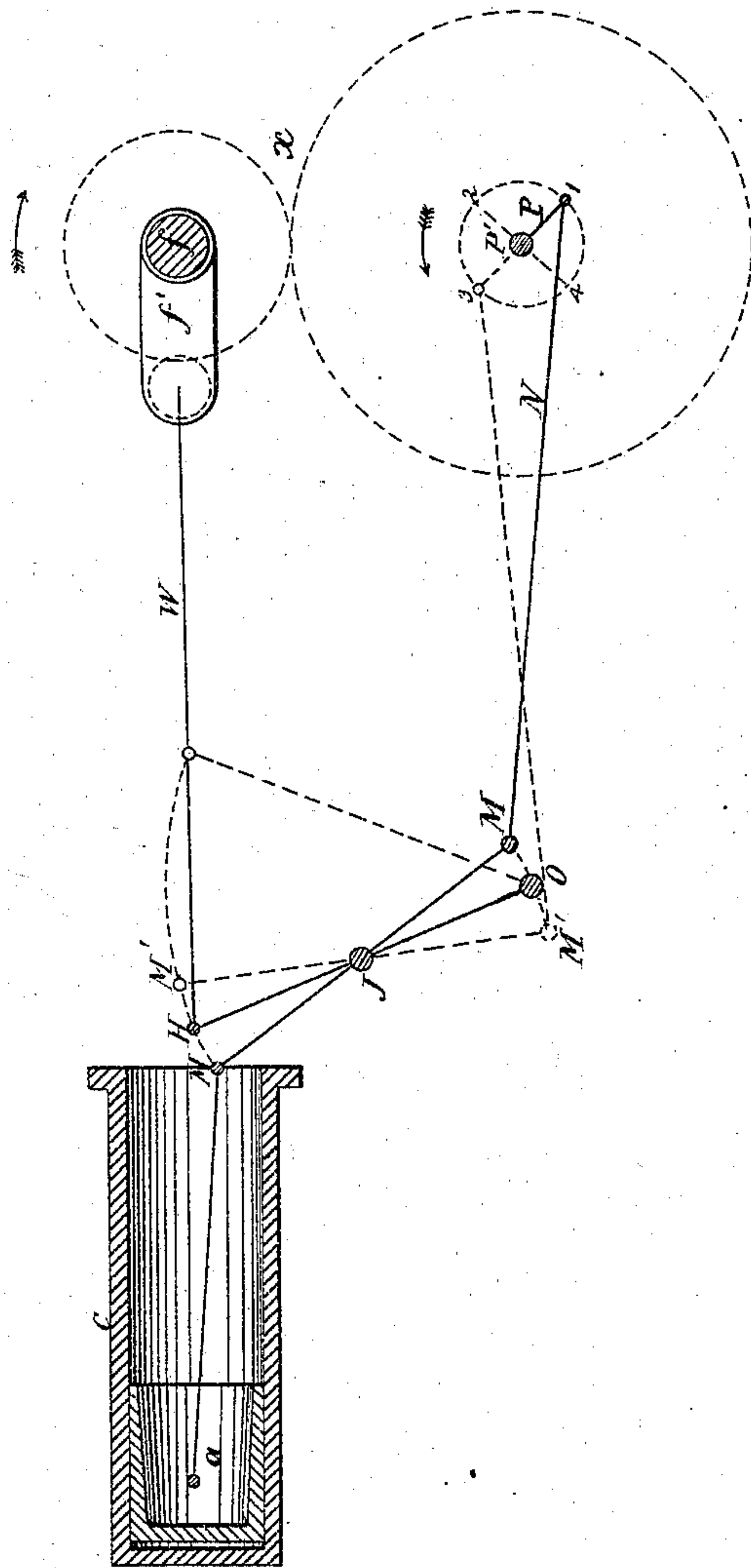


FIG. 2

Witnesses.
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UNITED STATES PATENT OFFICE.

NICOLAUS A. OTTO, OF DEUTZ-ON-THE-RHINE, GERMANY.

GAS-MOTOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 241,706, dated May 17, 1881.

Application filed March 28, 1881. (No model.) Patented in England January 5, 1881.

To all whom it may concern:

Be it known that I, NICOLAUS AUGUST OTTO, a citizen of Prussia, residing at Deutz-on-the-Rhine, in the German Empire, have invented a new and useful Improvement in Gas-Motor Engines, (for which a patent in Great Britain has been obtained by Charles Denton Abel, as a communication to him from abroad by me, bearing date 5th January, 1881, No. 60,) of which the following is a specification.

In gas-motor engines it is found to be very advantageous to ignite the combustible gaseous charge while the piston is still at the dead-center, before commencing the working stroke, or when it has only moved slightly from that position.

In the construction of the gas-motor engine now generally known as the "Otto Silent Engine," and described in the specification to former Letters Patent granted to me, a space was provided in the cylinder beyond the piston when at the end of its instroke for containing the combustible charge, whereby the engine was enabled to be worked in the manner above mentioned, and the space thus formed remained charged with air or products of combustion after the piston had performed its return-stroke after the working outstroke. According to the present invention, the said space is still retained at the end of the cylinder; but the products of combustion are removed therefrom at the end of each return-stroke of the piston after the working outstroke by causing the piston to perform strokes of variable lengths in such manner that during the return-stroke after the working outstroke it advances to near the inner end of the cylinder, so as to expel the whole of the products of combustion, while at the end of the compressing instroke, when it is on or near the dead-center, the piston is situated at some distance from the end of the cylinder, so as to leave a space into which the combustible charge is compressed.

According to another feature described in the before-mentioned previous patent, the combustible charge for the engine was so formed that while a portion of the charge at the point of ignition consisted of undiluted explosive mixture, which rendered ignition certain, the other portion of the charge consisted of combustible gas more or less diluted with or dis-

persed among non-combustible or inert gases, whereby the combustion of the charge, and consequent expansion of the gas, was made to take place gradually. This mode of forming the combustible charge is also applicable with the above-described modes of operating by causing air alone to be drawn in at the commencement, and afterward a combustible mixture of gas and air.

Figure 1 of the accompanying drawings shows a sectional plan of one construction of gas-motor engine operating according to my said invention, only so much of the engine being shown as is necessary to explain the action thereof, the other parts of the engine being either of the same construction as that described in my previous patents of 30th May, 1876, and 14th August, 1877, or of any other known construction of a similar nature.

c is the working-cylinder, and *a* its piston; *b*, the piston-rod; *d*, its cross-head, working in guides, (not shown;) *e*, the connecting-rod; *f*, the crank-shaft, which is provided with a fly-wheel; *g*, the slide-valve, with ports and passages for the admission and ignition of the combustible charge in the manner described in my said patents, for which purpose it is worked by the crank *h'* on counter-shaft *h*, driven by gearing *i* from the crank-shaft *f*, so as to rotate at half the speed of the latter. *k* is the escape-valve for the products of combustion, actuated by lever *l* and cam *o* on shaft *h*, so as to be opened at every alternate instroke of the piston.

As described in my said patents, the piston at its first outstroke draws in a charge of combustible gas and air, then compresses it by the next instroke, after which the charge is fired, causing the piston to perform its working outstroke, and, lastly, the products of combustion are expelled by the following instroke. The rod *b* of the piston is not fixed to the cross-head *d*, but is capable of sliding through the same to an extent limited by the collars *m m'*, fixed thereon, a spring, *n*, tending to maintain the piston in the position with its collar *m'* bearing against the cross-head, so that when no counter-pressure is opposed to the pressure of the spring, the piston will at the end of its instroke be situated close against the cylinder-bottom, as shown, and it will thus be caused

to expel the whole of the products of combustion during its expelling instroke, the escape-valve *k* being open; but when, during the compressing instroke, the pressure of the compressed gases rises above that of the spring *n*, the piston will be forced back until the collar *m* comes in contact with the cross-head *d*, and thus when the piston has arrived at the end of its stroke there will be a space between it and the bottom of the cylinder containing the compressed charge. It will be evident that with this arrangement the charge might also be compressed by a separate pump before being introduced into the cylinder, the pressure of the inflowing charge being made to force back the piston *a* against the action of its spring. In this case the slide-valve *g* would, of course, be arranged to admit a combustible charge at the end of each instroke of the piston, and the escape-valve *k* would be opened at the end of each outstroke, the arrangement of the gear for this purpose being the same as that of any known construction of engine in which the charge is admitted under compression.

Fig. 2 shows diagrammatically an arrangement in which the piston receives a positive movement for effecting the alternate longer and shorter instrokes above described. For this purpose the crank *f'* of the engine-shaft *f* is connected by rod *W* to one end of a lever, *H O*, rocking on a fixed fulcrum at *O*. On a pin, *J*, on this lever is mounted a double-ended lever, *M M*, whose one end is connected to the piston *a*, while its other end is connected by a rod, *N*, to a crank, *P*, on a shaft, *P'*, driven by gearing *x* from shaft *f* at half the speed of the latter. The crank *P* is arranged in the position shown relatively to crank *f'*, so that while piston *a* is performing its suction outstroke crank *P* moves from 1 to 2, and during the following compressing instroke it moves from 2

to 3, thereby moving the lever *M M* relatively to lever *H O* from the position shown in full lines into that shown in dotted lines at *M'*, so that the piston *a* will at the end of the compressing stroke be situated a distance away from the bottom of the cylinder corresponding to the distance between the points *M* and *M'*, thus leaving the requisite space for containing the compressed charge at the end of the cylinder. During the following working outstroke and expelling instroke the crank *P*, in moving from 3 to 1, will move lever *M M* back from the dotted into the full position relatively to *H O*, so that at end instroke piston *a* will be situated close against the cylinder-bottom, as shown.

Having thus described the nature of my invention and in what manner the same is to be performed, I claim in respect of a gas-motor engine whose piston is connected to a crank on the engine-shaft, and in which a space for containing the combustible charge exists between the end of the cylinder and the piston when this is at the end of its stroke—

1. In a gas-motor engine, a working-piston caused to make strokes of different lengths, the rod of said piston being connected to the crank by the intervention of a spring, all constructed and arranged for operation substantially as and for the purpose specified.

2. The combination of cylinder *c*, piston *a*, rod *b*, with collars *m m'*, cross-head *d*, connecting-rod *e*, and crank-shaft *f*, arranged and operating as herein set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 9th day of March, A. D. 1881.

NICOLAUS AUGUST OTTO.

Witnesses:

GUSTAV KLEINJUNG,
EDUARD KIRSCHSIEPER.