No. 696,518. Patented Apr. 1, 1902.

E. THOMSON.

GAS OR OIL ENGINE.

(Application filed June 10, 1899.)

(No Model.) 4 Sheets—Sheet 1.

FIG-1.

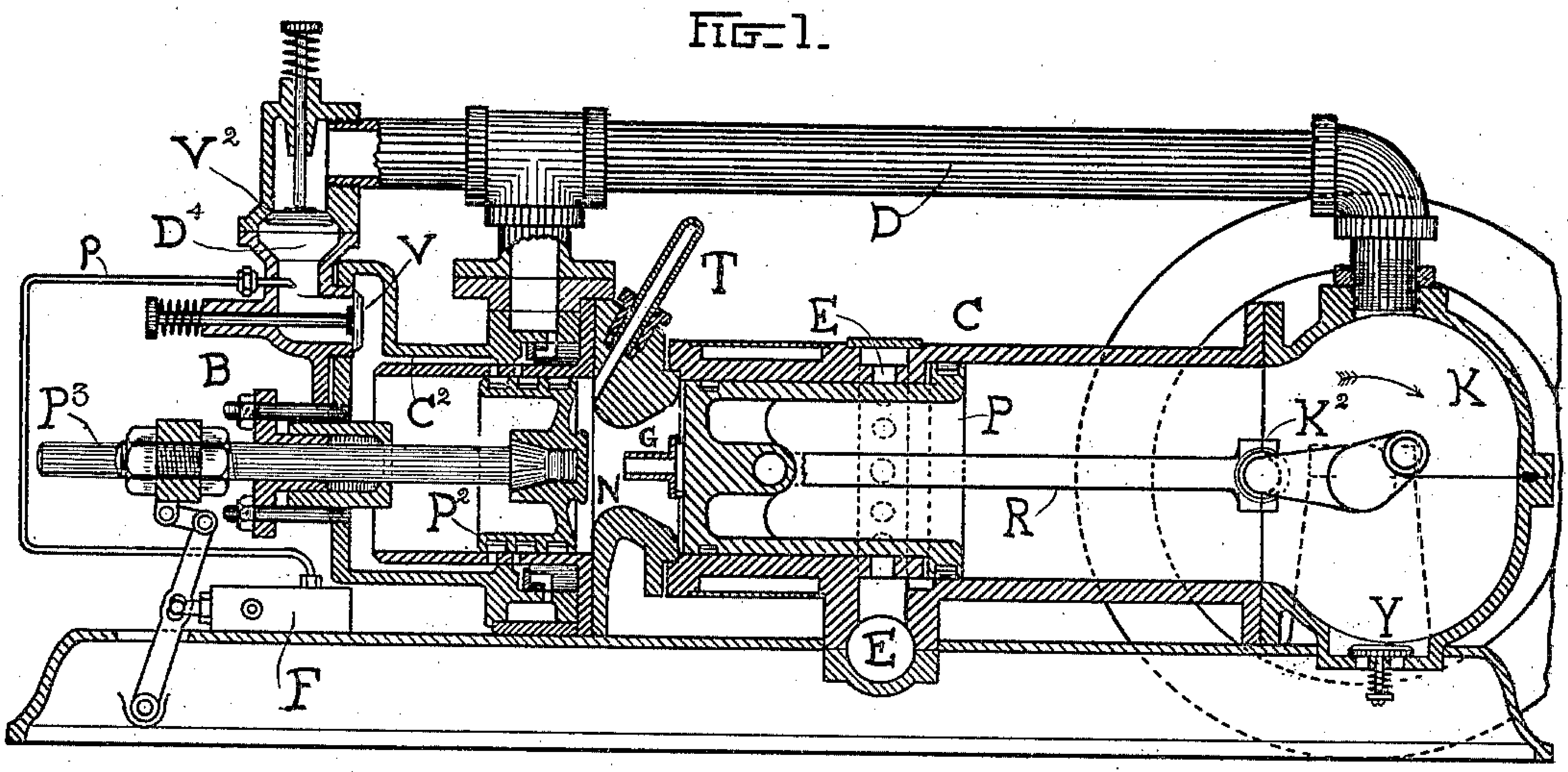


FIG-2.

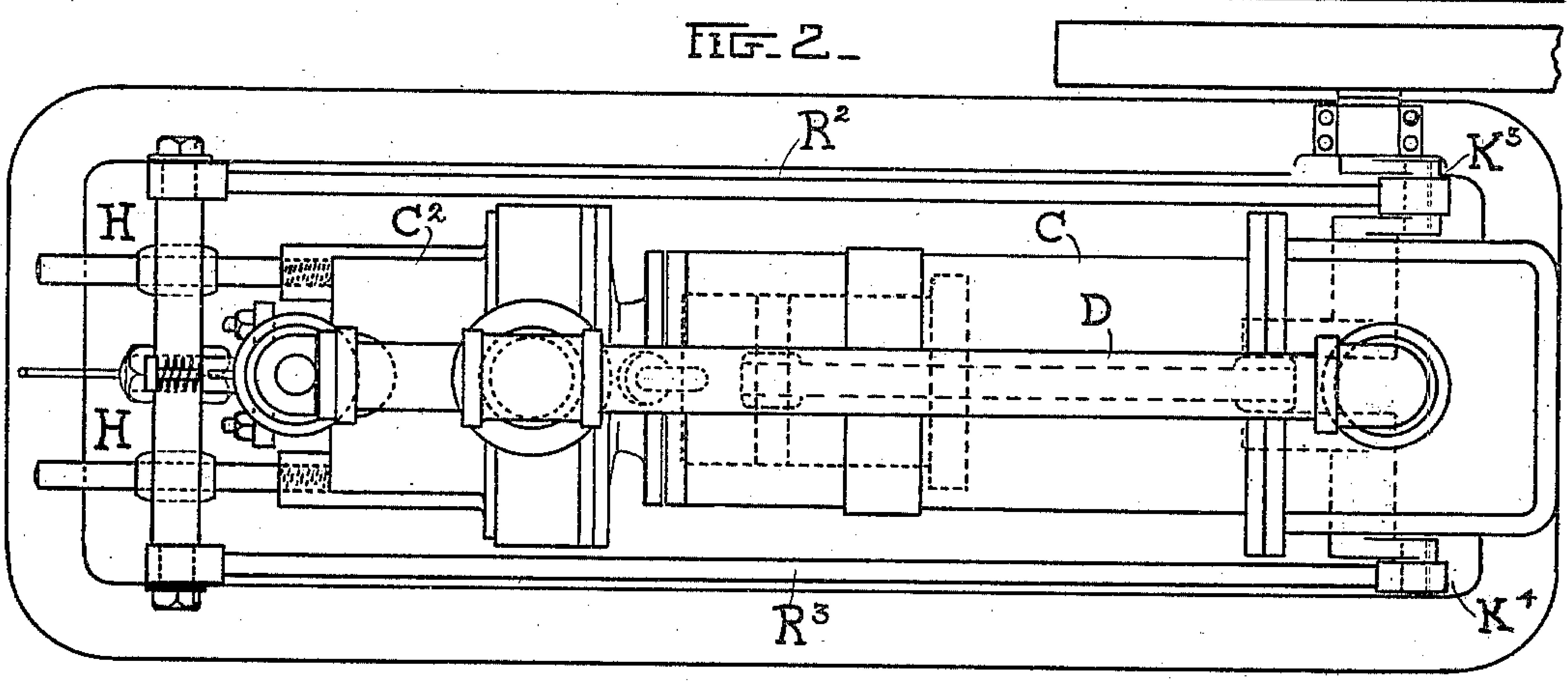


FIG-3.

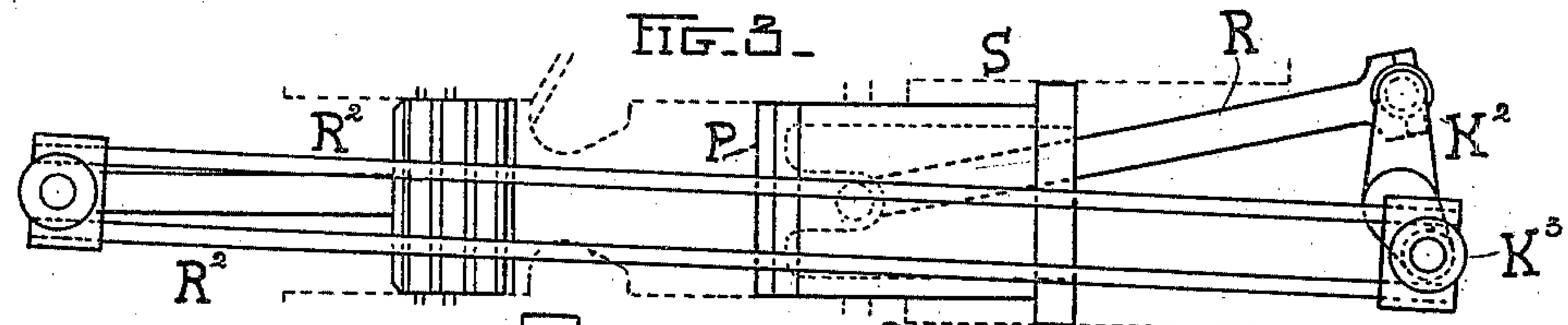
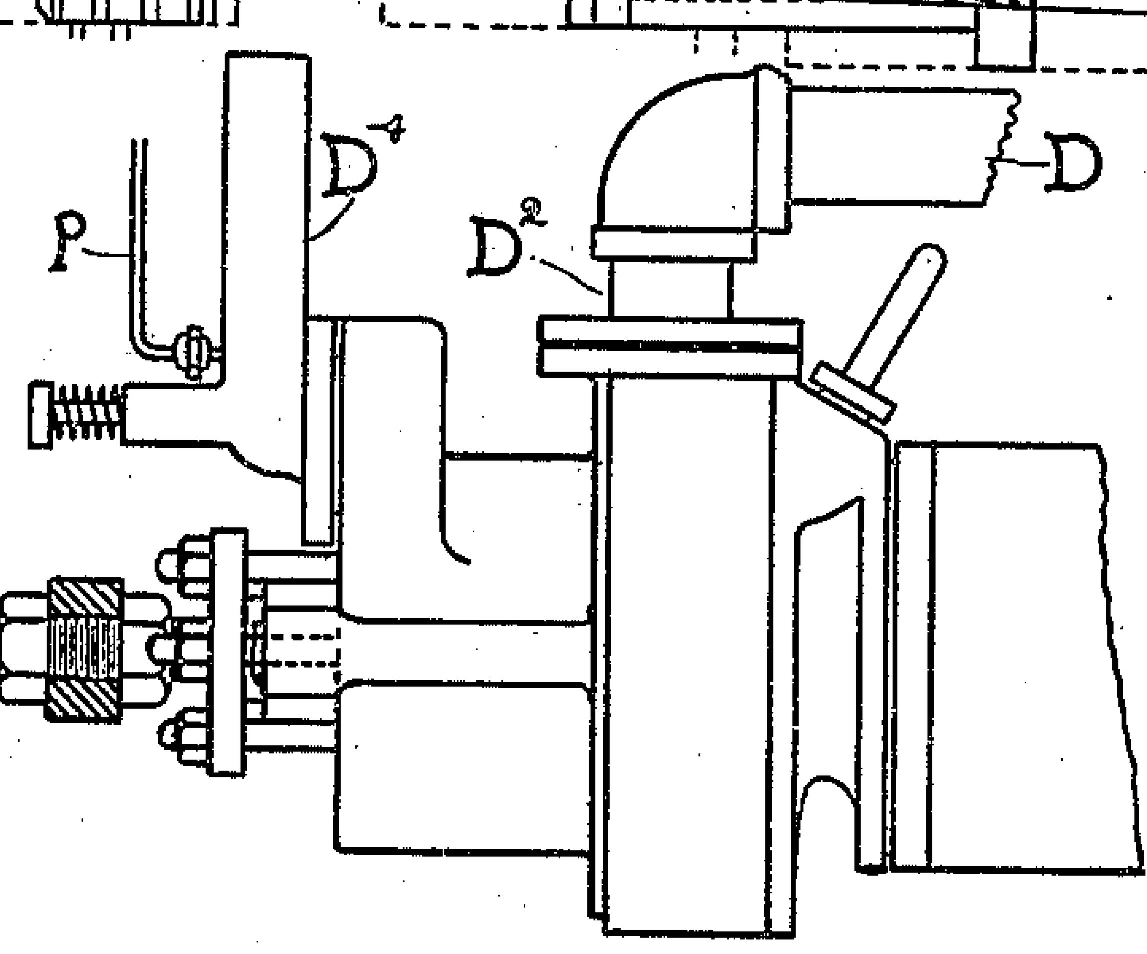


FIG-4.



WITNESSES.

Henry O. Westendarp

Dugald McKillop.

INVENTOR.

Elihu Thomson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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FIG. 5.

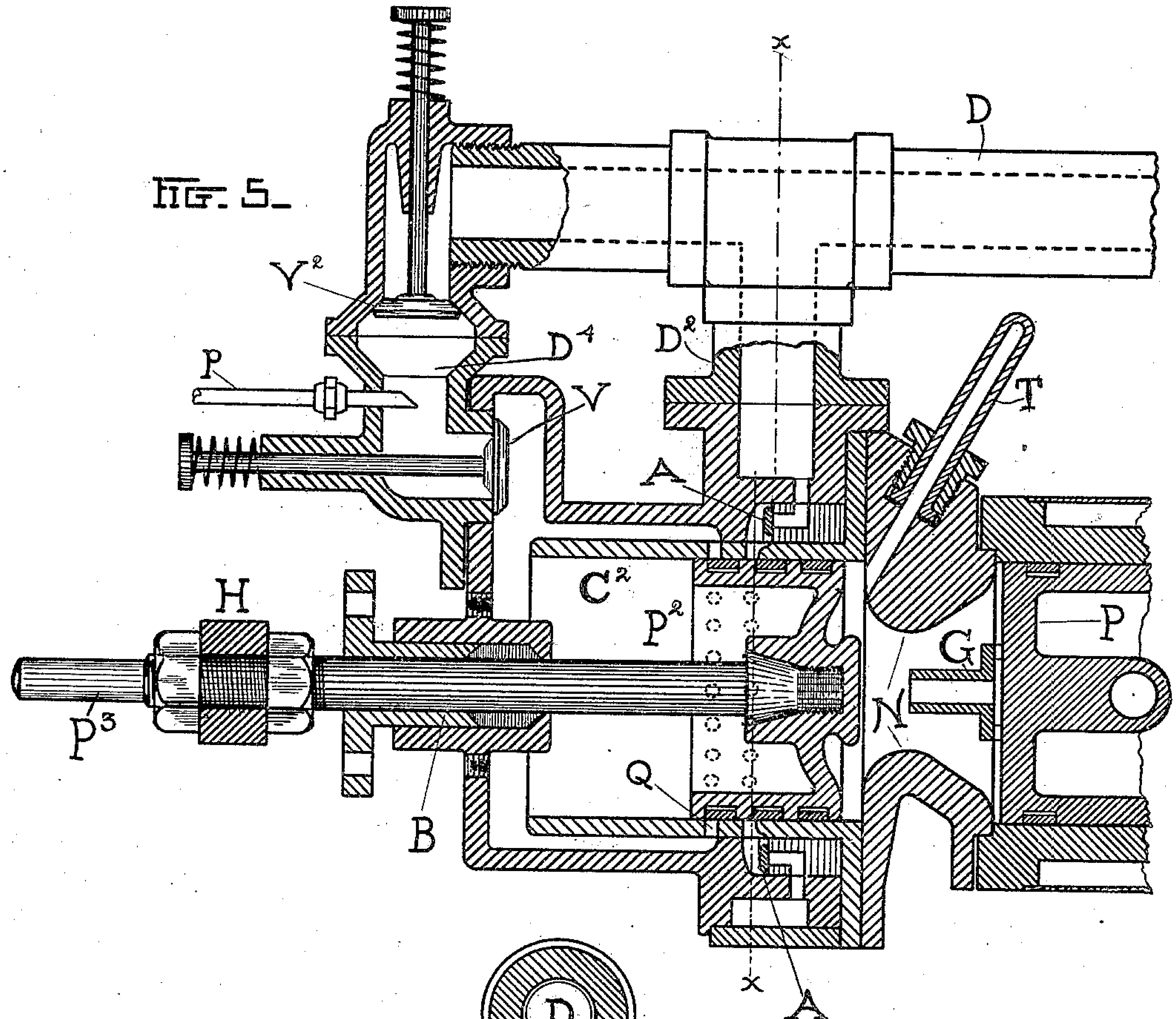
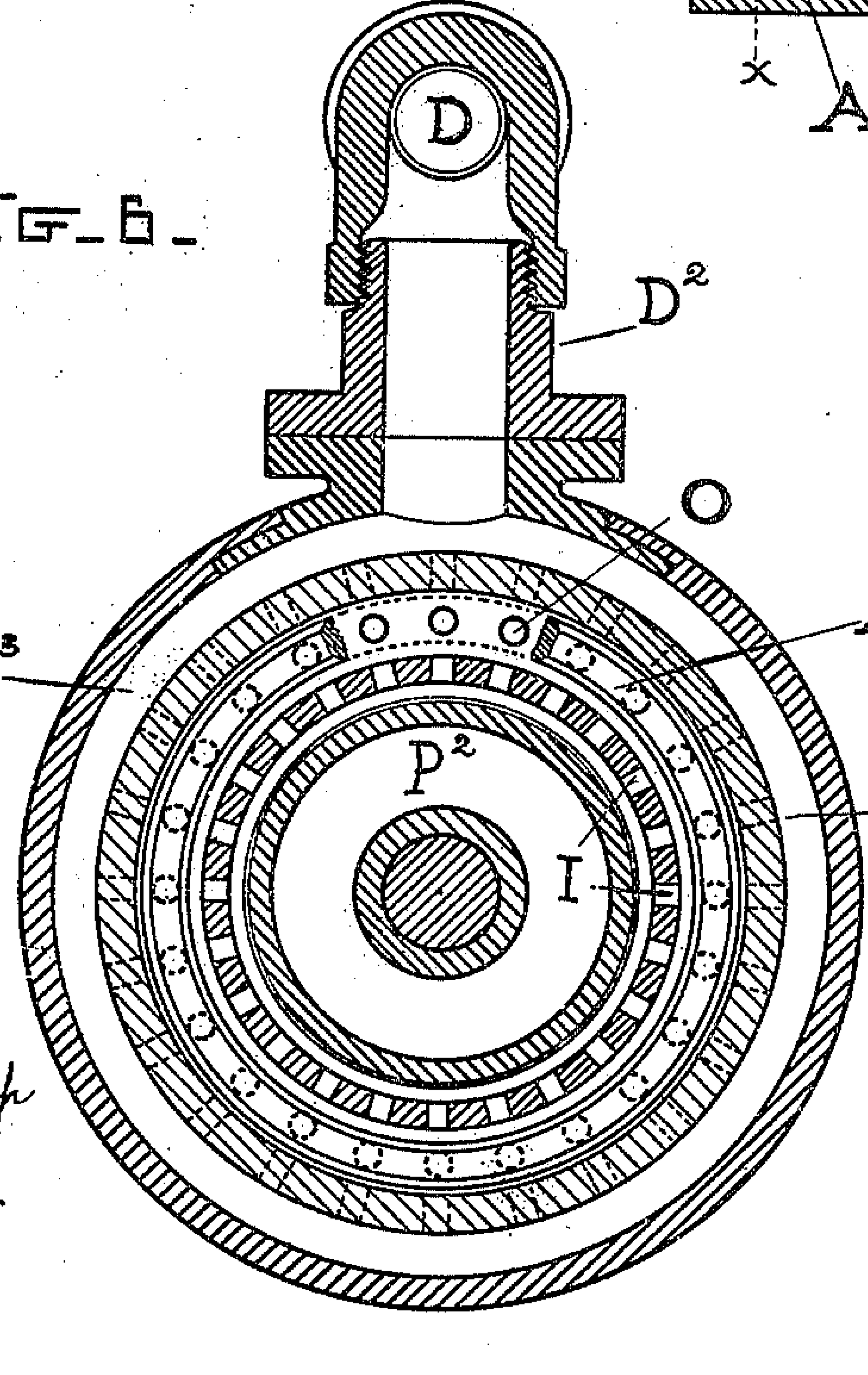


FIG. 6.



WITNESSES.
Henry O. Westendarp
Dugald McKillop.

INVENTOR.
Elihu Thomson.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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4 Sheets—Sheet 3.

FIG. 7.

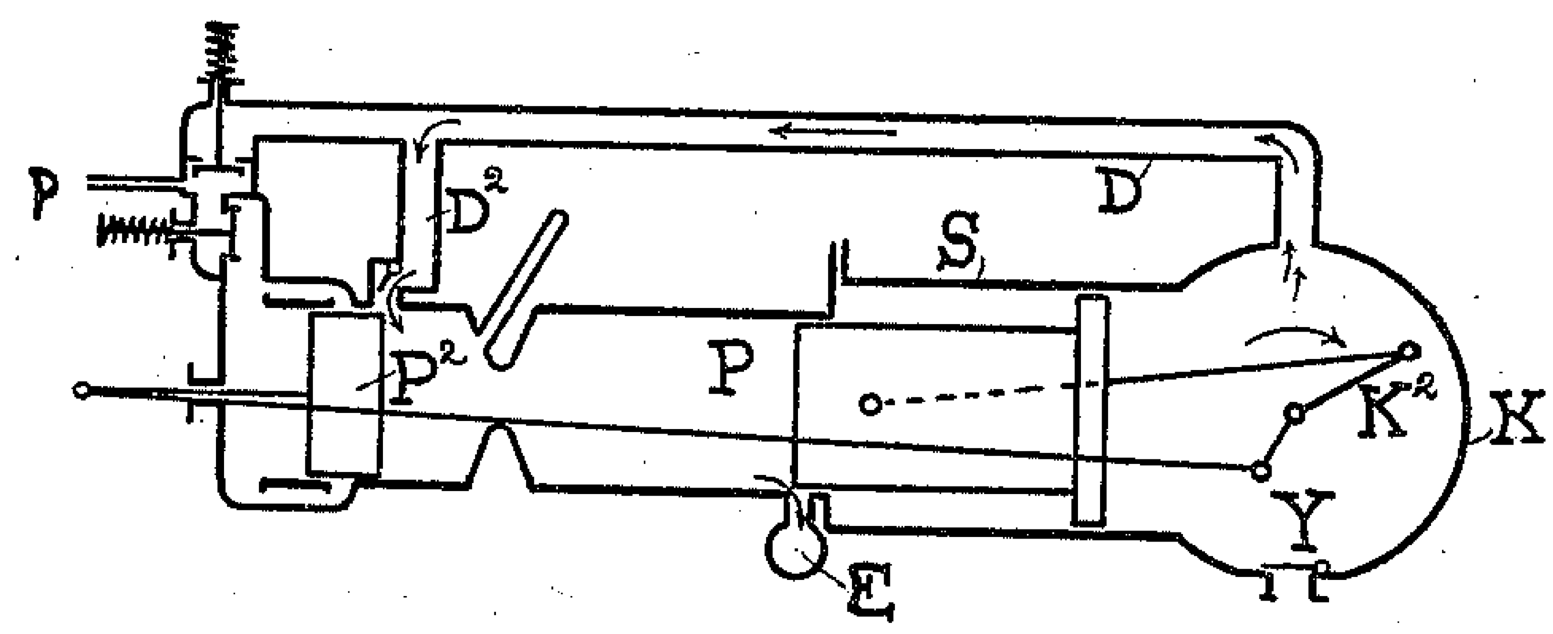


FIG. 8.

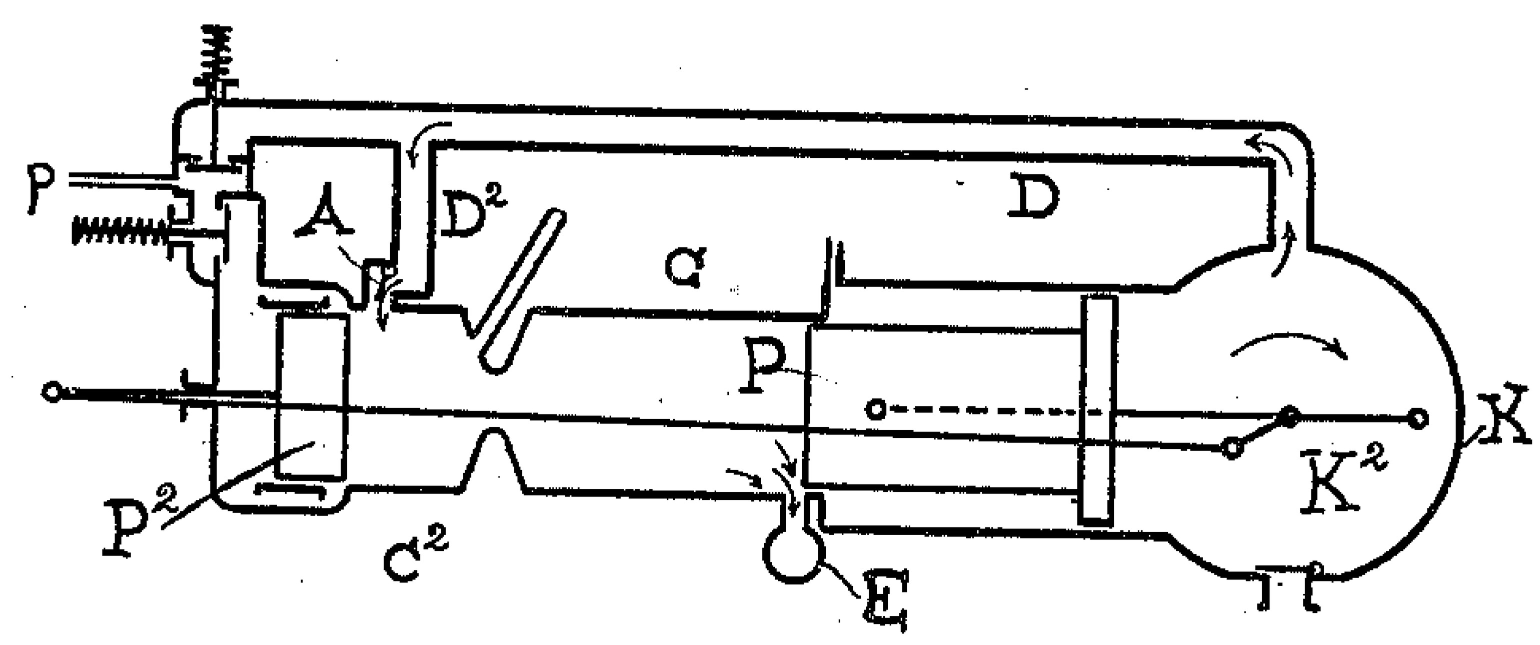


FIG. 9.

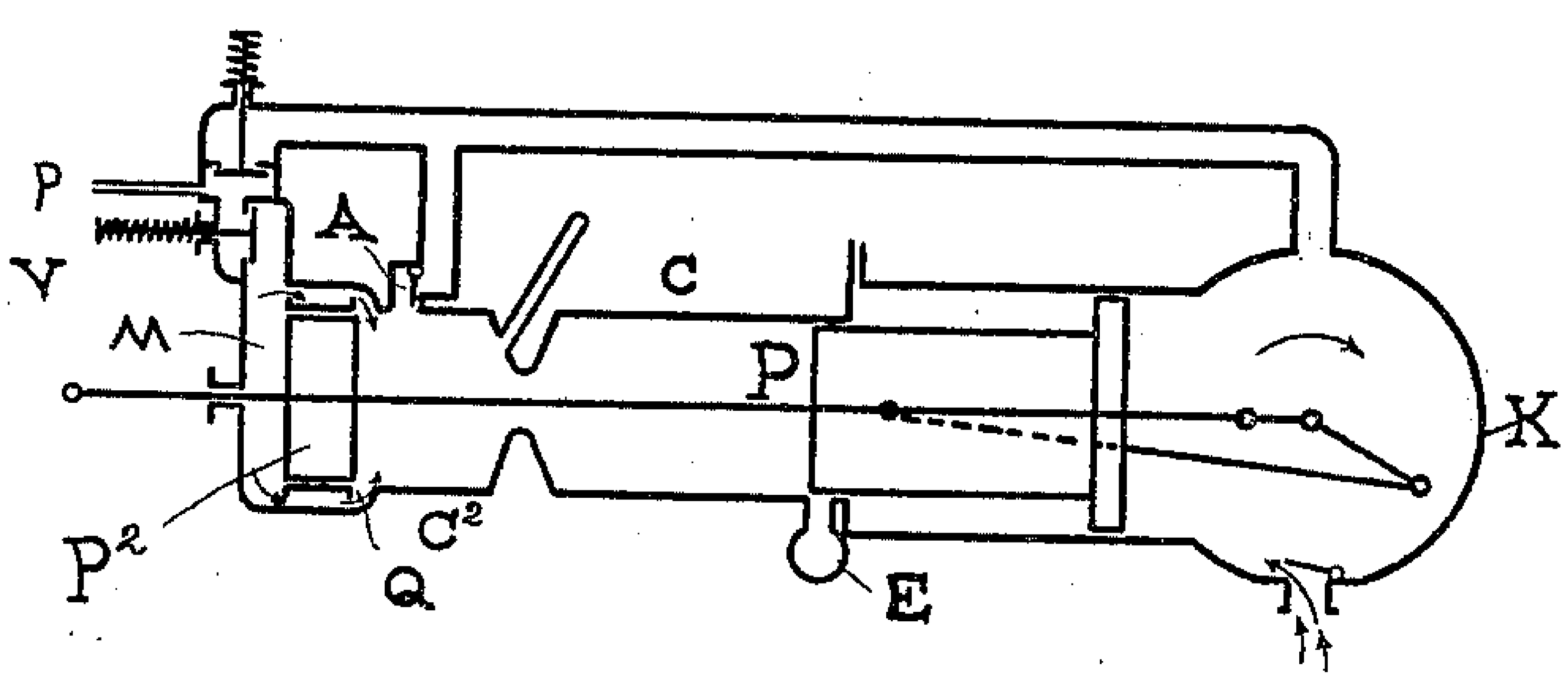


FIG. 10.

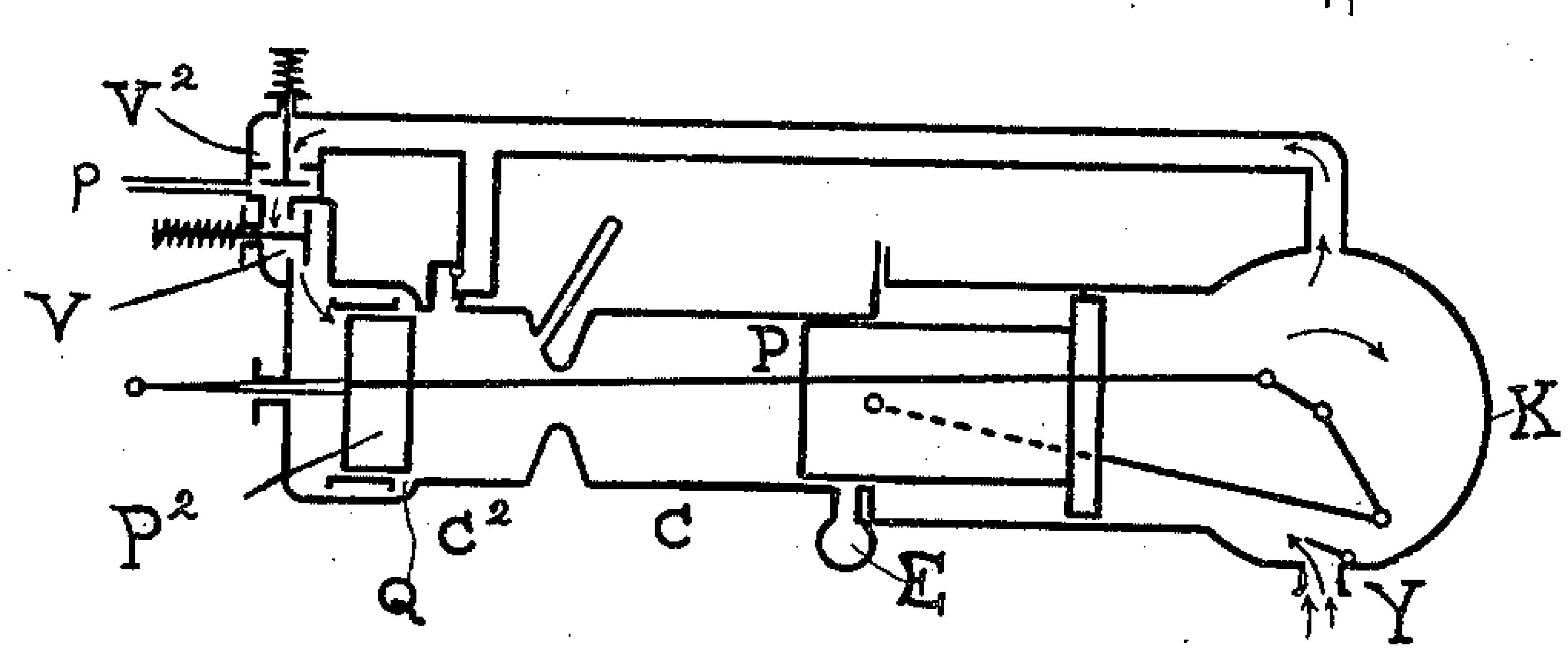
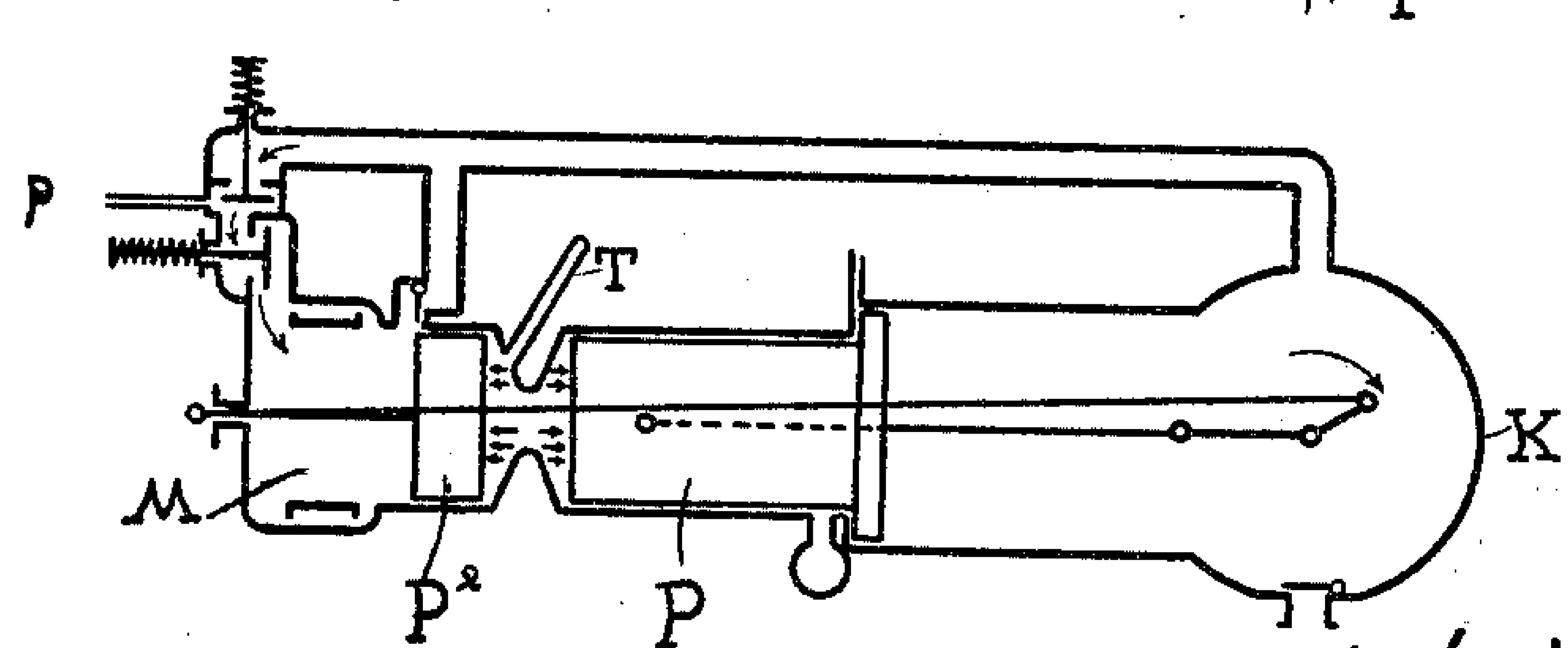


FIG. 11.



WITNESSES.

Henry O. Westendarp

Dugald McKillop.

INVENTOR.

Elihu Thomson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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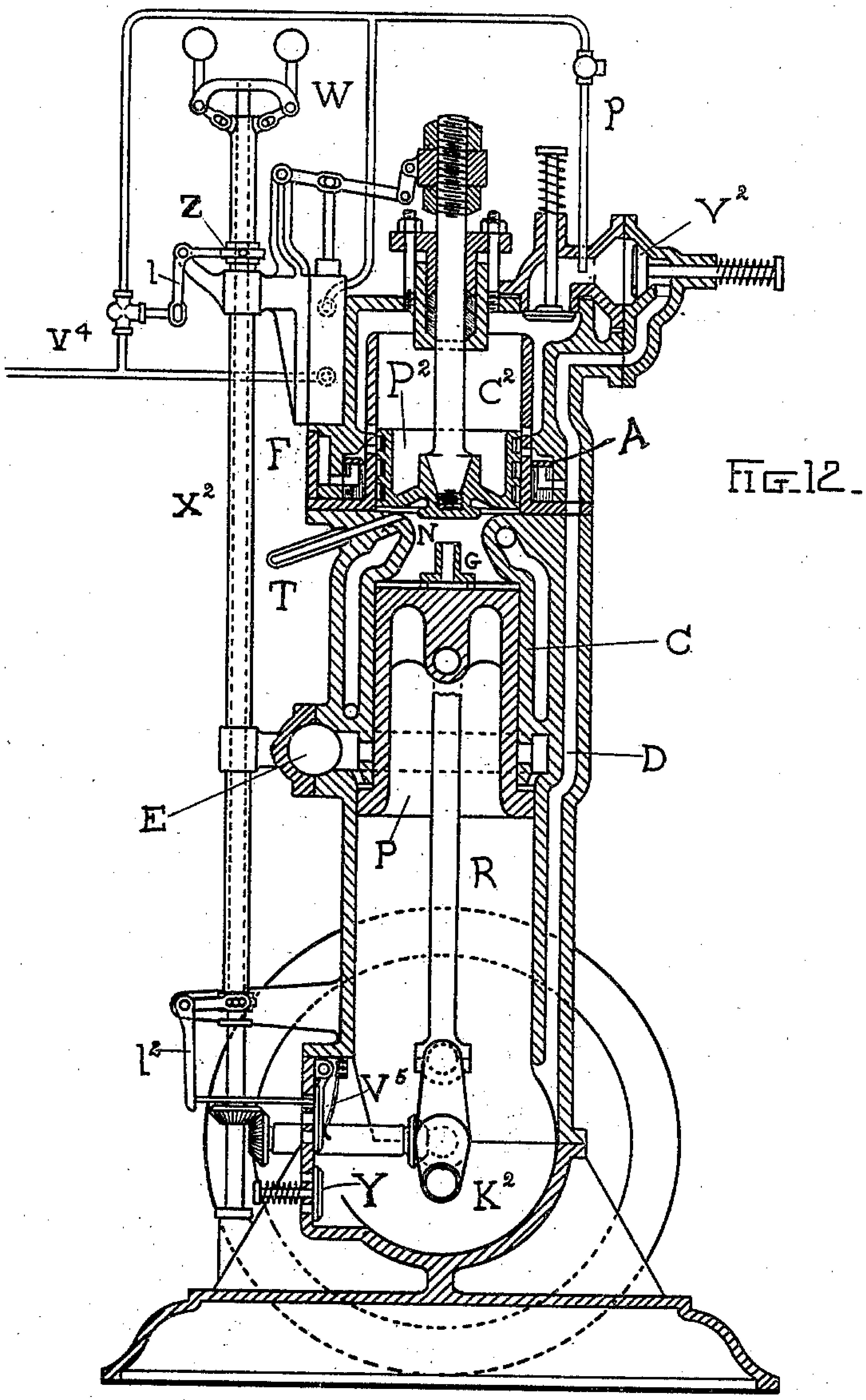
E. THOMSON.

GAS OR OIL ENGINE.

(Application filed June 10, 1899.)

(No Model.) 4 Sheets—Sheet 4.



WITNESSES.
Henry O. Westendarf.
Dugald McKillop

INVENTOR.
Elihu Thomson.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS.

GAS OR OIL ENGINE.

SPECIFICATION forming part of Letters Patent No. 696,518, dated April 1, 1902.

Application filed June 10, 1899. Serial No. 720,010. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing in Swampscott, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Gas or Oil Engines, of which the following is a specification.

The present invention relates to gas or oil engines.

The object of the invention is to secure in a gas or oil engine the advantages of what I designate as my "transfer type" of engine, described in a former application for Letters Patent, Serial No. 666,901, filed January 17, 1898.

In the present invention the operation is modified so as to permit of working on what is called the "two-cycle" plan instead of the four-cycle or Otto cycle.

The invention provides means also for the removal of the exhaust-gases and rinsing or introduction of fresh air.

The invention also provides means for the introduction of a combustible charge in a novel way—*i. e.*, after the scavenging or rinsing by the introduction of air has taken place and after the exhaust-ports are closed. In this respect the present invention differs from others, with the great advantage that none of the new charge while being introduced is ever permitted to pass out of the exhaust, a condition which is not secured in the ordinary two-cycle engines, where, in general, the new charge is introduced while the exhaust is still open. Some of the new charge or fresh charge passes out of the exhaust along with the burned charge while the displacement is being made.

The invention also provides means for the drawing in of a properly-mixed charge and the moderate compression of the same before it is driven into the cylinder-space where it is to be burned.

In my improved engine the burned gases are driven forward by the introduction of the air charge followed by the introduction back of the air charge of the rich fuel charge, whereby a body of air nearly without admixture is "interposed," so to speak, between the exhaust-gases of the former stroke and the new gases introduced. The result of this is that there is much less liability to preignition, because none of the hot exhaust charge is fixed with the new or fuel charge. The temperature of the combustible charge is therefore during compression lower than it would otherwise be, while the regularity and uniformity of the explosions obtained are greatly increased. It will, however, be better understood by reference to the accompanying drawings and the specification relating thereto which follows.

Figure 1 is an elevation, partly in section, of an engine embodying my invention. Fig. 2 is an outline plan. Fig. 3 is an illustrative diagram of the relation of the cranks. Fig. 4 is an enlarged view of some of the parts in elevation; Fig. 5, another enlarged view in section of similar parts to those shown in Fig. 4. Fig. 6 is a sectional detail of the ports for the entrance of the air charge, taken on line *x x* of Fig. 5. Figs. 7, 8, 9, 10, and 11 are diagrams showing the actions occurring during the movements of the parts of the engine throughout its cycle of operations, and Fig. 12 shows a vertical type of engine.

Referring to Figs. 1 and 2, K is a crank-case in which the crank-shaft turns, the main crank K^2 being inclosed in this case. The case itself is a closed case, having an entrance-valve Y for admission of air and an outlet pipe or passage D for delivery of the air to the other parts of the engine. It is of course to be understood that a separate air-pump operated by another source of power, such as that of an engine, may serve the purpose or perform the function of the moving piston P and the closed crank-case here described. The main cylinder C has a piston P, connected to the main crank K^2 by a connecting-rod R, which moves piston P back and forth within the cylinder.

The exhaust E consists of a series of openings in the walls of the cylinder uncovered by the piston P at the extreme outward portion of the stroke. These openings are for the discharge of the products of combustion of the engine. Another cylinder C^2, with piston P^2, is placed in a tandem relation to the cylinder C, and the two cylinder-spaces between the pistons P^2 and P communicate by a narrow neck at N. It is of course not essential that these pistons and cylinders be placed in tandem relation, as they might be placed along-side of each other, with a proper port communicating between the cylinders, provided the relations of the parts of the actions are maintained. The disposition shown, however, conduces to balance the effect of the explosion-pressures, and by suitably-proportioned weights of the reciprocating parts a running balance may be secured.

In Fig. 5 some parts are shown enlarged. Piston P^2 is carried by a piston-rod P^3, passing through a stuffing-box B in the outer head of the cylinder C^2. This piston-rod P^3 is connected to a cross-head H H, to which it is firmly secured, and at each end of this latter are pivoted connecting-rods R^2 and R^3, respectively, Fig. 2, which connecting-rods engage with the cranks K^3 and K^4 on the main shaft. It is preferable that the cranks K^3 and K^4 be set with relation to the main crank K^2 somewhat lagging—*i. e.*, with a displacement from one hundred and eighty degrees to a position of thirty degrees to forty-five degrees in a direction opposite to that of the revolution. This displacement gives a sequence of action of the two pistons, which is very desirable, as will be pointed out farther on. The piston P^2 in moving outwardly uncovers in succession two sets of ports or openings in the walls, one set being uncovered some distance ahead of the completion of its outward stroke. These are the ports which are situated on the line x x, Fig. 5, while the other set of ports are indicated in Fig. 5 by the openings Q. The ports Q effect communication between the space to the left of the piston P^2 in Fig. 5 and within the cylinder C^2 and the space to the right of the same when the piston is moved back, so that any charge existing in the former space will be after undergoing compression transferred through the ports Q to the other side of the piston, or, in other words, to the space between the two pistons as joined by the narrowed portion or neck N. The ports on the line x x, Fig. 5, are in communication with the air-supply by a duct or pipe D D^2; but the passage is guarded by a valve A, shown as consisting of a flat ring or annulus acting as a check-valve and preventing any backward motion of gas through the ports on the line x x and from the cylinder-space, but permitting a free flow when the said ports are uncovered by the piston P^2 of the compressed air from the case K through the duct D D^2 to the space between the pistons. This annular valve A might be replaced by a number of separate check-valves or by a single large valve properly disposed between the duct D D^2 and the cylinder-ports. The purpose of the annulus-valve is to minimize as much as possible the dead-space between the ports on line x x and the valve itself. The annulus or annular valve A is shown partly cut away in Fig. 6, D^2 being the air-duct, as before, which spreads out into a circular space D^3, which annular space communicates with the openings O, upon which the annular valve A rests. By this arrangement the free flow of air from the duct D D^2 and its perfect distribution around the cylinder C^2 through the various ports of the line x x is secured. These ports are seen in Fig. 6, being the first row of openings around the piston P^2, since the section Fig. 6 is taken upon the line x x, Fig. 5. These ports are marked I I in the figure, there being a circular range. Located in the upper part of the head of cylinder C^2 is a valve V, which permits the free flow of air or vapor, or both, into the space back of piston P^2 when the piston moves forward. Entering just above the valve V in the duct D^4, leading to the valve, is an oil-pipe p for the introduction of oil, as by an oil-pump F, Fig. 1, actuated by the engine itself. Of course when the engine is employed with gaseous fuel the gas-delivery may take the place of the oil pumped in through the pipe p, or gasolene may be employed and is included under the designation "oil." Another check-valve V^2 is located above the valve V in the duct D^4 and serves to control the passage of air or vapor, preventing any backward flow of the fuel, oil, or gas mixed with air into the main air-duct D, which feeds air to both duct D^2 and D^4, as shown by the connections of the figure. This is not, however, essential, and in Fig. 4 it is indicated that duct D D^2 may terminate before reaching duct D^4, and D^4 may take its supply of air from the external atmosphere by indrawing and mixing the same with oil or gas introduced by a fuel-pipe p, as before. In this case also the valve V may alone be employed. When an oil requiring high temperature to vaporize it is used, duct D^4 may be kept hot, and in Fig. 4 this may be accomplished by the play upon the same of a flame, as is ordinarily the case with kerosene-oil engines having external vaporizers. This vaporization would naturally be resorted to in the case of the more difficult vaporizable oils, and particularly at starting. Frequently after starting the engine may supply sufficient heat by conduction through its various parts to accomplish the same result.

The charges of oil-vapor or gas and air may be fired between the two pistons in any of the usual ways—as, for example, by inserting in an ignition-opening the ignition-tube T, kept hot by a suitable flame. This opening extends into the space traversed by the piston P^2 in cylinder C^2. After the engine is in operation the ignitions may be made by an internal igniter G, constructed of some refractory metal, such as cast-iron or nickel and mounted upon the inner end of the piston P. It is shown as made of a short section of flanged tube, the flange portion being carried by the piston P, and it is preferable that this flange rest upon lugs or project over the piston or be supported from the body of the piston and separated therefrom by a small heat-insulating space. By the action of the engine the igniter G is brought to a high temperature and so maintained. It may, in fact, be made of refractory material, such as hard-baked clay. The heat of the walls of neck N may also be allowed to rise to a point sufficient for ignition in some cases.

The diagram Fig. 3 shows the relation of the pistons P and P^2 at about mid-stroke with the cranks K^2 and K^3 and connecting-rods R and R^2. The cylinders and their connecting-port N are shown in dotted lines only.

The operation of the engine which has been described may be best understood by referring to diagrams 7, 8, 9, 10, and 11. Piston P in all the figures is shown as a piston having an enlarged end near the crank-case, and the cylinder C has two bores, one larger than the other. This is not an essential feature, but it adds to the capacity of the piston, acting as a pump for air circulating through the crank-case K. It is to be understood also that the space S, Fig. 3 or Fig. 7—viz., that space which is traversed by the enlarged head of piston P—may be open to the exhaust E through suitable connections or ports or to the external air or may be used as a compression-space in which a body of air is confined and alternately expanded or contracted by the motions of the engine. In this case there is a clearance given in space S such as will secure the desired degree of compression when the piston is driven up to diminish the space. Lubricating-oil for the piston P may be pumped into the space S through a suitable pipe and serve to lubricate the parts.

In Fig. 7 by the forward motion of piston P the air taken in through valve Y in the crank-case K is forced, as indicated by the arrows, through duct D and D^2 into the space between the pistons P^2 and P by the uncovering of the first range of ports by piston P^2 as it moves to the left. This uncovering of the ports permits the air from the crank-case K to pass into the space between the pistons during the time of the opening of the exhaust-ports by piston P at E. The gases left from the former stroke accompanied by combustion are thus rinsed out by the introduction of fresh air; but there being no new charge or fuel charge introduced at this moment there is no possible escape of unburned charge through the exhaust, as occurs in almost all forms of two-cycle engine where the new charge is introduced at the time the exhaust-passages are open.

In Fig. 8 the piston P has reached its extreme forward point and the crank K^2 is on dead-center. Piston P^2 has not yet reached its farthest position out or to the left, and the transfer of air from the crank-case K through duct D into that space between the pistons which is nearest piston P^2 is about finished, while the exhaust-gases passing out at E have been followed by the introduction of fresh air chiefly in what may be called "cylinder" C^2. The connecting duct or passage N between the two cylinder-spaces is made narrow enough to insure a pretty thorough washing out of the burned gases from the cylinder-space in C^2, so that by the action which has been described the air introduced through duct D^2 past check-valve A fills the space left in C^2 by the outward motion of piston P^2, while in the space within the cylinder C air and some of the burned charge from a former stroke are mixed. It will be noted that the traverse of the pistons P and P^2 are shown as different in extent, though the diameters of the pistons are the same in the figures—*i. e.*, the crank moving piston P^2 is shorter than that moving piston P. Of course the diameter of piston P^2 might be made less and the stroke greater with the same result. In general it will be better to have the space traversed by the piston within the cylinder C^2 somewhat less, sometimes as small as one-half that traversed by piston P and cylinder C. By the continued motion of the cranks within case K we reach the condition shown in Fig. 9, where the exhaust at E is now closed by the piston P beginning to return. The valve at A automatically closes as a check-valve and the transfer-ports Q are uncovered by piston P^2, which has now reached its farthest position outward. The transfer-ports at Q, however, connect the space between the pistons P and P^2 with that between the outer head M of cylinder C^2 and piston P^2. In this space by the prior motion of the engine there has been drawn a mixed charge of oil-vapor and air, as will be described farther on. This fuel charge or combustible charge enters past the valve V and is compressed during the outward motion of piston P^2 ready for the transfer through ports Q. This charge is purposely made a rather rich charge, having in it an excess of fuel. The charge, however, in reaching the space between the pistons passes into the air already to the left of the passage N, which was introduced during the washing out of the exhaust charge through E; but as the exhaust-openings E are now closed none of the fuel charge can possibly escape. It simply mixes with the air in cylinder C^2 and is in a measure separated by a duct N from the charge in cylinder C, which consists of the burned charge plus atmospheric air chiefly. The continued motion now brings both pistons P and P^2 back or toward each other, the piston P, however, being in the lead. By virtue of this lead none of the combustible charge can reach the cylinder-space C, inasmuch as during the back stroke or compression-stroke now begun there is even a tendency to drive some of the charge in C, consisting of air and burned charge, through the passage N into the cylinder-space in C^2. At the same time that the piston P^2 moves toward piston P or toward the passage N it closes the ports at Q and draws in a charge at the back through valves V and V^2, while fuel—such as gas or oil—is fed through pipe *p* into the space between the valves V V^2. A thorough mixture of this fuel with the air takes place, the parts being supposed to be hot enough in the case of the use of oil of high vaporizing point for maintaining the vapor or preventing condensation and to vaporize the oil when it enters. While this is going on a new charge of air has entered through valve Y into crank-case K on account of the piston P moving back and increasing the space within the crank-case. Finally the cycle is completed by the pistons P and P^2 reaching the position shown in Fig. 11, where the charge between the pistons is under compression and fired by the action of the igniter-tube T, for example, or by other means. The explosion of the fired charge tends to drive the pistons apart, during which power is given out as to piston P and then to piston P^2 after it passes dead-center. The power-stroke is finished just before the action shown in Fig. 7 is again repeated. Meanwhile the new fuel charge has been taken into the space between the piston P^2 and the head M ready to be compressed and transferred as before, the series of actions thus detailed being repeated each revolution. During the burning of the charge the combustible mass of gas or vapor and air burns in front of piston P^2, and a blast of flame shoots through the passage N into the charge containing excess of oxygen, which has been compressed by piston P. The excess of oxygen so provided insures the complete combustion, whereby offensive odors in the exhaust-gases are obviated. At the same time the blast of flame plays upon the refractory piece G, carried by piston P and shown in Figs. 1 and 5. The repetition of this blast of flame soon brings piece G to a high temperature, (or in the other cases the walls of neck or duct N,) after which ignition-tube T is no longer needed, since the piston P projects or introduces the refractory piece G into relation to the compressed and mixed charge and fires the same. I call this form of engine of my invention my "two-cycle" transfer type, in virtue of the transfer of the charges from the point of entry past the piston P^2 and the subsequent transfer from cylinder C^2 to cylinder C in burning and exhausting.

The engine of my invention, while shown in Figs. 1 and 2 as a horizontal engine, is, on account of its construction, perhaps better adapted to be run vertically. This conduces to the better action of the annular valve A, where such valve is employed. Fig. 12, in fact, shows a section of the vertical engine of my invention. Similar parts of this engine are marked by similar letters to those in the preceding figures. The conduit D is made in the framework, as shown, and a water-jacket around cylinder C extends up around the neck N.

It is not necessary to describe in detail the various parts in their relations, as they are the same as in other figures. The vertical engine, Fig. 12, however, is shown as having a centrifugal governor W, geared by miter-gears to the main shaft and running on a vertical shaft X^2. The action of the governor, which moves a sleeve surrounding the shaft X^2, is to cut off or limit the oil as pumped by an oil-pump F by changing the stroke or by opening a by-pass or by any similar means on an increase of speed beyond the normal. The governor W is shown as moving a sleeve around the shaft, a collar on which (marked Z) as it rises and falls under the action of the governor-weights moved centrifugally changes the position of the bell-crank lever l, which controls a by-pass valve V^4, around the oil-pump F, which supplies oil to the engine through the small pipe p. In pipe p is a check-valve, as shown, for preventing the compressed air passing valve V^2 working back and driving the oil column back when the pump is not forcing oil. When the governor indicates that the engine has exceeded a certain speed, the collar Z is lifted and the by-pass valve V^4 opened, whereby the charges of oil fed through pipe p are weakened.

If gas be used as fuel, the same action of cutting off or controlling the supply by the governor can be employed. At the same time that the collar Z cuts off the oil-supply to a greater or less extent another bell-crank lever l^2, operated by the governor in a similar manner, breaks the compression in the crank-case by opening a flap-valve V^5 on increase of speed. This diminishes the pressure in the valve-case at the same time that the oil or fuel supply is diminished, the general effect being to weaken or cut off the charges, so that the engine cannot exceed a certain speed. The governer is of course not essensial where the work done is steady or where with an increase of speed there is an increase of counter torque, which restrains the engine, it being assumed that in this case a moderate variation of speed is permissible.

What I do claim as my invention, and desire to secure by Letters Patent, is—

1. In an oil or gas engine, the combination of two cylinder-spaces connected by a narrowed passage and traversed each by a piston connected to the main crank by suitable crank-arms and connecting mechanism; exhaust-ports opening from one of the cylinders, which may be called the main cylinder, and said ports uncovered or opened for expulsion of exhaust at or about the completion of the outward stroke of the piston within said cylinder; two ports or sets of openings in the second cylinder, one of which is for the passage of air under slight compression for scavenging or washing out the exhaust charge, and the other of which when opened after the exhaust-ports are closed introduces a fuel charge under compression, substantially as described.

2. In a fuel or gas engine, the combination of two cylinders, a piston for each cylinder, which pistons are operatively connected to furnish power, means for exhausting one cylinder on the completion of the power-stroke, and means for introducing a body of air into the second cylinder on the completion of the

power-stroke; means for cutting off the exhaust from the first cylinder, and means for introducing into the second cylinder a new charge of fuel and air, and a connection or port between the two cylinder-spaces, substantially as described.

3. In an oil or gas engine, the combination of two cylinders in communication through a narrowed port, pistons moving within said cylinders, cranks and connecting-rods for moving the pistons, one crank being set so as to have a lead over the other; exhaust-ports in the forward end of one cylinder uncovered by the piston on the completion of its stroke, and two ports or sets of ports in the other cylinder, and means for injecting air through the first open port or set of ports, with means for injecting the fuel charge through the second port or set of ports after the exhaust-passages of the engine are closed.

4. In an oil or gas engine, a crank-case inclosing the main crank, a space in which air is compressed during the motions of the main piston, ducts or delivery-ports extending from said crank-case for delivering air to the working cylinder-space, a piston moving within the main cylinder arranged to uncover the exhaust-ports on the completion of its outward stroke, an oppositely-moving piston arranged to uncover successively a port or set of ports for introducing air, and another set of ports for introducing the fuel charge into the explosion-chamber; cranks for moving the two pistons respectively; means for taking in and compressing the fuel charge, and means such as an oil-supply pipe and an air-duct for supplying fuel and air for their admixture before they pass the fuel-ports leading to the exploding-chamber, substantially as described.

5. In an oil or gas engine, the combination of a piston, which as it moves within the crank-case, compresses a charge of air, an exhaust-port which is uncovered at the end of the piston-stroke, a second piston moving oppositely to the first and lagging with respect thereto, a port communicating with the crank-case which is uncovered by the lagging piston during the interval that the exhaust-port is open, so that the burned gases are expelled, a fuel-port, also controlled by the lagging piston, for admitting fuel after the exhaust-port is closed, and means for indrawing and mixing the fuel charge and transferring it from one side to the other of the lagging piston.

6. In a two-cycle engine, the combination of a cylinder-space, a pair of pistons working therein and connected to the same crank, one of said pistons acting on its outward stroke to compress a charge of air, the other to compress a charge of gas or fuel, ports controlled by the gas-compressing piston for admitting a charge of air compressed by the first piston to the space between the pistons for discharging the burned gases and supplying air to a new charge, and other ports also controlled by the same piston for admitting the fuel charge to the cylinder-space.

7. In a two-cycle gas or fuel engine, the combination of two cylinder-spaces in communication through a port or restricted neck, each cylinder having a piston, means for exhausting the burned gases at one side of the restricted neck and from one end of the combined cylinder-space near its greatest volume owing to the motion of the pistons, means for inserting a new charge of air alone to the cylinder-space on the other side of the restricted neck, and means for subsequently inserting the fuel-admixture charge.

8. In a gas or oil engine, the combination of a pair of pistons, a cylinder for each piston, a body of metal uniting the cylinders which is provided with a restricted neck or port, a firing means mounted adjacent to said body, an exhaust-port controlled by one of the pistons, a port admitting air to the cylinder at or near the restricted neck, and a fuel-admitting port located beyond the air-admitting port, the last two ports being controlled by the second piston.

9. In a gas or oil engine, the combination of a cylinder, a piston therefor which compresses a charge of air on its outward stroke, a second piston which compresses a charge of fuel on its outward stroke, means for admitting fuel and compressed air to the compression-chamber, ports for admitting a charge of air to the chamber, ports for admitting a charge of air to the cylinder-space between the incoming fuel charge and the exhaust, and means for transferring the fuel from one side of the second piston to the other.

10. In an oil or gas engine, the combination of separate pistons which are operatively connected to the same power-shaft, a crank-case in which air is compressed by one piston, a case in which fuel is compressed by the end of a second piston, a port for admitting the compressed air into a space between the pistons, and means for transferring the compressed fuel charge from the end of one piston to a point between the pistons.

11. In a gas or oil engine, the combination of a pair of oppositely-moving pistons which are connected to the same driving-shaft, one of said pistons being arranged to lag slightly with respect to the other, a crank-case in which the air is slightly compressed by the leading piston, an exhaust-port which is uncovered by the leading piston, a chamber in which the fuel is slightly compressed by the lagging piston, a port which is uncovered by the lagging piston for admitting the air compressed by the leading piston to the space between the pistons, a second port, also uncovered by the lagging piston, for permitting the fuel charge to be transferred to a point between the pistons after the leading piston has closed the exhaust-port, and means for firing the fuel charge.

12. In a gas or oil engine, the combination

of a moving piston, a crank-case in which the piston compresses a charge of air, a source of fuel-supply, a port for admitting the compressed air into the cylinder for the purpose of washing out the products of combustion, which port is controlled by the movement of a piston, and a second port or valve for controlling the admission of the fuel charge, and a valve for regulating the air which is received from the crank-case and mixes with the fuel charge.

ELIHU THOMSON.

Witnesses:
DUGALD MCKILLOP,
CHAS. B. BETHUNE.