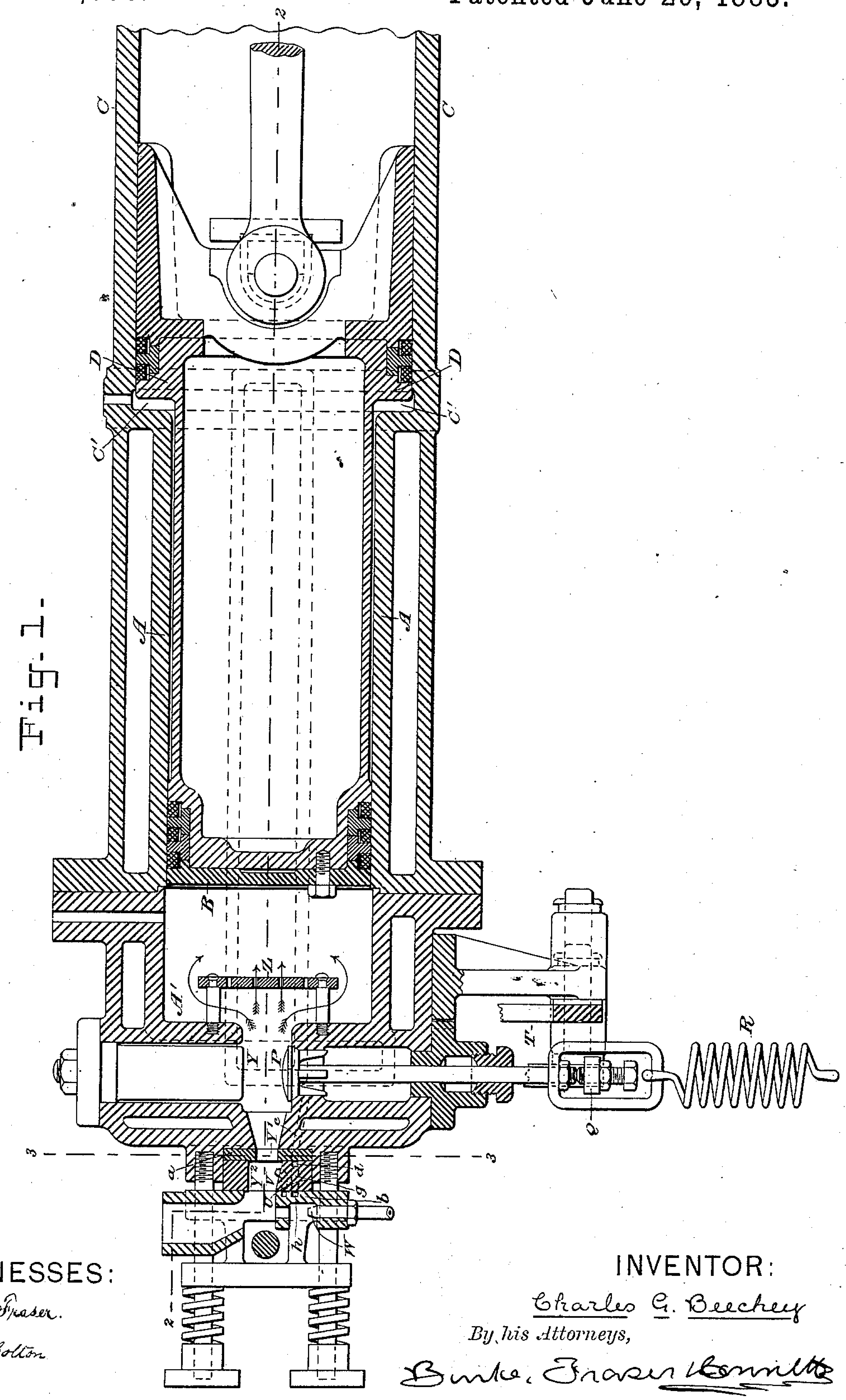
(No Model.)

4 Sheets—Sheet 1.

C. G. BEECHEY.

GAS MOTOR ENGINE.

No. 280,006. Patented June 26, 1883.



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(No Model.)

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Fig. 2.

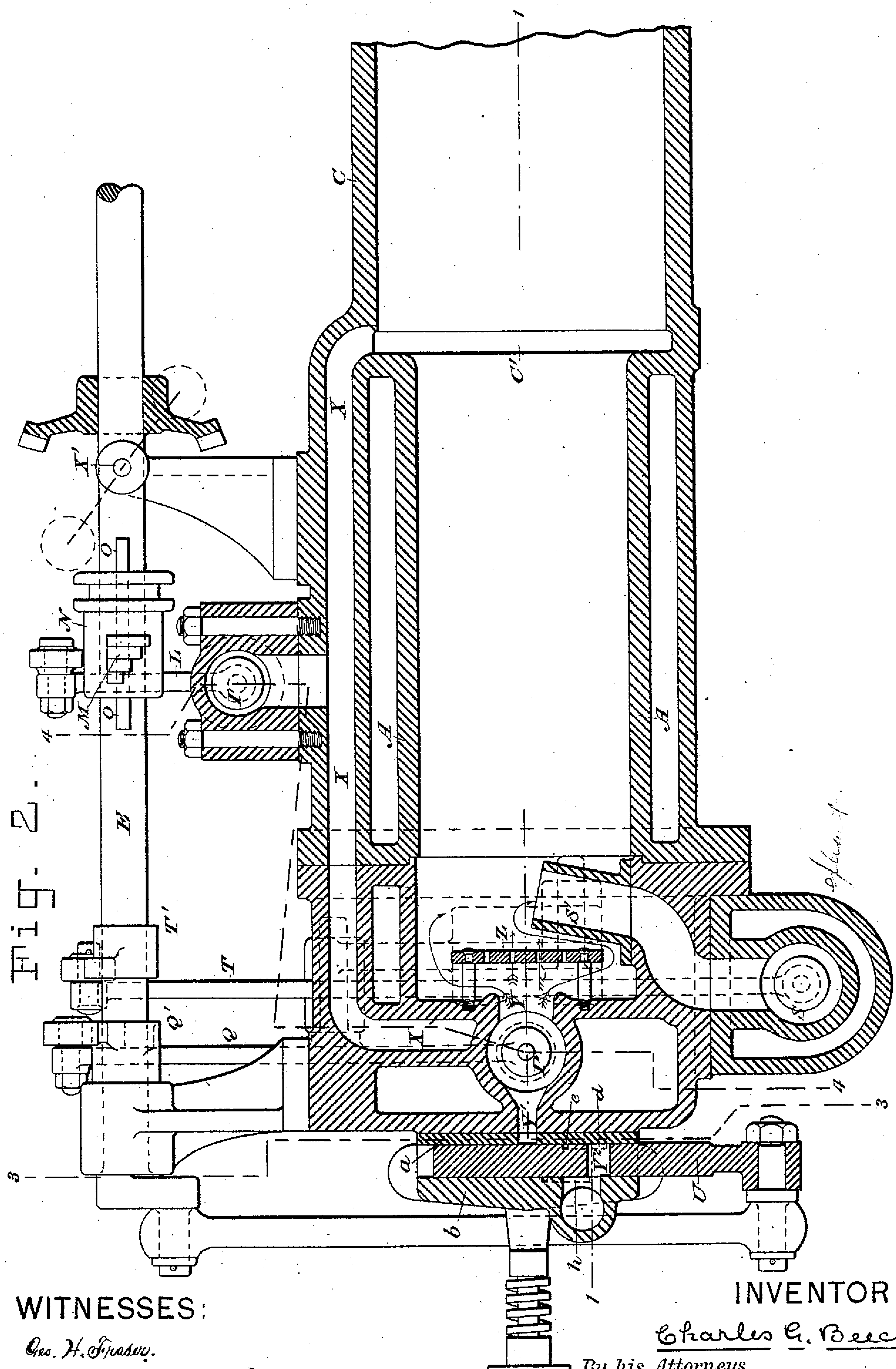

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Fig. 4.

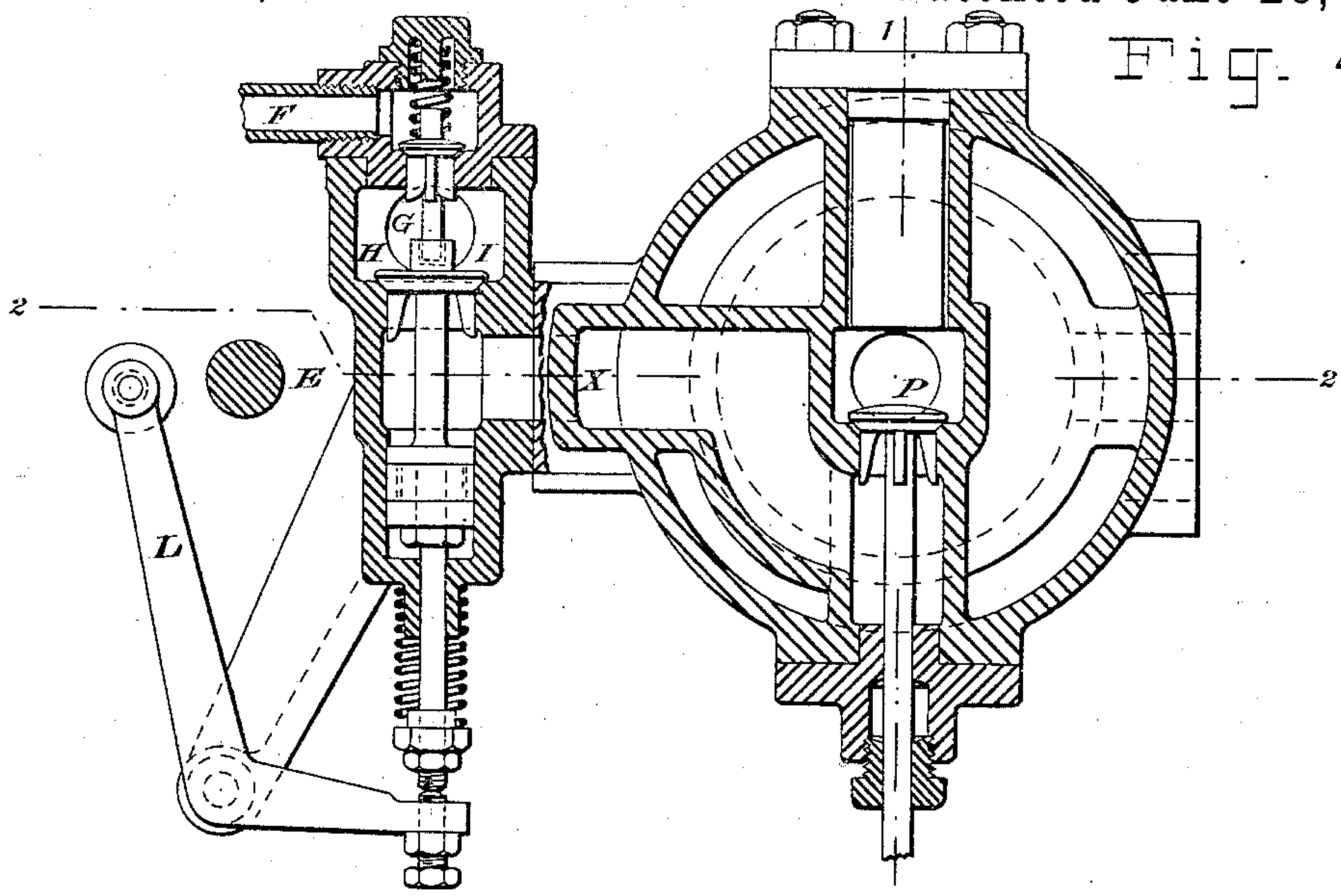
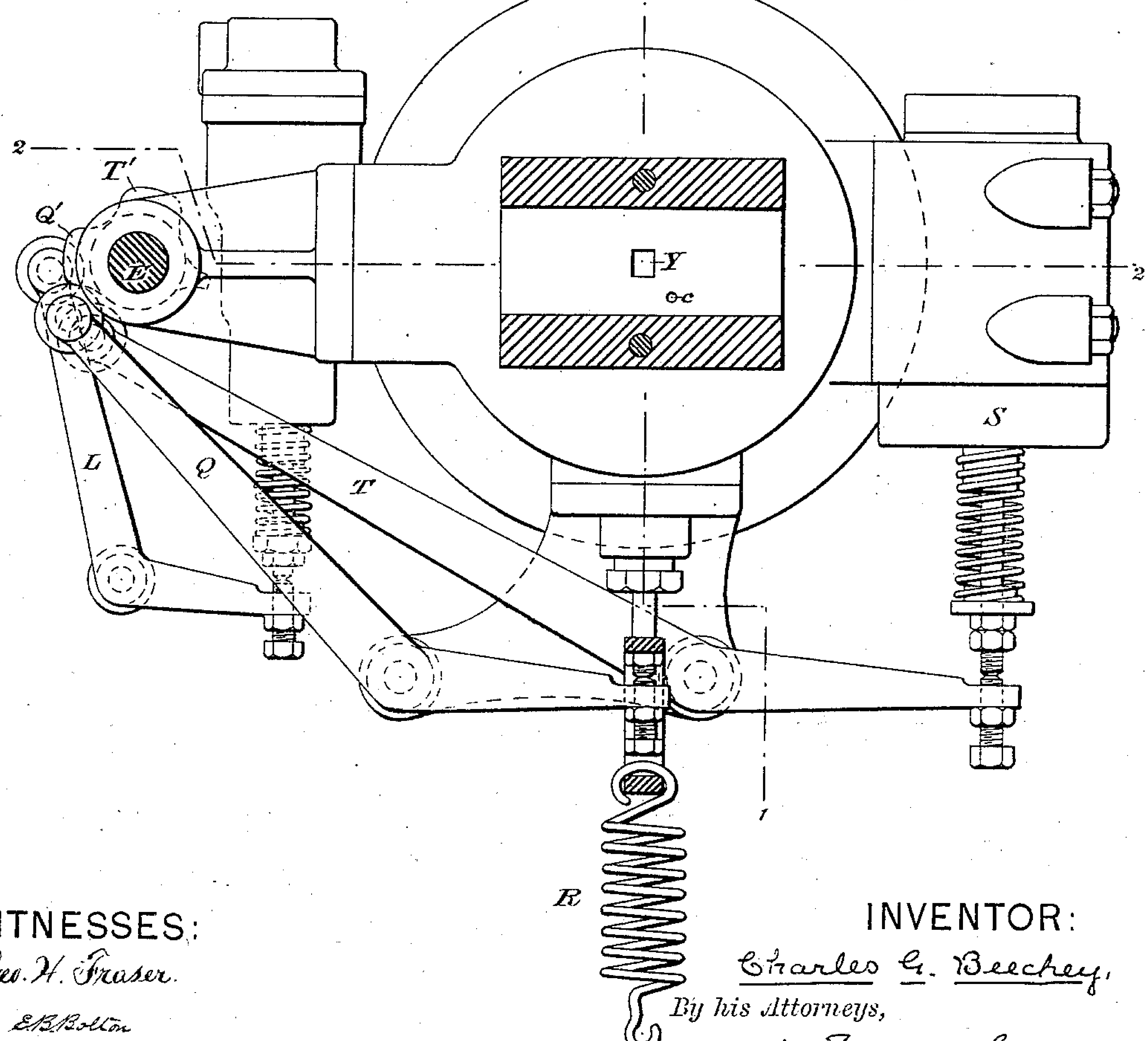


Fig. 3.



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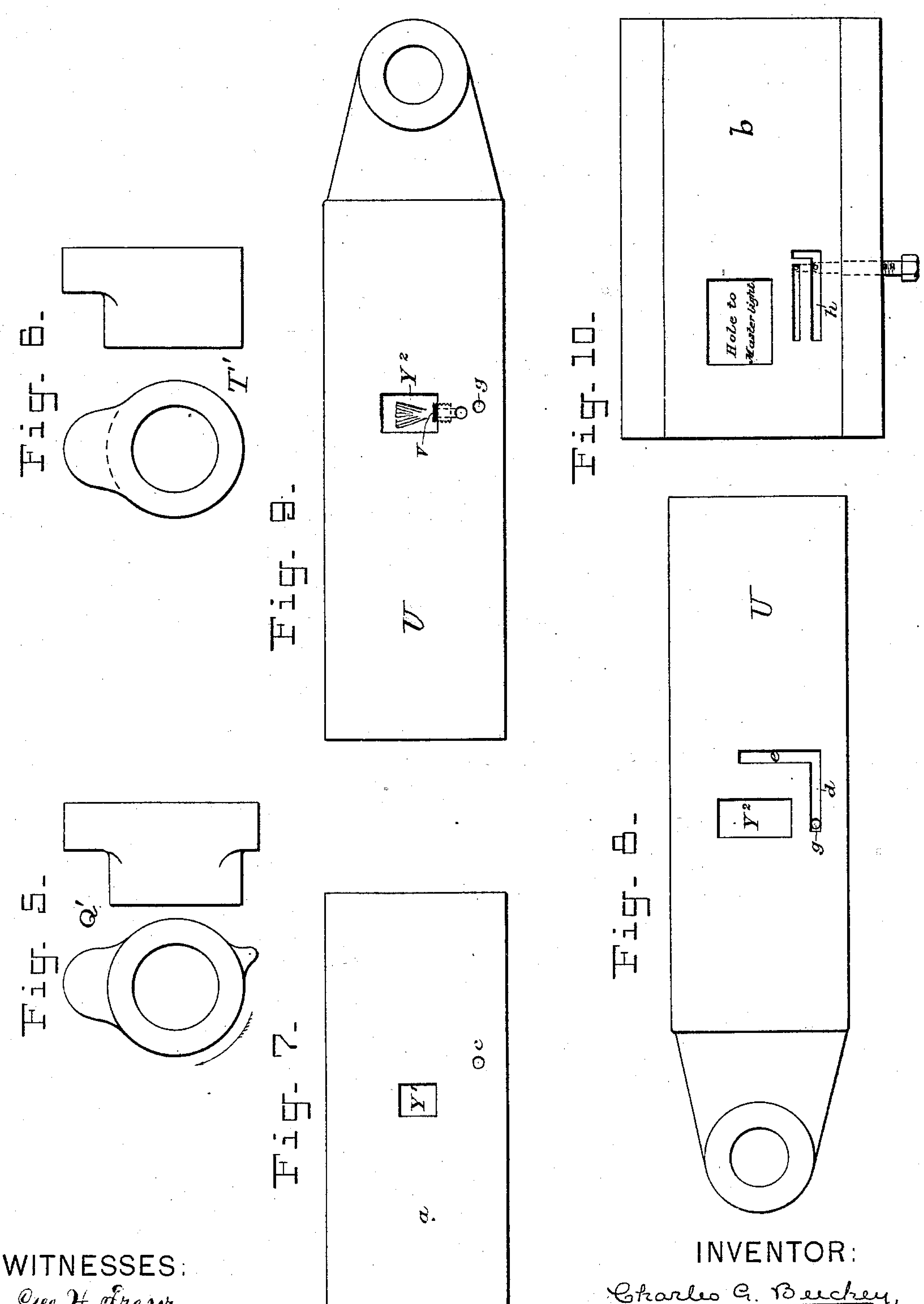

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UNITED STATES PATENT OFFICE.

CHARLES G. BEECHEY, OF LIVERPOOL, ENGLAND, ASSIGNOR TO WILLIAM THOMPSON MANN, JAMES GREGSON CHAPMAN, ALFRED CHAPMAN, AND HENRY SHIELD, ALL OF SAME PLACE.

GAS-MOTOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 280,006, dated June 26, 1883.

Application filed January 8, 1883. (No model.) Patented in England March 18, 1882, No. 1,318; in France September 18, 1882, No. 151,147, and in Belgium October 12, 1882, No. 59,268.

To all whom it may concern:

Be it known that I, CHARLES GRANTLEY BEECHEY, a subject of the Queen of Great Britain, residing at Liverpool, England, have invented certain Improvements in Gas-Motor Engines, of which the following is a specification.

My invention relates to a gas-motor engine wherein there is one explosion to two revolutions of the fly-wheel, and in which there are two pistons which reciprocate in unison—namely, the working-piston and the piston for compressing the charge of the explosive mixture of gases.

The primary object of my invention is to remove the whole of the products of combustion (commonly called "burned gases") from the explosion-chamber and adjacent passages after each explosion, and replace them by a measured proportion of the explosive mixture. This I accomplish by providing a space into which a small charge of the explosive mixture is compressed, which space has a capacity such that the compressed gases in it, when allowed to expand into the explosion-chamber, will just fill it with uncompressed gases. These drive out the burned gases, but do not waste through the exhaust. The working-piston, however, is relied on to expel, by its return or in stroke, the gases from the cylinder proper, amounting to about three-fourths of the whole, and the remaining fourth is expelled by the small preliminary charge of explosive gases, as above stated.

Another feature of my invention consists in the arrangement for equalizing the rotary motion of the crank-shaft by the formation behind the working-piston and compression-piston, during alternate outstrokes, of a partial vacuum, so as to aid the fly-wheel while making the instrokes.

Another feature of the invention relates to the means whereby the burned gases are removed from the passage between the igniting part and the explosion-chamber by means of a small charge of highly-compressed mixture of explosive gases.

The construction and arrangement of the various parts of my improved gas-motor engine are illustrated in the accompanying drawings, wherein—

Figure 1 is a longitudinal vertical section taken in the plane of lines 1 1 in Figs. 2, 3, and 4. Fig. 2 is a horizontal longitudinal section, taken in the plane 2 2 in Figs. 1, 3 and 4. Fig. 3 is an end elevation, partly in section, on line 3 3 in Figs. 1 and 2. Fig. 4 is a transverse section taken in two planes as designated by lines 4 4 in Fig. 2; and Figs. 5 to 10 are detail views, detached and on a larger scale, which will be referred to more particularly hereinafter.

The pistons are shown in Fig. 1 only.

As before stated, the crank-shaft makes two revolutions to each explosion, and the engine is of the class known as "single-acting."

A is the working-cylinder, in which plays the working-piston B, which is coupled to the crank-shaft by means of a connecting-rod in the usual way. I have not shown this shaft, nor the fly-wheel thereon, as these are common to all engines of this character.

C is the compression-cylinder, in which the charge of explosive gases is compressed before its admission to the explosion-chamber. This cylinder I prefer, for convenience, to arrange in front of the cylinder A and in line therewith.

D is the compression-piston, which is connected to and moves in unison with the working-piston B.

A′ is the explosion chamber, situated at the rear of the cylinder A, and C′ is a clearance or space at the rear end of the cylinder C.

P is a valve which controls the admission of the explosive mixture to the chamber A′ by way of the passage Y, and X is a passage which connects the space C′ with the chamber below the valve P.

I is the valve by which the explosive mixture of air and gas is admitted in regulated quantities to the engine, the air entering the box or chamber H at G and the gas at F, as clearly shown in Fig. 4.

S is the exhaust-valve, whereby the burned gases are allowed to escape from the working-cylinder.

I will now describe the mechanism for operating the three valves I, P, and S.

E is a shaft mounted rotatively at the side of the engine and driven by gearing from the crank-shaft of the same. This shaft drives a centrifugal governor, X′, in Fig. 2, which regulates the opening of the valve I, as follows: The valve is worked by an elbow-lever, L, which is actuated by a stepped or conical cam, M, on a boss, N, which is splined on the shaft E, the spline or key being represented by O in Fig. 2. The governor acts on the boss N in the usual way to move it along the shaft and to bring one or the other of the steps on cam M under the lever L, according to the position of the balls of the governor. The valve I is thus opened at the commencement of each alternate outstroke, and closed at an earlier or later portion of that stroke, according to the speed of the engine, and the amount of the explosive mixture admitted is thereby regulated. The valve is closed by a retracting-spring.

The valve P is operated by a lever, Q, through a cam, Q′, on the shaft E. This cam is shown detached in Fig. 5. The spring R tends to keep this valve normally closed. The exhaust-valve S is operated by a lever, T, through a cam, T, on the shaft E. This cam is shown detached in Fig. 6. It also is closed by a spring.

U is the slide-valve, carrying the igniting or exploding jet V, and W is the master light or jet.

Before proceeding further with the description, I will now explain the operation of the engine.

Supposing the pistons B and D to be at the end of their instroke just before the explosion, the chamber A′ will contain its charge of compressed combustible gases, and a smaller quantity of the combustible mixture in a highly-compressed state will be contained in the space C′ and the passage X, leading from the inlet-valve I to C′, but cut off from the chamber A′ by the valve P. When the explosion takes place in A′, the two pistons B and D are driven forward. During the first part of this outstroke, the compressed mixture in C and X expands; but the remainder of the stroke in the cylinder C is made in partial vacuum. When the outstroke is completed, the exhaust-valve S opens, and the fly-wheel, aided by the partial vacuum in C, brings back the pistons. The return of piston B on its instroke expels all of the burned gases from cylinder A. When, during this instroke, the partial vacuum in the cylinder C is spent, which will occur when the piston D has completed about seven-tenths of its stroke, the cam Q′ temporarily opens the valve P and permits the charge in C′ and X to flow into the chamber A′ and expel therefrom the remainder of the burned gases through the exhaust. This expulsion of the burned gases is facilitated by the narrow, tortuous passage formed by a plate, Z, (preferably perforated,) arranged in chamber A′ over the inlet Y, and the inward prolongation S′ of the exhaust-outlet. The amount of the compressed gases in C′ and X is sufficient, when expanded to the normal tension, to fill the chamber A′ and passage Y. When the burned gases have been driven out, the exhaust-valve S and the valve P close. The momentum of the fly-wheel then causes the pistons B and D to make an outstroke, the piston B doing so in a partial vacuum. The valve I being opened at the beginning of this outstroke, the piston D, by displacement, draws into cylinder C, space C′, and passage X a fresh charge of the combustible and explosive mixture. The quantity of this mixture admitted at any one time is controlled through the medium of the governor X′ and cam M, as before explained. Upon the next instroke of the pistons, caused in part by the momentum of the fly-wheel and in part by the partial vacuum in the working-cylinder, the charge in the compression-cylinder C is compressed until the piston has completed about one-third of its instroke, when the valve P is opened and the compressed charge flows from C into A′. The valve P might, however, be operated at the beginning of the instroke. The compression is then completed by the completion of the instroke, communication between the cylinders being established; but just previous to the completion of the instroke the valve P is permitted to close, whereby, through the completion of the instroke of piston D, an excess of pressure is obtained in C′ and X, from which the igniting-burner is supplied, as will be hereinafter described, with gas at a greater pressure than that in A′, in order to prevent the said burner from being extinguished. Before the explosion in A′ an amount of the combustible mixture in a highly-compressed state is left in C′ and X to be employed for expelling the burned gases from A′ upon the next instroke. The same cycle of operation is then repeated. As the charge enters at valve P and passes directly to the chamber A′, some of the burned gases are liable to remain in the passage Y, especially next the slide-valve U, and in order to expel these, which might have the effect of preventing by interposition the ignition of the charge in A′, I adopt the construction which will be best understood by reference to Figs. 1 and 2, and to the detail views, Figs. 7 to 10. Fig. 7 is a front view of the facing *a* at the end of the cylinder, that forms one seat for the valve U, and Fig. 8 is a view of the face of said valve which plays over said seat. Fig. 9 is a view of the opposite or outer face of said valve, which plays over the back face or seat, *b*. (Shown in Fig. 10.) *c* is a small hole or port which communicates through the seat *a* with the passage X below the valve P. *d* is a groove in the face or valve U, opposite to *c*, and *e* is a branch of same, which extends upward alongside of the igniting-port Y^2. Y′ is the firing or igniting port in face *a*, which is practically a continuation of the passage Y. Y′ and Y^2 are brought into coincidence by the movement of the valve. During the charging of A′, and just before the explosion, the movement of the valve U brings the vertical branch groove *e* opposite to the aperture Y′, and this permits a portion of the charge to pass through *c*, *d*, and *e* into Y′, which serves to expel or wash out any burned gas from the latter port or aperture and the passage Y. The ignition follows immediately afterward. This is quite important, as it insures against any non-combustible stratum being interposed between the igniting-jet and the charge in A′.

The manner in which the burner V is supplied at a higher pressure than that in the working-cylinder is as follows: I drill a hole, *g*, through the valve U into the groove or channel *d*. This hole plays over a groove, *h*, in the back plate, *b*, Fig. 10, which groove communicates with the burner V in a manner similar to that described in my Patent No. 264,126, of September 12, 1882. When the valve P is closed, just previous to the pistons completing their instroke, the groove *h* is still in communication by holes *c* and *g* with the passage X, and is therefore supplied with the explosive mixture at an excess of pressure due to the further instroke or movement of the piston D.

I am aware that it has been proposed to expel the burned gases from the explosion-chamber by injecting air into the said chamber during the instroke; but this differs from my mode of expelling these gases, as the said chamber is then filled with air instead of the explosive mixture of gases; and I am also aware that in some gas-engines it is proposed to expel the burned gases by means of the explosive charge itself. This I do not claim, and I find that it is difficult by this method to expel all of such gases. The result is that they mix with the explosive charge and produce slow combustion and all the bad effects resulting therefrom.

My invention comprises the following essential features: The explosion occurs at each alternate revolution; the compression-piston moves simultaneously with the working-piston, and both make their strokes in unison; the burned gases remaining in the chamber A′ are expelled by a distinct lesser charge of compressed gases introduced between the explosions; means are provided for expelling the burned gases that may remain in the passages between the igniting-port and the explosion-chamber by admitting some portion of the explosive charge through the valve U, whereas the main portion is admitted through the valve P, and the instrokes of the pistons are aided by the partial vacuum produced alternately in the cylinders A and C—that is to say, first in C, then in A, as described.

Having thus described my invention, I claim—

1. A gas-motor engine having a working-cylinder and a compressing-cylinder, and making two outstrokes for each explosion, and in which in the one outstroke a partial vacuum is formed behind the working-piston, and in the other outstroke a partial vacuum is formed behind the compression-piston, these partial vacuums aiding the momentum of the fly-wheel during the instrokes, substantially as herein described.

2. In a gas-motor engine making two outstrokes for each explosion, the combination, with the working-cylinder and its piston, the compression-cylinder and its piston, and the explosion-chamber, of a valve arranged to control the communication between said cylinders, mechanism for actuating said valve, constructed and operating substantially as described, whereby the explosive charge and a small charge of highly-compressed explosive gases are admitted to the explosion-chamber alternately, as described, and the exhaust-valve and its operative mechanism, all arranged to operate substantially as and for the purposes set forth.

3. The combination, in a gas-motor engine, of the cylinders A and C and their pistons, the chambers A′ and C′, the passages X, the valve P, arranged to control the communication between the cylinders, the mechanism, constructed substantially as described, for actuating said valves, and the exhaust-valve and its operating mechanism, the mechanism for actuating the valve P being arranged to admit two distinct charges alternately to the chamber A′—one large exploding-charge and one lesser charge for expelling the burned gases—substantially as and for the purposes set forth.

4. In a gas-motor engine, the construction and arrangement of the space C′ and passage X with capacity to contain compressed gases only sufficient, when expanded, to fill the explosion-chamber A′ and drive out the burned gases therefrom, whereby when the valve P opens on the instroke next after the explosion the said gases will be expelled and replaced by the lesser combustible charge without waste, substantially as set forth.

5. The combination, in a gas-motor engine, of the cylinders A and C, arranged one before the other in line, the pistons B and D, connected together as shown, and arranged to move in unison, the space C′, and explosion-chamber A′, the passages Y and X, the valve P, arranged to control communication between said passages, the gas inlet and exhaust valves, suitable means, substantially as described, for operating said valves, and suitable means, substantially as described, for igniting the charge of gases in A′, substantially as and for the purposes set forth.

6. In a gas-motor engine having passages X, Y, and Y′ and a valve, P, the valve U, provided with an angular channel, *d e*, and the seat *a*, provided with a passage, *c*, leading to the passage X below valve P, substantially as set forth.

7. In a gas-motor engine provided with a

space or clearance behind the working-piston when at the ènd of its instroke, to contain the charge of compressed combustible mixture for the explosion, the plate Z in said space or clearance, in combination with the prolongation S′ of the exhaust-passage, substantially as and for the purposes set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CHARLES GRANTLEY BEECHEY.

Witnesses:

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W. H. BUCHANNAN,
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