Nov. 28, 1950

G. R. BOUCHARD

2,532,254

DEVICE FOR CONVERTING MOTION

Filed Nov. 24, 1945

3 Sheets-Sheet 1

Fig. 1.

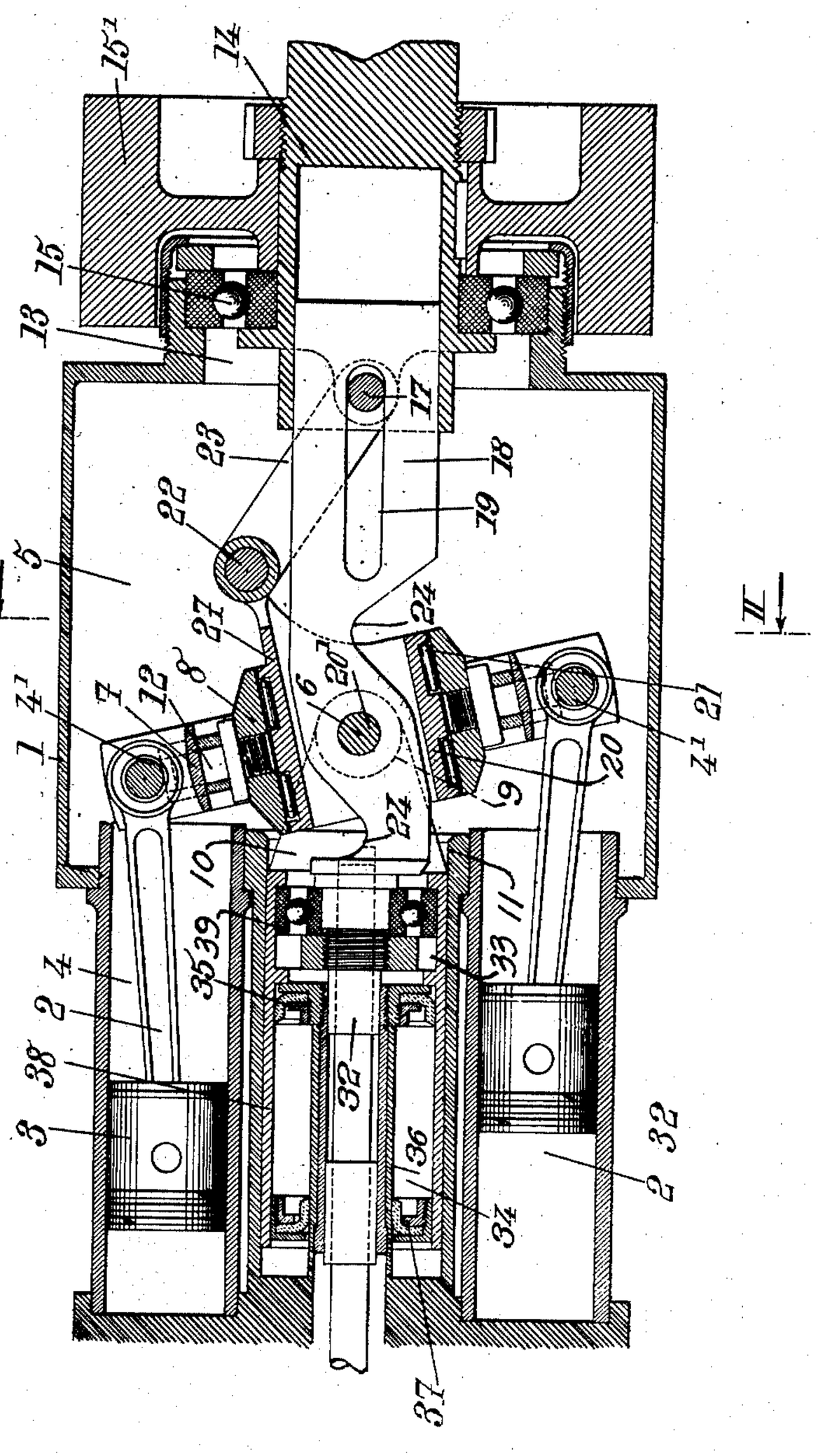

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Fig. 2

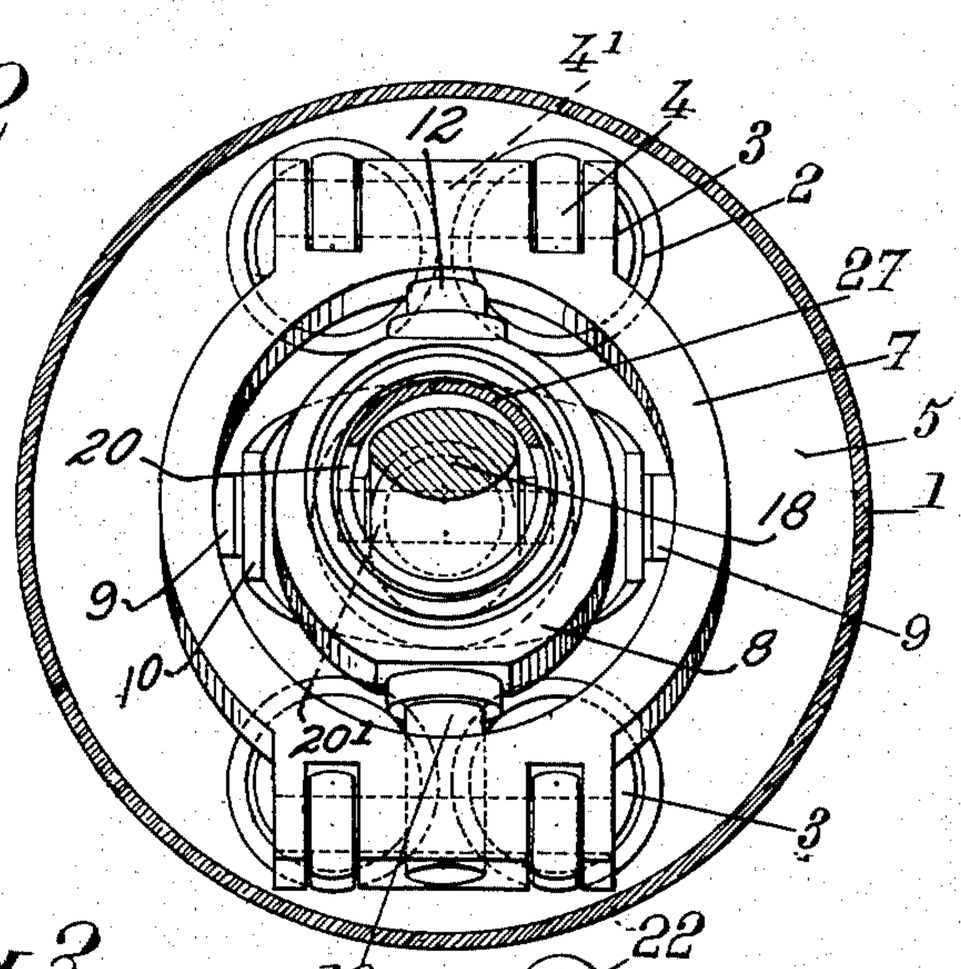


Fig. 3.

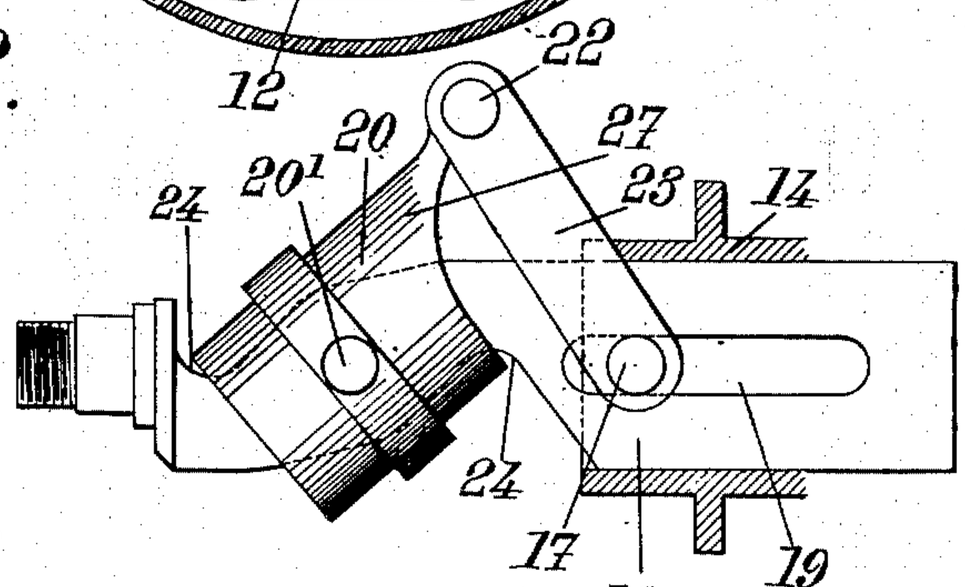


Fig. 4.

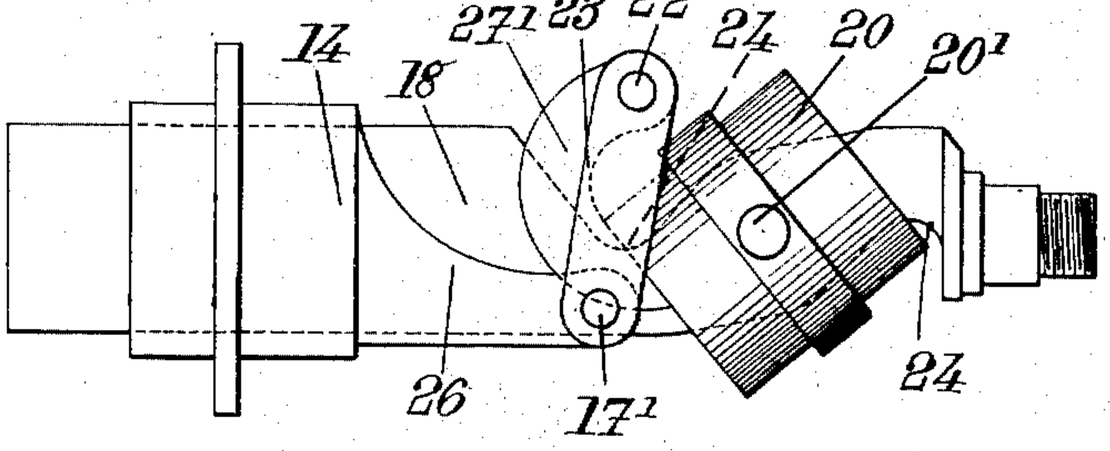
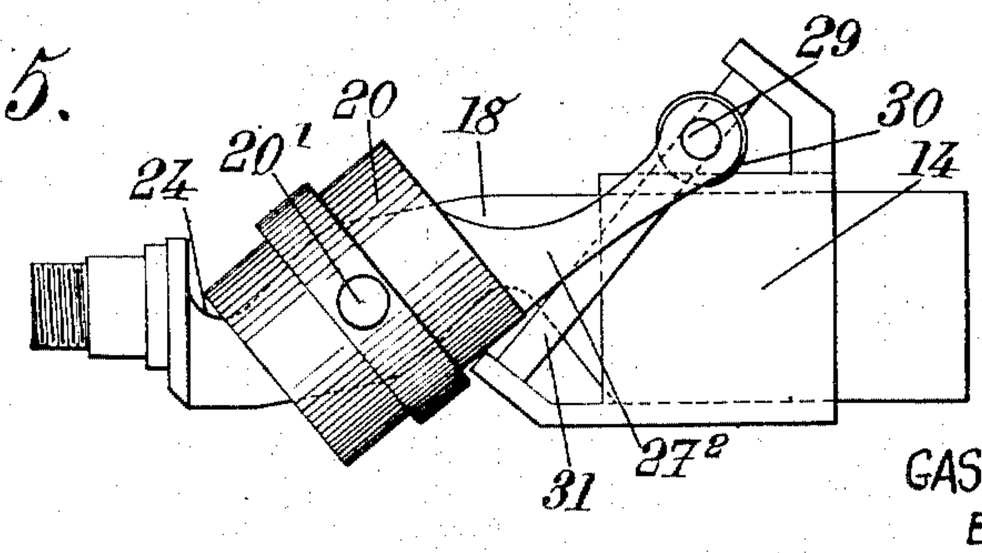


Fig. 5.



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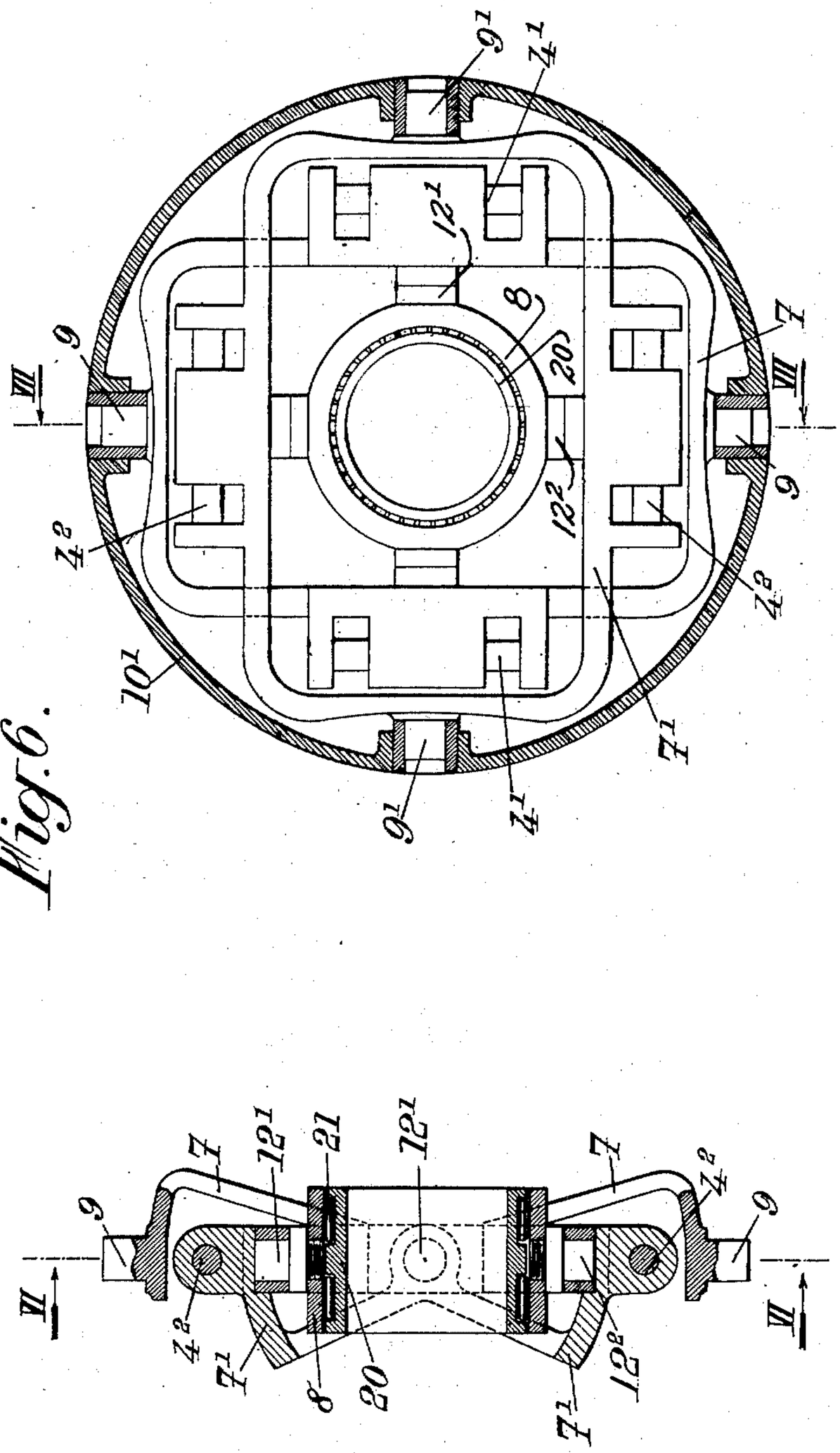

Fig. 6.

Fig. 7.

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DEVICE FOR CONVERTING MOTION

Gaston Robert Bouchard, Saint Germain en Laye, France

Application November 24, 1945, Serial No. 630,624
In France July 4, 1942

Section 1, Public Law 690, August 8, 1946
Patent expires July 4, 1962

9 Claims. (Cl. 74—60)

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The invention relates to piston machines, that is to say machines including several parallel cylinder-piston groups distributed about the main shaft and connected therewith through a wabbler assembly or the like and suitable link means, with a view to transforming the longitudinal efforts of the pistons into a torque applied to said shaft (case of a motor) or vice versa (case of a pump, compressor, etc.), this invention being more especially, but not exclusively, concerned with explosion engines for automobile vehicles.

The chief object of my invention is to provide a machine of this type which is adapted to comply, better than those of the same type made up to the present time, with the various requirements of practice, and, more particularly, which permits of obtaining a variation of the stroke of the pistons while maintaining a predetermined value of the ratio of compression.

Embodiments of my invention will be hereinafter described, with reference to the appended drawings, given merely by way of example, and in which:

Figs. 1 and 2 are diagrammatical views showing respectively in longitudinal section and in transverse section on the line II—II of Fig. 1, a four cylinder engine made according to the invention.

Fig. 3 is a side view (with portions in section) of certain elements of the machine shown by Figs. 1 and 2, but in a different characteristic relative position.

Figs. 4 and 5 are views, similar to Fig. 3, showing the same elements made according to two different modifications.

Figs. 6 and 7 show, respectively in vertical section on the line VI—VI of Fig. 7 and in vertical section on the line VII—VII of Fig. 6, another embodiment of the oscillating plate included in machines of the kind in question.

Frame 1, of hollow cylindrical shape, carries at one end thereof a plurality of hollow parts, parallel or substantially parallel to the longitudinal axis of said frame and adapted to form cylinders 2 distributed about said axis.

Each of these cylinders contains a piston 3 connected, through an ordinary connecting rod 4, with a wabbler assembly which will be more explicitly described hereinafter, this device being housed in a space 5 provided in frame 1 and in which said plate can oscillate, about a theoretical axis 6 (Fig. 1) parallel to the axes of the crank pins 4^1 of the connecting rods 4 when pistons 3 work in cylinders 2.

Said wabbler assembly is constituted by two annular pieces or rings 7 and 8 connected together by pivots 12, the outer ring 7 carrying the crank pins 4^1 of connecting rods 4. The cylinder-piston units occupy positions such with

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respect to oscillation axis 6 that, in the case of a four cylinder engine, two of these units form a group, either with a common crank pin 4^1 or not, located on one side of this axis 6 and the two other units form a second group, either with a common crank pin 4^1 or not, symmetrically located on the other side of said axis 6.

The outer ring 7 is mounted, through the intermediate of two pivots 9 perpendicular to pivots 12 and materializing theoretical axis 6, on a fork-shaped piece 10 housed in a central recess 11 of frame 1 provided between cylinders 2. Piece 10 can slide axially in recess 11 while being prevented from rotating about its longitudinal axis through any known conventional means (not shown) such as grooves, reaction arms, twin mounting, and so on. Therefore there is a Cardan connection between the crank pins 4^1 of connecting rods 4 and inner ring 8, on the one hand, and between said inner ring 8 and piece 10, on the other hand, which ensures freedom of movement of this ring 8 in all directions.

In the embodiment shown by Figs. 1 to 3, I provide, in the end of frame 1 opposed to that in which are fitted cylinders 2, a central housing 13, with a thrust bearing 15 for the main shaft 14 of the engine, this shaft being longitudinally fixed with respect to said frame and carrying among other things, a fly-wheel 15^1.

In the end of shaft 14 which projects into recess 5, I provide a cylindrical axial housing for an intermediate shaft 18, which is axially movable with respect to main shaft 14 but angularly connected therewith on the one hand through a transverse pin 17 slidable in a slot 19 of intermediate shaft 18 (or any other equivalent means, such as grooves) and/or, on the other hand, through a link system to be hereinafter described.

On intermediate shaft 18, and at the place where is located wabbler assembly 7—8 I mount a sleeve-shaped support 20, the inner ring 8 of said wabbler assembly bearing on said support 20 through the intermediate of needle or roller bearings 21 or antifriction bearings.

Support 20 is connected, on the one hand, with intermediate shaft 18 through pivots 20^1 (Figs. 2 and 3), whereby this support 20 shares in the rotation movement of intermediate shaft 18, and, on the other hand, through arm 27, pin 22, and links 23, with the transverse pin 17 which connects together shafts 18 and 14. This connection 20^1—20—27—22—23—17 constitutes the link system above referred to.

When piece 10 is caused to slide in one direction or the other with respect to frame 1, it produces a translatory displacement of the whole of wabbler assembly 7—8 in the same direction since ring 7 is connected to piece 10 through

pivots 9. Such a displacement simultaneously produces a modification of the inclination of support 20 and wabbler assembly 7—8, since said support 20 is connected through links 23 with the longitudinally fixed pin 17. As wabbler assembly 7—8 is connected with pistons 3 through connecting rods 4, said pistons follow the displacements of the wabbler assembly and I thus obtain an engine in which the strokes of the pistons are simultaneously variable according to an equal degree for all the pistons and the positions of the pistons called "upper dead points" follow a law determined as a function of the stroke, which permits of obtaining a ratio of compression of well defined value.

On Figs. 1 and 3, support 20 has been shown in two different characteristic positions for which its inclinations, with respect to the main shaft, respectively have minimum and maximum values, corresponding to the minimum and maximum strokes of the pistons. In order to permit angular displacement of support 20 with respect to intermediate shaft 18 while maintaining a radial dimension of the whole as small as possible, I provide in said shaft notches 24 in which certain portions of said support 20 can engage when the latter is very much inclined (Fig. 3).

Fig. 4 shows a modification of the arrangement above described, according to which main shaft 14 is housed in the central cavity 11 of the frame between the motor cylinders. In this case, the rotational connection between main shaft 14 and intermediate shaft 18 is also obtained through a link system constituted by a pin 17^1, carried by arm 26 rigid with shaft 14, and connecting rods 23 pivoted, through pins 22, to arms 27^1 carried by the variable inclination support 20.

I may also, as shown by Fig. 5, adopt an arrangement analogous to that of Fig. 3 but in which links 23 and pin 17 are replaced by two arms 27^2 rigid with support 20, and the free ends of which are pivotally connected, at 29, to a sleeve 30 slidable along a guide 31, suitably inclined and mounted on shaft 14 so as to turn together therewith and with intermediate shaft 18.

Any other means for ensuring in response to an axial displacement of fork-shaped piece 10, both a longitudinal displacement of intermediate shaft 18 and support 20 and an inclination of said support, and consequently of wabbler assembly 7—8, with an amplitude in direct relation to that of the axial displacement of said piece 10, could be utilized instead of the arrangements above indicated by way of example.

In order to obtain the axial displacement of fork shaped piece 10, I may have recourse to various mechanical, hydraulic, pneumatic, electromechanic or other means generally called "servo-control" means, and an example of which is shown by Fig. 1.

Piece 10 is rigid with a tubular piece 38 freely engaged in the central cavity 11 of the frame. In the cavity 33 of this piece, I fit a joint 35 carried by another tubular piece 36 rigid with frame 1 and the diameter of which is substantially smaller than that of the first whereby I form, between pieces 38 and 36, an annular interval 34 closed at one end by joint 35 and at the other one by a joint 37 carried by tubular piece 38.

When a pressure (or a depression) is caused to act in annular interval 34, limited by joints 35 and 37, through the intermediate of a liquid or gaseous fluid admitted through externally controlled valve means, I obtain the desired axial displacement of joint 37, acting as a hydraulic or pneumatic piston, together with sleeve 33 and piece 10, this pressure (or depression) being counter-balanced by the reaction exerted by pistons 3 and, if need be, by the intervention of one or several antagonistic springs, or by means of a "double action" arrangement bringing into play, for instance, a third joint (not shown) which would then be established at the place designated by 33. A bearing 39 is interposed between the sleeve 38 that is to be axially displaced and intermediate shaft 18, in order to hold this shaft in proper axial position.

I might also obtain the desired axial displacements of fork-shaped piece 10 and, consequently, of theoretical axis 6, by providing this fork-shaped piece with screw-thread, or rack, means cooperating with screw threads or a toothed wheel, the control of which, either from a distancec or not, would be easily accessible and operable even during operation of the engine.

A rod 32, rigid with shaft 18, is utilized for controlling the means for distributing fluid to the cylinders 2 of the engine, this distribution being for instance effected through any suitable means, for instance ordinary valves, rotary valves, perforated barrels, etc., not shown by the drawings because their disclosure is not necessary for a good understanding of the object of the invention. However, it should be noted that it is possible, owing to the possible translation of intermediate shaft 18, to obtain a variation of the angular relative position (with respect to intermediate shaft 18 acting as crankshaft) of the cam or cams utilized for distribution control. It is also possible to vary the working outline of these cams due to the translatory movement thereof when intermediate shaft 18 is displaced in one direction or the other.

On Figs. 6 and 7, I have shown, by way of example, the arrangement of an oscillating or wabbler assembly, analogous to that of Figs. 1 to 3, in the case of an engine including not four cylinders but eight cylinders distributed by pairs in a symmetrical manner with respect to the motor shaft or to the crankshaft.

In this case the support 20 of the plate also carries, through the intermediate of roller bearings 21 or the like, an inner ring 8 pivotally carried, through horizontal pivots 12^1, by the vertical sides of a rectangular frame 7 similar to the annular piece 7 of Figs. 1 and 2, these sides also carrying the crank pins 4^1 of the connecting rods 4 of the upper and lower pairs of cylinders. This inner ring 8 is also pivotally connected, through vertical pivots 12^2, with the horizontal sides of a second rectangular frame 7^1 which also carries the crank pin 4^2 of the connecting rods of the two pairs of lateral cylinders.

The horizontal sides of frame 7 are mounted, through pivots 9, on a sleeve 10^1, similar to the fork-shaped piece 10 of Figs. 1 and 2 and the vertical sides of frame 7^1 are pivotally connected, through pivots 9^1, to the same sleeve 10^1. I thus obtain the desired interrelation of the two link systems above described through which the efforts of the pistons of the eight cylinders are transmitted to the support 20 of the oscillating plate. In order to avoid interference between frames 7 and 7^1 in the course of their relative movements, it is necessary to give them a suit-

able shape, different from a plane shape, as clearly visible on Fig. 7.

In what precedes, it has been admitted that the transmission of the efforts of pistons 3 to driving shaft 14 takes place through a wabbler assembly including two rings 7 and 8, connected together by pivots 12, and oscillating about a theoretical axis 6 materialized by pivots 9, this axis 6 being admitted to be displaced, with a translatory motion, by external control means easily accessible and operable even during the operation of the engine.

In the case of the oscillation of plate 7—8 about a movable axis 6, the cylinders must be distributed in diametrally opposed or symmetrically mounted pairs with respect to this axis.

Finally, it should be noted that the invention is applicable with the same effects or advantages to steam engines or receiving machines, such as pumps, compressors, pump and motor units forming hydraulic transmissions, etc.

In all cases, the piston stroke adjustment control may be manual, automatic, or semi-automatic, and this control may be analogous to those already proposed for the regulation, either automatic or not, of the gear-boxes of engines or of some machine-tools.

The piston machine according to my invention permits of varying, at will and in a simple manner, the stroke of the pistons while obtaining for the ratio of compression a value which is substantially constant or determined according to a suitably established law which permits, among other things, of obtaining a linear velocity of the pistons—and, consequently, a power—which is substantially constant within certain limits of speed of revolution, thus ensuring a high torque at low speeds under good conditions of efficiency. With the construction according to my invention I therefore obtain, by means of the machine itself and through variation of stroke of its pistons, the same effect as with a variable speed transmission which is generally considered as forming a necessary adjunction to an explosion engine. More particularly in the case of the application of the invention to compressors, I obtain the advantage that it is possible to adjust the displacement of the piston or pistons as a function of the output that is required, thus avoiding the working on no load which results from the "hit or miss" adjustment.

Of course, the invention applies to the case in which, the relative movement between the main shaft and the support of wabbler assembly being maintained, the main shaft and the pieces that are carried by it form a fixed or non-rotary system while the frame and the cylinders with all the parts associated therewith are given a movement of rotation about said fixed system.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. A machine which comprises, in combination, a shaft, at least two cylinder and piston units parallel to said shaft, two concentric rings pivoted to each other about a common diameter thereof, at least two connecting rods for said pistons respectively, pivoted to the outer ring about axes perpendicular to said diameter, a part longitudinally slidable with respect to said shaft along an axis fixed in position with respect to said cylinder, said part being pivotally connected with said outer ring about an axis perpendicular to said common diameter at the middle point thereof, a shaft element slidably keyed to said shaft and journalled in said part to be axially movable together therewith, a bearing for the inner ring pivotally connected with said shaft element about an axis perpendicular to said shaft and passing through the point of intersection of said shaft axis and said common diameter, means for producing longitudinal displacements of said part with respect to said shaft, and link means between said bearing and said shaft for modifying the inclination of said bearing with respect to the axis of said shaft as a function of the longitudinal position of said part with respect to said shaft.

2. A machine which comprises, in combination, a frame, a shaft journalled in said frame, at least two cylinder and piston units carried by said frame parallel to the axis of said shaft and on either side thereof, two concentric rings pivoted to each other about a common diameter thereof, at least two connecting rods for said pistons respectively, pivoted to the outer ring about axes parallel to a direction perpendicular both to said diameter and to the shaft axis, said frame forming a central longitudinal recess between said piston and cylinder units, at least one part longitudinally slidable in said recess coaxially with respect to said shaft adapted to be prevented from rotating with respect to said frame about the axis of said shaft, the outer ring being pivotally connected with said part about an axis parallel to the above mentioned direction and passing through the point of intersection of said shaft axis and said common diameter, a shaft element slidably keyed on said shaft and axially movable together with said part, a bearing for the inner ring pivoted to said shaft element about an axis perpendicular to the shaft axis and passing through said point of intersection, means for producing longitudinal displacements of said part with respect to said shaft, and link means between said bearing and said shaft for modifying the inclination of said bearing with respect to the axis of said shaft as a function of the longitudinal position of said part with respect to said shaft.

3. A machine which comprises, in combination, a main shaft, a plurality of cylinder and piston units parallel to said shaft, means, including a wabbler assembly and connecting rods interposed between said pistons and said wabbler assembly, for transforming into one another the reciprocating longitudinal motion of said pistons with respect to their cylinders and the rotary motion of said shaft, a shaft element slidably keyed on said main shaft, a sleeve coaxial with said wabbler assembly mounted to act as a journal for said wabbler assembly, said sleeve being pivoted to said shaft element about an axis perpendicular thereto, means for producing longitudinal displacements of said sleeve with respect to said shaft, an arm rigid with said main shaft extending longitudinally therefrom, an arm extending from said sleeve longitudinally therefrom and a link pivoted at its ends to said arms respectively, about axes at right angles to the axis of said shaft, for modifying the inclination of said sleeve with respect to the axis of said shaft as a func-

tion of the longitudinal position of said sleeve with respect to said shaft.

4. A machine which comprises, in combination, a main shaft, a plurality of cylinder and piston units parallel to said shaft, means, including a wabbler assembly and connecting rods interposed between said pistons and said wabbler assembly, for transforming into one another the reciprocating longitudinal motion of said pistons with respect to their cylinders and the rotary motion of said shaft, a shaft element slidably keyed on said main shaft, a sleeve coaxial with said wabbler assembly mounted to ast as a journal for said wabbler assembly, said sleeve being pivoted to said shaft element about an axis perpendicular thereto, means for producing longitudinal displacements of said sleeve with respect to said shaft, a guide carried by said main shaft obliquely to the axis thereof, a piece slidable along said guide and an arm extending longitudinally from said sleeve pivoted to said slidable piece for modifying the inclination of said sleeve with respect to the axis of said shaft as a function of the longitudinal position of said sleeve with respect to said shaft.

5. A machine which comprises, in combination, a frame, a shaft journalled in said frame, at least two cylinder and piston units carried by said frame parallel to the axis of said shaft and on either side thereof, two concentric rings pivoted to each other about a common diameter thereof, at least two connecting rods for said pistons respectively, pivoted to the outer ring about axes parallel to a direction perpendicular both to said diameter and to the shaft axis, said frame forming a central longitudinal recess between said piston and cylinder units, at least one part longitudinally slidable in said recess coaxially with respect to said shaft adapted to be prevented from rotating with respect to said frame about the axis of said shaft, the outer ring being pivotally connected with said part about an axis parallel to the above mentioned direction and passing through the point of intersection of said shaft axis and said common diameter, a shaft element slidably keyed on said shaft and axially movable together with said part, a bearing for the inner ring pivoted to said shaft element about an axis perpendicular to the shaft axis and passing through said point of intersection, fluid pressure means for producing longitudinal displacements of said part with respect to said shaft, and link means between said bearing and said shaft for modifying the inclination of said bearing with respect to the axis of said shaft as a function of the longitudinal position of said part with respect to said shaft.

6. A machine which comprises, in combination, a shaft, at least two cylinder and piston units parallel to said shaft, two concentric rings pivoted to each other about a common diameter thereof, at least two connecting rods for said pistons respectively, pivoted to the outer ring about axes perpendicular to said diameter, a shaft element slidably keyed on said main shaft, a sleeve pivoted to said shaft element about an axis perpendicular thereto mounted to act as a journal for the inner ring, a part longitudinally slidable with respect to said shaft along an axis fixed with respect to said cylinders, said part being pivotally connected with said outer ring about an axis perpendicular to said common diameter of said rings, means for producing longitudinal displacements of said part with respect to said shaft, and link means between said sleeve and said shaft for

modifying the inclination of said sleeve with respect to the axis of said shaft as a function of the longitudinal position of said part with respect to said shaft.

7. A machine which comprises, in combination, a frame, a shaft journalled in said frame, at least two cylinder and piston units carried by said frame, with the axes of said cylinders parallel to the axis of said shaft and on opposite sides thereof respectively, a ring journalled with respect to said shaft about an axis intersecting the shaft axis obliquely thereto, a second ring pivoted to the first one about a common diameter of said two rings at right angles to said oblique axis and passing through the intersection of said oblique axis and said shaft axis, said second ring being pivotally mounted with respect to said frame about an axis perpendicular to both said shaft axis and said common diameter at their point of intersection, and two connecting rods for said pistons respectively pivoted to said second mentioned ring about axes parallel to the axis about which said ring is pivotally mounted in said frame.

8. A machine which comprises, in combination, a main shaft, a plurality of cylinder and piston units parallel to said shaft, means, including a wabbler assembly and connecting rods interposed between said pistons and said wabbler assembly, for transforming into one another the reciprocating longitudinal motion of said pistons with respect to their cylinders and the rotary motion of said shaft, a shaft element slidably keyed on said main shaft, a sleeve coaxial with said wabbler assembly mounted to act as a journal for said wabbler assembly, said sleeve being pivoted to said shaft element about an axis perpendicular thereto, means for producing longitudinal displacements of said shaft element with respect to said main shaft, and link means between said sleeve and said shaft for modifying the inclination of said sleeve with respect to the axis of said shaft as a function of the longitudinal position of said sleeve with respect to said shaft, said link means being located on the same side of said wabbler assembly as said cylinders.

9. A machine which comprises, in combination, a frame, a shaft journalled in said frame, at least two cylinder and piston units carried by said frame, with the axes of said cylinders parallel to the axis of said shaft and on opposite sides thereof respectively, a support operatively connected with said shaft, a ring journalled on said support about an axis intersecting the shaft axis obliquely thereto, a second ring pivoted to the first one about a common diameter of said two rings at right angles to said oblique axis and passing through the intersection of said oblique axis and said shaft axis, said second ring being pivotally mounted with respect to said frame about an axis perpendicular to both said shaft axis and said common diameter at their point of intersection, and two connecting rods for said pistons respectively pivoted to said second mentioned ring about axes parallel to the axis about which said ring is pivotally mounted in said frame.

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