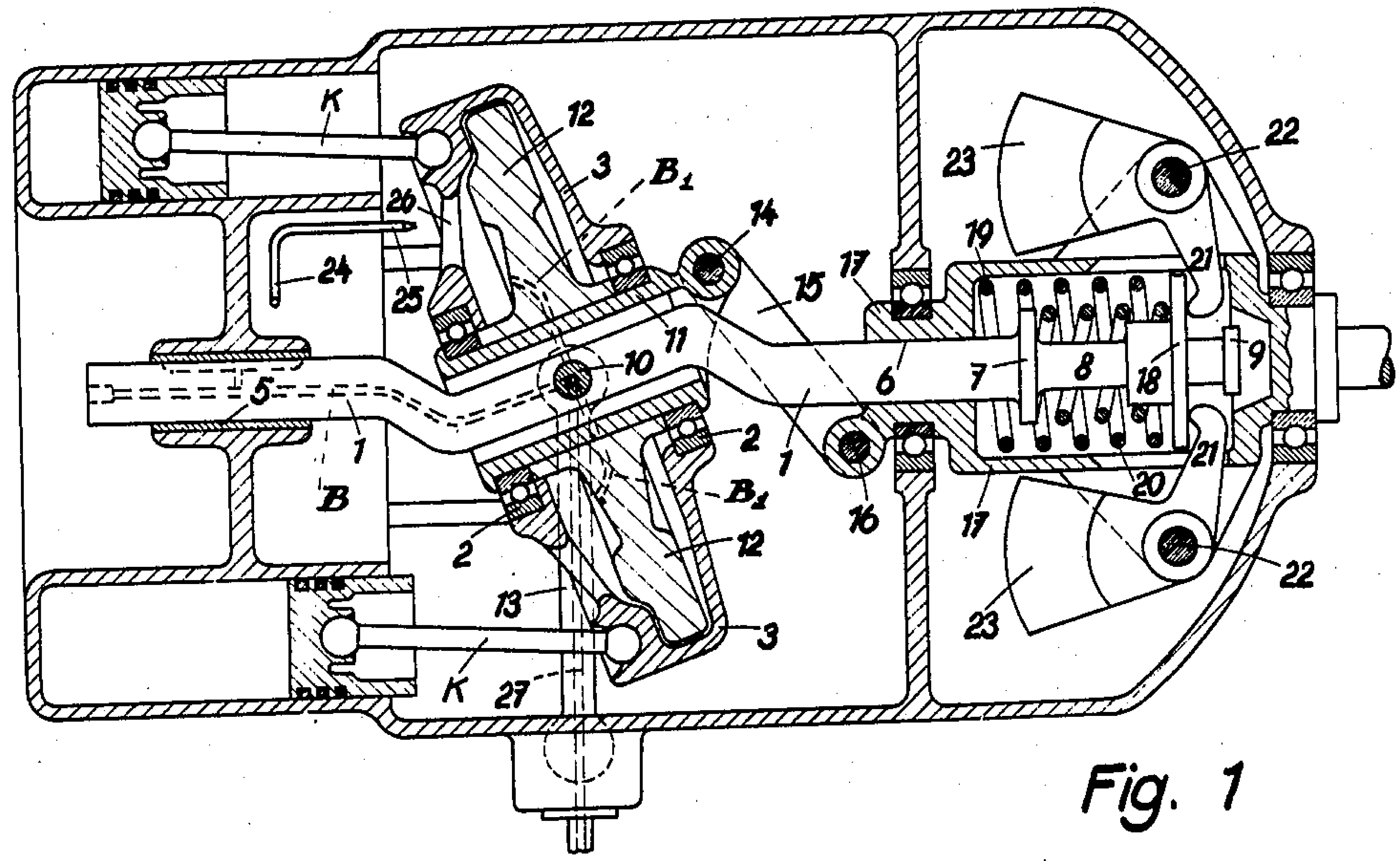
POWER TRANSMISSION FOR INTERNAL COMBUSTION ENGINES

Filed Jan. 6, 1931 2 Sheets-Sheet 1



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Filed Jan. 6, 1931 2 Sheets-Sheet 2

Fig. 3

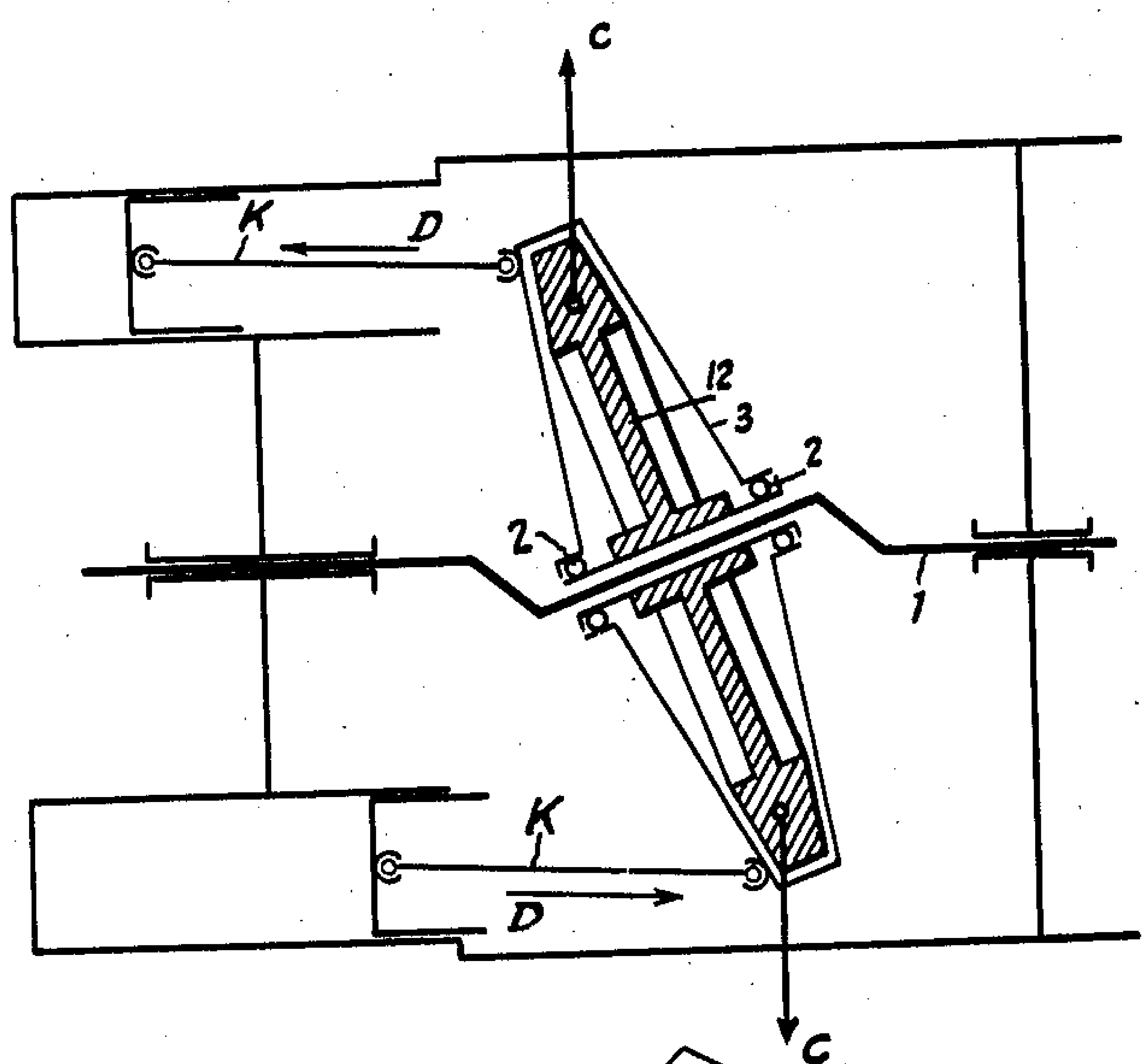
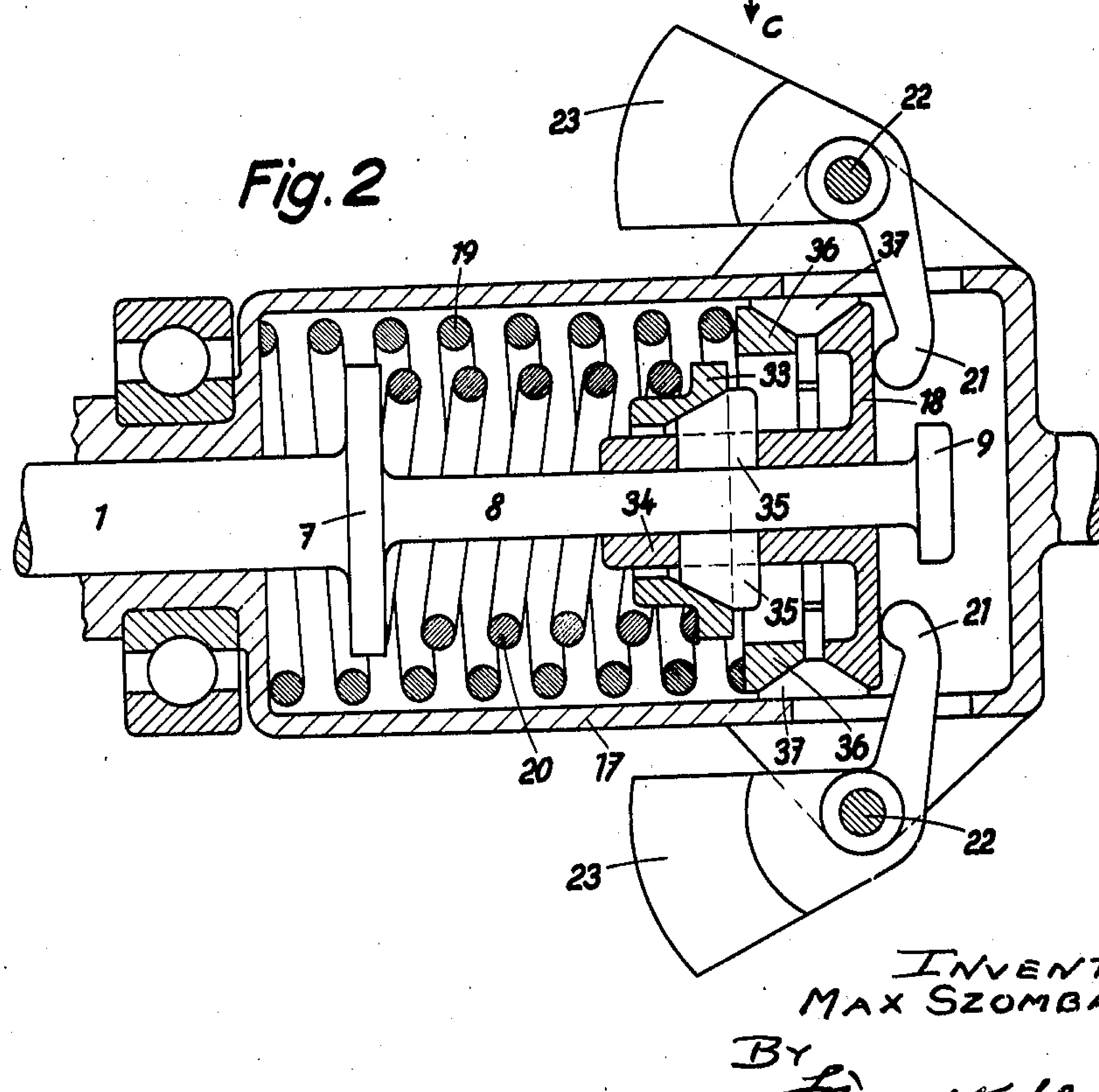


Fig. 2



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POWER TRANSMISSION FOR INTERNAL COMBUSTION ENGINES

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3 Claims. (Cl. 123—58)

The invention relates to a multicylinder internal combustion engine in which the variation of the stroke and of the ratio of compression positively depend on each other, so that a high thermal efficiency and security against detonation are attained in a quite satisfactory manner. The adjustment of the stroke and of the compression is carried out automatically, so that the driver has to control only the working pressure of the engine according to requirement. Working pressure may be called the sum of all gas pressures working at any moment in all cylinders and acting against the pistons, which is controlled by the driver for instance by means of a throttle. No-load pressure is called the working pressure during the no-load run of the engine.

The centrifugal governors already proposed for the automatic adjustment of the stroke possess the drawback in view of the increase of the centrifugal force in accordance with the square of the speed, that in all events they set the smallest stroke at a certain high speed. The result is an output diagram which, compared with that of a common engine of larger size, differs very slightly only and offers a far smaller advantage than in the case of an adjustment of the stroke and ratio of compression, for instance by hand, which however is not satisfactory in connection with motor vehicles. However by the automatic adjusting device according to the invention it is possible to keep up to practically uniform output within a large speed range until the highest speed and to maintain a small fuel-consumption at small working pressures and at the no-load pressure also within a large speed range. For this purpose the stroke of the engine is varied over the total range of its adjustment only if speed and working pressure of the engine are varying simultaneously. If only the speed of revolution or only the working pressure of the engine is varying, the corresponding variation of the stroke takes place only over a part of the total range of adjustment and in such a manner, that the stroke increases, if the working pressure increases or if the speed of revolution of the engine decreases and that the stroke decreases, if the working pressure decreases or if the speed of revolution of the engine increases. Thus the engine gives a sufficient large output of full admission up to the highest speed of revolution and the fuel consumption remains very small if the engine runs with small working pressures or with no load pressure.

An embodiment of the invention is illustrated by the drawings, Fig. 1 being an axial section through the engine. Fig. 2 is an axial section through a damping arrangement. Fig. 3 illustrates the arrangement for balancing the reciprocating masses of the engine.

The axially slidable crank-shaft 1 is rotatable and slidable in the bearing 5 and slidable in the bearing 6. At the right hand side it is extended to a collar 7, a pin 8 and a collar 9 and carries on the transverse bolt 10 the sleeve 11, which may be turned about the bolt 10 until its inner face strikes against the shaft 1. A swash-plate (disc) 3 is carried rotatably on the sleeve 11 by the bearings 2, 2. A wheel 12 is arranged within the swash-plate 3 and fixed to the sleeve 11. The piston rods K of the pistons P of the engine engage the inclined swash-plate 3, which is prevented from rotation and supported with respect to the casing by means of a link-support 13, engaging its outer face.

By means of the bolt 14, the link 15 and the bolt 16, the sleeve 11 is connected with the hollow shaft 17 so that by an axial sliding of the shaft 1 the inclination of the swash-plate 3 is varied, whereby the positive dependance between the variations of the stroke and the ratio of compression is given. A washer 18, supporting the compression springs 19, 20, is mounted longitudinally slidable on the pin 8. The other ends of the springs 19, 20 are resting on the front wall of the casing 17 and the collar 7 of the shaft 1 respectively. Further the lever-arms 21 of the centrifugal weights 23, which are rotatable on bolts 22 of extensions of the hollow shaft 17, act on the washer 18.

The engine operates in the following manner:

1. In the position of rest, both springs 19, 20 are relaxed. The spring 19 moves the washer 18 in the extreme right position, the centrifugal weights 23 occupy the most inner position. The spring 20 acts against the collar 7 integral with shaft 1 to move the shaft 1 in the left position. But as the other end of the spring 20 rests on the washer 18 which is in the extreme right position, the shaft 1 occupies a middle position.

2. If the engine runs with small speed and at a great working pressure, the spring 20 is compressed, the shaft 1 is shifted to the extreme right, the stroke attains its highest and the compression its lowest value.

3. If the engine runs with high speed of revolution and high working pressure, the centrifugal weights shift the washer 18 to the left until the springs 19 and 20 are fully compressed. The shaft 1 is in a middle position, stroke and compression are of a middle value.

4. If the engine runs with high speed and small working pressure or no-load pressure, the spring 19 is compressed, the spring 20 relaxed, the shaft 1 is shifted to the extreme left, the stroke has its lowest the compression its highest value.

The output diagram of the engine can be influenced within wide limits by suitable dimensioning the springs 19 and 20. The best output diagram results in the present construction if the stroke and the highest tension of the spring 20 amounts to about ⅝ of the corresponding values of the spring 19.

In order to render independent the adjusting device from the action of the reciprocating masses, the pair of forces caused by the inclined swash-plate 3 and the reciprocating masses connected with it, are neutralized according to the invention by the action of the inclined rotating wheel 12 disposed in the hollow inclined swash-plate 3 in such manner, that the centre of gravity and the principal gravity planes of the swash-plate 3 and the wheel 12 coincide entirely or practically entirely. The masses of the inclined wheel 12 rotating together with the shaft 1 give a moment of torsion (see the couple of forces C, C in Fig. 5) which at any of the varying inclined positions of this wheel endeavours to erect it. The swash-plate 3 and the pistons as well as the piston rods connected with the swash-plate give by their reciprocative movement a moment of torsion (see the couple of forces D, D in Fig. 5) the plane of which rotates as the engine runs and which endeavours to increase the inclination of the swash-plate 3. The moments of torsion caused by the swash-plate 3 (couple D, D) and the wheel 12 (couple C, C) are of opposite sense of rotation and both these moments become active on the bearings 2, 2. If the mass of the balancing wheel 12 is in suitable proportion to the reciprocating masses of the engine (swash-plate, pistons and piston rods) a quite full balancing of these masses is attained, not only outwardly, that is to say with respect to the foundation or frame of the engine, but also with respect to the stroke-adjusting device.

The adjusting device, designated by 18 to 23 in Fig. 1, does not satisfy all practical demands in the diagrammatic shape as illustrated. In order to prevent that the entire adjusting system is permanently rocked by the individual piston-shocks, which overstep or understep the medium total working pressure, a simple invariable friction brake may be added, but cannot be used alone, because it is too strong in case of small piston-pressures and too weak in case of large piston-pressures.

According to the invention a damping device is used, the action of which is proportional at any time to the whole working pressure. According to Fig. 4, the spring 19 rests at the right side on the washer 18, while the spring 20 rests on the washer 33. The boss 34 of the washer 18 is recessed for receiving the inclined sliding brake-shoes 35, which are pressed by the conically bored washer 33 against the pin 8 and act as friction-brake. Similarly a multi-part sliding brake-ring 37 arranged between the cone-shaped washers 18 and 35 is pressed against the inside of the hollow shaft 17 by the pressure of the spring 19 and also acts as a friction-brake. The inclination of the cones is such, that the sliding shoes absorb the fluctuations of the working pressure caused by the individual piston-shocks, but do not damp the fluctuations of the total working pressure and the automatic adjusting movement.

I claim:—

1. An internal combustion engine comprising a plurality of cylinders provided with reciprocating pistons, an axially displaceable driving shaft, a rotatable swash-plate arranged at an inclination on said driving shaft, piston rods connected with said pistons and having heads seated in the swash-plate at the periphery thereof, means for varying the inclination of the swash-plate, the stroke of the pistons and the compression ratio by the axial displacement of said driving shaft, a casing rotatable with the driving shaft but fixed against axial displacement, centrifugal weights pivoted on said casing, lever arms on said centrifugal weights, a washer slidable lengthwise of said driving shaft and engaged by said lever arms for permitting the centrifugal weights during increasing outward movements to axially displace the driving shaft for effecting a reduction in the strokes of the piston, a relatively strong spring of relatively longer throw compressed between said washer and the end wall of said casing for opposing the action of said centrifugal weights, a collar on said driving shaft, and a weaker spring of relatively lesser throw compressed between said washer and collar and operating on the driving shaft to effect a reduction in the piston strokes.

2. An internal combustion engine comprising a plurality of cylinders provided with reciprocating pistons, an axially displaceable driving shaft, a rotatable swash-plate arranged at an inclination on said driving shaft, piston rods connected with said pistons and having heads seated in the swash-plate at the periphery thereof, means for varying the inclination of the swash-plate, the stroke of the pistons and the compression ratio by the axial displacement of said driving shaft, a wheel connected to rotate with said driving shaft by a transverse bolt, and bearings whereby said wheel is connected with said swash-plate in such manner that it constantly has the same inclination as the swash-plate relatively to the shaft.

3. An internal combustion engine comprising a plurality of cylinders provided with reciprocating pistons, an axially displaceable driving shaft, a rotatable swash-plate arranged at an inclination on said driving shaft, piston rods connected with said pistons and having heads seated in the swash-plate at the periphery thereof, means for varying the inclination of the swash-plate, the stroke of the pistons and the compression ratio by the axial displacement of said driving shaft, a casing rotatable with the driving shaft but fixed against axial displacement, centrifugal weights pivoted on said casing, lever arms on said centrifugal weights, a washer slidable lengthwise of said driving shaft and engaged by said lever arms, a relatively strong spring of relatively longer throw compressed between said washer and the end wall of said casing for opposing the action of said centrifugal weights, a second washer slidable lengthwise of said driving shaft, a collar on said driving shaft, a weaker spring of relatively lesser throw compressed between said second washer and said collar, a brake shoe between said first mentioned washer and said casing adapted to be pressed against the latter by the stronger spring to develop a braking force, and a brake shoe between the second washer and the driving shaft adapted to be pressed against the latter by the weaker spring to develop a braking force.

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