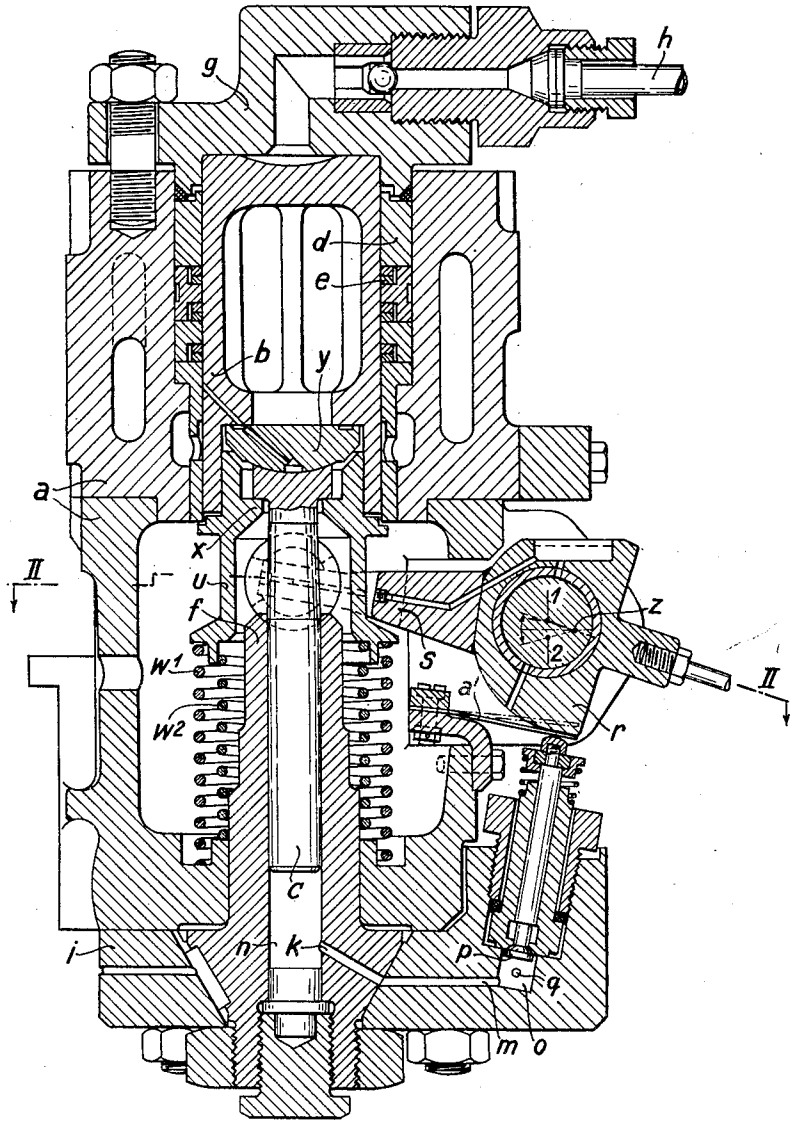
April 18, 1939. K. MOHR 2,155,098

FUEL INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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Fig. 1.



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Fig.2.

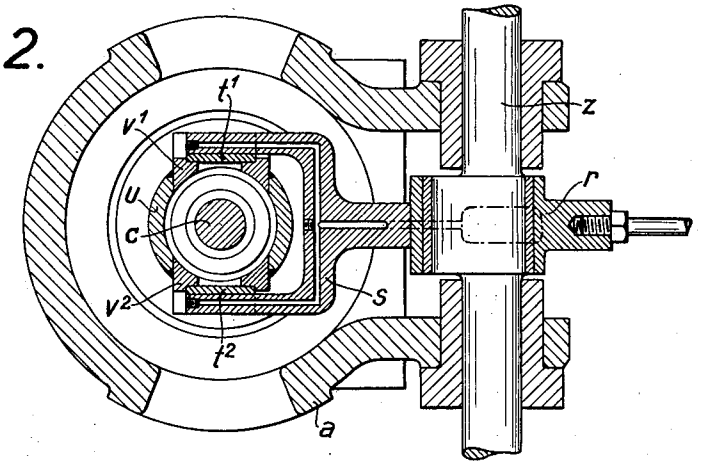
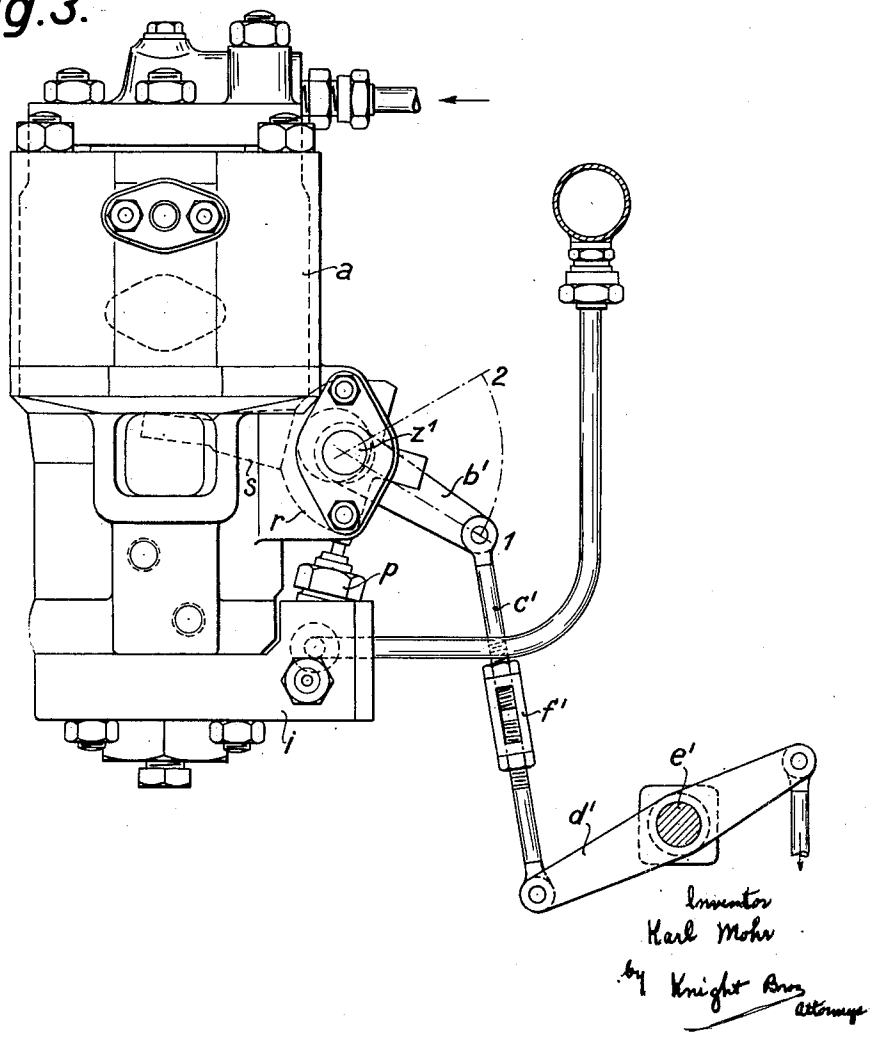


Fig.3.



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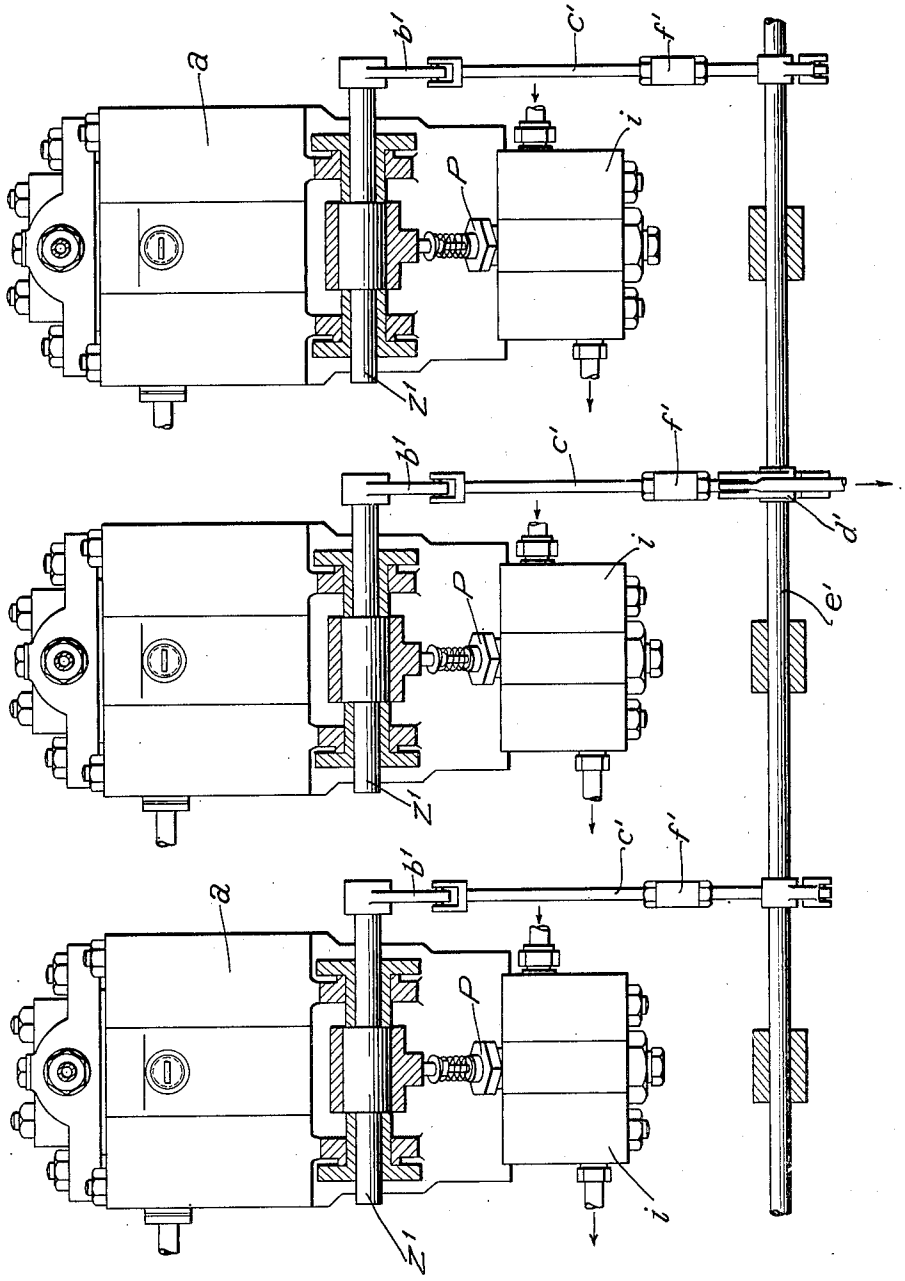


Fig. 4.

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FUEL INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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In Germany February 7, 1936

5 Claims. (Cl. 103—50)

The invention relates to a fuel injecting device for internal combustion engines in which a freely movable differential piston is acted upon by the compression pressure produced in the working cylinder of the engine. Such differential pistons consist of a large air piston and a small fuel pump piston which advantageously are arranged so as to be somewhat movable relatively to one another in order that they may adjust themselves in the correct position in case their guides should not be in correct alinement. If now a controlling member, such as a regulating lever attached to the differential piston, be hinged to the part of the pump piston outside of its guide in such a manner, that with certain positions of the lever a lateral force is exerted upon the piston, then the danger occurs of the pump piston due to its lateral play at one end canting against its guide at the other end and becoming seized. This occurs with such pistons, which are not positively actuated, particularly at outer dead center; for, in this position the guided portion of the piston is the shortest and the lever arm between the point of thrust of the lateral force and the guide sleeve is the longest.

The invention has for its object to eliminate this danger to the reliability of operation of fuel injecting devices of the type outlined hereinbefore and to afford a very suitable and reliable drive for a valve which drive is derived from the differential piston; for, a breakdown of these important members of the engine would entail stopping of the whole engine which would have very serious consequences, in particular with ships.

According to the invention the single valve to be controlled in the fuel injecting device and formed by a check valve simultaneously serving as suction and overflow valve, is actuated from the differential piston through an angle lever adapted to rock on a fixed journal. In order to avoid noxious lateral pressures on the small pump piston, one leg of the lever on the drive side is hinged to the large air piston or to a part mounted thereon, while the other lever arm, which actuates the valve, is in the form of a cam. The regulation of the fuel quantity to be injected takes place in known manner by displacing the eccentrically disposed journal of the lever.

In order that the invention may be clearly understood and readily carried into effect, an embodiment and a further development of the same are illustrated by way of example in the accompanying drawings, in which

Figure 1 is a longitudinal section of a fuel injecting device according to the invention,

Figure 2 is a cross section on the line II—II of Figure 1,

Figure 3 is the general view of a fuel injecting device according to the invention as applied to a multi-cylinder internal combustion engine, and

Figure 4 is another view of a fuel injecting device as applied to a multi-cylinder internal combustion engine.

Referring first to Figures 1 and 2, *a* denotes the two-part housing of a fuel injecting device in which is lodged a differential piston comprising a large air piston *b* and a small fuel pump piston *c* disposed below the former. The air piston *b* is guided in a sleeve *d* which is composed of several parts and has inserted into it inwardly contracting piston rings *e*. The fuel piston *c* is guided in a one-part sleeve *f*. The top cover *g* of the device has attached to it a conduit *h* communicating with the compression chamber of a working cylinder of the engine, through which conduit the pressure acts upon the differential piston on the downwardly directed pressure stroke of the latter. In the guide sleeve *f* of the fuel piston and in the bottom cover *i* carrying this sleeve are provided bores *k* and *m*, which bores intercommunicate and connect the pump space *n* situated below the piston *c* with a space *o* into which opens the suction valve *p*. A bore *q* issues from the space *o* and leads to the injection valve (not shown).

The suction valve *p* is lodged in an inclined position in the lower cover *i* of the housing and is controlled by an angle lever one leg of which forms a cam *r*, whilst the other leg *s* is bifurcated and is hinged to the differential piston in such a manner, that it takes part in the reciprocating motion thereof. The two arms of the bifurcated lever arm *s* engage on opposite sides of the fuel piston *c* with longitudinal play in blocks t^1, t^2, respectively, mounted in holding rings v^1, v^2 welded to a sleeve *u*. The lower end of sleeve *u* constitutes an abutment for two coiled springs w^1, w^2 and under the action of these springs abuts by means of an inner flange *x* against the upper enlarged end of the piston *c*. In this manner the spherically concave upper front surface of the piston *c* is kept in permanent contact with a correspondingly shaped companion surface of a pressure piece *y* supported by the air piston *b*, a certain clearance being provided between the periphery of the piece *y* and the opposite piston wall. The sleeve *u* is further guided on the cylindrical inner surface of the air piston *b*.

The particular advantage obtained by the construction hereinbefore described resides in the

fact that the lateral pressure exerted upon the differential piston and caused by the movement of the lever controlling the suction valve is not transmitted to the fuel pump, but is perfectly kept away therefrom and is taken up by the sleeve *u* which to this end has a sufficient extent of bearing surface against the air piston *b*. The air piston *b* in its turn has a comparatively great diameter and is firmly guided over its whole length so that any canting of this piston due to the thrust of the angle lever is excluded. A satisfactory and reliable operation of the fuel pump *c* is ensured further by the fact that its upper end is in permanent contact with the air piston, so that the two pistons do not lift from and violently strike against one another, but nevertheless owing to the positive contact of the two piston parts on the spherical surface the fuel piston can be slightly displaced if the guides of the two pistons be not in correct alinement. In addition, the guide sleeve *f* of the fuel piston can be made very long, since it is not in the way of the angle lever *r*, *s*.

Furthermore, a simplification is achieved by the described arrangement, when compared with known devices of this type, which resides in the fact that only one single bore opens into the pump space, through which the fuel is sucked, forced back and injected. The fuel quantity to be injected is adjusted by the hand regulating device or by the governor of the engine by turning a shaft *z* between the two limit positions 1 and 2 (full load and stop). This shaft *z* has eccentrically mounted on it the angle lever *r*, *s*. The cam *r* releases the suction valve sooner or later on the downward stroke of the differential piston according to its eccentric position, so that the suction valve can close under the action of the fuel pressure. The regulation may be such that on full load the suction valve is already closed at the beginning of the pressure stroke, so that the largest fuel quantity to be injected is equal to the stroke volume of the fuel piston formed between its upper dead center and the position in which the bore *k* is closed, see Figure 1. After the injection is terminated, the freely movable piston *b*, *c* is elastically braked in known manner by the fuel still enclosed in the pump space.

The springs w^1, w^2 are so determined as to be capable of not only securing the correct contact between the piston *b* and piston *c*, but also of reliably lifting the whole differential piston *b*, *c* on its filling stroke up to its stop formed by the upper cover, under certain conditions together with the fuel present under a certain overpressure in the pump space.

In order to prevent transmission of lateral pressure by friction to the stem of the suction valve *p*, during the motion of the angle lever *r*, *s* a flat spring *a'* is interposed between the cam *r* and the stem of valve *p*. One end of the spring *a'* is fixed in such a position that the spring in all positions of the angle lever abuts with a slight initial pressure against the contact surface of the cam *r*. In this way any lifting of the spring from the cam is avoided. In addition, the spring *a'* also takes elastically up the shocks of the head of the valve stem, which shocks otherwise would very soon cause wear of the exactly shaped curved surface of the cam.

With multi-cylinder internal combustion engines it is frequently impossible to mount the eccentric shaft *z*, which is to be turned by the governor or the hand mechanism in order to vary the fuel quantity, so that it extends along the whole length of the engine in the position of the shaft *z* in Fig. 1. This difficulty arises particularly in the reconstruction of engines in which the arrangement of the individual injecting devices depends upon the given conditions of space.

In order to provide the possibility of applying the above-described controlling mechanism also to such engines, the invention provides a further development of the arrangement described, in so far as the angle levers of the individual injecting devices of a multi-cylinder engine are mounted on individual short eccentric shafts which, in order to vary the fuel quantity to be fed, can be turned from a control shaft common to the whole engine, by means of systems of levers adapted to be adjusted independently of one another. Figure 3 is a side elevation of the parts under consideration of an injecting device of this type.

a denotes again the housing of the device. The freely movable differential piston (not visible) operating in the housing *a* is acted upon at its upper front end by the compression pressure of the working cylinder. The fuel fed to the device is supplied to the pump space by the suction valve *p* provided in the lower cover *i* of the housing. From the pump space also leads a pressure duct to the injection valve.

On the shaft z^1 is eccentrically mounted an angle lever one arm *s* of which is linked to the differential piston while the other arm *r* forms a cam and controls the opening stroke of the suction valve.

For every fuel-injecting device of the internal combustion engine is provided, according to the number of the working cylinders, an individual shaft z^1; as to the rest, the arrangement is the same as in the embodiment described and illustrated in Figures 1 and 2. The turning movement of the eccentric shafts z^1 required to vary the fuel quantity between the limit positions 1 and 2, that is "Full load" and "Stop", is effected through a system of levers *b'*, *c'*, *d'* attached to every shaft z^1 and actuated by a control shaft *e'* which is under the influence of the governor or the hand regulating mechanism.

The described arrangement makes it possible to apply an injecting device comprising the new controlling mechanism also in cases where no through-going shaft can be mounted immediately beside the controlling mechanisms. The control shaft *e'* is arranged anywhere at a suitable place independently of the location of the injecting device.

The required correct play between the cam *r* and the stem of the suction valve is set by slightly turning the eccentric shaft z^1 by means of a turnbuckle *f'* inserted in the link *c'*. The angle through which the eccentric shaft is turned has to be determined therefore to be somewhat greater than required for the two limit positions of the regulation of the fuel quantity to be fed. Every individual injecting device can thus be adjusted independently in such manner as is required in assembling the parts, and every injecting device can be re-adjusted at any time during service in case of wear on the suction valve. No dismantling or re-finishing of any parts is necessary in such cases, which is of great importance with ships on the high seas.

What I claim and desire to secure by Letters Patent is:—

1. In a fuel injecting device for internal combustion engines, a freely movable differential pis-

ton comprising a large end and a small end, said ends being relatively movable, cylinders for the respective ends of said piston, means forming a fuel inlet conduit to the cylinder space in which the small end of said piston operates, a fuel inlet valve controlling said conduit, and a pivoted control member for said valve comprising a lever arm linked to the large end of said differential piston.

2. In a fuel injecting device for internal combustion engines, a freely movable differential piston comprising a large end and a small end, said large end being composed of two parts between which an enlarged portion of the small end of said differential piston is clamped in a way permitting a limited relative movement of the two ends of said piston, cylinders for the respective ends of said piston, means forming a fuel inlet conduit to the cylinder space in which the small end of said piston operates, a fuel inlet valve controlling said conduit, and a pivoted control member for said valve comprising a lever arm linked to one of the parts of the large end of said differential piston.

3. In a fuel injecting device for internal combustion engines, a freely movable differential piston comprising a large end and a small end, cylinders for the respective ends of said pistons, said small end having an enlarged portion adjacent the large end of said piston, said large end comprising two relatively slidable parts between which the enlarged portion of said small end is clamped in a way permitting a limited relative movement of the two ends of said piston, one part of said large end having a bell-shaped sleeve adapted to pass over the cylinder in which the small end of said piston operates during the movement of said piston, means forming a fuel inlet conduit to the cylinder space in which the small end of said piston operates, a fuel inlet valve controlling said conduit, and a pivoted control member for said valve comprising a lever arm linked to said bell-shaped sleeve.

4. In a fuel injecting device for internal combustion engines, a freely movable differential piston comprising a large end and a small end, said ends being relatively movable, cylinders for the respective ends of said piston, means forming a fuel inlet conduit to the cylinder space in which the small end of said piston operates, a reciprocating fuel inlet valve controlling said conduit, and a pivoted control member for said valve comprising a lever arm linked to the large end of said differential piston and a cam coacting with said valve, and a flat spring inserted between said cam and said valve, said spring being anchored to a stationary support and disposed approximately normal to the axis of said valve.

5. In a fuel injecting device for multicylinder internal combustion engines, a plurality of freely movable differential pistons each comprising a large end and a small end, said ends being relatively movable, cylinders for the respective ends of said pistons, means forming fuel inlet conduits to the respective cylinder spaces in which the small ends of said pistons operate, fuel inlet valves controlling the respective conduits, a control member for each valve each comprising a lever arm linked to the large end of the differential piston to which it appertains, individual eccentric pivots for the respective control members, a common control shaft for all of said pivots, and adjustable devices individually connecting said pivots to said control shaft, whereby said pivots can be rocked simultaneously by said control shaft.

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