H. KNUDSEN.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 27, 1911.

1,041,303.

Patented Oct. 15, 1912.

3 SHEETS—SHEET 1.

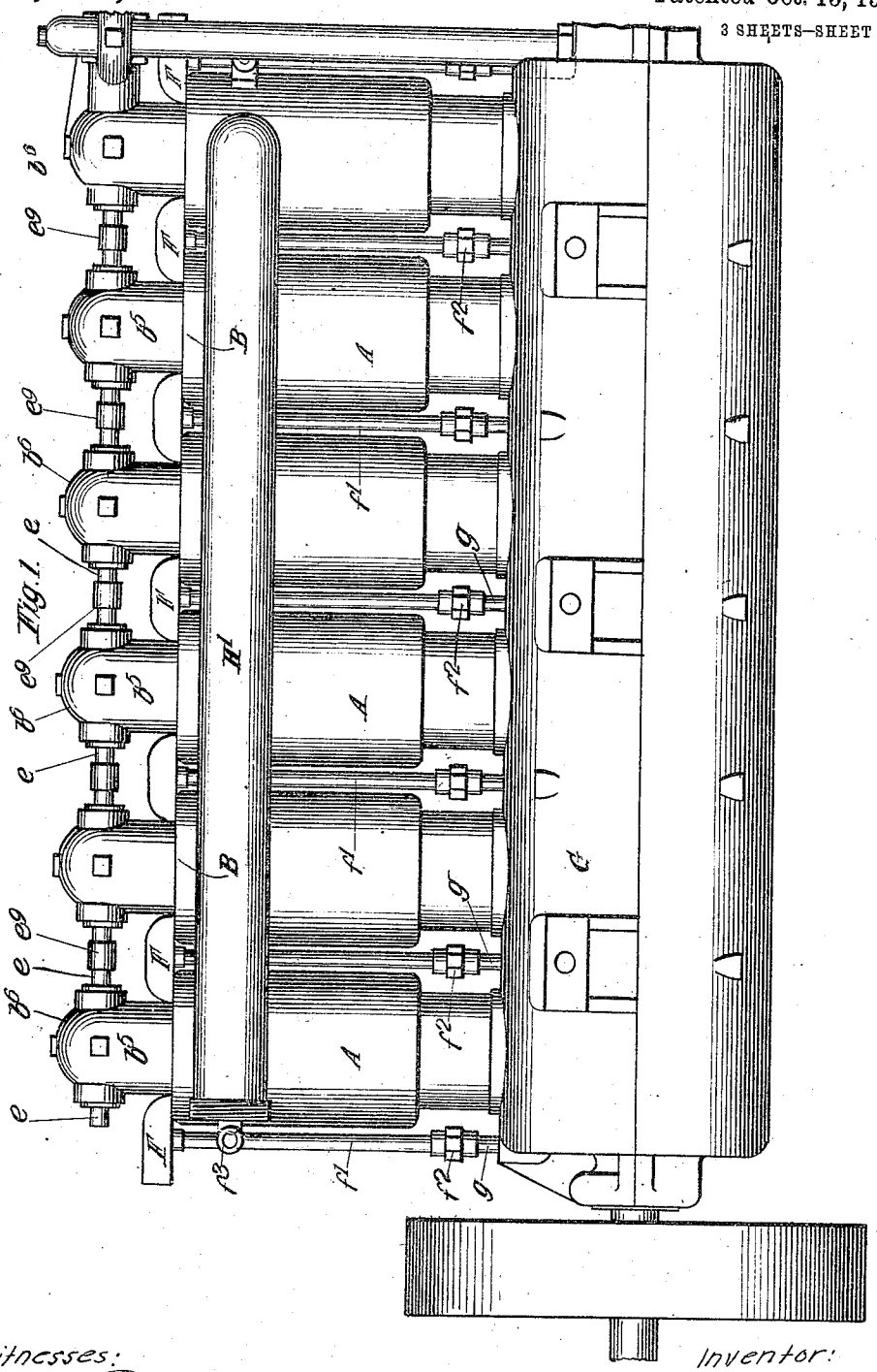

Fig. 1.

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3 SHEETS—SHEET 2.

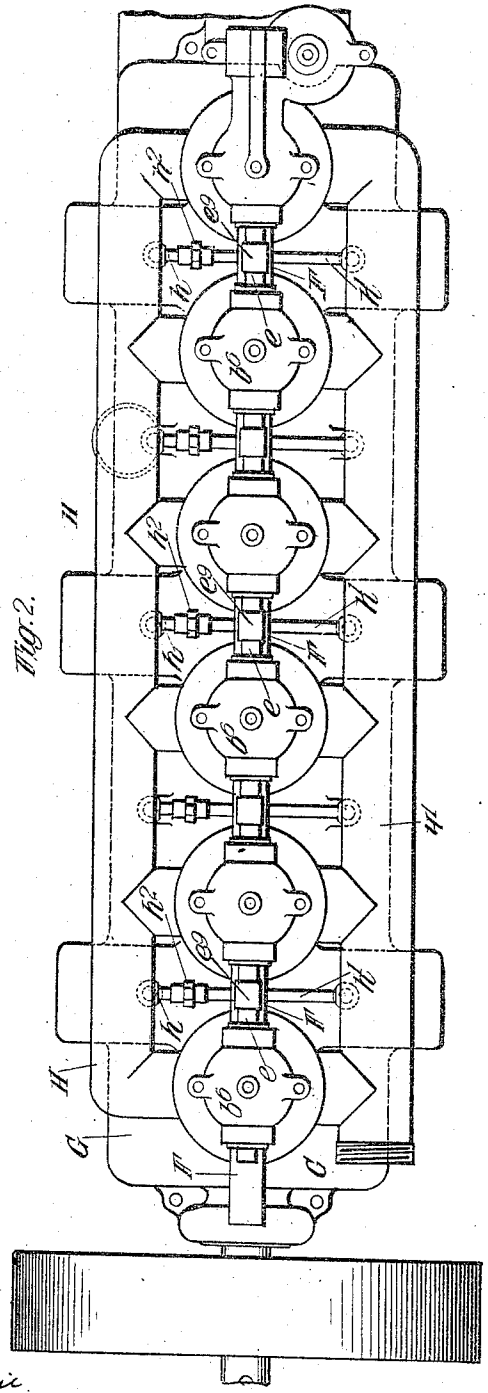

Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 3.

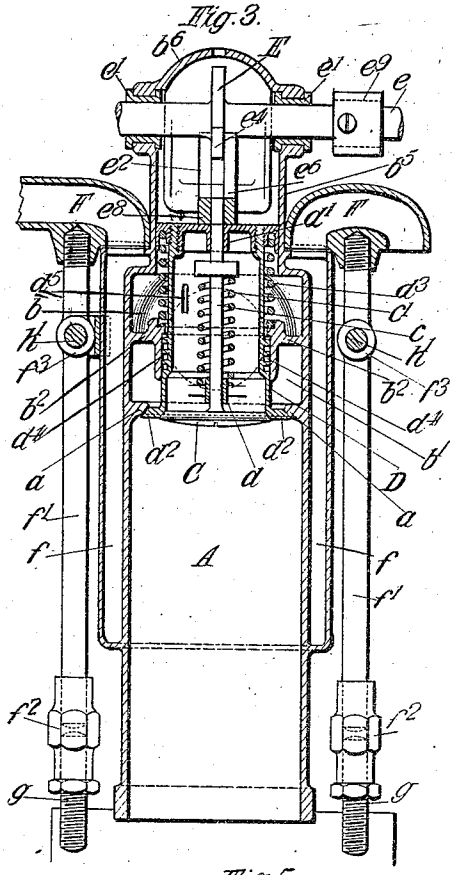


Fig. 4.

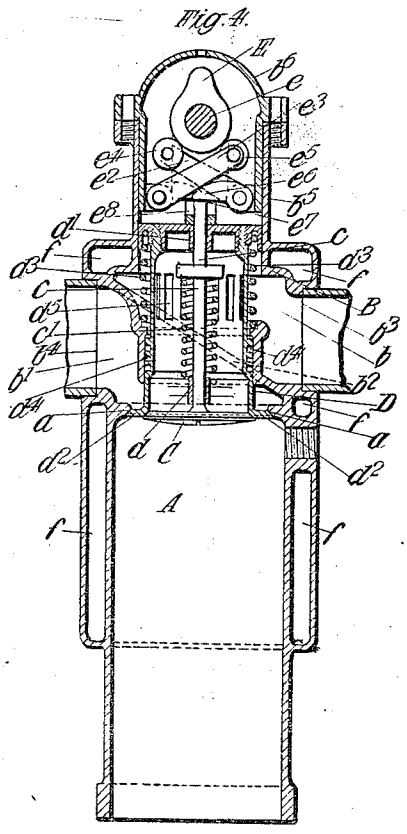


Fig. 5.

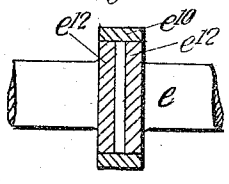
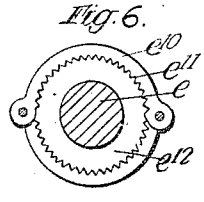


Fig. 6.



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UNITED STATES PATENT OFFICE.

HANS KNUDSEN, OF LONDON, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

1,041,303. Specification of Letters Patent. Patented Oct. 15, 1912.

Application filed February 27, 1911. Serial No. 611,447.

To all whom it may concern:

Be it known that I, HANS KNUDSEN, a citizen of the United States of America, residing at 12 Cyril Mansions, Battersea Park, in the county of London, England, have invented certain new and useful Improvements in or Relating to Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines of the kind in which concentric inlet and exhaust valves are arranged coaxially with the engine cylinder in a cylinder head that opens directly into the engine cylinder and is formed with inlet and exhaust chambers which encircle the exterior of the exhaust valve and terminate in apertures for the passage of the pressure fluid to and from the engine cylinder.

In engines of this class it has been customary to open and close the valves by externally arranged levers extending to one side of the engine and actuated directly from one or more cams on a shaft situated in proximity to the cylinder head, or to the crank shaft.

The present invention has for its chief object to simplify the construction of an engine of this class, to increase the accessibility of the working parts, to facilitate their removal and replacement, and to improve the appearance of the engine by arranging the various parts in a symmetrical and compact manner which renders their inclosure a comparatively simple matter.

According to this invention the levers for operating the inlet and exhaust valves are inclosed within a detachable cover situated in an extension of the cylinder head, and a preferred arrangement comprises two crossed levers pivoted to opposite sides of the cover and provided at their free ends with rubbing or rolling surfaces situated in the path of a cam that is mounted upon a shaft supported between the aforesaid cover and extension of the cylinder head, the aforesaid levers being provided with projections or tappets which rest upon the valves and operate first one and then the other for each revolution of the cam.

When the invention is applied to a multi-cylinder internal combustion engine, the cam shaft for actuating the valves is, as has previously been proposed, made in sections detachably connected together, but in this case the adjacent ends of the sections are preferably serrated and engage with corresponding serrations formed in a detachable coupling ring. The removal of the cylinders is provided for by clamping the same between the crank chamber and detachable pipes which constitute a part of the water circulating system. This is effected by means of bolts secured to such parts and connected together by right and left hand nuts. The main inlet and exhaust pipes are secured to their respective cylinders in a similar manner, that is to say by bolts passing between each cylinder and connected together by a right and left hand nut.

In order that my said invention may be clearly understood and readily carried into effect, I will describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a front elevation and Fig. 2 a plan of an internal combustion engine constructed in accordance with this invention. Fig. 3 is a vertical section of one of the engine cylinders. Fig. 4 is a similar view taken at right angles to Fig. 3. Figs. 5 and 6 are detached views of a suitable form of coupling for connecting the adjacent parts of the cam shaft when the same is constructed in sections.

A represents the engine cylinder, B the cylinder head, C the inlet valve and D the exhaust valve, E the cam for actuating the valves, F the detachable pipes which constitute a part of the water circulating system, G the crank chamber, H the main inlet pipe and H′ the main exhaust pipe.

Referring more particularly to Figs. 3 and 4, the inlet valve C is shown as a mushroom valve having its stem c slidably mounted in guides d d' forming part of the exhaust valve D, the guide d' constituting a cover which seals the outer end of such valve. The inner end of the latter constitutes a seat for the inlet valve C which is normally retained thereon by a spring c'. The exhaust valve D comprises a tube that is slidably mounted within the cylinder head B and is formed at its inner end with a flange d^2 which is normally retained by a spring d^3 upon a seat a formed on the outer end of the cylinder A, suitable packing rings d^4 being interposed between the valve

D and the inner part of the cylinder head to form a pressure tight joint between such parts. Extending through the tubular wall of the exhaust valve D, are a number of apertures d^5 which provide a communication between the inlet valve C and an inlet chamber b formed in the cylinder head. This chamber is separated from an exhaust chamber b' by means of a diaphragm b^2 and both these chambers extend completely around the wall of the exhaust valve so that the portions of the latter which are directly exposed to the cooling influence of the combustible mixture and to the heating influence of the exhaust gases are uniformly acted upon. The chambers b, b' terminate in apertures b^3 b^4 which are arranged directly opposite to each other and communicate with the inlet and exhaust pipes respectively.

The cam E of the valve actuating mechanism is formed upon a shaft e that is supported in bearings e' interposed between a tubular extension b^5 of the cylinder head and a detachable cover b^6 which is bolted or otherwise secured to such extension. Pivoted within this cover are two levers e^2 e^3 which are arranged to cross each other as shown in Fig. 4, and are provided at their free ends with anti-friction rollers e^4 e^5 situated in line with the cam. The lever e^2 is formed with a projection or tappet e^6 which rests upon the stem c of the inlet valve C, and the lever e^3 is in like manner formed with a projection or tappet e^7 which rests upon a block e^8 carried by the guide d' of the exhaust valve D. This arrangement of the levers facilitates the action of the cam in overcoming the resistance offered by the valves to their opening movements. The cylinder and cylinder head are surrounded as usual by a water jacket f which exerts a uniform cooling influence around the inlet and exhaust valves owing to such valves being placed in a central position relatively to the water jacket.

When the inlet valve C is opened during the suction period of the cycle by the lifting portion of the cam engaging with the rollers e^4 on the lever e^2, the combustible mixture is drawn into the engine cylinder through the openings d^5 in the tubular exhaust valve, and as the said mixture passes through the interior of such valve it exerts a cooling influence thereon. During the compression and ignition periods of the cycle, the inlet valve C is retained closed in the usual manner by the spring c'. When the lifting portion of the cam comes into contact with the roller e^5 on the lever e^3, the exhaust valve is opened and the products of combustion pass out of the engine cylinder during the exhaust period of the cycle.

When the invention is applied to a multi-cylinder internal combustion engine, the cam shaft e for actuating the valves is made in sections connected together by couplings e^9 to permit of the removal of any of the detachable covers b^6 with the valve actuating mechanism, or the removal of any of the cylinders with its valves and the replacement thereof by corresponding parts. Any suitable form of coupling may be employed for connecting the adjacent ends of the cam shaft sections together. For example in the arrangement shown in Figs. 5 and 6, the coupling comprises a hinged ring e^{10} serrated around its inner peripheral portion to engage with corresponding serrations e^{11} formed upon the peripheral portions of the disks e^{12} fixed on the adjacent ends of each cam shaft section.

The removal of the cylinders is conveniently provided for by clamping the same between the crank chamber G and the detachable pipes F which constitute a part of the water circulating system. In the example shown in Figs. 1 and 3, each of the pipes F is clamped to its respective cylinder or cylinders by a bolt f' which is fixed to each such pipe and extends along the cylinder into proximity to a bolt g fixed to the crank case G, the adjacent ends of such bolts being formed with right and left hand threads to receive a similarly threaded nut f^2 by means of which the clamping process is effected. The main inlet and exhaust pipe H H′ are shown connected to their respective cylinders in a similar manner, that is to say by bolts h h' secured to their respective pipes and connected together by right and left hand nuts h^2, the bolts h' passing through eyes f^3 formed in the bolts f'.

It is to be understood that the invention is ont intended to be limited to the precise details of construction described as these may be varied according to circumstances without departing from the nature of the invention.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In an internal combustion engine provided with concentric inlet and exhaust valves arranged coaxially with the engine cylinder in a cylinder head that opens directly into the cylinder, a cylindrical coaxial extension on the cylinder, a detachable cover fitting in the extension, a cam shaft section mounted in bearings between the cover and the extension, and valve operating levers mounted in the cover and removable therewith.

2. In an internal combustion engine provided with concentric inlet and exhaust valves arranged coaxially with the engine cylinder in a cylinder head that opens directly into the cylinder, a detachable cover situated coaxially with the engine cylinder, two crossed valve operating levers inclosed

within the cover and pivoted to opposite sides thereof, a cam acting upon the free ends of the levers, and bearing pieces for the valves situated between the free and pivoted ends of the levers.

3. In an internal combustion engine provided with concentric inlet and exhaust valves arranged coaxially with the engine cylinder in a cylinder head that opens directly into the cylinder, a detachable cover situated coaxially with the engine cylinder, two crossed levers inclosed within the cover and pivoted to opposite sides thereof, the free ends of the said levers being provided with rolling surfaces, a shaft rotatably mounted in bearings formed between the detachable cover and the cylinder head and a cam mounted upon such shaft in the path of the aforesaid rolling surfaces.

4. In an internal combustion engine provided with concentric inlet and exhaust valves arranged coaxially with the engine cylinder in a cylinder head that opens directly into the cylinder, detachable cover situated coaxially with the engine cylinder, two crossed levers inclosed within the cover and pivoted to opposite sides thereof, a projection on each lever arranged to rest upon one of the concentric valves, a roller mounted on the free end of each lever, a shaft rotatably mounted in bearings formed between the detachable cover and the cylinder head and a cam mounted upon such shaft in the path of the aforesaid rollers.

5. In an internal combustion engine provided with concentric inlet and exhaust valves arranged coaxially with the engine cylinder in a cylinder head that opens directly into the cylinder, a detachable cover situated coaxially with the engine cylinder, a cam shaft section rotatably mounted in bearings formed between the detachable cover and the cylinder head, serrations formed on the ends of the cam shaft section and a coupling ring formed with corresponding serrations.

6. In an internal combustion engine provided with concentric inlet and exhaust valves arranged coaxially with the engine cylinder in a cylinder head that opens directly into the cylinder, a detachable cover situated coaxially with the engine cylinder, a plurality of such cylinders, sectional cam shafts rotatably mounted in bearings between the detachable covers and the cylinder heads, serrations formed on the ends of the cam shaft sections and coupling rings adapted to engage the said serrations.

In testimony whereof I affix my signature in presence of two witnesses.

HANS KNUDSEN.

Witnesses:
T. SELBY WARDLE,
G. APPLEYARD.