

Feb. 12, 1929.

L. M. WOOLSON

1,701,550

INTERNAL COMBUSTION ENGINE

Filed May 24, 1923

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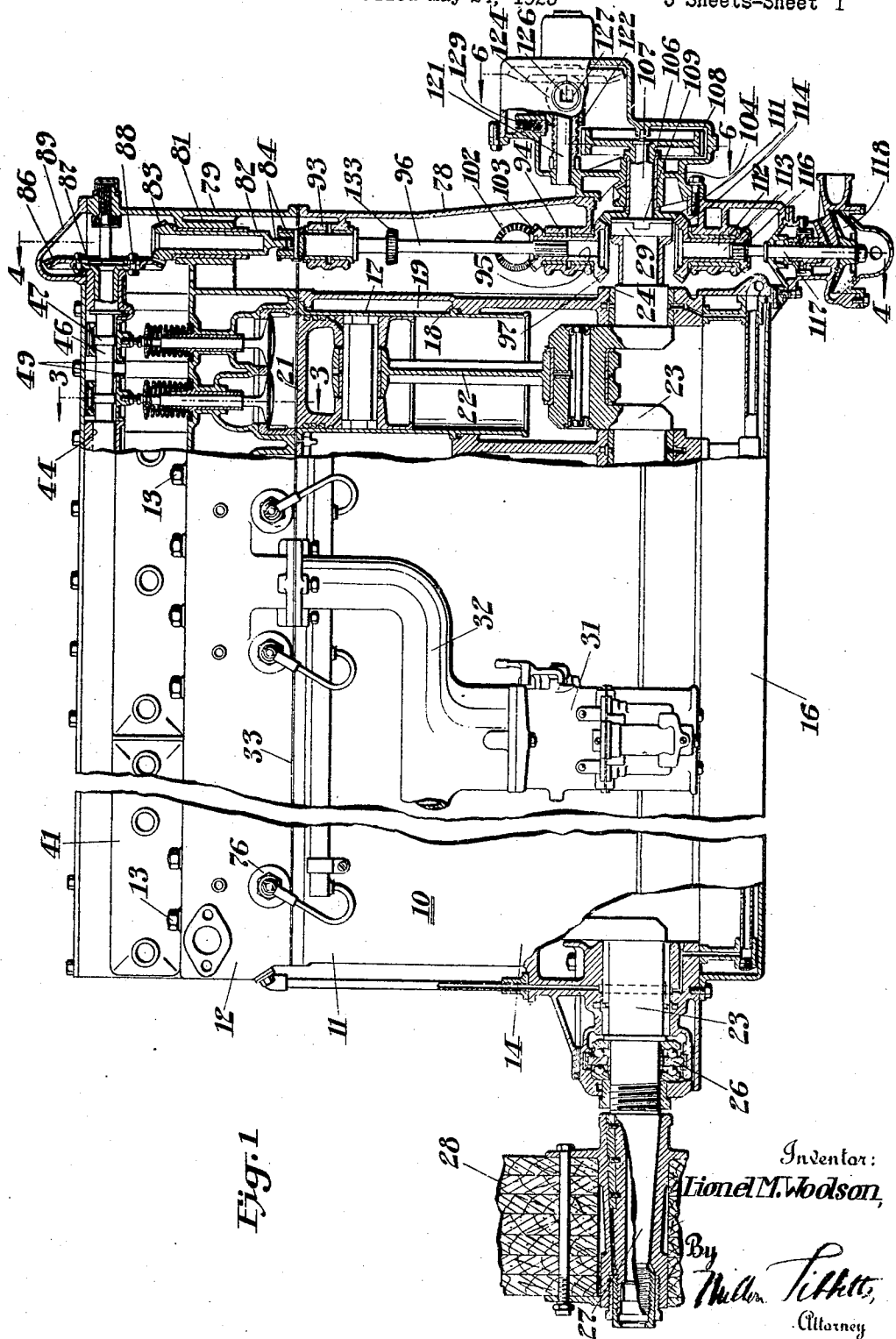


Fig. 1

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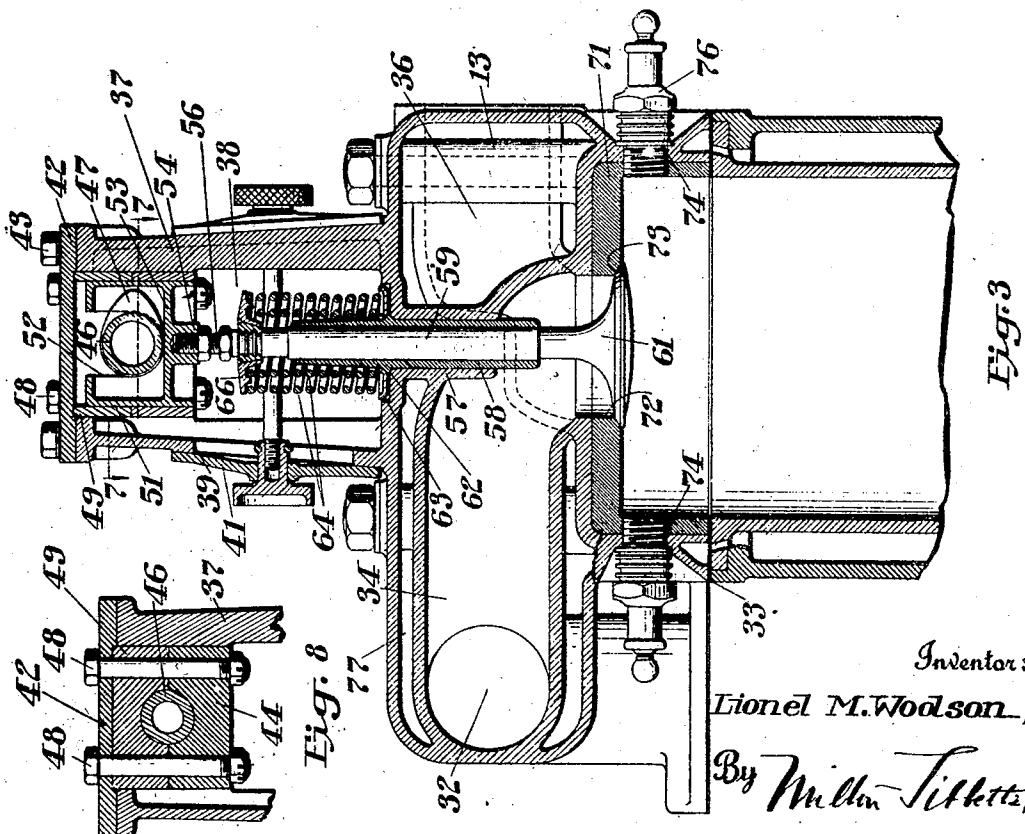
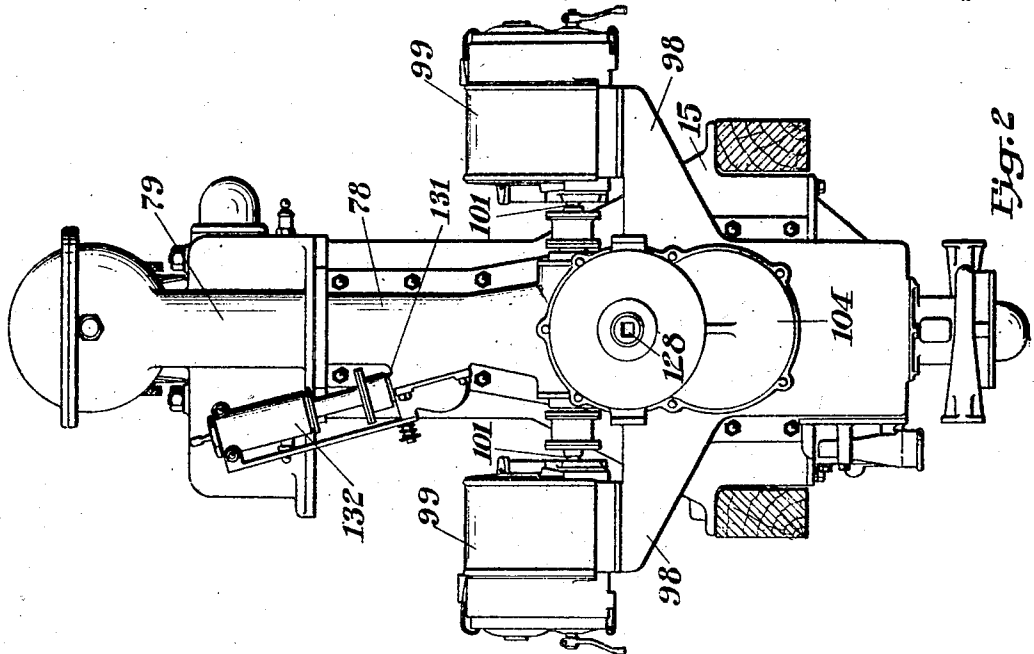
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Filed May 24, 1923

3 Sheets-Sheet 2



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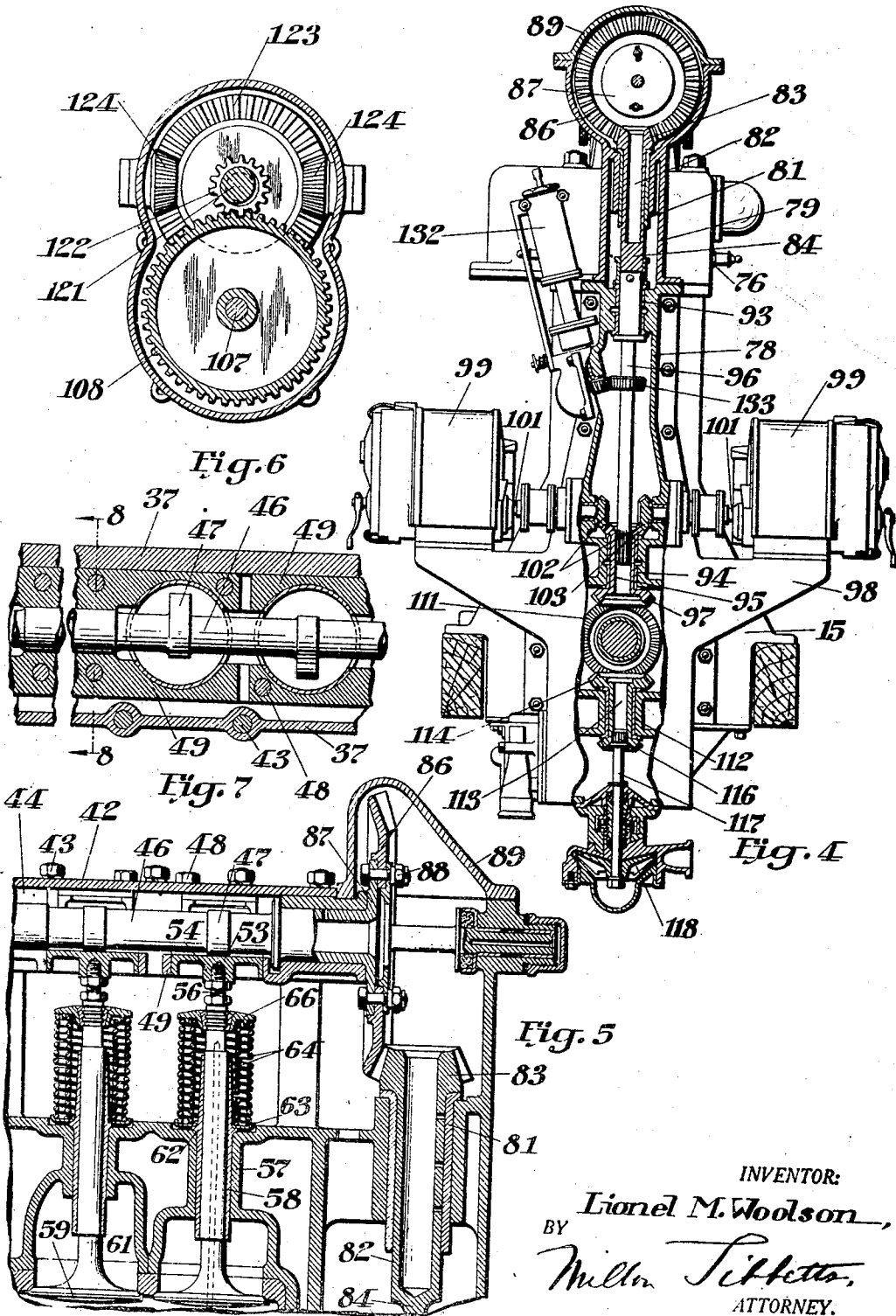
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# INTERNAL COMBUSTION ENGINE

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3 Sheets-Sheet 3



## UNITED STATES PATENT OFFICE.

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## INTERNAL-COMBUSTION ENGINE.

Application filed May 24, 1923. Serial No. 641,053.

This invention relates to internal combustion engines, more particularly to high speed, heavy duty engines such as are used to propel aircraft. It has for an object to provide an engine of the character designated which shall develop a large amount of power with respect to its weight and with a maximum degree of reliability.

Another object of this invention is to provide an engine of this type which shall be highly accessible for adjustments and repairs, especially under emergency conditions.

A further object is to provide an engine in which manufacture is facilitated and expense reduced by the use of unit assemblies.

Other objects of the invention will appear from the following description taken in connection with the drawing, which forms a part of this specification and in which:

Fig. 1 is a side view, partially in section and partially in elevation, of an engine constructed in accordance with this invention;

Fig. 2 is a rear elevation of the engine shown in Fig. 1;

Fig. 3 is an enlarged section through the head and valve operating mechanism of the engine, taken substantially on the line 3—3 of Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is an enlarged detail section showing the valve operating mechanism;

Fig. 6 is a section on the line 6—6 of Fig. 1;

Fig. 7 is a horizontal section on the line 7—7 of Fig. 3, and

Fig. 8 is a section on the line 8—8 of Fig. 7.

In the construction of power plants for aircraft it is essential to insure a high degree of reliability, the very nature of the service these engines are intended to perform making this a major necessity. Repairs and adjustments to such engines must sometimes be made under disadvantageous conditions, placing accessibility at a premium. Next to reliability in operation and accessibility in construction, it is desirable that an airplane engine develop relatively high power in proportion to its weight.

With these considerations in mind, the present invention provides a structure which is sturdy and rugged, which is arranged to be easily and quickly adjusted and repaired, and in which the weight per horsepower developed has been reduced to a minimum.

Referring to the drawings, at 10 is shown an internal combustion engine, adapted for use

with aircraft, having a cylinder portion 11 and a head portion 12 secured thereto as by a plurality of bolts 13. The cylinder portion 11, which is preferably a casting of aluminum alloy or other light metal, is provided with an integral crank case portion 14, having brackets 15 by which the engine is supported on the engine bearer members in the well known manner. The bottom of the crank case 14 is closed by a shallow oil pan or sump 16. The cylinder portion 11 comprises a series of cylinders 17, arranged in line, and which are preferably steel sleeves set into counterbores 18 in the cylinder casting, and spaced therefrom to define passages 19 for circulation of cooling water about the cylinders. The cylinders 17 are provided with suitable pistons 21, operatively connected by rods 22 with a crank shaft 23, which is journaled in bearings 24 in the crank case 14, in the usual manner. The forward end of the crank shaft 23 is preferably journaled in a suitable thrust bearing 26, and projected therethrough to provide a tapered spindle 27, adapted for attachment to a suitable airplane propeller 28. The other end of the crank shaft 23 is adapted to overhang the end main bearing 24, and is provided with a flexible coupling 29 of any suitable construction. The engine is equipped with the usual carburetor 31 adapted to supply fuel mixture to the engine through an intake manifold 32.

The head portion 12 of the engine is preferably a casting of light weight metal, such as aluminum alloy, and is adapted to seat on a suitable gasket 33 to seal the connection with the upper end of the engine cylinders, in the well known manner. The head casting 12, as best shown in Fig. 3, is cored to provide suitable intake and exhaust passages 34 and 36, adapted for respective communication with the intake manifold 32, and with the usual exhaust manifold (not shown). The head casting 12 is also formed, above the passages 34 and 36, with a pair of integral, longitudinally arranged walls 37, which form a housing 38 for the valve actuating mechanism of the engine. The housing 38 is provided with hand openings 39, covered by removable plates 41, to provide access for adjustment of the valve operating mechanism.

A cover plate 42, removably secured to the upper edges of the walls 37 by the screws 43, is adapted to close the housing 38 and to act as a supporting plate for the valve operating

mechanism. Attached to the plate 42, as by means of the bolts 48, are depending bearings 44, preferably arranged in two parts, in which is journaled a camshaft 46, on which  
 5 are formed cams 47 adapted to operate the engine valves. A plurality of guide members 49, preferably split along the axis of the camshaft 46, and arranged in pairs, two above each of the engine cylinders, are formed  
 10 integral with the bearings 44. Adapted for reciprocation in the guide members 49 are plungers 51, provided with U-shaped slots 52 through which passes the camshaft 46. The head portions 53 of the plunger 51  
 15 are provided on their lower faces with suitable bosses 54 which are drilled and threaded for adjustable tappet screws 56.

The head casting 12 is provided, in the median plane of each cylinder, with suitable  
 20 webs 57, in which are pressed valve guides 58, preferably of steel or other wear resisting material, adapted for the reception of stems 59 of the usual puppet valves 61. The valve guides 58 are preferably provided at a point  
 25 intermediate their length with circumferential shoulders 62, adapted for co-operation with the upper surface of the web 57, which serves as a stop to position them longitudinally. Surrounding the valve guide 58 to  
 30 engage the upper surface of shoulder 62 is an annular spring abutment 63, dished upwardly for co-operation with valve operating springs 64, and suitably secured to the upper end of the valve stem 59 is a complementary  
 35 spring abutment 66. The springs 64 are placed under compression between the abutments 63 and 66, urging the valve stem upwards in the well known manner. The upper end of the valve stem 59 is adapted for  
 40 engagement with the head of the tappet 56, so that downward motion thereof will be communicated to the valve stem 59 against the pressure of springs 64, as is usual in such mechanism.

The lower portion of the head casting 12, above the engine cylinders, is adapted to receive a cup-shaped combustion head 71, preferably formed of cast iron or other heat resisting metal and adapted to be pressed into  
 50 a suitable recess in the head casting. The lower edge of the combustion head 71 is adapted to seat on the gasket 33. The combustion head 71 is provided with ports 72, forming communicating passages between  
 55 the intake and exhaust passages 32 and 36, and the engine cylinders. The lower circumferential edges of the ports 72 are beveled to provide valve seats 73, adapted for co-operation with the puppet valves 61. The  
 60 head casting 12 and the combustion head 71 are drilled and tapped, as indicated at 74, for the reception of suitable spark plugs 76. The head casting 12 is also provided with the usual cored passages 77 for the circulation  
 65 of cooling water.

Vertically disposed at the rear of the engine 10 and removably secured thereto is a casing 78, extending to and co-operating with an extension casing 79 of the housing 38. The casings 78 and 79 are adapted to join,  
 70 in the plane of the cylinder head gasket 33, to form an oil tight joint. The casing 79 is provided with a vertically disposed bearing 81 in which is journaled a shaft 82 provided at its upper end with a bevel gear 83 and at  
 75 its lower end with one element of a flexible coupling 84. The gear 83 is adapted to mesh with a bevel gear 86 secured to a flange 87, which is integral with the end of the camshaft 46. The gear 86 is secured to the flange  
 80 87 by bolts 88, passing through co-operating holes in the hub of the gear 86 and the flange 87, and these holes are preferably spaced unequally so as to provide a means of effecting angular adjustment between the gear 86 and  
 85 the flange 87, whereby the angular relation of the camshaft 46 to the crank shaft 23 may be varied. Any other suitable connection, adapted to provide adjustability between the gear 86 and the flange 87 may, however, be  
 90 provided. The gear 86 is provided with a suitable cover 89 which co-operates with the casing 79 and with the plate 42, and which may be readily removed to gain access to the gear 86 and the bolts 88.

The casing 78 is provided with suitable bearings 93 and 94, in which is journaled a vertically disposed shaft 96 aligned with the shaft 82 and provided at its upper end with  
 100 a coupling member 84 adapted to cooperate with the coupling member on the lower end of the shaft 82. The lower end of the shaft 96 is splined into an aligned tubular shaft 95, journaled in the bearing 94 and provided with a bevel gear 97 by means of which it is  
 105 driven.

Integral with or suitably secured to the casing 78 are a pair of brackets 98 on which are supported a pair of magnetos 99 adapted to supply ignition current to the spark plugs  
 110 76 in the well known manner. The magnetos 99 are provided with horizontally disposed shafts 101, provided in their inner ends with bevel gears 102 adapted to mesh with and be driven by a bevel gear 103 suitably secured  
 115 to the upper end of the shaft 95 above the bearing 94.

Removably secured to the casing 78 is a casing 104 provided with a bearing 106 in which is journaled a shaft 107 having at  
 120 its outer end a spur gear 108, and at its inner end a flexible coupling member 109 adapted to engage the flexible coupling member 29 on the end of the crank shaft 23. Secured to the shaft 107 adjacent the coupling  
 125 109 is a bevel gear 111, adapted to mesh with and drive the bevel gear 97 at the lower end of the shaft 96. The portion of the casing 78 below the crankshaft 23 is provided with a bearing 112, in which is journaled a  
 130

shaft 113 provided at its upper end with a bevel gear 114 adapted to mesh with the gear 111 on the shaft 107, and at its lower end with a coupling 116 by which it is connected to a shaft 117 adapted to drive a water circulating pump 118 and a lubricating pump (not shown). The water pump 118 is adapted to circulate cooling water through the cooling system of the engine by means of suitable passages (not shown), in a manner well understood in the art to which this invention relates.

The casing 104 is adapted to contain a starting mechanism, by means of which the engine may be cranked from either side or directly from the rear. This mechanism includes a screw shaft 121 suitably journaled in the casing 104 and provided with a pinion 122 having internal screw threads adapted to engage the screw shaft 121 so as to travel thereon as a nut when the shaft 121 is rotated. The shaft 121 is provided at a point intermediate its ends with a bevel gear 123 adapted to mesh with bevel pinions 124 mounted on shafts 126 at either side of the engine, which are provided with square ends 127 adapted to co-operate with the ordinary hand starting crank. The extension of the shaft 121 is also provided with a squared end 128. A spring brake device 129 is adapted to prevent rotation of the pinion 122 with the shaft 121 as the latter is turned by means of the hand crank, thus sliding the pinion 122 along the shaft until it meshes with the gear 108. Continued rotation of the shaft 121 will result in rotation of the shaft 107, thus cranking the engine. When the engine starts the sudden change in speed of the shaft 121 will cause the pinion 122, by reason of its inertia, to spin backwards out of engagement with the gear 108, thus disengaging the cranking apparatus.

The drive assembly casing 78 may be provided with a suitable projection 131, to which may be attached any suitable form of gun synchronizing device 132, adapted to be driven from a bevel gear 133 on the shaft 96. The gun synchronizing device 132 is adapted to time the operation of a machine gun mounted on the aircraft to which this engine is applicable so that the discharge of the gun, when firing through the propeller, will not strike the propeller blades. Any suitable device of this character may be provided and may be removed from the engine when the airplane is not being used for military purposes, as is well understood.

As will be seen, this invention provides an engine the total weight of which is materially reduced in proportion to the power developed, without in any way lessening its sturdiness and reliability. It furthermore provides an assembly which is extremely accessible, removal of the cover plate 42 providing access to the cam shaft, which may be re-

moved as a unit therewith. Removal of the casing 78 also exposes the accessory drive shaft 96 and its various related gears.

Also this invention provides a structure which readily lends itself to unit assembly, the cam shaft, for example, being assembled in its bearings 44 on the plate 42 as a unit before placing in the engine.

It is to be noted that the cam shaft drive, pumps, magnetos, and other accessories are all mounted on the casing 78, which being bolted to the cylinder block, is removable therefrom as a unit. This structure is especially valuable when repairs become necessary under emergency conditions in use.

It will be understood that various forms of the invention other than those described above may be used without departing from the spirit or scope of the invention.

What is claimed is:

1. In combination in an internal combustion engine, a cylinder block, a recessed head casting therefor of light metal, and a combustion head of heat resisting metal, said combustion head being pressed into the recess in said casting and into direct contact therewith.

2. In combination in an internal combustion engine, an aluminum casting adapted to form a head therefor, integral side walls projecting above said casting to form a housing, integral combustion heads of heat resisting metal secured in said casting, valve guides secured in said casting and adapted to project into said housing, puppet valves mounted to operate in said guides having seats formed in said combustion heads, and means within the housing adapted to operate said valves.

3. The combination with an internal combustion engine of a head casting having upwardly extending parallel walls forming a housing and provided with intake and exhaust passages for the engine, ported combustion heads of heat resisting metal pressed into the casting, said ports communicating with the intake and exhaust passages, valves seating on the combustion heads to control said ports, valve guides rigidly supported in the casting, a cover plate for the housing, and means within the housing and secured to the cover plate adapted to actuate the valve.

4. In combination with an internal combustion engine, a head casting having longitudinal walls upwardly extended to form a housing, a cover plate removably secured to the housing, bearings carried by the cover plate, a camshaft journaled in the bearings within the housing, guide members removably secured to the cover plate, and plunger members reciprocable in the guide members and operable by the camshaft.

5. The combination with an internal combustion engine, of a valve operating assembly therefor, comprising a camshaft, a sup-

porting plate therefor removably secured to the engine, guide members removably secured to the plate, and plunger members within the guide members operable by the camshaft to actuate the engine valves.

6. The combination with an internal combustion engine having valves disposed in the head thereof, of a valve operating assembly comprising a supporting plate removably secured to the engine head, a camshaft mounted on the plate, guide members removably secured to the plate, hollow plungers having slotted sides mounted in the guide members to permit passage of the camshaft and operable therefrom, and adjustable means on the plungers to actuate the valves.

7. The combination with an internal combustion engine, of a head casting having valves and adapted to form a housing, a cover plate removably secured to the housing, a camshaft mounted on the plate within the housing, guide members arranged in pairs and removably secured to the plate within

the housing, and hollow plungers operable from the camshaft and adapted to actuate the valves, said plungers having slotted sides for passage of the camshaft therethrough.

8. In an internal combustion engine, in combination, an aluminum head casting, cup-shaped combustion heads pressed into the casting and having valve ports therein, valve guides pressed into the casting above said ports, valves in the guides, a cover plate removably secured to the casting, and valve actuating means secured to the cover plate.

9. In an internal combustion engine, in combination, a head casting for a removable cover plate forming a housing, a casing secured thereto and projecting downwardly at the rear thereof, a second casing secured to the engine and cooperating with the first named casing, a camshaft mounted on the cover plate, and driving means therefor mounted in the casings.

In testimony whereof I affix my signature.

LIONEL M. WOOLSON.