

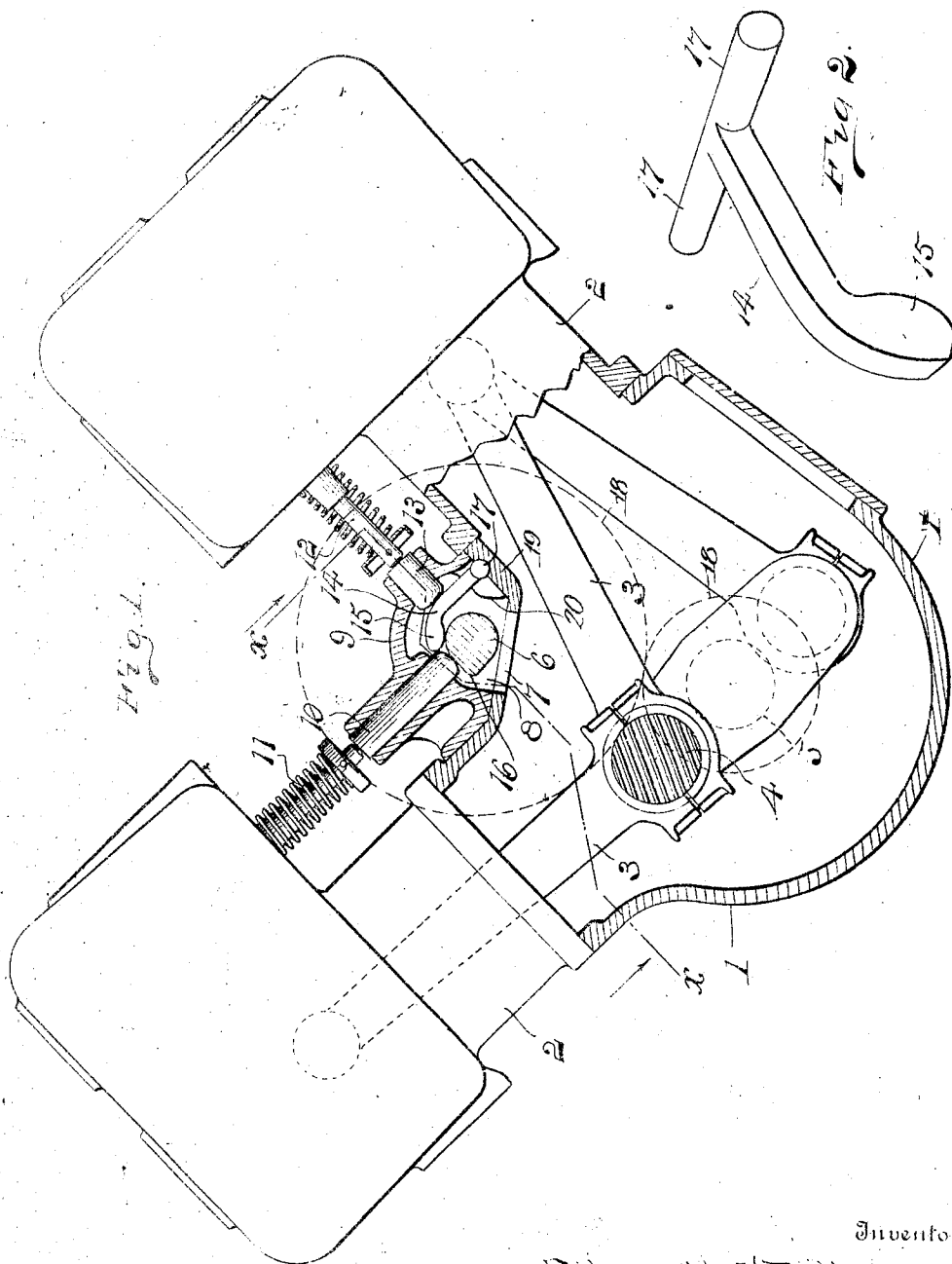
E. H. BELKNAP & J. W. SWARTZ.  
EXPLOSIVE ENGINE.

APPLICATION FILED SEPT. 15, 1910.

1,007,842.

Patented Nov. 7, 1911.

2 SHEETS-SHEET 1.



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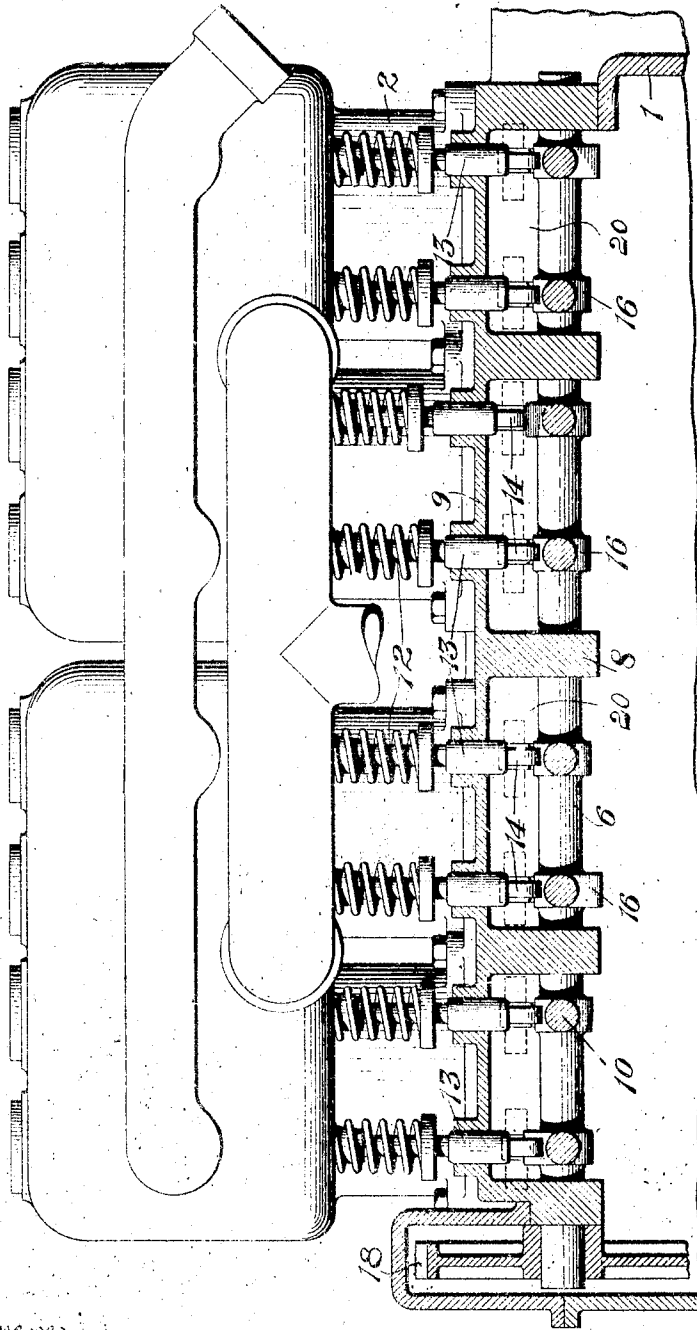


Fig. 3.

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# UNITED STATES PATENT OFFICE.

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EXPLOSIVE-ENGINE.

1,007,842.

Specification of Letters Patent.

Patented Nov. 7, 1911.

Application filed September 15, 1910. Serial No. 582,137.

*To all whom it may concern:*

Be it known that we, ELLSWORTH H. BELKNAP and JOHN W. SWARTZ, citizens of the United States of America, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

In explosive engines of the multi-cylinder type and conventional arrangement it is necessary to have separate valve operating cams for each cylinder and cranks on the main shaft for each piston.

This invention relates to a multi-cylinder explosive motor wherein the parts are so disposed that each crank of the crank shaft receives impulse from two cylinders and where one cam operates the valves of each pair of cylinders.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

In the drawings, Figure 1 is a view partly in cross section and partly in end elevation of a motor that embodies features of the invention; Fig. 2 is a view in detail of a valve finger; and Fig. 3 is a sectional view on the line *x-x* of Fig. 1.

As herein indicated a closed crank casing 1 supports series of cylinders 2 disposed in pairs at substantially right angles to each other. Connecting rods 3 of each pair of cylinders are secured to a single crank pin 4 of a main shaft 5 that is journaled in the crank case 1. A cam shaft 6 formed with cam projections 16 is journaled on the crank case between the oppositely disposed sets of cylinders, over an opening 7 into the crank case. Transverse walls 8 bridge the opening and form supports for bearings for the cam shaft, said walls being preferably formed integral with a cover 9 which is removably secured on the crank case over the said opening therein, said cover forming a housing for the cam shaft with which the shaft is removed when the cover is taken off. Said cover is also provided with guide apertures in which tappet rods 10 whose inner ends bear against the cam shaft 6 in the path of the cam projections thereon, reciprocate to move spring-retained valve stems 11 to open both inlet and exhaust valves of one set

of cylinders. Valve stems 12 operating both inlet and exhaust valves of the companion set of cylinders, bear against plungers 13 radially disposed in regard to the cam shaft 6 to reciprocate in guide apertures in the cover 9. The inner ends of the plungers 13 bear against fingers 14 whose outer enlarged tips 15 ride on the cam shaft in the plane of rotation of the cam projections 16 thereon, which cams are designed to lift the tappets 10 of the companion cylinders to the other side of the cam shaft. The inner ends of the fingers 14 have transverse journals 17 preferably formed integral with their shank portions which journals lie in bearings formed by registering semi-cylindrical grooves formed in the mating faces of the wall 19 of the casing 1, and an inwardly extending flange 20 on the cover 9, which flange is slotted inwardly from its down edge to permit the shanks of the fingers to extend therethrough, said slots forming guides for the fingers to prevent the lateral movement thereof and hold the fingers in alinement with their cams. The disposition of the cam points and of the tappet rods 10 and finger ends 15 in relation to said cams and to each other depends upon the number of cylinders employed. If the motor be supplied with eight cylinders as shown in the drawings, which it is desired to fire in series, it is obviously necessary that the inlet valves be opened one-eighth of a revolution of the cam shaft apart and that the exhaust valves be similarly operated. Accordingly the parts are so arranged that one of the valve tappets 10 for operating one of the valves of one cylinder of a pair, is first raised by the cam point in whose plane of rotation it lies and then the valve finger operating the tappet of the corresponding valve of the companion cylinder of the pair, is engaged and lifted by said cam when said cam has made one-eighth of a turn beyond its point of contact with the tappet. In a motor of the four cycle type and of this construction having eight cylinders, the four cam projections for operating the eight inlet valves of the cylinders are obviously set one-quarter of a revolution apart, the four cams for the exhaust valves being similarly arranged, and the cam shaft is driven from the crank shaft in the usual manner at one half the speed of said crank shaft, by two-

to-one gears 18 indicated in dotted lines in Fig. 1. The employment of any other number of cylinders, necessitates a corresponding spacing of the tappets of one cylinder of each pair from the contact ends of the fingers of the other cylinder of the pair.

The splash system of lubrication is used and the lubricant stored in the bottom of the casing is thrown by the cranks through the opening 7 on to the cam shaft and adjacent parts thereby affording a sure and simple method of keeping the parts well oiled. One feature of this arrangement is the perfect balance obtainable as any number of cylinders may be connected with the crank shaft and fired in proper timed relation by proper arrangement of the cams, tappets and lever fingers. Another feature is the simplicity of the valve mechanism wherein one cam operates like valves of a pair of cylinders. Another advantage is the coupling of the pistons of a pair of cylinders to a single crank pin whereby the weight and number of oscillating parts is reduced. Inasmuch as the cam shaft and housing may be bodily removed, the shaft together with adjacent parts may be easily inspected or replaced if needed. The disposition of the fingers with their elongated journals insures proper action as they cannot shift laterally and the bearing surfaces are so large in respect to the movement, that they are held constantly in alinement with their cams.

Obviously, changes in the details of construction may be varied without departing from the spirit of the invention.

We claim as our invention.

1. A multi-cylinder explosive engine comprising a base, a plurality of cylinders on the base arranged in pairs and the cylinders of each pair disposed in angular relation to each other, a crank shaft journaled in the base having a single crank for each pair of cylinders, a cam shaft journaled on the base parallel to the crank shaft between the cylinders of each pair, a cam on the shaft for each pair of cylinders, a cover detachably secured on the base over the crank shaft and provided with radially disposed guide apertures parallel to the respective axes of the cylinders of each pair of cylinders, a tappet rod for one cylinder of each pair adapted to be reciprocated in one of said guide apertures by direct contact with the cam, a plunger for the companion cylinder of each pair adapted to be reciprocated in the companion guide aperture of the cover, and a finger for each pair of cylinders journaled at its inner end between the casing and cover and bearing at its outer end on the cam shaft in the plane of rotation of the cam and arranged to lift the plunger.

2. A multi-cylinder explosive engine comprising a base, a plurality of cylinders on

the base arranged in pairs and the cylinders of each pair disposed in angular relation to each other, a crank shaft in the base having a single crank for each pair of cylinders, a cam shaft journaled on the casing between the cylinders of the pairs parallel to the shaft, a cam on the cam shaft for each pair of cylinders, a cover detachably secured on the casing over the cam shaft and provided with guide apertures each substantially parallel to the axis of each cylinder in the plane of rotation of a cam, a finger whose inner end is journaled in mating half bearings formed in the meeting faces of the cover and base and whose outer end bears on the cam shaft in the plane of rotation of a cam, a valve tappet rod for one cylinder of each pair reciprocable in a guide aperture of the cover, and a plunger for a companion cylinder reciprocable in the companion guide aperture of the cover with its inner end resting on a finger between the ends thereof.

3. A multi-cylinder explosive engine comprising a base, a plurality of cylinders on the base arranged in pairs and the cylinders of each pair disposed in angular relation to each other, a crank shaft in the base having a single crank for each pair of cylinders, a cam shaft journaled on the casing between the cylinders of the pairs parallel to the shaft, a cam on the shaft for each pair of cylinders, a cover detachably secured on the casing over the shaft and provided with guide apertures each substantially parallel to the axis of an adjacent cylinder in the plane of rotation of a cam, a finger whose inner end is journaled in mating half bearings formed in the meeting faces of the cover and base and whose outer end bears on the cam shaft in the plane of rotation of a cam, a valve tappet rod for one cylinder of each pair reciprocable in a guide aperture of the cover, and a plunger for a companion cylinder reciprocable in the companion guide aperture of the cover with its inner end resting on a finger between the ends thereof, the base being apertured adjacent the cam shaft.

4. In a multi-cylinder explosive engine, a base, a crank shaft journaled therein, a pair of cylinders secured thereon in angular relation to each other, a cam shaft journaled on the base between the adjacent portions of the cylinders parallel to the crank shaft, a single crank on the crank shaft for a pair of cylinders, a cover detachably secured on the casing over the crank shaft and provided with guide apertures each substantially parallel to a cylinder, a cam on the cam shaft, a tappet rod for one cylinder reciprocable in the guide aperture of the cover with its inner end bearing against the cam shaft in the plane of rotation of the cam, a finger oscillatory in the cover in the plane of rotation of the cam provided with journals at

its inner end lying in mating half bearings  
formed in the meeting faces of the base and  
cover and adapted to bear at its outer end  
on the cam shaft in the path of motion of  
the cam, and a plunger for the companion  
cylinder reciprocable in a guide aperture of  
the cover with its inner end resting on the  
finger between the ends thereof.

In testimony whereof we affix our signatures in presence of two witnesses.

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Witnesses:

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