June 1, 1948. R. P. PESCARA 2,442,470

ENGINE WITH SYNCHRONISED FREE OPPOSED PISTONS

Filed July 3, 1945

2 Sheets-Sheet 1

Fig. 1.

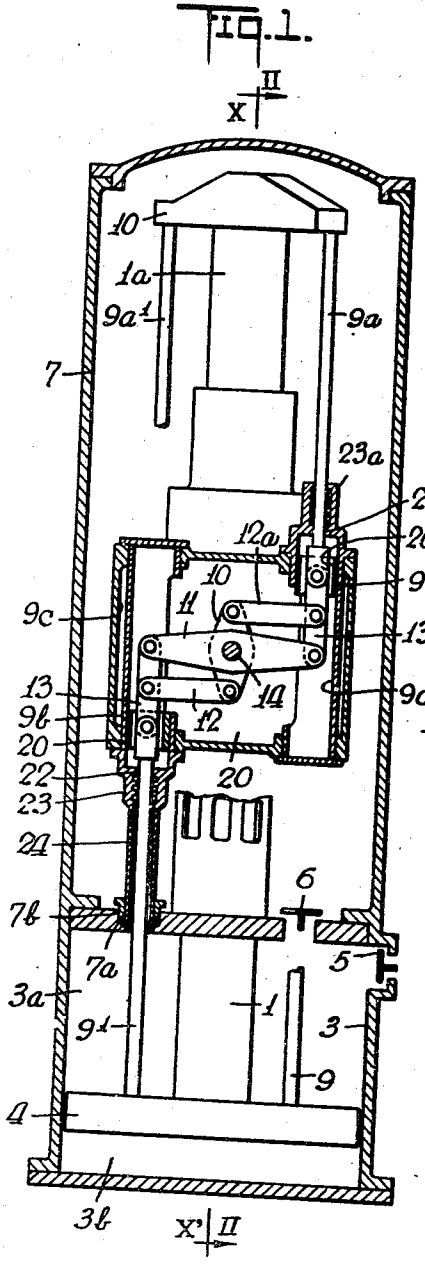
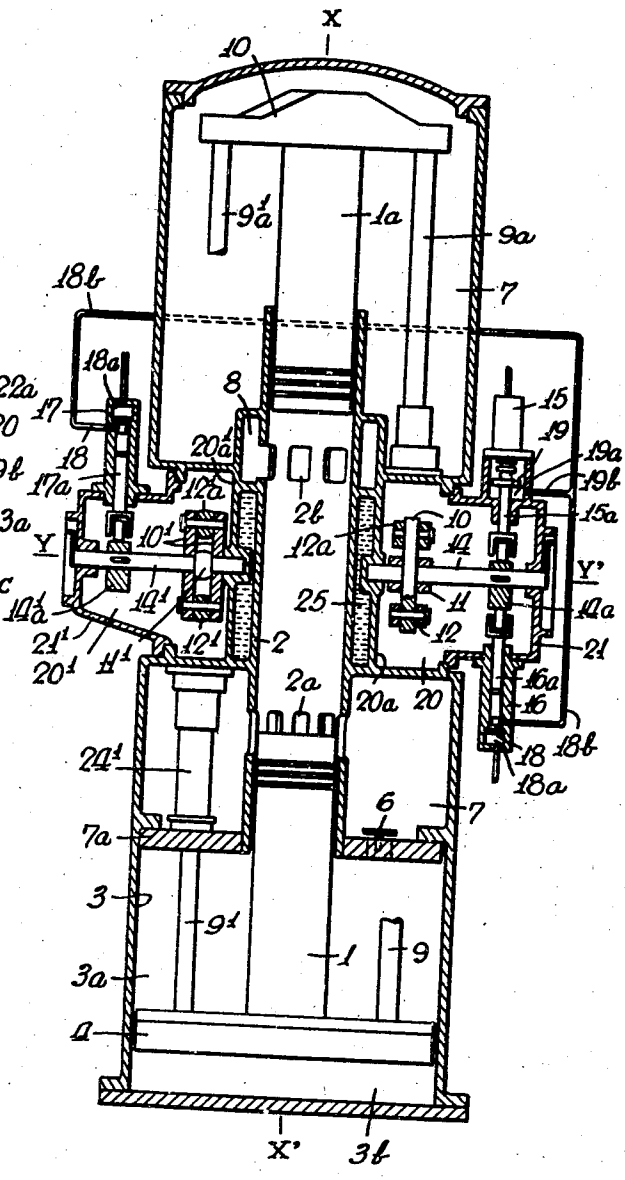


Fig. 2.



INVENTOR
Paul Pateras Pescara
BY
Dunn Fairbank & Hirsch
ATTORNEYS

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Fig. 5.

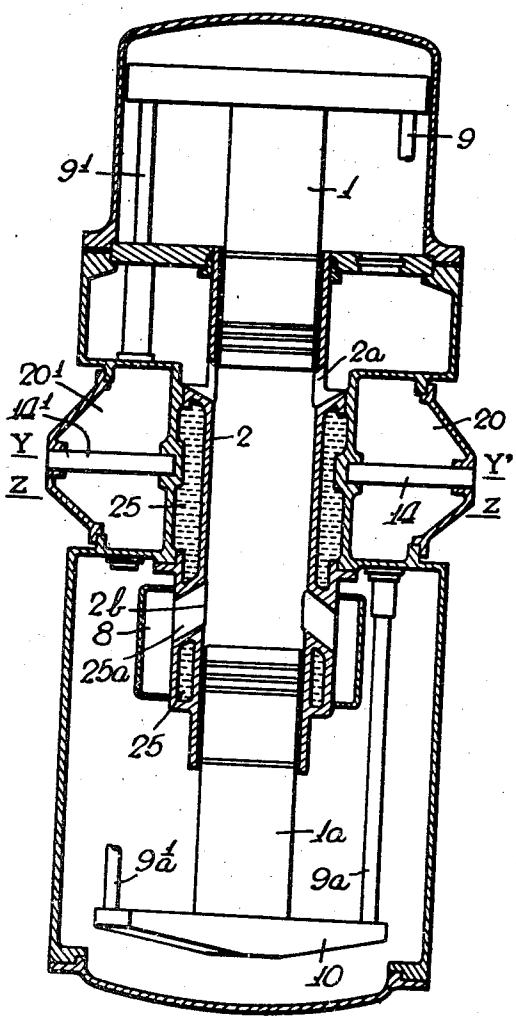


Fig. 3.

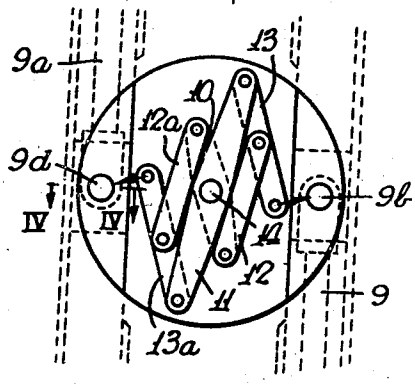
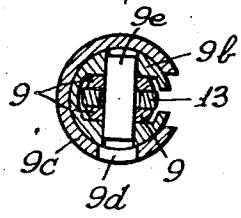


Fig. 4.



INVENTOR
Paul Pateras Pescara
BY
Dean Fairbank & Hirsch
ATTORNEYS

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ENGINE WITH SYNCHRONISED FREE OPPOSED PISTONS

Raul Pateras Pescara, Lisbon, Portugal

Application July 3, 1945, Serial No. 603,059
In France August 4, 1942

10 Claims. (Cl. 123—46)

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My invention relates to engines with synchronised free opposed pistons of the type wherein the piston synchronising device comprises a lazy tongs linkage pivoted about a fixed point.

The chief object of my invention is to provide an engine of this type which is better adapted to meet the requirements of practice than those made up to the present time.

In the annexed drawing:

Fig. 1 is a side view, with parts in section, showing an engine according to my invention.

Fig. 2 is a horizontal longitudinal section thereof taken along line II—II of Fig. 1.

Fig. 3 is an enlarged diagrammatical view showing the manner in which the lever gearing may be assembled with the piston rods according to a feature of my invention.

Fig. 4 is an enlarged section taken along line IV—IV of Fig. 3.

Fig. 5 is a horizontal longitudinal section of a modified form of my invention.

The free piston engine shown in Figs. 1 and 2 is an auto-generator intended to produce hot gases under pressure. But it could also be an air-compressor or any other type of machine, since my invention only refers to the motor parts proper.

This engine comprises two opposed pistons 1 and 1a which cooperate with a common cylinder 2, the geometrical axis of which is indicated at XX'. There is also provided a second cylinder 3, co-axial to cylinder 2 and cooperating with a piston 4 fixed to the outer end of piston 1. Piston 4, which is larger in diameter than pistons 1 and 1a, divides cylinder 3 into two chambers, the inner one 3a being used to compress air for scavenging cylinder 2, while the outer one 3b works as an air cushion to ensure the return stroke of the piston system.

Chamber 3a is provided with an air inlet valve 5 and with an air outlet valve 6 opening into a casing 7 arranged around one end of the motor cylinder 2 and communicating therewith through inlet ports 2a uncovered by piston 1 at the end of its outward stroke. The burnt gases and the excess of scavenging air escape through exhaust ports 2b provided toward the opposed end of cylinder 2, such ports opening into an annular exhaust 8 which is connected with the machines or apparatus adapted to use the exhaust gases under pressure.

Two longitudinal rods 9 and 9¹ are fixed to piston 4 in diametrically opposed relation. They are passed through the inner end partition 7a which separates cylinder 3 from casing 7, stuffing boxes or the like being provided to ensure tightness, as it will be described later.

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Piston 1a carries at its outer end a transverse bar 1b which is also provided with two longitudinal rods 9a and 9a¹. The geometrical axes of rods 9a and 9a¹ are respectively symmetrical of the axes of rods 9 and 9¹ with respect to the horizontal plane passing through X—X'.

The inner ends of rods 9, 9¹, 9a and 9a¹ are provided with slides 9b adapted to move along longitudinal guides 9c fixed to the engine frame.

The synchronising gearing proper comprises two pairs of lazy tongs scissors oscillatable about the same horizontal axis Y—Y' (Fig. 2) which intersects the longitudinal axis X—X' in the vicinity of the central part of the engine, and the two ends of each pair are respectively connected with the ends of a pair of rods 9, 9¹ and 9a, 9a¹, as shown in Fig. 1.

Each pair comprises two oscillating levers, respectively 10, 11 and 10¹, 11¹, which are appropriately pivoted about the said transverse axis Y—Y'. The ends of levers 10, 11 and 10¹, 11¹ are articulated with rods, respectively 12, 12a (for lever 10), 13, 13a (for lever 11), 12¹, 12a¹ (for lever 10¹) and 13¹, 13a¹ (for lever 11¹). Rods 12 and 13 are articulated together, as rods 12a and 13a, 12¹ and 13¹, and 12a¹ and 13a¹. And each pair of rods 12, 13, etc., is articulated with the end of a longitudinal rod 9, 9¹, 9a, 9a¹.

The relative lengths of the various rods and levers of the synchronising gearing are preferably such that levers 10 and 10¹, hereinafter termed levers of the first type, are in a position substantially perpendicular to the direction of motion of the pistons, i. e. to the axis of cylinder 2, when the latter are in their innermost position (inner dead point), while levers 11 and 11¹, or levers of the second type, are in a similar position when the pistons are in their outermost position (outer dead point). It will easily be understood that when these conditions are fulfilled, the ratio of the angular motion of levers 10, 10¹, 11, 11¹ to the rectilinear motion of the pistons is maximum for respectively one and the other dead points.

Lever 11 or 11¹ is then advantageously used to control the devices or apparatus which are to be operated at the outer dead point, such as for instance, a safety device to limit the outward piston strokes, while lever 10 or 10¹ controls the devices or apparatus which operate at the inner dead point, for instance the injection pump and a second safety device adapted to limit the inward piston strokes.

This may be obtained, as illustrated, by keying on shafts 14 and 14¹, respectively, a lever of the first type in the first pair of lazy tongs (lever 10, Fig. 2) and a lever of the second type in the

second pair of lazy tongs (lever 11^1, Fig. 2), shafts 14 and 14^1 being rotatably supported by the engine casing.

It will be observed that in the construction shown, lever 10, keyed on shaft 14, is in one piece, rods 12 and 12*a* parallel therewith, while lever 11 and rods 13 and 13*a* parallel therewith are in two parts, the whole being symmetrical with respect to a plane parallel to axis X—X'. In the other linkage system lever 10^1, loose on shaft 14^1, and rods 12^1 and $12a^1$ are in two parts, while lever 11^1 is in one piece, same as rods 13^1 and $13a^1$, the system being also symmetrical with respect to a plane parallel to X—X'. It will easily be understood that these constructive arrangements may be varied at will.

Figs. 1 and 2 diagrammatically show the devices controlled by the synchronising linkage systems through shafts 14 and 14^1.

Shaft 14 carries a cam 14*a* which drives two push-rods 15*a* and 16*a* actuating the fuel injection pump 15 and a safety device 16 adapted to limit the compression stroke of pistons 1 and 1*a*.

Shaft 14^1 is similarly provided with a cam $14a^1$ driving a push rod 17*a* which actuates a second safety device 17 limiting the expansion stroke of pistons 1 and 1*a*.

Fuel pump 15 may be of any convenient construction and it is connected in any appropriate manner with the injection nozzle not shown.

Safety devices 16 and 17 preferably comprise a valve 18 adapted to be pushed by the corresponding push-rod 16*a* or 17*a*, whereby a compressed-air chamber 18*a* (which communicates with a compressed air tank not shown) is connected with a conduit 18*b*. Pump 15 is provided with a piston 19 slidable inside a cylinder 19*a* and conduit 18*b* opens in cylinder 19*a* on the inner face of piston 19 (i. e. the face nearer to axis Y—Y'). With such an arrangement, when one of devices 16, 17 is operated due to the fact that pistons 1 and 1*a* move beyond their inner or outer safety end limits, compressed air is admitted under piston 19 which is forced outwardly, whereby push-rod 15*a* is disengaged from cam 14*a*, thus rendering pump 15 inactive.

The outer ends of shafts 14 and 14^1 are advantageously provided with pointers 30 which indicate the piston positions in the vicinity of their inner and outer dead points.

According to a feature of my invention, the synchronizing linkage means, i. e. the two pairs of lazy tongs, are preferably housed in fluidtight cases 20 and 20^1 into which rods 9, 9^1, 9*a*, $9a^1$ penetrate through suitable packing means, whereby the synchronising linkage means are insulated from the atmosphere inside casing 7. Cases 20 and 20^1 are formed by recesses 20*a* and $20a^1$ (Fig. 2) in the outer engine casing, such recesses being closed by means of covers 21 and 21^1 which preferably carry the fuel injection pump and safety devices. Shafts 14 and 14^1 may be mounted as shown, their outer ends being passed through covers 21 and 21^1.

Openings 22, 22*a*, Fig. 1, with stuffing boxes or packing glands 23, 23*a* are provided for the passage of rods 9, 9*a*, etc., such stuffing boxes or packing glands being preferably integral with the afore-described guides 9*c*. The latter are preferably driven through the corresponding case 20 or 20^1 and their free end is closed by an appropriate cover.

The openings, such as 22, which correspond to rods attached to piston 4 are connected with the openings provided through partition 7*a* by means of sleeves 24 (Fig. 1) and 24^1 (Fig. 2). Due to this arrangement each rod needs but one packing gland such as 23 which is preferably disposed in the immediate vicinity of the gearing case. Sleeves 24, 24^1 are fixed to partition 7*a* by means of appropriate screwed collars 7*b*.

This system works in the following manner:

When the outward strokes of pistons 1 and 1*a* reach the maximum values they should have, levers 11 and 11^1 are in positions substantially at right angles to the common axis of the cylinders. For this position of lever 11^1, the spindle 14^1 which is rigid therewith brings cam $14a^1$ into the position which operates the safety device 17 which is provided for preventing the piston from moving outwardly beyond a given limit position.

When the pistons are close to the ends of their inward strokes, levers 10 and 10^1 are in positions substantially at right angles to the common axis of the cylinders. For this position of lever 10, the spindle 14, which is rigid therewith brings cam 14*a* into the position operating the fuel injection pump. Accessorily, this cam also operates safety device 16.

Figs. 3 and 4 show an arrangement adapted to facilitate the mounting and dismounting of the synchronising gearing. Guides 9*c* are cylindrical and are laterally provided with a hole 9*d* disposed in front of covers 21 and 21^1 (supposedly removed in Fig. 3). Holes 9 are adapted to permit of introducing (or removing) a pin 9*e* by means of which slide 9*b* is simultaneously articulated with the corresponding piston rod 9, 9*a*, etc., and with the corresponding gearing rod 13, 13*a*, etc.

The lever gearing may easily be introduced into the corresponding case (Fig. 3) and thereafter extended to bring the free ends of rods 13, 13*a*, etc., to the proper position to receive the articulation pins 9*e*.

The gearing cases 20, 20^1 are preferably separated from the motor cylinder 2 by means of a water jacket 25 (Fig.2).

Fig. 5 shows a somewhat modified arrangement wherein the synchronising gearing is disposed unsymmetrically with respect to the transverse plane Z—Z' passing through the engine centre. The axis Y—Y' of the gearing is slightly displaced toward the admission ports 2*a* in order to leave more space for the arrangement of the annular exhaust 8. As shown, cases 20 and 20^1 terminate somewhat beyond ports 2*a* and the water jacket 25 extends beyond exhaust ports 2*b*, the annular exhaust 8 being disposed around jacket 25 and connected with ports 2*b* by means of conduits or nozzles 25*a*.

It should be borne in mind that the above description is only given by way of example and does not limit my invention the ambit of which is defined by the following claims.

I claim:

1. A machine of the type described which comprises, in combination, a cylinder, a pair of pistons freely movable in said cylinder, lazy tongs linkage means for synchronising the movements of said pistons, said linkage means including two levers pivoted with respect to each other and to said cylinder about an axis intersecting the cylinder axis perpendicularly thereto, and two auxiliary devices operative by said levers respectively for influencing the working of said engine when said pistons are close to their outer and inner dead points, respectively.

2. A machine of the type described which comprises, in combination, a cylinder, a pair of pistons freely movable in said cylinder, lazy tongs

linkage means for synchronising the movements of said pistons, said linkage means including two levers pivoted with respect to each other and to said cylinder about an axis intersecting the cylinder axis perpendicularly thereto, a safety device for limiting the outward movements of said pistons operative by one of said levers when said pistons are near the ends of their maximum outward strokes, and a fuel injection pump operative by the other lever when said pistons are near the ends of their maximum inward strokes.

3. A machine of the type described which comprises, in combination, a cylinder, a pair of pistons freely movable in said cylinder, lazy tongs linkage means for synchronising the movements of said pistons, said linkage means including two levers pivoted with respect to each other and to said cylinder about an axis intersecting the cylinder axis perpendicularly thereto, a safety device for limiting the outward movements of said pistons operative by one of said levers when said pistons are near the ends of their maximum outward strokes, a fuel injection pump and a safety device for limiting the inward movements of said pistons both said pump and said last mentioned device being operative by the other lever when said pistons are near the ends of their maximum inward strokes.

4. A machine of the type described which comprises, in combination, a cylinder, a pair of pistons freely movable in said cylinder, lazy tongs linkage means for synchronising the movements of said pistons, said linkage means including two levers pivoted with respect to each other and to said cylinder about an axis intersecting the cylinder axis perpendicularly thereto so that one of said levers is perpendicular to said cylinder axis when said pistons are near the ends of their maximum outward strokes and the other lever is perpendicular to said cylinder axis when said pistons are near the ends of their maximum inward strokes, a safety device for limiting the outward movements of said pistons operative by said first mentioned lever when the latter is perpendicular to the cylinder axis, and a fuel injection pump operative by the other lever when the latter is perpendicular to said cylinder axis.

5. A machine of the type described which comprises, in combination, a cylinder having inlet and exhaust ports, a pair of pistons freely movable in said cylinder, lazy tongs linkage means for synchronising the movements of said pistons, said linkage means including two levers pivoted with respect to each other and to said cylinder about an axis, nearer to said inlet port than to said exhaust port, intersecting the cylinder axis perpendicularly thereto, and two auxiliary devices operative by said levers respectively for influencing the working of said engine when said pistons are close to their outer and inner dead points, respectively.

6. A machine of the type described which comprises, in combination, a motor cylinder, a pair of pistons freely movable in said cylinder, a reservoir of compressed air for feeding and scavenging said cylinder, said reservoir surrounding said cylinder, means for synchronising the movements of said pistons including at least one oscillating part pivoted with respect to said cylinder and longitudinal rods rigid with said pistons operatively connected with said part for actuating it, fluidtight means for insulating said parts from the inside of said reservoir, and packing means for the passage of said rods through said fluidtight means.

7. A machine of the type described which comprises, in combination, a motor cylinder, a pair of pistons freely movable in said cylinder, a reservoir of compressed air for feeding and scavenging said cylinder, said reservoir surrounding said cylinder, means for synchronising the movements of said pistons including at least one oscillating part pivoted with respect to said cylinder and longitudinal rods rigid with said pistons operatively connected with said part for actuating it, means forming a fluidtight chamber inside said reservoir around said part so as to insulate it from the inside of said reservoir, and packing means in the walls of said chamber for the passage of said rods therethrough.

8. A machine of the type described which comprises, in combination, a motor cylinder, a pair of pistons freely movable in said cylinder, a casing surrounding said cylinder, forming a reservoir of compressed air for feeding and scavenging said cylinder, means for synchronising the movements of said pistons including at least one oscillating part pivoted with respect to said motor cylinder, near the middle part of said machine, and longitudinal rods rigid with said pistons operatively connected with said part for actuating it, means forming a fluidtight chamber inside said reservoir around said part so as to insulate it from the inside of said reservoir, and packing means in the walls of said chamber for the passage of said rods therethrough.

9. A machine according to claim 8 in which the means forming said chamber consist of the combination of a recessed portion of said casing and a cover.

10. A machine of the type described which comprises, in combination, a motor cylinder, a pair of pistons freely movable in said cylinder, a casing surrounding said cylinder, forming a reservoir of compressed air for feeding and scavenging said cylinder and a compressor cylinder, a compressor piston slidable in said compressor cylinder and rigid with one of said above mentioned pistons, means for synchronising the movements of said pistons including at least one oscillating part pivoted with respect to said motor cylinder and longitudinal rods rigid with said pistons operatively connected with said part for actuating it, one of said rods being directly fixed to said compressor piston, means for forming a fluidtight chamber inside said reservoir around said part so as to insulate it from the inside of said reservoir, a sleeve directly interposed between said chamber and said compressor cylinder, adapted to accommodate the rod fixed to said compressor piston, packing means between said sleeve and said last mentioned rod, and packing means carried by one wall of said chamber for fluidtight passage of the other rod therethrough.

RAUL PATERAS PESCARA.

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