Dec. 7, 1926. 1,609,388

A. TEBALDI

ENGINE

Filed Dec. 5, 1921 3 Sheets-Sheet 1

Fig. 1.

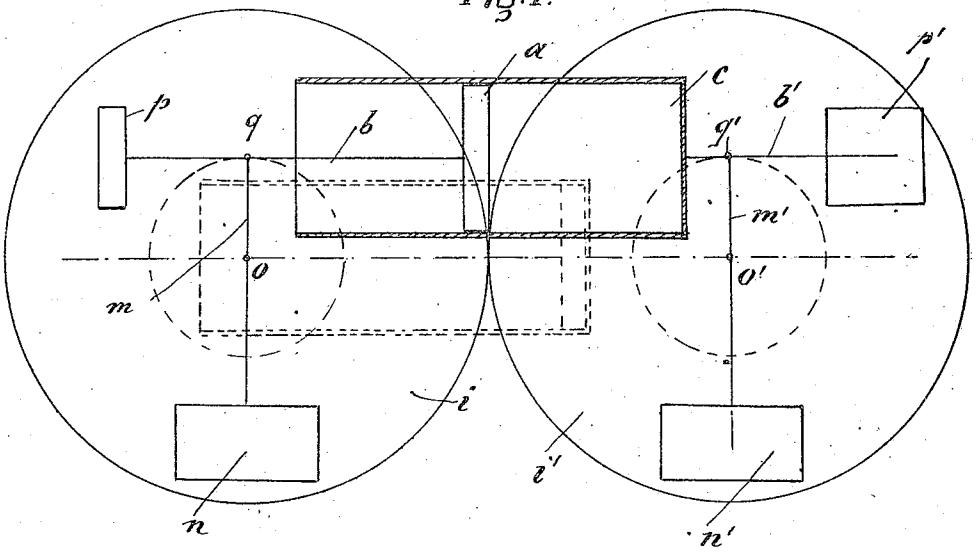
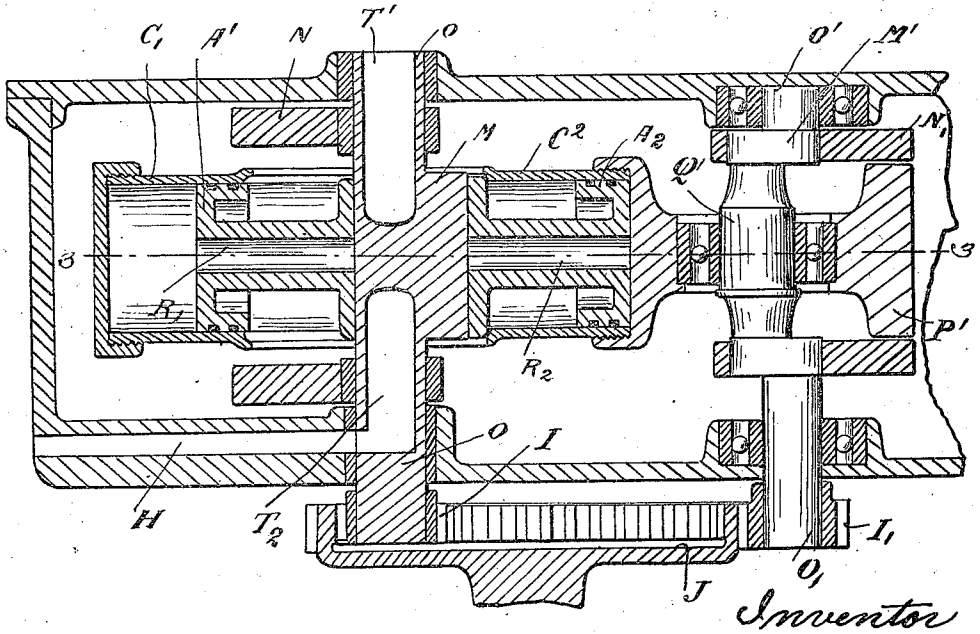


Fig. 2.



Inventor
A. Tebaldi,
By Marks & Clark
attys.

Dec. 7, 1926. 1,609,388

A. TEBALDI

ENGINE

Filed Dec. 5, 1921 3 Sheets-Sheet 2

Fig. 3.

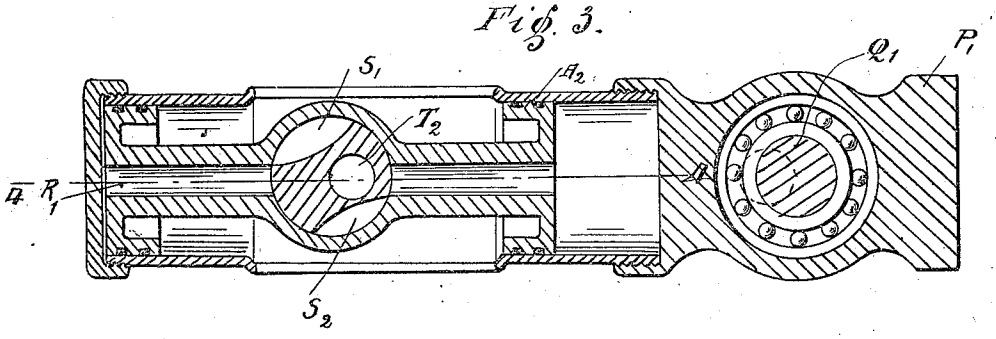


Fig. 4.

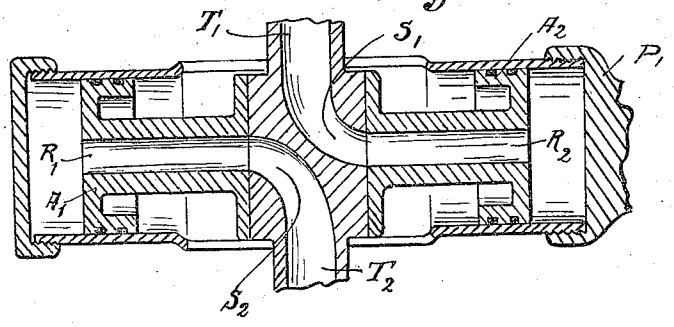
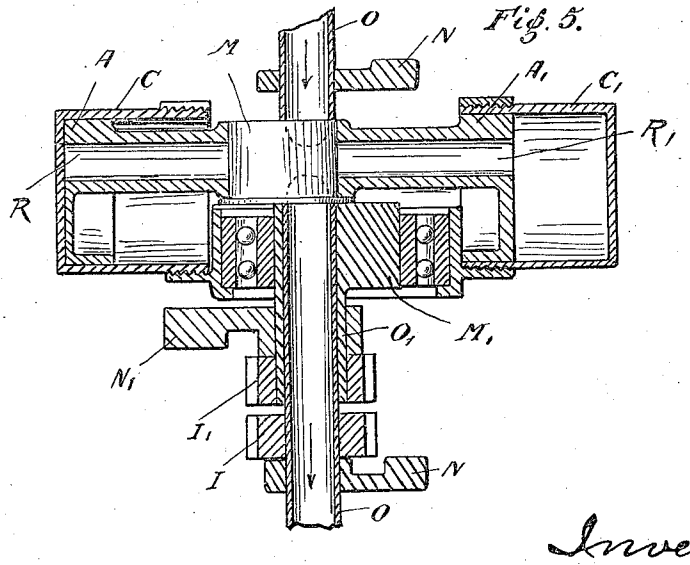


Fig. 5.



Inventor
A. Tebaldi
By Marks & Clerk
Attys.

Dec. 7, 1926. 1,609,388

A. TEBALDI

ENGINE

Filed Dec. 5, 1921 3 Sheets-Sheet 3

Fig. 6.

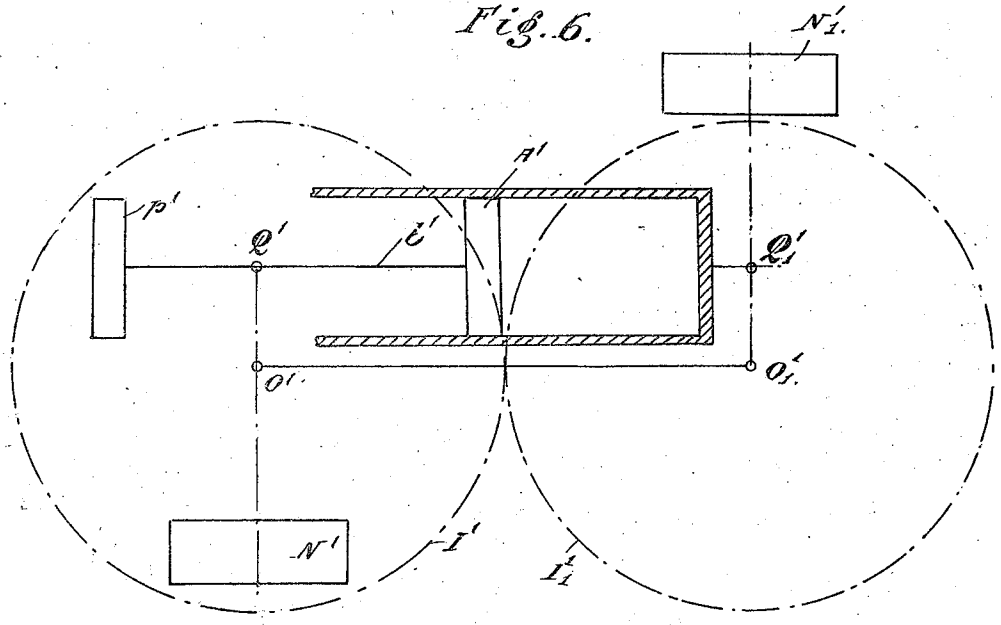
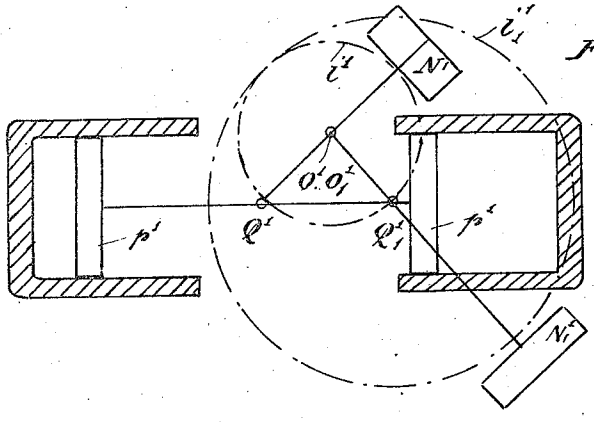


Fig. 7.



Inventor
A. Tebaldi,
By Marks & Clerk
Attys.

Patented Dec. 7, 1926. 1,609,388

UNITED STATES PATENT OFFICE.

ALESSANDRO TEBALDI, OF MILAN, ITALY.

ENGINE.

Application filed December 5, 1921, Serial No. 520,125, and in Italy December 15, 1920.

The invention relates to a motion transmitting arrangement in engines whereby the effects of the reciprocating masses in the combined cylinder and piston set are obviated for the object of lessening the resistances that are set up in the present piston engines utilizing the expansion of a gas, or to lessen the said resistances in the operating machines working on the reverse principle (pumps, compressors). The arrangement essentially consists in that the cylinder and piston are pivotally and under neutral equilibrium conditions carried by two parallel shafts, the two shafts being so interconnected that they turn at the same speed but in opposite directions.

In the accompanying drawings:

Figure 1 shows the arrangement diagrammatically.

Fig. 2 is a horizontal sectional view of a compressed air motor, a motor being shown at the end of its stroke.

Fig. 3 is a longitudinal sectional view taken on line 3—3 of Fig. 2.

Fig. 4 is a longitudinal sectional view of the combined cylinder and piston set of the motor taken on line 4—4 in Fig. 3.

Figure 5 is a longitudinal section showing the arrangement as applied to a compressed air motor of modified construction.

Figure 6 diagrammatically shows the arrangement when the cylinder is made stationary.

Fig. 7 relates to an alternative construction described hereinafter.

In a general way the arrangement. as may be seen from Fig. 1, consists in fixing a piston a to a crank m by means of a rod b provided with a counterweight p, in such a way that the pivoting point exactly coincides with the centre of gravity of the system comprising the piston, piston rod and counterweight.

An entirely similar system, in which however the piston is replaced by the cylinder c fitted with rod b', counterweight p' and crank m', completes the apparatus. The two cranks m and m' revolve in opposite directions about the axis o and o' respectively, arranged such a distance apart that, when the two crank pins q, q' respectively, of cranks m and m' are at their maximum distance from one another, the piston playing in the cylinder will have swept the maximum volume, and when the two crank pins are nearest one another, the volume enclosed in the cylinder will be reduced to the minimum (compression chamber or noxious space). In order to obtain a synchronous movement and opposite rotating direction of the two cranks, the two crank shafts o and o' are connected with one another by two gear wheels i and i' equal in diameter or by some other equivalent device.

It will be readily understood that the piston a, piston rod b and counterweight p constitute a rigid system which, when the apparatus is running, has a single rotary motion about the centre o and always remains parallel to itself and in order to maintain it in a given direction, if the motion is a uniform one, no effort is required since it is the question of a solid in a state of indifferent equilibrium because of having its center of rotation in its gravity center.

This rotating motion sets up a centrifugal force of constant intensity whose direction always coincides with the direction of the crank.

This centrifugal force can easily be counterbalanced by a convenient mass n fitted on the extension of crank q—o.

What has been said regarding the system made up of piston, piston rod and counterweight applies also to the system consisting of cylinder c, rod b' and counterweight p', the generated centrifugal force being balanced by the mass n'. The reciprocating stresses are therefore done away with, which in all applications of the combined cylinder and piston are set up by the to and fro motion of at least one of the said parts; such stresses are generated also in rotary engines and are due to the Corioli's acceleration.

In the application of the invention to a compressed air motor as per Figures 2, 3 and 4 capital letters have been used to indicate parts corresponding to those indicated by small letters in Fig. 1.

The piston A_1—A_2 is double and is revolved about the shaft O by the eccentric M. The two pistons slide in the cylinder C_1—C_2,

so that the system constitutes a two-cylinder motor, the crank M′ of the cylinder C_1—C_2 being secured to the shaft O′. On the ends of the two shafts O and O′ are keyed the gear wheels I and I_1 meshing with the toothed wheel J, I being toothed internally and I_1 externally, so that the two shafts O and O′ revolve in opposite directions. The crank pin to which O is attached and represented by the eccentric M itself constitutes the motor distributor. In fact in the pistons A_1 and A_2 ducts R_1 and R_2 are formed, through which the cylinder chambers are set in communication with the recesses S_1 and S_2 formed in the eccentric and merging into the ducts T_1 and T_2 formed in the shaft O; of the two ducts T_1 and T_2 one leads to the compressed air reservoir through H, and the other to the atmosphere.

As far as regards balancing, to the cylinder C_1—C_2 is fixed the counterweight P′ serving to bring the system's gravity center on the crank; to the shafts O and O′ are fixed the counterweights N—N and N′—N′ serving to balance the centrifugal forces set up by the cylinder and by the piston.

Fig. 5 illustrates a modified arrangement of the compressed air motor to which the above principle is applied.

In this arrangement, in order to dispense with the counterweight P′ balancing the weight of the cylinder C_1—C in the previously described motor and in order to thus lessen the engine dimensions, the shaft O′ has been made to coincide with the shaft O, so that also the rotation axis of the crank M_1 to which the cylinder C_1—C is attached passes through the cylinder's gravity centre.

As in the engine previously described, the double piston A—A_1 is carried by the eccentric M, so that the two pistons are slid to and fro in the cylinders C—C_1 carried by the crank M_1 fixed to the shaft O′.

Also here the eccentric M fitted to the shaft O (in conjunction with the connecting recesses formed in the eccentric, with the ducts R and R_1 and the further ducts T^1 T^2 in the shaft O) constitutes the compressed air distribution system.

The balancing of the centrifugal force due to the cylinder mass is effected by the counterweight N_1; the balancing of the centrifugal force due to the piston mass is effected by the two counterweights N and N.

On to the shafts O—O′ are keyed the gear wheels I and I_1 which, across suitable intermediate wheels, constrain the two shafts to revolve at the same angular velocity but in opposite direction.

In order to obtain a more uniform torque, these motor types may be built up of several motor groups fitted on shafts whose cranks are set at convenient angles to one another.

Similar arrangements can be designed for the application of the present invention to steam engines, internal combustion engines, pumps, compressors, etc.

If, for instance, constructional requirements involve the necessity of the cylinder being made stationary instead of rotatable, the system maintains its characteristic features, provided a suitably arranged counterweight is fitted. In fact it will be seen that the piston in this case no longer revolves but receives a harmonic motion, and that the inertia forces set up in the direction of the cylinder axis are exactly compensated for by the component, along this same axis, of the centrifugal force due to the piston counterweight. Such an arrangement, as may be seen from Fig. 6, is entirely similar to that already described. The centrifugal force of the combination made up by the piston and its counterweight, is balanced in the ordinary way by the counterweight N′. In fact in this case the rotation axis of the whole system will be the pin of the crank Q'_1 and the support by which the shafts O and O′ were formerly carried will now work as connecting rod. It appears that, when the system rotates, the axes O′ and O'_1 will describe circumferences having O′—O'_1 for their radius and that the rotation centre Q′ of the piston will be rotated by the gear wheels I′ and I'_1 at the same speed and in opposite direction as the point O'_1 about Q'_1. The composition of the two movements will constrain the point Q′ to displace itself with a reciprocating motion along the straight line representing the cylinder axis.

As ultimate result, on examining the motion of the system it will be apparent that the point Q′, viz, the supporting centre of the piston, rotates about O′ and consequently the centrifugal force set up by it is compensated for by the counterweight N′, and the point O′ together with the connecting rod O′—O'_1 revolves about Q'_1, the centrifugal force set up by the latter system being balanced by the counterweight N'_1. In the same way as in the arrangement previously described, the center O′ may be made to coincide with the centre O'_1 and in such a case there are only the two connecting rods Q′—O′ and Q'_1—O′ (Fig. 7) and the counterweights N′ and N'_1.

Having now particularly described the nature of my said invention and in what manner the same is to be performed, what I claim is:—

1. An apparatus of the class described comprising two co-axial pistons, two co-axial cylinders in which the pistons slide, a shaft for said pistons having an eccentric provided with bores, passageways in the pistons communicating with said bores and adapted to lead air into and out of said cylinders, a shaft for said cylinders provided with an eccentric engaging the cylinders, gear wheels

of substantially equal diameter arranged on said shafts, means connecting said gear wheels to drive the two shafts in opposite directions, a counterweight associated with the cylinder shaft to bring the center of gravity of the cylinders on the eccentric of the cylinders, and other counterweights secured to the piston shaft to balance the centrifugal forces engendered by the pistons and cylinders.

2. An apparatus as claimed in claim 1 in which the shafts are coaxial.

Signed at Milan, Italy, this 5th day of November, 1921.

ALESSANDRO TEBALDI.