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3,107,541

PISTON MACHINES

Filed March 8, 1961

2 Sheets-Sheet 1

Fig. 1

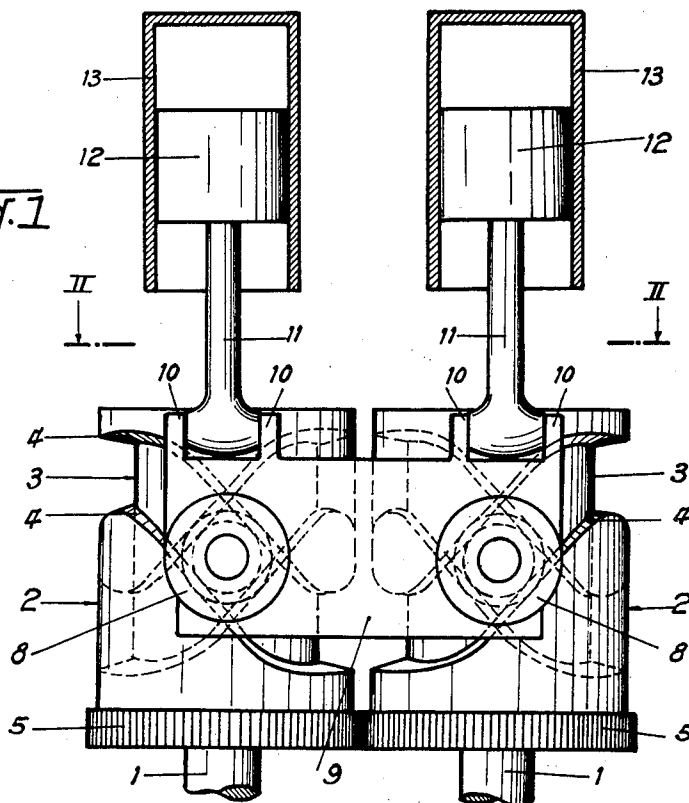
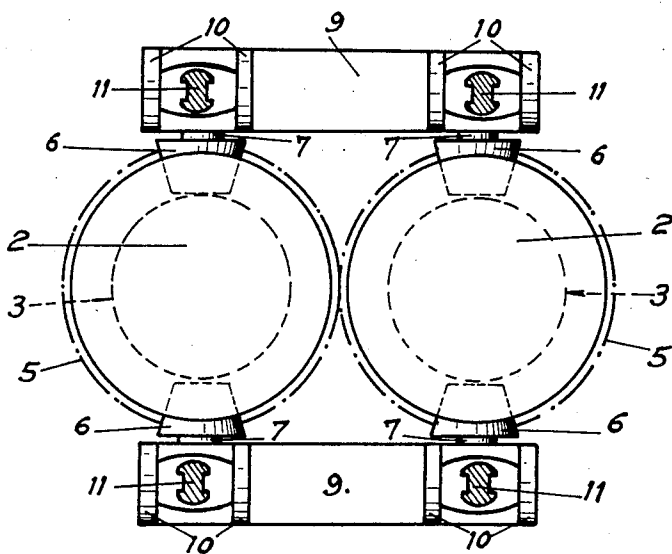


Fig. 2

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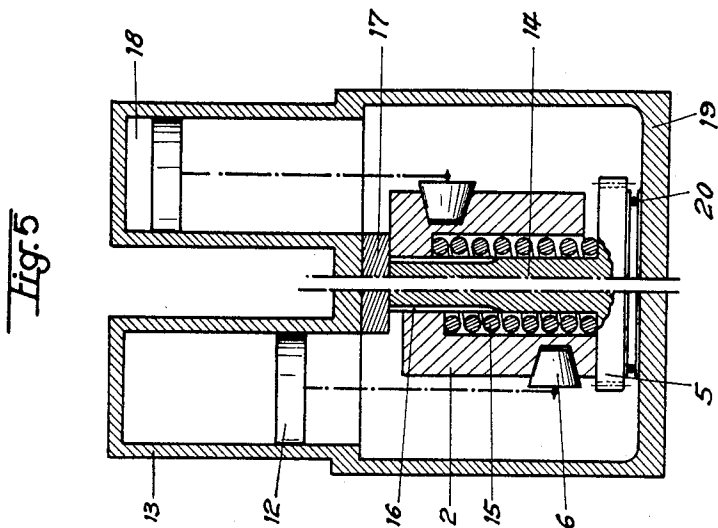
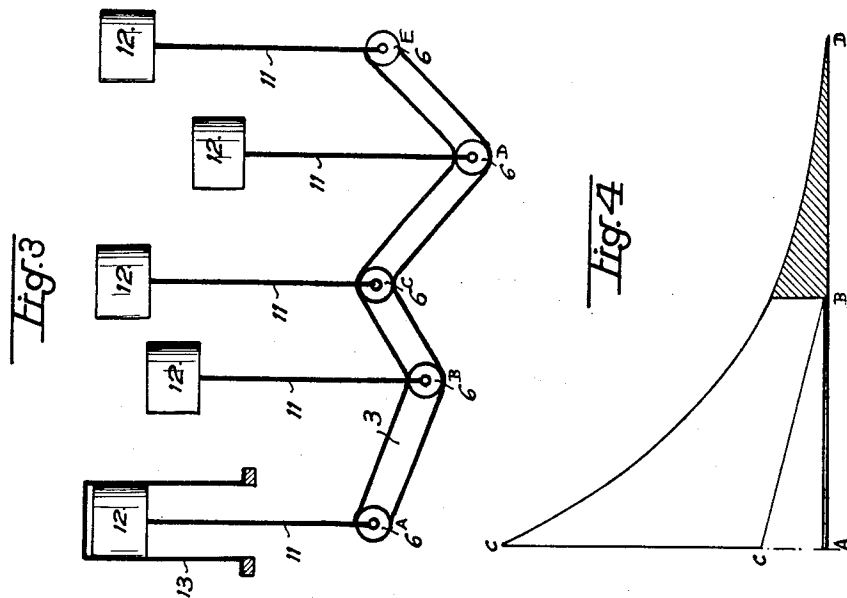
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PISTON MACHINES

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The present invention relates to improvements in piston machines of the type comprising at least one piston to which is imparted an alternating motion, and a continuous movement device, coupled together by means which ensure the transformation of movement. These machines can either be driving machines such as for example, internal combustion engines, or receiving machines such as for example, compressors, and it is known that, for the purpose of effecting the transformation of movement, machines of this type usually make use of a system of the connecting-rod crank type.

The defects of a system of this kind are also known, both from the point of view of efficiency and from the point of view of the wear and the maintenance of the connecting-rods and of the crank and even of other parts of the machine.

The well-known phenomenon of ovalisation of cylinders can be cited by way of example. Moreover, in the case of internal combustion engines, the use of the crank and connecting rod system entails the necessity of having a compression stroke which is identical to the exhaust stroke and an admission stroke which is identical to the expansion stroke, which is also prejudicial to the efficiency of these engines.

The present invention has for its object to overcome these disadvantages, and for this purpose, the invention is directed to machines of the type defined above and essentially characterized in that the means effecting the transformation of movement are constituted by a double-action cam carried by a body of revolution which is integral with continuous movement members, and by a cam-following roller which is integral with the piston and is guided so as to move in parallel relation to the said piston. It must be explained that a double-action cam is intended to mean a cam which either produces action on, or is thrust back by, the cam-following roller in the two directions parallel to the movement of the said cam-following roller. It will be immediately observed that a device of this type avoids the drawbacks of connecting-rod and crank units inasmuch as, on the one hand, the body of revolution to which a continuous motion is imparted becomes balanced and that, on the other hand, the connecting-rod which couples the piston to the cam-following roller does not carry out any pendulum-like movement. The majority of causes of poor working efficiency and wear, and in particular the phenomenon of ovalisation of cylinders, is thereby avoided. A further advantage conferred consists in the possibility of profiling the cams in such manner as to produce for each stroke, for example of an internal combustion engine, the displacements of the piston which are the most favorable for the speeds and accelerations which have the most beneficial effect on the working efficiency. For example, the movement of the piston during the expansion stroke can be different from its movement during the induction stroke.

In a preferred form of embodiment of the present invention, the cam is formed in the shape of a groove having divergent walls and cut in a cylindrical body, while cam-following rollers having a frusto-conical shape are fitted inside the said groove. Depending on the function of the machine comprising a device of this type, and depending on whether the stroke considered is a driving

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stroke or a resistive stroke, the effect will either be to drive the cylindrical body as a result of the pressure applied by the roller against one of the walls of the cam, or to produce the driving of the piston as a result of the pressure applied by the wall of the cam against the roller.

It must be noted however, that the reciprocal actions of the roller against the wall of the cam and vice versa, give rise to a component which is directed at right angles to the movement of the roller. Consequently, in accordance with an improvement in the invention, two units in accordance with the invention are disposed symmetrically with respect to a plane, while the bodies which are given a continuous movement engage with each other and the cam-following rollers are mounted in pairs on a single slide-block. In addition to the advantage mentioned above, this arrangement makes it possible to eliminate certain elements for guiding the rollers. A machine of this type will naturally have two cylinder-piston units working together at the same time and under the same conditions.

In accordance with a further improvement in the present invention, a certain number of rollers which are each coupled to a piston co-operate with a single cam. A number of rollers, each roller being coupled to one piston, are therefore mounted on the periphery of a single body of revolution, thereby permitting the transformation of motion to take place between a number of pistons and a single continuous motion element.

The present invention will in any case be more clearly understood with reference to the description which follows below, reference being made to the accompanying drawings which show, by way of example only and not in any sense by way of limitation, a certain number of forms of embodiment of the invention, and in which:

FIG. 1 is a partial view of a machine in accordance with the invention;

FIG. 2 is a view taken along the line II—II of FIG. 1;

FIG. 3 illustrates the development of a cam with a profile designed for an internal combustion engine;

FIG. 4 is a theoretical diagram illustrating the operation of the same internal combustion engine; and

FIG. 5 shows, in schematic cross-section, an alternative form.

Reference being made first of all to FIGS. 1 and 2, it can be seen that on two shafts 1, there are mounted two cylindrical bodies of revolution 2 in which are cut cams in the shape of grooves 3 having oblique walls 4. Two gears 5 which are rigidly fixed to the shafts 1 and the bodies 2 ensure the displacement in synchronism of the said cylindrical bodies, it being understood that the combined assembly of these elements is symmetrical with respect to the central plane of the engine which has been illustrated; it will be noted that one of the output shafts can, if necessary, simply play the part of a bearing, while the other shaft ensures the transmission of the movement. Cooperating with the grooves 3 are four frusto-conical rollers 6, the shafts 7 of which are mounted in bearings 8 carried by two slide-blocks 9. Each slide-block 9 is provided with four lugs 10 which provide, by means of pins which are not shown in the drawings, a coupling with two connecting-rods 11 which are in turn coupled to two pistons 12 moving inside cylinders 13. The guiding of the slide-blocks 9 in parallel relation to the axis of the cylinders 13 is effected by means which are not shown in the drawings. It will be understood that, as in the case of machines of conventional type, the four cylinders 13 and the elements of transformation of movement are mounted on a block which is not shown in the drawings and which comprises the known devices of lubrication, suspension, etc.

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Reference being made, for example, to an internal combustion engine, it can be seen that during the expansion stroke, a piston 12 communicates to the corresponding roller 6 a movement which is directed downwards in accordance with FIG. 1, and which is transmitted to the cylinder 2 as a result of the action on the oblique walls, of the grooves 3. It is observed that the two pistons which are coupled to the same slide-block are both in the expansion period at the same time and that, as a result, the components at right angles to the direction of displacement of the force which acts against the wall of the grooves cancel each other two by two.

This finding is confirmed during all the other strokes of the engine.

During the exhaust stroke, it is the wall 4 of the grooves 3 which drives the rollers 6 and therefore the pistons 12, the same applying during the admission and compression strokes.

It will also be noted that, while two of the pistons are in the period of expansion, the two other pistons which are coupled to the other slide-block are in the period of admission, with the result that the engine is thus given a good condition of balance.

FIG. 3 shows schematically a developed cam 3. It can be seen that in this case, and contrary to the case illustrated in FIG. 1, the movements of the piston are different according to whether they take place in the admission and compression phases or in the expansion or exhaust phases. In fact, in the drawing which is shown, A—B corresponds to the admission, B—C corresponds to the compression, C—D corresponds to the expansion, and D—E corresponds to the exhaust. The volume swept by the piston is therefore much greater during the phases C—D—E of expansion and exhaust than during the previous phases A—B—C. If reference is made to FIG. 4 in which the diagram of the engine in accordance with FIG. 3 has been illustrated in conventional manner, and in which the pressures have been plotted as ordinates while the volumes or strokes have been plotted as abscissae, it can be seen that the gain which has been achieved with respect to the conventional internal combustion engine is as shown by the shaded triangle having for its base the line B—D. In fact, the expansion could have taken place much further beyond and practically up to the exhaust pressure by virtue of the increase in the expansion stroke which has been made possible by the shape of the cam.

It is additionally noted, for example, that it has been possible to provide for an admission time which is much longer than the compression time, since the distance A—B is much greater than the distance B—C, this result being also very favorable to efficient performance. Finally, it has been possible to give the portions C—D and D—E of the cam a profile such that the developed surfaces thereof are rectilinear, with the result that the piston is thereby given a uniform movement which is particularly advantageous for its efficiency, whereas in the case of internal combustion engines of the conventional type, this movement had a sinusoidal shape, that is to say, accelerated during one half-stroke then retarded during the second half-stroke.

It can in fact be seen that it is possible to cut the cams such as the cam 3 in such manner as to obtain in each particular case the optimum efficiency of the engine or of the machine in accordance with the invention.

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FIG. 5 illustrates schematically two half-cross sections of an engine in accordance with the invention, in which are again shown the pistons 12 coupled to the rollers 6 which move inside the cams cut in the cylinders 2. It can be seen that these cylinders are mounted on shafts 14 which are rigidly fixed to gears 5 with interposition of a spring 15. Splines are provided at 16 so as to ensure the rotary drive, and abutments 17 limit the travel of the cylinders. This arrangement has for its object to maintain constant the pressure of compression which is in each case balanced by the spring 15, in accordance with the description given in the patent application filed on this day in the name of the present applicant, in respect of "Improvements in Piston Machines." In particular, in the right-hand portion of FIG. 5, the spring 15 has thrust upwards the combined unit formed by the cylinder 2, the roller 6 and the piston 12. This is therefore a case in which the quantity of fluid admitted was at the minimum, and in which the space 18 at the moment of compression and at top dead center, must therefore also be the minimum.

There has also been illustrated a casing 19 against which the gears 5 are applied by means of thrust-bearings 20 of conventional type.

It will be understood that the forms of embodiment of the present invention which have just been described have not been given in any sense by way of limitation and that any modifications can be made in said forms of embodiment without thereby departing from the scope or the spirit of the invention.

What I claim is:

1. A piston machine of the character described comprising a pair of cylindrical bodies positioned symmetrically with respect to a common plane and each carrying a double action cam, means coupling said bodies for rotation together but in opposite directions, a pair of slide blocks each positioned on an opposite side of both of said bodies, a plurality of rollers, means rotatably connecting each one of said slide blocks to a different pair of said rollers with each roller of said pair engaging the cam of one of said bodies, a plurality of piston carrying connecting rods, means pivotally connecting each one of said slide blocks to a different pair of said connecting rods, and cylinders having said connecting rod pistons slideably positioned therein for reciprocation.

2. A piston machine of the character described as claimed in claim 1 wherein said coupling means comprises a pair of shafts, said bodies each having an axial bore with one of said shafts extending therein, means slideably connecting each of said bodies to its shaft, a pair of meshing gears each fixedly connected to one of said shafts, a pair of springs each extending in one of said body bores and abutting the respective gear, a fixed base and thrust bearings rotatably supporting said gears on said base.

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