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Complete Specification Left, 21st Nov., 1905—Accepted, 22nd May, 1906

PROVISIONAL SPECIFICATION.

Communicated by ALBIN LOWENETZSKY, of 1 Fredsgatan, Helsingfors, Finland, Retired Captain

"Improvements relating to Hot Air Motors"

I, HENRY HARRIS LAKE, of the Firm of Haseltine, Lake & Co., Patent Agents, 7 & 8 Southampton Buildings, in the County of Middlesex, do hereby declare the nature of this invention to be as follows:—

This invention has for its object a hot air motor in which the movement of the compression piston is obtained without the intermediary of rods, cranks or eccentrics, but merely by the expansion of the heated air and the weight of the piston, whilst at the same time simple means for the regulation of the speed are provided, so that an engine inexpensive of construction and reliable in operation, such as is required for small industries, is obtained.

The construction of the motor is shown in the accompanying drawing, in which:

Figure 1 is a vertical section through the middle of the engine, and

Figure 2 is a section on the line A—B of Fig. 1.

The left hand side of Fig. 1 shows the work cylinder 1 with piston, connecting rod, crank shaft and fly wheel. In the cylinder 1 is a lateral opening 2 through which the air is able to enter the expansion chamber of the cylinder, when the piston is situated below the opening. The upper part of the cylinder is in communication by means of the pipe 3 with the compression chamber which at the same time constitutes the generator chamber. This compression chamber consists of an upper half 4 and a lower half 5, these parts being separated by means of the annular packing 6 of material which is a bad conductor of heat. The upper half is surrounded by a jacket 7. In the space between 4 and 7 cold water circulates in order to keep the upper part 4 cool. The cold water pump required for this and the necessary connections are not shown in the drawing.

The lower half of the compression chamber is constructed as a furnace 8 with grate 9 and charging aperture 10 for the introduction of the fuel. The combustion gases flow over the lower part of the compression chamber and pass through the opening 11 to a chimney, which is not represented, out into the atmosphere. In order to increase the heating surface, the part 5 of the casing is cast with ribs 12, as shown in Fig. 2.

In the compression or generator chamber is arranged a compression piston consisting of two parts 13 and 14 between which an insulating layer 15 is interposed. The lower part of this piston is highly heated by the surrounding hot portion of the casing, whilst the upper part is cooled. The insulating layer prevents an interchange of heat, so that the lower part is an auxiliary heating body and the upper part an auxiliary cooling body. The heating and cooling surfaces are by this means almost doubled, even though the auxiliary heating body has a lower temperature and the auxiliary cooling body a higher temperature than the portions of the casing surrounding them respectively.

[*Price 8d.*]

The compressor is provided at its upper part with a guide rod 16 which is guided in a part 17 arranged upon the compressor casing. At its lower part adjoining the compressor, this rod 16 carries a collar 18 which exactly fits within a recess 19 in the compressor casing and its addition 17. Upon the upper end of the guide rod is a collar 20 which is fixed there by means of a nut 21, and which in its lowermost position rests in a recess turned so as to exactly fit it in the part 17, the compressor being supported in such a manner that an interval invariably exists between it and the bottom of its casing. By adjusting this nut it is possible to regulate the power of the engine to a certain extent, as is hereinafter more particularly explained.

The motor operates in the following manner:

In the case of small engines the motor may be started by turning the fly wheel by hand. When the piston is situated below the opening 2, air enters from the exterior into the cylinder 1 and upon the return stroke of the piston, after the opening has been closed, it passes into the compressor casing and is at the same time slightly compressed. The main body of the air of course proceeds to the cooled upper part of the casing which is free. If the dimensions of the work cylinder, the compression piston, and the guide rod are correctly calculated it is easy to ensure that at a given moment, when the operating piston is situated in proximity to the dead point, that the pressure upon the bottom of the compressor piston is greater than the sum of the pressure above the piston, where the pressure face is smaller owing to the guide rod, of the weight of all the parts of the piston and of the frictional resistance of the guide rod in its guides. At this moment, therefore, the compressor piston will rise. The collar 18 enters the recess 19, the air cushion thereby formed in this recess absorbing the shock. Whilst previously the heat of the lower part of the compressor casing exerted comparatively little influence in increasing the tension of the air, as this latter was situated mainly in the upper cooled portion of the casing, this is now altered. The compression increases very speedily and in the first place exerts a braking action in the work cylinder similar to the cushioning in a steam engine, and, when the fly wheel has carried the piston beyond the dead point, it drives the work piston. The air then again expands. It should be specially noted here that the heating and the increase of tension take place especially at the moment at which the compressor rises and the air descends between the hot cylindrical walls. But whilst the air is already exerting a driving effect upon the work piston and is expanding, heating of the air also proceeds, although with less activity, in the lower part of the compressor casing, which heating opposes the tendency of the tension to decrease. When the sum of the pressure above the compressor piston, and of the weight of all the parts of the piston exceeds the sum of the pressure from below and of the frictional resistance of the guides, the compressor will again descend into its initial position the collar 20 then constituting an air cushion in the recess in the part 17 whereby the shock is absorbed. The moment at which the descent of the compressor takes place, may be varied by suitably dimensioning the collar 18 and the corresponding recess. This capacity for determining the period at which the compressor ascends and descends forms a special advantage of the present motor.

When the compressor descends, the air in the compressor casing returns to the upper part where it is cooled and compressed. Previously upon the descent of the compressor a speedy heating and increase of tension took place through the narrow path between the compressor and the compressor casing; the reverse now occurs on the passage through the upper cooled conduit. In the meantime, however, at the latest at the moment at which the compressor descends, the work piston will have passed by the opening 2, thus discharging a portion of the air. By the cooling of the air in the upper part of the compressor casing and the continued movement of the piston a vacuum is formed in the apparatus and fresh air is sucked in. The work piston is carried beyond the dead point by the fly wheel and again ascends closing the aperture 2, and the procedure previously described is repeated.

A special feature of this hot air motor is that the compressor piston and the work piston are not connected by a rod. In their operation and mutual arrangement the generator and work cylinders correspond with a boiler together with a steam engine with feed pump even to the connecting pipes. During the back stroke the work piston assumes the function of the feed pump. A cold water pump is, however, added to the hot air motor. In hot air motors as heretofore constructed the form of the steam engine has been closely followed, the work piston and the compressor being positively connected one with the other or with the driving shaft, by means of a rod. In accordance with the present invention, by suitably calculating the dimensions of the separate constructional parts, as regards mass and weight, a technical effect is obtained which renders such a rod entirely superfluous. The masses in movement are reduced, which is especially advantageous for running at high speeds. The only essential condition for the efficient operation of the motor is that the source of heat should be sufficiently powerful to store up in the lower part of the compressor adequate quantities of heat capable of being given off very quickly.

As already stated, by means of the nut 21 it is possible to effect a certain regulation of the piston velocity and of the power developed, by adjusting the initial position of the piston as regards height.

This regulation is based in the first place upon the fact that the greater quantity of air beneath the compressor, when this is set higher, receives a larger increase of tension by the heating, than with the normal position. The tension will therefore sooner reach that point at which the compressor is caused to rise. The large increase of tension which corresponds to the compression and cushioning in steam engines, likewise takes place sooner and accordingly brakes the work piston more than before.

Further, the cylindrical heating face of the compressor is in direct proportion to the immersion in the heating chamber. If this immersion is smaller, the heated surface likewise becomes smaller, with an approximately equal absorption of heat per unit of area. The quantity of heat that can be yielded up to the air passing downwards, is therefore smaller and the sudden increase of temperature does not attain the same magnitude as before. However, the air will remain in the heating chamber for a somewhat longer period so that it will be heated longer and more effectually than was previously the case.

Experience has demonstrated, however, that the sum of these three effects is prejudicial, and the smaller the depth to which the compressor is immersed in the heating chamber, the more prejudicial is the result. The efficiency of the motor becomes lower and the velocity falls.

The exceedingly simple regulation by means of a nut, which corresponds to some extent with the constructions employed in a Meyer or a Rider expansion valve, is quite a special feature in this hot air motor without connecting rod.

It may be added that the position for the insulating layer 15 relatively to the insulating layer 6 which is best in practice, is still being tested. At the present time it has been found best to place it rather higher than shown in the drawing.

Dated this 22nd day of May, 1905.

HASELTINE, LAKE & Co.,
7 & 8 Southampton Buildings, London, W.C.,
Agents for the Applicant.

COMPLETE SPECIFICATION.

"Improvements relating to Hot Air Motors".

I, Henry Harris Lake, of the Firm of Haseltine, Lake & Co., Patent Agents, 7 & 8 Southampton Buildings, in the County of Middlesex, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has for its object a hot air motor in which the movement of the compression piston is obtained without the intermediary of rods, cranks or eccentrics, but merely by the expansion of the heated air and the weight of the piston, whilst at the same time simple means for the regulation of the speed are provided, so that an engine inexpensive of construction and reliable in operation, such as is required for small industries, is obtained.

The construction of the motor shown in the drawing accompanying my Provisional Specification in which:—

Fig. 1 is a vertical section through the middle of the engine, and

Fig. 2 is a section on the line A—B of Fig. 1.

The left hand side of Fig. 1 shows the work cylinder 1 with piston, connecting-rod, crank shaft and fly-wheel. In the cylinder 1 is a lateral opening 2 through which the air is able to enter the expansion chamber of the cylinder, when the piston is situated below the opening. The upper part of the cylinder is in communication by means of the pipe 3 with the compression chamber which at the same time constitutes the generator chamber. This compression chamber consists of an upper half 4 and a lower half 5, these parts being separated by means of the annular packing 6 of material which is a bad conductor of heat. The upper half is surrounded by a jacket 7. In the space between 4 and 7 cold water circulates in order to keep the upper part 4 cool. The cold water pump required for this and the necessary connections are not shown in the drawing.

The lower half of the compression chamber is constructed as a furnace 8 with grate 9 and charging aperture 10 for the introduction of the fuel. The combustion gases flow over the lower part of the compression chamber and pass through the opening 11 to a chimney, which is not represented, out into the atmosphere. In order to increase the heating surface, the part 5 of the casing is cast with ribs 12, as shown in Fig. 2.

In the compression or generator chamber is arranged a compression piston consisting of two parts 13 and 14 between which an insulating layer 15 is interposed. The lower part of this piston is highly heated by the surrounding hot portion of the casing, whilst the upper part is cooled. The insulating layer prevents an interchange of heat, so that the lower part is an auxiliary heating body and the upper part an auxiliary cooling body. The heating and cooling surfaces are by this means almost doubled, even though the auxiliary heating body has a lower temperature and the auxiliary cooling body a higher temperature, than the portions of the casing surrounding them respectively.

The compressor piston is provided at its upper part with a guide rod 16 which is guided in a part 17 arranged upon the compressor casing. At its lower part adjoining the compressor piston this rod 16 carries a collar 18 which exactly fits within a recess 19 in the compressor casing and its addition 17. Upon the upper end of the guide rod is a collar 20 which is fixed there by means of a nut 21, and which in its lowermost position rests in a recess, turned so as to exactly fit it, in the part 17, the compressor piston being supported in such a manner that an interval invariably exists between it and the bottom of its casing. By adjusting this nut it is possible to regulate the power of the engine to a certain extent, as is hereinafter more particularly explained.

The motor operates in the following manner:

In the case of small engines the motor may be started by turning the fly wheel by hand. When the piston is situated below the opening 2, air enters from the exterior into the cylinder 1 and upon the return stroke of the piston, after the opening has been closed, it passes into the compressor casing and is at the same time slightly compressed. The main body of the air of course proceeds to the cooled upper part of the casing which is free. If the dimensions of the work cylinder, the compression piston and the guide rod are correctly calculated it is easy to ensure that at a given moment, when the operating piston is situated in proximity to the dead point, that the pressure upon the bottom of the compressor piston is greater than the sum of the pressure above the piston, where the pressure face is smaller owing to the guide rod, of the weight of all the parts of the piston, and of the frictional resistance of the guide rod in its guides. At this moment, therefore, the compressor piston will rise. The collar 18 enters the recess 19, the air cushion thereby formed in this recess absorbing the shock. Whilst previously the heat of the lower part of the compressor casing exerted comparatively little influence in increasing the tension of the air, as this latter was situated mainly in the upper cooled portion of the casing, this is now altered. The compression increases very speedily and in the first place exerts a braking action in the work cylinder similar to the cushioning or pre-admission in a steam engine, and, when the fly wheel has carried the piston beyond the dead point, it drives the work piston. The air then again expands. It should be specially noted here that the heating and the increase of tension take place especially at the moment at which the compressor rises and the air descends between the hot cylindrical walls. But whilst the air is already exerting a driving effect upon the work piston and is expanding, heating of the air also proceeds, although with less activity, in the lower part of the compressor casing, which heating opposes the tendency of the tension to decrease. When the sum of the pressure above the compressor piston, and of the weight of all the parts of the piston exceeds the sum of the pressure from below and of the frictional resistance of the guides, the compressor will again descend into its initial position the collar 20 then constituting an air cushion in the recess in the part 17 whereby the shock is absorbed. The moment at which the descent of the compressor piston takes place, may be varied by suitably dimensioning the collar 18 and the corresponding recess. This capacity for determining the period at which the compressor piston ascends and descends forms a special advantage of the present motor.

When the compressor piston descends, the air in the compressor casing returns to the upper part where it is cooled and compressed. Previously upon the descent of the compressor piston a speedy heating and increase of tension took place through the narrow path between the compressor piston and the compressor casing; the reverse now occurs on the passage through the upper cooled conduit. In the meantime, however, at the latest at the moment at which the compressor descends, the work piston will have passed by the opening 2, thus discharging a portion of the air. By the cooling of the air in the upper part of the compressor casing and the continued movement of the piston a vacuum is formed in the apparatus and fresh air is sucked in. The work piston is carried beyond the dead point by the fly wheel and again ascends closing the aperture 2, and the procedure previously described is repeated.

A special feature of this hot air motor is that the compressor piston and the work piston are not connected by a rod. In their operation and mutual arrangement the generator and work cylinders correspond to a boiler with a steam engine, feed pump, and necessary connecting pipes. During the back stroke the work piston assumes the function of the feed pump. A cold water pump is, however, added to the hot air motor. In hot air motors as heretofore constructed the form of the steam engine has been clearly followed the work piston and the compressor being positively connected one with the other or with the driving shaft, by means of a rod. In accordance with the present invention, by suitably calculating the separate constructional parts, as regards mass and weight, a technical effect is obtained which renders such a rod entirely superfluous. The masses in movement are reduced, which is especially advantageous for running at high speeds. The only essential condition for the efficient operation of the motor is that the source of heat should be sufficiently powerful to store up in the lower part of the compressor adequate quantities of heat capable of being given off very quickly.

As already stated, by means of the nut 21 it is possible to effect a certain regulation of the piston velocity and of the power developed, by adjusting the initial position of the piston as regards height.

This regulation is based in the first place upon the fact that the greater quantity of air beneath the compressor piston, when this is set higher, receives a larger increase of tension by the heating, than with the normal position. The tension will therefore sooner reach that point at which the compressor piston is caused to rise. The large increase of tension which corresponds to the compression and pre-admission in steam engines, likewise takes place sooner and accordingly brakes the work piston more than before.

Further, the cylindrical heating face of the compressor piston is in direct proportion to the immersion in the heating chamber. If this immersion is smaller, the heated surface likewise becomes smaller, with an approximately equal absorption of heat per unit of area. The quantity of heat that can be yielded up to the air passing downwards, is therefore smaller and the sudden increase of temperature does not attain the same magnitude, as before. However, the air will remain in the heating chamber for a somewhat longer period so that it will be heated longer and more effectually than was previously the case.

Experience has demonstrated, however, that the sum of these three effects is prejudicial, and the smaller the depth to which the compressor piston is immersed in the heating chamber, the more prejudicial is the result. The efficiency of the motor becomes lower and the velocity falls.

The exceedingly simple regulation by means of a nut, which corresponds to some extent with the constructions employed in a Meyer or a Rider expansion valve, is quite a special feature in this hot air motor without connecting rod.

It may be added that the position for the insulating layer 15 relatively to the insulating layer 6 which is best in practice, is still being tested. At the present time it has been found best to place it rather higher than shown in the drawing.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, as communicated to me by my foreign correspondent, I declare that what I claim is:—

1. A hot air motor consisting of a heating cylinder or compression chamber with a piston movable therein and a single-acting, single-cylinder reciprocating engine likewise acting as an air pump characterised by the fact that the compressor piston has its ends of unequal area and an extension of smaller diameter passing through the head of the heating cylinder, so that said compressor piston is actuated by the excess pressure on its bottom face arising from the heating of the air in the heating cylinder, thereby obviating the necessity of a special driving rod for the compressor piston.

2. A hot air motor in accordance with Claim 1, characterised by the fact that the extension of the differential compressor piston passing through the

head of the cylinder is provided with an adjustable nut, for the purpose of rendering it possible to adjust the interval between the piston and the bottom of the heating cylinder as desired, and of thus regulating the running of the engine.

Dated this 15th day of May, 1906.

HASELTINE, LAKE & Co.,
7 & 8 Southampton Buildings, London, W.C.
Agents for the Applicant.

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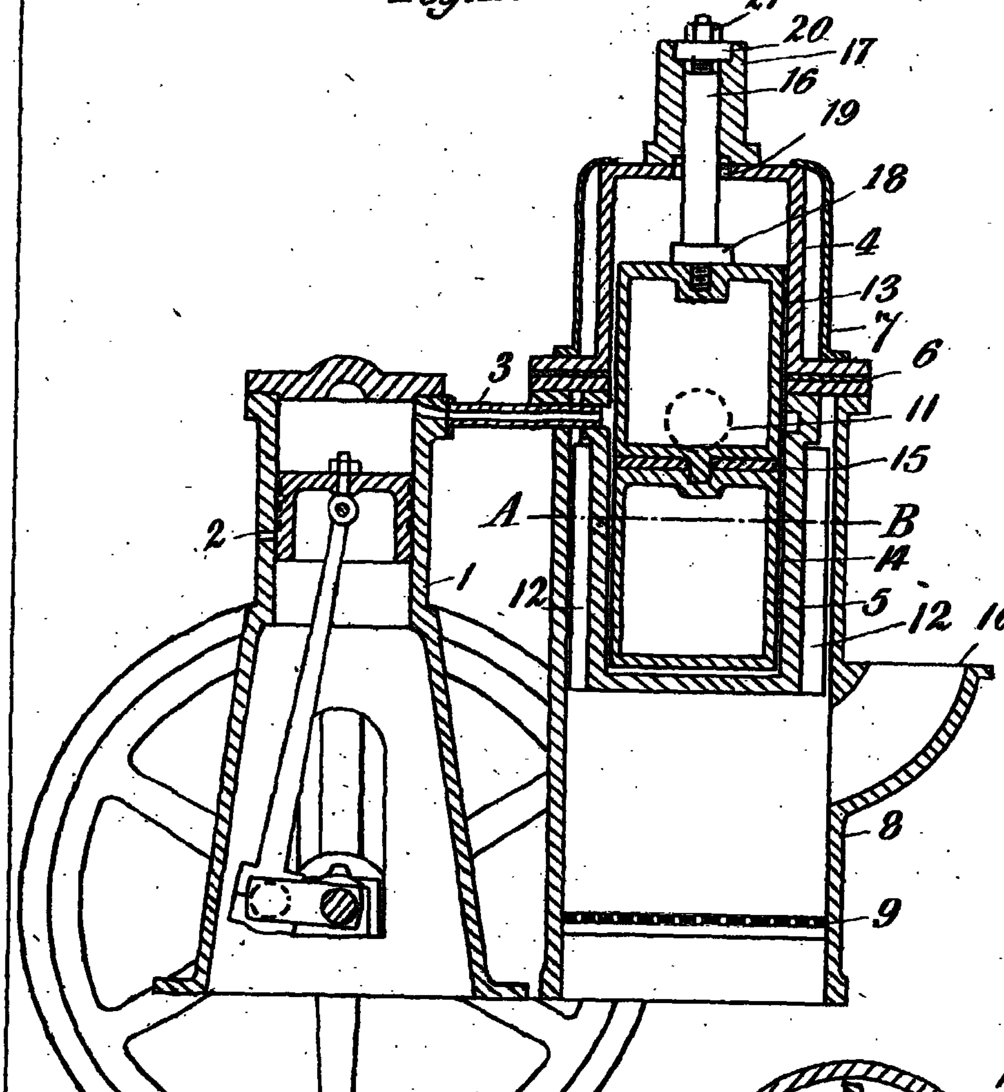
A.D. 1905. MAY 22. N.º 10,675.
LAKE'S PROVISIONAL SPECIFICATION.

(1 SHEET)

Fig. 1.



[This Drawing is a reproduction of the Original on a reduced scale]

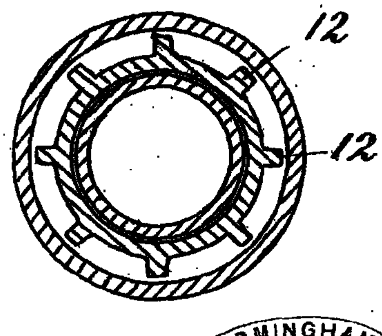


Fig. 2.

Malby & Sons, Photo-Litho.