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H. DÖLZ
ELECTRIC OSCILLATING COMPRESSOR, PARTICULARLY
FOR SMALL REFRIGERATORS

2,839,237

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2 Sheets-Sheet 1

FIG. 1

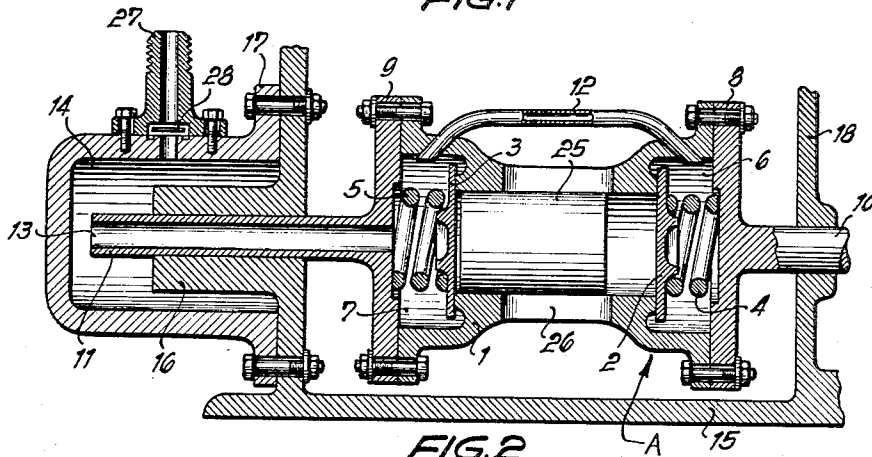


FIG. 2

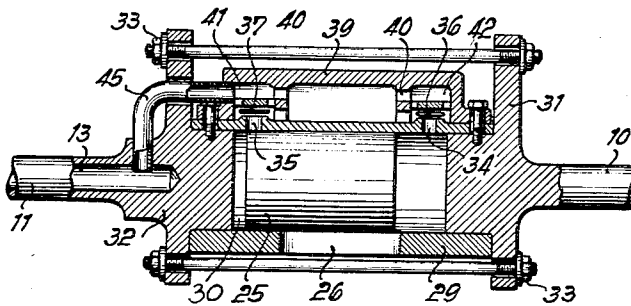
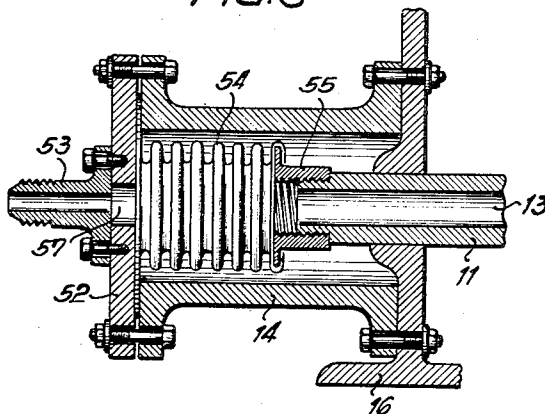


FIG. 3



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1957

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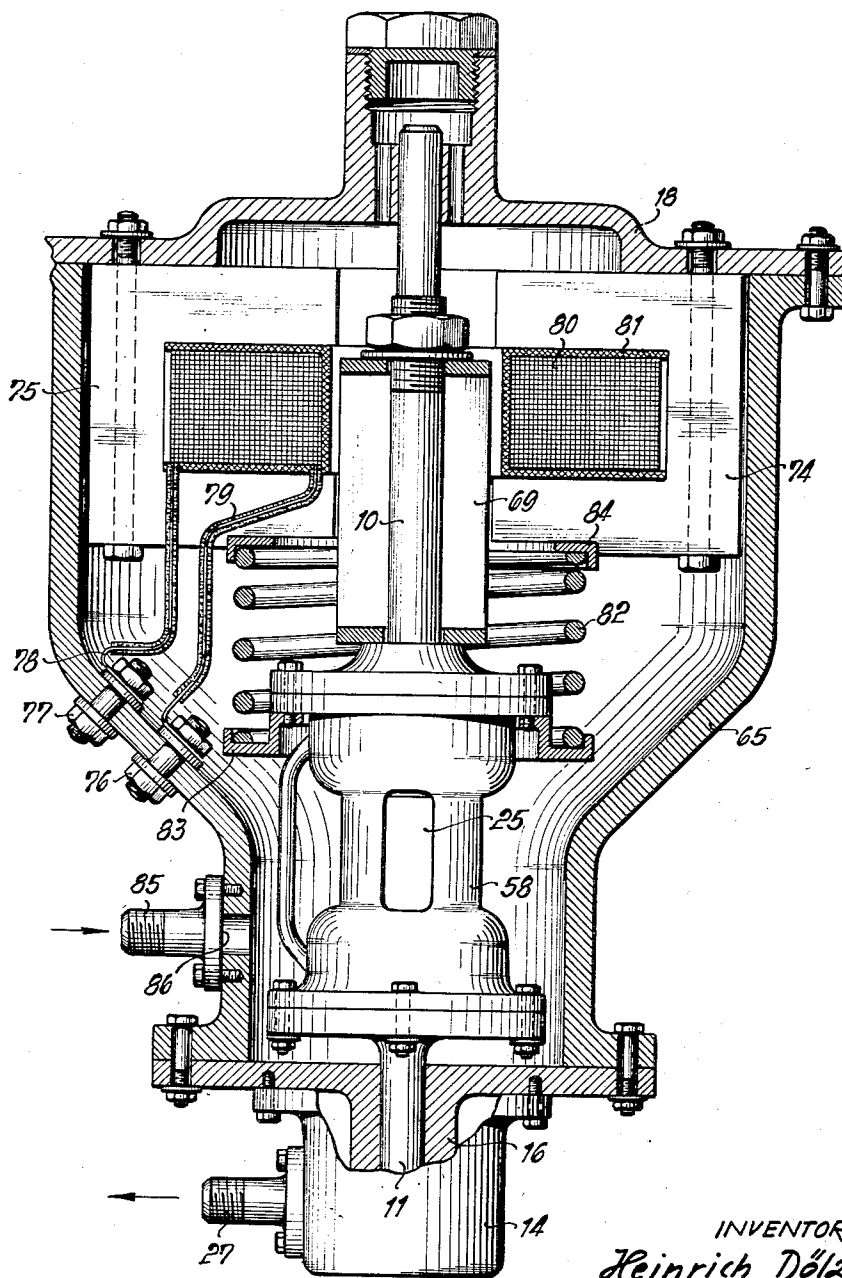
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FIG. 4



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2,839,237

ELECTRIC OSCILLATING COMPRESSOR, PARTICULARLY FOR SMALL REFRIGERATORS

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10 Claims. (Cl. 230—55)

The present invention relates to compressor units, particularly for small refrigerators wherein the driving force is provided by an electric oscillator, either with a non-polarized, for example, electromagnetic system, or a polarized, for example, electrodynamic system.

The present invention thus concerns electric driving means wherein an armature oscillates in a magnetic field which is energized periodically, or wherein the armature consists of a coil which is energized by a cyclic current and oscillates within a constant magnetic field.

It is a well-known fact that, regardless of the particular design and principle of operation of such electric driving means, their amplitude of oscillation or driving stroke depends to a large extent upon the mechanical energy or output required of them, the fluctuations in frequency and tension of the electric current supply, variations in friction within the bearings, variations in temperature, and other factors. Although these factors are of no particular importance in many kinds of oscillatory driving means, for example, for shaking screens, conveyors, or the like, the variations in the stroke length caused thereby have so far rendered electric oscillators impractical or entirely useless as driving means for operating compressors, and particularly those of customary design operating with a plunger piston. This was due to the fact that such variations in the stroke length of the oscillator resulted in similar variations in the stroke length of the compressor piston and thus in the output of the compressor. Although relatively complicated and expensive means for regulating the output of such oscillator-driven compressors have been proposed prior to this invention, the total lack of any simple and inexpensive means rendered this type of drive uneconomical and useless, especially for small compressors such as are used, for example, in refrigerators.

It is now the principal object of the present invention to overcome these disadvantages of the prior art and to provide simple and inexpensive means for converting the fluctuating strength and varying length of stroke of an oscillator into a steady power of compression.

More specifically, it is an object of the present invention to provide simple means for driving compressors for any purpose by means of electric oscillators, and to provide a new type of compressor which will operate economically and efficiently regardless of large variations in the length of the driving stroke furnished by an electric oscillator, and without any need of special control means for regulating such stroke.

Another object of the present invention is to provide an oscillating compressor unit which consists in a combination of an electric oscillator, either polarized or nonpolarized, and a cylinder which is connected to the oscillator, and a free piston which is able to reciprocate in the cylinder under the action of the forces of its own gravity and inertia.

The most important advantage of such a new combination of an electric oscillator with a compressor of the type described resides in the fact that the detriments resulting

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from the varying stroke of the electric oscillator may thereby be overcome in a very simple manner, thus making it possible for the first time to apply a simple electric oscillator as an efficient driving means for operating a compressor without any special auxiliary means for controlling the stroke either of such oscillator or such compressor.

The operation of the free piston compressor according to the invention is based upon the inventive concept that the cylinder of the compressor which is connected to the oscillator acts as an accelerator of a piston which is freely movable therein and reciprocates in consequence of its own gravity. The cylinder is thus reciprocated by the oscillator in a straight direction at an amplitude which varies in accordance with the fluctuations in the length of stroke of the oscillator. Such movement of the cylinder is transmitted to the free piston which then, in turn, reciprocates intermediate its two end positions within the cylinder and, as the result of its kinetic energy, exerts a compressive force in either direction of movement.

It is a further object of the present invention to improve the cooperation of the oscillator with the compressor by connecting the oscillating piston at its end positions with the cylinder not directly but indirectly by means of intermediate resilient means. These intermediate means may consist of mechanical springs, air cushions, or other suitable resilient means with or without separate shock absorbing means.

Further objects, features, and advantages of the present invention will be apparent from the following detailed description thereof, as well as from the appended drawings, wherein

Fig. 1 shows a longitudinal cross section through the essential parts of the new compressor;

Fig. 2 shows a similar cross section through a modification of the new compressor;

Fig. 3 shows a bushing with sealing means for the reciprocating shaft of the compressor; while

Fig. 4 shows a general view of the entire compressor, partly in cross section.

Referring to the drawings, and first particularly to Fig. 1, the compressor according to the invention consists of a cylinder 1 which is closed at its opposite ends by pressure valves 2 and 3, respectively. Each of these valves consists of a valve plate of a size substantially corresponding to the cross-sectional area of the cylinder 1, and a pair of coil springs 4 and 5 which act upon the respective valve plate so as to press the same against the outer edge of the cylinder which thus acts as a valve seat. A pair of pressure chambers 6 and 7 are disposed outwardly of the valve plates 1 and 2, respectively, and are closed, for example, by flanges 8 and 9 which are secured to guide rods or shafts 10 and 11, respectively. The two pressure chambers 6 and 7 may communicate with each other by a tube 12, while compression chamber 7, in turn, communicates through an axial bore 13 in the shaft 11 with the main pressure chamber 14 which is formed by a housing member 17 and a main housing or frame 15. Shaft 11 is slidably mounted in the left-hand bushing 16 of housing 15 which forms a gas-tight seal. Similarly, shaft 10 is mounted at the right side in a bushing in a cover or housing part 18 so as to be slidable therein in axial direction. Cylinder 1, valves 2 and 3 with springs 4 and 5, and shafts 10 and 11 together form an accelerator, generally identified by the letter A, which is connected with the driving member of an electric oscillator of any desired type so as to carry out reciprocating movements within the main housing 15. The driving member of the electric oscillator will, in the following description be called the armature or oscillator armature, regardless of the type of electric

oscillator used, that is, whether it is polarized, and preferably dynamic, or nonpolarized and preferably electromagnetic.

In the embodiment of the invention according to Fig. 1, piston 25 of a predetermined weight has been shown as consisting of a solid cylinder with straight end surfaces which are disposed vertically to the axis of the cylinder. When piston 25 is in either of its two end positions, it will open the intake slots 26. Thus, in the left end position, as shown in Fig. 1, intake slots 26 are opened at the right side to draw air or gas into that side of the cylinder.

If the armature of the oscillator reverses its direction of movement and moves toward the right, the accelerator A consisting of members 1 to 5, and 8 to 11 is likewise moved in that direction from the position shown and its velocity then increases from zero at the left point of reversal to the maximum of $V=\omega \cdot s$. The maximum velocity occurs when the oscillating armature and thus the accelerator have reached the center between the two opposite reversal points. The value s corresponds to one-half of the total stroke of the accelerator. During this first phase of the movement, the free piston 25, because of its own gravity and inertia, remains stationary and in engagement with valve plate 3, while spring 5 is slightly tensioned. This spring has to take up the accelerating force $m \cdot \omega^2 \cdot s (\sin \omega \cdot t)$ if the compression pressure upon valve plate 3 should not be sufficient to do so.

After passing beyond the central position, the second phase of movement of the accelerator begins. The velocity of the accelerator A decreases down to zero at the right-hand reversal point and then again increases in the opposite direction to the maximum value $V=\omega \cdot s$ when the accelerator moving from the right to the left has again reached its central position.

Since piston 25, because of its inertia, will at first retain its velocity, while that of the accelerator A decreases at the beginning of the second phase and continues to decrease during the entire second phase until such retardation reaches its maximum value at the right-hand reversal point of the accelerator, piston 25 retains the maximum speed of the accelerator at the end of the first phase and at the beginning of the second phase, and will at that time be lifted from the left valve plate 3. Therefore, during the entire second phase, piston 25 will be able to use its kinetic energy, which it has taken up at the end of the first phase, for compressing the gas which has been drawn into the right-hand cylinder chamber 19 through intake slots 26, and for expelling this gas from such cylinder chamber 19 into the pressure chamber 6.

If the arrangement is provided in such a manner that by predetermining the length of the stroke of piston 25 and the weight thereof, the kinetic energy which has been taken up by the piston will always be larger than the maximum effort of compression, piston 25 will reach the right-hand valve plate 2 even before the second phase of movement is completed and, while tightening the spring 4, will even move a small distance beyond the edge of cylinder 1 and thereby lift valve plate 2 mechanically. The excess of kinetic energy will then be taken up by spring 4. If the weight and stroke of piston 25 is thus determined, it will be certain that all the gas contained in the cylinder chamber will be forced into the pressure chamber 6, so that a dead space will be avoided and piston 25 will be in contact with valve plate 2 even before the end, or at least at the end of the second phase.

The third phase then proceeds exactly like the second phase, with the only difference that the movements and accelerations proceed in the opposite direction from the second phase. Piston 25 then compresses the gas which has been drawn into the left cylinder chamber of cylinder 1 through intake slots 26, and expels this gas into pressure chamber 7. The fourth phase of movement again

equals the second, the fifth phase the third, and so forth, thus periodically converting the kinetic energy of piston 25 into compressive energy.

The compressed gas in compression chamber 6 may pass through the tube 12 to pressure chamber 7 and thence through the bore 13 to a main pressure chamber 14, while the compressed gas in pressure chamber 7 passes directly through bore 13 to the main pressure chamber 14. From the latter, the compressed gas then passes through a pressure outlet nipple 27 to the point of consumption. A check valve 28 prevents any possible back flow of the compressed gas in the event that the compressor should stop or there should ever be a small leak between the shaft 11 and bushing 16. Although for many purposes check valve 28 may be omitted, it will be absolutely required at this or any other suitable place if the compressor is used for operating a small refrigerator.

Since the number of strokes of an oscillator per minute is equal to or a multiple of the frequency of the alternating current supply, such stroke number will be determined for such current once for all times depending upon the design and construction of the oscillator. The stroke length, however, of the oscillator may vary considerably. These variations react upon the compressor in such a manner that it will operate properly if the stroke of the oscillator exceeds a certain minimum, that is, when the stroke of the oscillator and thus of the accelerator A is sufficient to transmit to the oscillating piston the kinetic energy which it requires to carry out its work of compression. If the stroke of the oscillator exceeds such minimum stroke, the kinetic energy will always be larger than required to carry out the compressive work. Since the volume of the gas drawn into the cylinder is dependent upon the predetermined stroke of the oscillating piston rather than upon the variable stroke of the accelerator, the compressor will always execute its full compressive work, and its output will always be the same regardless of the stroke of the oscillator and accelerator.

Thus, the object of the present invention has been achieved, namely, of providing a compressor which may be driven by an oscillator and cooperates therewith so that, as long as the oscillator exceeds a certain minimum stroke length, the output of the compressor will be independent of such stroke length, so that the latter may vary within very large limits, and as much as $\pm 30\%$ and more, without affecting the output of the compressor to any noticeable extent.

Such uniform compressor output is a requirement especially for small refrigerators if their operation is to be economical. For that purpose it is necessary that the output of such compressor will remain uniform despite variations in the length of stroke of the electric oscillator to which it is connected, which, in turn, are caused by variations in frequency and tension of the current supply, the amount of pressure to be produced, variations in friction in the bearings, and other factors.

An important fact to be considered if the unit which consists of the combination of an oscillator with an oscillating compressor is to operate properly is that the oscillating piston will at its end positions engage the cylinder only through intermediate resilient means such as, for example, the valve springs 4 and 5. By such resilient means it will be possible to absorb the excess in kinetic energy of the oscillating piston which occurs primarily if the oscillator increases its stroke, so that both the piston as well as the cylinder will be protected from damage.

In place of springs, other suitable means, for example, pneumatic buffers or air cushions may be applied for taking up the excessive kinetic energy of the oscillating piston. An embodiment of the invention with pressure valves of such design is illustrated in Fig. 2, in which a small dead space 30 is provided between the piston 25 and the cylinder 29 so as to form an air cushion at either end position of piston 25. Cylinder 29 forms a tube in

which intake slots 26 are provided, and into the open ends of which cylinder heads 31 and 32 are fitted so as to seal the cylinder gas-tight at both ends. Stay bolts 33 rigidly connect these cylinder heads 31 and 32, thus forming with cylinder 29 a single compact unit. Outlet openings 34 and 35 for pressure valves 36 and 37 are provided laterally within the cylinder wall and a short distance before the cylinder heads 31 and 32. Thus, a gas or air cushion will be formed between outlets 34 and 35, and cylinder heads 31 and 32, respectively, as indicated at 30 at the left side of cylinder 29. Such gas or air cushions will safely prevent the piston from hitting against the cylinder heads.

Since piston 25 only has to be of a relatively small size and weight even though the output of the compressor might be quite large, the space between outlets 34 and 35 and cylinder heads 31 and 32 may be made very small. The pressure chamber 39 has two valve chambers 41 and 42 which are connected by apertures 40, and also communicates through a tube 45 with the bore 46 of shaft 11. The gas expelled by piston 25 may thus pass through outlets 34 and 35 and bore 13 into the main pressure chamber 14, as shown in Fig. 1, and thence through check valve 28 to the point of consumption.

The advantages of the embodiment of the invention as shown in Fig. 2 consists in the practically noiseless operation of the compressor which is due to the fact that piston 25, apart from its sliding engagement with cylinder 29, has no other contact therewith nor with any other elements. Thus, any hard shocks will be avoided which render this type of construction suitable particularly for use in refrigerators, and especially small refrigerators for households, in which a noiseless operation is one of the principal requirements.

Fig. 3 illustrates a modification of a part of the invention according to which the bushing 16, as shown in Fig. 1, which supports the reciprocating shaft 11, may be relieved of its second function of acting as a pressure seal. For this purpose a resilient bellows 54 may be mounted within the main pressure chamber 14 and connected at one end by means of a threaded socket 55 to the end of shaft 11, while the other end of bellows 54 may be secured gas-tight to the cover 52 of pressure chamber 52, for example, by means of a diaphragm secured between the flange at the end of chamber 14 and cover 52 by the bolts connecting the same. Cover 52 is provided with an axial bore 57 which connects with a pressure outlet nipple 53. The compressed gas then passes from bore 13 in the shaft 11 through socket 55 into bellows 54, and thence through bore 57 and outlet nipple 53 to a pressure line, not shown. This type of design permits the bushing 16 to be made much shorter and of simpler construction. In place of a bellows, other kinds of connecting means may be provided between the shaft end and the final pressure outlet, for example, corrugated metallic tubes, diaphragms, hoses of flexible synthetic material which is capable of withstanding high pressures, or the like. Also, these means may be resilient and the elastic force thereof be utilized for tuning the oscillator to the respective frequency of the current supply.

An example of a design and construction of a hermetically sealed compressor according to the present invention, especially for use as a refrigerating unit for a small refrigerator, has been illustrated in Fig. 4. The oscillating compressor 58, for example, as shown in Figs. 1 and 2, is slidably mounted by means of the left shaft 11 in a bushing 16, similarly as shown in Fig. 1. The main pressure chamber 14 with pressure outlet nipple 27 is likewise as in Fig. 1. Shaft 10 is slidably mounted within a suitable bushing in the cover plate 18 at the right side of housing 65. The two bushings and cover plates 16 and 18 together with housing 65 completely enclose the entire unit. Shaft 10 at the right side has also mounted thereon the oscillator armature 69, for example, 75

of an electromagnetic oscillator. In such a case, armature 69 is laminated and consists of a series of, for example, rectangular iron laminae which extend parallel to the plane of the drawing. The iron laminae may also be connected with each other by bolts or rivets, not shown, and form a solid stack with a central aperture mounted on the shaft 11 and screwed thereto. The stator of the electromagnetic oscillator consists of the two U-shaped stacks of laminations 74 and 75 which likewise extend parallel to the plane of the drawing and are held together by rivets or bolts.

If the stator winding 80 on the coil form 81 is supplied with alternating current through the leads 76 and 77 and the leads 78 and 79, the armature 69 will be drawn into the stator both during the positive as well as the negative half-cycle of the alternating current. During the dead phase of the current, armature 69 is then again pulled out of the stator by means of a return spring 82 which forms a part of the oscillating system and is disposed between spring washers 83 and 84. The resiliency of spring 82 should be determined so as to cooperate with the armature 69 to tune the operation thereof to the respective frequency of the current supply.

If the unit as described is to be hermetically sealed, the refrigerating gas will be drawn in through the inlet 85 and bore 36 and, after being compressed, returned to the cooling circuit through the outlet 27. If it is desired that the unit operate substantially without any noise, a compressor similar to that shown in Fig. 2 may be used. Furthermore, the entire unit should preferably be resiliently suspended within a second hermetically sealed casing. In such a case, it will not be absolutely necessary that housing 65 also be sealed hermetically since the outer casing may then be used as a suction chamber.

The compressors shown in Figs. 1 and 2 are double-acting since the piston 25 will compress the gas in both directions of its reciprocation. An equation which is easily drawn indicates that the piston stroke S should be no larger than $S = s(\omega t - \sin \omega t)$, wherein ωt should have a maximum value of $\omega t = \pi$. The stroke of the piston may thus have a length intermediate the theoretical value of zero and the maximum values of $s \cdot \pi$, and it may thus be even larger than the total stroke $2 \cdot s$ of the accelerator. It may therefore be freely selected to be of any length within a wide range. This constitutes a great advantage as it permits the stroke of the piston to be made considerably smaller than that of the accelerator A. Since this, in turn, means a considerably lower velocity of the piston, it forms a valuable improvement in the operation of the piston, as well as of the entire compressor. On the other hand, the longer stroke of the accelerator means less friction and wear upon the bushings or bearings of the shafts and thus an improvement in the life and reliability of performance of the compressor.

There is still another advantage in making the piston stroke small in comparison to the stroke of the accelerator. During the largest portion of the period of one reciprocation of the accelerator, the piston will remain in its two end positions and its stroke will require only a fraction of the time of the reciprocation of the accelerator. This means that the intake slots 26 will be left open for a long time so that the cylinder chamber will be filled with gas completely. This is very important in view of the fact that inlet valves in the form of intake slots did not prove successful in prior designs of plunger piston compressors because of the short period during which such slots were opened, as the result of which the cylinder chamber was filled incompletely, thus rendering the operation of the compressor uneconomical. The advantages of intake slots of not requiring any dead space in the compression chamber and of being the simplest possible construction have thus been fully realized in the design of an oscillating piston compressor according to the present invention.

Also, while the pressure valves of plunger piston com-

pressors according to prior designs did not operate as properly as desired, the valves according to the invention, and particularly, the valve arrangement 2 and 3 as shown in Fig. 1 operate without any difficulty and very successfully. This is due to the following facts:

Generally, the pistons of plunger piston compressors are positively actuated. If these kinds of compressors are so designed that the plunger piston in its upper dead-center position extends slightly beyond the cylinder edge, the valve plate which rests upon the piston under spring pressure should then, when the piston retracts, also move back to such an extent that it will rest upon and continue to remain on the cylinder edge. The movements of the valve plate are therefore determined by the positively actuated piston. However, generally, the valve plate does not follow the movements of the piston as accurately as required. Consequently, a portion of the compressed gas will flow back. The result is therefore the same as that of a dead space in the compression chamber.

Entirely different conditions, however, prevail in the oscillating compressor according to the present invention. If, in consequence of its kinetic energy, the free piston 25 moves beyond the cylinder edge, it will be moved back by the spring action of the valve spring 4 or 5. The movement of the piston and the extent thereof is therefore determined by the valve. Due to the fact that the motion phenomena are quite different from those of the plunger piston compressors of prior design, and are now directly determined by the valves themselves, those of the oscillating compressor according to the invention will always operate entirely satisfactory and reliably, while those of the prior compressors did not.

It has also been found that the greater the difference in weight between the accelerator and the oscillating piston, the smoother will be the operation of the entire compressor. Therefore, it is advisable to make the weight of the accelerator A larger than that of the oscillating piston. Thus, it is easily possible to make a piston of a weight of, for example, 2.6 oz., while the total weight of the oscillating system may be, for example, 17 oz.

A further improvement of the invention consists in designing the piston 25 as a differential piston and in shaping the compression chamber accordingly so as to obtain a two-stage compression wherein the first stage of compression is formed in one direction of movement of the piston, while the second stage of compression is formed in the opposite direction of movement. In such a case, the diameters of the stepped piston may then be made similarly as in two-stage compressors of prior design. Also it will be possible to use a piston of the same diameter in both stages if, by a suitable arrangement of the intake slots, the effective compression stroke will be made of different size, thus producing the same effect as with a differential piston. If an intermediate cooling should be required, the gas which has been compressed in the first stage may be supplied to the intermediate cooler through the left shaft of the compressor and then passed to the intake slot of the second stage through the shaft at the right side. The gas which is compressed in the second stage may be discharged through flexible tubes, provided one of the shafts is not mounted in two separate bushings and the gas is discharged behind the second bushing or between the two bushings. If the compression is to be carried out by more than two stages, several oscillating compressors according to the invention may be rigidly connected with each other and driven by a single oscillator.

Rather than using a free piston 25, the arrangement may also be reversed by making the cylinder the freely movable element and connecting the piston with the armature 69 of the oscillator. Of course, intermediate resilient elements, such as a spring 82, should then also be provided between the piston and the cylinder.

In place of the bushings 16 and 18, a leaf-spring mounting may also be provided. In such a case, the bushings may be replaced by leaf springs which are secured to the shafts, and the free ends of such springs may be connected with the housing so as to flex in the direction of movement of the oscillating armature and compressor, while vertically to such direction of movement they should have no or only very little resilience. The elasticity constant of these springs may also be used in combination with the oscillating system, so as to tune the same to the frequency of the respective current supply, in which case spring 82 might be superfluous.

Although previously described as a double-acting compressor, the free piston 25 may exert its compressive action in only one direction of its reciprocating movement.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof I wish to have it understood that it is in no way limited to the details of such embodiments or to the specific examples described, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. An electric oscillator driven compressor comprising, in combination, a compressor and an electric reciprocating motor having a driving armature reciprocated rectilinearly, said compressor comprising a cylinder connected to said armature of the electric reciprocating motor to be reciprocated thereby, a freely movable piston slidably mounted in said cylinder and acted upon by forces of inertia so as to reciprocate relative to said cylinder for compressing a gaseous medium within said cylinder in at least one direction of its reciprocating movement, inlet and outlet means for said medium, and means for controlling at least said outlet means.

2. An electric oscillator driven compressor as defined in claim 1, wherein the weight of said piston is such that the stroke of said piston relative to said cylinder will be shorter than the stroke of said cylinder relative to a fixed location.

3. An electric oscillator driven compressor as defined in claim 1, further comprising a pair of shafts secured to opposite ends of said cylinder and means for supporting said shafts for reciprocating movement, at least one of said shafts being hollow and serving as a passage for said medium.

4. An electric oscillator driven compressor as defined in claim 1 further comprising a shaft secured to the free end of said cylinder not connected to said oscillator, means for supporting said shaft for reciprocating movement, said shaft being hollow and serving as an outlet for the medium compressed in said cylinder, and a check valve for controlling the discharge of said medium from said hollow shaft.

5. An electric oscillator driven compressor as defined in claim 1, further comprising a shaft secured to the free end of said cylinder not connected to said oscillator, means for supporting said shaft for reciprocating movement, said shaft being hollow and serving as a discharge conduit for the medium compressed in said cylinder, a stationary outlet, and flexible means forming a gas-tight connection between said hollow shaft and said stationary outlet.

6. An electric oscillator driven compressor as defined in claim 1, further comprising a shaft secured to the free end of said cylinder not connected to said oscillator, means for supporting said shaft for reciprocating movement, said shaft being hollow and serving as a discharge conduit for the medium compressed in said cylinder, a stationary outlet, and resilient means forming a gas-tight connection between said hollow shaft and said stationary outlet and adapted to cooperate with said oscillator so as

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to tune the same to the respective frequency of the electric current supplied thereto.

7. An electric oscillator driven compressor as defined in claim 1, wherein said cylinder and piston are arranged for a multistage compression, wherein the first stage of compression is carried out by the piston moving in one direction and the second stage by the piston moving in the other direction of its reciprocation.

8. An electric oscillator driven compressor comprising, in combination, a compressor and an electric reciprocating motor having a driving armature reciprocated rectilinearly, said compressor comprising a cylinder connected to said armature of the electric reciprocating motor to be reciprocated thereby, a freely movable piston slidably mounted in said cylinder and acted upon by forces of inertia so as to reciprocate relative to said cylinder for compressing a gaseous medium within said cylinder in at least one direction of its reciprocating movement, resilient means interposed between the ends of said piston and cylinder to prevent them from coming in direct contact with each other, inlet and outlet means for said medium, and means for controlling at least said outlet means.

9. An electric oscillator driven compressor comprising, in combination, a compressor and an electric reciprocating motor having a driving armature reciprocated rectilinearly, said compressor comprising a cylinder connected to said armature of the electric reciprocating motor to be reciprocated thereby, a freely movable piston slidably mounted in said cylinder and acted upon by forces of inertia so as to reciprocate relative to said cylinder for compressing a gaseous medium within said cylinder in at least one direction of its reciprocating movement, inlet means for passing said medium into said cylinder, said

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cylinder having fixed heads at the opposite ends thereof and axially facing, annular valve seats spaced axially from said heads to define pressure chambers therebetween, valve plates adapted to extend across said cylinder and seat against said annular seats of said cylinder, resilient means acting upon said plates to urge the latter against said seats of said cylinder, thereby to control the discharge of compressed gas into said pressure chambers of said cylinder and to prevent the violent transmission of shocks from said piston to said heads.

10. An electric oscillator driven compressor comprising, in combination, a plurality of compressors each comprising a cylinder, means for mounting said cylinder for reciprocating movement, a freely movable piston slidably mounted in said cylinder and acted upon by forces of inertia so as to reciprocate relative to said cylinder for compressing gaseous medium within said cylinder in at least one direction of its reciprocation, inlet and outlet means for said medium, means for controlling at least said outlet means, a single electric reciprocating motor having a driving armature reciprocated rectilinearly for reciprocating said cylinders, and means for connecting said armature of the electric reciprocating motor with said cylinders.

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