July 23, 1957 V. S. MAKAROFF ET AL 2,800,274

COMPRESSORS

Filed June 7, 1954 3 Sheets-Sheet 1

Fig 1

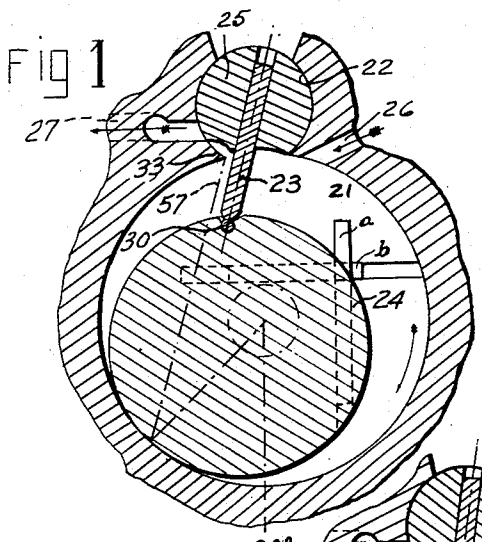
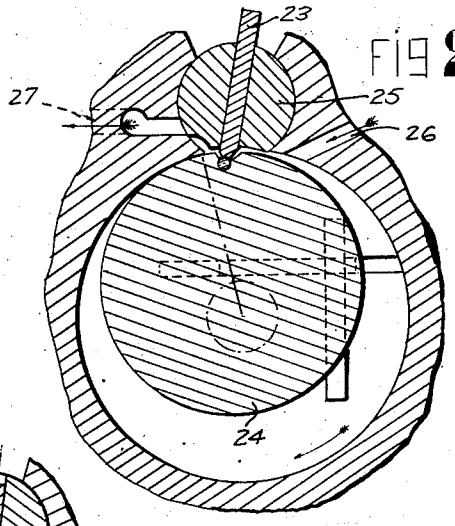


Fig 2



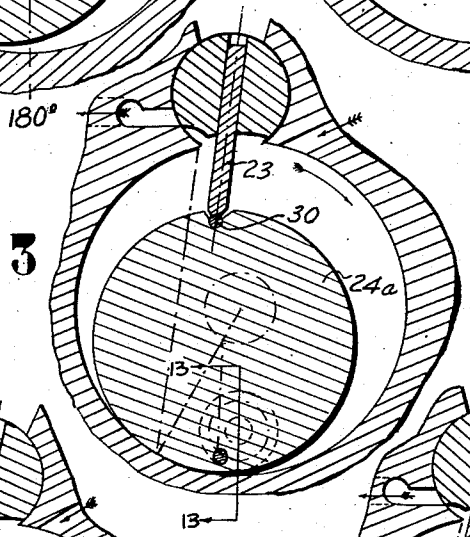


Fig 3

Fig 4

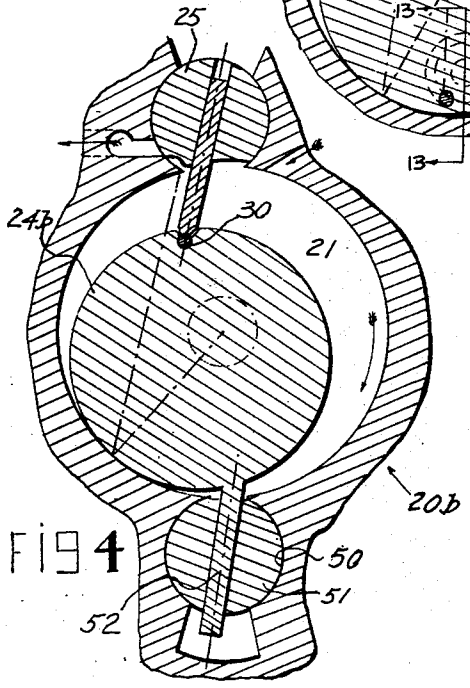
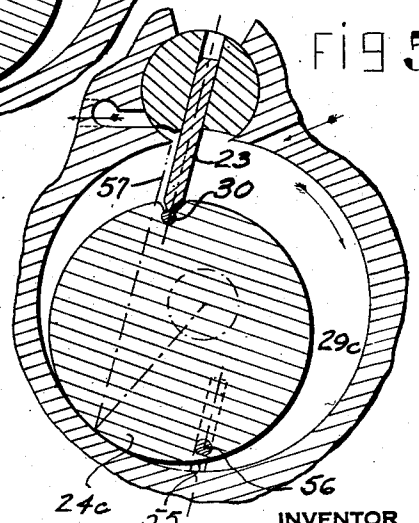


Fig 5



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Fig 6

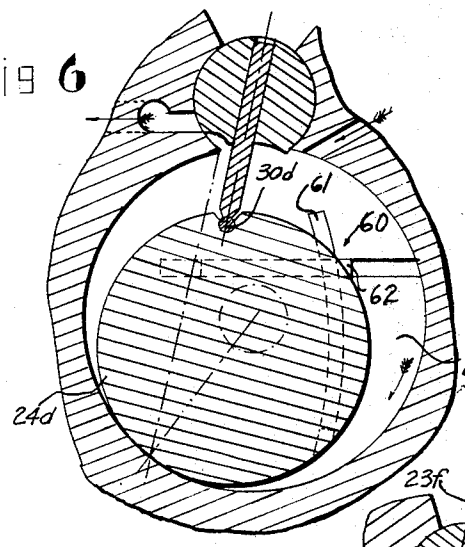


Fig 7

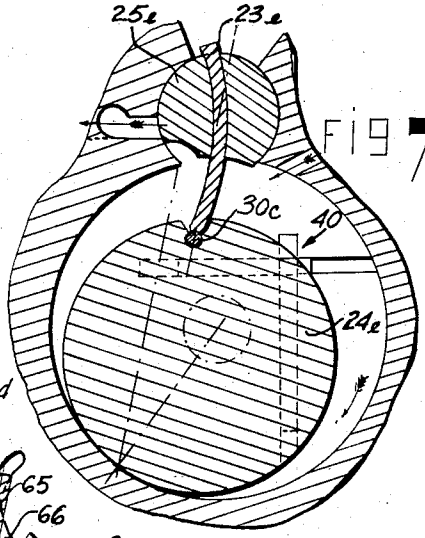


Fig 8

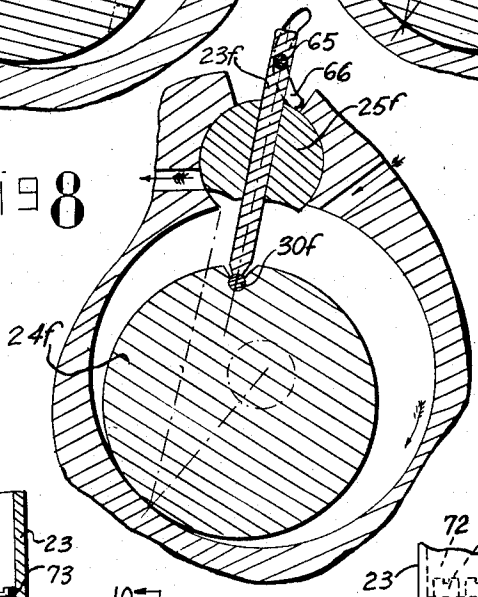


Fig 9

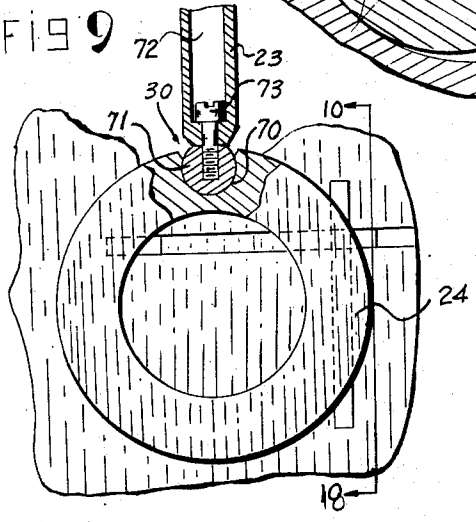
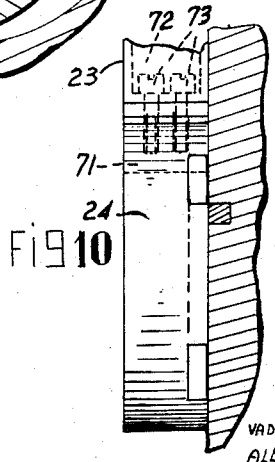


Fig 10



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COMPRESSORS

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Fig 11

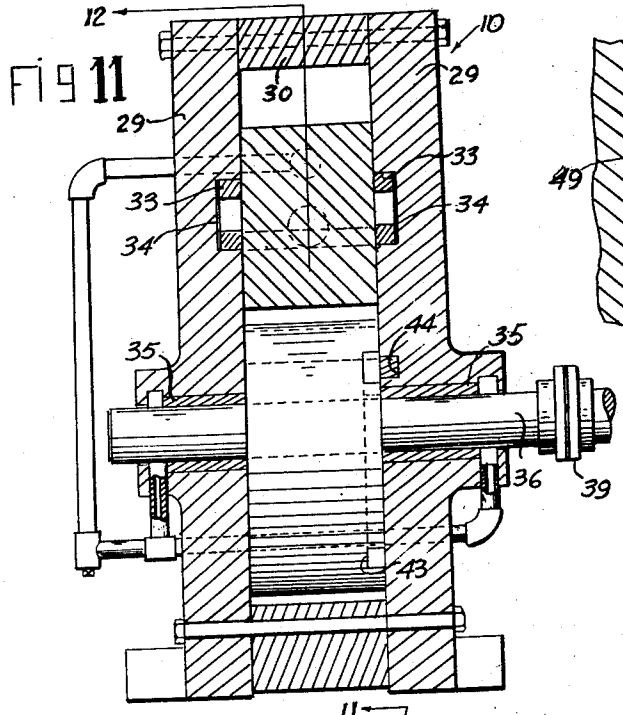


Fig 12

Fig 13

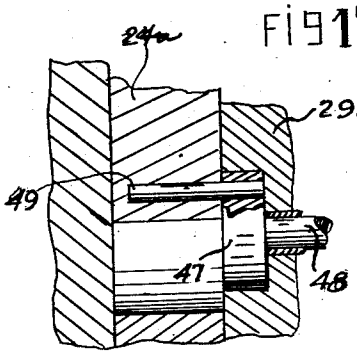
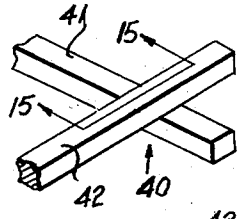


Fig 14



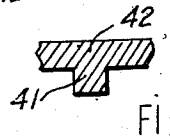


Fig 15

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2,800,274

COMPRESSORS

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Application June 7, 1954, Serial No. 434,737

9 Claims. (Cl. 230—147)

This invention relates generally to compressors, and the like, of the general type disclosed in our prior U. S. Patent No. 2,643,817, and is an improvement thereover.

The particular embodiment of the present invention, which is illustrated in the drawings and which will be described hereinafter in greater detail, comprises generally a main chamber having an eccentrically gyrating piston contained therein, a valve member adjacent to the main chamber and movable for opening and closing a discharge port, and a tail blade connected to the piston and the valve member for actuating the latter upon gyration of the piston.

In prior devices of this general type, the tail blade was rigidly fixed to the piston, and the angular disposition of the tail blade relative to the piston determined not only the piston position at which the exhaust port opened and closed, as described in the above-mentioned patent, but such rigid connection also determined the amount or size of the exhaust port opening. Further, the rigid tail blade construction of the prior art has been found to unnecessarily limit the size of exhaust port opening.

More specifically, the piston motion in the above-mentioned patent is not pure gyration, wherein a vertical diametral line through the piston would remain vertical during the entire cycle, but rather, such a line would be subject to rotary oscillation about its center point. Obviously, the amount of rotary piston oscillation will vary inversely as the distance from the center of oscillation or pivoting (the center of the piston) to the center of the valve member. By inspection of the drawings of applicants' prior patent, it will be observed that the direction of rotary piston oscillation is such as to decrease the size of the exhaust port opening during the entire discharging period. That is, during the entire open time of the exhaust port, the piston oscillates clockwise to impress a counterclockwise force on the valve member, which tends to close the latter.

Accordingly, it is one object of the present invention to provide an improved rotary compressor construction of the type described which retains all the advantages of the device of applicants' prior patent, and which includes novel means adapted to automatically increase the size of the exhaust port opening, or otherwise control the latter, as desired.

It is another object of the present invention to provide a compressor having the characteristics indicated in the foregoing paragraph, in which the principle of valve timing is the same as that of the above-mentioned patent, opening and closing of the discharge port occurring when the tail blade is in parallel relation with respect to a predetermined line.

It is a further object of the present invention to provide a compressor or the like having the advantageous features mentioned above, which is simple in construction and durable in operation, and which can be manufactured and sold at a reasonable cost.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings which form a material part of this disclosure.

The invention accordingly consists in the features of constructions, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter described, and of which the scope will be indicated by the appended claims.

In the drawings:

Fig. 1 is a sectional view showing a compressor constructed in accordance with the present invention, illustrating the position of the piston at the opening point of the discharge valve port.

Fig. 2 is a view similar to Fig. 1 showing the position of the piston at the closing point of the discharge valve port.

Fig. 3 is a sectional view showing a slightly modified compressor constructed in accordance with the present invention, and illustrating the piston position at the opening of the discharge valve port.

Fig. 4 is a sectional view showing another slightly modified compressor of the present invention and illustrating the position of the piston at the opening point of the discharge valve port.

Fig. 5 is a sectional view showing still another slightly modified form of the present invention, and illustrating the piston position at the opening point of the discharge valve port.

Fig. 6 is a sectional view showing another embodiment of the present invention, and illustrating the piston position at the opening point of the discharge valve port.

Fig. 7 is a sectional view showing yet another embodiment of the invention, and illustrating the piston position at the discharge valve port opening point.

Fig. 8 is a sectional view showing still a further embodiment of the present invention, and illustrating the piston position at the discharge valve port opening point.

Fig. 9 is a partial, enlarged view, partly broken away to more clearly show the details of construction of the embodiment of Figs. 1 and 2.

Fig. 10 is a sectional view taken substantially along the line **10—10** of Fig. 9.

Fig. 11 is a transverse vertical sectional view through a compressor of the form of Fig. 1, and taken substantially along the line **11—11** of Fig. 12.

Fig. 12 is a vertical sectional view of the compressor of the present invention, taken substantially along the line **12—12** of Fig. 11 and showing the discharge valve port in partially open condition.

Fig. 13 is an enlarged sectional view taken substantially along the line **13—13** of Fig. 3, and showing the piston in a different position of its gyratory movement.

Fig. 14 is a perspective view showing a cruciform type slide adapted for use in the embodiment of Figs. 1 and 2, as removed from the compressor.

Fig. 15 is a partial, sectional view taken substantially along the line **15—15** of Fig. 14.

Referring now more particularly to the drawings, and specifically to Figs. 1, 2, 11 and 12 thereof, the compressor structure will first be described. The compressor comprises a casing, generally designated **20**, having a main cylindrical chamber or cylinder **21**, a cylindrical valve housing **22** parallel thereto, the housing and chamber intersecting to form an arcuate space through which the tail blade **23** passes. An eccentrically gyrated cylindrical piston **24** is mounted in the main chamber, and an oscillatory valve block or member **25** is mounted in the valve housing **22**. One end of the tail blade **23** is pivotally connected, as at **30**, to the piston **24**, to permit swinging of the tail blade relative to the piston. The valve block or member **25** has a slot formed therein in which the tail blade **23** reciprocates.

The casing **20** has an inlet, low pressure duct or port **26**, and an outlet, high pressure duct or port **27**. The valve block **25** has a discharge port or passageway **28** adapted to connect the high pressure duct **27** and the main chamber **21** at times, and to disconnect the high

pressure duct and the main chamber at other times. The casing has a recess **31** to provide clearance for the tail blade **23**. It will be noted that the intersection of the valve housing **22** and the main cylindrical chamber forms a lip **32** adjacent to the port **28**. It will be seen from discussion below, and reference to U. S. Patent No. 2,643,817, that this lip **32** is a critical point for completion of the closing of the valve port **28**.

The casing **20** comprises a pair of end plates **29** with a body member **30** clamped between the end plates by a series of bolts. The end plates **29** have recesses **34** for ring-like hubs **33** which connect the two halves of the valve member **25** together. The valve member bears on and is journaled in the housing or socket **22** in parallelism with the gyratory axis of the piston **24**. The sides of the tail blade **23** engage with the end plate **29**.

The end plates **29** have bearings **35** journaling a main shaft **36**; and, an eccentric disc or circular member **37** is disposed within the chamber **21** and fixed to the main shaft. As best seen in Fig. 12, the piston **24** is circumposed about and slidable relative to the eccentric member **37** so as to be gyrated by the latter upon rotation of the main shaft **36**. A suitable lubricating system is, of course, desirable, as between the eccentric **37**, piston **24**, and chamber **21**, however such a system forms no part of the present invention and is omitted from the drawings for clarity of understanding.

The discharge duct **27** may connect with a high pressure storage tank (not shown) or other device, as desired. Such a tank may be provided with an oil reservoir and serve to feed oil through the compressor lubricating system.

It will be understood that the main shaft **36** is driven by any suitable means through a suitable coupling **39**. This causes the piston **24** to gyrate eccentrically around the main cylinder **21** in clockwise direction, as indicated by the arrows. Gas is drawn in through the intake duct **26** and discharged through the outlet duct **27**.

In the form of the invention illustrated in Figs. 1, 2, 11, 12 and 14, a cruciform slide, generally designated **40** is slidably mounted in both the piston **24** and one casing wall **29**. That is, the slide includes fixed crossed bars **41** and **42**; and, the piston and one casing wall are formed with elongated slots **43** and **44**, respectively, adapted to slidably receive the cross bars **41** and **42**, respectively. As the slots and slides in this modification are all straight, it will be apparent that the piston is constrained to vertical and horizontal movement, while being restrained against rotation. Stated otherwise, the piston is permitted pure gyratory movement about the cylinder, without tory oscillation.

As noted hereinbefore, rotary piston oscillation in the rigid type tail blade constructions was responsible for the exhaust port opening, and that elimination of the rotary piston oscillation will provide a larger exhaust port opening than was heretofore possible by bringing the center of pivot of the tail blade closer to the center of the rotary valve. Of course, this pure gyratory movement, or other constrained piston gyration is permitted by the pivotal connection between the tail blade **23** and the piston **24**. As the pivotal connection **30** is located near the periphery of the piston **24**, it is apparent that the distance from the center of the valve member **25** to the point of articulation of the tail blade, namely the pivotal connection **30**, is substantially less than in the rigid tail blade construction, where the point of tail blade articulation at least theoretically, was the center of the piston. This reduction in effective tail blade length will serve to increase rotary oscillation of the tail blade, and hence of the valve member **25**, so as to further increase the size of the exhaust port opening.

In Figs. 3 and 13 are shown another mode of practicing the present invention, wherein the piston gyration is constructed by means of a rotary member or drum **47** set into the casing cover **29***a* and including a stub shaft **48** journaled in the casing, parallel to the shaft **36**, and extending outwardly through the casing for connection to a driving means (not shown). A pivot pin **49** is supported in and extends between the drum **47** and piston **24***a*, being disposed eccentrically of both the drum and piston. In the illustrated embodiment the eccentricity of the pin **49** with respect to the drum **47** and shaft **48** is equal to the eccentricity of the disc **37** and hence of the piston **24**. Upon synchronized or in phase rotation of the drum **47** and pin **49** relative to the shaft **36** and disc **37**, it will be apparent from elementary kinematics that the piston **24***a* of Fig. 3 will execute pure gyratory movement being fully constrained against rotary oscillation.

In the form of Fig. 4, the casing **20***b* is provided with a second cylindrical chamber or housing **50** opposite to the valve chamber **22** and opening into the main cylindrical chamber **21**. A cylindrical member **51** is rotatably mounted in the chamber **50**, and a second tail blade **52** is fixedly secured to the piston **24***b* and extends slidably through the member **51** for reciprocation therein. This form of the invention combines the operating principles of the instant invention and the prior, above-mentioned patent, the tail blade **52** serving to impress rotary oscillation on the piston **24***b* as obtained in the device of the prior patent, while the shortened effective length of the tail blade **23** (between the pivotal connection **30** and the axis of the valve member **25**) increases the rotary oscillation of the latter.

In Fig. 5 is a simplified manner of constraining the gyratory motion of piston **24***c*, which may be desirable under certain circumstances. A slot **55** parallel to line **57** is formed in one wall **29***c* of the casing of Fig. 5, and a pin **56** projects from the piston **24***c* into the slot **55** for sliding movement therein. As the pin is disposed generally opposite to the pivotal connection **30** of the tail blade, it is seen that the lower portion of the piston **24***c* will be more or less constrained to vertical movement, while the pivotal connection point **30** will oscillate, but in a fully constrained manner adapted to increase the size of the exhaust port opening.

In all of the above described forms of the invention, namely those of Figs. 1, 3, 4 and 5, the valve timing operates on the same principle as that of the above mentioned prior patent. That is, the valve discharge port **28** commences to open when the longitudinal axis of the tail blade **23** is in parallel relation with respect to a line **57** extending from a predetermined point of contact between piston and cylinder at the instant the rotary valve commences to open, and the predetermined point of contact between piston and cylinder at the instant the rotary valve has completed its closing. Further, the exhaust port in each of these forms of the invention will close when the tail blade again moves into parallelism with the line **57** upon continued clockwise gyration of the piston. By way of comparison, in compressors of the above types, each having an exhaust port of one inch diameter, and a displacement of nine cubic feet per minute, at a corresponding position of piston gyration, the exhaust port openings will be as follows:

	Inches
Patent No. 2,643,817	.095
Figs. 1 and 3	.250
Fig. 4	.310
Fig. 5	.500+

There are, however, other ways of increasing the opening of the exhaust port without necessarily conforming to the timing disclosed in Patent No. 2,643,817. The following examples will serve to illustrate.

In the form of Fig. 6, a cruciform type slide **60** has its cross members **61** and **62** slidable, respectively, in slots formed in the piston **24***d* and casing wall **29***d*, in substantially the same manner as the slide **40** in the form of Fig. 1. However, the cross member **61** of the slide **60** is curved and slides in a correspondingly curved slot in the piston so as to effect a desired amount of rotary

piston oscillation in the counterclockwise direction, thereby increasing the exhaust port opening beyond that of Fig. 1.

In Fig. 7, the cruciform slide **40** having straight cross members is employed to eliminate rotary piston oscillation in the same manner as in Figs. 1 and 2. However the pivotally connected tail blade **23***e* in Fig. 7 is laterally bowed or curved in one direction or the other and slidably received in the valve member **25***e*. That is, the valve member **25***e* is formed with a curved slot in which the similarly curved tail blade reciprocates. The curvature of the tail blade serves to impress additional rotary oscillation upon the valve member during non-oscillatory gyration of the piston.

In Fig. 8 is shown still another slightly modified form of the present invention, wherein the tail blade **23***f* is straight, having one end pivotally connected at **30***f* to the piston **24***f*, and having a lateral projection or pin **65** on its other end. A curved slot or groove **66** is provided in the casing or some structure fixed relative to the casing, and the pin **65** is slidably received within the slot. That is, the pin **65** moves along the slot **66** upon reciprocation of the tail blade **23***f* in the valve member **25***f* and thereby constrains the tail blade to a predetermnied angular oscillatory movement. As illustrated, the pin and slot **65** and **66** serve to control oscillation of the valve member **25***f* and hence increase the size of the discharge port opening. However, it is fully appreciated that in all of the forms of Figs. 6, 7 nad 8, the curved constraining means may be reversely curved, or of different curvature, as desired, in order to achieve a particular size exhaust port opening. While the timing of the valve port opening and closing in the last three modifications is not exactly the same as that of Figs. 1–5, the same timing can be obtained by altering the above-mentioned parallel disposition of the tail blade, as required, in order to achieve valve port closing at a desired piston position.

In Figs. 9 and 10 are shown the pivotal connection **30** in greater detail, wherein the piston **24** is formed with a transversely extending, open-ended peripheral groove of socket **70**. In section, as best seen in Fig. 9, the socket is arcuate, comprising a circular arc of greater than 180°. A generally cylindrical swivel or pivot **71** is rotatably seated in the socket **70**, and the tail blade **23** is provided with an internal hollow **72**, into which are inserted the fasteners **73** for threaded securement to the pivot **71**. By this pivot construction, it is seen that the tail blade **23** is readily removable from the piston **24** for replacement, repair or otherwise, as desired.

While the foregoing detailed description has referred to the device of the present invention as a compressor, it is, of course, understood that the device may be used as a vacuum pump, motor, or the like, without modification thereof. Hence, in the claims the use of the term "compressor" and other terms to describe the compressor function are intended to cover the use as a vacuum pump and motor, as well as a compressor.

In view of the foregoing, it is seen that the present invention provides a compressor type device which fully accomplishes its intended objects, and which is well adapted to meet practical conditions of manufacture and use.

No doubt that other methods of increasing the opening of the valve can be designed by those familiar with the art. This invention pertains only to the increase of the exhaust port actuated by a one-piece rotary valve, and in this case the increase of the size of the exhaust port can only be obtained if the rotary valve is actuated by a tail blade pivotally attached to the piston.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention and scope of the appended claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. A rotary compressor comprising a casing having a main cylindrical chamber, a valve chamber intersecting said main chamber and forming a pair of lips therewith, an eccentrically gyrating piston in said main chamber, an oscillating valve member in said valve chamber, a discharge port in the valve member adjacent one of the lips, a tail blade pivotally connected to said piston, said valve member having a slot in which said tail blade reciprocates, said casing having a low pressure inlet duct and a high pressure outlet duct, said inlet duct communicating with said main chamber, said discharge port being adapted to connect said high pressure duct and said main chamber at times and to disconnect said high pressure duct and said main chamber at other times as said valve member oscillates, and means constraining the gyration of said piston to thereby predetermine the amplitude of valve member oscillation and hence the amount of opening of said discharge port during connection of said high pressure duct and main chamber.

2. A rotary compressor according to claim 1, said constraining means comprising a slot and slide connection between said piston and casing adapted to produce the desired rotary oscillation of said piston.

3. A rotary compressor according to claim 1, said constraining means comprising a generally cruciform slide slidable in both said piston and casing for producing the desired rotary oscillation of said piston.

4. A rotary compressor according to claim 3, wherein the cross members of said cruciform slide are substantially straight to eliminate rotary oscillation of said piston.

5. A rotary compressor according to claim 1, said constraining means comprising an end projection on said piston, there being a slot formed in said casing and slidably receiving said projection, said slot being shaped to produce the desired rotary oscillation of said piston during gyration thereof.

6. A rotary compressor according to claim 5, wherein said projection comprises a pin slidable and rotatable in said slot.

7. A rotary compressor according to claim 1, said constraining means comprising a lateral projection on said tail blade, there being a slot formed in said casing and slidably receiving said lateral projection, said slot being shaped to produce the desired rotary oscillation of said tail blade during reciprocation thereof in said valve member.

8. A rotary compressor according to claim 1, said constraining means comprising a second tail blade fixed on said piston and spaced from said first tail blade, a casing chamber spaced from said valve chamber and intersecting with said main chamber, and an oscillatory guide member in said casing chamber and slidably receiving said second tail blade to constrain rotary oscillation of said piston.

9. A rotary compressor according to claim 1, said constraining means comprising a member mounted for rotative movement in said casing in parallel spaced relation with respect to the axis of gyration of said piston, and a pivot pin connecting said piston to said member eccentrically thereof, the eccentricity of said pin relative to said member and the rotative speed of the latter thus serving to determine the rotary oscillation of said piston.

References Cited in the file of this patent

UNITED STATES PATENTS

822,700	Steele	June 5, 1906
2,227,740	Friedell et al.	Jan. 7, 1941
2,643,817	Makaroff et al.	June 30, 1953

FOREIGN PATENTS

146,300	Great Britain	Dec. 16, 1920