United States Patent [19]

Hudson, Jr.

[11] **3,766,619**

[45] **Oct. 23, 1973**

[54] **COMPRESSOR VALVE ASSEMBLY AND METHOD OF PRODUCING THE SAME**

[75] Inventor: **Sharon J. Hudson, Jr.**, Toledo, Ohio

[73] Assignee: **Sharon Manufacturing Company**, Toledo, Ohio

[22] Filed: **Nov. 17, 1971**

[21] Appl. No.: **199,550**

Related U.S. Application Data

[62] Division of Ser. No. 879,863, Nov. 25, 1969, Pat. No. 3,643,687.

[52] **U.S. Cl.** ..... **29/157.1 R**, 113/116 D

[51] **Int. Cl.** **B21d 53/00**

[58] **Field of Search** ..... 29/157.1 R, DIG. 18, 29/DIG. 33, DIG. 47; 72/356, 359, 334, 335; 113/116 D

[56] **References Cited**

UNITED STATES PATENTS

2,160,401	5/1939	Engelman	137/512.15
3,017,789	1/1962	Cobb	72/334
3,442,110	5/1969	Walton	29/159.01
2,935,248	5/1960	Gerteis	137/512.15
3,124,876	3/1964	Putetti	72/334
3,643,687	11/1969	Hudson, Jr.	137/512
3,541,657	11/1970	Ellingsen	29/157.1 R

FOREIGN PATENTS OR APPLICATIONS

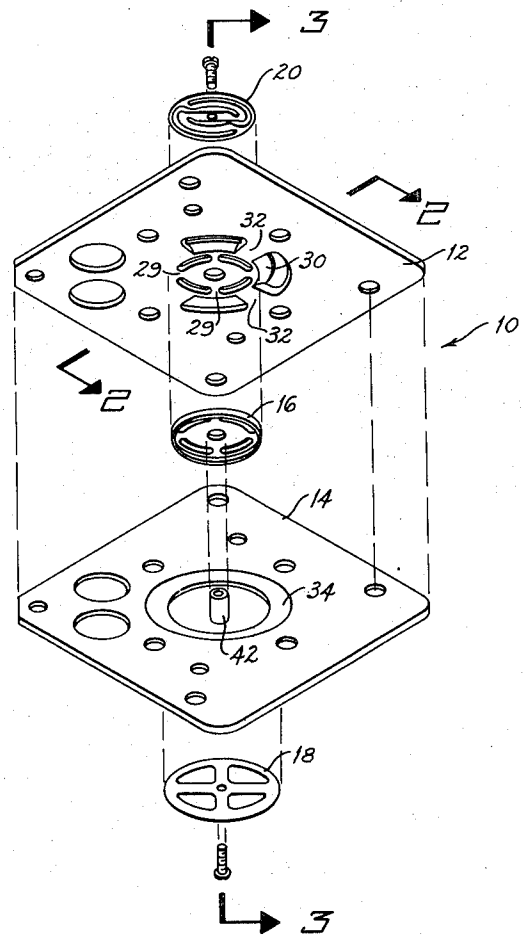
458,679	10/1949	Italy	137/512

Primary Examiner—Charles W. Lanham
Assistant Examiner—M. J. Keenan
Attorney—Harold F. Mensing

[57] **ABSTRACT**

A laminated valve plate assembly for a reciprocable piston compressor said plate being of the type formed substantially by stamping processes and characterized by being only two laminations thick and having at least some of the port defining surfaces which are smooth and have compound curvatures that are inclined with respect to the plane of the plate to provide a less turbulent flow through the ports and to reduce the required thickness of the finished valve plate. The outlet end portions of both the intake and exhaust means comprise continuous slots formed by stamping processes and stamped parts while the inlet end portions of these port means comprise a plurality of discontinuous slots. Perhipheral recesses are formed around the top and bottom surfaces of the plate by shearingly depressing the edges thereof to eliminate burrs and to protect the edges of the lapped top and bottom surfaces from damage due to rough handling prior to the installation of the valve assembly between the cylinder head and cylinder block of the compressor. The disclosure also includes novel methods for forming the above mentioned structures.

5 Claims, 6 Drawing Figures



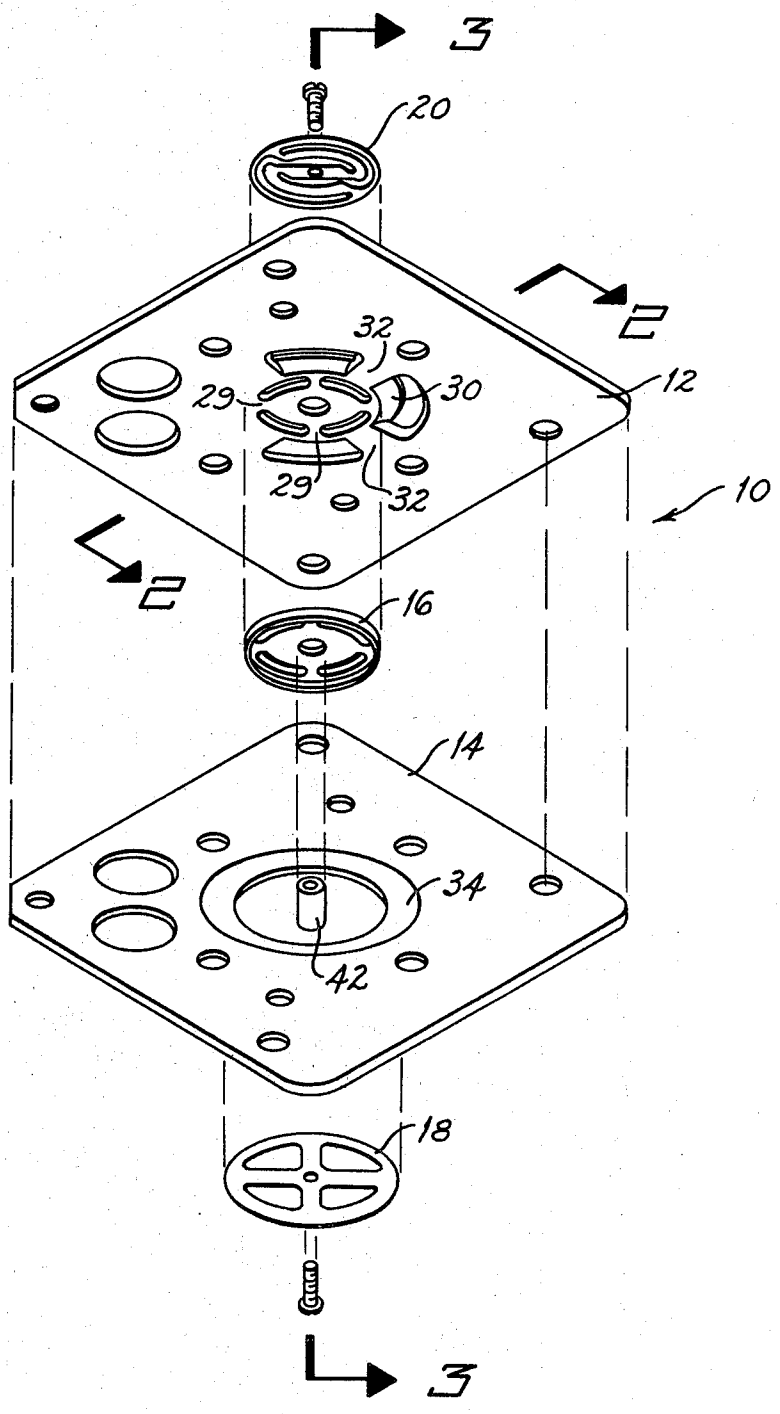


FIG. 1.

INVENTOR.
SHARON J. HUDSON JR.
BY
Harold E. Mensing
ATTORNEY

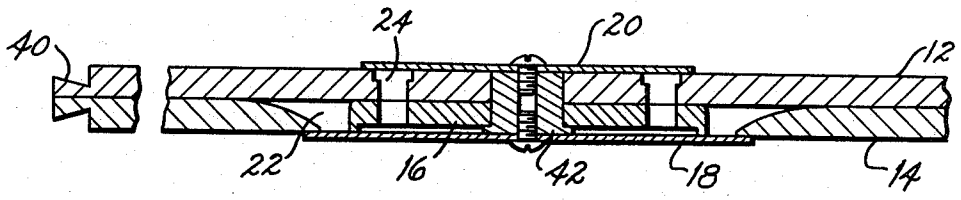


FIG. 2.

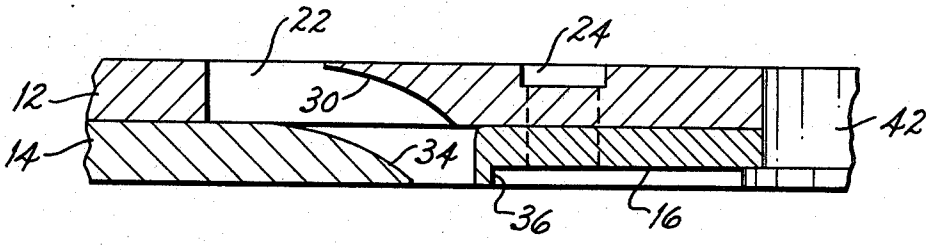


FIG. 3.

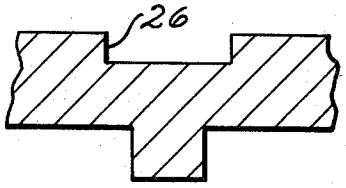


FIG. 4.

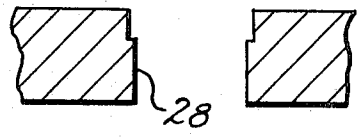


FIG. 5.

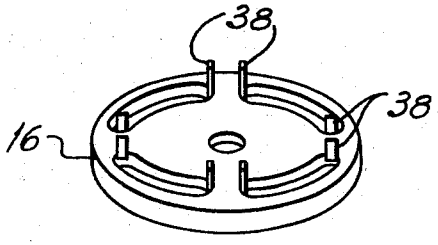


FIG. 6.

INVENTOR.
SHARON J. HUDSON JR
BY
Harold E. Mensing
ATTORNEY

COMPRESSOR VALVE ASSEMBLY AND METHOD OF PRODUCING THE SAME

This is a division of application Ser. No. 879863 filed 11/25/69, now U.S. Pat. No. 3,643,687.

BACKGROUND OF INVENTION

This invention relates to reciprocable piston compressors of the type used in refrigerators, air conditioners and air compressors. More specifically it relates to an improved valve assembly and a method of manufacturing the same for such compressors.

The widespread use of refrigeration units, home freezers and air conditioners has increased the demands for a compressor valve assembly of improved quality which can be economically produced by mass production methods. There are also demands for a valve assembly having increased efficiency, greater durability and more compactness. In prior art valve assemblies at least one of these features and sometimes more of them were sacrificed for one reason or another including a lack of knowledge of how to economically manufacture a valve assembly incorporating all of these features. In some of the prior art valve plates of the laminated type, three or more laminations were required to produce sufficient lateral offset between the intake and outlet ends of the intake ports. The ports in each laminations were perpendicular to the plane of the lamination and were laterally offset slightly from the ports in the adjacent laminations to produce a laterally stepped aperture or port. These steps or offsets cause undesired turbulence and impeded fluid flow therethrough.

Generally speaking the valve assembly of this invention basically has a laminated valve plate only two laminations in thickness. A series of intake ports and a series of exhaust ports are formed within these laminations primarily by stamping processes. Each series is arranged in a circle and the circles are concentric. All or a substantial portion of the intake port defining surfaces of the laminar members are smoothly coined surfaces as opposed to the relatively rough port defining surfaces formed in prior art plates by the shearing action of a piercing die or punch. The advantage of having a smooth port defining surface is twofold. It reduces the resistance to fluid flow through the ports. Also it prevents the formation of beads of brazing material on the port defining surfaces which occurs frequently on the roughly surfaced ports of prior art valve plates during the brazing process when the laminations are bonded together. The intake port defining surfaces are curved in the direction of fluid flow to provide an improved flow pattern. All or a substantial portion of the intake port defining surfaces are sharply inclined with respect to the plane of the plate to provide the desired lateral offset between the intake and outlet ends of the port in a minimum plate thickness.

The inlet end portions of both the intake and the exhaust ports comprise discontinuous annular slots disposed in the planes of their respective laminar members while the outlet end portions of these ports are uninterrupted or continuous annular slots similarly disposed in opposite laminar members. These continuous annular slots in the surfaces of the laminar members promote the most effective sealing of the ports when cooperating leaf valve members of the type common to such compressors are used. In prior art valve assemblies the continuous annular slots were machined in the

surfaces of the laminar members by rotary cutters. The outlet end portion of the exhaust port means is formed in its respective laminar member by an annular die which penetrates only a portion of the thickness of the member. A segmented annular die, which is slightly narrower than the first die, pierces the remaining thickness of the laminar member and forms a series of arcuate slots spaced apart by radially extending webs. The uninterrupted annular slot at the outlet end of the intake port means is formed in its respective member by the edge of a large circular opening therein and the upright peripheral flange of a stamped disk member mounted concentrically in the circular opening. The outside diameter of the rim portion of the disk is smaller than the inside diameter of the circular opening and the edge of the rim is flush with the outer surface of the laminar member. Inwardly from the rim of the disk is a concentrically located series of slots corresponding to those of the exhaust ports in the opposite laminar member. Means are provided for readily bringing the exhaust ports in the disk and the exhaust ports in the laminar member into registry with each other. The port defining members including the two laminar members and the stamped disk are preassembled and held together by rivit means and subsequently permanently bonded by brazing in a furnace. The planar surfaces of the plate are made parallel and smooth by machining, grinding and lapping after which the leaf valve members may be installed over the outlet ends of the ports to complete the valve assembly. A peripheral flange extending laterally outward from the sides of the valve plate is provided to protect the edges of the lapped surfaces from becoming damaged by improper handling.

Accordingly it is a general object of this invention to produce a compressor valve assembly having an improved design that is formed primarily by stamping processes.

It is another object of this invention to produce such a valve assembly in which at least some of the port defining surfaces are smoothly contoured to provide a more efficient fluid flow therethrough.

It is still another object of this invention to produce an improved valve assembly which is efficient, durable, compact and economical to manufacture.

The above mentioned objects and other objects and advantages and the manner of attaining them will be apparent from the following description of a preferred embodiment of this invention made with reference to the accompanying drawings.

BREIF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view on a reduced scale of the components for a valve assembly made in accordance with this invention showing the components displaced from their assembled positions to issustrate among other things the details of the abutting surfaces of the laminar members of the valve plate.

FIG. 2 is an enlarged sectional side view of a center portion of the assembled valve assembly taken along line 2—2 of FIG. 1 with parts broken away showing the cross sectional configuration of the exhaust ports and the protective peripheral rim.

FIG. 3 is a further enlarged sectional side view similar to FIG. 2 but taken along line 3—3 showing the cross sectional configuration of the intake port.

FIG. 4 is a still further enlarged sectional side view of an exhaust port portion of the top laminar member of the valve plate after the first step in the formation of this port has been completed.

FIG. 5 is a view similar to FIG. 4 taken after the second step in the formation of the port has been completed.

FIG. 6 is an enlarged perpsective view of the stamped ported disk having tab means for registering the ports therein with the corresponding ports in the abutting plate member.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the drawings, particularly to FIG. 1 of the drawings, the components of the valve assembly **10** are arranged with respect to their assembled positions but are displaced therefrom along a central axis. The basic components of the valve assembly are the top or first laminar member **12**, the bottom or second laminar member **14** a port defining central disk **16** and leaf valve members **18** and **20** respectively for closing the intake and exhaust port means in the laminar members. The laminar members **12** and **14** in combination with the circular disk **16** form the valve plate portion of the valve assembly **10.** Two series of ports each arranged preferably in a circular pattern and concentrically disposed with respect to each other are formed in a central portion of the valve plate by these three components **12, 14** and **16.** The outer series of ports is denoted as the intake port means **22.** The total open area of the intake port means is substantially larger than the total area of the inner series of ports which is denoted as the exhaust port means **24.** The ratio between the areas of the two series generally corresponds to the compression ratio of the compressor. The laminar members **12** and **14** are preferably flat steel blanks made by stamping processes. The blanks shown in the drawings are substantially square but rectangular or circular blanks or blanks of any other desired outline may be used.

The portion of the exhaust port means extending through the top laminar member **12** may be formed in two operations. First a continuous annular slot **26** may be formed at the outlet end of the port means by striking the top or outer surface of laminar member **12** with an annular die while supporting the under surface of the laminar member with a die member having a concentrically disposed interrupted or segmented annular cavity of slightly smaller radial width. The stamping means is adjusted so that the annular die penetrates only a portion of the thickness of the laminar member, see FIG. **4.** As a result metal is displaced from the surface of the laminar member and more or less extruded into the spaced apart sections of the segmented annular cavity of the supporting die member. The remaining portion **28** of the exhaust port means is produced by a piercing die or punch having a segmented annulus. The radial width of each of the annular sections of the piercing die is between the width of the continuous slot and the width of the metal portion extruded into the supporting die cavity, see FIGS. **4** and **5.** With this method the piercing die is required to shear only a partial thickness of the laminar member. The portion of the intake ports produced by the segmented annular die comprises a plurality of arcuate slots separated from each other by radially extending web members **29.**

The portion of the intake port means extending through the first laminar member may also be formed in two operations. First a piercing die or punch is used to produce a plurality of elongated slots having sides which are normal to the surfaces of the laminar member. Preferably these slots are arcuate with respect to the plane of the laminar members and are arranged annularly. The length of each slot, as defined by the number of degrees of arc included between its ends, is preferably between about 35° and 90°. Slots shorter than this range increase the resistance to fluid flow therethrough and if longer slots are used there is insufficient structual stability or support. To enhance fluid flow through the intake ports the sides of the slots nearest the center of the annulus are contoured and made smooth by means of a coining operation. Normally a finish having a roughness in the vicinity of about 50–150 microinches may be produced on the coined surfaces as opposed to a surface finish of about 250–500 microinches average on a sheared surface. The coined surface **30** may be straight or arcuate in the direction of fluid flow and have a slope of substantially less than 90° with respect to the plane of the plate as is best shown in FIG. **3.** Preferably the coined surface is concave in the direction of fluid flow and has an average slope of less than 45°. The sides of the web members **32** between the intake ports may converge in a direction towards the center of the laminar member **12.** One or more of the process steps may be combined. In the alternative, the port defining surfaces may be formed in about the same manner as the exhaust ports were formed in the top laminar member. That is by first using a contoured coining die to form a first portion of the port defining surfaces and then using a piercing die to produce the remaining portion.

Laminar member **14** contains the outlet end of the intake port means **22** and the inlet end of the exhaust port means **24.** One side of the continuous annular slot which forms the outlet end of the intake port means is defined by the surface of the large circular opening in laminar member **14.** This port defining surface **34** is contoured by a coining operation to conform with the contoured surface **30** of the top laminar member **12,** see FIG. **3.** The other side of the annular slot is formed by the peripheral surface of disk **16.**

Circular disk **16** has a peripheral flange **36** extending normally outward from its outer planar face and terminating flush with the adjacent surface of the surrounding laminer member **14.** Ports of the same lateral size and shape as the exhaust ports extending through the abutting surface of laminar member **12** are provided through the plane of the disk. Locating means such as pairs **38** of small tabs which embrace the web members **29** of laminar member **14** may be provided to insure registry between the ports of the two members **14** and **16.** The flange, tabs and ports may all be formed by stamping processes.

In order to assemble the components **12, 14** and **16** for brazing or bonding the abutting surfaces thereof together, apertures may be punched through the geometric centers of the port portions of laminar member **12** and disk **16** and also through outlying portions of laminar members **12** and **14.** After appropriate fluxing and brazing compounds have been applied to the abutting surfaces of the members **12, 14** and **16** headless pins or rivits may be inserted in the apertures and staked or otherwise expanded to firmly hold the members in posi-

tion while being transported through a brazing furnace. After brazing, the outer surfaces of the valve plate may be machined or ground to the desired degree of flatness and parallelism and then lapped to produce the desired finish. Prior to the final machining or grinding operation the top and bottom peripheral edges may be shearingly displaced towards the center of the plate a portion of the thickness of the laminar members. The tip of the shearing die member may be angled slightly so as to urge the displaced metal laterally outward thereby forming a laterally extending peripheral rim **40** to protect the edges of the plate surface from damage which may prevent effective sealing between the valve plate and the compressor head or block.

Valve members **18** and **20** may be installed over the outlet ends of the intake and exhaust port means **22** and **24** respectively by drilling and tapping the center pin **42** and attaching the valve members by means of fasteners, such as screws or rivits. The valve members are of the leaf type commonly used for compressors. They differ from each other primarily in size and the shape of the spring spokes. Both of the valve members have an annular port sealing portion of adequate size to seal their respective annular port outlets. Integrally attached to the annular portion of each valve member and extending to its apertured center is a pair of arcuate spring elements.

While the invention has been illustrated and described with respect to preferred structures and processes, it is to be understood that various modifications of the above will be apparent to those skilled in the art without departing from the scope of the intention which is defined by the appended claims.

What is claimed is:

1. A method of producing a laminated valve plate assembly comprising the steps of stamping an annular groove in the surface of a first planar plate member, subsequently removing portions of said plate underlying said groove by means of a segmented annular die having a slightly narrower width than the width of said groove to produce a first port means having a continuous annular opening extending partially through said plate and communicating with a segmented annular opening extending through the remaining thickness of said first member, piercing a concentrically disposed series of elongated arcuate ports in said first plate member around the outside of said first port means such that their port defining surfaces are perpendicular to the plane of the plate member, said series of ports having their innermost surfaces disposed along a common first circumference and their outermost surfaces disposed along a second circumference spaced outwardly from said first circumference, striking only the inner circumferential edge portions of the ports of said series on the side of said plate member opposite the said annularly grooved side with a coining die having the desired inclined surface configuration so as to produce a work-hardened port defining surface that is inclined with respect to the plane of said first plate member while leaving the outermost circumferential surfaces of said ports of said series perpendicular to the plane of said first plate member, forming port means in a second plate member, said port means having a port defining surface inclined correspondingly with the inclined port defining surfaces of said first plate member, superimposing one plate member upon the other with their inclined surfaces facing each other, bonding said members together and abrasively finishing the outer surfaces of the laminated plate assembly formed thereby.

2. A stamping process according to claim **1** wherein the inclined surface of said coining die is curved in the direction of incline and the coined port surface produced thereby has a surface roughness between 50–150 microinches.

3. A stamping process for producing a ported valve plate, said process including the steps of stamping an annular groove in one of the planar surfaces of said plate and subsequently removing portions of said plate underlying said groove by means of a segmented annular die having a slightly narrower width than said groove to produce a port means having a continuous annular opening extending partially through said plate and communicating with a segmented annular opening extending through the balance of said plate.

4. A process according to claim **1** including the step of shearingly depressing the peripheral edges of the bonded plate so as to remove burrs therefrom and protect the finished planar outer surfaces thereof from damage prior to installation in a compressor.

5. A method of producing a valve plate having a series of elongated arcuate ports with the innermost port defining surfaces of each port of the series disposed along a common first circumference and with the outermost port defining surfaces disposed along a common second circumference spaced from said first circumference, said method comprising the steps of: piercing the ports such that their port defining surfaces are perpendicular to the plane of the plate and subsequently striking only the inner circumferential edge portions of said ports with a coining die having the desired incline and surface configuration so as to produce a work-hardened port defining surface that is inclined with respect to the plane of the plate while leaving the outermost circumferential surfaces perpendicular to the plane of the plate.

* * * * *