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Huang et al.

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(54) **VALVE RECESS IN CYLINDER BLOCK OF A COMPRESSOR**

(75) Inventors: **Yong Huang**, Ann Arbor; **Laviesh Sud**; **Shane Harte**, both of Farmington Hills, all of MI (US)

(73) Assignees: **Ford Motor Technologies, Inc.**; **Visteon Global Technologies, Inc.**, both of Dearborn, MI (US)

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(52) **U.S. Cl.** **417/269**; 137/856
(58) **Field of Search** 417/269, 270, 417/255, 312; 137/856; 62/217

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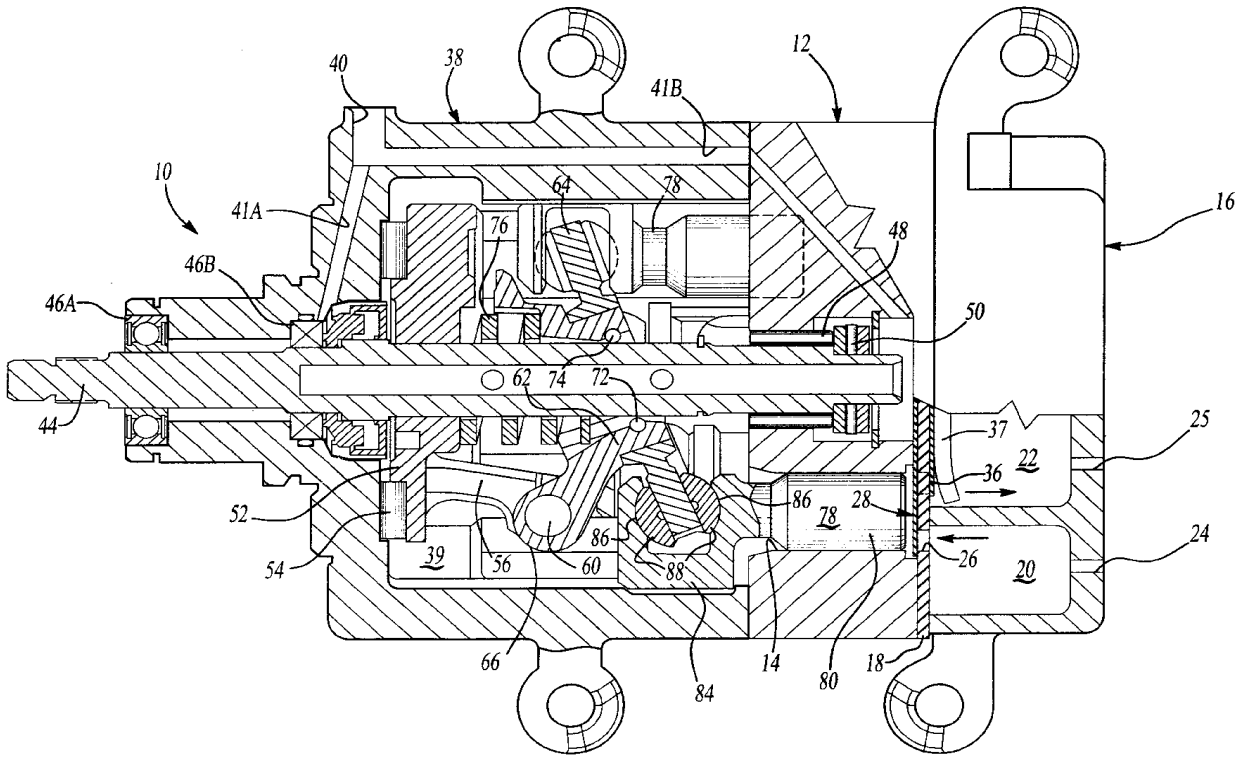
Primary Examiner—Teresa Walberg
Assistant Examiner—Leonid M Fastovsky

(57) **ABSTRACT**

A compressor **(10)** for a vehicular air conditioning system includes a cylinder block **(12)** having a bore **(14)**. A piston **(78)** is slidingly received in the bore **(14)**. A cylinder head **(16)** is mounted on the cylinder block **(12)** and includes a suction chamber **(20)** and a discharge chamber **(22)**. A valve plate **(18)** is provided between cylinder block **(12)** and the cylinder head **(16)**. The valve plate **(18)** includes a suction port **(26)** and a discharge port **(35)**. A suction valve **(28)** cooperates with the suction port **(26)** to permit refrigerant to enter the bore **(14)** from the suction chamber **(20)**. The suction valve **(28)** includes a terminating portion **(28A)** and a flexing portion **(28B)**. A recess **(32)** is formed in the cylinder block **(12)** adjacent the flexing portion **(28B)** of the suction valve **(28)**. The recess **(32)** provides a linear clamping line (C) on the suction valve **(28)** between the valve plate **(18)** and the cylinder block **(12)**.

14 Claims, 2 Drawing Sheets



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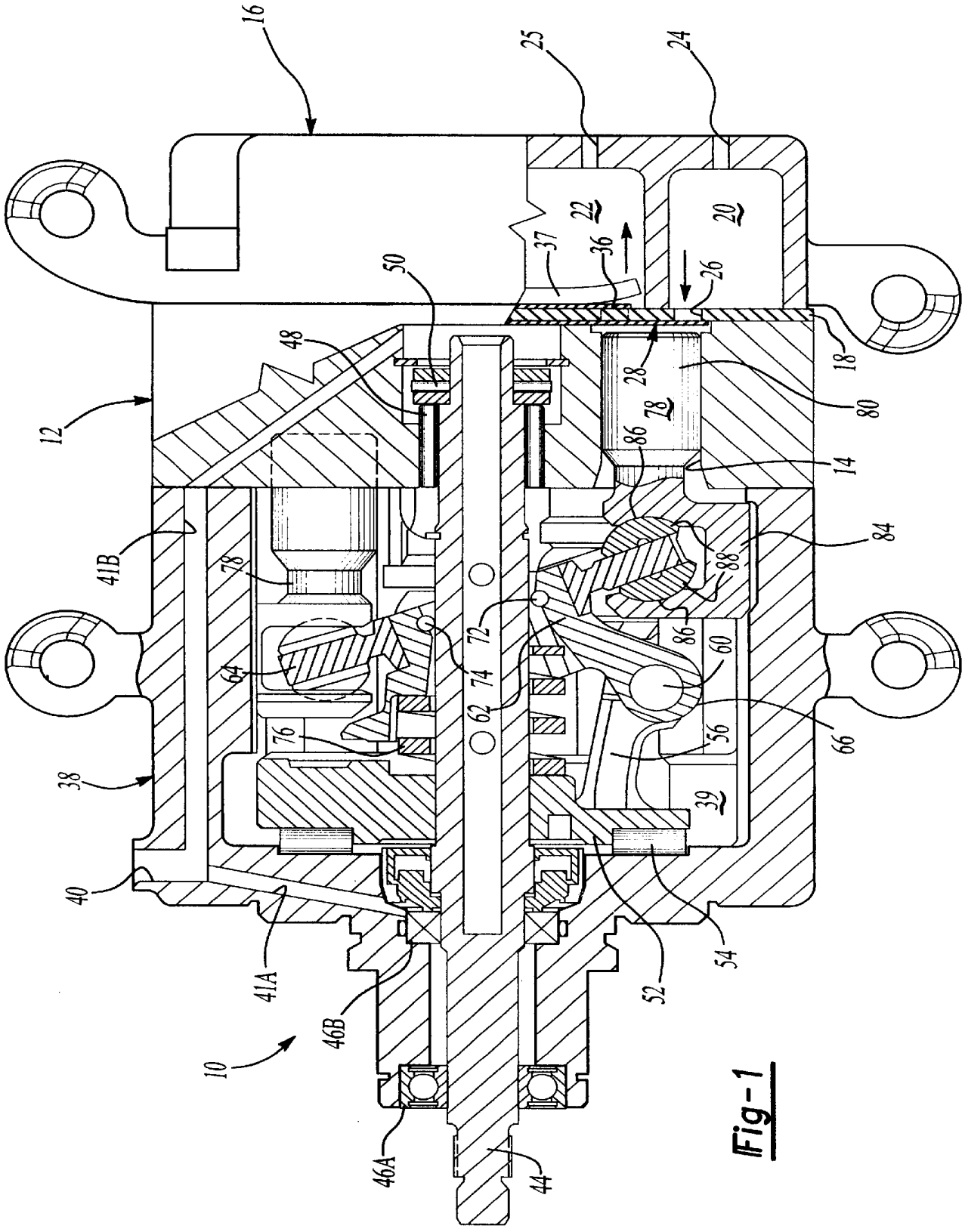

Fig-1

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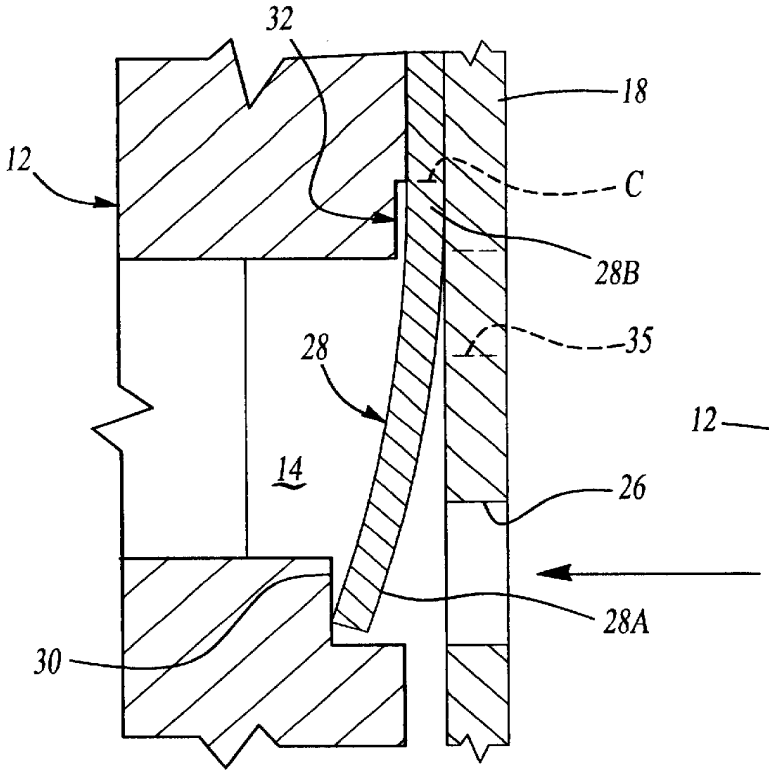

Fig-2

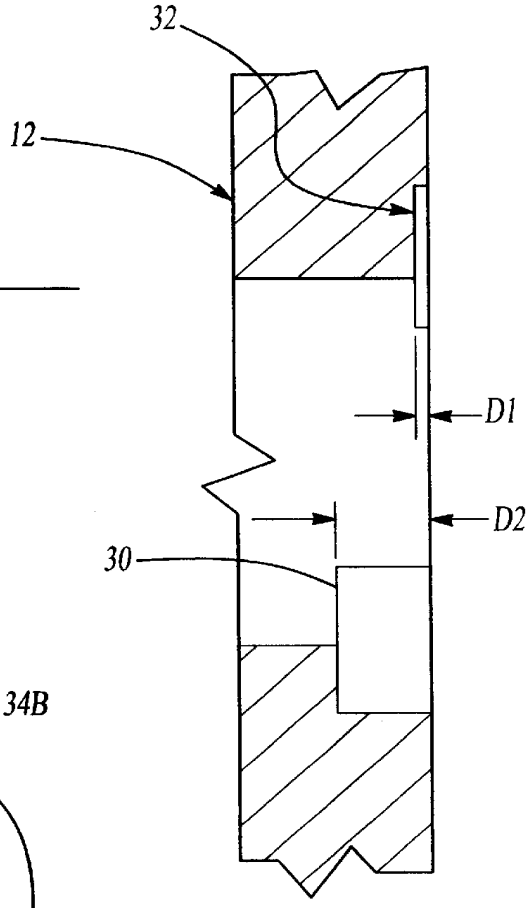

Fig-4

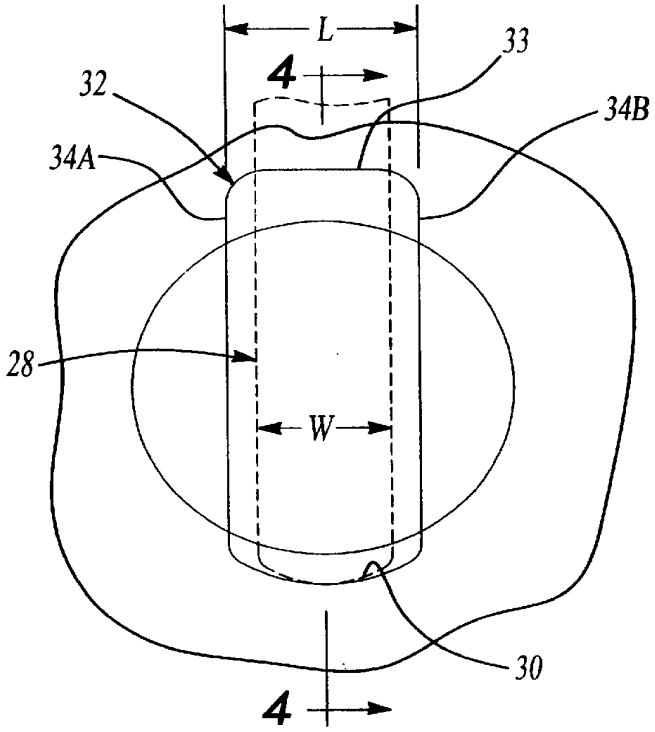

Fig-3

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VALVE RECESS IN CYLINDER BLOCK OF A COMPRESSOR

BACKGROUND OF THE INVENTION

This invention relates in general to vehicular air-conditioning systems. In particular, this invention is concerned with a recess for a suction valve in a compressor of a vehicular air conditioning system.

Air-conditioning systems are provided in vehicles for maintaining interior air at desired temperatures. Conventional vehicular systems include a compressor, a condenser, an expansion valve (or orifice tube), and an evaporator. A refrigerant is repeatedly circulated through the cycle of compressor, condenser, expansion valve, and evaporator to maintain interior air at desired temperatures.

A typical refrigerant cycle operates in the following manner. A refrigerant is first compressed by a compressor to a high temperature and high pressure gas and then directed to a condenser. In the condenser, the gas is changed to a lower temperature, high pressure liquid as it is cooled by a heat exchanger operating with the surrounding atmosphere or cooling water. The high pressure liquid loses pressure and becomes chilled when it passes through an expansion valve. When the low pressure liquid passes through an evaporator, it evaporates as it absorbs ambient heat. The evaporated refrigerant, i.e. a gas, flows into the compressor and the process is repeated.

A typical compressor includes a suction chamber and a discharge chamber. A valve is provided at a suction port between the suction chamber and a bore of a cylinder block for a piston in the compressor. The valve, commonly known as a suction valve, is commonly formed by a reed valve.

The suction valve flexes or bends as it opens to permit refrigerant to pass into a bore of the cylinder block. The suction valve is subjected to stresses as it bends and encounters the lip of the bore.

SUMMARY OF THE INVENTION

The present invention includes a compressor of a vehicular air conditioning system. The compressor includes a valve recess in a cylinder block to accommodate the bending of a suction valve. As refrigerant passes into a bore in a cylinder block, a linear wall of the recess reduces the stresses incurred by the suction valve. The reduced stresses improve the life of the suction valve.

In a preferred embodiment, a compressor for a vehicular air conditioning system includes a cylinder block having a bore. A piston is slidingly received in the bore. A cylinder head is mounted on the cylinder block and includes a suction chamber and a discharge chamber. A valve plate is provided between cylinder block and cylinder head. The valve plate includes a suction port and a discharge port. A suction valve cooperates with the suction port to permit refrigerant to enter the bore from the suction chamber. The suction valve includes a terminating portion and a flexing portion. A recess is formed in the cylinder block adjacent the flexing portion of the suction valve. The recess provides a linear clamping line on the suction valve between the valve plate and the cylinder block.

Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partly sectional view of a compressor for a vehicular air-conditioning system according to this invention wherein a suction valve is shown in the closed position.

FIG. **2** is an enlarged view of a portion of the compressor of FIG. **1** wherein the suction valve is shown in the open position.

FIG. **3** is an end view of a portion of the cylinder block of the compressor of FIGS. **1** and **2** and illustrating the suction valve in phantom.

FIG. **4** is a sectional view taken along line **4**—**4** of FIG. **3** with the suction valve removed.

DETAILED DESCRIPTION

A compressor is indicated generally at **10** in FIG. **1**. The compressor **10** is particularly adapted for a vehicular air conditioning system. The compressor **10** can be used with a refrigerant such as carbon dioxide. The compressor **10** discharges compressed refrigerant to a vehicular air condition system that can include a condenser, an expansion valve, and an evaporator, none of which are illustrated.

At its mid portion, the compressor **10** includes a cylinder block **12** having a plurality of bores **14**. The cylinder block **12** is preferably formed as a housing. A cylinder head **16** is mounted on and sealingly closes one end of the cylinder block **12**. A valve plate **18** is disposed between the cylinder block **12** and the cylinder head **16**.

The cylinder head **16** includes a suction chamber **20** and a discharge chamber **22**. The suction chamber **20** has an inlet port **24** formed in the cylinder head **16**. The discharge chamber has an outlet port **25** formed in the cylinder head **16**.

The suction chamber **20** communicates with each of the bores **14** through a respective suction port **26** formed in the valve plate **18**. Each of the suction ports **26** is opened and closed by a suction valve **28**. As illustrated best in FIG. **2**, the suction valve **28** is a thin, flexible member, preferably formed by a reed valve. The suction valve **28** flexes away from the suction port **26** as refrigerant is received into the bore **14**.

As illustrated in FIGS. **2**, **3** and **4**, a step **30** is provided about a portion of a perimeter of the bore **14** in a face of the cylinder block **12**. The step **30** is positioned adjacent a terminating end **28**A of the suction valve **28**. The step **30** acts as a stop or limiter for the terminating end **28**A of the suction valve **28** when the suction valve **28** is opened. The step **30** has a sufficient depth to permit the suction valve **28** to open and permit flow into the bore **14**.

A recess **32** is provided about a portion of a perimeter of the bore **14** in the face of the cylinder block **12**. The recess **32** is formed opposite the step **30**. The recess **32** is positioned adjacent a flexing portion **28**B of the suction valve **28**. Preferably, the recess **32** includes a linear or straight wall **33** spaced from an inner cylinder surface and perimeter of the bore **14**. The recess **32** also includes side walls **34**A and **34**B that are preferably perpendicular to the linear wall **33** and parallel to one another. Preferably, the linear wall **33** has a length L greater than a width W of the flexing portion **28**B of the suction valve **28**. Preferably, the side walls **34**A and **34**B do not contact or interfere with the flexing of the suction valve **28**. The linear wall **33** and the side walls **34**A and **34**B form three boundaries of the recess **32**. The lip of the bore **14** forms A fourth boundary.

When the suction valve **28** opens, the termination portion **28**A is received against the step **30**. The flexing portion **28**B bends and flexes along linear wall **33** of the recess **32**. A linear or straight clamping line C is formed on the suction valve **28** where the valve plate **18** presses along the linear wall **33**. The flexing portion **28**B is subjected to less stress

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along the linear clamping line C than prior art suction valves that were subject to an arcuate clamping line formed along an portion of the perimeter of a bore. Reducing the stress in the flexing portion **28**B increases the life of the suction valve **28** and improves its performance as compared to prior art suction valves.

As illustrated in FIG. **4**, a depth D1 of the recess **32** is preferably less than a depth D2 of the step **30**. The depth D1 can be sized to permit a longer bending radius of the suction valve **28**. The length of the suction valve **28** (limited by the diameter of the bore **14**) to valve lift ratio can be limited by material strengths. Increasing the bending radius with recess **32** can be accomplished without affecting the performance of the compressor **10**. Preferably, the depth D1 of the recess **32** and the spacing of the linear wall **33** from the perimeter of the bore **14** are sized so that the flexed suction valve **28** does not contact the arcuate lip or perimeter of the bore **14**.

Each of the bores **14** communicates with the discharge chamber **22** through a respective discharge port **35** formed in the valve plate **18**. The discharge port **35** is circumferentially spaced from the suction port **26** and is schematically illustrated in dashed lines in the figures. Each discharge port **35** is opened and closed by a discharge valve **36**. A retainer **37** restricts the opening of the discharge valve **36**.

A crankcase **38** is sealingly disposed at the other end of the cylinder block **12** opposite the cylinder head **16**. The crankcase **38** and cylinder block **12** cooperate to form an airtight crank chamber **39**. An inlet port **40** is provided to the crank chamber **39**. Refrigerant and oil are routed to the crank chamber **38** via conduits **41**A and **41**B.

A drive shaft **44** is centrally disposed within and arranged to extend through the crankcase **38**. One end of the drive shaft **44** is rotatably supported by bearings **46**A and **46**B mounted in the crankcase **38** and the opposite end is rotatably supported in a bearing **48** mounted in the cylinder block **12**. Longitudinal movement of the drive shaft **44** is restricted by a thrust bearing **50** mounted in the cylinder block **12**.

A rotor **52** is fixedly mounted on an outer surface of the drive shaft **44** adjacent within the crank chamber **39**. A thrust bearing **54** is mounted on an inner wall of the crankcase **38** in the crank chamber **39** and disposed between the crankcase **38** and the rotor **52**. The thrust bearing **54** provides a bearing surface for the rotor **52**. An arm **56** extends laterally from a surface of the rotor **52**. A pin **60** has one end slidingly disposed in the arm **56** of the rotor **52**.

A swash plate assembly includes a hub **62** and an annular plate **64**. The hub **62** includes an arm **66** that extends outwardly and laterally from the surface of the hub **62**. One end of the pin **60** is slidingly disposed in the arm **56** of the rotor **52**, while the other end of the pin **60** is fixedly disposed in the arm **66** of the hub **62**.

Two pins **72** and **74** are disposed in the hub **62** diametrically opposed to one another with a portion of the outer surface of the pins **72** and **74** exposed in a central opening of the hub **62**.

The annular plate **64** has a centrally disposed opening adapted to receive the hub **62**. The drive shaft **44** is slidably received within the opening formed in the hub **62** of the swash plate assembly.

A spring **76** is disposed to extend around the outer surface of the drive shaft **44**. One end of the spring **76** abuts the rotor **52**. The opposite end of the spring **76** abuts the hub **62** of the swash plate assembly.

A piston **78** is slidably disposed in each of the bores **14** in the cylinder block **12**. Each piston **78** includes a head **80** and a bridge portion **84**. A pair of concave shoe pockets **86** is formed in the bridge portion **84** of each piston **78** for rotatably supporting a pair of semi-spherical shoes **88**. The spherical surfaces of the shoes **88** are disposed in the shoe pockets **86** with a flat bearing surface disposed opposite the spherical surface for slidable engagement with opposite surfaces of the annular plate **64** of the swash plate assembly.

As refrigerating enters a bore **14** through a section port **26**, a piston **78** is forced toward the crankcase **38**. Pressure in the crank chamber **39** forces the pistons **78** to slide toward the cylinder head **16**, expelling refrigerating through the discharge ports **35** to the discharge chamber **22**. Pressurized refrigerant exits the compressor **10** through the outlet port **24** to the remainder of the vehicular air condition circuit.

The cylinder block **12** and the suction valve **28** form a subassembly of the compressor **12**. This subassembly can be used in other types of compressors.

In accordance with the provisions of the patent statutes, the principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A compressor for a vehicular air conditioning system comprising:

a cylinder block having a bore;

a piston slidingly received in the bore;

a cylinder head mounted on the cylinder block, the cylinder head including a suction chamber and a discharge chamber;

a valve plate provided between cylinder block and cylinder head, the valve plate including a suction port and a discharge port;

a suction valve cooperating with the suction port to permit refrigerant to enter the bore from the suction chamber, the suction valve including a terminating portion and a flexing portion; and

a recess formed in the cylinder block adjacent the flexing portion of the suction valve, wherein the recess provides a linear clamping line on the suction valve between the valve plate and the cylinder block.

2. The compressor specified in claim **1** wherein the recess includes a linear wall spaced from a perimeter of the bore.

3. The compressor specified in claim **2** wherein the suction valve has a width and the liner wall has a length, wherein the length of the linear wall is greater than the width of the suction valve.

4. The compressor specified in claim **2** wherein the recess includes side walls perpendicular to the linear wall.

5. The compressor specified in claim **1** including a step formed in the cylinder block adjacent the terminating portion of the suction valve, wherein the recess is formed opposite the step.

6. The compressor specified in claim **5** wherein a depth of the recess is less than a depth of the step.

7. The compressor specified in claim **1** wherein the suction valve is a reed valve.

8. A cylinder block and suction valve subassembly for a compressor of a vehicular air condition system, the cylinder block and suction valve subassembly comprising:

a housing;

a bore formed in the housing;

a piston slidably received in the bore;

a suction valve provided over an end of the bore, the suction valve including a terminating portion and a flexing portion;

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a step formed in the housing about a portion of the bore for receiving the terminating portion of the suction vale; and

a recess formed in the housing about a portion of the bore providing a linear clamping line on the suction valve when it flexes into the step.

9. The subassembly specified in claim **8** wherein the recess includes a linear wall spaced from a perimeter of the bore.

10. The subassembly specified in claim **9** wherein the suction valve has a width and the liner wall has a length, wherein the length of the linear wall is at least equal to the width of the suction valve.

11. The subassembly specified in claim **10** wherein the recess includes side walls perpendicular to the linear wall.

12. The subassembly specified in claim **8** including a step formed in the cylinder block adjacent the terminating portion of the suction valve, wherein the recess is formed opposite the step.

13. The subassembly specified in claim **12** wherein a depth of the recess is less than a depth of the step.

14. The subassembly specified in claim **8** wherein the suction valve is a reed valve.

* * * * *

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,318,972 B1
DATED : November 20, 2001
INVENTOR(S) : Yong Huang et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [75], change the first name of the second listed inventor from "**Laviesh**" to -- **Lavlesh** --.

After "Assistant Examiner—Leonid M Fastovsky" add
-- [74] *Attorney, Agent, of Firm*—Larry I. Shelton --.

Signed and Sealed this

Second Day of July, 2002

Attest:

Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

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