

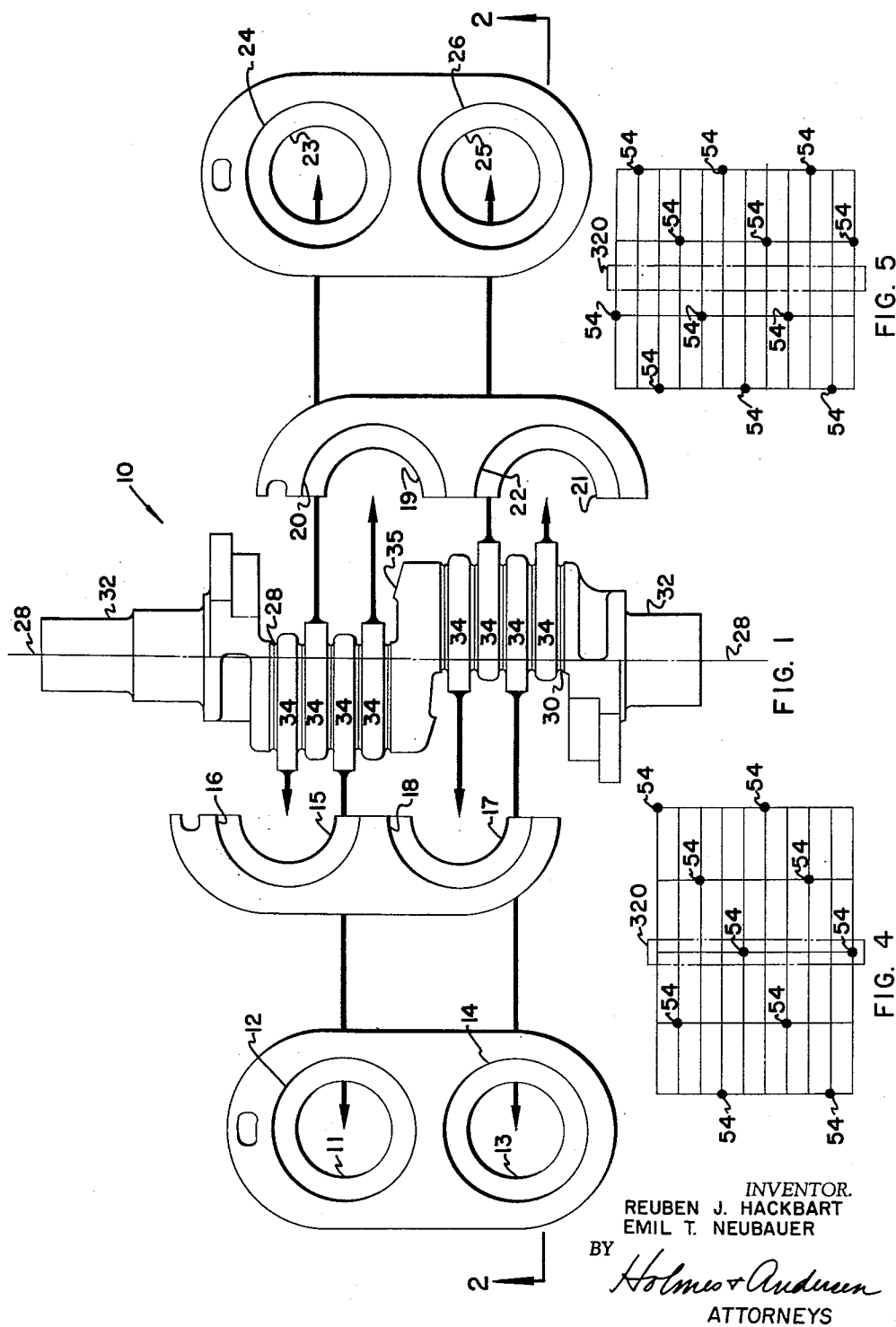
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RECIPROCATING PISTON COMPRESSOR

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2 Sheets-Sheet 1



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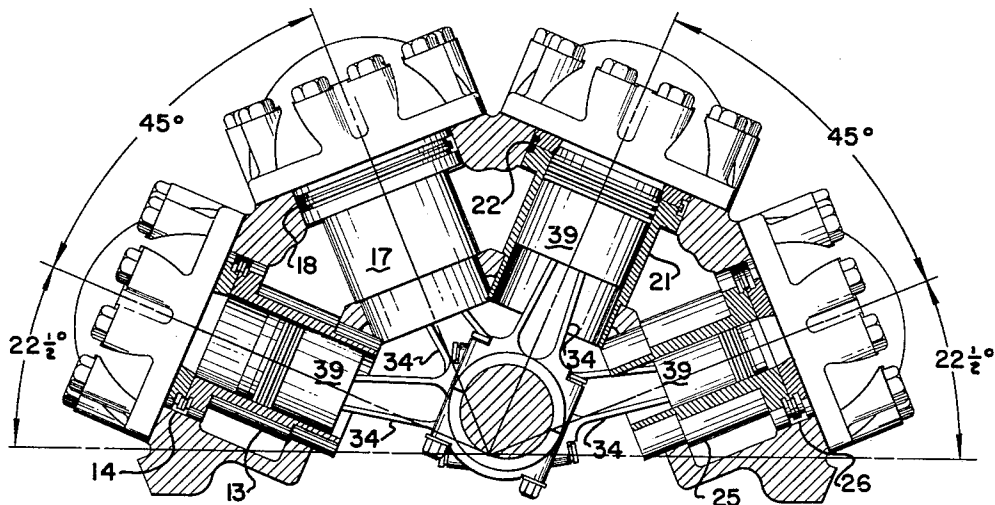


FIG. 2

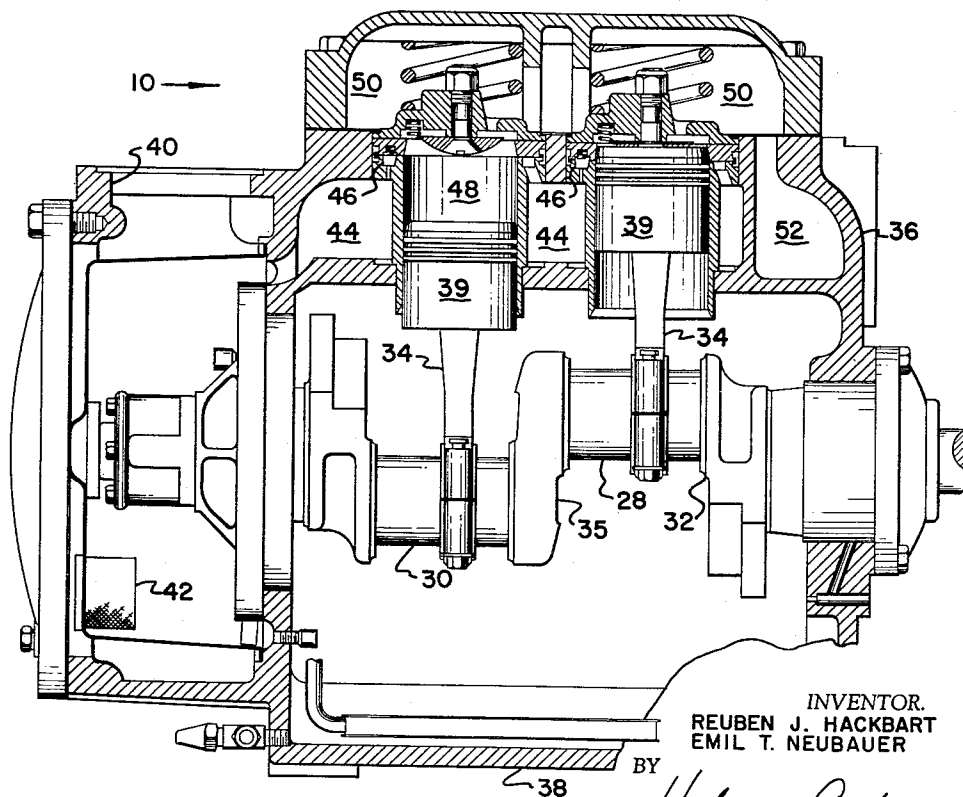


FIG. 3

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RECIPROCATING PISTON COMPRESSOR

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This invention relates to a reciprocating piston compressor and more particularly to a multi-cylinder reciprocating compressor in which the angularly adjacent cylinders in each row of cylinders are staggered a fixed determined distance from one another in the axial direction of the crankshaft.

An object of this invention is to provide a compact multi-cylinder reciprocating compressor which is economical to manufacture and easy to assemble.

Another object of the invention is to provide a reciprocating piston compressor with the same capacity and number of cylinders as contemporary compressors but which is smaller, more compact, lighter, and cheaper to manufacture.

The third object of the invention is to provide a compact multi-cylinder reciprocating piston compressor which has the cylinders staggered to allow the cylinders to be placed closer to the crankshaft in order to reduce the size of the compressor housing and the length of the connecting rods.

A further object of the invention is to provide a multi-cylinder compressor with a two-throw crankshaft in which the angularly adjacent cylinders connected to each throw are staggered a fixed determined distance from one another in the axial direction of the crankshaft.

A still further object of the invention is to provide an eight cylinder, two-throw refrigeration compressor in which the cylinders connected to each throw are staggered at least two connecting rod widths in the axial direction of the crankshaft from the next angularly adjacent cylinder connected to the same throw.

Other objects and advantages of the invention will be clearly apparent as the specification proceeds to describe the invention with reference to the accompanying drawings in which:

Fig. 1 is a roll out view of the cylinder banks of an eight cylinder compressor with the connecting rods shown schematically;

Fig. 2 is a section view on line 2—2 of Fig. 1 showing one row of cylinders as they appear around the periphery of the compressor housing;

Fig. 3 is a section view through one bank of cylinders in the compressor showing the cylinders in operative position;

Fig. 4 is a diagrammatic roll out view of ten cylinder compressor; and

Fig. 5 is a diagrammatic roll out view of a twelve cylinder compressor.

Previous to our invention, the cylinder rows of a reciprocating piston compressor were normally spaced around the periphery of the housing in a spiral configuration with each adjacent cylinder in each row spaced from one another one connecting rod width in the axial direction of the crankshaft. The result of which was that compressors having the same number of cylinders, bore, and stroke would necessarily have a limiting size which is determined by the minimum radial distance of the cylinders from the axis of the crankshaft. This minimum distance being

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from the point where the operation of one cylinder does not interfere with the operation of any of the other cylinders in the compressor.

Our improved cylinder arrangement is applicable to reciprocating piston compressors of eight cylinders or more. For the sake of clarity and disclosure, an eight cylinder refrigeration compressor will be discussed holding in mind that the invention is applicable to other reciprocating piston compressors within the scope of the claims.

Referring now to Fig. 1, cylinders 12, 14, 16, 18, 20, 22, 24, and 26 of compressor 10 with cylinder liners 11, 13, 15, 17, 19, 21, 23, and 25 therein respectively are shown schematically connected to throws 28 and 30 of compressor crankshaft 32 by means of connecting rods 34.

Our new cylinder design encompasses staggering of the cylinders in order to allow the cylinders to be located closer, in the radial direction, to the crankshaft 32 in order to reduce the size of the compressor and some of the component parts. The staggering of cylinders is accomplished by designing the compressor housing so that the axial centerlines of angularly adjacent cylinders in each row are separated from one another in the axial direction of the crankshaft by at least a distance equivalent to two connecting rod widths. This staggering of the cylinders is maintained by connecting the adjacent connecting rods of each throw to cylinders which are spaced two arc angles apart. One arc angle being the angle between two adjacent cylinders in the same row. For example, the arc angle of the eight cylinder compressor is 45°. It should be noted that maintaining the adjacent connecting rods on each throw two arc angles from one another will not space the connecting rods 34 adjacent the crank web 35 two arc angles apart. The required staggering of the cylinders is maintained by making the center crank web 35 between the throws at least two connecting rod widths apart so as to maintain a minimum distance between angularly adjacent cylinders.

As an example of the above, cylinders 20 and 22 are connected to the first connecting rods on throws 28 and 30 respectively, and cylinders 24 and 26 are connected to the third connecting rods on throws 28 and 30 respectively. Then necessarily, cylinders 12 and 16 will be connected to the remaining connecting rods on throw 28 and cylinders 14 and 18 will be connected to the remaining connecting rods on throw 30. The disclosed arrangement is merely exemplary and other designs are feasible within the scope of the invention as long as the axial distance between adjacent cylinders in each row is at least two connecting rod widths. Note that the adjacent connecting rods 34 on each throw connect the crankshaft to cylinders which are spaced from one another at least two arc angles from one another. As an example, the connecting rods connecting cylinders 22 and 14 are spaced from one another through an angle of 90° which is equivalent to two arc angles of 45°.

As is well known in the art, the cylinders of each row of cylinders are spaced around the periphery of the compressor housing 36 as shown in Fig. 2 with the centerline of cylinder 14 being located 22½° clockwise of a line perpendicular to the axis 28 of the crankshaft 32 and parallel to the base 38 of the compressor 10. The centerlines of cylinders 18, 22, and 26 are spaced 45°, 90°, and 135°, respectively, clockwise around the periphery of the compressor housing 36 from the above mentioned centerline of cylinder 14. Cylinders 12, 16, 20, and 24 are also spaced in like manner around the upper half of the circumference of the compressor housing 36. The cylinders are so spaced so as to lessen the possibility of slugging which would increase if some of the cylinders were located in the lower half of the compressor housing 36.

As discussed above, there is a minimum radial distance between the crankshaft and the cylinder which must be

maintained in order for the compressor to operate efficiently. This minimum distance is determined by the length of the cylinder liner. It is obvious that compressors of equal capacity, same number of cylinders, same bore, same stroke, and using the same refrigerant require cylinder liners of the same approximate length. Therefore, the only way to reduce the size of the compressor is to design a compressor which allows the liners to be placed closer in a radial direction to the crankshaft.

Looking at Fig. 2, it can be seen that the staggered relationship of the cylinders allows the cylinder liners to overlap one another in order to be able to project the cylinders radially closer to the crankshaft. Obviously, the greater the distance between angularly adjacent cylinders, the closer to the crankshaft the cylinders may be projected in the radial direction. Therefore, since by our invention the angularly adjacent cylinders are at least two connecting rod widths apart, we have provided a cylinder design which is smaller and more compact than contemporary compressors since contemporary compressors provide only one connecting rod width between cylinders.

The operation of the compressor is typical and not part of the invention. In Fig. 3 it can be seen that when the pistons 39 descend on the suction stroke that gaseous refrigerant and oil are drawn through suction inlet 40, through suction strainer 42, and into suction manifold chamber 44. From suction manifold chamber 44 the refrigerant gases are drawn through suction ports 46 into compression chamber 48.

On the compression stroke, the gaseous refrigerant is compressed and discharged into discharge chambers 50. The compressed refrigerant is then collected in discharge manifold chamber 52 and directed to the point of use.

Figs. 4 and 5 represent diagrammatic roll out views of a ten and a twelve cylinder reciprocating compressor with cylinders located in accordance with our invention. Figs. 4 and 5 are similar to that of Fig. 1 wherein the vertical lines represent the axis of the banks of cylinders and the horizontal lines represent the axis of the connecting rods. Obviously, the distance between horizontal lines represent connecting rod widths and the distance between vertical lines represents arc angles between banks of cylinders. Dots 54 represent cylinders and reference number 320 represents the crankshaft location.

Figs. 4 and 5 are merely shown to illustrate that the staggered cylinder of our invention is applicable to other compressors of different size and not merely restricted to an eight cylinder compressor.

Our above disclosed compressor is smaller, more compact, and cheaper to manufacture than contemporary compressors of the same capacity. Our compressor by comparison with other compressors with the same number of cylinders, capacity, stroke, and bore will have a compressor housing of smaller diameter, lighter bob weights, and shorter connecting rods. Obviously, the above improvements result in a lighter, cheaper, and more compact compressor. Further, our compressor may be used in applications where size is paramount and other compressors may not be used. Also, our compressor allows us to reduce the size of any packaged air conditioning equipment in which we desire to use the above disclosed compressor. Finally, our new and improved compressor allows us to compete successfully against contemporary compressors due to lower cost of production and lower shipping costs which result from the reduction of weight and size of component parts.

Although we have described in detail the preferred embodiments of our invention, we contemplate that many changes may be made without departing from the scope or spirit of our invention, and we desire to be limited only by the claims.

We claim:

1. A compressor comprising; a housing, a first row of four cylinders and a second row of four cylinders in the upper half of said housing with the axes of adjacent cylinders in each of said rows having an arc angle therebetween said arc angles between adjacent cylinders in each row being substantially equal, a crankshaft having a first throw and a second throw rotatably supported by said housing substantially perpendicular to the axes of said cylinders, piston means slidably supported in said cylinders four connecting rods rotatably connected at one end to said first throw and operably associated with said piston means of said first row at the other end, and four connecting rods rotatably connected at one end to said second throw and operably associated with said piston means of said second row at the other end, the adjacent connecting rods on each throw being connected to piston means whose axes are separated by at least two arc angles whereby the axes of adjacent cylinders in each row are displaced from one another in the axial direction of the crankshaft a distance at least equal to the width of two connecting rods.

2. The structure of claim 1 wherein the cylinders in said first row are in alignment in the axial direction of the crankshaft with the corresponding cylinders in said second row.

3. A compressor comprising; a housing, at least one row of four cylinders in the upper half of said housing with the axes of adjacent cylinders in said one row having an arc angle therebetween, said arc angles between adjacent cylinders in said one row being approximately 45° , a crankshaft rotatably supported by said housing substantially perpendicular to the axes of said cylinders having at least one throw, piston means slidably supported in said cylinders, and four connecting rods rotatably connected at one end to said one throw and operably associated with said piston means of said one row at the other end with adjacent connecting rods on said one throw being connected to piston means whose axes are separated by at least two arc angles whereby the axes of adjacent cylinders in said one row are displaced from one another in the axial direction of the crankshaft a distance at least equal to the width of two connecting rods.

4. A compressor comprising; a housing, at least one row of four cylinders in the upper half of said housing with the axes of adjacent cylinders in said one row having an arc angle therebetween, said arc angles between adjacent cylinders in said one row being substantially equal, a crank shaft rotatably supported by said housing substantially perpendicular to the axes of said cylinders having at least one throw, piston means slidably supported in said cylinders, and four connecting rods rotatably connected at one end to said one throw and operably associated with said piston means of said one row at the other end with adjacent connecting rods on said one throw being connected to piston means whose axes are separated by at least two arc angles whereby the axes of adjacent cylinders in said one row are displaced from one another in the axial direction of the crankshaft a distance at least equal to the width of two connecting rods.

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