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Cylinder Side-Inlets for Improving Volumetric Efficiencies of Reciprocating Refrigeration Compressors

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CYLINDER SIDE INLETS FOR IMPROVING VOLUMETRIC EFFICIENCIES OF RECIPROCATING REFRIGERATION COMPRESSORS

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INTRODUCTION

For this Compressor Technology Conference, this paper is presented with the following thoughts in mind. One being that the information presented here is of academic interest. Secondly, the information presented here could be used in late designs of refrigerant compressors.

In 1938 Charles R. Neeson[1] patented an idea which is little used today. This patent was studied and as a result three things were concluded:

1. An actual improved volumetric efficiency can be obtained over standard compressor by the use of side inlet ports as depicted by Charles Neeson. The idea is shown in Fig. 1 as depicted by Mr. Neeson.

2. Engineers can see that cylinder capacity can be reduced also by moving the side inlets up further into the compression stroke of the piston cylinder arrangement as shown in Fig. 2.

3. A yet unexplored third use of the side inlet ports can be used for compressors in the high compression ratio range where additional lubrication of the piston ring as well as the suction and discharge valving is needed. By placing the inlet port at the near bottom dead center of the compression stroke, and by proper design where these inlets communicate to the crankcase an oil mist could be admitted into the cylinder chamber (See Fig. 3).

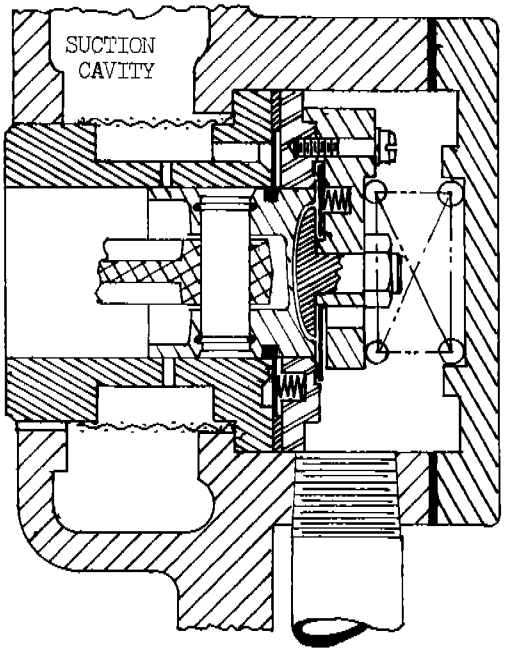

Fig. 1

**PATENT 2,137,965
C.R.NEESON
IDEA TO IMPROVE CYLINDER
GAS FILLING.**

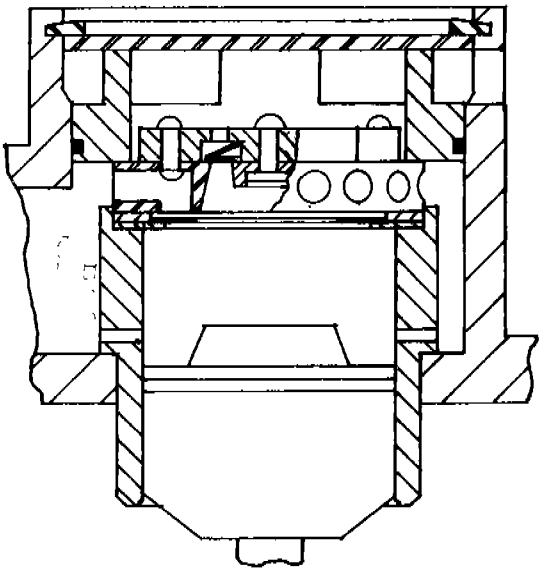

Fig. 2

A METHOD TO REDUCE THE CAPACITY PER CYLINDER.

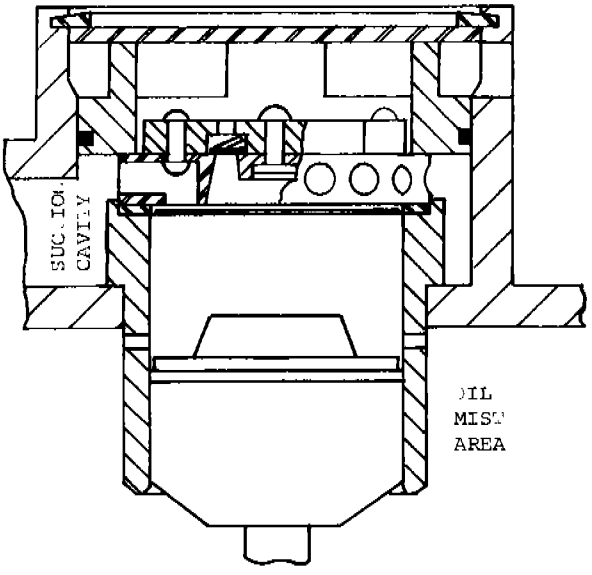

Fig. 3

A METHOD TO IMPROVE PISTON AND VALVE LUBRICATION.

TESTS & DESIGN CONSIDERATION

Although tests of this idea were primarily conducted for improving performance of the compressor, it would be quite easy for the compressor designer to explore the other two presented ideas.

Referring to Figure 4, one finds a plot of the effects of cylinder side inlets on volumetric efficiency. The tests were conducted with a three cylinder machine having a capacity of 71,000 BTU/HR at 45°F evaporator temperature, 125°F condensing temperature, 65°F return gas, and rated with 0°F of sub-cooling. The compressor as stated was three cylinder with a 1.875" diameter bore and a 1" stroke. RPM was rated at 3450.

Two side inlet areas were tested. One was 0.049 square inches, and the second was 0.098 square inches.

Although these areas appear to be very small, one can see from the curve that significant changes in volumetric efficiency are shown.

Note that the plot shows volumetric efficiency vs. the placement of the cylinder side inlet holes from the top of the cylinder piston ring to the cylinder side inlet holes in percent of the total stroke.

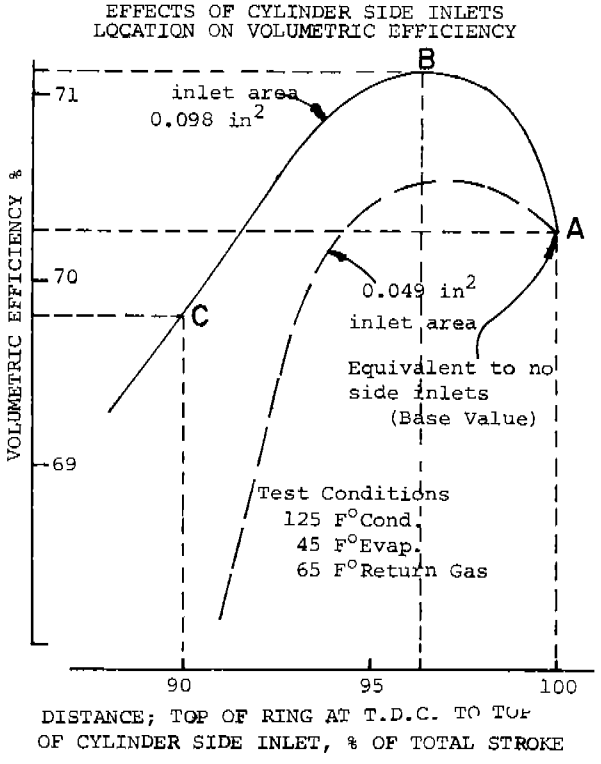

Fig. 4

Fig. 4 shows three points A, B, & C on the curve 0.098 in^2 inlet area. Point A indicates the volumetric efficiency of the machine without side inlet ports. Point B shows that there is a maximized volumetric efficiency for a given side inlet location. Point C shows that if the ports are moved up enough from bottom dead center an actual decrease in volumetric efficiency will result.

Fig. 5 shows the area in which cylinder pressure is below suction cavity pressure. Note point where piston is at bottom dead center. Note also that to the left is where side inlet ports should be placed. This point is about equal distance from where the piston is at bottom dead center to where the cylinder pressure is raised back to suction pressure during the compression stroke.

Referring to Figure 2, it is logical to conclude that you could also use this type of arrangement for permanent cylinder capacity reduction. This could be of consideration where existing tooling would be too costly to change if slight reduction in machine capacity was needed. Of course, this would result in actual reduction of the performance of the machine at the expense of simplicity of lowering the capacity of the machine.

Referring now to Figure 3 which shows the possibility of improving the lubrication of the compressor in the area of the cylinder and valving area. A designer can see that by communicating these ports to the crankcase of the compressor, and placing the ports in the position where actual improvement in volumetric efficiency occurs that fine mist particles of oil could be introduced into the cylinder chamber. As designers have noted that the crankcase portion of a refrigerant compressor is always a very dense fog of refrigerant oil. By taking advantage of the oil mist area of the compressor and communicating to the cylinder, then excellent oiling of the cylinder chamber can be provided. This will work where the crankcase is open to the suction of the compressor and will even further work with improvement in a closed crankcase compressor. The reason for this is that blow-by-past the rings in a closed crankcase compressor design as shown here in Figure 6 can actually cause a positive pressure in the crankcase area vs. the inner portion of the compressor shell. This phenomena would provide the designer with the ability to move the side inlets even further up from bottom dead center if desired.

CONCLUSION

In closing there are three possibilities shown here, one of which was the original idea by Charles Neeson of Chrysler Air Temp in the late 1930's. The second being cylinder capacity reduction can be derived by this type of side inlet ports. Thirdly, for those people experiencing difficulty in lubricating their cylinders as well as their valving, the side inlet ports can be an easy means of providing lubrication. It has been noted that some people actually take small metering tubes and insert them into the suction inlet tubes and place these in oil for providing cylinder lubrication. They may find that the cylinder side inlet hole would give them even superior lubrication over a wider range of performance possibly at reduced costs.

REFERENCES

1. Neeson, C. R., Patent No. 2,137,965, Nov. 22, 1938.

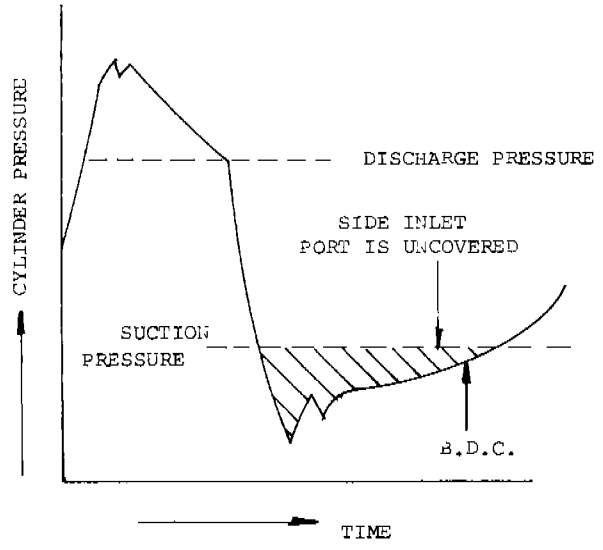

Fig. 5

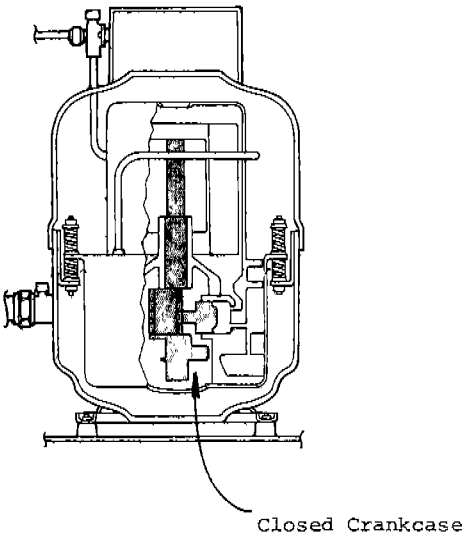

Fig. 6