June 17, 1947. W. B. WINSLOW 2,422,327

RESILIENT PISTON PIN BUSHING

Filed June 10, 1944

Fig. 1

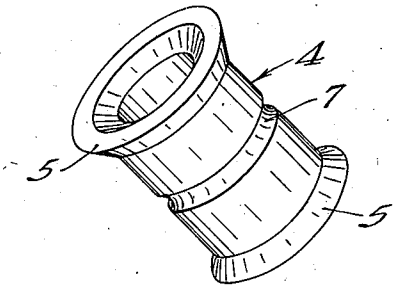


Fig. 2

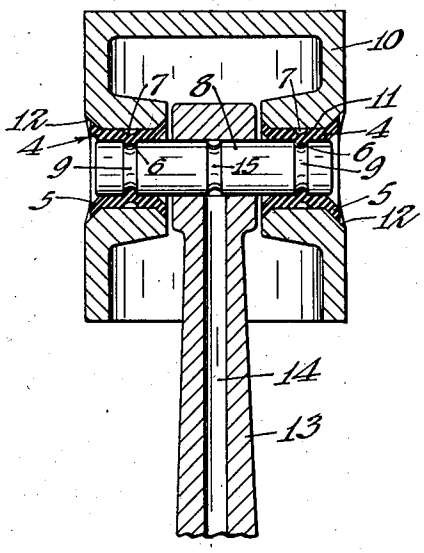
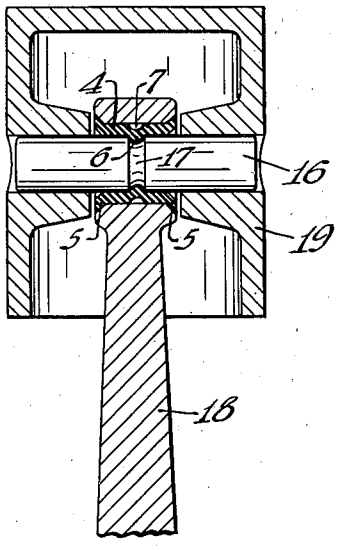


Fig. 3



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RESILIENT PISTON PIN BUSHING

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6 Claims. (Cl. 309—18)

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This invention relates to piston pin bushings, and more particularly to piston pin bushings of a resilient material for use in refrigeration compressor pistons.

In many refrigeration installations it is highly desirable to have the compressor function as quietly as possible. Household refrigerators are one example of such installation. Another example is the self-contained unit air conditioner.

When the compressor in units of this class is of the reciprocating type using a piston in a cylinder for effecting compression, a clicking noise is often caused by the sudden pressure drop in the cylinder as the piston starts on the suction stroke from upper dead center. It has been learned from careful laboratory experiments that this particular clicking noise referred to does not result from a sudden contact of mechanical parts. Compressors have been built wherein the piston pin was fit to the piston with a light press fit that would admit of no relative movement in the direction of piston travel, and wherein the connecting rod fit on the piston pin and crankshaft would not permit a relative movement between said parts, and yet a clicking noise would occur at the point of sudden pressure reduction in the cylinder at the start of the suction stroke.

It was found that this clicking noise is louder in fast operating compressors than in those being driven at a relatively slow speed. It is particularly noticeable in compressors being driven between 1700 R. P. M. and 1800 R. P. M. by standard 60 cycle alternating current motors having four poles in the stator.

It has also been discovered that a compressor operating at a five pound gauge suction pressure with one of the well known refrigerants such as Freon and producing a clicking noise, will have that noise gradually diminish in intensity as the suction pressure is gradually increased. The clicking noise has been observed to diminish to inaudibility upon an increase of suction pressure to 40 pounds gauge pressure. During these experiments the head pressure, or end pressure of compression, was approximately 100 pounds per square inch gauge pressure. These observations bear out the conclusion that the said clicking noise is caused by the sudden reduction of pressure in the compressor cylinder at the beginning of the suction stroke, for when the amount of pressure reduction is diminished to a certain extent by an increase of suction pressure the clicking noise stops.

A similar clicking noise is often observed in steam radiators which are cold when steam is

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first admitted. In this instance there is no question as to the possibility that the click be originated by sudden mechanical contacts, for there are no separate parts within the radiator. Likewise, in the radiator, the clicking noise is caused by a sudden reduction of pressure. The sudden condensation of steam causes the sudden pressure drop, and the resultant clicking noise.

It is highly desirable to eliminate the clicking noises of refrigeration compressors. Precision fitting parts are now the rule, yet in spite of this and all other mechanical refinements of compressors as known and constructed today, an objectionable clicking noise persists in many compressors.

I have discovered that by the use of piston pin bushings constructed of a resilient material the maximum frequency of pressure waves within the cylinder can be reduced below the frequency that produces an audible clicking noise.

An object of this invention is a resilient piston pin bushing that will limit the frequency of pressure waves with the cylinder of a compressor to less than a disagreeably audible frequency.

A further object is a resilient piston pin bushing which will retain a piston pin in substantially fixed relation to a connecting rod.

Still another object of this invention is a pair of resilient piston pin bushings which will retain a piston pin in substantially fixed relation to a piston.

Improved volumetric efficiency of compression is also an object of this invention.

These and other objects and advantages of the invention will more fully appear from the following description made in connection with the accompanying drawings, wherein like reference characters refer to the same parts throughout the views, and, in which:

Figure 1 is a perspective view of a resilient piston pin bushing adapted for use in an assembly including a connecting rod, a piston, and a piston pin;

Figure 2 is a vertical sectional view through a piston assembly which utilizes two bushings of the type shown in Figure 2; and

Figure 3 is a vertical sectional view through a piston assembly utilizing the bushing in a different type of piston construction.

In Figure 1 the numeral 4 refers to the complete resilient piston pin bushing shown. This bushing is constructed preferably of a synthetic rubber such as Neoprene, having a durometer hardness reading of between 40 and 100 points. The selection of hardness is to be specifically determined by

the mechanical requirements for the desired natural frequency of the piston on the resilient bushing. These mechanical requirements are met by the selection of appropriate relationship between the piston head area, the projected area and wall thickness of the bushing or bushings used, and the working pressures within the cylinder generated by the piston. Annular flanges 5 at each end of bushing 4 has a cross section thickness substantially equal to that of the tubular body of the bushing. It flares outwardly at an angle of approximately 45 degrees. Bushing 4 has an internal concentric annular rib 6 and an external concentric annular groove 7 in the plane of annular rib 6, of such proportions that the wall section of bushing 4 retains approximately an equal thickness throughout its length.

In Figure 2, piston pin 8 has concentric annular grooves 9 near each end. Two bushings 4 are assembled to piston pin 8 with their annular ribs 6 fitting in piston pin grooves 9. This fit establishes a substantially fixed relationship between bushing 4 and piston pin 8. Piston 10 has a piston pin hole 11 in each side; each hole 11 having both its outer and inner ends chamfered at an angle of 45 degrees as at 12 to mate with external annular flanges 5 of bushing 4. The flanges 5 establish a substantially fixed relationship between bushing 4 and piston 10.

A connecting rod 13 is assembled to piston 10 by means of the piston pin 8. An oil hole 14 in the connecting rod 13 is in registry with an annular oil groove 15 midway between the ends of piston pin 8. This structure described, and shown in Figure 2, is adapted for refrigeration compressors having pressure feed of lubricating oil through the hole 14 in connecting rod 13 to its bearing on piston pin 8.

In Figure 3 a piston pin 16 has an annular groove 17 midway between its ends. This groove is of the same shape and serves the same function as the grooves 9 in piston pin 8 of Figure 2. The bushing 4 is assembled to the piston pin 16 with its annular rib 6 fitting in the annular groove 17. This fit substantially fixes the relationship between the bushing 4 and piston pin 16.

The connecting rod 18 has a hole to receive the bushing 4. Both ends of the said connecting rod hole are chamfered at 45 degrees to receive annular flanges 5 of bushing 4, which flanges maintain a substantially fixed relationship between the bushing 4 and connecting rod 18. This structure described, and shown in Figure 3, is suitable for compressors having splash lubrication for the bearing of the piston pin 16 in the piston 19.

The assembly of the parts shown in Figure 2 is made by first assembling one of the bushings 4 to one end of piston pin 8. Next, a second bushing 4 is assembled into the piston pin hole in one side of piston 10. The annular flange 5 is flexed to a circumference equaling the diameter of the piston pin hole as it is inserted and with a rotary motion it is pressed in. Next, the bearing of connecting rod 13 is aligned with the piston pin holes 11 in the piston 10. Next, the end of the piston pin 8 without the bushing assembled, is inserted in the piston pin hole 11 in which there has not been a bushing assembled. The end of piston pin 8 passes through the connecting rod bearing and enters the second bushing 4, as flange 5 of the first bushing assembled enters the chamfer of the piston pin hole in which the insertion has been made. By flexing flange 5 to the diameter of the piston pin hole and imparting a rotary motion as it is pressed in, piston pin 8 and said first assembled bushing 4 may be pressed into place in piston 10. When the leading end of the piston pin 8 reaches the internal annular rib 6 in the second bushing 4, the rotary motion and pressure used for assembling will cause annular rib 6 to flex into the annular groove 7 which is made of such size that this method of assembly may be executed. The continuation of rotary motion and pressure will produce the alignment and assembly of parts as shown in Figure 2. The piston pin 8 will be retained in its operating position within the piston 10, by the resistance of the internal ribs 6 and external flanges 5 to flexing.

The assembly of the parts shown in Figure 3 is made by first assembling the bushing 4 in connecting rod 18. Next the connecting rod 18 is assembled within the piston 19 so that its bearing is in alignment with the piston pin holes. Next, piston pin 16 is inserted in the piston pin hole on one side of the piston and pressed through the bushing 4 in connecting rod 18 until it reaches its final position where the internal annular rib 6 engages the annular groove 17 in the piston pin 16. The piston pin 16 will be retained in its operating position within the piston 19, by the resistance to flexing of internal rib 6 and external flanges 5.

In operation the heads of pistons 10 and 19 are subjected to full compressive forces at the end of the compression stroke and the bushings 4 are subjected to compression to the same degree. Immediately subsequent to the ending of the compression stroke the suction stroke begins, and the fluid pressure within the cylinder drops to the suction pressure of the fluid entering the compressor. The sudden release of pressure from the pistons releases the compression pressure from bushings 4 which by their elasticity then return to their normal balance of assembly stress within the piston pin holes of the piston or the connecting rod as the case may be. Under the shock of sudden pressure reduction the pressure waves set up within the cylinder cannot exceed the natural frequency of the pistons on the resilient piston pin bushings. The resilience of the bushings is such that the piston frequency is lower than the frequency of sound waves which are heard as a click or other objectionable sound. Thus the resilient bushings of this invention eliminate an objectionable sound of compressor operation.

Sometimes refrigeration compressors are constructed so that a greater than minimum volume of compressed fluid is purposely retained within the cylinder at the beginning of the suction stroke. As the suction stroke progresses this compressed fluid re-expands until the suction pressure fed to the compressor is reached. When the re-expansion time is thus increased to make the pressure reduction wave frequency below the frequency of a clicking sound, then the compressor is rendered more quiet by the increased volume of re-expanding fluid.

However, re-expanding fluid in a compressor cylinder reduces the amount of low pressure fluid that can be drawn in on the suction stroke. In other words, the volumetric efficiency of the compressor is reduced. When quietness of operation is an important factor of compressor design, the volumetric efficiency, and thus refrigeration capacity, is often sacrificed to gain quietness by the means explained above. This invention gains quietness of compressor operation in compressors having a minimum of fluid re-expansion and having the resulting high efficiency and refrigeration

capacity. It eliminates the need for reduced refrigeration capacity for the purpose of obtaining quiet operation. Thus this invention attains its object of improved compressor efficiency.

Although I have illustrated and described a specific design of resilient piston pin bushing for refrigeration compressors, it is, of course, to be understood that various changes can be made in the form, details, materials and arrangement and proportions of the bushing and its associated parts without departing from the scope of my invention.

What I claim is:

1. A cushioning device for use with a reciprocating piston adapted to operate in a cylinder, a connecting rod and a piston pin, wherein the piston is provided with a piston pin aperture having flared ends, comprising a yieldable bushing adapted to fit between said piston pin and said piston and in said opening, said bushing having outwardly flared end portions adapted to fit the contour of said opening in said piston to prevent movement of said bushing relative to said piston.

2. A cushioning device for use with a reciprocating piston adapted to operate in a cylinder, connecting rod and piston pin, wherein said connecting rod is provided with a piston pin bearing aperture, comprising a yieldable bushing adapted to fit within said connecting rod piston pin bearing aperture, said bushing having flared ends to prevent displacement of the bushing relative to said connecting rod bearing aperture.

3. A cushioning device for use with a piston, a connecting rod and a piston pin, wherein said piston pin is provided with an annular groove, comprising a sleeve-like bushing having an internal rib moulded to fit said annular groove and adapted when assembled into said annular groove to resist longitudinal movement relative to said piston pin.

4. A cushioning device for use with a piston having a piston pin bore and a piston pin adapted to fit within said bore, comprising a resilient bushing moulded to an external shape adapted for nesting into a portion of said piston bore and moulded to an internal shape adapted to be assembled contiguous with a portion of the external surface of said piston pin, the said piston pin bore having an irregular shape longitudinally such that a flexing of said resilient bushing is required for its assembly or disassembly within said piston pin bore, and the external shape of said piston pin being irregular longitudinally such as to require a flexing of said resilient bushing for its assembly on or disassembly from said piston pin.

5. A cushioning device for use with a piston, a connecting rod and a piston pin wherein said connecting rod is provided with a bore adapted to receive said piston pin, comprising, a resilient bushing moulded to an external shape adapted for nesting into the bore in said connecting rod and moulded to an internal shape adapted to be assembled on a portion of the external surface of said piston pin lying within said bore in said connecting rod, said bore having an irregular shape longitudinally such that flexing of said resilient bushing is required for its assembly or disassembly within said connecting rod bore, and the external shape of said piston pin being irregular longitudinally such as to require a flexing of said resilient bushing for its assembly on or disassembly from said piston pin.

6. A cushioning device for use with a piston, a connecting rod and a piston pin, wherein said piston pin is provided with an annular groove, comprising a resilient sleeve-like bushing having an internal rib formed to fit said annular groove and adapted, when assembled into said annular groove, to resist longitudinal movement relative to said piston pin.

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