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(54) **A refrigeration compressor.**

(57) An electric compressor, particularly for household refrigerators, comprising an outside casing (1), an inside body (2), a cylinder head (3), a silencer (4) interposed between the cavity inside the compressor casing and the gas inlet pipe within the cylinder head (3), wherein the silencer (4) is substantially L-shaped, the greater side containing the expansion chamber (5) and the lesser side leading to the gas admission port (7) in the inlet valve and then to the outlet pipe (9) toward a Helmholtz resonator, the Helmholtz resonator being formed in the compressor body.

The ratio between the area of the admission pipe (6) and the transverse section of the chamber (5) must be approximately 0.03, and the length of the chamber (5) must be approximately 34 mm.

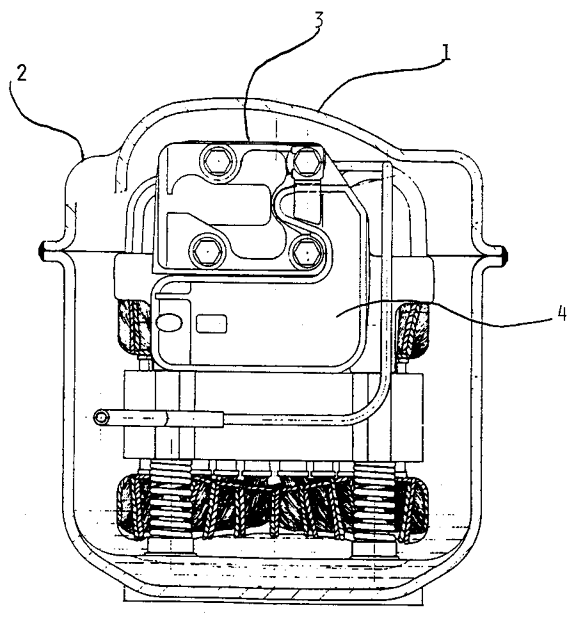

FIG. 1

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The present invention relates to a special form of inlet pipe for cooling gas inside an airtight enclosure containing an electric compressor, particularly employed in refrigerators for household use.

For better illustration of the present invention it is assumed that the pipe operates in close association with the compressor and that it is made of injection-molded or stamped plastic. This naturally does not limit the invention to this type of material and to this connection.

The fluctuations of gas pressure inside displacement compressors particularly for household refrigerators are of considerable importance in view of their influence on the efficiency and the level of acoustic power emitted by the compressors. Therein the cooling gas coming from the inlet pipe enters inside the airtight housing of the compressor.

The body of the compressor has an inlet pipe inside the casing connected to the inlet valve via various channels and cavities that permit the drawn-in gas to be conveyed inside the cylinder.

Being in contact with all the hot surfaces of the compressor, the gas heats up and reduces its density during these passages.

This leads to a reduction in the cylinder fill and thus ultimately to a reduction in the cooling capacity of the compressor.

The basic mechanisms regulating the dynamics of the gas movements are as follows.

1) The mechanism of restriction of flow through each "collar" and each connecting cavity constituting the system is regarded as an opening constricting the flow of gas. This effect is of virtually static character since the inertia of the gas is low, normally negligible, in the inlet and outlet passages which have reasonable dimensions.

2) The second mechanism is essentially of a dynamic nature, relating to the sudden opening and closing of the inlet and outlet valves. The sudden discharge of an amount of gas inside a cavity of the system causes an acceleration in the mass of the gas already existing in the passages downstream of the cavity, thus permitting the arriving gas to alter its thermodynamic characteristics minimally. The inertia of the gas offers resistance to this variation of motion and results in a pressure increase inside the cavity. Once this change of state has been established the gas persists in its motion (due to inertia), producing a rarefaction of gas in the cavity in which there was previously an overpressure. The repetition of this process, as is characteristic of reciprocating displacement compressors, produces a vibration of the gas.

From the point of view of efficiency alone, the ideal solution would be the total elimination of any system of pipes, manifolds and cavities that have the function of collecting the gas upstream and downstream of the automatic valves.

However, maximizing thermodynamic efficiency in this way would accordingly increase the level of acoustic power emitted, particularly during intake, that is transmitted directly outside the casing of the compressor, thereby compromising the requirements of quietness.

It would therefore be desirable, and is the object of the present invention, to realize a compressor that combines high efficiency with low noise, and is reliable, economical and easy to assemble while using materials and techniques permitted by the state of the art.

This object is achieved with the device described, by way of example and nonrestrictively, with reference to the adjoined figures in which:

Fig. 1 shows a view of the inside of the compressor casing with the device shown from the front, comprising a silencer interposed between the intake of the gas from outside of the compressor and the cylinder head;

Fig. 2 shows a front inside view of the cover of the silencer;

Fig. 3 shows a lateral view of the same detail;

Fig. 4 shows a front inside view of the body of the silencer;

Fig. 5 shows a lateral section of the same detail.

The essential idea of the invention is described here as follows.

In order to maintain the process of gas intake within an adiabatic change (thereby preserving the cooling efficiency of the compressor), the acoustic control system is preferably made of plastic material.

An expansion silencer is realized between two pipes (having different sections) and by a Helmholtz resonator whose collar is positioned along the pipe at the outlet of the silencer on the side of the inlet valve.

Inside the silencer the spread of the acoustic waves is subject to interference and reflection phenomena that attenuate their acoustic intensity (understood to be the energy flow per unit of area).

Experiments have shown the transfer function of this component (understood to be the relation between an acoustic signal at the input and an acoustic signal at the output) when the silencer is subjected to an accidental-type acoustic signal, in static states and in air. The silencer has been found to be a low-pass acoustic filter, equipped with two resonances f1 and f2 (see Fig. 6). The attenuation of the acoustic intensity to resonant frequencies f1 and f2 is obtained by means of the

Helmholtz resonator.

It is known that in systems composed of several weakly coupled components (silencer and resonator) the (generally complex) resonant frequencies are divided and shifted along the axis of the frequencies of a known range, so that one frequency is higher and one is lower than the frequency of the unmodified system.

Thus, if a resonator is applied to a cavity (and tuned to have the same natural frequency as an acoustic mode of the cavity), two new coupled modes are produced whose natural frequencies are disposed on the edges of the original frequency. The separation between the frequencies is proportional to the value of the coupling parameter.

To obtain good results with this type of coupling it is necessary to optimize the volume of the resonator in accordance with the volume of the cavity and also the position of the resonator neck, which must be located near a loop of the acoustic mode tending to attenuate to a greater extent. It is therefore necessary to apportion these parameters to obtain a reduction of acoustic pressure to the starting frequency, whereby the reduction should be considerable but not excessive so as not to be compensated by a considerable increase of acoustic pressure to the two new frequencies that will be produced.

It is furthermore stressed that there is no flow of gas through the resonator cavity. Since there is thus no variation in the gas temperature due to the interposed cavity, the efficiency characteristics of the thermodynamic cycle are maintained unchanged.

The gas entering the compressor and coming from the inlet pipe is not dispersed in the casing to be then drawn into the inlet pipe present in the compressor body, but is immediately "intercepted" and directed toward the head without being allowed to spread.

For this purpose a silencer is designed and mounted for guiding the path of the gas and connecting on one side the area facing the gas entry port in the casing, and on the other side the inlet port in the cylinder head. The separation which the flow of gas thus undergoes and the particular path that develops achieve the result of preventing the gas from overheating and of blocking the intake noise within the pipe.

The features of the invention are specified in the claims that follow.

Referring to the figures we can see the following components:

1) compressor casing
2) compressor body
3) cylinder head
4) silencer, seen from its cover
5) expansion chamber of silencer
6) gas entry pipe into chamber 5
7) gas admission port in inlet valve
8) gas outlet pipe from chamber 5
9) outlet pipe to Helmholtz resonator

Connected to head 3 of the compressor cylinder is intake silencer 4 made of plastic material, with gas entry port 6 and gas outlet pipe 8 from chamber 5, followed by port 7 toward the gas inlet valve in the head.

The cooling gas in pipe 6 enters chamber 5 inside silencer 4.

The silencer is interposed between the cavity inside the compressor casing and the gas inlet pipe within cylinder head 3, and is substantially L-shaped, whereby the greater side, widened at the center and virtually box-shaped, contains expansion chamber 5 and gas admission pipe 6 into the chamber, and the restriction of the lesser side constitutes gas outlet pipe 8 from chamber 5.

After the restriction the lesser side leads first to gas admission hole 7 in the inlet valve and then to outlet pipe 9 toward a Helmholtz resonator, consisting of a suitable cavity formed within the compressor body.

Expansion chamber 5 can have different forms, but preferably has two substantially parallel plane opposing walls and two curved opposing walls with the same direction and with substantially the same angle of curvature.

Chamber 5 can also have different forms provided that the following proportions are maintained between some critical dimensions.

The ratio between the area of admission pipe 6 and the transverse section of chamber 5 must be approximately 0.03.

Furthermore the length of cavity 5 must be approximately 34 mm.

In order to maintain the process of gas intake within an adiabatic change (thereby preserving the cooling efficiency of the compressor), the silencer is preferably made of plastic material.

It is understood that what has been said and shown with reference to the adjoined drawings is intended only to exemplify the invention, and that numerous variants and modifications may be produced without departing from the present invention.

Claims

1. An electric compressor, particularly for household refrigerators, comprising an outside casing (1), an inside body (2), a cylinder head (3), a silencer (4) interposed between the cavity inside the compressor casing and the gas inlet pipe within the cylinder head (3), characterized in that in the chamber (5) inside the silencer (4) the ratio between the area of the admission pipe (6) and the transverse section of the chamber (5) must be approximately 0.03, and the length of the chamber (5) must be approximately 34 mm.

2. The compressor of claim 1, characterized in that the silencer (4) is substantially L-shaped, whereby the greater side contains the expansion chamber (5) and the gas admission pipe (6) into the chamber, and the lesser side constitutes the gas outlet pipe (8) from the chamber (5).

3. The compressor of claim 2, characterized in that the lesser side leads first to the gas admission port (7) in the inlet valve and then to the outlet pipe (9) toward a Helmholtz resonator.

4. The compressor of claim 3, characterized in that the Helmholtz resonator is formed within the compressor body.

5. The compressor of claim 4, characterized in that the expansion chamber (5) has two substantially parallel plane opposing walls and two curved opposing walls with the same direction and substantially the same angle of curvature.

6. The compressor of the preceding claim, characterized in that the silencer (4) has a constructional form substantially as shown in Figs. 2, 3, 4, 5.

7. The compressor of any of the above claims, characterized in that the silencer (4) performs the function of reducing noise within an adiabatic change.

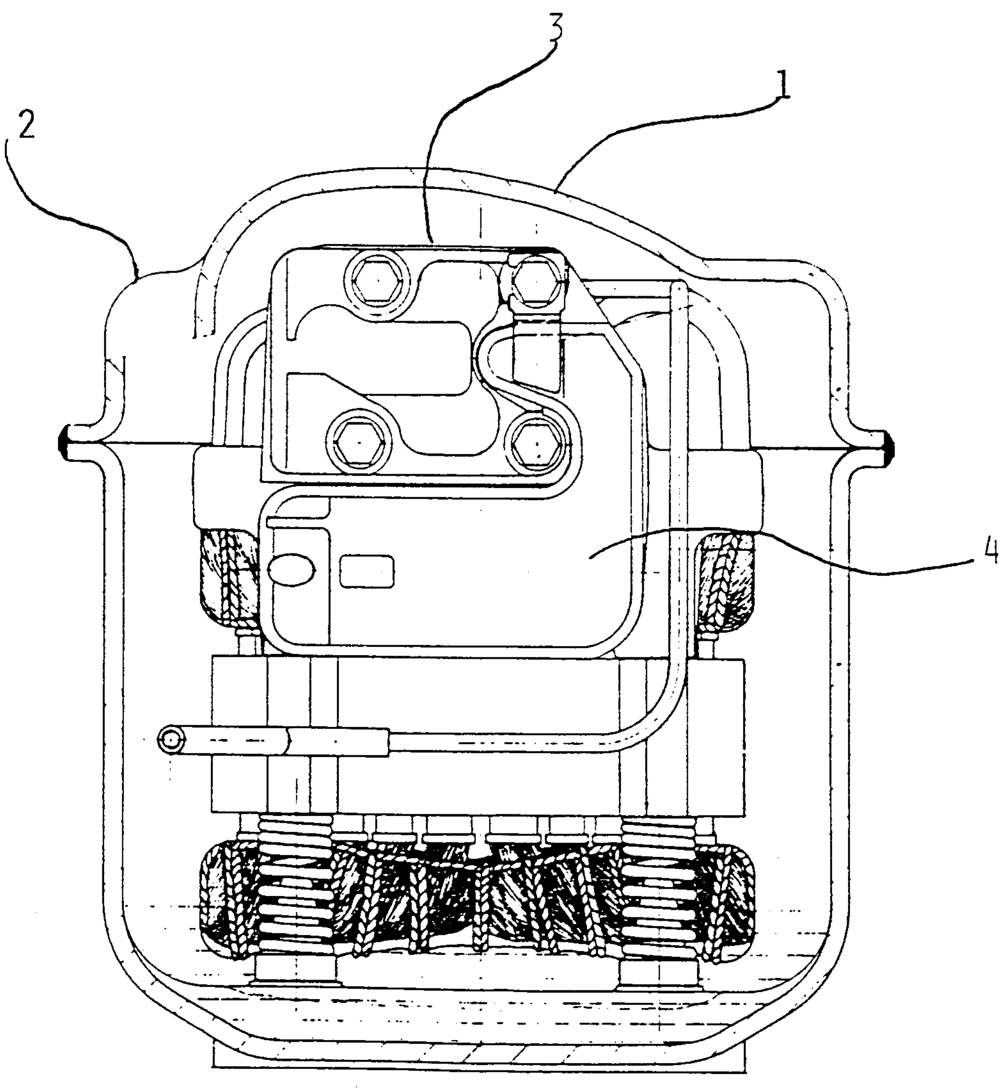

FIG. 1

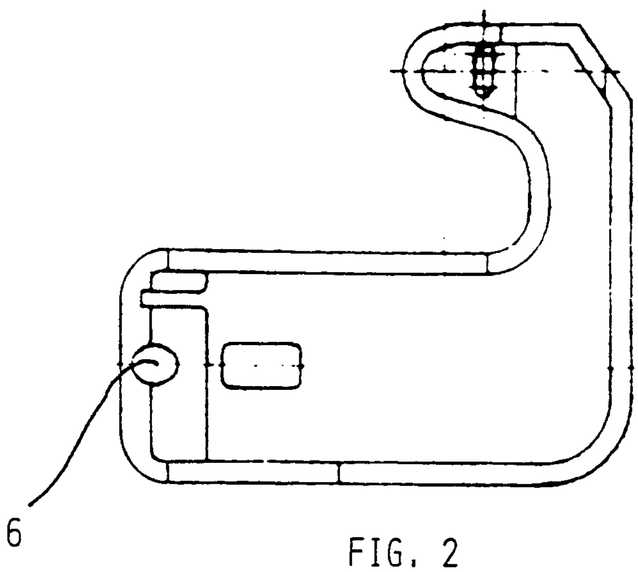

FIG. 2

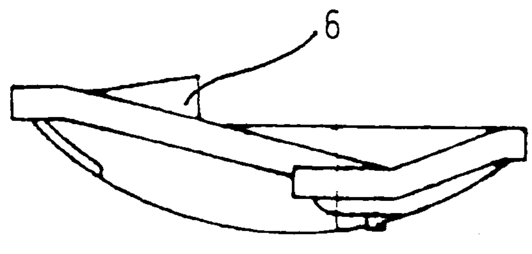

FIG. 3

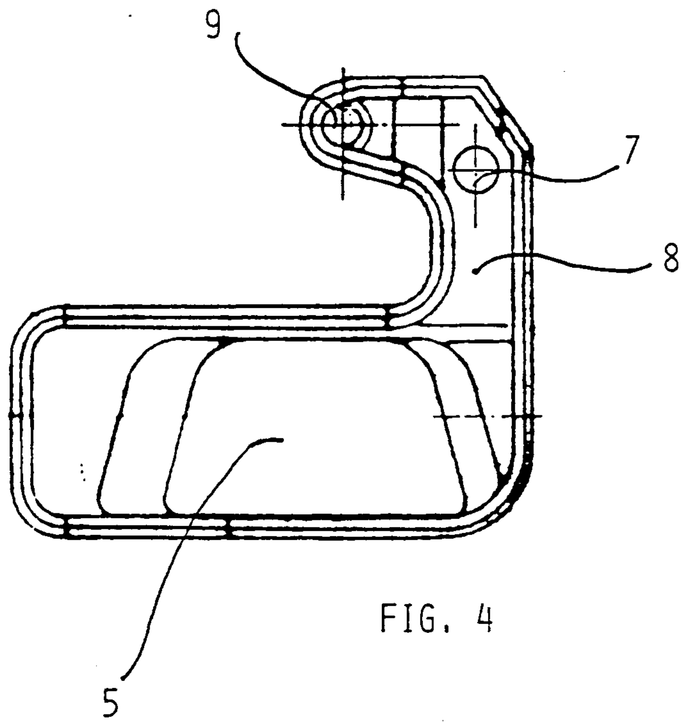

FIG. 4

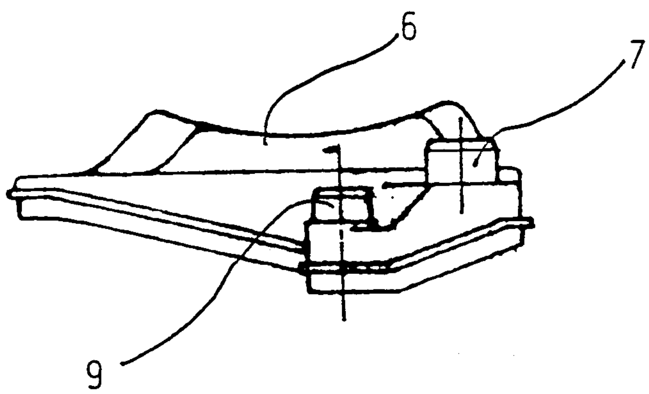

FIG. 5

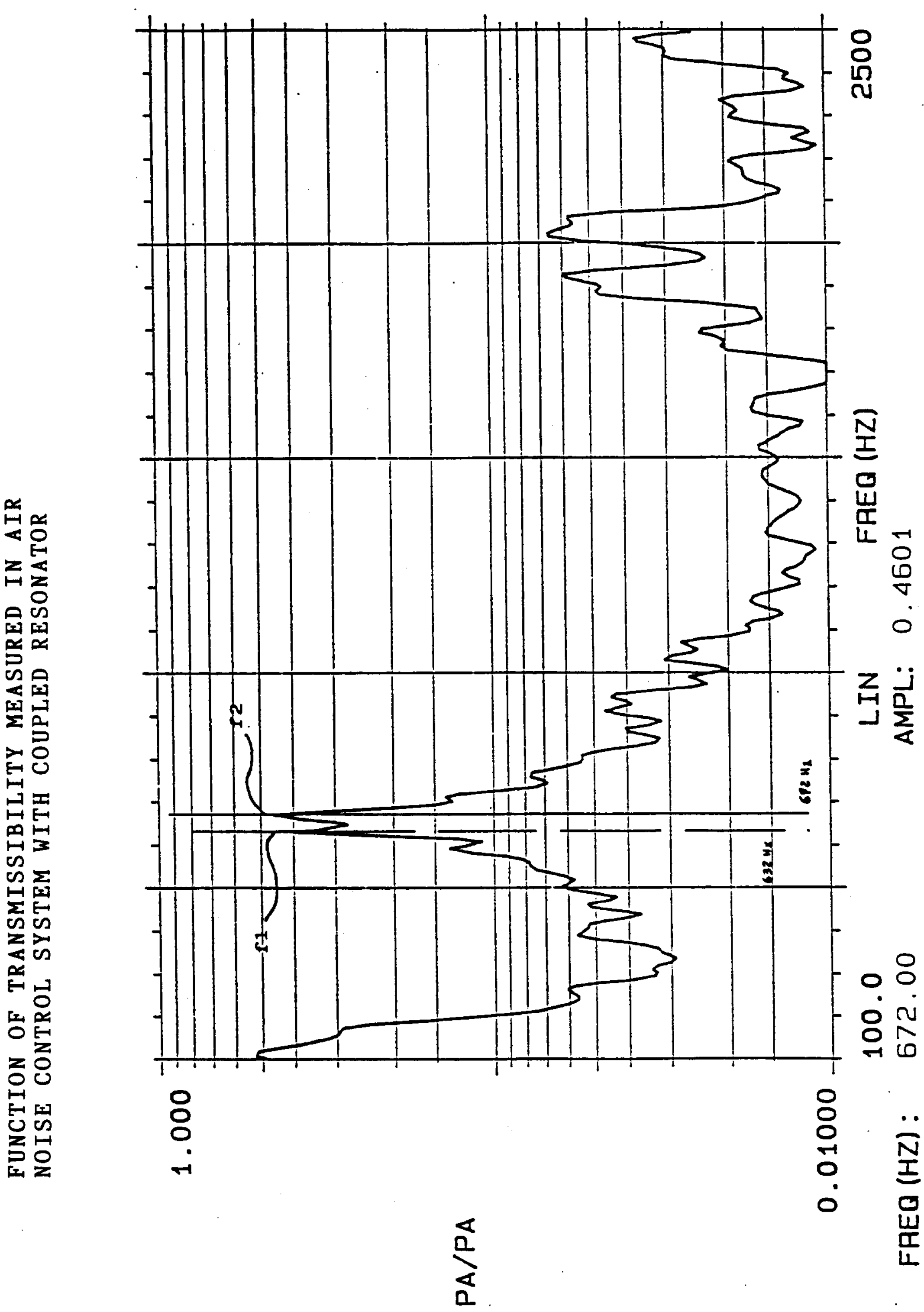
FUNCTION OF TRANSMISSIBILITY MEASURED IN AIR
NOISE CONTROL SYSTEM WITH COUPLED RESONATOR
PA/PA
1.000
0.01000
FREQ(HZ):
100.0
672.00
LIN
AMPL: 0.4601
FREQ(HZ)
2500
f1
f2
632 Hz
672 Hz

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 4357

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4 960 368 (LILIE) * column 3, line 48 - column 4, line 41; figures * ---	1	F04B39/00
P,A	DE-A-4 217 591 (HEINZELMANN) * column 5, line 7 - column 8, line 21; figures * ---	1	
A	GB-A-2 190 151 (TODESCAT ET AL) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 JUNE 1993	VON ARX H.P.

CATEGORY OF CITED DOCUMENTS

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