(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 052 975**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 81305315.4

(22) Date of filing: 10.11.81

(51) Int. Cl.^{3}: G 10 K 9/18

(30) Priority: 22.11.80 GB 8037506

(43) Date of publication of application: 02.06.82 Bulletin 82/22

(84) Designated Contracting States: DE FR GB IT

(71) Applicant: LUCAS INDUSTRIES LIMITED
Great King Street
Birmingham, B19 2XF(GB)

(72) Inventor: Hibell, Ernest George
40 Innsworth Drive
Castle Vale Birmingham(GB)

(72) Inventor: Dawes Cyril
17 Clarry Drive
Sutton Coldfield West Midlands(GB)

(74) Representative: Pearce, Anthony Richmond et al,
Marks & Clerk Alpha Tower ATV Centre
Birmingham B1 1TT(GB)

(54) **Horn body and horn having such a horn body.**

(57) An electromagnetic horn, has a dished body (10) containing a coil (11), an armature (12), and a make-and-break mechanism 14. The body (10) has an integral flange (17) to which a diaphragm (13) is secured in surface-to-surface contact by an aluminium clamping ring (18). The horn has pleasant tonal characteristics because it is formed of a non-alloy steel having nitrogen diffused therein so as to be in solid solution in a ferritic matrix and also has an epsilon iron nitride surface layer. Part of the layer is porous and contains oil with the result that it has a high corrosion resistance. The good tribological properties of the epsilon iron nitride layer enable the usual paper gasket between the diaphragm (13) and the flange (17) to be dispensed with.

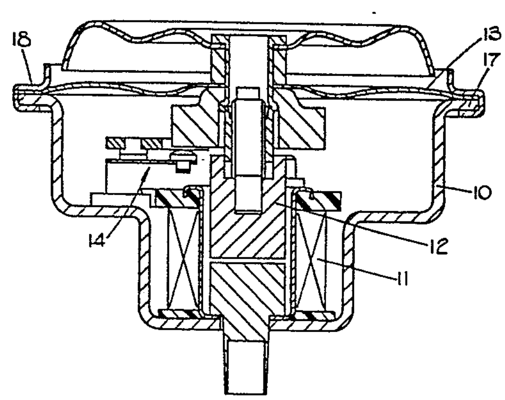

FIG. 1.

EP 0 052 975 A1

This invention relates to a horn and is particularly, though not exclusively, concerned with a diaphragm horn, e.g. an electro-magnetically operated diaphragm horn for use in a motor vehicle. The invention may also be applied to a horn having another type of sound-making mechanism, for example a reed and compressor type horn.

The applicants have surprisingly found that the tonal qualities of a horn can be materially improved by using a horn body which has been treated in a particular way.

In accordance with one aspect of the present invention, there is provided a horn body formed of a non-alloy steel having nitrogen dispersed through substantially the whole of the section thereof, the nitrogen being in solid solution in a ferritic matrix.

In accordance with another aspect of the present invention, there is provided a horn body formed of a non-alloy steel having an epsilon iron nitride layer thereon.

In accordance with the still further aspect of the present invention, there is provided a horn comprising a hollow body and a sound-making mechanism in the hollow body, wherein the hollow body is as defined in any one of the last preceding three paragraphs.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is an axial section through an electromagnetic horn in accordance with the present invention,

Figure 2 is a typical schematic section through part of the horn body of Fig. 1 showing the structure of the body,

Figure 3 is a graph in which sound pressure level is plotted against frequency for a conventional horn and a horn according to the present invention.

Referring now to Fig. 1, the horn illustrated therein is an electro-magnetically operated diaphragm horn for use in a motor vehicle. The precise construction of the electro-magnetic horn will not be described in any great detail herein except to state that it basically comprises a dished metal body 10 having a sound-making mechanism therein, the sound-making mechanism including a coil 11, an armature 12 secured to a diaphragm 13, and a make-and-break mechanism 14. As will be well appreciated by a person skilled in the art, energisation of the coil 11 is effected through the make-and-break mechanism 14 so as to cause the armature 12 and diaphragm 13 to vibrate. Vibration of the diaphragm 13 cause the horn to sound.

In this embodiment, however, the body 10 is formed of mild steel (which is a non-alloy steel) having a carbon content of 0.1 to 0.2%. The body 10 is press formed form a sheet of mild steel having a thickness of 1.6mm. The mild steel of the body has been treated in a manner to be described hereinafter. As a result of this treatment, the body 10 is provided with a core 15 having nitrogen diffused into the whole of the volume thereof, and a surface layer 16 on each side of the core 15. Thus, the dished body is provided externally and internally with the surface layer 16. The nitrogen in the core 15 is in solid solution in a ferritic matrix. Each surface layer 16 is of epsilon iron nitride and is constituted by two portions 16a and 16b. Portion 16a is porous, about 10 micrometres thick, and lies on the opposite side of the core 15 to the respective portion 16b.

The portion 16b is relatively non porous and has thickness of about 8 micrometres. Thus, the total thickness of each epsilon nitride surface layer 16 is about 18 micrometres.

The body 10 is provided with the structure as described above with reference to Fig. 2 by pressforming it from the non-alloy mild steel described above and then heat treating the body in a furnace at 570°C for two hours in an atmosphere consisting of ammonia and an endothermic gas mixture (carbon monoxide, carbon dioxide, nitrogen and hydrogen). During heat treatment, the residual level of ammonia was maintained at about 42% and 5 volume changes per hour were effected. The body after heat treatment was immediately oil quenched to ensure that the nitrogen which had diffused into the body remained in solid solution in the ferritic matrix within the core 15. As a result of the oil quenching, oil was retained within the pores in the portion 16a of each epsilon nitride surface layer 16 to give good bearing properties to the surface.

In order to test the effect produced, two electro-magnetic horns were tested, one of the horns was provided with a body which had merely been formed from mild steel by pressing, whilst the other horn was provided with a body which had been press formed out of the same mild steel but subsequently heat treated in the manner described hereinabove. In the test, the sound pressure levels at various audio frequencies were measured and the results are shown in Fig. 3. Curve A relates to the horn having the un-heat-treated body whilst curve B relates to the horn having the heat-treated body according to the present invention. As can be seen fron Fig. 3, additional harmonics or frequency components are obtained from the horn of the present invention. Subjectively, it was found that the horn which produced curve B had much more pleasant tonal characteristics than the horn which produced curve A.

As a further advantage, it was found that the body 10 had very good anti-corrosion properties and so did not need to be surface treated to prevent it from rusting. Furthermore, because of the tribological properties of the epsilon nitride layer on the body 10, it was possible to dispense with the usual paper gasket which is normally provided between the diaphragm 13 and the body. Thus, it will be seen from Fig. 1 that the diaphragm 13 is in direct ie surface-to-surface contact with an integral flange 17 of the body 10 and that these two components are secured together by means of a spun-over clamping ring 18. In this embodiment the clamping ring 18 was formed of aluminium (a material softer than that of the diaphragm) although it could have been formed of steel which had been coated with a suitably soft material such as plastics. With such a construction, it was also found possible to dispense with the usual paper gasket between the diaphragm 13 and the spun over clamping ring so that there is surface-to-surface contact between the diaphragm and the ring.

Whilst in the above-described embodiment, the non-alloy steel body 10 having a low carbon content was heat treated in an atmosphere of ammonia and an endothermic gas mixture, it is to be appreciated that any form of treatment which is capable of diffusing nitrogen substantially through the whole of the section of the body, and/or which is capable of producing an epsilon nitride surface layer, can be employed in the treatment of the body 10.

Whilst the mechanism which enables the tonal qualities of the horn to be improved is not fully understood, it is believed that the tonal qualities are improved mainly because of the presence of nitrogen in solid solution throughout substantially the whole of the ferritic matrix. Being dissolved interstitially, the nitrogen will considerably distort the alpha-iron lattice which will then collect and help to immobilise dislocation atmosphere, which then require an increased stress or strain energy to set them in motion again. The resultant heat treated body has a higher yield point than the unheat treated body and this, it appears, affects the resonating characterisitics of the body 10 under the influence of the vibrating diaphragm.

CLAIMS

1. A horn body formed of a non-alloy steel characterized in that nitrogen is dispersed through substantially the whole of the section of the horn body, the nitrogen being in solid solution in a ferritic matrix.

2. A horn body formed of a non-alloy steel characterized by having an epsilon iron nitride layer (16) thereon.

3. A horn body as claimed in claim 1, characterized by having an epsilon iron nitride layer (16) thereon.

4. A horn body as claimed in any preceding claim, which is of dished form having an integral flange (17) to which a diaphragm is secured in use, the dished body being arranged to receive a coil, an armature and a make-and-break mechanism in use.

5. A horn comprising a hollow horn body and a sound-making mechanism in the hollow horn body, characterized in that the horn body 10 is as claimed in any one of claims 1 to 3.

6. A horn as claimed in claim 5, characterized in that a surface layer portion (16a) of the horn body (10) is porous and contains oil.

7. A horn as claimed in claim 5 or 6, wherein the horn body (10) is of dished form having an integral flange (17), the sound-making mechanism includes a diaphragm (13) which is secured to the flange (17), characterized in that the diaphragm (13) is in surface-to-surface contact with the flange (17).

8. A horn as claimed in claim 7, wherein a clamping ring (18) is provided for securing the diaphragm (13) to the flange (17), and wherein the clamping ring (18) has a diaphragm-engaging surface formed of a softer material than that of the diaphragm (13), characterized in that there is a surface-to-surface contact between the clamping ring (18) and the diaphragm (13).

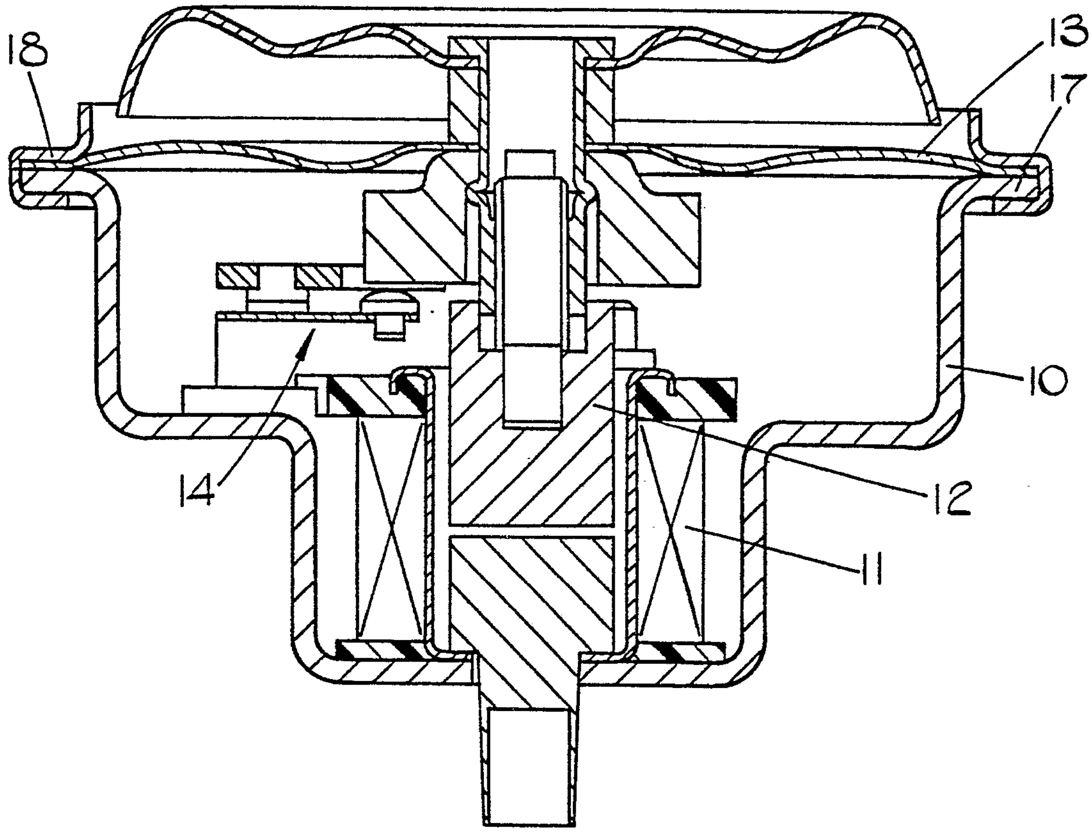

FIG. 1.

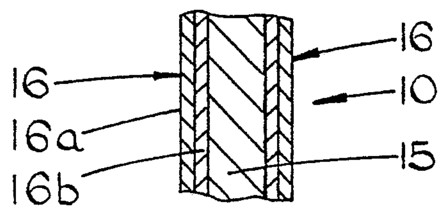

FIG. 2.

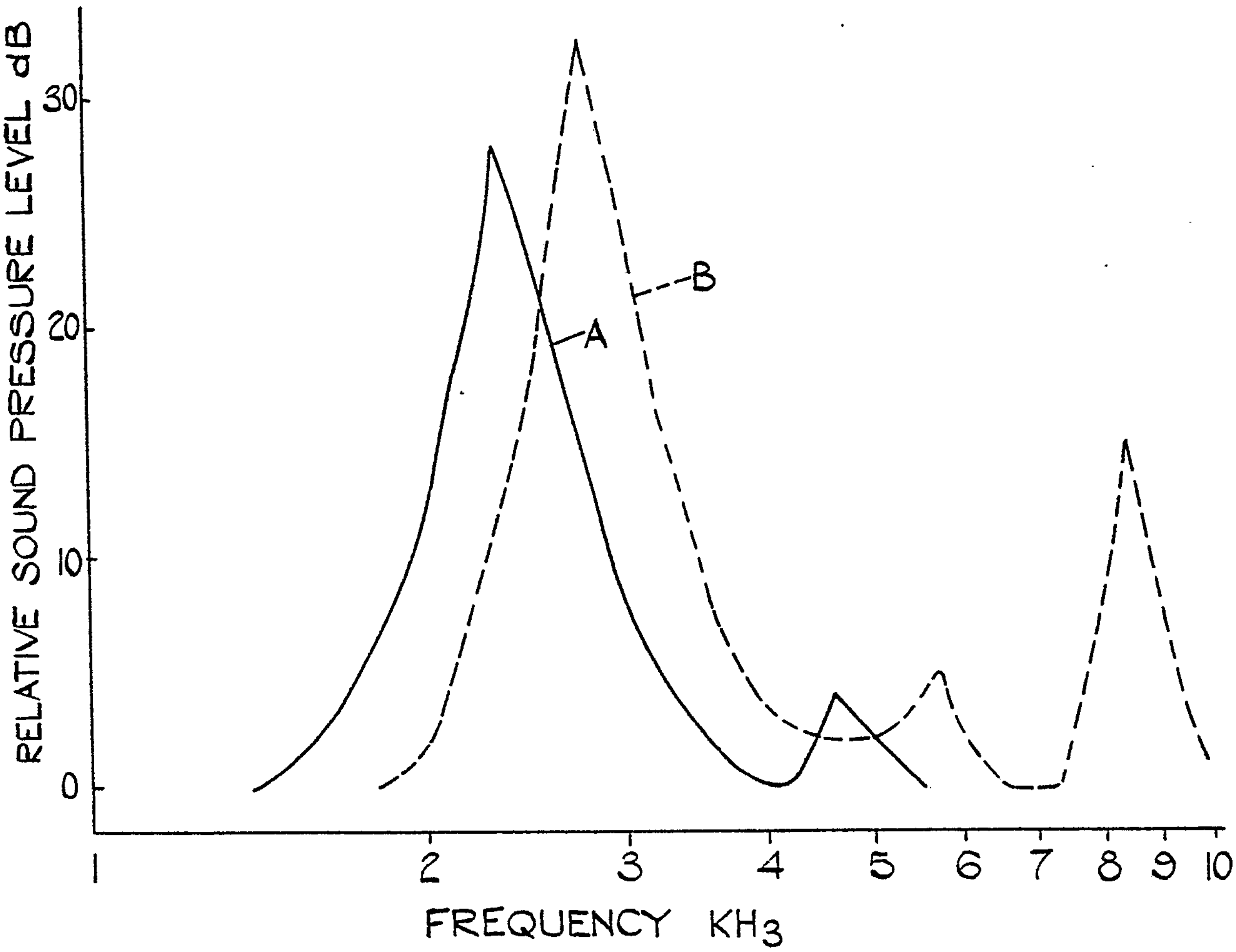
RELATIVE SOUND PRESSURE LEVEL dB
30
20
10
0
B
A
1
2
3
4
5
6
7
8
9
10
FREQUENCY KH3

FIG.3.

0052975

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 81 30 5315

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	JOURNAL OF SPACECRAFT AND ROCKETS, vol. 12, no. 1, January 1975, New York (US) R.H. SHOEMAKER et al.: "Improvement in wear and fatigue properties of structural metals through liquid nitriding" pages 51-53 * Page 51, excluding the section "Wear properties" *	1-3	G 10 K 9/18
	--		TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
A	HARTEREI TECHN.MITTEILUNGEN, vol. 32, no. 4, April 1977, München (DE) J. MATAUSCHEK et al.: "Neue Erkenntnisse über den Aufbau und die Porigkeit der beim Badnitrieren erzeugten Verbindungsschicht" pages 177-181 * Page 177, up to and including 1st paragraph of right-hand column *	2,3	G 10 K C 23 C
	--		
A	CHEMICAL ABSTRACTS, vol. 93, no. 18, November 1980, page 223, left-hand column, abstract 171735t Columbus, Ohio (US) C. DAWES et al.: "A re-appraisal of nitrocarburizing and nitriding when applied to the design and manufacture of non-alloy steel automobile components" & J. HEAT TREAT 1979, 1(2) 30-42 * Abstract *	1,2	CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
	-- ./.		
/	The present search report has been drawn up for all claims		&: member of the same patent family, corresponding document

Place of search	Date of completion of the search	Examiner
The Hague	03-03-1982	STUBNER

EPO Form 1503.1 06.78

0052975

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 81 30 5315
- 2 -

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
A	CHEMICAL ABSTRACTS, vol. 90, no. 4, January 1979, page 242, left-hand column, abstract 27235a Columbus, Ohio (US) & JP - A - 78 102 842 (ASAHI CHIYODA KOGYO K.K.)(07-09-1978) * Abstract *	1,6	
	--		TECHNICAL FIELDS SEARCHED (Int. Cl.3)
A	US - A - 2 787 786 (ZEININGER AND ISSLER) * Column 1, lines 53-65; figures 1,4 *	4,7,8	
	--		
A	FR - A - 2 242 921 (ROBERT BOSCH G.M.B.H.) * Page 2, lines 7-29; figures 1-3 *	4,7,8	

EPO Form 1503.2 06.78