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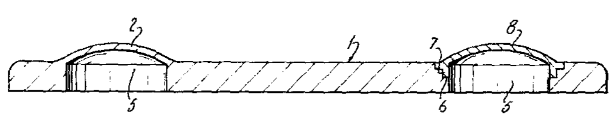
(54) **Isolation pads.**

(57) An isolation pad for absorbing vibration transmitted from a loudspeaker to a support for that loudspeaker has a mat (1) which acts as an acoustic mass for the support and hollow domes (2) projecting from the mat (1) on which the loudspeaker rests. The domes (2) act as spring elements with non-linear characteristics which isolate the loudspeaker from the support. The mat (1) is made of a high density elastomer which conforms to the surface of the support on which it rests and the domes (2) may be made of the same material or a different material. In the latter case, the domes (8) may be made interchangeable with other domes of different spring characteristics, to suit the loudspeakter used. A flock coating is applied to the upper surface of the mat to dissipate air vibrations between the mat (1) and the loudspeaker.



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ISOLATION PADS

This invention relates to pads for absorbing vibration.

Such pads are of course in general very well known, for example, pads being put under typewriters to absorb the vibration that they generate, and pads or springs being interposed between vibrating machines and their mountings.

The present pad has a highly specific application namely to be interposed between a loud-speaker and its support, and is intended for the "hi-fi" or audiophile market.

Loud-speakers are frequently rested on shelves or other pieces of furniture. Characteristically these are much less robust than the cabinet or other structure housing the loud-speaker.

When the loud-speaker generates sounds, two kinds of vibration may be transmitted to the shelf or other support. One results from audio coupling of the shelf to the signal produced by the loud-speaker through the sound vibrations in the air, and the other through the mechanical transmission of vibration from the loud-speaker structure to the shelf or other support.

The present invention is a pad for interposition between a loud-speaker and its support so as to diminish or remove the vibration occurring in the shelf or other support. It diminishes the effect of any acoustic coupling between the two and also diminishes or removes the mechanical transmission of vibration between them.

The pad acts as an acoustic mass loading in relation to the shelf or other support which characteristically will be comapratively readily energised by soundwaves in the air (or by mechanically transmitted vibrations).

The mat should preferably provide a mass loading of between 1 and 2 kgs to the support system to attenuate airborne vibrations in the support. If this is done the under-surface of the mat should be essentially flat and smooth and the mat made of a material which will conform to the surface on which it rests without movement. For aesthetic reasons the mat should not be too thick, hence a high density elastomeric material is desirable for the main body of the mat.

The mat as a whole should be compliant.

Although the presence of any elastomeric pad between the loud-speaker and its support would per se isolate a certain amount of the mechanical vibration of the speaker, we provide specifically for the efficient mechanical isolation of loud-speakers of a wide range of weights. We therefore provide specific spring elements in the pad.

For the best results the spring rate of the spring elements should be such that the resonant frequency of the speaker, mounted on to the mat, should be below 20Hz. A single mat or a single set of spring elements has to cater for a range of speakers whose masses may differ by a factor of 5:1. If the spring elements had linear characteristics, then the deflections would be excessive with the heavier speakers and could lead to some instability and large amplitude movements at resonance.

The amplitude at resonances is controlled by the "Q" factor. One means of reducing the Q factor would be to use a high damping rubber but this would lead to a greater transmissibility of the higher frequencies. The alternative means of lowering the Q factor is to have a non-linear spring rate. The most desirable condition is to have the spring rate proportional to the static load applied by the speaker which will give constant resonant frequency.

A most economical way of achieving this within the present invention is to form the spring elements in the mat as a series of domes. The action of the domes can be simply understood by considering the fact that when a light load is placed on the dome, the greater part of the dome is free to deform under shear but, when a heavy load is applied, the whole of the central area will be immobilised against the load and only a narrow annulus is now free to deform. Loud-speakers are usually of box construction and resonances within the loud-speakers are at their greatest in the centre of the box sections. Conversely these resonances will be at a minimum at the corners of the box. Hence, there are preferably four spring elements in the mat which are situated to support the corners of the loud-speaker.

These four elements are arranged so as to contact the speaker enclosure as near as possible to the corners or edges of the enclosure at which points the amplitude of mechanical vibration of the enclosure is smallest. This prevents mechanical vibrations from the centre of the lower panel of the loud-speaker enclosure from being transmitted to the support. The spring elements isolate mechanical vibrations from the support at frequencies above the natural resonant frequency produced by the loud-speaker with the enclosure supported by the spring elements. It is advantageous that this resonant frequency occurs between 10 and 20 Hz to prevent coupling of vibration within the range detectable by the ear and prevent the enclosure from being unstable when mounted on the mat. The use of domed pads as spring elements has the useful property of providing a more or less constant resonant frequency for a wide range of weights of loud-speakers. Large amplitudes of vibration can be induced if sound is reproduced by the loud-speaker at the appropriate frequency when the enclosure is mounted on linear spring elements.

The material of the spring elements may be the identical material of the rest of the appropriate surface of the pad, i.e. the pad may be formed in an integral forming operation or it may be an inserted plug of a different material, inserted into a formed aperture in the pad.

Elastic mouldings for the spring elements may be separately moulded in a different material to the main body of the pad. In this way the elastic and damping properties of the spring element may be optimised to minimise the mechanical transmissions from a given loud-speaker to a given shelf or other support. Such inserts may be coded in some way, as for example by colour, to the intended use.

Typically, the thickness of material in a dome will be not more than one third and preferably not more than one quarter of the thickness of the remainder of the pad, and the degree of projection above the upper surface of the pad to the upper surface of the projection will be of the order of 1½ times the thickness of the pad.

The pad (excepting the spring element) will preferably be made of a single material but may be made of a plurality of materials laminated or bonded together; it is desirable for it to have a pile or flock coating, particularly on the surface adjacent to the loud-speaker.

As the lower surface of the loud-speaker enclosure vibrates, supported by the corners on the spring elements, the volume of air contained between the enclosure and the mat changes. Hence the mats "pump" air as the speaker enclosure flexes adding to the sound produced by the loud-speaker. This undesirable effect inherent in any system which separates the centre of the speaker enclosure from the support, may be minimised by coating the upper surface of the mat with a fine dissipative material such as flock.

A particular example of the pad is to be seen in the accompanying drawings, wherein:

Figure 1 is a face view;

Figure 2 is a section on the line 2-2 of Figure 1 but showing also a modification;

Figure 3 shows graphs of tests carried out with and without a pad embodying the invention; and

Figures 4 and 5 are graphs of spring

deflections and resonant frequencies versus load.

Figure 1 shows an acoustic isolating pad 1 embodying the inventionfor interposition between the loud-speaker and its supporting surface such as a shelf. It is a rectangular one-piece moulding of the high-mass, compliant elastomer material. The moulding has a plurality of specific spring elements 2 towards each of the corners and these are upwardly domed portions in the upper surface of the pad under which are formed voids or hollows. These are for primarily supporting the loud-speaker on the pad. Apart from these the lower surface of the pad is completely flat as is also the upper surface except for marginal bevelled area 3.

Figure 2 shows a section through the pad and shows two alternative ways of forming the spring elements. The left hand side of Figure 2 shows an integral discontinuity as described with reference to Figure 1, the projection 2 being formed of a thin portion of the same elastomer material bridging over in a part-dome the void 5 underneath it. It is preferred however to form a pad in the manner seen in the right hand part of Figure 1 where the hollow is provided at its upper end with seat 6 for receiving the flange 7 of a domed cap-like plug insert 8. The provision of such inserts 8 has the advantage that either in the factory or in the hands of the user inserts 8 of different characteristics may be placed in the mat in order to accommodate most efficiently the weight, size or other characteristics of different loud-speakers.

As has been mentioned the spring elements whether they be integral or due to the inserts 8 have the function of primarily absorbing mechanical vibration generated in the loud-speaker while the rest of the mat lying dead and flat upon the shelf or other support for the loud-speaker acts as a massive acoustic load for that support and deadens the vibration of the support due to any acoustic coupling through the air.

Figure 3 is a graph showing the response of a given shelf and loud-speaker at a range of frequencies, i.e. the acceleration of the shelf immediately below the speaker resulting from a constant mechanical shock, in Figure 3a showing the position without the inserted pad and in Figure 3b showing the response of the shelf when the pad was inserted, the latter demonstrating a dramatic decrease in the stray and unpredictable resonances which would otherwise have impaired the true response characteristics for which the loud-speakers were designed.

Figure 4 is a graph of the deflection of an integral spring element which was a dome of 6 mm thick elastomer integral with the pad, curved at a radius of 53 mm and with a diameter of the aperture of 45 mm. The elastomer was natural rubber.

Figure 5 shows the self-resonant frequency of a system incorporating that pad and a number of loud-speakers of different weights. It will be seen that a substantially constant self-resonant frequency of below 15Hz can be obtained over a range of speaker weights from about 2 Kg to about 14 Kg.

CLAIMS:

1. An isolation pad for interposition between a loudspeaker and a support comprising a mat (1) so as to absorb vibration, adapted to act as an acoustic loading for the support;

characterised in that:

a plurality of spring elements (2) project from a surface of the mat (1) for supporting the loudspeaker.

2. An isolation pad according to Claim 1, wherein each spring element (2) is in the form of a hollow dome (8).

3. An isolation pad according to Claim 2, wherein the thickness of material forming the dome (8) is not greater than one third of the thickness of the mat (1).

4. An isolation pad according to any one of the preceding claims, wherein said spring elements (2) have a non-linear characteristic.

5. An isolation pad according to Claim 4, wherein the spring rates of the spring elements (2) are proportional to the static load applied to the respective spring element (2).

6. An isolation pad according to any one of the preceding Claims, wherein the spring elements (2) are interchangeable with spring elements (2) of different spring characteristics.

7. An isolation pad according to any one of the preceding Claims, wherein said mat (1) is compliant and adapted to conform to the surface on which it rests.

8. An isolation pad according to any one of the preceding Claims, wherein the mat (1) is made of a high density elastomeric material.

9. An isolation pad according to any one of the preceding Claims, wherein the spring elements (2) are formed from a different material from the mat (1).

10. An isolation pad according to any one of the preceding Claims, having a coating of dissipative material on the surface of the mat (1) from which the spring elements (2) project.

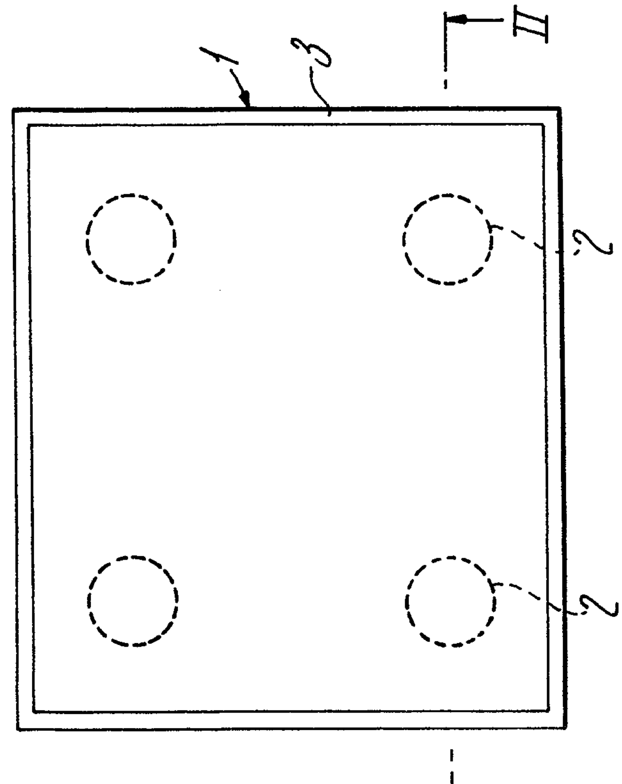


Fig.1.

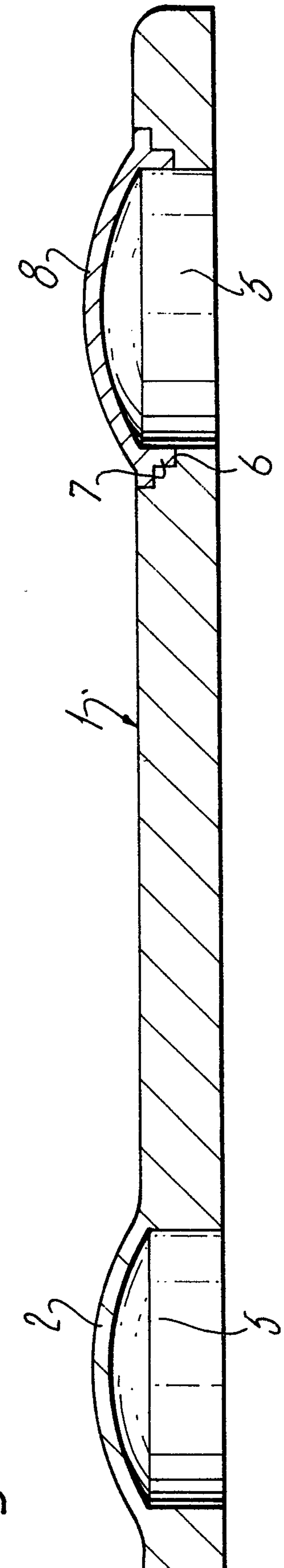


Fig.2.

Fig. 3a.

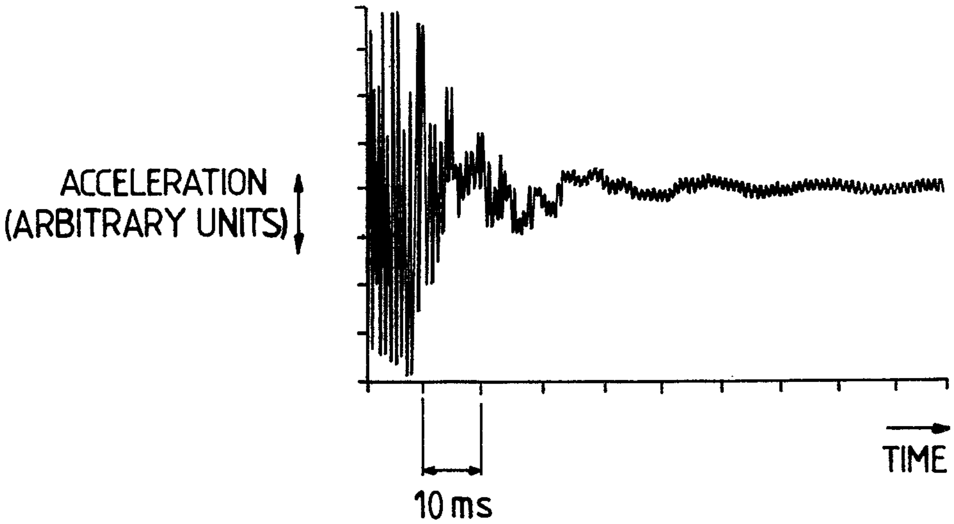

ACCELERATION
(ARBITRARY UNITS)
TIME
10 ms

Fig. 3b.

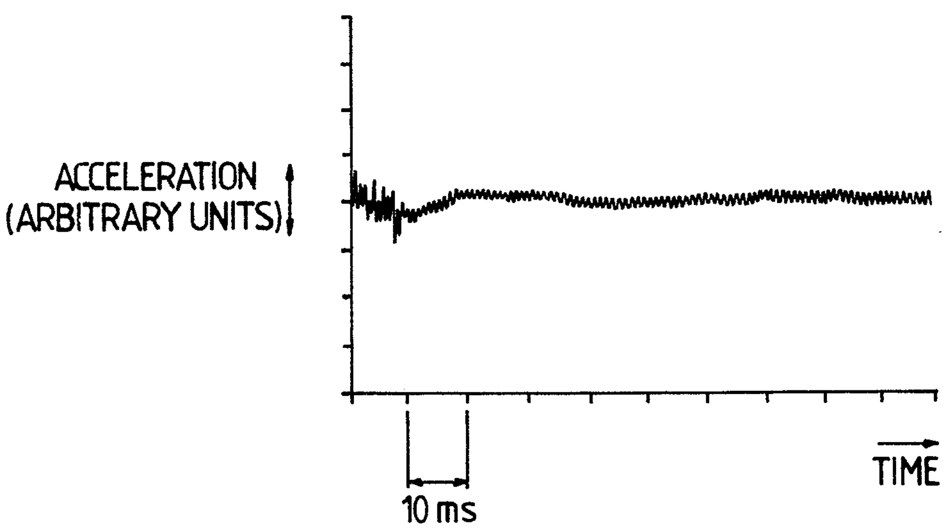

ACCELERATION
(ARBITRARY UNITS)
TIME
10 ms

Fig.4.

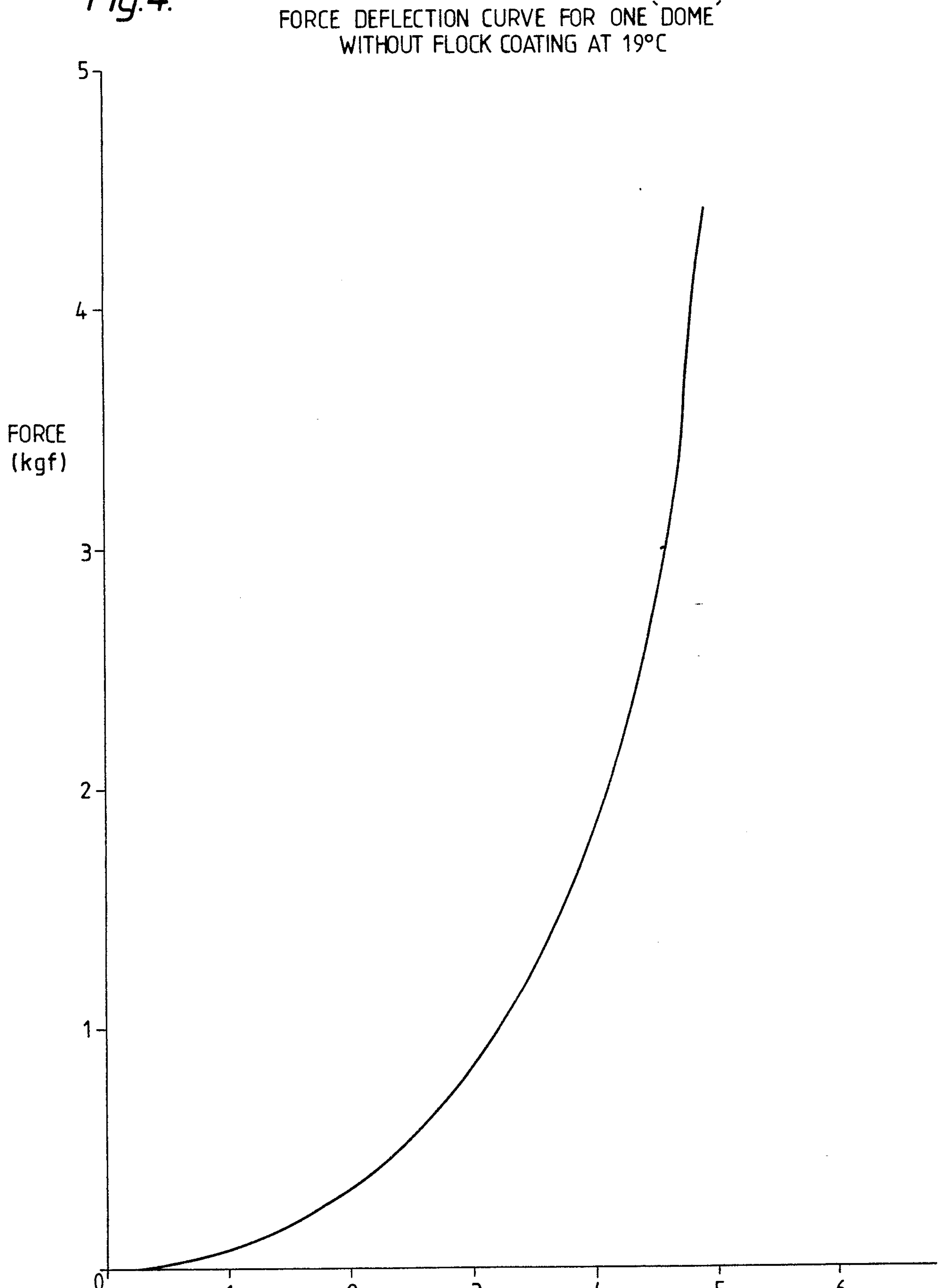
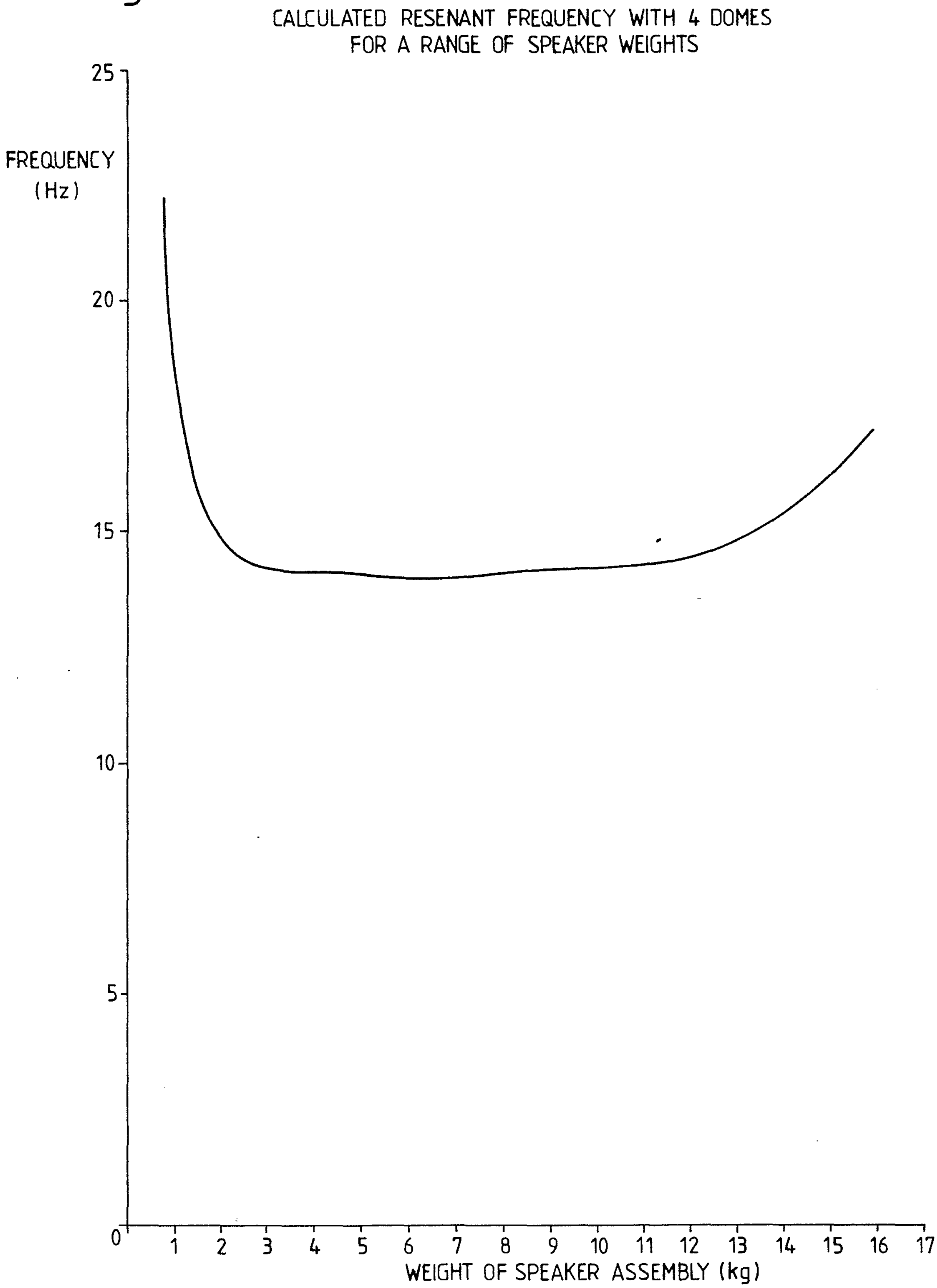

FORCE DEFLECTION CURVE FOR ONE `DOME´
WITHOUT FLOCK COATING AT 19°C
FORCE
(kgf)
5
4
3
2
1
0
1
2
3
4
5
6
DEFLECTION (mm)

Fig. 5.


CALCULATED RESENANT FREQUENCY WITH 4 DOMES
FOR A RANGE OF SPEAKER WEIGHTS
FREQUENCY
(Hz)
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
WEIGHT OF SPEAKER ASSEMBLY (kg)

European Patent Office

EUROPEAN SEARCH REPORT

0078649

Application number

EP 82 30 5655

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. 3)
Y	US-A-4 251 045 (MEYERLE) *Column 4, lines 8-68; column 7, line 46 to column 8, line 24; figure 4*	1,5,6	G 10 K 11/00 G 10 K 11/16
Y	GB-A-1 422 255 (KURAISURA DENKI KABUSHIKI KAISHA) *Page 1, line 89 to page 2, line 24; figure 1*	1,2	
A	US-A-3 647 022 (MEYER et al.) *Column 3, lines 22-59; figures 1,2*	6,8	
A	US-A-2 541 159 (GEIGER) *Column 5, line 41 to column 6, line 9; figures 1-3*	1,2,7	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	DE-A-2 433 795 (MESSERSCHMIDT-BÖLKO-BLOHM GmbH) *Page 5, paragraph 4; figure 3*		G 10 K
A	EP-A-0 025 632 (DELHEZ PHILIPPE) *Page 5, lines 24-32; figures 1,2*		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-01-1983	STUBNER E.B

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
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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