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(54) IMPROVEMENTS IN OR RELATING TO NOISE ABATEMENT TECHNIQUES AND SYSTEMS

(71) We, DELTA MATERIALS RESEARCH LIMITED, a British Company of P.O. Box 22, Hadleigh Road, Ipswich, Suffolk, IP2 OEG, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to noise abatement techniques and systems and is particularly concerned with methods and apparatus for acoustically cladding machines and other noise-generating sources and to machines and noise-generating sources, particularly stock tubes for use with automatic lathes, so cladded.

Noise emanating from or generated by industrial equipment and processes creates many problems including physical effects induced in personnel working in noisy environments leading to such personnel becoming irritated and tense, and consequently, in many cases, accident prone.

Noise is also known to damage hearing and noise abatement is a financial incentive because the potential damages that can be awarded for noise induced hearing loss are considerable. In situations where noise cannot be controlled for some reason, it is necessary to at least ensure that the noise in the working environment is kept within the overall level prescribed by law, the provision of personal hearing protection often being permissible only as a temporary measure until a more permanent solution is found.

Certain kinds of noise are identifiably and definitely injurious and some action must be taken to control same. The ideal solution would of course be to remove or reduce the noise at the source, but this is not always feasible or easy. Some types of noise, possibly a majority of them are due to the design and perhaps assembly of the equipment, while others are produced by the method of operation, such as is the case with automatic lathes, plastics granulating machines, transformers, motors and pumps, air or gas intakes and discharges, pile-driving hammers, etc.

A variety of noise control equipment is available. Thus there are damping materials for control of plant noise the principal areas of application thereof being in the control of impact-generated noise; enclosures with walls and covers made of or lined with noise absorbing insulation materials; and there are also available noise reducing doors, panels, and silencers for engines, compressors, and the like.

As noted, in most noise control situations the object of the exercise is to prevent the noise being generated in the first instance but, also as noted, this is not possible in many applications or, where possible, the noise reduction achieved is not sufficient to reduce the noise emanating from the machines or the like to an acceptable level. When noise has been generated the problem then becomes that of containing the noise, reducing its ability to spread and affect personnel or quiet areas in a factory, plant or the like. The majority of the techniques presently available for preventing the spread of noise depend upon the use of enclosures which, while more or less effective in containing the noise, present many problems including those of floor space requirements, access to the machine for operating and servicing same and in most cases such enclosures present difficult ventilation problems.

It is an object of the present invention to overcome or minimize the aforenoted problems by providing a method of reducing the noise emanating from or generated by industrial equipment and processes and other noise-generating sources and an acoustic cladding for use therein which offers a high degree of noise insulation and hence has an excellent ability to contain noise.

Another object of the invention is to provide an effective noise reducing cladding that can be applied to vibrating surfaces to reduce the noise emanating from such surfaces by providing a noise insulating barrier thereat.

A further object of the invention is to provide a stock tube having an acoustic cladding effective to improve the noise characteristics of the stock tube enabling the noise emission from the stock tube to be controlled within acceptable limits irrespective of the machine density.

The invention provides a method of reducing the noise emanating from a noise-generating source, comprising

(a) covering a surface from or via which the noise emanates with a first layer of a resilient vibration-isolating material, the said first layer being in contact with and supported by the said surface;

(b) covering the said first layer with an intermediate layer of a heavy limp sound-insulating barrier material, the first layer being in contact with and supporting the intermediate layer and decoupling the intermediate layer from the said surface; and

(c) covering the intermediate layer with an outer surface-protective layer resistant to impact, wear, and abrasion.

The invention also provides a cladding for reducing the noise emanating from a noise-generating source having a surface from or via which the noise emanates, the cladding consisting of a flexible layered structure adapted to cover the said surface, the layered structure adapted to cover the said surface, the layered structure comprising:

(a) a first layer of a resilient vibration-isolating material, the first layer being adapted to be positioned in contact with and supported by the said surface;

(b) an intermediate layer of a heavy limp sound-insulating barrier material, the first layer being in contact with and bonded to the intermediate layer and serving to decouple the intermediate layer from the said surface; and

(c) an outer surface-protective layer resistant to impact, wear, and abrasion, bonded to the face of the intermediate layer remote from the first layer.

The cladding may be applied to a diverse range of machines, amongst which may be noted by way of example, the stock tubes of automatic lathes, the machine surfaces of plastic granulators, the body panels of processors, and machines where there is a need for part enclosure effects, such as presses and lathes.

Preferably, the first or inner layer, which serves as a vibration-isolating layer, positioned in immediate contact with the surface from or via which the noise emanates, consists of a non-rigid plastic or rubber foam or fibrous material having a hardness in the range 0 to 100 degrees on the Shore 00 scale. More particularly it is preferred that the material has a hardness in the range 5 to 95 degrees and still more preferably in the range 25 to 70 degrees on the Shore 00 scale. It is also preferable that this inner layer should be self-adhesive.

Alternatively the first or inner layer may consist of soft rubber one surface of which is castellated or formed with a series of projections adapted to engage the surface from or via which the noise is transmitted and which construction ensures that the area in contact with the said surface is the minimum necessary to support the cladding. The inner layer may suitably be fabricated of soft rubber in the hardness range of 0 to 50 degrees, preferably 10 to 30 degrees, on the Shore A scale. The inner layer may alternatively be fabricated of foam or of fibrous material.

The intermediate layer serves as a heavy, limp, sound-insulating barrier and may suitably be fabricated of lead sheet or may be in the form of a metal-loaded plastics barrier sheet.

The third or outer layer, which is designed to provide resistance to impact, wear, and abrasion, is suitably made of a hard rubber, plastics material, or bitumastic material having a hardness in the range 50 to 100 degrees on the Shore A scale and preferably in the range 90 to 100 degrees on the Shore A scale.

The aforementioned techniques and claddings have proved effective to reduce noise by about 22 dB(A) and can be classed as single stage noise reduction treatments. Other single stage treatments would, for example in the case of stock tubes, consist in the introduction of a non-metal liner into the stock tube to reduce the impact noise of the stock and tube; a variation of this would be the use of a stock carriage spring in lieu of a liner; and another approach to the noise reduction problem would be the use of a steel outer tube separated from the stock tube by an isolating media pad.

In another aspect, the invention provides a stock tube provided with a cladding comprising:

(a) a first layer of a resilient vibration-isolating material, the first layer being in contact with and enclosing the outer surface of the stock tube;

(b) an intermediate layer of a heavy limp sound-insulating barrier material, the intermediate layer being in contact with and enclosing the first layer, the first layer decoupling the intermediate layer from the outer surface of the stock tube; and

(c) an outer surface-protective layer resistant to impact, wear, and abrasion, enclosing the intermediate layer.

The invention will be described further with reference to Figures 1 to 3 of the drawings accompanying the Provisional Specification and to Figures 4 to 6 of the accompanying drawings, which show exemplary embodiments of the invention and in which:

Figure 1 shows, diagrammatically, a section of cladding material according to the invention as applied to a machine surface;

Figures 2a and *2b* are cross-sectional views showing different embodiments of cladding material according to the invention as applied to a stock tube for an automatic lathe;

Figure 3 is a fragmentary view in section showing cladding material according to the invention as applied to a plastics granulator;

Figures 4a and *4b* are cross-sectional views showing embodiments of a two-stage noise-reducing treatment cladding as applied to a stock tube; and

Figures 5 and *6* are longitudinal section views of stock tubes as shown in Figures 4*a* and 4*b* showing different embodiments of end cap arrangements which may be employed.

Referring to Figure 1 which shows the basic construction of the cladding material according to the invention, it will be seen that it comprises three laminates or layers.

The first or inner layer 2 is designed to abut against the surface from or *via* which noise is generated or transmitted, such as the vibrating surface 4 of a machine. This inner layer 2 may or may not be castellated or otherwise profiled in one surface with a pattern of projections adapted to engage the surface 4.

The second or intermediate layer 6 comprises a heavy, limp, sound insulating material.

The third or outer layer 8 constitutes the outer protective cover of the cladding designed to provide impact-, wear- and abrasion-resistance and physical support.

The constitution of the basic cladding as shown in Figure 1 and in specific applications in each of Figures 2 and 3 may take numerous forms and various examples of cladding involving laminations or layers of different combinations of materials are set forth in Table 1 hereafter.

Preferably, the overall thickness of the cladding to include all three laminations, is in a range up to about 6 mm.

TABLE 1

Example	First or inner Layer 2			Second or intermediate layer 6		Third or outer Layer 8		
	Material	Hardness on Shore Scale (degrees)	Thickness (mm)	Material	Thickness (mm)	Material	Hardness on Shore Scale (degrees)	Thickness (mm)
1	Profiled or castellated soft rubber	A - Scale 0 to 50	1.0 to 5.0	heavy, limp sound insulating barrier	0.25 to 2.5	rubber or plastics or bitumastic	A - Scale 0 to 100	0.1 to 3.0
2	plastics or rubber foam or fibrous material	00 - Scale 0 to 100	1.0 to 5.0	heavy, limp sound insulating barrier	0.25 to 2.5	rubber or plastics or bitumastic	A - Scale 0 to 100	0.1 to 3.0
3	Profiled or castellated soft rubber	A - Scale 10 to 30	1.0 to 5.0	lead sheet	0.25 to 2.5	rubber or plastics	A - Scale 50 to 100	0.1 to 2.0
4	plastics or rubber foam	00 - Scale 5 to 95	1.0 to 5.0	lead sheet	0.25 to 2.5	rubber or plastics	A - Scale 50 to 100	0.1 to 2.0
5	Profilled or castellated soft rubber	A - Scale 10 to 20	1.0 to 5.0	lead sheet	0.4 to 1.2	rubber or plastics	A - Scale 50 to 100	0.1 to 2.0
6	plastics or rubber foam	00 - Scale 10 to 90	1.0 to 5.0	lead sheet	0.4 to 1.2	rubber or plastics	A - Scale 50 to 100	0.1 to 2.0
7	plastics or rubber foam	00 - Scale 15 to 80	1.0 to 5.0	lead sheet	0.4 to 1.2	plastics or rubber or bitumastic	A - Scale 50 to 100	0.1 to 2.0
8	plastics or rubber foam	00 - Scale 25 to 70	1.0 to 3.0	lead sheet	0.8 to 1.2	plastics or rubber or bitumastic	A - Scale 50 to 100	0.1 to 2.0
9	PVC or polyethylene foam	00 - Scale 25 to 70	1.0 to 3.0	lead sheet	0.8	PVC or polyurethane or polyetheylene	A - Scale 90 to 100	0.1 to 1.5

Practical applications of the above described cladding material are shown in Figures 2 and 3.

Thus Figure 2 shows two variations of the cladding material applied in the form of a sheath to a tube 10 such, for example, as the stock tube of an automatic lathe or the stock tube of a reeler straightening machine.

In Figure 2(a) the inner laminate 2 has a non-castellated inner surface whilst in Figure 2(b) the inner laminate 2 is of castellated configuration. In the applications shown in Figures 2(a) and 2(b) the cladding is effective to reduce the noise emanating from tube 10 as the bar stock strikes the walls of the tube.

In experiments made, by way of example, with a bar stock tube for an automatic lathe with 99.5 per cent of the surface being covered with a cladding constituted as in Example 9 (Table 1) it was found that a reduction of some 23dB(A) was achieved when compared to a similar stock tube devoid such cladding.

Figure 3 shows the application of the cladding material to a plastics granulating machine, generally designated 12, for which it provides an insulating barrier which constitutes an effective noise reducing cladding that can be applied to reduce the noise emanating from the surfaces of the granulator. In this embodiment the corners of the cladding are sealed as, for example, by polyvinylchloride tape 14.

In experiments made with a plastics granulating machine provided with cladding constituted as in Example 9, applied to 95 per cent of the machine surface it was found that a reduction of some 14 dB(A) was achieved as compared to the same machine not so cladded.

In some applications, single-stage noise reducing treatments as described in the foregoing may not provide the desired degree of noise attenuation, as, for example, where the requirement is to reduce the noise from a stock tube of an automatic lathe to at least 6 dB(A) below the noise produced by the lathe to which the stock tube is attached. In a typical situation of this kind under semi-anechoic conditions, measuring the noise 1 metre from the machine surface and 1.5 metres above floor level, it has been found that a typical automatic lathe produces a noise level of about 84 dB(A). If the lathe stock tube and the lathe are considered as separate noise sources and if the stock tube produces a noise level of 84 dB(A), the stock tube noise added to the lathe noise would produce a combined noise level of 87 dB(A). To provide maximum effectiveness in noise reduction a stock tube noise level 10 dB(A) below machine noise level is necessary, i.e. 74 dB(A). To achieve this it has been found necessary to employ a two-stage noise reducing treatment. As shown in Figure 4, this may be effected, in the case of a stock tube, for example, by cladding the tube 10 in the manner described with reference to Figures 2*a* (as shown in Figure 4*a*) and 2*b* (as shown in Figure 4*b*), but replacing the third or outer surface-protecting layer 8 by another vibration-isolating layer 11 of a resilient material such as foam plastic or rubber, and inserting the whole assembly inside a noise-insulating surface-protective outer steel tube 16. With this arrangement, special care must be taken to prevent bridging of the vibration-isolating layers 2 and 11, which would permit vibration flanking paths to be set up. Such paths would counteract the effect of the treatment. For this reason, the ends of the tube are provided with seals made of a suitable material such, for example, as a soft silicone or polyurethane rubber.

Table II shows the comparative results for a number of different type stock tubes and the noise produced by such tubes when driven by ¼-inch A.F. hexagonal steel stock rotating at 8,000 rpm. From Table II it will be appreciated that a two-stage noise reduction sytem is necessary if the stock tube noise is to be reduced 10 dB(A) below the lathe noise level, i.e. to 74 dB(A) A lathe noise level on the order of 84 dB(A) is about the maximum that can be tolerated if the recommended noise level of 90 dB(A) is to be achieved in an automatic lathe shop. This is due to the high machine density and hence the additive noise effects that are prevalent in such automatic lathe shops.

TABLE II

Item	*Stocktube Type* Tubes 2-6 one-stage noise reduction Tubes 7-10 two-stage noise reduction	Maximum stock size for tube (inches)	Outer diameter of stock tube (inches)	Surface in contact with stock	Noise level on test rig dB(A)	Noise reduction compared with Plain steel tube - Item 1 - dB(A)
1	Plain steel tube.	0.63	0.79	steel	103.0	0
2	Plain steel tube fitted with a spring.	0.58	1.00	steel spring	76.0	27.0
3	Plain steel tube fitted with a nylon liner.	0.44	1.00	Nylon	90.0	13.0
4	Two concentric steel tubes with the space therebetween filled with expanded soft polyurethane foam.	0.58	1.625	steel	77.0	26.0
5	Moulded plastics inserts inside a steel tube to define a concentric plastics inner tube with the space between not filled.	0.53	1.13	Nylon	78.0	25.0
6	Steel tube wrapped with isolating material supporting a wrapping of insulating material and surface protecting layer.	0.63	1.25	steel	82.0	21.0
7	As tube 6 but with convolute spring inserted into the inner tube	0.58	1.25	steel spring	66.0	37.0
8	High molecular weight polyolefin tube (such as polyethylene or polypropylene) spirally wrapped with polyurethane foam in an outer steel sheath.	0.56	1.25	Nylon	77.0	26.0
9	As tube 6 but with a nylon tube inserted into the inner steel tube.	0.63	1.25	Nylon	77.0	26.0
10	A two-stage noise reduction tube according to the present invention as shown in Figures 4*a* to 6 and consisting of a steel inner tube supporting a layer of closed cell isolating foam, a noise insulating or barrier layer and a further layer of closed cell isolating foam, all inserted into an outer steel tube.	0.53	1.00	steel	70.0	33.0

To avoid bridging of the vibration isolating layers 2 and 11 and thereby avoid the establishment of sound transmission paths between the inner tube 10, the intermediate sound insulating layer 6 and the outer tube 16 of the composite stock tubes according to the present invention same are terminated in a suitable manner suvch as shown in Figure 5 or 6.

In the arrangement shown in Figure 5 a bush or spacer 17, preferably of rubber suitably having a hardness in the range 10° to 70° on the Shore A scale, is fitted over and protrudes beyond each end of the inner tube 10 into abutting relationship with the vibration isolating layers 2 and 11 and the sound insulating layer 6. The end portions 18 of outer tube 16 extend beyond the bushes or spacers 17 and are turned inwardly into engagement with the outer end of each of the bushes or spacers 17 to retain same in position. The outer end portions of the sound insulating layer 6 are preferably, although not necessarily, undercut in the manner shown at 15 in Figure 5 so that they terminate inwardly of the ends of the vibration isolating layers 2 and 11 which latter are themselves terminated inwardly of the ends of tube 10. This arrangement avoids any possibility of setting up sound transmission paths between the outer tube 16, the inner tube 10 and the intermediate sound insulating layer 6.

In the arrangement shown in Figure 6 the end portions of the sound insulating 6 are preferably slightly undercut in the manner shown at 28 with respect to layers 2 and 11. At the left hand end of the stock tube as viewed in Figure 6 there is provided an annular bush or spacer 20 preferably of rubber suitably having a hardness in the range 0 to 70 degrees on the Shore A scale and having an outside diameter corresponding to that of the outer tube 16. The bush 20 is secured in abutting relationship with the end of the composite tube by means of an end cap 24 suitably of steel and adapted to be removably fitted over the end of the composite tube and secured thereon by means of screws or pins 26. At its other end the composite tube shown in Figure 6 is provided with a similar though non-apertured end cap 32 with a solid bush 30 therein.

In all cases it will be appreciated that one end cap must be annular to permit insertion of a workpiece within the stock tube and hence each composite tube may, for example, be provided with one end cap 24 and one end cap 32 (i.e. the arrangement shown in Figure 6) or, alternatively, with two of the end caps 24, or each end may be terminated in the manner shown in Figure 5.

WHAT WE CLAIM IS:-

1. A method of reducing the noise emanating from a noise-generating source, comprising

(a) covering a surface from or *via* which the noise emanates with a first layer of a resilient vibration-isolating material, the said first layer being in contact with and supported by the said surface;

(b) covering the said first layer with an intermediate layer of a heavy limp sound-insulating barrier material, the first layer being in contact with and supporting the intermediate layer and decoupling the intermediate layer from the said surface; and

(c) covering the intermediate layer with an outer surface-protective layer resistant to impact, wear, and abrasion.

2. A method as claimed in claim 1, including the further steps of interposing between and in contact with the intermediate and outer layers an additional layer of a resilient vibration-isolating material, the additional layer decoupling the outer layer from the intermediate layer.

3. A method as claimed in claim 1 or 2, in which the resilient vibration-isolating material is plastics or rubber foam, rubber, or fibrous material.

4. A method as claimed in claim 3, in which the resilient vibration-isolating material has a hardness in the range 0 to 100 degrees on the Shore 00 scale or 0 to 50 degrees on the Shore A scale.

5. A method as claimed in claim 4, in which the hardness is in the range 5 to 95 degrees on the Shore 00 scale or 10 to 30 degrees on the Shore A scale.

6. A method as claimed in claim 5, in which the hardness is in the range 25 to 70 degrees on the Shore 00 scale.

7. A method as claimed in any of claims 1 to 6, in which the face of the said first layer adjacent the said surface has a series of castellations or projections in contact with the said surface.

8. A method as claimed in any of claims 1 to 7, in which the sound-insulating barrier material is lead or metal-loaded plastics material.

9. A method as claimed in any of claims 1 to 8, in which the outer layer is of hard rubber, plastics material, or bitumastic material.

10. A method as claimed in claim 9, in which the material of the outer layer has a hardness in the range 50 to 100 on the Shore A scale.

11. A method as claimed in claim 10, in which the hardness is in the range 90 to 100 on the Shore A scale.

12. A method as claimed in any of claims 1 to 11, in which the or each layer of the resilient vibration-isolating material is 1 to 5 mm thick, the intermediate layer of heavy limp sound-insulating material is 0.25 to 2.5 mm thick, and the outer surface-protective layer is 0.1 to 3 mm thick.

13. A method as claimed in claim 12, in which the total thickness of the layers is at most 6 mm.

14. A cladding for reducing the noise emanating from a noise-generating source having a surface from or via which the noise emanates, the cladding consisting of a flexible layered structure adapted to cover the said surface, the layered structure comprising:

(a) a first layer of a resilient vibration-isolating material, the first layer being adapted to be positioned in contact with and supported by the said surface;

(b) an intermediate layer of a heavy limp sound-insulating barrier material, the first layer being in contact with and bonded to the intermediate layer and serving to decouple the intermediate layer from the said surface; and

(c) an outer surface-protective layer resistant to impact, wear, and abrasion, bonded to the face of the intermediate layer remote from the first layer.

15. A cladding as claimed in claim 14, in which the resilient vibration-isolating material is plastics or rubber foam, rubber, or fibrous material.

16. A cladding as claimed in claim 15, in which the resilient vibration-isolating material has a hardness in the range 0 to 100 degrees on the Shore 00 scale or 0 to 50 degrees on the Shore A scale.

17. A cladding as claimed in claim 16, in which the hardness is in the range 5 to 95 degrees on the Shore 00 scale or 10 to 30 degrees on the Shore A scale.

18. A cladding as claimed in claim 17, in which the hardness is in the range 25 to 70 degrees on the Shore 00 scale.

19. A cladding as claimed in any of claims 14 to 18, in which the face of the first layer remote from the intermediate layer has a series of castellations or projections.

20. A cladding as claimed in any of claims 14 to 19, in which the sound-insulating barrier material is lead or metal-loading plastics material.

21. A cladding as claimed in any of claims 14 to 20, in which the outer layer is of hard rubber, plastics material, or bitumastic material.

22. A cladding as claimed in claim 21, in which the material of the outer layer has a hardness in the range 50 to 100 on the Shore A scale.

23. A cladding as claimed in claim 22, in which the hardness is in the range 90 to 100 on the Shore A scale.

24. A cladding as claimed in any of claims 14 to 23, in which the first layer is 1 to 5 mm thick, the intermediate layer is 0.25 to 2.5 mm thick, and theouter layer is 0.1 to 3 mm thick.

25. A cladding as claimed in claim 14, in which the total thickness of the three layers is at most 6 mm.

26. A stock tube provided with a cladding comprising:

(a) a first layer of a resilient vibration-isolating material, the first layer being in contact with and enclosing the outer surface of the stock tube;

(b) an intermediate layer of a heavy limp sound-insulating barrier material, the intermediate layer being in contact with and enclosing the first layer, the first layer decoupling the intermediate layer from the outer surface of the stock tube; and

(c) an outer surface-protective layer resistant to impact, wear, and abrasion, enclosing the intermediate layer.

27. A stock tube as claimed in claim 26, in which the outer layer is a rigid metal tube, further comprising an additional layer of a resilient vibration-isolating material, the additional layer being between and in contact with the intermediate layer and the rigid metal tube and decoupling the latter tube from the intermediate layer.

28. A stock tube as claimed in claim 27, in which the rigid metal tube is of steel.

29. A stock tube as claimed in claim 26, in which the outer layer is of hard rubber, plastics material, or bitumastic material.

30. A stock tube as claimed in claim 29, in which the said material has a hardness in the range 50 to 100 on the Shore A scale.

31. A stock tube as claimed in claim 30, in which the hardness is in the range 90 to 100 on the Shore A scale.

32. A stock tube as claimed in any of claims 26 to 31, in which the resilient vibration-isolating material is plastics or rubber foam, rubber, or fibrous material.

33. A stock tube as claimed in claim 32, in which the resilient vibration-isolating material has a hardness in the range of 0 to 100 on the Shore 00 scale or 0 to 50 degrees on the Shore A scale.

34. A stock tube as claimed in claim 33, in which the hardness is in the range 5 to 95 degrees on the Shore 00 scale or 10 to 30 degrees on the Shore A scale.

35. A stock tube as claimed in claim 34, in which the hardness is in the range 25 to 70 degrees on the Shore 00 scale.

36. A stock tube as claimed in any of claims 26 to 35, in which the face of the said first layer adjacent the outer surface of the stock tube has a series of castellations or projections in contact with the said surface.

37. A stock tube as claimed in any of claims 26 to 36, in which the sound-insulating barrier material is lead or metal-loaded plastics material.

38. A stock tube as claimed in any of claims 26 to 37, provided at each end with a termination effective to prevent establishment of any sound transmission path between the stock tube, the intermediate layer, and the outer tube.

39. A stock tube as claimed in claim 38, in which each said termination comprises an annular bush disposed in abutting relationship with an end of the stock tube within the outer tube, the bushes being retained in position by end portions of the outer tube which are bent inwardly into engagement therewith.

40. A stock tube as claimed in claim 39, in which the bushes are made of a material having a hardness in the range 10 to 70 degrees on the Shore A scale.

41. A noise-generating source treated according to the method as claimed in any of claims 1 to 13.

42. A stock tube treated according to the method as claimed in any of claims 1 to 13.

43. A noise-generating source provided with a cladding as claimed in any of claims 14 to 25.

44. A stock tube provided with a cladding as claimed in any of claims 14 to 25.

45. A stock tube substantially as described herein with reference to, and as shown in, Figure 2*a* or 2*b* of the drawings accompanying the provisional specification of Figure 4*a*, 4*b*, 5, or 6 of the accompanying drawings.

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1582863 COMPLETE SPECIFICATION

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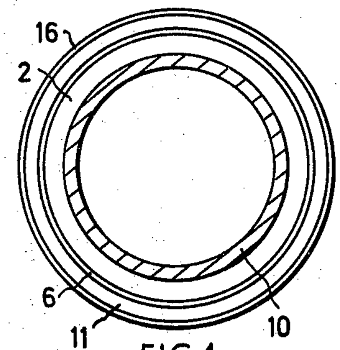

FIG.4a.

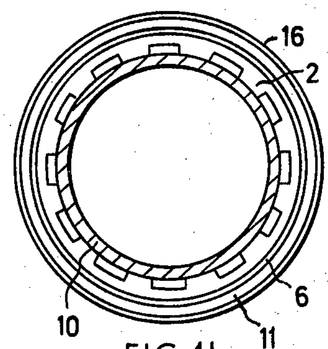

FIG.4b.

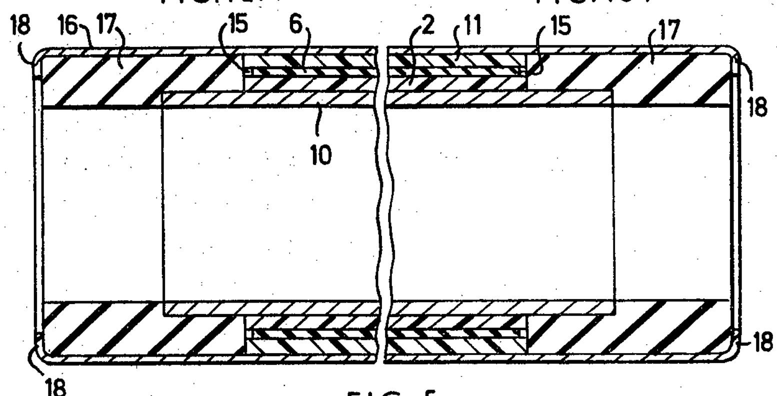

FIG. 5.

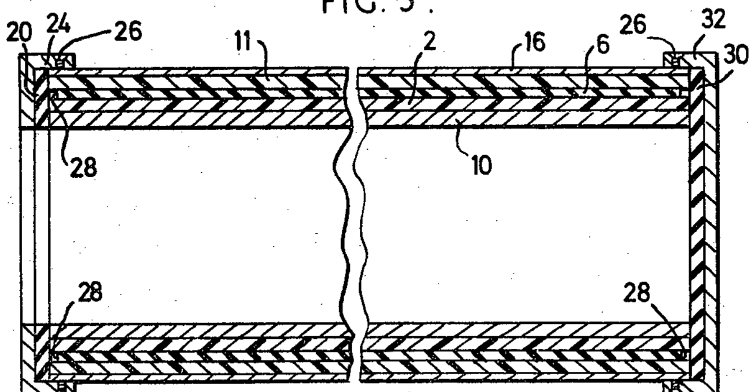

FIG. 6.

1582863 PROVISIONAL SPECIFICATION

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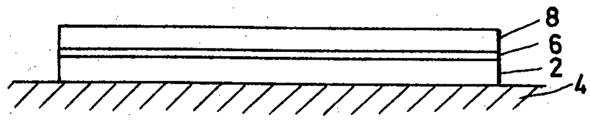

FIG.1.

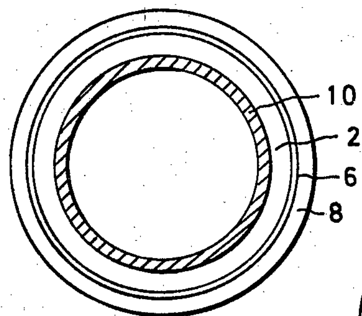

FIG.2a.

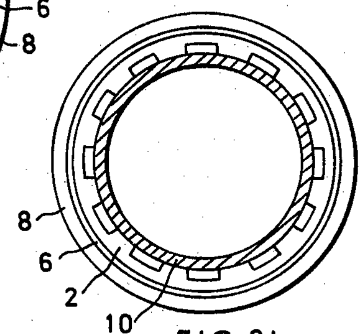

FIG.2b.

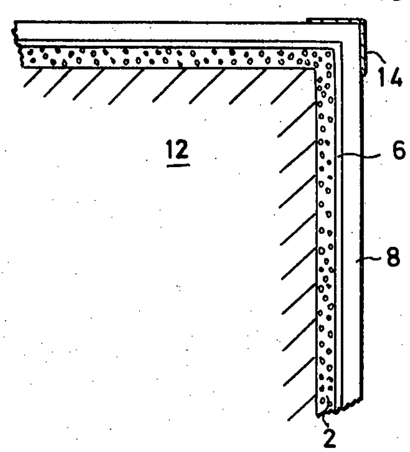

FIG.3.