March 23, 1926. 1,577,741

A. DU BOIS-REYMOND ET AL

ELECTROMAGNETIC SOUND APPARATUS

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Fig. 1.

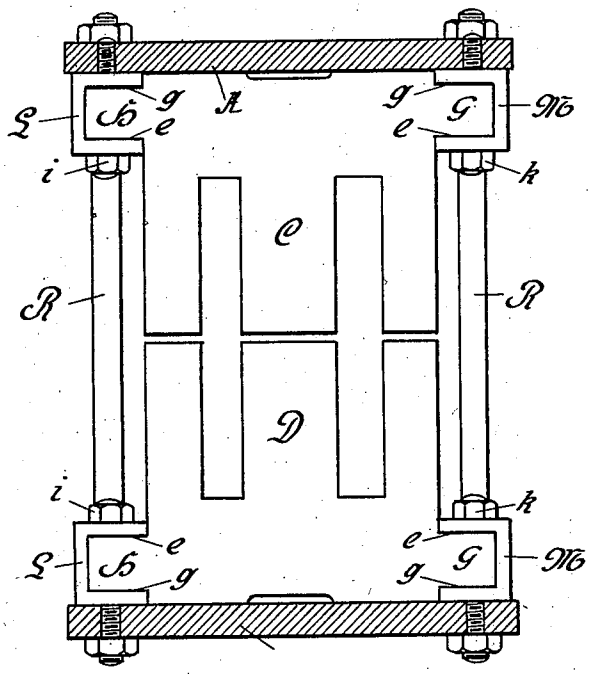
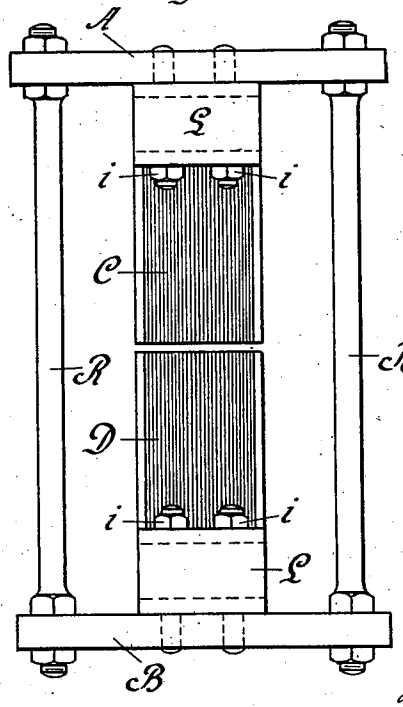


Fig. 2.



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Fig. 3.

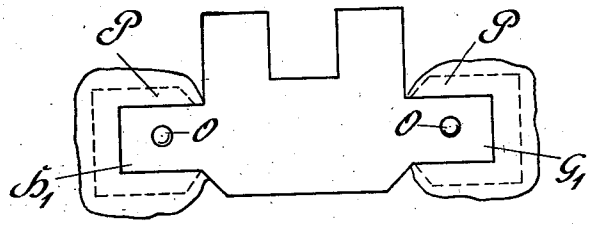


Fig. 4.

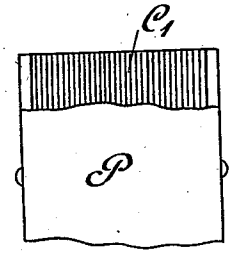


Fig. 5.

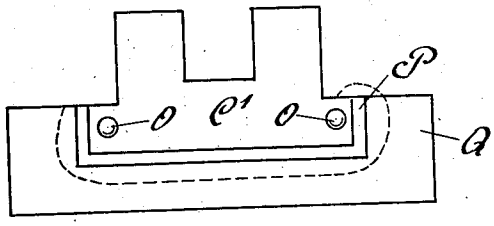


Fig. 6.

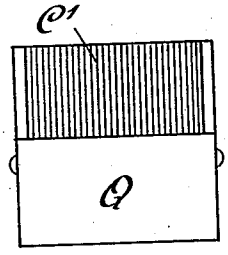
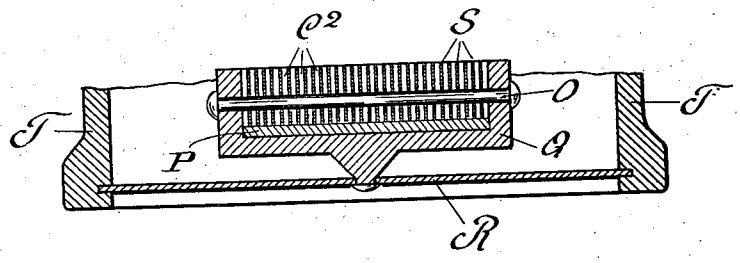


Fig. 7.



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Fig. 1a.

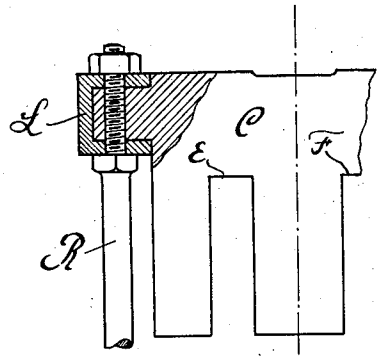
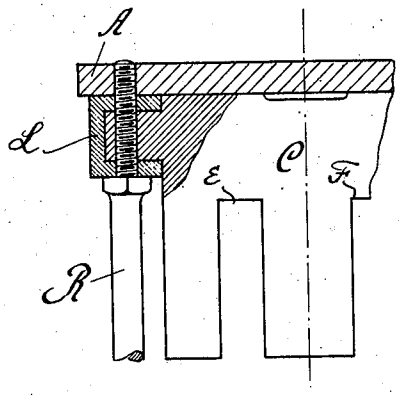


Fig. 1b.



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Patented Mar. 23, 1926. 1,577,741

UNITED STATES PATENT OFFICE.

ALARD DU BOIS-REYMOND, OF PLON, NEAR KIEL, AND LEONID ADELMANN, OF KIEL, GERMANY, ASSIGNORS TO THE FIRM SIGNAL GESELLSCHAFT M. B. H., OF KIEL, GERMANY.

ELECTROMAGNETIC SOUND APPARATUS.

Application filed January 5, 1921. Serial No. 435,297.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that we, ALARD DU BOIS-REYMOND and LEONID ADELMANN, citizens of the German Republic, and residing at Plon, near Kiel, and at Kiel, county of Schleswig-Holstein, and State of Prussia, Germany, have invented certain new and useful Improvements in Electromagnetic Sound Apparatus (for which applications were filed in Germany, July 12, 1915; Feb. 17, 1916; March 15, 1916; Austria, August 12, 1916; August 25, 1916; Oct. 4, 1916; Hungary, August 16, 1916; August 31, 1916; and November 4, 1916; and German patents issued Feb. 10, 1918, and March 2, 1918), of which the following is a specification

This invention relates to electromagnetic sound signalling apparatus and more particularly to submarine sound signalling apparatus esuipped with magnets whose active iron is laminated or built up of iron sheets insulated from each other for the purpose of preventing current losses, and held together by bolts. In all of the known types of such magnets air-gaps remain between the individual sheets or laminæ of the finished magnet which enable these sheets to vibrate against each other and to thus give rise to a damping that increases the deleterious damping effect of the apparatus.

A known method of holding laminated iron cores together consists in passing pins which are insulated from the iron through the sheets and riveting them at both ends, and in providing thick end-plates which are fixed by screws to the parts to which the entire laminated iron core is to be attached; but this method of assembling is not satisfactory in cases where the electromagnet itself is to act as a vibrating part of a sound signalling apparatus, i. e., as a part of a vibratory structure capable of producing or receiving sound waves, and the higher the rate of vibration or frequency is the less satisfactory this method will be. The fact has been revealed that during each vibration of the entire laminated iron core the individual laminæ execute separate motions with respect to each other and in so doing they consume so much energy by friction, or produce so large a deleterious damping effect, that it becomes impossible to obtain a sufficiently sharp tuning of the vibratory structure. The reason for this is that such a pack of metal sheets, when compelled to execute sound vibrations which are more rapid than a very low frequency, will only behave like an integral body if the sheets are firmly fixed to each other, it being also necessary under certain circumstances to place them so that their main surfaces extend in the direction of the vibrations.

The object of the invention is to prevent the individual parts or laminæ of such composite vibrating members from moving relatively towards and away from each other, or at least to reduce such motion to a minimum. This is accomplished by employing special binding agents or means which, with due consideration to the aforementioned points, are so selected and arranged that they prevent individual motions of the various parts or laminæ of which composite bodies, intended to vibrate as a whole, are made up. These methods, means or agents may be of different kinds and may consist:

1. In joining together the edges of sheets placed side by side by means of a layer of metal applied to the edges in a liquid state, and in then fixing the finished packs to the rigid parts of the apparatus for which they are intended by screws, soldering, welding etc.,

2. In filling the interstices or gaps between the laminæ with gums, varnishes or other equivalent binding agents which bind the laminæ so as to form an integral body devoid of any internal damping effect.

3. In combining the means described in 1 with that described in 2.

The invention is illustrated in the drawings in which constructional forms of apparatus are shown embodying the aforementioned methods. In these drawings

Fig. 1 is a sectional elevation and

Fig. 2 a side elevation of electromagnets having laminated iron cores whose laminæ are soldered together at their edges, the laminated cores being fixed to solid metal plates by clamping members which extend in the direction in which the entire system of cores and metal plates, vibrates.

Figs. 1^a and 1^b are two modified forms in which the laminated core is fixed to its supports.

Fig. 3 illustrates a method of uniting the

individual laminæ or iron stampings by encasing their fixing lugs with coatings of molten metal, these coatings then being shaped so as to form fixing bars.

Fig. 4 is an end view of Fig. 3.

Fig. 5 shows a method similar to that of Figs. 3 and 4 except that the molten coatings after they have been worked into the proper shape, are fixed to a back-plate or magnet yoke.

Fig. 6 is an end view of Fig. 5.

Fig. 7 shows a cross section of a part of an apparatus in which a vibrating plate is connected to an armature of an electromagnet which is composed of iron stampings fixed to each other by gum or varnish so as to form a solid mass.

In Figs. 1 and 2 A and B are metal slabs or plates interconnected by elastic members such as elastic rods or tubes R. Fixed to the two plates A and B are the laminated iron cores C and D of a subdivided electromagnet which are intended to vibrate as a whole together with their plates when the active parts of the apparatus are excited by sound producing forces or waves in such a manner as to cause the two divided masses C and D to alternately approach and recede from each other. The sound producing or exciting forces may be generated by means of an electric coil placed in the slots E and F and periodically energized by a suitable alternating electric current from an alternating current generator (coil and generator not shown here). The individual sheets of which the core of the electromagnet is built up are provided with integral fastening lugs G and H, and the surfaces *e*, and *g* formed by the edges of the sheets are made smooth and polished. Before the cores C and D are fixed to the plates A and B, holders L, M of U-shaped cross section are fitted on to the lugs G and H of the assembled or stacked laminæ and then soldered to these lugs, preferably with solder of a high melting point. The lugs, after they have thus been combined with solder, may be treated as solid beams or bars, so that holes can be drilled through them in the main direction in which the individual laminæ extend, after which they may be fastened to the plates A and B by screws *i* and *k*. In this method of joining the cores and plates the fixing screws lie outside the path of the magnetic flux. The laminated electromagnet cores obtained in this manner vibrate together with their plates or other parts to which they are attached, without giving rise to an inordinate damping. Instead of attaching the fixing lugs to plates A, B they may be screwed or soldered to the interconnecting members directly as shown in Fig. 1^a, so that the plates A and B may be dispensed with. Another advantageous arrangement, shown in Fig. 1^b, consists in using the elastic rods R themselves instead of separate screws as a means for fixing the packs of laminated iron to the plates A or B, or to a vibrating plate by which sound energy is radiated.

A drawback in the method of joining the various sheets of the bunches C and D by soldering is that it involves very troublesome preparatory operations and can only be carried out by very experienced and conscientious workmen. Another feature of the invention therefore provides a simpler means of joining the sheets, according to which the surfaces to be joined and the fixing lugs are prepared similarly, but in a more convenient manner than if they are to be soldered together. This means consists in coating the sheets or laminæ with a layer of molten iron by welding them together or by welding additional metal onto them. This layer may be arranged to form either a substitute for the fixing bars (L, M Figs. 1 and 2), or simply an intermediate layer between the lugs and the fixing bars, which will enable the process of soldering the pack to a back-plate to be carried on more easily than if the edges of the laminæ themselves are directly soldered thereto. These methods of uniting the laminæ and of fixing the complete packs of sheets to their holders are shown in Figs. 3 to 6.

In all these figures C^1 denotes iron horseshoe stampings of the kind ordinarily employed for the magnetically active laminated cores of electromagnets. In accordance with Fig. 3 the stampings are formed at both ends with fixing lugs H^1 and G^1 which are outside the path of the magnetic flux and held together by rivets O. Coatings of iron P, as indicated in Fig. 3 by irregular full lines, are welded onto the fixing lugs by means of an oxyacetylene or electric welding apparatus or the like. Since the inner surfaces of the iron coatings or casings thus formed are welded to the edges of the lugs H^1, and G^1 of all of the laminæ or sheets C^1, the pack of sheets is united into a single body all of whose individual sheets vibrate in unison in the direction in which each sheet chiefly extends (vertical in the drawing). After the applied casings P have cooled down they are worked into the shape indicated by broken lines in Fig. 3 and the complete iron core may then be treated as a single piece and screwed fast by means of the fastening lugs to a corresponding part of the frame of the device or electromagnet in which it is to be used.

Figs. 5 and 6 show a modified constructional form of the above-described pack which is adapted to be fixed to the solid iron or yoke of the magnet. In this case the pack of sheets C^1, is also first held together by pins O. Then the whole back of the pack is covered with a layer P of

iron aproximately as indicated by the curved dotted line in Fig. 5, after which this coating P is worked into the shape indicated by the solid lines of Fig. 5, and fixed in the iron block Q. Finally the fissure between P and Q may be filled up by soldering. By bridging over the narrow surfaces or edges of the sheets C by means of a coating of metal welded onto them, a uniform clean metallic surface is obtained that can be easily soldered. Thus a perfectly reliable connection between each individual stamping C^1 of the pack and the block or backplate Q is obtained, so that the entire piece can then be readily connected to the other parts of the apparatus by screws, or by soldering or welding the joints between the back-plate and the said other part, etc.

In the constructional forms hereinbefore described it is desirable to so arrange the sheets of the laminated core that their principal surfaces extend in the direction of the vibrations which they are caused to execute. By the method explained with reference to Fig. 7, but applicable to all other modifications, this is rendered unnecessary.

In this figure R is a diaphram or vibrating plate, Q is a frame for the pack of plates which is held together by a rivet O. C^2 are the individual sheets or stampings, and the spaces between them are filled with gum S. T is a fragment of a casing in the cylindrical wall of which diaphragm R is fixed.

The varnishes or gums used for filling the interstices between adjacent stampings preferably consist of liquid natural or synthetic gums or solutions such as phenolic condensation products for example. By these gums all interstices or cavities between the individual sheets, which might be due to unevenness of the surfaces of the latter, are completely filled so as to prevent vibrations of the parts relatively to each other and to unite the whole into a single body which will operate in a sound signalling or vibrating aparatus without producing losses or trouble due to internal damping.

The pack is preferably placed in a vacuum when the filling substances are inserted, so as to completely remove the air from the extremely narrow interstices. The preferred procedure is to put the packed sheets or core into a vessel from which the air is then evacuated.

The vacuum is maintained during the introduction of the binding agent and then pressure is applied to thoroughly drive the agent into the interstices. When this has been done the described operations are repeated. Finally the gummed body is dried.

If a suitable phenolic condensation product is used as a binding agent it is introduced into the interstices in a liquid condition at a temperature of about 50° Celsius and dried at a temperature above 150°.

It will be obvious that even if the sheets or laminæ are united in the manner illustrated in Figs. 1 to 6 they may also be gummed together by inserting a binding agent into the interstices between them.

I claim:

1. A method of producing a laminated electrimagnetic vibratory system consisting in uniting the laminæ by a coating of molten metal at portions outside of the normal magnetic flux path so as to form a pack in which movements of the laminæ relatively to each other are prevented, in shaping and smoothening the said coating of metal, and in joining and fixing the smooth surfaces to the vibratory system.

2. An electromagnetic system comprising a vibrating member and laminated iron electromagnet cores having portions located outside of the normal magnetic flux path and adapted to cooperate with the vibrating member, the laminæ of the iron cores extending in the direction of the vibrations of the vibrating member and being welded together at said outside portions by means of metal applied to the said edges in molten state, and a solid iron body to which at least one of the said cores is welded.

3. An electromagnetic system comprising a vibrating member and laminated iron electromagnet cores having portions located outside of the normal magnetic flux path and adapted to cooperate with the vibrating member, the laminæ of the iron cores being welded together at said outside portions.

4. An electromagnetic system comprising a vibrating member and laminated iron electromagnet cores having portions located outside of the normal magnetic flux path and adapted to cooperate with the vibrating member, the laminæ of the iron cores extending in the direction of the vibrations of the vibrating member and being welded together at said outside portions.

5. An electromagnetic system comprising a vibrating member and laminated iron electromagnet cores adapted to cooperate with the vibrating member, said laminæ having lateral fixing lugs outside of the normal magnetic flux path and being welded together at the outer edges of said lugs.

In testimony whereof we have affixed our signatures.

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LEONID ADELMANN.