Feb. 12, 1935. H. C. HARRISON 1,991,206

APPARATUS FOR MAKING ACOUSTIC RESISTANCES

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FIG. 3

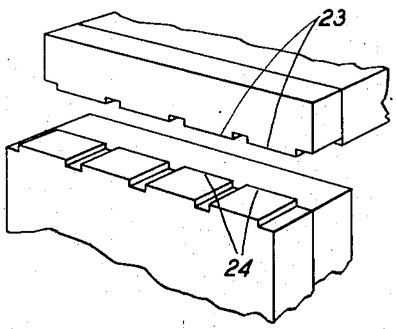

FIG. 1

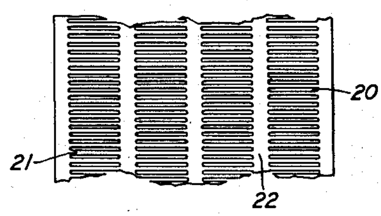

FIG. 2

FIG. 6

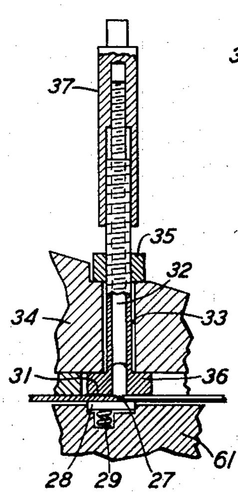

FIG. 4

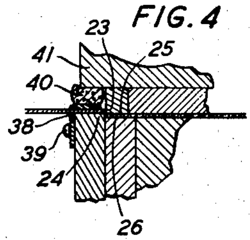

FIG. 5

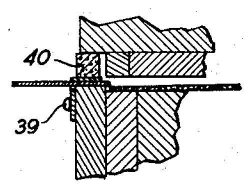

FIG. 7

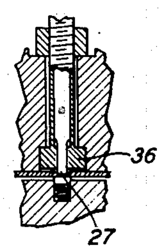

FIG. 8

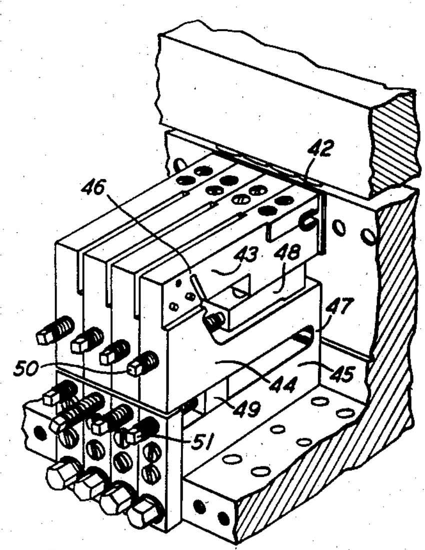

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FIG. 9

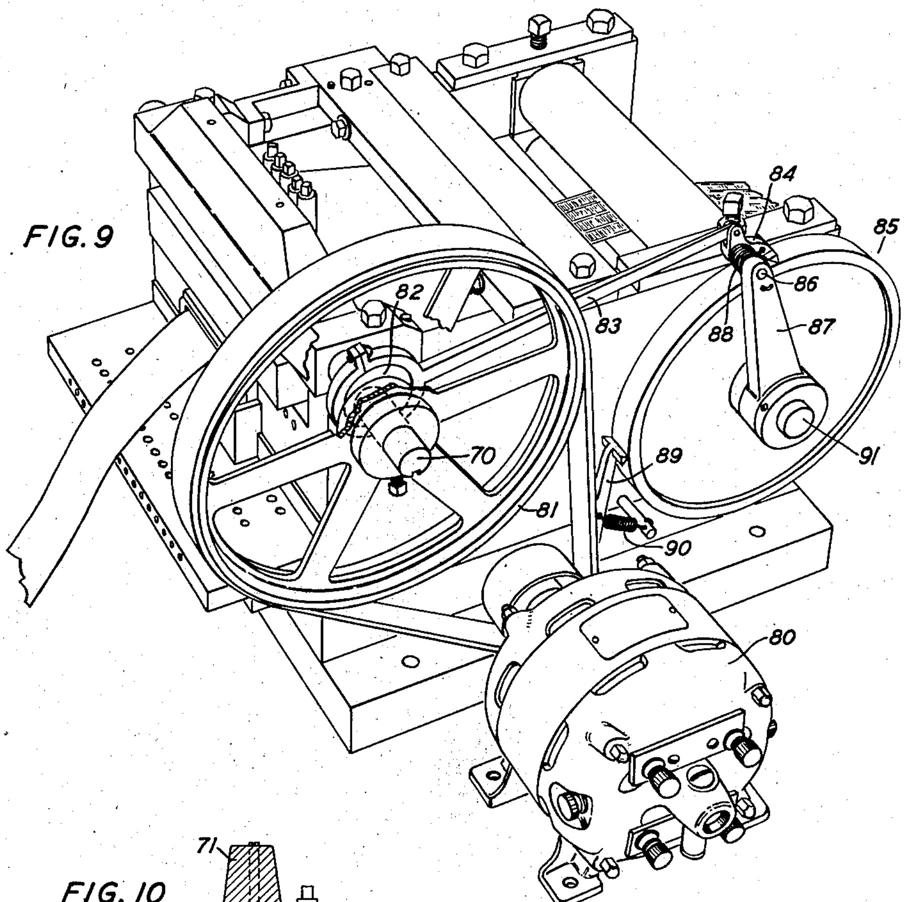
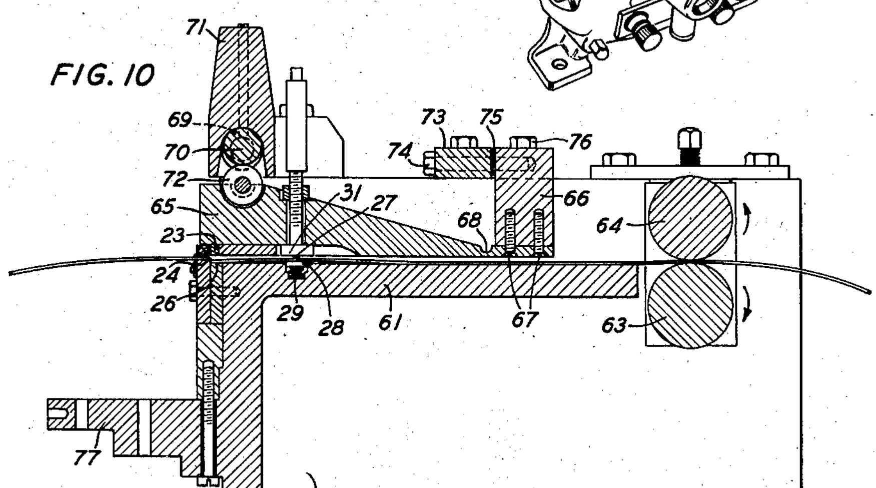


FIG. 10



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UNITED STATES PATENT OFFICE

1,991,206

APPARATUS FOR MAKING ACOUSTIC RESISTANCES

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Application March 16, 1933, Serial No. 661,045

10 Claims. (Cl. 29—34)

This invention relates to acoustic material and to the apparatus by which it is made.

An object of this invention is the provision of apparatus for making a fire-proof sound absorbing material suitable for damping sound vibrations in sound studios, auditoriums and like places.

Another object of the invention is the provision of apparatus for making with a high degree of precision an acoustic impedance for controlling acoustic vibrations.

In accordance with the invention a sheet of metal, as for example, zinc, aluminum, duralumin, brass or any other suitable material is formed with very narrow slots at a distance apart such that the sheet so formed presents substantially no reflecting surface to sound waves.

In the formation of the acoustic resistance, a thin sheet of metal is sheared into a plurality of very narrow parallel bars joined at intervals by unsheared portions and the unsheared portions are swedged to separate the bars.

The acoustic resistance and the machine by which it is made are shown in the accompanying drawings in which:

Fig. 1 is a plan view of the acoustic resistance with the slots therein greatly enlarged;

Fig. 2 is a front elevation of the resistance of Fig. 1, sectioned through the lands;

Fig. 3 is a perspective of the knives used to shear the material;

Figs. 4 and 5 are side elevations in section of the knives and material showing the knives in operative and inoperative positions, respectively;

Fig. 6 is a side elevation in section of the swedge;

Fig. 7 is the corresponding front elevation of Fig. 6;

Fig. 8 is a perspective of an alternative form of knife;

Fig. 9 is a perspective of the machine showing the material entering and leaving it; and

Fig. 10 is a side elevation of the machine sectioned through the center to expose the working parts thereof.

The principle on which the design of the sound absorbing material is based is well known and is described at length in United States Patent No. 1,854,830 to P. B. Flanders, filed April 28, 1928 and dated April 19, 1932. It will suffice for the purposes of this invention to state that the material must have a series of openings, the number and magnitude of which are such that the viscosity of the air moving therein is effective to impede the progress of sound waves impinging upon the material. The openings used may be rectangular slots in which case the width of the slot determines the ratio of resistance to reactance of the damping material and this together with the spacing of the slots determines the magnitude of the impedance of the material. By changing the width and spacing of the slots a wide range of acoustic impedances may be secured.

The preferred form of the acoustic damping material is shown in Figs. 1 and 2. The slot 20 may be approximately 0.0015″ wide and $\frac{1}{32}$″ long and the bars 21 formed by the material between the slots 20 are approximately 0.01″ wide. Between the rows of slots there is left a solid portion or land 22 which may be $\frac{3}{32}$ inch in width. The thickness of the material and hence the depth of the slot is .007″. These dimensions are purely illustrative and may be varied to suit particular conditions. The spacing of the slot, that is, the width of the bars 21, is limited, however, by that width at which the bars begin to vibrate under the influence of sound waves.

The material must be ductile to withstand swedging without cracking. Zinc has been found to be very satisfactory in this respect and it has in addition the quality of non-inflammability which is necessary for fire-proof constructions.

It is apparent that the thinness of the material and the microscopic width of the slot preclude the use of ordinary perforating and shearing methods in making the material. For example, in shearing thin stock with parallel knives (as must be the case here), unless certain precautions are taken the material will bend instead of shear. Then, too, it is almost impossible to construct a punch of the order of .0015 inch by $\frac{1}{32}$ inch which will last for any practical length of time.

Attempts have been made to etch the slots into the material but such methods usually require considerable time and the slots made thereby are usually ragged and not uniform.

The present method may be divided into two general steps, the first of which merely makes an incision in the material and the second squeezes the material at the ends of the incision to spread its walls. The first step is illustrated in Figs. 4 and 5 and the second in Figs. 6 and 7.

Referring to Fig. 4 the blank material is fed from the left between the upper knife 23 and lower knife 24. The knives used are shown in perspective in Fig. 3 and comprise two hardened metal blocks with sharpened edges which are divided into a series of cooperating cutting edges by shallow slots the purpose of which is to form the lands 22 of the finished material. Adjacent each knife is a flat surface 25 and 26. Surface 25 is a continuation of the cutting edge of the upper knife 23, but surface 26 is depressed below the cutting edge of lower knife 24 a distance which is less than the thickness of the blank material. These surfaces serve two important functions one of which is to prevent the material from bending and thus escaping shear and the other is to prevent the shear at the knife edges from being complete. As shown in Fig. 4, the upper knife 23 is at the bottom of its stroke and the material has been partly sheared.

When the upper knife 23 is raised, the material is advanced to the right a distance equal to the width of the bars 21 of Fig. 1. The material is now deformed as shown in Fig. 5. Due to the incompleteness of the shear the material tends to adhere to the upper knife and thus blocks any attempt to feed it through the machine. For this reason a strap 38 supported by a screw 39 riding in a vertical slot in the strap 38 is made to bear down upon the material at all times by means of a resilient medium 40 such as rubber interposed between the strap 38 and the upper knife support 41. On descending upon the material, the upper knife 23 again partly shears the new material, but the surface 25 cooperating with surface 26 depresses the material between the previous shear and the new shear and in doing so completes the previous shear and forms a distinct bar. There is no separation between the bars at this point, however, and the material is opaque. The shear is merely an incision such as is made by a sharp blade in a block of rubber.

The second step is to separate the bars and this is done by compressing the unsheared lands 22 beyond the elastic limit of the material and thus producing a permanent longitudinal elongation therein which causes the bars to separate. For this purpose a wedged shaped swedge with a blunt edge is used.

Referring to Fig. 6, 27 is a side view of the swedge. Directly beneath the swedge 27 and extending considerably beyond both sides of it is an anvil 28 mounted upon a stiff spring or other resilient support 29 which is set into a rigid frame 61. Secured to the swedge 27 is a flat hammer 31 which is substantially coextensive with the anvil 28. The swedge 27 is not in the plane of the hammer 31 but extends slightly below it and as the swedge and hammer descend upon the material, the swedge is the first to contact the material. Since its area of contact is small, the total pressure exerted upon the anvil 28 by the swedge 27 is not large enough to depress it against the force of spring 29. The swedge is consequently driven into the material and compresses it transversely but elongates it longitudinally and the bars are separated. The swedge continues to squeeze the material until the hammer 31 engages the material, at which point the pressure increases rapidly to a predetermined limiting value greater than the resistance of the spring, and the anvil is depressed. When the swedge is raised the material will be found to be permanently elongated and the bars separated.

It is evident that the amount of elongation depends upon the depth to which the swedge is forced into the material and the frequency of the swedging stroke per unit length of material. To change the spacing of the bars it is, therefore, necessary to change one or both of these factors. In the present apparatus it has been found more expedient to make the swedging depth the adjustable factor rather than the frequency of the stroke and accordingly means are provided for changing the amount of protrusion of the swedge 27 below the hammer surface 31. Since the material used is very thin the adjustment of the swedge must be very fine, but at the same time the adjusting means must be capable of withstanding the swedging pressures. The differential screw has been found to be satisfactory for this purpose. It is incorporated into the swedge in the following manner:

The swedge is formed from a rod 32 threaded at its upper end and free to move vertically in a hollow bolt 33. The bolt 33 is threaded on the outside with a coarser thread than the thread on the rod 32 and is held securely to the reciprocating frame 34 by nut 35. The head 36 of the bolt forms the hammer 31. The rod 32 is restrained torsionally by a suitable dog arrangement such as a non-circular opening in the head 36 of the bolt 33 cooperating with a similarly shaped portion of the rod 32. A cap 37 fits over the bolt 33 and the protruding rod 32 and is threaded so as to engage the threads of both rod and bolt. As the cap is turned, it moves relative to the bolt and rod but due to the difference in the pitches of the bolt and rod threads, the rod moves with the cap at a rate equivalent to the difference in the pitches of the thread.

Thus, each thread is made large enough to possess the requisite strength and yet the swedge is capable of adjustment to a fraction of a thousandth of an inch.

A somewhat similar differential thread may be used to adjust the individual knives of Fig. 8. The blade 42 is supported in an S-shaped section comprised of horizontal sections 43, 44 and 45 connected together by spring hinges 46 and 47. Between the horizontal sections are wedges 48 and 49 cooperating with the adjacent and non-parallel sides of the horizontal sections. The wedges are controlled by turn buckles 50 and 51, the threads of which may be of the same kind but of different pitches. With this arrangement a large number of turns of the turnbuckles 50 and 51 results in a small movement of the wedges which in turn results in a still smaller vertical motion of the knife 42. This method of adjusting the height of the knife does not lessen its rigidity under working pressures. The individual knives are used with very wide material where it is difficult to secure absolute alignment of two rigid blades such as those of Fig. 3.

For uniformity in the finished product, it is necessary that the shearing, swedging and feeding operations be in synchronism with one another. This can best be achieved by incorporating the several operations into a single machine. Such a machine is shown in Figs. 9 and 10.

Referring to Fig. 10 in which a cross-section of the machine is shown, 60 is a rigid frame supporting a bench 61 along which the material passes. At one end of the bench 61 is the lower knife 24, adjacent surface 26, anvil 28 and supporting spring 29. Some distance removed from the knife 24 and at the opposite end of the bench 61 is a pair of feed rolls 63 and 64. A reciprocating head 65 bearing the upper knife 23, adjacent surface 25, hammer 31 and swedge 27, is suspended over the bench 61 from a rigid iron beam 66 to which it is secured by suitable screws 67, and as this comprises the sole means of support, the head 65 forms a cantilever beam. The vertical dimension of the head at the support 58 is reduced so that it forms a spring hinge about which the head can vibrate.

The head 65 is driven by rotating cams 69 keyed to cam shaft 70 and supported in a rigid beam 71 which is secured to the frame 60. The cam cooperates with roller followers 72 in the head 65. To maintain the followers in contact with the rotating cams an initial flexure is introduced into the spring hinge 68. It is often desirable to adjust the position of the head 65 relative to the lower knife 24 and to this end a second rigid beam 73 firmly secured to frame 60 is provided with a bolt 74 holding the beam 66 to beam 73. The adjusting is done by inserting shims 75 between beams 66 and 73. Beam 66 is secured to frame 60 by bolts 76 cooperating with a slotted opening in the beam and when the adjustment is completed these bolts are tightened.

A bracket 77 is provided to support the adjustable lower knives of Fig. 8.

The driving means for the machine is shown in Fig. 9. An electric motor 80 or other source of power is belt connected to a pulley 81 which is keyed to cam shaft 70. The feed rolls 63 and 64 are driven from the cam shaft 70 by an eccentric 82, eccentric rod 83 and bell crank 84 cooperating frictionally with wheel 85 which is keyed to the shaft 91 of the lower roll 63. The bell crank 84 is pivoted about a pin 86 secured to lever 87 which is free to rotate about shaft 91, and the arm in contact with the surface of wheel 85 is held against the wheel by means of a spring 88. A brake against the counter-clockwise rotation of wheel 85 is secured by means of a pivoted arm 89 and a spring 90.

As the pulley 81 is rotated, cams 69 force the head 65 downward against the action of the spring hinge 68 and the shearing and swedging operations are then performed. While the knives and swedges are in contact with the material, eccentric 82 is moving the eccentric rod 83 to the left which releases the pressure of arm 86 on wheel 85. The wheel is held motionless under the action of brake 89 and no pull is exerted upon the material by rolls 63 and 64. When the cam permits the head to return to its upper position and so release the material, the eccentric 82 pushes eccentric rod 83 to the right which increases the pressure between arm 86 and wheel 85 whereupon the wheel is rotated until the eccentric rod ceases to move, at which point the pressure of the brake 89 will exceed the pressure of arm 86 and the wheel will stop. While it is moving, the rolls 63 and 64 are advancing the material past the knives, a distance equal to the width of a bar 21 (Fig. 1).

In addition to feeding the material through the machine the rolls 63 and 64 can be made to take the place of the swedge 27 by providing ridges (not shown) on the rolls to cooperate with the lands and thus by the application of sufficient pressure, reduce the thickness of the lands and elongate the material.

It is understood that the machine and method shown can be used with materials of greater width than that indicated in Fig. 1 and that the scope of the invention is not to be limited to the specific form illustrated, but is to be determined by the appended claims.

What is claimed is:

1. Apparatus for making an acoustic resistance of solid material comprising a pair of shearing knives, a flat surface adjacent each knife, one of said surfaces being a continuation of the cutting edge of one of the knives and the other being removed from the cutting edge of the second knife, means for feeding the material regularly to the knives, and means for causing the knives and surfaces to move relative to one another whereby the material is first partly sheared by the knives and on feeding new material to the knives the shear is completed by the action of the adjacent surfaces on the material.

2. In a device for making an acoustic resistance, a shearing knife and means for reciprocating said knife comprising a spring hinge support for the knife, rollers in the support and cams cooperating with the rollers to depress them at predetermined intervals.

3. A machine for making an acoustic resistance of sheet metal comprising a shearing knife adapted to make an incision in the material and a swedge adapted to cooperate with the material to separate the walls of the incision, said swedge comprising a hammer, a protrusion on the hammer, an anvil cooperating with the hammer, a support for the anvil and spring means intermediate the anvil and anvil support yieldable only under a predetermined pressure greater than that between the protrusion and anvil and less than that between the hammer and anvil whereby the protrusion is effective to swedge the material.

4. A machine as in claim 3 and means for varying the height of the protrusion of the swedge above the surface of the hammer whereby the extension of the material can be varied.

5. A machine for making an acoustic resistance of sheet metal comprising a pair of cooperating shears adapted to make a plurality of incisions in the material, separated by lands, means for simultaneously swedging the lands and means cooperating with the shears and swedging means for drawing the material through the machine at predetermined intervals.

6. A machine as in claim 5 and means for removing the material from the shears after each incision to permit it to be drawn through the machine.

7. A machine for making an acoustic resistance comprising a plurality of shears comprised of a plurality of individual knives cooperating with portions of a common knife, means for moving the common knife and individual knives relative to one another, and means on the individual knives for adjusting the amount of the relative motion beyond the cutting edge of the common knife.

8. A machine for making an acoustic resistance of thin material comprising a pair of cooperating shearing knives, parallel flat surfaces adjacent each knife, one of said surfaces being a continuation of the cutting edge of one of the knives and the other being removed less than the thickness of the material away from the cutting edge of the second knife, and means for moving one of the knives relative to its cooperating knife comprising a support, rollers therein, rotating cams cooperating with the rollers, driving means therefor and resilient means for maintaining the rollers in contact with the cam, means for swedging the material comprising a pair of parallel surfaces adapted to move relative to one another, a protrusion on one of the surfaces and means for limiting the pressure between the surfaces whereby the thickness of the material passing therebetween is reduced and its length increased, and means in synchronsim with the shearing and swedging means for feeding the material into the machine, comprising a pair of rollers driven intermittently from the shaft of the rotating cam.

9. Apparatus for making an incision in a thin

flat material comprising means for holding a portion of the material stationary, means for displacing the adjacent portion transversely of its surface whereby the adjacent portion is severed from the stationary portion and means for restoring the displaced portion to the plane of the stationary portion.

10. Apparatus for making an incision in a thin flat material comprising means for holding a portion of the material stationary, means for displacing the lesser width of the adjacent portion transversely of its surface, whereby the lesser width is severed from the stationary portion and a pair of relatively movable similar surfaces adapted to bridge both portions to restore them to the same plane.

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