

[54] **APPARATUS FOR PROVIDING DELAY OF AN ELECTRICAL SIGNAL**

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[58] Field of Search 179/1 J; 84/1.24, 84/1.26, 1.13, 1.14, 1.16; 333/30, 71; 332/2, 26, 5

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Primary Examiner—Kathleen H. Claffy

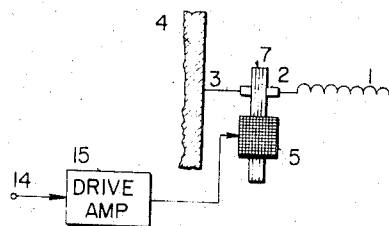
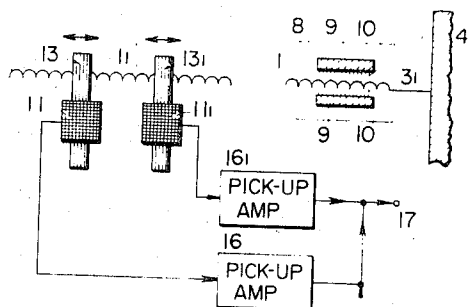
Assistant Examiner—Jon Bradford Leaheey

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[57] **ABSTRACT**

In audio signal delaying apparatus including a vibration transmission coil spring, an electro-mechanical driver means provided in the vicinity of one end of the spring, and a mechano-electrical pickup means for detecting a signal from the motion of the spring driver due to an input signal through the driver means, the improvement comprises a vibratile motion terminating means provided between the other end of the spring and the pickup means so as to prevent a reflection of vibration at the other end of the spring, said pickup means being movable along the length of the spring, and said coil spring being magnetized. The arrangement can improve the frequency characteristics of the detected signal and enables the provision of an output signal having any delay time.

5 Claims, 35 Drawing Figures



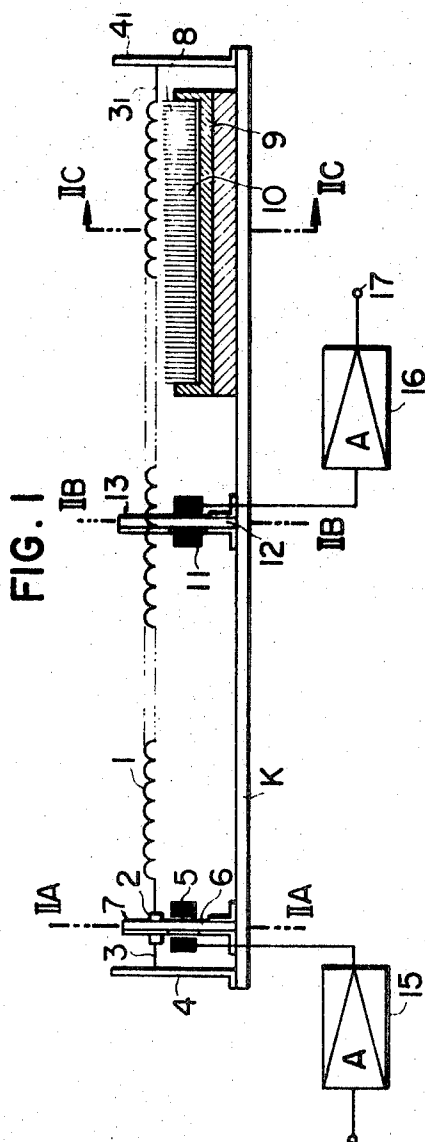


FIG. 2e

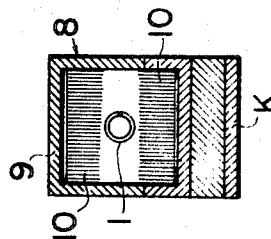


FIG. 2d



FIG. 2c

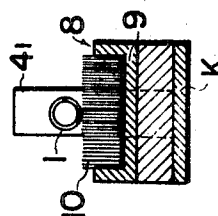


FIG. 2b

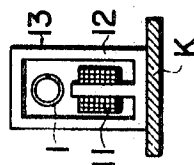
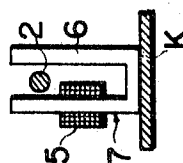


FIG. 2a



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FIG. 2g

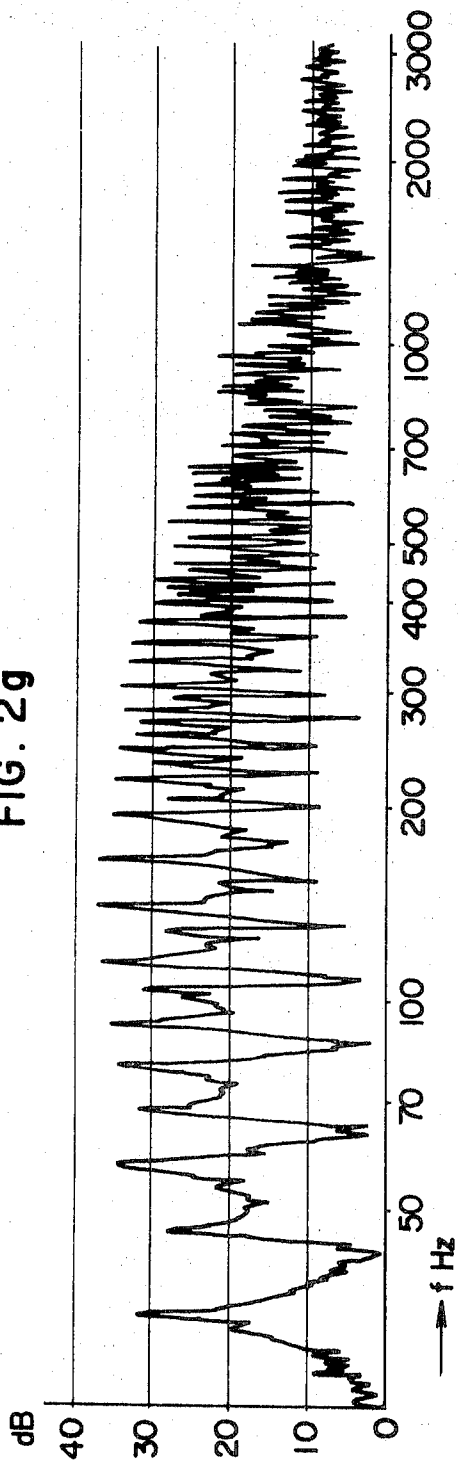
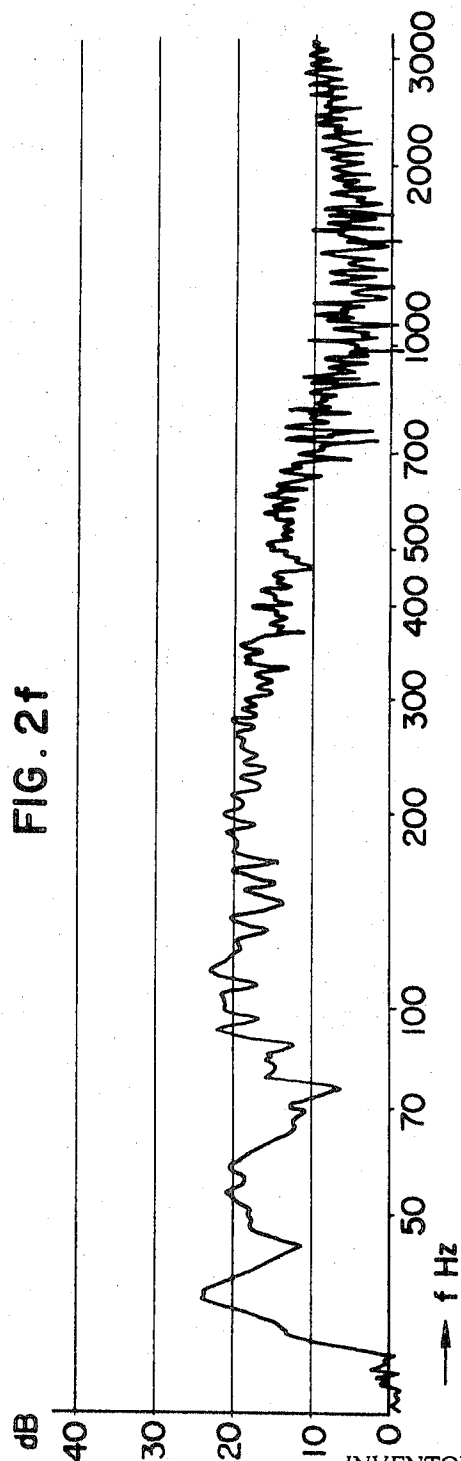


FIG. 2f



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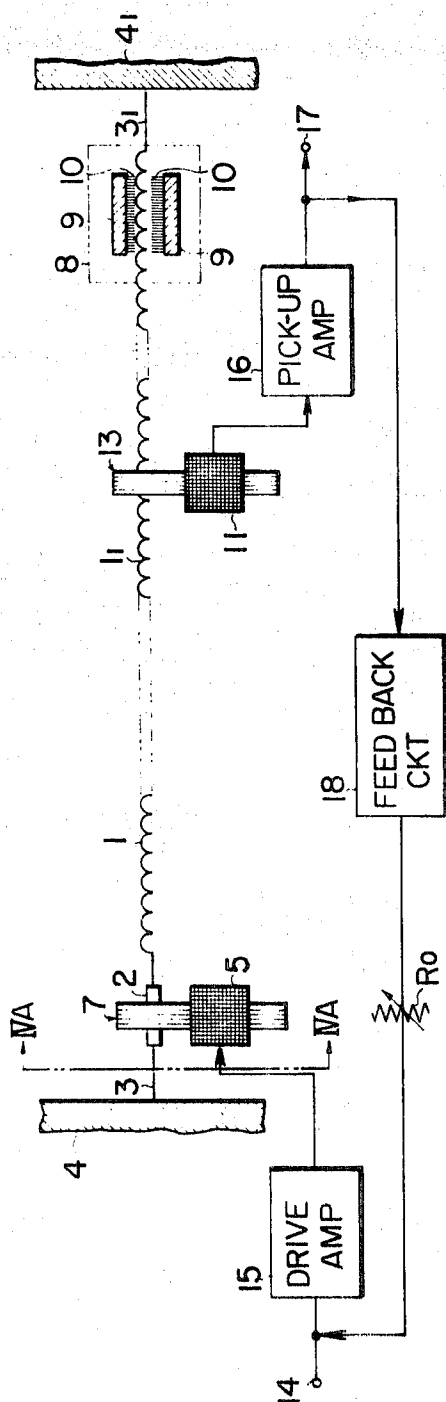


FIG. 4b

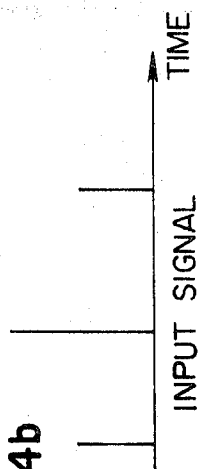


FIG. 4c

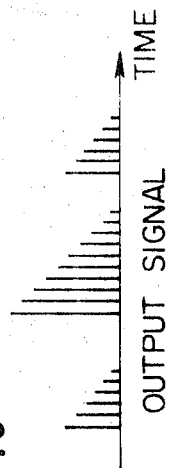
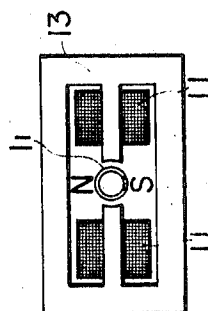


FIG. 4a



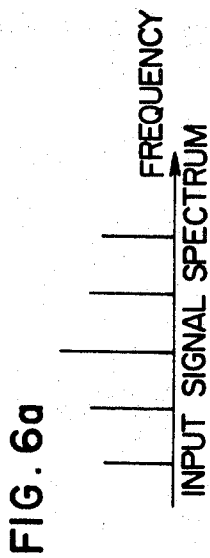
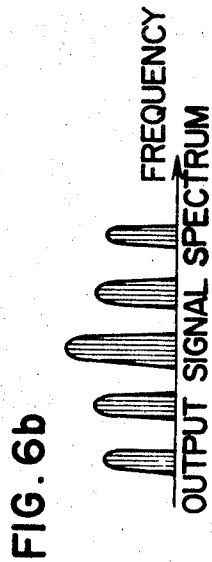
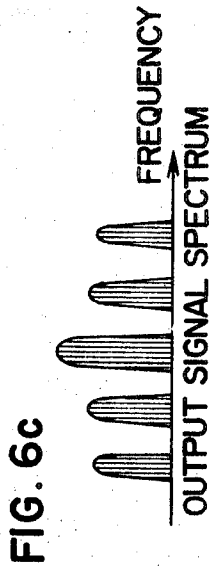
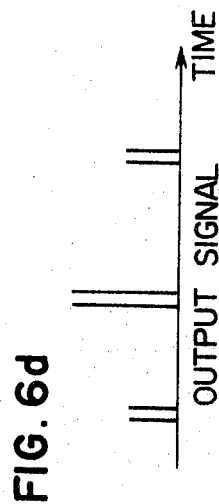
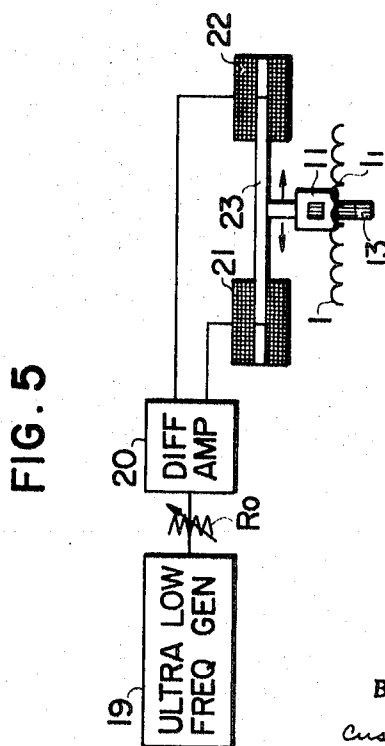
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FIG. 7

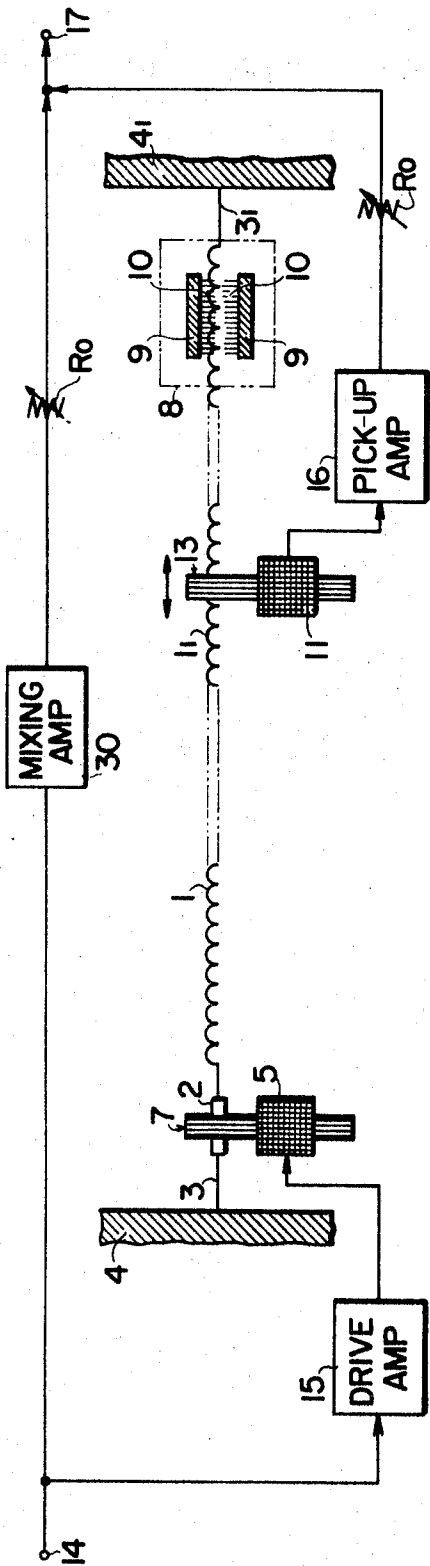
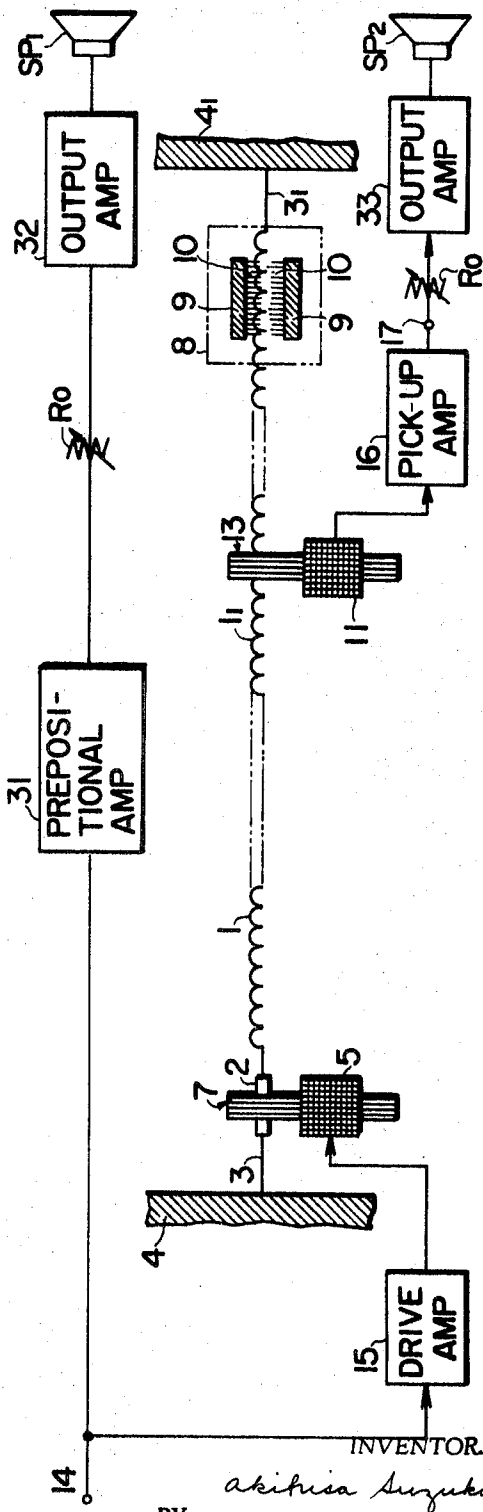
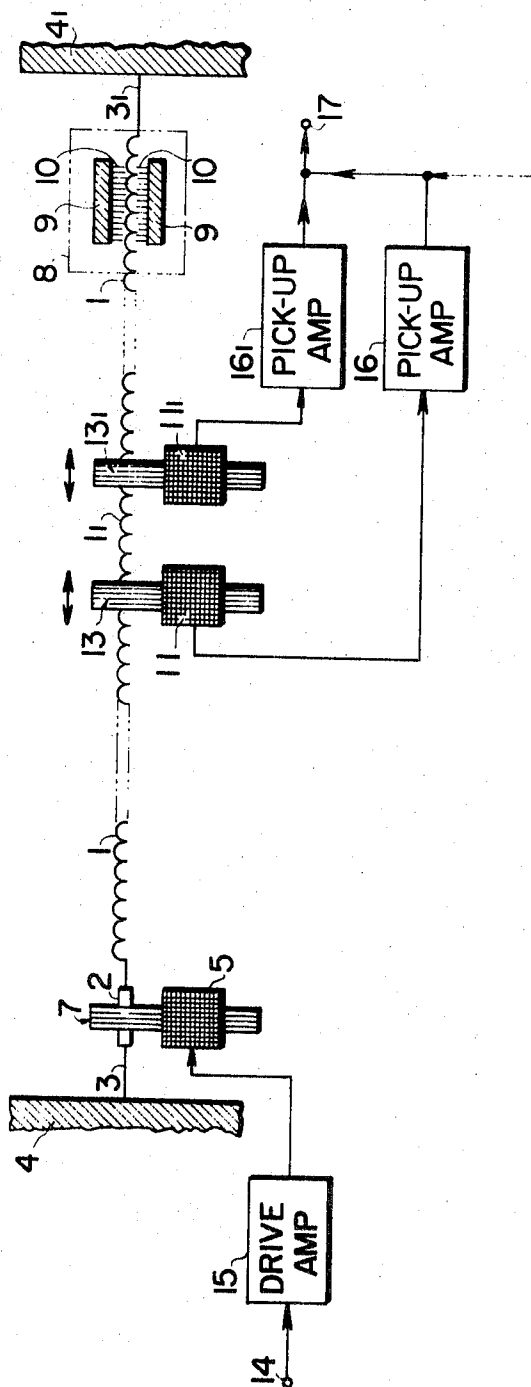


FIG. 8



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FIG. 9



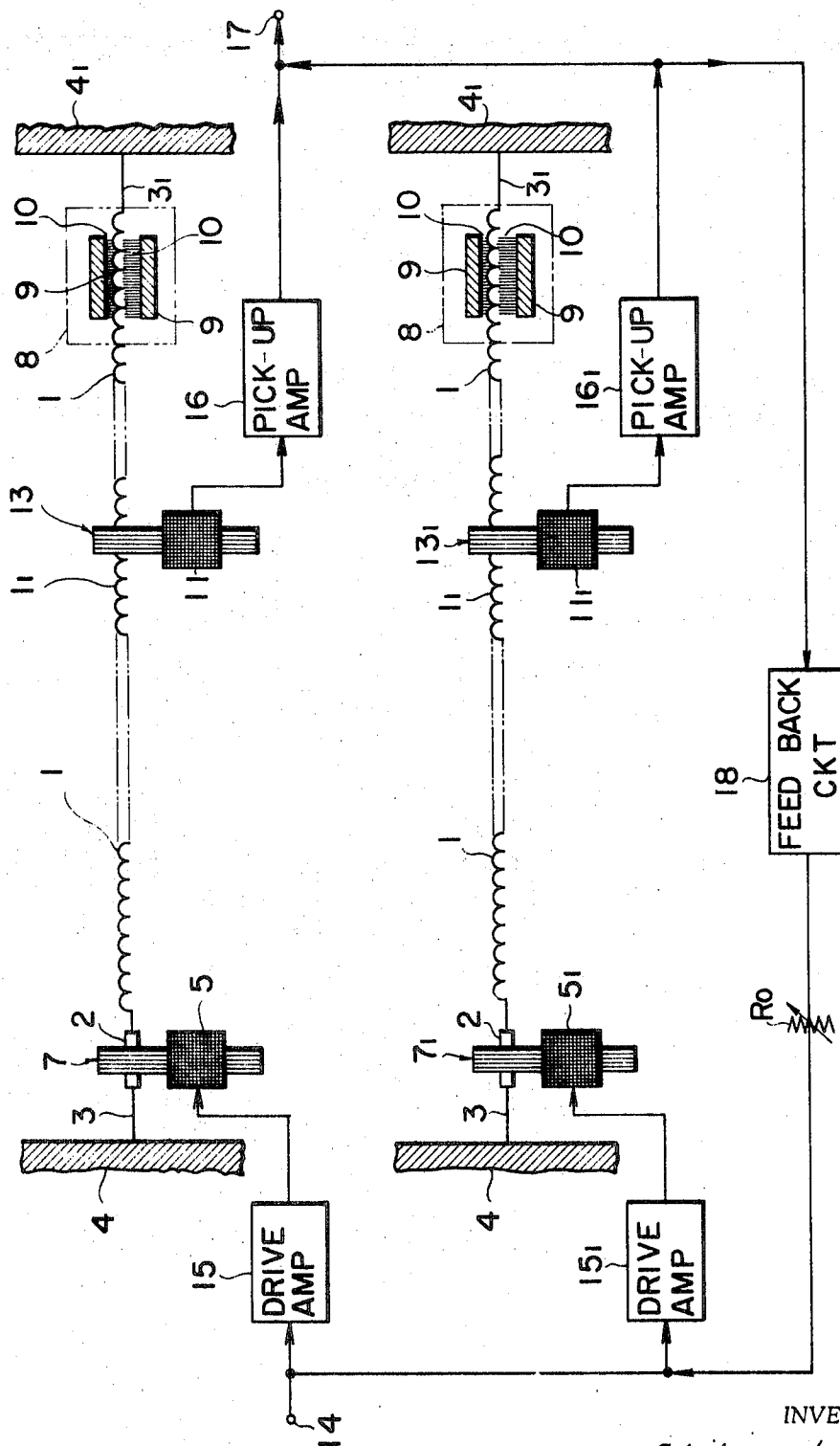
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FIG. 11



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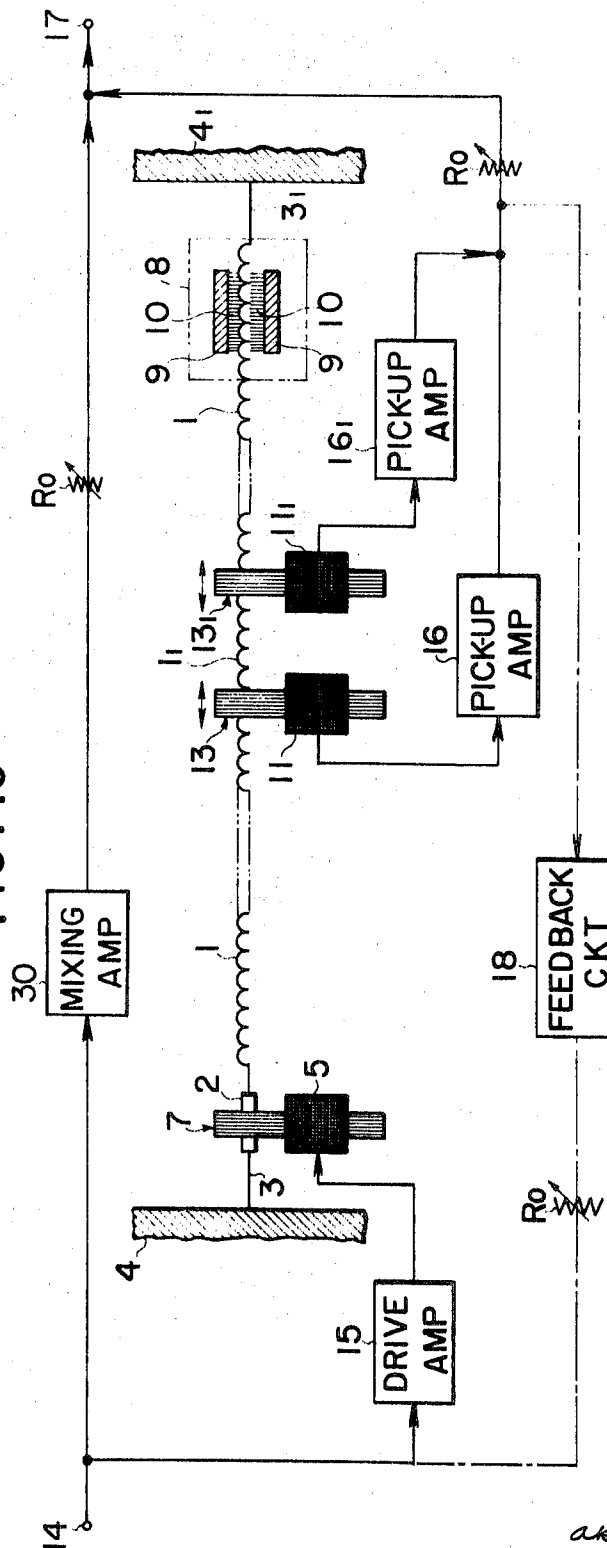
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FIG. 13



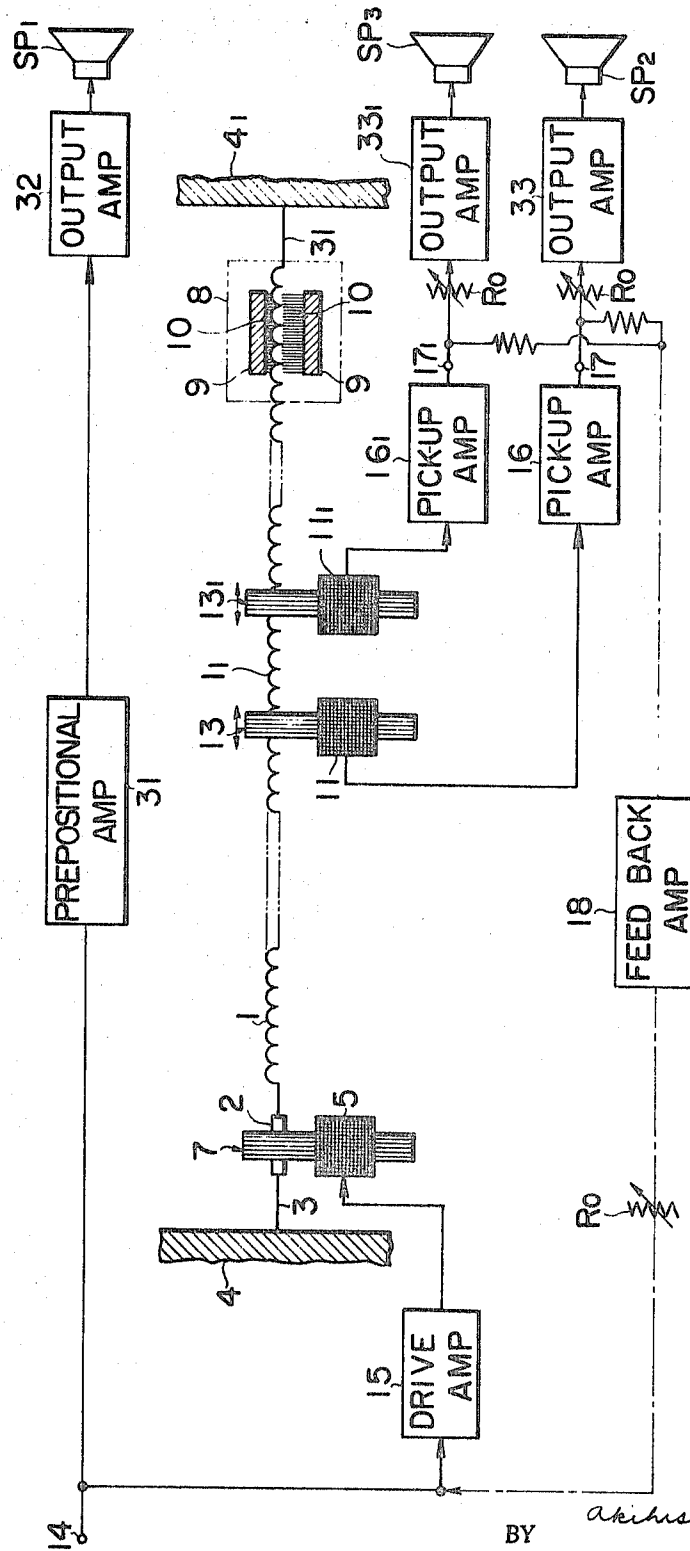
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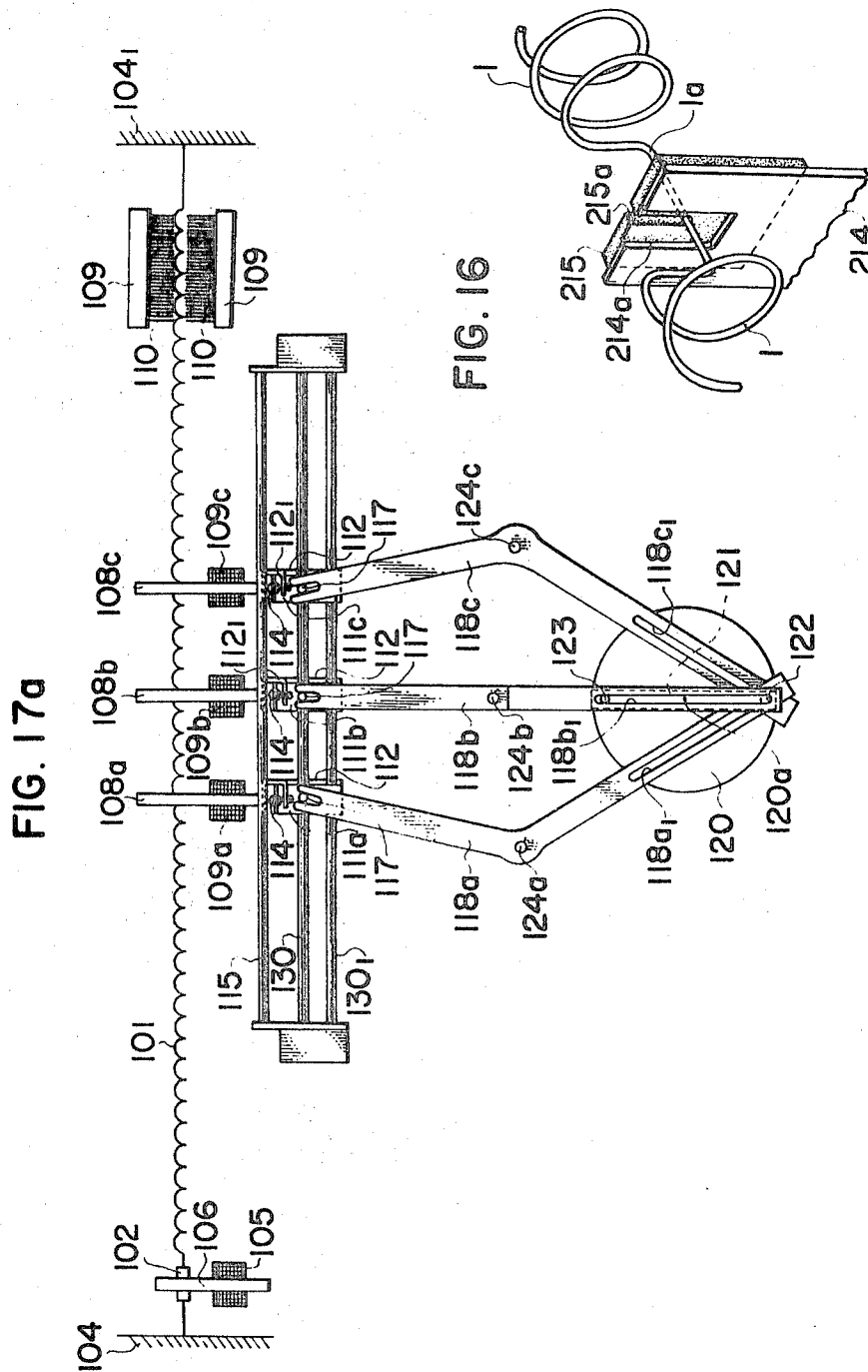
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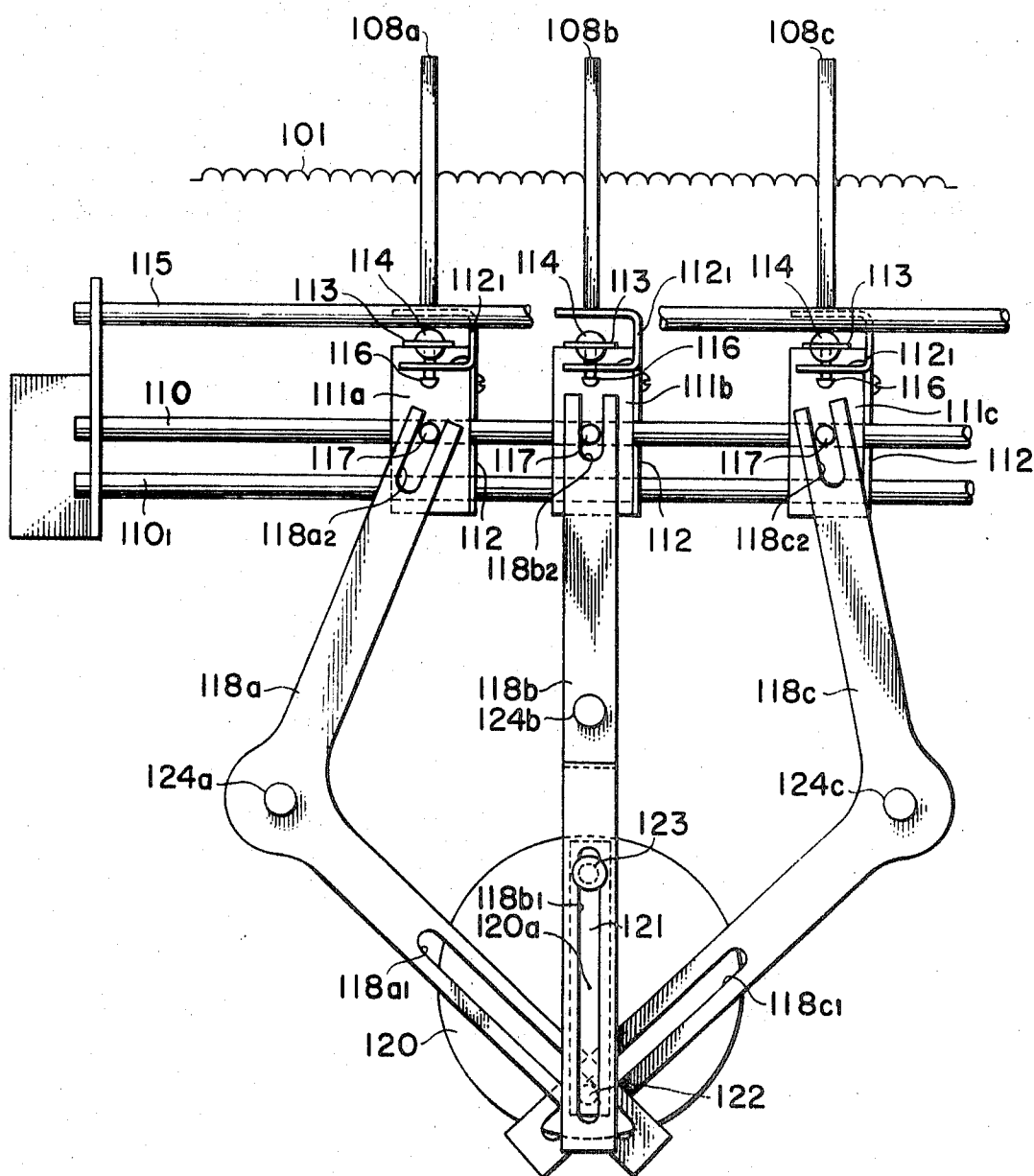
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FIG. 17c



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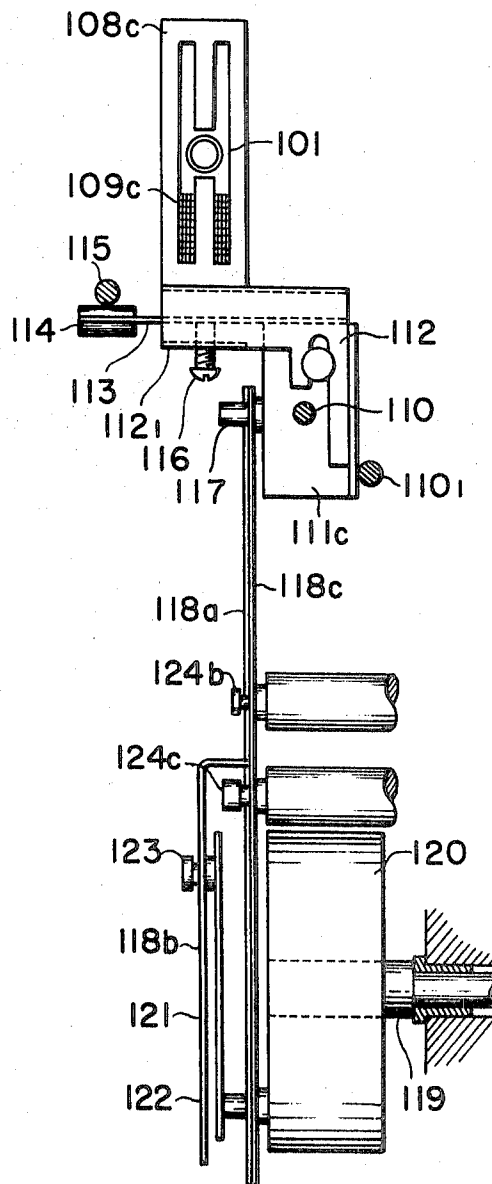
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FIG. 17d



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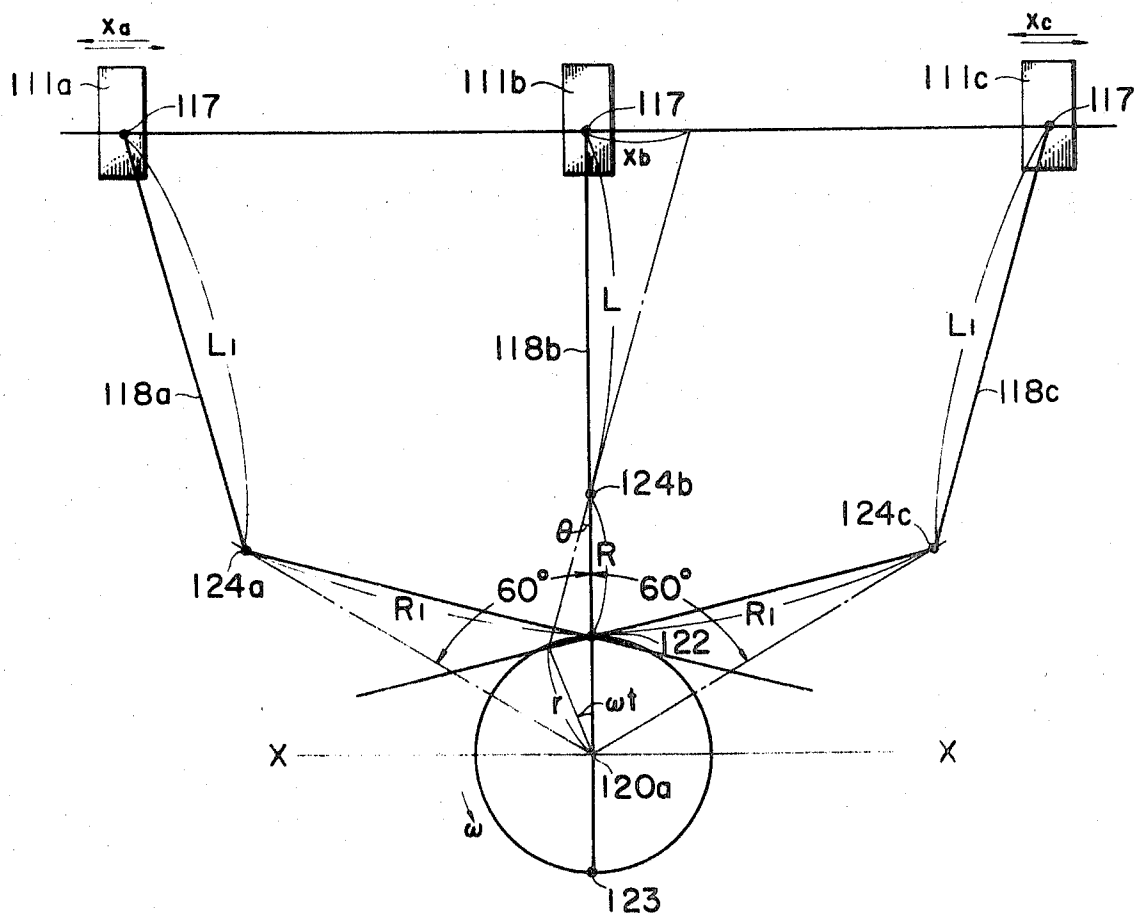
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FIG. 18a



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FIG. 18b

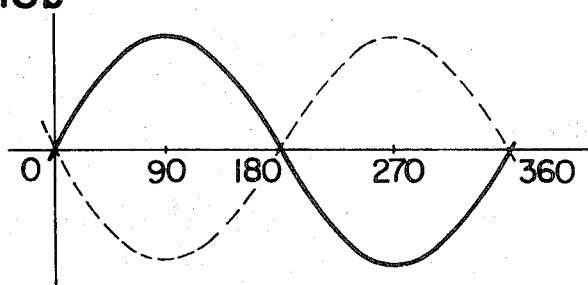


FIG. 18c

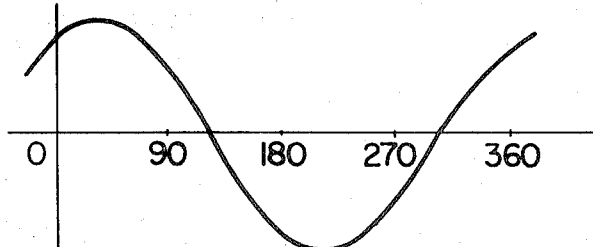
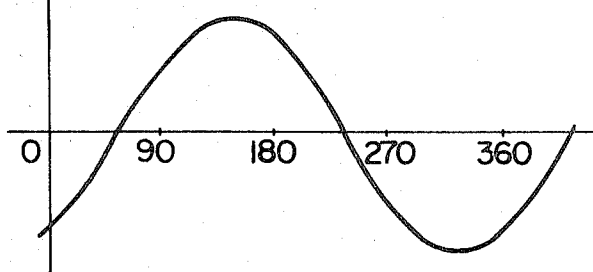


FIG. 18d



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APPARATUS FOR PROVIDING DELAY OF AN ELECTRICAL SIGNAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for providing delay of an electrical signal, and more particularly to an improvement in an electro-mechanical signal delay apparatus.

2. Description of the Prior Art

In the prior art apparatus of this type, there has been proposed a signal delaying apparatus which comprises an electro-mechanical converter for converting an input electrical signal to a mechanical vibration at its input side, a mechano-electrical converter for converting the mechanical vibration to an electrical signal, a coil spring arranged between both the converters for propagating the generated vibration thereon, said both ends of the coil spring being connected to respective magnets of the converters mounted on support plates through support wires, whereby the magnet of the electromechanical converter causes a rotational vibration with an audio signal applied to the input converter, and the other magnet detects the rotational vibration propagated on the spring into an electrical signal. In such a delaying apparatus, however, a wave propagating the converted vibration is reflected at the termination of the spring and the reflected wave causes an interference with the forward wave, with a result that there occur remarkable variations in the frequency characteristics of the output signal detected by the mechano-electrical converter. Also, the apparatus is disadvantageous in that, since the delay time of the signal thus obtained has been made constant with the length of the coil spring, no output signal having any delay time can be produced.

SUMMARY OF THE INVENTION

Therefore, the principal object of the present invention is to provide an improved signal delaying apparatus utilizing a mechanical vibration and capable of easily providing an electrical signal which is arbitrarily delayed in time as desired.

Another object of the invention is to provide a novel signal delaying apparatus in which a delayed signal having good frequency characteristics without distortion can be obtained.

A further object of the invention is to provide a novel signal delaying apparatus which is simple in constitution, easy to manufacture, and low in manufacturing cost.

A still further object of the invention is to provide a novel signal delaying apparatus capable of producing a frequency modulated signal from a non-modulated input signal in addition to delaying the latter.

Other object, features and advantages of the present invention will become apparent from the following description of preferred embodiments when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view illustrating the construction of an embodiment of an apparatus for providing delay of an electrical signal according to the present invention;

FIGS. 2a, 2b and FIGS. 2c, 2e (a modification) are views of sections taken along lines IIA—IJA, IIB—IJB and IIC—IJC shown in FIG. 1 respectively;

FIG. 2d is an enlarged view of another example of a damper portion shown in FIG. 1;

FIGS. 2f and 2g are diagrams showing the frequency characteristics according to the present invention and the prior art, respectively;

FIG. 3 is a view showing another embodiment of the invention;

FIG. 4a is a sectional view of another embodiment showing driver means and/or pickup means taken along line IVA—IVA shown in FIG. 3, and FIGS. 4b and 4c are diagrams for illustrating the functions of the invention;

FIG. 5 is a view showing a driving device for mechanically actuating a mechano-electrical pickup means used in the present invention;

FIGS. 6a to 6d are diagrams for explaining the operation of the invention;

FIGS. 7 to 9 and 12 to 15 are views of modifications of FIG. 1, using the device shown in FIG. 5;

FIGS. 10 and 11 are views of modifications of FIG. 1;

FIG. 16 is an enlarged perspective view showing a support for supporting an intermediate portion of a coil spring used in the invention;

FIG. 17a is a view showing an apparatus according to another embodiment of the invention;

FIGS. 17b to 17d are perspective plan and side views of an essential portion of the embodiment shown in FIG. 17a, respectively; and

FIGS. 18a to 18d are diagrams for explaining the operation in phase of the apparatus shown in FIG. 17a.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the description of the following embodiments, same reference numerals and symbols indicate same parts.

Now, by referring to FIG. 1, there is shown an apparatus according to an embodiment of the present invention, in which numeral 1 represents an elongated coil spring formed with minute wires made of stainless steel, bicalloy, cunife, cunico, or the like, which is magnetized throughout the length thereof or in an appropriate intermediate portion thereof along its length. One end of the coil spring 1 is connected to a support wire 3 having a pillar-shaped magnet 2 and the other is connected to another wire 3₁. These support wires 3 and 3₁ are fixed to support plates 4 and 4₁ mounted on a mount K, respectively, between which the coil spring 1 are subjected to tension to an extent that they are not energized against each other. Close to the magnet 2 a U-shaped magnet core 6 around which a coil 5 is wound is arranged to position the magnet within the U-shape of the core, thus forming an electro-mechanical converter 7 at the input side. Numeral 8 represents a damper located at the side of the other end of the coil spring 1, which includes, for example, a substrate 9 and an electrically implanted pile surface formed thereon, said piles 10 being made of acrylic fibre and substantially long. The pile surface is arranged in contact with the side of the coil spring. Alternatively, as shown in FIG. 2d, the portion of the coil spring located close to the other end may be provided, on the respective turns, with electrically implanted piles 10a formed thereon by the use of an adhesive agent in such a way that they contact with each other and that thus they absorb substantial portion of the rotational vibration reaching said

other end of the spring. Close to its magnetized portion located between the damper 8 and the electro-mechanical converter 7 which is provided at the side of signal input, there is arranged a magnetic core assembly 12 having a wound coil 11 therein, said core assembly encircling the magnetized portion of the spring un-
touchably therewith, and thus, the assembly 12 constitutes a mechano-electrical converter 13.

The apparatus for providing delay of an electrical signal operates in the following manner. That is, an input electrical signal applied to an input terminal 14 of the apparatus is amplified by an input amplifier 15, and an output signal derived from the amplifier 15 is supplied to the coil 5 of the electro-mechanical converter 7. With the supplied current to the coil 5, fluxes are produced in the core 6 to thereby cause the magnet 2 to be moved. Thus, the magnet 2 is caused to spirally vibrate in accordance with the variation of the input signal and, thus the coil spring serves as the vibration transmitting means. The spiral vibration is thus propagated through the coil spring and detected by the core 12 of the detecting converter 13. More specifically, the core 12 produces variations in the fluxes existing in the core assembly, thereby inducing a voltage in the coil 11. The induced voltage is then amplified through a detecting amplifier 16, and the output of the amplifier 16 is derived as an output signal of the apparatus at an output terminal 17. In this case, any reflected spiral vibration occurring at the other end of the spring may be substantially absorbed by the function of the damper 8, resulting in substantially no reflection of the vibration and thus, interferences occurring between the reflected vibration and a subsequent forward vibration may be reduced to a remarkable extent. As a result, the output signals derivable from the terminal 17 may have frequency characteristics of negligible levels. In the embodiment, each of the converters employs a magnetic core around which is wound a coil, but each of such converters may be only coil assembly without cores so arranged that it is close to either the magnet or the spring coil. Also, as the vibration absorbing means for preventing reflection of vibration at the propagating signal terminating end, there may be provided means for submerging the coil spring in a liquid of a quantity, such as glyceryl hydroxide.

A modified damper means is shown in FIG. 2e, in which pile implanted assemblies as shown in FIG. 2c are coupled symmetrically with respect to the coil spring.

As a result of comparative experiment between the present apparatus with the damper and the conventional one without damper, the respective frequency characteristics of the output signal were found to be as shown in FIGS. 2f and 2g, wherein

coil spring is made with: stainless steel wire
diameter of steel wire: 0.35 mm
diameter of a turn of coil: 5.00 mm
number of coil turns: 500
length of coil spring mounted: 280 mm
length of substrate: 100 mm
width of same: 20 mm
diameter of implanted pile: 20 μ
height of same: 7 mm,

the vibration pickup mechano-electrical converter was located 130 mm from the input mechano-electrical driver along the length of the coil spring.

As is comparatively seen from the characteristic diagrams of FIGS. 2f and 2g, the present apparatus employing a damper is much superior in frequency-level response of an output signal to one without the damper.

In the construction of the invention described above, it is to be understood that, since there are provided a vibration-absorbing damper in the vicinity of one end of a vibration transmission coil spring and a vibration detecting mechano-electrical converter between an electro-mechanical converter provided in the vicinity of the other end of the spring and said damper along the length of the spring being magnetized, the electrical signal detected by the converter can have any desired time delay and a good frequency-level characteristic.

Now, in the experiment as described above, when the propagating speed of a vibratile signal generated from the magnet 2 was about 6500 millimeters per second, the propagation time, i.e., the delay time of the signal was found to be in the order of 40 millisecond, and the pickup means 13 for detecting the vibratile signal was movably located along the length of the spring at a distance from the magnet to provide a delay time, for example, of 20 milliseconds. Further, in contrast with the conventional reverberation producing apparatus, the present apparatus, did not cause any comb-shape resonance phenomena with an extremely high Q due to mutual interference occurring between a direct wave propagating on the spring and its reflected wave, thus resulting in no distortion nor hauling toward the input signal.

In FIG. 3, there is shown a modification of the apparatus shown in FIG. 1, which includes a feedback circuit 18 between the output terminal 17 and the input terminal 14 through a variable attenuator R_0 , such as a variable resistor so that the output of the pickup amplifier 16 is partially fed back to the input amplifier (drive amplifier) 15. The vibration absorbing means 8 can be of the type as shown in FIG. 2e. As the driver unit 7 or the pickup unit 13, a symmetric structure type may be used as shown in FIG. 4a. Also, the driver unit 7 may be arranged so that it can drive directly a magnetized portion of the coil spring 1. The pickup unit 13 is located at a magnetized portion 1₁ of the spring coil.

The above-mentioned arrangement as well as that of FIG. 1 is suitable for use in an apparatus for providing reverberation of an audio signal, i.e., an echo effect in sounds. That is, when an audio input signal, for example, as the one shown in FIG. 4b is applied to the input terminal 14 of the apparatus having a feedback circuit, the signal is subjected to delaying for a given time due to the coil spring, and the delayed output is fed back to the input terminal, and as a result, an output signal derived at the output terminal 17 becomes one as shown in FIG. 4c of which the waveform is seen gradually attenuating with time due to the feedback action. Thus, reverberation or an echo effect of the audio signal can be obtained. Now, the degree of gradual attenuation in the delayed signal may be varied by setting the variable resistance R_0 .

Next, description will be made of embodiments in which the pickup means 13 is reciprocally actuated along the length of the coil spring to provide a frequency-modulated signal.

In the apparatus of FIG. 1, the pickup means 13 may be provided with means for reciprocally driving it linearly along the length of the spring 1 as shown in FIG. 5. The drive mechanism is so constructed that an out-

put signal of an ultra low frequency signal generator 19 having a sinusoidal wave in the order of 0.5 to 10 Hz is applied subsequently through a variable resistor R to the input side of a differential amplifier 20 of a push-pull type, and that then two signals derived from the output side of said amplifier 20, which are opposite in phase to each other, are supplied to plunger coils 21 and 22, respectively. Thus, a magnetic force induced alternately from two coils causes a piston 23 — which is formed of magnetic material and loosely engaged into the coils — to be moved linearly and reciprocally. The required stroke of the linear movement of the piston 23 is adjustable by the operation of the resistor R. The piston 23 is adapted to fit at its center portion to the pickup unit 13 having a coil 11.

Let us now assume that the range or stroke of the movement of the pickup unit 13 which is indicated by x is ± 20 millimeters and that the repetitive stroke frequency F is 0.5 Hz, the variation in the relative velocity of the pickup unit 13 with respect to the spring 1 can be expressed by $\pm 2\pi Fx$, i.e., ± 62.8 millimeters per second and the variation rate of frequency $\dot{x}/v$ becomes ± 0.97 percent, i.e., ± 16.3 cents. Therefore, when an input signal having such a frequency spectrum as shown in FIG. 6a is applied to the input terminal 14, the signal is frequency-modulated — by 16.3 cents due to the motion of the pickup unit 13 — into a signal of a band spectrum having a frequency width as shown in FIG. 6b at the output of the pickup unit 13. The output signal thus obtained is amplified by the amplifier 16 and derived at the terminal 17. If the amplified signal is in the audio range, it may have a chorus effect and a celesta effect.

Furthermore, if the repetitive stroke frequency of the pickup unit F is made to be 6 to 8 Hz and its stroke x made to be ± 2 millimeters, the frequency variation $\dot{x}/v$ becomes ± 19.6 to 26 cents, and the input signal is thereby frequency-modulated. Accordingly, a signal which has been fluctuating with time at repetitive frequencies of 6 to 8 Hz is obtained at the output terminal 17. That is, the output signal provides a vibrato effect in use for acoustic purposes. The frequency variation rate may be made above 50 cents by adjustment of the pickup drive means as required. Though the pickup drive means as described above employs plungers, there may be used rotatable cams or cranks to provide the reciprocal movement of the pickup means in place of the plungers.

In FIG. 7, there is shown a modification of the preceding embodiment with the pickup drive means, which includes a mixing amplifier 30 between the input terminal 14 and the output terminal 17 through a resistive attenuator R_0 . In such an arrangement, when a signal having a frequency spectrum as shown in FIG. 6a is applied to the input terminal 14, there is detected at the output terminal 17 an output signal whose frequency spectrum is as shown in FIG. 6c. The provision of such complex frequency spectrum is effective for providing audible sounds having good build-up amplitudes in electronic and electric musical instruments.

FIG. 8 illustrates a further modification of the preceding embodiment, in which at the terminal 14 a pre-amplifier 31 is connected whose output is entered via a variable resistor R_0 and an output amplifier 32 to a loudspeaker SP_1 , while the output of the pickup amplifier 16 is entered via a variable resistor R_0 and an output amplifier 33 to another loudspeaker SP_2 . The ar-

rangement provides a stereo sound effect as well as the same effect as the preceding modification by mixing two sounds emitted from the two speakers into space.

FIG. 9 shows another embodiment in which there are provided a plurality of separate pickup means, for example, two separate mechano-electrical pickup means 13 and 13₁, spaced at a distance from each other, said means having the respective pickup coils 11 and 11₁. The outputs of the pickup means are introduced through corresponding pickup amplifiers 16 and 16₁ into the output terminal 17. In case these pickup means are fixed at appropriate positions along the length of the magnetized portion 1₁ of the spring 1, there is derived an output signal as shown in FIG. 6d at the terminal 17 by application of the signal of FIG. 4b at the terminal 14. On the other hand, it will be understood easily that the pickup means may be driven by corresponding pickup actuating means such as those shown in FIG. 5 to provide frequency-modulated output signals in the same manner as that described above. Especially, it is effective in providing various advantageous characteristics in the outputs that said plurality of pickup means are actuated in different modes, i.e., frequency, amplitude and/or phase relative to one another.

Referring to FIGS. 12 to 15, various modifications of the apparatus with a plurality of pickup means as described above having its drive means as shown in FIG. 9 are illustrated.

FIG. 12 shows an arrangement in which the feedback circuit 18 is provided between the input and output terminals 14 and 17 through the resistor R_0 in the apparatus of FIG. 9. FIGS. 13 and 14 show modified arrangements of FIG. 12, in which the former includes the mixing amplifier 30 added in parallel with the feedback circuit 18, while the latter has the preamplifier 31 and output amplifiers 32 and 33, and loudspeakers SP_1 and SP_2 in the same manner as in FIG. 8.

FIG. 15 shows a modification of FIG. 14 in which the outputs of the pickup amplifiers 16 and 16₁ have respective output amplifiers 33 and 33₁ and respective loudspeakers SP_2 and SP_3 to thereby provide much more complicated delicate effects in output sounds.

FIGS. 10 and 11 show examples of combination of a plurality of apparatus shown in FIG. 1 whose vibration absorbing means is substituted by the type as shown in FIG. 2e. In FIG. 10, by the application of one input signal, there can be derived two output signals having different delay times from each other at the output terminal 17. That is, the output signal of FIG. 6d is derivable with the input signal of FIG. 4b.

FIG. 11 is a further modification of FIG. 10 made by the provision of a feedback circuit 18 in the same manner described above.

FIG. 16 shows a support means for supporting the coil spring 1 to prevent undesirable vibration from occurring therein. In this support means, at least one straight portion 1a is provided in an intermediate portion of the coil spring, said portion 1a being axially centered on the coil. Numeral 214 represents a support plate extending upright from the platform or pedestal K in the vicinity of the straight portion 1a whose upper end portion has a relatively large cutout portion 214a. A contact member 215 formed with a soft material such as a soft foamed rubber, for example, "Softprene" (trade name) — which is relatively small in thickness — is secured to the support plate over the cutout portion 214a. In the contact member, there is formed an

elongated recess 215a at a position centrally of the cut-out portion. This recess 215a is adapted to receive the straight portion 1a of the spring therethrough. Thus, the coil spring 1 is supported during its length in slight contact with the member 215 by the support plate 214.

Referring to FIGS. 17a to 18d, description will be made of an embodiment of the present apparatus featured by three pickup unit drive means. According to this embodiment, the three pickup means of which each provides an output signal having a different delay time are rendered shiftable for the same period and with the same amplitude, concurrently keeping predetermined relative phases to one another, and thus there are provided the respective outputs having been subjected to complicated frequency modulation. Such an apparatus provides still more complex and delicate vibrato effects in electronic musical instruments or like instruments. In FIG. 17a, numerals 101 to 110 generally correspond to numerals 1 to 10 of the preceding embodiments. Therefore, description of these details is omitted.

Along magnetized portions of the coil spring, there are arranged three vibration detecting pickup units which comprise pickup cores 108a, 108b and 108c and pickup coils 109a, 109b and 109c, respectively, so that each of them may be reciprocally movable linearly with the spring 101. These pickup means are supported by a slide assembly which will be described later, while there are arranged — on one side of the coil spring 101 — a plurality of guide levers 130 and 130₁ in parallel with the spring 101, said levers staggering in position. One lever 130 engages into slide members 111a, 111b and 111c. The lower end portions of these slide members are slidably mounted on the other lever 130₁ so that each slide member may be rendered slidable along the length of the corresponding levers. The pickup cores 108a, 108b and 108c are connected with the slide members 111a, 111b and 111c by means of respective connecting members 112 and 112₁. In their linkage, appropriate gaps are kept between the slide members and the pickup cores. At the slide member side of each gap, there is fitted a leaf spring upright, at the top of which is fixed a contactor 114 in contact with a transverse lever 115 disposed in parallel with the guide lever 130. In order that each of the contactor 114 may provide a contact force toward the transverse lever 115, there are provided U-shaped members 112, so as to extend from the connecting members 112 and to depart to some extent from leaf springs 113, said leaf springs being pressed by screws 116 which are threaded into the members 112, and thus, the sliding condition of the slide members may be adjusted by the use of suitable means, or in other words by adjusting the magnitude of the contact force to be applied. Numerals 117 represent pins each being embedded in the center of the upper surface of each of the slide members 111a, 111b and 111c, with which are engaged pickup arms 118a, 118b and 118c adapted to be actuated by a drive means as will be described later, respectively.

As shown in FIGS. 17b, 17c and 17d, the pickup drive means has a pin 122 provided on an upper peripheral portion of a disk 120 rotatable through a drive shaft 119 which is adapted to rotate via accelerating mechanism (not shown) or decelerating mechanism (not shown). An arm 121 is provided on the pin 122 in such a manner that the former is located diametrically of the disk 120. At the opposite end of the arm 121, there is

provided a pin 123, and it is positioned so that the pin 122 travels by forming a circle. Accordingly, the pins 122 and 123 are located at an equal distance from the center 120a of the disk.

As the pin 122 is engaged by said pickup arms 118a and 118c at their elongated slots 118a₁ and 118c₁, formed at their one ends, notches 118a₂ and 118c₂ of these arms formed at the other ends are engaged by pins 117 provided on the respective slidable members 111a and 111c to connect the latter with the rotatable disk.

Furthermore, the pin 123 is engaged into an elongated slot 118b₁ formed at one end portion of a pickup arm 118b, while a notch 118b₂ formed at its opposite end is engaged by a pin 117 of the slide member 111b to connect the latter with the disk. In the state in which the pickup arm 118b and the arm 121 are made aligned in superposition with each other, the arm 118b is pivotally supported by a pivot 124b which is provided at a position intermediately of the arm 118b. Then, other pickup arms 118a and 118c are pivotally supported at pivots 124a and 124c, respectively, so as to make a phase difference of 120° between one another, both arms being symmetrically formed with respect to the arm 118b.

In operation, with the revolution of the disk 120, the pins 122 and 123 are rotated about the disk center 120a to serve as their rotational center points symmetrically with each other, while the pickup arms 118a, 118b and 118c are reciprocally moved through the respective slots about the respective pivots 124a, 124b and 124c along the travelling circle of the pin 122. At the same time, these pickup arms cause the slide members 111a, 111b and 111c to slide with the same stroke, resulting in reciprocal motion of the respective pickup units along the length of the spring 101.

Though the pickup means travel through the same range, the phases of the travelling pickup means are different from each other as explained by illustrations of FIG. 18a to 18d. However, the detailed explanation thereof is omitted for the sake of simplicity.

While particular embodiments of the invention have been described only by way of example, it will be apparent to those skilled in the art that other modifications and changes may be made with respect to the form and construction thereof without departing from the scope or spirit of the invention.

I claim:

1. An apparatus for providing delay of an electrical signal comprising at least one magnetized coil spring means for supporting said spring under tension at both ends thereof, electro-mechanical driver means having an electrical input terminal and provided in the vicinity of one end of said coil spring for vibrating said spring in accordance with a signal applied to said input terminal, vibration absorbing means provided at the side of the other end of said coil spring for preventing reflection of the vibration and at least one mechano-electrical pickup means located intermediately of the length of said coil spring between said ends untouchably therewith for magnetically detecting the vibration of the spring and converting it to an electrical signal, said pickup means having an electrical output terminal, and means for moving reciprocally said pick-up means along the length of said coil spring to thereby produce a frequency modulated signal at the output terminal of said pick-up means.

2. The apparatus according to claim 1, which comprises a feedback circuit connected between the input terminal of said driver means and the output terminal of said pickup means.

3. The apparatus according to claim 1, which comprises a mixing circuit for superposing the input signal on the frequency modulated signal derived at the output terminal of said pickup means.

4. The apparatus according to claim 1, which comprises a first and a second electro-acoustic transducers connected with said input terminal and said output terminal respectively, said first and second transducers generating sounds from said input signal and said frequency modulated signal respectively so that said sounds are mixed.

5. An apparatus for providing delay of an electric sig-

nal comprising: a magnetized coil spring supported under tension at both ends thereof; electro-mechanical driving means having an electrical input terminal and provided in the vicinity of one end of said coil spring for vibrating the latter in accordance with a signal applied to said input terminal; vibration absorbing means provided at the side of the other end of said coil spring for preventing reflection of the vibration; a plurality of mechano-electrical pickup means located intermediately of the length of said coil spring untouchably therewith for magnetically detecting the vibration of the spring and converting it to an electrical signal, each of said pickup means having an electrical output terminal; and actuating means for reciprocally moving said pickup means along the length of the coil spring.

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