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 [33] **Japan**
 [31] **41/48204, 41/48205, 41/51550 and**
42/UM.9111

[50] Field of Search..... 84/1.01,
 1.03, 1.18, 1.24, G, 1.82, 1.04, 1.06—1.08, 1.11,
 1.14

[56]

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[54] **AUTOMATIC RHYTHM PLAYER EMPLOYING**
PHOTOELECTRIC AND ELECTROMAGNETIC
MATRIX ELEMENTS
23 Claims, 16 Drawing Figs.

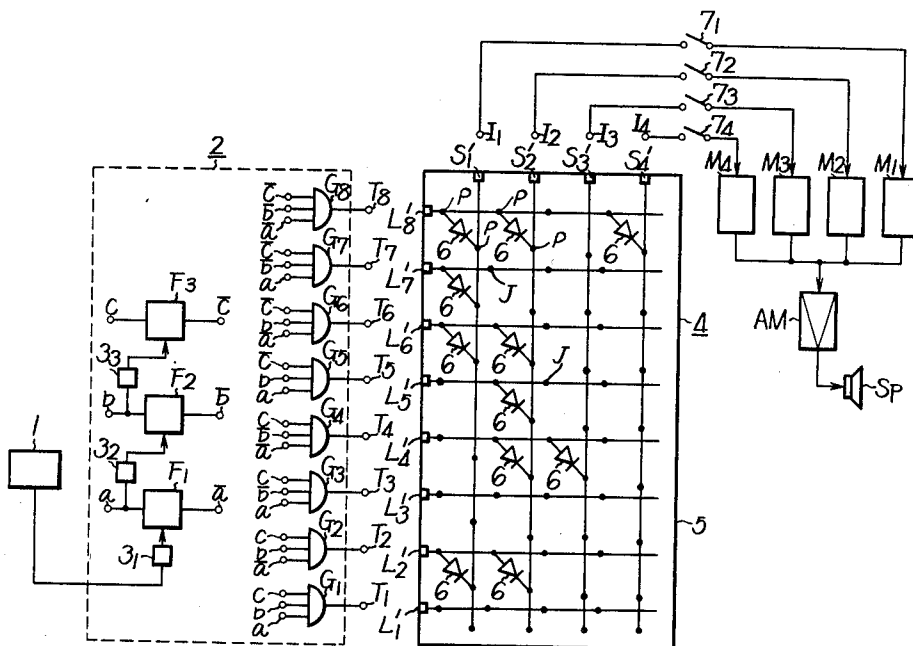
[52] U.S. Cl. 84/1.03,

84/1.18, 84/1.24

[51] Int. Cl. G10f 1/08,

G10h 5/02

ABSTRACT: An automatic rhythm player comprising a pulse oscillator generating pulses of a period corresponding to the time duration of the shortest note in a rhythm, a pulse developing circuit supplied with the output pulses of the oscillator and producing pulses sequentially phase-shifted by a time of the shortest note a rhythm-producing circuit for producing pulses corresponding to a desired rhythm, sound source circuit supplied with the pulses from the producing circuit and a speaker for announcing the rhythm. Various means including photoelectric and electromagnetic means for providing the coupling between the rhythm-producing circuit and the sound source circuit are disclosed. Means for accentuating the rhythm is also incorporated.



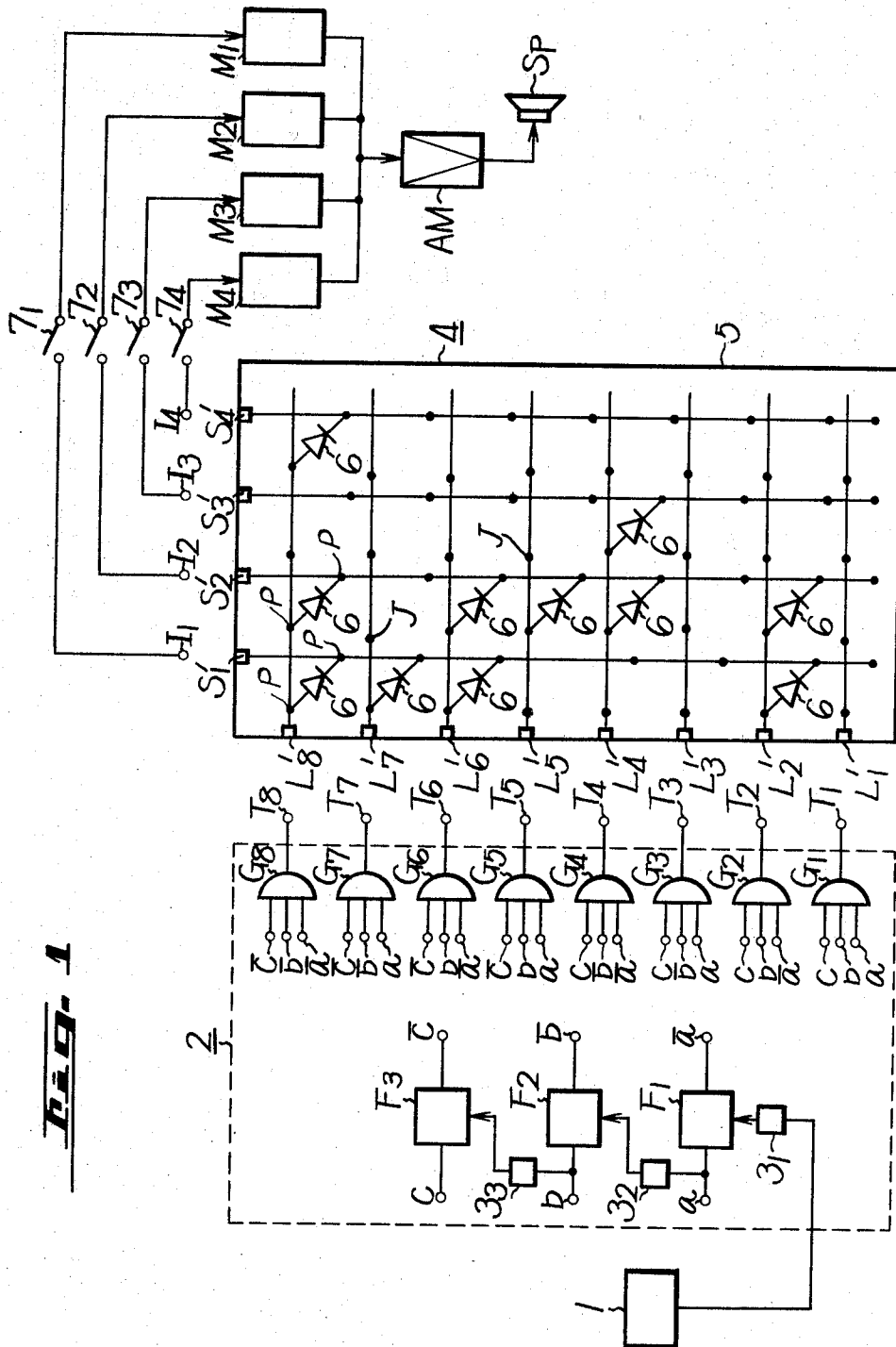
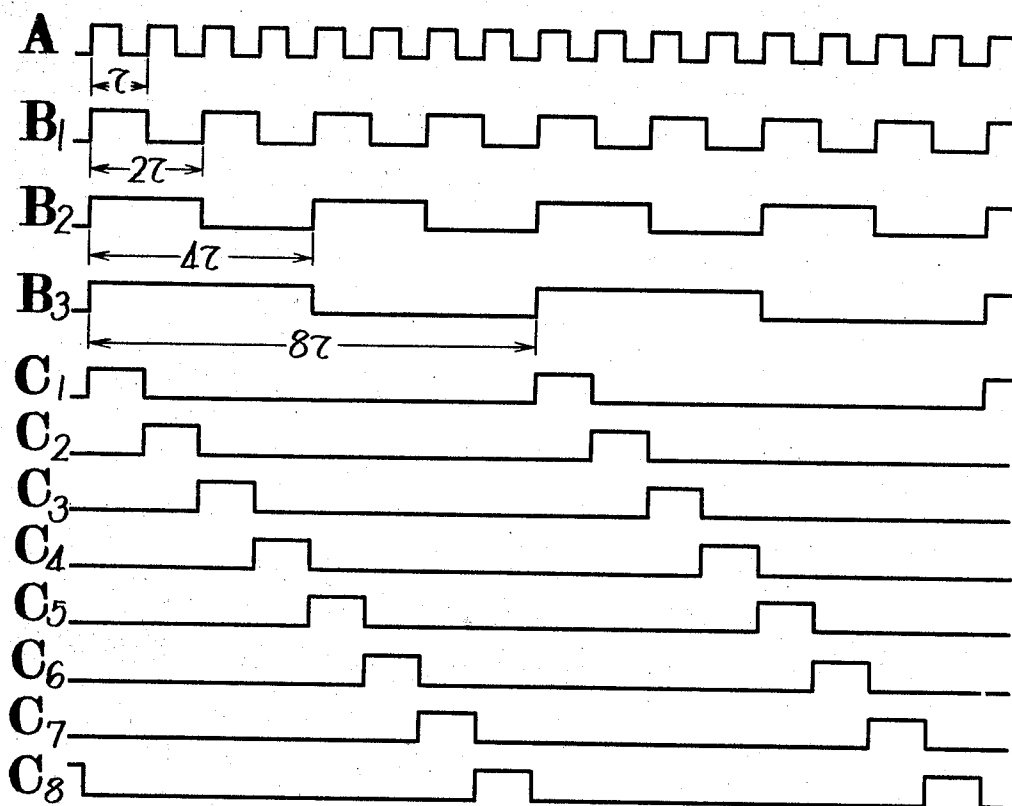


Fig. 1

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Fig. 2



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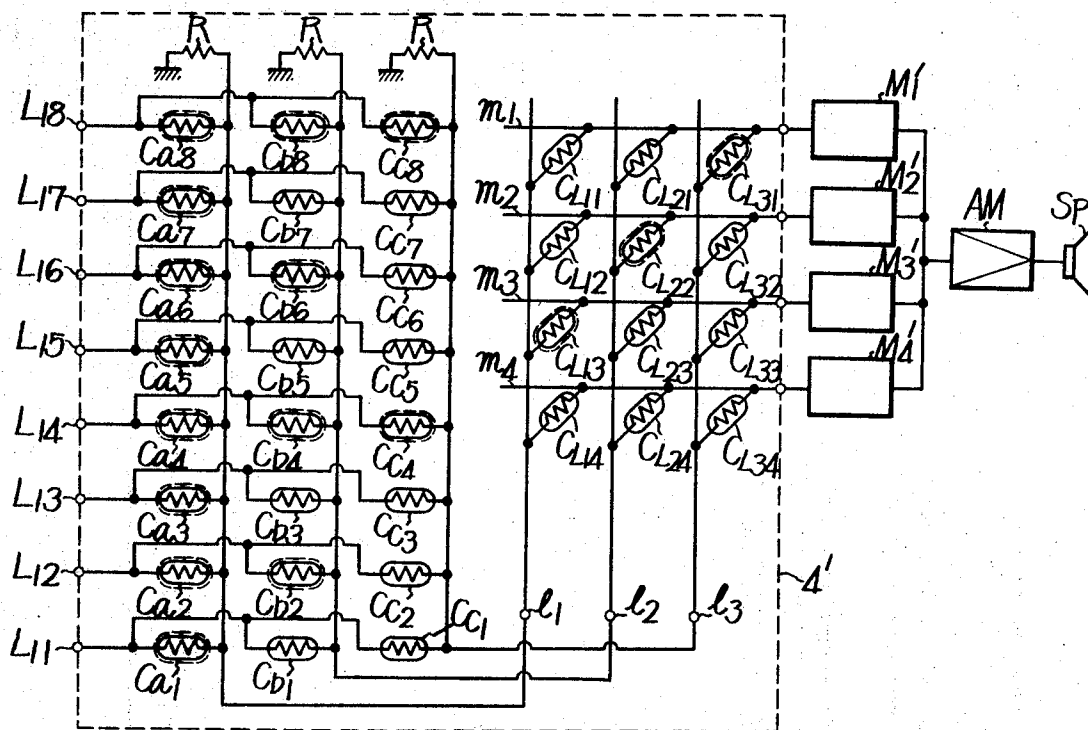
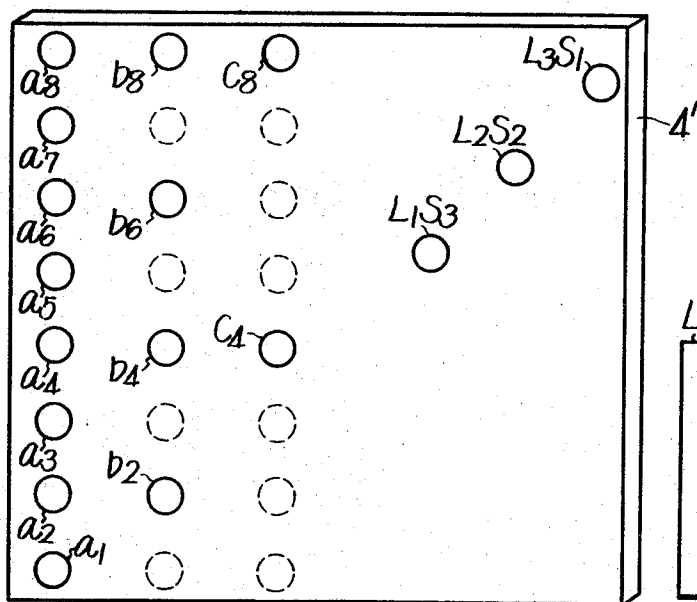
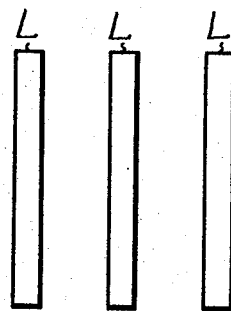
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Fig. 3



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Fig. 4

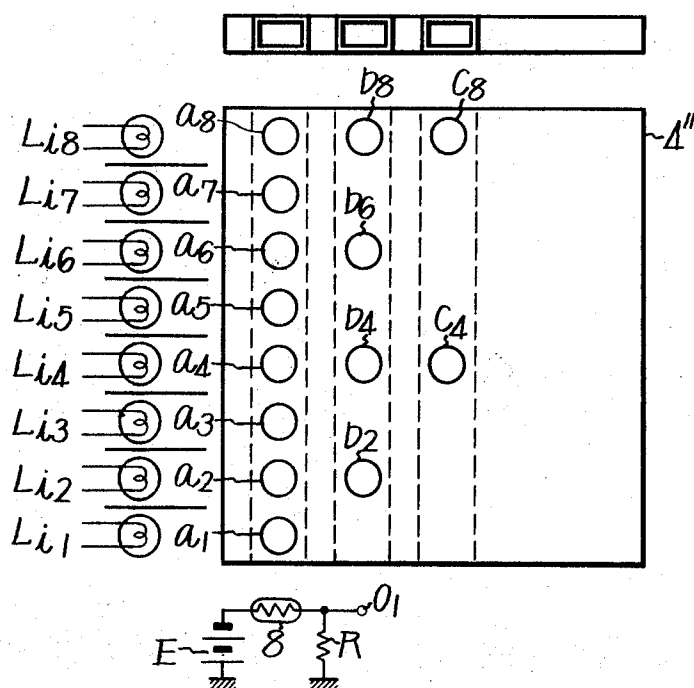
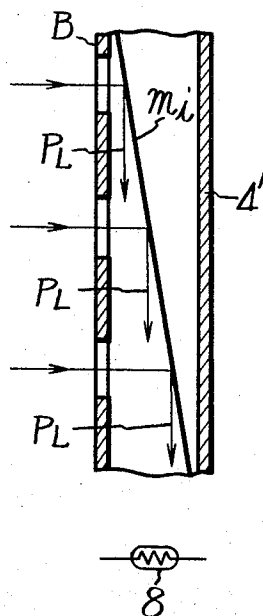


Fig. 5



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Fig. 7

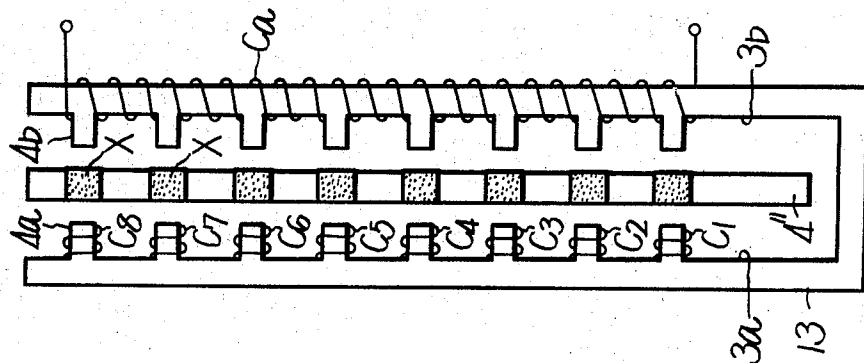
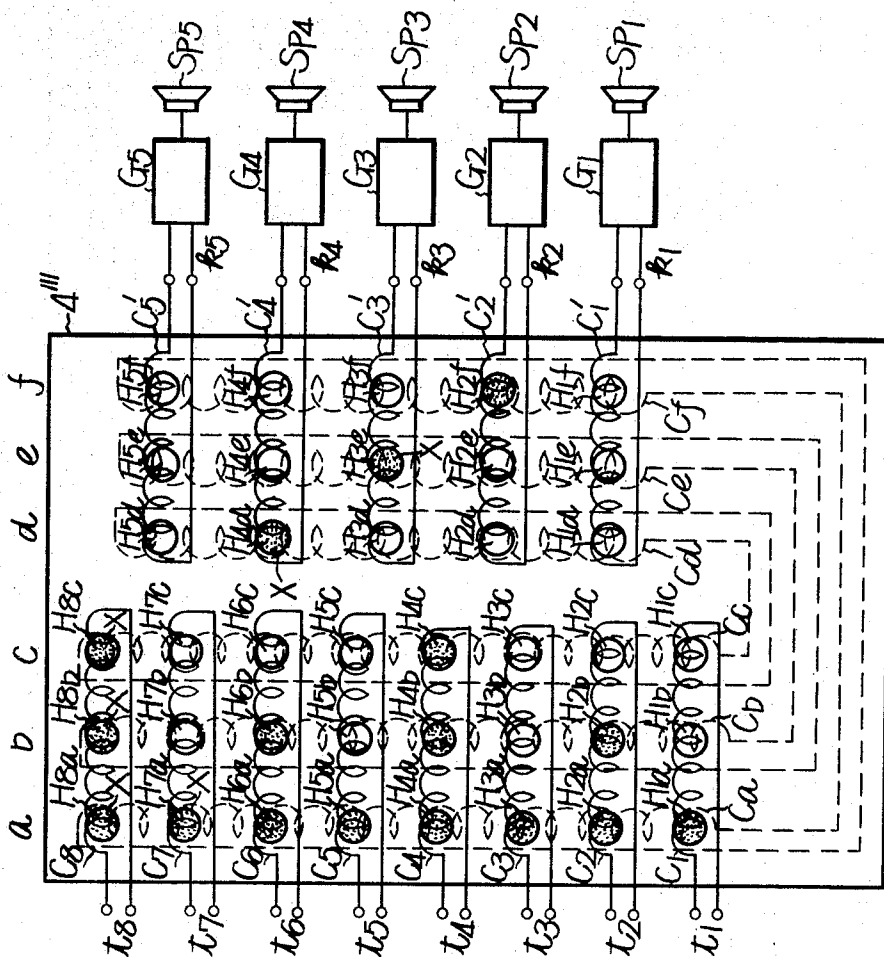


Fig. 6



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Fig. 9

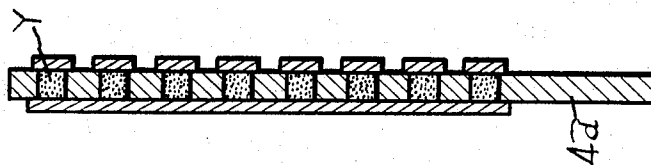
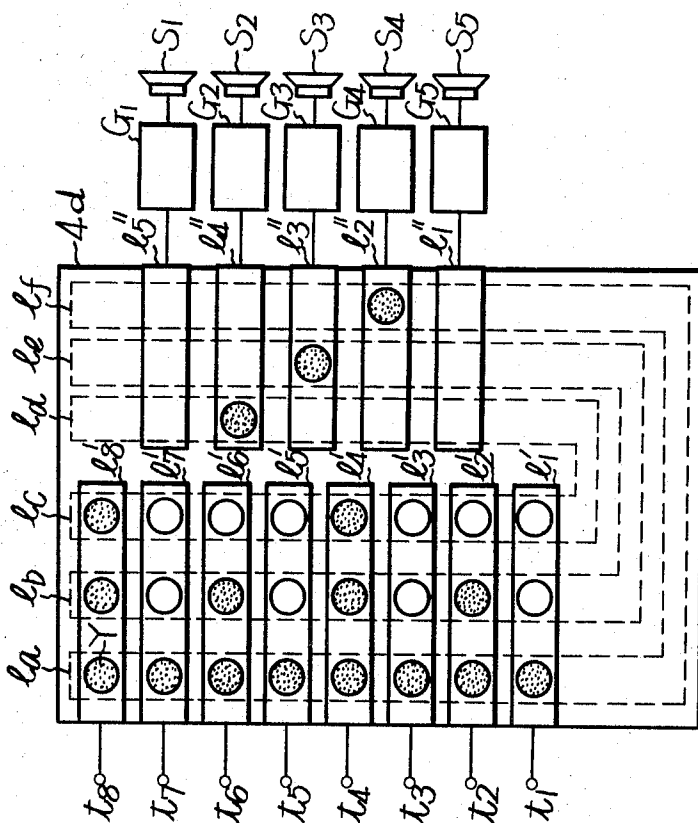


Fig. 8



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Fig. 10

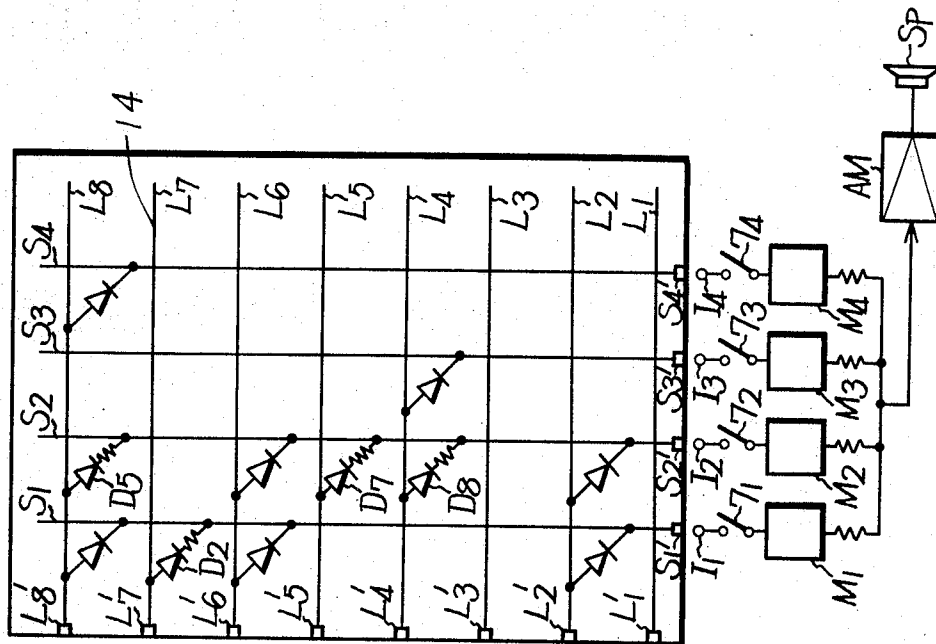
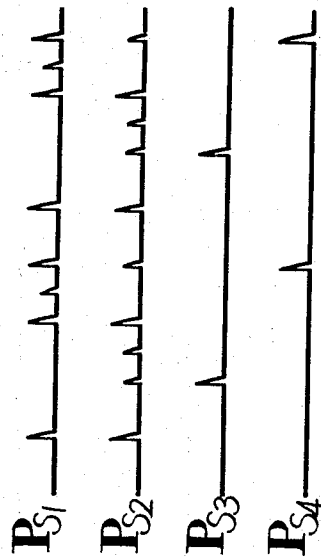


Fig. 11



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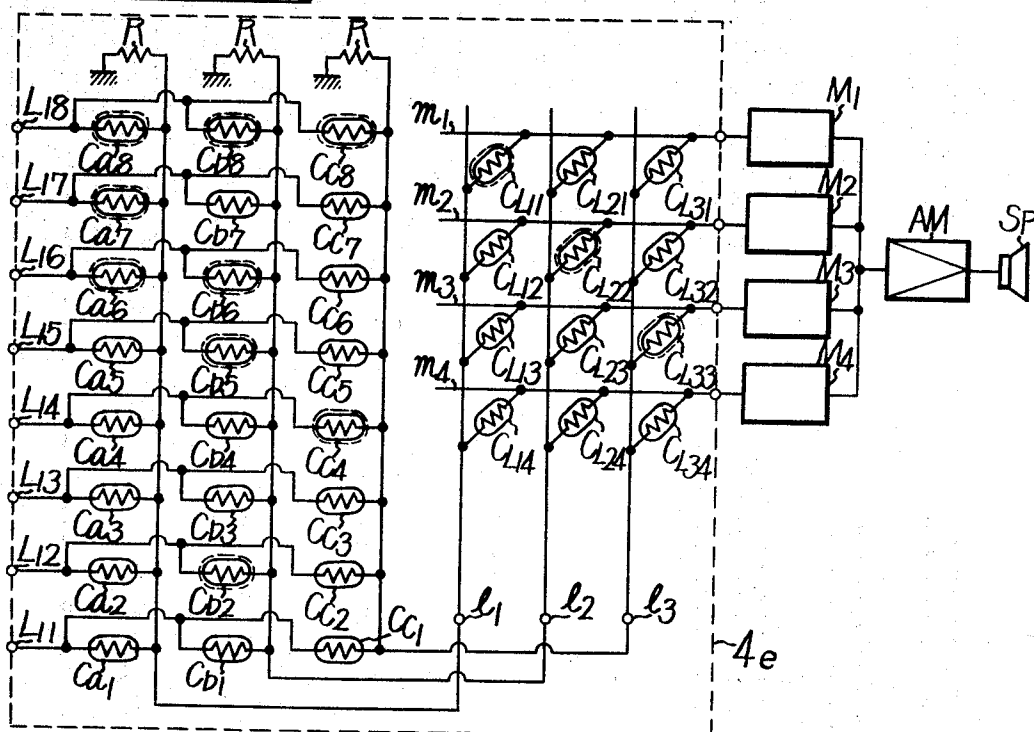
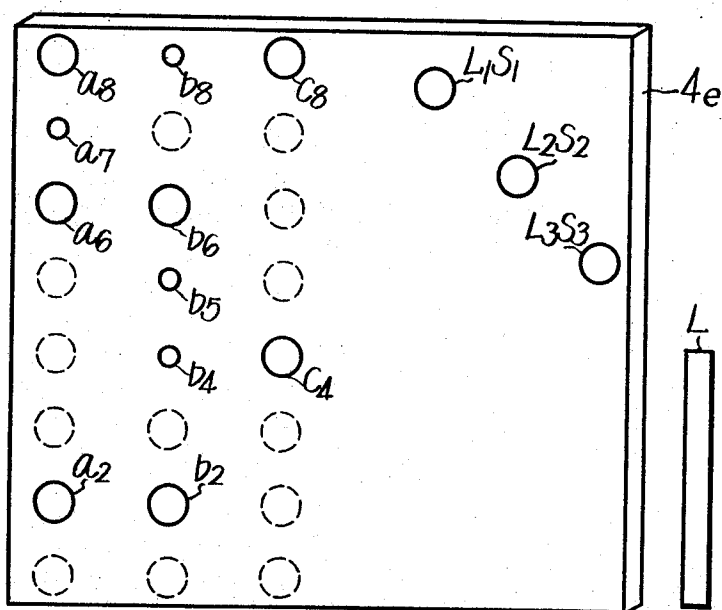
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Fig. 12



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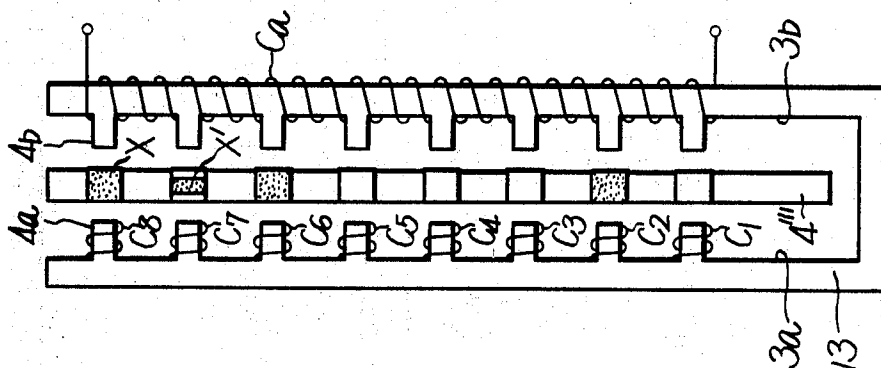
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Ex. 13

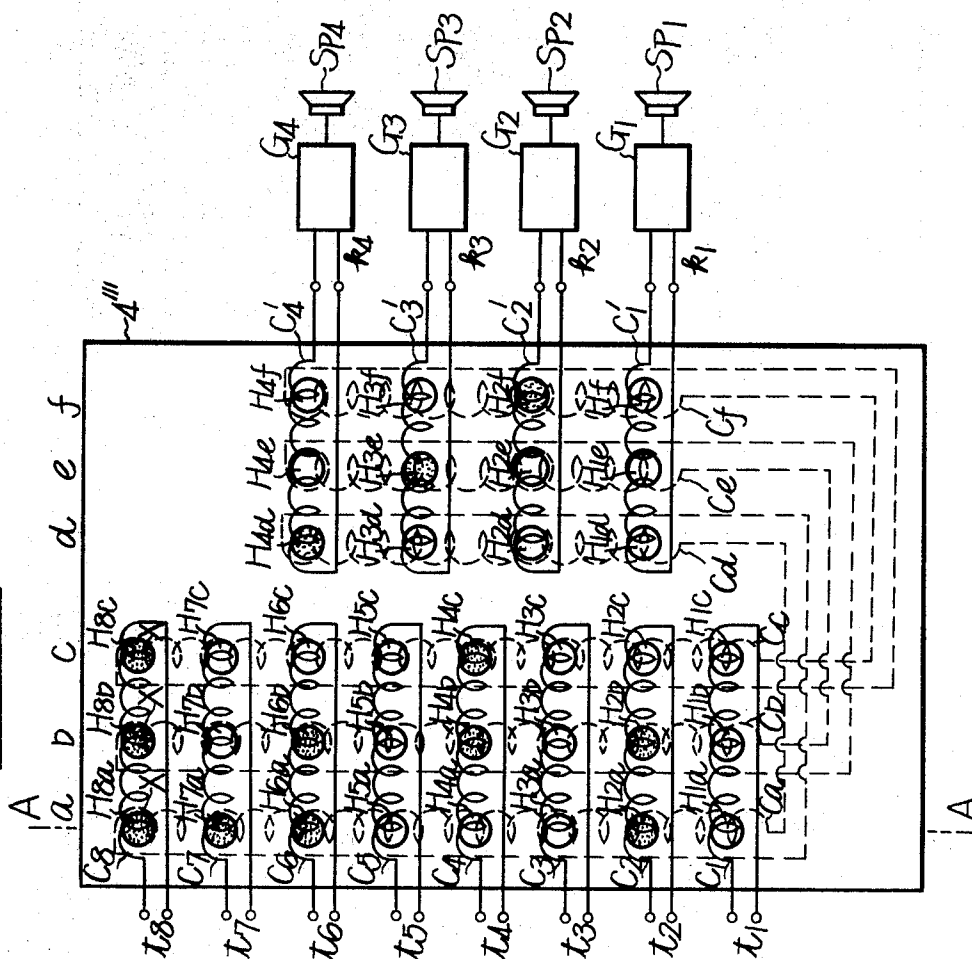


Fig. 16

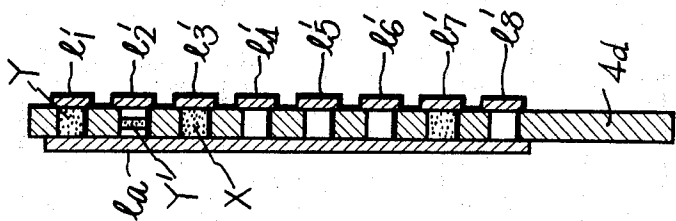
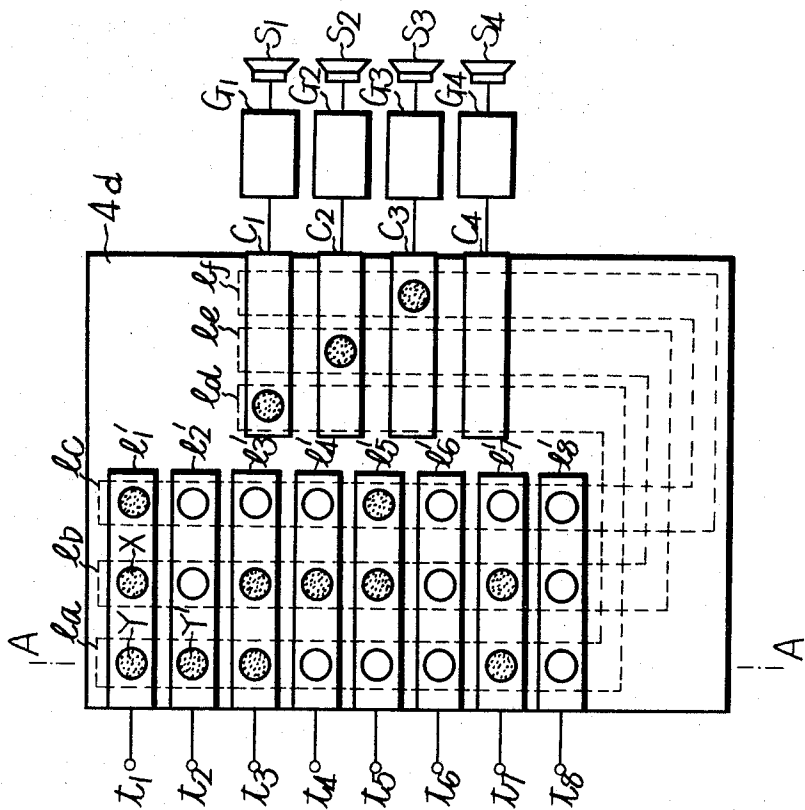


Fig. 15



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AUTOMATIC RHYTHM PLAYER EMPLOYING PHOTOELECTRIC AND ELECTROMAGNETIC MATRIX ELEMENTS

BACKGROUND OF THE INVENTION

This invention deals with an automatic rhythm player including many electric circuits such as an oscillator, a pulse-developing circuit, a rhythm-producing circuit, sound source circuits, and a speaker.

SUMMARY OF THE INVENTION

This invention relates to an electronic musical instrument, and more particularly to an automatic rhythm player which is capable of playing a desired rhythm in a desired tone color by means of a combination of an electrical circuit for producing electrical pulses of a period corresponding to the time duration of, for example, the shortest note in a rhythm, an electrical circuit for producing pulses of a duration τ and a period of 8τ with mutual phase displacement of τ , an electrical circuit for producing the desired rhythm and an electrical circuit for producing the tone color of a desired musical instrument.

The present invention is directed to an automatic rhythm player which is capable of easy playing of many rhythms in different tones of various musical instruments with simple operations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a connection diagram of the entire system illustrating one example of an automatic rhythm play of this invention; FIG. 2 shows current waveforms for explaining this invention;

FIG. 3 is a connection diagram illustrating another example of the automatic rhythm player;

FIGS. 4 and 5 are explanatory diagrams of a further example of this invention;

FIGS. 6 and 7 are explanatory diagrams of still further examples of this invention;

FIGS. 8 and 9 are connection diagrams illustrating still other examples of this invention;

FIG. 10 is a connection diagram showing another example of this invention;

FIG. 11 shows current waveforms for explaining the example depicted in FIG. 10;

FIG. 12 is an explanatory diagram of another example of this invention;

FIGS. 13 and 14 are explanatory diagrams illustrating another examples of this invention; and

FIGS. 15 and 16 are explanatory diagrams of another examples of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 there is illustrated one example of the automatic rhythm player according to this invention, in which reference numeral 1 indicates a pulse oscillator producing a pulse train such as shown in FIG. 2A, which is of a period τ corresponding to the time duration of the shortest note in a desired rhythm of the greatest common measure of the shortest measures or time in many kinds of rhythms, for example, one-eighth time in a musical bar. Reference numeral 2 designates a pulse-developing circuit which is supplied with the pulse output from the pulse oscillator circuit 1 and develops it. The pulse-developing circuit 2 comprises three bistable multivibrator circuits (flip-flop circuits) F_1 , F_2 and F_3 and, for instance, eight AND-gate circuits G_1 to G_8 . However, the pulse-developing circuit 2 may be replaced with a circuit such as a ring counter.

Now, a description will be given of the pulse-developing circuit 2 in detail. The flip-flop circuits F_1 , F_2 and F_3 are connected in cascade, with positive output terminals a , b and c of the respective circuits being connected to input terminals of the succeeding stages, and the output of the pulse oscillator 1 is applied to the input terminal of the first flip-flop circuit F_1 . Reference numerals 3₁, 3₂, 3₃ identify polarity discriminator

circuits connected to the input sides of the flip-flop circuits F_1 , F_2 and F_3 , which are adapted so that the flip-flop circuits F_1 , F_2 and F_3 are sequentially switched on and off, for example, at every rise of the pulse output or a rectangular wave output. With such connections, rectangular wave outputs such as illustrated in FIGS. 2B₁, 2B₂ and 2B₃ are available at the positive output terminals a , b and c of the flip-flop circuits F_1 , F_2 and F_3 , while outputs opposite in sense to them are available at negative output terminals $\bar{a}$, $\bar{b}$ and $\bar{c}$.

A unique combination of three terminals selected from the output terminals a , b , c , $\bar{a}$, $\bar{b}$ and $\bar{c}$ is connected to each of the AND-gate circuits G_1 to G_8 , as illustrated in FIG. 1. That is, the AND-gate circuit G_1 has connected thereto the output terminals a , b and c , the AND-gate circuit G_2 has connected thereto the output terminals $\bar{a}$, b and c , the AND-gate circuit G_3 has connected thereto the output terminals a , $\bar{b}$ and c , the AND-gate circuit G_4 has connected thereto the output terminals $\bar{a}$, $\bar{b}$ and c , the AND-gate circuit G_5 has connected thereto the output terminals a , b and $\bar{c}$, the AND-gate circuit G_6 has connected thereto the output terminals $\bar{a}$, b and $\bar{c}$, the AND-gate circuit G_7 has connected thereto the output terminals a , $\bar{b}$ and $\bar{c}$, and the AND-gate circuit G_8 has connected thereto the output terminals a , b and c , as illustrated in FIG. 1. Consequently, the AND-gate circuits G_1 to G_8 produce, at their output terminals T_1 to T_8 , pulse outputs such as illustrated in FIGS. 2C₁ to 2C₈, which are phase-shifted from adjacent ones by a degree corresponding to the width τ and each of which has a duration τ and a period 8τ . Reference numeral 4 indicates generally a rhythm-producing circuit (tablet) for producing desired rhythms. The output terminals T_1 to T_8 of the pulse-developing circuit 2 are respectively connected to terminals L_1' to L_8' of a group of conductors L_1 to L_8 arranged horizontally on a base plate 5 of the rhythm-producing circuit 4, made of an insulating material. Meanwhile, there are provided, for example, four rhythm sound sources, namely sound source circuits M_1 to M_4 which are driven by pulses to electronically produce different tones of a drum, maraca and so on. The input terminals I_1 to I_4 of the sound source circuits M_1 to M_4 are connected respectively to terminals S_1' to S_4' of a second group of conductors S_1 to S_4 arranged vertically on the base plate 5. The two groups of conductors L_1 to L_8 and S_1 to S_4 are selectively connected at their crossing points or in the vicinity thereof by means of unidirectional conductive elements such, for example, as diodes 6 in accordance with rhythms desired in the respective sound source circuits M_1 to M_4 . As indicated in FIG. 1, the diodes thus may be provided with plugs P at their ends which are receivable in sockets J so that they may be selectively connected as shown. The sound source circuits M_1 to M_4 are connected to a speaker SP through an amplifier AM in common to them. Reference numerals 7₁ to 7₄ designate respective sound-source-selecting switches interposed between the sound source circuits M_1 to M_4 and the conductors S_1 to S_4 .

With such an arrangement described above, pulses are sequentially supplied to the conductors L_1 to L_8 at a time interval τ corresponding to one-eighth time, while being phase-shifted a degree corresponding to one-eighth time. Therefore, in the example shown in FIG. 1 closing of, for example, the switch 7₁ provides a repetition of a rhythm $\|: \gamma \beta \gamma \gamma \gamma \beta \beta \beta \|$ in the system of the sound source circuit M_1 .

In accordance with the invention the rhythm-producing circuit (tablet) 4, which has previously produced various rhythms, is designed to be detachably interposed between the pulse-developing circuit 2 and the sound source circuits M_1 to M_4 . This enables automatic playing of desired rhythms by selectively inserting between the pulse-developing circuit 2 and the sound source circuits a desired one of rhythm-producing circuits, prepared in advance, which have produced various rhythms by various connections of diodes in the respective sound source systems.

FIG. 3 illustrates a modified form of the rhythm-producing circuit 4, and reference characters Ca_1 to Ca_8 , Cb_1 to Cb_8 , and Cc_1 to Cc_8 designate photoelectric conversion elements such as photocells or phototransistors arranged in the manner of matrix. The respective one ends of the photoelectric conversion elements, for example, Ca_1 to Ca_8 on the first column line from the left are connected through their respective terminals L_1 to L_8 to the output terminals T_1 to T_8 of the pulse-developing circuit 2 shown in FIG. 1, while the other ends of the photoelectric conversion elements shown in FIG. 3 are connected together to a conductor I_1 , which, in turn, is grounded at one end through a resistor R. In a similar fashion, the photoelectric conversion elements on the other columns are respectively connected to conductors I_2 and I_3 , each of which is likewise grounded at one end through a resistor R. Reference characters m_1 to m_4 indicate conductors arranged across the conductors I_1 to I_3 (being a matrix), and these conductors m_1 to m_4 and I_1 to I_3 are connected at their crossing points by means of photoelectric conversion elements C_{L11} to C_{L14} , C_{L21} to C_{L24} and C_{L31} to C_{L34} . The output sides of sound source circuits M_1' to M_4' are connected together to a speaker SP through a common amplifier AM. In this case, the output of each sound source circuit is adjusted in its level, if required, and is then amplified by the amplifier AM, thereafter being fed to the speaker SP. The value of the resistor R is determined in accordance with the characteristic value of the photoelectric conversion elements in such a manner that when no light is directed to the photoelectric conversion elements Ca_1 to Ca_8 , Cb_1 to Cb_8 and Cc_1 to Cc_8 to hold their resistances high, the outputs of the pulse trains fed to the terminals L_1 to L_8 become attenuated substantially negligible on the output sides of the photoelectric conversion elements because the voltage-dividing values of voltage divider circuits consisting of the photoelectric conversion elements and the resistors R become small, and that when the photoelectric conversion elements are exposed to light to lower their resistances, almost all the outputs of the pulse trains appear on the output sides of the photoelectric conversion elements.

Reference numeral 4' represents a base plate (tablet) which does not essentially permit passage of light therethrough and is of such a size as geometrically covers the photoelectric conversion elements connected as previously described. The base plate 4' has formed therein apertures or transparent portions a_1 to a_8 on the first column, b_1 , b_4 , b_6 and b_8 on the second column, c_4 and c_8 on the third column at those locations corresponding to predetermined photoelectric conversion elements. The transparent portions and the photoelectric conversion elements correspond in function to the unidirectional conductive elements 6 depicted in FIG. 1, and the transparent portions are provided in the base plate 4' in such a number and at such locations as corresponding to desired combinations of rhythms and tones. In the illustrated example the transparent portions a_1 to a_8 correspond to the photoelectric conversion elements Ca_1 to Ca_8 , and the transparent portions b_4 , L_1S_3 , L_2S_2 , L_3S_1 and so on similarly correspond to the photoelectric conversion elements Cb_4 , C_{L13} , C_{L22} , C_{L31} and so on. That is, these transparent portions a_1 to a_8 are provided in the tablet 4' at those locations where lights passing through the transparent portions reach their corresponding photoelectric conversion elements. In other words, the transparent portions are positioned at predetermined crossing points of assumed columns and rows on the tablet 4' corresponding to the arrangement of the photoelectric conversion elements. With the arrangement described above, when light from a light source L, disposed on the opposite side from the photoelectric conversion elements with respect to the tablet 4', passes through the transparent portions of the tablet 4' and arrives at their corresponding photoelectric conversion elements (such, for example, as those surrounded by dotted lines in the FIG.) to sensitize them, the photoelectric conversion elements, for example, Ca_1 to Ca_8 become sensitized to produce in the line I_1 pulses each of which is delayed by a time τ and has a period of 8τ . The sensitization of the photoelectric conversion elements

C_{L13} by the light passing through the transparent portion L_1S_3 leads to electrical connection of the conductors I_1 and m_3 to drive the sound source circuit M_3' , the output of which is amplified by the amplifier AM and is then applied to the speaker SP. Namely, the apertures or the transparent portions a_1 to a_8 and L_1S_3 of the tablet 4' determine the combination of the tone color corresponding to the sound source circuit M_3' and the rhythm of 8-time.

In exactly the same manner, a combination of a tone color corresponding to the sound source circuit M_2' and a rhythm of 4-time is determined by the transparent portions b_2 , b_4 , b_6 , b_8 and L_2S_2 , and a combination of a tone color corresponding to the sound source circuit M_1' and a rhythm of 2-time is determined by the transparent portions c_4 , c_8 and L_3S_1 in the illustrated example.

Thus, the use of the above-described tablet 4' in the present example leads to playing of an 8-time rhythm in the tone color of the sound source circuit M_3' , a 4-time rhythm in the tone color of the sound source circuit M_2' and a 2-time rhythm in the tone color of the sound source circuit M_1' . It will be understood that a desired combination of a rhythm and a tone color can be obtained by providing in the tablet 4' the transparent portions in accordance with the desired combination.

In FIGS. 4 and 5 there is illustrated another embodiment of the rhythm-producing circuit 4 of this invention. The present example employs a tablet 4'' of exactly the same construction as that previously described with FIG. 3, but differs from the example of FIG. 3 in that a reflector mi is provided in back of the tablet 4'', namely on the opposite side from light sources L with respect to the tablet 4'' as illustrated in FIG. 5, and lights PL passing through the transparent portions aligned are reflected downwardly by the reflector mi substantially in parallel with one side of the tablet 4'' as shown in the FIG. These reflected lights are received by a photoelectric conversion element 8 which is in common to the transparent portions on each column. That is, the photoelectric conversion element corresponding to the transparent portions a_1 to a_8 is only one, and the photoelectric conversion element respectively corresponding to the transparent portions b_1 to b_8 and c_1 to c_8 is similarly only one. This example employs eight light sources L_1 to L_8 , which are respectively connected to the output terminals T_1 to T_8 of the pulse-developing circuit 2 and are adapted to be sequentially switched on and off by the output of the pulse-developing circuit 2, while each being delayed by a time τ and having a period of 8τ . This provides a desired pulse train corresponding to the apertures or transparent portions formed in the tablet as desired as in the foregoing example, which pulse train can be combined with a desired one of the sound source circuits. Since the combination with the sound source circuit is exactly the same as in the foregoing example, no description will be given in this connection. That is, the example shown in FIGS. 4 and 5 employs less photoelectric conversion elements, and hence eliminates necessity of making complicated electrical wirings on the tablet 4''. Therefore, the tablet of simple construction can be easily made at low cost. It is a matter of course that desired various rhythms each can be obtained at will by using a desired one of the tablets having the transparent portions formed at different locations in the same manner as in the example shown in FIG. 3. Further, a desired rhythm can be obtained by optically covering selected ones of a plurality of transparent portions formed in the tablet at all of the crossing points of columns and rows arranged in matrix.

FIGS. 6 and 7 illustrate still other modified forms of the rhythm-producing circuit 4 of this invention. Reference numeral 4''' designates a base plate (tablet) formed of a non-magnetic material in which two groups of apertures H_{1a} to H_{8a} , H_{1b} to H_{8b} and H_{1c} to H_{8c} , and H_{1d} to H_{8d} , H_{1e} to H_{8e} and H_{1f} to H_{8f} are respectively formed on columns and rows in the manner of matrix, as shown in FIG. 5. Namely, the apertures are formed at crossings of the rows and columns of the matrix. Magnetic pieces X formed of permalloy, ferrite or the like are selectively inserted into the apertures in accordance with a

rhythm desired. Further, there are provided on one side of the base plate 4''' coils C_1 to C_8 each corresponding to each triad of the apertures arranged in rows across the first three columns (H_a to H_c), and terminals t_1 to t_8 are provided on both ends of the respective coils C_1 to C_8 . Similarly, coils C_1' to C_5' , each corresponding to each triad of the apertures aligned in rows across the last three columns (H_d to H_f), are provided and terminals k_1 to k_5 are connected to both ends of the respective coils C_1' to C_5' . Meanwhile, there are provided on the other side of the base plate 4''' coils C_a to C_f each corresponding to each group of the apertures aligned in columns, as illustrated in FIG. 6. The coils C_a and C_b , C_b and C_c , C_c and C_d are respectively interconnected in pairs. Thus, the rhythm-producing circuit 4, consisting of the base plate, the coils and the magnetic pieces, is formed.

The output terminals T_1 to T_8 of the aforementioned pulse-developing circuit 2 are respectively connected to terminals t_1 to t_8 of the tablet 4, by which the coils C_1 to C_8 are sequentially supplied with pulses such as depicted in FIGS. 2C₁ to 2C₈, which are phase-shifted by τ . Further the terminals k_1 to k_5 of the coils C_1' to C_5' are respectively connected to sound source circuits G_1 to G_5 , each producing, in the form of an electrical signal, a musical tone corresponding to, for example, a drum, a maraca or the like, and speakers SP_1 to SP_5 are respectively connected to these sound source circuits G_1 to G_5 .

With such an arrangement as above described, the coils disposed on the both sides of the base plate 4''' at those locations thereof where the magnetic pieces X are inserted into the apertures are electromagnetically coupled with each other through the magnetic pieces X. In the illustrated example, since the magnetic pieces X are inserted into all of the apertures H_{1a} to H_{8a} , the coil C_a produces pulses corresponding to all the pulses fed to the terminals t_1 to t_8 . These pulses are applied to the sound source circuit G_2 through the coils C_f and C_2' coupled therewith by the magnetic piece X inserted into the aperture H_{2f} , and the output of the sound source circuit G_2 is fed to the speaker SP_2 to drive it to give off a note corresponding to the sound source circuit. In the second column, the magnetic pieces X are inserted into only the even number apertures H_{2b} , H_{4b} , H_{6b} and H_{8b} , so that the coil C_b produces pulses at a time interval of 2τ . The resulting pulses are applied to the sound source circuit G_3 through the coils C_e and C_3' , which is electromagnetically coupled therewith through the magnetic piece X disposed in the aperture H_{3e} . As a result of this, the sound source circuit G_3 is driven to thereby drive the speaker SP_3 . Further, in the third column the magnetic pieces X are disposed in the apertures H_{4c} and H_{8c} , and hence pulses having a period of 4τ are fed to the sound source circuit G_4 through the coils C_c , C_d , the magnetic piece X disposed in the aperture H_{4d} and the coil C_4' , thereby driving the speaker SP_4 . In this manner, various pulse trains are produced in response to the positions of the magnetic pieces X and are applied to the sound source circuits selected by the positions of the magnetic pieces, by which the speakers connected to the sound source circuits go give off musical notes in accordance with the pulse trains applied thereto, thus producing a composite rhythm. In this case, alteration of the apertures for the magnetic pieces to be inserted in enables production of various pulse trains (pulse patterns) and selection of various sound source circuits. By selectively using a plurality of tablets with the magnetic pieces disposed in different apertures, various composite rhythms can be obtained, and in this case the connections of the tablets with the pulse signal sources and the sound source circuits are selectively altered.

In addition, it is also possible to use a tablet, consisting of a base plate 4''' and magnetic pieces X disposed in suitable apertures thereof, in combination with a case 13 such as shown in FIG. 7. As depicted in the FIG., the tablet is inserted into the case 13, which has provided on the opposite inside surfaces 3a and 3b thereof bosses 4a and 4b at the locations corresponding to the apertures of the base plate 4''' and in which the aforementioned coils C_1 to C_8 , C_a to C_f and C_1' to C_5' are wound on the bosses. In this case, various composite

rhythms can be obtained as desired by replacing the tablet 4''' with desired ones.

In the foregoing the magnetic pieces X are employed as coupling elements, but it is also possible to insert ferroelectric pieces Y such as barium titanate into suitable apertures of the base plate 4d, as illustrated in FIGS. 8 and 9. In such a case, electrodes are used as signal transmitters in place of the aforementioned coils. That is, electrodes l_1' to l_8' and l_1'' to l_5'' are respectively disposed on one side of the base plate 4''' in place of coils C_1 to C_8 and C_1' to C_5' and electrodes l_a to l_f are disposed on the other side in place of coils C_a to C_f , as depicted in FIG. 8. In this case, it is possible that the electrodes on either side are inductively coupled with those on the other side through the ferroelectric pieces Y. Other operations are effected in the same manner as in the examples shown in FIGS. 6 and 7. Although the speakers are respectively connected to the sound source circuits in the examples illustrated in FIGS. 6 and 8, it is of course possible to employ a single speaker in common to the sound source circuits, as in the examples shown in FIGS. 1 and 3.

In FIG. 10 there is illustrated a further example of the rhythm-producing circuit comprising a base plate (tablet), on which two groups of row conductors L_1 to L_8 and column conductors S_1 to S_4 are arranged in a manner to cross substantially at right angles, as in the example shown in FIG. 1. The conductors L_1 to L_8 have their terminals L_1' to L_8' respectively connected to the output terminals T_1 to T_8 of the pulse-developing circuit 2 (not shown), while the conductors S_1 to S_4 have their terminals S_1' to S_4' respectively connected to sound source circuits M_1 to M_4 . In a manner similar to that in FIG. 1 the two groups of conductors are selectively connected at their crossing points by means of unidirectional conductive elements such, for example, as diodes D_2 , D_5 , D_7 and D_8 in accordance with desired rhythms. In the present example resistors are connected in series to diodes, for example, D_2 , D_5 , D_7 and D_8 , by which when pulse trains shown in FIGS. 2C₁ to 2C₈ are applied to the input terminals L_1' to L_8' of the conductors L_1 to L_8 , pulse trains P_{11} , P_{52} , P_{73} and P_{84} such as depicted in FIG. 11 respectively appear at the output terminals S_1' to S_4' of the conductors S_1 to S_4 in accordance with the arrangement of the unidirectional conductive elements. The height of the pulses passing through the diodes connected with the resistors in series are smaller than those of the other pulses. Upon application of the pulse trains to the sound source circuits M_1 to M_4 , the sound circuits are excited by the pulses to produce rhythms in their particular tone colors of percussion instruments such as a drum, a maraca and so on, and the rhythms are given off through the speaker SP. In this case, since the pulses fed to the respective sound source circuits are different in level, the resulting rhythms are not monotonous but accented. Further, the positions of the accent of the rhythms can be adjusted by controlling the resistance values of variable resistors connected in series to the diodes.

FIG. 12 illustrates still a further modification of the rhythm-producing circuit produced in accordance with this invention, which is adapted to selectively place accents on the rhythms obtainable in the example of FIG. 3. The present example is based upon the fact that the resistance value of the photoelectric conversion element varies with the intensity of light directed thereto. In the light of this fact, in this example the quantity of light passing through the apertures bored in the base plate 4' is controlled by changing their diameter to place accents on the rhythms at predetermined positions. In FIG. 12 the diameter of the apertures a_7 , b_4 and b_5 and b_8 are made smaller than that of the other apertures, so that the variations in the resistance value of the photoelectric conversion elements C_{a7} , C_{b4} , C_{b5} and C_{b8} corresponding to the apertures can be decreased. As a result of this, output pulses from these photoelectric conversion elements become smaller than those from the other elements in their heights, by which the rhythms become accented. The other elements in FIG. 12 are exactly the same as those in FIG. 3, and hence no further description will be given.

In FIGS. 13 and 14 there is shown a further modified form of the rhythm-producing circuit of this invention, which employs the tablet shown in FIGS. 6 and 7 utilizing electromagnetic coupling and is adapted to produce accented rhythms. That is, if the thicknesses of the magnetic pieces X as of permalloy, ferrite or the like for coupling the coils arranged on the rows and columns are suitably selected to be different (as depicted in FIG. 14 where a thinner coupling element is indicated at X'), the thicker magnetic pieces X and the thinner ones X' are different in the degree of coupling the coils. Namely, the magnetic pieces X' couple the coils to a lower degree than the magnetic pieces X, so that the height of pulses obtained at the output terminals of the coils coupled through the magnetic pieces X' is small, as compared with that of the pulses obtained at the output terminals of the coils coupled through the magnetic pieces X. Consequently, even if the pulses of the same height such as depicted in FIG. 2C are fed to the input terminals of the coils, pulses appearing at the output terminals of the coils are different in height. In short, accented rhythms can be produced at will by the use of the magnetic pieces of different thicknesses as in the case of the example shown in FIG. 10.

FIGS. 15 and 16 illustrates a modification of the rhythm-producing circuit shown in FIGS. 8 and 9, which is adapted to produce accented rhythms by the employment of inductive coupling elements of different intensities. Reference character Y indicates ferroelectric pieces as of barium titanate, and in this case the thicknesses of the ferroelectric pieces can be selected to be different as at Y' so as to produce accented rhythms as in the foregoing examples. The other elements are the same as those in the example shown in FIGS. 8 and 9, and hence no description will be given.

In the foregoing, for instance in the example of FIG. 1, the number of rhythms produced by one tablet is limited, and hence playing of various rhythms requires preparation of a considerable number of tablets and is very uneconomical.

This can be avoided in the following manner. That is, for example in the example of FIG. 1 plugs are attached to both ends of diodes 6 which electrically connect the two groups of conductors L₁ to L₈ and S₁ to S₄ at their crossing points, and jacks for receiving the plugs of the diodes are attached to the conductors near their crossing points. With the arrangement, the two groups of conductors are electrically connected by selectively inserting the plugs of the diodes into the jacks of the conductors provided near the crossing points, which enables production of desired rhythm with only one tablet and by merely changing the connections of the diodes and further enables a user to make a rhythm by choice.

In the example of FIG. 3, apertures are provided in the tablet 4' corresponding in number to the photoelectric conversion elements and the apertures are selectively covered by suitable means in accordance with a desired rhythm. In the case of the utilizing the electromagnetic coupling the electromagnetic coupling elements are similarly adapted to be detachable, by which desired rhythms can be obtained through the use of one tablet. It is to be realized that in the present invention, although in certain embodiments light sources have been illustrated as, for example, light sources L and light sources L₁ to L₈, light emitted from other sources such as the sun, or available at the location of the automatic rhythm player of the invention may be used. For example, covers or shutters may be placed over the photoelectric conversion elements of the invention as so as to selectively energize those upon which the light impinges. Thus, sunlight or light from any other available source may be utilized in the invention without the necessity of a specific light source or a plurality of light sources.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention.

We claim:

1. An automatic rhythm player comprising a pulse oscillator for producing pulses of a period corresponding to the time du-

ration of the shortest note in a rhythm, a pulse-developing circuit supplied with the output of the pulse oscillator and producing pulses sequentially phase-shifted a time corresponding to the time duration of the shortest note, a rhythm-producing circuit supplied with the pulses from the pulse-developing circuit and producing pulses corresponding to desired rhythms, sound source circuit supplied with the output from the rhythm-producing circuit through switching means and determining the tone of the rhythm, and a speaker connected to the sound circuits, in which the rhythm-producing circuit is adapted to produce rhythms as desired and said rhythm-producing circuit comprises a substantially opaque base plate, a plurality of photoelectric conversion elements arranged on one side of the base plate in the manner of matrix, the photoelectric conversion elements aligned on each column of the matrix being connected together at one end and being connected at the other end to the pulse-developing circuit, and the photoelectric conversion elements aligned on each row of the matrix being sequentially connected to adjacent ones, the base plate having bored therein apertures at locations corresponding to the photoelectric conversion elements of a desired rhythm, and light sources disposed at the opposite side of the photoelectric conversion elements with respect to the base plate the other ends of the photoelectric conversion elements being connected together and to the sound source circuits through switching means.

2. An automatic rhythm player as claimed in claim 1 wherein the base plate is detachable between the photoelectric conversion elements and the light source to selectively produce desired rhythms by changing the position of the apertures.

3. An automatic rhythm player as claimed in claim 1 wherein the switching means consist of photoelectric conversion elements arranged in matrix, a light source arranged opposite to said photoelectric conversion elements, and a base plate, having apertures bored therein through which light from the light source is selectively passed to said photoelectric conversion elements to thereby selectively control tone color of the rhythm to be announced.

4. An automatic rhythm player as claimed in claim 1 wherein the diameters of the apertures bored in the base plate are altered to vary the quantity of light passing therethrough to place accents on a rhythm.

5. An automatic rhythm player comprising a pulse oscillator for producing pulses of a period corresponding to the time duration of the shortest note in a rhythm, a pulse-developing circuit supplied with the output of the pulse oscillator and producing pulses sequentially phase-shifted a time corresponding to the time duration of the shortest note, a rhythm-producing circuit supplied with the pulses corresponding to desired rhythms, sound source circuit supplied with the output from the rhythm-producing circuit through switching means and determining the tone of the rhythm, and a speaker connected to the sound source circuits, in which the rhythm-producing circuit is adapted to produce rhythms as desired therein the rhythm-producing circuit comprises a substantially opaque base plate, apertures made in the base plate in the manner of matrix in accordance with desired rhythms, a plurality of light sources disposed on one side of the base plate, the light sources being supplied with the output of the pulse-developing circuit, photoelectric conversion elements each being arranged to correspond to the apertures disposed on each column, and means for directing lights passing through the apertures to each photoelectric conversion element.

6. An automatic rhythm player comprising a pulse oscillator for producing pulses of a period corresponding to the time duration of the shortest note in a rhythm, a pulse-developing circuit supplied with the output of the pulse oscillator and producing pulses sequentially phase-shifted a time corresponding to the time duration of the shortest note, a rhythm-producing circuit supplied with the pulses from the pulse-developing circuit and producing pulses corresponding to desired rhythms, sound source circuit supplied with the output

from the rhythm-producing circuit through switching means and determining the tone of the rhythm, and a speaker connected to the sound source circuits, in which the rhythm-producing circuit is adapted to produce rhythms as desired wherein the rhythm-producing circuit comprises a base plate having bored therein a plurality of apertures at predetermined locations in the manner of a matrix, a plurality of coupling elements inserted into the apertures at the positions corresponding to desired rhythms, signal transmitting coils disposed on one side of the base plate, each coil being in common to the apertures aligned on each row and being supplied with the output of the pulse-developing circuit, and coils arranged on the other side of the base plate for picking up the outputs of the coils on the rows, each coil being in common to the apertures on each column, the outputs from the coils on the columns being applied to the sound source circuits through switching means.

7. An automatic rhythm player as claimed in claim 6 wherein the switching means consist of column coils arranged on one side of the base plate, each column coil connected to each of the first-mentioned column coil, row coils arranged on the other side of base plate each row coil being common to all the second-mentioned column coils and connected to each sound source circuit, and a base plate having bored therein apertures at the positions corresponding to overlapping portions of the column and row coils and coupling elements inserted into the apertures at the positions corresponding to desired sound source circuits.

8. An automatic rhythm player comprising a pulse oscillator for producing pulses of a period corresponding to the time duration of the shortest note in a rhythm, a pulse-developing circuit supplied with the output of the pulse oscillator and producing pulses sequentially phase-shifted by a time corresponding to the time duration of the shortest note, a rhythm-producing circuit supplied with the pulses from the pulse-developing circuit and producing pulses corresponding to desired rhythms, sound source circuits supplied with the output from the rhythm-producing circuit through switching means and determining the tone of the rhythm, and a speaker connected to the sound source circuits, the improvement comprising said rhythm-producing circuit is detachably connected between said pulse developing circuit and said sound source circuits.

9. An automatic rhythm player as claimed in claim 8 wherein said rhythm-producing circuit consists of a base plate, a plurality of first conductors arranged horizontally on said base plate of insulating material and a plurality of second conductors arranged vertically on said base plate, said first and second conductors being connected at their desired crossing points; a plurality of input terminals provided on said base plate, each of said plurality of input terminals being connected to each of said first conductors; a plurality of output terminals provided on said base plate, each of said plurality of output terminals on said base plate being connected to each of said second conductors; said pulse-developing circuit has a plurality of output terminals; and each of said sound source circuits has an input terminal through a switching means, whereby when said rhythm-producing circuit is inserted into said rhythm player said input terminals provided on said base plate are respectively connected to said output terminals of said pulse-developing circuit and said output terminals provided on said base plate are respectively connected to said input terminals of said sound source circuits so as to play a desired rhythm.

10. An automatic rhythm player as claimed in claim 8 wherein the rhythm-producing circuit comprises a substantially opaque plate, a plurality of photoelectric conversion elements arranged on one side of the base plate in the manner of a matrix, the photoelectric conversion elements aligned on each column of the matrix being connected together at one end and being connected at the other end to the pulse-developing circuit, and the photoelectric conversion elements aligned on each row of the matrix being sequentially con-

nected to adjacent ones, the base plate having formed therein apertures at locations corresponding to the photoelectric conversion elements of a desired rhythm, and light sources disposed at the opposite side of the photoelectric conversion elements with respect to the base plate, the other ends of the photoelectric conversion elements being connected together and to the sound source circuits through switching means.

11. An automatic rhythm player as claimed in claim 10 wherein the switching means consist of photoelectric conversion elements arranged in a matrix, a light source arranged opposite to said photoelectric conversion elements, and a base plate having apertures formed therein through which light from the light source is selectively passed to said photoelectric conversion elements to thereby selectively control tone color of the rhythm to be produced.

12. An automatic rhythm player as claimed in claim 8 wherein the rhythm-producing circuit comprises a substantially opaque base plate, apertures formed in the base plate in the manner of a matrix in accordance with desired rhythms, a plurality of light sources disposed on one side of the base plate, the light sources being supplied with the outputs of the pulse-developing circuit, photoelectric conversion elements each being arranged to correspond to the apertures disposed on each column, and means for directing lights passing through the apertures to each photoelectric conversion element.

13. An automatic rhythm player as claimed in claim 8, wherein the rhythm-producing circuit comprises a base plate having formed therein a plurality of apertures at predetermined locations in the manner of a matrix, a plurality of magnetic coupling elements inserted into the apertures at the positions corresponding to desired rhythms, signal-transmitting coils disposed on one side of the base plate, each coil being in common to the apertures aligned on each row and being supplied with the output of the pulse developing circuit, and coils arranged on the other side of the base plate for picking up the outputs of the coils on the rows, each coil being in common to the apertures on each column, the outputs from the coils on the columns being applied to the sound source circuits through switching means.

14. An automatic rhythm player as claimed in claim 13, wherein the switching means consist of column coils arranged on one side of the base plate each column coil connected to each of the first-mentioned column coil, row coils arranged on the other side of the base plate each row coil being common to all the second-mentioned column coils and connected to each sound source circuit, and a plurality of magnetic coupling elements, each being inserted into an aperture bored in the base plate, the positions of the second-mentioned apertures corresponding to desired sound source circuits and to overlapping portions of the column and row coils.

15. An automatic rhythm player as claimed in claim 10, wherein the diameters of the apertures formed in the base plate are altered to vary the quantity of light passing therethrough to place accents on a rhythm.

16. An automatic rhythm player as claimed in claim 8, wherein the rhythm-producing circuit comprises a base plate having formed therein a plurality of apertures at predetermined locations in the manner of a matrix, a plurality of inductive coupling elements inserted into the apertures at the position corresponding to desired rhythms, signal-transmitting electrodes disposed on one side of the base plate, each electrode being in common to the apertures aligned on each row and being supplied with the output of the pulse-developing circuit, and electrodes arranged on the other side of the base plate for picking up the outputs of the electrodes on the rows, each of the second-mentioned electrodes being in common to the apertures on each column, the outputs on the columns being applied to the sound source circuits through switching means.

17. An automatic rhythm player as claimed in claim 16, wherein the switching means consist of column electrodes arranged on one side of the base plate each column electrode

connected to each of the first-mentioned column electrodes, row electrodes arranged on the other side of the base plate each row electrode being common to all the second-mentioned column electrodes and connected to each sound source circuit, and a plurality of inductive coupling elements, each being inserted into an aperture bored in the base plate, the positions of the second-mentioned apertures corresponding to desired sound source circuits and to overlapping portions of the column and row electrodes.

18. An automatic rhythm player as claimed in claim 9, wherein unidirectional conductive elements are respectively inserted between said first and second conductors at their desired crossing points, a plurality of resistors with each resistor being connected to a desired one of the unidirectional conductive elements in series thereto to place accents on a rhythm.

19. An automatic rhythm player as claimed in claim 13, wherein the thickness of the magnetic coupling elements is varied to place accents on a rhythm.

20. An automatic rhythm player as claimed in claim 16, 20

wherein the thickness of the inductive coupling elements is varied to place accents on a rhythm.

21. An automatic rhythm player as claimed in claim 9, wherein unidirectional conductive elements are respectively inserted between said first and second conductors at their desired crossing points and plugs are attached to both ends of each unidirectional conductive element and jacks for receiving the plugs of each unidirectional conductive element are attached to the conductors near their crossing points to produce a desired rhythm with only one base plate.

22. An automatic rhythm player as claimed in claim 13, wherein the magnetic coupling elements are detachable from their corresponding apertures to produce a desired rhythm with only one base plate.

23. An automatic rhythm player as claimed in claim 16, wherein the inductive coupling elements are detachable from the base plate to produce a desired rhythm with only one base plate.

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