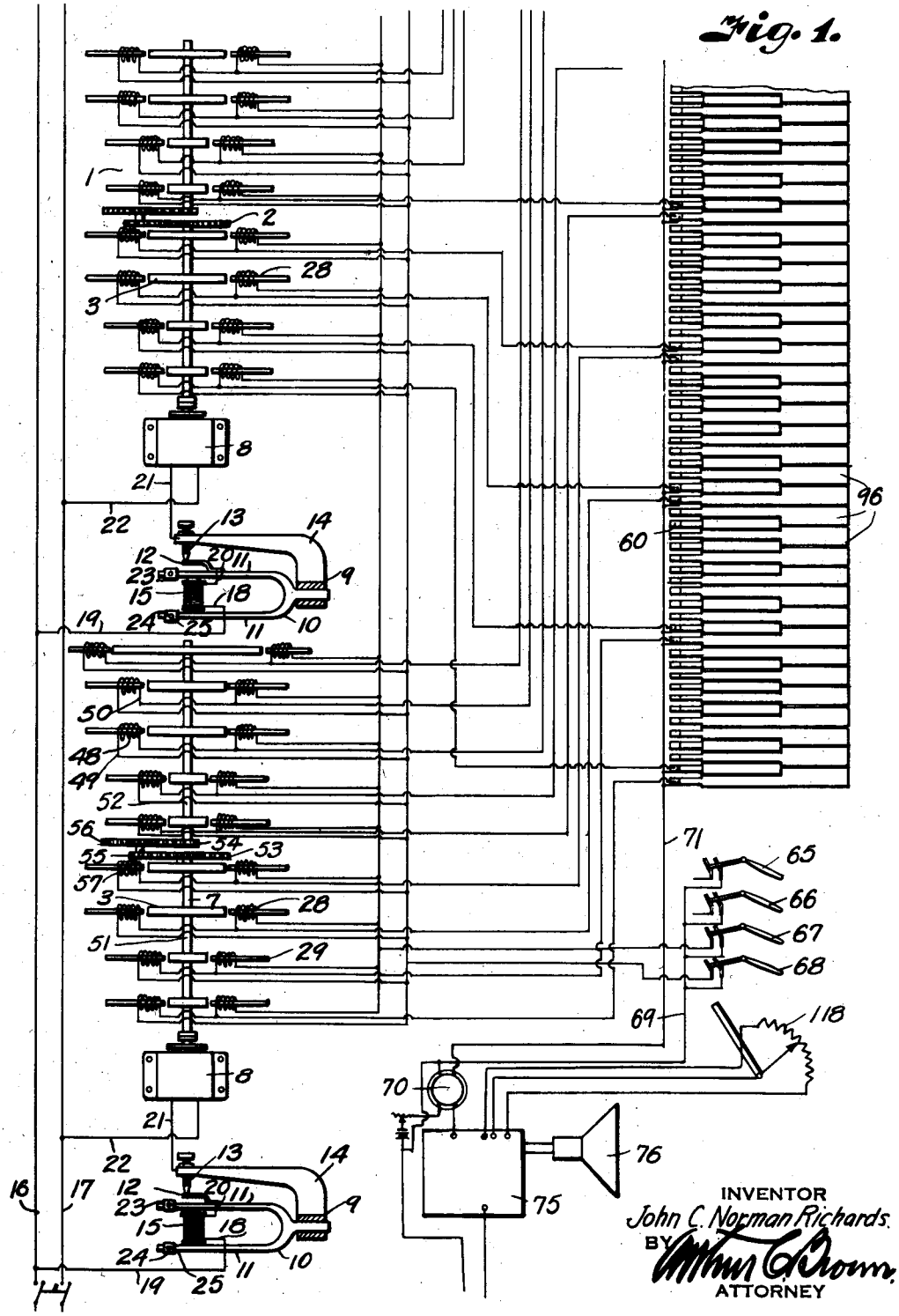
Sept. 13, 1938. J. C. N. RICHARDS 2,130,251

MUSICAL INSTRUMENT

Filed Jan. 23, 1936 4 Sheets-Sheet 1

Fig. 1.



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Sept. 13, 1938. J. C. N. RICHARDS 2,130,251

MUSICAL INSTRUMENT

Filed Jan. 23, 1936 4 Sheets-Sheet 2

Fig. 2.

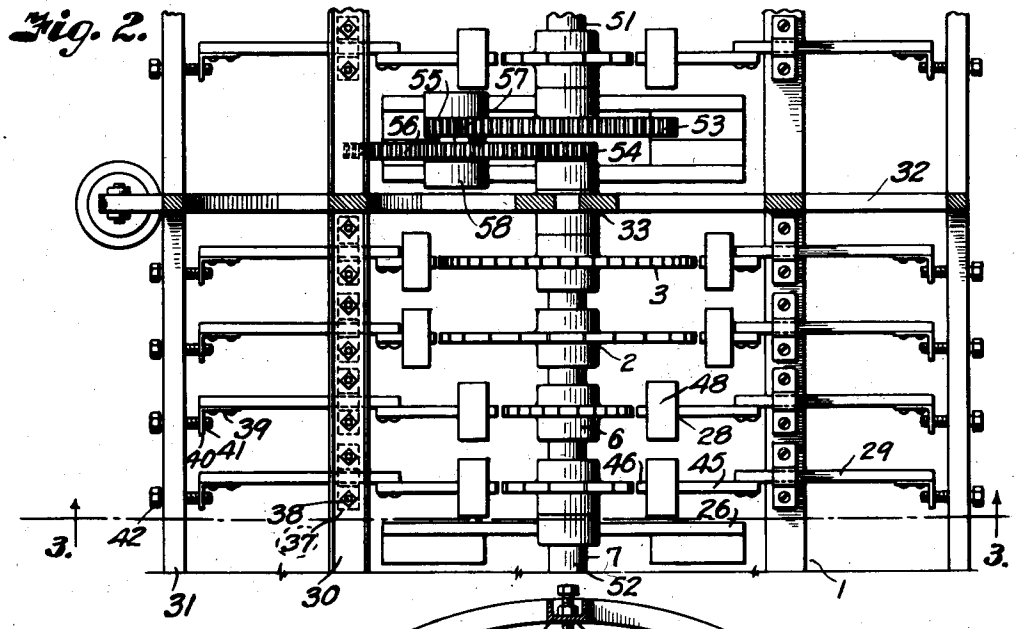
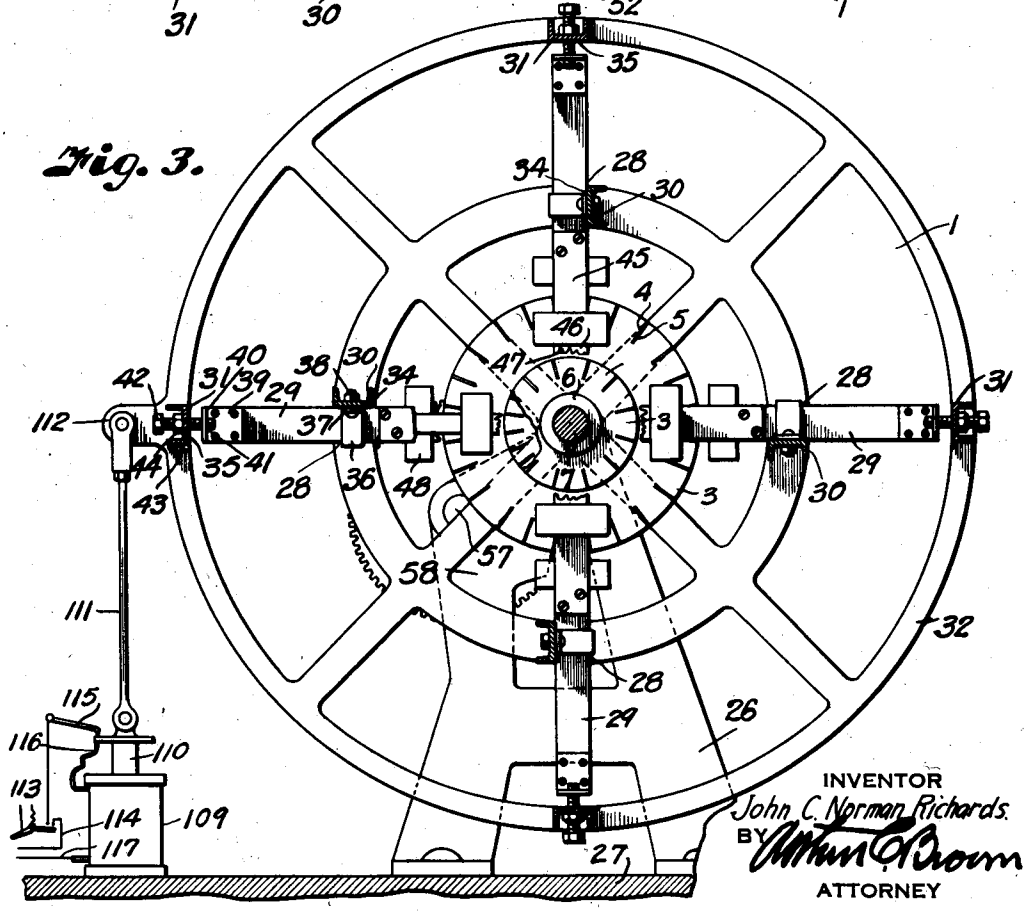


Fig. 3.



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MUSICAL INSTRUMENT

Filed Jan. 23, 1936 4 Sheets-Sheet 3

Fig. 4.

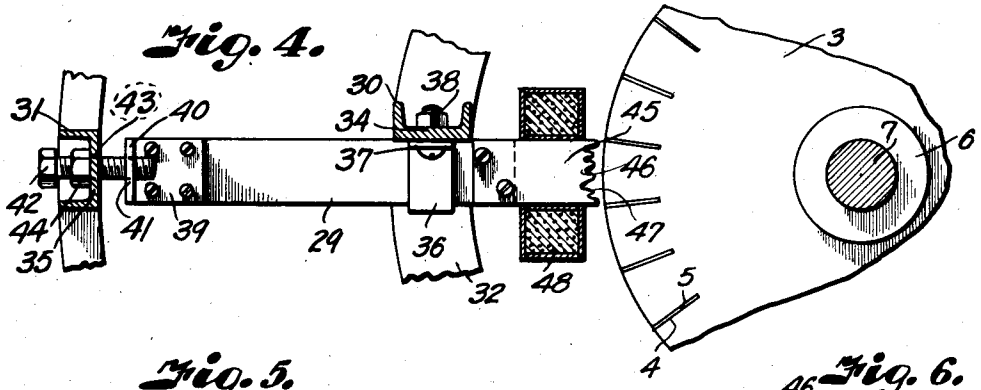


Fig. 5.

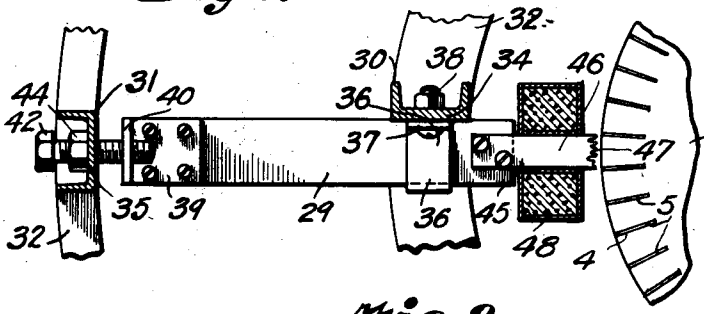


Fig. 6.

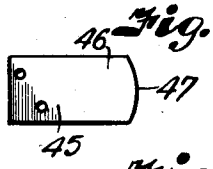


Fig. 7.

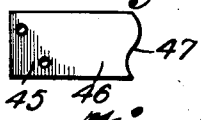


Fig. 8.

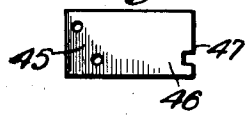


Fig. 9.

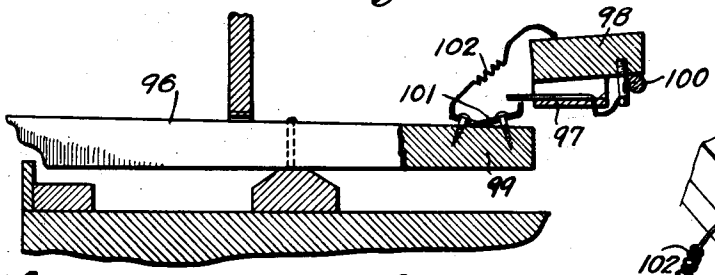


Fig. 10.

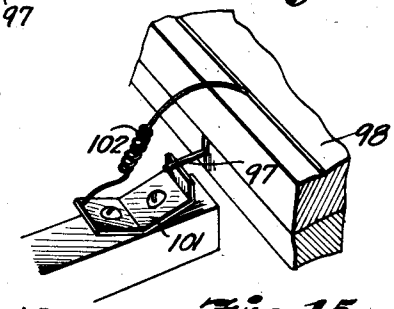


Fig. 11.

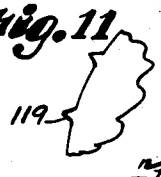


Fig. 12.



Fig. 13.

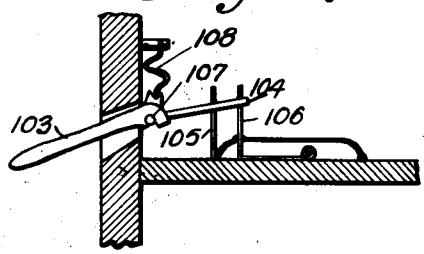


Fig. 14.

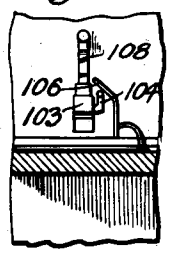
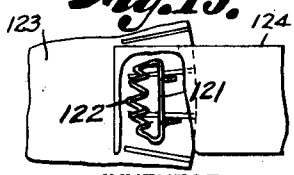


Fig. 15.



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Sept. 13, 1938. J. C. N. RICHARDS 2,130,251

MUSICAL INSTRUMENT

Filed Jan. 23, 1936 4 Sheets-Sheet 4

Fig. 16.

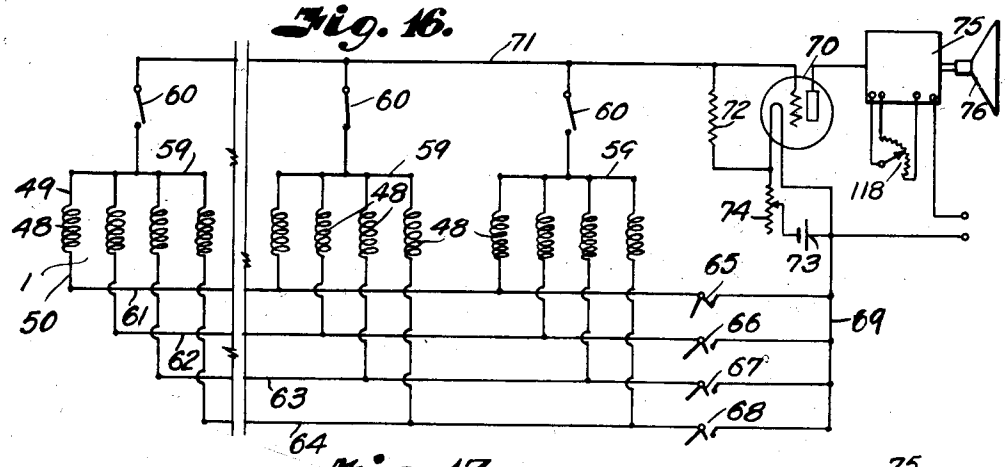


Fig. 17.

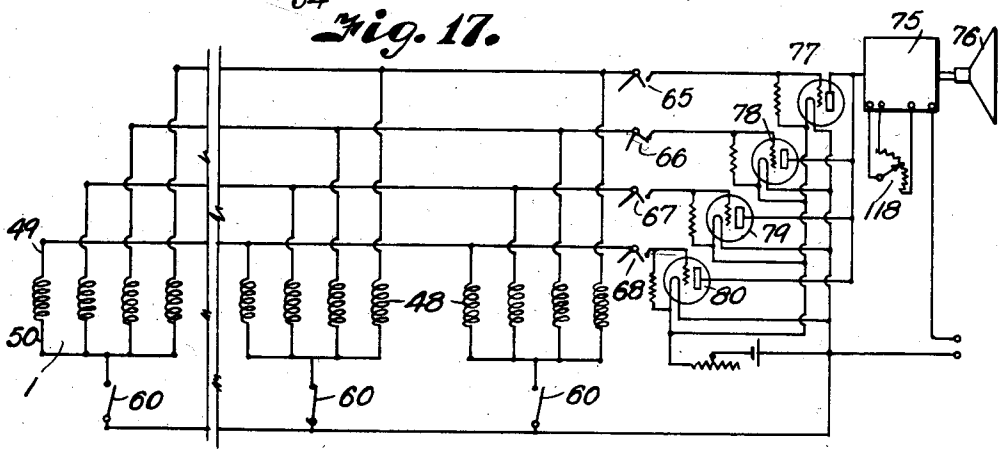
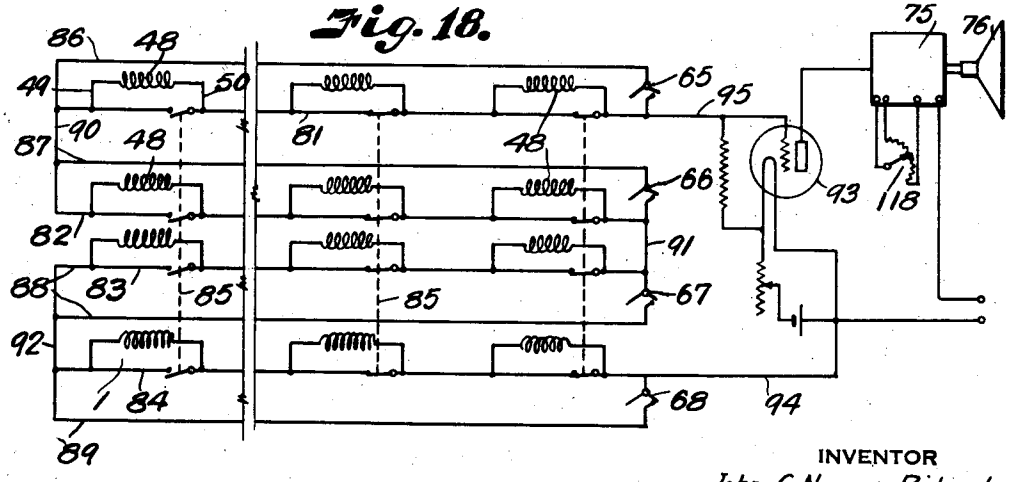


Fig. 18.



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Patented Sept. 13, 1938 2,130,251

UNITED STATES PATENT OFFICE

2,130,251

MUSICAL INSTRUMENT

John C. Norman Richards, Lincoln, Nebr.

Application January 23, 1936, Serial No. 60,489

15 Claims. (Cl. 84—1)

This invention relates to musical instruments, and particularly to those of that character wherein musical notes are produced synthetically through mechanical generation of electrical currents having frequencies capable of conversion into audible sound waves. In carrying out experiments with this type of instrument, I have found that with present methods of producing electric currents by rotation of a shaped disk in the field of an electromagnet it is impracticable to generate the complex frequencies necessary to give all of the tone characterizations and harmonics required to faithfully simulate the natural tone qualities of a string or wind instrument. Moreover, this type of instrument is of such complicated character that it is impossible to produce a practical apparatus capable of simulating a number of natural musical instruments played in harmony, such as a present day organ.

It is well known that a sustained musical sound, for example, a single note of a given pitch, consists of a fundamental tone of definite amplitude and a plurality of secondary amplitudes of different harmonics of the fundamental. While not all of these harmonics are perceptible in themselves, they are all necessary in establishing the timbre or color of true musical notes. I therefore find it necessary to produce not only the fundamental and harmonics of the lower order within the range of perceptibility, but it is also desirable to produce harmonics of the higher order.

I have found that by analyzing any given tone through reduction of its wave frequency to a visible record, for example with the aid of an oscillograph or the like, the characteristics of the sound frequencies can be readily noted including the harmonics which are so necessary in distinguishing a musical note from a sound having the same frequency as the fundamental. In carrying out my experiments I have found that these same visible records can be produced synthetically in an electrical generating device having as one of its generating elements a magnet or magnetizable element profiled to produce an electrical potential giving substantially the same graphic record as that produced from a natural musical note.

It is, therefore, the principal object of the present invention to provide a method and apparatus whereby musical notes may be synthetically produced through generation of complex electrical frequencies required in faithfully producing the timbre or color of a natural tone.

It is also an important object of the present invention to provide an instrument of this character which is of simple construction and capable of simulating a plurality of string or wind instruments or a combination of wind and string instruments played in harmony.

Other important objects of the invention are to provide a simple manual control of electrical circuits whereby any one of the respective generating devices may be made selectively effective in rendering a given harmony; to eliminate interference caused by feed back of electrical current from any one generating device to another that may be simultaneously in circuit with the translating portion of the apparatus; to provide a simple mechanism for producing a tremolo in the notes produced by the organ; to provide means for selectively varying the tone volume; and to provide an organ construction which lends to a simplified manual control so that the instrument may be played with ease by any musician familiar with an ordinary organ manual.

In accompanying these and other objects of the invention, as hereinafter pointed out, I employ electric potential generating devices, each including a magnet or magnetizable profile element inductively associated with an electrical circuit in which a varying voltage is impressed incidental to a periodic change in flux of the magnetic field surrounding the profile element, as illustrated in the accompanying drawings, wherein:

Fig. 1 is a schematic diagram of a portion of the generating devices, electrical circuits and keyboard manual of an organ constructed in accordance with the present invention.

Fig. 2 is a detail plan view of a portion of a pair of interconnected generating units for the synthetic production of electrical frequencies.

Fig. 3 is a vertical section on the line 3—3 of Fig. 2.

Fig. 4 is a detail fragmentary section through a portion of one of the generating devices particularly illustrating one of the pickup units for generating an electric potential which may be translated to produce a synthetic musical note in simulation of an actual note as produced by a conventional string or wind instrument, for example a violin or a flute.

Fig. 5 is a similar view showing a portion of the generating unit for producing the same note but in a higher octave than that produced by the generating device illustrated in Fig. 4.

Figs. 6, 7 and 8 show other types of profiles for the pickup units.

Fig. 9 is a detail section through the keyboard manual particularly illustrating the key and switch mechanism for selectively rendering any one of the generating units effective.

Fig. 10 is a detail perspective view of the switch element illustrated in Fig. 9.

Figs. 11 and 12 show modified forms of scanning disks.

Fig. 13 is a section through the key manual particularly illustrating a stop for selectively rendering any one set of the pickups effective.

Fig. 14 is an end elevational view of the switch illustrated in Fig. 13.

Fig. 15 shows a modification of the invention wherein the pickup coil is profiled rather than the magnetic member.

Fig. 16 is a wiring diagram of the pickup circuits, particularly illustrating their connection with the amplifying circuit.

Fig. 17 is a similar view of a modified form of circuit wherein a separate amplifying tube is employed for each of the respective sets of pickups used in generating electric potentials for simulation of each respective musical instrument imitated on the organ.

Fig. 18 is a further modified form of wiring wherein the pickups of each respective set are connected in series and in shunt relation to the key switches of the manual.

Referring more in detail to the drawings:

1 designates a plurality of generating units constructed in accordance with one form of the present invention and which are grouped in sets 2, corresponding in number to the notes in an octave with each set including a plurality of individual generating devices for producing the same respective notes in a plurality of octaves. For example, in a standard organ there are eight octaves with twelve notes to an octave, which, with top "C," makes a total of ninety-seven different mustical notes, therefore the instrument illustrated will consist of twelve sets of generating units and each set will comprise eight individual generating devices with one extra generating device on the set for producing the "C" notes.

In the form of the invention illustrated, each generating device includes a scanning disk 3 having a plurality of radial slots 4 extending through the periphery thereof and located in such spaced relation relatively to the peripheral speed of the disk that the slots will successively pass a given point at the same frequency as that of the fundamental for the musical note to be produced by that unit. Fixed in each slot 4 is an insert 5 formed of a metal that is capable of effecting change in flux of a magnetic field as later described. Each disk 3 is provided with a hub 6 keyed to a shaft 7 that is rotated at a fixed speed by means of a motor 8. The motor 8 is caused to operate at constant speed under control of a governor mechanism 9.

The governing mechanism 9 includes a tuning fork 10 having prongs 11, one of which is provided with a contact 12 cooperating with a fixed contact 13 carried by a fixed frame member 14 that supports the tuning fork. The prongs of the tuning fork are vibrated by means of an electromagnet 15 connected in circuit with current supply lines 16 and 17 through the contact elements 12 and 13 and winding of the motor 8, the supply line 16 being connected to one of the leads 18 of the magnet through a conductor 19. The other lead 20 of the magnet is connected to the contact 12 so that when the contact 13 is engaged thereby a circuit is completed through a conductor 21 leading from the contact 13 to one of the motor terminals and through a conductor 22 leading from the other terminal of the motor to the other supply line 17.

The prongs of the tuning forks are provided with adjustable weights 23 and 24 which may be moved longitudinally thereon and locked in adjusted position by means of set screws 25. By shifting the weights the vibration frequency of the tuning fork may be varied to produce a pulsating current of the proper frequency for driving the motor 8 at a constant rotational speed. Each set of generating units is similarly driven at its proper fixed speed by means of a separate motor 8 under control of an individual governing device 9, as above described. The shafts for each set may be supported at the ends thereof in suitable bearing contacts 26 carried upon a suitable framework of the organ, as indicated at 27, which also forms a support for the motors.

Associated with each disk is a plurality of pickup devices 28 arranged radially about the periphery thereof as best illustrated in Fig. 3. Each of the pickup devices includes a magnet 29 preferably formed of a magnetizable metal capable of retaining magnetism that is imparted to it so as to form a permanent magnet having its field influenced by the inserts 5 as they successively move thereby, incidental to rotation of the disks. The respective magnets for each set of disks are adjustably carried by channel members 30 and 31 supported at their respective ends on spider-like frames 32 having hubs 33 oscillatably mounted on the shaft 7.

The channels 30 and 31 are similar, but the web portions 34 of the channels 30 are arranged at right angles to the web portions 35 of the channels 31 so that the outer ends of the magnets align with the channels 31 when the sides thereof engage the webs of the channels 30. The magnets are slidingly retained relatively to the channel members 30 by means of U-shaped guides 36 straddling over the magnets and having flanged ends 37 which are connected by suitable fastening devices, such as bolts 38, with the webs of the channels.

Fixed to the outer ends of the magnets are angle clips 39 having laterally extending portions 40 provided with threaded openings 41 in which are threadedly engaged adjusting screws 42. The adjusting screws 42 are loosely mounted in openings 43 in the webs 35 of the channels 31, and are retrained in adjusted position by jam nuts 44 threaded on the shanks thereof and engaging the respective faces of the webs.

Fixed to the opposite end of each magnet, and in registering relation with the peripheral edges of the disks, are magnetizable plates 45 preferably formed of soft metal so that the ends 46 thereof, which register with the peripheries of the disks, may be readily profiled, as at 47, to respectively correspond with the characteristics of a sound wave of a natural musical tone.

The profilings 47 may be approximately determined by observing the visible record produced by the same note of an instrument to be simulated by each pickup. The profile may not follow exactly the desired wave form, but the exact form required may be determined through alteration of the profile until the same record is produced as that produced from a corresponding natural tone, the alteration being determined by calculation and experiment, as in voicing organ pipes. However when the exact profile is once determined, it is easily duplicated on a production basis by means of dies, jigs, or the like.

Associated with each of the profiled elements 45 is a coil of wire 48 having its leads 49 and 50 connected with an amplifying circuit, as later described.

With the disks under rotation, fluctuating electrical potentials are generated in the respective coils. As each succeeding insert passes through the field of a magnet, similar pulsations occur, having a frequency governed by the rate

of speed at which the inserts pass the respective magnets.

During travel of the inserts past the points of the profiled magnets, the electric potentials are altered to produce complex waves corresponding to the profiled sound waves of natural musical notes, which, when translated, produce notes having all of the timbre and tone color of the natural notes.

The important points in the present apparatus are that the profile of the wave form is associated in fixed relation with the electrical circuit as a pickup, and scanned by the series of magnetic points or inserts.

Since the frequency of a note doubles in number of vibrations at each successive octave, disks giving the octaves of any one note are mounted on the same shaft as above mentioned, and the frequency may be successively doubled by doubling the number of inserts on each successive disk. I find, however, that this doubling of the number of inserts on the successive disks is not very practicable due to the fact that the inserts on the higher frequency disks become too close together. Since the profile must usually be equal in length to the insert spacing, it is difficult to accurately produce the profiles in sufficient detail. It is, therefore, desirable to construct four of the disks in pairs, each pair being of different diameter to give the desired spacing for the required frequencies. The other four disks in the set may be constructed to conform in diameter and insert spacing with the first pair, but they are mounted to be driven at a higher speed so that the inserts move past the respective magnets at a higher peripheral speed.

This is accomplished by dividing the shafts 7 into separate sections 51 and 52 at a point intermediate the central disks, as best illustrated in Fig. 2. The ends of the shafts are then provided with differentially sized gears 53 and 54, which are coupled together by differentially sized pinions 55 and 56 on a counter-shaft 57. The counter-shaft 57 is rotatably mounted in suitable arms 58 of the shaft supports 26. The drive of the motor is then through the shaft section 51, gear 53, meshing pinion 55, counter-shaft 57, pinion 56 and meshing gear 54 to the shaft section 52. Thus the generating elements required in producing the same relative note in eight different octaves are driven at their proper peripheral speeds so that the inserts carried thereby will travel past their respective magnets to give the required frequencies corresponding to the wave frequencies of the same natural musical notes.

As above mentioned, each of the pickups that are arranged radially around the respective disks are profiled corresponding to the same note in an octave, but their profiles are varied to give a different timbre or tone color, thereby respectively imparting wave frequencies, which, when translated, produce musical tones of the respective musical instruments from which the profilings were calculated.

It is to be understood that there may be any number of pickups arranged in circular series about the respective disks as desired, the disks being made in diameter suitable to accommodate the required number of pickups. All the pickups for the respective sets of octaves are arranged in phase relation to the inserts.

As illustrated in Fig. 16, one of the leads for all of the pickup coils, associated with each disk, is connected to common conductors 59 and connected with key operated switches 60, later described. The other leads of the coils for the respective disks are connected by individual conductors 61, 62, 63 and 64 with stop switches 65, 66, 67 and 68, which in turn are connected with a common conductor 69 leading to one of the filament terminals of an amplifying tube 70. The switches 60 are connected by a conductor 71 with the grid terminal of the amplifying tube, which is also connected with the filament by a suitable gridleak 72. The filament current supply for the tube is supplied from any suitable source, such as a battery 73, and is controlled by means of a rheostat 74.

It is obvious that when any of the stop switches 65 to 68 are closed, closing of the key swithes 60 brings the pickup coils that are connected in circuit with the closed stop switches into a closed circuit so that they become effective in generating electrical potentials which are amplified in the tube 70, therefore when the operator closes the key switches, as when playing the organ, he causes varying potentials in the vacuum tube which, when translated, will produce musical notes.

The translating device, connected with the output of the vacuum tube, may be any type of current amplifier, as indicated by the housing 75, to which is connected a sound amplifier such as a loud speaker 76, which converts the amplified currents to audible sounds corresponding to natural musical notes of the instruments represented by the respective pickups that are associated with the respective disks.

In the form of wiring illustrated in Fig. 17, separate amplifying tubes 77, 78, 79 and 80 are provided for each stop circuit, otherwise the wiring is substantially identical to that of the form illustrated in Fig. 16.

In Fig. 18 the corresponding pickup coils of all of the respective disks are connected in shunt with common conductors 81, 82, 83 and 84, and the key switches are located in the respective conductors 81 to 84 intermediate the leads of the respective pickup coils. The switches rendering the pickup coils for each disk effective are connected to a common key, as indicated by the dotted lines 85.

The conductors 81, 82, 83 and 84 form one side of closed loop circuits, the other side of which is formed by wires 86, 87, 88 and 89 connected at one end with the conductors 81, 82, 83 and 84 and at their opposite ends by the stop switches 65, 66, 67 and 68, which in turn are connected to the conductors 81, 82, 83 and 84 respectively. The loop circuits formed by the conductors 86—81, 87—82, 83—88, 84 and 89 are connected in series, at the respective alternate ends thereof, by conductors 90, 91 and 92, and the conductors 81 and 84 are connected with the grid and filament terminals respectively of a single amplifying tube 93 by means of conductors 94 and 95.

The amplifying and loud speaker circuits in all of the wiring arrangements may be identically the same construction. With the circuit illustrated in Fig. 18; the key switches are normally retained in closed position so that the pickup coils are shorted out of the circuit, however when a key is operated to open a set of connected switches, and a stop switch for the respective loop circuits is opened, the pickup coils associated with those switches become effective in generating electrical potentials which are delivered to the amplifying tube 93.

The key switches are best illustrated in Fig. 9,

and are operated by conventional keys 96 such as form a part of a conventional organ manual. One element 97 of the switches is mounted on a bar support 98 extending along the rear ends 99 of the keys, and is connected with the respective wires leading to the groups of pickup coils, the wires being located in a suitable conduit 100 carried by the bar 98. The other contact element 101 for each switch is mounted on the rear ends of the keys and is connected by flexible leads 102 with the common conductor leading to the grid of the amplifying tube, as in the case of the wiring diagram shown in Fig. 16.

The stop switches are illustrated in Figs. 13 and 14, and are shown as including a conventional stop lever 103 having a contact 104 adapted to engage contact arms 105 and 106. The stop arm 103 is pivotally mounted on a fulcrum 107 and is retained in either one of its positions by a snap action spring 108.

In order to produce a tremolo in the music, the pickup elements may be oscillated about the axis of the shafts 7 by means of electromagnets 109, having armatures 110 connected by links 111 with ears 112 projecting from the spider-like frames. The electromagnets are selectively energized by means of suitable switches 113 having one lead 114 connected with a current supply and its other end connected with circuit breakers 115 connected with one of the leads 116 of the electromagnets.

The other leads 117 of the electromagnets are connected with the supply line to complete the circuit. It is thus obvious that when the switch is closed the circuits through the magnets will be alternately made and broken to effect continuous reciprocation of the armature. This movement of the armature effects slight oscillation of the pickup elements to give the desired tremolo.

The volume of the musical tones may be controlled at the will of the operator by means of a suitable potentiometer or rheostat 118 connected in circuit with the amplifier 75.

In Fig. 11 is shown a modified form of disk wherein the periphery thereof is provided with a plurality of points or projections 119 that correspond in function to the inserts 5 of the disks illustrated in Figs. 4 and 5.

Fig. 12 shows a still further modified form of disk having spaced slots 120 which will effect periodic generation of electrical potentials when the disk is rotated past the pickup elements.

Another modification of the pickups would be to profile the coils 121. In this form the coils 121 are made relatively flat and the profiled portions 122 are pressed into the convolutions thereof as shown in Fig. 15. Coils of this character would be placed close to the sides of the scanning disk 123 and juxtaposed by powerful magnets 124 having rather large pole pieces to make large fields across the disks. The inserts of the disks, or projections, as the case may be, will then drag the lines of magnetic forces circumferentially and edgewise to the flat pickup coils. This effect produces varying voltages in the coils, as in the other forms of the invention.

Attention is here directed to the fact that the windings of all the pickup coils are made from high resistance wire in order to eliminate "robbing" or feedback of currents between the coils should two or more of them be simultaneously connected in circuit. The high resistance does not interfere with the operation of the apparatus, since it is the voltage which is the important factor, the output current of the generating units being negligible.

In playing an organ constructed and assembled as described, the operator will manipulate the desired keys in the same manner as when playing a conventional organ and will close the stop switches corresponding to the type or types of musical instruments which he desires to simulate, then when the keys 96 are operated electrical potentials are caused to be generated in the proper coils and amplified by the tube 70 for translation into audible musical tones in the amplifier 75 and loud speaker 76.

From the foregoing it is obvious that I have provided a method and apparatus for producing musical notes synthetically through generation of complex electrical frequencies corresponding to the wave profile characteristics of natural tones, and that due to the profiling the tones produced have all of the timbre and color of natural tones. It is also obvious that the organ may be readily constructed to simulate tones of a plurality of musical instruments played individually or in harmony, by providing a plurality of the proper profiled pickups encircling the respective disks of the generating units. It is also possible to produce tones having new qualities not heretofore produced.

What I claim and desire to secure by Letters Patent is:

1. In an apparatus for synthetically producing a musical note, an electrical circuit, a relatively stationary profiled member having differentially projecting point-like portions definitely related to the tone characterizations and harmonics in the wave form of a natural musical note, and movable means cooperating with the profiled member for establishing a periodically varying magnetic flux in the zone of said profile for inducing a fluctuating electrical potential in said circuit corresponding in character to the wave characteristics of said natural musical note.

2. In an apparatus for synthetically producing a musical note, a selectively stationary magnetic profiled member having a series of differentially projecting point-like portions definitely related to the respective tone characterizations and harmonics in the wave form of a natural note, a circuit associated with the magnetic profiled member, and means cooperating with said profiled member for establishing a fluctuating electrical potential in said circuit corresponding in character to the wave characteristics of the profiled wave form of said natural note.

3. In an apparatus for synthetically producing a musical note, a magnetic profiled member having an irregularly arranged series of differentially projecting portions respectively related to the tone characterizations and harmonics present in the wave form of a natural note, a circuit associated with said profiled member, a field influencing member having a succession of regularly arranged field influencing portions cooperating with the magnetic profiled member, and means for moving said field influencing member relatively to the magnetic profiled member for establishing a fluctuating potential in said circuit corresponding in character to the wave characteristics of the profiled wave form of said natural note.

4. In an apparatus for synthetically producing a musical note, a magnetic member having a profiled portion provided with differentially projecting point-like portions definitely and respectively related to the wave characteristics of a natural

note, a coil mounted in the field of said magnetic member, a rotor having a succession of regularly arranged field influencing portions, and means for actuating the rotor in said field for periodically influencing the field of said magnetic member for impressing variable voltage in said coil modified by said profiled portion.

5. In an apparatus for synthetically producing musical notes, a plurality of magnetic profiled members grouped about an axis of rotation and each having a differently profiled portion definitely and respectively related to the wave characteristics of a differently timbred musical note, circuits associated with said magnetic profiled members, and means cooperating with the magnetic profiled members for establishing fluctuating electrical potentials in said circuits corresponding in character with the wave characteristics of said differently timbred musical notes.

6. In an apparatus for synthetically producing musical notes, a plurality of magnetic profiled members grouped about an axis of rotation and each having a differently profiled portion respectively related to the wave characteristics of a differently timbred musical note, circuits associated with said magnetic profiled members, means cooperating with the profiled members for establishing fluctuating electrical potentials in said circuits corresponding in character with the wave characteristics of said differently timbred musical notes, and means for selectively rendering said circuits effective.

7. In an apparatus for synthetically producing musical notes, a plurality of magnetic members grouped about an axis of rotation and each having a differently profiled portion respectively related to the wave characteristics of a differently timbred musical note, pick-up coils mounted in the fields of said magnetic members, a field influencing member supported for rotary movement in said axis of rotation and having a succession of field influencing portions, and means for actuating said field influencing member for periodically influencing the fields of said magnetic members for impressing variable voltages in said coils modified by said profiled portions.

8. In an apparatus for synthetically producing a musical note, a profiled member having differentially projecting point-like portions definitely related to the tone characterizations and harmonics in the wave form of a natural musical note, a circuit associated with said profiled member, means cooperating with said profiled member for establishing a fluctuating electrical potential in said circuit corresponding in character to the wave characteristics of the profiled wave form of said natural note, and means for oscillating the profiled member relatively to said cooperating means to effect tremolo in the natural musical note translated from said fluctuating electrical potential.

9. In an apparatus for synthetically producing a musical note, a magnetic member having a profiled portion provided with differentially projecting portions respectively related to the wave characteristics of a natural note, a coil mounted in the field of said magnetic member, a rotor having a succession of regularly arranged field influencing portions, means for actuating the rotor in said field for periodically influencing the field of said magnetic member for impressing variable voltage in said coil modified by said profiled portion, and means for oscillating the magnetic member including said coil about the axis of said rotor to effect tremolo in the note translated from said variable voltage.

10. In an apparatus for synthetically producing musical notes, a plurality of magnetic members grouped about an axis of rotation and each having a differently profiled portion respectively related to the wave characteristics of a differently timbred musical note, pick-up coils mounted in the fields of said magnetic members, a field influencing member supported for rotary movement in said axis of rotation and having a succession of field influencing portions, means for actuating said field influencing member for periodically influencing the fields of said magnetic members for impressing variable voltages in said coils modified by said profiled portions, and means for oscillating said magnetic members including said coils about said axis of rotation.

11. In an apparatus for synthetically producing a musical note, a magnetic profiled member having differentially projecting point-like portions definitely related to the tone characterizations and harmonics in the wave form of a natural note, a circuit associated with said profiled member, means cooperating with said profiled member for establishing a fluctuating electrical potential in said circuit corresponding in character to the wave characteristics of the profiled wave form of said natural note, and means for movably supporting the profiled member for movement to and from said cooperating means for varying intensity of said electrical potentials.

12. In an apparatus for synthetically producing a musical note, a coil having a profiled portion definitely related to the wave form of a musical note, a magnetic member associated with said coil, a field influencing member having a succession of field influencing portions, and means for actuating said field influencing member for periodically influencing the field of said magnetic member for establishing a fluctuating electrical potential in said coil modified by said profiled portion.

13. In an apparatus for synthetically producing a musical note, a coil having a profiled portion definitely related to the wave form of a musical note, a magnetic member associated with said coil, a field influencing member having a succession of field influencing members for periodically influencing the field of said magnetic member for establishing a fluctuating electrical potential in said coil modified by said profiled portion, and means for oscillating said coil for effecting tremolo in the note translated from said fluctuating potential.

14. In an apparatus for synthetically producing a natural note, an electromagnetic member having a head provided with a plurality of differentially projecting point-like portions definitely related to the tone characteristics and harmonics in the wave form of a natural note.

15. In an apparatus for synthetically producing a natural note, a magnetic member, a coil member associated with the magnetic member, one of said members having a profiled portion forming a plurality of differentially projecting portions definitely related to the tone characterizations and harmonics represented in the wave form of a natural musical note.

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