May 31, 1949. W. MUTH ET AL 2,471,534

MUSICAL INSTRUMENT

Filed March 29, 1943 5 Sheets-Sheet 1

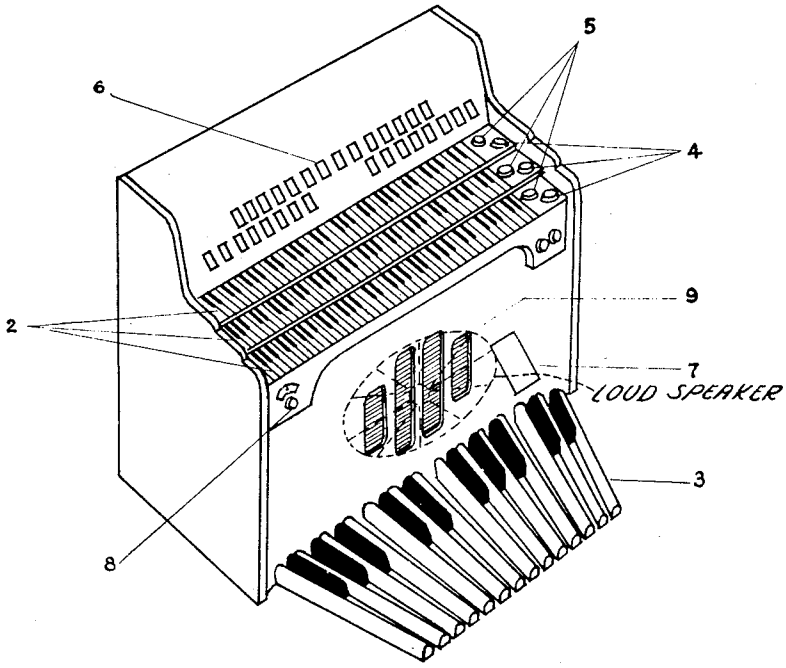


Fig. 1

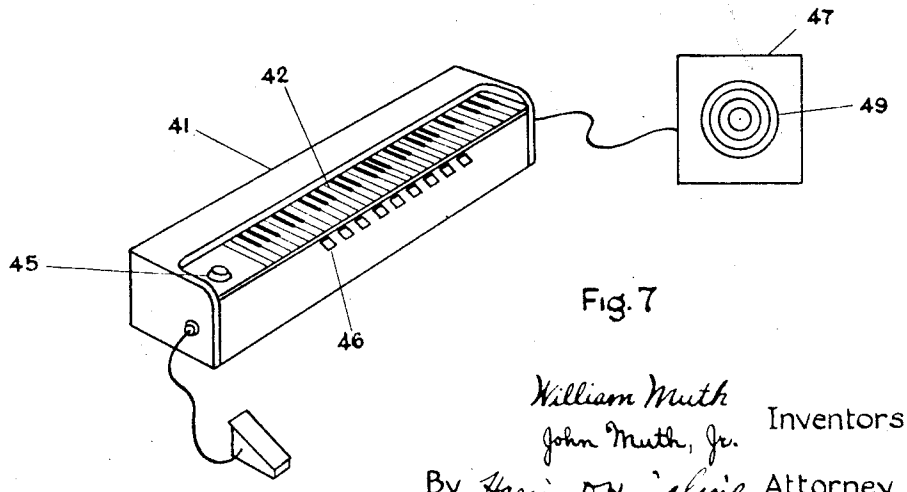


Fig. 7

William Muth
John Muth, Jr. Inventors

By Harris D. Hinkins Attorney

May 31, 1949. W. MUTH ET AL 2,471,534

MUSICAL INSTRUMENT

Filed March 29, 1943 5 Sheets-Sheet 2

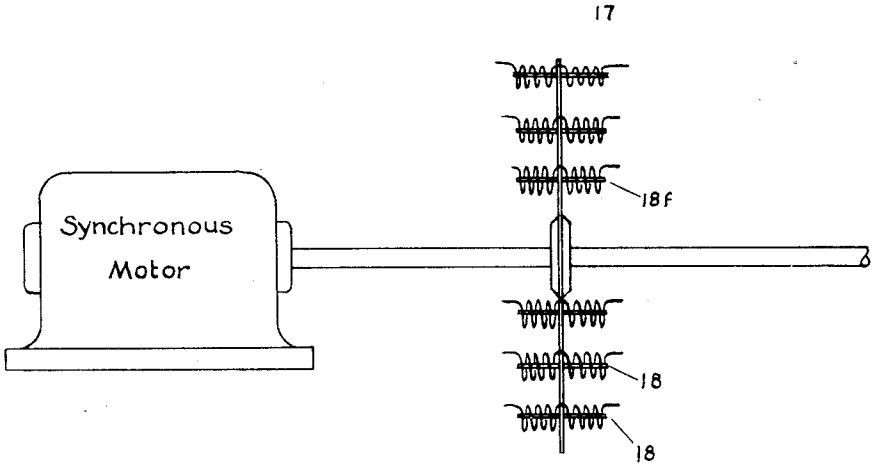


Fig 2

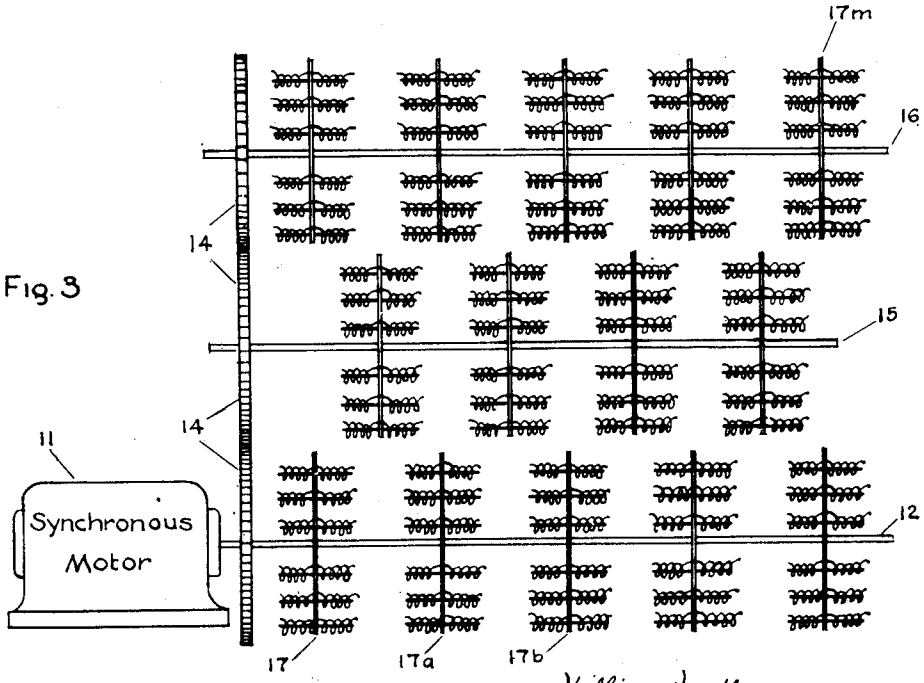


Fig. 3

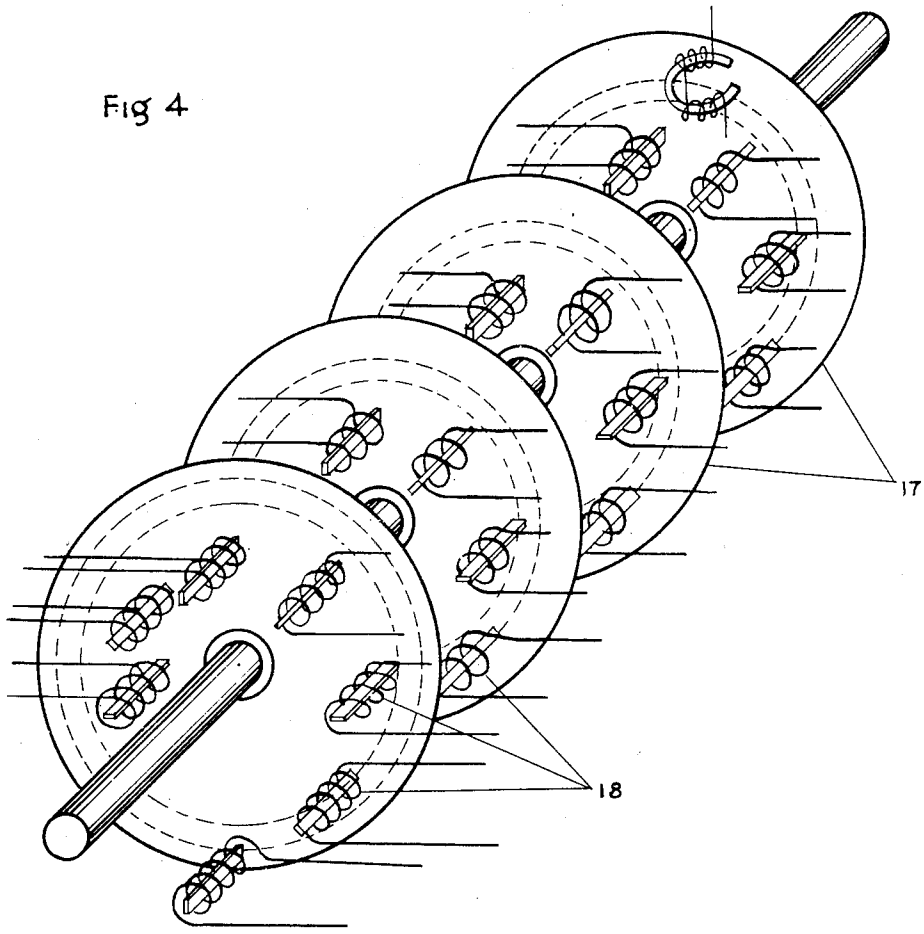
William Muth
John Muth, Jr. Inventors
By Harris O'Hinckle, Attorney

May 31, 1949. W. MUTH ET AL 2,471,534

MUSICAL INSTRUMENT

Filed March 29, 1943 5 Sheets-Sheet 3

Fig 4



William Muth
John Muth, Jr. Inventors

By Harris D. Hinckley, Attorney

May 31, 1949. W. MUTH ET AL 2,471,534

MUSICAL INSTRUMENT

Filed March 29, 1943 5 Sheets-Sheet 4

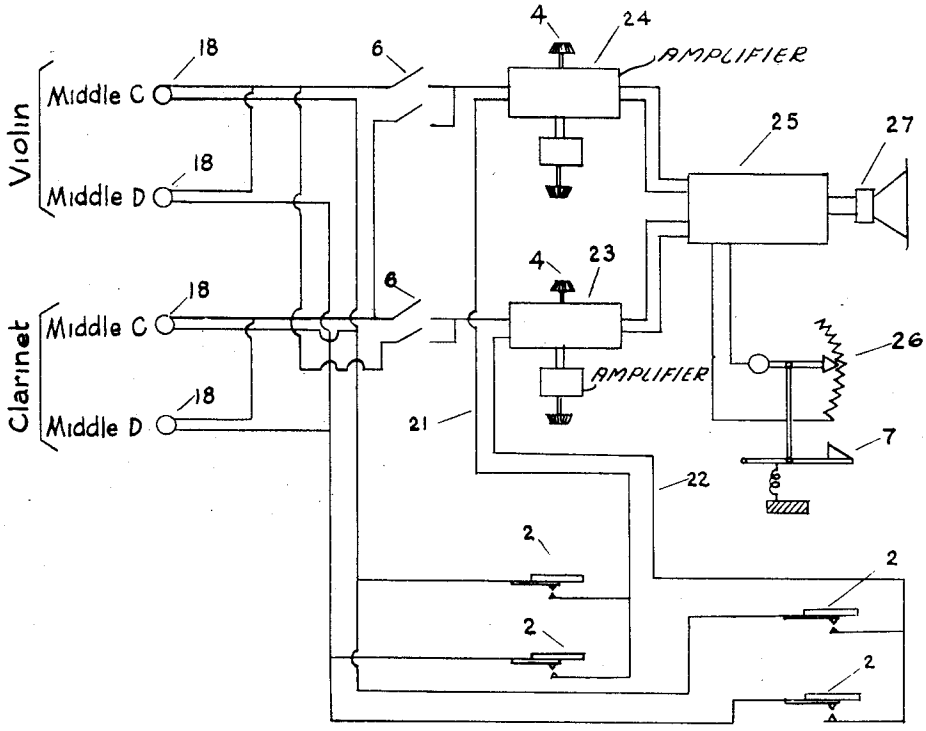


Fig. 5

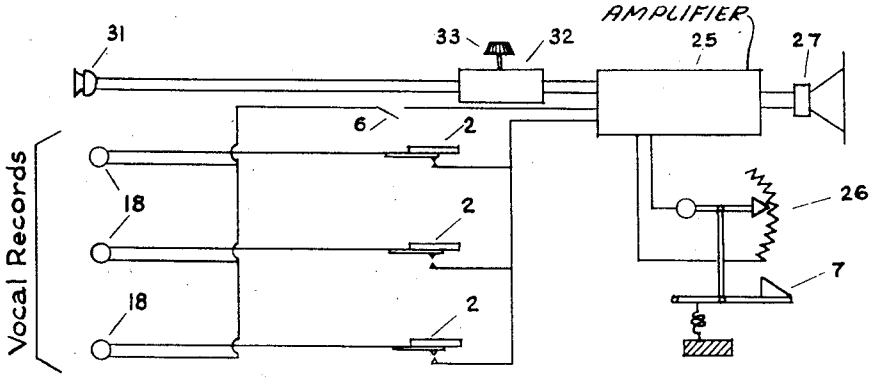


Fig. 6

William Muth
John Muth, Jr. Inventors
By Harris D Hinckley Attorney

May 31, 1949. W. MUTH ET AL 2,471,534

MUSICAL INSTRUMENT

Filed March 29, 1943 5 Sheets-Sheet 5

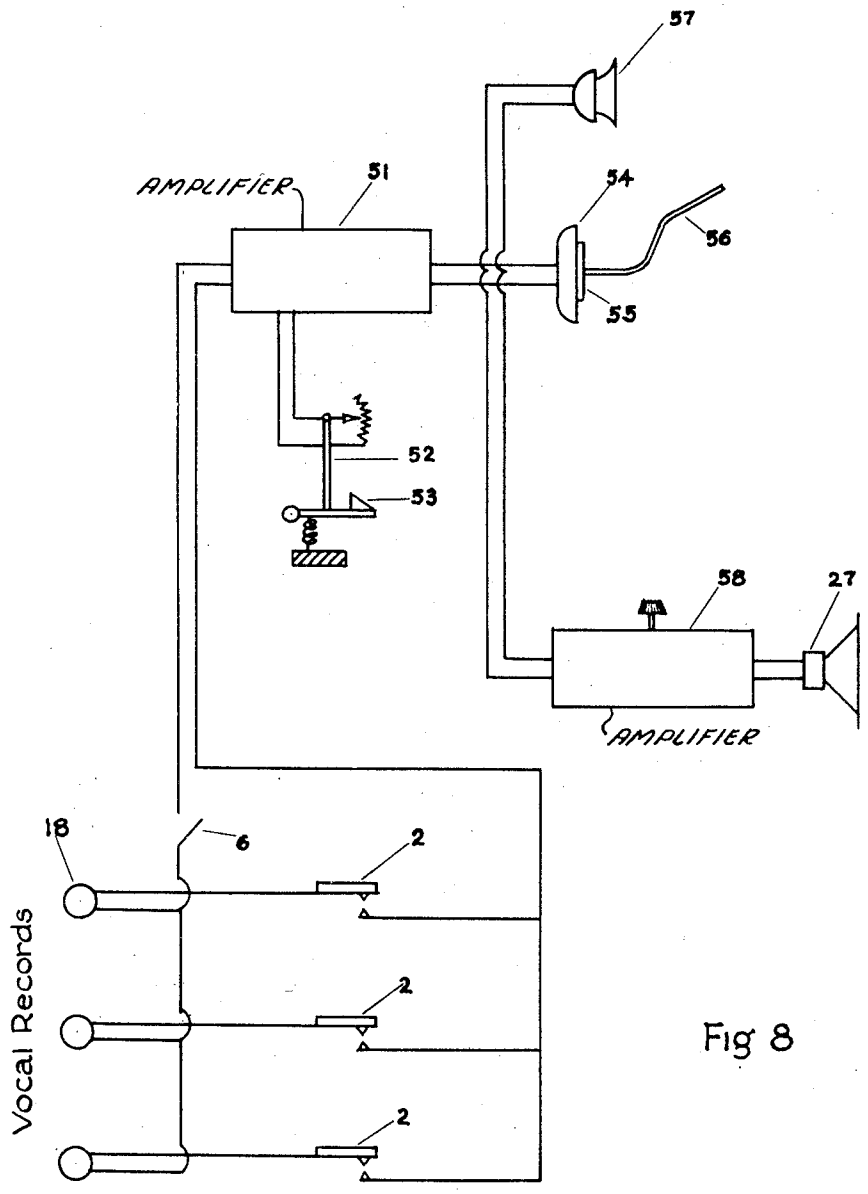


Fig 8

William Muth
John Muth, Jr. Inventors
By Harris D. Hinkle Attorney

Patented May 31, 1949

2,471,534

UNITED STATES PATENT OFFICE

2,471,534

MUSICAL INSTRUMENT

William Muth and John Muth, Jr., Brooklyn, N. Y.

Application March 29, 1943, Serial No. 480,910

12 Claims. (Cl. 84—1.28)

1

This application relates to musical instruments, relates particularly to musical instruments for reproducing the tone color, quality and timbre of individual orchestral instruments, or other musical sound sources, and relates especially to an instrument for imitating an orchestra by a single performer utilizing a series of sets of concentric sound records of a variety of orchestral instruments and other musical sound sources, and means for the pitch, volume and attack control for the tones of each of the various individual orchestral instrument records.

Many attempts have been made to imitate orchestral instruments; the standard pipe organ containing various stops which are voiced as imitations of various orchestral instruments, particularly certain of the "string stops" which attempt to imitate various string tones, and certain of the reed stops which attempt to imitate the brasses. Also various electric oscillator instruments have been constructed with the thought of control of electrically produced sound by keys, but with little or no success in imitating orchestral instruments. The well-known phonograph does an excellent job of reproducing orchestral instruments, but there is no control from a given record of the selection played, only the musical selection recorded in the spiral groove on a given record being reproduceable therefrom.

The present invention provides a musical instrument in which a considerable number of sound records is mounted upon shafts driven at a constant speed, and recordings made therefrom in concentric circles—not spirals—of single notes of individual orchestral instruments, each set of records having a sufficient number of concentric recordings to cover all of the notes available within the range of that instrument (or, as is the case with the saxophone, the entire range of a group of instruments of the same type of construction and operation may be so recorded, if desired), a substantial number of different sets of recordings, each representing a different orchestral instrument or other musical sound source, being made. The finished instrument of the present invention then utilizes this plurality of sets of concentric sound records of the individual notes of the individual orchestral instruments with separate pick-up means cooperating with each of the concentric records to make available to the artist at any time any note recorded on any set. The several pick-ups are then each independently connected to keys preferably of the type used in the piano or pipe organ and each set of records of a given instrument is then controlled by a master switch in a manner somewhat analogous to the stops of a pipe organ. The oscillatory electrical currents produced in the pick-ups are controllably connected to an amplifier and the amplified vibrations are delivered to an appropriate loud speaker for transmission through the air to the ears of an auditor or audience.

2

Independent controls are provided for the several sets of recordings representing the various instruments in the orchestra, and independent volume and attack controls are likewise provided. In addition, several keyboards may be utilized; with the several sets of recordings independently connected through each of the several keyboards to the main amplifier such that a single sound recording, say of the notes of a violin, may be utilized simultaneously for the playing of a melody such as a violin solo, and at the same time the playing of a violin accompaniment of first, second and third violins, violas, cellos, bass viols, and the like, thereby permitting from one set of records, the playing of as instrument solo and simultaneously the accompaniment of that solo by a group of other instruments picked up from the same group of sound records, and from other sound records an additional accompaniment or even a duet of other instruments such as flute type, saxophone type, cornet type, woodwinds, and the like.

Thus the device of the invention provides a musical instrument playable by a single performer, or, if desired, by two performers on the order of a keyboard duet, or by two or more performers, using two or more separate keyboards connected to the same set of concentric recordings and pick-ups, with independent controls, and, if desired, independent head amplifiers, and main amplifiers and the same or different loud speakers, as desired, by which the exact tones of the desired musical instruments in exact color, timbre and auditory stimulus are supplied, under the control of the performer to imitate a complete orchestral rendition with the full equipment of strings, brasses, wood-winds, and the like, as produced under the tutelage of a conductor; or the tones may be modified to obtain timbres, colorings, and the like, not otherwise available. Also both percussion instruments and vocal effects may be obtained.

Other objects and details of the invention will be apparent from the following description when read in connection with the accompanying figures in which

Fig. 1 is a view in perspective of the instrument;

Fig. 2 is a view in vertical elevation, partly diagrammatic of the record member, pick-up member and driving member of the invention;

Fig. 3 is a side view, partly diagrammatic, of a plurality of sets of records of various orchestral instruments according to the present invention;

Fig. 4 is a perspective view of a set of recordings for a single instrument;

Fig. 5 is a diagrammatic representation of the circuits of the invention;

Fig. 6 is a circuit diagram of an alternative embodiment;

Fig. 7 is a view in perspective of an alternative embodiment of the device of the invention suitable for use with a piano; and

Fig. 8 is a diagrammatic view of a method for obtaining articulation control of tones to reproduce a vocal solo or a vocal duet or chorus with musical accompaniment.

Referring to the figures, the operative mechanism may be housed in a case member 1, as shown in Fig. 1 and a plurality of keyboards 2, together with a pedal keyboard 3 are also provided, if desired. Volume control members 4, and attack control members 5 are provided associated with each of the keyboards 2, and preferably also with the keyboard 3. In addition, selector members 6 are also provided for the control of the various types of instrument to be reproduced. A master volume control 7 is also desirably provided in the form of a foot pedal for convenient operation, with, if desired, a permanent master control 8 in the form of a dial to limit the maximum volume obtainable, or to control the range of tone volume from maximum to minimum. A "loud speaker" or sound reproducer 9 is also provided which may be placed in the front of instrument, as shown in Fig. 1, but is preferably placed in a separate movable cabinet to permit of the convenient placing of the reproducer in the best relationship to the audience. Several speakers may be used simultaneously and some may be placed in other panels of the cabinet, both back, sides and top, if desired, and operated individually or in various combinations and various combinations with movable speakers.

Within the cabinet 1, there is positioned a motor 11, as shown in Fig. 3, having a shaft 12 and a gear train 14, through which other shafts 15 and 16 are driven. Upon these shafts are mounted disc sound records 17 to 17*m* inclusive, as shown in Fig. 3. Each of these records 17 cooperates with a series of reproducers 18 to 18*f*, as shown in Fig. 2. Each disc carries a plurality of circular concentric sound recordings or record tracks 19, as shown in Fig. 4, and each reproducer 18 cooperates with a separate circular record track. The discs 17 preferably are made of magnetic material, and each recording preferably is in the form of a magnetic recording, the magnetic flux density fluctuating along the path of each recording. The reproducers 18, cooperating with the records 17 preferably are of the well-known "Telegraphone" type consisting of a magnetic-material-core of low coercive force having a winding thereon cooperating with the electric and magnetic circuits. These reproducers 18 conveniently consist of a horseshoe-shaped core preferably made of iron having a high permeability and low coercive force, with a copper coil winding thereon through which a current may flow, a vibratory current from a microphone being caused to flow through the coils for the recording operation. For reproducing the record, the varying magnetic flux of the disc record induces a variable magnetization in the soft iron core, thereby inducing a fluctuating current in the coil winding to be transmitted through the control means to the amplifier and loud speaker. A steady direct current through the coils induces in the core a substantial magnetic flux, which serves to erase from the record any prior variable magnetization, thereby preparing the record for the application thereto and development thereon of a magnetic sound record. The recording is conveniently accomplished by passing through the coil winding a steady direct current in the reverse direction from the erasing current and of approximately one-half the intensity, down to an amount about equal to the peak recording current, or, in some instances, the steady direct current may be omitted, and superposing upon this current the pulsating current corresponding to the microphone pick-up. Thus the vibratory sound frequency input to a reproducer of this type will produce a sound record in the form of fluctuating magnetization on the magnetic material record. The same structure then serves for reproducer, converting the fluctuating sound record on the rotating disc into an alternating current which is amplified and fed to the speaker. It may be noted that each reproducer is fixed in position to cooperate to best advantage with its own particular circular sound track; and the reproducers do not move across the face of the record in the manner of the ordinary phonograph record reproducer.

Each circular concentric recording may represent one note or pitch of one instrument or may represent the combined tones of several instruments, of the same or different pitches. Fig. 4 shows a suitable arrangement of records and concentric recordings, but considerable variability of arrangement is possible. It may be noted that uniform accuracy of reproduction is best obtained by a speed of travel of the record under the reproducer which is neither too fast nor too slow. Accordingly, it is desirable that the lower notes be recorded on a record which has a relatively low rate of linear travel, and that the higher frequencies be recorded on a record having a considerably higher rate of linear travel. This may be accomplished by the arrangement shown in Fig. 4 in which the lowest note of a given octave is recorded nearest to the center of the record with the highest note recorded at a greater distance from the center. That is, the eleven recordings required for an inner octave may be put concentrically upon a single record with the lowest note in the octave nearest the center, and the highest note furthest from the center. A plurality of shafts may be utilized, as is shown in Fig. 3, running at different speeds, and by the arrangement the rate of linear travel of each record may be adjusted to the optimum for the particular frequency recorded, whether at the bottom or top of the gamut. Thus, for a range of eight octaves, eight different shafts 12 may be utilized, each carrying a group of records, at the optimum speed for recording. It may be noted that in the highest frequencies the rate of travel of the record path must be such that the inches per second traveled are equal to at least twice the product of the width of the recording magnet poles multiplied by the number of vibrations per second of the frequency recorded; otherwise no record is made. Likewise, at the lower ranges the record travel in inches per second must be

such that more than one complete vibration is made made per revolution, since otherwise a complete vibration is not recorded. Preferably the rate of record travel is arranged about midway between these limiting values so that a considerable number of vibrations is recorded for each concentric record, but with each complete vibration recorded over a record path having a range which is a considerable number of times the width of the recording pole pieces. It will be obvious that unless a given vibration of a given record occupies a distance along the sound record more than 16 times the width of the pole pieces, the upper partials present will be lost, and it is preferable that the length of record path occupied by a given fundamental vibration be 32 or 64 or even 128 times the width of the pole pieces of the recording and reproducing magnet in order to obtain a reasonably complete recording of the harmonics which give to a tone its timbre, color and auditory characteristics. With these requirements in mind, the position of the concentric recordings may be varied according to the designer's likes. All of the recordings for a given unison may be placed upon a single record, in which case 88 discs will be required for a full range. Alternatively, recordings from single instruments may be grouped in partial octaves with partial octaves from several instruments upon a given disc.

Thus, if, as may be convenient, one inner octave for a given instrument is recorded upon a disc, and mounted upon a shaft driven at a given speed, each shaft may carry a number of discs near to the total number of instruments recorded, and a number of shafts may be provided, each carrying discs adjustable according to the overall range desired, which, for the ordinary 88 note keyboard may conveniently be eight shafts.

It may be noted that some instruments or families of instruments do not cover the full eight octaves and for these instruments some of the keyboard range need not be supplied with available recordings. For instance, the flute does not normally go below middle C, and accordingly, the lower octaves would not be represented. Alternatively, it may in some instance be desirable to fill out the full range of a keyboard with a given characteristic tone in order to permit of the playing of the full range with the same tone characteristics throughout. Thus, the flute tone, for instance, may be provided over the entire range by recording a standard flute on records run at double or quadruple speed, then transferring the record discs to lower speed shafts and running them in the instrument for reproduction at these lower speeds to provide one or two or more lower octaves below those normally provided by the flute. For ordinary orchestral effects, however, this may not be desirable since such tones cease to be those of a real orchestral instrument, and merely simulate a new instrument not really known to the orchestra. On the other hand, in some instances experimentation with new sound colorings and effects may be desirable and a certain amount of such experimentation becomes possible with recordings of this type. Such a situation does not hold in the violin family, since the bass viol covers the bottom range with the cello, viola and violin covering overlapping portions of the upper range. In this situation, it is obviously possible to provide separate sets of recordings for each instrument without regard to the overlap, or to provide merely a series of recordings of the violin family, discontinuing the recording of each member at a point where the overlap occurs.

As above pointed out, a separate and independent reproducer **18** is provided for each pitch or tone record. One terminal of each of these reproducers for a given instrument or tone color is connected to a common lead under the control of a selector **6**, as shown in outline in **Fig. 1** and in detail in Fig. 5. The second terminal of each reproducer is connected to one of the pair of contacts under a key **2**, as shown in Fig. 5. The second contact of each key pair is connected through a common lead **21** or **22** to a head amplifier **23** or **24**, each equipped with independent volume control and contact control, as shown in Figs. 1 and 5. It will be noted that maximum flexibility of control is obtained by the use of a plurality of keyboards and a plurality of sets of selectors **6**, as shown in Figs. 1 and 5, making it possible to reproduce the desired tones through either of the keyboards, each keyboard having its own head amplifier to transmit the desired tones to the master amplifier and loud speaker. Thus, the outputs from the head amplifiers **23** and **24** are conveyed through leads, as shown, to a main mixer-amplifier **25**, which, in turn, has a main volume control **26** actuated by a foot pedal **7**. The output from the main mixer-amplifier **25** is transmitted through leads, as shown to the speaker system **27** which may be one or more loud speakers, as desired.

Methods of amplification and circuits usable in this invention are well shown in U. S. Patent No. 2,144,844.

In the operation of the device, the desired tones are first recorded upon the discs **17**. For this purpose a microphone and recording amplifier (which may be the master amplifier **25**, if desired) are provided, and arrangements are provided for connection from the microphone-amplifier system to single recorder-reproducer members **18**. A good musician then plays single notes upon the desired pitch of the particular record. The successive recorder-reproducer members are then connected in succession to the amplifier, while successive notes are played, conveniently according to the chromatic scale, and all of the notes are recorded at half tone intervals over the entire range of the selected instrument. This procedure usually requires the services both of the musician, and of a technician, to shift the circuit connections from the amplifier output to the successive recorder-reproducer members. When the entire range of one instrument is recorded, another instrument of the same family may be used to record upon similar discs either as an extension of the range by a separate and independent instrument, or as an extension of the range of the first instrument, as desired. When a full range of recordings of one instrument or family of instruments is completed, another instrument or family of instruments is similarly recorded upon another set of discs and this is repeated until all of the desired instruments have been recorded in all of their tonal range.

For this purpose, the electro-magnetic or "Telegraphone" type of recording is particularly convenient, since the same mechanism will serve for both recording and reproducing, and, in addition, any undesired record is very readily erased from the record disc which is not possible with any other type of recording. Also this type of record has the very great advantage that it does

not wear, whether the reproducer is run in direct mechanical contact with the disc, or run with a small or substantial spacing between the disc and the reproducer pole pieces.

Thus, in preparing for the recording, the disc 17 is rotated at a constant speed, and a relatively strong direct current, preferably supplied by a battery or by a well-filtered rectifier from the master amplifier 25 is sent through recorder 18. The presence of this current develops a strong magnetic flux in the recorder-reproducer 18 and results in a magnetically saturated concentric path on the disc. This current may be maintained for one or more complete revolutions of the disc and is then discontinued. This step prepares the disc for the recording process and erases any prior recordings on the disc. To record the desired tone, the vibratory current from the microphone, with, or without, a steady direct current in the reverse direction and of suitable magnitude is supplied to the recorder-reproducer 18. The amplitude of the vibratory current is controlled by the master amplifier to obtain a recording at good volume level and the two currents are kept flowing for a time interval slightly greater than the time required for one revolution of the disc. This procedure places upon the disc a magnetic flux pattern varying in flux intensity along the concentric path corresponding to the vibrations of the tone to be recorded. In reproducing, this flux pattern induces an oscillatory current in the reproducer 18 which, under the control of the selector 6 and the keys 2, is fed to the head amplifier 23 or 24 and the main amplifier 25, amplified therein to a desired power level, and delivered to the loud speaker 27 in which it is converted into the desired sound. It will be noted that in all three processes of erasing, recording and reproducing, only one head member 18 is required; this one member serving successively as eraser, recorder and reproducer. Also, as above pointed out, optimum results are obtained since this arrangement of parts permits the most favorable possible combinations of frequency and linear speed of record travel.

It will be noted that difficulty is encountered in the cutting of the phonographic record, since the starting and stopping of the cutting in the groove must be very accurately timed, and the cutter needle must be inserted with great care at the beginning of the recording and removed with great care and suddenness at the end of one complete revolution, since otherwise a click or "bump" is produced at the junction of the beginning and end of the record groove. Similarly, in the making of a photographic recording, the recording light must be turned on and turned off with great care and accuracy at the beginning and end of the sound record to avoid an overlap. With the "Telegraphone" type of recording, these factors are not troublesome since minor overlap of the records may cause a sufficient erasure of the beginning of the recording to avoid troublesome out-of-phase superposition. It may be noted that some care is required to obtain a smooth joining of the beginning and end of the initial recording.

The recording disc may take any one of a number of different forms. The preferred form is a disc of magnetic material of relatively high coercive force. A good grade of mild steel is desirable, or a non-magnetic disc, such as brass, bronze or copper may be used with a heavy plating of nickel thereon. It is desirable that the nickel plating be sufficiently thick to avoid

pinholes, which yield false sounds. A good pinhole-free plate of one-half thousandth inch in thickness is sufficient. Alternatively, however, thicknesses up to several thousandths are preferable since they give a better recording. Or a plating of iron with electro-precipitated graphite, heat-treated to convert it into steel, may be used, or a solid disc, or a plated film on a non-magnetic disc may be used consisting of an alloy of about equal parts of copper, nickel and iron; deposited from the simple mixed sulfates or the simple mixed chlorides, or from the double salt of the fluoborates, or successive layers of the three metals may be deposited and homogenized by heat treatment. Alternatively, a steel disc may be used. However, care is required to use a disc with a minimum amount of crystal structure, since, if there is a crystal patterns in some one direction, false sounds may also be produced.

Alternatively, other forms of records may be utilized such as drums with the recording upon a surface; or even flexible steel bands may be used. In some instances endless wires, one wire for each tone, may likewise be used. These structures are however somewhat more complicated and the simple discs are preferred.

In making the recording, the preferred procedure is to produce by the desired instrument precisely the tone to be recorded. This is not however imperative, since a series of discs and recorders may be arranged such that one disc runs at its normal speed and other discs run at higher and lower speeds. Recordings are made on all of these discs simultaneously and the discs are then all run at their normal speeds. This procedure permits the obtaining of an unlimited number of octaves from a single note and insures uniformity of tone, character, timbre and color throughout the range. Usually, however, there is a change in color and timbre of any instrument as different portions of the range are utilized and this difference which usually is characteristic, can only be obtained by an actual recording of the actual note at normal speed.

Likewise, for some instances where two or more instruments are desired together, throughout a given production, the two instruments may be recorded simultaneously throughout the range covered by them. By this arrangement, the touching of a single key 2 under the control of a single selector 6 may be caused to yield the tones of two instruments either in unison or in any desired chord of two or more notes. Thus, a clarinet and flute may be recorded simultaneously or a saxophone and trombone or saxophone, trombone and clarinet, and the like.

This arrangement is particularly convenient because of its flexibility of recording and if a change in the type of record is desired between performances, the undesired recording is readily erased and replaced by the desired recording.

When the recordings are completed, the instrument is ready for the performer. For this purpose the driving motor is again energized, the amplifiers 23, 24 and 25 are energized and the instrument is ready for operation. The touching of any one of the keys 2 (with a selector switch 6 closed) closes the associated contacts thereunder and delivers the desired vibratory electric currents from a pick-up 18 cooperating with a disc 17 to the head amplifier 23 or 24 and the main amplifier 25, resulting in the production of a tone from the speaker 27. The volume of this

tone may be adjusted by adjustment of the volume controls 4 and the adjustment of the main volume control 26 by the foot pedal 7. Other keys too may be pressed simultaneously to yield a chord, the character of which is controlled by the selector switches 6 which may be closed or opened, as desired, to pick out the particular instrument or combination of instruments desired by the performer.

The performer may then set upon one keyboard a considerable number of instruments and adjust the volume control output according to the notes of a desired accompaniment at a suitable volume level for the particular auditorium in which the instrument is located. He may then select for another keyboard a solo instrument, setting the volume control for the second keyboard to the desired tone volume for a solo instrument. He may then play the solo melody upon one keyboard, and play the accompaniment upon the other keyboard, supplementing the accompaniment by a pedal keyboard, if desired. Alternatively, he may play two notes upon the solo keyboard, thereby simulating a duet of two similar instruments, or alternatively he may play an accompaniment upon one keyboard, a solo melody upon a second keyboard, and a second solo melody upon a third keyboard such as the pedal keys. Alternatively, two performers may be utilized, one playing accompaniment upon one keyboard, and another playing a second instrument duet upon a second and third keyboard, pedal keys being simultaneously utilized to supplement the accompaniment or as a third solo instrument. Or, by the use of additional keyboards and performers, as many instruments may be played as desired. Alternatively, the artist may select for one keyboard a given type of instrument, such as the wood-winds, or the brasses, or the flutes, or the strings, and for another keyboard another family of instruments, and, if desired, for the pedal keys, still another family of instruments and he may then play the appropriate notes for the respective instruments upon the different keyboards, according to the score of the selection he wishes to play.

The instrument is readily "tuned" or adjusted in pitch merely by changing the speed of rotation of the shafts. The present-day commercial 60-cycle frequency is extremely stable because of the large rotating masses of the generator and accordingly the records 18 may be driven by a synchronous motor at an extremely constant, steady speed which yields a uniform steady frequency from the reproducers. Alternatively, a variable speed motor may be utilized with a good speed control. Likewise, the device becomes capable of automatic transposing merely by changing the speed of the driving motor. By this procedure, which is especially suitable for accompaniment uses, if the key in which the musical selection written is unduly high or unduly low, it is readily transposed by any desired number or half tones up or down merely by adjustment of the motor speed control, thereby permitting the music to be adjusted to any desired range.

Likewise, by the application of appropriate amplification control, preferably of the head amplifiers 23 and 24, any desired tremulo or vibrato can be obtained, or, if the rotating discs are relatively light, the effect of vibrato can be obtained by rapid, minor speed variations of the shafts carrying the desired recording. This is perhaps most easily obtained by the use of a spring coupling between shaft and disc, with, if desired, a magnetic pulser cooperating between the two,

varying the angular relationship between shaft and disc by a desired amount at a desired frequency.

The recording and reproduction of instruments which normally produce sustained tones is readily accomplished by the arrangement as above described. However, percussion tones such as the piano or harp, guitar, banjo, kettledrums, and the like, are somewhat more difficult to obtain. For the reproducing of these instruments, special precautions are required. For the piano, as an instance, the recording of the piano tone is preferably made at constant amplitude over the whole of the record. This may be conveniently obtained by the incorporation into the recording amplifier of an automatic volume control. With this arrangement, the piano key is struck and after the first impact vibration is over, the recording is begun with the automatic volume control in the recording amplifier maintaining the amplitude constant during the entire recording, even though the volume of the piano note decreases rapidly. For the reproduction of piano tones, a special head amplifier is preferably used with an automatic decrement provision, substantially equivalent to an automatic volume control in reverse, such that when the key is first closed, tone at full volume is provided and then caused to decrease relatively rapidly (as by negative regeneration in the head amplifier) to substantially complete disappearance at a rate depending upon the type of piano to be imitated. This procedure yields tones which simulate very closely those of the piano or harp or other decremental tones.

In some instances it is desirable to use the instrument as an accompaniment for a singer. For this purpose the structure shown in Fig. 6 may be utilized. In this figure a plurality of reproducers 18 cooperating with the records 17 are provided under the control of keys 2 as in Fig. 5, a similar stop switch 6 likewise being provided. The pick-up from the reproducers 18 under the control of the keys 2 and stop switch 6 may be conveyed directly to the master amplifier 25 and the loud speaker 27 under the control of a volume control 26 and foot pedal 7; or head amplifiers 23 may be interposed between the keys 2 and the main amplifier 25. This portion of the instrument serves for the accompaniment. A microphone 31 for the singer is also provided and connected through a head amplifier 32 having a volume control 33 to the main amplifier 25. By this procedure, a soloist may obtain sufficient voice volume to fill any desired auditorium, while the performer on the keys 2 provides the desired accompaniment.

When a vocal solo is to be accompanied in this fashion, it is frequently convenient to provide the effect of a choral accompaniment by recording on an additional set of discs 17 an appropriate voice accompaniment either in the form of one or more series of selected vowels, or humming, if desired. These records may then be played through reproducers 18 and keys 2 exactly as the orchestral instruments are played to obtain the effect of a choral accompaniment in addition to the orchestral accompaniment.

In some instances, it is desirable that a relatively non-skilled singer should be enabled to imitate a highly skilled, trained singer. This is readily accomplished by the structure of Fig. 8 in which a series of vocal records of sustained inarticulate sounds are provided. These vocal records are connected through keys 2 and a control switch 6 to a special head amplifier 51

equipped with a volume control 52 actuated by a foot pedal 53. The output from the amplifier 51 is delivered to a "Sonovox" type of reproducer 54 consisting of a diaphragm member 55 actuated by a magnetic structure (not shown) with a glass rod 56 connected to the diaphragm. There is provided in addition a microphone 57 connected to a second amplifier 58, which, in turn, is connected to the loud speaker 27, either directly or through the main amplifier 25, as desired. In the operation of this embodiment, the voice records cooperating with the reproducers 18 are arranged to reproduce the voice, timbre, color and pitch of a trained vocalist. The desired melody is then played upon the keys 2 and sent to the glass rod 56, the rod 56 is inserted into a performer's mouth, delivering the desired tone to the oral cavity. The performer then articulates, in a whisper, to impress upon the tones delivered through the rod 56, the desired articulation. The articulate sound is then received by the microphone 57, the output from which is amplified by the amplifier 58 and delivered through the loud speaker 27. It may be noted that this procedure relieves the performer of the necessity of attention to his tone quality and breathing and leaves upon him only the burden of careful articulation. The result is very high-grade vocalization.

If single successive notes only are played upon the keys 2, the performance is equivalent to a vocal solo. However, it is not necessary that a simple single note melody be played, since two or more keys may be depressed simultaneously. This procedure results in the effect of a vocal duet, trio, quartette, or even chorus, as desired, according to the number of keys depressed, and also according to the character of the recording, since for choral reproduction, it is usually desirable that the effect of many simultaneous voices at approximately a single pitch be recorded upon the discs 17.

In some instances also it is desirable to utilize this structure with a piano under the control of a single player. For this purpose the structure shown in Fig. 7 may be utilized, a case 41 being provided which can be attached to the piano, preferably under the treble keys. A set of keys 42 is likewise provided and a set of selectors 46 is also provided together with a volume control 45. An appropriate set of records 17 mounted upon a shaft 12 cooperating with reproducers 18 is provided and mounted within the speaker cabinet 47 within which the speaker 49 is also mounted. By this arrangement a pianist may play an appropriate melody on the piano and accompany the piano melody by an orchestral accompaniment played on the keys 42, or the player may play an orchestral melody on the keys 42 and accompany the orchestral melody by a piano accompaniment, as desired.

Thus the device of the invention provides a musical instrument in which accurate continuous records of the tones of various orchestral instruments are provided, together with cooperating pick-ups, selectors, keys, amplifiers and speakers by which any desired orchestral instruments or combination of instruments may be followed under the hands of a single performer to give an accurate reproduction of orchestral music.

While there are above disclosed but a limited number of embodiments of the device of the invention, it is possible to produce still other embodiments without departing from the inventive concept herein disclosed, and it is therefore desired that only such limitations be imposed on the appended claims as are stated therein or required by the prior art.

The invention claimed is:

1. In combination, a plurality of circular record discs having thereon a plurality of circular concentric endless recordings of musical tones according to the musical scale, the said recordings being characterized by a smooth overlapping of start and finish without respect to phase relationships of the recorded vibrations between the start portion and finish portion as produced by simultaneous magnetic erasing and recording, a plurality of shafts for carrying said record discs, means for driving the respective shafts at different steady speeds, a plurality of electrical recorder-reproducers adapted to simultaneously erase and record sound vibrations on said discs respectively cooperating with said circular recordings, microphone members adapted to take a pick-up from a musical instrument and an amplifier connectable between said microphone and said recorder-reproducers for producing said concentric endless recordings of musical tones, the said recordings comprising magnetic material discs, the said electrical recorder-reproducers comprising high permeability magnetic systems, cooperating with electrical windings thereon, a plurality of keys respectively having electrical contacts connected to said reproducers, an amplifier connected to said keys and a loud speaker system supplied with electrical vibrations from said amplifier.

2. In combination, a plurality of circular record discs having thereon a plurality of circular concentric endless recordings of musical tones according to the musical scale, the said recordings being characterized by a smooth overlapping of start and finish without respect to phase relationships of the recorded vibrations between the start portion and finish portion as produced by simultaneous magnetic erasing and recording, a plurality of shafts for carrying said record discs, means for driving the respective shafts at different steady speeds, a plurality of electrical recorder-reproducers adapted to simultaneously erase and record sound vibrations on said discs respectively cooperating with said circular recordings, microphone members adapted to take a pick-up from a musical instrument and an amplifier connectable between said microphone and said recorder-reproducers for producing said concentric endless recordings of musical tones, a plurality of keys respectively having electrical contacts connected to said reproducers, an amplifier connected to said keys and a loud speaker system supplied with electrical vibrations from said amplifier, the said keys comprising a plurality of independent keyboards, together with control members associated with groups of reproducers for the control of reproductions from a group of recordings of different notes of a single characteristic tonal effect.

3. In combination, a plurality of circular record discs having thereon a plurality of circular concentric endless recordings of musical tones according to the musical scale, the said recordings being characterized by a smooth overlapping of start and finish without respect to phase relationships of the recorded vibrations between the start portion and finish portion as produced by simultaneous magnetic erasing and recording, a plurality of shafts for carrying said record discs, means for driving the respective shafts at different steady speeds, a plurality of electrical

recorder-reproducers adapted to simultaneously erase and record sound vibrations on said discs respectively cooperating with said circular recordings, microphone members adapted to take a pick-up from a musical instrument and an amplifier connectable between said microphone and said recorder-reproducers for producing said concentric endless recordings of musical tones, a plurality of keys respectively having electrical contacts connected to said reproducers, an amplifier connected to said keys and a loud speaker system supplied with electrical vibrations from said amplifier, the said keys comprising a plurality of independent keyboards, together with control members associated with groups of reproducers for the control of reproductions from a group of recordings of different notes of a single characteristic tonal effect, and means for the control of sound volume produced by said loud speaker.

4. In combination, a plurality of circular record discs having thereon a plurality of circular concentric endless recordings of musical tones according to the musical scale, the said recordings being characterized by a smooth overlapping of start and finish without respect to phase relationships of the recorded vibrations between the start portion and finish portion as produced by simultaneous magnetic erasing and recording, a plurality of shafts for carrying said record discs, means for driving the respective shafts at different steady speeds, a plurality of electrical recorder-reproducers adapted to simultaneously erase and record sound vibrations on said discs respectively cooperating with said circular recordings, microphone members adapted to take a pick-up from a musical instrument and an amplifier connectable between said microphone and said recorder-reproducers for producing said concentric endless recordings of musical tones, a plurality of keys respectively having electrical contacts connected to said reproducers, an amplifier connected to said keys and a loud speaker system supplied with electrical vibrations from said amplifier, the said keys comprising a plurality of independent keyboards, together with control members associated with groups of reproducers for the control of reproductions from a group of recordings of different notes of a single characteristic tonal effect, and means for the control of sound volume produced by said loud speaker comprising a pedal-operated volume control member associated with said amplifier.

5. In combination, a plurality of endless recordings of the successive individual notes of the entire ranges of a plurality of different orchestral instruments, the starting and finishing ends of the recording being united by a process of simultaneous magnetic erasure and recording of the individual notes, a plurality of recorder-reproducers adapted to simultaneous magnetic erasure and recording of individual musical notes respectively individually cooperating with said endless recordings, a microphone suitable for taking a pick-up from different orchestral instruments, an amplifier connected to said microphone and a switch member for connecting said amplifier to successive recorder-reproducers, according to the tone sounded by the said orchestral instrument, a plurality of control members for connecting one side of an electric circuit between said recorder-reproducers and an amplifier, a plurality of keys respectively connecting individual recorder-reproducers on a given pitch to an amplifier, a vacuum tube amplifier supplied from said reproducers under the control of said keys, and a loud speaker energized from said amplifier.

6. In combination, a plurality of circular recordings of the successive notes of musical instruments, the starting and finishing ends of the recording being united by a process of simultaneous magnetic erasure and recording of the individual notes, a plurality of electrical recorder-reproducers adapted to simultaneous magnetic erasure and recording of individual musical notes respectively cooperating with said recordings, a microphone suitable for taking a pick-up from different orchestral instruments, an amplifier connected to said microphone and a switch member for connecting said amplifier to successive recorder-reproducers, according to the tone sounded by the said orchestral instrument, a plurality of keyboards having key contacts, the corresponding keys of both keyboards being connected together to appropriate recorder-reproducers, a plurality of groups of selectors, each group cooperating with an individual keyboard, for completing circuits to the reproducers, a plurality of head amplifiers respectively connected to said reproducers through a keyboard and a cooperating group of selectors, a main amplifier connected to said head amplifiers and a loud speaker system supplied from said main amplifier.

7. In combination, a plurality of circular recordings of the successive notes of musical instruments, the starting and finishing ends of the recording being united by a process of simultaneous magnetic erasure and recording of the individual notes, a plurality of electrical recorder-reproducers adapted to simultaneous magnetic erasure and recording of individual musical notes respectively cooperating with said recordings, a microphone suitable for taking a pick-up from different orchestral instruments, an amplifier connected to said microphone and a switch member for connecting said amplifier to successive recorder-reproducers, according to the tone sounded by the said orchestral instrument, a plurality of keyboards having key contacts, the corresponding keys of both keyboards being connected together to appropriate recorder-reproducers, a plurality of groups of selectors, each group cooperating with an individual keyboard, for completing circuits to the reproducers, a plurality of head amplifiers respectively connected to said reproducers through a keyboard and a cooperating group of selectors, a main amplifier connected to said head amplifiers and a loud speaker system supplied from said main amplifier, and a microphone and auxiliary head amplifier connected thereto and to said main amplifier.

8. In combination, a plurality of circular recordings of the successive notes of musical inments, the starting and finishing ends of the recording being united by a process of simultaneous magnetic erasure and recording of the individual notes, a plurality of electrical recorder-reproducers adapted to simultaneous magnetic erasure and recording of individual musical notes respectively cooperating with said recordings, a microphone suitable for taking a pick-up from different orchestral instruments, an amplifier connected to said microphone and a switch member for connecting said amplifier to successive recorder-reproducers, according to the tone sounded by the said orchestral instrument, a plurality of keyboards having key contacts, the corresponding keys of both keyboards being connected together to appropriate recorder-repro-

ducers, a plurality of groups of selectors, each group cooperating with an individual keyboard, for completing circuits to the reproducers, a plurality of head amplifiers respectively connected to said reproducers through a keyboard and a cooperating group of selectors, a main amplifier connected to said head amplifiers and a loud speaker system supplied from said main amplifier, certain of said recordings representing percussion instruments, and auxiliary head amplifiers having decrement control means therein, connected through a said keyboard and selector to a reproducer cooperating with a recording of a percussion instrument, the said decrement control amplifier also being connected to said main amplifier and loud speaker.

9. In combination, a plurality of circular recordings of the successive notes of musical instruments, the starting and finishing ends of the recording being united by a process of simultaneous magnetic erasure and recording of the individual notes, a plurality of electrical recorder-reproducers adapted to simultaneous magnetic erasure and recording of individual musical notes respectively cooperating with said recordings, a microphone suitable for taking a pick-up from different orchestral instruments, an amplifier connected to said microphone and a switch member for connecting said amplifier to successive recorder-reproducers, according to the tone sounded by the said orchestral instrument, a plurality of keyboards having key contacts, the corresponding keys of both keyboards being connected together to appropriate recorder-reproducers, a plurality of groups of selectors, each group cooperating with an individual keyboard, for completing circuits to the reproducers, a plurality of head amplifiers respectively connected to said reproducers through a keyboard and a cooperating group of selectors, a main amplifier connected to said head amplifiers and a loud speaker system supplied from said main amplifier, certain of said recordings representing vocal notes, the reproducers cooperating with said vocal recordings being connected through key contacts and selectors to an auxiliary amplifier, an auxiliary amplifier having a diaphragm and sound conveyor rod, and an auxiliary microphone and amplifier system adjacent said conveyor rod, for cooperating with an artist for the production of articulated tones.

10. In combination, a plurality of circular recordings of the successive notes of musical instruments, the starting and finishing ends of the recording being united by a process of simultaneous magnetic erasure and recording of the individual notes, a plurality of electrical recorder-reproducers adapted to simultaneous magnetic erasure and recording of individual musical notes respectively cooperating with said recordings, a microphone suitable for taking a pick-up from different orchestral instruments, an amplifier connected to said microphone and a switch member for connecting said amplifier to successive recorder-reproducers, according to the tone sounded by the said orchestral instrument, a plurality of keyboards having key contacts, the corresponding keys of both keyboards being connected together to appropriate recorder-reproducers, a plurality of groups of selectors, each group cooperating with an individual keyboard, for completing circuits to the reproducers, a plurality of head amplifiers respectively connected to said reproducers through a keyboard and a cooperating group of selectors, a main amplifier

connected to said head amplifiers and a loud speaker system supplied from said main amplifier, certain of said recordings representing vocal notes, the reproducers cooperating with said vocal recordings being connected through key contacts and selectors to an auxiliary amplifier, an auxiliary amplifier having a diaphragm and sound conveyor rod, and an auxiliary microphone and amplifier system adjacent said conveyor rod, for cooperating with an artist for the production of articulated tones, certain of said vocal recordings comprising the tones of a single vocalist, other of said recordings comprising the tones of a group of vocalists simultaneously.

11. A musical instrument comprising in combination a shaft, a plurality of steel discs carried thereon and rotated thereby, a plurality of electro-magnetic recorder-reproducer elements associated with each of said discs and fixedly positioned respectively at different radial distances from said shaft, means for energizing said recorder-reproducer members simultaneously to erase and record under each recorder-reproducer an endless sound record comprising a microphone taking a pick-up from a sound source whereby the beginning end and the finishing end of the recording of said endless record are united by magnetic erasure of a portion of the beginning end and simultaneous magnetic recording of the finishing end thereover without regard to phase relationships, whereby no sudden change in phase is produced, an amplifier connected between said microphone and said recorder-reproducer; the same microphone-amplifier combination being connectable successively to various recorder-reproducer members to record on the several discs a complete series of characteristic tones of various pitches from a single instrument; a loud speaker member connectable to said recorder-reproducer members through an amplifier, and a plurality of keys and key contacts for the control of the connections between said loud speaker, amplifier and recorder-pick-up members, through an amplifier, and a plurality of keys and key contacts for the control of the con- and recorder-pick-up members, according to the requirements of a musical selection.

12. A musical instrument comprising in combination a shaft, means for driving said shaft at a speed which has no fluctuations at a frequency within the audible range, a plurality of steel discs attached to and rotated by said shaft, means for producing on each disc a plurality of concentric endless electro-magnetic recordings of characteristic musical instrument tones comprising a microphone adapted to take a pick-up from a musical instrument comprising an electro-magnetic eraser-recorder by which a portion of the starting end of the record is erased and a finishing end of the recording simultaneously recorded thereover without regard to phase displacement therebetween, to avoid a sudden shift in phase of the reproduced sound, and an amplifier connected between said microphone and said electro-magnetic recorder-reproducer; and a musical reproducing means comprising a keyboard having key contacts associated respectively with the appropriate recorder-reproducer members for the control of a pick-up therefrom, and an amplifier and loud speaker system connectable by said key contacts to said recorder-reproducer members.

WILLIAM MUTH.
JOHN MUTH, JR.

(References on following page)

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
836,339	Pedersen	Nov. 20, 1906
1,218,324	Severy	Mar. 6, 1917
1,326,955	Mueller	Jan. 6, 1920
1,665,331	Thomson	Apr. 10, 1928
1,678,872	Potter	July 31, 1928
1,941,036	Lenk	Dec. 26, 1933
1,956,350	Hammond	Apr. 24, 1934
1,991,727	Brimberg	Feb. 19, 1935
2,041,480	Oexmann	May 19, 1936
2,166,202	Waters	July 18, 1939
2,178,706	Severy	Nov. 7, 1939
2,199,948	Brockway	May 7, 1940
2,224,358	Quisling	Dec. 10, 1940