March 6, 1934. A. E. ZOPPA 1,949,771

METHOD OF AND APPARATUS FOR PRODUCING SYNCHRONIZED RECORDS

Original Filed July 24, 1929 3 Sheets-Sheet 1

Fig. 1.

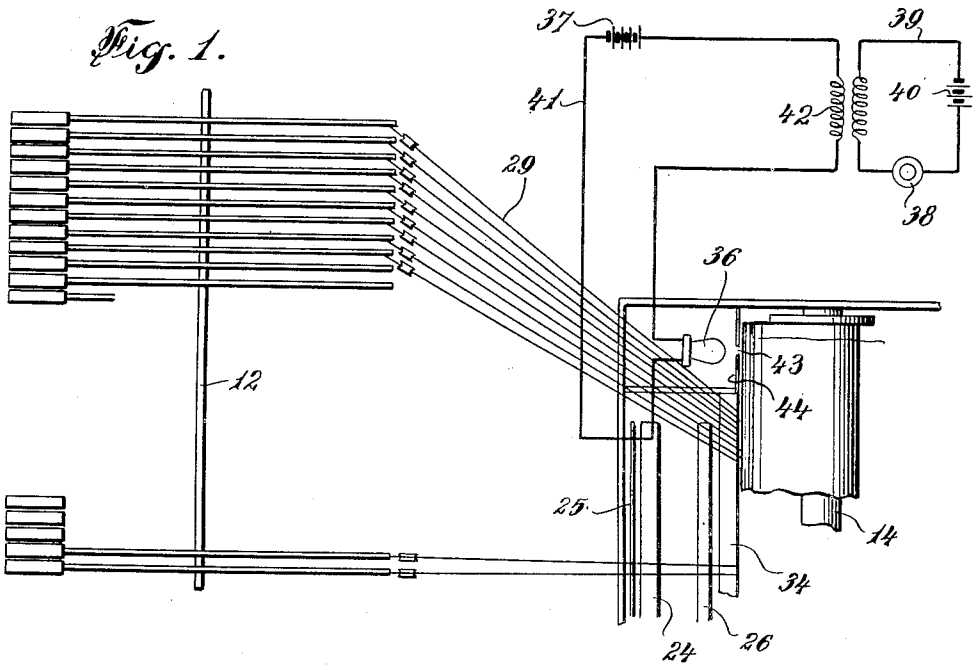


Fig. 4.

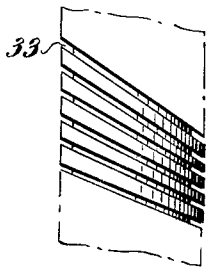
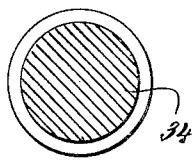
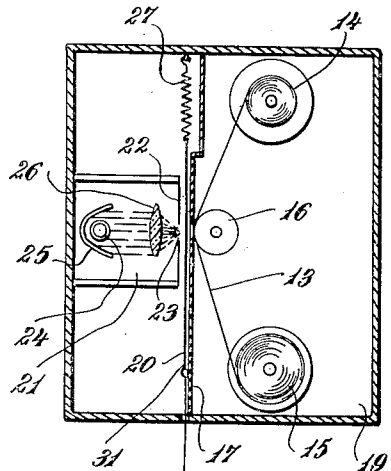


Fig. 5.





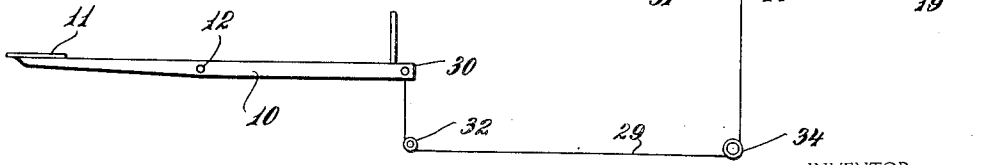


Fig. 2.

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METHOD OF AND APPARATUS FOR PRODUCING SYNCHRONIZED RECORDS

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Fig. 7.

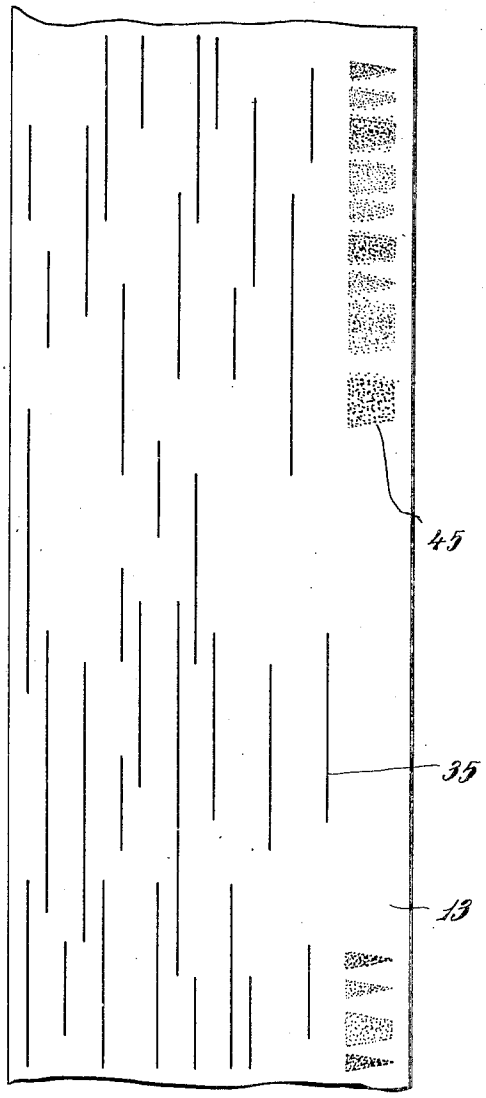


Fig. 8.

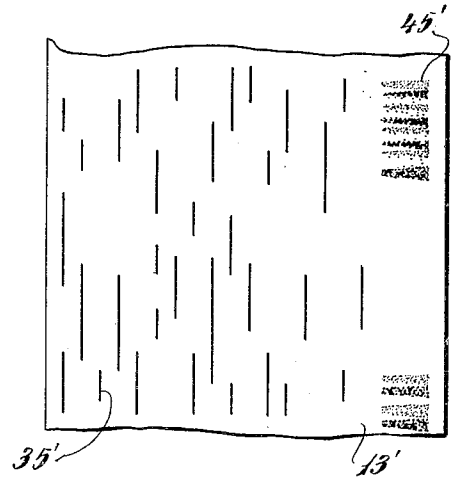
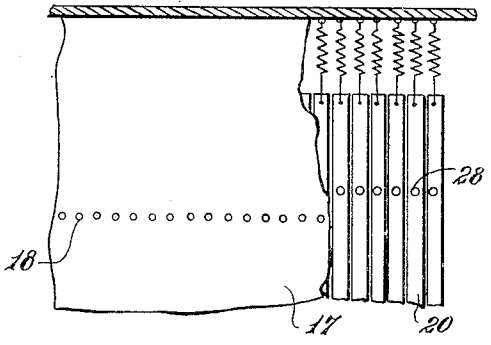


Fig. 3.



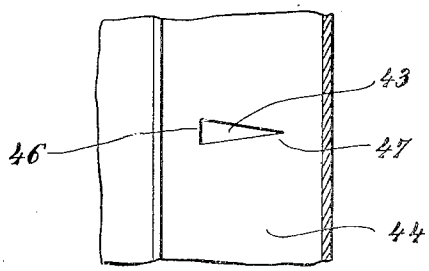


Fig. 6.

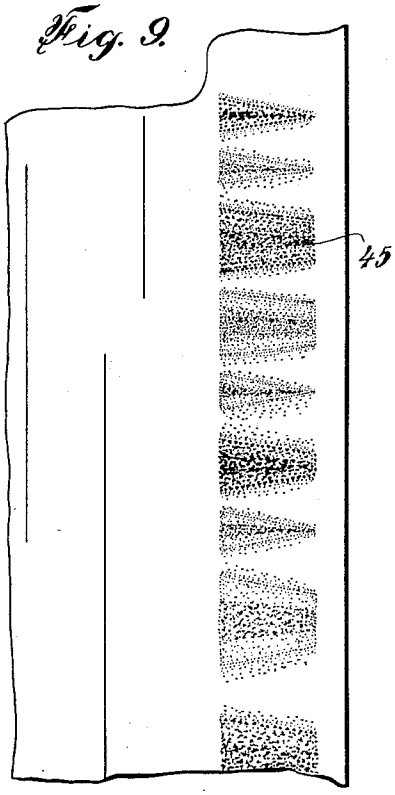
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METHOD OF AND APPARATUS FOR PRODUCING SYNCHRONIZED RECORDS

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Fig. 9.



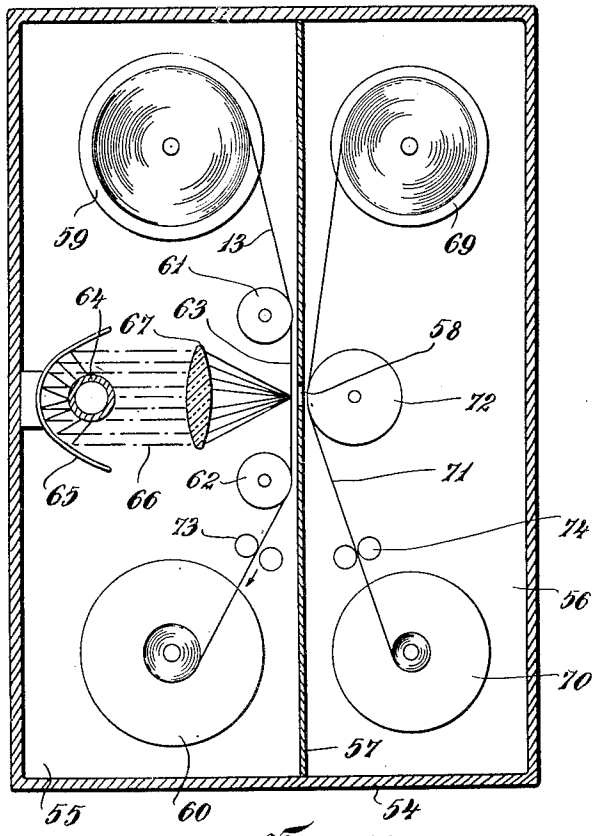


Fig. 12.

Fig. 11.

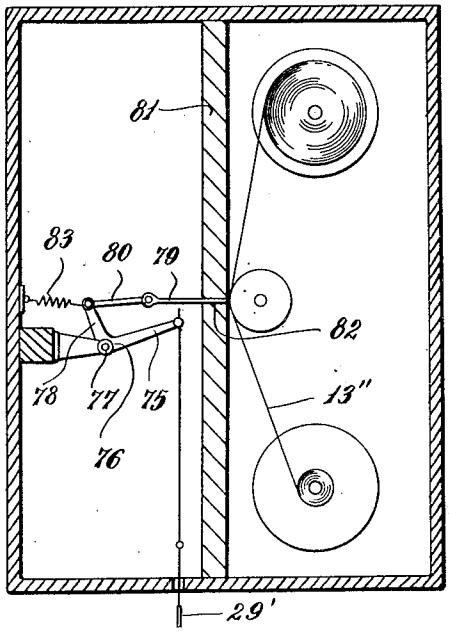
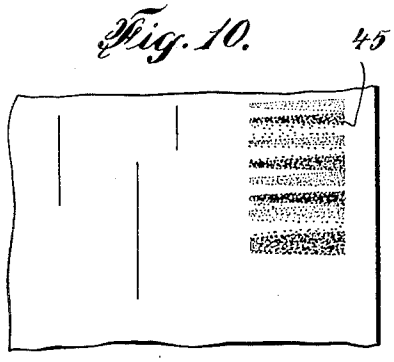


Fig. 10.



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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR PRODUCING SYNCHRONIZED RECORDS

Arthur Edward Zoppa, New York, N. Y.

Application July 24, 1929, Serial No. 380,648
Renewed July 15, 1933

22 Claims. (Cl. 84—461)

This invention relates to the art of reproducing music and more particularly refers to improvements in methods of and apparatus for producing player piano and similar records synchronized with sound records of orchestral or other accompanying music, whereby concert effects can be reproduced at will.

The primary object of this invention is to provide a novel and improved method of simultaneously recording music played upon a key operated instrument such as a piano, and accompanying music such as that of an orchestra or of the human voice for the purpose of producing a sound record adapted to control an audio-frequency circuit for the purpose of transforming the current variations in said circuit into sounds in accompaniment to the music produced by the player piano record.

Another object is to provide a method of producing a musical record as above specified, in which the sound record of the music played in accompaniment to the piano or similar music is obtained by suitable photo-electric means on the same web or on a web different from that upon which the piano music is recorded.

A further object is to provide a novel and improved method of producing a sound record, whereby the music is first translated into a master record which is caused to travel at a speed greater than the operating speed of a record used for reproducing music, said master record being then translated into another record which is caused to travel at the ordinary operating speed.

A still further object is to provide a photoelectric method of producing music obtained by playing a piano or like instrument, whereby a photographic master record may be obtained, said record being suitable for further translation into perforated records of the ordinary type.

An additional object is to provide novel and improved apparatus of a simple design whereby my method of producing music records may be carried into practice.

Other objects and advantages of the present invention will more fully appear as the description proceeds and will be set forth and claimed in the appended claims.

In another pending application entitled Musical record and method of producing same, Serial No. 272,775, I have described and claimed a new type of record in which an ordinary player piano record is combined and synchronized with a sound record adapted to produce or induce pulsating currents in an electric circuit.

In another pending application, entitled Apparatus for musical reproductions, Serial No. 272,774, I have furthermore described and claimed a player piano especially adapted for use in connection with musical records above mentioned, said player piano being equipped with means for controlling a loud speaker circuit in cooperation with a sound record associated with the player piano record.

My application #272,775, relates more especially to a record in which the piano music and the accompanying music are recorded upon the same web, said records being synchronized and producing a concert effect when the record is caused to travel at the proper reproducing speed.

The method forming the subject of the present invention can be applied in connection with records of this character and can equally well be applied in connection with records in which the electric sound record is obtained on a web separate from the piano record proper.

When the two records are produced upon two separate webs, it is obvious that the two webs can be made to travel at different speeds when in operation, although their respective records must always play in unison; this simply means that the record marks will be distributed along the webs in accordance to the relative speeds at which the webs are to be operated.

It is also obvious that while the electric sound record may be of the photoelectric type, the method can be applied equally as well when a magnetic sound record is produced upon a strip made of a metal possessing the necessary magnetic properties.

Practical considerations make it desirable to produce musical records of the character specified in a manner permitting of these records being played at speeds such as are now ordinarily employed in player piano instruments, or at speeds which may be somewhat greater but not excessively so as to require considerable departures in instrument manufacturing and operating practice.

To make this point clear, it will be observed that the frequencies used in radio transmission practice vary from 30 to 3500 and that for the majority of the musical tones employed in musical compositions, frequencies varying from 30 to 2000 would provide a sufficient range for records to be used in reproducing instruments.

If the electric sound record is of the photoelectric type consisting of minute lines one thousandth of an inch thick and one thousandth of inch apart, one inch of record is sufficient to produce five hundred variations and therefore a speed of four inches per second would be sufficient to produce the 2000 variations.

The normal operating speed of a player piano record is from two to three inches per second, and if the piano record is made so that it can be operated at a somewhat higher speed, the photoelectric sound record may be carried by the same web.

On the other hand, it is possible to produce the electric sound record on a different web and

to simultaneously operate the two records at different translatory speeds if desired. This condition may actually have to be met in practice if the electric sound record is of the magnetic kind because the magnetic impressions cannot be produced in as close a series as photoelectric impressions.

As an assertion which applies generally to all types of records however, it may be stated that it is desirable to maintain the length of the record within limits as short as may be consented by ordinary practice; on the other hand, the resulting closeness to one another of the resulting sound impressions, constitutes a serious bar to the production of the original records without detriment to the clarity of the sounds reproduced thereby.

In order to prevent confusion and overlapping of sound impressions it is therefore desirable to use higher speeds when an original or master record is produced, so that the sound impressions will be spaced a greater distance from each other. This greatly enhances the clarity and correctness of the record produced, and this remark applies equally as well to the production of player piano records and to that of electric sound records.

However, if a master record is obtained at a speed greater than the operating speed of reproduction, it will be necessary to use said master record for the production of other records which may be used at a lower or normal speed. The latter records will in their turn retain the clarity and faithfulness of reproduction of the master record, due to the proper spacing and distinct impressions of the sound variations.

This method of producing record may to a certain extent be compared to that ordinarily followed in the production of photo-engraving where a large drawing or picture is reduced in size so as to obtain fine details and lines which could be obtained if the original drawing or picture where made in the size of the reproduced drawing or picture.

My invention will be more clearly understood by referring to the accompanying drawings, in which:

Fig. 1 is a fragmentary plan view in diagrammatic form of the keyboard of a piano and master record producing device controlled thereby together with a microphone circuit for the production of a photographic sound record of music accompanying that of the piano;

Fig. 2 is a view in elevation of the same in diagrammatic form illustrating the production of the master record of the piano music;

Fig. 3 is a fragmentary rear view in elevation of the diaphragm and shutters employed in producing the master record of the piano music;

Fig. 4 is a fragmentary plan view in an enlarged scale of the guiding means for the flexible connections between the piano keys and the shutters;

Fig. 5 is an end view in elevation thereof;

Fig. 6 is a detail view in elevation in an enlarged scale illustrating a special type of opening which may be used for producing a photographic master sound record of the music played in accompaniment to the piano;

Fig. 7 is a fragmentary plan view of a master record produced according to the method illustrated in Figs. 1 and 2;

Fig. 8 is a fragmentary plan view of a secondary master record obtained therefrom, for the production of records to be operated at normal or reduced speed;

Fig. 9 is a fragmentary plan view in an enlarged scale illustrating a type of master sound record produced by using the opening shown in Fig. 6;

Fig. 10 is a plan view of a secondary master record obtained therefrom for the production of records operated at normal or reduced speed;

Fig. 11 is a fragmentary side sectional view of a mechanical recording device which may be used in place of the photographic recording device shown in Figs. 1 and 2; and

Fig. 12 is a side sectional view in diagrammatic form of a device which may be used for producing an auxiliary master record at reduced speed of the type shown in Fig. 8, from an original master record of the type shown in Fig. 7.

In the embodiment of my invention, in Figs. 1, 2, 3, the player piano record and the auxiliary sound record synchronized therewith are produced upon the same web, the production of the original master record of the piano music being mechanically controlled by the piano keys.

In said drawings, the piano keys are represented by levers 10 provided with a key portion 11, said levers being pivotally mounted at 12. The master record of the piano performance is produced upon a web 13 which may be caused to travel at a certain speed from a supply roll 14 to a take-up roll 15, said web passing over a guiding roller 16 directly behind a diaphragm 17 which is provided with a series of small spaced openings 18 distributed along a line parallel to the axis of guide roller 16.

In the method illustrated the web 13 is provided with a sensitized surface which may be affected by rays of light and therefore said web and rolls 14, 15 are enclosed in a receptacle 19 forming a dark chamber.

Openings 18 correspond in number to the keys of the piano and are distributed along the width of the master record of the piano music to be produced, this width corresponding to that of the records to be ultimately obtained for actual use in a suitable reproducing instrument.

In front of diaphragm 17 and spaced therefrom a small distance sufficient to permit the passage of a plurality of individual shutters 20, is placed a light chamber 21, the inner wall 22 of which is provided with an elongated slot or with a series of openings 23 directly opposite openings 18 in diaphragm 17.

A suitable source of light, for instance an elongated lamp or tube 24, is placed within chamber 21 in correspondence of slot or openings 23 or a certain distance therefrom.

The light generated by said lamp is preferably concentrated upon slot or openings 23 by means of a parabolic reflector 25 placed behind the lamp and a condensing lens 26 placed between the lamp and slot or openings 23 as shown.

A shutter 20 is provided for each opening 18 and said shutters normally prevent the rays of light issuing through slot or openings 23 from reaching openings 18, said shutters being maintained in their normal closing position by individual tension springs 27.

Said shutters are each provided with an opening 28 adapted to register with slot or openings 23 and the corresponding opening 18 when one or the other of said shutters is lowered so as to bring this opening 28 in line with the corresponding opening 18.

When this is done, the sensitized surface of web 13 will be affected by the ray of light reaching it through the opening 18 opposite the shutter

which has been lowered, and as a result, a dot or line will be imprinted upon the surface of web 13, according to whether the shutter is left in its lower position for only an instant or for a certain length of time, the length of the line thus produced being, of course, a function of the speed of the web as well as of the time of exposure.

The operation of shutters 20 is controlled by the piano keys by means of individual flexible member such as 29 connecting the rear end 30 of each lever 10 to the lower end 31 of the corresponding shutter.

Flexible connections 29 are arranged in a series converging from levers 10 to points directly underneath the shutters, as shown in Fig. 1, and suitable means are therefore provided for guiding said flexible connections.

For instance, each flexible connection may first run downwardly to a guiding pulley 32, then rearwardly and inwardly to a groove such as 33 (see Figs. 4 and 5) provided in a horizontal bar 34 arranged directly underneath the series of shutters. Each flexible connection runs then upwardly from said bar to the shutter to be operated thereby, as shown in Fig. 2.

By virtue of this construction therefore, when any one key is depressed its corresponding shutter is lowered to operative position against the action of its corresponding spring 27, and said shutter will remain in said position as long as the key remains depressed.

Music played on the piano board will therefore result in the production of a plurality of laterally spaced longitudinal series of dots and lines upon web 13, such as illustrated at 35 in Fig. 7.

One of the marginal portions of web 13 is reserved for the production of the auxiliary sound record for recording orchestral or voice music which is being played at the same time. The drawings illustrate the production of a photographic sound record recording the variations of the light produced by a suitable light source controlled by a microphone circuit.

This illustration is given by way of example since it is obvious that other methods of production of a sound record can be used. In the arrangement illustrated one of the marginal portions of web 13, which as stated, has a sensitized surface, is caused to pass in front of a source of light 36 which may be a luminous gas discharge or glow lamp energized by any suitable source of current, for instance, a battery 37. 38 designates the transmitter or microphone which is inserted in a closed circuit 39 with a source of current 40.

Lamp 36 is of the type adapted to produce a light of varying intensity according to the fluctuations produced in its circuit 41. The microphone circuit is inductively associated through a transformer coil 42, with circuit 41, so that the sound waves reaching the microphone give occurrence to pulsating currents which affect the closed circuit 41 of lamp 36, thereby causing slight variations in the current flowing therethrough which produce variations in the intensity of the light generated by the lamp. Lamp 36 is placed directly in front of a transversal opening 43, provided through a diaphragm 44, which is interposed between the lamp and the web 13. The light emanating from lamp 36 is, therefore, recorded upon the sensitive surface in the form of a continuous succession of varying light exposures as shown at 45 in Fig. 9; the intensity of said exposures being in accordance with the sound waves induced in the microphone circuit by the instrument or voice, the sound of which is to be reproduced by the photographic sound record.

The specific arrangement described for recording fluctuations taking place in the current induced by a microphone circuit however is only intended as an illustration of a possible way of producing a photographic sound record. This arrangement is not of itself a part of the present invention except in a generic sense and it will be understood that any other suitable arrangement may be used.

Insofar as the piano music record is concerned, both the length of each sound impression and the distance separating successive sound impressions in the same longitudinal series are a function of the speed at which web 13 is made to travel; and in a similar manner the distance between successive sound impressions 45 is also a function of said speed.

As stated above, the speed at which the master record is produced should preferably be materially higher than the speed at which records are operated in an ordinary player piano; I have found that in practice a speed of 80 to 100 ft. per minute is desirable for the faithful recording of all sound vibrations, while player piano records are operated at speeds which are considerably lower.

In Fig. 7, I illustrate a master record obtained at relatively high speed; it is obvious that in order to obtain a record which can be played at ordinary speed, it will be necessary to proportionately reduce the length and the relative distance between the various sound impressions in a longitudinal sense.

An illustration of an auxiliary master record produced by means of a reducing process from an original master record is given in Fig. 8 where 13' designates the auxiliary master record containing impressions 35', corresponding to the piano music record and impressions 45' corresponding to the photographic sound record.

This auxiliary master record may be used for subsequently producing in any suitable manner actual records to be played; for instance, the dots and lines 35' may be reproduced in the form of slots of corresponding lengths, while the sound impressions 45' may be reproduced by a photographic process.

It will be observed that the width of auxiliary master record 13' is the same as that of original master record 13, the reduction taking place in a longitudinal sense only. This reduction may be produced in any suitable manner, for instance, by employing the method and apparatus schematically shown in Fig. 12.

In said figure, 54 designates a chamber divided into a light compartment 55 and a dark compartment 56 by a partition 57 which is provided with a transversal slot or series of openings 58 corresponding in length to the width of records 13, 13'.

The original master record 13 is caused to travel within the light chamber from a supply reel 59 to take-up reel 60 at a certain predetermined speed, said record being caused to pass over guiding rollers 61, 62 maintaining an intermediate portion 63 of said record directly in front of slot or openings 58.

A suitable source of light, for instance, a luminous tube 64 is placed at the rear of record 13 in a position where the light generated thereby

will be directed against that portion of said record which is directly opposite slot or openings 58. For instance, lamp or tube 64 may be placed in the focus of a parabolic reflector 65 which will direct a beam of parallel rays of light 66 against a condensing lens 67 introduced between said lamp and reflector and central portion 63 of record 13.

Lens 67 in its turn will concentrate the rays of light towards slot or openings 58, thus producing an intense illumination of the markings upon the record web as they pass in front of slot or openings 58.

In a similar manner, within the dark compartment 56 is mounted a sensitized web 68 which is used to produce the auxiliary master record 13', said web being caused to travel from a supply reel 69, to a take-up reel 70 at a certain predetermined speed which is lower than the speed at which a record 13 is caused to travel in the light compartment; the ratio between the two speeds being a function of the ratio between the speed at which the master record has been produced and the speed at which the playing record will have to be operated.

An intermediate portion 71 of web 68 is caused to pass over a roller 72 directly opposite to slot or openings 58, so that the two webs will travel simultaneously in the same direction but at different speeds, their intermediate portions passing in close proximity of slot or openings 58.

It is obvious that in this manner, the markings of web 13 will be photographically transferred onto web 68, the length of markings 35 and the distance separating said markings 35 and markings 45 however, being reduced in proportion to the speed ratio.

The movement of the two webs may be caused in any suitable manner as will be understood; in practice, it may be preferable to cause each web to travel at a uniform speed, this making it easier to maintain a definite ratio between the two speeds, and to this end a set of feed rollers 73 is shown in the drawings for advancing web 13 and a similar set of feed rollers is shown for advancing web 68.

It will be understood that both the original master record and the auxiliary master record will be subjected to proper chemical treatment in order to insure their permanency as is customary in the production of photographic films after use.

In processes of photographic sound recording heretofore in use, opening 43 has usually been made in form of an exceedingly narrow slot the width of which is usually one-thousandth of an inch. For the distance of one-thousandth of an inch between successive sound impressions, it is, therefore possible to produce five hundred impressions per running inch; for frequencies of up to two thousand, therefore, it is necessary to run the recording web at a speed of six inches per second.

In the present case, however, I use considerably higher speeds for the production of the original master record, and, therefore, I can use a wider slot. When the slot has a uniform width from end to end, however, distortions and overlappings of successive sound impressions may take place, due to the higher frequencies which are occasionally produced and due to the overtones; the clarity of the rendition is, therefore, seriously affected.

On the other hand, in the process of record production described it is desirable to use a relatively wide slot for the production of the original master record, this permitting a more clearly defined impression when the auxiliary master record is produced.

I have, therefore, conceived the idea of making opening 43 triangular in form, the same being relatively wide at one end 46 and terminating in an apex 47 at the other end. By virtue of this arrangement the normal frequencies are recorded throughout the entire length of the slot, while the higher frequencies and the overtones will also be recorded at the pointed end.

The successive sound impressions 45 are not, of course, sharply defined or separated from one another; rather, they merge into one another forming a continuous band varying in intensity in a longitudinal sequence without sudden or sharp changes.

In this manner both the tones and overtones will be clearly recorded, and when the original master record is transferred to the auxiliary master record the clarity of the record is maintained, although the various sound impressions will be narrower and closer to one another as shown at 45'. Said sound impressions, however, will have a greater unitary intensity than the original impressions 45, due to their relatively more prolonged exposure.

Markings or impressions 35 can also be produced mechanically instead of photographically if desired; for instance, in Fig. 11 I show an arrangement where each flexible element 29' is connected to the arm 75 of a crank lever 76 pivotally mounted at 77 said crank lever being provided with another upwardly directed arm 78, which is connected to a stylus 79 by a connection 80.

Instead of partition 17 provided with openings 18 as shown in Fig. 3, in the present instance, I use a partition 81 provided with a series of openings 82 through which are inserted styluses 79. By virtue of this arrangement, each time that a key is depressed as shown in Fig. 2, its corresponding crank lever 76 connected thereto by a flexible element 29' will be moved a certain angle in a clockwise direction against the action of a spring 83. The point of the corresponding stylus 79 will therefore be forced against the sensitized surface of web 13'' and will scratch the sensitized coating thereof.

If the sensitized web is at the same time or subsequently exposed to the action of light, a developing process will cause the scratches to appear as white lines against a dark background, whereas when the photographic process illustrated in Figs. 1 and 2 is used, the web or film is not exposed to light and the markings will result in the form of black lines against a transparent background.

In either case, the subsequent reduction to the form of auxiliary master records can be made according to the method illustrated in Fig. 12 while the method of producing playing records from the auxiliary master record is a matter of the proper selection of means which are well known and which do not involve invention.

From the foregoing it will be seen that I provide a method of producing records of piano and accompanying music, whereby a perfect synchronization may be obtained; said method being furthermore preferably applied while employing a recording speed greater than the operating speed, and reducing the master record obtained at the higher speed to a form usable at the lower

operating speed, in order to increase the artistic value of the record thus produced.

It is obvious that broadly my invention is not limited in its scope to the methods and means of production shown and described; its most important feature being the provision of a method of producing synchronized records of piano and accompanying music, whereby the original records of both the piano music and the accompanying music are produced at the same time irrespective of the means employed.

The drawings will therefore be understood as being intended for illustrative purposes only and not in a limiting sense. Accordingly, I reserve the right to carry my invention into practice in all those ways and manners which may enter, fairly, into the scope of the appended claims.

I claim:

1. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in producing while mechanically controlling its production, a record of the key action of the key operated instrument, at the same time producing a record of the electrical variations induced in a microphone circuit by the accompanying music.

2. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in producing a mechanically controlled photographic record of the key action of the key operated instrument, at the same time producing a record of the electrical variations induced in a microphone circuit by the accompanying music.

3. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in mechanically controlling the production of a record of the key action of the key operated instrument, at the same time producing a photographic record of the electrical variations induced in a microphone circuit by the accompanying music.

4. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in producing a photographic mechanically controlled photographic record of the key action of the key operated instrument, at the same time producing a record of the electrical variations induced in a microphone circuit by the accompanying music.

5. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in mechanically controlling the production of a record in web form of the key action of the key operated instrument, at the same time producing a record of the electrical variations induced in a microphone circuit by the accompanying music, on the same web.

6. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in mechanically controlling the production of a record in web form of the key action of the key operated instrument, at the same time producing a photographic record of the electrical variation induced in a microphone circuit by the accompanying music, on the same web.

7. The method of recording music such as produced by a key operated instrument and accompanying music, which consists in producing a photographic mechanically controlled photographic record in web form of the key action of the key operated instrument, at the same time producing a record of the electrical variations induced in a microphone circuit by the accompanying music, on the same web.

8. In a method of producing a record roll of music such as produced by a key operated instrument and accompanying music, the step which consists in producing a mechanically controlled original master record in web form, of the key action of the key operated instrument, at a speed higher than the operating speed of a record roll to be produced thereby, at the same time producing an original master record of the electrical variations induced in a microphone circuit by the accompanying music, on the same web, then transferring the sound impressions of both said original master records onto an auxiliary master record from which said record roll may be obtained, said sound impressions and the distances therebetween being transferred in a reduced longitudinal ratio, said ratio being a function of the difference between the original master record producing speed, and the record roll operating speed.

9. In a method of producing a record roll of music such as produced by a key operated instrument and accompanying music, the step which consists in producing a mechanically controlled original master record in web form, of the key action of the key operated instrument, at a speed higher than the operating speed of a record roll to be produced thereby, at the same time producing an original photographic master record of the electrical variations induced in a microphone circuit by the accompanying music, on the same web, then transferring the sound impressions of both said original master records onto an auxiliary master record from which said record roll may be obtained, said sound impressions and the distances therebetween being transferred in a reduced longitudinal ratio, said ratio being a function of the difference between the original master record producing speed, and the record roll operating speed.

10. In a method of producing a record roll of music such as produced by a key operated instrument and accompanying music, the step which consists in producing a mechanically controlled original photographic master record in web form, of the key action of the key operated instrument, at a speed higher than the operating speed of a record roll to be produced thereby, at the same time producing an original photographic master record of the electrical variations induced in a microphone circuit by the accompanying music, on the same web, then transferring the sound impressions of both said original master records onto an auxiliary master record from which said record roll may be obtained, said sound impressions and the distances therebetween being transferred in a reduced longitudinal ratio, said ratio being a function of the difference between the original master record producing speed, and the record roll operating speed.

11. In a method of producing a record roll of music such as produced by a key operated instrument and accompanying music, the step which consists in producing a mechanically controlled original photographic master record in web form, of the key action of the key operated instrument at a speed higher than the operating speed of a record roll to be produced thereby, at the same time producing an original photographic master record of the electrical variations induced in a microphone circuit by the accompanying music,

on the same web, and photographically transferring the sound impressions of both said original master records, onto an auxiliary master record from which said record roll may be obtained, while said original master record is caused to travel at a given speed, and said auxiliary master record is caused to travel in the same direction at a lower speed, the difference between the speeds of said master records being a function of the difference between the original master record producing speed, and the record roll operating speed.

12. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of means operatively associated with the keys of said keyboard for recording the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously recording the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

13. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of means operatively associated with the keys of said keyboard for producing a photographic record of the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously recording the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

14. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of means operatively associated with the keys of said keyboard for recording the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously producing a photographic record of the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

15. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of means operatively associated with the keys of said keyboard for producing a photographic record of the key action of music played upon said instruments, a microphone circuit, and means associated with said circuit for simultaneously producing a photographic record of the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

16. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of a record web, means for continuously advancing said web in a given direction, means operatively associated with the keys of said keyboard for recording upon said web, the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously recording the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

17. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of a record web, means for continuously advancing said web in a given direction, means operatively associated with the keys of said keyboard for recording upon said web, the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously recording upon the same record web the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

18. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of a record web having a sensitized surface, means for advancing said web in a given direction, means operatively associated with the keys of said keyboard for producing upon said web a photographic record of the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously producing, upon the same record web, a photographic record of the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

19. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of a record web, means for continuously advancing said web in a given direction, at a speed higher than the normal operating speed of an ordinary player piano record, means operatively associated with the keys of said keyboard for recording upon said web, the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously recording the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

20. In apparatus of the class described the combination, with a musical instrument comprising a keyboard, of a record web having a sensitized surface, means for advancing said web in a given direction, at a speed higher than the normal operating speed of an ordinary player piano record, means operatively associated with the keys of said keyboard for producing upon said web a photographic record of the key action of music played upon said instrument, a microphone circuit, and means associated with said circuit for simultaneously producing, upon the same record web, a photographic record of the electrical variations induced in said circuit by music played in accompaniment to said instrument music.

21. In apparatus of the class described the combination, with a record web, having a sensitized surface, of means for advancing said web in a given direction at a speed higher than the normal operating speed of an ordinary player piano record, and means for simultaneously producing, upon said web, while travelling at said speed, a record of the key action of music played upon a keyboard operated instrument, and a photographic record synchronized therewith, of music played in accompaniment thereto.

22. In apparatus of the class described the combination, with a record web, having a sensitized surface, of means for advancing said web in a given direction at a speed higher than the normal operating speed of an ordinary player piano record, and means for simultaneously producing, upon said web, while travelling at said speed, a photographic record of the key action of music played upon a key board operated instrument, and a photographic record synchronized therewith, of music played in accompaniment thereto.

ARTHUR EDWARD ZOPPA.