C. F. STODDARD.

METHOD OF RECORDING MUSIC.

APPLICATION FILED NOV. 12, 1910. RENEWED JULY 14, 1920.

1,367,634. **Patented Feb. 8, 1921.**

2 SHEETS—SHEET 1.

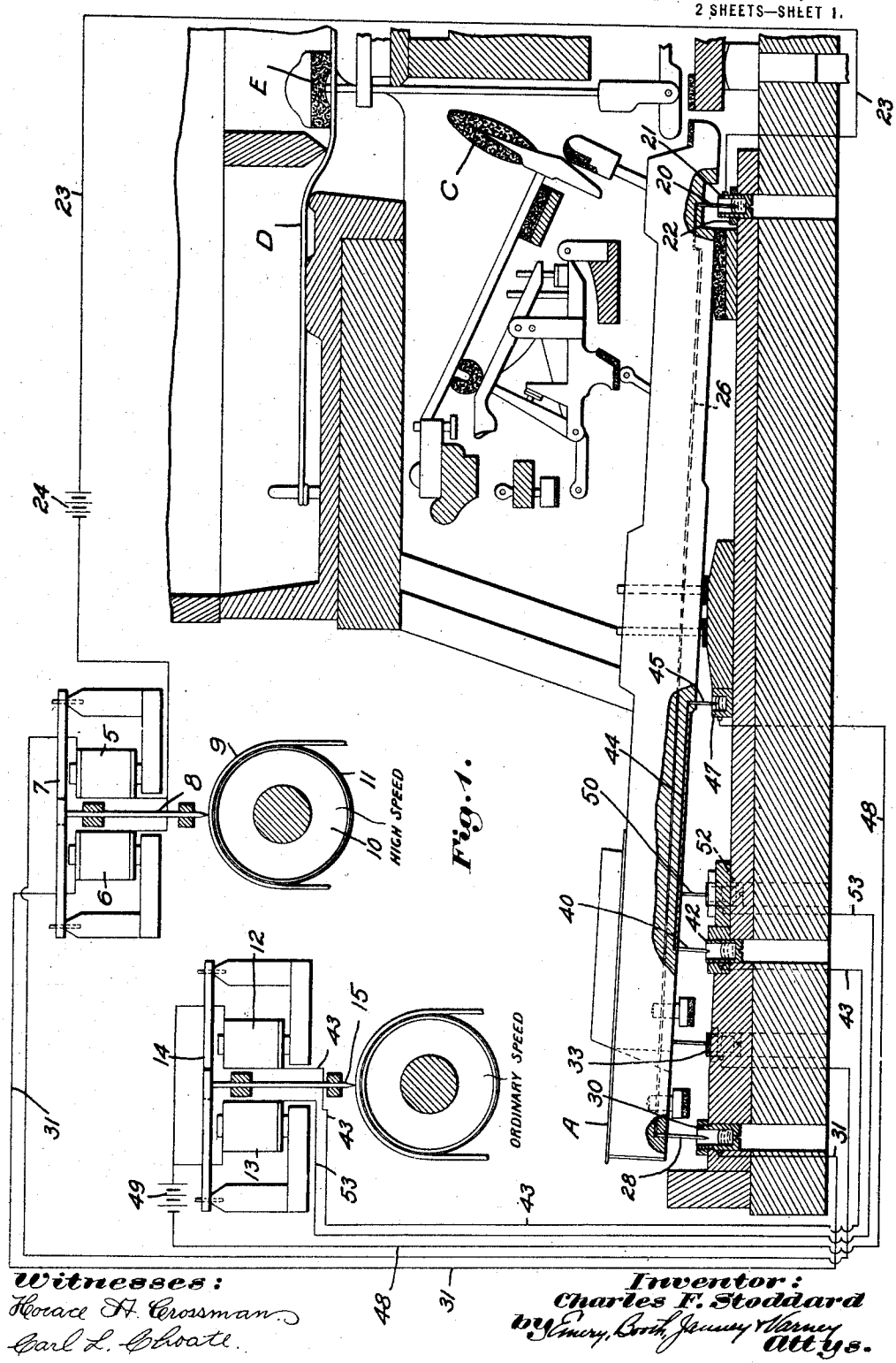


Fig. 1.

Witnesses:
Horace H. Crossman
Carl L. Choate.

Inventor:
Charles F. Stoddard
by Emery, Booth, Jenney & Varney
Attys.

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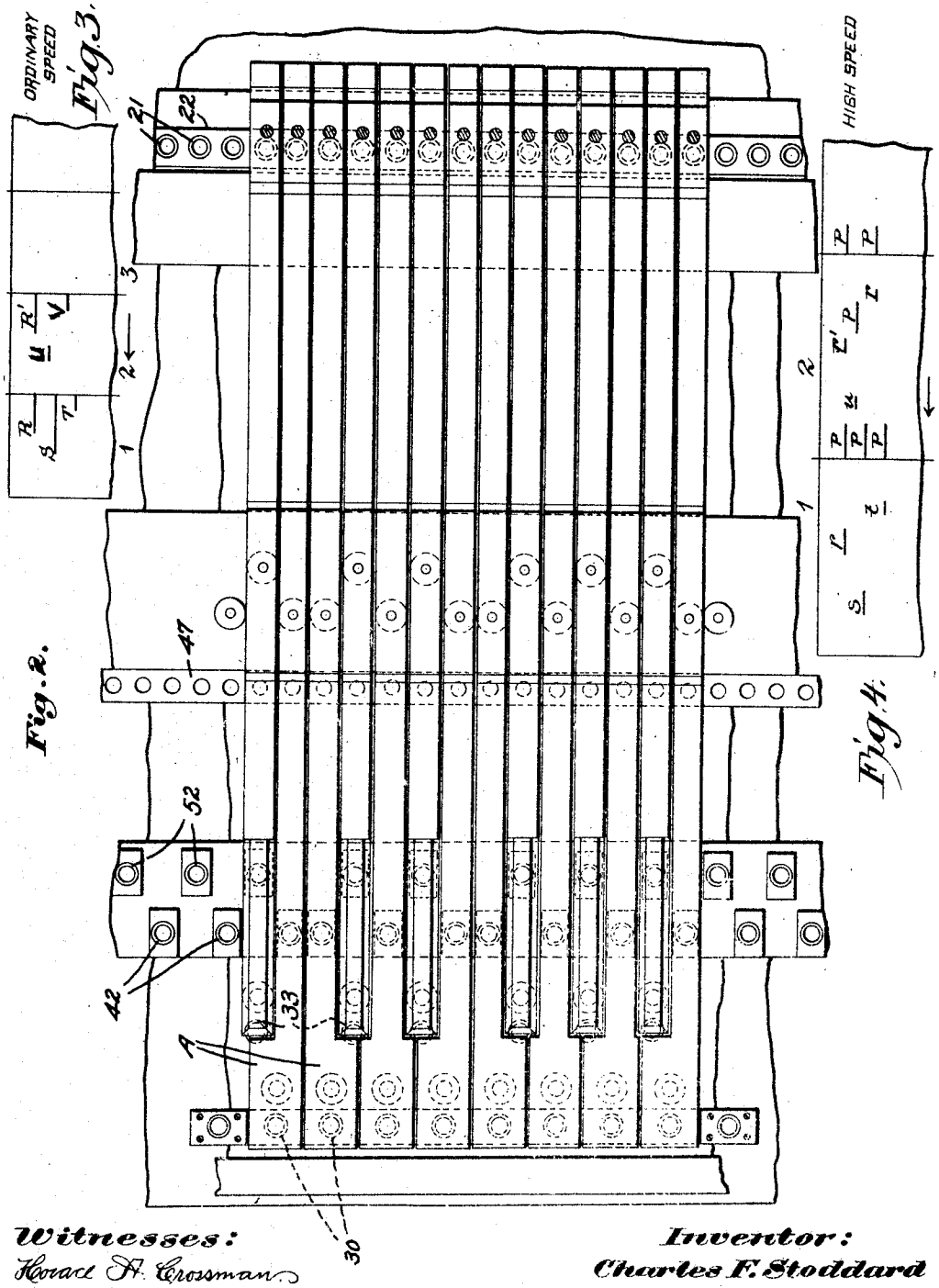


Fig. 3.

Fig. 4.

Fig. 2.

Witnesses:

Horace F. Crossman

Earl L. Sloate

Inventor:

Charles F. Stoddard

by Emery, Booth, Janney & Varney

Att'ys.

UNITED STATES PATENT OFFICE.

CHARLES F. STODDARD, OF NEW YORK, N. Y.

METHOD OF RECORDING MUSIC.

1,367,634. Specification of Letters Patent. Patented Feb. 8, 1921.

Application filed November 12, 1910, Serial No. 592,014. Renewed July 14, 1920. Serial No. 396,337.

To all whom it may concern:

Be it known that I, CHARLES F. STODDARD, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented an Improvement in Methods of Recording Music, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to a method of recording the characteristics of musical notes and groups of notes, including, if desired, duration, tempo and features of expression.

The character of the invention may be understood readily by reference to an illustrative method, described herein for convenience as practised by means of a suitable form of apparatus shown in the accompanying drawings, in which—

Figure 1 is a vertical section of a keyboard of a grand piano, showing a white key and an ordinary unit of the action in side elevation, and showing also diagrammatically, recording mechanisms and electrical connections therewith; and

Fig. 2 is a fragmentary plan view of the keyboard shown in Fig. 1, the piano action and other parts being omitted for simplification.

Fig. 3 shows a fragment of a record of the durations and intervals between successive notes;

Fig. 4 shows a fragment of a record of features of expression of the notes recorded in Fig. 3.

Referring to Fig. 1, a typical action is shown in its normal position of rest. When the key A is depressed the action throws the hammer C up to strike a string B, at the same time lifting the damper E out of contact with the string.

Obviously, any practicable action may be used in conjunction with other elements in the practice of the illustrative method.

Each key carries a number of contacts, which are divided into two groups; one group controlling a recording mechanism which makes a record of features of expression; and the other group controlling a second recording mechanism which makes a record of other note characteristics such as duration and intervals between successive notes. It is preferred thus to employ separately controlled recording mechanisms for several reasons; for instance, an expression record for one note of a given loudness is desired to be differentiated as much as possible from an expression record of another note only slightly louder than the first. If, for illustration, the intensity of one note be represented by a straight line of a certain length, it is desirable than even a minutely different intensity of another note be represented by another line having a difference in length from the first line, as great as it is practicable to procure. This purpose is well served by having intensity lines drawn by styli upon a moving sheet of paper; and if the paper moves at high speed all of the lines made by the styli will be long and readily differentiated.

For the reasons just described, it is preferred to have an expression recording mechanism provided with rapidly moving record-receiving material. At the same time it is a substantial convenience in manufacturing perforated note sheets or the like from a record of duration and kindred characteristics, to have the note records of substantially the same length as the perforations to be made for the respective notes. For instance, it is convenient that a note of a given duration be recorded by a line having the same length as the perforation by which the note of such duration is to be reproduced. This purpose may be served by having the record sheet of the duration-recording mechanism move past its styli at substantially the same rate of speed at which a perforated note sheet made from such record will be moved past the tracker of a reproducing instrument.

Thus, by providing two separately-governed recording mechanisms, it is practicable to record expression characteristics at a high rate of speed, and to record duration and kindred characteristics at a lower rate of speed, more nearly appropriate to the intended speed of reproduction.

Furthermore, the making of two separate records permits one to be verified and checked by reference to the other so that, for example, the accidental omission to make any record pertaining to a given note upon one recording mechanism can be detected by reference to the record of other characteristics of the same note made by the second recording mechanism.

To illustrate practicable means for prac-

tising the features of the illustrative method just suggested, Fig. 1 of the drawings shows an electrically controlled expression-recording mechanism, comprising electromagnets 5, 6, one for each key. Each electromagnet has an armature 7, resting upon the upper end of a stylus 8, the lower end of which rests upon a sheet 9 of paper or other record-receiving material. The record sheet 9 may rest upon a roll 10 and the latter may have upon its periphery a suitable recording medium such, for instance, as a sheet 11 of carbon paper, the record sheet 9 resting directly upon the recording medium 11. The combined weights of the armature 7 and stylus 8 are insufficient to press the record sheet 9 against the recording medium 11 hard enough to make a mark on the former; when, however, the electromagnet 5 is energized and the armature attracted, the stylus forces the record sheet 9 against the recording medium 11 and, so long as the electromagnet 5 remains energized, a line will be made upon the under side of the record sheet 9.

A second recording mechanism is provided, comprising electromagnets 12, 13, armatures 14, styli 15 and a record sheet 16, all of which may be duplicates of the corresponding parts of the expression-recording mechanism. A magnet 12 or 13 is provided for each key of the piano.

As is well understood in the art, the intensity of a note played upon a piano depends upon the force with which the hammer strikes the string; the mass of the hammer being a constant, the force with which the hammer strikes the string is varied by varying the speed of the hammer. The varying hammer speeds are readily measurable by reference to the periods of time of hammer travel, and these varying periods of time are recordable upon the specific expression-recording apparatus shown in the drawings.

In Fig. 3 line R designates by its length the duration of a corresponding note and in Fig. 4 the line r designates by its length the relative intensity with which the same note was sounded. In the same way the lines S, T, U and V designate the duration of notes to which they correspond, and in Fig. 4 the lines s, t, u and v designate the intensity of the tones represented by the lines S, T, U and V respectively. The fragment of the record sheet shown in Fig. 3 is that sheet which is preferably moved past the recording points at the ordinary speed, that is, a speed approximately the speed of an ordinary note sheet as used in a player piano. The fragment of the record sheet shown in Fig. 4 is that which is preferably driven at a higher rate of speed than the record sheet of Fig. 3. In Fig. 4 the intensity record sheet is shown as being driven at twice the speed of the duration record sheet. This is graphically illustrated by the vertical lines dividing these sheets into what may be termed measures. It will be seen that measures 1 and 2 of Fig. 3 take up one-half the space of measures 1 and 2 in Fig. 4, thus indicating that the intensity record sheet is driven twice as fast as the duration record sheet.

It will be seen that the duration of the tone represented by the letter S was greater than the duration of the tone represented by the letter R but by reference to the intensity record it will be seen that the two notes were sounded with the same intensity by reason of the fact that the lines s and r are of the same length. For further illustration it will be seen that the note T was sounded with greater intensity than the notes R and S because the line t is approximately one-half the length of the lines r and s. Similarly notes R′, U and V will, by reference to the intensity lines r', u and v, be seen to have been sounded with a greater intensity than any of the preceding notes. It will be apparent that the louder the tone the more rapid must be the travel of the tone sounding element whose movement is recorded on the sheet of Fig. 4 (in this case the key) and therefore the shorter time interval between the making and the breaking of the contacts controlled by said tone sounding element will cause a shorter line to be drawn on the intensity sheet. The lines R and R′ represent the sounding and re-sounding of the same note. The lines r and r' represent the intensity with which the note was sounded and then re-sounded and indicate that the note was re-sounded with greater intensity. It will be noted that the intensity lines terminate substantially at the point where the duration lines would begin if incorporated in Fig. 4. For example, the sounding of the note indicated by line R begins substantially midway of the measure 1 while the intensity line r terminates substantially midway of measure 1 similarly with the other record lines.

In Fig. 4 the six lines designated by p represent the marks made when the key is released and the circuit is again closed for a moment while the two contact points 20 and 28 are in their mercury baths at the same time, but as heretofore explained these lines p so recorded are disregarded.

The inner end of the key A carries a contact point 20 which, when the key is at rest, projects into a mercury bath in a cup 21. The cups 21 for all of the keys are mounted in the same metallic strip 22, and the latter is connected by a wire 23 through a battery 24 to all of the electromagnets of the expression-recording mechanism. The contact point 20 is connected by a wire 26 embedded in the key with a second contact point

28 carried proximate the front end of the key and arranged to enter a mercury bath in a cup 30. There is a separate cup 30 for each white key, and each cup is insulated from the others and connected by a wire 31 with one of the electromagnets 5 or 6. The arrangement of the black keys may be substantially identical with that just described as pertaining to the white keys except, in the specific apparatus of the drawings, each black key has a cup 33 positioned to the rear of the cups 30 for the white keys.

When the key is at rest, as shown in Fig. 1, the circuit through the expression-recording mechanism is broken between the contact point 28 and the mercury cup 30; when the key is depressed, however, the point 28 enters the mercury bath in the cup 30 and closes the circuit from the battery 24 through the wire 23, mercury cup 21, contact point 20, wire 26 in the key, contact point 28, mercury cup 30, wire 31 to a single electromagnet 6 of the recording mechanism, and thence by a wire 35 back to the battery. This initial closing of the expression-recording circuit preferably occurs at an intermediate stage in the depression of the key, and at such a time as the hammer has attained its maximum speed. For instance, the contact point 28 and mercury cup 30 may be relatively so adjusted that the former will enter the mercury bath of the latter after the key has been depressed say one-fourth of its full downward movement. By the described apparatus this closing of the expression-recording circuit energizes one of the recording magnets and initiates a line on the record sheet 9, and that line continues to be drawn so long as the circuit is maintained.

At a later stage in the depression of the key, and preferably at or about the time the hammer strikes the string, the contact point 20 is withdrawn from the mercury in the cup 21, thereby breaking the circuit and immediately terminating the record line. The line so drawn represents with close approximation the period of time occupied by the hammer in moving from its first recorded position to its last recorded position at or about the time the string is struck. When the key is released the circuit is again closed for a moment while the two contact points 20 and 28 are in their mercury baths at the same time, but the line so recorded is disregarded in the described illustrative expression-recording mechanism.

The preceding description has pertained principally to the recording of expression characteristics. The illustrative apparatus comprises also means whereby a second recording mechanism may be controlled by the key to record duration, tempo, etc.

Each white key is provided with a contact point 40, adapted to enter the mercury bath of a cup 42. Each such cup is insulated and connected by a wire 43, with one of the electromagnets 12 or 13 of the note recording mechanism. The contact point 40 is connected by a wire 44 with a second contact point 45 upon the same key. The point 45, in the specific apparatus, projects constantly into the mercury bath of a cup which is drilled in a metal strip 47 extending under all of the keys, the operation of which is to be recorded. A wire 48 connects the strip 47 through a battery 49 with all of the electromagnets of the note recording mechanism. Each black key has a contact point 50 to enter a mercury bath in an insulated cup 52, the point 50 and its cup 52 exactly corresponding to the point 40 and cup 42 for each white key. Likewise, the contact point 50 of each black key is connected by a wire on the key with a contact point 45 projecting into one of the cups of the strip 47. A wire 53 leads from each cup 52 to one of the magnets 12 or 13.

With the described arrangement the circuit is made and broken only between a contact point 40 or 50 and its mercury cup. Preferably the circuit is made during depression of the key at substantially the time that the hammer C hits the string and initiates the sounding of a note. The circuit being so made, the recording mechanism starts a line on the record sheet at substantially the moment the note begins. This line continues so long as the circuit is closed between the point 40 and cup 42, by depression of the key. When the key is again elevated the circuit is broken, preferably at substantially the moment the damper damps the vibration of the string to terminate the sounding of the note. This breaking of the circuit terminates the recorded line at substantially the moment the note ceases to sound. In this manner an accurate record of the duration of the note may be procured, and, as already stated, the recording operation may be conducted at such speed that the record line shall be of substantially the same length as a perforation by which the note is to be reproduced with the same duration.

If the same key is struck twice in succession, the termination of the first duration line marks the beginning of the time interval between the first and the second notes sounded by the key; and the beginning of the second duration line indicates the end of said interval. Accordingly, note records made by a plurality of depressions of the key record both the duration of notes and the intervals between successive notes. In like manner, the relative durations of, and intervals between, notes sounded by different keys are duly recorded as will be understood by those skilled in the art.

It is to be understood, of course, that this invention is in no degree limited to the specific apparatus shown in the drawings, or to

any particular construction or organization of apparatus. On the contrary, a method embodying the features of this invention may be practised in a variety of ways within the scope of the subjoined claims.

Claims:

1. The improvement in the art of recording the notes of a musical composition as played upon a key operated musical instrument, which includes recording upon a moving sheet initially a stage in the travel of an element of the tone sounding mechanism prior to the sounding of a note, and recording a subsequent stage in the travel of said element, representing by the intervening space between said two records the relative speed of movement of said element of the tone sounding mechanism; and simultaneously recording separately upon another moving sheet the beginning and end of the sounding of said tone.

2. The improvement in the art of recording the sequence, duration and intensity of the sounded notes of a musical composition as played upon a key operated musical instrument, which consists in marking upon a moving sheet a series of parallel lines, one for each sounded note, representing by the relative positions of their advance ends substantially the relative instants of complete depression of the respective keys and by their relative lengths substantially the intervals throughout which the respective keys are maintained in depressed position, thereby to record substantially the sequence and duration of the sounded notes; and simultaneously marking an independent series of parallel lines, one for each sounded note, representing inversely by their relative lengths the speed of depression of the respective keys, thereby to record substantially the relative intensities of the sounded notes.

3. The improvement in the art of recording the sequence, duration and intensity of the sounded notes of a musical composition as played upon a key-operated musical instrument, which consists in marking upon a moving sheet a series of parallel lines, one for each sounded note, representing by the relative positions of their advance ends substantially the relative instants of complete depression of the respective keys and by their relative lengths substantially the intervals throughout which the respective keys are maintained in depressed position, thereby to record substantially the sequence and duration of the sounded notes: and simultaneously marking upon a second sheet moving at a constant greater speed than the first sheet a second series of parallel lines, one for each sounded note, representing inversely by their relative lengths the relative speed of depression of the respective keys, thereby to record substantially the relative intensities of the sounded notes.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

CHARLES F. STODDARD.

Witnesses:

C. D. DOUBLEDORF,

J. E. ROBERTS.