M. L. SEVERY & G. B. SINCLAIR.

ELECTRIC MUSICAL INSTRUMENT.

APPLICATION FILED MAY 25, 1910.

1,098,983.

Patented June 2, 1914.

3 SHEETS—SHEET 1.

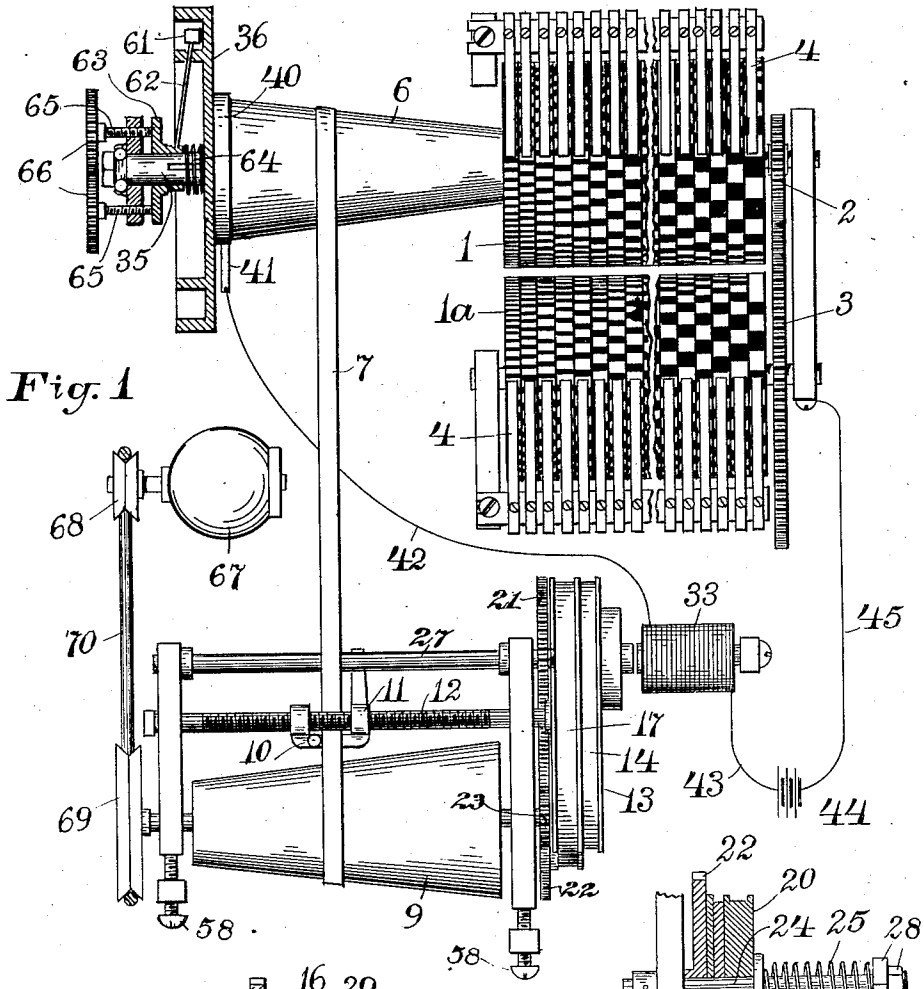


Fig. 1

Fig. 3

Fig. 2

Witnesses;

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3 SHEETS—SHEET 2.

Fig. 4

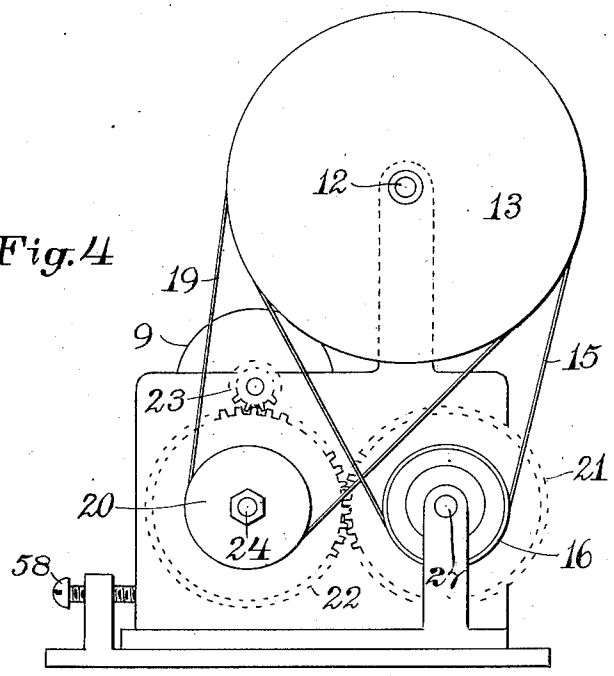
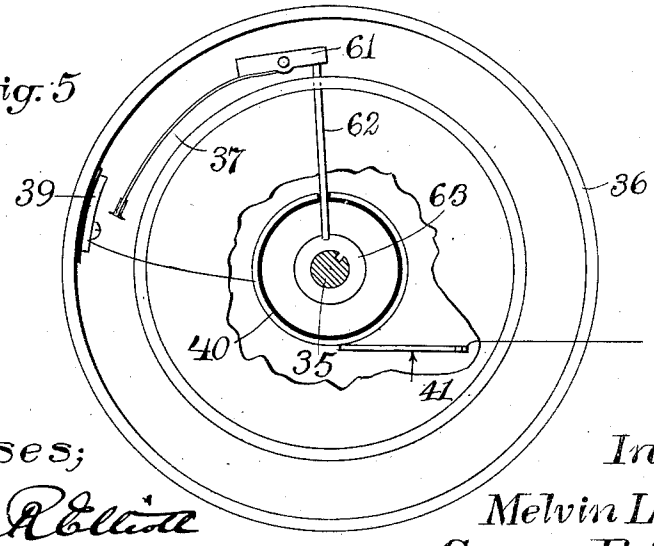


Fig. 5



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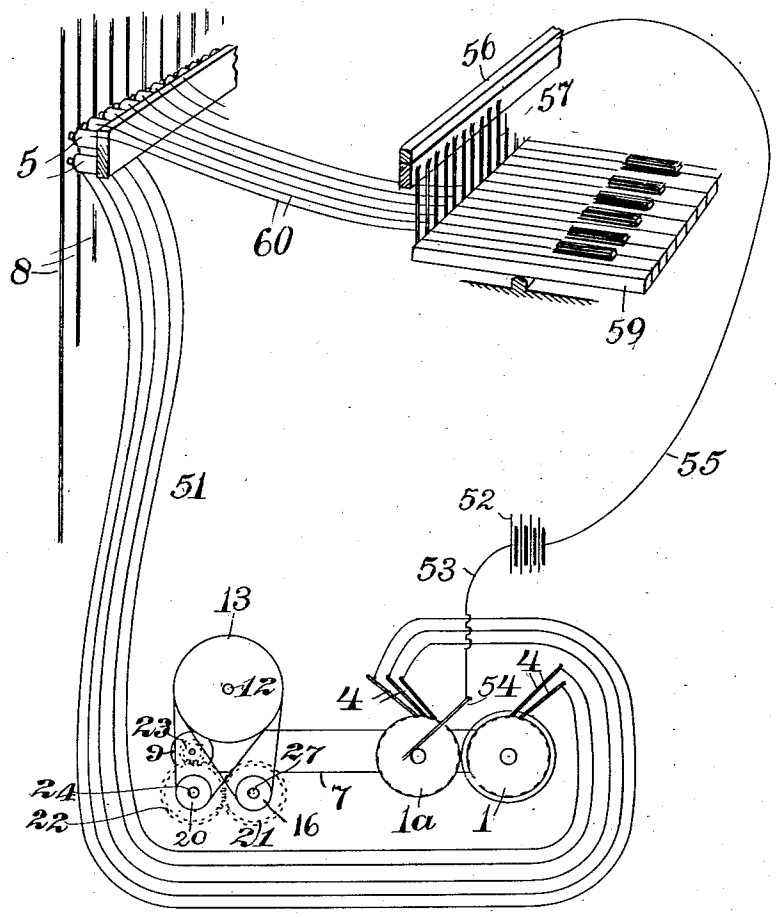


Fig. 6

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UNITED STATES PATENT OFFICE.

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ELECTRIC MUSICAL INSTRUMENT.

1,098,983. Specification of Letters Patent. Patented June 2, 1914.

Original application filed August 7, 1905, Serial No. 273,200. Divided and this application filed May 25, 1910. Serial No. 563,437.

To all whom it may concern:

Be it known that we, MELVIN L. SEVERY, of Arlington Heights, in the county of Middlesex and Commonwealth of Massachusetts, and GEORGE B. SINCLAIR, of Medford, in the said county and Commonwealth, both citizens of the United States, have invented certain new and useful Improvements in Electric Musical Instruments, of which the following is a specification.

This invention relates to musical instruments wherein tuned sonorous bodies are vibrated by electromagnets to which properly timed electric pulsations are communicated, and this application is divisional from our application filed Aug. 7, 1905, Serial No. 273,200. Previous to our invention, no practical way has ever been devised for securing and delivering to these electromagnets properly timed electric pulsations. Rheotomes, reeds, tuning forks and microphones have all been tried, but they have each failed to produce the desired result, because totally unfitted to the end in view. Some had one set of defects, and others another set, but each and all were unreliable, incapable of tuning, and unable to create strong and properly timed impulses. Prior to our invention, a practical instrument was an impossibility, for the reason that no one had ever made a rotative pulsation device which could convey to said electromagnets sets of pulsations bearing fixed and unchangeable ratios to each other, and the periodicity of each set being in such perfect accord with some one of the vibrational frequencies of its associated sonorous body as to cause the same to vibrate in perfect synchronism therewith, and to emit a full, true, beautiful and powerful tone. Without this synchronism, the electromagnetic attractions were mutually annihilatory, producing but the slightest vibration of the associated sonorous body, and that of a periodicity causing the slight tone that was emitted to be false in timbre and of no musical significance. Worse than that, this false quality of tone was continually changing both in timbre and loudness, being at one instant faint and "snarly," at another louder and more dismal, and yet again feebler than before as well as thinner and more "whining," while at no time would it ever be full, true, constant, or in any way dependable. After years of experimentation, we finally constructed a musical instrument of the electromagnetic type wherein the frequencies of the magnet pulsations equaled the rates of vibrations of the tuned sonorous bodies associated with the respective magnets; to this end devising a pulsation-producing means in which there is no variation in speed of movement, but in which every pulsation communicated to an electromagnet continues exactly to synchronize with the vibration of the sonorous body controlled thereby, from the beginning of a musical performance upon the instrument until the same is completed.

We speak of our pulsation device as rotating at exactly constant speed and producing in the magnets pulsations exactly synchronizing with the vibrations of their associated sonorous bodies, for the reason that to all intents and purposes such is the case. If it were possible to construct a rotating pulsation-producing device whose rotations were theoretically and mathematically absolutely constant, and whose middle C, for instance, was theoretically and mathematically absolutely 256 pulsations per second, then with our own device set for the same speed, the best trained human ear in existence would be powerless to detect the slightest difference in pitch consequent upon the interruptions, between those of the theoretically perfect device and those of the corresponding interrupter on our own device. Our device therefore insures synchronism of the pulsations in the electromagnets with the vibrations of their associated sonorous bodies. This condition of affairs justifies the use of the phraseology herein employed.

Referring to the drawings forming part of this specification, Figure 1 is a plan view, partly in section, of a pulsation-producing device adapted for practically perfect synchronism of the magnet pulsations and the free vibrations of the sonorous bodies associated with the respective magnets. Fig. 2 is a sectional detail view of a portion of the synchronizing means. Fig. 3 is a sectional detail view of another part of the same. Fig. 4 is an end elevation of a part of the synchronizing means. Fig. 5 is a detail view of the centrifugal contact finger and

certain connected parts. Fig. 6 is a perspective diagrammatic view illustrating the principle of the complete instrument, the brushes of successive disks being shown out of alinement in order that a plurality may be seen.

In Fig. 1, the reference numeral 1 designates a group of toothed disks or rotors connected by reducing gears 2, 3 to a similar group 1^a; each disk having a brush 4 contacting therewith for taking the current-interruptions adapted for energizing the electromagnets 5 which control the tuned sonorous bodies or strings 8. Rigid with the group of disks 1 is a cone 6 connected by a belt 7 to a similar but oppositely tapered cone 9. A guide-finger 10 carried by the traveler 11 serves to shift said belt along said cones and so to vary the speed transmitted from one to the other. The power by which the cone 9 is driven is designed to be ample for the maximum effort of the instrument, and to be unaffected by the governing device; the latter acting only to reduce the speed delivered to the toothed disks when the velocity of the motive power becomes too high, and to increase it when too low. The traveler 11 is mounted on the threaded rod 12 upon the outer end of which is fixed a drum 13. Said drum has two belt-grooves; the one marked 14 being connected by belt 15 to a pulley 16; while the groove 17 is joined by belt 19 to the pulley 20. See Figs. 1 and 4. Said pulleys are made to rotate in opposite directions by means of the intermeshing spur gears 21, 22; the latter being turned by the pinion 23 fixed on the shaft of the cone 9. Said gear 22 is mounted upon the spindle 24, together with the pulley 20; said pulley and gear being each free to turn upon said spindle and independently of each other, except as influenced by the friction between them and the interposed leather disk 26, incident to the pressure afforded by spring 25. See Fig. 3. The nuts 28 are adjusted on the threaded end of said spindle until the friction is sufficient to cause the pulley 20 to turn the drum 13, and thereby move the belt-shifter or traveler 11. Hence the normal action of said pulley is to shift the belt 7 toward the larger end of the cone 9 and thereby accelerate the speed of the disks 1, and 1^a. The gear 21 above referred to is fixed upon its shaft 27 (Fig. 2), while the pulley 16 is freely mounted thereon. This pulley is chambered to inclose both a leather ring 29 fixed therein, and also a friction disk 30 fixed upon the end of said shaft 27. Attached to the chambered pulley is a diaphragm 31 carrying an armature 32 which is positioned in the field of a fixed electromagnet 33. When said electromagnet is energized, said armature is attracted to bring the ring 29 into frictional contact with the disk 30. This causes said pulley to be rotated by the gear 21, and said pulley to turn the drum 13, inasmuch as the frictional engagement between the disk and leather ring is made greater than that between the pulley 20 and gear 22. To thus energize the electromagnet 33 the instant the speed of the disks 1 begins to rise the slightest possible degree above normal, the shaft 35 of the cone 6 is provided with a flanged wheel 36, preferably made sufficiently heavy to serve as a balance-wheel, and carrying a centrifugally operated spring contact arm 37, as shown in Fig. 5. At any infinitesimal increase in speed, this arm is moved into touch with the contact 39 carried by, but insulated from, said wheel. This contact is electrically connected with a ring 40 carried by the cone 6 but insulated therefrom, as in Figs. 1 and 5; this ring is connected by a brush 41 and wire 42 to said electromagnet 33 (Fig. 1), the latter being joined by wire 43 to the source of current 44, and the remainder of the circuit being the wire 45 and the framework and running parts of the machine. Hence the instant the contact arm 37 touches the contact 39, the circuit between said source and electromagnet is completed, the latter energized, and the drum and threaded rod or worm shaft 12 rotated as above described.

This spring contact arm is so adjusted that it will be held almost in touch with the contact 39 so long as the wheel is revolving at standard speed; but upon the slightest accession in speed, the increased centrifugal force will carry the arm into engagement with the contact and energize the electromagnet 33. In actual practice we find this synchronizinz device exceedingly sensitive; the two pulleys each acting for a moment, first one and then the other, to shift the belt 7 back and forth on the two cones 6 and 9, and neither ordinarily turning more than a small fraction of a revolution, the motion being hardly more than a mere tremor.

Referring to Fig. 6, it will be seen that the toothed disk 1, 1^a of the pulsation device have their brushes 4 connected by wires 51 to the electromagnets 5 which control the tuned strings 8. The circuit from the source 52 to said disk consists of a wire 53 and brush 54; and the circuit from said source to said electromagnets 5 is through the wire 55 to the contact 56, any one or more of the brushes 57 brought by the keys 59 into touch with said contact, and the wires 60 from said brushes to said electromagnets. By thus causing the pulsation device to exactly accord with the vibrational frequencies of the sonorous bodies 8, the latter are made to speak with a volume, perfection of tone and steadiness of voice never before approached in an instrument of the kind.

It should be noted that the alternate high and low resistance instrumentalities compos-

ing the sections on the members 1 and 1ª, as shown in Fig. 1, are substantially of equal length on each said instrumentality, so that the attractive pull given to each sonorous body is thereby caused to continue throughout each vibrational approach of such body to its electromagnet. This actuates such body with a maximum of energy for the current employed. With any other possible pulse-creating device, as the tuning fork, reed and the like, previously referred to, the electric contact is always undependable and is usually continued but a small fraction of the time necessary to secure the maximum efficiency, it being absolutely fatal to results if it be continued too long. In other words, with prior devices the current is at its ebb for a much longer time than at its flood, with the result that the sonorous body is given a mere succession of very short jerks, instead of a series of pulls each lasting entirely during the advance of the said sonorous body toward its actuating electromagnet.

In order that the belt 7 may always contact with the guiding finger 10 so that the latter shall be the sole controller of the belt, it is necessary to slightly adjust the axes of the two cones out of parallelism, as by the adjusting screws 58, as shown in Figs. 1 and 4. The adjustment is such that the left-hand ends of the cones are farther apart than their right hand ends.

The position of the spring arm 37 or the relation of its free end to contact 39 (Fig. 5) is adjusted by having the same carried by the small block 61 pivotally held by the fly-wheel 36, and having the rear end of said block pressed outwardly by a slender strut 62 rising obliquely from the sliding collar 63 (Figs. 1 and 5), said collar being pressed from said wheel by a coiled spring 64 upon the shaft 35. A couple of screws 65 made respectively right and left handed, and simultaneously turned by the intermeshing gears 66, enable said collar to be moved in toward the wheel 36 and thereby make said strut more nearly radial, and said spring arm slightly farther removed from its associated contact 39.

The means illustrated for revolving the cone 9 is a motor 67 connected to the shaft of said cone by grooved pulleys 68, 69 and belt 70.

It will be observed that in the embodiment of our invention here illustrated, no attempt is made to govern the speed of the motor 67, or to compensate for variations in the force actuating said motor, whether this be steam, water, electricity or other, but having provided a motor of power adequate to maintain at all times a sufficient speed of rotation of the rotor or pulsation-producing device, we control the turning of said rotor, keeping its speed practically constant, and such that the pulsations produced in the magnets shall have the same periodicities as the vibrations of the associated sonorous bodies when giving off their respective tones. In other words, such pulsation-producing member of the rotor is adapted when rotated at a predetermined speed, to produce pulsations in the magnet which it controls having the same frequency or periodicity as the vibrations of the sonorous body associated with its magnet, when such body is giving off its proper fundamental tone, and this predetermined speed of rotation is maintained by interposing between the rotor and the prime motor, the controlling device whereby the speed of rotation is maintained constant, and the pulsations in the respective magnets are synchronized with the vibrations, or rates of vibration, of the sonorous bodies which they actuate. This form or embodiment of our invention is preferred, for the reason that it has been found to give excellent practical results, and because we have encountered less difficulty in directly controlling the rotor by the synchronizer, than in indirectly controlling it by applying the synchronizing or controlling mechanism to the motor. We, however, believe ourselves to be the first to produce any efficient or satisfactory means for insuring absolute or substantially perfect synchronism between the frequencies of pulsation of the magnets and the frequencies or periodicities of vibration of their associated sonorous bodies, when the latter give off the tones for which they are tuned. As before stated, rheotomes, tuning forks, and like devices, have been employed in an effort to effect such synchronizing of the magnet pulsations with the periods of vibration of sonorous bodies necessary to the generation of the intended tones. These devices and all others, so far as we are aware, which have been produced for the purpose, have proven incapable of attaining the end sought, or of producing that perfection of synchronism essential to the generation of full, clear and true tones. We therefore mean to claim such combination broadly, and without restriction to the location of the controlling or synchronizing means.

The synchronism of the magnet pulsations and the vibrations of the associated sonorous bodies, resultant upon the use of the synchronizer herein set forth, is so close that the resultant tone is full, clear and true, and no deviation can be discovered by the human ear, or any test so far devised. To all intents and purposes, and so far as can be discovered, the synchronism is perfect, and the accord between the pulsations and the vibrations exact. If there be any deviation whatsoever, it is negligible as measured by the results produced. The term "exact" hereafter appearing in a claim or claims, is

hence to be understood as referring to such perfection or approximation to perfection, as renders detection of any existing error or deviation impracticable by even a trained ear. This explanation is made for the reason that few things performed by human agency can be said to be exact within a literal or rigid definition of the word, though they be so for practical purposes.

It has long been common to provide non-metallic strings and other vibrating bodies with metallic armatures, which being alternately attracted and repelled by magnets, or freed from attraction, were thrown into musical vibration. It is obvious that the same may be done in the present instance, and hence it is to be understood that the present invention comprehends as a magnetically attractable body, any sonorous body, whether it be made of magnetically attractable material, or merely supplied with an armature of such material placed within the field of attraction of the magnet.

In the foregoing description the "lag" of the string or other sonorous body as related to the impelling force, is not noted, for the reason that such lag is more or less a controverted matter, and its injection would simply tend to confusion. The essential point is that whether the two be absolutely in phase or there be a lag of the string or sonorous body, the relationship necessary to generation of the proper tone is made and maintained constant, and the desired result is thereby assured. If there be such lag, it must be uniform, and the movement if commencing later will finish correspondingly later; hence the effect will be that the length of time during which the attractive force is maintained will precisely equal the length of time during which the movement in response to that attraction continues. The foregoing description and the claims are hence to be read with this understanding.

The synchronizer *per se* and apart from tuned sonorous bodies necessary to produce a musical instrument, is made the subject-matter of another application, Serial No. 754,475, filed as a renewal or revival of the subject-matter of application Serial No. 273,200, and hence is not claimed herein except as part of a complete musical instrument, or in combination with tuned sonorous bodies, electric circuits, and circuit closers under control of the keys of the instrument, as hereinafter expressed in the claims. The synchronizer *per se* is hence reserved for said application, Serial No. 754,475, filed March 15, 1913.

In application Serial No. 619,633, filed April 7th, 1911, (a sole application of M. L. Severy), there is claimed broadly the combination with a driven mechanism, of a driving mechanism including a prime mover and a variable power transmission means, and means adapted to be controlled by the variation of the speed relation subsisting between said driven and driving mechanisms for varying the effect of said power transmission means, this subject-matter being stated in said application in varying forms of expression and in different combinations of elements. Said subject matter is hence not broadly claimed herein, but is reserved for said application Serial No. 619,633.

In our joint application, Serial No. 384,872, filed July 22, 1907, is further disclosure and description of features more or less in common with features of this present application. To the extent that such matters are claimed in said application Serial No. 384,872 they are not claimed herein, but are reserved to said earlier application. Like reservation is also made as to matter common to the present application and to our joint application, Serial No. 302,331, filed February 23, 1906, and not specifically claimed herein.

What we claim as our invention and for which we desire Letters Patent is as follows, to wit;—

1. The combination of a tuned sonorous body; an electromagnet to vibrate the same; a source of electric current; a circuit including said current-source and said electromagnet; a rotative pulsator for said current included in said circuit; a motor for rotating said pulsator; and a synchronizer interposed between the motor and the pulsator, and serving to maintain the latter at a speed affording pulsations in the magnet of proper frequency to produce in the associated sonorous body, vibrations of the frequency necessary to generate the normal fundamental tone of said body.

2. A musical instrument comprising, in combination, tuned sonorous bodies; electromagnets arranged in attractive relation to said bodies; a source of electric current; a rotor in circuit with the source of electric current and the electromagnets and composed of individual members adapted to cause delivery of electric impulses to the respective electromagnets; a prime motor; and means interposed between said motor and said rotor, whereby the latter is caused to rotate constantly at a speed to produce in the respective electromagnets pulsations of such frequencies as will cause vibration of their associated sonorous bodies at the rate necessary to the generation of their normal or fundamental tones.

3. In a musical instrument, in combination, a plurality of tuned sonorous bodies; a plurality of electromagnets respectively arranged in attractive relation to said sonorous bodies; a source of current for said electromagnets; a rotor comprising individual members each included in the circuit of one or an-

other of the electromagnets, and each adapted to produce at predetermined speed of rotation, pulsations in its magnet of a frequency to cause the sonorous body associated therewith to give off vibrations of a frequency to produce some one of the musical tones for which it is tuned; a motor for rotating said rotor; and means to maintain constant the predetermined speed of rotation of the rotor, and thereby to synchronize the periodicities of the magnet pulsations with the periodicities of vibration of their associated sonorous bodies requisite to the generation of such tones.

4. A musical instrument comprising, in combination, a tuned sonorous body; an electromagnet in attractive relation to the same; a rotating pulsation-producing device in circuit with said electromagnet; a source of current for said circuit; a motor for rotating said pulsation-producing device; and means for controlling said pulsation-producing device, and maintaining such speed of rotation thereof as shall cause the pulsations in the magnet to be synchronized with the natural vibrational periods of the associated sonorous body.

5. In a musical instrument, the combination of tuned sonorous bodies; electromagnets in attractive relation thereto; a source of current for said electromagnets; pulsation-producing devices included in the magnet circuits, and adapted to deliver to each magnet electric impulses the frequencies of which are in exact synchronism with those of the free vibrations of the associated sonorous body, the conducting contacts of said pulsation-producing devices being adapted to maintain the flow of current at each impulse, throughout the time occupied by such associated sonorous body in making its approach to its actuating electromagnet.

6. A musical instrument comprising, in combination, sonorous bodies tuned to different pitches; electromagnets adapted to actuate the same; a source of current for the electromagnets; a group of pulsation-producing members, each having alternate sections of high and low resistance, the low resistance sections of each member having a length bearing definite relation to the frequency and duration of contacts necessary to produce vibrations giving the predetermined pitch of the sonorous body with which said member is associated; and means for maintaining the low resistance section of each member in conducting relation with the magnet and the source of current during those intervals in which the associated sonorous body, in vibrating to produce its predetermined tone, moves toward its magnet.

7. A musical instrument comprising, in combination, tuned sonorous bodies; electromagnets adapted to actuate the same; a source of current for said magnets; a plurality of rotative, pulsation-producing instrumentalities, each having alternate sections of high and low resistance, adapted to deliver to the associated electromagnet electrical pulsations the duration of each of which impulses is coextensive with the magnet-approaching phase of its associated sonorous body; and means whereby the frequencies of magnet pulsations are maintained constant, and synchronized with the periodicities of vibration of the sonorous bodies necessary to the generation of their predetermined tones.

8. A musical instrument comprising tuned sonorous bodies; electromagnets respectively arranged in attractive relation to said sonorous bodies; a source of current for said electromagnets; a rotor interposed between the source of current and the respective electromagnets, and comprising a series of individual members, one for the electromagnet of each sonorous body, each adapted to deliver to its magnet pulsations of the precise frequency necessary to impart to the associated sonorous body vibration of proper periodicity to produce its predetermined tone; a motor for rotating said rotor; and means whereby the speed of said rotor is maintained constant regardless of variations in the speed of the motor.

9. In combination wtih a sonorous body, an electromagnet for actuating the same; a source of current for the electromagnet; and a pulsation-producing member adapted to deliver current impulses to the magnet of duration corresponding to the duration of the movement of the sonorous body toward the magnet, when said body is vibrating at the rate to produce its predetermined tone.

In testimony that we claim the foregoing invention, we have hereunto set our hands this 19th day of May, 1910, and 17th day of May, 1910, respectively.

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