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COMPLETE SPECIFICATION.

“ Apparatus for Graduating the Striking of the Keys in Mechanical Piano Playing Apparatus ”.

We, BERTHOLD WELTE, EMIL WELTE and MICHAEL WELTE, trading under the Firm of M. Welte & Söhne, of 7 Lehener Strasse, of Freiburg, in the Grand Duchy of Baden, Germany, Manufacturers, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

The subject of the present invention is an arrangement in mechanical piano playing apparatus, by which the striking of the keys can be graduated as desired, in the most perfect manner. This is obtained according to this invention by the different arrangement of bellows, which are operated dependently on each other by relays.

The arrangement is illustrated in Figures 1 and 2.

Figure 1 shows a cross section through the main bellows, governing bellows and regulating bellows.

Figure 2 shows in section the various relays for actuating and disengaging the “ forte-piano ”, “ crescendo ” and “ mezzoforte ”-action.

A constant vacuum is produced in a bellows *a*, Figure 1, by an electro-motor or by pedal action. Several air channels *b* branch off from this main bellows and are closed by slides *c* adapted to be regulated. These slides *c* interrupt the connection between the main bellows *a* and small regulating bellows *d*, which are connected with the corresponding divisions of the relays of the keys.

The slides *c* and the regulating bellows *d* are dependent on one another in their movement in the following manner.

Above the slide *c* of the regulating bellows *d* is situated a small governing bellows *e*, on the lower movable flap *f* of which is arranged a roller *g*. A wire or the like is carried from the slide *c* over this roller and is then fixed to the bottom of the bellow *d*.

The arrangement is adjusted so that, as soon as the governing bellows *e* is out of action, *i.e.*, when the bellows is not exhausted and the flap *f* is in its lowest position, the slide *c* occupies such a position that the channel *b* is slightly open.

In consequence the regulating bellow *d* is exhausted by the main bellows *a*, the

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Graduating the Striking of the Keys in Mechanical Piano Playing Apparatus.

bottom of the former rises and the slide *c* gradually closes the channel *b*. The regulating bellows *d* will therefore remain in equilibrium at a certain height corresponding to a certain vacuum ("piano"-position).

If however, the small bellows *e* is exhausted by the relay the slide *c* is correspondingly lifted and opens the channel *b* so that the regulating bellows *d* is further exhausted until equilibrium has been produced again between slide *c* and bellows *d*. Projections may be provided on the governing bellows *e* in suitable manner in order to maintain the regulating bellows in certain positions after the exhaustion by the relay, whereby different degrees of strength are produced in the regulating bellows ("mezzoforte"-arrangement). In Figure 1 is illustrated a form of construction by way of example, a small bellows *h* being provided beside the governing bellows *e*; which has a projection *i* on its movable flap.

This projection as soon as the governing bellows *e* has been exhausted engages with lugs or the like suitably arranged on the bellows *e* so that the same is held in this position until the bellows *h* is again out of action.

The manner of operating the bellows *e* varies. Either all the air may be gradually exhausted which will result in a slow rise of the regulating bellows *d* and therefore in a crescendo action, or it may be quickly exhausted which will result in a sudden "forte". Reversely this is also the case in the change from "forte" to "piano".

Further, the position of the bellows *e* permits of the arrest of the regulating bellows *d* in any desired position (according to the desired strength of tone) independent of the amount of air used at the time.

For operating the governing bellows *e* a special graduation relay is designed illustrated in Figure 2 and constructed as follows:—A relay *r*¹ for sudden "forte" action, a relay *r*² for sudden piano action, a relay *r*³ for crescendo action and a relay *r*⁴ for disengaging the crescendo action.

The connection between the graduation relay and the governing bellows *e* is effected in the manner shown in Figure 1. From the valve chamber *k*¹ of the relay *r*¹ ("forte") is carried a large pipe *l* directly into the governing bellows *e*. From the relay *r*² ("piano") a small pipe *m* is carried to a small valve bellows *n* which closes the orifice *o* on the governing bellows *e*. The relay *r*³ ("crescendo") is connected with the governing bellows *e* by a very small pipe *p*. With the relays *r*¹ to *r*⁴ are connected two more relays *r*⁵ and *r*⁶, which are designed for the operation and disengagement of the bellows *h*, provided with the projection *i*, by which the governing bellows *e* is maintained in various positions.

The action of these relays is as follows:—

If a sudden "forte" is to be produced the "forte" relay *r*¹ comes into operation and exhausts the governing bellows *e* suddenly. Thereby the slide *c* is opened quickly and the regulating bellows *d* is exhausted quickly by the main bellows *a*. "Crescendo" is actuated always simultaneously with "forte", so that the governing bellows is held in "forte" position by the "crescendo" relay as soon as the "forte" hole in the notes sheet has passed.

If "piano" is to be produced, the "piano" relay *r*² is operated. This produces a vacuum in the valve bellows *n* by means of the pipe *m*. The orifice *o* in the governing bellows *e* is then opened and the governing bellows *e* spring from the "forte" position back into the "piano" position. The decrescendo relay *r*⁴ is actuated always simultaneously with "piano" so that "crescendo" is disengaged, which has till now maintained the governing bellows *e*, in the "forte" position.

If a "crescendo" action is to be produced, the "crescendo" relay *r*³ comes into operation and gradually exhausts the governing bellows *e* by means of the small pipe *p*. If "decrescendo" is to be protected the "crescendo" action is disengaged by the relay *r*⁴ and the governing bellows *e* is gradually filled with atmospheric air by means of the small pipe *p* and returns slowly into the "piano" position.

Graduating the Striking of the Keys in Mechanical Piano Playing Apparatus.

The relay r^5 is designed for the production of "mezzo-forte". This exhausts the bellows h , whereby the projection i becomes situated in the path of the governing bellows e . The "forte" relay is operated shortly afterwards by which the governing bellows e is exhausted until it rests against the projection i .

5 It is held thereby the "crescendo relay" which has come into operation simultaneously. If "piano" is to be produced again "mezzo-forte" and "crescendo" are disengaged by the relays r^3 and r^4 and the piano relay r^2 enters into action.

10 If it is desired to change from "mezzo-forte" through "decrecendo" to "piano" the "mezzo-forte" and "crescendo" are disengaged and the governing bellows e returns slowly into its "piano" position. If it is desired to change from "mezzo-forte" through "crescendo" to "forte", only the "mezzo-forte" is disengaged and the "crescendo" moves the governing bellows into the "forte" position.

15 If it is desired to change suddenly from "forte" to "mezzo-forte", the latter is engaged first, and the projection i is thus pushed into the path of the governing bellows e , the "crescendo" being disengaged and the "piano" relay operated.

If it is desired to change from "forte" through "decrecendo" to "mezzo-forte", the latter is engaged and "crescendo" disengaged, the governing 20 bellows e then gradually returns to the projection i of the bellows h . In this manner the most various actions can be obtained.

The governing bellows e may be operated mechanically instead of pneumatically, for instance by adjusting the governing bellows e by hand or foot levers. The pneumatic functions effected by the sheet of music notes are then superseded 25 altogether

The governing bellows may be omitted altogether, the roller g is then actuated directly by foot or by hand.

In order that the above described pneumatic function caused by the governing bellows e may be started by the note, sheet or roll of music, the relay is 30 provided with the following arrangement:—

Above the relay r^1 ("forte"-valve) is situated a diaphragm q , and a chamber s closed by the diaphragm q at the top is connected by a bore-hole t with the valve chamber k^1 , which is connected by the pipe l with the governing bellows e . A bore hole v extends from a point below the diaphragm q in the chamber u 35 to the neighbouring valve chamber k^2 (chamber of the "piano" valves).

As soon as a vacuum is produced in the valve chamber k^1 by the movement upwards of the double valve the space above the diaphragm q is also exhausted and prevents the descent of the valve when the force which has lifted the double valve ceases to act. The valve is maintained in the raised position, 40 until the neighbouring relay allows air to enter the chamber u below the diaphragm q and thus maintains the latter in equilibrium.

The object attained thereby is that only short openings need be provided in the roll of notes or music in order to cause effects of long duration.

In order to be able to control the playing by hand levers at any time, 45 during the automatic playing in which the operations of the governing bellows e are effected pneumatically by the above mentioned valve arrangements, atmospheric air is allowed to enter below the diaphragm of the "piano" valve so that the same are thrown up as long as the manual control takes place thus preventing the operation of the "forte" valves by the sheet of notes.

50 The governing bellows e will then follow exactly the pressure exerted on it mechanically.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

55 1st. An arrangement for graduating the striking of the keys in mechanical

Graduating the Striking of the Keys in Mechanical Piano Playing Apparatus.

piano playing apparatus, in which the operation, of one or more regulating bellows are effected by slides or valves and governing bellows or levers connected therewith the position of the slide being regulated automatically according to the amount of air used, so that a certain position of the regulating bellows giving a certain strength of operation, corresponds to each position of the governing bellows, substantially as described. 5

2nd. In mechanical piano playing apparatus according to Claim 1 an arrangement for automatic engaging and disengaging in which a connection of the spaces above and below a diaphragm to the valve chambers of the valves is provided for operation or disengagement, such diaphragm being also connected to the valves. 10

3rd. The arrangement and construction of devices for graduating the striking of keys in mechanical piano playing apparatus, substantially as described and illustrated in the accompanying drawings.

Dated this 15th day of May 1905.

FELL & JAMES
Agents for the Applicants.

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[This Drawing is a reproduction of the Original on a reduced scale.]

