PART II.

THE CONSTRUCTION OF THE PIANOFORTE.

CHAPTER I.

The pianoforte appears usually in one of three forms; called respectively the grand, the square, and the upright. In the two former, the strings lie horizontally; in the latter, they are placed vertically. In entering on the construction of the instrument, it must be borne in mind that the pianoforte, whatever its shape, consists of four distinct parts; viz. the framing and sound-board, the stringing, the keys and machinery attached for striking the strings (technically called the action), and the ornamented case enclosing the whole. The latter of these belongs to cabinet manufacture and decorative art, with which we have nothing to do. The other three offer subjects for our consideration; and first, of

THE FRAMING.

When we open a pianoforte, especially a "grand," we are struck by the appearance of bars, and rods, and strengtheners of various kinds, placed in different directions, not merely with a view to give form and stability to the instrument, but to resist the powerful strain to which it is exposed by the tension of the strings. This tension is something extraordinary, and requires, for its due appreciation, a little consideration of the phenomena of a stretched string or wire. Let us suppose that a wire is wound round two pegs or pins placed a yard apart, and that it is merely brought into a straight line, without any attempt at stretching it. If struck with a soft hammer, it will yield a low sound, due to a small number of vibrations per second;

but if we wish to elevate the pitch of the tone, we can do so by increasing the tension or stiffness of the wire. A tuning key being placed on one of the pegs to which the wire is attached, the peg can be turned round, and a portion of the wire wound on it: this necessarily increases the tension of the portion of wire extending between the pegs; the increase of tension increases the rapidity of the vibrations when the wire is struck, and this increased rapidity gives a more elevated pitch to the tone elicited. Now, in conformity with one of the laws of force, the wire pulls with a power equal to that by which it has been stretched; it tends to regain the state which it originally had, and by this tendency exerts a powerful dragging or pulling force on the pins to which its two ends are attached, and on the frame-work wherein the pins are inserted. This force is exerted by every wire, according to the tension given to it; and the aggregate force is surprisingly great. It is calculated that the tension of the strings in a full-sized grand pianoforte amounts to eleven or twelve tons, or about twenty-five thousand pounds! This is, in fact, the force tending to draw together the two ends of the frame-work to which the wires are attached. It may easily be conceived that the strength of the framing necessary to resist this force must be very considerable. The various pieces of wood are in many places "glued up" so that the grain of one component part shall extend in one direction, and that of the other at right angles to it.

"Formerly," says a writer* whom we shall frequently quote in the ensuing pages, "this framing was constructed of timber only. The strings were looped at one end upon studs driven into a solid block of wood, which we may call the string-block; while the other ends were wrapped round a series of iron pins, called wrest-pins†, and inserted into another bed of timber, called the wrest-plank. The string-block and the wrest-plank, thus carrying the two ends of the strings, were kept apart by a framing of carpentry, trussed in such a manner as to offer the best conditions for resisting the tension. But, however ingenious this trussing might be contrived, or

* William Pole, Esq. F.R.A.S.—*Musical Instruments in the Great Industrial Exhibition of* 1851. Printed for private circulation.

† These are often erroneously called *rest*-pins; but, Mr. Pole says, the orthography in the text is the true one; the word *wrest*—"to twist by violence"—referring to the action of drawing up the strings in tuning.

however carefully seasoned the timber of which it was composed, it was found insufficient in strength, and subject, in course of time, to give way and become distorted in shape under the immense strain,—causing the pianoforte to lose its permanence of pitch, and to get out of tune. Moreover, the want of reliance on this part of the instrument prevented the introduction of heavier strings, which the makers, urged by the general call for improvement, were desirous of adopting, in order to increase the power, and augment the tone. At length, the idea arose of strengthening the framing with the more permanent and stronger material—metal; and a series of improvements were made, which have resulted in the compound wood and metal framing, now used, with slight modifications, by all makers; and which, in its general features, as applied to the grand pianoforte, may be described as follows. The studs, upon which the back ends of the strings are secured, instead of being driven into a wood block, as formerly, are now attached to an iron plate, curved to the form of the hollow side of the instrument, and called the *string-plate*. From this plate, metallic bars are extended longitudinally above the strings, and parallel with them, to the wrest-plank; their ends being so firmly connected with the string-plate and wrest-plank respectively, as to take upon themselves, in a great measure, the force of tension of the strings. At the same time, the string-plate, being screwed firmly down to the timber-framing below, and the metallic bars also secured thereto at intervals in their length, the whole forms one strong combined trussing, in which both wood and iron contribute to the strength. The bars and string-plate are usually of wrought-iron or steel. The principal parts of the wood-framing are composed of the best and soundest oak, thoroughly seasoned and dried, and " glued up" in several thicknesses, by which greater permanence of form is secured."

" It will be noticed, on inspecting a grand pianoforte," continues Mr. Pole, " that the wood-framing under the strings is, of necessity, severed completely across by the opening through whieh the hammers rise to strike the under side of the wires. To convey the thrust across this chasm, small thin arches of metal are interposed, abutting on one side against the wrest-plank, and on the other against a transverse rail, forming a portion of the main body of the framing, and called the belly-rail. This interruption to the continuity of the under framing is a great, but unavoidable inconvenience, and did it not exist, probably the aid of the metal bars might be dispensed with altogether."

The introduction of metallic bracing was suggested by the important part which iron, under the auspices of the engineering profession, began to take in the constructive arts at the commencement of the present century. As early as 1808, Messrs. Broadwood applied metal tension bars to the treble. In 1820, Mr. Stodart patented the first perfect system of metallic bracing for grand pianos*, consisting of the string-plate and bars united. And between this date and 1827, other makers applied various modifications of this system, which has resulted in the general plan now in use.

Stodart's patent, besides being entitled to especial notice as the first of its kind, professed other important considerations than that of merely strengthening the framing of the instrument; it was intended to prevent those fluctuations in the pitch of the strings which arise from change of atmospheric temperature. The idea is simple and philosophical, and has been long since applied to chronometers, though its operation in those delicate instruments is the reverse of that to which it has now been turned. The principle is to compensate the natural expansion of strings through heat, or their contraction through cold, by providing an apparatus possessing the same properties as the strings themselves, upon which they are stretched. To this intent, a plate of brass is laid over the belly of the instrument, of about two inches wide, and corresponding in shape with, and placed close to, the curved side of the instrument: to this the strings are fastened in the usual way. The bar which constitutes the front is fixed in its place, about nine inches from the front, by iron clamps, which preclude its moving, and under this bar the strings pass to the pegs, as is customary in other pianofortes. Within this frame, and parallel to the strings, but above them, are placed tubes, about three quarters of an inch in diameter, of a similar metal to the string beneath—i. e. brass above the brass, and steel above the steel. One end of these tubes is placed against the curved side of the frame, the other against the straight bar. They are prevented from rising or curving upwards, through the stress of the tension upon the string, by stout bars of wood laid across. The effect contemplated

* Purchased of Messrs. Thom and Allen, two ingenious workmen in his establishment.

in this construction is, that as the temperature affects the strings either by expansion or contraction, it will also affect the tubes, which extending or relaxing consentaneously, as it were, with the strings*, will compensate the difference by allowing the whole frame to coincide with their action. The only conjecture unfavourable to this project which reason suggests, appears to lie in the size of the different masses of metal to be acted upon by heat and cold; but, according to an authority, " experiment has determined that the expansion and contraction of the larger and the smaller body are so nearly alike as entirely to answer the purpose." A grand pianoforte, it is said, has been removed from a low to a high temperature, and back again, without undergoing any perceptible difference in the pitch, or going out of tune in the smallest degree.

An instrument of the grand form, by Messrs. Stodart, upon this plan, was exhibited in 1851, upon which Mr. Pole makes the following sensible remarks: " This is the original of all the varieties of metallic bracing now in use, and its leading features—viz. a metallic string-plate kept apart from the wrest-plank by a system of longitudinal metallic bars—are essentially the same as have ever since been followed. The only variations from the more modern systems in matters of detail are, that the longitudinal stretchers are hollow tubes instead of flat bars, and that the string-plate is detached from the wood framing below. With regard to the form of the stretcher, there is no doubt the hollow tube is the more correct form, on mechanical principles, as being better calculated to offer the greatest resistance to a compressive force, with the least quantity of material. Every one acquainted with constructive science knows that a hollow tube is the most advantageous form for a column; and the function of the metallic stretchers in a pianoforte is precisely analogous. The object of leaving the string-plate detached from the wood-work below, was to allow the whole metallic frame, with the strings it carried, to contract and expand together, under atmospheric changes, without straining the wood-work, since wood and metal are, as is well known, differently influenced in this respect. The experience of other makers has not shown

* Some authorities tell us that strings will stretch almost indefinitely if the tension be conducted slowly and gradually; but this theory is not supported by facts.

this to be of much importance in practice; and therefore the separation of the wood and metal framing is but seldom adhered to; but the idea is ingenious, and the principle correct. Altogether, Mr. Stodart's system of metallic framing, adopted at such an early date, is a good example of the application of scientific knowledge to the construction of the pianoforte; and the very general way in which it has been since followed, corroborates the universal rule, that improvements based on correct principles are those which will be ultimately found of the greatest practical value. A peculiarity in the framing of this pianoforte, although not a part of the original system, is, that the wrest-plank is turned upside down, being placed above the strings, instead of below them. By this arrangement the strings are struck against their rests without the necessity for an upward bearing stud; while the metallic stretcher-bars bear directly against the plank, instead of being cranked down to it, as in the common plan. The wrest-pins pass completely through the plank, and their squared ends appear above it, so as to offer facilities for tuning. The inverted wrest-plank is a remnant of a system introduced by Mr. Wornum, in which the entire wood-framing was placed above the strings; but which, from its inconvenience, has not continued in use."

Messrs. Broadwood adopt, in some cases, a metal bar, running transversely over the wrest-plank, in a direction nearly at right angles to the longitudinal bars, and secured firmly thereto. From this transverse bar, a set of screws descend into the wrest-plank; the object being to hold this part of the frame more firmly in its place, and thereby to insure the stability of the instrument, and the steadiness of the tone. When this bar is added, the number of longitudinal bars may be reduced from four or five to two. The same firm have also lately adopted another system of metallic bracing, the peculiarity of which is, that some of the tension bars, instead of running parallel with the strings, are placed diagonally*.

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* Messrs. Broadwood introduced the following improvements in 1847:—

1. A newly revised harmonic scale of strings.
2. A peculiar method of fixing the sounding-board.
3. The transverse metal suspension bar, by which several tension-bars were dispensed with.
4. The construction of the tension-bars, so as to combine the maximum of *strength*, with the minimum of weight.

Messrs. Erard exhibited, in 1851, a full-sized grand instrument, the peculiarity of which was, that, in addition to the metallic string-plate and longitudinal tension bars, the wrest-block was also of metal, being formed of a frame-work of brass, in which was fixed a strip of beech-wood to receive the wrest-pins. This, in conjunction with the longitudinal bars and the string-plate, formed an entire metallic framing, extending from one end of the instrument to the other. Frames partially of metal had previously been used for upright instruments in this country.*

Entire frames of metal have lately been adopted in America and Denmark, for grand and square instruments. Messrs. Chickering, of Boston, exhibited, in 1851, a grand in which the whole framing, consisting of string-plate, longitudinal bars, wrest-block and drilled bridge (for upward bearing), was of cast iron, cast in one piece. This plan has since been followed by several American makers. Hornung, of Copenhagen, exhibited two instruments, a grand and a square, in which the various parts were cast in one piece of iron, on the American plan.

We agree with Mr. Pole that the growing tendency to the use of too much metal in the construction of pianofortes, is injurious to the quality of the tone. It also adds greatly to the weight of the instrument, and consequently diminishes its portability and general usefulness. Nevertheless, the use of metal up to a certain point has its advantages; in fact, owing to the increased weight of the strings, it cannot now be dispensed with.

The square pianoforte presents considerable difficulties, as regards the strengthening of its frame, by reason of the separation of the wrest-plank from the string-plate, by the wide and deep space required for the keys and action. The strengthening is principally effected by bolting the wrest-plank and string-plate firmly down to a strong bed of timber, extending underneath the keys over the whole surface of the instrument, and forming thereto a thick, solid bottom. In addition to this, one or two

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5. The fixing these tension-bars in the string-plate by means of wedges, thus ensuring equal tension.

6. The diagonal tension-bars. These abut against the strongest angle of the wrest-plank and *bass* scale. They meet effectually what is termed the "side-swag" of the string-plate, and they enable the maker to do with a single direct tension bar.

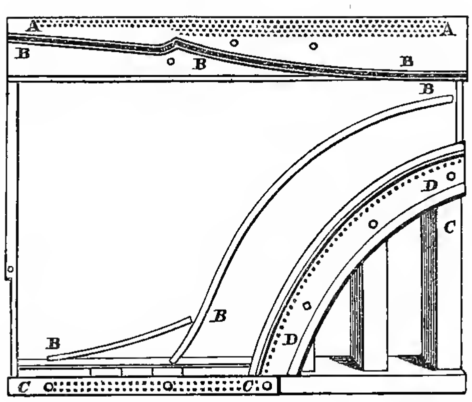
* By John Isaac Hawkins. See the *Repertory of Arts*, vol. xiv, p, 143.

metallic bars are, in the best instruments, stretched across from the string-plate to the wrest-plank, over the strings and parallel to them.

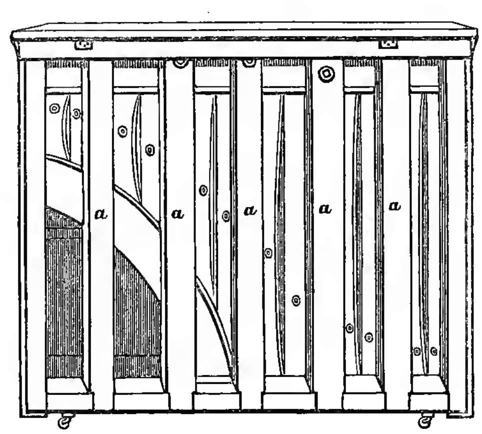
A simple and philosophical alteration has lately been made in the construction of the square pianoforte by an American maker, Mr. Spencer Driggs, of New York. By this invention, the thick plank bottom and the interior blocking of wood are dispensed with, and a greater strength and compactness gained by means of an entire iron frame, independent of the case*.

The framing of the upright pianoforte is perhaps the most simple of any description of pianoforte, in consequence of its continuity being unbroken by any openings. This may easily be seen by the following diagrams :

Front View without the Strings.



Back View, showing the Bracings a a a a.



The letters (A A), in the first diagram, show the round pegs of iron, the ends of which screw into the wooden substance of the sounding-board, and may be turned at pleasure by a tuning key, so as to increase or diminish the tension of a string. The thickness of wire used for each note is determined by pieces of wood called bridges, fixed firmly on the sounding-board (B B). The curve and position of the top and lower bridges are regulated by a guage, as is also the arrangement of the pins inserted in it. These pins are so placed that the strings rest against them, being thereby bent out of their rectilinear course, and their vibration thus limited to the space between the bridges (B B). The metallic plate (C C) is used to check the violent pull of the bass strings upon the sounding-board, and is an improvement now in general use. The belt (D D) serves to give additional strength.

* This remarkable pianoforte is highly spoken of by some of the most eminent pianoforte players, including Thalberg. A company has been formed in New York for its manufacture, under the title of "The Wallace Pianoforte Company," and from the prospectus now before us we extract the following particulars:—"The strength

The tension is sustained by strong struts or bars of timber placed vertically at the back of the instrument (*see the second diagram*), to which the wrest-plank and string-plate are firmly secured ; so that the force of the tension is resisted by the bars in the direction of their length. As Mr. Pole remarks, " they are, in fact, simple columns, and receive their load in nearly the same manner as pillars supporting a building." Iron bracing is sometimes used at the back of the framing to counteract the pull of the strings on the opposite side ; but perhaps the most satisfactory and philosophical mode of strengthening the upright pianoforte is the tubes of metal, in place of the bars of timber, as invented by Mr. Rüst. The metallic tubes not only strengthen the instrument in the most satisfactory manner, but also materially improve the tone of the pianoforte.

The surface of wood lying extended immediately under the strings, in a grand

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of these instruments, by which is meant their power to hold or resist the tension of the strings, is derived wholly from an iron frame, so constructed as to unite the greatest strength with the least weight. This iron frame, and a light wooden frame, having the general form of the piano, and to which the iron frame is let in and bolted, constitute the interior of the instrument. The wrest-plank is fastened to the top of the iron frame or plate, and rests firmly against a flange, elevated from its inner margin. The sounding-board, which is made thin and arching, and *without ribbing*, preserves its shape and stiffness by means of a small iron frame into which its edge is fastened, thus retaining all its delicate sensitiveness and vibratory power. The bridge, which is made in a peculiar manner, is glued along the most crowning part of the sounding-board, and secures the equal and continuous bearing of the strings. At this point in their manufacture, the strings are put on and drawn up, and the action is put in and fitted. It will be observed that all this is done *independent of the case*. This is a mere shell, only three quarters of an inch thick, and which in the mean time has been making in another part of the factory. It is now slipped on over the instrument, and glued to it. The bottom sounding-board, which is a single veneer, about the eighth of an inch thick, made arching, and slightly ribbed, with its convex surface downward, is then glued on to the under side of the wooden frame, with its edges resting against a projection of the case which comes slightly below it. This lower sounding-board, covering the whole expanse of the instrument, and connected to the upper one by a sound-post, through which the least vibration of the one is instantly conveyed to the other, is an exceedingly valuable feature in the invention, and one which it is impossible to use in any other Pianoforte. To any one acquainted with the method of making the ordinary Piano, and with the laws of sound, it must be apparent that the process here described differs in all respects from that method; and that this new and perfected instrument, preserving in its construction the principal characteristics of the violin, with its immense sounding surfaces, its vast and unobstructed chamber, and its exquisite sensitiveness to the slightest vibration of the strings, must, in all philosophy and reason, be much better adapted to the production of musical sounds than the common Piano. That has a thick case, with ponderous inside blocking; a bottom from four to six inches in thickness; a small, flat, and heavily-ribbed sound-board; its strength, durability, and tone, all depending on the uncertain seasoning of its wood, and forming together a solid, dull mass, with barely sufficient room inside for the working of the action."

or square pianoforte, or behind them in an upright instrument, is called the *sounding-board* (sometimes *sound-board)*, or belly. In a grand pianoforte, it occupies the entire area of the instrument: in the square, about two fifths of its length. It is analogous to the belly of the violin, and is composed of a thin boarding of the best Swiss pine, or of fir-wood, perfectly free from knots or imperfections, cut in a particular direction of the grain, and thoroughly seasoned. It is about one fifth of an inch in thickness, strengthened on the under side with small ribs, and put together with the utmost possible care. The edges of the sounding-board are attached to the framing of the instrument, the whole of the middle part being left perfectly free, to vibrate under the impulse received from the percussion of the strings*.

It will be observed, from what we have said, that the only support of the sounding-board consists in the bars glued on at the back. If these are sufficiently strong to resist the pressure of the strings, they are found too stiff to allow of the requisite vibration. If, on the contrary, the bars are made sufficiently weak to admit of a free vibration, they are found unequal to resist the pressure of the strings, and the sounding-board is deflected, or forced out of its true position—that of a perfectly flat surface,—its relation to the strings deranged, and the tone of the instrument constantly impaired by degrees, as has been found frequently in pianofortes after they have been in use for some years.

These considerations have led to the invention of the " Harmonic Chambers," which are hollow generators of sound, made on the principle of a violin, applied to the sounding-board, and adjusted by screws to any pressure, thus giving the exact amount of support that may be required. This invention has been patented by Mr. Dreaper, of Liverpool; but we have had no means of testing its merits.

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* Dr. Brewer says—" The *sound-board* should be made of some light pale wood. The slit cut along it in the shape of a fanciful curve (!), as well as the two carved openings covered with silk in the front board, are designed to allow the air in the case to play more freely on the external air; so that the wooden lining called the belly, the sounding-board, and the vast body of air enclosed, all vibrate in unison with the strings, and contribute to augment the force of the sound." (! !)—*Sound and its Phenomena*, p. 163. The author has committed a two-fold blunder. He supposes the sounding-board and the belly to be two distinct parts of the instrument; whereas they are one and the same thing. What he dignifies by the name of the sounding-board is merely the " shade" of the old square pianoforte, invented to keep out the dust!

There is little doubt that the derangement of the sounding-board, by the constant tension of the strings, is the principal reason why pianofortes have generally lost their tone as they have become older; for we know, by the analogy of the violin, that, supposing all the parts to remain undisturbed, the effect of age ought rather to improve than to deteriorate instruments depending on wood for their sonority.

M. Pape, an ingenious Frenchman, gets rid of this evil by placing the sounding-board on the opposite side of the framing to that occupied by the strings. A strong open frame of cast-iron, or wood strengthened with iron, extends over the whole size of the instrument, forming the bottom of the piano. On the upper side of this, the strings are stretched; and on the lower side is fixed the sounding-board; by which arrangement the pull of the strings can have no tendency to compress the sounding-board; but if any action at all is produced upon it, it must be that of extension, which is rather beneficial than otherwise. The bridge over which the strings pass (and which, in the ordinary construction, is glued upon the sounding-board) is, in the new arrangement, a loose piece, communicating with the sounding-board by sound-posts, similar to that of a violin, which transmit the vibrations to the sounding-board exactly in an analogous manner. Another advantage is obtained by this arrangement; viz. that the sound-board may be considerably enlarged. In the ordinary construction, its size is bounded by the blocks and points of attachment of the strings to the framing; whereas, in this plan, no such limitation being necessary, the sounding-board may extend over the whole surface of the instrument, by which increase of dimensions a proportionately greater resonance is obtained. This is of especial value in the small upright forms. Another alteration in the sounding-board is in the position of the strengthening ribs. These are usually fixed on the side opposite to the strings. M. Pape places them towards the strings; which position he considers much more favourable, inasmuch as the strain tends to fix them more firmly, instead of to loosen their ends, as in the ordinary plan. The sounding-board is also made thicker and more solid than usual. M. Pape occasionally makes grands of the compass of eight octaves, F to F. For these, the new arrangement of the sounding-board gives the means of obtaining the requisite length for the tenor notes, without increasing the size of the case beyond that of an ordinary grand.

Mr. Cadby considers the ordinary mode of glueing the edges of the sounding-board firmly to the framing of the instrument, very detrimental to the brilliancy of the tone, owing to the fact that it is not strained tight. He has adopted the plan of securing the sounding-board to the frame-work of the instrument solely by metal clamps, in such a manner as to admit of its being strained and tightened when desired, like the parchment head of a drum. The principle is undoubtedly good, and, probably, at some future time will be generally adopted.

CHAPTER II.

THE STRINGING.

Preparatory to noticing this important part of the pianoforte, we must offer a few words on the *vibrations of strings*, which we are enabled to do, satisfactorily, from Dr. Brewer's recently published work on *Sound and its Phenomena.*

Sounds differ from each other in three essential particulars: 1, In pitch, that is, in gravity or acuteness; 2, In loudness, or intensity; 3, In *timbre*, or quality of tone.

The pitch of a sound always depends on the number of vibrations communicated to the air in a given time. Rapid vibrations produce sharp, shrill sounds; slower vibrations, those which are more grave.

The low C of a pianoforte gives a deep bass note; the highest C, an acute treble one. Not that one of these notes is touched more energetically than the other, but that the string of the former *vibrates more slowly* than that of the latter. Thus the lowest C of a six-octave piano makes only 64 vibrations, while the highest C makes 2048.

A string is made to vibrate more slowly: 1, By augmenting its length; 2, By augmenting its weight; 3, By decreasing its tension.

The canons of vibrating strings, which had engaged the attention of philosophers for about half a century, were first established by Dr. Brook Taylor, of Edmonton, who published his valuable treatise, called *Methodus Incrementum,* in the year 1716.

These canons were established by means of the monochord, or sonometer, which consists of a single string of wire or catgut, fixed at one end, and stretched by a weight at the other over a frame. The *tension* of the string is increased or diminished by increasing or diminishing the weight attached to it; and the *length* of the vibrating part is varied by means of a moveable bridge on which the string rests.

Suppose the string of a monochord adjusted for any given note, and you require to produce its octave: this may be accomplished in three different ways: (1) By shortening the string; (2) By stretching it with a greater weight; and (3) By employing another string less heavy. If the *first* of these plans be adopted, you must shorten the string *one half*. If the *last*, you must use a string of *half* the weight. If the middle plan be preferred, the weight employed to stretch the string must be *four times* as heavy as the former.

First Canon of the Stretched String.

The vibrations of stretched strings are in inverse proportion to their lengths; or, in other words, as a string is *lengthened*, it vibrates more slowly, and produces a graver note; as it is *shortened*, it vibrates more quickly, and gives a higher note.

The diminution of length needful in order to obtain the successive notes of an octave, is not the same for any two intervals. If a string 180 lines (15 inches) long give the C of any octave, it must be shortened 20 lines in order to obtain D, 16 more to produce E, only 9 more for the next note, F, 15 more for G, 8 for A, and 12 for B. Supposing the length of the string in the first instance to be one yard, or one foot, it will be found by the monochord that the relative lengths of string for the seven successive notes will be as follows:

Relative Length of each String.

C	D	E	F	G	A	B	C octave.
1	$\frac{8}{9}$	$\frac{4}{5}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{3}{5}$	$\frac{8}{15}$	$\frac{1}{2}$

That is—if a string 1 yard or 36 inches long give C, in order to produce D it must be eight-ninths of a yard, or 32 inches; in order to produce E, it must be four-fifths of a yard, or $28\frac{4}{5}$ inches; in order to produce F, it must be three-fourths of a yard, or 27 inches; &c.—and in order to produce the octave, it must be exactly half its original length.

As the number of vibrations from different strings is always in *inverse proportion* *to their length*, the relative number of vibrations of any given octave may be obtained by inverting the fractions of the foregoing table. Thus:

For	C	D	E	F	G	A	B	C
	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2

Or, in whole numbers:

C	D	E	F	G	A	B	C
24	27	30	32	36	40	45	48

That is, in the time that C is making 8 vibrations, D makes 9; in the time that C is making 4 vibrations, E makes 5; in the time that C is making 3 vibrations, F makes 4; &c.—and in the time the fundamental note makes 1 vibration, its octave makes 2.

It will now be readily understood why the strings of a harp, or of a pianoforte, differ in length; and why their difference of length is not *uniform.*

Second Canon of the Stretched String.

The vibrations of stretched strings are in proportion to the square root of their tension. If the string of a monochord stretched by the weight of 1 lb. gives a certain number of vibrations in a second, and you wish, without altering its length, to obtain from the same string the octave, a note which gives *twice* the number of vibrations in the same time, you must change the weight for one of 4 lbs. If, again, you would obtain from the same string the 12th (or *octave* of the *fifth*), which makes *three* vibrations for one of the fundamental, you must apply a weight equal to 9 lbs. If you wish to procure from the same string, without altering its length, the *double* octave, a note which vibrates *four times* as fast as the fundamental, you must attach to the end a weight of 16 lbs.; and so on.

Hence it may be perceived that the *tighter* a string is drawn, the *faster* it vibrates, and the sharper or higher its pitch. On the other hand, the *looser* a string, the *slower* its vibrations, and the flatter or graver the note which it produces.

Third Canon of the Stretched String.

When strings have the same length and tension, but differ in *weight* or thickness, their vibrations are in inverse proportion to their weight. If a given string makes a certain number of vibrations in a second, another *twice as heavy* will, under similar circumstances, give only *half* the former number of vibrations in the same time; one *thrice as thick* will make *one third* as many; and one *four times as heavy* will produce only *one-fourth* the number of the first string.

This law finds an illustration in the common practice of making bass strings of musical instruments *thicker*, or of a heavier material, than the treble ones. Sometimes a metal wire is coiled round the lower strings of a harp or pianoforte, to increase their weight. Sometimes different metals are employed, as copper, brass, and steel; the heaviest metal being always made to represent the lowest notes.

Thus, the manufacturer does not adopt any one of these methods of adjusting tones of which we have spoken, to the exclusion of the others: he avails himself of all. "Twelve strings of the same length and thickness," writes Mr. Dodd, in a clever article on the pianoforte in *BritishManufactures**, "might be so different in tension as to yield the twelve semitones of an octave; twelve strings of the same thickness and tension might be of such different lengths as to yield the twelve semitones; or, lastly, twelve strings of the same length and tension might be made to produce these effects by having the thicknesses different. But, in practice, the tones produced by either of these methods would be very defective in character. Each degree of thickness, of length, and of tension, produces its own peculiar effects on the *timbre*, or quality of tone. If two strings of the same length and thickness were so stretched as to produce tones differing by an octave in pitch, one would be strained nearly to breaking, and the other would produce a dull, weak, and smothered sound. If, while producing these two notes, the strings differed only in length or in thickness, the qualities of tone would not be so much at variance as in the case just supposed; but still the required equable character of tone would not be produced. The plan adopted, therefore, is to let the length, the thickness, and the tension, all vary together.

* 2 vols. 12mo. 1847.

"This explanation will enable us to understand the reason for the observed difference in the strings of the pianoforte. We perceive that the strings for the upper notes are not only shorter, but also thinner, than those for the lower; and we should find, though it is not perceptible to the eye, that the tension is likewise different. The thickness, the length, and the tension, all diminish (but not uniformly) from the lower to the upper notes; *tension* being here used to express the force employed in stretching the string to the required degree. In a grand pianoforte there are fourteen different thicknesses of wire; the smaller, for the upper notes, being plain polished steel wire, and the thicker, for the lower notes, being coated with a very fine coil of copper wire."

The strings of the pianoforte were originally of very thin wire. The difference indeed between them and those now in use is very striking. As an illustration, we may remark that the smallest wire formerly used for the C in the third space of the treble staff was No. 7; that now used for the same note is No. 16. The weight of the striking length of the first is five and a half grains; of that of the second, twenty-one grains. This is sufficient to account for the increased bracing required in the modern pianoforte.

Grand pianofortes have three strings to each note; upright instruments, generally two. Of late, however, three strings are often used in grands for the treble notes, two for the middle of the instrument, and one for the bass. The strings for upright pianofortes, instead of being placed vertically, sometimes (in more modern instruments) run obliquely across the frame, by which a greater length is gained, without increasing the height of the case.

Formerly each string was formed of a separate wire, one end of which was twisted into a loop, and passed over the stud in the string-block; the other end being wrapped round the wrest-pin. A great improvement in the mode of applying the string, so as to avoid the noose by which they are ordinarily attached, was patented by Messrs. Collard in 1827. This is effected by using only one hitch-pin (of double the usual size), instead of two, and passing the string from one tuning-pin to the other round this single hitch-pin, in one continuous piece of wire. The object of this is to prevent the distortion of the fibres of the wire by twisting, which often makes them false, to obviate the giving of the wire at the noose, and to avoid the frequent snapping of the string at the twist. Notwithstanding that both unisons are made by one continuous wire, yet such is the tenacity caused by the friction on the single hitch-pin, that one of the unisons may be lowered several semitones without in the least affecting the pitch of the other. So great is the advantage gained by this mode of applying the strings, that a string is seldom or never known to break; it is brought up to its pitch almost instantaneously; and a person who has never before put a string on a pianoforte, may do it without the smallest difficulty. Since the expiration of the patent, this method of stringing has been almost universally adopted.

Another important improvement, applied to the stringing of grand pianofortes, is that of the upward bearing of the string at the striking end. In describing this, we shall use Mr. Pole's words. "The length of the vibrating part of the string is determined by two bridges, over which each wire passes; one fixed to the sound-board, the other to the wrest-plank, a little in front of the striking point of the string. Now the original plan was, so to arrange the levels of these two bridges, with reference to the ends of the wire, that the string might, when stretched, have a downward pressure upon both. But since the hammer strikes upwards, it is evident that a heavy blow must exert a tendency, more or less, to lift the string off its bearing; the effect of which is considered detrimental to the tone. On this account, the direction of the bearing on the front bridge was reversed, or rather the bridge itself was changed for a plate pierced with a series of holes, through which the strings passed, turning immediately upwards towards the wrest-pins. This gave each string an upward, instead of a downward bearing at the front end; the effect of the blow being, under these altered circumstances, to force the string against its rest, instead of lifting it from it, as before. The upward bearing is claimed by Messrs. Erard, as having been described by them in a patent of 1808, and modified and improved in 1821."

The plan of employing one large string to each note of the pianoforte, upon which the French dilate largely, is an invention, if it may be so called, derived from this country. Lord Stanhope, in 1815, was amongst the first who made this attempt; but the false and crazy tone rendered by the treble strings, particularly when so enlarged as to produce the quantity of tone required, was an insurmountable obstacle to its success. A contemporary journal speaks of this instrument in the following manner:

"Mr. D. Loeschmann, Newman Street, has lately constructed a new pianoforte, under the direction of Earl Stanhope, with *single* steel wires to each finger key, of his lordship's invention. The lower wires are about the tenth of an inch in diameter, and more resemble musical bars than wires, in their tone and effect." *

The "unachord" instruments have been greatly improved since the time of the noble Earl; and when we consider the diminution of outlay in their construction, it will be at once seen that the plan possessed some advantages.

In 1819, the ingenious Mr. Wornum turned his attention to the reduction of all the strings to one size and tension. The origin, progress, and effects of his enquiries, are thus explained in the *Quarterly Musical Review* for 1820:† "All pianofortes are subject to a falling of the middle and upper octaves; and so much are most manufacturers accustomed to this circumstance, that it is now scarcely considered in any other light than that of a failing in the tuning. But it seems that Mr. Wornum did not so regard it, but in the light of a distinct evil, and as one of a most disagreeable character, especially when two performers are engaged at one instrument. In the course of last year, he was led to make particular enquiry into the subject; and his first effort in the cause was to examine minutely the construction and parts of a cabinet pianoforte. The materials were evidently well selected, the workmanship was good, the construction of the case perfectly mechanical, and the action neat, simple, and efficient. To these parts, therefore, it did not appear that any portion of the defect could possibly attach. He then directed his attention to the stringing, where he scarcely expected to make any progress in his pursuit, the scale having been laid down on the most approved principle, and the strings being all of Berlin steel. However, for enquiry's sake, he proceeded, laid aside the approved character of the scale, and argued that, as the effect was imperfect, it was probable that the cause was incorrect. Thus presuming, he tried the octaves, and found them, as usual, all flat —less so in the bass than in the treble; the unisons, generally speaking, were in

* Gentleman's Magazine, September, 1815.

† Vol. ii, p. 305.

tune. His next proceeding was to examine the octaves and unisons in their relative construction and circumstances. The construction of the octave he found to be of *unequal tension*, and, at certain distances, of *unequal size;* but the construction of the unisons were of *equal tension invariably*, and the *same* in *size*. And here at once was discovered the seat and cause of the defect under enquiry; for it was evident that the superior accordancy of the unisons arose from their being of equal size and tension, and that the defective state of the octaves arose from their want of *similar uniformity*. Mr. Wornum now transferred his enquiry to the monochord, where, by taking the length of the longest plain string, and subdividing that length, according to a given temperament, into all the ascending degrees of the scale, he graduated an entirely new scale for the pianoforte; in which all the plain strings were reduced to one size and tension, and such as required covering were severally weighted with covering wire until they arrived at the same force. The instruments constructed from this scale answered most satisfactorily, and were an ample reward for the labours of the experiment. Their tones were firm, sonorous, and brilliant; and their standing warranted the highest opinion of the principle. On comparing the best common method of laying down scales for the strings of pianofortes, with the one above described, a very great difference will be observable. By the equal tension, the octaves are all doubled, and the other intervals are severally taken as given by the length and tension of the octaves. In the common method, the octaves are not doubled, but are successively reduced, and larger-sized wire employed, at certain distances, to correct the bad effects of that reduction; and the other intervals receive the lengths that *may fall* to them by the *accidental* circumstance of an *easy sweep* from one octave to another in the formation of the patterns. Now, in the new method, we have perfect equality; in the old, systematic inequality. The former is the dictate of nature—consequently of pure science; but for the latter we are indebted entirely to mechanical *convenience*, which, in the present enlightened state of society, is rather a compromise than an attainment of the object."

Notwithstanding the philosophy and excellence of the late Mr. Wornum's discovery, a patent for which was taken out in 1820, the system of *equal tension* never came into general use.

The curved piece of wood fixed on the sound-board which regulates the sounding length of the strings, is called the bridge. Messrs. Clementi and Collard invented, in 1821, an additional bridge, not for the purpose of regulating musical intervals, but of augmenting the duration of the vibration, and consequently increasing and beautifying the tone. This new bridge, called "the bridge of reverberation," was placed at a regulated distance on the sound-board, and the important advantage resulting from it was, that the motion given to the principal part of the string by the impulse of the hammer was kept up by the bridge of reverberation, instead of being suddenly checked by an attachment to an unyielding substance. The prolonged vibration produced an extraordinary purity, power, and continuity of sound somewhat resembling the richness of an octave below.

On the old plan of passing the strings directly from the side of the case to the original bridge on the sound-board, it became necessary, in order to prevent the jarring noise of those portions of the wire which lie between them, not only to place some soft substance on the top of the moulding, but also to weave a piece of cloth between the strings. In the invention under notice, a novel action was substituted for those portions of the string situated between the two bridges, yielding most sweet and melodious tones. The performer, by lifting a valve, was enabled to elicit those harmonious sounds, through a well-known sympathetic relation between accordant strings, without touching those portions of the strings which produce them. The augmentation of sound caused by this means resembled in some measure the effect of lifting the dampers, but without producing the same confusion, since every note on the body of the instrument was regularly damped as the performer lifted his finger. By this apparatus a threefold power of augmenting the sound was acquired; whereas, instruments of the common construction have but the one caused by lifting the dampers. The first augmentation of power was by lifting the harmonic swell. The second—by dropping the harmonic swell and raising the dampers. The third—by raising the harmonic swell and the dampers together. By the last means, the performer added all the tones which were sympathetically elicited from the strings between the original bridge and bridge of reverberation, over and above all that could be produced on instruments of the common construction, and the effect was accordingly of extraordinary richness and power. These inventions were applied to upright and square pianofortes, but, like many other excellent improvements, are now only numbered among the " things that were."

A great improvement in the stringing of grand horizontal pianofortes has of late years been introduced by Erard. Formerly, each note of the lowest octave of the bass has been produced by the action of the hammer upon two strings. It was found that in strings of such length, there was a constant liability of their striking each other, and jarring during their vibration; and this injured the effect of their tone. This defect is removed, in the improved instrument, by making each hammer of the lowest octave act upon a single string, whose thickness is increased as well as its length. By this expedient, the jar which prevailed previously is effectually prevented, and force and fulness of tone are obtained, which exceed in a striking degree the effect of the instruments of the old construction.

The strings of the early pianofortes were partly of steel and partly of brass, the treble notes of steel, and the lower notes of brass, a few of which in the bass were over-lapped or covered, rather open, with plated copper wire. The covering was to give them more gravity according to the length attainable in the instrument. But modern pianofortes have steel wire throughout, with about one octave in the bass closely lapped. The wrapping wire is of soft iron for the upper part of the octave, and of copper for the lower. The wrapping too is close, like that of the fourth string of a violin; whereas, formerly, it was open like the worm of a corkscrew. In the lowest bass notes of grand instruments, the copper-lapped strings are of considerable diameter.

The steel wire now in general use is the manufacture of Mr. Webster, of Penn's Mills, near Birmingham, and is greatly superior to the once-famed Berlin wire, now no more in esteem with English manufacturers, from the bad quality of the metal, and the very imperfect manner in which it was drawn; when perfectly round, which it ought always to be, it was generally too soft; and when sufficiently hard, it was scarcely ever well manufactured, from which circumstance it was constantly false in vibration.

CHAPTER III.

THE ACTION.

By the action is understood the machinery through which the impulse given by the finger of the performer is transmitted to the string of the instrument. The parts we have hitherto considered may be said to be parts at rest, whose peculiarities consist in their statical qualities. The action is the *moving* part, and upon its capability to speak the will or mind of the player depends its excellence.

The earliest actions, as we have seen, were very rude. The hammer was lifted by an upright wire, attached to the back end of the key, and capped with a leather button, which came in contact with the under side of the hammer. The height of this button was so adjusted, that when the key was pressed down as far as it would go, the hammer was a short distance from the string; the effect of this adjustment being, that, after the impulse given to the hammer had caused it to strike the blow, it fell back upon the button, and so left the string free to vibrate. This was called the "single action." "It was," says Mr. Pole, "the simplest form of mechanism, and probably the earliest that obtained for the pianoforte any share of public favour. Square instruments were made with this action as late as the commencement of the present century, and probably many of them are in existence still."

The invention of the "hopper" was the next great improvement. "The evil of the single action," says the authority we have quoted, "was, that owing to the adjustment already mentioned, the hammer would not reach the string, unless the key were thrust down with sufficient force to give it considerable impetus; — so that it was impossible to play very *piano;* while if, to remedy this evil, the adjustment of the button was altered to bring the hammer nearer to the string, there was a danger of its not leaving it after the blow—a defect technically called 'blocking.' The hopper remedied this evil. It was a jointed upright piece, attached to the back end of the key, and used to lift the hammer, in place of the stiff wire and button of the former mechanism. When the key was pressed down, the hopper, engaging in a notch on the under side of the hammer, lifted it to within a very short distance of the string; so near, in fact, that almost the slightest pressure would cause it to strike; but at this moment, while the key was still pressed down, the jointed part of the hopper coming in contact with a fixed button as it rose, escaped from, or 'hopped' out of the notch, and let the hammer fall clear away from the string. This mechanism, as applied, with trifling variation, to the square pianoforte, was called the 'double action,' and is extensively in use for this and the upright form at the present day."

The invention of the "check" remedied a defect which we shall next explain. "The hammer, when liberated from the hopper, fell upon a rail covered with cloth, or some other soft bed prepared to receive it. Now, when a forcible blow was struck, there was always a danger of the hammer rebounding; or, in other words, the elasticity of the struck wire would send it down with such force that it rebounded from its bed, touched the string a second time, and so damped the vibration and injured the tone. The remedy for this was found in fixing to the back end of the key a projection called a 'check,' which caught the edge of the hammer as it fell, and held it down so firmly that it could not again rise. The check was one of the most important additions ever made to the action; and no pianoforte, of any pretensions, is considered complete without it."

The next invention applied to the action of the pianoforte is called the "repetition" mechanism, and its object is thus explained: "In the ordinary action, after the hammer has fallen, the key must rise to its position of rest before the hopper will engage again in the notch of the hammer, so as to be ready for another stroke; and hence a note cannot be repeated without not only requiring the finger to be lifted through the entire height of the key's motion, but also demanding a length of time between the repetitions sufficient to allow of its full rise. The contrivances by which this inconvenience has been overcome, are of various kinds, according to the fancy or ingenuity of the makers; but they all act on the same principle; namely, by holding up the hammer at a certain height while the key returns; by which means the hopper is allowed to engage itself under the hammer earlier, and to reproduce the note in less time, and with less labour to the finger, than before."*

The last invention, which seems to have brought the mechanism of the pianoforte to perfection, is the repetition and "tremolo" action of the Messrs. Hopkinson. This is accomplished by means of a pin-jointed sticker, attached to the key and hammer-stick; which sticker, being in connection with the relieving action, brings the action of the hammer upon the strings completely under the control of the performer. A check is provided to prevent the hammer from vibrating after a powerful stroke; but for a gentle touch the check is not required, and the hammer remains near the string, ready to be acted upon by the slightest movement of the finger. By means of this mechanism, the utmost possible delicacy of touch is combined with a far greater power than has hitherto been obtained in any pianoforte we have seen. So sensitive is this action, and so accurately may the amount of tone desired be regulated, that the "tremolo" (similar in effect to that produced by the violinist, or the voice of a finished singer) may be produced by the mere trembling of the finger when pressed upon the key; at the same time, a performer of only moderate power of finger can by it fully develop the most powerful effects of the modern style of pianoforte playing.

We shall now give a brief explanation of the action of a pianoforte, and shall take for our example the mechanism of the ordinary upright instrument, termed the "Cottage."

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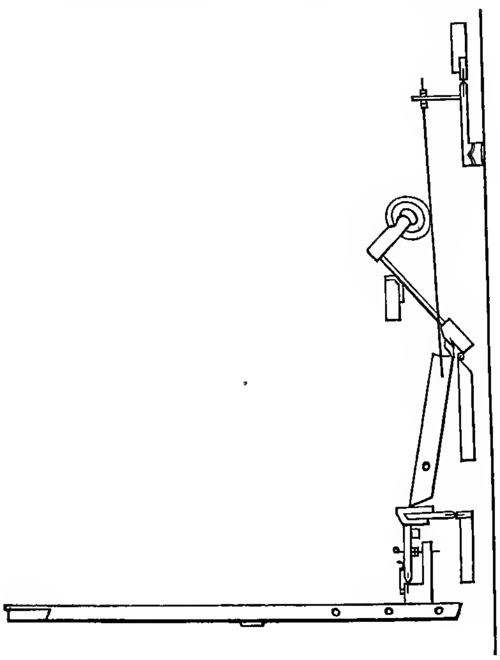
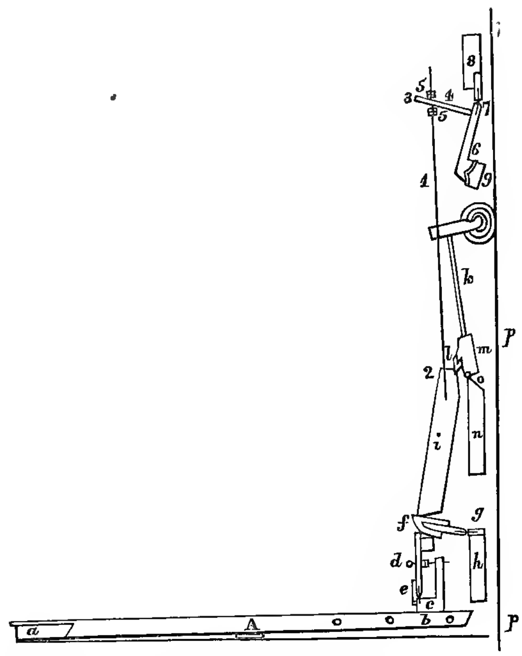
* "When it is considered that all the delicacies of expression and articulation, and all the lights and shades of the performance depend upon the precision, certainty, and promptitude with which the hammer responds to the touch of the finger, the immense importance of the mechanism of the key will be duly appreciated. Yet it is a curious fact in the records of the progress of this instrument, that the mechanism of the key has been the last part of it to which attention has imparted perfection; and that, even at the present time, notwithstanding the advanced state of the musical art, and the all but universal cultivation of the pianoforte, the key mechanism is constructed on imperfect principles, and is, consequently, productive of unsatisfactory effects."—Dr. Lardner's *Popular Essays on Scientific Subjects*, 1852, 12mo.

The Action while the Key is at Rest.



The same with the Key pressed down.



The key (A) forms a lever, one end of which (*a*), being pressed down, raises the other end (*b*), which in turn pushes up the hopper (*c*). (The regulating pin (*d*) and spring (*e*) determine the touch). The hopper is met by the lever or under hammer (*f*), which by a hinge (*g*) is fastened to the lever rail (*h*). Above this is the sticker (*i*), to which the hammer (*k*) is hinged at (*l*) by a fastening of wash-leather. The butt (*m*) of the hammer being hinged to the hammer rail (*n*), in the point (*o*), it is obvious that the pressing down of the key (A) must drive up the sticker (*i*), and consequently cause the hammer (*k*) to strike against the string (*p p p*).

Thus far, then, we have the means of producing the sound from the string. But a little consideration will show us that we also require the means of limiting the *duration* of each particular sound. For this purpose the damper is employed, the form and parts of which, viewed sideways, are shown in the above diagrams.

The damper wire (1) is fastened sideways into the sticker at (2), so as to pass upright between the butts (*m*). The top of the wire forms the screw (3), passing through the arm of the damper (4), which is secured to it by buttons (5 5). The damper (6), which is fixed by a hinge (7) to the damper rail (8), being thus elevated with the sticker (*i*), raises its felt surface (9) off the string (*ppp*), and leaves the sound clear and open. Immediately upon the hand being taken off the key, the weight of the sticker (*i*) causes the wire to fall, and consequently presses it against the string, muffling and stopping the vibration. Thus, as long as the hand is held on the key, the vibration will continue, and no longer.

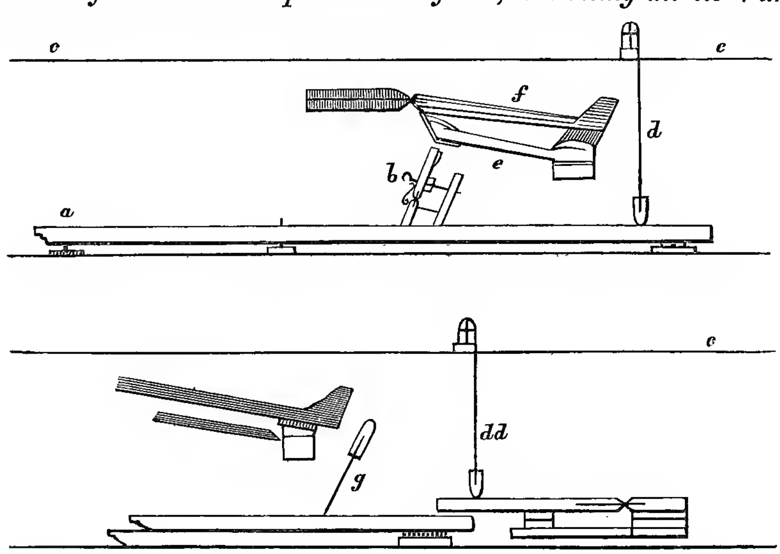
Some pianos have two *pedals ;* one to soften the sound, and the other to augment it. When a piano has but one, it is always the "*forte*" pedal. The usual action of the " *soft* " pedal is to shift the hammers sideways, so that they strike only *one* string instead of two, or two strings instead of three, for each note.

The action of the "*forte*" pedal is to lift the dampers off the strings, so that each set of strings may have a larger field of vibration, and that all the strings together may contribute to swell the force of the note struck, by sympathetic vibrations. Immediatelythe foot is removed, the hammers and dampers return to their original position, and the effect of the pedal ceases.

The action of the pianoforte has afforded unlimited scope for.the ingenuity of the manufacturers; and almost every maker of note has his own particular mechanism. The same essential parts, however, are found in all the best instruments, more or less modified in their shape and arrangement. Thus we have the hammer, the hopper, the check, and the contrivance for repetition. To particularize all the various actions of the 200 pianoforte makers whose names are found in the London Directory, would be an unprofitable labour; or even all the good actions: we must be content with a few of those in common use.

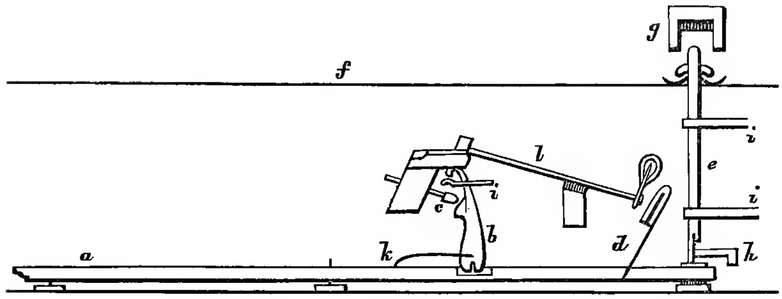
ACTIONS OF VARIOUS MAKERS.

The Action of the modern Square Pianoforte, exhibiting all its Varieties.



a, key. *b*, hopper by which the escape of the hammer is effected. *c*, string. *d*, Irish damper. *d d*, crank damper. *e*, under hammer. *f*, hammer. *g*, check.

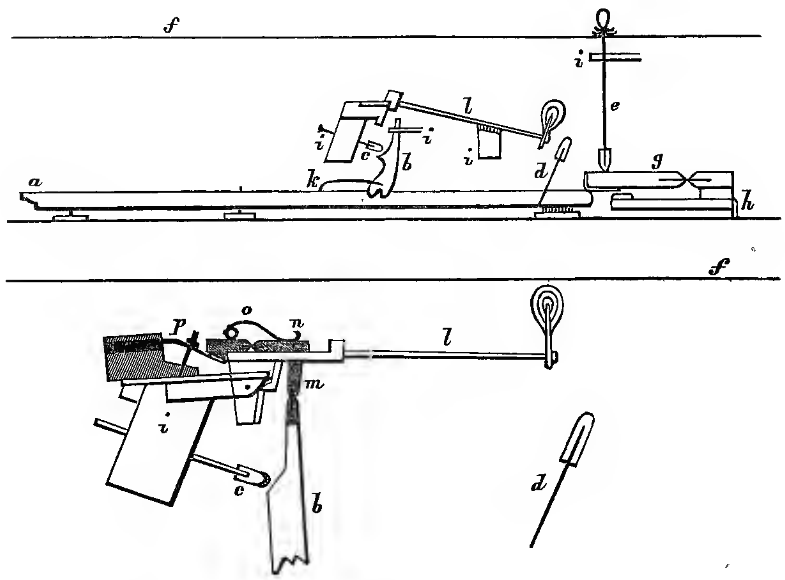
The common Grand Pianoforte Action.



a, key. *b*, lever. *c*, button. *d*, check. *e*, damper. *f*, string. *g*, ruler. *h*, damper pedal lifter. *i i i*, rails and sockets. *k*, spring. *l*, hammer.

Messrs. Broadwood's former and new Patent Grand Actions.

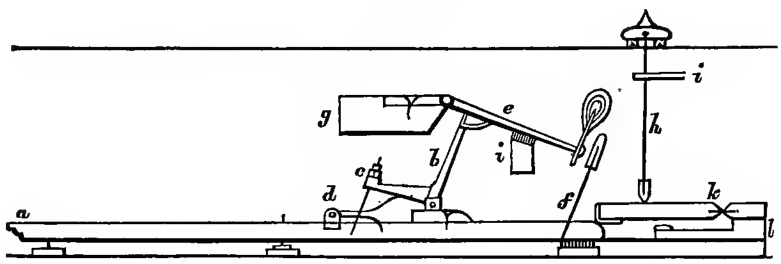
[*The improvements by Mr. Southwell.*]



The shaded parts show the new additions; the improvement being the keeping the hammer at a certain distance from the string when the finger is on the key.

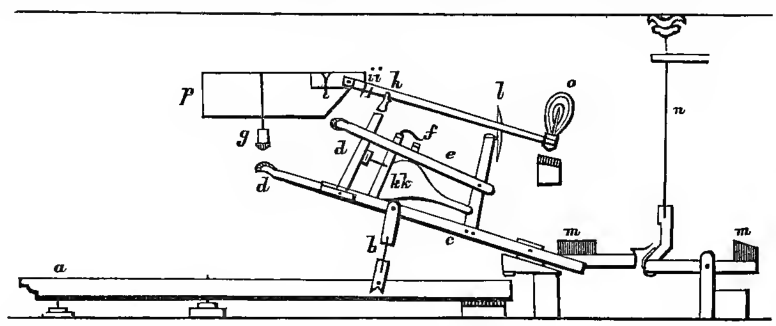
a, key. *b*, lever. *c*, button. *d*, check. *e*. damper. *f*, string. *g*, crank for damper. *h*, damper pedal lifter. *i i i i*, rails and socket. *k*, spring. *l*, hammer. *m*, *n*, block passed through the hammer butt. *o*, spring fixed at the back of *n*, and pressing upon the front of it; by which arrangement, when the lever passes the notch, it is caught by *m*, and the hammer is sustained at the given height. *p*, another spring, which regulates the action of *a*, and determines the height it shall rise.

Messrs. Collard's Patent Grand Action. (Invented by Mr. George Stewart.)



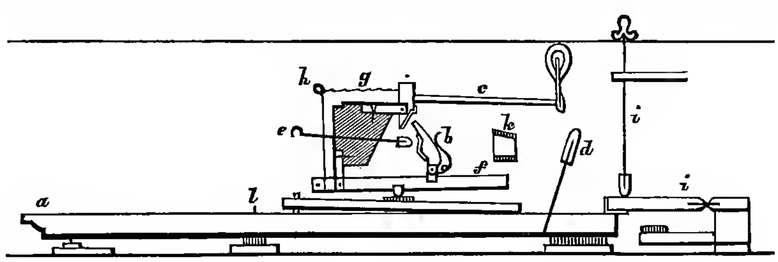
a, key. *b*, hopper. *c*, button. *d*, hopper spring. *e*, hammer. *f*, check. *g*, hammer rail. *h*, damper. *i i*, rail and socket. *k*, crank for damper. *l*, damper pedal lifter.

Erard's Patent Grand Action. (Invented by Sebastian Erard.)



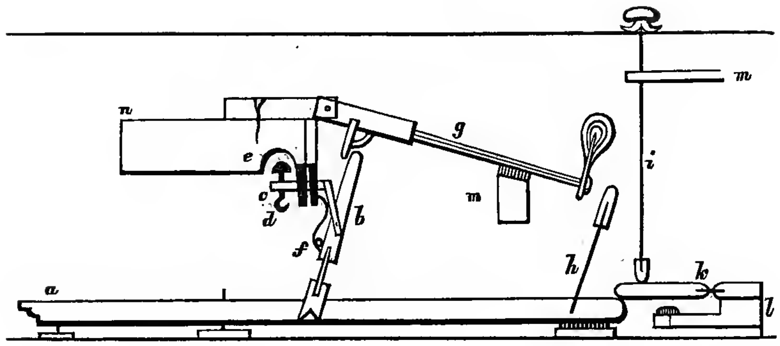
a, key. *b*, lifter centered in the key and the hopper lever. *c*. hopper lever. *d d*, hopper. *e*, hammer sustaining lever. *f*, stop for *e*. *g*, hopper button. *h*, butt for the hopper to strike against. *i i*, two small wire stops acting upon *e*. *k k*, springs acting upon hopper lever and hammer lever. *l*, check. *m m*, balance weights of lead. *n*, damper. *o*, hammer. *p*, hammer rail.

Wornum's Grand Action. (This action is based on the Piccolo Action.)



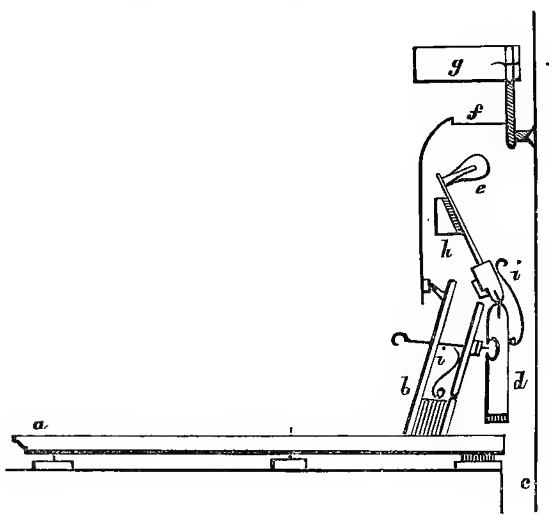
a, key. *b*, hopper and spring. *c*, hammer. *d*, check. *e*, button to set off the hopper. *f*, hopper lever. *g*, tie attached to the butt of the hammer. *h*, sustaining spring linked at the end of the tie, and fixed in the front end of the hopper lever, the rising of which puts the sustaining spring in action. This spring gives the *piano* blow and assists in the *forte* and repetition. damper and fixings. *k*, hammer ruler and back touch. *l*, wood spring to set up the hoppers.

Zeitter's Grand Action.



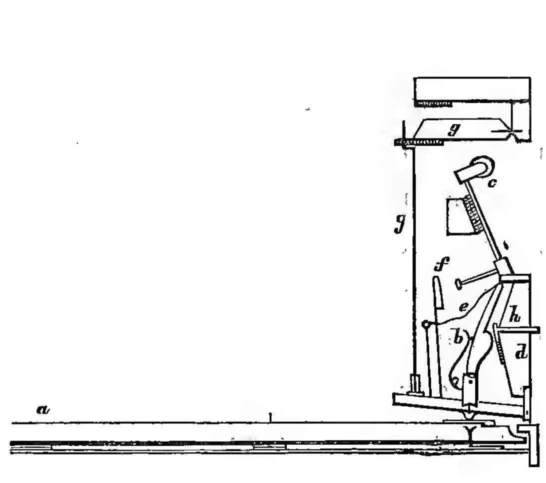
a, key. *b*, hopper, which works in the key with what is called a *bird's mouth*. *c*, escapement part of the hopper, and the setting off which is effected by the button working in the arched part above it, *d*, *e*. *d*, button and wire. *e*, arch in which the button acts. *f*, hopper spring. *g*, hammer. *h*, check. *i*, damper. *k*, damper crank. *l*, damper pedal action. *m m*, rail and socket. *n*, hammer rail.

Wornum's Unique Action.



a, key. *b*, hopper. *c*, string. *d*, hammer rail. *e*, hammer. *f*, damper and wire. *g*, damper rail. *h*, ruler. *i i*, springs.

Wornum's Double or Piccolo Action.



a, key. *b*, hopper and spring. *c*, hammer. *d*, hammer rail. *e*, tie and wire. *f*, check. *g g*, damper and wire. *h*, setting off screw.

While the improvements in the mechanism of the action have been in progress, others have been effected, individually less important, and demanding less refined efforts of invention, but which collectively have augmented the power, improved the tone, and increased the durability of the pianoforte, rendering it at the same time more retentive of pitch and tone, and more capable of withstanding the deteriorating influences of climate and vicissitudes of temperature.

In treating of the action of the pianoforte, our work would be incomplete without some notice of the German mechanism known as the "Vienna action." This we shall briefly record in the words of the eminent pianist, M. Thalberg.

"During the first years of this century, two systems chiefly prevailed with regard to the grand piano: the older one followed by the London makers, known as the English system, and the newer one in Germany, called the Vienna system. The difference was principally in the action; that of the English being the common grand action, the origin of which is unfortunately unknown; and that of Vienna, a new action, invented, it is said, at Augsburg, by an organ-builder. The old grand action gave a more powerful blow, and produced a fuller and finer tone, while the lightness of touch of the Vienna action afforded far greater facilities of expression, and caused it, therefore, to be adopted by most of the eminent pianists of the time. This is not at all to be wondered at, when we consider the immense importance of the action of the piano in bringing out the elements of expression which are peculiar to the instrument. Between the mind of the player that conceives, and the string that expresses by its sound the conception, there is a double mechanical action: one belonging to the player, in his fingers and wrists; the other to the piano, in the parts which put the strings in motion. No two piano players touch the instrument alike; that is, no two players have the same mechanical action in their fingers, or produce the same tones; and the difference in the style and degrees of excellence of pianists is more owing to this than to any other cause. It is, therefore, self-evident that that part of the piano which continues the action of the fingers, and completes the connection between the mind of the player and the strings of the instrument, should have a delicacy and a power answering as near as possible to those of the hand of the player. Every difference in the action of the piano will give a corresponding difference in tone and expression; and hence this part of the instrument has at all times been justly considered of paramount importance, not only by the great professional pianists, but by the highly cultivated amateur player. Now, however, we have an action, the invention of the late Sebastian Erard, which gives a more powerful blow than the old grand action, and a far more rapid and delicate effect than the old Vienna action—thus combining the advantages of both systems.

"To give an idea of the degrees of perfection attained at the present day in the construction of the piano, we will describe one of the grand pianos in the Exhibition*. This instrument is 8¼ feet in length, and 4½ feet in its greatest width; its frame is of an enormous strength, compared with the instruments of former times, being heavily braced with wood below the strings, having a complete system of metallic bracing above the strings, firmly abutted, and consisting of longitudinal bars let into metal at each end, and having the curved side formed of a number of separate pieces glued together in a mould, to ensure durability and fixedness of form. Its sounding-board extends to the frame on all sides, except the space left for the action. The strings are made entirely of steel, and of wire so thick that the tension necessary to bring them to the proper pitch, produces an aggregate strain equal to at least twelve tons weight, while they are passed through studs drilled into the metal wrest-plank, thus giving the strings an upbearing position, which prevents the slightest displacement of the point of contact by any force of the hammers; and the system of placing the strings on the instrument, determined by accurate acoustic experiments, causes them to be struck by the hammer at the precise nodical point which produces the freest and clearest tone. The compass is extended to seven octaves, from A to A. The action of this piano is described by Dr. Lardner, in a work just published on Mechanics†, as 'a beautiful example of complex leverage in the mechanism which connects the key and hammer. In this instrument, the object is to convey, from the point where the finger acts upon the key to that at which the hammer acts upon the string, all the delicacy of action of the finger; so that the piano may participate, to a certain extent, in that sensibility of touch which is observable in the harp, and which is the conse-

* The magnificent instrument by Erard in the British department of the Exhibition of 1851.

† See Dr. Lardner's *Popular Essays on Scientific Subjects*, 12mo. Longman, 1852.

quence of the finger acting immediately on the string in that instrument, without the intervention of any other mechanism.' The power of this instrument depending on the quantity of matter brought into vibration, the resonance, or the perfection of that vibration, depending on the correct proportions of its parts, and the accuracy of intonation depending on the nature of the bridging, the proportions of the strings, and their arrangement with regard to the blow of the hammer, are all most admirable; while the action depending on the peculiar mechanism employed far surpasses every thing else of the kind; for it enables the player to communicate to the strings all that the finest-formed and most skilful hand can express, and becomes, as it were, a part of himself, reflecting every shade of his feelings, from the most powerful to the softest and most delicate sounds. This action is indeed so perfect, particularly in its power of delicate repetition, that if any note is missed in execution upon it, it is the fault of the player, and not of the instrument. Many persons have a very meagre notion of the power of expression possessed by the pianoforte. The fact is, however, that it really possesses almost all those elements of expression which belong to any other instrument, and several which are peculiar to itself, from the circumstance of the various parts of music adapted to the instrument being brought out by the same hand and the same feeling. An immense difference of volume of tone, and of effect, is produced by the manner of touching the keys, and by the use of the pedals, especially upon an instrument of great power, fine quality of tone, and delicate mechanism in the action." *

From the earliest period in the history of the pianoforte, as we have shown in the first part of our volume, makers have bestowed their time and attention in contriving a system of action for striking the strings *downwards*, instead of upwards. In addition to the early makers whom we have named, we may instance Messrs. Stodart, Wornum, Kollman, and Pape. Many advantages undoubtedly attend this plan, some of which are enumerated in the following extract from a report on M. Pape's instruments, signed by Cherubini, Lesueur, Boieldieu, Auber, Paer, and Berton:

" The advantages which these newly invented pianos offer are the following :—

* M. Thalberg's remarks in the Jury Report of the Exhibition of 1851.

they unite more richness, as well as sweetness of tone and power, to a greater solidity and less external size. One of the greatest defects in the old system, against which the manufacturers have struggled in vain for the last twenty years, arose from the mechanism being placed beneath the sounding-board; whence it became necessary, in order that the hammers might strike the string, to form an opening in the sounding-board, by which the solidity of the instrument was more or less compromised. Endeavours had been made to remedy this defect by double bracing, so as to prevent the resistance of the strings; but complete success had never attended these attempts: and as to the opening on the sounding-board, and the injurious influence it had in diminishing the tone of the instrument, it was impossible, under such a system, to obviate it. With such difficulties, therefore, it became necessary to change the whole plan.

"In the new invention of M. Pape, the mechanism of the instrument being placed above the sounding-board, the two blocks now form but one; since they are, as well as the sounding-board, directly united and without any opening whatever; by which arrangement such a solidity is obtained, that it is next to impossible for the sounding-board or block to give way—a circumstance of very frequent occurrence in pianos constructed upon the old system. Besides, the keys communicating more immediately with the mechanism of the instrument; and the hammers striking the strings from above, against the bridge and the sounding-board, there results a much greater power and clearness of sound, as well as a greater facility in execution. The strings likewise being pressed by every stroke of the hammer upon the bridge, retain the instruments in tune a greater length of time than in the old pianos, in which the strings were continually being lifted up. A fortunate circumstance in the present invention is, that it requires much less solid wood; and the iron bars which they were compelled to make use of under the old plan, have been entirely laid aside."

The arrangement of the mechanism in M. Pape's instruments has likewise another peculiarity. In the generality of down-striking actions, the hammers are situated at the back end of the key frame, and are moved by the back ends of the keys; in the present action, on the contrary, the hammers are placed under the keys, and are worked from their *front* ends, directly under the part struck by the fingers; so that the thrust passes immediately downwards, in a direction nearly vertical, from the finger to the hammer, and thence to the string below. The firmness which this direct action gives to the blow may be easily understood. Moreover, there is another great advantage attending this disposition of action, namely, that from the hammers being brought so far forward, a much greater length of string is obtained than on the ordinary plan, with the same length of case. In up-striking instruments (as well as in down-striking ones having the hammer at the back), the front end of the string must, of necessity, lie at some distance from the front end of the instrument; while in M. Pape's arrangement the string is brought completely up to the front, and thus an increase of about a foot in length is obtained, or, which is the same thing, an equal diminution in the length of the instrument for the same length of string.

"There are some peculiarities," says Mr. Pole, "common to all the varieties of action, as made by M. Pape, well worthy of imitation, but which have been little attended to by the majority of makers. All the parts are perfectly accessible, and every point liable to wear is provided with a mode of adjustment. For example, the grand action, although apparently buried in the case, can in a moment be turned round, and every part exposed to view; while the escapement, the effective length of hopper, the key-centre, and the front pinhole, the dampers, the height of the key, &c. have all adjusting screws, by which they can be regulated with the greatest facility when worn, or otherwise out of adjustment. By these means, all rattling of the keys and action, unevenness in the touch, imperfect damping, &c. which so often occur almost irremediably in old instruments, may be at once removed, and the mechanism restored to its original good condition. The key-centres, instead of working on a vertical pin, as commonly made, turn on a horizontal wire—a plan more in accordance with mechanical rules, and less liable to derangement."

CHAPTER IV.

VARIOUS MECHANICAL CONTRIVANCES APPLIED TO THE PIANOFORTE IN ORDER TO OBTAIN SUSTAINED SOUNDS.

THE absence of the means of sustaining sounds in the pianoforte has suggested to ingenious men, at various periods, the possibility of devising some intermediate agent, to act between the keys and the strings, that would accomplish this desired object. But, as it has been remarked, it is much more easy to draw true harmony from square or cylindrical pipes by artificial means, than to intone elastic strings, which borrow a part of their sound from the body upon which they are mounted. The bow, in the hand of an able performer, has power to act upon the mass of air contained in the sonorous body of the violin, tenor, or bass, and to bring it in contact with the external air; but it is different to produce the same effect by means of a mechanical bow. If it is sought to give it sufficient power for this purpose, the motion of the machine becomes hard, restive, and almost impossible. On the contrary, if that degree of suppleness be left to the bow which is often necessary, the only sound obtained is meagre and devoid of intensity. All the researches and trials hitherto made have failed in removing these obstacles, and perhaps the latest invention is as imperfect as the first.

The earliest attempt to produce sustained sounds in a keyed-stringed instrument was made by John Heyden, about the year 1600. The instrument was called the "*Clavecin viole*," or "*Geigen clavicymbal.*" The mechanism consisted of a series of cylindrical bows, made to act, by means of a pedal, upon an ordinary harpsichord with metallic strings. Heyden was a distinguished musician of Nuremberg, and the organist of the church of St. Sebald in that city*. He visited Prague early in the seventeenth century, and exhibited his instrument to Rudolph the Second, from which prince he obtained for himself and his heirs the sole right of constructing the instrument. In 1605 and 1610, he published descriptions of his invention, in German and Latin; and it is honourably mentioned by Prætorius and Mersennus, in their respective works†. Heyden died at Nuremberg in 1613.

More than a quarter of a century afterwards, Father Kircher, the visionary author of *Musurgia Universelle*, mentions the possibility of constructing an instrument upon a similar plan; but his description is too vague to be of any interest at the present day.

In 1664, John Evelyn records, in his valuable Diary—"October 5th—To our Society [i. e. the Royal] there was brought a new-invented instrument of music, being a harpsichord with gut-strings, sounding like a concert of viols with an organ, made vocal by a wheel and zone of parchment that rubbed horizontally against the strings." ‡

In 1717, Marius, the harpsichord maker of Paris (before noticed as a claimant to the invention of the pianoforte), contributed an instrument of a similar description, to which he gave the name of *Clavecin vielle*. It met with the approval of the *Académie des Sciences*, and the model is, we believe, still to be seen among the collection of "machines" preserved by that institution.

In 1754, Hohlfeld, an ingenious mechanic of Berlin, who had rendered himself worthy of notice by several important inventions, conceived the idea of his *Bowed* harpsichord, a model of which he presented to the King of Prussia in that year. This instrument was mounted with cat-gut strings, under which was placed a hair bow, put in motion by a little wheel. Small hooks attached to the keys pressed the strings upon the bow, which, by its action on the strings, drew forth the sounds. It differed very little, we believe, from Marius's *Clavecin vielle*.

* He was the son of Sebastian Heyden, and born in 1540. See Fétis's *Biographie des Musiciens*.

† Prætorius gives a drawing of the mechanism of Heyden's "Geigen clavicymbal" (*Syntagma Musicum*, tom. ii, p. 67). An engraving of the exterior may also be seen in Doppelmayr's *Nachricht von dem Nürnbergischen Mathematicis und Kunstlern*, folio, Nuremberg, 1730.

‡ *Diary*, vol. i, p. 381, edit. 1850.

This was followed by the Lyrichord, an instrument exhibited in London in 1755; and afterwards by the Celestina, an invention of Adam Walker, the philosopher, and friend of Dr. Priestly.* Walker introduced it with considerable effect in his *Eidouranion*, or transparent orrery, exhibited at the Haymarket Theatre in 1778.

About the same time, the Rev. William Mason, whom we have before had occasion to mention, in connection with the pianoforte, turned his attention to the subject under consideration. Horace Walpole, in a letter to the poet, dated Feb. 29, 1776, says, speaking of Dr. Burney, "I perceive he did not know that you are an *inventor* in the science, and have begotten a new instrument by the marriage of two others." This instrument was called the *Cœlestinettes.* The Rev. J. Mitford, in his *Correspondence of Horace Walpole and the Rev. William Mason*, published in 1851, adds, in a note (vol. i, p. 431): "It [the Cœlestinettes] is not, however, to be found among the other works of art still remaining at Aston; all his music [and instruments] having, I believe, been bequeathed to a friend. However, by the favour of Miss Alderson, a MS. description of it, in Mason's writing, dated Aston, March 30, 1761, is now before me. It consists of ten pages, and enters into all the minute particulars of its formation. The beginning is as follows: 'For the proper preparation of the horse-hair of the bow used in performing on the Cœlestinettes, the clearness of the tone of the instrument, the facility of its touch, and, in short, every thing that makes any degree of execution practicable upon it, all depends principally on that part of it which is employed in making it sound; namely, the single horse-hair attached to the moveable ruler or bow, which is drawn backwards and forwards over the strings by the left hand of the performer, while his right is employed in pushing down the keys. To perform this properly, four circumstances must be particularly attended to: 1, the size of the hair; 2, its length; 3, its texture; 4, and principal, its due degree of resin;' &c. The instrument is still remembered at Aston, as resembling in shape the old spinette or harpsichord."

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* This invention is included in the patent granted to Adam Walker, of Manchester, "teacher of natural philosophy," July 29, 1772. See page 149, *ante*.

Towards the close of the eighteenth century, Gerli, a mechanist of Milan, produced an instrument mounted with cat-gut strings, and acted upon by means of finger-keys and horse-hair bows, in the manner of the clavecins we have described, but with a greater degree of perfection. According to the Italian journals, it was used at several concerts, and introduced into the churches; but it seems probable that the instrument was found to have insurmountable defects, for it soon fell into oblivion.

The next attempt of the kind was by Schmidt, a pianoforte manufacturer at Paris*, who produced an instrument in the form of a long square chest, which was shown in the exhibition of the products of industry at the *Invalides* in 1806. At one of the extremities of his instrument was a key-board, with the mechanism of a common pianoforte; at the other was another key-board, intended to put in motion a number of small cylindrical bows, by means of which the cat-gut strings were intoned. The sounds obtained by this mechanism resembled those of the cymbal; not corresponding to the intention of the maker, who sought to imitate bowed instruments. However, M. Schmidt obtained an honourable mention of his endeavours.

In 1810, M. de St. Perne, an amateur, invented, under the name of *Organon-Lyricon*, an instrument which, besides the common pianoforte, comprised a dozen wind instruments, all of which could act in concert with it. By an ingenious, but somewhat complicated piece of mechanism, the performer could, by the assistance of a double key-board, produce the tones, either separately or together, of the pianoforte, flute, oboe, clarionet, &c.

About the same time, Pouleau invented his *Orchestrina*, which bore a considerable degree of analogy to the instrument of Schmidt, just mentioned. What particularly distinguished M. Pouleau's Orchestrina from all other inventions of the same kind, was a horse-hair bow, made without any visible suture, the secret of which he never revealed.

The next invention worthy of notice is that of our own countryman, Mr. Isaac Mott. The *Sostinente* is said to have resembled, in its tone, the *celestina* stop of the

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* This artist, a distinguished mechanist, was born in the duchy of Nassau in 1768, and settled at Paris in 1795. He died in 1821.

harpsichord. But the effect was produced, not by drawing a skein of silk over the strings, as in that invention, but by a different and novel principle. A strong silk thread was stretched across the strings of the pianoforte, and to each finger-key there was also a silk thread, to which was attached a skein of silk, which skein passed over a cylinder of about two inches diameter, and was ultimately attached by three threads to the cross thread above mentioned. When the finger-key was pressed, it stretched the skein over the cylinder, and caused the cross thread to press on the string. At the same time the cylinder was turning on its axis, and, being touched with the dust of fiddle rosin, communicated vibration to the string*. This instrument was made in the grand upright form.

In 1822, the Abbe Gregorio Trentia invented an instrument to which he gave the name of *Violicembalo.* The *Gazetta di Milano* gives the following account of it: "The strings are of cat-gut, of various dimensions, of which the lowest are covered with metal wire, and each string is appropriated to a single tone. At the extremity of each key is a horizontal lever, by means of which the string is raised upwards to meet the action of the bow. This bow consists of a piece of woollen stuff, inwrought with silk threads instead of hair, which is drawn backwards and forwards by means of two cylinders, affixed to the sides, and set in motion by means of a fly wheel, worked by the right foot." The *Breton*, a journal of literature, &c. published at Nantes, says: "It is, perhaps, the most perfect instrument of the kind produced; yet it fails with respect to the bow, which, being made of *hairs* [*sic*], produces tones of a wiry and shrill kind. It seems to want the bow composed by M. Poulleau, the secret of which unfortunately died with him." A long article upon this invention, by the Conte Leopoldo Cigonare, may be seen in the *Effemeridi Litterarie di Roma*, vol. v, p. 29.

M. Lange, of Munich, next invented an instrument called the *Æolodikon.* It is said to have resembled the *Celestina* of Adam Walker; but we have not been able to meet with any account of it.

M. Gama, a pianoforte-maker of Nantes, invented, in 1827, an instrument to

* The patent for this ingenious invention is dated Feb. 1, 1817. See p. 152, *ante*.

which he gave the name of *Plectroeuphon* (i. e. harmonious bow). "While in its mode of performance," according to the journal of the time, "it comprises all the facilities of the piano, it possesses all the additional advantage of diminishing or reinforcing the sounds at pleasure, and producing with ease the finest gradations of tone. It can, as occasion requires, supply the place of four stringed instruments; and offers, in other respects, resources not possessed by the piano." Notwithstanding this recommendation, the attempt to introduce it at Paris was altogether unsuccessful.

The imperfections of the previous instruments suggested to M. Dietz, of Paris, in 1827, his *Polyplectron*. The principles upon which it was constructed are more conformable to what observation teaches with respect to the resonance of instruments of the bow kind, than those adopted by his predecessors. Whether the bow acts longitudinally, or whether it be cylindrical, its horizontal movements can necessarily produce only a feeble sound, because, in acting upon the string, it can make it vibrate only in an opposite direction to the vibrations of the sounding-board. This was the predominant defect in all the instruments which have been described; and the observation of this led M. Dietz to form the idea of making his bow act perpendicularly on the strings, after the manner that the violin, bass, and every other bowed instrument is played. In order to effect this he had need of as many bows as notes; and this has been effected by means of a piece of mechanism of the most ingenious kind. Numerous bows, composed of thin slips of leather, were made to circulate upon a cylinder placed upon the upper part of the instrument, and over pulleys ranged on the lower. The motion of the key brought the bow in contact with the string, by means of a small thin piece of copper, and the sound was instantaneously produced. This sound was capable of assuming different characters, according to the degree of pressure applied to the key. Thus, when the artist played with a firm touch and *legato*, he obtained the effect of an excellent organ, and of a voluminous tone. If he played with lightness, whether *legato* or *staccato*, he produced the effect of bowed instruments. In the deeper part of the scale, and in the medium, the analogy was almost perfect with the double bass, violoncello, and tenor. In the higher range of notes, the sound assumed the character of different kinds of violas, rather than of the violin. The inventor did not succeed in producing the long-sought imitation of this admirable instrument.

The Polyplectron was also distinguished from the other instruments of its kind by the rapidity of its articulations, which allowed of its being played with all the facility of the pianoforte, in executing the most rapid and complicated passages.

Notwithstanding all these presumed advantages, M. Dietz's invention has shared the fate of its predecessors, and long since passed away.

This brings us down to the Great Industrial Exhibition of 1851. "We all remember," says a pleasant writer in *Chambers's Edinburgh Journal* (Oct. 27, 1855), " that ear-rending and infinitely distressing anomaly, the fiddle-piano, in the American department of the Industrial Building of 1851, wherein a violin, connected by mechanism with a second row of keys, played a dismal unison with the right hand of the performer, and put every listener out of spirits for the rest of the day."

Other attempts, similar to those we have briefly narrated, have boen tried at various times, by Garbrecht, Grainer, Meyer, Müller, Hackel, Hawkins, Fiebig, &c.; but we are unable to describe them particularly; and as the results have not, in one single instance, been crowned with success, this is the less to be regretted.

The object so long sought after, of obtaining a sustaining power in the pianoforte, has been attempted in another way. The principle, which has been perfected by M. Isoard, an ingenious engineer and mechanician, consists in causing a current of air to act on the string, which prolongs its vibration somewhat on the principle of the Æolian harp. For this purpose there is an opening opposite to each string, through which a stream of air passes from a bellows, when a valve, corresponding to the given note, is opened by the key. The bellows are moved by pedals, in the same manner as those of the seraphine or harmonium*.

According to the following statement, which has lately gone the round of the press, this principle is about to be carried out in our own country; but we have little faith in its success.

* The application of wind to cause the vibration of strings was first tried at Paris about seventy years ago by a German pianoforte maker named Schnell (born in 1740). The idea was suggested to him by a harp hanging in the air. Many instruments of various kinds were constructed, such as the *Anemochorde*, the *Violine-eolie*, &c. before any perfection was attained.

"IMPORTANT MUSICAL INVENTION.—Mr. F. J. Julyan, of Gerrard-street, Soho-square, has invented and patented a new method of producing musical sounds, that will be the means of effecting great improvements in the construction of wind and stringed instruments. After making a great variety of experiments relating to the effect of wind upon musical strings; he has discovered a very simple and practicable means of causing strings and wires in a state of tension to vibrate without the agency of either percussion or friction, in fact without touching them. The motive power employed is a small current of air, either from the human mouth or a wind chest, being made to impinge upon the string at one end of it, passing over the string and into a narrow slit or groove immediately under it, the groove being quite parallel to the string and extending one-tenth along the length of it, leaving nine-tenths of the string available for fingering or attaching to a sound-board. The rapid alternate rarefaction and condensation of the air at the slit or mouthpiece performing a part equivalent to the bow of a violin, and sustaining the sound as long as the wind continues to act upon it. We have seen it applied to a sound-board and organ-pipes; and we have seen and heard an instrument made upon this principle, called the 'Eolian Monochord,' which has one bass string fifteen inches long, one end of which is fixed over a mouth-piece one and a half inch long, in the manner described above. It is held in the same position as a flute and blown with the breath. Three chromatic octaves can be produced on this very simple instrument. The tones are of a peculiar kind and of excellent quality."

CHAPTER V.

MELOGRAPHIC, MECHANICAL, AND TRANSPOSING PIANOS.

The idea of constructing a harpsichord or pianoforte by means of which the improvisations of a composer might be preserved, has considerably occupied the attention of several ingenious mechanists. The Rev. Mr. Creed, a clergyman of London, first conceived the idea of a musical instrument that, while performed upon, should trace on paper the music executed; and, in 1747, he submitted his project to the consideration of the Society for the Encouragement of Arts and Manufactures, in a memorial entitled *A Demonstration of the Possibility of making a Machine that shall write extempore Voluntaries, or other Pieces of Music, &c.** It is asserted also, that a monk, of the name of Engramelle, about the year 1770, made an instrument of this kind, the success of which was complete; but the explanations which are given of it are very obscure, and of a kind to give rise to doubts concerning the truth of the facts. On the other hand, John Frederick Unger, counsellor of justice at Brunswick, in a German work printed in 1774, has claimed the invention of the instrument attributed to Creed, and proved that he had previously made a similar one†.

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* *A Letter to the President of the Royal Society, inclosing a Paper of the late Rev. Mr. Creed, concerning a Machine, &c.* is contained in the *Philosophical Transactions*, vol. xliv, p. 445. The author of the letter advocating Mr. Creed's notions was John Freke, the celebrated surgeon.

† *Entwurf einer Maschine, wodurch Alles, was auf dem Clavier gespielt wird, sie von selber in Noten setzt, im Jahr* 1752, *an die Königliche Akademie der Wissenshaften zu Berlin eingesandt, nebst dem mit dem Herrn Doctor Euler, darüber geführten Briefwechsel, und einigen an dem diesen Entwurf betreffenden Nachrichten.* Brunswick, 1774. 4to.

Hohlfeld, however, the ingenious mechanic of Berlin before mentioned, has the best claim to the invention. Availing himself of the suggestions of Euler, he, in 1752, made an instrument similar to that proposed by Creed and Unger, and presented it to the *Académie.* The invention consisted of two cylinders, so applied to a pianoforte, that, as they revolved during the performance, one received the paper unrolled from the other. By this means the notes were marked by a crayon upon the paper, which a spring kept in motion. But the operation was so fatiguing, that the *Académie* contented itself with admitting the great ingenuity of the contrivance, and awarding the inventer a handsome gratuity in compensation for his talents and trouble. Hohlfeld received back his machine, and, some years afterwards, sent it to his country seat near Berlin; where, in 1757, it was consumed by an accidental conflagration.

In the month of August, 1827, M. Carreyre made trial, before the Committee of the Fine Arts of the Institute of France, of a *melographic* piano, which consisted of a clock movement, which unrolled from one cylinder to another a thin plate of lead, on which were impressed, by the action of the keys of the instrument, certain peculiar signs, which might be translated into the ordinary notation by means of an explanatory table. After the experiment, the plate of lead was removed, to make the translation, and a commission was appointed to report; but as no report was ever made, it is probable that the translation was not found to be exact. At the same time, M. Baudouin read before the Institute a paper, accompanied with drawings, concerning another melographic piano; upon the merit of which we do not find that the Institute pronounced.

Self-acting virginals and harpsichords existed at an early period, as we have shown in our historical introduction. A self-acting pianoforte was invented by Messrs. Clementi and Collard early in the present century, which professes to be the first of its kind. According to the notices that appeared at the time, "This curious instrument, furnished with a horizontal cylinder, similar to that of a barrel-organ, and put in motion by a steel spring, performs, without external force or manual operation, the most intricate and difficult compositions; and, by comprising in its mechanism two complete instruments, each independent of the other, it admits, while the operation of the self-actuated instrument is proceeding within, of a distinct accompaniment on the keys without, which occupy the usual place in front, and may be played on at pleasure, with or without the self-acting part of the machine. This, the first instrument of its kind, when the spring is fully wound up, will act for more than half an hour, and may be again prepared for performance in half a minute; and, if required, stopped in an instant, while in full action. The time in which it executes any movement may be accelerated or retarded at pleasure: and while, by the delicacy and perfection of the mechanism, the *piano* and the *forte* passages are given with correctness and effect, the *fortzandi* and *diminuendi* are produced by the slightest motion of the hand applied to a sliding ball at the side of the instrument. When we consider the state of the pianoforte as originally constructed—its thin, wiry, jangling tone, ineffective weakness, and other numerous imperfections, and witness the complicated beauties and powers of this self-acting instrument, we must be both delighted and surprised,—and almost be persuaded, that to ingenuity, science, and industry, no excellence in musical mechanism is unattainable."

An ingenious contrivance of M. Debain, of Paris, intended to supersede the barrel hitherto employed, was shown in the London Exhibition of 1851. Instead of the music being pricked on a barrel, it is formed by a series of pins, fixed on the plane surface of a thin oblong tablet of wood, a few inches broad, giving to it the appearance of a currycomb. This is drawn, by a rack and pinion, through a frame, in which project wedge-shaped ends of levers, connected by rods with the hammers of the piano; so that, when any pin in the tune-tablet passes over one of these wedge-shaped lever ends, it depresses it, and thereby lifts the hammer, which, when the pin has passed over, is thrown back by a spring against the string. The mechanical apparatus is made to fit on the top of an ordinary cottage pianoforte, and may be detached at pleasure, leaving the instrument in its natural state for performance by the fingers.

Transposing instruments, the object being to suit voices of different compasses, are not of modern invention. Besides the instances noticed in the historical portion of our work, we may mention that Bauer, counsellor and chamberlain to the Prince of Prussia in 1786, constructed an instrument, the key-board of which was moveable, "transposing music one or two notes higher." Roller, of Paris, also manufactured pianos with a key-board capable of transposing 1, 2, 3, 4, or 5 *half-tones higher* or *lower*.

Transposing pianos are differently constructed. Sometimes the key-board and action, or the strings and framing, are shifted laterally, so as to make one hammer strike different strings, according to its position. The Royal Albert transposing piano differs from other instruments; as neither action nor strings are moveable. The keys may be described as divided at half their length, the front and back ends being capable of moving independently of each other, and the connection being made between them by means of a shifting lever underneath; so that by altering the position of this lever, the front end of the key C, for example, may be made to act at the back end of either of the keys C sharp, D, B, B flat, &c.

In the sketches which we have given of what relates to pianofortes and their manufacture, the reader may have been struck with the prodigious fruitfulness of imagination manifested in all these inventions. Will things remain stationary in this respect, or not? This is doubtful. The imagination of man will always be active; but it may be doubted whether there will be produced hereafter effects greatly superior to those which are now obtained. All the distinguished men, who have employed themselves in the construction of instruments, have sought to make improvements in them by a more severe application of theoretical principles; but, in practice, the results have not been such as they expected, either from unknown causes, or from their not having taken the necessary precautions. Theory is sometimes found in opposition to practice. For example, the principles of the sounding of vibrating surfaces demonstrate that violins, violas, and basses, are constructed on arbitrary rather than scientific rules; but, in the application of these principles, no one has yet been able to make instruments so good as those which were made by rules the foundation of which is unknown. The same thing may be remarked of pianofortes. Time alone will shed light on these mysterious circumstances*.

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* These remarks are translated from M. Fétis's admirable little volme, *La Musique misè à la Partée de tout le Monde.* 2nd edit. Brussels, 1839.

CHAPTER VI.

STATISTICS OF PIANOFORTES AND PIANOFORTE MANUFACTURING AS AN ARTICLE OF TRADE; MATERIALS USED IN THE CONSTRUCTION OF PIANOFORTES, &c.

THE manufacture of pianofortes has become a branch of national industry of considerable importance, whether it be regarded with reference to the scale upon which it is conducted, or the class of labour it employs. Dr. Lardner* took some pains to collect statistical information; but remarks—" we have not been able to obtain any certain or exact statistical data by which a calculation of its magnitude or value can be estimated. In the absence of such precise data, however, some approximation may be made by comparison with the ascertained extent of the same manufacture in a neighbouring country, where it is certainly fifty per cent. less in quantity and value than in England.

" At the Great Exhibition of the Products of French Industry, which was held in Paris in 1849, it was ascertained, by official documents placed at the command of the juries, that the annual value of the pianos fabricated in France was above eight millions of francs; and, inasmuch as the manufacture was then, and has since been, in rapid development and increase, we shall not probably over-estimate its present amount by stating it at ten millions of francs, or four hundred thousand pounds sterling.

" So great a consumption of this manufacture may be explained, partly by the

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* *Popular Essays on Scientific Subjects*, by Dr. Dionysius Lardner. 8vo. London, 1852. A charming series of papers, which originally appeared in the " Times," during the progress of the Great Exhibition of 1851. (Essay xiv, p. 363.)

inevitable effects of time and climate even on the most solid and durable mechanism, partly by the wear and tear proceeding from use and abuse, especially in the extensive class of instruments used for teaching, and partly by the augmented population to whose enjoyment the instrument administers; but much also must be ascribed to the increased cultivation of music, and to the rapidly progressive improvement of the mechanism of the piano, which presents to the more affluent a constant inducement—nay, a social necessity—to reject the pianos they possess, not because they are impaired by time or use, but because the genius and invention of the makers have placed before them better and more powerful instruments.

" Considering that by far the largest number of instruments constructed are of a small size and low price, we may take the average cost, one with another, at about a thousand francs, which would give the number of pianofortes annually fabricated in France to be ten thousand, of which about thirty per cent., or three thousand, are exported.

" The industry occupied in this business is nearly all of the class of skilled and artistic labour, and is consequently highly remunerated. In the report of the jury on the French Exposition, the average wages were estimated at five francs per day. The number of pairs of hands occupied in the manufacture may therefore be estimated at nearly seven thousand.

" If, in the absence of better and more exact means of calculation, it be assumed that the manufacture in England is double this in quantity and value, we may infer that in the United Kingdom the fabrication of pianos produces a gross return of £800,000; that about 20,000 instruments are fabricated annually; and that about 14,000 pairs of skilled hands are occupied in the business.

" This approximate estimate, considerable in amount as it will appear, is below that which has been made by others who have investigated the statistics of this branch of industry. The following appeared in one of the reviews of the Great Exhibition, which appeared in the journals.

" *Estimate of Pianofortes annually made in London.*

1,500	grands, bicords, and small grands, at	£110 each	£165,000
1,500	squares	60	90,000
20,000	uprights of various kinds	35	700,000
23,000			£955,000

" According to this approximate estimate, the produce of the London manufacture alone, not including that of the cities of Edinburgh and Dublin, besides towns of less magnitude, amounts to a million sterling. If this estimate be correct, the extent of this branch of industry, in England, is about three times its amount in France."

The population returns of 1841, according to the Rev. W. W. Cazalet*, show that there were then in England and Wales 378 organ builders; but, singularly enough, the pianoforte makers are not separately specified in the returns. From information given to the writer in 1851, the Messrs. Collard sold annually 1,600 instruments; or a gross amount, during the last twenty years, of about 32,000. The Messrs. Broadwood, during the same period, have sold 45,863 instruments, or an annual average of 2,293 and a fraction. " Taking the annual business," says the same writer, " of these houses at a round number of 4,000 pianos, and at an average price of 60 guineas, which must be much below the mark, it gives, for these two firms alone, the enormous gross return of upwards of a quarter of a million." Mr. Cazalet's deductions arrive at the same conclusion we have already given. He says, " Now the number of pianoforte makers in London is about 180. (I have taken this from the Directory.) It is not unreasonable, therefore, to state the gross return of this branch at considerably more than a million; as, by a probable estimate that has been made, it would appear that the number of instruments made and sold in the year is about 23,000, of all sorts."

* *A Lecture on the Musical Department of the late Great Exhibition, read before the Society of Arts*, May 6th, 1852. 8vo. 1852. The historical part of this lecture is very meagre and incorrect.

The prices of instruments made by the best houses, in plain mahogany cases, are for grands, 125 to 135 guineas; for bicord and small grands, 80 to 105 guineas; for grand squares, 50 to 100 guineas; for plain squares, 35 to 50 guineas; for cabinets, 75 to 85 guineas; for cottage and other small uprights, 45 to 70 guineas. These prices are often, however, increased for more expensive cases, in rose, walnut, or other fancy woods, enriched with ornamental carving or inlaying. Beautiful specimens of such were seen in the Great Exhibition of 1851. Messrs. Collard's principal instrument was valued at 500 guineas; Messrs. Erard's at 1000 guineas; and Messrs. Broadwood's at, we believe, 1200. "The enormous money value of these," says Mr. Pole, "is solely on account of the external decoration; as musical instruments, they are in no wise superior to the ordinary grands, sold at the prices above named. On the other hand, a class of instruments has been lately introduced by Messrs. Collard, with the laudable object of bringing the price of the ornamental part down to the lowest possible sum; and so putting pianofortes of the best make within the reach of purchasers with limited means. With this view, the most useful variety of the small upright is made, in a neat, plain case of deal or other cheap wood, and sold for about 30 guineas." The appearance of these instruments is very neat, and, we think, far preferable to the profusion of ornament, in the vilest possible taste, with which some makers cover their pianos. Small uprights, by makers of little eminence, are sold at much less prices than those of the large houses.

The principle of division of labour is adopted to a considerable extent in pianoforte making, precision of detail being of the utmost possible consequence. As an illustration of this, we may state that a grand pianoforte, in the course of its progress to completion, passes under the hands of upwards of forty different workmen, each of whom, with his assistants, is exclusively engaged in a special branch of the manufacture. They are as follows:*

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* The documents upon which our information is founded were prepared by Messrs. Broadwood, on the occasion of the Great Exhibition of 1851. They show in detail the various classes of operations, and the different qualities and sorts of materials used in the manufacture of pianofortes. They are inserted in Dr. Lardner's interesting work before referred to; also in Mr. Pole's privately printed brochure.

1. The *key-maker* forms the entire key-board from one piece of lime-tree wood; fixes on the pieces of ivory and ebony; bores the necessary holes; and, finally, cuts the whole up into separate keys with a fine saw.

2, 3, 4, 5. The *hammer-maker*, the check-maker, the *damper-maker*, and the *damper-lifter-maker*, construct the parts of the action to which these names refer.

6. The *notch-maker* covers, with doe-skin and cloth, the notches or ends of the hammer-shanks into which the hoppers work.

7. The *hammer-leatherer* covers the hammer-heads with their different coats of leather and felt, and cuts them to their proper size.

8. The *beam-maker* makes the mahogany beam or rail extending across the action and covered with brass, in which the hammers are centered.

9, 10, 11. The *brass-stud-maker* and *brass-bridge-maker* form the upward bearing-studs and bridge; and the *wrest-pin-maker*, the iron tuning pins.

12, 13, 14, 15. The *metallic-brace-maker*, the *metallic-plate-maker*, the *steel-arch-maker*, and the *transverse-bar-maker*, all construct part of the metallic bracing. (The makers of the iron and brass work, for pianofortes and other musical instruments, are called *music-smiths.*)

16. The *spun-string-maker* makes the lapped or spun wires.

These parts, and other minor preparations, being supposed ready, the body of the instrument is made as follows:

17, 18. The *sawyer* saws the timber roughly into shape; the *bent-side-maker* then cuts it more accurately to its size and thickness, and bends, by a steaming process, the pieces destined to form the curved side of the instrument.

19, 20. The *case-maker* fashions, puts together, and veneers the timber-framing forming the principal body of the instrument; he also forms and fixes the wrest-plank. The *bracer* inserts the timber cross-bracing in the frame: this is, however, sometimes done by the case-maker.

21. The *bottom-maker* makes and fixes the framed bed, at the lower part of the instrument, to receive the key-board.

22, 23. The *sounding-board-maker* selects the timber for, cuts out, and joints, the sound-board. The *belly-man* planes it to its proper thickness, shapes it, finishes it, and fixes it in the case. He also forms and fixes upon it the beech bridge, upon which the strings take their bearing.

24. The *marker-off* has more to do than his name implies. He marks out the scale for the strings, fixes the pins on the beech bridge, and finishes it to its proper shape; he inserts the upward bearing bridge and studs in the wrest-plank, and bores it ready to receive the tuning pins; he also fits and fixes the metallic string-plate, longitudinal stretcher-bars, and other parts of the metallic bracing, by which the pianoforte is made ready to receive the strings.

25. The *stringer* puts on the strings, and fixes the wrest-pins in their places.

26. The *finisher* receives the keys and the various parts of the action from their respective makers; he constructs

the action-framing, puts the action together, fixes it in its place, and brings the whole of the mechanism generally into playing order.

27, 28. The *rougher-up* then tunes the instrument for the first time, stretching the strings to their proper tension; after which, the *tuner* puts it thoroughly and permanently in tune.

29, 30. The *regulator of action* then examines and carefully adjusts every part of the action, and completes the regulation of the touch; and, finally, the *regulator of tones* examines the tones and corrects all irregularities, making the pianoforte sound and perfect throughout.

The following operations, which have reference to the external part of the instrument, are done at various times in the course of its construction.

31, 32. The *top-maker* constructs and veneers the cover, and puts on the hinges. The *plinther* fixes and veneers the plinth.

33. The *fronter* shapes, hinges, and centres the fall or cylinder front; shapes the cheeks, makes and fixes the mouldings, puts on the locks, and attaches the ornaments.

34. The *canvass-frame-maker* makes an open wood frame-work, covered with canvass, which is fixed in the bottom of the instrument.

35. The *lyre-maker* makes the lyre-shaped bracket fixed under the instrument to carry the pedals.

36, 37. The *leg-block-maker* makes and fixes the blocks into which the legs are screwed; and the *leg-maker* makes the legs themselves.

38, 39, 40. The *tuner*, the *carver*, and the *gilder*, do all work wanted in their respective departments.

41, 42. The *scraper* scrapes and cleans the surface of the case, and prepares it, by rubbing it with glass-paper, for the *polisher*, who gives it its coat of French polish.

It is almost superfluous to add, that all the hands employed in the manufacture must be well skilled in their respective departments; and that the whole of the operations (but most particularly those connected with the framing and action) must be done with the utmost care, or a good result cannot follow. It is moreover found necessary, in order to ensure the good quality of the instrument, that the work be not hurried; but that it should progress slowly and gradually to completion. A grand pianoforte usually remains in hand upwards of six months.

The following table gives a list of the different materials required in the construction of a pianoforte, specifying the parts of the instrument where they are used.

MATERIALS.		WHERE USED.
Woods	*from*	
Oak	Riga	Framing, various parts.
Deal	Norway	Wood-bracing, &c.
Fir	Switzerland	Sounding-board.
Pine	America	Parts of framing, key-bed or bottom.
Mahogany	Honduras	Solid wood of top, and various parts of the framing and the action.
Beech	England	Wrest-plank, bridge or sound-board, centre of legs.
Beef-wood	Brazils	Tongues in the beam, forming the divisions between the hammers.
Birch	Canada	Belly-rail, a part of the framing.
Cedar	South America	Round shanks of hammers.
Lime-tree	England	Keys.
Pear-tree	———	Heads of dampers.
Sycamore	———	Hopper or levers, veneers on wrest-plank.
Ebony	Ceylon	Black keys.
Spanish Mahogany	Cuba	For decoration.
Rosewood	Rio Janeiro	For decoration.
Satinwood	East Indies	For decoration.
White Holly	England	For decoration.
Zebra-wood	Brazils	For decoration.
Other fancy woods		For decoration.

Woollen Fabrics.

Baize; green, blue, and brown	Upper surface of key-frame, cushions for hammers to fall on, to damp dead part of strings, &c.
Cloth, various qualities	For various parts of the action and in other places, to prevent jarring; also for dampers.
Felt	External covering for hammers.

Leather.

Buffalo	Under covering of hammers—bass.
Saddle	Ditto ditto tenor and treble.
Basil	Various parts of the action.
Calf	Various parts of the action.
Doeskin	Various parts of the action.
Seal	Various parts of the action.
Sheepskin	Various parts of the action.
Morocco	Various parts of the action.
Sole	Rings for pedal wires.

Metal.

Iron. Steel. Brass. Gun-metal	Metallic bracing, and in various small screws, springs, centres, pins, &c. &c. throughout the instrument.
Steel wire	Strings.
Steel spun wire	Lapped strings.
Covered copper wire.	Ditto—lowest notes.

Various.

Ivory	White keys.
Black lead	To smooth the rubbing surfaces of cloth or leather in the action.
Glue (of a particular quality, made expressly for this trade)	Woodwork throughout.
Bees'wax, emery paper, glass paper, French polish, oil, putty powder, spirits of wine, &c. &c. ...	Cleaning and finishing.

The materials must all be of the best possible kinds. The timber especially, being the most important, must be selected of the soundest quality; it requires to be thoroughly seasoned (a process often of several years), and must then be dried by artificial heat before it is worked for use. A similar degree of care must be taken in the selection and preparation of all the other materials, or the quality of the instrument will suffer.

In comparing the French pianofortes exhibited at the Paris Exhibition of 1849, with the British instruments presented for exhibition in 1851, we observe one curious fact, which we must presume is to be ascribed to the fact that in this country the manufacture is limited to a small number of great capitalists, while in France it is distributed among a much greater number of makers working on a smaller scale. With a manufacture upon less than half the scale, and without the stimulus offered by unlimited, or indeed any, foreign competition, there were in the Paris Exposition nearly ninety exhibitors; while, with all the extraordinary excitement presented by the World's Fair, the Crystal Palace produced only forty native exhibitors.

The following carefully prepared table shows the proportions of pianofortes upplied by the industry of different countries, and also the particular description of nstrument exhibited by each maker.

	ENGLAND. I.—LONDON.	*No. in the Catalogue.*	*Grand.*	*Square.*	*Cottage.*
1	Addison	487			1
2	Akerman, W. H.	490			1
3	Allison.	478			1
4	Allison, Ralph	480			1
5	Broadwood and Sons	518	4		
6	Brinsmead, J.	474			1
7	Cadby, C.	471	1		2
8	Collard and Collard	168	2	1	3
9	Deacon.				1
10	Ennever and Steedman.	479			2
11	Erard, P. O.	496	4		3
12	Greiner, J. F.	468	1		
13	Harrison, J.	464			1
14	Harwar, J.	493a			1
15	Holderness, C.	482			1
16	Hopkinson, J. and J.	500	1		2
17	Hund, F. and Son	486			1
18	Hunt, F.	477a		1	
19	Jenkins, W. and Son	484			2
20	Jones, J. C. and Co.	481			1
21	Kirkman and Son.	487	3		1
22	Lambert and Company.	100			2
23	Luff and Son.	477			1
24	Metzler, George	475			1
25	Moore and Co.	476			1
26	Mott, J. H. R.	498	1		1
27	Oetzman and Plumb	683			2
28	Peachy, George.				2
29	Rolfe, W. and Son	472			3
30	Southwell, W.	469	1		
31	Stodart and Son	470	1		
32	Towns and Packer	494	1		1
33	Wheatstone and Company	526			1
34	Wornum, R.	499	1		2

			No. in the Catalogue.	Grand.	Square.	Cottage.
	II.—PROVINCIAL TOWNS.					
1	M'Culloch..............	Belfast.	483			1
2	Smith and Roberts......	Birmingham.	491			1
3	Dimoline, A............	Bristol	489			2
4	Aggio, G. H...........	Colchester.	488			1
5	Mathews, W...........	Nottingham	550			1
6	Woolley, F.	„	493			2
	III.—COLONIES.					
1	Herberth and Co......	Montreal..............	92			1
2	Phillips, J. B.	Halifax...............				1
		Total...		21	3	53
	UNITED STATES.					
1	Chickering, J.	Boston	458	1	1	
2	Gilbert and Co	„	435		1	
3	Hews, G.	„	438		1	
4	Meyer, Conrad	Philadelphia	59		2	
5	Nunns and Clark......	New York.	374		2	
6	Pirsson, James	„	90	1	1	
7	Wood, James S.	„			1	
		Total...		2	9	
	AUSTRIA.					
1	Hoxa	Vienna		1		
2	Pottje, J..................	„	141a	1		
3	Schneider, J............	„	140	1		
4	Seuffert, E.............	„	141b			1
5	Viasky, J...............	Prague	141	1		
		Total...		4		1
	BELGIUM.					
1	Aerts, F. G.	Entwerp	186			1
2	Berden, F. and C.......	Brussels	174			3
3	Deffaux..................	„	188			3
4	Jastrzébski, F.	„	176			3
5	Sternberg, L............	„	180			2
6	Verhasselt d'Oultrepont	„	179			1
7	Vogelsang, F. and J...	„	181	1		1
		Total...		1		14

	DENMARK.		No. in the Catalogue.	Grand.	Square.	Cottage.
1	Hornung, C. C.	Copenhagen	30	1	1	
2	Rühms, H.	Altona	14			1
		Total...		1	1	1
	FRANCE.					
	I.—PARIS.					
1	Aucher and Son		404			2
2	Bord		1099	1		
3	Collin					2
4	Debain, A. C.		1172			2
5	Détis and Co.		476			2
6	Domeny, L. F.		477			1
7	Erard, P.		497	3	1	1
8	Franche, C.		1234			2
9	Herz, H.		1268	2		1
10	Jaulin, J.		1274			1
11	Kleinjasper, J. F.		1633			1
12	Mercier, S.		633			2
13	Montal, C.		1665			4
14	Van Overberg					1
15	Pape, J. H.		943	1	2	2
16	Roller and Blanchet		1687			6
17	Scholtus		1482			2
18	Soufleto		1482			3
		Total...		7	3	35
	II.—PROVINCES.					
1	Herding	Angers	335	1		1
2	Zeiger.	Lyons	747			1
3	Cropet.	Toulouse	131			2
		Total...		1		4
	SWITZERLAND.					
1	Hüni and Hubert	Zurich	87	1		
2	Kützing	Berne	89	1		
3	Sprecher and Beer	Zurich	103	1		
		Total...		3		

	GERMANY (ZOLLVEREIN), AND HAMBURG.		No. in the Catalogue.	Grand.	Square.	Cottage.
1	Dieudonné and Blädel ...	Stuttgart............	20	1		
2	Dörner, F..................	"	21	1		1
3	Lipp, R. R.	"	22			2
4	Schiedmayer and Son....	"	23	1	1	1
5	Scheel, C.	Cassel	668			1
6	Breitkopf and Härtel....	Leipzig.	25	1		
7	Zeitter and Winkelmann.	Brunswick..........	709	1	1	1
8	Kühmst, G.	Darmstadt..........		1		
9	Schott and Son...........	Mayence	25	1		
10	Westermann and Co......	Berlin...............	80	1		
11	Bessalié, H. P.	Breslau..............	71	1		
12	Klems, J. B...............	Dusseldorf..........	595	1		
13	Gebauhr....................	Konisberg.	848	1		
14	Heitermayer, T.	Münster	486		1	
15	Adam, G.	Wesel	487	1		1
16	Gurike, B...................	Zoffen	73	1		
17	Schröder, C. H.	Hamburg	13	1		
		Total...		14	3	7
	HOLLAND.					
1	Cuijpers, J. F.	Hague..............	95			1
	RUSSIA.					
1	Lichtenthal, M............	St. Petersburg......	172	2		

SUMMARY.

	Makers	Grands	Squares	Cottages
England and the Colonies........................	42 makers, exhibiting	21 *grands,*	3 *squares,*	53 *cottages.*
France...	21	8	3	39
Germany and Hamburg...........................	17	14	3	7
United States....................................	7	2	9	
Belgium..	7	1		14
Austria...	5	4		1
Holland and Switzerland........................	4	3		1
Denmark and Russia............................	3	3	1	1
Total......	106	56	19	116

Mr. Pole, to whose labours we have been so largely indebted in the second part of our volume, speaking of the pianofortes in the Exhibition, has some very sensible remarks, which, as they immediately bear upon the portion of the subject before us, we beg to transfer to our pages.

"Notwithstanding the great intelligence and care that are brought to bear on the manufacture of pianofortes, we doubt whether the aid of science has been called in to the extent that could be wished, to guide their construction. Arrangements are often seen which appear unwarranted by the principles of mechanics; and, generally speaking, the *engineering* of the construction is not so well studied as it ought to be. But, in the application of the acoustical science, pianoforte-making is yet more behind hand. The theory of the production of tone, at least as regards its quality, is at present wrapt in mystery. Few persons seem to have any definite idea what are the essential conditions under which a good tone, in general, or still less, any particular quality of tone, can be ensured. A series of tentative experiments leads to certain methods of construction which are considered good; and all possible care is then taken to avoid defects in the manufacture; but the result is, after all, frequently due to some fortuitous combination of circumstances, which cannot be foreseen. Hence arises the variety in the qualities of tone, not only of instruments by different makers of equally good repute, but also in those turned out from the same house, and made apparently in precisely the same manner. Nay, even in the same pianoforte, it frequently happens that the practised ear can detect considerable variations. Sometimes a certain portion of the scale may be far superior to the rest; sometimes a few notes here and there may be deficient in resonance; sometimes one note only in the whole instrument may be faulty: but the reason for these anomalies it is impossible to explain.

"The general excellence of a pianoforte depends, however, not only on the design of its various parts, but also, as we have already stated, on the quality of the materials, and the amount of care bestowed on the workmanship. It is due principally to the great attention paid to these latter points by the chief London houses, that English pianoforte-making has obtained, and still retains, its high reputation.

"If there is any point to which, in preference, future attention should more particularly be directed, we think it is the *cheapening* of the better classes of instruments. A hundred and twenty or thirty guineas for a grand is a price altogether beyond the reach of multitudes, who both need and know how to appreciate a good piano. And yet the tendency of late has been rather to increase than diminish the cost. We admit readily that a good pianoforte, made purposely to attain the highest possible grade of perfection, must always bear a high price; but, at the same time, it is but reasonable that means should be found to bring a class of instruments, equal to the ordinary grand, within the reach of persons by whom it is now quite unattainable. The expediency of combining cheapness with excellence in quality has long been acknowledged and acted upon in almost every branch of manufacturing art, and indeed seems to be the ruling principle of commerce in the present day. It is beginning, though tardily, to extend itself to the pianoforte manufacture; and we hope, for the sake of the art, that the time may soon come when its influence will be more general."