

sonry, from the spring of the arch to the key, and that of the upper part of the tower, which also contributes to its stability, are more than sufficient to compensate for the weight of the apparatus for illumination, which rests upon the summit of the arch. But notwithstanding this, as the three openings in it somewhat diminish its strength, the precaution was taken, in order to avoid the least displacement, to fasten all the arch stones of the second and third courses, together with those of the first,, with iron clamps, one and a half inches thick by three inches wide, let into the arch stones and fastened to each of them by a bolt, which passes through two-thirds of their thickness, well secured with lead.

*Materials.*—The stone used in the construction of the tower was taken from the quarries known here by the name of *playa de chivos*, immediately at the point where the tower stands, and preferable to the stone found at any other place in the vicinity, because, although not of the hardest quality, they are still sufficiently so, and of a more equal and homogeneous texture than the others. Great care was also taken to use blocks of the most durable kind in the exterior surface of the wall, and for the steps of the stairway.

The lime and sand employed were both of excellent quality; the former made of a very hard and clean stone, and the latter containing no saline matter. The mortar was made with great care, composed of two-fifths of lime and three-fifths of sand, mixed with fresh water and well stirred, so as perfectly to incorporate the ingredients.

The doors, windows, interior balustrades, and hand rails of the staircase are of mahogany.

After the completion of the edifice, in order to preserve it from the effects of moisture and of nitrous salts, inasmuch as the stone, as already stated, is not of the hardest kind, it was covered, both on the interior and exterior surface, with a very thin and well laid coat of painted stucco.

The cost of the whole structure, when completed, was very nearly that calculated in the original estimate.

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FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*On Balances.* By FRANKLIN PEALE, Chief Coiner of the Mint of the United States.

(With two Plates.)

In order to insure precision and regularity, to obtain facility and rapidity, and, above all, to avoid liability to error, it has been found necessary to combine, in the balances used in the mint, not only all the arrangements known to us that have heretofore been found important, but also such improvements as have been the growth of our own experience.

The result has been satisfactory, in a remarkable degree; so much so, as to be a subject of surprise to the most experienced of the corps of officers of this establishment.

In the present communication, no attempts will be made to establish claims of invention, either for ourselves or others. In fact, it would be impossible to do so with justice. Balances of every variety of structure have long been made, and may be readily met with; and all that we can now claim is, after much experience in their use, to have combined their best parts, and, in doing so, to have introduced such modifications and adaptations as have been found desirable.

In the balances, of which this notice treats, two considerations have claimed particular attention: the first is precision, the second construction.

Under the former head, a descriptive notice will embrace remarks on such provisions and operations as are deemed important; and under the latter, a description of construction, illustrated by engravings of the balance as erected, and of the separate parts in detail.

To obtain the greatest degree of uniform precision, it is requisite that the beam should be lifted, from a state of rest, in a perfectly level position, and that the stirrups should be lifted, simultaneously, with their loads, from their rests, or supports; also that the oscillations of the stirrups should be prevented or checked at the earliest moment; and, finally, that the whole system should be left at liberty with delicacy and exactitude, so as to remain in equilibrium, or vibrate, as the case may be.

To command the above conditions, the beam should be supported upon cones, at each extremity, adjusted level with each other, from which it is lifted, by a plane which rises under its centre knife-edge, and to which it is returned by its depression, the cones guiding the beam to the same position exactly from which it was elevated.

The stirrups, in like manner, should hang upon hollow cones or V's, so as to be taken up from, and returned, invariably, to the same position.

The support for the centre knife-edge, as well as the hangers which rest upon the knife-edges at the extremities of the beam, should be planes, and not portions of hollow cylinders, as is usual.

The beam should rest upon its cones, and the stirrups should be supported by their V's at such heights as to relieve entirely the knife-edges, with a sufficient space between them and their respective planes to permit inspection and wiping, when it may be needed. This construction admits of the placing of the weights, &c., and guards the knife-edges from the consequences of displacement during use.

The beam should be raised by the elevation of the centre plane, subsequently lifting with it the stirrups with their weights and load, and all oscillation checked by platforms placed in the table under the centre of the stirrups, which should be made to rise simultaneously, and should be counter-weighted to the requisite delicacy.

The descent of these platforms, effected by the pressure of a finger on a lever conveniently placed, will leave the stirrups, &c., at liberty to vibrate, or bring the beam to a horizontal position, at the will of the operator; being a convenient, certain, and rapid method of manipulating, not equalled by any other arrangement, and, in fact, essential to a well-constructed balance.

The knife-edges should be constructed of the best cast steel, hardened to the utmost ability of that metal, and the planes upon which they bear should be made as true and perfect as possible; those for the finer or more elaborately finished beams, should be of agate, or chalcedony.

Having thus concisely stated the essential qualities in balances for accurate and rapid weighing, it will be proper to explain the construction by which these qualities are acquired, being the second branch of this essay. In explanation of this, reference is now made to engravings which accompany this notice: one, exhibiting a front view of the whole; the other, the parts separate and in detail.

*Description of the Plates, with Explanatory and General Remarks.*

Plate I represents a front view of the balance drawn on a scale corresponding to a beam four feet in length, suited, in its proportions, to weigh one thousand dollars in silver. The weight to which it is limited should not exceed one thousand ounces troy.

A beam of three feet in length is suited to drafts of five thousand dollars in gold coin, and the maximum weight should not exceed, in any case, three hundred ounces troy.

The proportions exhibited in these plates may be maintained throughout for the above sizes, or any other, either greater or less, than those which are stated.

A table, marked A, is furnished with leveling screws upon the front and back edge, and at each end, marked *b*. In plate II, which exhibits different views of all the parts, the leveling screws are marked *b*, and their positions in the table (the view of the under side of which is given) are marked *c*.

The balance is intended to be placed upon a counter, or any other firm support, and the table leveled by means of the screws last described, its true position being indicated by a plumb-line and weight, occupying the rear opening in the column; (plate I, fig. *c*;) the plumb-line and weight being marked *d*.

The column, marked C, in plates I and II, contains the lifting apparatus, and supports the cap-plate, marked D, plates I and II. The cap-plate guides the lifting apparatus, and supports the V's, or hollow cones, for the stirrups, and is strengthened and stayed by braces, marked E; the section of which braces is cruciform, with circular ends, for firm bearing upon the plate and base of the column, to which they are secured by screws.

Plate II exhibits upper and under views of the table, column, plate, &c., also upper and lower end views of the column, showing the means of its attachment to the table and cap-plate.

Balances intended for service alone may be made of cast iron, exclusive of the beam. For small balances, or when higher finish and display is designed, bronze, or ordinary brass, may be used.

The lifting apparatus consists of a winch-handle, marked *f*, plate

II, fitting upon a round shaft, *g*, with a feather, so as to admit of its convenient removal; upon this shaft is fitted a cam, *h*, also secured by a feather; the cam is carefully constructed, so as to give equal elevation to equal parts of its revolution; and upon the cam rests a roller, *i*, which turns upon a pin in the frame, *j*, intended to reduce friction, and give facility in raising the beam with its load.

The lifting frame, *j*, is forked cross-wise, so as to straddle the shaft and accommodate the cam and roller, at the same time that it allows the necessary vertical motion, without the possibility of being displaced; all of which is exhibited in the two views of the lifting frame marked *j*, which is also accompanied by sections in proximity to the parts which they are intended to explain.

The handle is so placed as to be on the left when the beam is down and at rest, and to the right when the beam is raised, in the act of weighing, and makes, together with the cam, more than three-fourths of a revolution, the cam having a very slight depression upon its upper, or highest point, into which the roller falls, maintaining it in its position when the beam is raised. It is then extended beyond the centre of the roller, so as to be stopped at the limit of motion, as exhibited in fig. *h*, plate II.

The lifting frame is forked at the top for the accommodation of the beam. Upon it rests the plane, the top and side view of which are marked *k*, for the support of the centre knife-edge, secured to the frame by screws. In balances of ordinary construction, this plane may be made of hardened cast-steel; in finer instruments, of bronze, or brass, with an inserted block of polished agate, secured by fusible metal, or cement.

The position of the handle, lifting frame, &c., are exhibited with sufficient clearness in the front view, plate I.

The cap-plate, views of the upper and under sides of which are given in plate II, fig. D, is constructed with horizontal spaces at the centre and each end. In the middle it is secured to the column by four screws, and to the braces B in the same manner, the holes for which are marked in all the views.

The square opening in the middle serves as a guide and support to the lifting frame, which must be accurately fitted, so as to prevent any lateral play.

The horizontal spaces at the extremity of the cap-plate support short pillars terminated by cones, upon which the beam rests; these pillars are secured to the cap-plate by screws passing through it from the under side, the holes through which they pass being large enough to admit of the adjustment of the beam to its proper place, previous to their being permanently fastened down.

The details of these pillars are given in plate II, fig. *l*, the cones being constructed of cast steel, hardened and polished.

The same space also supports the V's, or guide supports of the hangers, different explanatory views of which are given in plate II, the V's being marked *m*, and the hangers *n*. All these parts have been devised with reference to the simplest and most economical con-

struction consistent with the requisite accuracy, and for affording the greatest facility in the final adjustment of the balance.

The most important part of the balance is the beam, the form and material of which, both with reference to use and construction, have been carefully considered. Plate II, fig. *o*, exhibits side and top views. It will be observed that the beam is perfectly simple in its form, thickened at the centre and extremities, for the security of the knife-edges, the arms being diminished, in depth, regularly, from the middle to the extremities, a section in any part of which would represent a sharp wedge, with its extremities rounded, as shown by the dotted lines at *p*, the thicker being the upper edge of the beam. The projections marked *q*, are the supports of the beam when at rest; the conical cavities, indicated by dotted lines, being made to fit the cones marked *l*.

This form of beam affords facility in construction, being composed of straight surfaces, without ribs, or curves; is well adapted to maintain its form when loaded; affords the least surface for accumulation of dust, and is readily wiped when it may be necessary. The means of adjustment for the length of arm is exhibited in fig. *r*, plate II.

As a general rule, convenient and accessible means of adjustment are to be deprecated. Balances should be constructed with reference to the use to which they are destined, and the necessary accuracy and sensibility given in construction. It will be found, it is believed, more inconvenient than desirable, to attempt to change the sensibility of a beam devoted to different uses. Again, a person might have sufficient mechanical skill to use a balance and weigh accurately whilst it is in order, who would be much embarrassed by the consequences of a change in the centre of gravity, affecting the accuracy and sensibility respectively, without consciousness of the cause, or knowledge of the effects. A repetition of the remark, that prominent and accessible means of adjustment are to be deprecated, will be excused, as having a tendency to invite to attempts at adjustment by the incompetent and unskilful, or it may be to derangement, by the meddlesome.

The material best suited to the construction of beams will depend upon the purposes to which they are destined. For mint usage they should be of rolled brass, or a malleable alloy of copper and tin, well hardened by heavy hammering. The difficulty of procuring castings perfectly sound, and free from "blows" being a sufficient reason for the rejection of cast metal of any kind.

It will be seen, that the needle of the balance, which is the subject of description, is pointed downwards, and there are good reasons for this disposition. In the first place it is directly before the eye of the operator, and therefore more convenient in use, than it is, when elevated above; again it may be made longer than the arms of the beam, and will consequently describe a larger arc, and thus give more distinct indications, whilst the whole arrangement need occupy no more space than is requisite for the other parts; and finally, the needle is protected from external injury by the lifting-frame and column, in the centre of which it is placed.

The parts which remain to be described have been usually consi-

dered of minor importance, but experience has shown that this estimate is scarcely a just one, inasmuch as they afford facilities for accuracy and rapidity, that leave no doubt of their value, and place them in a most important position in practice. The parts now alluded to, constitute the system by which the operator is enabled to find the equilibrium of which he is in search. It consists of the pedestals, as they have been termed, marked *s*, plates I, and II, and the parts connected with them, marked *t*, *u*, *v*, and *w*, in plate II; a light shaft, made of tubular iron, *t*, supported by pivots *u*, which pivots are screwed through a piece cast on the under side of the table, marked V; upon the ends of this shaft there are levers, W, upon the ends of which levers, when in place, the pedestals rest.

The remaining part of this system is a double armed lever, placed in the middle of the shaft, *t*, (represented in the engraving detached,) and marked *x*; it is connected by a pin, with the trigger, *z*, represented in its place in plate I, with the same letter. Upon the other end of the lever, *x*, there is a weight, *y*, capable of adjustment by a screw upon which it traverses, so as to be approached to, or receded from the shaft, *t*.

The action of this system is easily understood, its whole object is to depress the platforms by sufficient force, applied by the finger, to the trigger, the counter weight returning them to their original position, after its removal.

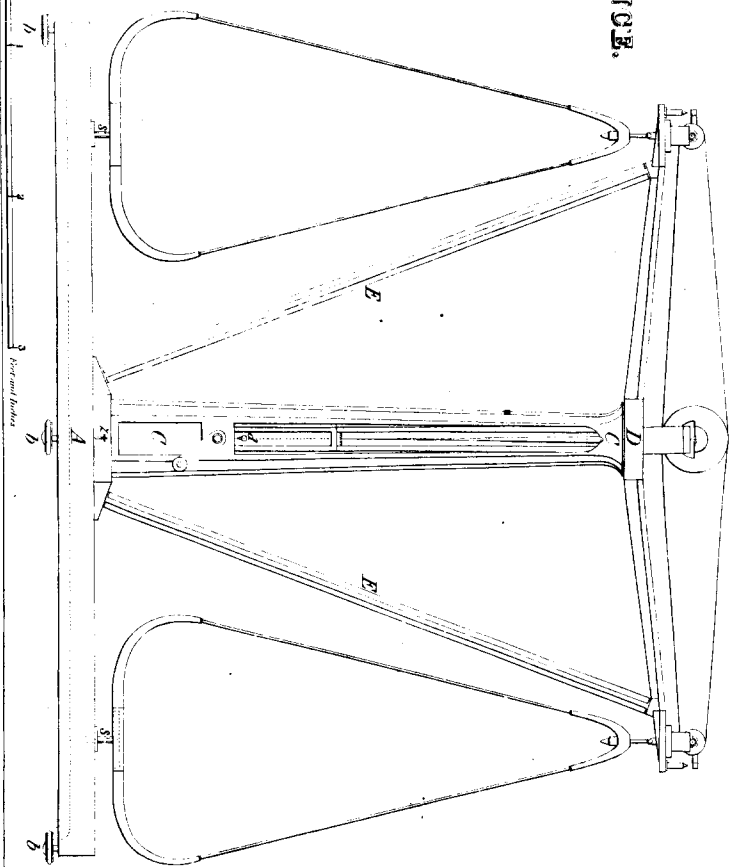
It will be seen, by reference to plate I, that the under sides of the stirrups have a space, represented by dotted lines, in which the platforms are placed, which allows the stirrups to oscillate within its limits, but beyond which they cannot move. This construction is intended to guard the hangers from displacement, and to prevent injury by too much movement of the stirrups, an accident very likely to occur, when the pans or weights are hastily removed, especially in the use of the larger balances with heavy weights or large masses.

The cavity, whose object was described in the last paragraph, forming the under side of the base of the stirrups, is turned as truly as possible in the form of a portion of a sphere, whose radius is its distance from the bearing of the knife-edge. The platforms are adjusted by means of the counter weight, so as to press lightly up against the stirrups, and to follow them when raised.

It is found convenient in practice to turn the handle of the balance but a small portion of its movement, if the weights are not equal on opposite sides, a circumstance to be expected when searching for a weight. The heavy side will remain down, and the needle will indicate whether addition of weight, or its removal is requisite. These trials are continued until the platforms follow up the whole lift, the needle remaining opposite the middle line of its scale, until the handle is stopped by its limit of motion, where it remains. The finger, then, by pushing down the trigger, will depress the platforms, when smaller weights are employed until the needle indicates equilibrium.

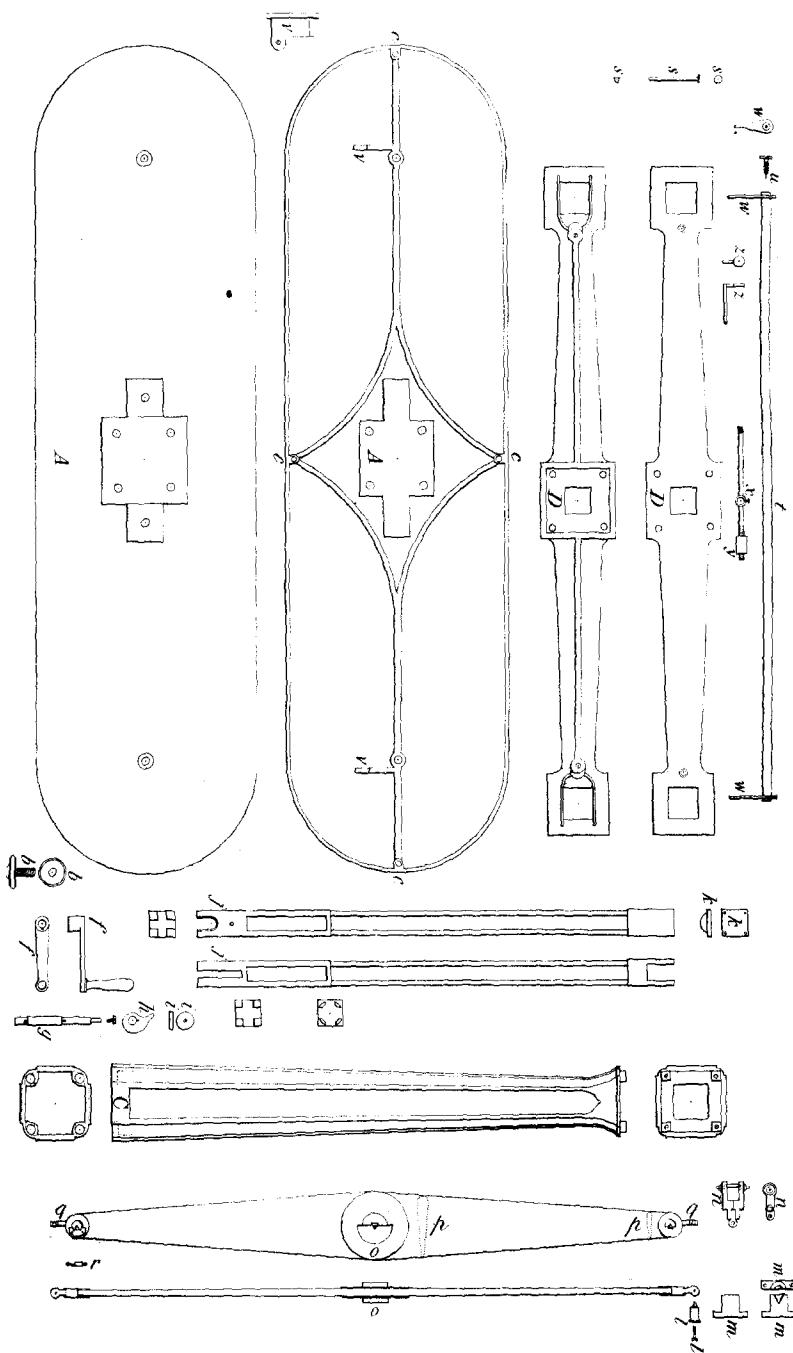
In this balance there is little or no embarrassment from oscillation, because the stirrups immediately accommodate themselves to the position of the weights, the light pressure permitting them to take any

# PEABE'S BALANCE.



Scale for a Beam of 1 foot

1 2 3 4 5 6 7 8 9 10 11 12





position required by the load; nevertheless, having sufficient power, from their pressure, to prevent any swinging. If from any cause the stirrups should be in motion, three consecutive depressions of the platforms, will bring them to a state of rest, with absolute certainty, and with a loss of time so short as to be entirely immaterial.

The stirrups are connected with the hangers, by a rod, which is double-jointed, as near to the hangers as possible, so as to allow perfect freedom of motion; at the same time, so well fitted as to allow no change of position in the parts. On the lower ends of these rods, there are screws and nuts, to regulate the height of the stirrups, together with a jam nut, to prevent any change after the adjustment has been satisfactorily made.

The bases of the stirrups are designedly made small, requiring the use of a dish on the one side, and a platform for weights on the other. This dish and platform being made of equal weight, renders the use of a counter weight unnecessary, and as the balance cannot be used without both, the liability to mistakes from this cause is entirely avoided.

For the adjustment of weights, or any other use of balances requiring the greatest degree of delicacy and care, it is necessary to protect the instrument and the operation, by a case, with doors sliding vertically, and glazed, so as to permit inspection, undisturbed by currents of air. This arrangement, entirely essential for such uses, is inadmissible for ordinary weighing, involving too much delay in the necessity for opening and shutting the doors.

In the balance for weighing gold coins, which was placed in the exhibition of the Franklin Institute, in 1846, and which is now in use in the weighing and counting room of the chief coiner's department in the mint of the United States, all the parts, with the exception of the stirrups, are covered by plate glass, inserted into the framing, so as to protect the balance as much as possible from currents of air, dust, and external influences of all kinds. This balance has been made with the utmost care in all respects, upon the principles detailed in the foregoing notice, and the result has been satisfactory in the highest degree. In illustration of which, it may be stated, that with its maximum load of six hundred ounces, three hundred on each side, it is sensible to the ten-thousandth of an ounce. This fact is not mentioned as very remarkable, because it is comparatively easy to give great sensibility to balances: but it is worthy of note, that it is invariable in showing this minute fraction of its load. As regularity is of the greatest value in operations with balances, we may be excused for drawing attention to a quality of so much importance.

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*Descriptive Memoir of a New Process for Manufacturing White Lead, or Carbonate of Lead, invented by M. Gannal.*

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

The difficulties which are known to exist in the manufacture of white lead by the processes now in use, and the dangers to which the