April 9, 1850.

WILLIAM CUBITT, President, in the Chair.

No. 832. "On the Construction of Locks and Keys."* By John Chubb, Assoc. Inst. C.E.

THE subject of locks and keys will not, it is presumed, be uninteresting, as their antiquity, the ingenuity that has been displayed in devising improvements in their construction, and the great extent of their manufacture, combine to give an interest to the subject, and to render it worthy of attention.

The most ancient lock, of the form and construction of which there is any certain knowledge, has been, it is said, in use in Egypt for above four thousand years.† This lock was described by Eton, in his "Survey of the Turkish Empire," published in 1798, but it was not generally known in Western Europe, until the French invasion of Egypt, at the beginning of the present century, when a further account of it was given by M. Denon, in his great work on that country. The evidence of its antiquity is chiefly derived from the figure of one being sculptured among the basso-relievos which decorate the Great Temple of Karnac; by this it was shown, that during forty centuries, the lock had undergone no sensible alteration. This lock and its key were principally made of wood, but, in some instances, it is probable they were made of metal.‡

It is evident, however, that in the East, another lock and key, of a different description, were in ordinary use, for fastening large doors and gates. There is nothing recorded as to the construction of the lock; but it can be inferred from the description given of the key, which is stated to have been in the form of a large sickle.

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* The discussion upon this paper extended over a portion of two evenings, but an abstract of the whole is given consecutively.

† It has been stated by Mr. W. C. Trevelyan, in "The Journal of Design and Manufactures," No. XVII., for July, 1850, p. 160, that the locks which have been in use in the Faroe Islands, probably for centuries, were identical in their construction with the ancient Egyptian locks. The Faroese locks and keys were both made entirely of wood, and so closely resembled, in structure and appearance, those found in Egyptian catacombs, as to be scarcely distinguishable from them.

‡ Some interesting information is also given in "A Sketch of the History of Ancient Door Fastenings, &c.," by Edward Higgin, Esq. Excerpt from a paper read before the Historic Society of Lancashire and Cheshire, 7th February, 1850. Tract, 8vo, 1850.

Aratus, in order to give his readers an idea of the form of the constellation Cassiopeia, compares it to a key; and Huetius states that the constellation answers to such a description,—the stars to the north composing the curved part, and those to the south the handle.

There is some curious information on this subject in Parkhurst's Hebrew Lexicon.* "In the early ages," he observes, "they made use of certain crooked keys, having an ivory, or wooden, handle. These keys were placed in the holes of doors, and by turning them one way, or the other, the bolt was moved forward, or backward, in order to open, or shut, the door. This is evident from the testimony of Homer, where he says (Odyssey, xxi.), that Penelope, wanting to open a wardrobe, took a brass key, very crooked, hafted with ivory. On which Eustathius† remarks, that this kind of key was very ancient, and differed from the keys having several wards, which have been invented since, but that those ancient keys were still in use in his time. The poet Ariston, in the Anthologia, book vii., gives a key the epithet *βαθυκαμπη*, i.e., *one that is much bent*. These crooked keys were in the shape of a sickle, *δρεπανοειδεις*, according to Eustathius, but such keys not being easily carried in the hand, on account of their inconvenient form, they were carried on the shoulder, as we see our reapers carry on their shoulders, at this day, their sickles, joined and tied together. Callimachus, in his Hymn to Ceres, says, that that Goddess, having assumed the form of Nicippe, her priestess carried a key, *κατωμαδιαν*, that is, *superhumeralem*, "fit to be borne on the shoulder."

It is most probable, that the "crooked keys" here spoken of, were used to fasten and unfasten a simple, horizontal, wooden bar, moving into, and out of, a staple on the door-post, the key being inserted in a hole in the door, at some distance below the bar, and then turned to the right, or left, by its handle.

According to Pliny and Polydore Virgil, the invention of keys is erroneously attributed to Theodore of Samos; they are, however, by other authors, mentioned as having been used before the siege of Troy.

The word סגר (sagar) to close in, used in Genesis, chap. xix. ver. 6, is the root of the word מסגר (misgar), rendered "smith" in our translation, Jeremiah, chap. xxiv. ver. 1, and "locksmith" by Buxtorf.

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* *Vide* Parkhurst's Lexicon, מפתח, Fifth Edition, page 600. London, 1807.

† Eustathius, a Greek commentator on the works of Homer, flourished at Constantinople about A.D. 1170.

The word מפתח (key) occurs in Judges, chap. iii. ver. 25, and in Isaiah, chap. xxii. ver. 22.

In the treatise on keys "De Clavibus veterum," by L. Molinus, printed at Upsal, the Latin name "clavis" is derived from the Greek κλειω, and it states, that at that period the use of keys was still unknown in many parts of Sweden.

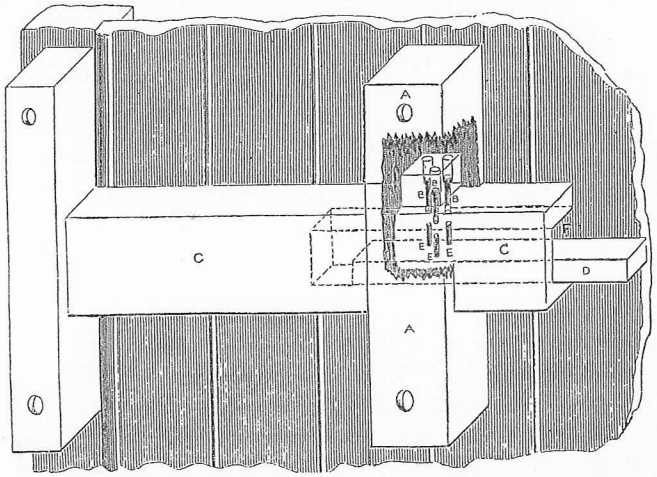
The Laconic keys consisted of three single teeth, in the figure of the letter E; which form may still be seen in ancient cabinets.

There was also another key, called by Polybius βᾶλᾶνάγρα, made like a small screw, and having a corresponding female screw in a bolt affixed to the door.

The construction of the ancient Egyptian lock is shown in Fig. 1,

Fig. 1.

Egyptian Lock.



which is copied from a wooden lock recently brought from Alexandria. A staple A is fixed to the outside of the door, into the upper part of which three loose pins B B B are fitted; these pins drop into three corresponding holes in the bolt C, so as to fasten the door when the bolt is pushed in to its full extent. The key D is a straight piece of wood, and, at one end, there are three pegs E E E, corresponding in position with the pins in the lock. The key is inserted lengthways through a slot F, formed in the bolt, and then the pins in the key, corresponding with the vertical holes in the bolt C, into which the pins of the lock have dropped, lift up the said pins, raising them flush with the top side of the bolt, thus

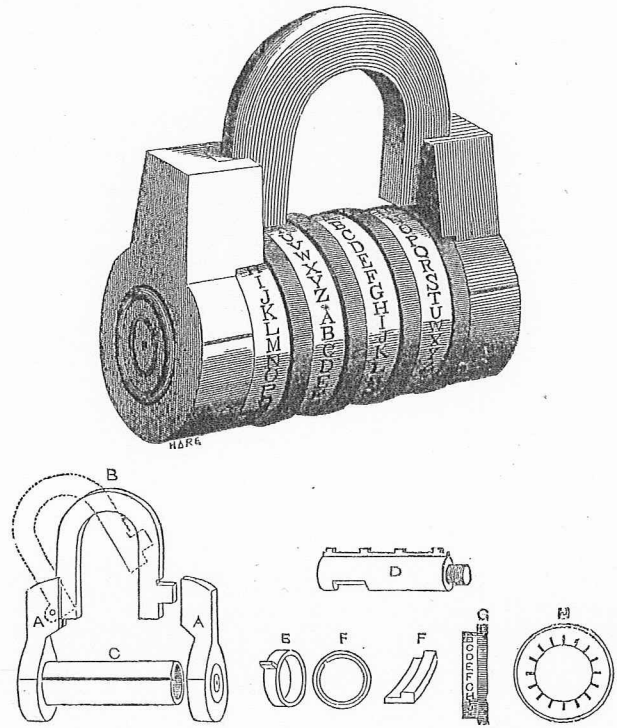
disengaging the moveable pins from the bolt, and allowing it to be moved backwards and forwards.

The representations of warded keys in early missals, and other MSS. since the commencement of the Christian era, prove that warded locks are also of great antiquity, and have been in general use for a long period; they are almost universally adopted in this country, and indeed throughout the whole world. These locks were constructed in metal, and had fixed wards, of various shapes, placed in the case of the locks, forming obstructions to the ingress of any instrument, intended to grapple with the bolt, the web of the key being cut, so as to pass these wards, before they released the bolt. From the faulty principle of fixed wards, however, no essential improvement has been made, and indeed from the specimens handed down to us, from the mediæval age, the warded locks and keys of the present day cannot, in many cases, be compared with those of our ancestors. In some of the old locks of British and French manufacture, numerous secret contrivances were adopted, of such a character, that a person could not open a lock, even with its own key, except by some peculiar method of using it—contrivances which were more ingenious than useful, for the secret being once revealed, or discovered, no security remained.

Another description of lock is that well known by the name of the "Letter Lock," Fig. 2, which is usually made in the form of a padlock, and though apparently complicated, its construction is really very simple:—A A are the ends of the lock, to one of which the shackle B is hinged, and a barrel C is fixed. D is the spindle which screws into the opposite end of the lock; it has four projections, and fits inside the barrel C. E is one of four rings, (of which a side view, and an enlarged section are given at F, F,) having grooves on the inside, so as to fit over the barrel C, and small projecting nibs on the outside, just over the grooves. G is one of the four external rings, which fit over the ring E; they have marked, on the outside, the whole, or a certain number, of the letters of the alphabet, and on the inside, under each letter, there is a groove, as shown by the side view, H, of one of these rings. The rings E are riveted to the barrel C, the inner edge of the end ring being bevelled for that purpose, but they are left to revolve freely. The external rings G are then put on, at any combination of letters which may be required, taking care that the groove under each particular letter shall be exactly over the projection on the inner ring. When these letters are brought into a line with the notches on the ends of the lock, the grooves in the inner rings and the barrel will be also in a line, and the spindle

D will slide backwards and forwards. By shutting down the shackle, pushing the end of the lock up close, and turning the rings, the interior flanges prevent the withdrawal of the spindle, until the same letters are again in a line. The spindle is prevented from coming out farther than to admit of the shackle being released, by a small screw, inserted through a hole in one of the inner rings.

Fig. 2.
Letter Lock.



Respecting this lock, Vanhagen von Ense, in his *Memorabilia*, furnishes the following information:—Speaking of M. Regnier, Directeur du *Musée d'Artillerie* in Paris, he says, "Regnier was a man of some invention, and had taken out a patent for a sort of lock, which made some noise at the time: everybody praised his invention, and bought his locks. These consisted of broad steel rings, four, five, or eight deep, upon each of which the alphabet was engraved; these turned round on a cylinder of steel, and only separated where the letters, forming a particular word, were in a

straight line with one another. The word was selected from among a thousand, and the choice was the secret of the purchaser. Any one not knowing the word, might turn the rings round for years without succeeding in finding the right one. The workmanship was excellent, and Regnier was prouder of this, than he was of the invention itself. The latter point might be contested. I had a vague recollection of having seen something of the sort before, but when I ventured to say so, my suspicions were treated with scorn and indignation, and I was not able to prove my assertions; but many years afterwards, when a book, which as a boy I had often diligently read, fell into my hands, Regnier's lock was suddenly displayed. The book was called *Silvestri a Petrasancta Symbola Heroica*, printed at Amsterdam in 1682: there was an explanation at page 254, attached to a picture; these were the words:—*Honorius de Bellis, serulæ innexæ orbibus volubilibus ac literatis circumscripsit hoc lemma—Sorte aut labore.* However, neither luck nor labour would have done much towards discovering the secret of opening Regnier's locks, from the variety of their combinations; and their security seemed so great, that the couriers' despatch boxes were generally fastened with them."

Although these locks are not so ancient as the Egyptian, and the warded locks, yet the credit of their invention cannot be claimed by M. Regnier. In Beaumont and Fletcher's play of the "Noble Gentleman," Act 5th,* the following allusion to a lock of this sort occurs:—

> "A cap case for your linen, and your plate,
> With a strange lock that opens with A. M. E. N."

In some verses by Carew, addressed to May, on his "Comedy of the Heir,"† there is the following passage:—

> "As doth a lock,
> That goes with letters; for, till every one be known,
> The lock's as fast, as if you had found none."

There was also another lock constructed on the warded principle, but with the addition of a single tumbler, which prevented the bolt from being shot back, until it was lifted up by the key.

However, as it is not the design of this paper to enter into the details of, and describe the multifarious alterations, and improvements in, the construction of locks, it is now proposed to trace the four principal and ancient inventions, upon which, as far

* Written before 1615, first published in 1647, folio.

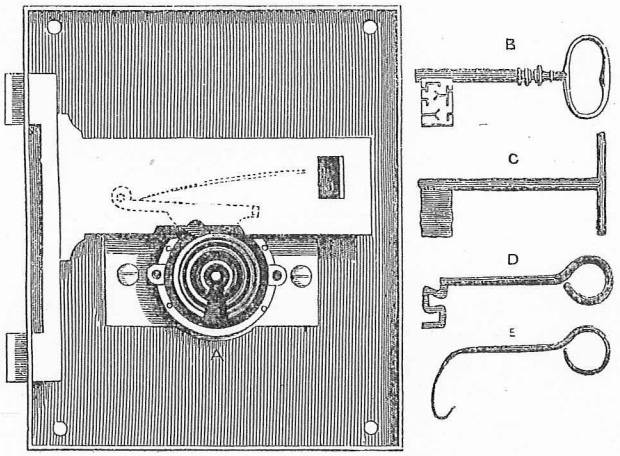
† "The Heir," a Comedy, by Thomas May, acted by the Company of Revels, in 1620.

as can be ascertained, most, if not all, modern locks are based. The Egyptian, the warded, the letter, and the single-tumbler locks, with more, or less alteration, and the exercise of ingenious invention, are, in principle, the foundation on which all modern locks are based.

1st. *The letter locks.*—These are made as padlocks in considerable numbers; and from the circumstance that no key is required to open them, they are so far convenient. There is one adaptation of the principle of this lock, designed as a 'scutcheon lock,' for securely closing the key-holes of locks for strong doors and iron safes,* but it is too expensive and complicated for general use.

2nd. *Locks with fixed wards.*—The warded lock, like the ancient Egyptian, has received no improvement, and to prove its utter insecurity, a drawing has been made of a lock and key, with picklocks (Fig. 3), which is copied from a lock taken off the strong room

Fig. 3.
Warded Lock.



of a London banking-house. A, shows the wards of the lock; B, the original key, with the cuts in the web exactly corresponding to the wards in the lock; C, is a burglar's instrument, made of tin, having a composition of wax and yellow soap fitted on one side of the bit, so that on its being inserted into the key-hole, a perfect impression of the wards is taken. To make a picklock, it is only necessary to preserve the end of the web which moves the bolt; this is accomplished by the instrument D, which is made so as to escape the wards, and will open or shut the lock, as well as the

* See "Transactions of the Society of Arts," vol. iii. p. 78.

original key. The pick-lock E, also, by passing round the wards, will easily open the lock.*

Not only is the principle of these locks faulty, but many thousands are made yearly for the same keys to pass, and sold to different persons; it is, therefore, quite possible, that twenty skeleton keys might be made, which would open the majority of the street doors in London. Moreover, vast numbers of common locks are made with keys so cut as to represent intricate wards, and on being opened, nothing but the bolt, and perhaps a single tumbler, will be found, without any wards in the case.

3rd. *Locks having a single tumbler in addition to fixed wards.*—A tumbler is a sort of spring latch for detaining the bolt of the lock, so as to prevent its motion, until the key, in turning, first lifts the tumbler out of contact with the bolt, before moving it. Tumbler locks certainly afford more security than warded locks, but the former, as usually made, can be lifted by a picklock, or false key.

4th. *The Egyptian lock.*—The essential principle of this lock is, that of having moveable pins, or nails, dropping into, and securing the bolt, each pin falling by its own weight, independently of the others, but all of them requiring to be raised together to the proper height, by corresponding pins in the end of the key, before the bolt can be unfastened.

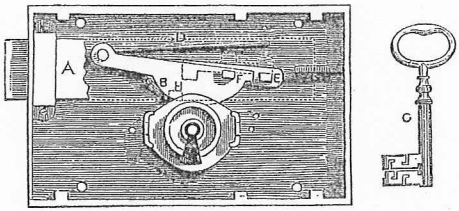
This lock, although unknown in Europe until the latter end of the last century, contains the true principle of security, viz., that of several independent moveable detainers of the motion of the bolt, any one of which would alone prevent that motion: the key was adapted to move and arrange all those detainers simultaneously, and into such positions as would alone permit the bolt to be moved.

Most of the ingenious inventions of late years have been based on a like principle of security. The forms of these moveable obstructions to the bolt, in locks of modern date, are of course various, some acting vertically, others horizontally, some with a revolving motion about a fixed centre, and, in fact, in almost every way it is possible to conceive. Without intending in any way to depreciate the numerous inventions for the improvement of locks (many of which possess great merit), it will be sufficient to describe particularly the three principal locks, which are well known and generally appreciated, namely, Barron's, Bramah's, and Chubb's.

* The original lock, key, and picklocks were exhibited, and also a few picks, selected from about a ton weight of such instruments, captured by the Police, and deposited in Scotland Yard.

In the year 1774, Mr. Barron patented his very useful and secure lock. In this lock, (Fig. 4,) A is the bolt, B and C are the two tumblers, which are kept in their position by the spring D. The studs E and F, attached to the tumblers, retain the bolt in its locked position, and it is only by the application of its own key, G, which is cut in steps of different radii, to correspond with the varying lifts of the two tumblers, that these tumblers can be raised to the exact height, to bring the studs into a line with the slot in the bolt, and thus allow the top step of the key to act on the talon

Fig. 4.
Barron's Lock.



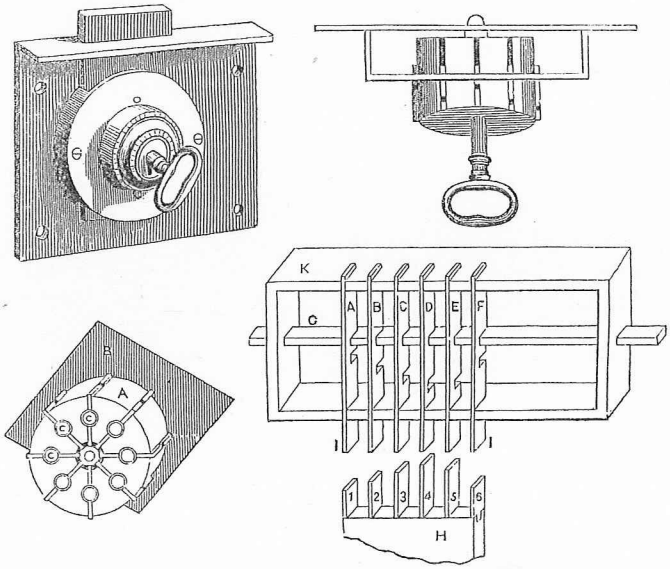
H, and unlock it. It will be observed, that there are upper transverse notches in the bolt, so that in attempting to pick the lock, it is impossible to tell whether either tumbler is lifted too high, or not high enough. This overlift is a vast improvement on the Egyptian, and the single tumbler locks, and is also found in Bramah's and Chubb's locks. In Barron's locks, wards are also used, giving a further slight security; but on account of only two tumblers being used in these locks, it is obvious that no great change, or permutation, can be made in the combinations, so as to prevent the evil of keys passing a lock for which they were not made.

Mr. Bramah, in the year 1784, patented the lock which bears his name, and is so celebrated, Fig. 5. The following description of it is from the specification of the patent, published in the "Repertory of Arts."* "G represents a sliding bar, or bolt, in the frame K, that hath cut in its edge six notches of any proper depth. In these notches are placed six sliders, or small bars, A B C D E F, that are sunk into the bottom of each notch, so that the motion of the bar or bolt G is thereby totally prevented, till these sliders are moved some way or other to give it liberty, which must be done from their ends at I I, as no other part of them is meant to be exposed for the purpose of moving them; which ends at I I always have an equal projection when the bar G is set fast. Now, we will suppose each of these sliders capable of being pushed up-

* *Vide* Repertory of Arts, &c., vol. v. for 1796, p. 217, *et seq.*

wards towards A B, &c., to any determined distance, and, when each of them has exactly received its due motion, the bar G is set at liberty, so as to slide backwards and forwards as required. Now, in order to determine the separate and distinct motion that shall be given to each, we will suppose the part H to be made; which part serves to represent a key, and the ends 1 2 3 4 5 6 are cut of different lengths, either by rule, or by chance, so that, when pushed against the ends of the sliders at I I, they will cause each of them to be slided up at different times, and to different distances, from I I, in a form exactly correspondent to the ends of the part H. When they have thus received their correspondent position, and their ends at I I form a complete tally with the part H, by making a notch in each slider at 1 2 3 &c., in a line with the bar G, the said bar will then have liberty to be slided backwards and forwards without obstruction; and, when brought into its original situation, and the part H withdrawn, the sliders, A B C, &c., will then fall down into their notches, and fasten it as usual; their ends at I I will be restored perfectly even, as before, and not the least trace be left, of the position required in them to set the bar G at liberty."

Fig. 5.
Bramah's Lock.



"A is a frame, or barrel that moves the bolt by its turning, in which barrel or frame are fixed eight, or any other given number of

sliders. B is a thin plate fixed in the lock, through which the barrel, or frame A passes, and is prevented from turning for the purpose of moving the bolt, by the projecting parts of the sliders that move in the fixed plate B, till the notches in each of them are, by the application of the correspondent part of the key, pushed into contact, or in a line with the plate A. At the end of each slider, in the cylindrical parts C C C &c., is fixed a spiral spring, which always restores them after the key is withdrawn, similar to A B C &c., by their own gravity."

It will be observed, that in Bramah's lock, a compound of both endway pushing and revolving motion is given to the key, instead of the simple rotatory movement of Barron's lock.

For many years, indeed until the present time, both Barron's and Bramah's locks have maintained their ground, which is owing, in a great degree, to the care and attention paid to their manufacture, by the original makers and their successors. Those who are practically acquainted with the inconvenience resulting from the ordinary locks, which are generally very badly made, will appreciate the advantage of a well-made and properly-acting lock, on either of the principles now described.

The original patent for Chubb's lock was taken out in the year 1818, by Jeremiah Chubb; this has been improved upon by the successive patents of Charles Chubb, in 1824; by Charles Chubb and Ebenezer Hunter, in 1833; by John Chubb, in 1846; and by John Chubb and Ebenezer Hunter, in 1847.

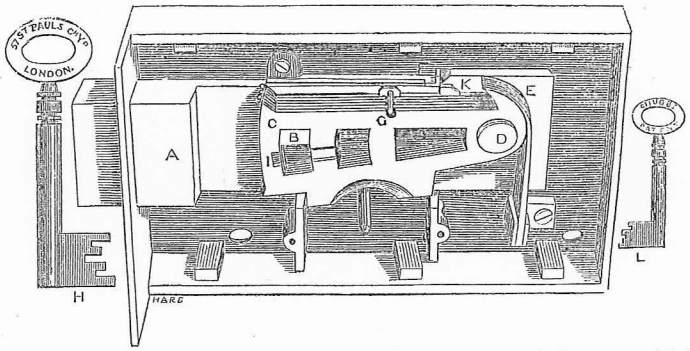
It will be sufficient to describe the last-patented lock, which, while retaining the peculiarities of the former inventions, has received such modifications and improvements as were, in practice, found to be necessary.

It may here be stated, in order to render the drawing more intelligible, that Chubb's lock consists of six separate and distinct double-acting tumblers, with the addition of a "detector," by which any attempt to pick, or open the lock, by a false key, is immediately notified on the next application of its own key. The detector is the great and peculiar feature by which Chubb's lock is so well known.

Fig. 6 gives a representation of a lock made on this principle. A is the bolt, B the square stud riveted into, and forming part of the bolt; C are the tumblers, six in number, moving on the centre pin D, placed one over the other, but perfectly separate and distinct, so as to allow all of them to be elevated to different heights. E is a divided spring, forming six separate springs, pressing upon the ends of the six tumblers. F is the detector-spring. It will be observed,

that the bottom tumbler has a tooth near the detector-spring. G is a stud, or pin fixed into, and forming part of the bottom tumbler, and H is the key. Now it will be obvious, that the whole of the tumblers must be lifted precisely to the different heights required, to allow the square stud B to pass through the longitudinal slots of the tumblers, so that the bolt may be withdrawn. There is no means of telling when any one tumbler is lifted too high, or not high enough, much less can the combination of the six be ascertained; and if a false key should be inserted, and any one of the tumblers should be raised beyond its proper position, the detector-spring F, will catch the bottom tumbler C, and retain it, so as to prevent the bolt from passing; and thus, upon the next application of the true key, immediate notice will be given of an attempt having been made to pick the lock, as the true key will not then at once unlock it. By turning the key, however, the reverse way, as in locking, the tumblers will be brought to their proper bearing, allowing the bolt to move forward, and the stud B to enter into the notches I. The bevelled part of the bolt A will then lift up the detector-spring F, and allow the bottom tumbler C to fall into its place. The lock being now restored to its original position, may be opened and shut in the ordinary manner. It will be seen, that when the lock is detected, nothing but its own key can restore it to its former condition.

Fig. 6.
Chubb's Lock.



The following calculation will show the number of changes which may be made in the combinations of Chubb's locks; the same principle will, of course, apply to any other locks, having a number of moveable tumblers, or sliders.

The number of changes which may be effected on the keys of a three-inch drawer lock, L, (Fig. 6,) is $1 \times 2 \times 3 \times 4 \times 5 \times 6 =$

720, the number of different combinations which may be made on the six steps of unequal lengths, without altering the length of either step. The height of the shortest step is, however, capable of being reduced twenty times, and each time of being reduced, the 720 combinations may be repeated, therefore $720 \times 20 = 14,400$ changes. The same process, after reducing the shortest step as much as possible, may be gone through with each of the other five steps; therefore, $14,400 \times 6 = 86,400$, which is the number of changes that can be produced on the six steps. If, however, the seventh step, which throws the bolt, be taken into account, the reduction of it, only ten times, would give $86,400 \times 10 = 864,000$, as the number of changes on locks, with the keys all of one size. Moreover, the drill pins of the locks, and the pipes of the keys, may be easily made of three different sizes, and the number of changes will then be, $864,000 \times 3 = 2,592,000$, as the whole series of changes, which may be gone through with this key.

In smaller keys, the steps of which are only capable of being reduced ten times, and the bolt step only five times, the number of combinations will be $720 \times 10 \times 6 \times 5 \times 3 = 648,000$. On the other hand, in larger keys, the steps of which can be reduced thirty times, and the bolt step twenty times, the total number of combinations will be $720 \times 30 \times 6 \times 20 \times 3 = 7,776,000$.

Chubb's locks, like the others, are made in series, having a separate and different key to each, and a master key for opening any number that may be required. So extensive are the combinations, that it would be quite practicable, to make locks for all the doors of all the houses in London, with a distinct and different key for each lock, and yet that there should be one master key to pass the whole.

A most complete series of locks was constructed, some years ago, by the late Mr. Chubb, for the Westminster Bridewell. It consists of about eleven hundred locks, forming one series, with keys for the master, sub-master, and warders. At any time the governor has the power of stopping out the under-keys, and in case of any surreptitious attempt being made to open a lock, and the detector being thrown, none of the under-keys will regulate it, but the governor must be made acquainted with the circumstance, as he alone has the power, with his key, to replace the lock in its original state. These locks, although they have been in constant wear for sixteen years, are still in perfect condition.*

It need scarcely be stated, that Barron's, Bramah's, Chubb's, and most other locks, are adapted for all purposes, from the smallest cabinet, to the largest prison doors, or strong room.

* *Vide* Appendix, Note C, p. 326.

As has been already stated, various and numerous patents have been taken out,* among which will be found those of Stansbury, Street, Young, Parsons, Longfield, Fenton, Williams, and Gerish. Ingenious, however, as are some of the arrangements, they appear to have complicated, rather than simplified, the general construction.

It is submitted, that the true principles of perfect security, strength, simplicity, and durability should be combined in every good lock.

1st. Perfect security is the principal point to be attended to, as without it no lock can be considered as answering the intended purpose.

2nd. The works of a lock should, in all cases, possess strength, and be well adapted, especially in the larger ones, to resist all attempts to force them open; and both in the larger and the smaller kinds, the works should not be susceptible of injury, or derangement, from attempts with picklocks, or false keys.

3rd. Simplicity of action is requisite, so that any person having the key, and being unacquainted with the mechanism of the lock, should not be able to put it out of order.

4th. The workmanship, materials, and interior arrangement of a lock should be so combined, as to insure the permanent and perfect action of all its parts, and its durability under all ordinary circumstances.

The manufacture of locks and keys is carried on, principally, at Wolverhampton, and the adjacent towns in Staffordshire, as well as in Birmingham, and in London, and gives employment to thousands of persons. Besides the home consumption, a large export trade is also carried on, and it is gratifying to know, that the use of the best locks, on which a great amount of labour is expended, is increasing, whilst greater attention has lately been paid to the style and character of the ornamental parts of both locks and keys. It is to be hoped, that, in the great Exhibition of Manufactures in 1851, the lock-makers of England will enter into a generous rivalry with those of other nations, and, by combining correct and elegant forms, with the application of their undoubted ingenuity and excellent workmanship, will produce such specimens as shall be unequalled by the rest of the world.

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* *Vide* Appendix, Note D, p. 326.

APPENDIX.

Note A.

"In a country where a large class subsist by robbery, and where the means of effecting it securely, is the constant study of skilful and ingenious thieves, the only means of baffling them, and of protecting the ordinary depositories of valuables, from their felonious attacks, are to call in the aid of the greatest mechanical skill with reference to locks and fastenings, and to exercise unceasing care and vigilance. The bank robberies, during late years, show that they have been planned with extraordinary sagacity, and have been effected with a degree of skill, which proves that they are not undertaken by ordinary thieves. The large amount of money which the housebreakers are confident of obtaining, in the case of a successful burglary at a bank, induces them to act with a degree of skill and caution, proportionate to the expected booty, and it is for this reason, that an unsuccessful attempt to rob a bank is seldom heard of. When "a set" is made at a bank, every information is, in the first place, sought for, by the burglars, of the means of security adopted, and it has been ascertained, that many weeks, and even months, have been occupied in this manner. Attempts are made to tamper with the servants, and an acquaintance is formed, if possible, with some of the female domestics. If, upon inquiry, it is found that the means of security are so numerous and inviolable, as to give no chance of success, the matter is quietly dropped; but if any opportunity presents itself, no time is deemed too long to wait, for the proper moment when the bank may be entered, the misnamed safe, or strong room be opened, and a clean sweep be made of all the convertible securities and money it may contain.

"There is no harm in calling attention to these circumstances, even though they may appear trite enough; for we have recently had our confidence in the apparent security of an iron strong-room door very much shaken by the inspection of an instrument most ingeniously and skilfully constructed, expressly for the purpose of tearing out the centre locks of iron doors. It is in the possession of Messrs. Chubb, of St. Paul's Church-yard, and was presented to them by the Commissioners of the Metropolitan Police, by whom it was taken from some burglars. It is impossible for us to describe this instrument (which, we understand, is well known to the thieving fraternity by the name of the "Jack-in-the-Box"),* without the aid of an engraving; but as Messrs. Chubb are polite enough to allow it to be inspected, we recommend our readers to call and see it. It is small in compass, so that it might be easily carried about the person, and yet it has the power of lifting three tons weight; and the pressure being applied to the key-hole of an iron door of the ordinary kind, it will force the door open in less than fifteen minutes! We have seen a portion of an iron door, on which an attempt had been made by this instrument, but which was defeated in consequence of a new arrangement of the lock, invented by Messrs. Chubb, which has removed the parts of the door on which the instrument must press, as a fulcrum, before it can act. But even in this case, the iron

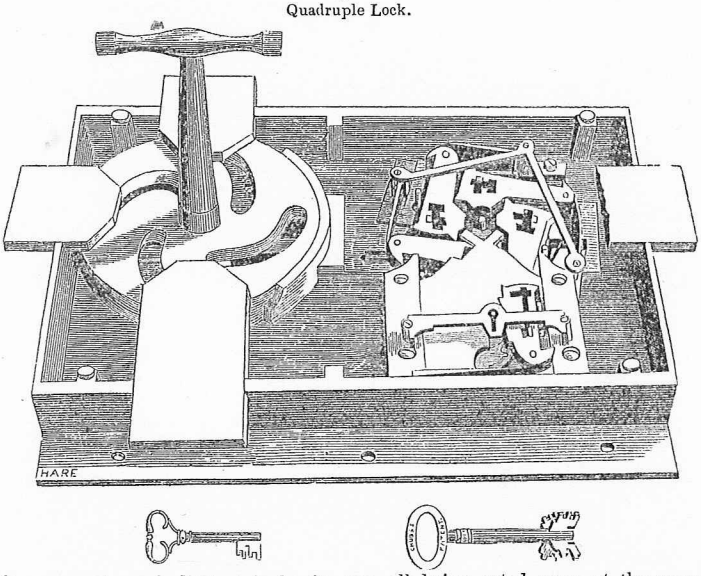
* *Vide* page 330.

plates around the lock were broken away, as if they had been merely cardboard. We have thought it right to bring these circumstances under the notice of our readers, for the subject is of such extreme importance, that it cannot be too often considered. In all cases, where practicable, we should recommend the use of an iron bolt and gratings, in addition to the iron door; the bolt to proceed through the floor of the sleeping-room of the party having charge of the bank, and being immediately over the strong-room, and to be fastened down by him every night."—*Bankers' Magazine, April* 1845.

Note B.

The lock patented by John Chubb in 1846 is especially intended for the fastenings of bankers' and merchants' strong rooms, and other analogous uses. It is called "The Quadruple Lock," (Fig. 7,) and consists of a combination of

Fig. 7.
Quadruple Lock.



four separate and distinct locks in one, all being acted upon at the same time by a single key with four bits. It will be seen, in Fig. 7, that the main bolts are attached to an eccentric wheel, throwing them each way; and to these bolts ten, or twenty bolt-heads may be fitted. The Quadruple Lock has six tumblers in each set, making altogether twenty-four tumblers, all of which must be acted upon simultaneously, by the motion of the proper key, before the eccentric wheel can be turned; it is thus utterly impossible, from the extensive combinations, for any attempt by a false instrument to succeed in unlocking it.

As a further security, there is a check-lock, with a small key, which throws a hard steel plate over the large key-hole. Thus, in a banking establishment, a confidential clerk may carry the quadruple key, and the principal having the smaller key can at all times prevent the fire-proof safe, or strong room from being opened, unless in his own presence.

NOTE C.

The following letter has been received from Lieut. Tracey, Governor of Westminster Bridewell, and is submitted as a testimonial in favour of the security and durability of Chubb's Patent Locks, and their consequent applicability for prisons, or other places, in which those qualities are requisite.

"*House of Correction, Westminster,*
"SIR, "*March* 11, 1850.

"IN reply to your communication of this morning, I have no difficulty in stating my entire approval of the locks prepared by you, and in constant use in this large prison. Very many are necessarily exposed to the weather, from being fitted to the entrances of the several buildings, and although in constant wear, they have proved both secure and capable of resisting wet. I am of opinion, after an experience of nearly sixteen years, that your locks are admirably adapted for every use in prisons, and wherever security is deemed an important consideration.

"I am, Sir,
"*John Chubb, Esq.*, "Your obedient Servant,
"*St. Paul's Church Yard.*" "AUG. FRED. TRACEY, *Governor.*

NOTE D.

LIST of PATENTS for LOCKS and LATCHES,

Granted since the Establishment of the Patent Laws.

As no complete List of the Patents granted for Locks, from the time of James I., has hitherto been published, it is believed that the following list, which has been very carefully drawn up, and which comprises all Patents from the year 1774, when the first Patent for a lock was granted, to the present time, will be found useful as a reference for all who are interested in the subject.

1774	May 27	Black, George, Berwick-on-Tweed.
,,	,,	Barron, Robert, London.
1778	May 29	Martin, Joshua Lover, Fleet-street, London.
1779	May 28	Henry, Solomon, Swithin's-lane, London.
1780	March 4	Campion, John, Newcastle-court, Strand, London.
1782	Jan. 18	Hutchinson, Samuel, Marylebone, London.
1784	,,	Bramah, Joseph, Piccadilly, London.
1789	July 7	Cornthwaite, Thomas, Kendall, Westmoreland.
1790	Feb. 23	Rowntree, Thomas, Surrey-street, Blackfriars, London.
,,	Oct. 29	Bird, Moses, Wardour-street, London.
1791	July 19	Ferryman, Rev. Robert, Gloucester.
,,	Nov. 3	Antis, John, Fulneck, near Leeds.
1797	Nov. 18	Langton, Daniel.
1798	May 3	Bramah, Joseph.
,,	Dec. 8	Turner, Thomas.
1799	April 11	Davis, George.
1801	Feb. 10	Scott, Richard, Lieut.-Col.
,,	June 24	Holemberg, Samuel, London.
,,	,,	Roux, Albert, Switzerland.
1805	May 18	Stansbury, Abraham Ogier, New York.
,,	Dec. 29	Thompson, William, Birmingham.
1815	March 7	Mitchell, William, Glasgow; and Lawton, John, London.
1816	May 14	Ruxton, Thomas, Esq., Dublin.
1817	Feb. 8	Clark, William, Esq., Bath.

1818	Feb.	3	Chubb, Jeremiah, Portsea.
1819	Oct.	18	Strutt, Anthony Radford, Mackeney.
1820	April	11	Jennings, Henry Constantine, Esq. Middlesex.
,,	Dec.	14	Mallet, William, Dublin.
1823	July	10	Fairbanks, Stephen, Middlesex.
,,	Nov.	13	Ward, John, Middlesex.
1824	June	15	Chubb, Charles, Portsea.
1825	May	14	Young, John, Wolverhampton.
1828	May	17	Chubb, Charles, London.
1829	June	1	Gottlieb, Andrew, Middlesex.
1830	Jan.	18	Carpenter, James, and Young, John, Wolverhampton.
,,	Jan.	26	Arnold, John, Sheffield.
1831	April	14	Rutherford, William, Jedburgh, N.B.
,,	May	23	Barnard, George, Bristol.
,,	July	27	Young, John, Wolverhampton.
1832	Dec.	20	Parsons, Thomas, London.
1833	Dec.	3	Parsons, T., Newport, Salop.
,,	Dec.	20	Chubb, Charles, London, and Hunter, E., Wolverhampton.
1834	Sept.	6	Longfield, William, Otley.
,,	Oct.	11	Audley, Lord Baron, Stafford.
1835	March	18	Hill, R., Birmingham.
,,	Dec.	16	Warwick, J., London.
1836	Feb.	10	Fenton, Rev. S., Pembroke.
1838	June	30	Uzielli, M., London.
,,	Nov.	13	Thompson, S., London.
1839	Feb.	21	Uzielli, M., London.
,,	June	12	Sanders, J., Stafford.
,,	July	3	Cochrane, A., Strand, London.
,,	July	20	Schwieso, J. C., London.
,,	August	1	Williams, W. M., London.
,,	Dec.	2	Guest, J., Jun., Birmingham.
1840	Feb.	27	Williams, W. M., London.
,,	March	20	Gerish, F. W.
,,	May	2	Pearce, W., Hoxton, Middlesex.
,,	June	13	Wolverson, J., and Rawlett, W., Stafford.
,,	Oct.	22	Clark, T.
,,	Dec.	23	Baillie, B., London.
1841	March	29	Tildesley and Sanders, Willenhall and Wolverhampton.
,,	May	6	Hancock, James, Sidney-square, Mile End.
,,	July	14	Berry, Miles, Chancery-lane.
,,	Sept.	28	Strong, Theodore Frederick, Goswell-road.
,,	Nov.	9	Smith, Jesse, Wolverhampton.
1842	Jan.	15	Poole, Moses, Lincoln's-inn.
,,	May	24	Duce, Joseph, Wolverhampton.
,,	June	13	Williams, W. M., 163, Fenchurch-street.
,,	Dec.	29	Rock, Joseph, Jun., Birmingham.
1843	Nov.	25	Tann, E. E. and J., Hackney-road.
,,	,,		Rock, Joseph, Jun., Birmingham.
1844	July	30	Fletcher, Rev. William, Moreton House, Buckingham.
1845	April	15	Carter, George, Willenhall.
,,	July	12	Ratcliff, Edmund, Birmingham.
,,	Dec.	4	Poole, Moses, Lincoln's-inn.
,,	Dec.	22	Smith, Philip, High-street, Lambeth.
1846	July	6	De la Fons, John Palmer, Carleton-hill, St. John's Wood.
,,	July	15	Thomas, William, Cheapside.
,,	Dec.	14	Chubb, John, St. Paul's Churchyard.
1847	Jan.	11	Chubb, John, and Hunter, Ebenezer, Sen., St. Paul's Churchyard.
,,	April	11	Collett, Charles Minors, 62, Chancery-lane.
1848	Sept.	28	Newall, Robert Stirling, Gateshead.
1849	May	8	Wilkes, Samuel, Wednesbury-heath, Wolverhampton.

NOTE E.

LIST of REFERENCES to the "TRANSACTIONS of the SOCIETY of ARTS," on the subject of LOCKS.

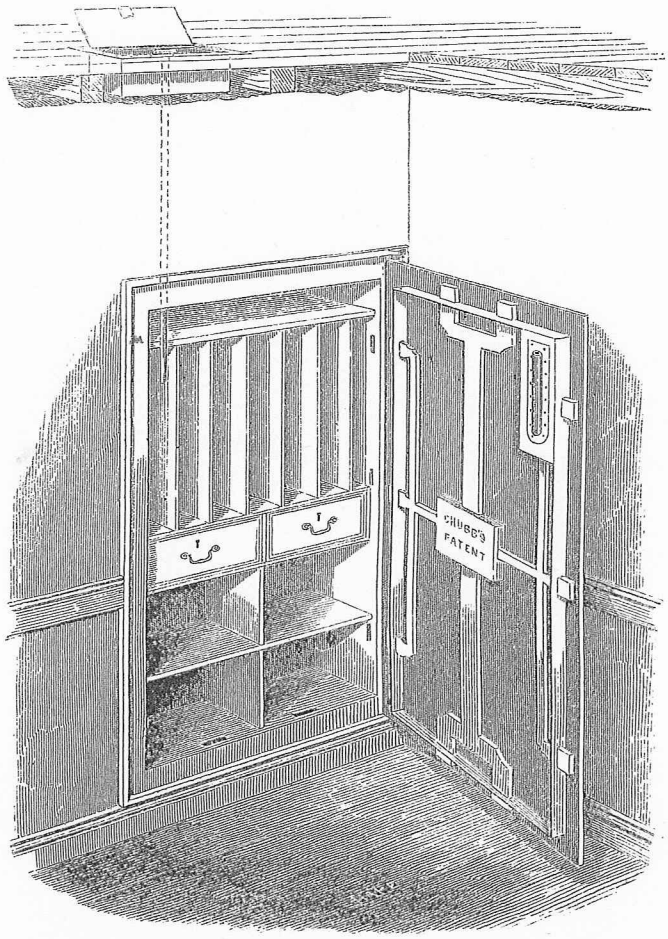
Vol. 1.	Page 317	Mr. Moore.
„ 2.	„ 187	„ Cornthwaite.
„ 3.	„ 160	Marquis of Worcester.
„ „	„ 165	Mr. Taylor.
„ „	„ 163	„ Marshall.
„ 18.	„ 239	„ T. Arkwright.
„ „	„ 243	„ Bullock.
„ 19.	„ 290	„ W. Bullock.
„ 36.	„ 111	„ M. Somerford.
„ 38.	„ „	„ A. Ainger.
„ „	„ 205	„ Bramah.
„ 42.	„ 125	„ J. Duce.
„ 43.	„ 114	„ W. Friend.
„ 45.	„ 123	„ Machin.
„ 48.	„ 132	„ S. Mordan.
„ 50.	„ 86	„ A. Mackinnon.
„ 51.	„ 128	„ J. Meighan.

Mr. CHUBB said, that in writing the paper, the greatest difficulty was to condense the voluminous mass of information within the necessary limits. He had, however, prepared an Appendix, containing some suggestions as to the best means of securing the strong rooms of banks, and other places, and also a chronological list of patents for improvements in locks, since the establishment of the first patent law, in the reign of James I., together with a list of those persons who had received prizes from the Society of Arts, for various improvements in secure fastenings.

It was a well-known fact, that an unsuccessful attempt to rob a bank was scarcely ever heard of, the anticipated booty being so considerable, that the burglars could afford to spend considerable time in devising complete and effective plans. Indeed they frequently spent months in examining the locality, and in obtaining information, when, if no chance of success appeared, the enterprise was quietly abandoned. In many country banks, great carelessness was shown, both in regard to the quality of the locks, and in the custody of the keys. A good plan, sometimes adopted, was to have a bolt extending from a room on the second, or third story, which after traversing the back of the iron door of the strong room, was let into a socket in the top, and sometimes down into the bottom cill of the door; in some cases, the room fixed upon was the bedroom of the manager, so that the bolt could only be raised, or lowered, with his knowledge.—(Fig. 8.)

Fig. 8.

Chubb's Fire-proof Iron Safe.



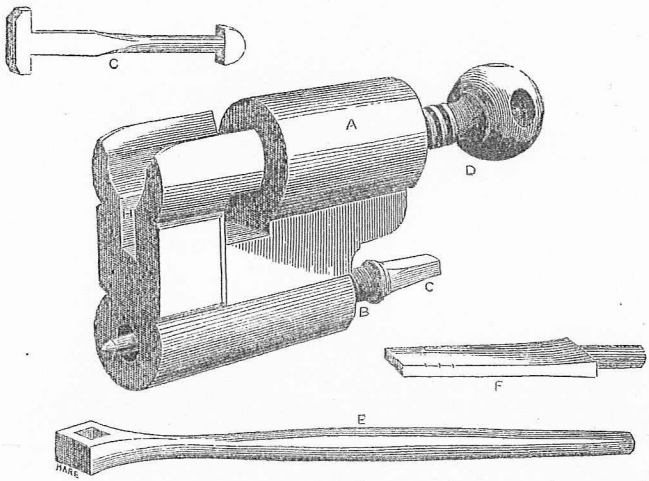
Another plan was to have a dry well beneath the floor of the basement, into which the safe was lowered every night, the greatest care being taken to guard against damp. No one lock should be depended on, but security should be obtained by having three, or four locks of different combinations.

It must also be borne in mind, that fire-proof safes and chests were required to preserve books, documents, and money, as much from fire as from thieves. Many safes which were sold as fire-resisting, were made of the thinnest plate iron, so that they would

of course be crushed, and the contents destroyed, in case of timbers, or brickwork, falling upon them. They should consist of a double casing of strong wrought iron, the intermediate space being filled with a good non-conducting substance; bolts should shoot out from all sides of the door, so that if the whole building fell, the iron safe would not be injured either by the heat, or by the fall of the materials. The best practical proof of the efficiency of strong, well-constructed fire-proof safes, was, that of some thousands made on this principle by Mr. Chubb, there was not a single instance of a failure having occurred from any cause.

Some years ago, one of Chubb's locks, fixed on a common iron safe, was forced open by a burglar's instrument, called a "Jack-in-the-Box." That instrument was of such ingenious construction as to demand a particular description.—(Fig. 9.)

Fig. 9.
Jack-in-the-Box.



A was the stock, made of solid brass; B was a strong screw with a point, which was worked at the end C by means of a spanner, or lever key, E. D was a powerful screw, working in the upper part of the stock A, and turned backwards, or forwards, by the handle of the lever E. The point of the screw D was made hollow, to receive a straight steel bar F. G was a steel clamp, with square shoulders at each end.

The manner in which this instrument was used to open doors and safes might be thus described. One end of the clamp G was inserted sideways into the keyhole, and turned a quarter round, whilst the other end was slipped into the groove H in the stock.

The point of the screw B was then screwed up close to the front of the safe, and the instrument was fixed. The large screw D was then withdrawn to fit the bar F into the socket at its end, and by applying the lever E to the head of the screw D, the bar F was forced steadily onwards, until either the lock was broken, or the door was burst open.

As this instrument had the power of lifting three tons weight, it was evident that some part of the door must give way under its pressure; and, in doors made on the common principle, the lock and a portion of the lock-case must be torn away, then by throwing back the bolts, the contents of the safe were in the power of the burglars.

Since the occurrence of the before-mentioned accident, Mr. Chubb had adopted the plan, in his recent safe locks, of cutting a square piece out at the back of the keyhole, and refixing it only by small screws, so that on the application of the "Jack-in-the-Box," that piece only was removed. He produced a lock constructed in this manner which had been so operated upon; the plate had been forced away, leaving the lock and bolts, and thus the burglars were baffled in their attempt.

Mr. FAREY observed, that the mechanism of locks had been a favourite subject with him, from an early period of his studies, when he had the good fortune to be intimate with Mr. Joseph Bramah, and had acquired a knowledge of his locks, which were then in high repute. The secret workshops, wherein the locks were manufactured, contained several curious machines, for forming parts of the locks, with a systematic perfection of workmanship, which was at that time unknown in similar mechanical arts. These machines had been constructed by the late Mr. Maudslay, with his own hands, whilst he was Mr. Bramah's chief workman.

The important part of Bramah's lock was the central hollow part, called its revolving barrel, with steel locking sliders, to receive the end of the key. On looking into this barrel, the narrow ends of the six steel sliders could be plainly seen, all radiating from the centre pin; at the end of the key, there were six corresponding radiating notches, but the length of each notch was different.

In using the lock, the key was first pushed endways into the barrel, as far as it would go, when it was felt to be entering in opposition to a spring. The key acted against all the six sliders at once, but it pushed back each slider to a different distance, according to the lengths of the several notches in the key, which were just suitable for placing each one in, what might be called, its unlocking position; and all the six sliders being so placed at the same time,

they would leave the barrel at liberty to be turned round by the key; the bolt of the lock was shot by a curious crank-pin motion, in a slot, but the key itself had no communication with the bolt, as in all other locks.

The steel sliders, which should be at least six in number, were lodged in as many detached grooves, cut out lengthways in the metal of the barrel, so as to allow each slider to have an independent endway motion in its own groove. The barrel was held in its place in the lock sideways and endways, by being truly fitted into a circular hole in a fixed steel plate, in which hole the barrel could be turned round by the key, after it had been inserted, and had moved all the sliders, to their unlocking positions. On removing the key from the lock, all the sliders were pushed endway forwards, by their spring, interlocking into corresponding radial notches in the steel plate, so as to fasten the barrel and prevent it from turning round.

The unlocking position of each slider was, when that slider was moved so far in its groove, that an unlocking notch in the outer edge of the slider, came precisely opposite to the edge of the fixed steel plate, which would then allow the barrel to turn round, provided that every one of the sliders was so moved to its unlocking position at the same time; but any slider which was not moved far enough in its groove, would not arrive at its unlocking position; or any slider, being moved in its groove beyond its unlocking position, would interlock anew with the steel plate, and hold the barrel fast.

The machines, before mentioned, were adapted for cutting the grooves in the barrels, and the notches in the steel plates, with the utmost precision. The notches in the keys, and in the steel sliders, were cut by other machines, which had micrometer screws, so as to ensure that the notches in each key should tally with the unlocking notches of the sliders in the same lock. The setting of these micrometer screws was regulated by a system, which ensured a constant permutation in the notches of succeeding keys, in order that no two should be made alike. Mr. Bramah attributed the success of his locks to the use of those machines, the invention of which had cost him more study than that of the locks; without the machines, the locks could not have been made in any great number, with the requisite precision, as an article of trade. There was great originality in those machines, which were constructed before analogous cases (beyond the clock-makers, wheel-cutting machines) were in existence.

The security of Bramah's lock against being picked, depended upon the circumstance that its several sliders must, each one for itself, be pushed in so far and no farther; but how far, the lock

afforded no indication. It was nevertheless very objectionable, that the sliders should be so completely exposed to view. It had been suggested, that an universal false key for Bramah's locks might be made, with the bottoms of its several notches formed by as many small steel sliders, extending beyond the handle of the key, so as to receive pressure from the fingers, for moving each one of the sliders within the lock, with a sliding motion in its own groove, independently of the others; and during such sliding motion, a gentle force could be exerted, tending to turn the barrel round. Under such circumstances, supposing that the motion of the barrel was prevented by any one slider only, that one having to resist all the turning force, would be felt to slide more stiffly endways in its groove, and therefore it could be felt when its unlocking notch arrived opposite the steel plate, and left some other slider to begin to resist the turning force; such a circumstance presumed a palpable inaccuracy in the radiating correspondence between the notches in the steel plate, and the grooves for the sliders in the barrel, which could not happen with Bramah's workmanship.

It might be concluded, that a good Bramah's lock was not easily picked, by finding out its combination; but unfortunately if a Bramah's key fell into dishonest hands, even for a very short time, an impression could be easily taken, and a false key as easily made. A turkey quill notched into the form of a key, had sufficed to open a Bramah's lock; and an efficient false key could be formed out of a pocket pencil-case. Such facility of fabrication was an invitation to dishonesty, and as an abortive attempt left no trace, the impunity was an encouragement to repeat the attempt until success was attained.

A similarity of principle might be observed in Bramah's sliders, and the pins of the ancient Egyptian lock, the motions of the sliders, in the former case, and of the pins, in the latter, being in both independent, whereby any one out of the whole number would of itself secure the lock, which could not be opened until all the sliders, or pins, were brought to their unlocking position. Bramah's sliders required, however, great precision in the extent of this motion, and had also the advantage, that any one which was moved beyond its exact locking position, would interlock anew as effectually as if it had not been moved far enough.

In Barron's lock, a vast improvement was made by rendering the tumblers double-acting, and by combining two such tumblers. A common tumbler would only catch and detain the bolt, when the tumbler was let down, but it ceased to afford any security, if it was lifted beyond its contact with the bolt; hence an ordinary tumbler lock, with only one common tumbler, might have that tumbler

lifted, and kept up, by a picklock, so as to leave the bolt quite at liberty, to be moved by another picklock.

The double acting tumbler would only release the bolt, by being lifted to the exact height required for releasing it, and no higher; for if the tumbler was lifted any higher, it caught the bolt anew, and (by what was called "overlift") detained it as securely, as if the tumbler had not been lifted high enough. In attempting to lift this tumbler with a picklock, there was nothing to indicate when the tumbler was lifted to its exact height, and with two such tumblers requiring to be lifted independently, each one to its own proper height, but no higher, it was difficult to conceive how picklocks could be available.

Chubb's lock was a very improved modification of Barron's, containing six double-acting tumblers combined together, and also possessing the important adjunct of the "detector." In no instance had one of Chubb's locks been opened by picklocks, and, indeed, with a combination of six tumblers, it became exceedingly difficult to make a false key sufficiently accurate, to open a lock, because each step of the key required to be just sufficient to lift the tumbler, to which that step belonged; if the step was too long, the tumbler would be overlifted, and would thereby detain the bolt, or if the step was too short, it would not lift the tumbler high enough to release the bolt; no indication could be obtained by the trial of a false key in the lock, as to which of the steps was too long, or too short. The lock would be secured against unlocking, by any one, or more of the six tumblers, being either overlifted, or not lifted high enough; but it could not be ascertained which tumbler detained the bolt, or which step of the false key was incorrect. In such a state of uncertainty, all attempts to rectify the inaccuracy of the false key, must be directed by mere guess, and alterations were as likely to be made in the steps which were nearly correct, as in those which were wrong.

It was formerly thought, that a skilful workman, furnished with impressions taken from the true key, in wax, or soap, could make a false key to open any lock; and in common locks with the most elaborate wards, but with only one common tumbler, also in Bramah's locks, there was much truth in the notion; but for a lock with six double-acting tumblers combined, a false key made ever so carefully, according to impressions, would not be likely to open the lock, for want of exactitude in the lengths of the several steps; and if the key could not be made exact from the impressions, there would be no chance of rectifying it by trial, in the lock, on account of the total uncertainty as to which part required alteration.

Chubb's detector being combined with the six double-acting

tumblers, added very greatly to the security of the lock; for in the course of making trials with a picklock, or false key, if any one of the tumblers was lifted too high, it overset the detector detent, which by a spring action fastened the bolt, so as to secure it from being afterwards withdrawn; and although the bolt should be released from all obstruction by the other tumblers, the fastened tumbler would of itself continue to hold the bolt, as an additional detention, not capable of being removed, even by an ordinary application of the true key, which would not go round in the lock, after the detector was brought into action; and thus notice was given, that a fraudulent attempt had been made to violate the lock. To set the detector free, the true key required to be first turned partially round, in a reverse direction, whereby the detector was restored to its quiescent position, and then the true key would operate in the usual manner. It was only by overlifting any one, or more of the tumblers, that the detector could be brought into action, and the use of the true key could never overlift any tumbler, or disturb the detector.

In making a false key, the bit was usually left rather too long, being gradually reduced by trial until the proper length was attained. Though this process might succeed with a common lock, it had no chance with Chubb's lock, which would become detected by one trial with a false key, having even but one step too long, and if a step was too short at first, it was not easy to lengthen it. Hence the maker of a false key was beset with difficulty at every stage of his operations; and without tolerably accurate information respecting the true key, it was scarcely possible to find out the combination of the six tumblers, or to avoid bringing the 'detector' into action.

Mr. CHUBB said, in reply to Captain Moorsom, that if a lock had only one key, and it should happen to be lost, when the lock was fastened, the door would require to be forced open, but good locks generally had two keys, one of which was deposited in a place of safety. Two hundred and twenty locks might be made with one keyhole, and a separate key to each, yet having one master key for the whole; but if a greater number was required, it would be necessary to have two keyholes. In the event of the master-key being stolen, he knew of no remedy, but replacing the locks, or altering their combinations.

It was impossible to take a sufficiently correct impression, in wax, for the purpose of making a false key, as the locks were manufactured with such delicacy and nicety, that the slightest alteration, or difference in the key, would prevent the lock being opened by it.

Mr. VARLEY thought, that Somerford's lock was equal to Mr. Chubb's, and had double the power, as a key was weakened by the introduction of many wards. Somerford's lock had a series of tumblers, one-half of which had to be pulled by the key out of the notches, and the other half to be pushed out with false notches on the other sides, to re-lock by any excess of motion. That lock had been favourably noticed many years back by the Society of Arts, and was one of the most perfect of the tumbler kind. Mr. Bramah's first locks had been picked, and the late Mr. Clements had picked a beautiful lock made by Jacob Perkins. The false notches, subsequently introduced by Mr. Bramah, added wonderfully to the security of his lock.

With respect to the number of combinations of which locks were capable, it did appear to him that a certain limit should be assigned to it, in order to prevent any necessity for such close fitting, that rust, or dust on the key would prevent its opening the lock. A lock was exhibited some time back, the key of which had at first easily opened the lock; but when it was warmed the slight expansion caused by the heat prevented the key from acting on the bolts.

Mr. HODGE said, that in America he had repeatedly seen impressions taken of locks having twelve, or fourteen tumblers; certainly they were not made by Mr. Chubb, but were such perfect imitations of his locks, having even the detector, that there did appear to be a possibility of picking these locks; in fact, he would undertake to bring a man from New York who would be capable of doing it.

Mr. Mackinnon, after having succeeded in picking a tumbler lock, introduced an additional protection, which he termed a "curtain," made of a plate of case-hardened iron, three-quarters of an inch thick, radiating from the common centre of the lock, which prevented anything from reaching the tumbler, without first cutting through the curtain, which was next to impossible. The same gentleman had also made an expanding key, which was found to be very useful.

Mr. Hodge had recently purchased at a sale, an old bookcase, which had been made in Geneva, about the year 1762, having a lock with a protecting curtain, though without the expanding key; this curtain revolved when the key was inserted.

Mr. STEPHENSON, M.P., *V.P.*, imagined, that though it might be possible to take a wax impression of a warded lock, such could not be taken from a tumbler lock, for there was nothing in a lock of the latter description which could give, by any injection of wax, a knowledge of the length of travel of the different tumblers. He there-

fore considered Mr. Hodge had raised a problem which did not admit of solution, and he would venture to say, that it was not possible to pick one of Chubb's locks by the aid of any wax impression.

Mr. CHUBB produced specimens of Davis', Parsons', Williams', and Nettlefold's locks, and gave a brief description of each.

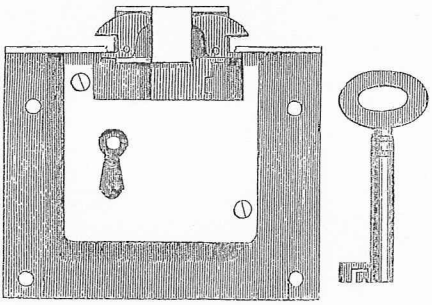
Davis' lock was made with a double chamber, and had wards on the sides of the keyhole. The key was inserted into the first chamber, and turned a quarter round; it was then pushed forward into the inner chamber, where there was a rotating plate, containing a series of small pins, or studs, which were laid hold of by the key. By turning the key, the plate was moved round, the tumbler was raised, and the bolt shot backwards, or forwards. This lock was now used to some extent on the Cabinet despatch-boxes; but it was expensive, without affording any very great security.

In Parsons' lock, the tumblers were of a particular form, being hinged on a pivot in their centres, and worked into, and out of, two notches cut in the under side of the bolt.

Williams' lock consisted of a number of pins, similar to those in the Egyptian lock, and operated upon by a spring, in the same manner as Bramah's lock. On the pins being pushed down by the key to their respective positions, the bolt was set at liberty, and was pushed backwards and forwards by two springs, one of which was strong enough to overcome the resistance of the other, during the action of locking, and was forced back by the key, to allow the weaker spring to act in unlocking. It had, like Bramah's, Barron's, and Chubb's locks, the advantage of the over-lift; but it was liable to be easily deranged, and was much too delicate for general use. In 1845, a joint-stock company was projected, with a capital of £30,000, for the purpose of working Williams' patent; but although the lowest amount of profit was estimated at £10,300 per annum, the shares were not taken up.

The peculiar feature of Nettlefold's lock (Fig. 10) was, that as

Fig. 10.
Nettlefold's Lock.



the bolt was shot out by the key, two teeth, or quadrants, were projected from the sides of the bolt, which took a firm hold of the plate fixed on the door-post or edge. It was much used for sliding-doors, and was found to answer exceedingly well. The same peculiar movement had also been applied to many other locks, by different makers, under the authority of licences from Mr. Nettlefold.*

Mr. HODGE explained the system he had previously alluded to, as having been employed in America for ascertaining the range of the tumblers. The process was described to be, that the operator, after thoroughly oiling the inside, and inserting two pieces of India-rubber, to limit the sphere of action, injected from a force-pump, a composition of glue and molasses, in a heated state, which chilled quickly, and, although extremely elastic, had the property of retaining the form and position of the lower side, or bellies of the tumblers, and that after being cut out of the lock by a thin-bladed instrument, a key could be made from the impression sufficiently accurate to open the lock. This had repeatedly been done with the best tumbler locks, even on Chubb's principle; although he could not vouch for its having proved successful with any locks made by Mr. Chubb.

The case-hardened iron curtain, he had mentioned, would effectually prevent the success of such a process, for obtaining the range and curve of the bellies of the tumblers.

He thought, that the locks made in New York, were generally superior to those made in England, and he attributed it partly to the use of good machinery, for the production of the parts of the locks, instead of the primitive tools in use at Wolverhampton and other places, and partly to the small expense of patents in America, inducing the exercise of more ingenuity and invention among practical men. At a late exhibition of the American Institute, fifty, or sixty new and ingenious locks, of very superior workmanship, were produced, and he believed that nearly all were invented by practical workmen.

In making these remarks, it was not his intention to detract from the reputation of the late Mr. Chubb, whose ingenuity he much admired, and of whose locks he admitted the general superiority in England; but he must assert, that he had seen more ingenious and better locks in America.

Mr. CHUBB regretted, that what had been stated by Mr. Hodge, had not happened in London, instead of in New York; it must, however, be evident, that such a method was totally incapable of application to a lock of Mr. Chubb's own manufacture, though he

* Nettlefold's lock was patented in 1839, by J. C. Schwieso.

could not answer for the workmanship, or the security of those made by other persons, in imitation of his locks. If a workman did not understand how to make one of his locks, he might leave a similarity between the bellies of the tumblers when at rest, and the steps in the bit of the key, but he denied the possibility of this in any of the locks made by him, and in proof of this, the locks then exhibited were referred to. There was no reason why the bellies of the tumblers should not be perfectly uniform, and in the same plane, and it would be seen from the lock made on that principle, that an impression of the inside of such a lock must be utterly useless for any felonious purposes.

Mr. STEPHENSON, M.P., *V.P.*, said he had been under the impression, that the bellies of the tumblers in Mr. Chubb's lock were always flush, or in the same plane, when the lock was in a state of rest, and that the lift of the tumblers was entirely regulated by the notches, or steps in the key; therefore, it was evident, that unless the impression could be taken from the key, any attempt to make a false key must be futile, and even a fac-simile of the interior of the lock would be useless. When the lower side of the tumblers were flush, as in the lock then produced by Mr. Chubb, it did not seem probable that any scheme could be devised, by which an impression of the lock could afford any assistance for picking the lock.

Mr. FAREY coincided in Mr. Stephenson's opinion, of the improbability of the American plan of taking an impression of the bellies of the tumblers, being at all effective, in aiding to pick a lock really made by Chubb, whatever it might do in the case of bad imitations of that kind of lock.

Mr. WHITWORTH said he had much pleasure in bearing testimony to the great value of Mr. Chubb's locks; he used them almost invariably in his establishment, and never found them get out of order. The workmanship in them was of the best kind, and he thought it would be impossible to pick them, by the means that had been mentioned, or by any picklock keys, as long as the detector was in good order; that was the main feature of the lock, and distinguished it from all other tumbler locks.

Capt. D. O'BRIEN was sorry to differ, in some degree, from the opinion expressed by Mr. Chubb relative to the value of Davis' "Cabinet" locks. The Cabinet boxes frequently contained secret papers, and the promulgation of their contents might be of serious consequence. He formerly had occasion to open from ten to twenty of them daily, during a period of two years, and he never once observed the locks to be out of order; in fact they always appeared to afford great security.

As an Inspector of Government Prisons, his attention had been directed to the subject of secure locks, and he produced specimens of those in use at the Millbank and Pentonville Prisons, which, though not of first-rate workmanship, were tolerably safe, strong, and cheap; most important considerations, when from seven hundred to eight hundred locks had to be provided.

The lock from the Millbank Prison was a good common tumbler lock, with a bolt and a brass guard, in which there was a slot for a pin to slide in, to keep the bolt in its place; it only locked singly, but as yet it had defied ordinary attempts to pick it.

That from the Pentonville Prison was of a better description; it was the invention of Mr. Thomas, of Birmingham, and consisted of a common tumbler, a bolt, and a brass guard flap, retained in position by a spring inserted at the back of the lock. The key, in its revolution, lifted the guard flap, at the same time acting upon the tumbler, which threw the bolt. The lock had also a handle on the outside attached to a trigger, which caught the bolt, when shot back by the key in opening the door, and retained it until the handle was touched, which put the bolt on half lock. This contrivance, the object of which was to save the time of the turnkeys, placed the bolt in such a position, that on closing the door from the inside, the lock could only be opened by the application of the key from the outside, and every prisoner was obliged, by the rules, to touch the handle of the trigger, and thus shut himself into the cell. These locks had been in use eight years, during which period not one had required to be replaced, and any trifling derangements had been made good whilst the prisoners were at exercise. They only cost ten shillings each, notwithstanding that the offers, in the first instance, ranged from twenty-five shillings to forty shillings.

Mr. CHUBB said, he was prepared to produce a workman who would pick any number of Davis' Cabinet locks, of different combinations, which he had never seen before, taking only half an hour for each lock.

He was willing to make the same offer with respect to the locks from the Pentonville Prison; and he might state, that in point of security, he considered them absolutely worthless: in proof of which he exhibited one of them, and a common burglar's tool, by which the lock could be opened with the greatest ease.

Mr. CHARLES HART said, he had some experience in locks, and was conversant with the merits of all the different kinds. From his experience, he considered Chubb's locks were the most secure, and were generally made better than any others. Many inferior locks made on the same principle, were commonly sold, but he had

never yet met with a man who could pick a lock of Mr. Chubb's own manufacture.

Mr. Owen said, there were one or two incidents connected with the early history of Mr. Chubb's lock which might be interesting.

A convict on board one of the prison ships, at Portsmouth dock-yard, who was by profession a lock-maker, and who had been employed in London in making and repairing locks for several years, and subsequently had been notorious for picking locks, asserted that he had picked, with ease, one of the best of Bramah's locks, and that he could pick Chubb's locks with equal facility. One of the latter was secured by the seals of the late Sir George Grey, the Commissioner, and some of the principal officers of the dock-yard, and given to the convict, together with files, and all the tools he stated to be necessary for preparing false instruments for the purpose; as also blank keys to fit the pin of the lock, with a lock exactly the same in principle, so that he might examine it, and make himself master of its construction: promises of a reward of £100 from Mr. Chubb, and of a free pardon, were also made to him in the event of his success.

After trying for two, or three months, to pick the sealed lock, during which time, by his repeated efforts, he repeatedly overlifted the detector, which was as often undetected, or re-adjusted, for his subsequent trials, he gave up the attempt, saying that Chubb's were the most secure locks he had ever met with, and that it was impossible for any man to pick, or to open them, with false instruments.

In order to compare the merits of Bramah's and of Chubb's locks, Mr. Owen had suggested a mechanical contrivance, which was applied to one of Bramah's six-spring keyed padlocks, belonging to the Excise. It was hung upon a nail, in a vertical position, secure from side oscillation; a self-acting apparatus was then applied, consisting of a pipe with hexagonal grooves, and a stud, or bit, corresponding with the divisions of the lock, and secured to it by a spring; in the grooves of this pipe, small slides were inserted, which pressed against the spring keys of the lock; to these slides were attached levers, acted upon by eccentrics, moved by a combination of wheels, whose teeth varied in number by one (or a hunting tooth), so as to perform the permutation required for the different depths of the spring keys, corresponding with those of the proper key to the lock; when, by the automaton machine being set in motion from a weight and line over a barrel, and so left, the combination was attained, which occupied from half an hour to three hours, according to the state of permutation, the position of the

eccentrics were in, at the time of the introduction into the lock, of the pipe, or false key, to which was attached a rod and weight at right angles to it, the notches in the spring keys being brought in a line with the plane of the plate, or diaphragm of the lock, the rod and weight turned the false key, or pipe, opened the lock, and stopped the further motion of the automaton. In that state, the slides indicated the exact depth of the grooves of the proper key, and gave the form of a matrix, by which to make a key similar to the original one.

In order to ascertain the result of friction on Chubb's detector lock, one of them was subjected to the alternate rectilinear motion of a steam-engine, in the Portsmouth dock-yard, and was locked and unlocked upwards of four hundred and sixty thousand times consecutively, without any appreciable wear being indicated by a gauge applied to the levers and the key, both before, and after this alternate action.

He believed Chubb's locks had never been picked; the detector was the main feature of its excellence; and additional precaution, therefore, was only departing from its simplicity, and adding to the expense without any commensurate advantage.

Mr. FAREY said, before closing the discussion, he desired to direct attention to the importance of the means of securing iron chests, or safes. The bolts should be so arranged as to shoot out from all the four sides of the door (Fig. 8, p. 329), by the action of a handle, which should be secured from being opened by one, or two small locks; this was a much safer plan than having large keys, capable of throwing the bolts, as the large keyholes and greater space within the locks, afforded facilities for tampering with them.

The letter locks, which had been only cursorily alluded to, were invented by Cardon, who advanced no further than using one word; they were improved by Regnier, who placed the letters on moveable rings, so as as to permit a great extent of permutation. These locks were, however, not safe, as they might be easily picked, by suspending a weight on the hasp, and turning round the rings seriatim, until it was felt that the combination was arrived at, by the pin holding in the notch of the ring.

Mr. STEPHENSON, M.P., *V.P.*, said it might be assumed as proved from the discussion, and therefore it was the duty of the Institution to express the conviction, that no locks really made by Chubb, had ever been picked, either in Great Britain or on the other side of the Atlantic; that they did, in fact, combine that strength, simplicity, easy action, and security, without which the most ingenious locks were utterly useless.

Notwithstanding the circumstantial description of the ingenious method employed in the United States, for taking an impression of the interior of a lock, it had not been proved to have been successful with one of Chubb's locks; and indeed, he must repeat, that it was evident it could not be so, unless the lift of the tumblers was identical with the position of the bellies, when in a state of rest, which was not the case; and if the bellies of the tumblers were flush, an impression of them was still more useless.

The thanks of the Institution were most justly due to Mr. Chubb, for bringing before the Members so interesting a subject, which he had treated in so able a manner.

Mr. CHUBB said, with respect to the locks which had been stated to have been picked, he could assure the Members that they had never been issued from his manufactory, although they were very probably marked with his name. Many spurious imitations of the first expired patent, marked "Chubb's Patent," had been sold in large quantities, until the makers were stopped by legal process, when it was ruled, both at law, and equity, that, although after the expiration of a patent, any person might manufacture the article, he had no right to pirate a peculiar trade mark, or to use a distinctive stamp, which was irrespective of any patent right.

Since he had been connected with the Institution, he had derived so much pleasure, instruction, and profit from it, that he felt it equally a pleasure and a duty to communicate the paper which had been so fortunate as to receive the approbation of the Members.

In closing the discussion he might be permitted, as the result of his practical experience, to state that, as Mr. Stephenson had ably expressed it, the main features of a good lock were security, simplicity, and strength; if these were wanting, however ingenious an invention might be, it was for all practical purposes worthless.

A manufacturer should never, through fear of competition, reduce the quality, of either the materials, or the workmanship of his locks; but should study to produce the best of whatever kind he manufactured.

Masters should treat their workmen as men ought to be treated, and if a high character of work was required, good wages must be paid; for if the workmen saw that a master cared for them, and took an interest in their welfare, they would have an equal pride with himself in the character of the manufacture, and would strive faithfully to maintain his reputation, by the utmost exertion of that skill and ingenuity, for which the British handicraftsmen were so justly celebrated.