lever holds the bolt, when locked, until it is released, by the tail of the detector-plate pressing the pin. Thus there are provisions introduced, to meet almost every imaginable mode of opening the lock. The triple sets of tumblers, a portion of which retain the position given to them by the key, and the wall of iron, which shields the most important of these from any contact with the key, point to the guiding principle of this lock; but there are, in addition, peculiar adaptations of contrivances already well known.

In conclusion it may be remarked, that questions will continually arise as to the violability, or inviolability of particular locks, and especially of new inventions. The hints already given may serve to show, that any new modification, or arrangement of the parts which do not affect the principle of construction, can have no particular claims to security, or conversely, if it can be shown, that any lock is constructed on a principle not hitherto violated, it may be deemed secure, but certainly not unless such a claim can be established.

With respect to the locks alluded to in this Paper, and their alleged insecurity, the Author finds justification for what has been said in these two facts:—that he has pointed out the principles on which the picking may be conducted, and that he has himself performed all that he describes. And it is to be hoped, that what has been done and said to enlighten the public, as to the insecurity of many locks now in use, instead of causing any unpleasant personal feelings, will stimulate lock manufacturers to produce what the public really require, viz., secure locks, adapted to all purposes, of good workmanship, and at a moderate price.

The Paper is illustrated by a series of diagrams, explanatory of the mechanism of the different locks.

Mr. HOBBS explained in detail the action of the permutating lock, and pointed out the additional security gained by the division of the tumblers into primary and secondary, the former alone to be acted on by the key and the latter to act upon the bolt. Any inspection of the interior of the lock was prevented by the revolving curtain: should this be displaced, it brought into action the detector-plate, which not only covered the key-

hole, but by means of the stud, fixed in the case of the lock, which was immediately brought to bear against the plate, securely held the bolt, and rendered useless any further attempt to withdraw it. But the great security was in the moveable bits of the key only acting indirectly on the secondary tumblers; whilst the primary tumblers being always at rest, did not convey the slightest knowledge of the arrangement of the others. The secondary tumblers were protected by a wall of metal in two directions, so that they could not be reached, by an instrument inserted through the key-hole; their relative position, therefore, could not be ascertained by pressure. It was in this, that the main difference between the American lock and other changeable locks consisted; the latter could easily be picked, because it was possible to find out by pressure, the positions in which the tumblers had been left. To open the American lock, it would be necessary to have a duplicate key, and to ring the changes, until the right one was accidentally found, but that this was a hopeless task, was evident from the vast number of permutations of which the bits were capable.

It was from a careful study of the principles and construction of locks, that he had been led to the introduction of the moveable stump in his ' protector-lock.' He had found, that by maintaining through the key-hole a permanent pressure upon the bolt, the points of resistance were indicated by the stump, and it was not difficult to ascertain, by a delicate touch, which of the tumblers was, successively, the cause of the impediment; the insertion of false notches into the tumblers merely delayed the operation, without affecting the result. It was upon this principle, that he had opened both Chubb's and Bramah's locks. By making the stump moveable, it would no longer afford information as to the positions of the tumblers.

Mr. E. B. DENISON, Q.C., said, that in the lock which he had recently invented, he had endeavoured to combine simplicity with security. The tumblers were made to turn on a pin placed at about the middle of their length, and between them were separating plates, which exercised just sufficient pressure to enable them to stand indifferently in any position: they were less liable to get out of order than those of ordinary construction, as they were not acted upon by springs. The bolt was furnished with a stump so placed, that when the bolt was shot by means of the

handle, the stump was entirely removed beyond the jaws of the tumblers. After the bolt was shot, the handle could be made, at will, to depress the tumblers: in that position, the lock could not be opened again without the aid of the key. Behind the key-hole, there was a curtain which was pressed up against the cap of the lock by two spiral springs, one on each side; and at the back of the curtain, there was a square plug with a notch in it, through which the bolt could pass, but only when the curtain was up. The act of pushing in the key depressed this plug, and caused it to fall into a corresponding notch in the bolt, which was thus held fast in the position just described, with the stump beyond the jaws of the tumblers. Although, therefore, it was not difficult to raise the tumblers by means of a false key, the relative position of the jaws and the stump could not be ascertained, since the stump did not bear against the tumblers: on the other hand, if the bolt were drawn back by the handle, so as to bring the stump against the tumblers, the curtain-plug could not then be pushed into the notch of the bolt, and the key-hole, consequently, remained perfectly closed. When the bolt was locked, it could only be opened by putting in the proper key and turning it round, so as to bring the tumblers to the requisite height for the stump to pass; the key must then be taken out, for so long as it was in the lock, the curtain-plug held the bolt fast. The key being withdrawn, the curtain closed the key-hole, releasing the plug from the notch of the bolt; and the plug then presented its own notch for the free passage of the bolt, which could be drawn back by the handle. The advantages which he claimed for this lock were,—that it could be locked by the handle alone, at will;—that the key was smaller than usual, (a large lock requiring only a very small key,) and that it was only used for raising the tumblers, and consequently, for unlocking;—that the key-hole being completely closed by a curtain, except while the key was actually in the lock, the latter was effectually protected from dust;—that the smallness of the key-hole prevented the introduction of any instrument strong enough to open the lock by violence;—that the tumblers could not stick together, as occasionally happened in Chubb's and other locks by the coagulation of the oil applied to the tumbler-pin, and that in this lock, friction, so far from being injurious, was absolutely necessary;—that the

lock was simple in its construction, demanding no delicacy of execution, or accuracy of workmanship, as the tumblers required no finishing, and were not acted upon springs;—that it could be manufactured at a cheap rate;—and above all, that it was absolutely secure against any known mode of picking, being the only English lock which was admitted to be so in Messrs. Hobbs and Tomlinson's 'Rudimentary Treatise on the Construction of Locks.'

Mr. HODGE observed, that at the discussion upon this subject which had taken place at the Institution, in 1850,[1] he had stated his disbelief in the security of Chubb's lock, but he was the only person who then held that opinion, and he was met by the rejoinder, that the locks upon that principle which had been picked were not manufactured by Mr. Chubb. Recent facts had, however, fully justified the opinion he had given on that occasion, as also his assertion, that the American locks were superior both in ingenuity and in security to those made in England. The revolving curtain, however, which was introduced, some time ago, by Mr. Mackinnon, who was connected with Day and Newell, and which was considered, at the time, to be a new invention, he had since found in a lock of the date 1530. He considered, that the perfection of the American locks chiefly arose from machinery being used in their manufacture, and for cutting the keys; work of this kind done by hand, must necessarily be uncertain, and even defective. It was very difficult to punch many holes simultaneously in plates; but this was now accurately effected by Mr. Hobbs, through metal $\frac{1}{8}$th of an inch in thickness.

He took this opportunity of stating, that although it had been claimed by others, it was he who had invented the dioptric system, shown at the Great Exhibition of 1851.

Mr. JABEZ JAMES said, that in his opinion, Larivière's system for simultaneously punching a number of holes was perfect: by it almost any number of perforations could be made at one time. This system had been first used for strainers, filters, and other similar purposes. It was then applied to blinds and ornamental cards and paper. In fact, almost, if not quite, all the perforated work of the present day, was executed by this process.

[1] *Vide* Minutes of Proceedings Inst. C.E., 1849-50, vol. ix., pages 338, 343.

Mr. MARTIN thought, that any lock might be picked, which would permit the entry and exit of a key. In the design, therefore, which he had proposed, the key locked itself in, and could not be withdrawn; if a false key were used, that also would be held permanently in the lock.

Mr. HOBBS said, that as long ago as 1815, Messrs. Mitchell and Lawton obtained a patent for a lock with a revolving curtain for closing the key-hole, and a number of moveable pieces, which, on introducing a key, prevented its being turned back, or withdrawn. It was necessary to press the true key quite round, so as to unlock, before it could be withdrawn, and a false key, being held permanently, could only be released by destroying the lock. Ruxton, in 1816, patented another contrivance for retaining a false key, with this singular recommendation:—"It is true, that in this case, the lock will have to be destroyed, in order to open the door; the result is frightful: but we think the more terrible the result, the less likely would any one be to tamper with it." There was not anything novel in Mr. Denison's plan of locking by means of the handle only: in iron doors it was generally the handle which shot the bolts. Small keys for strong locks were also not uncommon, but he did not conceive this to be so great an advantage, as the smaller the key, the greater chance was there of its being imitated. In Bramah's lock, the projection, or nib, on the key required to be always inserted at the same part, but if the nib was cut off, the key could be used in any other position. It was only requisite to cut a series of notches in a triplet tube, and with a little 'tickling,' the lock could be easily opened. Cotterell's 'patent climax detector lock' was still worse in this respect: nine out of ten could be opened by the pressure of a pine stick against the ends of the slides, as the range of combinations in a six-slide lock was very small, and the slides might be said to furnish their own key by the impressions they made upon the stick. There were, it was true, a series of false notches, but they could be easily ascertained through the key-hole, and by the least motion, they were at once thrown out. As to the detector, the merest tyro could always find out its position, and the security it was thought to afford, was quite illusory, as was also the principle of self-locking. The series of revolving discs, in the 'snail-wheel lock' of Dr. Andrews, presented no greater obstacle than the

same number of tumblers. Better security could be obtained by making a bit to the key, and the longer it was, the larger would be the number of permutations of which it was susceptible, and consequently, the greater the number of chances against opening the lock.

Mr. E. B. DENISON, Q.C., said, that although small keys for strong locks were already in existence, they only worked small locks fastening into the bolts, and these, when shot by the handle, only possessed the security due to the small lock; whereas, in his plan, there was all the strength of a large lock, notwithstanding the smallness of the key. It was also requisite to state, that the lightness of the key was not produced by shortening the length of the bits, but by reducing them in thickness; and also that the key was solid and not made with a pipe. He was quite opposed to the principle of holding the key permanently fixed in the lock, as the least mistake in the key was attended with such destructive consequences; the same object was sometimes attained, by means of a subsidiary lock and key.

With respect to the permutating lock, he thought the size of the key would be found objectionable, and unless the bits were regularly changed, it would not be of any use. It laboured also under this disadvantage, that after using the key, the owner must keep a memorandum of the relative position of the different bits, or he could not open his own lock.

Mr. WHISHAW explained the action of his lock, which was now exhibited at the Polytechnic Institution, and which was extremely simple. He had combined electro-magnetism with the ordinary mechanical principles, so that the bolt being made to shut against the sides of a magnet, it was held so securely, that it could not be arrived at, nor was it possible to pick the lock. The magnetic action was induced by passing an electric current through wire, coiled round a plate of soft iron, in the form of a horse-shoe, secured inside the door, and wires covered with gutta percha communicated in the same way with the other locks which might be required, and which were all under the control of one key.

The introduction of Mr. Hobbs' lock had led to great improvements in the principles and manufacture of locks, in this country, and the more general adoption of internal curtains.

He was desirous of knowing whether any of the curtain locks had been picked.

Mr. GOATER said, that about a year and a half ago, he obtained one of Mr. Hobbs' protector locks, and after having carefully examined its construction, he prepared suitable instruments with which he picked the lock in five minutes, with the cap screwed on, and at the third attempt, he effected the same operation in one minute and a half.

On the 13th of February, 1854, two of Mr. Hobbs' best patent protector locks, with different keys, were purchased at the warehouse in Cheapside, and were at once taken to Messrs. Liddiard and Co., in Friday-street, where the bolt of one of them was shot by means of its own key, and the lock was enveloped in paper and sealed, the key-hole only being left open. This lock was placed the same evening in the hands of Mr. Goater, and he returned it picked, and still sealed up as when given to him, on the 15th of February. The second lock was then sealed in the same manner, and this was delivered at nine o'clock the next morning to Mr. Goater, who picked it, and returned it sealed, at three o'clock the same afternoon. He had picked both these locks solely through the key-holes, and neither previously, nor since, had he seen either the keys, or the interior of the locks. On the 10th of March, his employer, Mr. Chubb, placed in his hands another of Mr. Hobbs' locks, to the interior of which he had access only through the key-hole; and after making fresh instruments for the purpose, he succeeded in picking it in two hours; and on the 17th of March, Mr. Carpmael had given him a lock, which he had picked the same afternoon. The method which he employed, was first to fix, or fasten the moveable stump, by inserting through the key-hole, and under the bolt, a piece of common watch-spring, so as to press against it, and the proper pressure was maintained by means of a weight, or screw. He then got the usual bearing on the talon of the bolt, and with the ordinary pick, he felt his way, tumbler after tumbler, till the bolt was released. He believed, however, that there were several other methods, by which the lock could be picked.

Mr. CARPMAEL said, that lock-makers were greatly indebted to Mr. Hobbs for showing them the weak points of the locks constructed in England, prior to 1851, and since that time, the

art had, in consequence, made great progress. The Author deserved great credit for the ingenuity he had displayed in the introduction of the moveable stump, but, unfortunately, the protector lock he had constructed upon that principle, had proved to be vulnerable by the very process by which Mr. Hobbs had succeeded in establishing the insecurity of the locks of Bramah, Chubb, and others. Mr. Carpmael could entirely confirm the statement which had just been made; the lock which he had purchased at Mr. Hobbs' was picked, in a short time, by Mr. Goater, who never had an opportunity of seeing either the interior of the lock, or the key. Mr. Goater pointed out two several methods, by which the operation could be effected, and although during the process he broke an instrument in the lock, this accident did not prevent his success.

Mr. CHARLES CHUBB also confirmed the statement of Mr. Goater, relative to the lock which he had given him to pick.

Mr. HOBBS said, that the opening of the till-locks had been effected in a perfectly legitimate manner, and he was glad to be apprised of any defect in their construction, so that he might be prepared with a remedy. To prevent any future access to the moveable stump from under the bolt, he had already effected some alterations: he had inserted in the back plate a tongue fitting into a corresponding groove in the back of the bolt, and he had also placed an effectual barrier between the key-hole and the stump, by riveting into the front plate, a piece of steel which passed through the tumblers, and fitted into a groove prepared for it in the bolt. Thus it would in future be impossible to insert the piece of steel spring by which the stump had been held, during the operation of picking. He believed the principle of a moveable stump to be correct, and that it would not in future be possible to fix the stump. It had been objected, that the stump was liable to rust, but before this could happen, the entire lock would be rusted throughout, and it was unreasonable to expect, that locks should last for ever, especially in a London atmosphere; locks, like all other machines, required to be occasionally cleaned. But the locks in question did not profess to give that high amount of security afforded by the permutating lock, which he believed it was impossible to pick, but which was only adapted for banks and other establishments requiring extreme precautions for safety. His object in

introducing the protector lock had been to supply, at a moderate price, a secure lock for ordinary purposes, and this he believed he had effected. Hitherto, in this country, whilst the price of common and insecure locks had been very low, the price of locks of good construction had been enormously high, and a change in this respect could only be brought about, by substituting the rapidity and accuracy of machinery, for the slow and expensive process of hand-labour; by manufacturing them in factories, furnished with all the improved mechanical appliances, instead of constructing them in attics and cellars by aid of the bow, the drill-stock, and other imperfect instruments. By pursuing this system of manufacturing on a large scale by the aid of machinery, he saw no reason why good and secure locks should not be reduced to one quarter of their present price, since by the application of the same system to the manufacture of American clocks, it had been found practicable to produce them for $62\frac{1}{2}$ cents, or two shillings and sixpence each.

With respect to the curtain locks, curtains, like false notches, did not add any real security to the lock, they merely retarded the operation of picking it. It might be safely asserted, as a general maxim, that where a key could enter, an instrument of suitable size and form could follow.

Mr. SIMPSON,—President,—expressed the gratification it afforded him to witness the kind and liberal spirit in which the Paper had been received, and the good feeling which had characterised the discussion.

February 21, 1854.

JAMES SIMPSON, President,
in the Chair.

THE discussion upon the Paper, No. 902, "On the Principles and Construction of Locks," by Mr. A. C. HOBBS, being renewed, was extended to such a length, as to preclude the reading of any other communication.
