



The Birmingham Association  
of Mechanical Engineers.

Address on

**“Locks & Lock Manufacture”**

BY

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AT THE GRAND HOTEL, BIRMINGHAM,  
ON FRIDAY, DECEMBER 4th, 1936.

INTRODUCTION.

*Mr. President and Gentlemen.*

Having only returned from a visit to the United States a month ago, I have not had time to prepare a written paper.

However, I have written some historical notes, which I will read first, then I will talk about the eighty slides which I have arranged in a certain order.

HISTORY.

At what stage in history did man feel the need to provide protection against the attack of wild beasts and enemies?

We can safely surmise that, in the earliest existence of man, he must have felt the necessity to provide protection against attack and must have secured the entrance of his cave or hut by some means or other. Wood was undoubtedly the material employed and most likely the earliest fastenings were simply wooden bars or bolts.

The object of making these rather obvious remarks is merely to draw attention to the fact that the history of locks and fastenings is probably as old as the history of civilization.

There is abundant proof of fastenings of various kinds having been in use for thousands of years. If I quoted all the Biblical references, the early part of this address would sound more like a sermon than anything else.

Seals were used in very early days, and we read that they were applied to the den of lions which Daniel entered.

In the Songs of Solomon there is a reference to "the handles of the lock."

The first lock of which there is any distinct account or representation is the Egyptian lock, which is probably the form referred to in Nehemiah in the quotation ending "and set up the doors thereof, the locks thereof and the bars thereof."

In the quotations I have given you, you will probably have noticed that keys are not mentioned but in the last verse in the third chapter of Judges we read about a key being taken to open doors.

Many years ago Joseph Bonomi wrote a book called "Nineveh and its Palaces," in which he describes the Egyptian lock. This was used for securing the gate of an apartment in one of the palaces. A further reference is made to this lock in Eaton's "Survey of the Turkish Empire," and there are also sculptured representations of the lock amongst the adornments of the great temple of Karnac, which indicates that this type of lock has been used in Egypt for at least 4,000 years.

Whilst on this subject, it is very interesting to find that a correspondent to a technical journal declared, over eighty years ago, that he had found some locks in the Faroe Islands which were identical to the Egyptian locks.

2,000 years before the Christian era the Pharoes deposited offerings of gold, ivory and rare spices in securely fastened rooms.

In ancient China a lock with movable wards was in regular use.

There is some doubt about the type of fastenings used in ancient Greece ; but the Romans undoubtedly used locks and keys.

We simply must leave this early history if we are to get on with the slides—so we will jump a few centuries.

Until the reign of James 1 there is little to record relative to inventions. I understand that the first invention was secured by law in 1617.

One of the oldest types of locks used in Europe is the puzzle or letter lock, but we must pass over this.

From the 15th to the 18th centuries, very elaborate locks were made in France. Much of the fancy work was quite unnecessary, however, from the point of view of security.

Somewhere I have seen a list of over 90 patents, relating to locks, taken out between 1774 and 1851.

It seems desirable to mention some of these :—

In 1778 Robert Barron invented a special lever tumbler mechanism and anticipated the two chambered lever which is used to this day.

Joseph Bramah invented a sliding tumbler lock in 1784. This was a great move forward. He contended that movable wards were superior to fixed ones.

We will now skip to 1818 when Jeremiah Chubb invented the detector.

Another famous lock was invented by Robert Newell, an American, in 1841, but it was little known in England until 1851 when the English patent was granted. A feature of this lock was that the key combination could be changed at will.

Linus Yale invented the pin tumbler cylinder lock about 1848. This was based on the principle of the Egyptian lock.

I will now, with your permission, commence the slides and amplify my historical references as I proceed.

#### NOTES ON THE ADDRESS.

The simplest form of lock is the back-spring type but it has little or no security. This observation calls to my

mind the whole subject of security, and it is perhaps as well to point out, at this stage, that the need for security varies considerably. Locks are regularly produced to suit all kinds of applications and, unfortunately, the lock manufacturer has little control or say as to whether the right lock is used for a given purpose.

It is obvious that very simple mechanisms are required for money boxes used by children. The locks for inside doors of houses need not, as a rule, be manufactured with a large number of differs or changes. Some people like all the locks in their homes to differ from each other, but it is usually needless for them to be different to the combinations of locks in other houses. On the other hand it is desirable that locks and latches used for main entrances to houses should differ in large numbers.

For hotels, offices, blocks of flats, factories and warehouses, still greater security is needed. Maximum security is necessary for banks and safe depositories.

The simple lever tumbler with a projection which locates in two slots or rackings, in a bolt tail or lath, is more secure than the back-spring lock. However, it can be picked easily by over-lifting it.

Fine wards are expensive to make because concentric rings of complicated shape are brazed on to a bridge piece and keys have to be cut away on the "bits" to suit these impediments.

Solid wards are cast solid on bridge pieces. They are usually made of brass and formed into shape by hollow-milling. The rings are not at all complicated and the key work is simpler than for fine wards in consequence.

Side wards are useful and quite effective for the cheaper forms of locks. The name is given to specially shaped keyholes. Unless a key is the same shape as the keyhole it cannot be inserted unless, of course, it is filed to suit.

Sash wards are extensively used. In the United States they are called end wards, because they are attached to the

cover or case of a lock (or both) and keys cannot be rotated unless they are cut on the sides of the bits to correspond with the shape of the wards.

Mr. Ramsell next showed and described a number of pictures of ancient keys found on the sites of Pompeii and Herculaneum. He pointed out that the Romans must have used wards. The fact that only keys had been found suggested that the locks were made of wood and had therefore perished.

Four slides were shown which illustrated the various types of locks in regular use. Latches have one spring bolt, deadlatches are latches provided with a means for deadlocking the bolt. The mechanism of both of these types may be operated by a key from both sides of a door, but it is more usual for operation to be by means of a knob from inside and a key from outside.

Deadlocks have one bolt, usually of rectangular section, and are generally operated by means of a key from both sides.

Locks are generally understood to have two bolts, one latch bolt and one deadbolt. As a rule the former is operated by means of knobs or lever handles and the latter by a key from both sides of a door.

Rim locks and latches are secured to the surface of a door. The mortice types are let into the edge or framework of doors.

Cabinet locks are, as the term suggests, used for drawers, cupboards, boxes, etc.

Padlocks are familiar to all. Unlike other locks they are "loose" locks and used in conjunction with hasps and staples.

A full description of Baron's lever, referred to in the historical notes, followed. Then the speaker described various levers as used in present day locks and referred to the methods of master-keying lever and warded locks.

The principles of lock mechanisms were next explained. There is quite a lot in the choice of springs, as also in the design of hubs or "followers." The latter are, as the terms suggest, the parts through which there are square holes for the spindles on which the knobs are mounted.

A photograph of an ancient Egyptian lock was followed by a diagram showing the mechanism. From this the speaker proceeded to describe the pin-tumbler cylinder mechanism the idea of which was based by the inventor, Mr. Linus Yale, on the Egyptian lock.

It is commercially possible to make cylinders, having five pins, with over 27,000 combinations, or changes, on one keyway. Many sections are in regular use and innumerable others can be evolved. This is why the number of changes can be considered "unlimited."

One advantage, apart from that of security, is that whatever the thickness of a door, only a small convenient key is required for a cylinder lock.

The actual mechanism of the locks and latches can be very simple because the security is in the cylinders, which are separate units. However, many ingenious mechanisms are used so that latches can be deadlocked. In some designs, the knobs can be locked by turning the keys a second time from the outside. This is very useful for lock-up shops, etc., with glass panelled doors, garages, etc. Some latches are made with automatic dead locking features.

One of the most interesting parts of the address was the description of master keying cylinder locks. This is done, in general, by having three pins instead of two in each position. Where possible six sets of pins are employed instead of five as used in regular cylinders.

To further add to the security of master keyed suites, special keyways are used. Every suite is registered in the name of the actual user and can only be added to, or extra keys supplied with his permission. All records of combinations etc. are kept in a fire-proof vault.

A typical layout of a suite was shown in diagrammatic form. It represented two wings of a three storey building.

A separate sub-master could be provided to control all the locks on each of the six floors; those in one wing being A,



B and C, and in the other X, Y and Z. A master key could operate all the locks under A, B and C, and another master key all those under the sub-masters X, Y and Z. The whole could be operated by a grand master key.

One more advantage of the cylinder locks was emphasized. All kinds of locks, latches, cabinet locks and padlocks could be incorporated in one suite. This is impracticable in lever or warded locks because the keys for the door locks would be too large for padlocks and cabinet locks. An executive can, therefore, with a master keyed suite of cylinder locks, gain access to all or any by means of one key.

In another example selective master keying was explained. A managing director could have a key to open every lock in his factory and offices. The chief accountant could have one to open all locks in the offices, and the works manager, all the works locks, and, for instance, certain office doors. Other persons could carry keys to open locks in certain departments only.

After showing an aerial picture of the Yale works at Willenhall, where 1,500 people are employed, Mr. Ramsell presented pictures of the inside of the works.

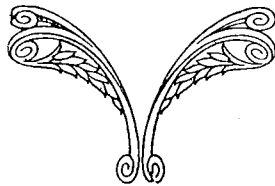
The brassfoundry is very modern. The furnaces are at floor level and the four pouring hearths are radially disposed. During the pouring process the crucibles are carried in special trolleys, running on a radial track. Fitted to each trolley there is a large pipe connected to a fan which disposes of the fumes.

The press shop is equipped with a very fine selection of power presses. Pictures of typical press tools were shown and described. Although every press is guarded, the possibilities of further protection are studied before every new tool is issued and, where possible, guards are fitted in the tool room. The risk is not taken of leaving such guarding to toolsetters.

Several ingenious jigs and fixtures are, as may be supposed, used in the machine shops and many of these were described.

The pin holes in brass cylinders are drilled at 12,000 r.p.m.

Towards the end of the address Mr. Ramsell described the toolroom, polishing shop, electro-plating department, inspection, cardboard box room, the packing case department and the warehouse.





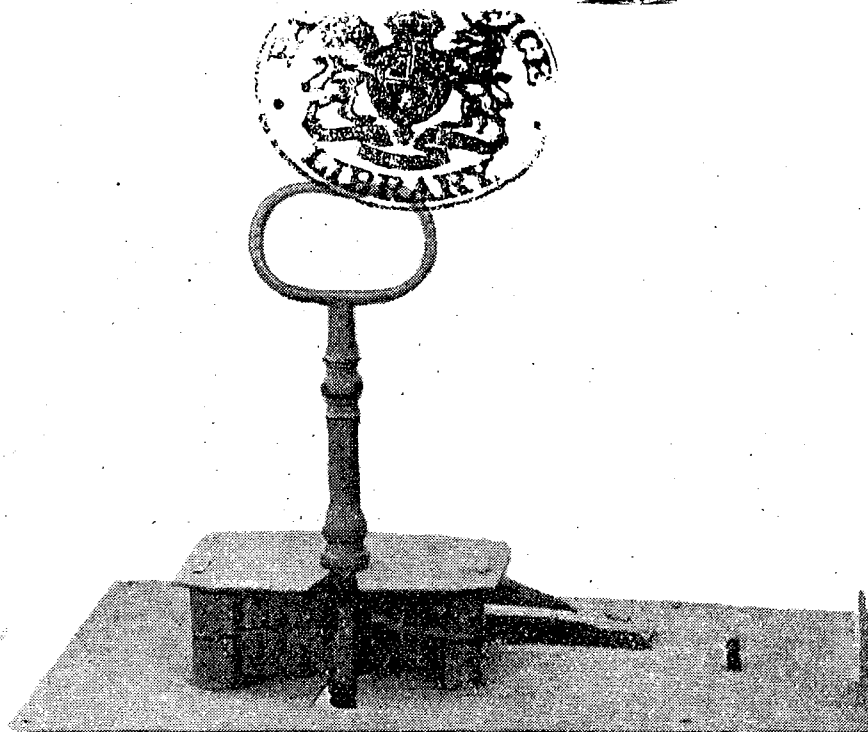


Fig. 1.

This photograph shows a key in the position of just beginning to pass over a form of obstruction known as a Fine Ward. It will be noted that a number of concentric rings of various shapes are mounted on a bridge plate, the whole being partly cut away for the insertion and withdrawal of the key.

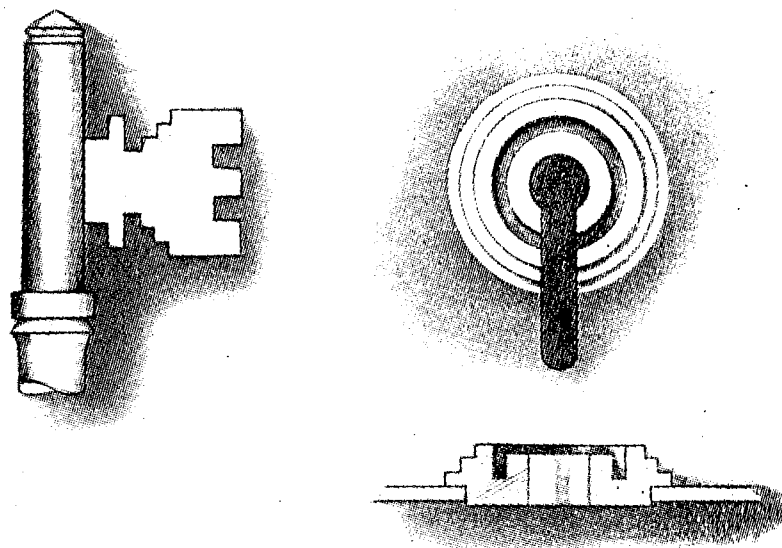


Fig. 2.

Shows a Sash Ward and the key used with it. This ward is made of brass or gunmetal, and is rivetted to the top and/or bottom plates of a lock. Sash warding obviously does not weaken the "bit" of the key like the warding required for Fine Wards. The notches in the edge of the "bit" parallel with the pin, are provided to operate levers.

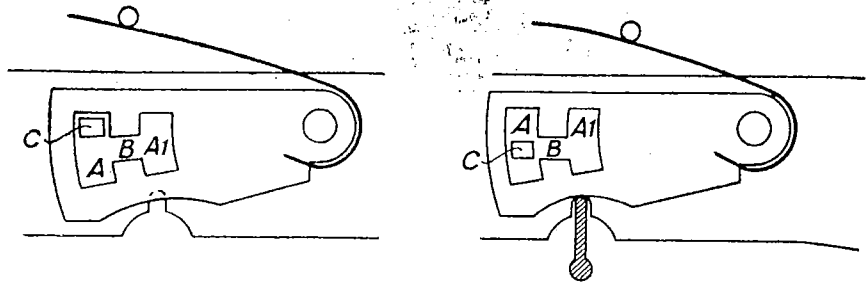


Fig. 3.

Illustrated the type of lever in common use. Such levers are made of brass or iron, perforated with two chambers A and A1, joined by a "channel" or "gate" B. The latter is just wide enough to permit a "talon" C on the bolt to pass from one chamber to the other. It will be noted with this type of lever the bolt cannot be moved unless the lever is lifted to the exact height at which the talon will pass through B. One lever gives fairly good security, but the degree can be increased by using 2, 4, 6 or more levers. When more than one lever is used they are all mounted on the same pivot, but each may be differently pierced and thus have to be lifted a different height.

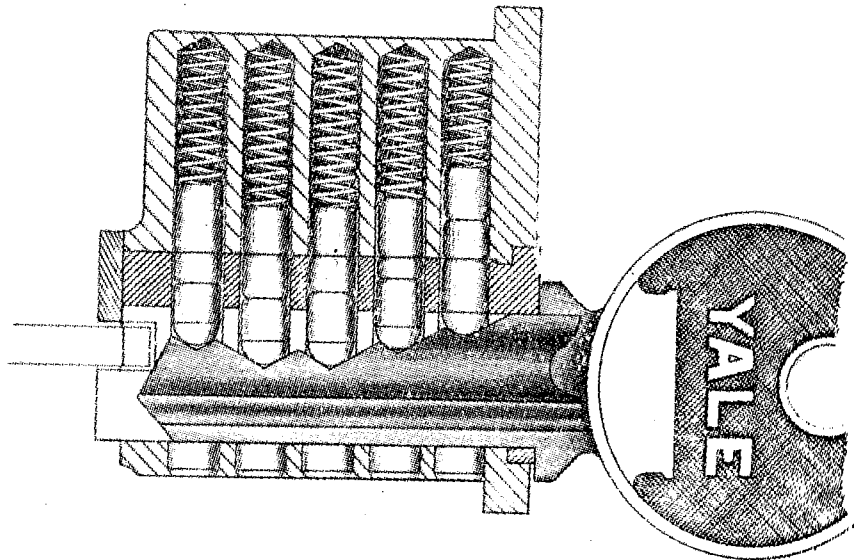


Fig. 4.

So much interest was displayed in the Yale pin tumbler cylinder lock that it has been decided to reproduce a slide showing a section through a master keyed cylinder.

Fig. 4.

Shows a cylinder with an ordinary change key inserted. The arrangement of the pin tumblers is clearly shown in this illustration. By having three pin tumblers in each position, it is possible to make all the locks to differ from each other but for a master key to operate all the locks in a given suite by having one common set of pins to suit the master key in each of the cylinders. In the illustration it is possible to imagine another key, namely, a master key being inserted which would lift two pins into the body of the cylinder in the four holes from the left, and only one pin into the body of the cylinder in the fifth pin nearest to the point of entry.

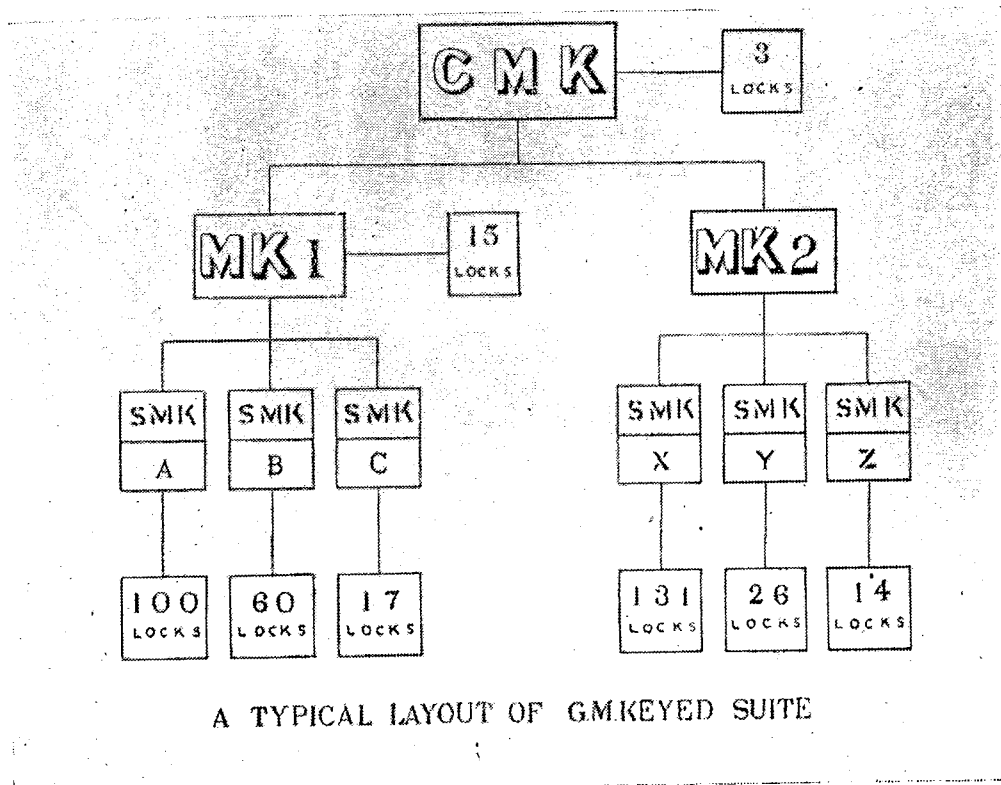


Fig. 5.

Here we have a typical layout of a Grand Master Keyed Suite. The example is actually quite a simple one and comparatively few locks are involved. It may be assumed that Master Key No. 1 (MK1) controls all the locks in a three storey factory, Sub Master Key A operating the ground floor, Sub Master Key B the 1st floor and Sub Master Key C the second floor. It should be understood that all the locks in the three Sub Suites may differ from each other. Master Key No. 2 (MK2) could operate another wing of the factory with Sub Master Keys X, Y and Z for the different floors. The Grand Master Key (GMK) could operate the whole of the locks in the premises. Possibly some Official in charge of the factory under MK1 may require a number of locks under his personal key. Similarly, it is possible for a number of locks to be arranged under the Grand Master Key only.

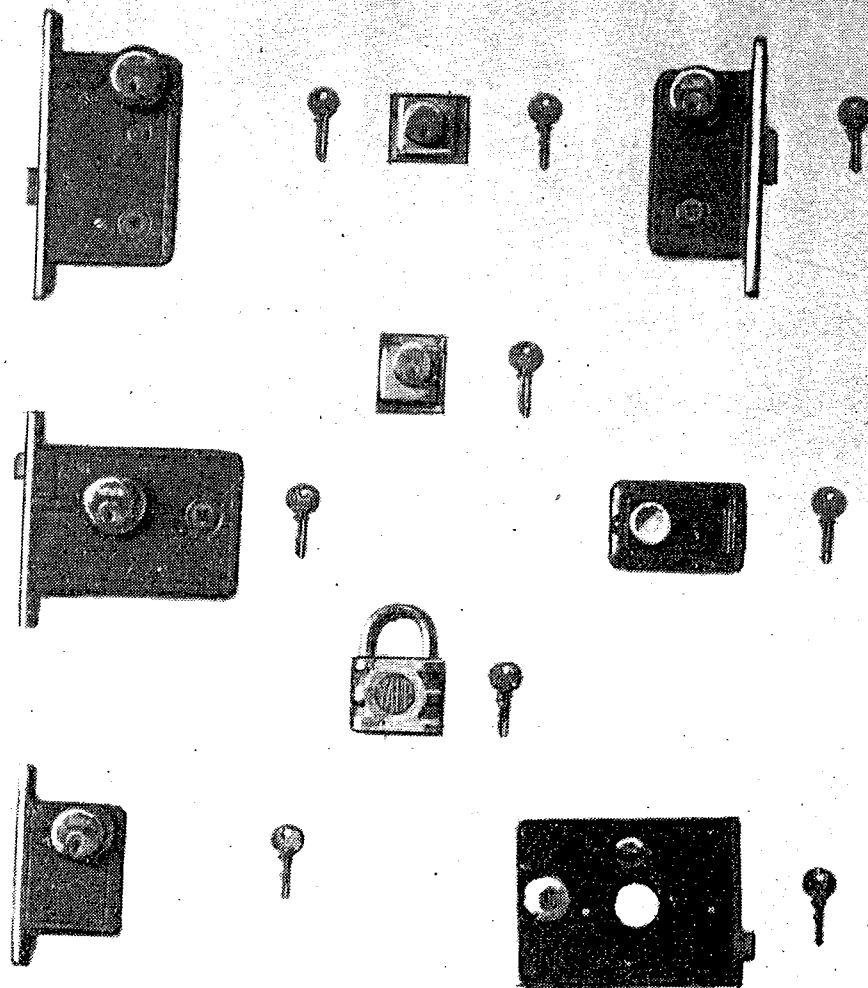


Fig. 6.

This illustration shows that all kinds of locks can be incorporated in one Master Keyed Suite of cylinder locks. There are Mortice Locks with two Bolts, Mortice Deadlocks, Mortice Latches, Rim Latches and Rim Locks with two Bolts. There can also be a Desk Drawer Lock, a Cupboard Lock and a Padlock. This does not by any means complete the range which can be suited together. It is interesting to note that whatever thickness of the door, or the type of lock, a small convenient key can be used for all of them. This convenience is impracticable in levered and warded locks because large keys are required for large locks and small keys for small locks.

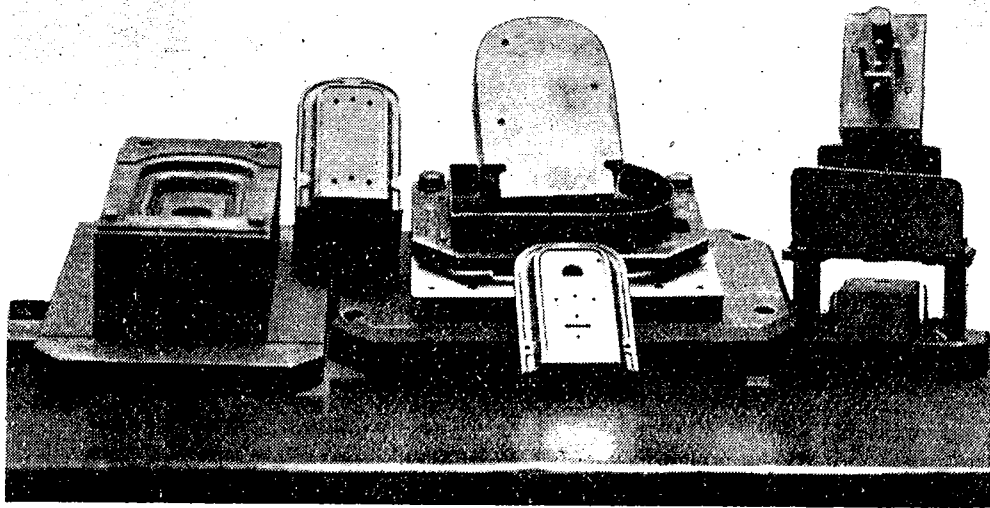


Fig. 7.

Shows a kit of tools for blanking, raising and piercing the case of a pressed steel rim lock and the sash warded type. Note that guards are fitted to the blanking and piercing tools before they leave the tool room. The guarding is not left to the discretion of tool setters.



## DISCUSSION.

The President (MR. JOHN BELLISS, M.I.Mech.E.)

We are most grateful to Mr. Ramsell for the very interesting address he has given us this evening. Personally, I had no idea that a hundred and forty to a hundred and fifty operations were required to make a lock and key. The next time I undertake to do any repairs to a lock at home, I shall ask my wife to go and buy a new one. I am sure it is the easiest thing to do and will save me a lot of worry.

The photographs he has shown us do give us a good idea of the different types of locks that have been made for centuries back. I wonder whether he includes in his category of locks and keys, buttons and button holes? I do not know whether Jacob's coat of many colours had buttons and button holes, or whether some of the people who went into the ark had buttons and button holes on their clothing, but I suppose Noah did not have a lock and key on the ark? Perhaps Mr. Ramsell has not gone so far back into history. It is a great pity the Garden of Eden had not a lock and key, or we probably should not be having some of the troubles we hear of to-day.

MR. C. E. FORRYAN (Member)

Mr. Ramsell has given us an interesting lecture to-night, with a little information on "How to pick Locks," but I think too much thought has been given to the safety of the cylinders and not enough to the safety of the bolts, and I was hoping that Mr. Ramsell was going to tell us to-night of an absolutely safe lock.

Mr. Ramsell has told us about a double lock where you turn the key twice, but if you had a number of these locks in a building, it would be impossible to go round to every lock, (every time you went out) to double lock them. Also if you had double locked the locks from outside it would be impossible to come in one door and try to get out of another one that was double locked outside.

Would Mr. Ramsell tell us if there is any type of lock that it is impossible to prize the bolt back with a gimlet when it is locked, but yet be able to open the door from both outside and inside with the key.

MR. RAMSELL (Replying)

In answer to that question, I ought to have shown you another slide, but I did not bring it to-night.

There is one latch which is slightly larger in size than the usual ones: the distance from the edge of the door to the cylinder is about the same but the body or case is a little larger. In the case portion of the lock a very small cylinder is inserted which will operate with the same key as the outside cylinder. You insert the key into the small cylinder, turn it through a complete turn, pull it out again and put the key away. When you have done that the knob is deadlocked, the bolt is deadlocked, the whole business is deadlocked. You do not have to go outside to do it.

Another advantage is that this can be done when the door is open and the door is slammed afterwards.

Other types have mechanisms by which the bolt automatically shoots an extra distance and is deadlocked when a door is closed, yet the normal operation by knob inside and key outside is not affected.

Mr. I. H. WRIGHT, M.I.Mech.E., (Member):

In speaking of cylinder locks, Mr. Ramsell showed us pictures of pins assembling in the holes. He said that in the case of master locks there are some of these being handled which are .040" in length on the axis and .100" in diameter.

It seems to me that the most wonderful bit of production in the whole thing is to produce those lengths so accurately that they can be assembled like that and will actually coincide exactly with the circumference of the cylinder.



I should like to ask Mr. Ramsell if there is any finishing operation on the ends of the pins after they are assembled in the cylinder or the key to ensure them being perfectly coincident with the circumference of the cylinder? It seems to me to be very exacting work to avoid some slight projection at the ends of the pins.

Mr. RAMSELL (replying):

In reply to Mr. Wright, I would say that the pins are made on very accurate machines, and we work to ordinary commercial limits.

The people who put the pins into the rotating portion or plug work independently of those who put the pins and springs into the cylinder portion. I did not make that clear. There are people who do nothing else but assemble pins in plugs to suit the keys.

They have some very small fixtures right on the assembly table. They are provided with strips of about 1" wide emery paper, and after the pins have been put into a plug to suit a given key, they just give them a little rub over on the top. The operation is more like polishing to correctness than actually emeryclothing them, as so little metal is removed.

Mr. W. BAILEY (Member):

One thing that interested me in the course of the lecture was the peculiar shaped slots in the barrels of the cylinder keys. Could Mr. Ramsell tell us how those are put in? I was interested in those slots because I once had to attempt to make some of them as a hot stamping and I did not know quite how you made them.

Mr. RAMSELL (replying):

That is a very interesting job. We have a number of special broaching machines. The frames are vertical and the slides counterbalanced. The broaches themselves are made of pieces of steel  $1\frac{7}{8}$ " long, about  $1\frac{1}{4}$ " wide and  $\frac{1}{8}$ " thick. These



little blades are put into special fixtures in the tool room, and form milled for a given section, and then the teeth are milled and finished off on a grinding machine. These blades are all numbered from one upwards and are readily inserted in the correct position in the slide to replace broken ones.

Mr. W. H. CARTER (Member):

I would like to ask Mr. Ramsell a question in connection with padlocks. With all the time and thought that has been put into the lock, it seems to me that it is very easy to break down the lock due to the fact that if the shackle is made of such soft material it can easily be filed through. They are not even case-hardened in the majority of instances.

Mr. RAMSELL (replying):

Many good quality padlocks are regularly made with case-hardened steel shackles, but, because of trouble with corrosion, many users insist upon cast bronze shackles, or shackles made from phosphor bronze wire.

As I have previously stated, the variety is available and the lock manufacturer has no say in the type of lock chosen by a user.

With good padlocks it is necessary to use good hasps and staples and there are some good ones on the market which can be fixed with concealed screws.

Mr. J. C. BAYLEY (Member):

One question I should like to ask Mr. Ramsell is, what means of identification the firm have for reference to the various types of combinations they issue to the general public? I ask this because if one rather shirks going to Woolworths' and goes to an accredited agent to have a duplicate key made, the number that is stamped on the key is not sufficient; they must have the key to send back to Yale Company to have it made. It is very inconvenient.

Mr. RAMSELL (replying):

It is rather a nuisance, there is no doubt about that. However, it would be rather awkward if any of us left out keys lying about and some unauthorized person made a note of a key number and ordered a duplicate key. It is far better for it to be a bit of trouble to get a key, don't you think so, Mr. Bayley?

Mr. BAYLEY:

Yes, but it is rather a remote possibility.

Mr. RAMSELL:

I ought to say that all master keyed combinations are registered in special books, and it is only possible for the owner of the master-keyed suite to get an additional key or additional locks by proper authorization. Our recording system has cut out the necessity for sending keys back to the Works in connection with master-keyed registered suites.

Mr. JOHN BELLISS (The President):

Before closing the meeting, I am sure you would wish to show your appreciation of the great amount of work Mr. Ramsell has put into getting this address together, and in preparing the slides. He has given us a most interesting address.

