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Key Interlocks

Their Application . . . and Use

"Kirkey"

by K. G. Hepler

INTRODUCTION

The emphasis of this article is directed toward the application and use of key interlocks. It might be considered as a sequel to the article **KEY INTERLOCKS . . . What they are . . . and Why?** published in the April issue of **The National Locksmith.**

It will illustrate three main points: (1) the need for and appreciation of the unique engineering philosophy of the key interlock specialist as based upon the engineering philosophy of the locksmith; (2) the need for this unique engineering philosophy in developing the functional requirements from which key interlock specifications are prepared; and, (3) the preparation of a few linear interlock systems based upon established requirements or specifications.

INTANGIBLE REQUIREMENTS

Key interlock systems depend upon and are possible only because of a key (or keys) that the operator **must** use at each step in a preestablished sequence of operations. The key allows him to perform each operation, but **only** if he performs the operation in its proper sequence. A key is thus the mechanical linkage between the equipment or devices being interlocked.

Therefore, the success of key interlock systems depends upon locksmithing skills and knowledge. However, additional skills and knowledge are also necessary to develop a key interlock system, and to determine the required locks and keys necessary to provide the proper coordination.

The engineering philosophy of the skilled locksmith is unique. This uniqueness is the result of a continuous evolution of education and knowledge developed over a period of more than 4,000 years of lock-

smithing activities. It is this unique engineering philosophy which makes it possible for the locksmith to make substantial contributions for the betterment of mankind and society — especially during periods of increasing crime and tension, such as the present. It is the successful result of this unique engineering philosophy that has produced the cliche — "locksmiths must **think** like thieves to be successful."

The engineering philosophy of the key interlock specialist is even more unique and complex than that of the locksmith. It involves a number of different facets or areas, and disciplines. These include, among others: locksmithing, lock and key oriented design engineering and manufacturing engineering, accounting (none of us can succeed in our activities if the profit motive is not understood and maintained as an objective), sales, and the art and skill of the interrogator coupled with keen discernment — and paraphrasing the locksmith cliche — the ability to see and recognize those areas or steps in an operating procedure where an operator is most likely to act absentmindedly, with dire or hazardous results.

As an illustration, one very important device utilized in the I-T-E Kirk Interlock Systems was re-designed as a result of key interlock engineering philosophy. This device now comprises a key interlock, plus eight other minor elements which can be attached to the interlock in different ways providing practically unlimited functional variations. For example, the drawings, manufacturing instructions and ordering information for this device were completely re-arranged. This resulted in substantial cost reductions, and made available over 6,000 functional variations of the device, for each specific lock and key combination — all without any further engineering or manufacturing instructions.

No such universal device is available from any other key interlock manufacturer in the world, primarily because **their** managements have failed to appreciate or recognize the existence of different types of engineering philosophy — especially the unique key interlock engineering philosophy (with all of its different facets and disciplines) as applied to the design, application, manufacture, and use of key interlocks.

The full import of proper recognition of the different engineering philosophies upon the financial well-being of the modern corporation is believed to be beyond the scope of this article, even though it may well affect the financial security and well-being of everyone.

GENERAL REQUIREMENTS

Key interlocks for all practical purposes can be mounted on anything to **guarantee** any required sequence of operation. However, the Ultimate User of the key interlocks may not be fully aware of the scope

of the equipment (key interlocks) he has purchased. He is primarily interested in obtaining "insurance" which will protect his manufacturing equipment, his valuable product, and the lives or safety of his employees. Normally, he couldn't care less how the key interlocks work or function. He is only interested in results — preventing the authorized operator from absentmindedly or unintentionally performing an unauthorized act.

Frequently the Ultimate User may not even be aware of the fact that he is obtaining key interlocks. He may have purchased his operating equipment or plant for a specific purpose through a general engineering firm or "turn-key" contractor. Key interlocks are then, at times, used primarily to protect only the equipment. Protection for the operators and of the manufactured product thus all too often become incidental requirements. This tends to impose unusual problems upon the key interlock specialist.

The suppliers of key interlock systems (and those locksmiths who might consider servicing interlock locks and keys) must recognize that their primary responsibility as an "insurer" is with the Ultimate User of the key interlocks, and not necessarily with their immediate customer. It is in this area where the engineering philosophy of the key interlock specialist can clash with entrenched "naive" sales and engineering philosophies of the modern business world.

For example, at times, it may be necessary to question or suggest changes in a "customer's" key interlock application. Functioning as an "insurer" for the Ultimate User, it may even be necessary to refuse to sell or apply key interlocks for a specific application unless the customer changes his requirements or operating arrangements. The key interlock specialist must, therefore, carefully analyze the objectives and functional requirements of each key interlock system before providing the necessary key interlocks.

KEY INTERLOCK SYSTEMS

A key interlock system includes a minimum of two or more key interlocks, and in some systems well over 1,000. Each interlock is operated only by its own key (or keys). And these keys can be removed from their interlocks **only** when the locking bolt is in a prescribed position. The keys thus function as a mechanical linkage between the various interlocks in an interlock system. Each interlock controls the operation or movement of the equipment or devices on which it is mounted. They lock, for example, the equipment or device in either the ON or OFF, OPEN or CLOSED, UP or DOWN, etc., positions. Therefore,

should an operator accidentally try to perform an operation out of sequence, the key will not work the interlock, and the equipment on which the interlock is mounted can not be operated.

Key interlocks can be arranged to provide either a linear, circular or random system. However, the specific sequence of operations being interlocked dictates the type of system and the key interlocks to be used.

In a linear interlock system the pre-established sequence of operations follow a straight line. Step 1 in the sequence is followed, for example, by steps 2, 3, 4, 5, 6, etc. Then, to restore operations to their original status, it is merely necessary to perform these operations in their reverse sequence — step 6 followed by steps 5, 4, 3, 2, and 1.

In a circular interlock system the pre-established sequence of operations follow what might be considered a circle. Step 1 in the sequence is followed, for example, by steps 2, 3, 4, 5, and 6, after which the sequence is repeated — moving directly from step 6 to step 1, as the sequence is started over again.

In a random interlock system there is no apparent "rhyme or reason" to the sequence of operations — except that only a specific number of operations (one or more) can be performed at any given time or step in the sequence. However, each step in most random interlock systems actually involves a separate or independent linear or circular system. Random interlock systems are, therefore, usually much more involved or complex than either the linear or circular systems.

Linear interlock systems are generally used when it is desired to isolate a specific device for servicing — such as in electrical utilities, pipe line operations, etc. — or when it is necessary to temporarily shift from a normal method of operations to an alternate method of operations. In contrast, circular and random interlock systems do not normally fall into any specific area of activity. However, they are usually employable in processing plant operations.

DEVELOPING FUNCTIONAL REQUIREMENTS

The first step in designing a key interlock system is to acquire a thorough knowledge and understanding of the operating requirements of the sequence to be "insured" with key interlocks. Just as the locksmith must evaluate the various degrees of security from a "time" (of defeating the lock) standpoint when evaluating a total locking problem, the key interlock specialist must evaluate all possible steps in an operating sequence for the degree of potential hazards which might

result if an operator should absentmindedly attempt to perform an incorrect operation.

Each new interlock application also requires that the interlock specialist quickly acquire a knowledge of the jargon of the specific industrial discipline involved. This is necessary, because unfortunately (as observed over approximately 25 years as a key interlock specialist) very few management personnel are familiar with all of the hazards involved with the sequential operations under their control.

The second step is to develop a "single-line" schematic sketch of the equipment or devices to be interlocked. Then as a third step, it is necessary to develop a tabular operating specification of the entire interlock system — i.e., setting forth all conditions which must, must not, and/or may, exist before each step can be made in the entire operating sequence.

The next or fourth step is to prepare an "interlock arrangement" sketch of the system. This is a schematic sketch symbolically illustrating each device being interlocked and the functional requirements of the specific key interlocks to be mounted on each device. It is at this point that the skills and knowledge of the locksmith are paramount — namely, selecting the proper locks and keys (master locks, master-keyed locks, non-master-keyed locks, specially designed locks, etc.) to provide the necessary locking and interlocking requirements to guarantee the proper sequence of operations in the interlock system.

These last two steps are critically important. The profits from many successful years of operation can be wiped out as a result of one "insurance" claim, which might have been avoided in the development of the interlock system, and the proper selection and application of the required locks and keys.

ILLUSTRATIVE LINEAR INTERLOCK SYSTEMS

The following illustrations are representative of simple linear key interlock systems. They include the functional requirements or specification, and an "interlock arrangement" sketch or solution of the systems. The interlocks are shown as being mounted on electrical devices. However, it should be realized that these devices might be anything upon which an interlock can be mounted; such as for example, doors, valves, drawbridges, de-rails, conveyors, ladders, centrifuges, etc.

FIRST, in Figure 1, we illustrate a simple transformer circuit employing a primary switch and a secondary breaker. The specification

for this interlock system might be: (1) the switch must not be operated (opened or closed) under full load conditions; and (2) to permit servicing and operation of the breaker while deenergized.

As may be noted in the sketch, this can be done with a single lock interlock mounted on each device with both locks having the same combination (A-1) and with only one key A-1 being accessible to the operator.

The key A-1 is retained in the breaker L-O (locked open) interlock while the breaker is closed. The key A-1 can be removed from its lock only when the breaker is locked open. Key A-1 can then be used to unlock the switch, permitting the switch to be opened. With the switch locked open and the breaker deenergized, key A-1 can be returned to the breaker for servicing.

The key A-1 will be retained in the L-O-C (locked open or closed) interlock during the operation of the switch. It can be removed only when the switch is locked in either the open or closed position.

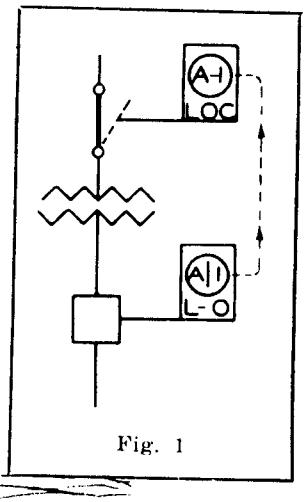

Fig. 1

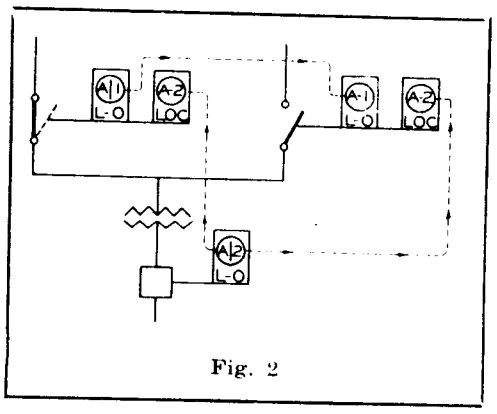

Fig. 2

SECOND, in Figure 2, we illustrate substantially the same arrangement as shown in Figure 1, except that we now have two power sources feeding the transformer, with one switch being locked open. The specification for this system might be: (1) the switches must not be operated (opened or closed) under load conditions; (2) the two power sources must not be connected in parallel (both switches being closed at the same time); and, (3) to permit servicing and operation of the breaker while deenergized.

This can be done with a single (L-O) interlock on the breaker and two single lock (L-O) and (L-O-C) interlocks on each switch. The L-O interlocks mounted on the switches have the same combination (A-1) with only one key A-1 being available. The L-O-C interlocks mounted on the switches and the L-O interlock mounted on the breaker all have the same combination (A-2) with only one key A-2 being available.

Key A-1 is normally retained in the L-O interlock on the closed switch. The key A-1 can only be removed after the switch has been opened, and locked open. The second switch can then be unlocked and closed only after the first switch is locked open, with the key A-1 being retained in the L-O interlock on the second switch.

The L-O-C interlock on each switch guarantees that neither switch can be operated (opened or closed) until the breaker is locked open, and the key A-2 removed from the L-O interlock on the breaker. With the switches locked open and the breaker deenergized, key A-2 can be returned to the breaker for servicing.

THIRD, in Figure 3, we illustrate a system utilizing master locks. Four incoming power sources (A, B, C and D) each having its own circuit breaker are shown feeding four loads (M, N, P and R). Tie breakers (E, F, G and H) are shown connecting together each of the four sources. The specification for this interlock system might be:

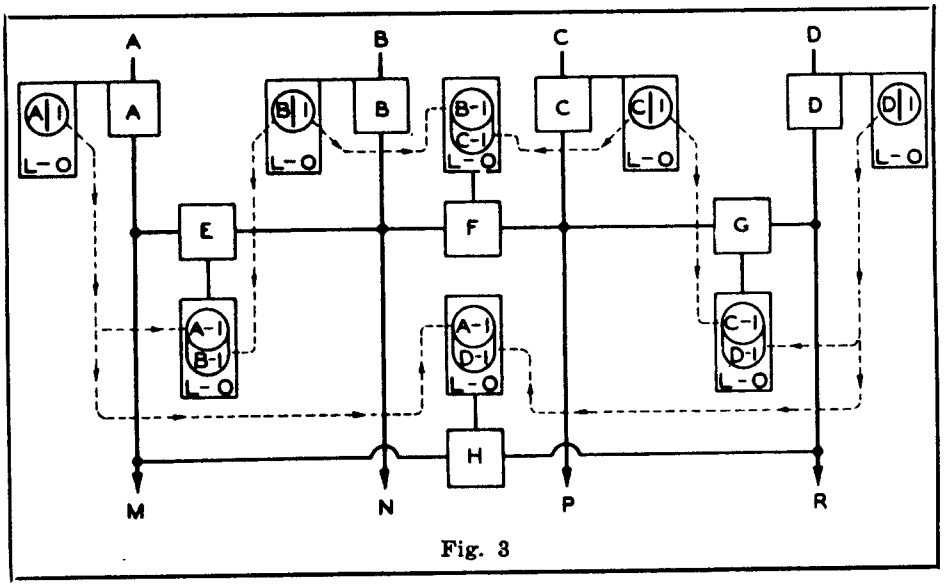

Fig. 3

(1) to prevent paralleling any two or more power sources; and, (2) to permit supplying the four loads from any power source.

As may be noted in the sketch, this can be done with a single lock L-O (locked open) interlock on each power source and tie breaker. The power source breakers are normally closed, and the tie breakers are locked open. Four different keys are used. Key A-1 is retained in the L-O interlock on breaker A. Keys B-1, C-1, and D-1 are retained in the L-O interlocks on their respective breakers (B, C and D).

Single master lock L-O interlocks are mounted on each tie breaker. The A-1 & B-1 master lock L-O interlock on tie breaker E can be operated by either key A-1 or B-1. Either key B-1 or C-1 will operate the B-1 & C-1 (L-O) interlock on tie breaker F. Either key C-1 or D-1 will operate the C-1 & D-1 (L-O) interlock on tie breaker G. And either key A-1 or D-1 will operate the A-1 & D-1 (L-O) interlock on tie breaker H.

By using master locks in the tie breaker interlocks, it will be noted that any power source breaker key (obtainable only when its breaker is locked open) will unlock and permit the closing of either adjacent tie breaker. However, in contrast, no tie breaker can be closed while its two adjacent source breakers are closed. This, therefore, prevents the paralleling of any of the power sources, while permitting the various loads to be supplied from any power source.

CONCLUSION

In conclusion, understanding that key interlocks can be applied to practically any device, it is possible to select and arrange key interlock systems which will prevent and eliminate the destructive and sometimes fatal hazards resulting from human absentmindedness. The saving of one life, the preventing of costly damage to operating equipment, or preventing the loss of scarce materials, through the use of a key interlock system is well worth the effort involved. In his way, locksmiths and key interlock specialists make but another contribution for the betterment of mankind and society.

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I-T-E Imperial Corporation

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