NATIONAL BUREAU OF STANDARDS REPORT

2806

ELECTRICAL TYPE DOOR INTERLOCK

by

Alfred B. Castle

to

Engineering Division, Military Construction
Corps of Engineers
Department of the Army

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT 0602-10-4716 | September 21, 1953 | **NBS REPORT** 2806

ELECTRICAL TYPE DOOR INTERLOCK

by

Alfred B. Castle
Mechanical Instruments Section
Mechanics Division

Developed for

Engineering Division, Military Construction
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NBS

U. S. DEPARTMENT OF COMMERCE
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FOREWORD

Door interlocks of both mechanical and electrical types have been developed concurrently for the Engineering Division, Military Construction, Corps of Engineers, Department of the Army, during the present calendar year in the Mechanical Instruments Section principally under NBS Project No. 1000-10-4716 as authorized in the letters references (1) and (2). Only the electrical type is described in this report.

The interlocks are designed primarily for use on multiple doors of a bathroom in veterans' hospitals 1) to lock the bathroom so as to afford privacy during occupancy, 2) to make it equally accessible to all potential users when idle, and 3) to open it easily in emergencies.

Walter Ramberg, Chief
Mechanics Division

A. V. Astin, Director
National Bureau of Standards

ELECTRICAL TYPE DOOR INTERLOCK

by

Alfred B. Castle

ABSTRACT

An electrically operated door interlock specifically for use on multiple doors of a bathroom in veterans' hospitals was developed. The interlocks are supplementary controls on ordinary door latches. With the interlocks, all doors to the bathroom can be locked by the occupant, and all doors are unlocked when the bathroom is unoccupied. Several interlocks have been constructed for test in a service installation. Design details are included in the report.

1. INTRODUCTION

Simple and automatic means for obtaining privacy for all parties concerned using one bathroom connecting between two or more rooms in hospitals has been a need particularly of U. S. Government operated hospitals.

The privacy desired is such that the user cannot be intruded upon from outside but when the room is not in use it remains equally available to all users. Also, in case of emergency the room should be easily opened from without.

Up until the development of the electrical interlock system described herein, no other hardware was known which would fit the need and yet be simple and easy to operate, such as by a weak patient. It had been reported that there is one commercial type of mechanical interlock which can be

applied to two doors that are reasonably close together and opposite each other. Also there is an NBS developed mechanical system (see reference (c)) which can be applied to two or possibly three doors regardless of orientation and up to moderate distances apart.

2. REQUIREMENTS

The interlocks, when installed on bathroom doors connected with two or more rooms, should meet the following minimum requirements:

a). It should be possible to lock the bathroom doors from within against intrusion from without, simply by closing the doors and actuating a single handle or knob on any one door.

b). Upon opening any one door, all doors must thereby become unlocked and remain so as long as any door remains open.

c). While in the bathroom, locking any one door will simultaneously lock all other doors.

d). When necessary it shall be possible to open any door from without by application of a simple tool or key or by interrupting the electrical current.

e). Failure of the voltage shall either automatically unlock or permit emergency unlocking of all doors. No undue hazard of electrical shock must be introduced by operating the locks electrically.

f). The materials, workmanship and design of the locks shall afford a reasonably long trouble-free life.

The following additional features are desirable:

g). An indicator that the bathroom is occupied should be easily visible from both connecting rooms.

h). The locks should be applicable to either old or new construction and use existing types of hardware with little or no modification.

i). Locking knobs or handles should be similar to those normally used to obviate learning any new locking technique.

3. DESCRIPTION

Views of the hardware of one interlock are shown assembled in figure 1 and disassembled in figure 2. A conventional latch with dual knobs, modified to operate with the electrical interlock, is shown at the bottom left in each figure. The jamb unit associated with the latch is shown at the bottom right and is essentially a solenoid controlled locking device for bolt 23. The solenoid controls are shown at the top of the figures, the door unit with signal light and switch control at the left and the jamb unit with the switch itself and signal lamp at the right.

The electrical circuit diagram for a two-door installation is given in figure 3 and constructional details in figure 6. When a door is open two mercury type switches and a pair of contacts, all located in the door jamb unit, are in "open circuit".

The general design may be illustrated by a cycle of operation. If both doors are open, a person enters the bathroom and closes both doors. This closes one of the two mercury switches in each of the door jamb units, No. 1, figures 1 and 2. Turning the switch knob to "lock" closes the remaining open switch, energizes the solenoid, actuating the locking device.

In the actuated condition the solenoid mechanically holds closed the auxiliary "seal in" contacts. The solenoid remains activated, and the doors locked, through a circuit containing the "seal in" contacts and the normally closed "interlock" switch, although the switch knob returns to neutral and the normally open switch now opens, when the operator removes his hand.

To unlock the doors, the switch knob is turned to "unlock", which opens the normally closed switch, breaking the circuit through the solenoid. As the solenoid is de-energized, the door is unlocked and at the same time the "sealed in" contacts are opened. The mechanism is now ready for the next cycle of operation.

3.1 Door Units of Interlock

The mechanical latch assembly 23, figures 1, 2 and 6, may be of any conventional type with a groove milled in the latch bolt suitable for engagement with the lock bar 17. As long as the tongue of 17 is engaged with 23, by action of the relay 16, the bolt normally cannot be retracted for opening the door.

Switch actuating unit 2 contains two springs 11, figures 2 and 6, two pin plungers 12, which are retracted by the springs after being deflected singly by the turning of cam 13, figures 2 and 6. Knob 27 is used to turn the cam through parts 14 and 15, figures 2 and 6.

Door unit 2 has a Lucite rod indicator 22 which receives light from jamb unit 1, deflecting it toward both sides of the door by means of the polished "V" cut near the middle of the rod. The light is on when the doors are locked by

the jamb units. This signal is obtained by wiring the lamp in parallel with the holding relay. If preferred a pilot light jewel may be mounted in the jamb units for transmitting directly the indicator light.

3.2 Jamb Units of Interlock.

The hardware of the jamb part of the interlock consists of a relay lock unit 3 and a switch and pilot light unit 1.

The relay unit 3 consists principally of the relay 16 (a modified Potter and Brumfield type MS2A) with a lock bar extension 17 attached to the regular armature and a contact assembly 18, figure 6. The latter is closed or "sealed in" mechanically by the relay when it is energized. This "seal in" contact maintains the relays energized and hence the doors closed after the operating switch and switch knob return to the neutral or open switch position. The switch knob of either door is now in position to be turned to "unlock".

When the "unlock" switch, held in clip 19, figure 6, is operated by the "unlock" plunger 12 by a proper twist of the knob 27, a switch mount 8 is deflected so as to break the contact in a mercury switch 20. This switch is open when the door associated with it is open because the interlock tab or pawl 5, is spring held out and the lower mercury switch 20 is at such an angle that no contact is made. This switch is normally closed when the door is closed because the door edge deflects the tab and rotates the switch mount so that the mercury contacts close. This switch can be rotated slightly as stated above, by the "unlock" plunger, in its secondary mount 8, because it is spring coupled to tab 5. When thus rotated the switch contacts break the circuit.

The "lock" switch (A), figure 3, is also a mercury type mounted first in clip 9, figure 6, and then in bracket 10 which is both spring and gravity held in an inclined "unlocked" position until deflected by a plunger 12 actuated from the "dead bolt" switch knob 27.

With the "interlock" contacts in their normally closed position, meaning that both doors are closed, either "lock" switch may be used to "seal in" and lock the doors.

Admittedly the interlock switches with tabs and openings exposed can be manually "fooled" and thereby made ineffective for performing their normal function. To make the picking of the interlock difficult would probably unduly complicate the device. However, unless something is actually pushed into the units so as to damage the mechanism the units will function properly even after tampering.

3.3 Installation Details

The interlock system may be installed in old as well as in new work provided that the latch bolt in the two doors selected can be modified as shown for part 23, figure 6. Identically wired units are installed at each door. One of the interlock switch pawls may require reversing on its pivot screw depending on the opening of the door, right or left hand. Opposite the regular latch unit, the striker plate and interlock relay unit 3 is so located and mortised into the jamb that the locking bar will engage the recess cut in the latch bolt. Refer to template, figure 5. Above unit 3, also in the jamb, is located the switch and pilot light unit 1. The switch actuating unit 2 is installed in the door directly facing unit 1, located as for a separate dead bolt.

For installation in new construction units 1 and 3 are mounted directly on plate 4, figure 6.

Each switch housing unit has a terminal strip to which the external leads are connected to the electrical service and to the other housing unit as shown in figure 3.

The power supply required is 110 volts, a.c. The lamp and magnet together require a current of about .07 amperes and consume about 6 watts while the door is locked.

3.4 Opening of Locked Doors

a) Normal Opening. Either door of the bathroom is unlocked simply by momentarily turning the switch control knob of the door unit in the direction indicated for opening and then releasing it. The door may then be opened by the customary operation of the primary door knob.

Incidently, turning the knob in the alternate direction from that required to open the door does no harm; the doors simply remain locked.

b) Emergency Opening. Either door may be unlocked from without simply by interrupting the electrical current to the doors. If this is inconvenient the shaft 15 which extends to the outside of either door may be turned with a screw driver or preferably with a radiator type key and thereby made to unlock the doors.

4. EXTENSION TO MORE THAN TWO DOORS

The interlock although made initially for use on two doors can be extended theoretically to apply to any number of doors. The practical limit is determined only by the size of electrical conductors required to carry the locking

and indicating current. The hook-up diagram for four or more such door units is given in figure 4. The voltage supply may be connected to any of the terminal pairs marked (1) and (6). The initial and final units each have an external jumper connected between a certain pair of terminals as shown in figure 4. As can be noted all "seal in" contact pairs are in parallel; hence the complete system will work reliably as long as the "seal in" switches in at least two door units make proper contact. When only one "seal in" switch remains intact a vigorous manipulation of the door may momentarily break the circuit allowing the relay to release. In respect to "seal in" contacts the more units connected in parallel the more reliable the operation.

5. REFERENCES

1. Letter from Engineering Division, Military Construction, Corps of Engineers, Department of the Army, dated January 13, 1953, reference ENGLS.

2. Letter from Engineering Division, Military Construction, Corps of Engineers, Department of the Army, dated May 13, 1953, reference ENGES.

3. NBS Report No. 2807 on Mechanical Type Door Interlock, under preparation.

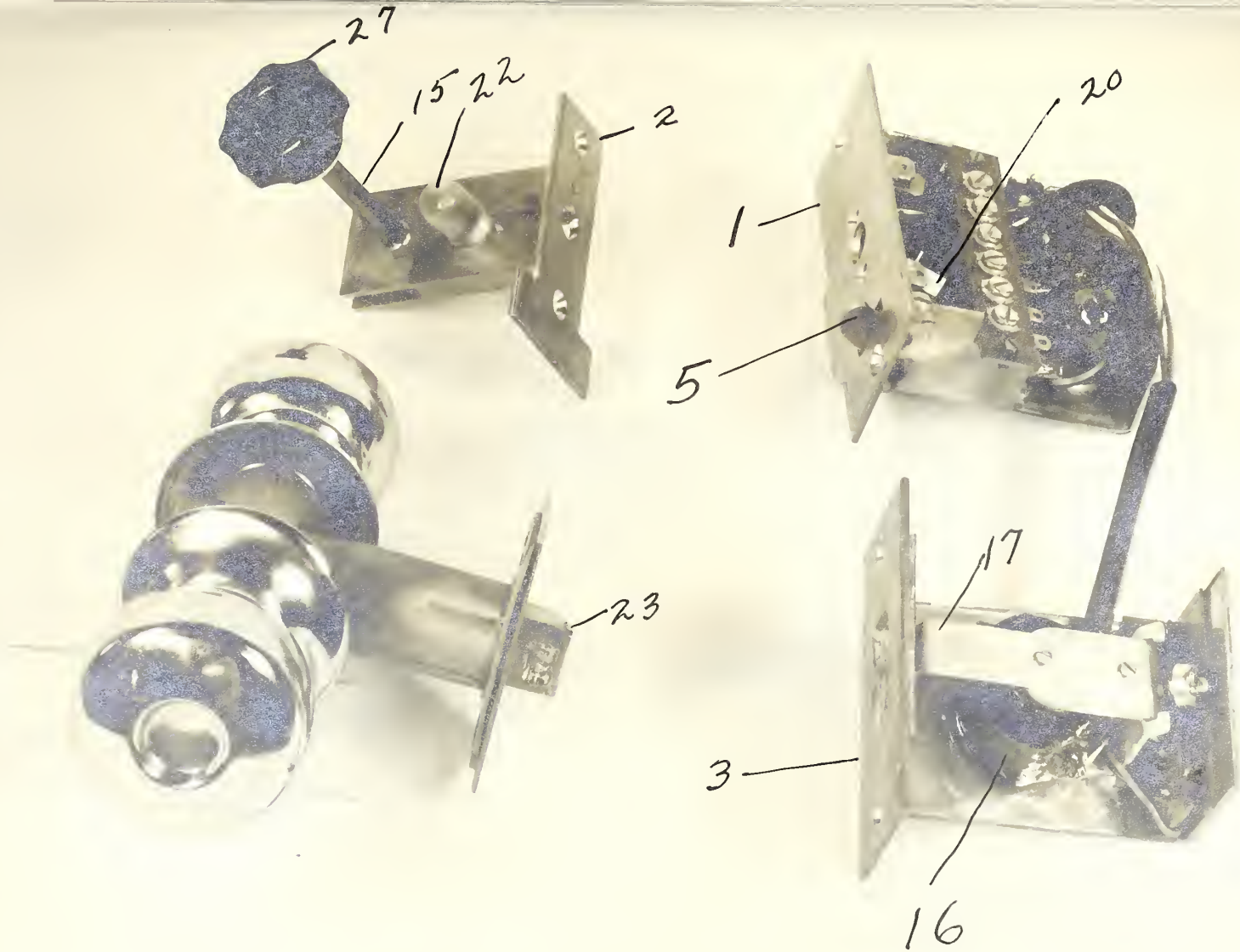


FIG-1

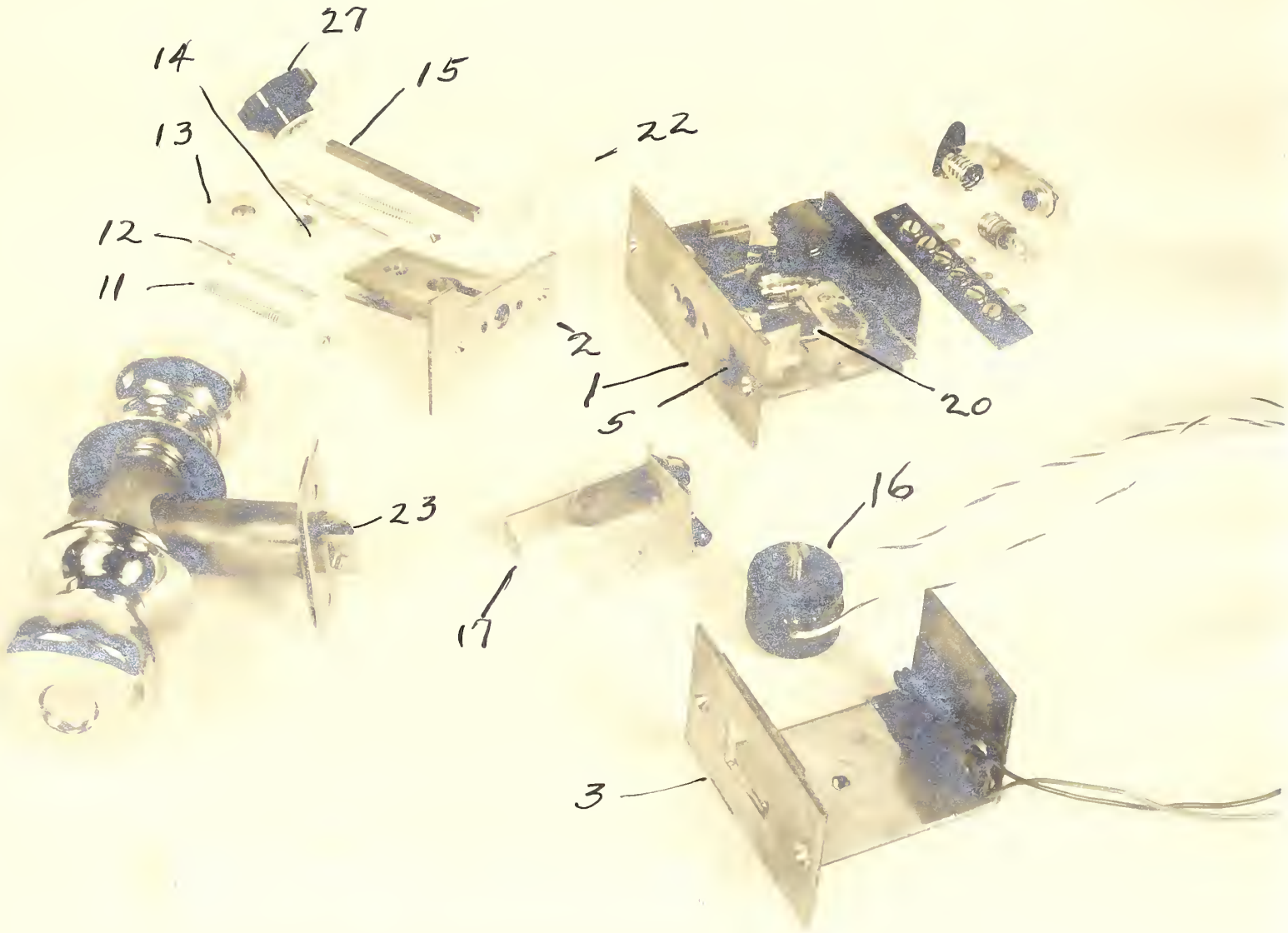
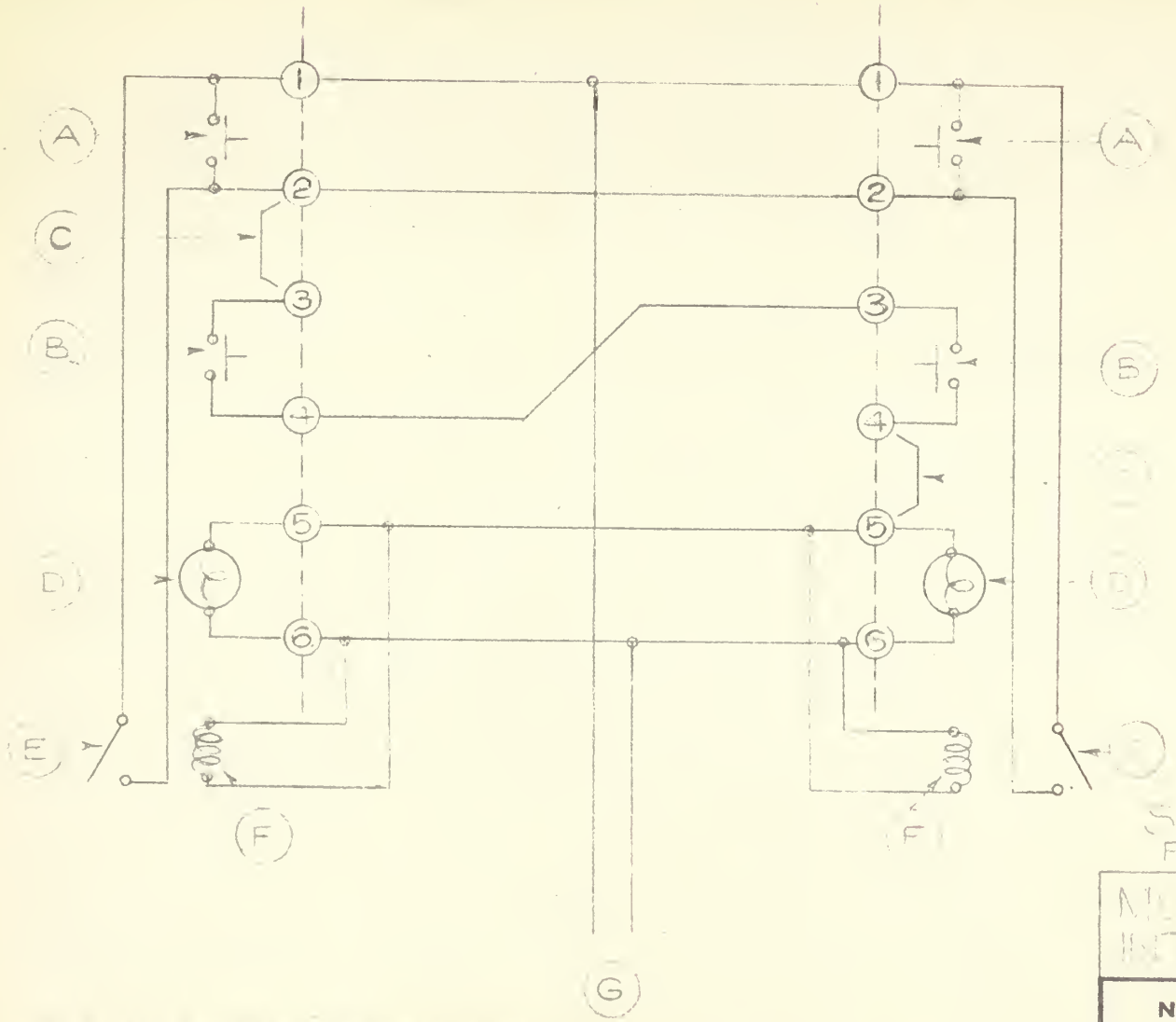


FIG-2

(29 REFERENCE G 857)



A LOCK MERCURY SWITCH

B INTERLOCK & UNLOCK MERCURY SWITCH

C EXTERNAL JUMPERS

D [illegible]

E SEAL IN - CLOSED BY LOCK BAR

F LOCK BAR OPERATING COIL

G 110v AC SUPPLY

1 SCREWS OF TERMINAL BOARD
6

SCHEMATIC WIRING FOR TWO DOORS

(A) MERCURY SWITCH OPERATED BY TOP DEAD BOLT PIN MAKING THIS CONTACT

(B) MERCURY SWITCH OPERATED BY BOTTOM DEAD BOLT PIN TO BREAK CONTACT WHEN DOOR IS OPEN

MULTIPLE DOOR INTERLOCK ELECTRIC

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DRAFTSMAN	DATE	SCALE
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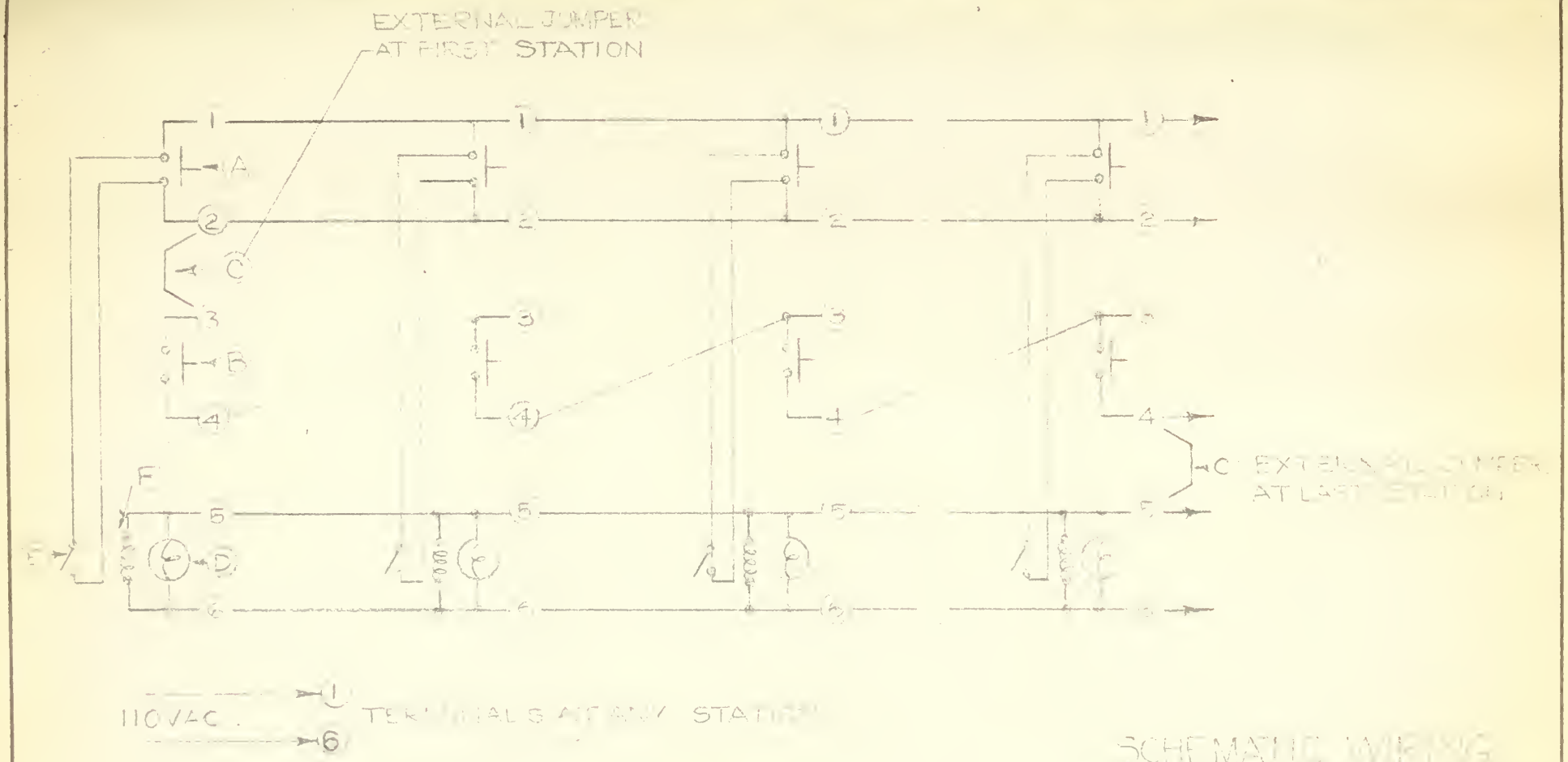
DIV. 6 SEC. 2	856/FIG. 3	



SCHEMATIC WIRING
FOR MORE THAN
INTERLOCK - ELECTRIC

FOR EXPLANATION REFER TO DRAWING [illegible] 857

31 REF. DWG. 857

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DRAFTSMAN	DATE	SCALE
A.B.C.	[illegible]	

DIV	SEC.	
6	2	859 / FIG. 4

ORIGINAL DATE OF DRAWING

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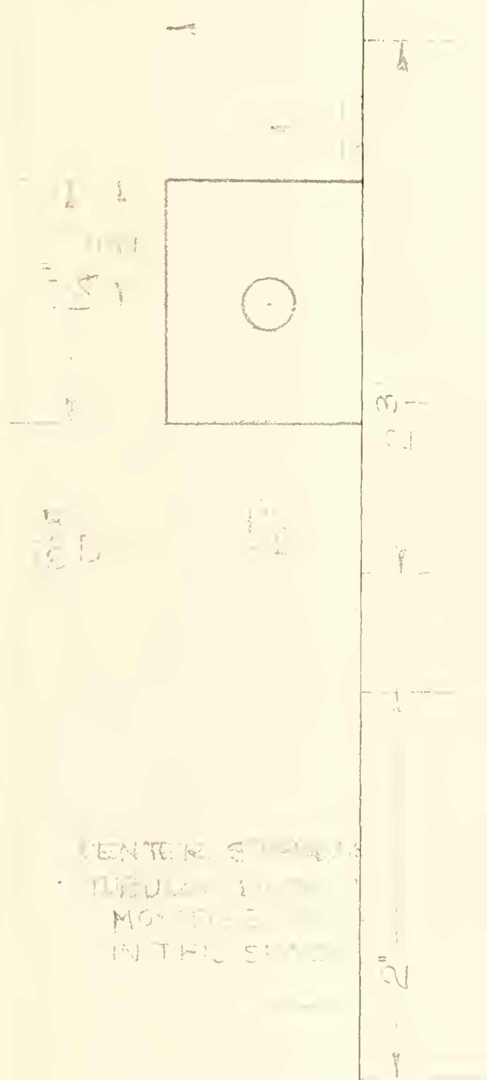

(30) REF. DWG 857

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MULTIPLE

FOR ELECT

MODEL	TYPE	SCALE 1"=1"
DIMENSIONS IN INCHES (*Unless otherwise specified*)	DRAFTSMAN	CHECKER
TOLERANCES (*Unless otherwise specified*)	PROJECT ENGR.	PROJECT ENGR.
DECIMALS ±.005 FRACTIONS ±.015 ANGLES ±½°	SUBMITTED BY CHIEF. SEC.	
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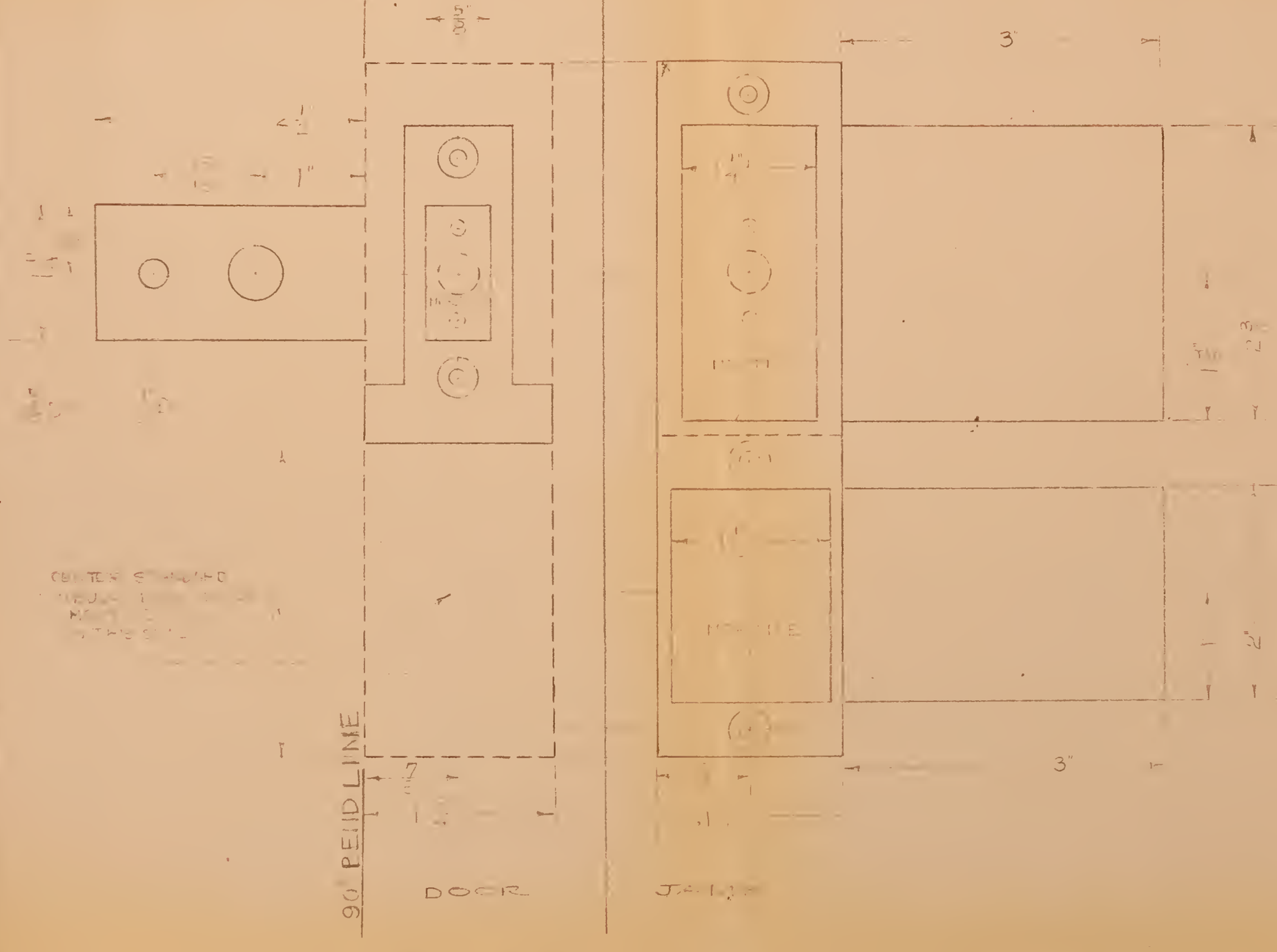

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MULTIPLE DOUBLE THROW

FOR ELECTRONICS

MODEL	TYPE	SCALE 1=1
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TOLERANCES (Unless otherwise specified)	PROJECT ENGR.	PROJECT ENGR.
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24

1

1 HOUSING-SWITCHES & PILOT

PIECE NO	NOMENCLATURE
1	HOUSING-SWITCHES & PILOT

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MULTIPLE DOOR INTERLOCK

FOR ELECTRICAL

MODEL 1	TYPE 1	SCALE
DIMENSIONS IN INCHES *Unless otherwise specified*	DRAFTSMAN	CHECKER
TOLERANCES *Unless otherwise specified*	PROJECT ENGR	PROJECT ENGR
DECIMALS .001	SUBMITTED BY	CHIEF SEC
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EXCEPT AS NOTED


27 DEADBOLT CONTROL KNOB
26 PIVOT PIN
25 UNLOCK SW. RESET SPRING
24 LOCK SW. RESET SPRING
23 DOOR BOLT GROOVE
3 LOCK RELAY HOUSING
NOMENCLATURE
NATIONAL BUREAU OF STANDARDS
WASHINGTON 25 D.C.
ELECTRICAL
MODEL
TYPE
SCALE
DRAFTSMAN
CHECKER
PROJECT ENGR
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TAP 6-40
FRONT VIEW
DOOR BOLT
GROOVE
MODIFIED RELAY
TAP

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