J. O'Brien

61
Memorandum M-1985

Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: OPERATION OF INDICATOR LIGHTS AND INTERVENTION REGISTERS
(Supplement to M-1815)

To: C.R. Wieser, Grp. 6345

From: B. Morriss, G.Young

Date: May 1, 1953

Abstract: Methods of inserting data into WWI through switches and obtaining indicator light outputs from the computer which are independent of test storage are to be installed by the summer of 1953. This report describes how these in-out units will operate and be integrated into WWI.

SUBJECT INDEX: 6.0 EQUIPMENT PLANNING AND INSTALLATION

TABLE OF CONTENTS

1.0 Introduction

Methods of inserting data into the computer through switches and obtaining indicator light outputs from the computer which are independent of test storage are to be installed by the summer of 1953.

The purpose of this report is to describe how these in-out units will operate and be integrated into WWI.

Switches will be provided to insert up to 480 binary digits of information into the computer. These switches will control the digits of thirty 16-digit registers, the insertion registers, which may be sampled directly by the computer. In order to indicate to the computer when these switches should be sampled, 32 activate buttons will be available. Each activate button will control one digit of two 16-digit registers, the activate registers, which may also be sampled directly by the computer.

Eight 16-digit indicator light registers will be available which may be read into directly from the computer. Each digit of each register may have up to four indicator lights on the "one" side and up to four indicator lights on the "zero" side.

The insertion switches, activate buttons, and indicator lights, along with display scopes and light guns, will be distributed among several console positions. Each position may be controlled by a different operator. Since it is impossible to predict exactly how the equipment should be distributed among the consoles, a distribution panel, the remote station junction box, will be included in the system. The tie-in between the various units and the consoles will be done at this junction box. The junction box will facilitate any desired changes in distribution of various indicators, displays and controls at each console. The connections at the junction box will be semi-permanent, and because changes will affect the work of many people any changes must be carefully planned and should not be contemplated on a day-to-day or program-to-program basis, but should be used to facilitate any general change in procedure.

The following block diagrams are included in this memorandum:

B-37446 - Block Diagram, WWI, 551, Indicator Light Register

B-37457 - Block Diagram, WWI, 562, Insertion Register

B-37458 - Block Diagram, WWI, 561, Activate Registers

2.0 Intervention Registers

At times a person may desire to insert information into a computer while a program is being performed. An Intervention Register controlled by switches presents one means of accomplishing this insertion.

The purpose of this section is to discuss the system of Intervention Registers to be constructed by July 1953.

2.1 Description of the Intervention Registers

2.1.1 Remote Station Switch Inputs

The system provides several sets of switch inputs. Each set may be controlled by different persons, or may signify different types of information. These switches will be distributed among several remote station console positions, with an arbitrary but pre-determined number of switches at each position. There will be a push-button (activate button) and an activation indicator light associated with each set of switches. If a person desires to insert information into the computer, he will place the information into a set of switches and press the associated activate button. This indicates that the informatation is ready to be read into the computer. Each time the activate button is pressed, the indicator light at the console position will be turned on. The computer will acknowledge receipt of this information by turning off the indicator light.

There will be a total of 480 binary digits of information controlled by switches and 32 activate buttons.

The computer program must be able to determine which activate button has been pressed and then read the information from the associated switches into the computer. To accomplish this, each activate button will be associated with one digit of two 16-digit registers (the activate registers). The switches will be associated with the digits of thirty other 16-digit registers (the insertion registers). Thus, the program can determine from the activate registers which sets of switches have been set to useful information. The program can then extract this information from the contents of the insertion registers. These registers are discussed in greater detail in the following paragraphs.

2.1.2 The Activate Registers

A circuit consisting of two gas tubes will be associated with each activate button. When an activate button is pressed, the first of these gas tubes will be fired. The activate indicator light is controlled by this gas tube and therefore will be turned on. The second gas tube may fire only if the first tube is fired and a gating voltage is placed on one of its grids. When the second tube is fired, a pulse will be generated. This pulse will be used to set one digit of IOR. The firing of the second tube will turn off the first tube, which will, in turn, turn off both the indicator lamp and the second tube.

This circuit assures that only one pulse will be received by IOR each time an activate button is pressed. It also will "remember" that the activate button has been pressed until the computer is ready to receive this pulse. Each activate register will consist of sixteen of these circuits, with each circuit connected to a different digit of IOR. Thus, when an activate register is selected by IOS and sensed, a "one" will be placed in IOR for every activate button which has been pressed and the register will be cleared.

2.1.3 The Insertion Registers

The switches at the remote stations will control the digits of the thirty insertion registers. Each insertion register will consist of sixteen crystal "and" gates. A gate will be "on" if the associated switch is "on" and IOS selects the gate. Any "on" gate will activate a read-out gate which is common to all insertion registers and associated with a digit of IOR. Thus, when an insertion register is selected by IOS and the read-out gates are sensed by the computer, a "one" will be placed in IOR for each "on" switch associated with a digit of the selected insertion register.

It should be noted that the information contained in the set of switches associated with any one activate button need not be placed in one insertion register. The information may fill parts of one or more insertion registers or even completely fill several registers. The distribution of the switch indications in the registers as well as the number of switches per activate button is arbitrary.

2.1.4 Remote Station Junction Box

There will be a distribution panel, the remote station junction box, associated with the intervention registers to facilitate any desired changes in the distribution of the switches. Each console position will have a fixed number of switches as well as an activate button. Any or all of these switches may be cabled to the insertion registers through the distribution panel. Thus, both the number of switches associated with each activate button and the distribution of the switch indications in the insertion registers may be changed. Similarly, the digit associated with each activate button in the activate registers may be changed.

Any changes in the junction box should not be contemplated on on a day-to-day basis. The panel is designed to facilitate any changes brought about by a general change of procedure and cannot be changed to satisfy the whim of every program.

2.2 Program Requirements

Reading from the activate and insertion registers may be accomplished by an si command, which will select the register and transfer its content to IOR, and an rd command, which will transfer the content of IOR to AC. Each rd command must be preceded by an si command. The si addresses for the intervention registers are si 300 to si 337 (octal). The activate registers will be selected by si 300 and si 301 (octal), while si 302 to si 337 (octal) will select the insertion registers.

As stated previously, each time an activate button is pressed, a "one" will be placed in a digit of an activate register and an indicator light will be turned on. The activate registers indicate which sections of the insertion registers contain useful information. The activate indicator lights will be extinguished as soon as the content of the activate register is read into the computer. The extinguishing of the indicator lights should indicate that the content of the associated set of switches has been read into the computer and the observer should feel free to place new

information into the switches. This is not necessarily the case unless the program reads from the pertinent insertion registers soon after the information contained in the activate register has been read. How soon is predicted on the extenguishing time of the indicator lamp (about 10 ms) and the reaction time of the observer. These delays should allow enough time to read in and store all of the information. Although this method of operation may slightly inconvenience the programmer, it is felt that the inconvenience is not great enough to warrant the extra equipment required to overcome it.

The bi command cannot be used with the intervention registers. A special indexing system would have to be constructed to use this mode of operation. It is felt that any advantages that might be gained would not warrant the addition of the extra equipment.

2.3 Light Guns as Activate Indications

Light guns may be used in place of activate buttons to indicate that information has been placed in the insertion registers through a set of switches. A person may place information in a set of switches and then use the light gun on a point being displayed. By giving an rd command after the rc command which displayed the point, the program can determine who gave the return and thus will know which section of the insertion registers contains the information. By using the light gun, information in the computer at the time of the display can also be utilized.

2.4 Logical Operation of the Intervention Registers

The following paragraphs discuss the logical operation of the intervention registers on the si and rd commands.

It is assumed that the reader has read E-466, Operation of the In-Out Element, and is familiar with the general philosophy and operation of the In-Out Element. The operation timing on the si and rd commands are discussed in E-466. The content of the intervention register selected will be transferred to IOR on the si command, as described below. The content of IOR will be transferred to AC on TP7 of the rd command.

No delays or special operations are required for reading from the intervention registers. Therefore, the only actions in IOC are those common to all terminal equipment described in E-466.

2.4.1 The Insertion Registers

Each digit of the insertion registers is a crystal gate which will have an output if both the associated switch at the remote station position and IOS select the gate. The outputs from any one digit of all insertion registers are mixed into a read-out gate (see B-37457) associated with a digit of IOR. Thus, when an insertion register is selected by IOS, the information contained in the associated switches is transferred to the read-out gates (GT's 01). If these gates are sensed by a computer pulse, the information will be transferred to IOR.

The EU start pulse on TP1 of the si command will be used to sense the read-out gates and transfer the information to IOR. This pulse will be gated by GT02, which will be activated by IS33 whenever an intervention register is selected. This gating has no logical significance, but is provided to prevent every EU start pulse from sensing GT's 01.

Thus, Line IS33 and one of the lines IS03 to IS32 will be activated on an si command selecting an insertion register. This will transfer the information contained in the insertion switches to the read-out gates. The EU start pulse will pass through GT02 of the insertion registers, sense the read-out gates, and trasnfer the information to IOR.

An rd command will transfer the word from IOR to AC.

2.4.2 The Activate Registers

The activate registers remember which activate buttons have been pushed between samplings of the activate registers by the computer. A 2μs gate is required to transfer the information from an activate register to IOR. Therefore, each activate register will have a gate generator (blocking oscillator) which will change a computer pulse into a 2μs gate. The EU start pulse on TP1 of an si command will be used to read out of the activate registers. A gate tube controlled by IOS must be provided for each activate register (see B-37458) so that a computer pulse will only read out of the register when an si command selecting the register has been given.

Line IS33 and either IS01 or IS02 will be activated on an si command selecting an activate register. Again, the selection of IS33 has no logical significance. IS01 and IS02 will activate GT's 01 of activate registers #1 and #2, respectively. The EU start pulse will pass through GT01, transfer the information from the activate register to IOR, and clear the activate register.

An rd command will transfer the information from IOR to AC.

3.0 Indicator Lights

Indicator lights will be provided for displaying binary information from the computer by July, 1953. These lights will be distributed among the console positions. The lights will be controlled by the indicator light registers, described below. Either "ones," "zeros," or both "ones" and "zeros" in the indicator light register may turn on lights at the console. Up to four "one" lights and four "zero" lights may be connected to each digit of each indicator light register.

Special purpose indicators, such as binary-to-octal converters and audible alarms, may also be controlled by the indicator light registers. Each of these special purpose indicators must be treated as a separate design problem.

The indicator lights at each console position may be connected to the indicator light registers in any desired manner through the remote station junction box. A light may be connected to the "zero" or "one" side of any digit of any one of the indicator light registers. Again, it should be remembered that these changes should not be contemplated on a day-to-day basis.

3.1 Description

There will be eight 16-digit indicator light registers provided. Each of these registers may be cleared by the computer or receive information from IOR. Each of these registers will consist of sixteen gas tubes plus a clearing circuit. The register will be cleared when first selected by IOS. After being cleared, a gas tube will be fired for every digit of IOR which contains a "one." If the register remains selected and a digit of IOR changed from "one" to "zero," the associated gas tube will remain fired and that digit of the indicator light register will still contain a "one." After being cleared, the gas tubes corresponding to digits of IOR which contain a "zero" will remain cleared. If the register remains selected and a digit of IOR changed from "zero" to "one," the associated gas tube will be fired and that digit of the indicator light register will contain a "one."

The circuit which clears the indicator light register has a long recovery time, approximately 2 seconds. If a register should be selected more often than this, it might not be cleared.

3.2 Program Requirements

Information may be placed in an indicator register as follows:

si y - select the desired register and clear it.

rc - place a "one" in every digit of the indicator light register corresponding to the digits of AC which contains "ones."

The si addresses for the Indicator Light Registers are si 510 to si 517 (octal).

More than one rc command may be used with each si command. The content of the indicator register after several rc commands may best be shown by an example. Let the storage register x contain 1110011000 . . . and storage register y contain 1110001110 . . . . Now let us consider the content of an indicator register after each command of the following sequence of commands.

1. si (indicator register)
2. ca x
3. rc
4. ca y
5. rc

After the si command, the register will be cleared and contain 000000000000 . . .. After the first rc command, the indicator register will contain the content of register x, namely 1110011000 . . .. After the second rc command, each digit of the indicator register will contain a "one" if the corresponding digit of either x or y contained a "one." Therefore, after the second rc, the indicator register will contain 1110011110 . . ..

The clearing circuits of the indicator registers have a recovery time of about 2 seconds. This means that at least 2 seconds must exist between successive si commands selecting any one indicator register. This delay cannot be conveniently counted by the in-out system and must be taken care of by the program. If an si command is given too soon, some of the digits of the register selected may fail to be cleared, and false information may be placed in the indicator lights.

3.3 Logical Operation of Indicator Light Registers

The following paragraphs discuss the logical operation of the indicator light registers on the si and rc commands.

Again, it is assumed that the reader has read E-466, Operation of the In-Out Element, and is familiar with the general philosophy and operation of the In-Out Element.

The operation timing on the si and rc commands is given in E-466. Only the operations pertinent to the indicator light registers are discussed in this section.

Each indicator light register contains a gas tube clear circuit and 16 gas tube memories. (See B-37446) The clear circuit operates on the rise-time of the IOS line selecting the register. Each digit of the indicator light register consists of a gas tube which will be fired if selected by IOS and the associated digit of IOR contains a "one."

Thus each indicator light register requires one IOS line and 16 inputs from IOR. The gas tube clear circuits will clear the register as soon as it is selected by IOS. Once the clearing process has been completed, the "ones" in IOR will fire the associated gas tubes in the indicator light register selected, and the "one" lights associated with these gas tubes will be turned on. The gas tubes will remain fired until extinguished by another si command. At least 2 seconds should exist between si commands selecting a particular register (see Section 3.2).

At the time the selected register is cleared, IOR must either contain the word to be placed in the indicator light register or remain cleared until the word can be placed in IOR. IOS is changed on TP7 of the si command. At present information left in IOR from a previous in-out operation is not cleared out until TP8 of the si command. If the computer is operating on push button, it is possible to read this false information into the indicator lights. Therefore, IOR will be cleared on TP7 of the si command, instead of TP8 as shown in E-466. The register will remain cleared until TP1 of the rc command, when the content of AC is transferred to IOR.

The process of clearing and reading into a particular indicator light register requires about 700μs. The word to be recorded must remain in IOR at least 25μs after the clearing process has been completed to assure that the gas tubes will be fired. To assure this, a 700μs delay will be counted in IOC on the rc command. Another in-out operation will not be able to continue until this delay has been completed.

Thus, on TP7 of the si command IOR will be cleared and IOS line C08 as well as one of the IOS lines IL01 to IL08 will be activated, depending on the indicator light register selected. The associated gas tube clear circuit will clear the selected register.

On TP1 of the rc command, the content of AC will be transferred to IOR. The "ones" in IOR will fire the associated gas tubes in the indicator light register selected, and the "one" lights associated with these gas tubes will be turned on.

On TP3 of the rc command, an IOC reset (rc) pulse will set the IOC interlock, pass through GT13 of IOC reset control and set and start IODC for a 700μs delay. (See SE-37442, Block Diagram, WWI, 410, In-Out Control. This drawing is not included with this report.)

C08 is mixed with C01 so that, along with any successive rc commands, a successive si command will sense the interlock. This will assure that no further In-Out operations may be started until the 700μs delay has been completed.

Signed G.A. Young
G.A. Young

B.E. Morriss
B.E. Morriss

Approved E.S. Rich
E.S. Rich

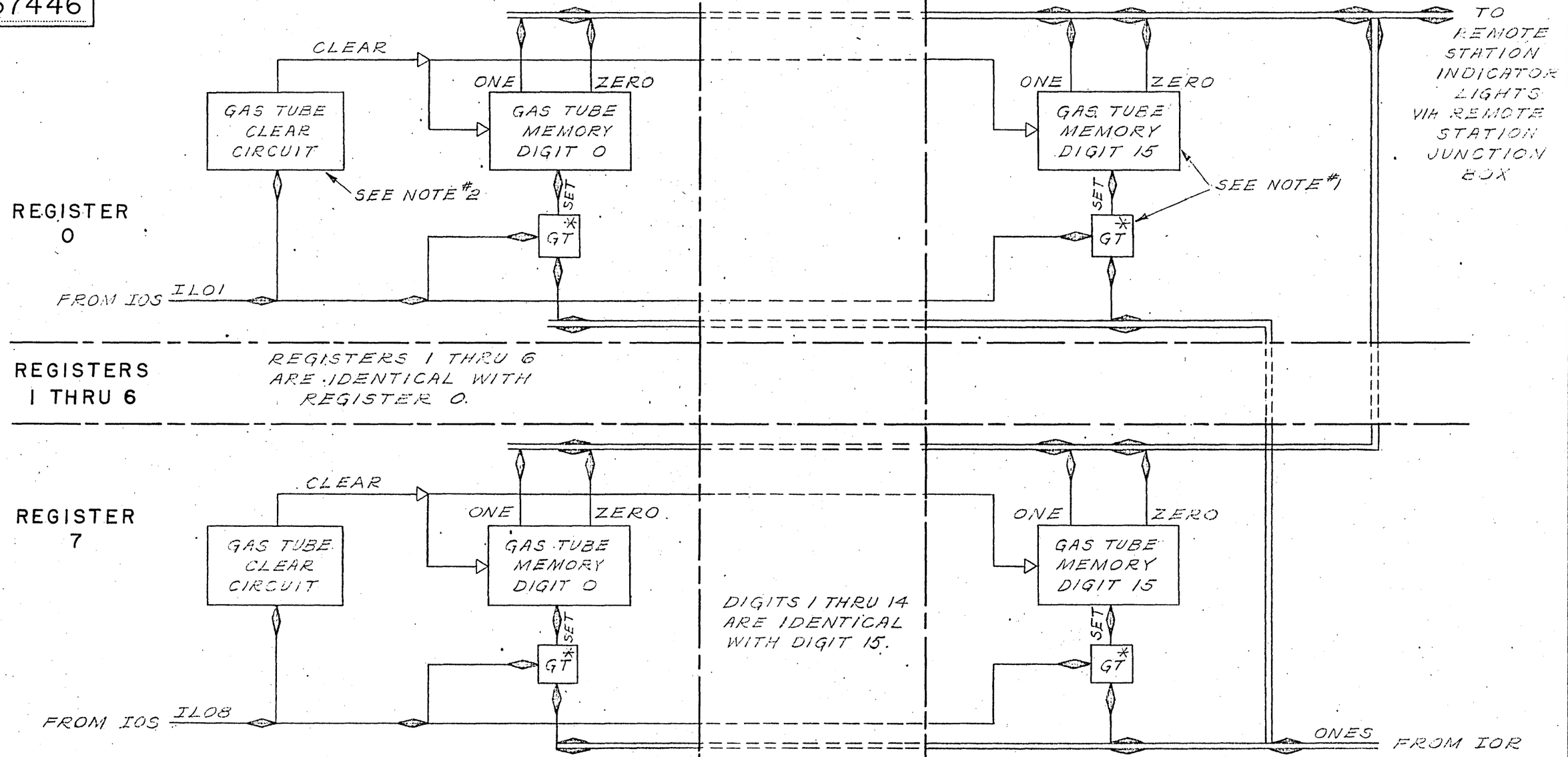
GY/BM/mrs
Drawings: B-37446
B-37457
B-37458

TABLE I

The si Addresses for Intervention Registers and Indicator Light Registers

Activate Registers -	si 300 and si 301 (octal)
	or si 192 and si 193 (decimal)
Insertion Registers -	si 302 to si 337 (octal)
	or si 194 to si 223 (decimal)
Indicator Light Registers -	si 510 to si 517 (octal)
	or si 328 to si 335 (decimal)

B-37446



NOTES:
1. EACH GAS TUBE MEMORY AND THE ASSOCIATED GATE ARE PHYSICALLY A SINGLE GAS TUBE.
2. THE CLEAR CIRCUIT WILL CLEAR THE REGISTER WHEN FIRST SELECTED BY IOS.

GRADED BY: DATE: THIS IS A GRADED DRAWING OF HIGHEST GRADE APPROVED BELOW:
GRADE I FOR REFERENCE ONLY
GRADE II PRELIMINARY DESIGN
SHS 5/12/53 GRADE III FINAL DESIGN

CHG.	CN#	DATE	APPD.
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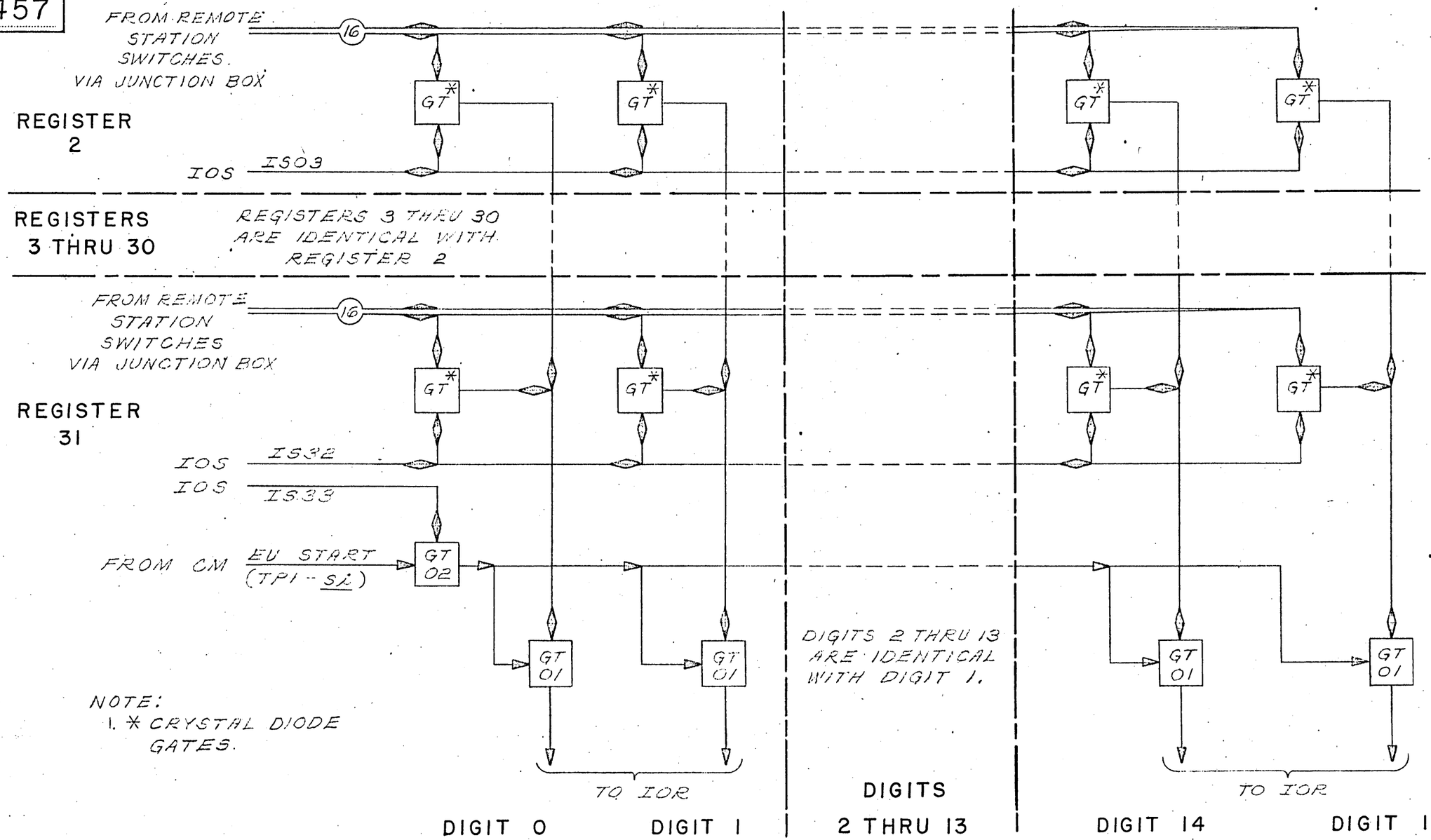
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DIGITAL COMPUTER LABORATORY
DEPT. OF ELECTRICAL ENGINEERING — D. I. C. PROJECT NO. 6889

BLOCK DIAGRAM, 551, INDICATOR LIGHT REGISTER, WWI

SCALE: —— DR. BRM 5-1-53 B-37446

ENG. May 5/7/53 CK. 5/11/53 APPD. 5-11-53

B-37457



NOTE:
1. * CRYSTAL DIODE GATES.

GRADED BY: DATE: THIS IS A GRADED DRAWING OF HIGHEST GRADE APPROVED BELOW:

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GRADE II PRELIMINARY DESIGN

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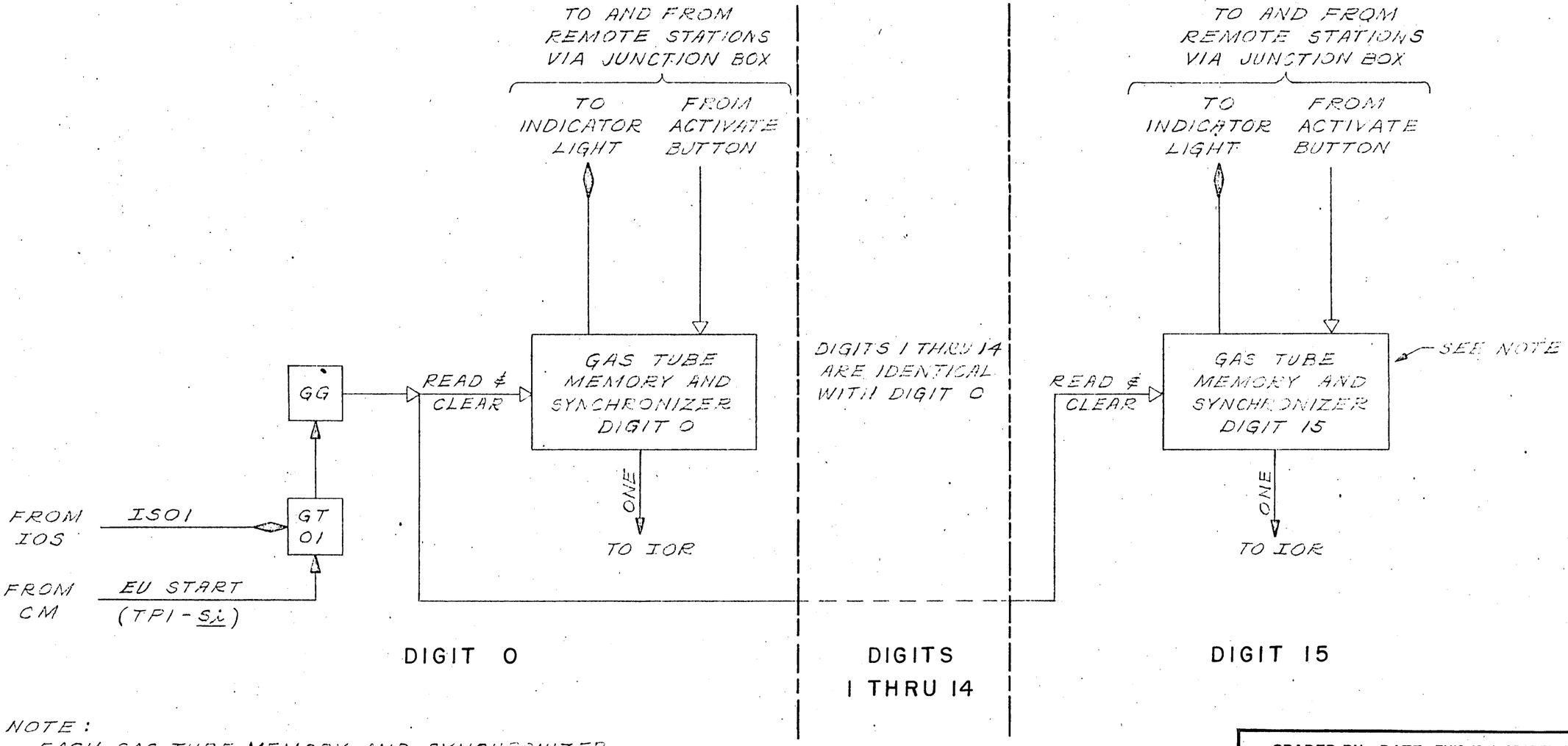
BLOCK DIAGRAM, 562, INSERTION REGISTERS, WWI

SCALE: ——— DR. BRM 5-1-53

ENG. DAM 5/7/53 CK. [illegible] APPD. 5-11-53

B-37457

B-37458



NOTE:
EACH GAS TUBE MEMORY AND SYNCHRONIZER IS A TWO GAS TUBE CIRCUIT. WHEN THIS CIRCUIT IS SENSED, A PULSE WILL BE SENT TO IOR FOR EVERY ACTIVATE BUTTON WHICH HAS BEEN PUSHED. REGISTER #1 IS IDENTICAL EXCEPT SELECTED BY IOS LINE IS02.

GRADED BY: DATE: THIS IS A GRADED DRAWING OF HIGHEST GRADE APPROVED BELOW:
GRADE I FOR REFERENCE ONLY
GRADE II PRELIMINARY DESIGN
5/12/53 GRADE III FINAL DESIGN

CHG.	CN#	DATE	APPD.
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BLOCK DIAGRAM, 561, ACTIVATE REGISTER #0, WWI

SCALE: ——— DR. BRM 4-30-53

ENG. CK. APPD. 5-11-53

B-37458

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