

# TOP SECRET

TOP SECRET  
Op-20-G/ep

5 March 1945.

## TECHNICAL FEATURES OF R5W ENIGMA MACHINE

The principle feature of the R5W Enigma can be studied in the attached photographs and drawings. As previously described in the cryptographic discussion, the R5W is, in short, a five wheel Enigma with pluggable reflector and fixed "stecker." The plain text is typed on a modified keyboard, at a maximum speed of approximately five characters per second. The R5W includes two printers, one of which types the text exactly as typed on the keyboard; the other printer produces the cipher text in five letter code groups (or plain text -- in the case of deciphering). Both units print on 3/8" tape.

1. Nature of Machine Keyboard. The keyboard of the R5W is shown in Drawing 1. It consists of 26 keys, the lower case of which forms a part of the standard typewriter keyboard. In order to take care of figures and the space bar, however, it is necessary to rob three of the 26 keys of their standard letter functions. As shown in the drawing, the "Figs" case shift is mechanically tied to the "Z" letter key. Hence, when a shift to "Figs" is desired, the "Z" letter key is operated. In a similar fashion, the "V" letter key is associated with the "Letter" case shift, the "X" letter key with the "space" bar. Of course, this robs ordinary plain text of the three letters V, X, Z. So they are simply put in the "Figs" case, over C, G, D respectively. When deciphering, however, the standard keyboard is restored (a cipher "Z" will be struck on the conventional "Z" key). Finally, when a cipher letter, say "G", stands for a "space," the second printer will space when "G" is deciphered.
2. Provision for a Stecker. Consult the cryptographic section, together with Drawing 1.
3. Wiring of Right Contact Plate. (Input Head). See cryptographic section and Drawing 1.
4. Wheels and Cores. See cryptographic section and Figure 5. The latter shows both sides of a wheel (No. 5), the obverse face of Hub A, and the reverse face of Hub B (mounted in position in the wheel on an axle). (Hub = core).
5. Reflector. As shown in Drawing 1, the reflector head is wired through a Jones plug to a plugboard where reflector links can be arbitrarily set into the machine by plug cords. (See Figures 1 and 2).

TOP SECRET  
Op-20-G/ep

5 March 1945.

Subj: TECHNICAL FEATURES OF R5W ENIGMA MACHINE.

6. Nature of the Stepping. Three of the five maze wheels step, as designated in Drawing 1. The fast wheel (center) steps every time a key is depressed, being driven by the stepping eccentric (Figure <sup>3</sup>4) every time the clutch is tripped. The medium wheel steps every time one of the four turn-over notches of the fast wheel appears at the stepping tooth. This happens at fast wheel window settings F, M, S and Z (in conventional designation set up by cryptographic report). In a similar manner, the slow wheel steps whenever one of the four turn-over notches of the medium wheel appears at the stepping tooth level (medium wheel window settings F, M, S, Z). As is commonly known by those acquainted with Enigma machines, the window readings in the vicinity of a "double" turn-over point would be:

DYL  
DYM  
DZN ← Shown in Figure <sup>3</sup>4.  
EAO  
EAP

The stepping teeth can be seen in the photograph (Figure <sup>3</sup>4). Fast and medium wheel teeth are shown still engaged at the end of the first part of a double turn, DZN. The previous position was DYM, the next would be EAO.

In every case the wheels step before the character is enciphered.

A feed-out key (not shown in illustrations) is located on the cover which has been turned back in Figure 2. This key merely holds the main clutch out, permitting tape to feed out and wheels to step without printing any text. Conceivably, this key could also be used to introduce an extra garble stepping in the wheel motion, although the inconvenience of its operation would make such application improbable.

7. Bench Mark Levels. See cryptographic write-up and Drawing 1.

8. Circuit Description. The circuit in which the two printers operate has been designated to print both a letter typed upon the keyboard (plain printer) and the same letter through the maze (cipher printer). As a safety feature, the circuit will not permit the plain printer to operate unless the cipher

# TOP SECRET

TOP SECRET  
Op-20-G/ep

5 March 1945.

Subj: TECHNICAL FEATURES OF R5W ENIGMA MACHINE.

-----  
printer receives a letter. This is done by operating the letter solenoids of the two printers in series, and insuring that a link through the maze is present before either letter can print.

As an example, suppose we wish to encipher the letter "B." Notice in Drawing 2 that depressing the "B" key on the keyboard operates a transfer contact connecting the "B" plain printer solenoid to the maze. This establishes a path from + (through the cam contact) to the "B" plain solenoid, through the illustrative maze link to the "V" cipher solenoid to -, and both printers print: "B" plain, "V" cipher. When the next key is depressed, the wheels step, changing the maze, and another encipherment takes place in the same fashion.

In explanation of the case shift and spacing operations mentioned in Part 1, we might review the substitutions taking place in order to accommodate these additional manipulations.

ENCIPHERING ACTION		
KEY CONTACT	PLAIN PRINTER	CIPHER PRINTER
CARRYING CURRENT		
V	LETTERS CASE	V
X	SPACE	X
Z	FIGS CASE	Z

DECIPHERING ACTION		
KEY CONTACT	PLAIN PRINTER	CIPHER PRINTER
CARRYING CURRENT	(TAKING CIPHER TEXT)	(PLAIN TEXT FROM MAZE)
V	V	LETTERS CASE
X	X	SPACE
Z	Z	FIGS CASE

The shift of functions for V, X, Z key contacts necessary in changing from enciphering to deciphering is accomplished by the "cipher-decipher" switch shown in Drawing 2, and Figures 2 and 4. This switch merely substitutes case magnets and a "space" resistor for the V, X, and Z solenoids of the proper printer.

To encipher a change to Letters case, for example: When the Letters (and "V") key is depressed, the plain printer goes to the letter case, while (through the illustrative link) this action is enciphered as a "B" on the cipher printer. When deciphering the "B," the "cipher-decipher" switch directs the second printer current to the letter case shift through the same maze link.

# TOP SECRET

TOP SECRET  
Op-20-G/ep

5 March 1945.

Subj: TECHNICAL FEATURES OF R5W ENIGMA MACHINE  
-----

In setting up the machine to begin a message, it may be necessary to shift the printer manually to the letter case. External shifts are provided for either printer and are labeled FIGS and LTRS in Drawing 2, Figures 2 and 4. These push button switches operate their respective magnets without affecting the clutch or stepping circuits.

9. Mechanical Description. An induction motor (capacity split-phase) drives the clutch system of the printers. Whenever the universal key contact is depressed (actuated by any key lever) the ECM type clutch engages the cam system, makes one revolution, and drops out again. The clutch magnet and trip are shown in Figure 3. A number of actions take place during the clutch cycle: The key interlock cam locks the depressed key down until the stepping eccentric has stepped the wheels and the tape feed cam has operated; before the interlock re-opens the cam contact closes to allow the printer solenoids to print. At the end of the cycle the detent cam drops into place, holding the cam shaft in the "home" position until the clutch again operates.

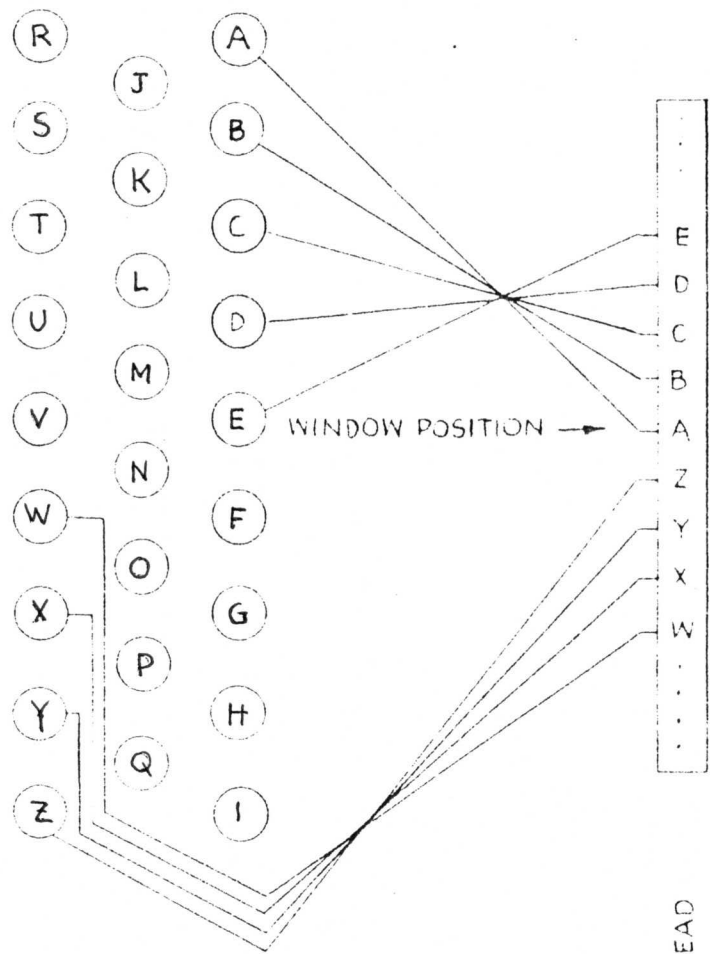
In addition to the main clutch shaft there are two secondary case shift cam systems, one for either printer. The FIGS and LTRS magnets for the plain printer are labelled in Figure 3. These two latch magnets permit consecutive half-revolutions of the cam system. The shift cam thereby assumes one of two extreme positions (depending upon which of the latch magnets has been most recently operated) and operates the printer shift. An ingenious device, the tape feed lock mechanically holds up the next tape feed-out of the proper printer when the key lever depressed has operated a case shift in that printer.

One further refinement -- a double feed-out cam automatically divides the cipher text (on the proper printer) into five-letter code groups. This cam action is permitted by one of a pair of levers on the two sections of the "cipher-decipher" switch.

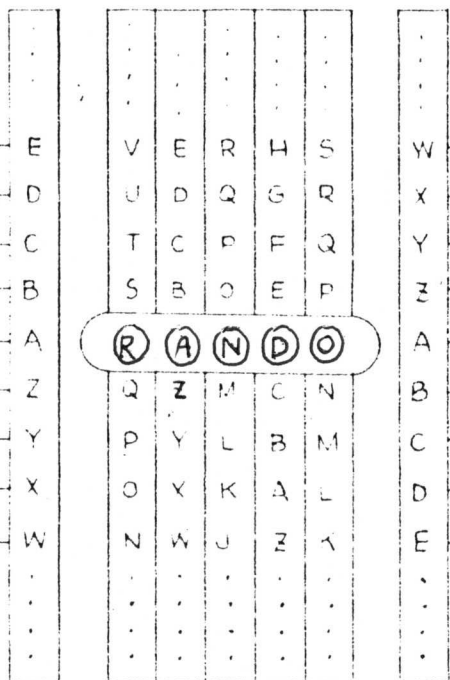
Provision has been made for tandom operation of the R5W through two shaft couplers at either side of the machine.

10. Title Plate:

Stores Ref. No. 106/652  
Machine Type X Mark II  
Serial No. 2026



PLUGBOARD REFLECTOR

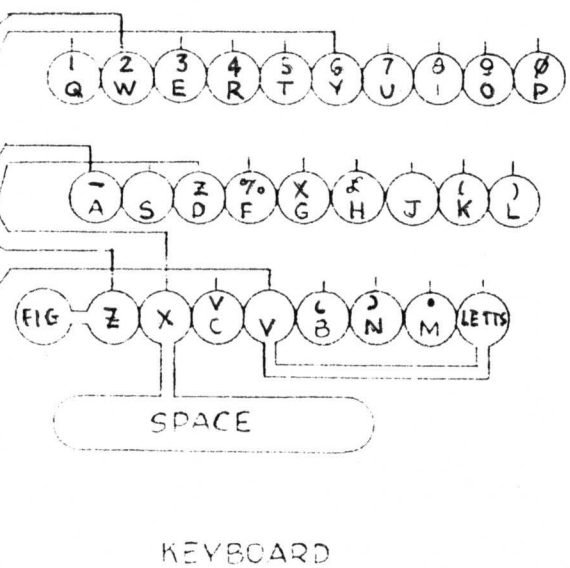


REFLECTOR HEAD

STEPPING WHEELS  
(STEPPING TOWARDS  
OBSERVER)

NON-STEPPING  
WHEELS

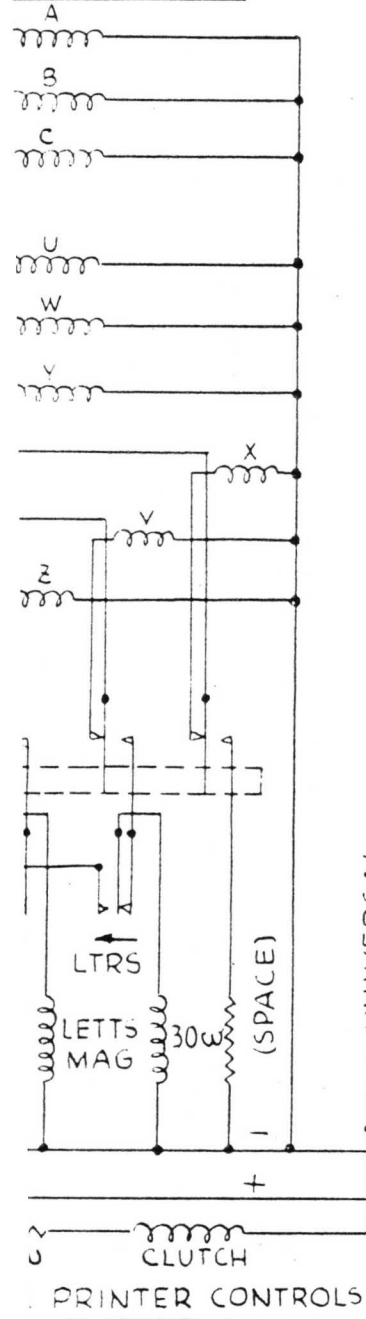
INPUT HEAD



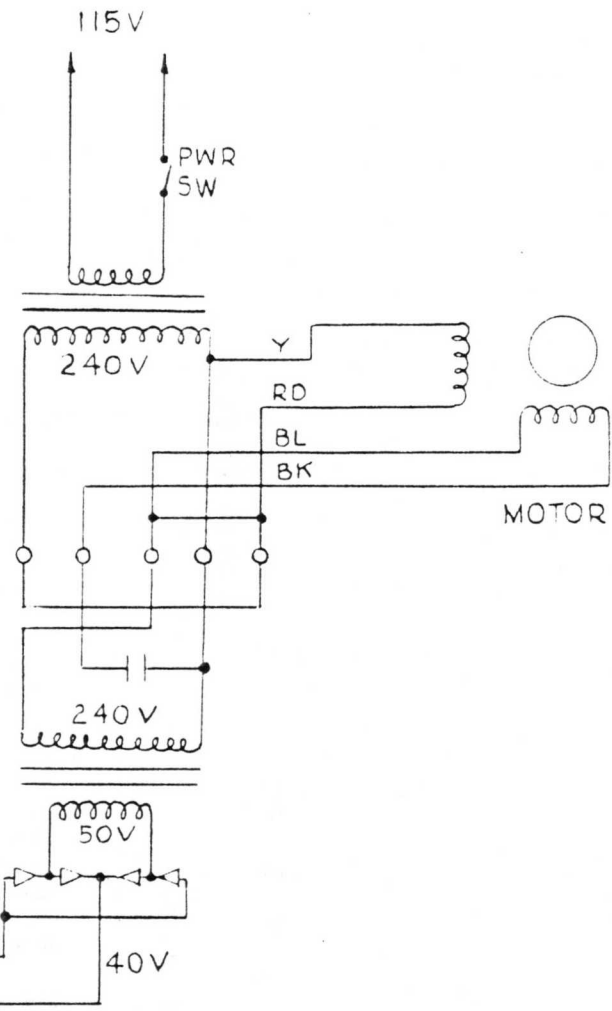
KEYBOARD

NAVAL COMMUNICATIONS ANNEX WASHINGTON D.C.	
R5W MAZE CIRCUIT	
Dr by: E HIGGINS	Chkd:
Tr by:	App. by:
DATE:	SCALE:
SECTION: G-4-D-1	DWG NO. 1

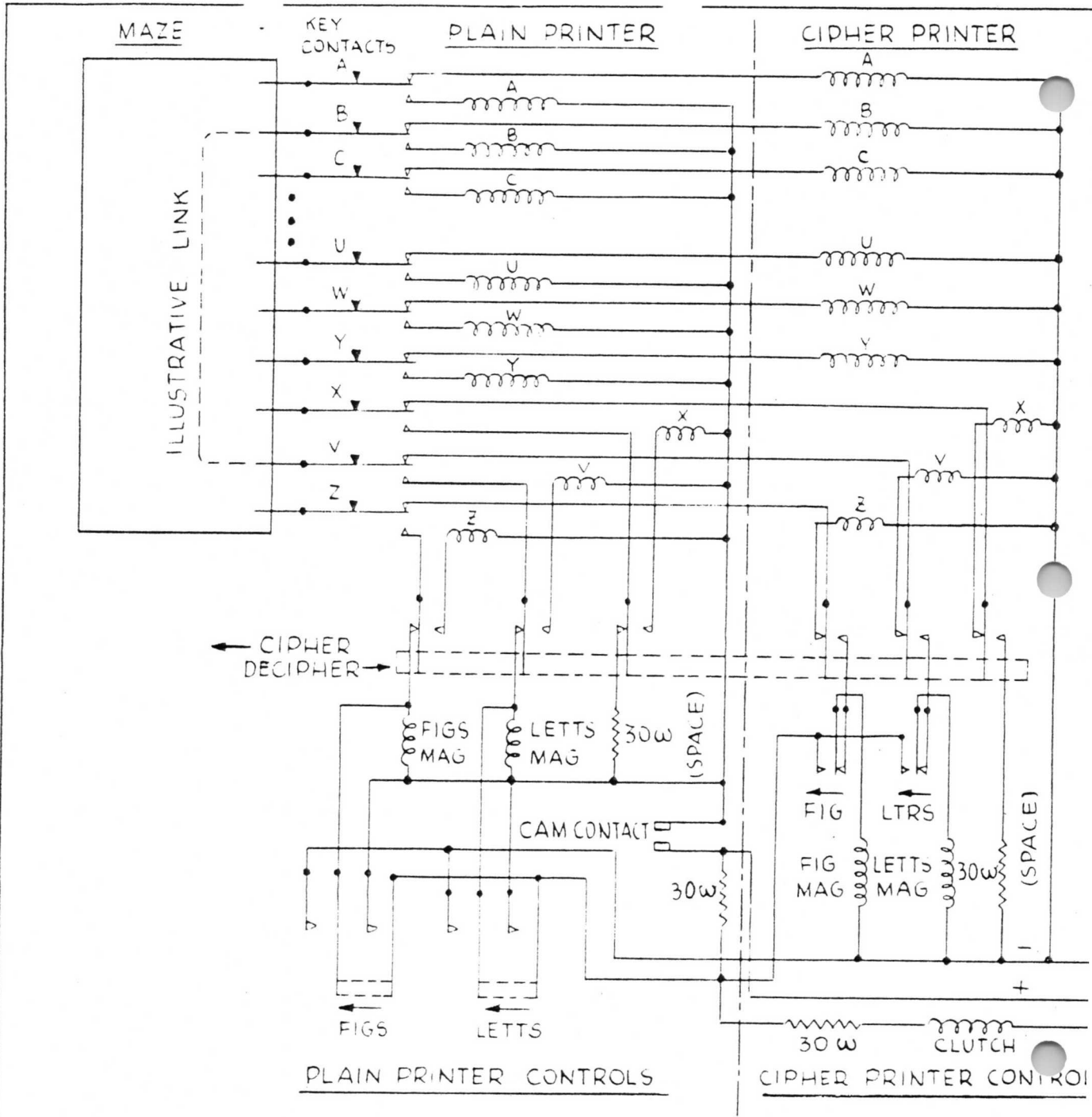
OTHER PRINTER



POWER AND DRIVE UNITS



NAVAL COMMUNICATIONS ANNEX WASHINGTON, D.C.	
R5W PRINTING CIRCUIT	
Dr by: E HIGGINS	Chkd by:
Tr by:	App by:
DATE:	SCALE
SECTION G-4-D-1	DWG NO 2

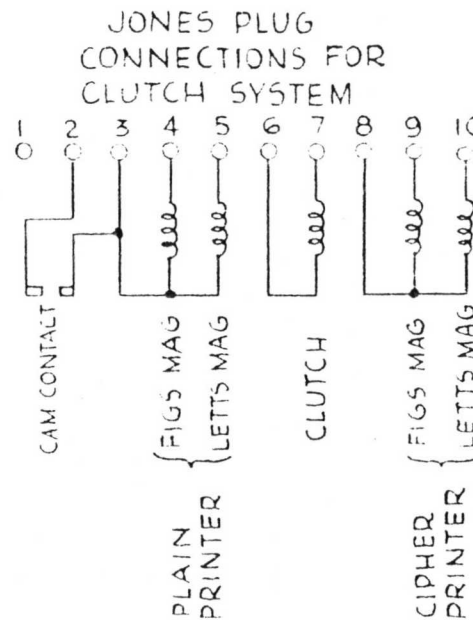


SECRET

TABLE OF JONES PLUG CONNECTIONS FOR PRINTER			
A - 16	H - 11	O - 18	V - 4
B - 3	I - 19	P - 17	W - 25
C - 5	J - 10	Q - 26	X - 6
D - 14	K - 9	R - 23	Y - 21
E - 24	L - 8	S - 15	Z - 7
F - 13	M - 1	T - 22	
G - 12	N - 2	U - 20	

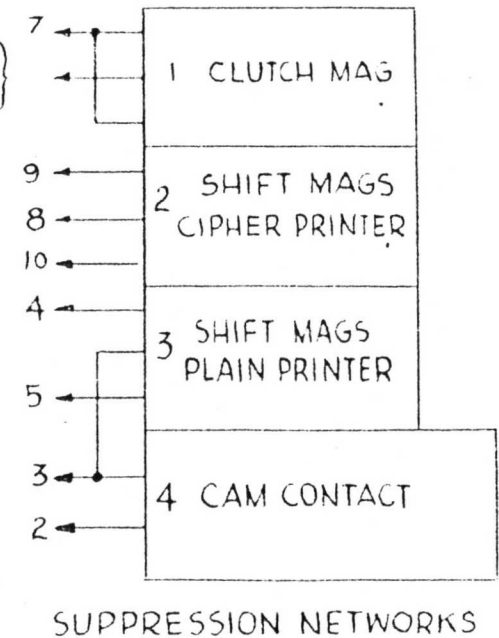
TABLE OF JONES PLUG CONNECTIONS FOR REFLECTOR			
A - 1	H - 8	O - 15	V - 22
B - 2	I - 9	P - 16	W - 23
C - 3	J - 10	Q - 17	X - 24
D - 4	K - 11	R - 18	Y - 25
E - 5	L - 12	S - 19	Z - 26
F - 6	M - 13	T - 20	
G - 7	N - 14	U - 21	

SECRET



BTWN TWO  
30W RES.  
IN + LINE

NUMBERS INDICATE  
CONNECTIONS TO CLUTCH  
SYSTEM JONES PLUG



ALL "JONES" PLUG CONNECTIONS  
READ FROM LEFT TO RIGHT  
FROM FRONT VIEW OF SOCKET.

NAVAL COMMUNICATIONS ANNEX  
WASHINGTON, D.C

R5W  
JONES CONNECTORS AND  
SUPPRESSION NETWORKS

Drawn by: E.H.  
App by:

SECTION G-4-D-1

DWG NO. 3



TOP SECRET

SP. 02391 (H)

SP. 02391 (Code)

A	B	C	D	E	F	G		1	2	3	4	5	6	7	
A	V	J	P	Z	N	N	Y	A	V	J	P	Z	N	N	Y
B	G	S	C	Y	C	L	V	B	G	S	C	Y	C	L	V
C	U	E	T	D	S	G	K	C	U	E	T	D	S	G	K
D	M	N	L	J	Y	V	O	D	M	N	L	J	Y	V	O
E	F	U	Q	R	X	F	Z	E	F	U	Q	R	X	F	Z
F	D	Y	E	A	J	S	U	F	D	Y	E	A	J	S	U
G	R	F	I	H	X	O	B	R	F	I	H	X	O	B	R
H	W	L	A	W	J	S	X	W	L	A	W	J	S	X	W
I	O	P	D	M	E	O	M	O	P	D	M	E	O	M	O
J	L	Q	O	V	W	J	C	L	Q	O	V	W	J	C	L
K	H	E	X	E	D	C	Q	H	E	X	E	D	C	Q	H
L	P	I	H	I	M	B	M	P	I	H	I	M	B	M	P
M	Z	G	V	L	T	K	L	Z	G	V	L	T	K	L	Z
N	P	A	H	T	G	R	Z	P	A	H	T	G	R	Z	P
O	I	R	W	S	K	D	R	I	R	W	S	K	D	R	I
P	E	Q	M	Q	A	H	R	E	Q	M	Q	A	H	R	E
Q	A	C	V	K	U	W	Q	A	C	V	K	U	W	Q	A
R	Z	T	F	X	O	Y	T	Z	T	F	X	O	Y	T	Z
S	X	X	N	B	R	I	J	X	X	N	B	R	I	J	X
T	C	O	W	L	Z	E	N	C	O	W	L	Z	E	N	C
U	J	H	S	T	P	I	A	J	H	S	T	P	I	A	J
V	Q	M	Y	B	F	A	E	Q	M	Y	B	F	A	E	Q
W	N	K	K	P	V	X	S	N	K	K	P	V	X	S	N
X	B	D	R	G	P	A	H	B	D	R	G	P	A	H	B
Y	S	W	J	C	H	X	P	S	W	J	C	H	X	P	S
Z	S	W	M	O	H	X	P	S	W	M	O	H	X	P	S

TOP SECRET

2 April 1945

MEMORANDUM

The following information was obtained from various sources:

- SP-02384 -- Set of wheels, permanent type. No reversible inserts. (7 wheels to set)
- SP-02390 -- Set of wheels, permanent type. No reversible inserts. (7 wheels to set)
- SP-02390 (H) -- Set of wheels with reversible inserts. Inserts are wired same as SP-02390 when installed in normal manner. (7 wheels to set)
- SP-02391 -- Set of wheels, permanent type. No reversible inserts. (7 wheels to set)
- SP-02391 (H) -- Set of wheels with reversible inserts. Inserts are wired same as SP-02391 when installed in normal manner. (7 wheels to set)

The following sets of 7 inserts -- A - G -- have been on this station:

Y-103, 104, 105, 106, 107, 108, 109, 110  
Y-269, 270, 331  
SY-23

The following sets of <sup>7</sup> inserts -- H - N -- have been on this station:

Y-104, --- 106, 107, 108, 109, 110  
Y-269, 270, 331  
SY-23

**TOP SECRET**

OBVERSE WIRING SPECIFICATIONS  
FOR R5W ENIGMA.  
(OBVERSE FACE OF WHEELS IS RIGHT FACE)

Y-269

RIGHT FACE  
ALL WHEELS

LEFT FACE OF WHEELS

A	B	C	D	E	F	G	H	I	J	K	L	M	N
U	Y	H	Q	Y	E	K	H	B	K	W	I	H	L
W	G	W	Y	I	X	B	Q	U	C	J	G	D	C
I	B	A	B	L	A	O	X	M	H	A	S	R	M
R	A	O	U	O	Y	I	C	P	G	V	O	Z	S
L	O	W	T	H	B	Z	N	Z	D	E	Y	V	B
Z	B	M	K	A	T	M	B	V	V	C	L	L	E
P	O	T	Y	O	B	T	I	Y	U	I	D	B	I
E	M	J	J	A	H	X	R	K	M	Q	J	T	O
B	T	R	O	O	V	R	H	J	O	N	A	I	E
J	J	H	N	C	U	C	D	X	B	K	M	O	W
O	R	P	J	T	S	G	C	G	M	Z	V	C	C
D	F	E	F	L	H	P	P	T	L	G	H	K	N
K	N	N	I	Z	P	X	O	A	R	D	R	S	S
V	F	F	S	V	D	D	R	F	F	B	C	Y	F
A	C	C	W	A	J	A	O	W	W	S	X	F	X
X	X	X	F	U	S	U	Y	T	N	P	F	X	M
G	Z	L	Q	M	Z	V	G	K	Q	X	P	Z	T
N	S	S	Z	E	R	L	Z	L	I	M	T	Q	N
Q	V	S	R	E	J	Q	S	E	A	F	H	B	W
			K		R	E	W	W	E	R	K	J	A

**TOP SECRET**

TOP SECRET

SP. 02390

SP. 02390 (H)

A -- G assumed to be the same as SP. 02390

	1	2	3	4	5	6	7
A	R	O	T	L	K	G	L
B	F	L	W	Y	G	M	L
C	N	T	B	U	B	R	S
D	V	G	H	M	T	U	Y
E	B	E	Q	X	Y	Y	E
F	K	N	D	S	S	B	I
G	T	Z	U	F	O	J	T
H	I	U	R	B	A	Z	R
I	H	J	M	P	I	H	J
J	X	D	L	Z	V	F	A
K	Q	I	N	O	X	K	P
L	G	B	I	N	C	T	F
M	C	Y	E	K	J	D	K
N	W	P	A	J	P	W	W
O	A	S	K	C	R	Q	C
P	E	A	S	E	Q	C	O
Q	O	F	V	Q	Z	S	S
R	L	W	O	I	N	H	X
S	S	R	Y	A	L	F	A
T	M	Q	C	T	F	W	I
U	P	M	J	G	W	E	E
V	Y	C	G	W	U	P	N
W	D	X	X	R	E	N	V
X	Z	K	F	H	M	V	L
Y	U	H	P	D	D	L	D
Z	J	V	Z	V	D	L	D

TOP SECRET