NO. 2125574
SHEET 0
OF 27

DIAGNOSTIC TEST

TITLE 1620 INDIRECT ADDRESSING DIAGNOSTIC TEST - CU03
MACH.TYPE 1620 BY J.H.M. APPR. GIA DATE 4-11-62

ENGINEERING CHANGE HISTORY

E/C NO.	DATE	SHEETS AFFECTED
404568	12-15-60	1-27
404618	5-15-61	1, 1A, 4, 5A, 10, 14, 16, 20, 27
404675	4-11-62	2, 3, 4, 5A, 8, 13, 14, 16, 23, 26, 27

E/C NO.	404568	404618	404675				
DATE	12-15-60	5-15-61	4-11-62				

INDIRECT ADDRESSING

A. SCOPE:

This test is essentially a fault detection test designed to check the indirect addressing circuits. Both the P and Q fields are used as indirect addresses and specify data fields in both even and odd memory positions. Chaining of indirect addresses in both the P and Q fields is checked for two addresses.

All immediate operation codes, write alphabetic, branch, branch indicate, and branch no indicate codes are checked to determine that a flag in the low order position of the Q field will not indicate an indirect address.

The control code is checked to determine that the P field is not indirect addressable, and both the P and Q fields for branch back, NOP, and halt are checked for being non-indirect addressable.

B. SET UP:

Data Switches should normally be set to STOP. This will cause the program to stop at the end of the cycle on which a parity error occurs.

The four console switches should be set as desired. The normal setting is, all switches OFF. These switches have the following functions in this test:

SWITCH #1	ON -	Bypass error type out
	OFF -	Type out routine number on error
SWITCH #2	ON -	Loop in routine
	OFF -	Continue to next routine
SWITCH #3	ON -	Stop on error
	OFF -	Do not stop on error; continue
SWITCH #4	ON -	Repeat test CU03

NORMAL LOAD FROM PAPER TAPE READER:

To run the entire test, load the tape in the reader, put in REEL mode, and READY the reader. Reset the 1620. Insert, key in the instructions:
360009600300
4900828. (MAR should read 00018) Release and start, then follow instructions typed out.

NORMAL LOAD FROM CARD I/O:

Place card deck in the reader. Reset 1620. Depress load key located on the card reader. The first card is read into the buffer and its data automatically transferred into the first 80 positions of core storage. Following the transfer of data into the 80 low order positions of core storage, the computer will simulate a release and program start at location 00000.

TO PRODUCE A NEW PAPER TAPE:

To regenerate, or produce another tape for input, read the Master tape into the last part of memory and then dump memory to the paper tape punch. The instructions required to load and dump memory to produce another paper tape are:

```
36 14444 00300
35 14444 00200
48
```

C. TEST METHOD:

The test is composed of sub-routines, each of which is designed to check some aspect of the Indirect Addressing feature.

A failure of a sub-routine to perform the indirect addressing properly will initiate an error routine. There are three different formats for the error routines; typeouts, halts, and "hang-ups" in indirect addressing cycles.

The normal run of this test performs each routine 100 times before testing sense switch #4. If sense switch #4 is off, the test completed routine is executed and the halt operation code is tested to determine that the P and Q fields are not indirect addressable.

The first sub-routine executed types the setting of the sense switches, the name of the test, and instructions to follow.

Routines 002-005 check for P field indirect addressing on the immediate operation codes add and subtract. If the indirect address defines the field of the augend or minuend, a certain answer is obtained. The result of the arithmetic operation is compared against the predetermined answer and equal comparison indicates that the indirect address operation was correct. If the augend or minuend is not defined by the indirect address, a different answer results. If the first comparison is unequal, the results of the arithmetic operation is compared against the predetermined error result. (The result if indirect addressing is not executed). If this comparison is equal, an error routine is executed and the routine number typed out. If the comparison is unequal, the program halts. Displaying IR-1 will indicate the routine number in which the program halts.

Routines 006-008 check for the chaining of two indirect addresses in the Q field of a multiply operation. The product is compared against a predetermined answer. An equal comparison indicates that the chaining of indirect addresses functioned properly. If this comparison is unequal, another comparison is made against a predetermined answer that would result in the first indirect address was not recognized. An equal comparison on this second compare initiates the execution of an error routine that types the routine number;

while an unequal comparison on the second compare causes the program to halt.

Routines 009 and 010 check for the chaining of two indirect addresses in the P field of a transmit field operation. The transmitted field is compared against predetermined results. An equal comparison indicates that the chaining operation was performed correctly, and the program branches to the next routine. An unequal comparison on the first compare initiates a second compare against a result that would occur if the first indirect address was ignored. An equal comparison branches to an error routine that types out the routine number; while an unequal comparison halts the program.

Routines 011-016 check that a flag bit on the low orde position of the Q field of the immediate operations add, subtract, multiply, compare, transmit digit, and transmit field does not define an indirect address. The routine numbers will type out as an error indication if the Q field is recognized as an indirect address.

Routine 017 checks that the Q field of the write alphabetic operation will not recognize an indirect address. A T should be typed for each routine pass. If the Q field is recognized as an indirect address, the program will "hang-up".

Routine 018 checks that the Q field of a transmit record can be an indirect address. A comparison is made to determine if the indirect address was used or ignored. An equal comparison advances the program to the next routine. An unequal comparison advances the program to the error routine that types out the routine number and the record transmitted.

Routines 019 and 519 check that the Q field of the branch and transmit immediate operation and both the P and Q field of the branch back operation will not recognize an indirect address. The routine number is typed out if the incorrect field is transmitted on the branch and transmit immediate operation. If the P and Q fields of the branch back instruction recognize indirect addresses, the program will "hang-up" in indirect addressing cycles on the branch back instruction.

Routines 020-022 check that the Q field of a branch indicate, branch no indicate, and branch operation will not recognize an indirect address. If the Q fields of these operations recognize an indirect address, the addresses are such that the program will "hang-up" in indirect address cycles on the "op code" being checked.

Routine 023 checks that on NOP the P and Q fields will not recognize indirect addresses. The indirect address in the P field is the Q field address, and the indirect address in the Q field is the P field address. If an indirect address is recognized, a loop will be set up and the program will "hang-up" in indirect address cycles.

Routine 024 checks that the P field of a control operation does not recognize an indirect address. A'hang-up" in indirect address cycles will result if an indirect address is recognized.

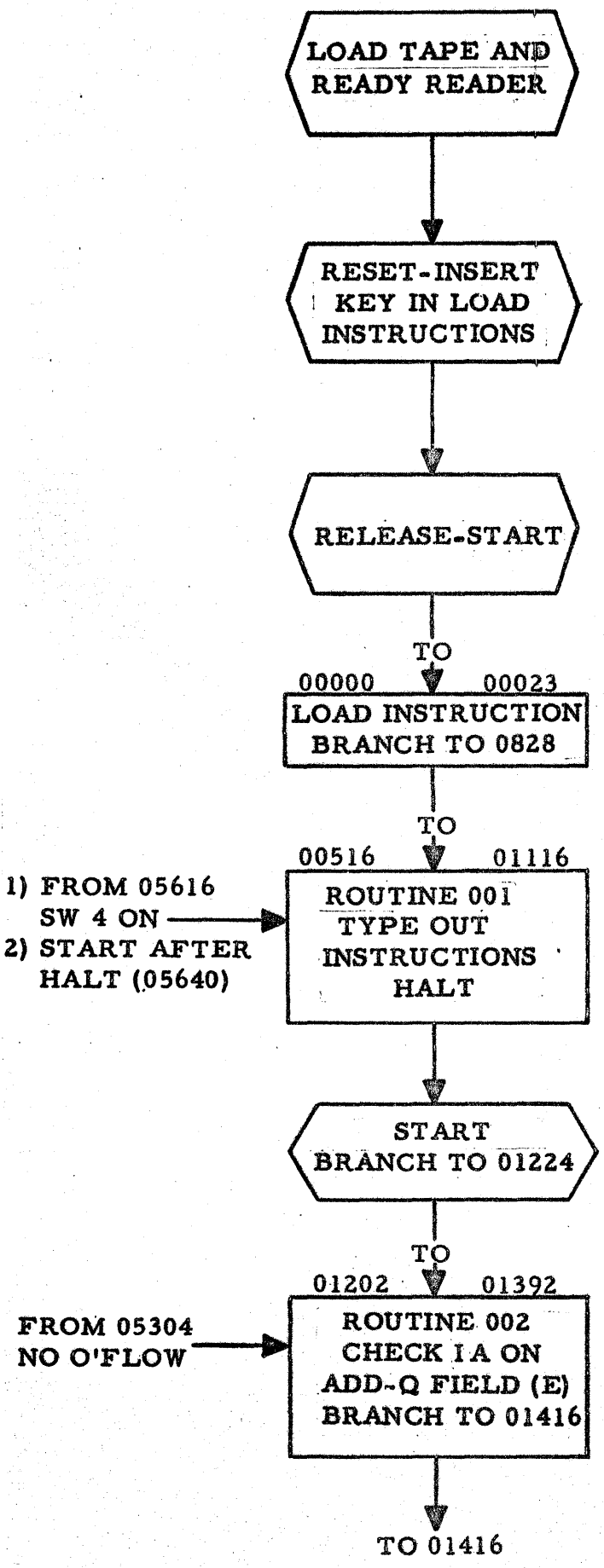
Routine 025 is the times 100 routine, and routine 026 is the test completed routine and also checks that on a halt operation neither the P nor the Q fields will recognize an indirect address.

The complete normal typeout information will be as follows:

```
SW 1 OFF SW 2 OFF SW 3 OFF SW 4 OFF SET SWS FOR INDIRECT
ADDRESSING TEST. THEN START.
START ROUTINES. ETOS FOLLOW.
T T T T T T T T T T T T T T T T T T T T T T T T
T T T T T T T T T T T T T T T T T T T T T T T T
T T T T T T T T T T T T T T T T T T T T T T T T
T T T T T T T T T T T T T T
TEST ROUTINES COMPLETED. IF SW1 OFF, NO ROUTINE NOS TYPED
 OUT, AND NO HANG-UPS, MACHINE PERFORMED TESTS PROPERLY.
```

INDIRECT ADDRESSING

FLOW CHART

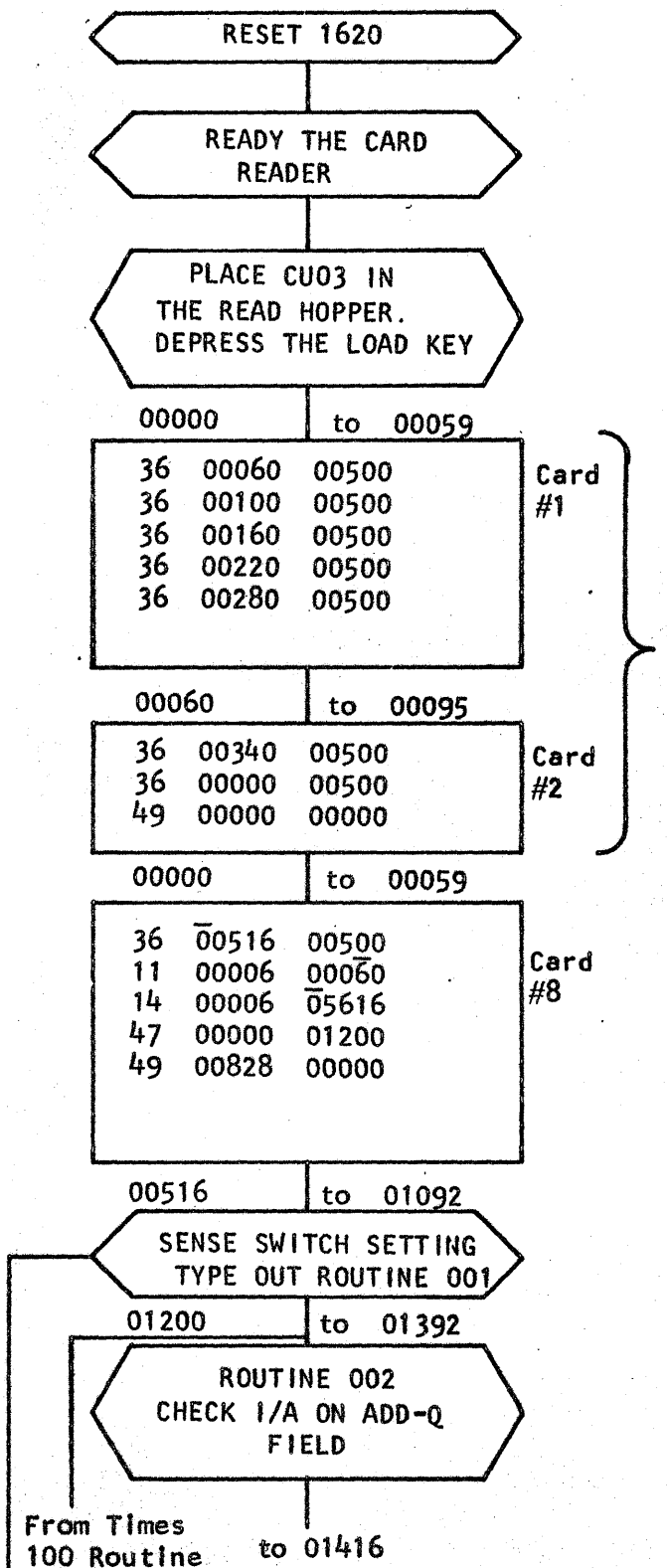


LOAD INSTRUCTIONS ARE
36 0009600300
4900828

IF THE ADD IS 077 THE I/A WAS
077 CORRECT.
154

IF THE ADD IS 077 THE I/A WAS NOT
210 INITIATED
287

PN 2125574
EC 404568



First and second Load Cards load the math tables and Program Load Card. (Cards 3 through 7 contain the math tables.)

Eighth Load Card contains instructions for loading core storage.

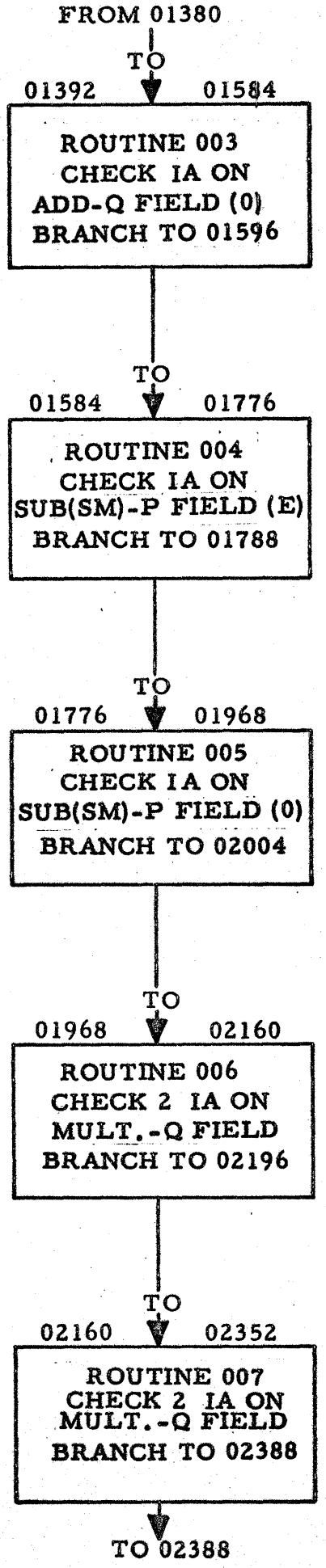
This routine will indicate if BI and/or BNI are working. The 1620 will halt with 01091 in MAR

If Add IS $\left\{\begin{array}{r}\bar{0}77\\ \bar{0}77\\ \hline 154\end{array}\right\}$ the I/A was correct

If Add Is $\left\{\begin{array}{r}\bar{0}77\\ \bar{2}10\\ \hline 287\end{array}\right\}$ the I/A was not initiated

PN 2125574
EC 404675

1) SW 4 On (05616)
2) Start After Halt (05640)



IF THE ADD IS $\bar{0}99$ THE I/A
$\bar{0}99$ WAS CORRECT
$\bar{1}98$

IF THE ADD IS $\bar{4}03$ THE I/A WAS
$\bar{0}99$ NOT INITIATED
$\bar{5}02$

IF THE SUBT. IS $\bar{0}99$ THE I/A WAS
$-\bar{0}66$ CORRECT
$\bar{0}33$

IF THE SUBT. IS $\bar{5}92$ THE I/A WAS
$-\bar{0}66$ NOT INITIATED
$\bar{5}26$

IF THE SUBT. IS $\bar{0}99$ THE I/A WAS
$-\bar{0}77$ CORRECT
$\bar{0}22$

IF THE SUBT. IS $\bar{7}83$ THE I/A WAS
$-\bar{0}77$ NOT INITIATED
$\bar{7}06$

IF THE MULTIPLY IS $\bar{6}66$ THE I/A WAS
$x\bar{9}9$ CORRECT
$\bar{6}5934$

IF THE MULTIPLY IS $\bar{6}66$ THE FIRST I/A
$x\bar{7}\bar{2}$ WAS NOT
$\bar{4}7952$ INITIATED

IF PRODUCT IS $\bar{5}0616$, 2ND I/A WAS NOT INITIATED

IF THE MULTIPLY IS $\bar{8}88$ THE I/A WAS
$x\bar{6}7$ CORRECT
$\bar{6}8376$

IF PRODUCT IS $\bar{5}7720$, THE I/A WAS NOT INITIATED

IF PRODUCT IS $\bar{5}9496$, THE 2ND I/A WAS NOT INITIATED

FROM 02340

02352 02544

ROUTINE 008
CHECK 2 IA ON
MULT-Q FIELD
BRANCH TO 02580

IF MULTIPLY IS $\bar{4}44 \times \bar{3}3 = \bar{1}4652$ THE IA WAS CORRECT

IF THE PRODUCT IS $\bar{2}5308$, THE I/A WAS NOT INITIATED. IF THE PRODUCT IS $\bar{2}6640$, THE 2ND I/A WAS NOT INITIATED.

TO

02544 02772

ROUTINE 009
CHECK 2 IA ON
TF - P FIELD
BRANCH TO 02808

IF FIELD 02562-02566 IS $\bar{7}0248$, I/A WAS CORRECT. IF FIELD 02556-02560 IS $\bar{7}0248$, FIRST I/A WAS NOT INITIATED. IF FIELD 02544-02548 IS $\bar{7}0248$, 2ND I/A WAS NOT INITIATED.

TO

02772 03000

ROUTINE 010
CHECK 2 IA ON
TF - P FIELD
BRANCH TO 03036

IF FIELD 02791-02795 IS $\bar{8}2047$, I/A WAS CORRECT. IF FIELD 02785-02789 IS $\bar{8}2047$, I/A WAS NOT INITIATED. IF FIELD 02773-02777 IS $\bar{8}2047$, 2ND I/A WAS NOT INITIATED.

TO

03000 03216

ROUTINE 011
CHECK FOR NO IA
ON AM-Q FIELD
BRANCH TO 03240

I/A SHOULD BE INHIBITED. IF SUM IS $\bar{5}877$, NO I/A. IF SUM IS $\bar{9}110$, I/A WAS NOT INHIBITED.

TO

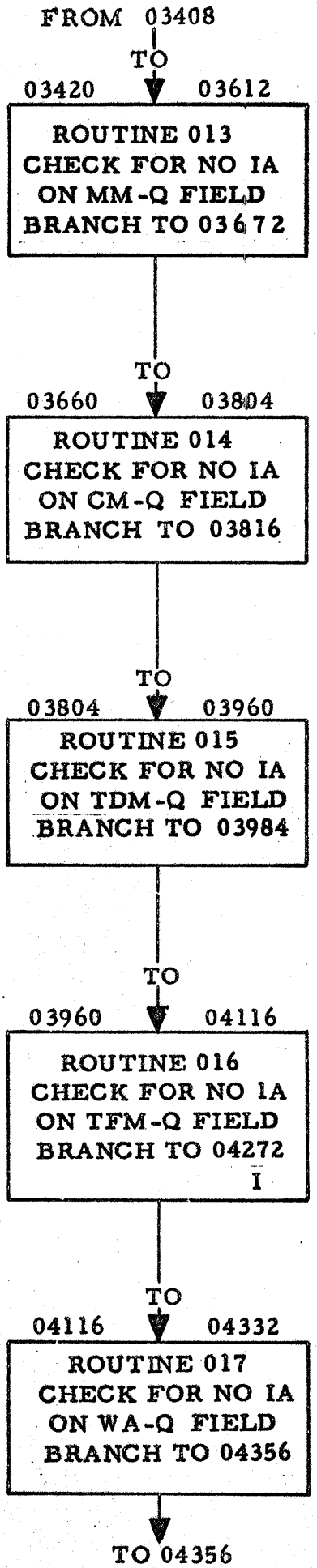
03216 03420

ROUTINE 012
CHECK FOR NO IA
ON SM-Q FIELD
BRANCH TO 03444

I/A SHOULD BE INHIBITED. IF REMAINDER IS $\bar{8}004$, NO I/A. IF REMAINDER IS $\bar{7}333$, I/A WAS NOT INHIBITED.

TO 03444

PN 2125574
EC 404568



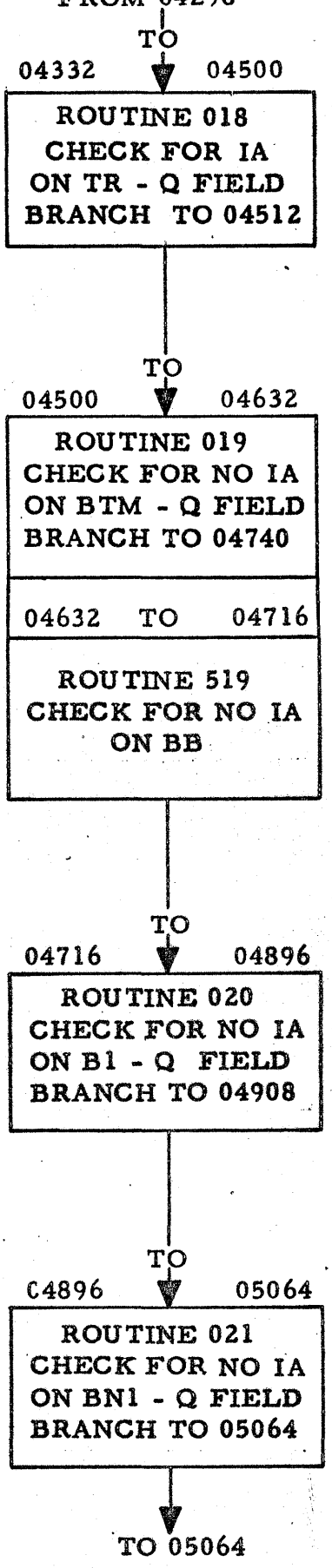
IF PRODUCT IS $\bar{3}441$, I/A WAS INHIBITED. IF PRODUCT IS $\bar{2}442$, I/A WAS NOT INHIBITED.

IF E/Z AFTER COMPARE, I/A WAS INHIBITED. IF ERROR TYPE OUT, COMPARE UNEQUAL.

IF TRANSMITTED DIGIT IS $\bar{5}$, NO I/A. IF TRANSMITTED DIGIT IS 9, I/A WAS NOT INHIBITED.

IF TRANSMITTED FIELD IS $\bar{0}397\bar{1}$, NO I/A. IF TRANSMITTED FIELD IS $\bar{1}287$, I/A WAS NOT INHIBITED.

A "T" SHOULD BE TYPED FOR EACH ROUTINE PASS. A "HANG-UP" INDICATES I/A IS NOT BEING INHIBITED.



IF TRANSMITTED RECORD IS $\bar{9}68$, I/A WAS EXECUTED. IF TRANSMITTED RECORD IS $\bar{1}28$, NO I/A.

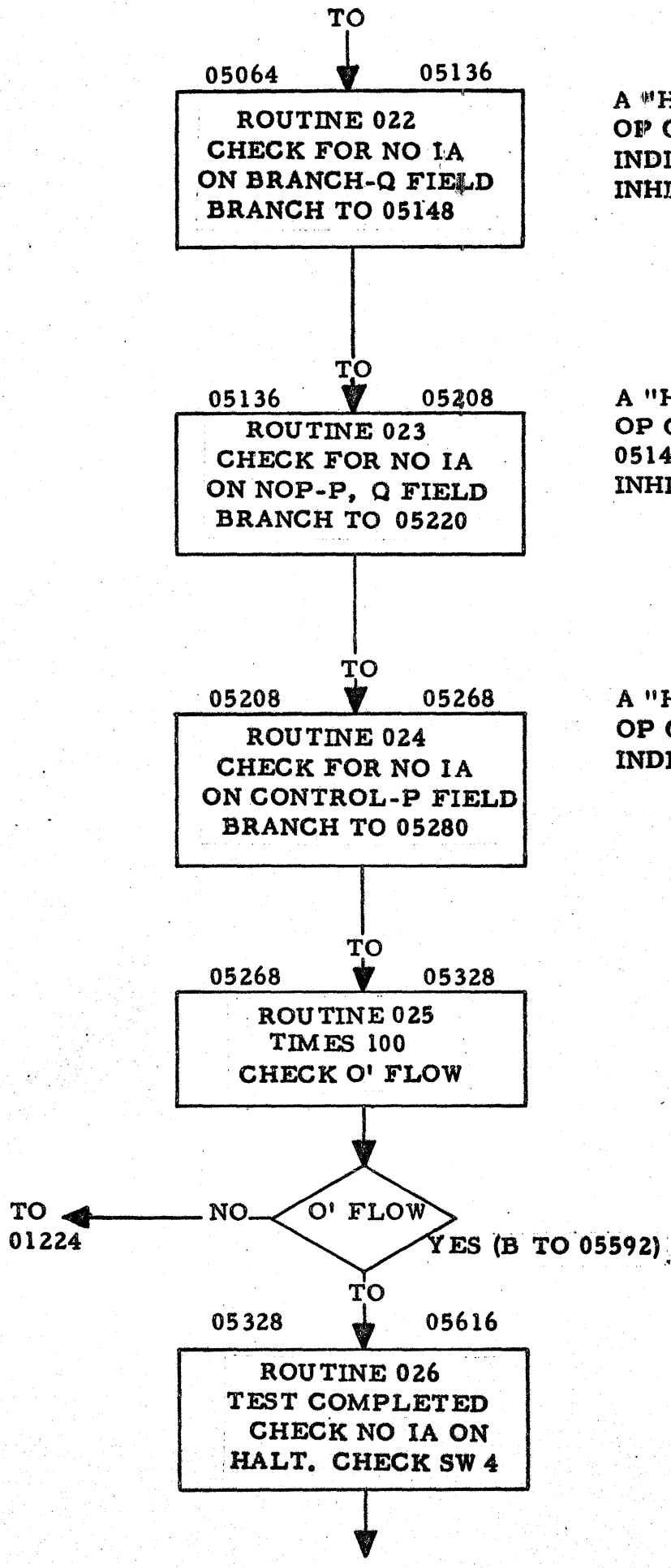
IF TRANSMITTED FIELD IS $\bar{0}451\bar{1}$, NO I/A. IF TRANSMITTED FIELD IS $\bar{9}8765$, I/A WAS EXECUTED.

A "HANG-UP" IN I TIME WITH A 42 OP CODE AT INSTRUCTION 04680 INDICATES I A IS NOT BEING INHIBITED.

A "HANG-UP" IN I TIME WITH A 46 OP CODE AT INSTRUCTION 04764 INDICATES IA IS NOT BEING INHIBITED.

A "HANG-UP" IN I TIME WITH A 47 OP CODE AT INSTRUCTION 04932 INDICATES I A IS NOT BEING INHIBITED.

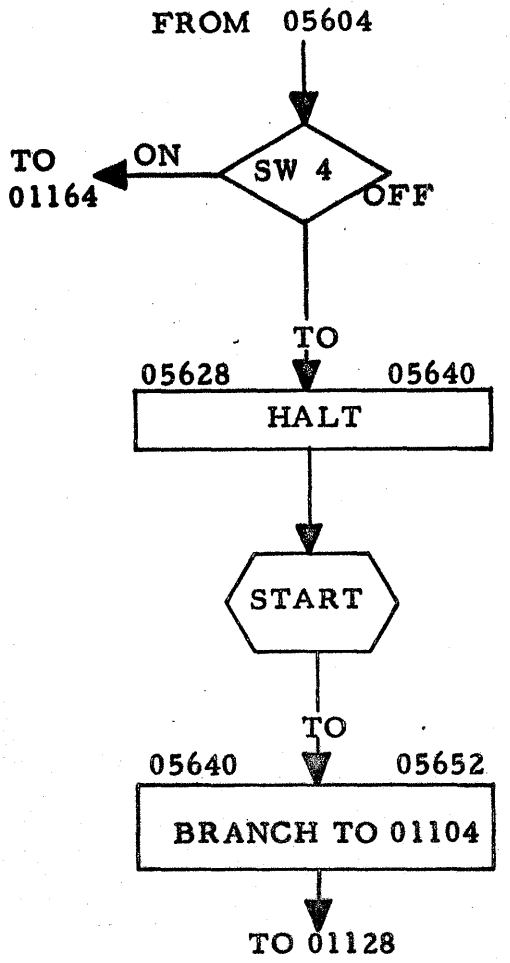
PN 2125574
EC 404568



A "HANG-UP" IN I TIME WITH A 47 OP CODE AT INSTRUCTION 05076 INDICATES IA IS NOT BEING INHIBITED.

A "HANG-UP" IN I TIME WITH A 41 OP CODE AT INSTRUCTION ON 05148 INDICATES IA IS NOT BEING INHIBITED.

A "HANG-UP" IN I TIME WITH A 34 OP CODE AT INSTRUCTION 05232 INDICATES IA IS NOT BEING INHIBITED.



A "HANG-UP" INDICATES 1A IS NOT BEING INHIBITED.

TO PRODUCE A NEW TAPE:

1. LOAD MASTER TAPE INTO MEMORY STARTING 14444
2. DUMP NUMERIC TO PAPER TAPE PUNCH.
3. WHEN PROGRAM HALTS, NEW TAPE HAS BEEN GENERATED.

```
RESET
INSERT
KEY IN  3 6 1 4 4 4 4 0 0 3 0 0
        3 5 1 4 4 4 4 0 0 2 0 0
        4 8
RELEASE
START
```

PN 2125574
EC 404568

1620 DIAGNOSTICS

CU03 INDIRECT ADDRESSING TEST

DESCRIPTION

MEM LOC	00 01	PPPPP 23456	QQQQQ 78901	TYP
096		000	00000	MT
108	00	00102	03040	MT
120	00	20406	08000	MT
132	30	60902	10040	MT
144	80	21610	05001	MT
156	51	02006	02181	MT
168	42	00704	11282	MT
180	00	80614	22300	MT
192	90	81726	30000	MT
204	00	00005	06070	MT
216	80	90012	14161	MT
228	81	51811	24272	MT
240	02	42822	36352	MT
252	03	53045	40363	MT
264	24	84455	32494	MT
276	65	36048	46546	MT
288	27	54453	62718	MT
300	01	23456	78912	AT
312	34	56789	$\bar{0}2345$	AT
324	67	$89\bar{0}\bar{1}3$	45678	AT
336	$9\bar{0}$	$\bar{1}\bar{2}456$	$789\bar{0}\bar{1}$	AT
348	$\bar{2}\bar{3}$	56789	$\bar{0}\bar{1}\bar{2}\bar{3}\bar{4}$	AT
360	67	$89\bar{0}\bar{1}\bar{2}$	$\bar{3}\bar{4}\bar{5}78$	AT
372	$9\bar{0}$	$\bar{1}\bar{2}\bar{3}\bar{4}\bar{5}$	$\bar{6}89\bar{0}\bar{1}$	AT
384	$\bar{2}\bar{3}$	$\bar{4}\bar{5}\bar{6}79$	$\bar{0}\bar{1}\bar{2}\bar{3}\bar{4}$	AT
396	$\bar{5}\bar{6}$	$\bar{7}\bar{8}$ ≠		AT
408				X
420				X
432				X
444				X
456				X
468				X
480				X
492				X
504				X

ROUTINE 001

TYPE OUT SENSE SWITCH SETTING AND NAME OF TEST

516	62	66 7	1 56	X	SW 1 0
528	55	0≠6	266	X	N≠ SW
540	71	564	646	X	1 OFF
552	0≠	6266	72	X	≠SW 2
564	56	55 0	≠6266	X	ON ≠SW
576		72 5	64646	X	2 OFF
588		0≠626	6 73	X	≠SW 3
600		5655	0≠62	X	ON ≠S
612	66	73	5646	X	W 3 OF
624	46	0≠6	266	X	F ≠SW
636	74	565	5 0≠	X	4 ON ≠
648	62	66 7	4 56	X	SW 4 0
660	46	46 0	≠6245	X	FF ≠SE
672	63	626	662	X	T SWS
684	46	5659	4955	X	FOR IN
696	44	49594	54363	X	DIRECT
708		41444	45945	X	ADDRE
720	62	62495	547	X	SSING
732	63	45626	303	X	TEST.
744	63	48455	5 62	X	THEN S
756	63	41596	303	X	TART
768	0≠	62634	15963		≠START
780	00	59566	46349		ROUTI
792	55	45620	30045		NES. E
804	63	56620	04656		TOS FO
816	53	53566	6030≠		LLOW.≠

828	46	00852	00100	BI	CHECK FOR SW1 ON
840	47	00876	00100	BNI	CHECK FOR SW1 OFF
852	39	00517	00100	WA	SW 1 ON
864	49	00888		B	

876	39	00535	00100	WA	SW 1 OFF
888	46	00912	00200	BI	CHECK FOR SW 2 ON
900	47	00936	00200	BNI	CHECK FOR SW 2 OFF
912	39	00555	00100	WA	SW 2 ON
924	49	00948		B	
936	39	00573	00100	WA	SW 2 OFF
948	46	00972	00300	BI	CHECK FOR SW 3 ON
960	47	00996	00300	BNI	CHECK FOR SW 3 OFF
972	39	00593	00100	WA	SW 3 ON
984	49	01008		B	
996	39	00611	00100	WA	SW 3 OFF
1008	46	01032	00400	BI	CHECK FOR 4 ON
1020	47	01056	00400	BNI	CHECK FOR SW 4 OFF
1032	39	00631	00100	WA	SW 4 ON
1044	49	01068		B	
1056	39	00649	00100	WA	SW 4 OFF
1068	39	00669	00100	WA	SET SWS FOR 1A THEN START
1080	48			H	
1092	34		00102	K	CARRIAGE RETURN
1104	39	00771	00100	WA	ETOS FOLLOW
1116	34		00102	K	
1140	49	01224		B	
1152				X	
1164				X	
1176				X	
1188				X	

ROUTINE 002

CHECK FOR I/A Q. FIELD, EVEN POSITION, ON ADD OPERATION

1200	01	$\bar{2}10$	$\bar{0}77$	X	CONSTANTS AND WORKING AREA
1212				X	WORKING AREA
1224	26	01207	01210	TF	SET AUGEND
1236	21	01207	$01\bar{2}0\bar{4}$	A	ADD WITH INDIRECT ADDRESS
1248	14	01207	$\bar{1}54$	C	CHECK FOR CORRECT ANSWER
1260	46	01368	01200	BI	CHECK E/Z FOR E/Z
1272	14	01207	$\bar{2}87$	C	CHECK FOR ERROR ANSWER
1284	46	01320	01200	BI	CHECK FOR E/Z FOR E/Z
1296	48	00002		H	
1308	49	01368		X	

ERROR ROUTINE

1320	46	01344	00100	BI	
1332	39	01357	00100	WA	
1344	47	01368	00300	BNI	
1356	48	70707	2 0≠	H	
1368	46	01224	00200	BI	
1380	49	01416		B	

ROUTINE 003

CHECK FOR I/A Q FIELD, ODD POSITION,
ON ADD OPERATION

1392	0	1403	099	X	CONSTANTS AND WORKING AREA
1404				X	WORKING AREA
1416	26	01400	01403	TF	SET AUGEND
1428	21	01400	01397	A	ADD WITH INDIRECT ADDRESS
1440	14	01400	198	CM	CHECK FOR CORRECT ANSWER
1452	46	01560	01200	BI	CHECK E/Z FOR E/Z
1464	14	01400	502	CM	CHECK FOR ERROR ANSWER
1476	46	01512	01200	BI	CHECK E/Z FOR E/Z
1488	48	00003		H	
1500	49	01560	00100	BI	

ERROR ROUTINE

1512	46	01536	00100	BI	
1524	39	01549	00100	WA	
1536	47	01560	00300	BNI	
1548	48	70707	3 0≠	H	
1560	46	01416	00200	BI	
1572	49	01596		B	

ROUTINE 004

CHECK FOR I/A P FIELD, EVEN POSITION
ON SUBTRACT OPERATION

1584	01	592	099	X	CONSTANTS AND WORKING AREA
1596	26	01592	01595	TF	SET MINUEND
1608	12	01588	066	SM	SUBTRACT WITH INDIRECT ADDRESS
1620	14	01592	033	CM	CHECK FOR CORRECT ANSWER
1632	46	01752	01200	BI	CHECK E/Z FOR E/Z
1644	14	01588	00526	CM	CHECK FOR ERROR ANSWER
1656	46	01692	01200	BI	CHECK E/Z FOR E/Z
1668	48	00004		H	
1680	49	01692		B	

ERROR ROUTINE

1692	16	01588	$\bar{5}92$	TFM	RESTORE CONSTANTS
1704	46	01728	00100	BI	
1716	39	01741	00100	WA	
1728	47	01752	00300	BNI	
1740	48	70707	4 0≠	H	
1752	46	01596	00200	BI	
1764	49	01788	0	B	

ROUTINE 005

CHECK FOR I/A P FIELD, ODD POSITION
ON SUBTRACT OPERATION

1776	$1\bar{7}$	83 $\bar{0}$	$\bar{0}99$	X	CONSTANTS AND WORKING AREA
1788	26	01783	01786	TF	SET MINUEND
1800	12	$01\bar{7}\bar{7}\bar{9}$	$\bar{0}77$	SM	SUBTRACT WITH INDIRECT ADDRESS
1812	14	01783	$\bar{0}22$	CM	CHECK FOR CORRECT ANSWER
1824	46	01944	01200	BI	CHECK E/Z FOR E/Z
1836	14	01779	$\bar{7}06$	CM	CHECK FOR ERROR ANSWER
1848	46	01884	01200	BI	CHECK E/Z FOR E/Z
1860	48	00005		H	
1872	49	01884		B	

ERROR ROUTINE

1884	16	01779	$\bar{7}83$	TFM	RESTORE CONSTANTS
1896	46	01920	00100	BI	
1908	39	01933	00100	WA	
1920	47	01944	00300	BNI	
1932	48	70707	5 0≠	H	
1944	46	01788	00200	BI	
1956	49	02004		B	

ROUTINE 006

CHECK FOR TWO I/A'S, Q FIELD, TWO EVEN
POSITION, ON A MULTIPLY OPERATION

1968	01	$9\bar{7}6$	$\bar{9}9\bar{6}66$	X	CONSTANTS
1980	01	$9\bar{7}\bar{2}$		X	CONSTANTS
1992				X	WORKING AREA
2004	23	01979	$0198\bar{4}$	M	MULTIPLY WITH 2 INDIRECT ADDRESSES

2016	14	00099	$\bar{6}5934$	CM	CHECK FOR CORRECT ANSWER
2028	46	02136	01200	BI	CHECK E/Z FOR E/Z
2040	14	00099	$\bar{4}795\bar{2}$	CM	CHECK FOR ERROR ANSWER
2052	46	02088	01200	BI	CHECK E/Z FOR E/Z
2064	48	00006		H	
2076	49	02136		B	

ERROR ROUTINE

2088	46	02112	00100	BI
2100	39	02125	00100	WA
2112	47	02136	00300	BNI
2124	48	70707	6 0≠	H
2136	46	02004	00200	BI
2148	49	02196		B

ROUTINE 007

CHECK FOR TWO I/A'S, Q FIELD, TWO ODD POSITION, ON A MULTIPLY OPERATION

2160	0	$21\bar{6}7\bar{7}$	7 $\bar{8}88$	X	CONSTANTS
2172	0	$21\bar{6}\bar{5}$		X	CONSTANTS
2184				X	WORKING AREA
2196	23	02171	$0217\bar{7}$	M	MULTIPLY WITH 2 INDIRECT ADDRESSES
2208	14	00099	$\bar{6}8376$	CM	CHECK FOR CORRECT ANSWER
2220	46	02328	01200	BI	CHECK E/Z FOR E/Z
2232	14	00099	$\bar{5}772\bar{0}$	CM	CHECK FOR ERROR ANSWER
2244	46	02280	01200	BI	CHECK E/Z FOR E/Z
2256	48	00007		H	
2268	49	02328		B	

ERROR ROUTINE

2280	46	02304	00100	BI
2292	39	02317	00100	WA
2304	47	02328	00300	BNI
2316	48	70707	7 0≠	H
2328	46	02196	00200	BI
2340	49	02388		B

ROUTINE 008

CHECK FOR TWO I/A'S, Q FIELD, ODD-EVEN POSITION, ON A MULTIPLY OPERATION

2352	0	23$\bar{6}$0	$\bar{3}3\bar{4}44$	X	CONSTANTS
2364	02	3$\bar{5}\bar{7}$		X	CONSTANTS
2376				X	WORKING AREA
2388	23	02363	0236$\bar{8}$	M	MULTIPLY WITH 2 INDIRECT ADDRESSES
2400	14	00099	$\bar{1}$4652	CM	CHECK FOR CORRECT ANSWER
2412	46	02520	01200	BI	CHECK E/Z FOR E/Z
2424	14	00099	$\bar{2}$530$\bar{8}$	CM	CHECK FOR ERROR ANSWER
2436	46	02472	01200	BI	CHECK E/Z FOR E/Z
2448	48	00008		H	
2460	49	02520		B	

ERROR ROUTINE

2472	46	02496	00100	BI
2484	39	02509	00100	WA
2496	47	02520	00300	BNI
2508	48	70707	8 0≠	H
2520	46	02388	00200	BI
2532	49	02580		B

ROUTINE 009

CHECK FOR TWO I/A'S, P FIELD, EVEN POSITION ON A TRANSMIT FIELD OPERATION

2544	02	566≠	$\bar{7}$0248	X	CONSTANTS
2556	$\bar{0}$2	54$\bar{8}$≠$\bar{0}$		X	CONSTANTS
2568				X	WORKING AREA
2580	26	0256$\bar{0}$	02555	TF	TRANSMIT FIELD WITH 2 INDIRECT ADDRESSES
2592	14	02566	$\bar{7}$0248	CM	CHECK FOR CORRECT ANSWER
2604	47	02652	01200	BNI	CHECK E/Z FOR E/Z
2616	16	02566	$\bar{0}$0000	TFM	RESTORE WORKING AREA TO ZERO
2628	16	02560	$\bar{0}$254$\bar{8}$	TFM	RESTORE WORKING AREA
2640	49	02748		B	

ERROR ROUTINE

2652	46	02700	00100	BI
2664	39	02713	00100	WA
2676	38	02556	00100	WN
2688	38	02544	00100	WN
2700	47	02724	00300	BNI

2712	48	70707	9 0≠	H	
2724	16	02560	02548	TFM	
2736	16	02548	02566	TFM	
2748	46	02580	00200	BI	
2760	49	02808		B	

ROUTINE 010

CHECK FOR TWO I/A'S, P FIELD ODD POSITION,
ON A TRANSMIT FIELD OPERATION

2772	0	2795≠	82047	X	CONSTANTS
2784	0	2777≠	0	X	CONSTANTS
2796				X	WORKING AREA
2808	26	02789	02783	TF	TRANSMIT FIELD WITH 2 INDIRECT ADDRESSES
2820	14	02795	82047	CM	CHECK FOR CORRECT ANSWER
2832	47	02880	01200	BNI	CHECK E/Z FOR E/Z
2844	16	02795	00000	TFM	RESTORE WORKING AREA TO ZERO
2856	49	02976		B	
2868				X	

ERROR ROUTINE

2880	46	02928	00100	BI	
2892	39	02941	00100	WA	
2904	38	02785	00100	WN	
2916	38	02773	00100	WN	
2928	47	02952	00300	BNI	
2940	48	70717	0 0≠	H	
2952	16	02789	02777	TFM	
2964	16	02777	02795	TFM	
2976	46	02808	00200	BI	
2988	49	03036		B	

ROUTINE 011

CHECK FOR NO I/A ON ADD IMMEDIATE,
Q FIELD

3000	88	88≠	03011	X	CONSTANTS
3012			0222	X	CONSTANTS
3024				X	WORKING AREA
3036	16	03003	8888	TFM	SET AUGEND
3048	11	03003	03011	AM	CHECK FOR NO I/A ON ADD IMMEDIATE
3060	14	03003	5877	CM	CHECK FOR CORRECT ANSWER
3072	46	03192	01200	BI	CHECK E/Z FOR E/Z

3084	14	03003	9110	CM	CHECK FOR ERROR ANSWER
3096	46	03144	01200	BI	CHECK E/Z FOR E/Z
3108	38	03000	00100	WN	TYPE ANSWER
3120	48	00011		H	HALT
3132	41			NOP	

ERROR ROUTINE

3144	46	03168	00100	BI	
3156	39	03181	00100	WA	
3168	47	03192	00300	BNI	
3180	48	70717	1 0≠	H	
3192	46	03036	00200	BI	
3204	49	03240		B	

ROUTINE 012

CHECK FOR NO I/A ON SUBTRACT IMMEDIATE, Q FIELD

3216		$\bar{4}44$	03222	X	CONSTANTS
3228				X	WORKING AREA
3240	16	03219	$\bar{7}777$	TFM	SET MINUEND
3252	12	03219	$03\bar{2}2\bar{7}$	SM	CHECK FOR NO I/A SUBTRACT IMMEDIATE
3264	14	03219	$\bar{8}004$	CM	CHECK FOR CORRECT ANSWER
3276	46	03396	01200	BI	CHECK E/Z FOR E/Z
3288	14	03219	$\bar{7}333$	CM	CHECK FOR ERROR ANSWER
3300	46	03348	01200	BI	CHECK E/Z FOR E/Z
3312	38	03216	00100	WN	TYPE ANSWER
3324	48	00012		H	HALT
3336	41			NOP	

ERROR ROUTINE

3348	46	03372	00100	BI	
3360	39	03385	00100	WA	
3372	47	03396	00300	BNI	
3384	48	70717	2 0≠	H	
3396	46	03240	00200	BI	
3408	49	03444		B	

ROUTINE 013

CHECK FOR NO I/A ON MULTIPLY IMMEDIATE, Q FIELD

3420	$\bar{1}1$	$\bar{1}2\bar{2}$	03424	X	CONSTANTS
3432				X	WORKING AREA

3444	13	03422	0343̄1̄	MM	MULTIPLY IMMEDIATE
3456	14	00099	3̄441	CM	CHECK FOR CORRECT ANSWER
3468	46	03588	01200	BI	CHECK E/Z FOR E/Z
3480	14	00099	2̄442	CM	CHECK FOR ERROR ANSWER
3492	46	03540	01200	BI	CHECK E/Z FOR E/Z
3504	48	00013		H	HALT
3516	49	03540		B	
3528				X	

ERROR ROUTINE

3540	46	03564	00100	BI
3552	39	03577	00100	WA
3564	47	03588	00300	BNI
3576	48	70717	3 0≠	H
3588	46	03444	00200	BI
3600	49	03672		B
3612				X
3624				X
3636				X
3648				X

ROUTINE 014

CHECK NO I/A ON COMPATE IMMEDIATE, Q FIELD

3660	0̄3	671̄	5̄5555	X	CONSTANTS AND WORKING AREA
3672	14	03664	0̄3671̄	CM	CHECK FOR NO I/A ON COMP IMMED Q FIELD
3684	47	03732	01200	BNI	CHECK E/Z FOR E/Z
3696	49	03780		B	
3708				X	
3720				X	

ERROR ROUTINE

3732	46	03756	00100	BI
3744	39	03769	00100	WA
3756	47	03780	00300	BNI
3768	48	70717	4 0≠	H
3780	46	03672	00200	BI
3792	49	03816		B

ROUTINE 015

CHECK FOR NO I/A ON TRANSMIT DIGIT IMMEDIATE, Q FIELD

3804	65	9 6	03806	X	WORKING AREA
3816	15	03809	03815	TDM	CHECK FOR NO IA ON TDM Q
3828	24	03809	03805	C	CHECK CORRECT DIGIT TRANSFERRED
3840	47	03888	01200	BNI	CHECK E/Z FOR E/Z
3852	15	03809	0	TDM	RESTORE WORKING AREA
3864	49	03936		B	
3876				X	

ERROR ROUTINE

3888	46	03912	00100	BI
3900	39	03925	00100	WA
3912	47	03936	00300	BNI
3924	48	70717	5 0≠	H
3936	46	03816	00200	BI
3948	49	03984		B

ROUTINE 016

CHECK FOR NO I/A ON TRANSMIT FIELD IMMEDIATE, Q FIELD

3960			1287	X	WORKING AREA
3972			03971	X	CONSTANTS
3984	16	03966	03971	TFM	CHECK FOR NO IA ON TFM Q FIELD
3996	24	03966	03983	C	CHECK CORRECT DATA TRANSFERRED
4008	47	04044	01200	BNI	CHECK E/Z FOR E/Z
4020	16	03966	00000	TFM	RESTORE WORKING AREA
4032	49	04092		X	

ERROR ROUTINE

4044	46	04068	00100	BI
4056	39	04081	00100	WA
4068	47	04092	00300	BNI
4080	48	70717	6 0≠	H
4092	46	03984	00200	BI
4104	49	04272		B

ROUTINE 017

CHECK FOR NO I/A ON WRITE ALPHABETIC, Q FIELD

4116	63	0≠		X	T
4128				X	
4140				X	
4152				X	
4164				X	
4176				X	
4188				X	
4200				X	
4212				X	
4224				X	
4236				X	
4248				X	
4260				X	
4272	16	10100	04295	TFM	SET DATA IN IA FIELD
4284	39	04117	10100	WA	CHECK FOR NO IA IN Q ON WA
4296	49	04356		B	
4308				X	
4320				X	

ROUTINE 018

CHECK FOR I/A ON TRANSMIT RECORD, Q FIELD

4332			04351	X	CONSTANTS AND WORKING AREA
4344	28	≠	968≠	X	CONSTANTS AND WORKING AREA
4356	31	04332	04343	TR	CHECK FOR IA IN Q FIELD ON TR
4368	14	04334	968	CM	CHECK FOR CORRECT TRANSFER
4380	47	04428	01200	BNI	CHECK E/Z FOR E/Z
4392	49	04476		B	
4404				X	
4416				X	

ERROR ROUTINE

4428	46	04452	00100	BI	
4440	39	04465	00100	WA	
4452	47	04476	00300	BNI	
4464	48	70717	8 0≠	H	
4476	46	04356	00200	BI	
4488	49	04512		B	

ROUTINE 019

CHECK FOR NO I/A ON BRANCH AND TRANSMIT IMMEDIATE, Q FIELD

4500		98765	04506	X	CONSTANTS AND WORKING AREA
4512	17	04644	04511	BTM	CHECK NO IA ON BTM
4524	48	04643	00000	X	OP CODE 48 OR 16 IF HALT 519 NOT PERFORMED
4536	16	04525	48	TFM	SET P CODE 48 IN
4548	49	04608		B	

ERROR ROUTINE

4560	46	04584	00100	BI	
4572	39	04597	00100	WA	
4584	47	04608	00300	BNI	
4596	48	70717	9 0≠	H	
4608	46	04512	00200	BI	
4620	49	04740		B	

ROUTINE 519

THIS IS ROUTINE BRANCHED TO IN 019 CHECKS FOR NO I/A ON BRANCH BACK

4632				X	WORKING AREA
4644	14	04643	04511	CM	CHECK TF OF ROUTINE 019 CORRECT
4656	47	04560	01200	BNI	CHECK E/Z TRIG FOR E/Z
4668	16	04525	16	TFM	SET OP CODE 16 IN 04524
4680	42	04691	04686	BB	IF HANGS UP IN THIS STEP IA ON BB
4692				X	
4704				X	

ROUTINE 020

CHECK FOR NO I/A ON BRANCH INDICATE, Q FIELD

4716			000	X	WORKING AREA
4728				X	WORKING AREA
4740	11	04727	01	AM	SET H/P TRIG H/P
4752	16	11104	04775	TFM	SET UP IA AT 11104
4764	46	04788	11104	BI	CHECK NO IA ON BI Q FIELD
4776	49	04824		B	ENTER ERROR ROUTINE
4788	16	04727	000	TFM	CLEAR ADD FIELD
4800	49	04872		B	
4812				X	

ERROR ROUTINE

4824	46	04848	00100	BI
4836	39	04861	00100	WA
4848	47	04872	00300	BNI
4860	48	70727	0 0≠	H
4872	46	04740	00200	BI
4884	49	04908		B

ROUTINE 021

CHECK FOR NO I/A ON BRANCH NO INDICATE, Q FIELD

4896			00	X	WORKING AREA
4908	11	04907	22	AM	SET H/P TRIG H/P
4920	16	11109	04943	TFM	SET UP IA AT 11109
4932	47	04992	11109	BNI	CHECK NO IA ON BNI
4944	16	04907	000	TFM	CLEAR ADD FIELD
4956	49	05040		B	
4968				X	
4980				X	

ERROR ROUTINE

4992	46	05016	00100	BI	
5004	39	05029	00100	WA	
5016	47	05040	00300	BNI	
5028	48	70727	1 0≠	H	
5040	46	04908	00200	BI	
5052	49	05064		B	

ROUTINE 022

CHECK FOR NO I/A ON BRANCH,
Q FIELD

5064	16	11114	$\bar{0}508\bar{7}$	TFM	SET UP IA AT 11114
5076	49	05112	$1111\bar{4}$	B	CHECK NO IA ON BRANCH
5088				X	
5100				X	
5112	46	05064	00200	BI	
5124	49	05148		B	

ROUTINE 023

CHECK FOR NO I/A ON NO OPOSITION
P AND Q FIELDS

5136				X	
5148	41	0515$\bar{9}$	0515$\bar{4}$	NOP	CHECK FOR NO IA ON NOP
5160	49	05184		B	
5172				X	
5184	46	05148	00200	BI	
5196	49	05220		B	

ROUTINE 024

CHECK FOR NO I/A ON CONTROL,
P FIELD

5208				X	
5220	16	10101	$\bar{0}523\bar{8}$	TFM	SET $\bar{0}523\bar{8}$ AT 10101
5232	34	1010$\bar{1}$	1010$\bar{1}$	K	CHECK NO IA ON CONTROL P FIELD
5244	49	05280		B	
5256				X	

ROUTINE 025

TIMES 100 ROUTINE

```
5268                    0000    X       WORKING AREA
5280    46      05292   01400   BI      TURN OFF OVERFLOW
5292    11      05279     10    AM      ADD ONE
5304    47      01224   01400   BNI     CHECK FOR OVERFLOW
5316    49      05592           B
```

ROUTINE 026

TEST COMPLETED ROUTINE

```
5328                            X
5340                            X
5352    63      45626   3 59    X       TEST R
5364    56      64634   95545   X       OUTINE
5376    62        435   65457   X       S COMP
5388    53      45634   54403   X       LETED
5400            4946     6266   X       IF SW
5412    71        564   64623   X       1 OFF,
5424            5556     5956   X       NO RO
5436    64      63495   545     X       UTINE
5448    55      5662     6368   X       NOS TY
5460    57      4544     5664   X       PED OU
5472    63      23 4    15544   X       T, AND
5484            5556     4841   X       NO HA
5496    55      47206   45762   X       NG-UPS
5508    23        544   14348   X       , MACH

5520    49      5545     5745   X       INE PE
5532    59      46565   95445   X       RFORME
5544    44        634   56263   X       TEST
5556    62        575   95657   X       S PROP
5568    45      59536     803   X       ERLY.
5580    ≠                       X       ≠
5592    34              00102   K       CARRIAGE RETURN
5604    39      05353   00100   WA      TYPE TEST COMPLETED
5616    46      01092   00400   BI
5628    48      05634   05639   H
5640    49      01104       E   B
                            L
```