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Culley

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[54] **ELECTRONIC LEARNING AID**

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[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

[21] Appl. No.: **115,840**

[22] Filed: **Jan. 28, 1980**

Related U.S. Application Data

[63] Continuation of Ser. No. 843,018, Oct. 17, 1977, abandoned.

[51] **Int. Cl.**[3] **G09B 7/02**; G09B 19/02

[52] **U.S. Cl.** **434/201**; 434/202; 434/335

[58] **Field of Search** ..... 434/201, 202, 325, 335; 40/450; 273/85 G; 340/774, 366

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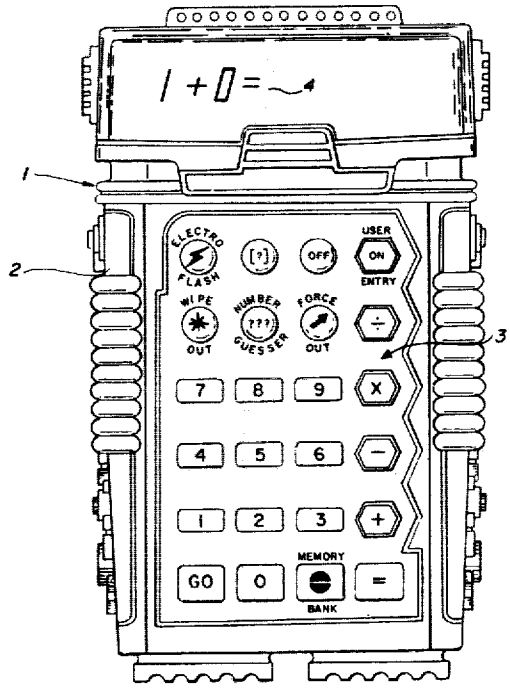
Attorney, Agent, or Firm—William E. Hiller; Melvin Sharp; James T. Comfort

[57] **ABSTRACT**

An electronic learning aid is provided with a display, a keyboard and circuits for posing a set of problems at the display and for comparing the operator's responses entered at the keyboard with correct solutions to the problems. A memory is provided for counting the total number of problems posed and the number of problems answered correctly. A circuit is provided for actuating the segments of the display with one of at least two different display presentations depending on the difference, if any, between the number of problems posed and the number answered correctly. The display presentations are fanciful actuations of the segments of the display of differing complexity of duration. The display presentations give the operator a "reward" for answering the set correctly. Also, particular display presentations may be initiated after each correct answer is entered. Further, a display presentation wherein the segments of the display are randomly actuated (at least in appearance to a casual observer) may be initiated for incorrect answers and/or a set of problems being answered with a low degree of correctness.

21 Claims, 14 Drawing Figures



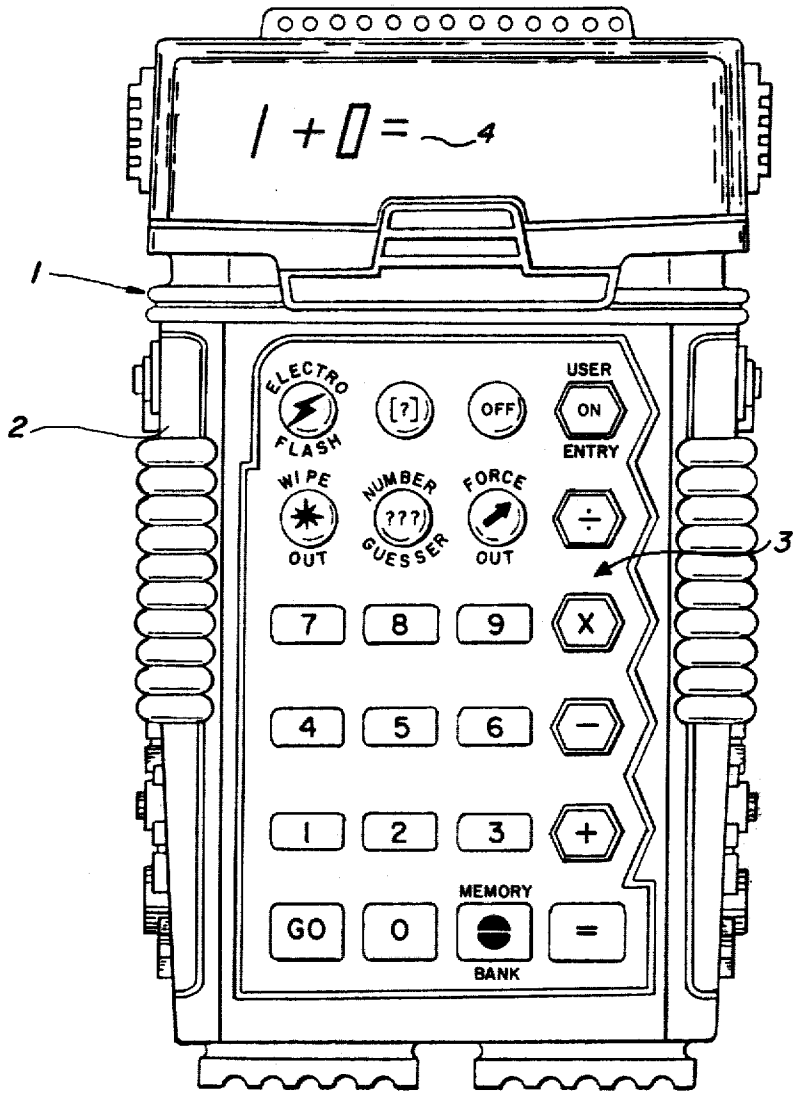

1 + 0 =
4
1
2
3
ELECTRO FLASH
[?]
OFF
USER ON ENTRY
WIPE OUT
NUMBER ??? GUESSER
FORCE OUT
÷
7
8
9
X
4
5
6
−
1
2
3
+
GO
0
MEMORY BANK
=

Fig. 1

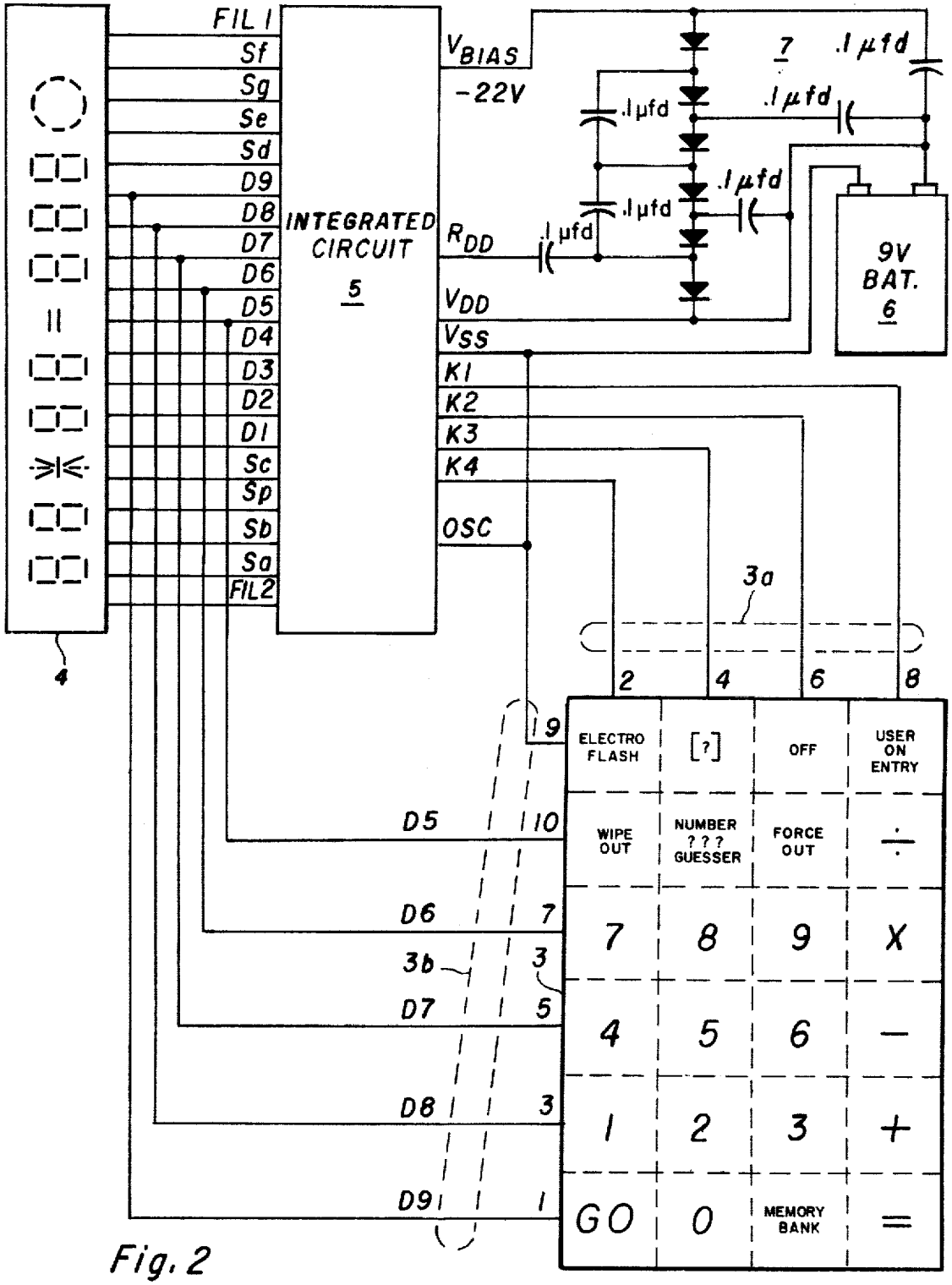

FIL 1
Sf
Sg
Se
Sd
D9
D8
D7
D6
D5
D4
D3
D2
D1
Sc
Sp
Sb
Sa
FIL2
INTEGRATED CIRCUIT
5
4
VBIAS
-22V
RDD
VDD
VSS
K1
K2
K3
K4
OSC
.1µfd
7
9V BAT.
6
3a
2
4
6
8
9
10
7
3
5
3
1
3b
D5
D6
D7
D8
D9
ELECTRO FLASH
[?]
OFF
USER ON ENTRY
WIPE OUT
NUMBER ??? GUESSER
FORCE OUT
÷
7
8
9
X
4
5
6
−
1
2
3
+
GO
0
MEMORY BANK
=

Fig. 2

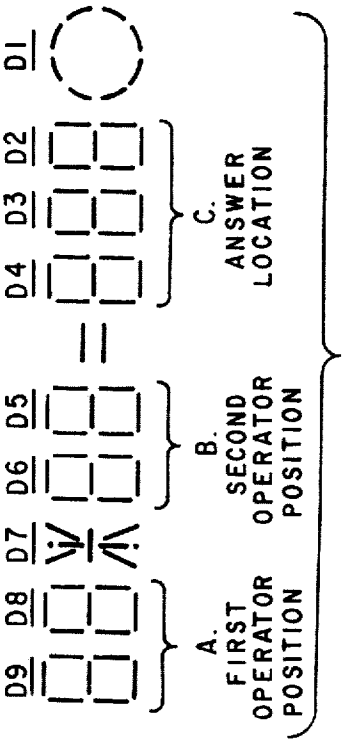


Fig. 3

Fig. 3a

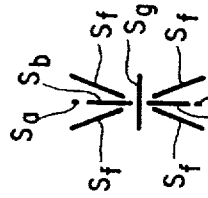


Fig. 3b

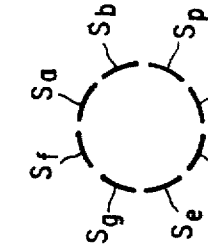


Fig. 3c

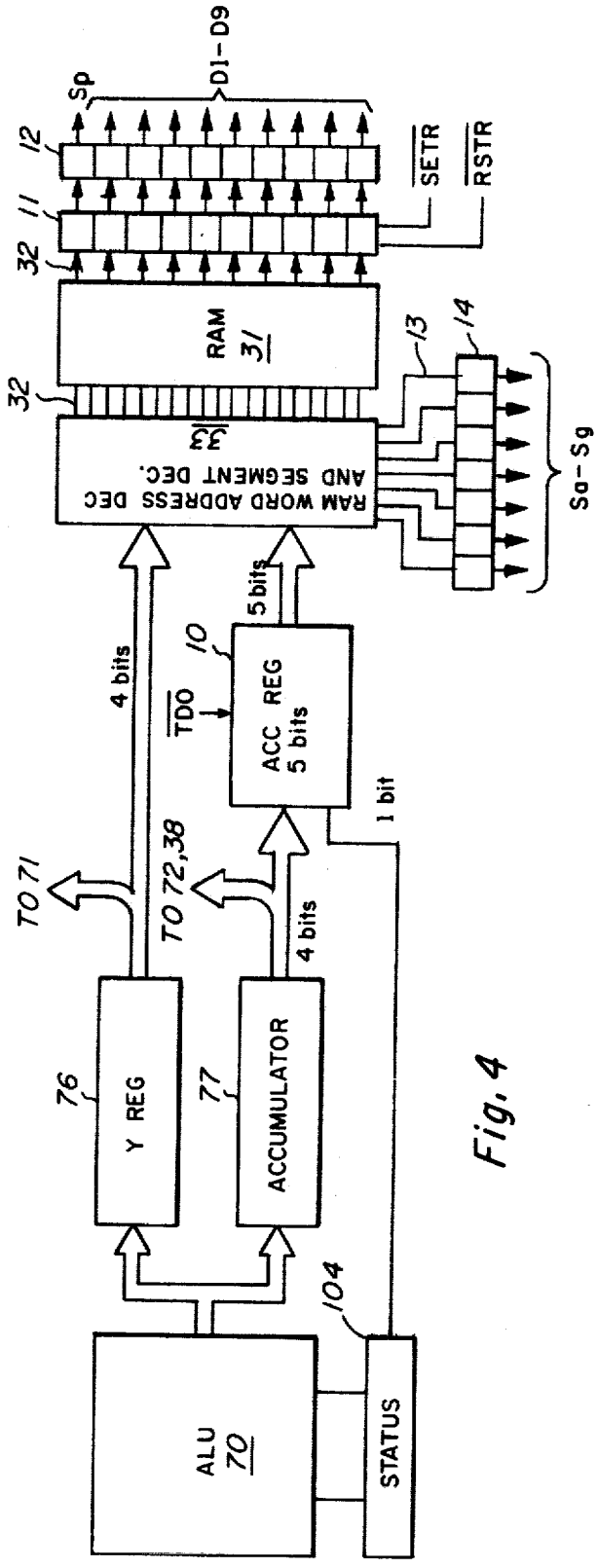


Fig. 4

Fig. 5

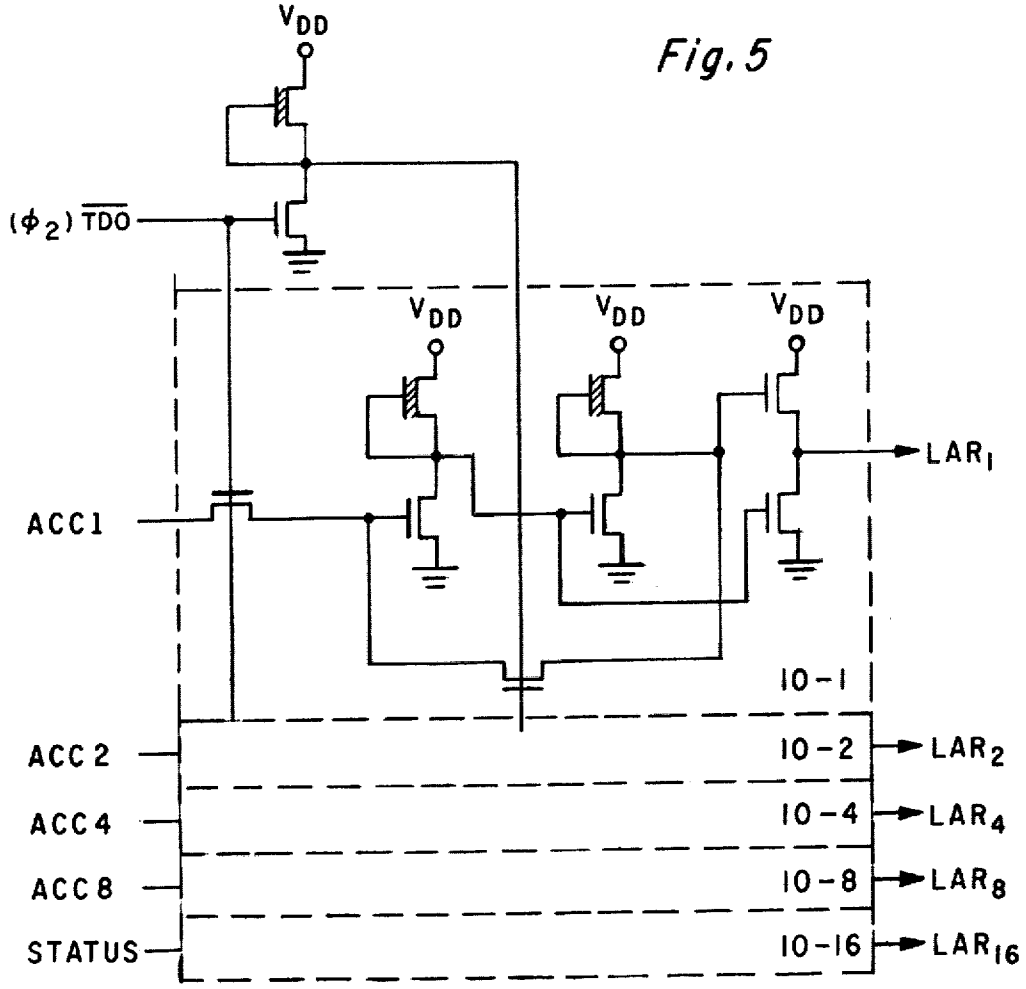
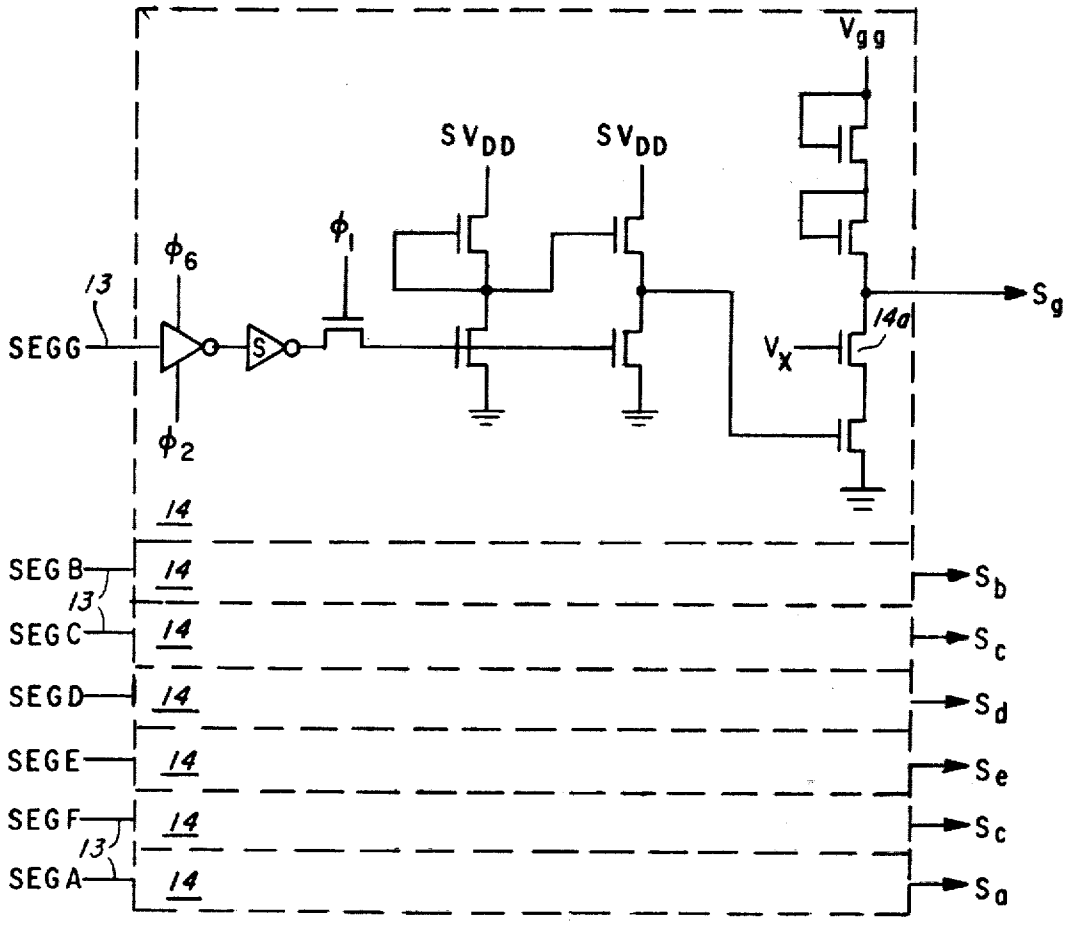

V_{DD}
$(\phi_2)\ \overline{TDO}$
V_{DD}
V_{DD}
V_{DD}
LAR_1
ACC1
10-1
ACC 2
10-2
LAR_2
ACC 4
10-4
LAR_4
ACC 8
10-8
LAR_8
STATUS
10-16
LAR_{16}

Fig. 6


V_{gg}
SV_{DD}
SV_{DD}
ϕ_1
ϕ_6
ϕ_2
13
SEGG
S
V_X
140
S_g
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S_b
S_c
S_d
S_e
S_c
S_a

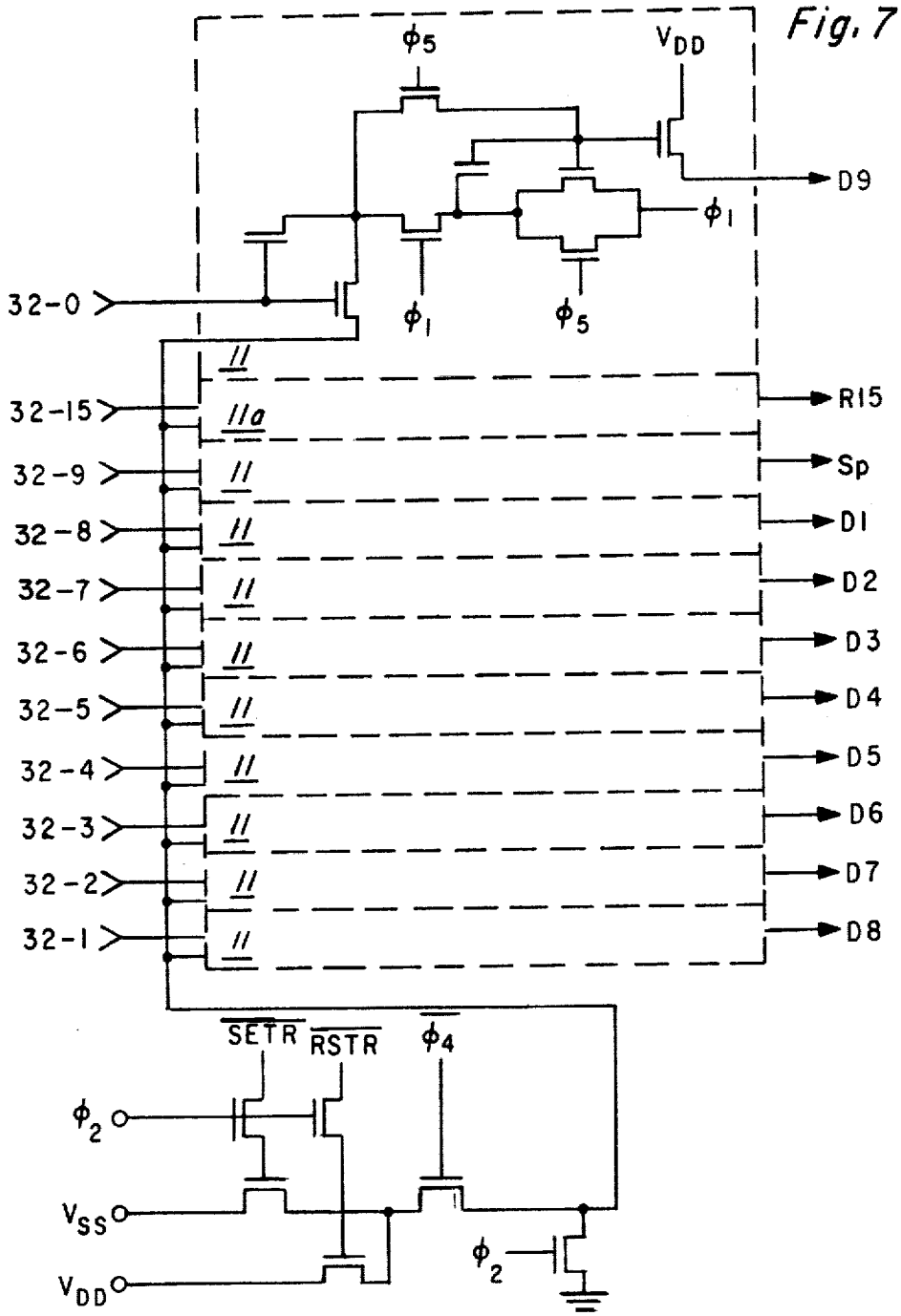
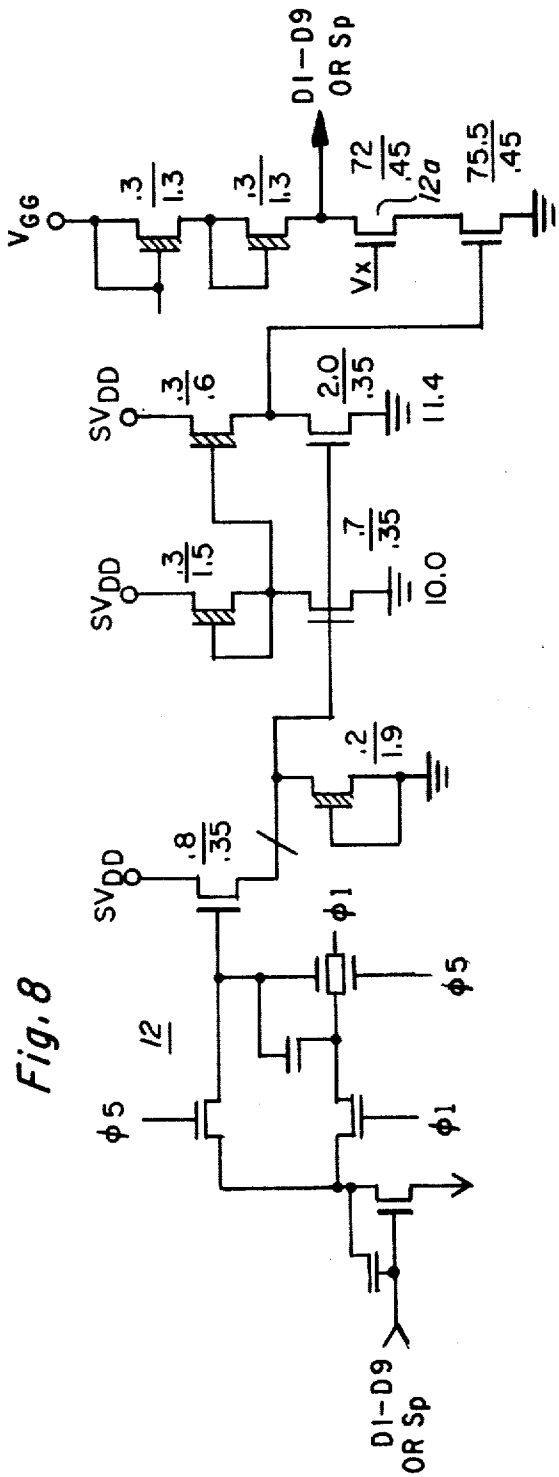
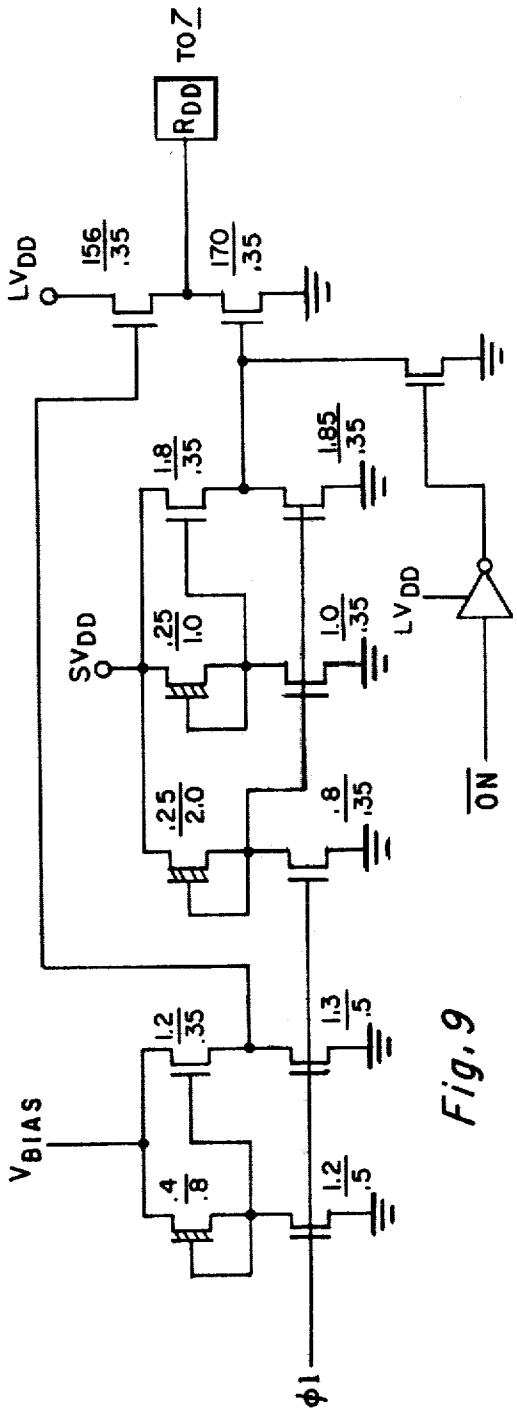

ϕ_5
V_{DD}
D9
ϕ_1
32-0
ϕ_1
ϕ_5
32-15
11a
R15
32-9
Sp
32-8
D1
32-7
D2
32-6
D3
32-5
D4
32-4
D5
32-3
D6
32-2
D7
32-1
D8
SETR
RSTR
ϕ_4
ϕ_2
V_{SS}
V_{DD}
ϕ_2

Fig. 7


D1-D9 OR Sp
V_{GG}
.3/1.3
.3/1.3
72/.45
12a
75.5/.45
Vx
SV_{DD}
.3/.6
2.0/.35
11.4
SV_{DD}
.3/1.5
.7/.35
10.0
.2/1.9
SV_{DD}
.8/.35
φ1
φ5
12
φ5
φ1
D1-D9 OR Sp

Fig, 8


TO Z
R_{DD}
LV_{DD}
156/.35
170/.35
1.8/.35
.85/.35
SV_{DD}
.25/1.0
1.0/.35
LV_{DD}
.25/2.0
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ON
1.2/.35
1.3/.5
V_{BIAS}
.4/.8
1.2/.5
φ1

Fig, 9

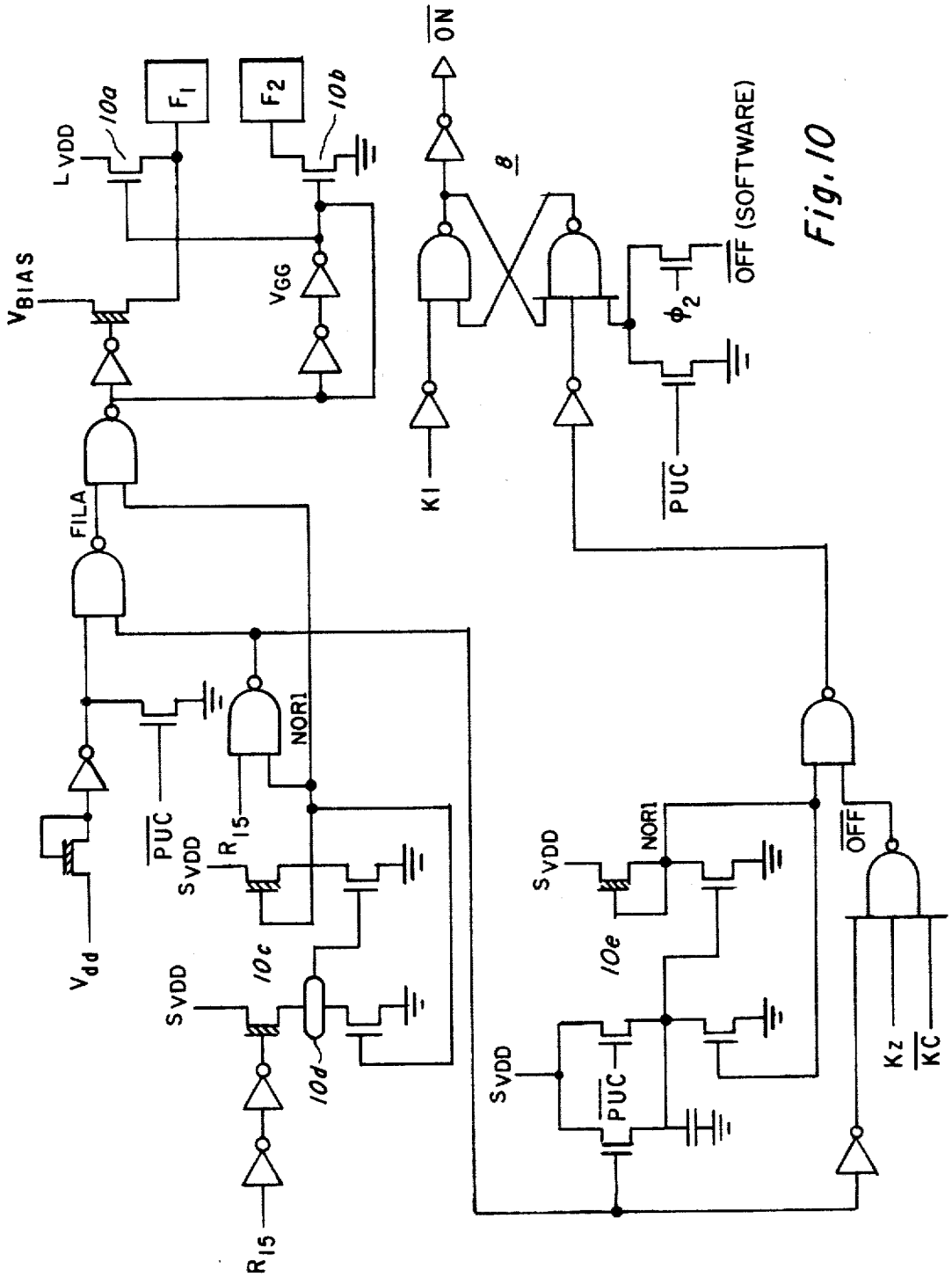
ON
F1
F2
10a
10b
LVDD
VBIAS
VGG
8
OFF (SOFTWARE)
φ2
K1
PUC
FILA
NOR1
PUC
R15
SVDD
Vdd
SVDD
10c
10d
R15
SVDD
NOR1
10e
OFF
SVDD
PUC
Kz
KC

Fig. 10

ELECTRONIC LEARNING AID

This is a continuation of application Ser. No. 843,018, filed Oct. 17, 1977, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to learning aids, and more specifically, learning aids of the type which may be used for teaching elementary arithmetic or other such subjects.

In the prior art, it has been known to provide learning aids for teaching children and adults arithmetic and other subjects as well. Early learning aids were essentially mechanical devices, such as that exemplified by U.S. Pat. No. 925,716 which issued June 22, 1909. More modernly, it has been known to use large electronic computers programmed for the purpose of teaching arithmetic. For example, in an article entitled "The Development of Computer Assisted Instruction" which appeared in IEEE Transactions on Human Factors and Electronics in June 1967, the use of an IBM 650 computer programmed for teaching binary arithmetic is discussed. Further, it has been known to provide desk model learning aids for teaching elementary arithmetic, such as those learning aids exemplified by U.S. Pat. Nos. 3,584,398 of June 15, 1971 and 3,947,976 of Apr. 6, 1976. Still further, it is known to implement an elementary arithmetic learning aid in a hand-held, battery-powered unit, which units have found their way into the market place under the trade name "Little Professor" manufactured by Texas Instruments Incorporated or "Quiz Kid" manufactured by National Semiconductor Incorporated.

While these prior art electronic learning aids are effective for informing the operator of the learning aid whether he or she has correctly solved a particular problem and may also report the operator's score for a set of problems, these learning aids do not "reward" an operator for each correct answer or for doing well on a set of problems by presenting a fanciful display by appropriate actuation of the segments in the learning aid's display device.

It was, therefore, one object of this invention to reward the operator for each correct solution entered into a learning aid.

It was another object to reward the operator after completing a set of problems, if the operator had done well.

It was another object to vary the reward according to how well the operator had done in the set of problems.

It was still another object to give the operator a visual disencentive for working problems incorrectly.

It is yet another object that the rewards and disencentives comprise preselected display presentations which occur at the display used to pose problems to the operator.

It is still another object that the display presentations include preselected actuations of the segments of the display device, the actuations being fanciful and ordered for positive rewarding presentations.

The foregoing objects are achieved as is now described. A learning aid is preferably implemented by a microprocessor type integrated circuit which is interconnected with a keyboard or other data entry means and a display device. A microprocessor type integrated circuit is preferably utilized because of the attendant flexbility in actuation of the segments of the display

device. The display device is preferably adapted for displaying numbers, annotator characters (plus, minus, divide or multiply signs), an equals sign and also a timing character, if desired. The timing character may be provided by a plurality of segments of the display device arranged in a generally circular configuration, for instance.

After each problem posed at the display is correctly answered (by the operator inputting the correct answer at the keyboard), the display is actuated to give the operator a positive, visual reward. In the following detailed description this reward is referred to as a "type C presentation" and generally is a "bull's eye" consisting of actuating all the G segments characters individually (and in sequence) followed by actuating all segments in the timing character. Thus, the travelling G segments might represent an arrow while the circular timing character, is its target.

After each problem posed is incorrectly answered, the display is actuated to give the operator a visual disencentive, which generally appears to the casual observer to be a random actuation of the segments of the display, in contradistinction to the fanciful, ordered "bull's eye" presentation. This disencentive visual display is referred to as a "type D presentation" in the following detailed description.

After each set of problems posed has been answered, the operator is given a visual reward or disencentive at the display depending on how well (or poorly) the operator did. In the embodiment disclosed, this is tied to the correctness of the answers entered by the operator: a type A presentation for all correct, a type B presentation for one wrong, a type C presentation for two wrong and a type D presentation for three or more wrong in a set. As will be seen, the type B and A presentations are progressively more complex and longer lasting variations on the "bull's eye" reward.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use and further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

FIG. **1** is a front view of a case in which a learning aid embodying the present invention may be disposed;

FIG. **2** is a simplified block diagram of the learning aid, including a voltage tripler circuit;

FIG. **3** depicts the segmented electrodes of the display and FIGS. **3***a*-**3***c* identify those segmented electrodes;

FIG. **4** is a block diagram of a portion of the microprocessor used in the learning aid;

FIG. **5** is a logic diagram of a latched accumulator register;

FIG. **6** is a logic diagram of the segment buffer circuits;

FIG. **7** is a logic diagram of the digit latches;

FIG. **8** is a logic diagram of the two digit buffer circuits;

FIG. **9** is a logic diagram of a circuit used to drive the voltage tripler of FIG. **2**; and

FIG. **10** is a logic diagram of a circuit used to drive the filament of a vacuum fluorescent display device.

DETAILED DESCRIPTION

Referring now to FIG. 1, there is shown a front view of a learning aid 1 which embody the present invention. The learning aid is disposed in a case 2, which in FIG. 1, is depicted as a stylized version of a "Spaceman" or other "Space-character". Of course, whether a case 2 is used at all and the style of the case used are design choices of those who desire to practice the present invention. Also in FIG. 1, the case is shown with a keyboard 3 and a display 4. Display 4 may be provided by a vacuum fluorescent display device, an array of light emitting diodes, a liquid crystal display device, gas discharge tube, electrochromic display device or other display means.

Referring now to FIG. 2, there is shown a simplified block diagram of the components preferably located in case 2 (FIG. 1). Keyboard 3 is preferably of the well known matrix type and in this embodiment has four column conductors 3*a* and six row conductors 3*b*. As is well known, in matrix keyboards, the column and row conductors thereof are arranged to cross over each other (in the form of the grids of a matrix) and connections preferably occur at the points of cross-over when the push-bottom switches associated therewith are depressed. Display 4 is preferably adapted to be actuated by multiplexed signals and, in this embodiment, display 4 is provided with nine character positions strobed by D (Digit) lines D1 through D9, with each character position having up to eight segments strobed by lines Sa-Sg and Sp.

Integrated circuit 5 is coupled to both display 4 and keyboard 3. Integrated circuit 5 strobes keyboard 3 on the D5 through D9 lines coupled to the row conductors and detects key closures by sensing K1, K2, K3 and K4 lines coupled to column conductors 3*a*. One of the column conductors is coupled to V_{SS}, rather than one of the other D lines (D1–D4) to provide the learning aid with an integrated on/off switch which is described in U.S. patent application Ser. No. 700,672 filed June 28, 1976, now U.S. Pat. No. 4,089,062 issued May 9, 1978. In lieu of using intergrated circuit 5, of course, a plurality of integrated circuits, a plurality of discrete devices or mixtures thereof could be used to perform the functions of integrated circuit 5; however, it will be appreciated by those skilled in the art that by integrating more electronic functions on a single integrated circuit (of reasonable dimensions), the cost of the entire learning aid system may be reduced. Integrated circuit 5 is preferably a microprocessor type device implemented in Metal Oxide Silicon (MOS) technology. Of course, as a matter of design choice, those practicing the present invention may wish, in the alternative, to use bipolar, integrated injection logic, charge-coupled, bucket brigade or other such technologies in implementing integrated circuit 5.

Preferably, integrated circuit 5 is provided with the microprocessor described in U.S. patent application Ser. No. 706,719 filed July 19, 1976, now U.S. Pat. No. 4,073,006 issued Feb. 7, 1978, modified as is hereinafter discussed with its read-only-memory being programmed with the instruction set of Table I. U.S. Pat. No. 4,073,006 is hereby incorporated herein by reference. The microprocessor chip described in U.S. Pat. No. 4,073,006 uses a segment scanning technique for driving its display. That is, the segments scan lines S_a–S_g and S_p which (See FIG. 3 of U.S. Pat. No. 4,073,006) are strobed sequentially while the digit drive lines, D1–D9, are selectively enabled to display appropriate numerals in the display used in conjunction with the microprocessor chip of U.S. Pat. No. 4,073,006. In the present embodiment, as a matter of design choice, a digit scan technique is used to actuate display 4. The D lines, D1–D9 are sequentially strobed while the segment lines, S_a–S_g and S_p are selectively enabled. As should be apparent to those skilled in the art, segment scan techniques are preferably used when display 4 is provided by an array of light emitting diodes, as is discussed in U.S. Pat. No. 4,073,006, while digit scan techniques are preferably used when display 4 is provided by a vacuum fluorescent display, for instance. The display used and the scanning technique used to drive the display are design choices to be made by those practicing the present invention; however, those who desire to practice the present utilizing the microprocessor of U.S. Pat. No. 4,073,006 and the ROM instruction set of Table I should be aware that the microprocessor of U.S. Pat. No. 4,073,006 is embodied with segment scanning while the program of Table I is set up for digit scanning to drive the display 4. Accordingly, appropriate modification to the microprocessor of U.S. Pat. No. 4,073,006 should be made to convert it from segment scanning to digit scanning or appropriate modifications should be made to the program of Table I to convert it from digit scanning to segment scanning. Modifications which may be made to the microprocessor of U.S. Pat. No. 4,073,006 to convert it to digit scanning are discussed subsequently.

Referring now to FIGS. 3 and 3*a*–3*c*, there are depicted the segment details of display 4. In FIG. 3, display 4 preferably includes a first operator location as provided by two seven-segmented characters for displaying numerals, for instance. Also included is a second operator location also preferably comprising two seven-segmented characters. The first and second operator locations are separated by an annotator location which may be used for displaying plus, minus, multiply or divide signs. Display 4 is further provided with an answer location, which, in this embodiment, has three conventional seven-segment characters. The answer location is separated, in this embodiment, from the second operator position by an equals sign annotator. Display 4 is also provided with an eight segmented, circular character, which is used at certain times as a timing indicator and for certain other display functions. When used as a timing indicator, the eight segments of the circular character may be sequentially actuated, each segment being actuated for a predetermined time interval. Of course, in certain applications it may be desirable to use a segmented oval, square, rectangular or spoked wheel character in lieu of the circular character shown in FIG. 3 or to use more or less than eight segments therefor.

Each character position of the display 4 preferably has a common electrode associated with each character position. Thus, the D1 electrode is associated with the timing indicator, while the D2–D4 electrodes are associated with the respective three characters in the answer location. The D5 electrode is associated with the least significant digit in the second operator position and with the equals sign, while the D6 electrode is associated with the most significant digit in the second operator position. The D7 electrode is associated with the annotator character while the D8 and D9 electrodes are associated with the respective digits in the first operator location. This relationship between the

D1-D9 electrodes and the character positions is depicted in FIG. 3.

In this embodiment of the display 4, a maximum of eight segments (Sa-Sg and Sp) is associated with each character position. Each segment is connected to one of the segment buses, Sa-Sg and Sp, as is identified in FIGS. 3*a*-3*c* for all characters and segments, save for the equals sign. The equals sign is coupled to the Sp segment bus in this embodiment.

Referring again to FIGS. 1 and 2, the learning aid is activated by depressing the "on/user entry" key. This action places the learning aid in a User Entry Mode, which will be subsequently described. Depressing the "off" push button turns the learning aid off. Depressing the "Electro-Flash", "Wipe-Out," "Number Guesser", "Force Out" or "Memory Bank" keys causes the learning aid to enter Math Table (Electro-Flash), Wipe-Out, Number Guesser game, Force Out gam or Memory Bank modes which also will be subsequently described. Depressing the key having a question mark enclosed in brackets causes the learning aid to enter a Box Problem Mode which likewise will be subsequently described. The function of the remaining keys, that is, the ten numerals keys, the "GO" key, the equals (=) key and the four arithmetic operator (+, −, x and ÷) keys, will be described with respect to the various modes in which the learning aid may be placed.

USER ENTRY MODE

The learning aid automatically enters the User Entry Mode upon energization. In the User Entry Mode (student entered problem mode), the learning aid actuates the equals sign in display 4. Thereafter, the operator of the learning aid may enter his or her own problem and a proposed solution to the problem. In the User Entry Mode the learning aid will indicate whether the proposed solution is correct or incorrect and will maintain a running score of the problems attempted. More particularly, in the User Entry Mode, after first depressing the User Entry key, a first number preferably having one or two numerals may be entered by the numeral keys followed by one of the four arithmetic operators, followed by a second number preferably having one or two numerals and then followed by the equals key. Then, the proposed solution is entered, by depressing one to three numeral keys, for instance. The first number is displayed at the first operator location (reference A) and the second number is displayed at the second operator location (reference B), while the proposed solution is displayed at the reference C location in display 4 (FIG. 3).

If the answer is correct then the display 4 so indicates by giving a type C presentation after the problem and correct solution are briefly displayed. During the type C presentation (as well as the type A, B and D presentations) the segments in display 4 are actuated in a preselected manner comprising a preselected sequence of various segments actuated at preselected times. The presentation preferably does not display alphanumeric information, but rather presents a fanciful, moving pattern of actuated display segments. The type A presentation is the most complex while the type D presentation is the least complex. The particular segments being actuated during the different types of presentations are described subsequently.

If, on the other hand, an incorrect proposed solution is entered at keyboard 3, the learning aid flashes "EEE" in the display and a type D presentation and gives the operator another opportunity to insert a correct answer, by again presenting the entered problem with no solution. If the second proposed solution is also incorrect, the learning aid will again momentarily flash "EEE", indicate the correct answer to the problem and display a type D presentation. If, on the other hand, the second proposed solution is correct, a type C presentation is initiated.

In subtraction problems, the operand may be either one or two digits and have either a one or two digit answer but the first operand, in this embodiment, is required to be larger than the second operand so that negative answers are avoided. A number entry which will make the second operand larger than the first operand is ignored. For example, if 8−5=3 were keyed in, the problem would be accepted and the type C presentation would be displayed to indicate that the solution was correct. Similarly, if 88−85=3 were keyed in, the problem would be accepted and the type C presentation would again be initiated because the solution is correct. However, if the operator attempted to key in 75−76, the numeral 6 would not be accepted or displayed in the second operator position. In this embodiment of the learning aid, and for this problem, only a numeral 5 or less will be accepted in the least significant digit position of the second operator, assuming of course, the second operator is to have two digits, the first of which is a seven.

In multiplication problems, in this embodiment of the learning aid, both operators may be one or two digits and the answer may be one, two or three digits. In the manner similar to the handling of negative answers for subtraction problems, multiplication problems which would result in a four digit result are ignored by inhibiting selected digits in the least significant digit position of the second operator, when required.

For division problems, each operator may have one or two digits. Of course, numbers which do not divide evenly have remainders associated therewith. In this embodiment, only the whole part of the answer need be entered and, after the whole part of the answer is correctly entered, the learning aid of this embodiment displays the remainder (which is previously calculated) preferably with a small case "r" before the numerical value of the remainder. Thus, if 9÷4=2 is entered, the learning aid responds by then displaying a lower case "r" and 1 followed by a type C presentation.

In the User Entry Mode, the learning aid of this embodiment scores the user entered problems. After a set of ten problems have been attempted, the learning aid displays, in the first operator position, the number of problems answered correctly on the first try and the number of problems attempted in the second operator position of display 4. The scoring is also preferably shown and associated with either a type A, B, C or D display presentation based on the number of correct answers. If all answers were correct on the first try, i.e., ten correct answers, a type A presentation is initiated. For nine correct answers a type B presentation is displayed while for eight correct answers a type C presentation is presented. For seven or fewer correct answers a type D presentation is begun. The different types of display presentations, types A-D, are described subsequently.

MEMORY BANK MODE

The Memory Bank Mode is used in combination with the User Entry Mode to store a series of up to ten prob-

lems. The problems are entered in nearly the same way as in the User Entry Mode but instead of pushing the "equals" key and inserting a proposed solution, the Memory Bank key is depressed. The sequence may be repeated up to ten times and the ten problems entered thereby are stored in a memory in integrated circuit **5** of the learning aid. The problems may then be sequentially outputted by depressing the "GO" key. The "GO" key also starts an elapsed time counter which times the operator as he or she solves the series of problems stored in the memory. The elapsed time counter counts only when the learning aid is waiting for the operator to respond to the problem being posed.

As in the User Entry Mode, the operator is given two opportunities to enter a proposed solution which is the correct solution to the problem being posed and the learning aid initiates either a type C or D presentation at display **4** for correct or incorrect answers, respectively. Also, as in the User Entry Mode, the number of correctly answered problems (on the first try) and the total number of problems presented are remembered by the learning aid. At the conclusion of the set of problems, three numbers are displayed in the first and second operator positions and the answer position of the display. In the first operator position, the number of correct answers is shown, in the second operator position the number of problems attempted is shown and in the answer position an elapsed time indication (a decimal number of up to three digits) is displayed. Thereafter, if the number of correct answers and the number of posed problems are identical then a type A display presentation is initiated while if the number of correct answers and number of problems presented differ then either a type B presentation is displayed if the difference is one or a type C presentation is started if the difference is two or a type D presentation is begun if the difference is three or more.

MATH TABLE MODE

The "Electro-Flash" (short for electronic flash card) key is depressed to put the learning aid in the Math Table Mode. The learning aid of this embodiment herein described then displays the numeral one in the operator position and a plus sign in the annotator position of display **4**. If the "GO" key is now depressed, the learning aid sequentially poses a problem of the type 1+X where X=0, 1, . . . 8,9. The number or arithmetic operator in the expression may be altered by depressing the appropriate number and/or arithmetic operator key before depressing the "GO" key. The math tables then tested will be presented as, for example, 6+X or X+6 (where X=0, 1, . . . , 9,) depending on the order in which the number and arithmetic operator are entered at keyboard **3**. Thus, after depressing the "Electro-Flash" key, if just the six numeral key or the six numeral key followed by the plus sign key is depressed, then the problems will be posed in the 6+X format whereas if the plus sign is depressed before the numeral six the problems will be posed in the X+6 format.

When the learning aid is doing addition tables, the problems may be of the form 2+X, or X+5, for instance, with X sequentially increasing from 0 to 9.

When the learning aid is doing subtraction tables, however, problems requiring a negative answer are not posed. Thus, for example, the 7−X tables are posed only for X=0, 1, . . . 6,7 and the X−7 tables are presented only for X=7, 8 and 9.

For the multiplication tables, 3 times X and X times 9 formats are permitted with X sequentially increasing from 0 through 9.

When doing division tables, no restraints are imposed which require the answer to be even. The operator need only to enter the whole part of the answer to receive a correct answer response and the learning aid responds by indicating what the remainder is, if any.

As in the User Entry Mode, the operator of the learning aid is given two opportunities to input a correct solution to the problem before the answer is provided by the learning aid. For each correct answer a type C presentation is initiated at the display. After completing each table, the score is displayed with the number of correct answers (on the first attempt) being placed in the first operator position, the number of problems attempted in the second operator position and the elapsed time being displayed in the answer location. Thereafter, a type A presentation is initiated if all problems were answered correctly, a type B presentation is shown for one incorrect answer, a type C presentation being shown for two incorrect answers and a type D presentation being displayed for three or more incorrect answers.

After completion of a table such as the 7+X table, the learning aid goes on to the next higher table, which in this case would be the X+8 table. After the 9's table is completed, the learning aid reverts to the 0's table for the function being tested.

WIPE-OUT GAME MODE

Depressing the "Wipe-Out" key causes a learning aid to enter the wipe-out game mode. In the wipe-out game mode, a series of problems are presented to the operator of the learning aid. When the game has been started by a depressing the "GO" key, the elapsed time counter contains a number indicative of the time elapsed since the "GO" key was depressed. After the counter reaches a randomly preselected count, the display is caused to present a type A presentation. The learning aid when in the wipe-out game mode, is intended to be used by a plurality of players or operators who each answer a problem before passing the learning aid to another player in the game. The player holding the learning aid when the type A presentation is displayed loses and drops out of the game. The game is then reinitiated and the remaining players are eliminated one by one until only one player is remaining who is the ultimate winner.

Upon depressing the "Wipe-Out" key, the machine is cleared and the display shows a plus sign in the annotator character location and displays the equals sign and a pair of brackets in the answer location. A left hand bracket is actuated by actuating the S_a and S_d–S_f segments (see FIG. **3***a*) and a right hand bracket is formed by actuating the S_a–S_d segments. The game and the elapsed time counter are initiated by depressing the "GO" key. The learning aid sequentially presents random "BOX" type problems of level one difficulty (see Box Problem Mode, which is discussed subsequently). Again, an operator is given two opportunities to enter a correct solution and if the first solution is not correct "EEE" is momentarily displayed followed by a type D presentation and the problem is repeated. After two incorrect attempts, the learning aid displays "EEE" momentarily, the problem and correct answer for a brief period followed by a type D presentation. Correct answers are displayed for about ½ seconds followed by

a type C presentation and then the learning aid automatically poses a new problem.

During the presentment of the problems in the wipe-out mode, the elapsed time indicator in display **4** is sequentially actuated, beginning at the five o'clock position and running clock-wise. As in the Memory Bank Mode, the elapsed time counter is activated only while the learning aid is awaiting a correct response.

NUMBER GUESSER MODE

The Number Guesser Mode is entered by depressing the "Number Guesser" key. In the Number Guesser Mode, the learning aid randomly selects a number in the range from 9 to 100. The object of the game is for the operator to guess the number randomly selected by the learning aid in as few attempts as possible.

After depressing the number guesser key, the possible range in which the number may lie is displayed by displaying the number nine in the first operator location, the number 100 in the answer location and brackets in the second operator location of display **4**. The operator then enters a guess by pressing the number keys, which guess is briefly displayed in the operator position. The guess is displayed for approximately 1 second and followed by a type C presentation before the learning aid replaces one of the end limits (i.e., either the end limit in the first operator position or in the answer location) with the number guessed so that the randomly selected number still lies within the range shown by the end limits. This sequence continues until the randomly selected number is guessed. If the number guessed lies outside the range of the end limits, a type D presentation is initiated. When the correct answer is entered, the number of guesses required is displayed in the first operator position for a short time followed by a type A presentation. As a matter of design choice, the elapsed time counter is not utilized in the Number Guesser Mode of the embodiment of the learning aid disclosed.

FORCE OUT GAME MODE

The learning aid is placed in the force out game mode by depressing the "Force Out" key on keyboard **3**. When initially placed in the force out game mode, the learning aid displays a randomly selected number in the first operator position, a minus sign in the annotator position, a pair of brackets in the second operator position and the equals sign of display **4**. This game is typically played by two operators. The first operator starts the game by entering a number between one and nine. The learning aid responds by calculating the difference and displaying it for approximately one second in the answer location and then transposes the difference into the first operator position. The second operator then may be given the opportunity of subtracting a number between one and nine. The game continues until the resulting difference equals zero, at which time a type A display presentation is initiated. The object of the force out game may be either (1) to be or (2) not to be the operator who enters a number leaving a difference that equals zero.

Should either operator enter a number which would result in a negative result, the display **4** provides a type D presentation and the attempted input is ignored.

BOX PROBLEM MODE

The box problem mode is entered by the operator depressing the key with the question mark enclosed by brackets on keyboard **3**. The learning aid responds by displaying a plus sign in the annotator character position and brackets enclosing the number one in the answer location position of the display. In the box problem mode, problems of the type $?+3=7$, $3+?=24$ and $40\div 5=?$ will be presented, the brackets being used to indicate in which position, i.e., the first operator, second operator or answer location that the unknown must be supplied. The position of the brackets may be moved from the answer location to the first operator position, from the first operator position to the second operator position or from the second operator position to the answer location by repeatedly depressing the bracketed question mark key. The particular arithmetic function to be tested can be changed by depressing the appropriate arithmetic operator key. The number one in the answer location indicates that the problems to be presented are of the first level difficulty. Problems of the second level difficulty may be selected by depressing the number two key. After the brackets are in the desired location and the desired function and level difficulty are selected, the "GO" key may be depressed to initiate the selection of a problem. The levels of difficulty are shown in Table II. Depressing the "GO" key starts a sequence of problems and initiates the elapsed time counter in the learning aid's memory and initiates the rotating actuated segment in the circular timer character of display **4**. After each correct answer, a type C presentation is displayed and the learning aid then poses another randomly selected problem. After ten problems have been posed and answered, the number of correct answers is displayed in the first operator position, the number of attempted problems is displayed in the second operator position and the count of the elapsed time counter is displayed in the answer location of display **4** for a brief period of time. Thereafter either a type A, B, C, or D presentation is begun based on the number of correct answers, as is done when the learning aid is in the User Entry Mode.

If an incorrect answer is entered at keyboard **3**, it is not displayed but the learning aid momentarily displays "EEE" in the answer location followed by a type D presentation and then the learning aid again poses the problem with the answer location blank. After two incorrect attempts, the learning aid displays the correct answer. A correct response receives a type C presentation.

ELAPSED TIME COUNTER

An elapsed time counter is provided by a memory in integrated circuit **5**. The counter is incremented approximately every $\frac{3}{4}$ second. The maximum count is 999 which is equivalent to about twelve minutes. When 999 is attained in the elapsed time counter, the operator may continue using the learning aid but the counter in this embodiment does not count above 999. During the time the elapsed time counter is counting, the timing indicator in the display **4**, comprising the circular arrangement of segments, is sequentially actuated, one segment at a time, starting from the five o'clock position and running clock-wise with each successive segment being actuated as the preceding segment becomes unactuated.

INSTRUCTION SET

In Table I (which comprises Tables I-1 through I-15) is listed the set of instructions which may be stored in the main read-only-memory of the microprocessor of U.S. Pat. No. 4,073,006 (with the modifications discussed herein) to provide the integrated circuit **5** of

FIG. 2. Referring now to Table I, there are several columns of data which are, reading from left to right: PC (Program Counter), LOC (Location), INST (Instruction), BRLN (Branch Line), Line and Source Statement (which includes name, title and comments). In U.S. Pat. No. 4,073,006, it will be seen that the main read-only-memory is addressed with a seven bit address in a program counter and a four bit address in a buffer. The address in the buffer is referred to as a page address in the main read-only-memory. The instructions listed on Table I-0 correspond to page zero in the microprocessor while the instructions listed in Table I-1 are those on page one and so forth through to the instructions in Table I-15 which are stored on page fifteen in the microprocessor.

The program counter of the aforementioned microprocessor is comprised of a feedback shift register and therefore counts in a pseudorandom fashion. Thus the addresses in the left hand column of Table I, which are expressed as a hexadecimal number, exhibit such pseudorandomness. The hexadecimal location code (LOC) refers to the physical location within the read-only-memory at which the instruction listed is stored. If the instruction starting at page zero were read out sequentially from the starting position in the program counter (**00**) then the instructions would be read out in the order shown in Table I. In the "line" column is listed a sequentially increasing decimal number associated with each source statement and its instruction and program counter address. The line number starts at line **29** merely for reasons of convenience not important here. When an instruction requiring either a branch or call is to be performed, the address to which the program counter will jump and the page number to which the buffer will jump, if required, is reflected by the binary code comprising the instruction or instructions performing the branch or call. For sake of convenience, however, the branch line column indicates the line number in Table I to which the branch or call will be made. For example, the instruction on line 32 (Page 0, Program Counter Address 07) is a branch instruction, with a branch address of 1111101 (7D in hexadecimal). To facilitate finding the 7D address in the program counter, the branch line column directs one to line 38, where the 7D address is located.

MICROPROCESSOR MODIFICATIONS

The microprocessor of U.S. Pat. No. 4,073,006 may be modified for segment decoding as is herein described. Referring now to FIG. **4**, there is shown a portion of the block diagram of the microprocessor. In FIG. **4**, the elements having reference numerals between 30 and 105 generally correspond with those having the same numerals in FIGS. 7a and 7b of U.S. Pat. No. 4,073,006. The segment latches 87, segment decoder 89, gate 96, buffers 94, latches 97, and output buffers 91 and 98 shown in FIG. 7b of U.S. Pat. No. 4,073,006 are eliminated and replaced with other components shown in the block diagram of FIG. **4**. The output of accumulator **77**, instead of being directly coupled to the Programmed Logic Array (PLA) in segment decoder **33** is instead coupled thereto via a latched accumulator register **10**. Register **10**, which is shown in greater detail in FIG. **5**, is five bits wide and latches four bits from accumulator **77** as well as one bit from status latch **104** in response to a $\overline{TD0}$ signal. The contents of register **10** are then clocked into the PLA of RAM word address and segment decoder **33** on a $\phi 1$ clock. Of course, the contents of Y register **76** are also clocked into the PLA, but on a $\phi 2$ clock. Inasmuch as register **10** stores five bits, the PLA of decoder **33** is modified to decode as many as thirty-two terms. However, inasmuch as RAM **31** and digit latches **11** are responsive to the four bit address in Y register **76**, only sixteen lines are needed to interconnect decoder **33** with RAM **31**.

Table III shows the thirty-two five bit codes (in hexadecimal location) storable in register **10** and the effect of decoding thereby by decoder **33**. Thus, Table III indicates the segments actuated according to the decoding of the five bit codes and the input as seen at display **4** (FIG. **2**), according to the segment connections of FIGS. *3a-3c*. The first hexadecimal digit in the five bit code indicates the state of the status latch **104** while the second hexadecimal digit corresponds to the four bits inputted into register **10** from accumulator **77**. For matters of convenience, a few of the five bit codes will be found to actuate the same set of segments in the display.

The PLA in RAM word address and segment decoder **33** decodes the five bit codes according to Table III and outputs segment actuation signals on lines **13** to segment buffers **14**. The segment buffers **14** are shown in greater detail in FIG. **6**.

The digit buffers **11** are similar in construction to the RAM cells in RAM **31**, but in lieu of being addressed by RAM pages address decoder **35** (see FIG. 7b of U.S. Pat. No. 4,073,006), these latches **11** are addressed by the $\overline{SETR}$ and $\overline{RSTR}$ commands. The $\overline{SETR}$ command sets the latch **11** whose input line **32** is selected by RAM word address decoder **33** to be set, while the $\overline{RSTR}$ command resets the latch **11** whose input line **32** is selected by decoder **33**. The $\overline{SETR}$ command was heretofore decoded by the microprocessor of U.S. Pat. No. 4,073,006; however, the $\overline{RSTR}$ command is a new command in this version of the microprocessor and is decoded when the instruction 0110110 is outputted from the read-only-memory of this microprocessor. The outputs of the digit latches **11** are coupled to the digit buffers **12**. The digit latches **11** and digit buffers **12** are shown in greater detail in FIGS. **7** and **8**, respectively.

Nine of the digit buffers **12** provide the **D1-D9** outputs to the grids of the vacuum fluorescent display device **4**, preferably used in this embodiment of the invention. One of the digit buffers is coupled to the S_p output which is coupled to the S_p plate of the vacuum fluorescent display device **4**. The S_a-S_g outputs from segment buffers **14** are coupled to the remaining plates in vacuum fluorescent display device **4**. The outputs from buffers **12** and **14** output zero volts to the respective plates and grids to actuate the desired segments. Typically, the digit lines, **D1-D9** are sequentially raised from approximately -25 volts to 0 volts while the segment lines S_a-S_g and S_p are selectively raised from approximately -25 volts to 0 volts. It can be seen from an examination of FIGS. **5** and **7** that the segment buffers and digit buffers selectively ground or connect the output lines to V_{bias} (about -25 volts).

It should be noted that the S_p segments are driven from a digit buffer **12** in lieu of being driven from a segment buffer **14**, as a matter of design choice. Of course, the S_p segment could be decoded in the PLA in decoder **33** and driven by a segment buffer, similar to the manner by which the S_a-S_g segments are actuated. Of course, driving the S_p segments from a digit buffer **12** requires that at least two digit latches **11** be set at the same time. This may be accomplished by first setting

one of the digit latches **11** using an address in Y register **76** and then setting another digit latch **11** using another address in Y register **76** before resetting the first latch **11** with the $\overline{\text{RSTR}}$ command.

Referring now to FIG. **5**, there is shown the five bit Latched Accumulator Register LAR **10** comprises stages **10-1** through **10-16**. Only one of these five stages, **10-1**, is shown in detail inasmuch as the other stages are identical thereto. As can be seen, register **10** is responsive to a decoded $\overline{\text{TD0}}$ command for loading the contents thereof from the four bits in accumulator **77** and one bit from status latch **104**.

In FIG. **6**, there is shown the seven aforementioned segment buffers **14**. Each of the SV_{DD} voltages refers to a switched V_{DD} provided by an integrated on/off switch if used. Otherwise each of these voltages may refer to a normal V_{DD} found in typical MOS chips. Device **14***a* which is coupled to a voltage V_x, is normally turned on by voltage V_x and thus is used merely for voltage protection purposes. In FIG. **7** there are shown the digit latches **11** in greater detail. As aforementioned, the digit latches are addressed by lines **32** from RMA Word Address and Segment Decoder **33** and are selectively set and reset by the $\overline{\text{SETR}}$ and $\overline{\text{RSTR}}$ commands. Each of the digit latches **11** (as well as latch **11***a*) are identical so only one is shown in detail in FIG. **7**. Lines **32-0** through **32-8** determine which latch **11** is to be set to provide the digit actuation signals for the D9 through D1 digits in display **4**, respectively. Line **32-9** permits the latch corresponding to segment S_p of display **4** to be set by a $\overline{\text{SETR}}$ signal, as aforementioned. Line **32-15** is coupled to a latch **11***a*, which is identical to the digit latches **11**; however, latch **11***a* is not coupled to a digit buffer **12**, as are latches **11**. Rather, latch **11***a* may be latched by the program in the ROM to provide an **R15** command which, as will be seen, is used in generating a filament voltage for display **4**. In FIG. **8**, one of the digit buffers **12** is shown in detail. Each of the ten digit buffers utilized in this embodiment are identical and therefore only one digit buffer **12** is depicted in FIG. **8**. V_x is the V_{bias} voltage provided by the voltage tripler circuit; the V_x voltage keeps device **12***a* on.

Referring now to FIG. **9**, there is shown the circuit for driving the voltage tripler circuit **7** in FIG. **2**. The LV_{DD} voltage refers to a "live V_{DD}" voltage, that is, a V_{DD} which is not controlled by the integrated switch but rather is directly coupled to the negative terminal of battery **6**. Referring briefly to FIG. **10** there is shown the circuit for driving the filament of display **4** as well as a latch **8** used to control an integrated on/off switch (not shown). The filaments are connected directly across the nine volt battery **6** via devices **10***a* and **10***b* whenever latch **11***a*, i.e., signals **R15** is set. Timer circuit **10***c* acts to turn off the filament should the **R15** signal, which is of course controlled by the program stored in the read-only-memory, occur for too long a period of time (because having nine volts coupled across the low voltage filament in display **4** for a long enough period of time will damage such filament). Normally, latch **11***a* is set under control of the program in the ROM of integrated circuit **5** approximately a third of the time display **4** is displaying information. In timer **10***c* is a P diffusion which due to its size, requires approximately 100 microseconds to charge or discharge. Timer **10***c* assures that the filament is not connected across battery **6** for longer than 100 microseconds each time the **R15** signal is generated. Another timer circuit **10***e* is provided for turning the learning aid off should the **R15** command fail to come up for an extended period of time. The integrated on/off switch controlled by latch **8** is shown in U.S. Pat. No. 4,089,062 and therefore is not depicted here.

DISPLAY PRESENTATIONS

It has been previously mentioned that several types of different display presentations, heretofore referred to as type A, B, C, and D display presentations, are presented at various times during the operation of the learning aid. These display presentations are preferably initiated at the same display **4** at which the problems posed by the learning aid are presented. Generally, a type D presentation is initiated whenever the operator proposes the solution to a problem which is incorrect or enters a number in the number guesser or force out game modes which violate the rules of the game. A type C presentation is generated for correct proposed solutions to individual problems or for guesses in a game which comply with the rules of the game. During operation of the learning aid in a game mode, a type A presentation is generally shown at the end of the game. For instance, in the wipe out game mode, the learning aid presents a type A presentation when the counter reaches its randomly preselected count (so that the operator then holding the learning aid knows to drop out of the game).

Generally, in the modes for which the operator is asked to solve an arithmetic problem, such as the User Entry Mode, Memory Bank Mode, and Box Problem Mode, type A, B, C, or D presentations are selectively generated at a conclusion of a set of arithmetic problems. A type A presentation is generated if the operator answered all the problems correctly on the first try while the B, C, and D type presentations are respectively generated if one, two and three or more errors are made in a set of problems. The type A, B, and C presentations as will be seen, occur as preselected, fanciful sequences of segments being actuated in the different positions of the display, the complexity and length of time to complete the presentation decreasing as the number of errors increases. That is, the complexity and length of time of the presentation is (1) less for the type C presentation than the type B presentation and (2) less for the type B presentation than the type A presentation. Also, as will be seen, the type D presentation is a preselected but unordered sequence of segments being actuated in the various segment positions, such that the actuation of the segments in display **4** would appear to the casual observer to be randomly generated. The patterns of actuated segments for these presentations are discussed in Table IV.

The learning aid gives the operator a positive reinforcement for a correct answer or proper response in a game by giving a type C presentation while indicating erroneous solutions or responses by initiating the type D presentation. Then upon completing a set of problems, the learning aid responds by initiating a display presentation whose complexity and duration are a function of the number of erroneous solutions entered by the operator to the set of posed problems. Thus, an operator who answers all problems correctly is "rewarded" with a type A presentation, but an operator who misses one problem receives only a type B presentation, and so forth. The operator, it is felt, will seek to receive the type A presentation and thereby improve his or her abilities with mathematics.

It should be evident to those skilled in the art, furthermore, that in addition to making the type of display presentation initiated a function of the number of errors in a set of problems that the type of presentation presented could be made also a function of the length of time required to solve the set of problems inasmuch as the learning aid disclosed herein includes a timer mechanism. That is for instance, a type A presentation might be initiated only if (1) all the problems in a set of problems are answered correctly and (2) the elapsed time counter incremented to a value no greater than some preselected value, say 30 for instance. As a matter of design choice, the learning aid disclosed herein does not use the contents of the elapsed time counter in determining the type of display presentation to be initiated upon the completion of a set of problems.

In Table IV the various display presentations are explained. It should be appreciated that these presentations occur rather quickly, having a duration of approximately one second for a type C presentation and approximately five seconds for a type A presentation. Further, while the A and B type presentations are broken down into a series of steps, a following step may be initiated before a prior step is completed, if desired. Further, the order, number and content of the various steps may be altered as desired for it should be evident to those skilled in the art that many, many different sequences of segment actuation may be substituted for those selected for the disclosed embodiment of the learning aid. Also, this technique of using the segments of the display (which are used to present the problems) to also present a selected display presentation may be used with learning aids teaching material other than arithmetic. For instance, this technique could also be used with learning aids teaching word based problems rather than number based problems.

I have described my invention in connection with certain specific embodiments thereof. It is to be understood that modifications may now suggest themselves to those skilled in the art and that this invention is not limited to the specific embodiment disclosed, except as set forth in the appended claims.

TABLE I-0

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS
0000	0000	001000101		0029	SCANT	TCY	10
0001	0003	000101001		0030		TMA	
0003	0007	011101001		0031		ALEC	9
0007	000F	101111101	0038	0032		BRANCH	SCANT2 IF B10 L,E, 9
000F	001F	010000110		0033	SCANT1	LDP	6
001F	003F	011100101		0034		ALEC	10
003F	007F	101011000	0855	0035		BRANCH	SCORE IF B10 = 10
007F	007E	010001001		0036		BL	BLOWUP IF B10 G,T, 10
007E	007D	101110011	1209	0037			
007D	007A	001001001		0038	SCANT2	TCY	9
007B	0076	000100001		0039		TBIT	2
0077	006E	100001111	0033	0040		BRANCH	SCANT1
006F	005E	000000110		0041	SCAN	CLA	CLEAR NOSCAN,KEYUP,KEYDN
005F	003E	010010010		0042		LDX	TIME
003E	007C	001000111		0043		TCY	14
007C	0079	001100000		0044		TCMIY	0
0079	0072	001101110		0045		TCMIY	7 LOAD 5 MIN TIME OUT
0073	0066	100011110	0049	0046		BRANCH	GOSCAN
0067	004E	000000110		0047	NOSCAN	CLA	
004F	001E	001110001		0048		ACACC	8 CLEAR KEYUP,KEYDN, SET NOSCAN
001E	003C	010010000		0049	GOSCAN	LDX	A
003D	0078	001001101		0050		TCY	KEYUP
007A	0075	000101111		0051		TAM	SAVE KEY FLAGS
0075	006A	001001111		0052		TCY	15
006B	0056	000101010		0053		TMY	
0057	002E	000110110		0054		RSTR	
002E	005C	001001111		0055	SCANH	TCY	15
005C	0039	000001101		0056		SETR	HEAT FILAMENT
0038	0070	001100001		0057		TCMIY	8
0070	0061	001001101		0058		TCY	KEYUP
0061	0042	000100011		0059		TBIT	3
0043	0006	100011011	0063	0060		BRANCH	NOSCNH
0006	000C	010001001		0061		BL	RANS
000D	0018	100010111	1254	0062			
0018	0037	001000010		0063	NOSCNH	TCY	4
0037	006F	000101011		0064		TYA	
006E	005D	000000100		0065	HDELAY	DYN	HEATER DELAY LOOP
005D	003A	101101110	0065	0066		BRANCH	HDELAY

TABLE I-0 (cont)

003A	0074	001111111		0067		ACACC	15	
0074	0069	101101110	0065	0068		BRANCH	HDELAY	
0069	0052	010010000		0069		LDX	A	
0053	0026	001000001		0070		TCY	8	
0026	004C	000101001		0071		TMA		GET TIMER DATA WORD
004C	0019	010011110		0072		LDX	H	
0018	0030	001001111		0073		TCY	15	
0031	0063	000110110		0074		RSTR		CLEAR HEATER
0062	0045	001000001		0075		TCY	8	ADDRESS TIMER STATUS LATCH
0045	000A	101100000	0084	0076		BRANCH	SCAN1A	
000A	0014	000000101		0077	SCAN2	IYC		
0015	002B	000110110		0078		RSTR		CLEAR OLD DIGIT LINE
002B	0057	100010111	0089	0079		BRANCH	DIGOUT	
0056	002D	000101111		0080	SCAN1	TAM	SAVE NEW R LINE	
002C	0058	000101000		0081		TAY		
0058	0031	000101001		0082		TMA		GET NEW DATA
0030	0060	010011110		0083		LDX	H	
0060	0041	000100011		0084	SCAN1A	TBIT	3	STATUS LATCH ?
[illegible]1	0002	100001010	0077	0085		BRANCH	SCAN2	YES BRANCH
[illegible]2	0004	000000101		0086	SCAN3	IYC		
0005	000B	000110110		0087		RSTR		CLEAR OLD DIGIT LINE
000B	0017	001110000		0088		ACACC	0	
0017	002F	010110000		0089	DIGOUT	TDO	OUTPUT NEW DIGIT	
002F	005F	000000100		0090		DYN		
005E	003D	000001101		0091		SETR		SET NEW DIGIT LINE
003C	007B	000100000		0092		TBIT	0	H SEGMENT ?
0078	0071	100001110	0097	0093		BRANCH	SCAN3A	
0071	0062	001001001		0094		TCY	9	
0063	0046	000110110		0095		RSTR		CLEAR H SEGMENT
0047	000E	101110110	0100	0096		BRANCH	SCAN3B	
000E	001C	001001001		0097	SCAN3A	TCY	9	
001D	003B	000001101		0098		SETR		SET H SEGMENT
003B	0077	101110110	0100	0099		BRANCH	SCAN3B	
0076	006D	010010000		0100	SCAN3B	LDX	A	
006D	005A	001001101		0101		TCY	KEYUP	
[illegible]B	0036	000001110		0102		KNEZ		KEY DOWN ?
[illegible]6	006C	100010000	0117	0103		BRANCH	KEYDN	YES BRANCH
006C	0059	101011001	0105	0104		BRANCH	SCAN5	
0059	0032	001001111		0105	SCAN5	TCY	15	
0032	0064	000000111		0106		DMAN		DECREMENT R LINE

TABLE I-0 (cont)

```
0064  0049  101010110  0080  0107          BRANCH   SCAN1     NOT R0 BRANCH
0049  0012  001001101        0108          TCY      KEYUP
0012  0024  000100010        0109          TBIT     1         KEY DOWN FLAG ?
0025  004B  100010100  0112  0110          BRANCH   SCAN6
004A  0015  010100001        0111          SBIT     2         IF NOT, SET KEYUP FLAG
0014  0028  010100110        0112  SCAN6   RBIT     1         CLEAR KEY DOWN FLAG
0029  0053  001000000        0113          TCY      0
0052  0025  000110110        0114          RSTR               CLEAR R0
0024  0048  010111111        0115          RETN               NOSCAN EXIT
0048  0011  100101110  0055  0116          BRANCH   SCANH
0010  0020  000100011        0117  KEYDN   TBIT     3         NOSCAN FLAG ?
0021  0043  101011001  0105  0118          BRANCH   SCAN5     YES BRANCH
0042  0005  010100010        0119          SBIT     1         SET KEY DOWN FLAG
0004  0008  000100001        0120          TBIT     2         KEYS UP FLAG ?
0009  0013  100100111  0123  0121          BRANCH   KEYDN1
0013  0027  101011001  0105  0122          BRANCH   SCAN5     NO BRANCH
0027  004F  001001101        0123  KEYDN1  TCY      11
004E  001D  000001010        0124          TKM                SAVE KEYS
001C  003B  001001111        0125          TCY      15
   39 0073  000101010        0126          TMY
0072  0065  000110110        0127          RSTR
0065  004A  001001111        0128          TCY      15
0048  0016  000101011        0129          TYA
0016  002C  000000100        0130  DELAY   DYN                KEY DELAY LOOP
002D  005B  100010110  0130  0131          BRANCH   DELAY
005A  0035  001111111        0132          ACACC    15
0034  0068  100010110  0130  0133          BRANCH   DELAY
0068  0051  000101010        0134          TMY
0051  0022  000001101        0135          SETR
0022  0044  001001101        0136          TCY      11
0044  0009  000001000        0137          TKA                RE-READ KEYS
0008  0010  000001001        0138          MNEA               SAME ?
0011  0023  101101111  0041  0139          BRANCH   SCAN      NO BRANCH
0023  0047  011100000        0140          ALEC     0         NON ZERO ?
0046  000D  101101111  0041  0141          BRANCH   SCAN      NO BRANCH
000C  001B  001001111        0142          TCY      15
   :9 0033  000000011        0143          XMA                GET R LINE
0033  0067  011101010        0144          ALEC     5         FORCE L.F. 5
0066  004D  100110101  0148  0145          BRANCH   KD1
004D  001A  000000110        0146          CLA
```

```
001A  0034  001111010          0147                ACACC    5
0035  0068  000000011          0148  KD1           XMA                  RESTORE P LINE
006A  0055  000110110          0149  RSTSG1        RSTR                 CLEAR ALL R LINES
0055  002A  000000101          0150                IYC                  BEFORE RE-CHECKING K INPUTS
002A  0054  001011111          0151                YNEC     15
0054  0029  101101010  0149    0152                BRANCH   RSTSG1       TO SEE IF A VSS KEY IS DEPRESSED
0028  0050  010001000          0153                 LDP      1
0050  0021  000001110          0154                 KNEZ
0020  0040  100000000  0158    0155                 BRANCH    VSSSEG
0040  0001  100000001  0159    0156                 BRANCH    ENDKEY
```

TABLE I-1

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS	
0000	0080	001101010		0158	VSSSEG	TCMIY	5	
0001	0083	001001111		0159	ENDKEY	TCY	15	A15 = DIGIT NO,
0003	0087	011101000		0160		ALEC	1	OPRKEY OR CLR ?
0007	008F	101010110	0209	0161		BRANCH	OPRKEY	YES
000F	009F	000100001		0162		TBIT	2	DIGIT 4 OR 5 ?
001F	00BF	100100111	0252	0163		BRANCH	TOPKEY	YES
003F	00FF	000110011		0164		KNEZ		DIGIT 0 ?
007F	00FE	100111110	0172	0165		BRANCH	NUMKEY	NO
007E	00FD	001110001		0166		ACACC	8	
007D	00FA	100001000	0267	0167		BRANCH	GOKEY	
0078	00F6	001110010		0168		ACACC	4	
0077	00EE	100111000	0186	0169		BRANCH	ZROKEY	
006F	00DE	010000100		0170		BL	MEMBNK	
005F	00BE	100000101	0345	0171				
003E	00FC	001110001		0172	NUMKEY	ACACC	8	1-9 KEYS
007C	00F9	101001111	0177	0173		BRANCH	KEYDIG	
0079	00F2	001111010		0174		ACACC	5	
0073	00E6	101001111	0177	0175		BRANCH	KEYDIG	
0067	00CE	001111100		0176		ACACC	3	
004F	009E	000000011		0177	KEYDIG	XMA		
001E	00BC	011101000		0178		ALEC	1	
003D	00F8	100101110	0184	0179		BRANCH	NUMKY2	
007A	00F5	011100100		0180		ALEC	2	
0075	00EA	101010111	0183	0181		BRANCH	NUMKY1	
0068	00D6	001110100		0182		ACACC	2	
0057	00AE	001110100		0183	NUMKY1	ACACC	2	

TABLE I-1 (cont)

```
002E  00DC  000010101          0184  NUMKY2   AMAAC
005C  0089  000101111          0185           TAM                NO, KEY TO A15
0038  00F0  001000111          0186  ZROKEY   TCY      MODE
0070  00E1  000100000          0187           TBIT     USER       NUMBER KEY IN A15, CHECK MODE
0061  00C2  101101001  0198    0188           BRANCH   USERPB
0043  0086  010000111          0189           LDP      14
0006  008C  000100010          0190           TBIT     1
000D  0098  100011011  1875    0191           BRANCH   GAMESDIG
0018  0087  010001010          0192           LDP      5
0037  00EF  000100011          0193           TBIT     3
006E  00DD  100011101  0742    0194           BRANCH   ELCNUM
005D  00BA  000100001          0195           TBIT     2
003A  00F4  100000000  0673    0196           BRANCH   BOXNUM
0074  00E9  101110111  0684    0197           BRANCH   BLUPNM
0069  00D2  001000011          0198  USERPB   TCY      12
0053  00A6  010000100          0199           LDP      2
0026  00CC  000100001          0200           TBIT     2          TEST CLR OR PROB FIN FLG
004C  0099  100000000  0287    0201           BRANCH   NEWENT
0018  0080  001001011          0202           TCY      13
0031  00E3  000100001          0203           TBIT     2          2ND OPRD ?
0062  00C5  101001111  0306    0204           BRANCH   SECOPR     YES
0045  008A  000100011          0205           TBIT     3          1ST OPRD ?
000A  0094  101111111  0294    0206           BRANCH   INSFST     YES
0015  00AB  010000101          0207           BL       CHKANS
002B  00D7  100000001  1324    0208
0056  00AD  000101001          0209  OPRKEY   TMA
002C  00D8  011100010          0210           ALEC     4
0058  0081  101000001  0214    0211           BRANCH   OPRKY
0030  00F0  010001111          0212           BL       CLREGA     R5 IS CLR KEY
0060  00C1  100000000  1969    0213
0041  0082  001000111          0214  OPRKY    TCY      MODE
0002  0084  000100000          0215           TBIT     USER
0005  008B  101111000  0222    0216           BRANCH   OPRUSE
0008  0097  000110011          0217           RNEZ
0017  00AF  101011110  0220    0218           BRANCH   OPRKYOTH
002F  00DF  100001001  0250    0219           BRANCH   DISPLAY    WIPE OUT NO-OP
005E  00BD  010000110          0220  OPRKYOTH BL       OPKOTH
003C  00F8  100000000  0802    0221
007A  00F1  010100110          0222  OPRUSE   RBIT     1
0071  00E2  011100000          0223           ALEC     0
```

TABLE I-1 (cont)

```
0063  00C6  101011001  0234  0224                BRANCH   EQUAL
0047  008E  001000011        0225  OPRUS1        TCY      12
000E  009C  000100001        0226                TBIT     2
0010  00BB  100001001  0250  0227                BRANCH   DISPLAY
003B  00E7  001001011        0228                TCY      13          TEST 1ST OPRD
 076  00ED  000100011        0229                TBIT     3
 06D  00DA  100110110  0232  0230                BRANCH   OPRKY1
005B  00B6  100001001  0250  0231                BRANCH   DISPLAY     IGNORE IF NO 1ST OPRD
0036  00EC  010001111        0232  OPRKY1        BL       OPRKY2
006C  00D9  101000110  2081  0233
0059  00B2  001001011        0234  EQUAL         TCY      13          TEST 1ST OPRD  (EQUAL KEY)
0032  00E4  000100011        0235                TBIT     3
0064  00C9  100001001  0250  0236                BRANCH   DISPLAY     IGNORE IF NO 2ND OPRD
0049  0092  001000011        0237                TCY      12
0012  00A4  000100001        0238                TBIT     2
0025  00C8  100001001  0250  0239                BRANCH   DISPLAY
004A  0095  001000010        0240                TCY      4
0014  00A8  000110010        0241                IMAC
0029  00D3  100001001  0250  0242                BRANCH   DISPLAY
0052  00A5  001001011        0243  EQUALS        TCY      13
0024  00C8  010100101        0244                RBIT     2
0048  0091  010100010        0245                SBIT     1           SET ANS FLG
0010  00A0  010011110        0246  SETEQ         LDX      H
0021  00C3  001000010        0247                TCY      4
0042  0085  010100000        0248                SBIT     0
0004  0088  010111111        0249                RETN
0009  0093  010000000        0250  DISPLAY       BL       SCAN
0013  00A7  101101111  0041  0251
0027  00CF  010001111        0252  TOPKEY        LDP      15
004E  009D  000100000        0253                TBIT     0           R5 ?
001C  00B8  101110100  2006  0254                BRANCH   VSSKEY      YES
 039  00F3  001000011        0255                TCY      12
0072  00E5  010100110        0256                RBIT     1           CLEAR TIMER FLAG
0065  00CA  001000111        0257                TCY      MODE        SET GAMES FLG
004B  0096  001100100        0258                TCMIY    2
0016  00AC  010000111        0259                LDP      14
0020  00D8  011100100        0260                ALEC     2
005A  00B5  100000000  1840  0261                BRANCH   FORCEOUT
0034  00E8  010001101        0262                LDP      11
0068  00D1  011100010        0263                ALEC     4
```

```
0051  00A2  100000000  1452  0264                BRANCH    NUMGUESS
0022  00C4  010001111        0265                BL        BLUPKY
0044  0089  100010110  2070  0266
0008  0090  001000011        0267    GOKEY       TCY       12
0011  00A3  010100010        0268                SBIT      1
0023  00C7  001000111        0269                TCY       MODE
0046  008D  000100000        0270                TBIT      0           TEST USER ENTRY MODE
000C  009B  101010000  0283  0271                BRANCH    USERGO
 019  00B3  001001011        0272                TCY       13
0033  00E7  001100100        0273                TCMIY     2
0066  00CD  000100010        0274                TBIT      1
004D  009A  100001001  0250  0275                BRANCH    DISPLAY
001A  00B4  010001010        0276                LDP       5
0035  00EB  000100011        0277                TBIT      3
006A  00D5  101001111  0692  0278                BRANCH    ELCGO
0055  00AA  000100001        0279                TBIT      2
002A  00D4  101001001  0752  0280                BRANCH    BOXGO
0054  00A9  010000010        0281              BL        BLUPGO
0028  00D0  100100111  0639  0282
0050  00A1  010000011        0283    USERGO      LDP       12
0020  00C0  010100010        0284              SBIT      1
0040  0081  100001011  1640  0285                BRANCH    MEMGO
```

LE I-2

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS	
0000	0100	001100000		0287	NEWENT	TCMIY	0	CLEAR TIMER, PROB FIN FLAG
0001	0103	010001111		0288		CALLL	CLCOM	
0003	0107	110000001	1970	0289				
0007	010F	010001111		0290		CALLL	BLANKD	
000F	011F	111111011	1979	0291				
001F	013F	001001011		0292		TCY	13	SET 1ST OPRD FLG
003F	017F	001100001		0293		TCMIY	8	
007F	017E	001001000		0294	INSFST	TCY	1	1ST OPRD
007E	017D	000000011		0295	INSNUM	XMA		
007D	017A	000000100		0296		DYN		
007A	0176	000000011		0297		XMA		
0077	016E	011101001		0298		ALEC	9	
006F	015E	100110000	0341	0299		BRANCH	REVERS	
005F	013E	000110011		0300		MNEZ		BLANK LEADING ZERO
003E	017C	101111001	0303	0301		BRANCH	INSNMI	
007C	0179	000101111		0302		TAM		

TABLE I-2 (cont)

```
0079  0172  010111111          0303  INSNM1   RETN
0073  0166  010000000          0304           BL        SCAN
0067  014E  101101111    0041  0305
004F  011E  001100010          0306  SECOPR   TCMIY     4          CLEAR 1ST OPR, REM FLAG & SET 2ND OPR
001E  013C  001000010          0307           TCY       4
003D  017A  111111110    0295  0308           CALL      INSNUM
007A  0175  001000010          0309  START    TCY       4
0075  016A  010010000          0310  START1   LDX       A          2ND OPRD TO DAM
006B  0156  000110010          0311           IMAC
0057  012E  100000110    0319  0312           BRANCH    START3
002E  015C  000101001          0313           TMA
005C  0139  010010001          0314           LDX       DAM
003A  0170  011111011          0315           YMCY      13
0070  0161  000101101          0316           TAMIYC
0061  0142  001010100          0317           YNEC      2
0043  0106  101110101    0310  0318           BRANCH    START1
0006  010C  010010001          0319  START3   LDX       DAM
000D  011A  011111011          0320           YMCY      13
001A  0137  000000110          0321  START4   CLA
0037  016E  000101100          0322  START5   TAMDYN
006E  015D  100110111    0322  0323           BRANCH    START5
005D  013A  010111111          0324           RETN
003A  0174  001001000          0325  START8   TCY       1
0074  0169  010010000          0326  START6   LDX       A          1ST OPRD TO REG B
0069  0152  000110010          0327           IMAC
0053  0126  100001010    0335  0328           BRANCH    START7
0026  014C  000101001          0329           TMA
004C  0119  010011000          0330           LDX       B
0018  0130  000000101          0331           IYC
0031  0163  000101100          0332           TAMDYN
0062  0145  000000100          0333           DYN
0045  010A  101110100    0326  0334           BRANCH    START6
000A  0114  010011000          0335  START7   LDX       B
0015  0128  000000101          0336           IYC
002B  0157  010111111          0337           RETN
0056  0120  110011011    0321  0338           CALL      START4
002C  0158  010001100          0339           BL        START9
0058  0131  101101110    0452  0340
0030  0160  000000011          0341  REVERS   XMA
```

TABLE I-2 (cont)

```
0060  0141  000000101          0342            IYC
0041  0102  000000011          0343            XMA
0002  0104  101111001  0303    0344            BRANCH   INSNM1
0005  0108  001000010          0345  MEMBNK    TCY      8
0008  0117  000110010          0346            IMAC
0017  012F  101111001  0303    0347            BRANCH   INSNM1
002F  015F  111000010  0377    0348  MEMR1     CALL     MEMCNT
005E  013D  001110110          0349            ACACC    6
003C  017A  101111001  0303    0350            BRANCH   INSNM1
0078  0171  010010000          0351            LDX      A
0071  0162  001000111          0352            TCY      MODE
0063  0146  000100000          0353            TRIT     0          USER ?
0047  010E  100011101  0356    0354            BRANCH   MEMBK1     YES
000E  011C  101111001  0303    0355            BRANCH   INSNM1
001D  013A  010100010          0356  MEMBK1    SBIT     1
003A  0177  001000011          0357            TCY      12
0076  016D  001100010          0358            TCMIY    8
006D  015A  010110010          0359            COMXB
005A  0136  111001101  0404    0360            CALL     DAMTOR
0036  016C  111000010  0377    0361            CALL     MEMCNT
006C  0159  000110010          0362            IMAC
0059  0132  000101111          0363            TAM
0032  0164  010010010          0364            LDX      E
0064  0149  001110110          0365            ACACC    6
0049  0112  101001101  0404    0366            BRANCH   DAMTOR     MOVE TO REG #10
0012  0124  010011100          0367            LDX      D
0025  0148  001111000          0368  MEMBK6    ACACC    1
004A  0115  101001101  0404    0369            BRANCH   DAMTOR     9TH
0014  0128  001111000          0370            ACACC    1
0029  0153  100100010  0394    0371            BRANCH   MOV59
0052  0125  001111000          0372            ACACC    1
0024  0148  100111001  0384    0373            BRANCH   MOV10
0048  0111  010111111          0374            RETN
0010  0120  010011010          0375            LDX      F
0021  0143  110100101  0368    0376            CALL     MEMBK6
0042  0105  010010100          0377  MEMCNT    LDX      C
0004  0108  001001111          0378            TCY      15
0009  0113  000101001          0379            TMA
0013  0127  010111111          0380            RETN
0027  014F  001110011          0381            ACACC    12
```

```
004E  011D  100100000  0413  0382                BRANCH   MEMRTN
001C  0138  100100101  0368  0383                BRANCH   MEMBK6
0039  0173  001000010        0384  MOV10         TCY      4
0072  0165  010110010        0385  MOV101        COMX8
0065  014A  000101001        0386                TMA
004B  0116  011111001        0387                YMCY     9
0016  012C  010110010        0388                COMX8
002D  015B  000101100        0389                TAMDYN
005A  0135  011111010        0390                YMCY     5
0034  0168  001011111        0391                YNEC     15
0068  0151  101110010  0385  0392                BRANCH   MOV101
0051  0122  101010000  0412  0393                BRANCH   MEMR
0022  0144  001000010        0394  MOV59         TCY      4
0044  0109  010110010        0395  MOV591        COMX8
0008  0110  000101001        0396                TMA
0011  0123  011110010        0397                YMCY     4
0023  0147  010110010        0398                COMX8
0046  010D  000101100        0399                TAMDYN
000C  011B  011110101        0400                YMCY     10
0019  0133  001011111        0401                YNEC     15
0033  0167  101000100  0395  0402                BRANCH   MOV591
0066  0140  101010000  0412  0403                BRANCH   MEMR
0040  011A  001000010        0404  DAMTOR        TCY      4
001A  0134  010110010        0405  MEMBK3        COMX8
0035  016B  000110010        0406                IMAC
006A  0155  100101010  0409  0407                BRANCH   MEMBK4
0055  012A  000101001        0408                TMA
002A  0154  010110010        0409  MEMBK4        COMX8
0054  0129  000101100        0410                TAMDYN
0028  0150  100011010  0405  0411                BRANCH   MEMBK3
0050  0121  010111111        0412  MEMR          RETN
0020  0140  010000010        0413  MEMRTN        BL       EFFIX
0040  0101  101010101  0667  0414
```

TABLE I-3

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS
0000	0180	010011000		0416	ADDB	LDX	B	B = B + DAM .
0001	0183	001000100		0417	ADD	TCY	2	
0003	0187	010110100		0418		REAC		
0007	018F	010110001		0419		SAL		
000F	019F	000010000		0420	ADDBEG	DMFA		

TABLE I-3 (cont)

```
001F  01BF  011010110        0421            TAMACS   6
003F  01FF  000011000        0422            CTMDYN
007F  01FE  100001111  0420  0423            BRANCH   ADDBEG
007E  01FD  000010010        0424            CCLA
007D  01FA  010111111        0425            RETN
007B  01F6  100110010  0493  0426            BRANCH   OPRFIN
0077  01EE  000100001        0427  SUBCHK    TBIT     2
006F  01DE  100000000  0416  0428            BRANCH   ADDB
005F  01BE  010011000        0429  SUBTB     LDX      B          B = B - DAM
003E  01FC  001000100        0430  SUBT      TCY      2
007C  01F9  010110101        0431            SEAC
0079  01F2  000010011        0432  SUBT1     NOMEA
0073  01E6  011010101        0433            TAMACS   10
0067  01CE  000011000        0434            CTMDYN
004F  019E  101111001  0432  0435            BRANCH   SUBT1
001E  01BC  000010010        0436            CCLA
003D  01FB  010111111        0437            RETN
007A  01F5  001111111        0438            ACACC    15
0075  01EA  100110010  0493  0439            BRANCH   OPRFIN
006B  01D6  000000110        0440  REVRS1    CLA                 BORROW ON SUBT
0057  01AE  001111111        0441            ACACC    15
002E  01DC  010010000        0442            LDX      A
005C  01B9  001000111        0443            TCY      14
0038  01F0  010001010        0444            LDP      5
0070  01E1  000100011        0445            TBIT     3
0061  01C2  100010110  0774  0446            BRANCH   NXTTABA
0043  0186  001001100        0447            TCY      3
0006  018C  010000100        0448            CALLL    REVERS
000D  019B  110110000  0341  0449
0018  0167  010000100        0450            BL       START
0037  01EF  101111010  0309  0451
006E  01DD  010001111        0452  START9    CALLL    CLCOM
005D  01BA  110000001  1970  0453
003A  01F4  010010000        0454            LDX      A
0074  01E9  001000101        0455            TCY      10
0069  01D2  000101001        0456            TMA                 OPR SEG NO TO ACC
0053  01A6  001000111        0457            TCY      14
0026  01CC  011101000        0458            ALEC     1
004C  0199  100000000  0416  0459            BRANCH   ADDB
0018  0180  011100100        0460            ALEC     2
```

```
0031  01E3  101110111  0427  0461                BRANCH  SUBCHK
0062  01C5  011101100        0462                ALEC    3
0045  018A  100010010  0496  0463                BRANCH  MULTP
000A  0194  000100001        0464                TBIT    2
0015  01AB  100010010  0496  0465                BRANCH  MULTP
002B  01D7  010010001        0466  DIVIDE        LDX     DAM
0056  01AD  001000100        0467  CHKZRO        TCY     2
002C  01DB  000110011        0468  DIVID1        MNEZ
0058  01B1  100001011  0475  0469                BRANCH  DIVID2
0030  01E0  000000100        0470                DYN
0060  01C1  100101100  0468  0471                BRANCH  DIVID1
0041  0182  010111111        0472                RETN
0002  0184  010001111        0473                BL      DIVZRO
0005  018B  100110011  2084  0474
000B  0197  010111111        0475  DIVID2        RETN
0017  01AF  111011111  0429  0476                CALL    SUBTB
002F  01DF  011100000        0477                ALEC    0       BORROW ?
005E  01BD  101101101  0488  0478                BRANCH  DIVID4  YES (REM)
003C  01FB  010010110        0479                LDX     6
0078  01F1  001000100        0480                TCY     2
0071  01E2  000110010        0481  DIVID3        IMAC
0063  01C6  000101111        0482                TAM
0047  018F  011101001        0483                ALEC    9
000E  019C  100001011  0475  0484                BRANCH  DIVID2
001D  01BB  001100000        0485                TCMIY   0
003B  01F7  001001000        0486                TCY     1
0076  01ED  101110001  0481  0487                BRANCH  DIVID3
006D  01DA  110000000  0416  0488  DIVID4        CALL    ADDB
005B  01B6  110010010  0496  0489                CALL    MULTP
0036  01EC  111010110  0467  0490                CALL    CHKZRO
006C  01D9  001011111        0491                YNEC    15
0059  01B2  100001100  0529  0492                BRANCH  REM
0032  01E4  010010000        0493  OPREIN        LDX     A
0064  01C9  010000001        0494  BLCNT         BL      MAYCNT
0049  0192  100010100  1143  0495
0012  01A4  001000100        0496  MULTP         TCY     2
0025  01CB  010011000        0497  EXCOM         LDX     8
004A  0195  000101001        0498                TMA
0014  01A8  000000000        0499                COMX
0029  01D3  000000011        0500                XMA
0052  01A5  000000000        0501                COMX
```

```
0024  01C8  000101100          0502                TAMDYN
0048  0191  100100101  0497    0503                BRANCH    EXCOM
0010  01A0  010010110          0504    SETG3       LDX       6
0021  01C3  001001100          0505                TCY       3
0042  0185  010111111          0506                RETN
0004  018A  001100100          0507                TCMIY     2
0009  0193  110010000  0504    0508    MULTP1      CALL      SETG3
0013  01A7  000101010          0509                TMY
0027  01CF  000000111          0510                DMAN
004E  019D  101001011  0516    0511                BRANCH    MULTP2
001C  01B8  110010000  0504    0512                CALL      SETG3
0039  01F3  000000111          0513                DMAN
0072  01E5  101101000  0521    0514                BRANCH    MULTP4
0065  01CA  100110010  0493    0515                BRANCH    OPREIN
0048  0196  000101111          0516    MULTP2      TAM
0016  01AC  110006000  0416    0517                CALL      ADDR
002D  01DB  011100000          0518                ALEC      0
005A  0185  100001001  0508    0519                BRANCH    MULTP1
0034  01E8  101101011  0440    0520    MULTP3      BRANCH    REVRS1
0068  01D1  000101111          0521    MULTP4      TAM
0051  01A2  010010001          0522                LDX       DAM
0022  01C4  001000100          0523                TCY       2
0044  0189  000000110          0524                CLA
0008  0190  000000011          0525    SHFL        XMA
0011  01A3  000000100          0526                DYN
0023  01C7  100001000  0525    0527                BRANCH    SHFL
0046  018D  100001001  0508    0528                BRANCH    MULTP1
000C  019B  001000100          0529    REM         TCY       2
0019  01B3  000101001          0530    MOVREM      TMA
0033  01E7  011110101          0531                YMCY      10
0066  01CD  000101100          0532                TAMDYN
0040  019A  011110010          0533                YMCY      8
001A  01B4  001010000          0534                YNEC      0
0035  01EB  100011001  0530    0535                BRANCH    MOVREM
006A  01D5  010010000          0536                LDX       A
0055  01AA  001000111          0537                TCY       14
002A  01D4  010001010          0538                LDP       5
0054  01A9  000100011          0539                TBIT      3
0028  01D0  100101001  0757    0540                BRANCH    ELCNXT
0050  01A1  001001011          0541              TCY       13
0020  01C0  010000001          0542                BL        MAYREM
0040  0181  101001010  1142    0543
```

TABLE I-4 SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS
0000	0200	001001010		0545	ERROR	TCY	5
0001	0203	010001111		0546		CALLL	BLANK1
0003	0207	111101111	1981	0547			
0007	020F	001000011		0548	ERRORB	TCY	12
000F	021F	010100101		0549		RBIT	2
001F	023F	010010001		0550		LDX	DAM
003F	027F	010001111		0551		CALLL	BLANK
007F	027E	111110111	1980	0552			
007E	027D	001001010		0553		TCY	5
007D	027A	001101011		0554		TCMIY	13
007B	0276	001101011		0555		TCMIY	13
0077	026E	001101011		0556		TCMIY	13
006F	025F	010000101		0557		CALLL	CNTDTG
005F	023E	110100010	1430	0558			
003E	027C	001001001		0559	EXRDM	TCY	9
007C	0279	000101001		0560	EXRDM1	TMA	
0079	0272	000011001		0561		XDA	
0073	0266	000101100		0562		TAMDYN	
0067	024E	101111100	0560	0563		BRANCH	EXRDM1
004F	021E	010111111		0564		RETN	
001E	023C	010001111		0565		CALLL	CLCDM
0030	0278	110000001	1970	0566			
007A	0275	001000001		0567		TCY	8
0075	026A	001100001		0568		TCMIY	8
0068	0256	010000000		0569	ERROR1	CALLL	NOSCAN
0057	022E	111100111	0047	0570			
002E	025C	001000101		0571		TCY	10
005C	0239	010000111		0572		CALLL	SHORTVAR
0038	0270	110001100	1954	0573			
0070	0261	001111111		0574		ACACC	15
0061	0242	101101011	0569	0575		BRANCH	ERROR1
0043	0206	010010000		0576		LDX	A
0006	020C	110111110	0559	0577		CALL	EXRDM
000D	0218	010011110		0578	STOPEQ	LDX	H
0018	0237	001000100		0579		TCY	2
0037	026F	001100001		0580		TCMIY	8
006E	0250	001000010		0581		TCY	4
0050	023A	001101000		0582		TCMIY	1

TABLE I-4 (cont)

```
003A  0274  010111111          0583                RETN
0074  0269  010011000          0584                LDX     B          B9 ERROR COUNT
0069  0252  001001001          0585                TCY     9
0053  0226  000100000          0586                TBIT    0
0026  024C  101100010  0591    0587                BRANCH  ERROR3
004C  0219  010100000          0588                SBIT    0
0019  0230  010001001          0589    BLRANT      BL      RANTHINK
0031  0263  100101110  1220    0590
0062  0245  001100001          0591    ERROR3      TCMIY   8
0045  020A  000110010          0592                IMAC
000A  0214  000101111          0593                TAM
0015  0228  010010000          0594                LDX     A
0028  0257  001000111          0595                TCY     10
0056  022D  000100001          0596                TBIT    2
002C  0258  100100010  0653    0597                BRANCH  BOXERA
0058  0231  001000100          0598    ERROR9      TCY     2
0030  0260  010011000          0599    ERROR4      LDX     8
0060  0241  000101001          0600                TMA
0041  0202  011110010          0601                YMCY    4
0002  0204  010010000          0602                LDX     A
0005  020B  000101111          0603                TAM
0009  0217  011111001          0604                YMCY    9
0017  022F  001011111          0605                YNEC    15
002F  025F  100110000  0599    0606                BRANCH  ERROR4
005E  023D  001001010          0607    LEADZ       TCY     5
003C  0278  000110011          0608    ERROR7      MNEZ
0078  0271  100001110  0613    0609                BRANCH  ERROR8
0071  0262  001101111          0610                TCMIY   15
0063  0246  001011110          0611                YNEC    7
0047  020E  100111100  0608    0612                BRANCH  ERROR7
000E  021C  010111111          0613    ERROR8      RETN
001D  0239  001001011          0614    BXER9       TCY     13
003B  0277  000100000          0615                TBIT    0
0076  0260  101011011  0618    0616                BRANCH  BXER10
0060  025A  101100100  0623    0617                BRANCH  BXER11
0058  0236  000000110          0618    BXER10      CLA
0036  026C  001111111          0619                ACACC   15
006C  0259  010010000          0620                LDX     A
0059  0232  010000101          0621                CALLL   INSREM
0032  0264  110000000  1323    0622
```

TABLE 1-4 (cont)

```
0064  0249  010000101        0623  BXER11   BL        SHOW
0049  0212  101010011  1364  0624
0012  0224  010010010        0625  TIMER0A  LDX       TIME
0025  0248  001000011        0626           TCY       12
004A  0215  000110010        0627  TIMOT1   IMAC
0014  0228  101000010  0635  0628           BRANCH    TIMOT2
0029  0253  000101111        0629           TAM
0052  0225  000000110        0630           CLA
0024  0248  001110100        0631           ACACC     2
0048  0211  001000011        0632           TCY       12
0010  0220  010000000        0633           BL        HDELAY
0021  0243  101101110  0065  0634
0042  0205  000101101        0635  TIMOT2   TAMIYC
0004  0208  001010000        0636           YNEC      0
0009  0213  101001010  0627  0637           BRANCH    TIMOT1
0013  0227  010110110        0638           OFF
0027  024F  010011000        0639  BLUPG0   LDX       8          RANDOM BLOW UP TIME
                             0640  *        @ 300KHZ, MIN TIME = 8 SEC, MAX TIME = 48 SEC
004E  021D  001000001        0641           TCY       8
001C  0238  000101001        0642           TMA
0039  0273  001001010        0643           TCY       5
0072  0265  101001011  0646  0644           BRANCH    BLUPR2
0065  024A  001110010        0645  BLUPR1   ACACC     4          6,7,8,9,6,7,8,9,8,9
0048  0216  011101010        0646  BLUPR2   ALEC      5
0016  022C  101100101  0645  0647           BRANCH    BLUPR1
002D  0258  000101111        0648  BLUPR3   TAM
005A  0235  010000001        0649  BOXG02   CALLL     CLSCOR     CLEAR B 9,10,11
0030  0268  111000001  1115  0650
0068  0251  010001110        0651           BL        BOXNXT
0051  0222  100000000  0931  0652
0022  0244  010000110        0653  BOXERA   CALLL     BOXAN
0044  0209  110011101  0871  0654
0008  0210  010000101        0655           CALLL     CNTDIG
0011  0223  110100010  1430  0656
0023  0247  010000101        0657  BOXERB   CALLL     CHKBOX
0046  0200  111111111  1330  0658
000C  021A  010000110        0659           CALLL     GETCNT
0019  0233  110101001  0886  0660
0033  0267  001001001        0661           TCY       9
0066  024D  000000111        0662           DMAN
```

```
004D  021A  100110101  0665  0653                BRANCH   BOXERC
001A  0234  100011101  0614  0664                BRANCH   HxER9
0035  026A  000101111        0665  BOXERC        TAM
006A  0255  100100011  0657  0666                BRANCH   BOXERB
0055  022A  010011000        0667  EFFIX  LDX    8
002A  0254  001001001        0668         TCY    9
0054  0229  010100100        0669         RBIT   0
0028  0250  010001111        0670         BL     BLANKD
0050  0221  101111011  1979  0671
```

TABLE I-5

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS	
0000	0280	001001011		0673	BOXNUM	TCY	13	ANS FLG ?
0001	0283	000100010		0674		TBIT	1	
0003	0287	101110111	0684	0675		BRANCH	BLUPNM	
0007	028F	010011000		0676		LDX	8	
000F	029F	001001100		0677		TCY	3	
001F	02BF	010100101		0678		RBIT	2	
003F	02FF	011101000		0679		ALEC	1	
007F	02FE	101111101	0682	0680		BRANCH	BOXNM2	
007E	02FD	010100001		0681		SBIT	2	
007D	02FA	010001111		0682	BOXNM2	BL	BOXOK1	
007B	02F6	100010000	2057	0683				
0077	02EF	001001011		0684	BLUPNM	TCY	13	
006F	02DE	010000110		0685		LDP	6	
005F	02BE	000100010		0686		TBIT	1	
003E	02FC	100011101	0871	0687		BRANCH	BOXAN	
007C	02F9	010000000		0688	BLSCN	BL	SCAN	
0079	02F2	101101111	0041	0689				
0073	02E6	010000101		0690	ELCANS	BL	CHKANS	
0067	02CE	100000001	1324	0691				
004F	029E	010001000		0692	ELCGO	CALLL	SETEO	
001E	02BC	110010000	0246	0693				
003D	02FB	010001111		0694		CALLL	CLREGB	
007A	02F5	110110101	2088	0695				
0075	02EA	010010000		0696	SETANS	LDX	A	
006B	0206	001001011		0697		TCY	13	
0057	02AE	001100100		0698		TCMIY	2	
002E	02DC	001001001		0699		TCY	9	
005C	02B9	001100000		0700		TCMIY	0	CLEAR DIGIT COUNT

TABLE I-5 (cont)

```
0038  02F0  001000011          0701            TCY     12
0070  02E1  000100000          0702            TRIT    0
0061  02C2  100001010  0721    0703            BRANCH  ELOPN
0043  0286  001000010          0704            TCY     4       SET 2ND OPRD = 0
0006  028C  001100000          0705            TCMIY   0
000D  0298  001001000          0706            TCY     1       TAB # TO ACC
0018  02B7  000101001          0707            TMA
0037  02EF  001000101          0708    ELNOP4  TCY     10      OP TO Y
006E  02DD  000101010          0709            TMY
005D  02BA  001010010          0710            YNEC    4       DIV ?
003A  02F4  101101001  0713    0711            BRANCH  ELNOP1  NO
0074  02E9  001101000          0712            TCMIY   1
0069  0202  010011000          0713    ELNOP1  LDX     8
0053  0246  001011100          0714            YNEC    3       * ?
0026  02CC  100110001  0718    0715            BRANCH  ELNOP3  NO
004C  0299  000101111          0716    ELNOP2  TAM
0018  02B0  101111100  0688    0717            BRANCH  BLSCN
0031  02E3  001001100          0718    ELNOP3  TCY     3
0062  02C5  000101100          0719            TAMDYN
0045  028A  101001100  0716    0720            BRANCH  ELNOP2
000A  0294  001000000          0721    ELOPN   TCY     0
0015  02AB  001101111          0722            TCMIY   15
0028  02D7  001100000          0723            TCMIY   0
0056  02AD  001000010          0724            TCY     4
002C  02D8  000101001          0725            TMA
0058  02B1  001000101          0726            TCY     10
0030  02E0  000100000          0727            TRIT    0
0060  02C1  100110111  0708    0728            BRANCH  ELNOP4
0041  0282  000100001          0729            TRIT    2
0002  0284  101111000  0737    0730            BRANCH  ELCDIV
0005  0288  001001000          0731            TCY     1
0008  0297  000101101          0732            TAMIYC
0017  02AF  010011000          0733    ELOPN1  LDX     8
002F  02DF  001011000          0734            YNEC    1
005E  02BD  101111100  0688    0735            BRANCH  BLSCN
003C  02F8  100110001  0718    0736            BRANCH  ELNOP3
0078  02F1  001111111          0737    ELCDIV  ACACC   15
0071  02E2  100010111  0733    0738            BRANCH  ELOPN1
0063  02C6  001111001          0739            ACACC   9
0047  028F  010001111          0740            BL      VSS1
```

TABLE I-5 (cont)

```
000E  029C  100100110  2011  0741
0010  02BB  001001011        0742  ELCNUM  TCY     13        ANS FLG ?
003D  02F7  000160010        0743          TBIT    1
0076  02ED  101110011  0690  0744          BRANCH  ELCANS    YES
006D  02DA  001000011        0745          TCY     12
0058  0286  000100000        0746          TBIT    0         OPR,NUM ?
0036  02EC  100110010  0750  0747          BRANCH  OPRN      YES
006C  02D9  001100010        0748          TCMIY   4
0059  02B2  011111101        0749          YMCY    11        NUM,OPR
0032  02E4  011111110        0750  OPRN    YMCY    7         OPR,NUM
0064  02C9  101001100  0716  0751          BRANCH  ELNOP2    INSERT TABLE NUMBER
0049  0292  001000010        0752  BOXGO   TCY     4
0012  02A4  010000001        0753          CALL    CLANB     CLEAR ELAPSED TIME
0025  02C4  110000010  1117  0754
004A  0295  010000010        0755          BL      BOXGO2
0014  02A8  101011010  0649  0756
0029  02D3  001001010        0757  ELCNXT  TCY     5
0052  02A5  010001111        0758          CALL    BLANK1
0024  02C8  111101111  1981  0759
0048  0291  001000011        0760          TCY     12
0010  02A0  000100000        0761          TBIT    0
0021  02C3  101010001  0779  0762          BRANCH  ELCNX2    YES
0042  0285  001000010        0763          TCY     4
0004  0288  000110010        0764  ELCNX1  IMAC
0009  0293  000101111        0765          TAM
0013  02A7  010000100        0766          LDP     2
0027  02CF  011101001        0767          ALEC    9
004E  029D  101111010  0309  0768          BRANCH  START
001C  0298  001100000        0769          TCMIY   0
0039  02F3  010010000        0770          LDX     A
0072  02E5  010001010        0771          LDP     5
0065  02CA  001011010        0772          YNEC    5
004B  0296  100110100  0777  0773          BRANCH  OPNNXT
0016  02AC  001001000        0774  NXTTABA TCY     1
002D  02DB  010000110        0775  NXTTAB  BL      NXTTB1
005A  02B5  101000011  0833  0776
0034  02E8  001000010        0777  OPNNXT  TCY     4
0068  02D1  100101101  0775  0778          BRANCH  NXTTAB
0051  02A2  001000101        0779  ELCNX2  TCY     10
0022  02C4  000100001        0780          TBIT    2
```

0044	0289	100100011	0784	0781		BRANCH	ELCDV
0008	0290	001001000		0782		TCY	1
0011	02A3	100000100	0764	0783		BRANCH	ELCNX1
0023	02C7	001000010		0784	ELCDV	TCY	4
0046	028D	000101001		0785		TMA	
000C	0298	001001000		0786		TCY	1
0019	02B3	000010101		0787		ANAAC	
0033	02E7	100011010	0791	0788		BRANCH	OVR16
0066	02CD	011101001		0789		ALEC	9
004D	029A	100101010	0795	0790		BRANCH	ELCDV1
001A	0284	001110110		0791	OVR16	ACACC	6
0035	02EB	000101100		0792		TAMDYN	
006A	02D5	000110010		0793		IMAC	
0055	02AA	100100000	0799	0794		BRANCH	ELCDV3
002A	02D4	000101111		0795	ELCDV1	TAM	
0054	02A9	010011000		0796	ELCDV2	LDX	8
0028	02D0	001000100		0797		TCY	2
0050	02A1	100000100	0764	0798		BRANCH	ELCNX1
0020	02C0	001101000		0799	ELCDV3	TCMIY	1
0040	0281	101010100	0796	0800		BRANCH	ELCDV2

TABLE I-6 SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS
0000	0300	011100000		0802	OPKOTH	ALEC	0
0001	0303	101101111	0814	0803		BRANCH	NOPOPK = NO OP
0003	0307	000100010		0804		TBIT	1 GAME NO OP
0007	030F	101101111	0814	0805		BRANCH	NOPOPK
000F	031F	001001011		0806		TCY	13 ANS FLG SET ?
001F	033F	000100010		0807		TBIT	1
003F	037F	101101111	0814	0808		BRANCH	NOPOPK YES
007F	037F	010001111		0809		CALLL	SETOPR
007F	0370	110010101	2018	0810			
007D	037A	001000111		0811		TCY	MODE
007B	0376	000100011		0812		TBIT	3
0077	036E	100111110	0816	0813		BRANCH	ELCOPP
006F	035E	010000000		0814	NOPOPK	BL	SCAN
005F	033E	101101111	0041	0815			
003E	037C	001000011		0816	ELCOPR	TCY	12
007C	0379	000110011		0817		MNEZ	
0079	0372	101101111	0814	0818		BRANCH	NOPOPK
0073	0366	001101010		0819		TCMIY	5

TABLE I-6 (cont)

0067	034E	001001000		0820		TCY	1
004F	031E	000101001		0821		TMA	
001E	033C	001101111		0822		TCMIY	15
003D	037B	001000010		0823		TCY	4
007A	0375	000101111		0824		TAM	
0075	036A	101101111	0814	0825		BRANCH	NOPOPK
006B	0356	001000011		0826	NXTDIV	TCY	12
0057	032E	000100000		0827		TBIT	0
002E	035C	100111000	0830	0828		BRANCH	NXTDV2
005C	0339	101110100	0841	0829		BRANCH	NXTTB2
0038	0370	001000010		0830	NXTDV2	TCY	4
0070	0361	001101000		0831		TCMIY	1
0061	0342	101110100	0841	0832		BRANCH	NXTTB2
0043	0306	000110010		0833	NXTTB1	IMAC	
0006	030C	000101111		0834		TAM	
000D	0318	011101001		0835		ALEC	9
001B	0337	101110100	0841	0836		BRANCH	NXTTB2
0037	036E	001100000		0837		TCMIY	0
006E	0350	001000101		0838		TCY	10
005D	033A	000100001		0839		TBIT	2
003A	0374	101101011	0826	0840		BRANCH	NXTDIV
0074	0369	001001011		0841	NXTTB2	TCY	13
0069	0352	010100110		0842		RBIT	1
0053	0326	001000011		0843		TCY	12
0026	034C	000100000		0844		TBIT	0
004C	0319	100110001	0847	0845		BRANCH	NXTTB3
0018	0330	011110100		0846		YMCY	2
0031	0363	011111100		0847	NXTTB3	YMCY	3
0062	0345	001101111		0848		TCMIY	15 CLEAR VARIABLE OPERAND
0045	030A	001101111		0849		TCMIY	15
000A	0314	001001001		0850	NXTMEM	TCY	9
0015	032B	010011000		0851		LDX	8
002B	0357	010100001		0852		SBIT	2
0056	032D	010000101		0853		BL	ERRELF
002C	0358	101101100	1398	0854			
0058	0331	010010000		0855	SCORE	LDX	A
0030	0360	001000111		0856		TCY	MODE
0060	0341	000110011		0857		MNEZ	
0041	0302	100001011	0861	0858		BRANCH	SCOR1

TABLE I-6 (cont)

```
0002  0304  010000010          0859                BL          BOXGO2
0005  0308  101011010    0649  0860
0008  0317  010000010          0861    SCOR1       CALLL       EXRDM
0017  032F  110111110    0559  0862
002F  035F  010001111          0863                CALLL       BLANKD
005F  033D  111111011    1979  0864
003C  0378  010001111          0865                CALLL       CLCOM
0078  0371  110000001    1970  0866
0071  0362  001000001          0867                TCY         8
0063  0346  001100001          0868                TCMIY       6
0047  030E  010000001          0869                BL          SCORE2
000E  031C  100000000    1060  0870
001D  033B  001000000          0871    BOXAN       TCY         0           GET RID OF BRACKETS
003B  0377  000101001          0872    BOXAN2      TMA
0076  036D  011101001          0873                ALEC        9
0060  035A  101101100    0877  0874                BRANCH      BOXAN3
005B  0336  001010100          0875                YNEC        2
0036  036C  100100000    0928  0876                BRANCH      BOXAN4
006C  0359  000000101          0877    BOXAN3      IYC
0059  0332  001010001          0878    BOXAN5      YNEC        8
0032  0364  100111011    0872  0879                BRANCH      BOXAN2
0064  0349  010111111          0880                RETN
0049  0312  010000101          0881                CALLL       CHKBOX
0012  0324  111111111    1330  0882
0025  034B  001001111          0883                TCY         15
004A  0315  000001001          0884                MNEA
0014  0328  100100010    0909  0885                BRANCH      BOXERR
0029  0353  010011000          0886    GETCNT      LDX         6
0052  0325  001001100          0887                TCY         3
0024  0348  000100010          0888                TBIT        1
0048  0311  101101000    0907  0889                BRANCH      BOX3
0010  0320  000100000          0890                TBIT        0
0021  0343  100001001    0894  0891                BRANCH      BOX4
0042  0305  001001110          0892    BOX14       TCY         7
0004  030B  100010011    0895  0893                BRANCH      BOXAN1
0009  0313  001001000          0894    BOX4        TCY         1
0013  0327  010010000          0895    BOXAN1      LDX         A
0027  034F  000000011          0896                XMA
004E  031D  000000100          0897                DYN
001C  0338  000000011          0898                XMA
```

```
0039  0373  010111111          0899          RETN
0072  0365  010000101          0900          LDP     10
0065  034A  001110110          0901          ACACC   6
004B  0316  101110101  1346    0902          BRANCH  DECDIG
0016  032C  000000100          0903          DYN
002D  035B  001110101          0904          ACACC   10
005A  0335  000101111          0905          TAM
0034  036B  101110101  1346    0906          BRANCH  DECDIG
0068  0351  001000010          0907  BOX3    TCY     4
0051  0322  100010011  0895    0908          BRANCH  BOXAN1
0022  0344  010011000          0909  BOXERR  LDX     8
0044  0309  001001100          0910          TCY     3
0008  0310  000101001          0911           TMA
0011  0323  000100010          0912          TBIT    1
0023  0347  101101010  0922    0913          BRANCH  BOXER3
0046  0300  000100000          0914          TBIT    0
000C  0318  100110101  0921    0915          BRANCH  BXER1
0019  0333  001001010          0916          TCY     5
0033  0367  010010000          0917          LDX     A
0066  034D  001100101          0918          TCMIY   10
004D  031A  001101111          0919          TCMIY   15
001A  0334  100101010  0924    0920          BRANCH  BOXER4
0035  036A  001000000          0921  BXER1   TCY     0
006A  0355  010010000          0922  BOXER3  LDX     A
0055  032A  001100101          0923          TCMIY   10
002A  0354  001101101          0924  BOXER4  TCMIY   11
0054  0329  010111111          0925          RETN
0028  0350  010000010          0926          BL      ERRORB
0050  0321  100000111  0508    0927
0020  0340  001101111          0928  BOXAN4  TCMIY   15
0040  0301  101011001  0878    0929          BRANCH  BOXAN5
```

TABLE I-7

PC	LOC	INSTR.	BRLN.	LINE	SOURCE STATEMENT NAME	TITLE	COMMENTS
0000	0380	010001111		0931	BOXNXT	CALLL	BLANKD
0001	0383	111111011	1979	0932			
0003	0387	010011000		0933		LDX	B
0007	038F	000101001		0934		TMA	
000F	039F	001001000		0935		TCY	1
001F	03BF	010010000		0936		LDX	A
003F	03FF	000101111		0937		TAM	

TABLE I-7 (cont)

```
007F  03FE  001001110          0938  OPR29   TCY     7
007E  03FD  010011000          0939          LDX     8
007D  03FA  000101001          0940          TMA
007B  03F6  010010000          0941          LDX     A
0077  03EE  001000010          0942          TCY     4
006F  03DE  000101111          0943          TAM
005F  03BE  010111111          0944          RETN
003E  03FC  010001111          0945          CALLL   INSOPR
007C  03F9  110101100  2021    0946
0079  03F2  010011000          0947          LDX     8
0073  03E6  000100001          0948          TBIT    2
0067  03CE  101000101  0978    0949          BRANCH  LEV2
004F  039E  011101101          0950          ALEC    11
001E  03BC  101110000  0960    0951          BRANCH  LEV1AS
003D  03FB  011100011          0952          ALEC    12
007A  03F5  100110111  0966    0953          BRANCH  LEV1M
0075  03EA  111111111  0938    0954          CALL    OPR29
006B  03D6  011100010          0955          ALEC    4
0057  03AE  101011100  0958    0956          BRANCH  LEV1D
002E  03DC  001111101          0957          ACACC   11
005C  03B9  001111000          0958  LEV1D   ACACC   1
0038  03F0  000101111          0959  LEV1D1  TAM
0070  03E1  001000101          0960  LEV1AS  TCY     10
0061  03C2  000101001          0961          TMA
0043  0386  010000001          0962          LDP     8
0006  038C  011100100          0963          ALEC    2
000D  039A  101101010  1180    0964          BRANCH  LEVAS
001A  0387  101110010  1158    0965          BRANCH  LEVCHK
0037  03EF  111111111  0938    0966  LEV1M   CALL    OPR29
006E  03D0  001001000          0967          TCY     1
005D  03BA  000101001          0968          TMA
003A  03F4  011101010          0969          ALEC    5
0074  03E9  100111000  0959    0970          BRANCH  LEV1D1
0069  03D2  001110011          0971          ACACC   12
0053  03A6  100111000  0959    0972          BRANCH  LEV1D1
0026  03CC  111111111  0938    0973  LEV2D   CALL    OPR29
004C  0399  000110011          0974          MNEZ
0018  0380  101110000  0960    0975          BRANCH  LEV1AS
0031  03E3  001101110          0976          TCMIY   7
0062  03C5  101110000  0960    0977          BRANCH  LEV1AS
```

TABLE I-7 (cont)

```
0045  038A  001111100          0978  LEV2      ACACC   3
000A  0394  100100110  0973    0979            BRANCH  LEV2D
0015  03AB  001111000          0980            ACACC   1
0028  0307  100110110  1005    0981            BRANCH  LEV2M
0056  03A0  001001111          0982            TCY     15
002C  030B  000101001          0983            TMA
0058  0381  001001100          0984            TCY     3
0030  03E0  010010000          0985            LDX     A
0060  03C1  011100010          0986            ALEC    4
0041  0382  100000101  0989    0987            BRANCH  LEV2AS
0002  0384  001111101          0988            ACACC   11
0005  038B  000101111          0989  LEV2AS    TAM
000B  0397  000110011          0990  LEAD0     MNEZ
0017  03AF  101011110  0993    0991            BRANCH  LEAD01
002F  03DF  001101111          0992            TCMIY   15
005E  03B0  010111111          0993  LEAD01    RETN
003C  03F8  010011000          0994            LDX     B
0078  03F1  001001011          0995            TCY     13
0071  03E2  000101001          0996            TMA
0063  03C6  010010000          0997            LDX     A
0047  038E  001000000          0998            TCY     0
000E  039C  011100010          0999            ALEC    4
0010  03BB  101110110  1002    1000            BRANCH  LEV21
0038  03F7  001111101          1001            ACACC   11
0076  03E0  000101111          1002  LEV21     TAM
006D  03DA  110001011  0990    1003            CALL    LEAD0
005B  03B6  101110000  0960    1004            BRANCH  LEV1AS
0036  03EC  111111111  0938    1005  LEV2M     CALL    OPR29
006C  03D9  101110000  0960    1006            BRANCH  LEV1AS
0059  0382  010000010          1007  WHTBOX    CALLL   ERROR9    INS ANS
0032  03E4  111011000  0598    1008
0064  03C9  001000101          1009            TCY     10
0049  0392  000100000          1010            TBIT    0
0012  03A4  100010000  1019    1011            BRANCH  WHTBX1    *,* OK
0025  03C8  001001000          1012            TCY     1
004A  0395  000101001          1013  SUBDIV    TMA
0014  03A8  011111010          1014            YMCY    5
0029  03D3  000000011          1015            XMA
0052  03A5  011111001          1016            YMCY    9
0024  03C8  000101100          1017            TAMDYN
```

```
0048  0391  101001010  1013  1018          BRANCH   SUBDIV
0010  03A0  001000000        1019  WHTBX1  TCY      0
0021  03C3  010000001        1020          CALLI    CLANB
0042  0385  110000010  1117  1021
0004  0388  000100000        1022          TBIT     0
0009  0393  100001100  1044  1023          BRANCH   BOX1
0013  03A7  000100010        1024          TBIT     1
0027  03CF  101100110  1047  1025          BRANCH   BOX2
004E  039D  001000100        1026          TCY      2
001C  0398  011110010        1027  RESBOX  YMCY     4
0039  03F3  010010000        1028          LDX      A
0072  03E5  000110010        1029          IMAC
0065  03CA  101101000  1036  1030          BRANCH   WHTBX2
0048  0396  000101001        1031          TMA
0016  03AC  010011000        1032          LDX      8
002D  03DB  011110101        1033          YMCY     10
005A  0385  000101100        1034          TAMDYN
0034  03EB  100011100  1027  1035          BRANCH   RESBOX
0068  03D1  010000110        1036  WHTBX2  CALLL    BOXERR
0051  03A2  110100010  0909  1037
0022  03C4  001000011        1038  WHTBX4  TCY      12
0044  0389  001100100        1039          TCMIY    2
0008  0390  001100100        1040          TCMIY    2
0011  03A3  010111111        1041          RETN
0023  03C7  010000101        1042          BL       WHTBX3
0046  038D  101101000  1428  1043
000C  0398  010000100        1044  BOX1    CALLL    STARTB
0019  0383  110111010  0325  1045
0033  03E7  101101000  1036  1046          BRANCH   WHTBX2
0066  03CD  001000010        1047  BOX2    TCY      4
0040  039A  010010000        1048  MOV2ND  LDX      A
001A  03B4  000110010        1049          IMAC
0035  03EB  101010101  1052  1050          BRANCH   MOV21
006A  0305  000101001        1051          TMA
0055  03AA  011111011        1052  MOV21   YMCY     13
002A  03D4  010011000        1053          LDX      B
0054  03A9  000101100        1054          TAMDYN
0028  0300  011111000        1055          YMCY     1
0050  03A1  001010100        1056          YNEC     2
0020  03C0  101001101  1048  1057          BRANCH   MOV2ND
0040  0381  101101000  1036  1058          BRANCH   WHTBX2
```

TABLE I-8

PC	LOC	INSTR.	BRLN.	LINE	SOURCE STATEMENT NAME	TITLE	COMMENTS
0000	0400	001000111		1060	SCORE2	TCY	MODE
0001	0403	010010000		1061		LDX	A
0003	0407	000101001		1062		TMA	
0007	040F	011101000		1063		ALEC	1
000F	041F	101111100	1075	1064		BRANCH	SCORE3
001F	043F	001000010		1065		TCY	4
003F	047F	010011000		1066	INSTIM	LDX	B
007F	047E	000101001		1067		TMA	
007E	047D	000000101		1068	INSTI1	IYC	
007D	047A	010010000		1069		LDX	A
007B	0476	000101111		1070		TAM	
0077	046E	001011110		1071		YNEC	7
006F	045F	100111111	1066	1072		BRANCH	INSTIM
005F	043E	010000010		1073		CALLL	LEADZ
003E	047C	111011110	0607	1074			
007C	0479	010011000		1075	SCORE3	LDX	B
0079	0472	001000101		1076		TCY	10
0073	0466	000101001		1077		TMA	
0067	044E	001000010		1078		TCY	4
004F	041E	010010000		1079	INSSCO	LDX	A
001E	043C	011101001		1080		ALEC	9
003D	047B	101010111	1085	1081		BRANCH	INSSC1
007A	0475	000000110		1082		CLA	
0075	046A	000101100		1083		TAMDYN	
006B	0456	001111000		1084		ACACC	1
0057	042E	000101111		1085	INSSC1	TAM	
002E	045C	010111111		1086		RETN	
005C	0439	010011000		1087		LDX	B
003B	0470	001001101		1088		TCY	11
0070	0461	000101001		1089		TMA	
0061	0442	001001000		1090		TCY	1
0043	0406	111001111	1079	1091		CALL	INSSCO
0006	040C	010000000		1092	SCORE1	CALLL	NOSCAN
000D	041B	111100111	0047	1093			
001B	0437	001001111		1094		TCY	15
0037	046F	010000111		1095		CALLL	SHOWTVAR
006E	045D	110001100	1954	1096			
005D	043A	001111111		1097		ACACC	15
003A	0474	100000110	1092	1098		BRANCH	SCORE1

TABLE I-8 (cont)

```
0074  0469  010010000        1099              LDX     A
0069  0452  001000011        1100              TCY     12
0053  0426  010100001        1101              SBIT    2
0026  044C  010000010        1102              CALLL   EXROM
004C  0419  110111110  0559  1103
0018  0430  001000111        1104        TCY   MODE
0031  0463  000100000        1105        TBIT  USER
0062  0445  100010101  1109  1106        BRANCH SCORE4
0045  040A  010000010        1107        CALLL  STOPEQ
000A  0414  110001101  0578  1108
0015  0428  010001000        1109  SCORE4  CALLL  SETEQ
0028  0457  110010000  0246  1110
0056  042D  010011000        1111        LDX    B
002C  0458  001001101        1112        TCY    11
0058  0431  000101001        1113        TMA
0030  0460  001000101        1114        TCY    10
0060  0441  000110000        1115        SAMAN
0041  0402  001001001        1116  CLSCOR  TCY   9
0002  0404  010011000        1117  CLANB   LDX   B
0005  040B  001100000        1118          TCMIY  0
000B  0417  001100000        1119            TCMIY  0
0017  042F  001100000        1120              TCMIY  0
002F  045F  010111111        1121        RETN
005E  0430  001000010        1122        TCY    4
003C  0478  110000010  1117  1123        CALL   CLANB
0078  0471  010001001        1124        LDP    9
0071  0462  011100000        1125        ALEC   0
0063  0446  100111111  1197  1126        BRANCH ASTRODOM
0047  040E  011101000        1127        ALEC   1
000E  041C  101110101  1216  1128        BRANCH BUEYBLUP
0010  0438  011100100        1129        ALEC   2
0038  0477  100000000  1190  1130        BRANCH BULLSEYE
0076  046D  100101110  1220  1131        BRANCH RANTHINK
006D  045A  001000100        1132  MEM7  TCY    2
005B  0436  000101001        1133        TMA
0036  046C  001111110        1134        ACACC  7
006C  0459  001000101        1135        TCY    10
0059  0432  000101111        1136        TAM
0032  0460  010001110        1137        CALLL  WHTBX4
0064  0449  110100010  1038  1138
```

TABLE I-8 (cont)

0049	0412	010000010		1139		CALLL	STOPEQ
0012	0424	110001101	0578	1140			
0025	044B	101101010	1180	1141		BRANCH	LEVAS
004A	0415	010100000		1142	MAYREM	SBIT	0
0014	0428	001000111		1143	MAYCNT	TCY	14
0029	0453	000100001		1144		TBIT	2
0052	0425	100010000	1148	1145		BRANCH	MAYCNT1
0024	044B	000110011		1146		MNEZ	
0048	0411	101000010	1150	1147		BRANCH	MAYCNT2
0010	0420	010001110		1148	MAYCNT1	BL	WHTBOX
0021	0443	101011001	1007	1149			
0042	0405	010000101		1150	MAYCNT2	LDP	10
0004	0408	000101010		1151		TMY	
0009	0413	001011100		1152		YNEC	3
0013	0427	100100010	1430	1153		BRANCH	CNTDIG
0027	044F	001001011		1154		TCY	13
004E	0410	000100010		1155		TBIT	1
001C	0438	100100010	1430	1156		BRANCH	CNTDIG
0039	0473	101101010	1180	1157		BRANCH	LEVAS
0072	0465	000100001		1158	LEVCHK	TBIT	2
0065	044A	100100010	1167	1159		BRANCH	CHK1
004B	0416	001000010		1160		TCY	4
0016	042C	000110011		1161		MNEZ	
0020	0458	100100010	1167	1162		BRANCH	CHK1
005A	0435	010011000		1163		LDX	B
0034	0468	001001100		1164		TCY	3
0068	0451	000100000		1165		TBIT	0
0051	0422	101100110	1176	1166		BRANCH	CHG4
0022	0444	010010000		1167	CHK1	LDX	A
0044	0409	001001000		1168		TCY	1
0009	0410	000110011		1169		MNEZ	
0011	0423	101101010	1180	1170		BRANCH	LEVAS
0023	0447	010011000		1171		LDX	B
0046	0400	001001100		1172		TCY	3
000C	0418	000100010		1173		TBIT	1
0019	0433	101001101	1177	1174		BRANCH	CHG1
0033	0467	101101010	1180	1175		BRANCH	LEVAS
0066	044D	011110100		1176	CHG4	YMCY	2
004D	041A	011111011		1177	CHG1	YMCY	13
001A	0434	010010000		1178	CHG	LDX	A

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0035  0468  001101000          1179                TCMIY     1
006A  0455  010000100          1180  LEVAS         BL        START
0055  042A  101111010  0309    1181
002A  0454  010001111          1182  BOXML7        LOP       15
0054  0429  000100010          1183                TBIT      1
0028  0450  101010101  2090    1184                BRANCH    BOXNX1
0050  0421  000100000          1185                TBIT      0
0020  0440  100100000  2095    1186                BRANCH    BLDIS
0040  0401  101010101  2090    1187                BRANCH    BOXNX1

PC    LOC   INSTR.    BRLN.   LINE  NAME          TITLE     COMMENTS
                               1189  *             BULLS EYE DISPLAY SEQUENCE
0000  0480  110001101  1227    1190  BULLSEYE      CALL      DISPSAVE
0001  0483  001100101          1191                TCMIY     10          CONSTANT,SHIFT RIGHT,SINGLE
0003  0487  001100100          1192  BULLSUBR      TCMIY     2           TWO GROUPS
0007  048F  001100010          1193                TCMIY     GSEG
000F  049F  001101111          1194                TCMIY     MOSEG
001F  048F  101000011  1225    1195                BRANCH    DISPE1
                               1196  *             ASTRODOME DISPLAY SEQUENCE
003F  04FF  110001101  1227    1197  ASTRODOM      CALL      DISPSAVE
007F  04FE  001101101          1198                TCMIY     11          CONSTANT,SHIFT RIGHT,DOUBLE
007E  04FD  001101010          1199  ASTRODO2      TCMIY     5           FIVE GROUPS
007D  04FA  001100110          1200                TCMIY     ASEG
007B  04F6  001100100          1201                TCMIY     OSEG
0077  04EE  001100010          1202                TCMIY     GSEG
006F  04DE  001101011          1203                TCMIY     DIVSEG
005F  04BE  00[illegible]       1204                TCMIY     MOSEG
003E  04FC  101[illegible]      1225                BRANCH    DISPE1
                               1206  *             BLOW UP DISPLAY SEQUENCE
007C  04F9  010001111          1207  BLOWUPA       BL        BLUPKY
0079  04F2  100010110  2070    1208
0073  04E5  001111000          1209  BLOWUP        ACACC     1           SEQUENCE COMPLETE ?
0067  04CE  101111100  1207    1210                BRANCH    BLOWUPA     YES BRANCH
004F  049E  000101111          1211                TAM
001E  048C  110001101  1227    1212  AST2HALF      CALL      DISPSAVE
0030  04F8  001100001          1213                TCMIY     8           CONSTANT,SHIFT LEFT,SINGLE
007A  04F5  101111110  1199    1214                BRANCH    ASTRODO2
                               1215  *             BULLSEYE,BLOWUP DISPLAY SEQUENCE
0075  04EA  110001101  1227    1216  BUEYBLUP      CALL      DISPSAVE
0068  04D6  001101101          1217                TCMIY     11          CONSTANT,SHIFT RIGHT,DOUBLE
0057  04AF  100000011  1192    1218                BRANCH    BULLSUBR
```

TABLE I-9 (cont)

```
                                        1219    *         RANDOM THINKER DISPLAY SEQUENCE
002E  04DC  110001101   1227  1220    RANTHINK  CALL      DISPSAVE
005C  04B9  001100000         1221              TCMIY     0           RANDOM,SINGLE
0038  04F0  001100100         1222              TCMIY     2           TWO GROUPS
0070  04E1  001101101         1223              TCMIY     11
0061  04C2  001100101         1224              TCMIY     10
0043  04B6  010001011         1225    DISPE1    BL        DISPE
0006  04BC  100001000   1819  1226
000D  0498  010010000         1227    DISPSAVE  LDX       A           DSIPLAY DATA FILE
0018  04B7  001000000         1228              TCY       0
0037  04EF  000101001         1229    DSAVE1    TMA
006E  04DD  000011001         1230              XDA                   SAVE IN DAM
005D  04BA  001101111         1231              TCMIY     15          CLEAR DATA FILE
003A  04F4  001010101         1232              YNEC      10
0074  04E9  100110111   1229  1233              BRANCH    DSAVE1      SAVE 9 DIGITS
0069  04D2  010011110         1234              LDX       H
0053  04A6  001000010         1235              TCY       4
0026  04CC  000101001         1236              TMA
004C  0499  001000011         1237              TCY       12
0018  04B0  000011001         1238              XDA                   SAVE E,N, SEGMENT
0031  04E3  001000001         1239              TCY       8
0062  04C5  000101001         1240              TMA
0045  04BA  001000101         1241              TCY       10
000A  0494  000011001         1242              XDA                   SAVE TMR H SEGMENT
0015  04AB  001000100         1243              TCY       2
0029  04D7  000101001         1244              TMA
0056  04AD  001001101         1245              TCY       11
002C  04D8  000011001         1246              XDA                   SAVE OPERAND SEGMENT LATCH
0058  04B1  010010110         1247    DSAVE2    LDX       DISPLAYX
0030  04F0  001001000         1248              TCY       1
0060  04C1  001100000         1249              TCMIY     0           TEMP GROUP COUNT
0041  0482  001100000         1250              TCMIY     0           SUB GROUP COUNT
0002  0484  001101111         1251              TCMIY     15          INPUT DATA
0005  048B  001100000         1252              TCMIY     0           SCAN COUNT
000B  0497  010111111         1253              RETN
0017  04AF  010011000         1254    RANS      LDX       RANX
002F  04DF  001000011         1255              TCY       12
005E  04BD  000110010         1256    RAN1      IMAC
003C  04F8  000101111         1257              TAM
0078  04F1  011101001         1258              ALEC      9
```

TABLE I-9 (cont)

0071	04E2	100111011	1264	1259		BRANCH	RAN2	
0063	04C6	001110110		1260		ACACC	6	
0047	048E	000101101		1261		TAMIYC		
000E	049C	100111011	1264	1262		BRANCH	RAN2	
0010	04B8	101011110	1256	1263		BRANCH	RAN1	
003B	04F7	010111111		1264	RAN2	RETN		
0076	04ED	001001011		1265		TCY	13	
006D	04DA	000101001		1266		TMA		
005B	04B6	001110100		1267		ACACC	2	
0036	04EC	000101111		1268		TAM		
006C	04D9	111011110	1256	1269		CALL	RAN1	
0059	04B2	001000111		1270		TCY	14	
0032	04E4	000101001		1271		TMA		
0064	04C9	001110010		1272		ACACC	4	
0049	0492	000101111		1273		TAM		
0012	04A4	111011110	1256	1274		CALL	RAN1	
0025	04C3	010011000		1275		LDX	8	
004A	0495	001000001		1276		TCY	8	
0014	04A8	000110010		1277	TIMER1	IMAC		
0029	04D3	000101111		1278		TAM		
0052	04A5	011101001		1279		ALEC	9	
0024	04C8	100011100	1290	1280		BRANCH	TIMER3	
0048	0491	000000110		1281		CLA		
0010	04A0	000101100		1282		TAMDYN		
0021	04C3	001011100		1283		YNEC	3	
0042	0485	100010100	1277	1284		BRANCH	TIMER1	
0004	0488	001000010		1285		TCY	4	
0009	0493	001101001		1286		TCMIY	9	
0013	04A7	001101001		1287		TCMIY	9	
0027	04CF	001101001		1288		TCMIY	9	
004F	049D	001001100		1289		TCY	3	
001C	04B8	000101011		1290	TIMER3	TYA		
0039	04F3	010010000		1291		LDX	0	
0072	04E5	001000011		1292		TCY	12	
0065	04CA	000100010		1293		TBIT	1	TEST FOR TIMER ENABLE FLAG
0048	0496	100110100	1298	1294		BRANCH	TIMER3F	FLAG SET BRANCH
0016	04AC	001000001		1295		TCY	8	
002D	04DB	000000110		1296		CLA		CLEAR TIMER DIGIT
005A	04B5	101001101	1311	1297		BRANCH	TIMER3B	
0034	04E8	001111001		1298	TIMER3F	ACACC	9	HUNDRED MULTIPLE SCAN ?

```
0068  04D1  100100000  1320  1299            BRANCH   TIMER4     NO BRANCH
0051  04A2  001110100        1300  TIMER3A   ACACC    2          BLOW UP OVERFLOW ?
0022  04C4  100110011  1309  1301            BRANCH   TIMER3AA   NO BRANCH
0044  0489  001000111        1302            TCY      14
0008  0490  000110011        1303            RNEZ                BLOW UP MODE ?
0011  04A3  100110011  1309  1304            BRANCH   TIMER3AA   NO BRANCH
0023  04C7  001111011        1305            ACACC    13
0046  048D  010011000        1306            LDX      6
000C  0498  001000101        1307            TCY      10
0019  04B3  101110011  1209  1308            BRANCH   BLOWUP     START BLOWUP SEQUENCE
0033  04E7  001000001        1309  TIMER3AA  TCY      8
0066  04CD  000110010        1310            IMAC                UPDATE TIMER SEGMENT
004D  049A  000101111        1311  TIMER3B   TAM
001A  04B4  010011110        1312            LDX      M
0035  04EB  010100011        1313            SBIT     3          STATUS LATCH
006A  04D5  010100100        1314            RBIT     0          PRE-CLEAR M SEGMENT
0055  04AA  011101110        1315            ALEC     7          MODULO 8 COUNT ?
002A  04D4  100100000  1320  1316            BRANCH   TIMER4     NO BRANCH
0054  04A9  010100000        1317            SBIT     0          SET M SEGMENT
0028  04D0  010010000        1318            LDX      A
0050  04A1  001100000        1319            TCMIY    0          SET COUNT TO ZERO
0020  04C0  010000010        1320  TIMER4    BL       TIMER4A
0040  0481  100010010  0625  1321
```

TABLE I-10

SOURCE STATEMENT

```
 PC    LOC     INSTR.     BRLN.  LINE  NAME     TITLE    COMMENTS
0000  0500  001111011        1323  INSREM   ACACC    13
0001  0503  001001110        1324  CHKANS   TCY      7          INSERT NEW DIGIT
0003  0507  000000011        1325  SMSDIA   XMA
0007  050F  000000100        1326           OYN
000F  051F  001010010        1327           YNEC     4
001F  053F  100000011  1325  1328           BRANCH   SMSDIA
003F  057F  010111111        1329           RETN
007F  057E  001001001        1330  CHKBOX   TCY      9
007E  0570  000101001        1331           TMA
0070  057A  000100000        1332           TBIT     0
0078  057B  101111100  1338  1333           BRANCH   CHKAN2
0077  056E  001110111        1334           ACACC    14
```

TABLE I-10 (cont)

```
006F  055E  000100010        1335          TBIT    1
005F  053E  101111100  1338  1336          BRANCH  CHKAN2
003E  057C  001110010        1337          ACACC   4
007C  0579  000101000        1338  CHKAN2  TAY
0079  0572  010011000        1339          LDX     B
0073  0566  000101001        1340          TMA
0067  054E  010010000        1341          LDX     A
004F  051E  010111111        1342          RETN
001E  053C  001001110        1343          TCY     7
003D  057E  000001001        1344          MNEA
007A  0575  100100000  1449  1345          BRANCH  BLERR
0075  056A  001001001        1346  DECDIG  TCY     9
006B  0556  010010000        1347          LDX     A
0057  052F  000000111        1348          DMAN
002E  055C  101011010  1426  1349          BRANCH  CHKAN1
005C  0539  001001011        1350          TCY     13
0038  0570  000100000        1351          TBIT    0
0070  0561  110000000  1323  1352          CALL    INSREM
0061  0542  001001001        1353          TCY     9
0043  0506  010011000        1354          LDX     B
0006  050C  000110011        1355          MNEZ
000D  0519  101011101  1360  1356          BRANCH  NOINC
0018  0537  001001101        1357          TCY     11
0037  056F  000110010        1358          IMAC
006E  055D  000101111        1359          TAM
005D  053A  001001001        1360  NOINC   TCY     9
003A  0574  001100000        1361          TCMIY   0
0074  0569  000110010        1362          IMAC                  INCREASE SET
0069  0552  000101111        1363          TAM
0053  0526  010000000        1364  SHOW    CALLL   NOSCAN
0026  054C  111100111  0047  1365
004C  0519  001000111        1366          TCY     14
0018  0530  010000111        1367          CALLL   SHOWTVAR
0031  0563  110001100  1954  1368
0062  0545  001111111        1369          ACACC   15
0045  050A  101010011  1364  1370          BRANCH  SHOW
000A  0514  010010000        1371          LDX     A
0015  0528  001001011        1372          TCY     13
0028  0557  000100000        1373          TBIT    0
0056  052D  100010100  1406  1374          BRANCH  SHOWR
```

TABLE I-10 (cont)

```
002C  0558  001000111          1375                TCY     14
0058  0531  010001010          1376                LDP     5
0030  0560  000100011          1377                TBIT    3
0060  0541  100101001  0757    1378                BRANCH  ELCNXT
0041  0502  010001111          1379    USRER1      CALLL   BLANKD
0002  0504  111111011  1979    1380
0005  0509  001000111          1381                TCY     14
000B  0517  000100000          1382                TBIT    0
0017  052F  101111000  1587    1383                BRANCH  USENXT
002F  055F  000100001          1384                TBIT    2
005E  0530  010001110          1385                LDP     7
003C  0578  100000000  0931    1386                BRANCH  BOXNXT
0078  0571  010000011          1387    USENXT      LDP     12
0071  0562  000100010          1388                TBIT    1
0063  0546  101111000  1645    1389                BRANCH  MEMNXT
0047  050E  010001111          1390                CALLL   CLCOM
000E  051C  110000001  1970    1391
0010  0538  001000010          1392                TCY     4
003B  0577  010100000          1393                SBIT    0
0076  056D  010010000          1394                LDX     A
006D  055A  001000011          1395                TCY     12
0058  0536  001100010          1396                TCMIY   4
0036  056C  001100000          1397                TCMIY   0
006C  0559  010011000          1398    ERRELF      LDX     B
0059  0532  001001001          1399    USRNX1      TCY     9
0032  0564  000101001          1400                TMA
0064  0549  010100111          1401                RBIT    3
0049  0512  010001001          1402                LDP     9
0012  0524  001110001          1403                ACACC   8
0025  054A  100101110  1220    1404                BRANCH  RANTHINK
004A  0515  100000000  1190    1405                BRANCH  BULLSEYE
0014  0528  010100100          1406    SHOWR       RBIT    0
0029  0553  010001111          1407                CALLL   CLCOM
0052  0525  110000001  1970    1408
0024  054B  001000001          1409                TCY     8
0048  0511  001100001          1410                TCMIY   8
0010  0520  010001111          1411                CALLL   BLANKD
0021  0543  111111011  1979    1412
0042  0505  001001110          1413                TCY     7
0004  0508  011111010          1414    SHOWR1      YMCY    5
```

```
0009  0513  010010110         1415                    LDX       G
0013  0527  000101001         1416                    TMA
0027  054F  011111001         1417                    YMCY      9
004E  0510  010010000         1418                    LDX       A
001C  0538  000101100         1419                    TAMDYN
0039  0573  001011010         1420                    YNEC      5
0072  0565  100000100  1414   1421                    BRANCH    SHOWR1
0065  054A  001100011         1422                    TCMIY     12
0048  0516  010001110         1423                    CALLL     LEAD0
0016  052C  110001011  0990   1424
002D  055B  101010011  1364   1425                    BRANCH    SHOW
005A  0535  010001010         1426        CHKAN1      BL        ELNOP2
0034  056B  101001100  0716   1427
006B  0551  010001000         1428        WHTBX3      CALLL     SETEQ
0051  0522  110010000  0246   1429
0022  0544  010011000         1430        CNTDIG      LDX       B
0044  0509  001000000         1431                    TCY       0
0008  0510  000000110         1432                    CLA
0011  0523  001110100         1433                    ACACC     2
0023  0547  000110011         1434        CNTDG1      MNEZ
0046  050D  101001101  1440   1435                    BRANCH    CNTDG2
000C  051B  000000101         1436                    IYC
0019  0533  001111111         1437                    ACACC     15
0033  0567  100100011  1434   1438                    BRANCH    CNTDG1
0066  054D  001111000         1439                    ACACC     1
004D  051A  001001001         1440        CNTDG2      TCY       9
001A  0534  010010000         1441                    LDX       A
0035  056B  000101111         1442                    TAM
006A  0555  010111111         1443                    RETN
0055  052A  001000111         1444                    TCY       14
002A  0554  000100011         1445        OTHOPF      TBIT      3
0054  0529  101101100  1398   1446                    BRANCH    FPRELF
0029  0550  010000001         1447                    BL        BOXML7
0050  0521  100101010  1192   1448
0020  0540  010000010         1449        BLERR       BL        ERROR
0040  0501  100000000  0545   1450
```

TABLE I-11

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS	
0000	0580	001001110		1452	NUMGUESS	TCY	7	
0001	0583	000000110		1453	NGSUBR	CLA		
0003	0587	010010000		1454	NG0	LDX	4	
0007	058F	001111111		1455		ACACC	15	BLANK DISPLAY DATA FILE
000F	059F	000101111		1456		TAM		
001F	05BF	010011110		1457		LDX	14	
003F	05FF	001111000		1458		ACACC	1	CLEAR STATUS LATCHES
007F	05FE	000101100		1459		TAMDYN		
007E	05FD	100000011	1458	1460		BRANCH	NG0	
007D	05FA	010111111		1461		RETN		
007A	05F6	010010000		1462	NGRM	LDX	4	
0077	05EE	001000000		1463		TCY	0	
006F	05DE	001101111		1464		TCMIY	15	
005F	05BE	001101001		1465		TCMIY	9	OP1 = 9
003E	05FC	001001010		1466		TCY	5	
007C	05F9	001101000		1467		TCMIY	1	RESULT = 100
0079	05F2	001100000		1468		TCMIY	0	
0073	05E6	001100000		1469		TCMIY	0	
0067	05CE	001001000		1470		TCY	1	
004F	059F	010011000		1471	NG1	LDX	RANX	
001E	058C	011110011		1472		YMCY	12	
0030	05F8	000101001		1473		TMA		
007A	05F5	010010010		1474		LDX	NGX	
0075	05EA	011110010		1475		YMCY	4	
006A	05D6	000101100		1476		TAMDYN		COPY RANDOM NUMBER
0057	05AE	001011100		1477		YNEC	3	
002E	05DC	101001111	1471	1478		BRANCH	NG1	GO COPY SECOND DIGIT
005C	0589	000110011		1479		MNEZ		IS MSD = 0 ?
0038	05F0	100001101	1485	1480		BRANCH	NG2A	
0070	05E1	000101111		1481	NG2	TAM		COPY LSD TO MSD
0061	05C2	000110010		1482		IMAC		INCREMENT MSD
0043	0586	011101000		1483		ALEC	1	WAS MSD = 0 ?
0006	058C	101110000	1481	1484		BRANCH	NG2	YES BRANCH
000D	0593	001000000		1485	NG2A	TCY	0	
001A	0587	001101111		1486		TCMIY	15	CLEAR NUMBER OF GUESSES

TABLE I-11 (cont)

```
0037  05EF  001100000          1487          TCMIY   0
006E  05DD  010010000          1488  NG3     LDX     A
0050  05BA  001001100          1489          TCY     3
003A  05F4  001100101          1490          TCMIY   OPAREN     OP2 = BOX
0074  05E9  001101101          1491          TCMIY   CPAREN
0069  05D2  010010010          1492          LDX     NGX
0053  05A6  001001000          1493          TCY     1
0026  05CC  000110010          1494  NG13A   IMAC                INCREMENT NUMBER OF GUESSES
004C  0599  000101111          1495          TAM
0018  05B0  011100000          1496          ALEC    0
0031  05E3  100100110  1494    1497          BRANCH  NG13A       BLANK TO 1 FIX
0062  05C5  011101001          1498          ALEC    9
0045  05BA  100110000  1506    1499          BRANCH  NG13B
000A  0594  000000110          1500          CLA
0015  05AB  000101100          1501          TAMDYN
002B  05D7  100100110  1494    1502          BRANCH  NG13A
0056  05A0  001000000          1503          TCY     0
002C  05DB  001101001          1504          TCMIY   9
0058  05B1  001101001          1505          TCMIY   9
0030  05E0  010111111          1506  NG13B   RETN
0060  05C1  010000000          1507  NG4     BL      SCAN
0041  05B2  101101111  0041    1508
0002  05B4  000001001          1509  NG9A    MNEA                ACC = GUESS(1) ?
0005  05BB  101111000  1516    1510          BRANCH  NG10        NO BRANCH
0008  0597  011100000          1511          ALEC    0           ACC = 0 ?
0017  05AF  101100011  1518    1512          BRANCH  NGOUT       YES BRANCH
002F  05DF  001001000          1513          TCY     1
005E  05BD  000110010          1514          IMAC                ACC = OP1(2)+1
003C  05F8  001000010          1515          TCY     4
0078  05F1  000000001          1516  NG10    ALEM                ACC:MEM(GUESS(1) OR GUESS(2))
0071  05E2  100011101  1521    1517          BRANCH  NG11        L.E. BRANCH
0063  05C6  111101110  1488    1518  NGOUT   CALL    NG3
0047  05BE  010001001          1519          BL      RANTHINK
000E  059C  100101110  1220    1520
0010  05B8  001001010          1521  NG11    TCY     5
0038  05F7  000101001          1522          TMA
0076  05E0  011101000          1523          ALEC    1           RES(1)=1 ?
0060  05DA  100010100  1535    1524          BRANCH  NG13        YES BRANCH
0058  05B6  001000110          1525          TCY     6
0034  05EC  000101001          1526          TMA                 ACC = RES(2)
```

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TABLE I-11 (cont)

```
006C  05D9  001001100        1527              TCY     3
0059  05B2  000001001        1528              MNEA                ACC = GUESS(1) ?
0032  05E4  100100101  1533  1529              BRANCH  NG12        NO BRANCH
0064  05C9  001001110        1530              TCY     7
0049  0592  000101001        1531              TMA                 ACC = RES3
0012  05A4  001000010        1532              TCY     4
0025  05CB  000000001        1533  NG12        ALEM                ACC:MEM(GUESS(1) OR GUESS(2))
004A  0595  101100011  1518  1534              BRANCH  NGOUT
0014  05A8  001001100        1535  NG13        TCY     3
0029  05D3  110010011  1545  1536              CALL    NG13C
0052  05A5  000001001        1537              MNEA                ACC = GUESS(1) ?
0024  05CB  101000100  1560  1538              BRANCH  NG18        NO BRANCH
0048  0591  001000010        1539              TCY     4
0010  05A0  110010011  1545  1540              CALL    NG13C
0021  05C3  000001001        1541              MNEA                ACC = GUESS(2) ?
0042  0585  101000100  1560  1542              BRANCH  NG18        NO BRANCH
0004  0588  110000000  1452  1543              CALL    NUMGUESS
0009  0593  001001000        1544              TCY     1
0013  05A7  010010010        1545  NG13C       LDX     NGX
0027  05CF  000101001        1546              TMA
004E  05D0  010010000        1547              LDX     A
001C  05B8  010111111        1548              RETN
0039  05F3  000101100        1549              TAMDYN              MOVE NUMBER OF GUESSES TO OP1
0072  05E5  100010011  1545  1550              BRANCH  NG13C
0065  05CA  010000000        1551  NG13D       CALLL   NOSCAN
0048  0596  111100111  0047  1552
0016  05AC  010000111        1553              CALLL   SHOWTIME
002D  05DB  111000110  1953  1554
005A  05B5  001111111        1555              ACACC   15
0034  05E8  101100101  1551  1556              BRANCH  NG13D
0068  05D1  111111011  1462  1557              CALL    NGRM
0051  05A2  010001001        1558              RL      ASTRODOM
0022  05C4  100111111  1197  1559
0044  0589  000000001        1560  NG18        ALEM                ACC:MEM(GUESS(1) OR GUESS(2))
0008  0590  101001101  1569  1561              BRANCH  NG20        L.E. BRANCH
0011  05A3  001001000        1562              TCY     1
0023  05C7  011110100        1563  NG19        YMCY    2
0046  05BD  000101001        1564              TMA                 MOVE GUESS TO OP1
000C  0598  011110011        1565              YMCY    12
```

```
0019  0583  000101100          1566          TAMDYN
0033  05E7  100100011  1563    1567          BRANCH    NG19
0066  05CD  101010000  1577    1568          BRANCH    NG22
004D  059A  001001010          1569  NG20    TCY       5          GUESS TO RESULT
001A  0584  001101111          1570          TCMIY     15
0035  05EB  011110011          1571  NG21    YMCY      12
006A  05D5  000101001          1572          TMA
0055  05AA  011110100          1573          YMCY      2
002A  05D4  000101101          1574          TAMIYC
0054  05A9  010111111          1575          RETN
0028  05D0  110110101  1571    1576          CALL      NG21
0050  05A1  111101110  1488    1577  NG22    CALL      NG3        BOX TO OP2
0020  05C0  010001001          1578          RL        BULLSEYE
0040  0581  100000000  1190    1579
```

TABLE I-12

SOURCE STATEMENT

```
PC    LOC   INSTR.      BRLN.  LINE  NAME     TITLE     COMMENTS
0000  0600  001111111          1581  DISPAP   ACACC     15         WAS SG = 0 ?
0001  0603  100000010  1638    1582          BRANCH    DISPA4
0003  0607  001110110          1583          ACACC     6          SG = 5
0007  060F  000101111          1584          TAM
000F  061F  001000110          1585  DISPA1   TCY       6
001F  063F  000101001          1586          TMA                  GET G
003F  067F  001001000          1587          TCY       1          ADDRESS GT
007F  067E  000001001          1588          MNEA                 GT = G ?
007E  067D  100101011  1631    1589          BRANCH    DISPA3     NO BRANCH
007D  067A  000000110          1590          CLA
007B  0674  000101111          1591          TAM                  GT = 0
0077  066E  001001010          1592          TCY       5
006F  065E  000100000          1593          TBIT      0
005F  063E  100001010  1629    1594          BRANCH    DISPA2
003E  067C  001000001          1595          TCY       8
007C  0679  010001101          1596          CALLL     NGSUBR
0079  0672  110000001  1453    1597
0073  0666  010000000          1598  DPEDLY1  CALLL     NOSCAN
```

TABLE I-12 (cont)

0067	064E	111100111	0047	1599				
004F	061E	001001100		1600		TCY	3	
001E	063C	010000111		1601		CALLL	SHOWTVAR	
003D	0678	110001100	1954	1602				
007A	0675	001111111		1603		ACACC	15	
0075	066A	101110011	1598	1604		BRANCH	DPEDLY1	
006B	0656	001001001		1605	DREST	TCY	9	
0057	062E	010011110		1606	DREST1	LDX	H	
002E	065C	000000110		1607		CLA		
005C	0639	000101111		1608		TAH		CLEAR H FILE
0038	0670	000011001		1609		XDA		CLEAR DAM AND
0070	0661	010010000		1610		LDX	A	
0061	0642	000101100		1611		TAMDYN		RESTORE A FILE
0043	0606	101010111	1606	1612		BRANCH	DREST1	
0006	060C	010011110		1613	DREST2	LDX	H	
000D	0618	001000101		1614		TCY	10	
0018	0637	000011001		1615		XDA		
0037	066F	001000001		1616		TCY	8	
006E	0650	000101111		1617		TAM		RESTORE TIMER H SEGMENT
005D	063A	001000011		1618		TCY	12	
003A	0674	000011001		1619		XDA		
0074	0669	001000010		1620		TCY	4	
0069	0652	000101111		1621		TAM		RESTORE E,Q, SEGMENT
0053	0626	001001101		1622		TCY	11	
0026	064C	000011001		1623		XDA		
004C	0619	001000100		1624		TCY	2	
0018	0630	000101111		1625		TAM		RESTORE OPERAND SEGMENT LATCH
0031	0663	010011000		1626		LDX	B	ENTERED FROM DISPLAYS
0062	0645	010000000		1627		RL	SCANT	
0045	060A	100000000	0029	1628				
000A	0614	001100001		1629	DISPA2	TCMIY	8	
0015	0629	100001111	1585	1630		BRANCH	DISPA1	
0028	0657	000110010		1631	DISPA3	IMAC		GT + 1
0056	062D	000101111		1632		TAM		
002C	0658	001110110		1633		ACACC	6	FORM DATA ADDRESS
0058	0631	000101000		1634		TAY		
0030	0660	000101001		1635		TMA		PUT NEXT ARGUMENT
0060	0641	001001100		1636		TCY	3	
0041	0602	000101111		1637		TAM		INTO INPUT DATA

```
0002  0604  010001011          1638  DISPAA   BL        DISPAAA
0005  060B  100000000  1710    1639
0008  0617  010001111          1640  MEMGO     CALLL     CLREGB
0017  062F  110110101  2088    1641
002F  065F  010011010          1642            LDX       F
005E  063D  001001111          1643            TCY       15
003C  0678  001100000          1644            TCMIY     0
0078  0671  010001111          1645  MEMNXT    CALLL     BLANKD
0071  0662  111111011  1979    1646
0063  0646  010000100          1647            CALLL     MEMCNT     # PROBLEMS
0047  060E  111000010  0377    1648
000E  061C  010011010          1649             LDX       F
0010  0638  000001001          1650             MNEA
003B  0677  100110110  1655    1651             BRANCH    MEM1
0076  066D  001100000          1652             TCMIY     0
0060  065A  010000110          1653             BL        NXTMEM
0058  0636  100001010  0850    1654
0036  066C  000110010          1655  MEM1       IMAC                 INCR COUNT F15
006C  0659  000101111          1656             TAM
0059  0632  010010010          1657             LDX       E
0032  0664  001110110          1658             ACACC     6
0064  0649  100100111  1675    1659             BRANCH    MEM04
0049  0612  000000000          1660  MEM2       COMX
0012  0624  001111000          1661  MEM3       ACACC     1
0025  0648  100100111  1675    1662             BRANCH    MEM04
004A  0615  001111000          1663             ACACC     1
0014  0628  101001011  1681    1664             BRANCH    MEM59
0029  0653  001111000          1665             ACACC     1
0052  0625  101000100  1689    1666             BRANCH    MEM10
0024  0648  010111111          1667             RETN
0048  0611  010011010          1668             LDX       F
0010  0620  110010010  1661    1669             CALL      MEM3
0021  0643  001001111          1670             TCY       15
0042  0605  000101001          1671             TMA
0004  0608  001110011          1672            ACACC     12
0009  0613  100110011  1696    1673             BRANCH    MEM4
0013  0627  101001001  1660    1674             BRANCH    MEM2
0027  064F  001000010          1675  MEM04      TCY       4
004E  061D  000101001          1676  MEM041     TMA
```

```
001C  0638  000011001          1677                XDA
0039  0673  000000100          1678                DYN
0072  0665  101001110  1676    1679                BRANCH    MEM041
0065  064A  100110011  1696    1680                BRANCH    MEM4
004B  0616  001001001          1681    MEM59       TCY       9
0016  062C  000101001          1682    MEM591      TMA
002D  0658  011110101          1683                YMCY      10
005A  0635  000011001          1684                XDA
0034  0668  011111100          1685                YMCY      3
0068  0651  001010010          1686                YNEC      4
0051  0622  100010110  1682    1687                BRANCH    MEM591
0022  0644  100110011  1696    1688                BRANCH    MEM4
0044  0609  001000111          1689    MEM10       TCY       14
0008  0610  000101001          1690    MEM101      TMA
0011  0623  011111010          1691                YMCY      5
0023  0647  000011001          1692                XDA
0046  060D  011110001          1693                YMCY      8
000C  061B  001011001          1694                YNEC      9
0019  0633  100001000  1690    1695                BRANCH    MEM101
0033  0667  010111111          1696    MEM4        RETN
0066  064D  010010000          1697                LDX       A
004D  061A  001000010          1698                 TCY       4
001A  0634  010000010          1699                 CALLL     EXRDM1
0035  0659  111111100  0560    1700
006A  0655  001000000          1701                TCY       0
0055  062A  010001110          1702                CALLL     LEAD0
002A  0654  110001011  0990    1703
0054  0629  001001100          1704                TCY       3
0028  0650  010001110          1705                CALLL     LEAD0
0050  0621  110001011  0990    1706
0020  0640  010000001          1707                 BL        MEM7
0040  0601  101101101  1132    1708
```

TABLE I-13 SOURCE STATEMENT

```
PC    LOC   INSTR.      BRL.  LINE  NAME     TITLE   COMMENTS
0000  0680  001001010        1710  DISPAGA  TCY     5         ADDRESS MODE
0001  0683  000100011        1711           TBIT    3         CONSTANT DATA ?
0003  0687  101011111  1723  1712           BRANCH  DISPA5    YES BRANCH
```

TABLE I-13 (cont)

0007	068F	001001100		1713		TCY	3	
000F	069F	000101001		1714		TMA		
001F	06BF	001110111		1715		ACACC	14	INPUT DATA = 2
003F	06FF	000101111		1716		TAM		
007F	06FF	010010000		1717		LDX	A	
007E	06F0	001001001		1718		TCY	9	
0070	06FA	001111011		1719	RNDMFILL	ACACC	13	
0073	06F6	000101100		1720		TAMDYN		
0077	06EE	101111101	1719	1721		BRANCH	RNDMFILL	
006F	06DE	100100101	1791	1722		BRANCH	DISPC1	
005F	06BE	001000100		1723	DISPAS	TCY	2	
003E	06FC	000101010		1724		TMY		
007C	06F9	001010100		1725		YNEC	2	SG = 2 ?
0079	06F2	101001111	1729	1726		BRANCH	DISPA6	NO BRANCH
0073	06E6	001001100		1727		TCY	3	
0067	06CE	001101111		1728		TCMIY	15	INPUT BLANK
004F	069F	001001100		1729	DISPA6	TCY	3	
001E	06BC	000101001		1730		TMA		GET INPUT DATA
003D	06FB	001001010		1731		TCY	5	
007A	06F5	000100010		1732		TBIT	1	
0075	06EA	100101011	1760	1733		BRANCH	SHRDFFIL	SHIFT RIGHT BRANCH
006B	06D6	010010000		1734		LDX	A	
0057	06AE	001001110		1735		TCY	7	SHIFT LEFT
002E	06DC	000000011		1736	SHLLP	XMA		
005C	06B9	000000100		1737		DYN		SHIFT COMPLETE ?
0038	06F0	101011101	1747	1738		BRANCH	SHLC2	NO BRANCH
0070	06E1	010010110		1739	SHLC3	LDX	DISPLAYX	
0061	06C2	001001000		1740		TCY	1	GET GT
0043	0686	000101001		1741		TMA		
0006	068C	001000110		1742		TCY	6	
000D	069B	010111111		1743		RETN		
001B	06B7	000001001		1744		MNEA	GT = G ?	
0037	06EF	100011000	1754	1745		BRANCH	SHLC4	NO BRANCH
006E	06DD	101100100	1788	1746		BRANCH	DISPC	
005D	06BA	001010010		1747	SHLC2	YNEC	4	
003A	06F4	101101001	1750	1748		BRANCH	SHLC1	
0074	06E9	001001001		1749		TCY	9	
0069	06D2	001010001		1750	SHLC1	YNEC	8	

TABLE I-13 (cont)

```
0053  06A6  100101110  1736  1751          BRANCH  SHLLP
0026  06CC  001000010        1752          TCY     4
004C  0699  100101110  1736  1753          BRANCH  SHLLP
0018  06B0  001000100        1754  SHLC4   TCY     2
0031  06E3  000101001        1755          TMA
0062  06C5  001111101        1756          ACACC   11
0045  06BA  000110001        1757          CPAIZ                 V = 5 - SG
000A  0694  000101000        1758          TAY
0015  06AB  100011101  1779  1759          BRANCH  DISPB
002B  06D7  010010000        1760  SHRDPFIL LDX    A
0056  06AD  001000000        1761          TCY     0             SHIFT RIGHT
002C  06DB  000000011        1762  SHRLP   XMA
0058  0681  000000101        1763          IYC
0030  06E0  001011001        1764          YNEC    9
0060  06C1  100000010  1767  1765          BRANCH  SHRC1
0041  0682  101111000  1774  1766          BRANCH  SHRC4           SHIFT COMPLETE
0002  0684  001011010        1767  SHRC1   YNEC    5
0005  06BB  100010111  1770  1768          BRANCH  SHRC2
000B  0697  001001001        1769          TCY     9
0017  06AF  001010101        1770  SHRC2   YNEC    10
002F  06DF  100101100  1762  1771          BRANCH  SHRLP
005E  06BD  001001010        1772          TCY     5
003C  06F8  100101100  1762  1773          BRANCH  SHFLP
0078  06F1  111110000  1739  1774  SHRC4   CALL    SHLC3         GET GT
0071  06E2  011101000        1775          ALEC    1             GT = 1 ?
0063  06C6  101100100  1788  1776          BRANCH  DISPC         YES BRANCH
0047  068E  001000100        1777          TCY     2
000E  069C  000101010        1778          THY                   V = SG
001D  06B5  001010100        1779  DISPB   YNEC    2             V = 2 ?
003B  06F7  101101100  1785  1780          BRANCH  DISPB1        NO BRANCH
0076  06ED  001000001        1781          TCY     8
006D  06DA  010010000        1782          LDX     A
0058  06B6  001101011        1783          TCMIY   DIVSEG        GENERATE HALF DOTS FOR TIMER
0034  06EC  100010000  1798  1784          BRANCH  DISPB3
006C  06D9  000101011        1785  DISPB1  TYA
0059  06B2  011101000        1786          ALEC    1             V = 0,1 ?
0032  06E4  101010010  1795  1787          BRANCH  DISPB2        YES BRANCH
0064  06C9  001000001        1788  DISPC   TCY     8
0049  0692  010010000        1789          LDX     A
```

```
0012  06A4  001100000        1790            TCMIY   0           GENERATE BLANK DOTS FOR TIMER
0025  06C9  001000001        1791  DISPC1    TCY     8
004A  0695  010011110        1792            LDX     H
0014  06A8  001100001        1793            TCMIY   8
0029  06D3  100000100  1801  1794            BRANCH  CPYD3
0052  06A5  001000001        1795  DISPB2    TCY     8
0024  06C8  010010000        1796            LDX     A
0048  0691  001100111        1797            TCMIY   14          GENERATE FULL DOTS FOR TIMER
0010  06A0  001000001        1798  DISPB3    TCY     8
0021  06C3  010011110        1799            LDX     H
0042  0685  001101001        1800            TCMIY   9
0004  0686  010100011        1801  CPYD3     SBIT    3
0009  0693  000000100        1802  CPYD4     DYN                 SET ALL STATUS LATCHES
0013  06A7  100000100  1801  1803            BRANCH  CPYD3
0027  06CE  001001001        1804            TCY     9
004E  069D  010010000        1805  CPYD5     LDX     A
001C  06B8  000110010        1806            IMAC                IF DATA = 15, THEN
0039  06F3  101010000  1836  1807            BRANCH  CPYD7       GO CLEAR THIS STATUS LATCH
0072  06E5  000000100        1808  CPYD6     DYN
0065  06CA  101001110  1805  1809            BRANCH  CPYD5
0048  0696  010010000        1810  DISPD     LDX     A
0016  06AC  001001001        1811            TCY     9
002D  06DB  000101001        1812            TMA
005A  06B5  010011110        1813            LDX     H
0034  06EB  001000010        1814            TCY     4
0068  06D1  010100100        1815            RBIT    0
0051  06A2  001110100        1816            ACACC   2
0022  06C4  100001000  1819  1817            BRANCH  DISPE
0044  0689  010100000        1818            SBIT    0           LOAD E,0, SEGMENT IF DATA G,T,9
0008  0690  010010110        1819  DISPE     LDX     DISPLAYX
0011  06A3  001000010        1820            TCY     4
0023  06C7  000000111        1821            DMAN                SC=1
0046  068D  000000011        1822            XNA
000C  0698  000000001        1823            ALEM                WAS SC = 0 ?
0019  06B3  100011010  1929  1824            BRANCH  DISPA       YES BRANCH
                             1825  *         OUTPUT TO DISPLAY
0033  05E7  010000000        1826            CALL    NOSCAN
0066  06CD  111100111  0047  1827
004D  069A  100001000  1819  1828            BRANCH  DISPE
```

```
001A  06B4  001110001          1829  DISPA   ACACC   8
0035  06E8  000101111          1830          TAM                 SC = MAX
006A  06D5  001000100          1831          TCY     2
0055  06AA  000000111          1832          DMAN                SG=1
002A  06D4  000000011          1833          XMA
0054  06A9  010000011          1834          BL      DISPAP
0028  06D0  100000000  1581    1835
0050  06A1  010011110          1836  CPYD7   LDX     M
0020  06C0  010100111          1837          RBIT    3
0040  0681  101110010  1808    1838          BRANCH  CDYD6
```


TABLE I-14

SOURCE STATEMENT

```
 PC    LOC    INSTR.      BRLN.  LINE  NAME      TITLE     COMMENTS
0000  0700  010001101            1840  FORCEOUT  CALLL     NUMGUESS  BLANK DISPLAY DATA FILE
0001  0703  110000000  1452      1841
0003  0707  001001000            1842  FORM      TCY       1
0007  070F  010011000            1843  FORMA     LDX       RANX
000F  071F  011111011            1844            YMCY      13
001F  073F  000101001            1845            TMA                 MOVE RANDOM NUMBER TO OP1
003F  077F  010010000            1846            LDX       A
007F  077E  011111000            1847            YMCY      1
007E  077D  000101100            1848            TAMDYN
007D  077A  100000111  1443      1849            BRANCH    FORMA
0078  0776  001000000            1850            TCY       0
0077  076E  001111100            1851            ACACC     3         LOWER LIMIT IS 30
006F  075E  011100110            1852  F01       ALEC      6         UPPER LIMIT IS 69
005F  073E  101111001  1456      1853            BRANCH    F02
003E  077C  001110011            1854            ACACC     12        AVG NUMBER IS 48
007C  0779  101101111  1852      1855            BRANCH    F01
0079  0772  000101111            1856  F02       TAM                 PUT COMPRESSED RAN(1) IN OP1(1)
0073  0766  010011110            1857  F03       LDX       M
0067  074E  001000010            1858            TCY       4
004F  071E  001101000            1859            TCMIY     1         = SEGMENT
001E  073C  001000100            1860            TCY       2
003D  0778  010100011            1861            SBIT      3         OPERAND STATUS LATCH
007A  0775  010010000            1862            LDX       A
```

TABLE I-14 (cont)

```
0075  076A  001100010          1863                TCMIY     GSEG       MINUS OPERATOR
006F  0756  001100101          1864                TCMIY     OPAREN
0057  072E  001101101          1865                TCMIY     CPAREN     BOX TO OP2
002E  075C  001101111          1866                TCMIY     15
005C  0739  001101111          1867                TCMIY     15         BLANK TO RESULT
0038  0770  010111111          1868                RETN                 SUBROUTINE EXIT
0070  0761  010000000          1869  F03   BL        SCAN       GET DIGIT
0061  0742  101101111  0041    1870
0043  0706  111110011  1857    1871  F03A  CALL      F03                                    111
0006  070C  010001001          1872                BL        PANTHINK
000D  071B  100101110  1220    1873
                               1874  * RETURNS HERE AFTER DECODE WITH DIGIT IN ACC
001B  0737  010010000          1875  GAMESDIG LDX        A
0037  076F  001000100          1876                TCY       2
006E  075D  000101010          1877                TMY                  GET OPERAND DIGIT
005D  073A  000000101          1878                IYC                  OPERATOR BLANK IN NUMBER GUESSER ?
003A  0774  100100100  1927    1879                BRANCH    GAMRET0
0074  0769  110100100  1927    1880                CALL      GAMRET0                          4,340,374
0069  0752  011100000          1881  GAMRET1 ALEC      0          DIGIT = 0 ?
0052  0725  100011110  1212    1926
0024  0748  001001100          1927  GAMRET0 TCY       3
0048  0711  000000011          1928  NG4A  XMA                      PUT NUMBER IN OP2
0010  0720  011101001          1929                ALEC      9          2ND NUMBER ?
0021  0743  100011100  1937    1930                BRANCH    NG5        YES BRANCH
0042  0705  000101001          1931                TMA
0004  070A  000000101          1932                IYC
0009  0713  001101111          1933                TCMIY     15         BLANK 2ND DIGIT
0013  0727  010111111          1934                RETN
0027  074F  010000000          1935  NG4B  BL        SCAN       GO GET ANOTHER NUMBER
004E  071D  101101111  0041    1936                                                        112
001C  0738  000000011          1937  NG5   XMA                      RESTORE 1ST NUMBER
0039  0773  000000101          1938                IYC
0072  0765  000101111          1939                TAM                  FILL IN 2ND NUMBER
0065  074A  010000000          1940  NG6   CALLL     NOSCAN
004B  0716  111100111  0047    1941
0016  072C  111000110  1953    1942                CALL      SHOWTIME
002D  0758  001111111          1943                ACACC     15
005A  0735  101100101  1940    1944                BRANCH    NG6
```

TABLE I-14 (cont)

```
0034  0768  010010000        1945  NGBA      LDX       A
0068  0751  001000000        1946            TCY       0
0051  0722  000110010        1947            IMAC                ACC = OP1(1)+1
0022  0744  100001000  1950  1948            BRANCH    NG9       CARRY BRANCH
0044  0709  000101001        1949            TMA                 ACC = OP1(1)
0008  0710  001001100        1950  NG9       TCY       3
0011  0723  010001101        1951            RL        NG9A
0023  0747  100000010  1509  1952
0046  070D  001000011        1953  SHOWTIME  TCY       12        DEFAULT MSD COUNT
000C  0718  000101011        1954  SHOWTVAR  TYA                 OR VARIABLE
0019  0733  010010110        1955            LDX       6
0033  0767  001000111        1956            TCY       14
0066  0740  000110011        1957            ANEZ                MSD = 0 ?
0040  071A  100110101  1960  1958            BRANCH    SHOWT1
001A  0734  000101111        1959            TAM                 PRESET MSD COUNT
0035  076B  001001111        1960  SHOWT1    TCY       15        DECREMENT COUNTER
006A  0755  000000111        1961            DMAN
0055  072A  101010000  1966  1962            BRANCH    SHOWTEXT
002A  0754  000101100        1963            TAMDYN
0054  0729  000000111        1964            DMAN
0028  0750  000101111        1965            TAM
0050  0721  000000011        1966  SHOWTEXT  XMA
0020  0740  010111111        1967            RETN
0053  0726  101000011  1871  1882            BRANCH    F03A      YES BRANCH
0026  074C  011110101        1883  F05       YMCY      10
004C  0719  000101001        1884            TMA
0018  0730  011110010        1885            YMCY      4
0031  0763  000101101        1886            TAMIYC              MOVE OP1 TO RES
0062  0745  010111111        1887            RETN
0045  070A  110100110  1883  1888            CALL      F05
000A  0714  001001100        1889            TCY       3
0015  0728  000101001        1890            TMA
0028  0757  000110001        1891            CPAIZ               COMPLEMENT DIGIT
0056  0720  001000110        1892            TCY       6
002C  0758  000010101        1893            AMAAC               ADD OPU(2)
0058  0731  101011110  1903  1898            BRANCH    F07       NO BORROW
0030  0760  001110101        1895            ACACC     10        BCD ADJUST
0060  0741  000101100        1896            TAMDYN
0041  0702  000110010        1897            IMAC                GET OP2(1) TO DECREMENT
```

```
0002  0704  101000011   1871  1898                BRANCH   F03A      BLANK ALREADY
0005  0708  000000111         1899   F06          DMAN               OP2(1)=1
0008  0717  000101111         1900                TAM
0017  072F  011100000         1901                ALEC     0
002F  075F  100000101   1899  1902                BRANCH   F06       BLANK A LEADING ZERO
005F  0730  000101111         1903   F07          TAM
003C  0776  010000000         1904   F08          CALL     NOSCAN
0078  0771  111100111   0047  1905
0071  0762  111000110   1953  1906                CALL     SHOWTIME
0063  0746  001111111         1907                ACACC    15
0047  070E  100111100   1904  1908                BRANCH   F08
000E  071C  010010000         1909   F010         LDX      A
0010  073E  001001000         1910                TCY      1
0038  0777  011110010         1911   F011         YMCY     4
0076  076D  000101001         1912                TMA                MOVE RESULT TO OP1
0060  075A  011110101         1913                YMCY     10
0058  0736  000101100         1914                TAMDYN
0036  076C  100111011   1911  1915                BRANCH   F011
006C  0759  001111000         1916                ACACC    1         LEADING CHARACTER A BLANK ?
0059  0732  100010010   1921  1917                BRANCH   F013      YES BRANCH
0032  0764  111110011   1857  1918   F012         CALL     F03
0064  0749  010001001         1919                RL       BULLSEYE
0049  0712  100000000   1190  1920
0012  0724  001001000         1921   F013         TCY      1
0025  0748  000110011         1922                MNEZ               RESULT = 0 ?
004A  0715  100110010   1918  1923                BRANCH   F012      NO BRANCH
0014  0728  110000011   1842  1924                CALL     FORM      FORM NEW PROBLEM
0029  0753  010001001         1925                BL       AST2HALF
```

TABLE I-15

SOURCE STATEMENT

PC	LOC	INSTR.	BRLN.	LINE	NAME	TITLE	COMMENTS
0000	0780	010011110		1969	CLREGA	LDX	H
0001	0783	000000000		1970	CLCOM	COMX	
0003	0787	001000000		1971	CLALL	TCY	0
0007	078F	001100000		1972	CLALL1	TCMIY	0

TABLE I-15 (cont)

000F	079F	001010000		1973		YNEC	0	
001F	07BF	100000111	1972	1974		BRANCH	CLALL1	
003F	07FF	010111111		1975		RETN		
007F	07FF	110000000	1969	1976		CALL	CLREGA	
007E	07FD	001000111		1977		TCY	MODE	MODE = USER ENTRY
007D	07FA	010100000		1978		SBIT	USER	
007B	07F6	010010000		1979	BLANKD	LDX	A	
0077	07EF	001000000		1980	BLANK	TCY	0	BLANK 0=B OF A
006F	07DE	001101111		1981	BLANK1	TCMIY	15	
005F	07BE	001010001		1982		YNEC	8	
003E	07FC	101101111	1981	1983		BRANCH	BLANK1	
007C	07F9	010111111		1984		RETN		
0079	07F2	110000001	1970	1985		CALL	CLCOM	
0073	07E6	001000010		1986		TCY	4	
0067	07CE	010100000		1987		SBIT	0	
004F	079E	010010000		1988	CLRB	LDX	A	
001E	07BC	001000011		1989		TCY	12	
003D	07FB	001100010		1990		TCMIY	4	
007A	07F5	001000111		1991	ELCKEY	TCY	MODE	
0075	07EA	000101010		1992		TMY		
006B	07D6	001011100		1993		YNEC	3	
0057	07AF	101011100	1996	1994		BRANCH	BLUPK2	
002E	07DC	100100000	2095	1995		BRANCH	HLDIS	
005C	07B9	110110101	2088	1996	BLUPK2	CALL	CLREGB	
0038	07F0	010011000		1997	BOXKY2	LDX	B	
0070	07E1	110000001	1970	1998		CALL	CLCOM	
0061	07C2	010010100		1999		LDX	C	
0043	0786	110000011	1971	2000		CALL	CLALL	
0006	078C	110000001	1970	2001		CALL	CLCOM	
0000	0798	010011100		2002		LDX	D	
0018	07B7	110000011	1971	2003		CALL	CLALL	
0037	07EF	110000001	1970	2004		CALL	CLCOM	
006E	07DD	010010001		2005		LDX	DAM	
005D	07BA	110000011	1971	2006		CALL	CLALL	
003A	07F4	100100000	2095	2007		BRANCH	HLDIS	
0074	07E9	001000111		2008	VSSKEY	TCY	MODE	
0069	07D2	000100001		2009		TBIT	2	
0053	07A6	101011011	2042	2010		BRANCH	MOVBOX	
0026	07CC	110000000	1969	2011	VSS1	CALL	CLREGA	

TABLE I-15 (cont)

004C	0799	001000111		2012		TCY	MODE	
0018	07B0	000101111		2013		TAM		
0031	07E3	111111011	1979	2014		CALL	BLANKD	
0062	07C5	110000001	1970	2015		CALL	CLCOM	
0045	078A	000000110		2016	INSPLS	CLA		
000A	0794	001111000		2017		ACACC	1	
0015	07AB	001000101		2018	SETOPR	TCY	10	
0029	07D7	010010000		2019		LDX	A	
0056	07AD	000101111		2020		TAM		
002C	07D8	010010000		2021	INSOPR	LDX	A	
0059	0791	001000101		2022		TCY	10	
0030	07E0	000101001		2023		TMA		
0060	07C1	001000100		2024		TCY	2	
0041	0782	001111001		2025		ACACC	9	
0002	0784	000101111		2026		TAM		
0005	078B	010011110		2027		LDX	H	
000B	0797	001100001		2028		TCMIY	8	
0017	07AF	010010000		2029		LDX	A	
002F	07DF	010111111		2030		RETN		
005E	07BD	001000111		2031		TCY	MODE	
003C	07FB	000100001		2032		TBIT	2	
0078	07F1	100001110	2037	2033		BRANCH	BOXKEY	
0071	07E2	001001000		2034		TCY	1	ELCKEY
0063	07C6	001101000		2035		TCMIY	1	
0047	078E	101111010	1991	2036		BRANCH	ELCKEY	
000E	079C	001001010		2037	BOXKEY	TCY	5	
0010	07B8	001100101		2038		TCMIY	10	
0039	07F7	001101000		2039		TCMIY	1	
0076	07ED	001101101		2040		TCMIY	11	
0060	07DA	101001111	1988	2041		BRANCH	CLRB	
0053	07B6	000001001		2042	MOVBOX	MNEA		
0036	07EC	100100110	2011	2043		BRANCH	VSS1	
006C	07D9	010001101		2044		CALLL	NUMGUESS	
0059	07B2	110000000	1452	2045				
0032	07E4	110101100	2021	2046		CALL	INSOPR	
0064	07C9	010011000		2047		LDX	B	
0049	0792	000110010		2048		IMAC		
0012	07A4	011100100		2049		ALEC	2	
0025	07C3	101001000	2056	2050		BRANCH	BOXOK	

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0052  07A5  101001000   2056  2054                BRANCH    BOXOK
0024  07C8  001111011         2055    BOXKY1      ACACC     13
0048  0791  000101111         2056    BOXOK       TAM
0010  07A0  001001010         2057    BOXOK1      TCY       5
0021  07C3  110000111   1972  2058                CALL      CLALL1
0042  0785  010000110         2059                CALLL     BOXERR
0004  0788  110100010   0909  2060
0009  0793  001001011         2061                TCY       13
0013  07A7  001101011         2062                TCMIY     13
0027  07CF  001000110         2063                TCY       6
004E  079D  001101000         2064                TCMIY     1
001C  0783  011100100         2065                ALEC      2
0039  07F3  100111000   1997  2066                BRANCH    BOXKY2
0072  07E5  001000110         2067                TCY       6
0065  07CA  001100100         2068                TCMIY     2
0048  0796  100111000   1997  2069                 BRANCH   BOXKY2
0016  07AC  110000000   1969  2070    BLUPKY      CALL      CLREGA
002D  07D8  110000001   1970  2071                CALL      CLCOM
005A  0785  001000010         2072                TCY       4
0034  07E8  001101000         2073                TCMIY     1
0068  07D1  111111011   1979  2074                CALL      BLANKD
0051  07A2  111000101   2016  2075                CALL      INSPLS
0022  07C4  001001010         2076                TCY       5
0044  0789  001100101         2077                TCMIY     10
0008  0790  001001110         2078                TCY       7
0011  07A3  001101101         2079                TCMIY     11
0023  07C7  101001111   1988  2080                BRANCH    CLRB
0046  078D  010100001         2081    OPRKY2      SBIT      2          SET 2ND OPRD FLG
000C  0798  110010101   2018  2082                CALL      SETOPR     OPR SEG TO A10
0019  0783  100100000   2095  2083                BRANCH    BLDIS
0033  07E7  010010000         2084    DIVZRO      LDX       A
0066  07CD  001000010         2085                TCY       4
004D  079A  001101111         2086                TCMIY     15
001A  0784  100100000   2095  2087                BRANCH    BLDIS
0035  07EB  010011000         2088    CLREGB      LDX       B
006A  0705  100000011   1971  2089                BRANCH    CLALL
0055  07AA  001000101         2090    BOXNX1      TCY       10
002A  0704  010011000         2091                LDX       B
0054  07A9  010000101         2092                LDP       10
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0028  07D0  0001110011        2093  MNEZ
0050  0741  1010111001  1399  2094  BRANCH  USRNX1
0020  07C0  0100000000        2095  BL      SCAN    RLDIS
0040  0781  1011011111  0041  2096
0044  0795  0111011100        2051  ALEC    3
0014  07A8  1001001100  2055  2052  BRANCH  HOXKY1
0029  07D3  0111001110        2053  ALEC    6
```

TABLE II

LEVELS OF DIFFICULTY, BOX PROBLEM MODE	LEVEL 1	LEVEL 2
ADDITION PROBLEMS		
Addends	0 to 9	0 to 49
Sum	0 to 18	0 to 98
SUBTRACTION PROBLEMS		
Minuend	0 to 18	0 to 49
Subtrahend	0 to 9	0 to 49
Difference	0 to 9	0 to 49
MULTIPLICATION PROBLEMS		
Multiplicand	0 to 5	0 to 9
Multiplier	0 to 9	0 to 9
Product	0 to 45	0 to 81
DIVISION PROBLEMS		
Dividend	0 to 45	0 to 81
Division	1 to 5	1 to 9
Quotient	0 to 9	0 to 9

TABLE III

FIVE BIT LATCHED ACCUMULATOR REGISTER CODES		
S BIT CODE	SEGMENTS ACTUATED	OUTPUT DISPLAY
00	a,b,c,d,e,f	0
01	b,c	1
02	a,b,d,e,g	2
03	a,b,c,d,g	3
04	b,c,f,g	4
05	a,c,d,f,g	5
06	a,c,d,e,f,g	6
07	a,b,c	7
08	a,b,c,d,e,f,g	8
09	a,b,c,d,f,g	9
0A	a,d,e,f	[
0B	a,b,c,d	]
0C	e,g	r
0D	a,d,e,f,g	E
0E		Blank
0F		Blank
10		Blank
11	c	part of timer display
12	d	part of timer display
13	e	part of timer display
14	g	part of timer display
15	f	part of timer display
16	a	part of timer display
17	b	part of timer display
18	a,d	dots in divide sign
19		Blank
1A	b,e,g	plus sign
1B	g	minus sign
1C	f	multiply sign
1D	a,d,g	divide sign
1E	a,b,c,d,e,f,g	circle
1F		Blank

TABLE IV

DISPLAY PRESENTATIONS

TYPE A PRESENTATION

1. Sequentially energize the display's S_a segments starting at left hand side of the display (D9) and

proceed to right hand side (D2) and energize equals sign segments between the S_a segments at D5 and D4; follow the S_a segment at D2 by first actuating four segments at D1 (these segments are located at 90° positions to each other) and then by actuating all segments at D1.

2. Repeat step 1, substituting S_d segments for S_a segments.
3. Repeat step 1, substituting S_g segments for S_a segments.
4. Repeat step 1, substituting S_a, S_d and S_g segments for S_a segments.
5. Actuate circular character by first actuating four segments (at 90° positions to each other) at D1 and then actuating all segments at D1; sequentially energize the S_a segments starting at the right side (D2) and proceed to the left hand side (D9) and actuate the equals sign segments between the S_a segments at D4 and D5.
6. Repeat step 5, substituting S_d segments S_a segments.
7. Repeat step 5, substituting S_g segments for S_a segments.
8. Repeat step 5, substituting A, D and G segments for S_a segments.

TYPE B PRESENTATION

1. Sequentially energize the display's S_g segments starting at left hand side of the display (D9) and proceed to right hand side (D2) and energize the equals sign segments between the S_g segments at D5 and D4; follow the S_g segment D2 by first actuating four segments at D1 (these segments are located 90° positions to each other) and then by actuating all segments at D1.
2. After actuating all segments at D1, again actuate the four segments at D1; then sequentially energize the S_g segments starting at the right side (D2) and proceed to the left hand side (D9) and actuate the equals sign segments between the S_g segments of D4 and D5.

TYPE C PRESENTATION

Do step 1 of a type B presentation alone.

TYPE D PRESENTATION

Actuate the various segments in the various digit positions for approximately one second. The segments should appear to be randomly actuated to the casual observer; of course, the actual sequence selected for actuating the segments may be preprogrammed to merely appear to be random.

What is claimed is:

1. An electronic learning aid comprising:

problem posing means for posing a plurality of problems to an operator of the learning aid and for determining the correct solutions to the problems being posed;

display means operably associated with said problem posing means for visually presenting to an operator of the learning aid problems posed by said problem posing means, said display means including a plurality of individually actuatable segments visually observable when actuated to show at least the correct response to a problem as posed by said problem posing means;

operator input means for receiving an input from an operator of the learning aid as a proposed solution by the operator to the problem being posed as presented by said display means;

digital logic means including comparator means coupled to said problem posing means, said operator input means and said display means for comparing the input received by said operator input means from the operator with the correct solution to the problem being posed and for providing a difference signal indicative of any differences therebetween;

memory means for storing the number of problems posed to the operator as presented by said display means and the number of correct solutions provided by the input received by said operator input means as determined by said comparator means; and

display presentation means operably associated with said actuatable segments of said display means for selectively actuating segments of said display means in response to the number of correct solutions received by said operator input means from the operator as determined by said comparator means in relation to the number of problems posed by said problem posing means as presented by said display means to provide at least two different visually observable display presentations utilizing selectively actuated segments of said display means and indicative of the percentage of correct solutions entered by the operator at said operator input means with respect to the total number of problems posed, each of said different display presentations being a fanciful predetermined actuation of display segments and being capable of operator comprehension as individually related to the percentage of correct solutions entered by the operator at said operator input means.

2. An electronic learning aid as set forth in claim 1, wherein said plurality of individually actuatable display segments included in said display means are responsive to said problem posing means to be selectively actuated to provide a visually observable display of a problem as posed by said problem posing means.

3. An electronic learning aid as set forth in claim 2, wherein said individually actuatable segments of said display means are responsive to said problem posing means, said comparator means, said memory means and said display presentation means for being selectively actuated to be visually observable for displaying to the operator the number of problems posed and the number of correct solutions received by said operator input means from the operator as determined by said comparator means.

4. An electronic learning aid as set forth in claim 3, wherein said operator input means comprises a keyboard including a plurality of keys for respective touching by the operator in entering a proposed solution to the problem being posed.

5. An electronic learning aid as set forth in claim 4, wherein said problem posing means is effective for posing arithmetic problems to the operator of the learning aid and for calculating the correct solutions to the arithmetic problems being posed.

6. An electronic learning aid as set forth in claim 5, wherein the plurality of individual keys included in said keyboard are representative of the numbers "0" through "9".

7. An electronic learning aid as set forth in claim 6, wherein said problem posing means is effective for posing a set of arithmetic problems and for calculating the correct solution to each of the arithmetic problems included in the set thereof posed, and said memory

means is effective for storing the number of problems posed in said set of arithmetic problems and the number of correct solutions received by said operator input means from the operator as determined by said comparator means.

8. An electronic learning aid as set forth in claim 1, wherein the duration of the visually observable display presentation as presented by said display means in response to said display presentation means is a function of the number of correct solutions received by said operator input means from the operator as determined by said comparator means with respect to the number of problems posed.

9. An electronic learning aid comprising:

problem posing means for posing a plurality of problems and for determining the correct solutions to the problems being posed;

display means operably associated with said problem posing means for visually presenting to an operator of the learning aid problems posed by said problem posing means, said display means including a plurality of individually actuatable segments visually observable when actuated to show at least the correct response to a problem as posed by said problem posing means;

operator input means for receiving an input from an operator of the learning aid as a proposed solution by the operator to the problem being posed as presented by said display means;

digital logic means including comparator means coupled to said problem posing means, said operator input means and said display means for comprising the input received by said operator input means from the operator with the correct solution to the problem being posed and for providing a difference signal indicative of any differences therebetween;

memory means for storing the number of problems posed to the operator as presented by said display means and the number of correct solutions provided by the input received by said operator input means as determined by said comparator means; and

display presentation means operably associated with said actuatable segments of said display means for selectively actuating segments of said display means in a specific sequential series in response to the number of correct solutions received by said operator input means from the operator as determined by said comparator means in relation to the number of problems posed by said problem posing means as presented by said display means to provide a plurality of different visually observable display presentations utilizing selectively actuated segments of said display means in which at least one of said visually observable display presentations is a sequentially arranged order of actuated segments of said display means, each of said plurality of different visually observable display presentations being a fanciful predetermined actuation of display segments and being capable of operator comprehension as individually related to the percentage of correct solutions entered by the operator at said operator input means with respect to the total number of problems posed.

10. An electronic learning aid as set forth in claim 9, wherein said plurality of individually actuatable display segments included in said display means are responsive to said problem posing means to be selectively actuated to provide a visually observable display of a problem as posed by said problem posing means.

11. An electronic learning aid as set forth in claim 10, wherein said individually actuatable segments of said display means are responsive to said problem posing means, said comparator means, said memory means and said display presentation means for being selectively actuated to be visually observable for displaying to the operator the number of problems posed and the number of correct solutions received by said operator input means from the operator as determined by said comparator means.

12. An electronic learning aid as set forth in claim 11, wherein said operator input means comprises a keyboard including a plurality of keys for respective touching by the operator in entering a proposed solution to the problem being posed.

13. An electronic learning aid as set forth in claim 12, wherein said problem posing means is effective for posing arithmetic problems to the operator of the learning aid and for calculating the correct solutions to the arithmetic problems being posed.

14. An electronic learning aid as set forth in claim 13, wherein the plurality of individual keys included in said keyboard are representative of the numbers "0" through "9".

15. An electronic learning aid as set forth in claim 14, wherein said problem posing means is effective for posing a set of arithmetic problems and for calculating the correct solution to each of the arithmetic problems included in the set thereof posed, and said memory means is effective for storing the number of problems posed in said set of arithmetic problems and the number of correct solutions received by said operator input means from the operator as determined by said comparator means.

16. An electronic learning aid as set forth in claim 9, wherein the duration of the visually observable display presentation as presented by said display means in response to said display presentation means is a function of the number of correct solutions received by said operator input means from the operator as determined by said comparator means with respect to the number of problems posed.

17. An electronic learning aid as set forth in claim 9, wherein each of said plurality of different visually observable display presentations utilizing selectively actuated segments of said display means is a sequentially arranged order of actuated segments of said display means of a complexity increasing in relation to a corresponding increase in the percentage of correct solutions entered by the operator at said operator input means with respect to the total number of problems posed, and one of said visually observable display presentations having the appearance of an essentially random actuation of said display segments indicative of an undesirable percentage of correct solutions.

18. An electronic learning aid as set forth in claim 9, wherein said display presentation means is effective for selectively actuating segments of said display means in a manner providing an impression of movement from one side of said display means to the other in producing said at least one of said visually observable display presentations as a sequentially arranged order of actuated segments of said display means.

19. An electronic learning aid as set forth in claim 18, wherein said plurality of individually actuatable segments of said display means are arranged in sets of seven

segments disposed in a "FIG. 8" configuration including horizontal upper, lower and middle segments, each set of seven display segments being capable of selective actuation to provide a visual display of any of numerals "0" through "9", said plurality of individually actuatable display segments further including a circular character comprised of a plurality of individual display segments located at one end of said sets of seven segments; and

said sequentially arranged order of actuated segments comprising said at least one of said visually observable display presentations being defined by the sequential actuation of selected segments in each of said seven segment sets in a direction toward said segmental circular character whose segments are actuated following the actuation of a selected segment of said seven segment set nearest thereto.

20. An electronic learning aid as set forth in claim **19**, wherein said sequentially arranged order of actuated segments comprising said at least one of said visually observable display presentations is defined by the sequential actuation of the middle segments in each of said seven segment sets in a direction toward said segmental circular character whose segments are actuated following the actuation of the middle segment of said seven segment set nearest thereto.

21. An electronic learning aid as set forth in claim **19**, wherein said sequentially arranged order of actuated segments comprising said at least one of said visually observable display presentations is defined by the sequential actuation of the upper segments in each of said seven segment sets in a direction toward said segmental circular character whose segments are actuated following the actuation of the upper segment of said seven segment set nearest thereto, the sequential actuation of the lower segments in each of said seven segment sets in a direction toward said segmental circular character whose segments are actuated following the actuation of the lower segment of said seven segment set nearest thereto, the sequential actuation of the middle segments in each of said seven segment sets in a direction toward said segmental circular character whose segments are actuated following the actuation of the middle segment of said seven segment set nearest thereto, and the simultaneous actuation of the upper, lower and middle segments in a respective seven segment set followed in sequence by the simultaneous actuation of the upper, lower and middle segments of each seven segment set in a direction toward said segmental circular character whose segments are actuated following the simultaneous actuation of the upper, lower and middle segments of said seven segment set nearest thereto.

* * * * *