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AUTOMATIC FOIL ACTIVITY COUNTING FACILITY AND DATA-REDUCTION PROGRAM

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AUTOMATIC FOIL ACTIVITY COUNTING FACILITY AND DATA-REDUCTION PROGRAM

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K. E. Plumlee and M. T. Wiggins

I. INTRODUCTION

Critical experimentation often involves large amounts of foil-activation data. The labor and investment necessary for foil-activation counting have generally limited the amount of data obtained. Although several automatic counting systems have been reported,(1-3) additional features were needed for use by the Experimental Physics Section. These may be described as greater flexibility, more freedom from maintenance, and increased convenience of operation.

The increased flexibility included these abilities: to change counting intervals at will; to start or end traverses in any detector chain without complication; to take background counts intermixed at will between foil data; optional preset counting intervals or preset count accumulation; and provision for scaling data from various sources (other than foil-activation measurements).

Maintenance requirements were believed to be minimized by the use of carefully selected trouble-free components, including transistors and canned relays.

Convenience requirements included: output more suitable for computer processing; automatic sensing of the type of count recorded (i.e., background disc, foil holder, or end of traverse marker); and ready availability of data at all stages of processing.

II. SUMMARY

A transistorized automatic counting and recording system was built for the determination of foil-activation data. Output data is on IBM-printed and punched cards which may be processed by a high-speed computer. The computer produces tabular and graphical output, as well as punched data cards which may be used for further processing such as curve fitting.

The foil-activation data are taken from one to six chains operating in unison (normally sample-changer, detector, amplifier, analyzer, scaler, and read-out chains). Circuitry and logic of the system were greatly simplified by the use of a one-second interval marker which initiates and terminates each step of the cycle in full seconds rather than fractional seconds.

The equipment includes provision for optional preset counting interval or preset count accumulation. There are sensing devices to record the kind of measurement made (whether foil activation or background count), plus manual switches which may also specify how individual measurements will be processed later by the computer, on a card-by-card and scaler-by-scaler basis.

Data are processed by an IBM-704 computer programmed to produce plotted traverses as well as tabular data. From 25 to 100 foil-activation measurements per minute may be processed, depending on the number of entries per card and the use of preprocessing equipment.

The data reduction includes many repetitive steps which the computer does very precisely and economically.

III. ELECTRONIC DESCRIPTION

The data read-out system is composed of the following components:

A. IBM-526 punch;

B. Control chassis;

C. Translator;

D. Sample changers;

E. Card numberer;

F. Identifier chassis; and

G. Scalers.

The description of the various components of the system follow in the order given above. A photograph of the equipment is given in Fig. 1. A block diagram is given in Fig. 2. Circuitry is shown in Figs. 3 through 6. Up to six batches of foils may be processed simultaneously in six automatic sample changers. The foil activities are scaled by six scalers. In addition, there are a cycle counter (Veeder Root Counter), a run-time (1-sec interval) scaler, and a counting-interval time scaler. The scaled data are read out at the end of each counting interval, and are punched and printed on IBM data cards.

A. IBM-526 Punch

The IBM-526 Card Punch is a standard model with very minor modifications necessary to adapt to this system. Connecting circuitry is shown in Fig. 3. Control circuitry is shown in Fig. 6 (Keyboard/Summary Control insert). Data card format is given at the end of section V-Q.

The pick (energizing) of I6, 8, and 36 puts the IBM punch in summary operation. The punch will then step and punch an IBM card, one column at a time, sequentially. The row energized determines the digit punched in a column. The punch will impulse, sequentially and in step with the column punching, one of eighty outgoing lines. (Exactly: if we are to punch, say, in a column No. 8, emitter No. 8 is pulsed.) Normally, a pulse, called "P5 strobe," is applied to the emitter. We have slightly modified the punch in order to put an earlier pulse, P3 strobe, on the emitters. The ending of P3 strobe overlaps the start of P5 strobe.

The space coil is I15. Unlike a typewriter, it is permissible to pick "space" and a character at the same time. The character will punch, and then the card will space.

The punch will return to keyboard or to idle condition with the release of I5 and A21. For the auto-duplication feature of the punch, the punch must be restored to keyboard operation. Although the punch is shifted to the keyboard mode, the punch will continue punching after sensing auto-duplicate in the program card, as if it were still in summary operation.

The modifications of the IBM punch, then, are as follows:

The lead connecting (25-7) and (D4) is disconnected. P5 strobe (25-7) and P3 strobe (21-4) are brought out externally thru KBY44 and SP11, and back to the column Emitter Common (D4) as shown. A lead is merged to A21 and brought out externally.

B. Control Circuits

The control chassis activates the various components of the system in proper sequence. It requires that all sample changers reach counting readiness before scaling may commence. It starts and stops the scalers, initiates readout, and signals the sample changers to process the next foil. The sample changers and the card punch are self-contained automatic systems equipped with many of the features required in automation of the facility. Control circuitry is shown in Fig. 2. There are two basic cycles in the auto-mode type of control:

1. the counting cycle, and
2. the read-out cycle.

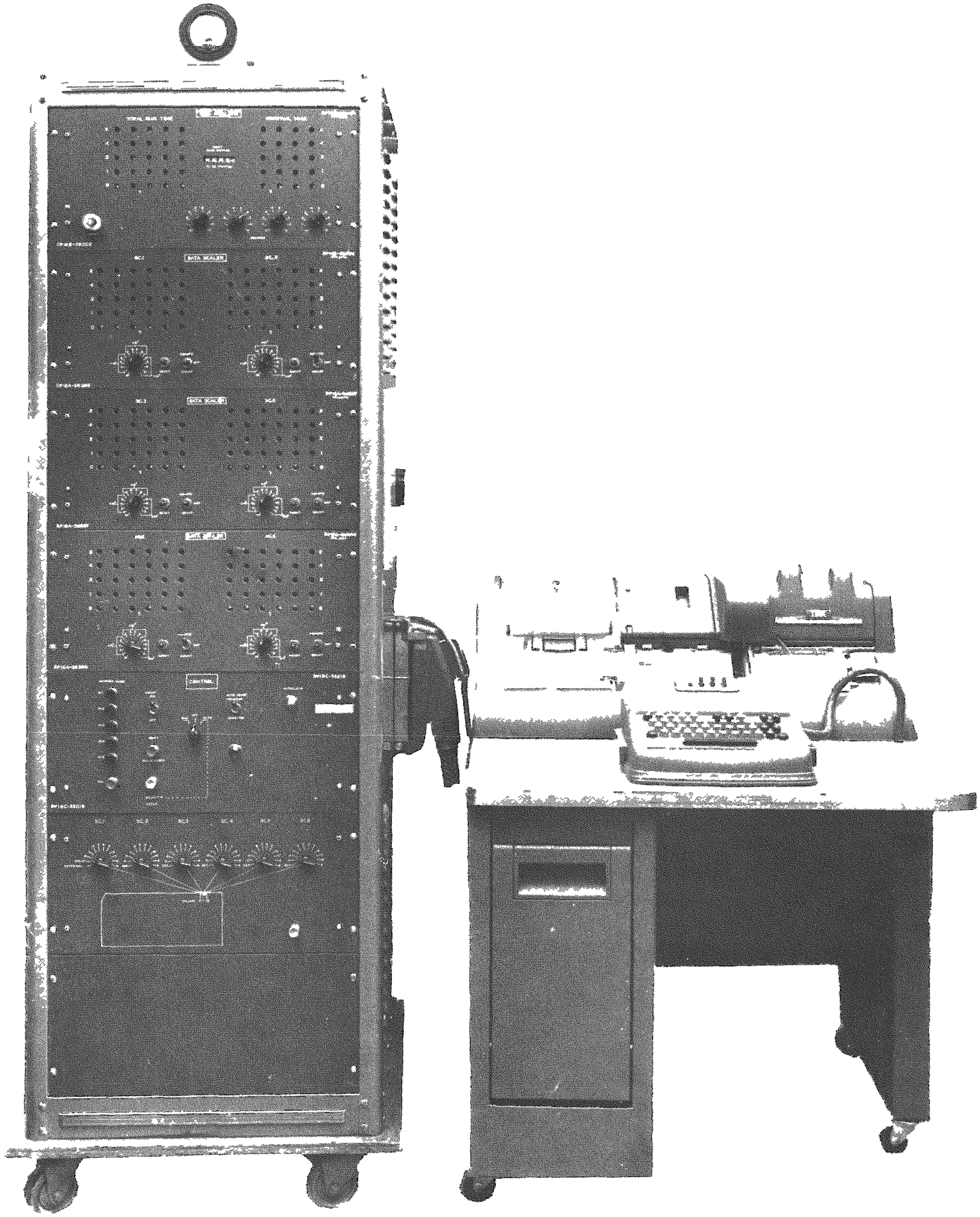
Both of these cycles are started and terminated exactly on one-second spaced pulses (pulse "D" or "D not"). Assume the system is in the counting cycle. From the count cycle portion of the drawings, it follows that relay SRO is not picked and relay CR is picked. Relay SRO will then be picked by the first "D" pulse after interval time or preset count is picked. (Q4, Q5, and Q6 form an "and" gate.)

When SRO picks, SRO-24 terminates the count cycle. (Note that CR is still picked.) SRO-34 will "trigger off" the IBM-526 punch for a read-out cycle. When the punch reaches column No. 73, emitter line No. 73 resets SRO (by way of AR, AR11, and SRO11). Scalers are reset at this time, and the card numberer advanced one count. The system could begin counting again, except that the earlier column No. 65 drove the CR relay to the not-picked condition. CR can only be picked, and a new count cycle started, when the sample changers have all loaded in the next sample holder to be counted. The first "D not" pulse after closure of w-x is the actual start.

C. Translator

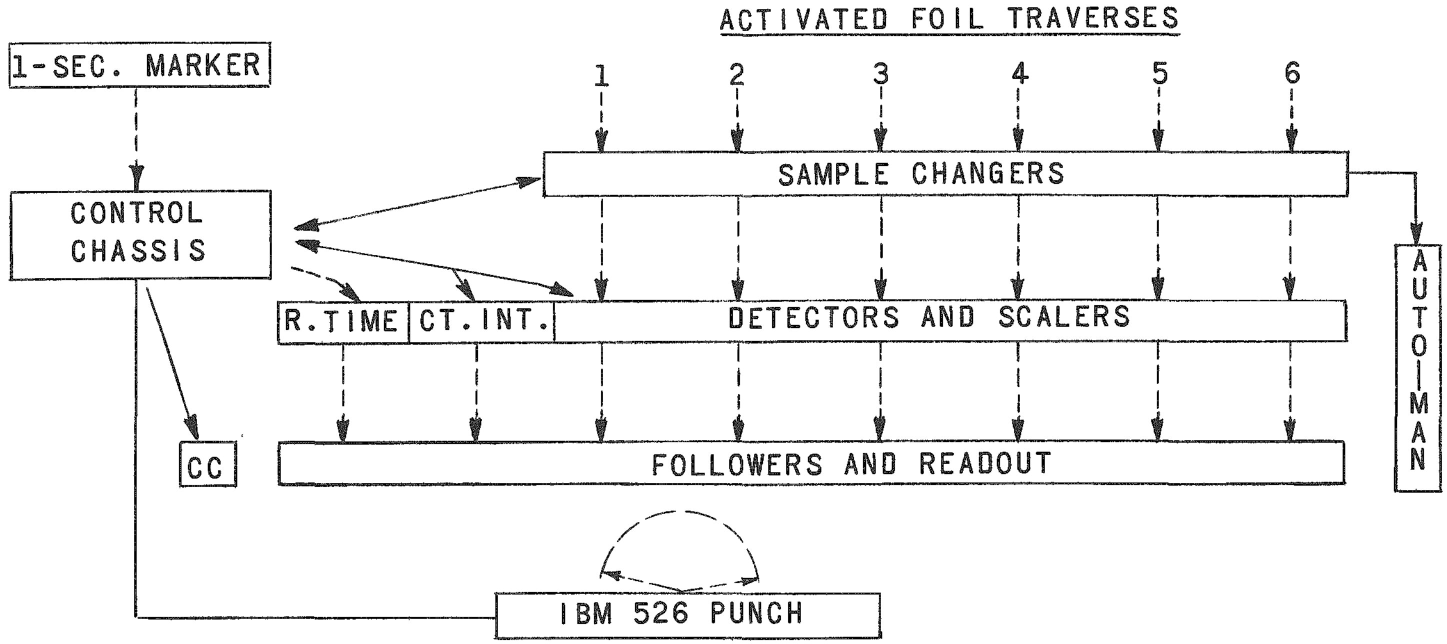
The translator, at the proper time, is required to select the proper digit of information to be punched. In addition, whenever the selected digit is in compact BCD code, the translator must convert this code to the "one line picked in twelve" code that the IBM punch uses.

Our normal operation is to have the emitter pulse (combination P3 strobe and P5 strobe), to pick a call-out relay assigned to an emitter line. The pick of this relay straps the digit information to four BCD lines. These lines, in turn, drive four translator relays. Contacts of the translator relays drive the ten punch magnet lines. The contacts are pulsed and only pulsed by P5 strobe. The set-up time allowed, then, is the time between the start of P3 strobe and the start of P5 strobe.



Neg. No. 143-464

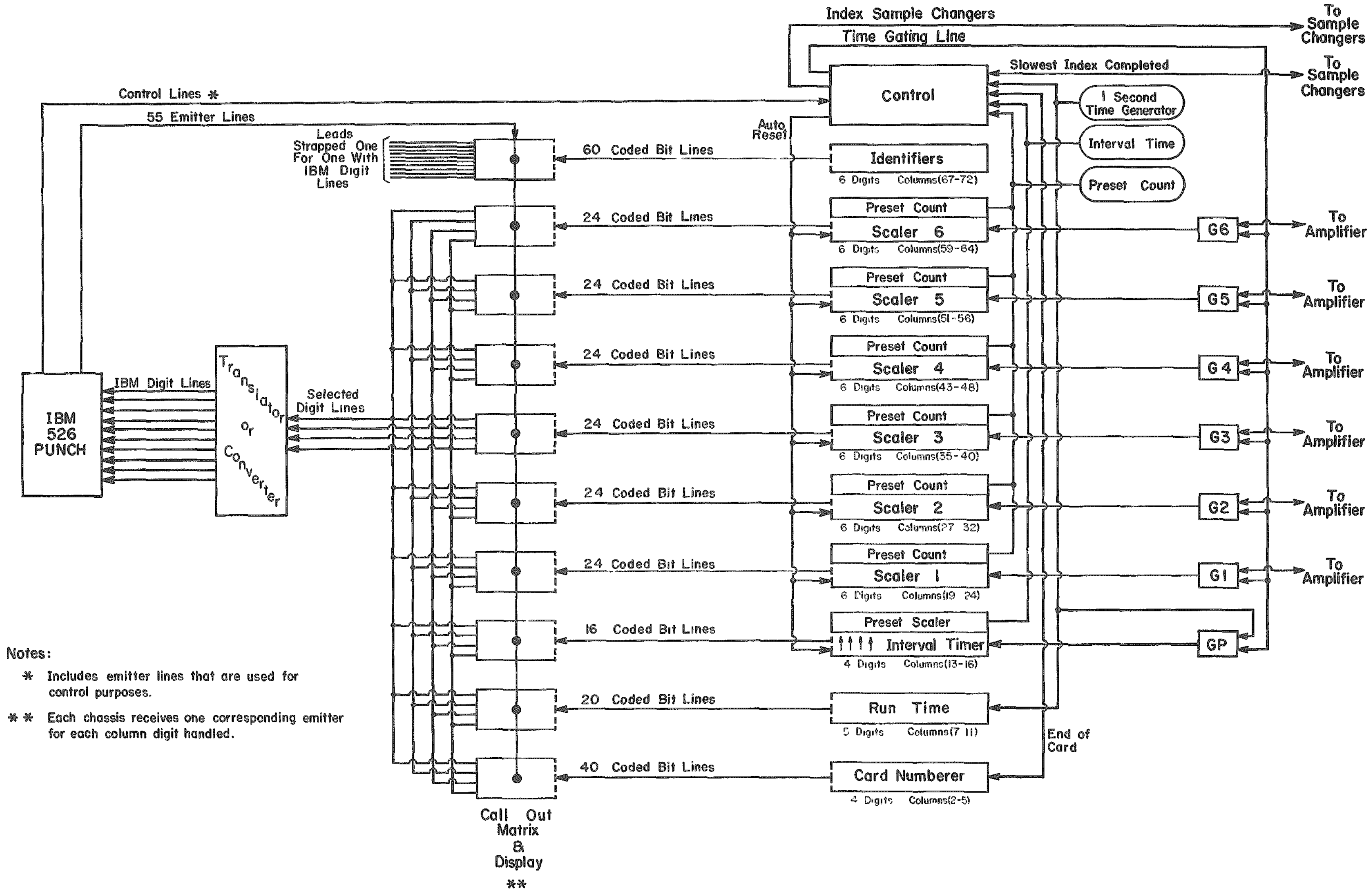
Fig. 1. Automatic Scalers and Recorder



2-5	7-11	13-16	19-24	27-32	35-40	43-48	51-56	59-64	67-72	73-80
CARD NO.	CLOCK TIME	COUNT INT.	← RECORDED DATA OF SIX SCALERS →						PROG. CONTROL	NOT READ

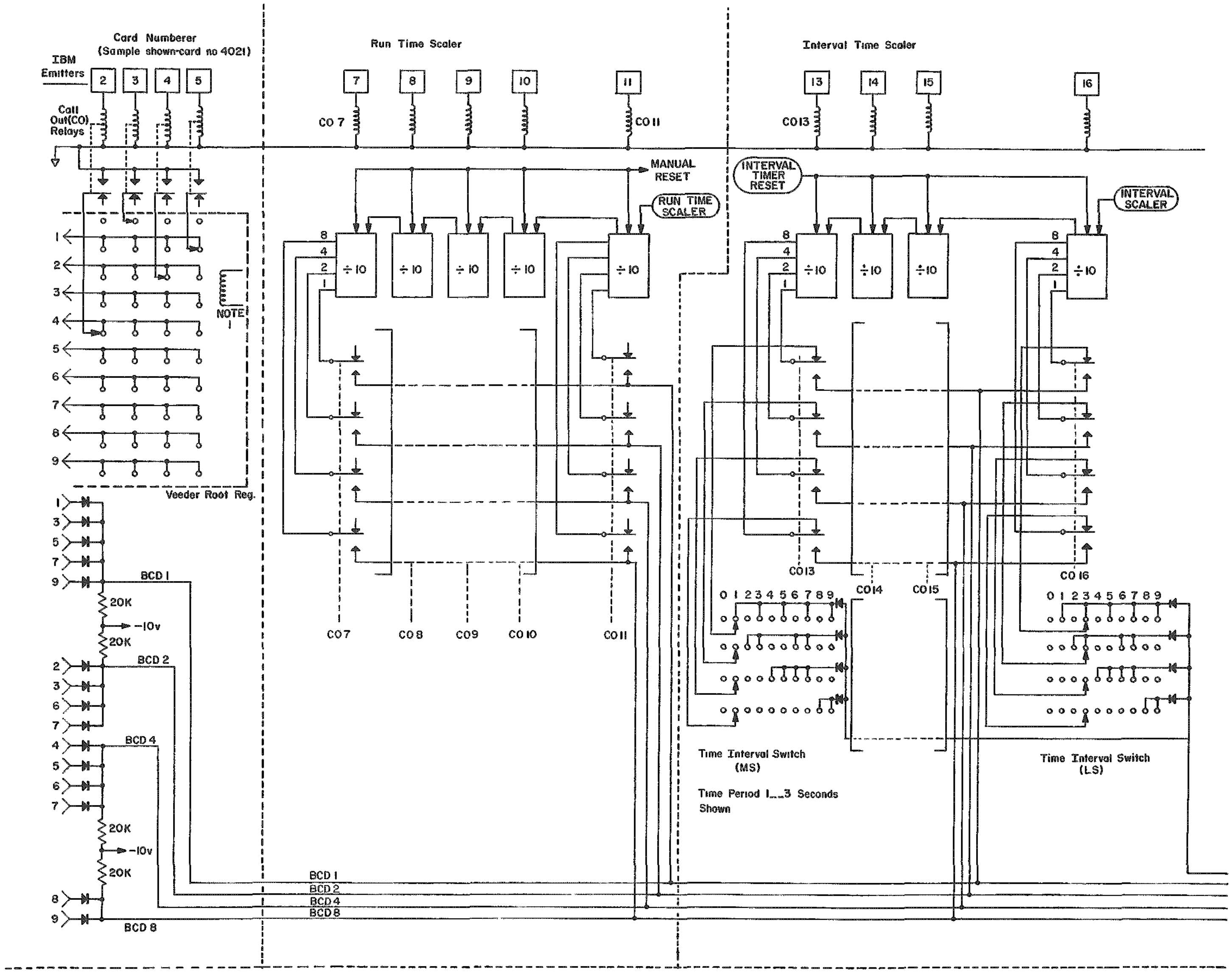
IBM DATA CARD FORMAT

Fig. 2. Foil Data Recording Block Diagram



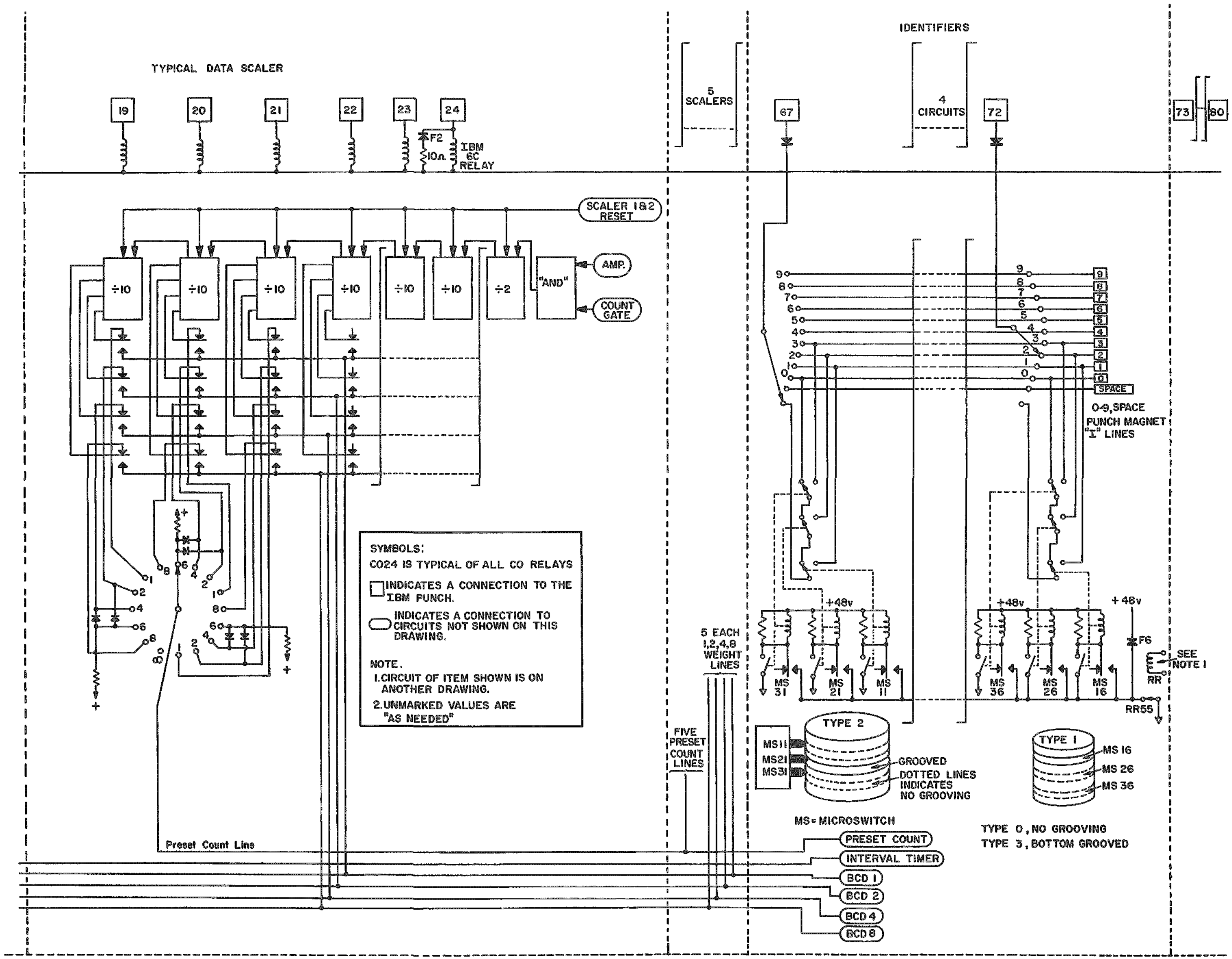
Neg. No. 143-824

Fig. 3. Connecting Circuitry



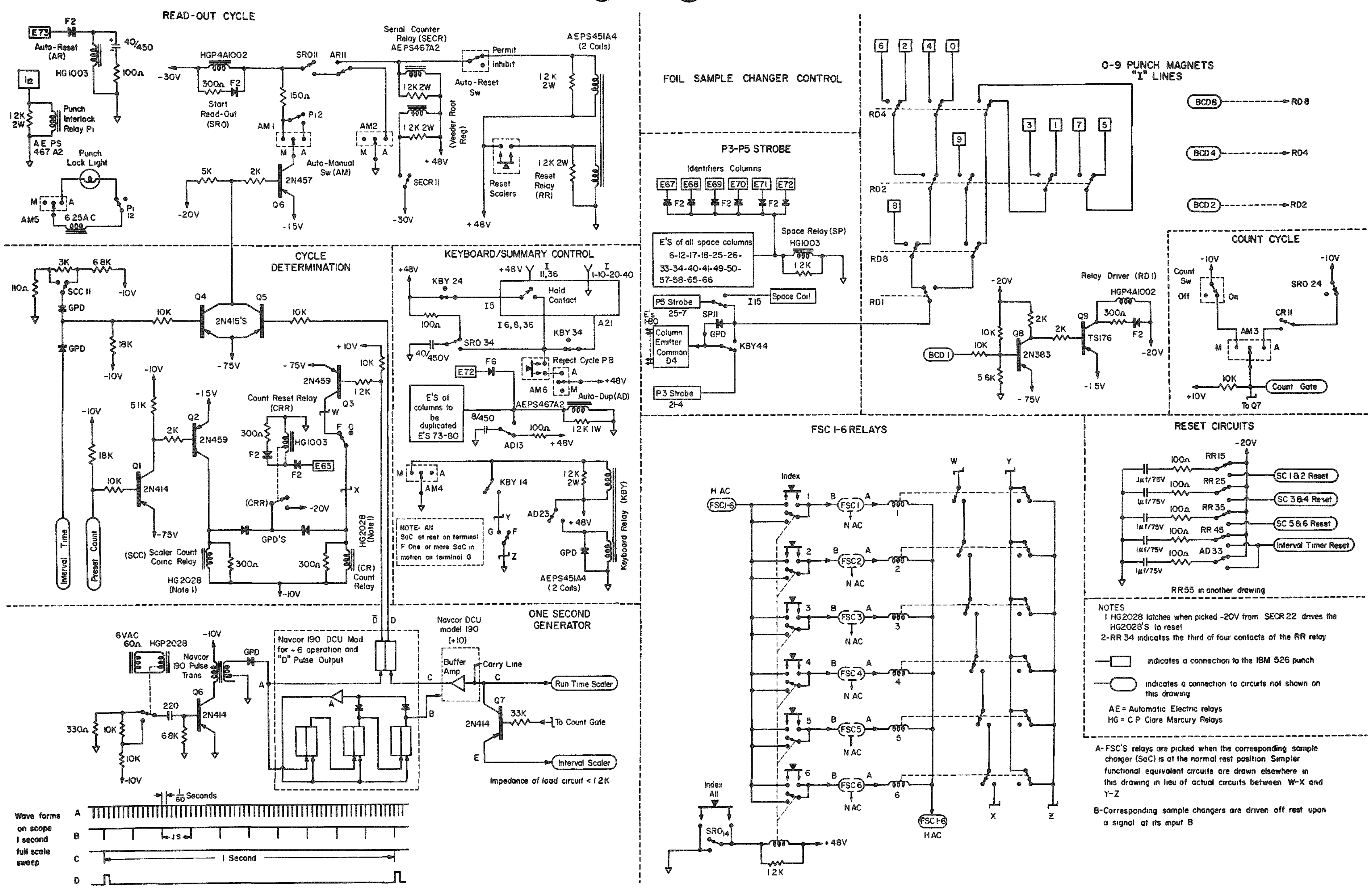
Neg. No. 143-826

Fig. 4. Time Scalers



Neg. No. 143-825

Fig. 5. Data Scalers and Identifier Circuits



Neg. No. 143-823 Rev.

Fig. 6. Control Circuitry

When no information at all is being supplied to the translator relays, RD1 tongue is tied to punch magnet "zero." P5 strobe must be removed, therefore, from the translator when a blank columm (space) is to be put/left on the IBM card. This is done by SP11. The problem does not exist for auto-duplicate operation, only because the IBM-526 punch, itself, internally blocks a P5 strobe signal when auto-duplicating.

D. Sample Changers

The Nuclear-Chicago sample changers (7) are nearly self-contained circuit-wise. Once driven off "home" by action of contact SRO-14, they will continue the sample-changing process until completed. After all of the changers have completed a change of samples, points w-x will be closed while an open circuit will exist between points y and z. Closing w-x is necessary to start a new count cycle; opening of y-z is needed to open keyboard "hold" so that SRO pick may later terminate the count cycle and start a new read-out cycle.

E. Card Serial Numbers

The Veeder Root register has an outgoing line for every digit number plus a common line for every digit position. The ten-line output is decoded to standard BCD code. The Veeder-Root count, which was produced by emitter No. 73 of the previous read-out cycle, is the count read-out by emitter pulses 2 through 5 of the present read-out cycle.

F. Identifiers

For each sample changer, there is a set of three microswitches which senses the sample holder as it is moving from the input stack to the counting station. If the holder is grooved, a microswitch rolling lever "drops in" the groove, and triggers a corresponding relay. These relays are decoded into the ten punch magnet lines, directly. (The card numberer and the identifiers were designed at a different time, which accounts for the different way of handling the coding. Either way is satisfactory.) The decoding relays are latching, the resetting action being initiated by emitter No. 73. Insofar as the IBM punch will reach and finish punching columns 67 through 72 before the sample holder now traveling from the input stack to the counting station reaches the microswitch, the IBM punch will punch out the latched information from the sample holder that has just been counted. (This sample holder is traveling from counting station to output stack, at this time.)

G. Scalers

All scalers are straightforward. The run-time scaler is never auto-reset and never gated. Since a read-out cycle is always started on a one-second marker, the run-time scaler will not receive another pulse until one second after SRO pick. The run-time scaler is read out in less than one second after SRO is picked, however. The recorded run time, then, is the time when counting actually stopped.

IV. OPERATION OF SYSTEM

A. Sample Changers

One or more sample changers or a facsimile must be connected into the system to obtain automatic cycling. The system requires that at least one changer be in the "Time Select" mode and "auto" count selection.(7) All changers which are inoperative must have the "counting light" on. Any unused changer may be disconnected, but a wired dummy connector must replace the sample-changer connector to satisfy the "counting light"-on requirement. The heavily shielded sample changer(6) and the facsimile each satisfies these requirements when operating.

Selection of the changer depends on the operation planned. The heavily shielded model is recommended for counting hard-gamma activities; however, it is less convenient and trouble-free than the Nuclear of Chicago Model C110-B sample changers. Selection of a sample changer for a given traverse may be based on the background count rate, on variability of background with traverse position in the stacks, on accuracy of foil position, or on speed of operation. The heavily shielded changer cycles in 13 sec and restacks in a minimum of 10 sec (+5 sec/planchet). The C110-B models(7) require about 15 sec/cycle and about 30 sec (+10 sec/planchet) when restacking. The C110-B changers are less subject to positioning errors; they have identifier sense switches added to mark background planchets, and they have more modes of operation. They are generally used for β and soft-γ counting. Shielding is 2-in.-thick lead in a specially built shield.

The facsimile circuit consists primarily of a pneumatic time-delay relay which requires 5 sec to reclose. This circuit simulates the "time select" mode and also the "counting on" circuit signal except for an interval of 5 sec commencing with read-out. This is necessary to maintain proper sequence when operating without sample changers. The 5-sec interval permits completion of read-out and reset.

B. Scalers

The six data scalers each include six commercial,(8) transistorized,* plug-in decade units with ANL-designed light and read-out followers. Since these are 100-kc decade units, a single, unrecorded 1-mc binary precedes

*These units require well-matched transistors for replacements. Stock orders do not assure satisfactory replacements.

them. This leaves an error of ($\pm\frac{1}{2}$) in the recorded count. The error is generally less than would be anticipated because of resolution losses if the incoming data were introduced directly into the 100-kc decade units.

The data scalers are assembled in pairs and may be switched to operate as three 12-decade scalers instead of six 6-decade scalers. Preset count switches permit selection of 1, 2, 4, 6, 8, or ∞ on the three higher decades of each scaler. Scaling continues until the next one-second marker following the preset count.

There is a reset toggle and a selector switch for off, on, or remote operation. Negative pulses (-10 to -50 v) of approximately one-microsecond duration may be scaled.

The run-time scaler is a five-decade scaler with a manual reset button only. It scales each one-second interval. The interval time scaler is a four-decade scaler with automatic reset and gang manual reset. It starts and resets with automatic counting. It may be preset to counting intervals of 1 to 9,999 sec.

The one-second interval marker consists of a 60-cps input marker derived from the ac power line, a modified (scale-of-six) and a standard (scale-of-ten) decade units.[8]

C. Identifier Chassis

The identifier chassis contains six manual switches which permit the operator to preselect the numbers punched into IBM card columns 67 through 72. There are also "space" (or blank) and "external control" positions. Each "external control" relay may be latched into a sense switch installed on a Nuclear of Chicago sample changer, and permits automatic recording of background and end-of-traverse planchets. The use of these numbers for program control is discussed in Section V-B-2.

D. Control Chassis

The control chassis contains the sequencing circuitry for automatic and manual gang operation of the system. Automatic operation commences after the sample changers are in station for counting, the rack door is closed, the card punch is ready (the first card must be rejected manually to turn out the red interlock light), and the control (Man-off-auto) switch is in the automatic position.

Counting intervals may be terminated by either preset time or preset count accumulation. The interval time scaler (scaling one count per second from the one-second marker) and one or more data scalers may (one or all) be preset to terminate counting intervals. Whichever reaches the preset accumulation first ends the count and initiates read-out for the entire system. The data and time scalers may both be preset to obtain adequate counting statistics and short counting intervals with the more active foils of a traverse and yet permit no counting interval of a less active foil to exceed a preset time (see V, G. Concurrent Normalization).

E. Card Punch

The IBM-526 card punch is necessary to the automatic cycle. In addition to the card punch being turned on, its program drum must be engaged, the added toggle switch (auto-other) must be turned to its automatic position, the auto-feed and auto-duplicate switches must be on, there must be cards in the input side, and one card must then be rejected by depressing the release button. The card punch may be used to terminate an unattended run by limiting the card supply.

The program drum controls the operation of the punch. The program card has the "1" row (numeric shift) punched to facilitate data recording from columns 1 through 72 (or 80). The "0" row is punched in columns 73 and 74 to initiate copying from the preceding card. The "12" row may be punched in columns 73 to 80 for field definition.

F. Cycle Counter

A Veeder-Root five-digit counter is advanced each time the scalers reset automatically (i.e., on completion of read out). The counter may be reset by access through the time chassis; however, this is rarely done. The left digit is not read out, but the other four appear as a serial number on each card, permitting card identification, filing, and sorting. This serial number is examined by the IBM-704 computer during data reduction to determine if the data card will be blank. In the event that the recorded four digits of the serial number are blank or zero, the computer will treat this card as the end of a deck.

G. Operating Check List

1. Record length of reactor run for foil irradiation. This will be required as RRT(I) for each scaler on the 6th card of 8-deck.

2. Turn on main power switch if not already on.

3. Record time elapsed TC(I) from end of irradiation to start of clock run-time scaler CRT. This is required for each scaler, on the 7th card of 8-deck.

4. Place traverse foils in selected sample changers with background and end-of-traverse planchets included as desired, leaving sample changers on and operable.

5. Clear interlock lights on control chassis.
   a. Rack door closed (green light on).
   b. Card punch on and operating (red light off).
6. Select timing interval (or preset count).
7. Turn control switch to automatic.
8. Dial identifier chassis selector switches as required for first card and reset if needed as counting progresses.
9. Check first card punched and printed.
   a. Did serial number and scalers record correctly?
   b. It may be worthwhile to note on this card the reactor run, date, traverse in each sample changer, voltage, gain, discriminator settings, and time of day.
   c. Columns 74 through 80 will be copied from one card to the next and may be used for run number, date, or any other information of seven digits or less.
10. Check card supply before leaving system unattended.
11. After completing counting, punch out 8-card deck.
12. Assemble 8-card deck and data cards (see Section V.B.4.). End of data-card deck is fixed by inserting a blank card.
13. Submit cards, computing time request, and instructions for running problem to IBM-704 computer staff.

V. DATA-REDUCTION PROGRAM

A. General Description

The FORTRAN II program for the IBM-704 computer produces tabulated and plotted data.(11) The program includes resolving loss correction, background subtraction, decay correction or alternatively concurrent normalization, deviation estimates, traverse normalization, and several choices in plotting. The program permits selection of different decay constants, resolution time, run time, etc., in each of the traverses being processed. These are accessible at any point during data processing (i.e., can be changed). The high degree of flexibility in handling as many as six scalers recorded on one data card leaves room for human errors; consequently, some care is necessary in setting up data for processing. The reward is in reducing days or weeks of tedious data treatment into a few minutes of computer time.

The FORTRAN source deck list is given in Table I. The flow charts in Figs. 7 to 9 indicate the more important branch points of the program. There are some 72 frequency statements in the list, which should indicate the variety of considerations affecting program control.

This program requires storage space of 22,170 words in the memory (not including 15 subroutines) and accommodates up to 360-card decks. An earlier version required storage of 6,440 words (not including 13 subroutines) but was restricted to 90-card (maximum length) data decks. There is no limit on the number of decks which may be processed. The instructions require 1,583 words of storage; however some curtailment is possible if storage is tight or read-in time must be curtailed. Drastic curtailment could be achieved by limiting the number of alternatives available in data processing.

B. Control of Data Processing

1. Sequence of Terms Affecting Branching

Branching is determined by the FORTRAN source list terms NUM(NO), NOS,IDC(I), NIL(I,NO), and DC(I) in sequence. The card serial number NUM(NO) $\neq$ zero holds the program in saturated activity computation or associated branches (see Fig. 7). If zero or blank, that operation terminates and traverse processing commences (see Fig. 8). NOS, supplied via the 8-deck, is the number of scalers to be treated. Any data from scalers numbered higher than NOS will be omitted. Alternatively, one may set DC(I) = zero (or two) to skip all data from a given scaler (I). If any traverse data output is desired from scaler (I), it is necessary that DC(I) $\neq$ zero (or two) in the end of a data-card deck. The use of DC(I) = unity or two is discussed in Section V-G, Concurrent Normalization. NIL(I,NO) is discussed under IDC(I) Code No. 2, below.

2. Identification Code Numbers, Data-card Columns 67-72

The identification code IDC(I) gives card-by-card and scaler-by-scaler control of computer processing. Column 67 applies to scaler No. 1, 68 to No. 2, etc. The following code numbers are used:

No. 1 indicates a background count which will be weighted by a factor BKW into the background count rate applied to subsequent scaler data. The use of this number results in a zero in the processed data table and omission from the plot. This may be recorded automatically by placing a No. 1 plastic disc between foil holders (and the identifier switch on external control).

No. 2 identifies a redetermination of background count rate, to replace the current value entirely. This too results in a zero in the processed data table and omission from the plot.

No. 3 in any column from 67 to 66 + NOS results in the next eight data cards being read as an 8-deck without interruption of traverses in the tabular and graphical output. Misuse of IDC(I) = 3 will inevitably ruin subsequent computations, until corrected.

No. 4 indicates end of traverse. This may be recorded automatically via a No. 4 plastic disc. In order to skip subsequent data from scaler (I) after appearance of an IDC(I) = 4, a term NIL(I,NO), which is normally zero, is set to unity. This term remains unity as processing continues until an IDC(I) other than zero, blank, or space occurs, at which point it reverts to zero. Data from scaler (I) are omitted entirely as long as NIL(I,NO) = 1. This branch separates traverse tabulations and plots, and saves computer time with unused scalers.

No. 5 identifies a standard foil to which the traverse will be normalized. If this is not the most active foil in the traverse, the larger points will be plotted full-scale as well as the standard foil. If no standard foil is indicated, the computer will select the most active foil and normalize thereto, generally resulting in only one full-scale point in each traverse.

No. 6 deletes data for the indicated scaler one point at a time. This produces a zero or a blank in the processed data output and is omitted from the data plot.

No. 7 produces double-spaced point in plot.

No. 8 produces triple-spaced point in plot.

No. 9 permits overprint in plot, using (X) rather than (*) for the overprinted point or points. This applies only to program control operation of the off-line printer, which is not advanced.

3. Sense Switch Functions

The six sense switches of the IBM-704 are used as follows in controlling data processing.

No. 1, while machine program is read, determines whether input data will be from magnetic tape No. 1 (sense switch No. 1 down - via INTAP 1 subroutine) or from on-line card reader (sense switch No. 1 up).

No. 1, while starting after PAUSE 6, determines re-entry point after completing a data-card deck. If up, the next eight cards are read as an 8-deck. If down, the constants from the most recent 8-deck are retained. This is necessary if a blank card or other inadvertent event should terminate a data card deck prematurely. It is rarely needed.

No. 2 down permits on-line printout (data sampling) but slows up computation. This does not apply to graphical output. It does not interfere with normal output on magnetic tape No. 2.

No. 3 down requires foil weights or calibration cards (see V-I, -J, -K- and L).

No. 4 down omits graph of output traverses.

No. 5 down produces punched cards from 1401 (off-line) data processor.(10)

No. 6 down produces detailed output of terms computed by IBM-704. This output is on Tape No. 3. It is slow and only a brief interval is usually needed to permit an evaluation of performance.

4. Problems in Control of Data Processing

Limitations in data processing arise from difficulty in indicating to the computer which branches are required. Most faults are the result of oversights in preparing data cards for reduction. These can be avoided by following a systematic pattern. The computer can readily process card-by-card and scaler-by-scaler controlled data. Some difficulty was encountered in writing the FORTRAN program so as to obtain consistent traverse treatment (see Fig. 8). Traverses for all scalers may be skipped if the decay constant for the last (NOS) scaler is zero or two. Earlier efforts failed to assure that all the traverses of a given scaler would be treated.

Automatic recording of background planchets and end-of-traverse planchets is very helpful, but further automation would be desirable. Decisions which affect large blocks of data require the attention of a technician or a physicist. Decay constants, resolving times, efficiencies, and other accessible constants must be supplied. The use of magnetic tape input vs. cards, and the selection from various modes of output must be indicated.

Although individual users tend to fall into patterns which require only a few 8-decks, the total number used in data reduction is quite large. Some users make up new 8-decks each time data are to be processed. Others change one or two items and duplicate the remainder. A user may follow a rigid routine requiring only one set of eight cards.

C. Eight-card Input (8-Deck) of Decay Constants, etc.

See statements 403-14, 60, 98.

Accessible constants of the FORTRAN program are included in an eight-card deck or 8-deck. This deck may be called in after any data card by punching an IDC(I) code No. 3 in the control column of any appropriate scaler. This revision does not interrupt traverses, but does show in the tabulated output of corrected activities.

1st Card - Title, any 72 characters may be entered here. This title heads output data tables, etc.

2nd Card - Specifies number of scalers (NOS): a fractional background weight adjustment (BKW, values usually between 0.00 and 1.00); coefficients of resolving correction equation (A, B and C); and scaler data multiplier (D) (see card 5, also items D, E, F, G).

3rd Card - Decay constants, up to six, for each scaler [DC(I)].

4th Card - Counter efficiencies for each scaler [EFC(I)]. If saturated activities are desired supply EFC(I)/DC(I) instead (see F and H).

5th Card - Initial background count rate for each scaler [BK(,1)].

6th Card - Reactor run time of foils for each scaler [RRT(I)].

7th Card - Time corrections TC(I) which the computer will add to the clock time (CRT) read from data cards. The sums of CRT and TC(I) should equal the time elapsed between the <u>end of the irradiation and the end of the counting interval for each foil.</u>

8th Card - Resolving time for each scaler [DT(I)].

D. Resolving Loss Correction

See statements 7, 15, 470, 71, 481, 482.

The resolving intervals are specified for each scaler on the eighth card of the 8-deck. They are carried as DT(I) throughout the FORTRAN program. Three constants of a polynomial equation (A, B, and C) are specified on the second card of the 8-deck. The corrected count is computed by the following formulation:

$$[\text{Corrected Count}] = [\text{Actual Count}] \quad \{1 + AM(DT) + BM^2(DT)^2 + CM^3(DT)^3\},$$

where M is the count rate (actual count/counting interval). The actual count is the product of the recorded scaler datum DATA(I,NC) and the multiplier D. The resolving loss correction precedes background count rate correction. The equation permits use of standard expressions for resolving loss corrections.

E. Background Correction

See statements 7, 12, 41, 43, 46, 48, 51, 53, 570, 471, 483, 85, 214, 215, and 241.

The computer carries forward a background count rate BK(I,1) which is multiplied by the counting interval CT(NO) and the multiplier D. This is subtracted from each count, D X DATA(I,NO), after resolution loss correction. The background rate is involved in other computations as well. BK(I,NO) is stored for each scaler datum processed, except for the NO = 1 location which always is the current adjustment and will correspond with the value supplied for the last NO read rather than the first. The values stored as BK(I,1) are initially supplied by the 5th card of the 8-deck. These values may be replaced by background counts identified by IDC(I) code No. 2. They may be adjusted by background counts identified by IDC(I) code No. 1, each count being weighted by the factor BKW and the preceding value by the factor (1-BKW).

F. Decay Correction

See statements 8, 70, 571, 472, 477, 73, 76, 77, 79, 4201, and 202.

Decay constants are specified on the third card of the 8-deck. They are carried as DC(I), one for each scaler, in the FORTRAN program. If DC(I) is unity or two, this results in concurrent normalization branch treatment. Otherwise, the following takes place. Datum is multiplied by the scaling factor (D) from the second card of the 8-deck. Resolution loss and background corrections are applied. The resulting term is divided by (TJ), below, and stored as SACT(I,NO). The value actually stored may be $V\Sigma_a\phi/\lambda$ or it may be saturated activity $V\Sigma_a\phi = n\sigma_a\phi$. See H: Corrected Activity, and 4th card of 8-deck.

$$TJ = EFC(I)\,[\exp(-\lambda t_1) - \exp(-\lambda t_2)]\,[\exp(-\lambda t_3) - 1.0]$$

t_1 = CRT + TC(I) = time elapsed from end of irradiation to end of counting interval.

t_2 = t_1 + RRT(I) = t_1 plus the irradiation time.

t_3 = CT(NO) = the counting interval, read from each data card.

λ = DC(I) = the decay constant of foil.

EFC(I) is the counting efficiency or inter-scaler calibration (see E. and H.).

It should be noted that the term TJ is computed only once in the event that adjacent scalers have identical decay constants. In the rather unusual event that RRT(I) or TC(I) are not the same, but the decay constants are, it is necessary to shade the decay constants by altering the sixth significant figure. This will result in recomputation of TJ.

G. Concurrent Normalization

See statements 472, 487.

If indicated by decay constant DC(I) = 1.0, foil data will be normalized against concurrently counted standard foils,[2] rather than decay corrected. This option is used with uranium fission product activities for which no single half-life is generally counted. One or more sample changers are turned off after insertion of reference foils for repetitive counting. Counting intervals may be terminated by preset count, preset time, or by both. Data from these foils are recorded along with concurrently counted traverses in operating sample changers. The normalizing foils are indicated by decay constants DC(I) = 2.0. It is not necessary to process this type of data in a computer. If the reference foil is preset count, traverses may be plotted from the data cards without further decay correction.

The standard deviations of the normalizing foils should be added to the tabulated columns for relative deviation and net deviation since the computer does not compute deviations for concurrent normalizing foils.

A comparison is given in Table IV of corrected activities for a single traverse of known half-life. The concurrent normalized data scatter about the decay-corrected data with the standard deviation expected from counting statistics of the reference foil. The scatter could have been reduced by the use of two or three reference foils rather than one.

Resolving loss adjustment and background subtraction are made with all concurrent normalized foils and standards. No provision was made for differences in counter efficiencies, since the technique requires carefully matched counter chains and the normalization is heavily dependent on a fixed proportionality being maintained between scalers.

H. Corrected Activity

See statements 4-18, 476-97.

The tabulated activities include resolving loss corrections, background subtraction, and decay correction. These are the tabulated terms SACT(I,NO). In order to obtain saturated activities ($V\Sigma_a\phi$ or $n\sigma_a\phi$), it is necessary to insert for counter efficiency (card No. 4 of 8-deck) the term (counter efficiency/decay constant); otherwise, the output will be $V\Sigma_a\phi/\lambda$ (see E. and F.).

I. Specific Activity

See statements 204-4223.

The tabulated specific activities utilize foil intercalibration, weight, volume, or cross-section information if supplied. The computed result may be either intercalibrated activity, specific activity, or flux, depending on the information supplied by the experimenter. The computer divides the corrected activity by a term W(LN) supplied as described below.

The use of this feature is controlled by sense switch No. 3. If up, no change is made in the corrected activity. If down, the computer reads cards (or tape) to obtain foil weights (or cross sections), four per card, plus standard deviation data for each weight. Consequently, these cards follow the blank card terminating a data deck. The weights must be in sequence as the foil data are processed. This commences with the first foil in the first sample changer used, proceeds through the foils in that changer, and on to the next sample changer.

J. Normalized Activity

See statements 221-233, 239.

If a standard foil is indicated by an IDC(I) code No. 5, the traverse in which it is included will be normalized to this standard foil. If none is indicated, the computer selects the most active foil of the traverse for normalization. See item L.

K. Relative Deviation

See statements 2, 4, 214, 215, 4215, 4217.

The tabulated relative deviations are computed as follows:[9]

$$\text{Relative Deviation} = (\text{Count} + \text{Background})^{\frac{1}{2}} / (\text{Count} - \text{Background}).$$

If foil weight errors WE(LN) are supplied, these are treated in statements 216 and 217, adding to the relative deviation.

L. Net Deviation

See statements 237, 238.

Net deviation combines the relative deviations involved in traverse normalization. The entry of the normalizing foil, having a normalized activity of unity, will be $\sqrt{2}$ times the relative deviation of the single foil represented, and should be ignored.

M. Data Plot[5]

See statements 244, 246-256.

Since IBM off-line printout is 120 columns in width, columns 20 through 120 are used for a data plot, and the magnitudes of the points are tabulated alongside. Therefore, the points may plot on 100 equal increments from zero to 100% of the normalized curve. If an off-scale point is encountered, it will be plotted full-scale, but the printed number will be correct. Each point plotted is in the nearest column, and the maximum plotting error is ± a half-column in amplitude if the point is on-scale.

Spacing can be controlled by use of the IDC(I) code numbers (columns 67 through 72 of the input data cards). See item V - B., Control of Data Processing, and Fig. 9.

The plot may be omitted by depressing sense switch No. 4, when desired.

N. Punched Cards[10]

See statements 257, 3258-3263.

Traverse output data may be punched, when needed on IBM cards, by depressing sense switch No. 5. The cards are obtained by off-line equipment, an IBM 1401 data-processing unit which punches any line initiated by a letter (P) in the first column. The format includes the serial number from the parent input data card, the increment between this and the preceding datum point, the specific activity, and the relative error.

O. Scaler Identification

The subscript (I) designates the scaler being treated at any point in the FORTRAN program. The data columns are treated arbitrarily, and scalers are counted from left to right as recorded on the data card.

P. Card Identification

Data cards are counted in sequence beginning with the first card of each deck of data cards. The 8-deck input cards are not counted. The sequence number is used for terminating loops and storing data.

The serial number punched into each data card by the automatic counter system is for the user's convenience. This serial number must be some number other than zero since the computer program interprets a zero serial number as a blank card terminating a data deck.

Q. Input Data Card Format

The data cards prepared by the automatic system include the following information.

Column No.	Type of Information	FORTRAN Term
1	unused (blank)	Read with Cols. 1-5
2 - 5	Card serial No.	NUM(NO)
6	unused (blank)	Read with Cols. 6-11
7 - 11	Clock time	CRT
12	unused (blank)	Read with Cols. 12-16

Column No.	Type of Information	FORTRAN Term
13 - 16	Counting interval	CT (NO)
17 & 18	unused (blank)	Read with Cols. 17-24
19 - 24	Data Scaler #1	DATA (1,NO)
25 & 26	unused (blank)	Read with Cols. 25-32
27 - 32	Data Scaler #2	DATA (2,NO)
33 & 34	unused (blank)	Read with Cols. 33-40
35 - 40	Data Scaler #3	DATA (3,NO)
41 & 42	unused (blank)	Read with Cols. 41-48
43 - 48	Data Scaler #4	DATA (4,NO)
49 & 50	unused (blank)	Read with Cols. 49-56
51 - 56	Data Scaler #5	DATA (5,NO)
57 & 58	unused (blank)	Read with Cols. 57-64
59 - 64	Data Scaler #6	DATA (6,NO)
65 & 66	unused (blank)	
67 - 72	Program control	IDC(1) to IDC(6)
73 - 80	Any	Not read by 704 computer

If a scaler overflows, it is satisfactory to punch the appropriate number into an unused column.

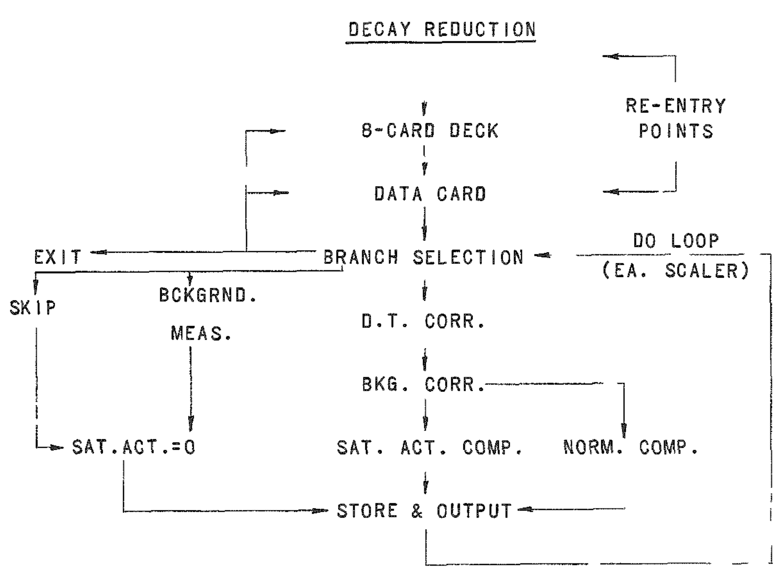


Fig. 7. Decay Reduction

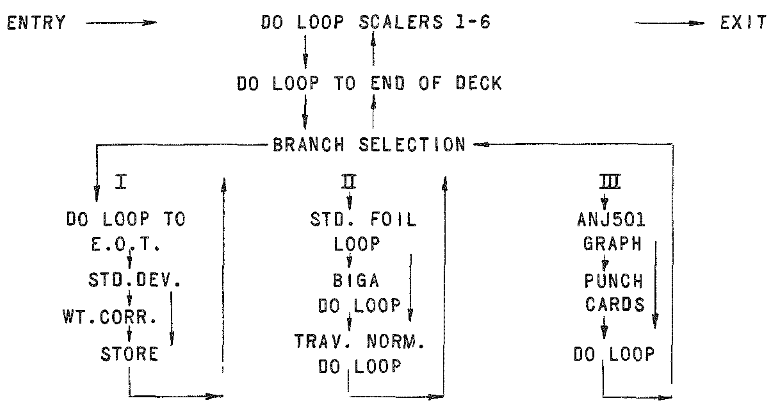


Fig. 8. Traverse Treatment

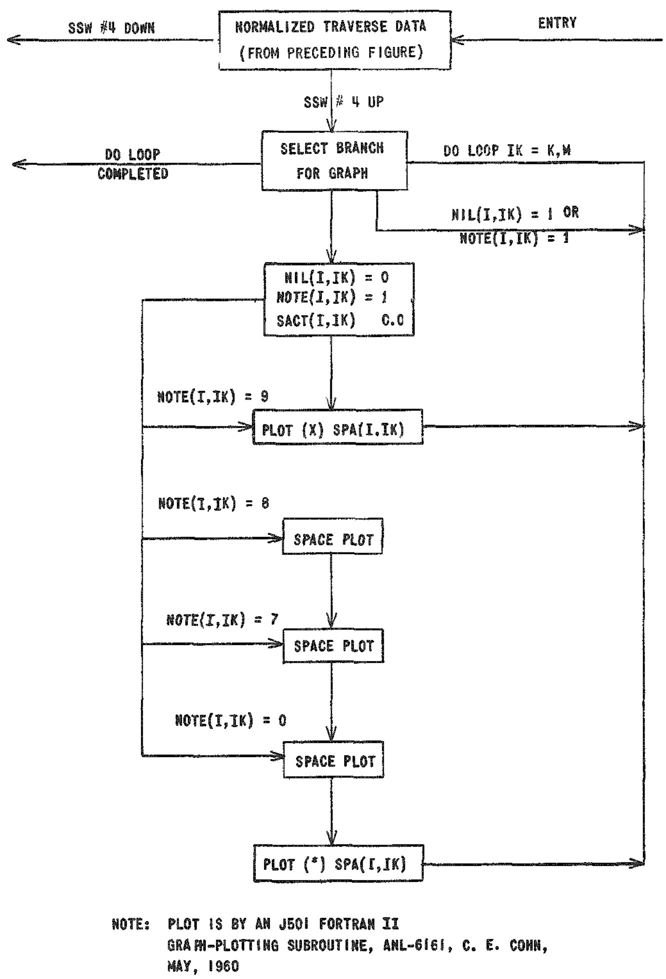


Fig. 9. Traverse Plot

Table I

FORTRAN SOURCE LIST FOR FOIL DATA REDUCTION

```
C  ANL 807/RE-202 FORTRAN SOURCE PROGRAM FOR FOIL DATA DECAY REDUCTION
  130 DIMENSIONDC(6),EFC(6),RRT(6),TC(6),DT(6),IDC(6),NOT(6),W(4),BK(6,3
     X60),LOC(6,360),SACT(6,360),NIL(6,360),ER(6,360),SPA(6,360),WE(4),N
     XUM(360),CT(360),DATA(6,360),CACT(360),NOTE(6,360),TITLE(12)
    2 IF(SENSESWITCH1)3,4
    3 CALLINTAP1(1)
S   4 STZ NO
  403 READ103,(TITLE(I),I=1,12)
  404 IF(SENSESWITCH2)5,6
    5 PRINT1031,(TITLE(I),I=1,12)
    6 WRITEOUTPUTTAPE2,1031,(TITLE(I),I=1,12)
    7 READ104,NOS,BKW,A,B,C,D
    8 READ105,(DC(I),I=1,NOS)
    9 READ105,(EFC(I),I=1,NOS)
   10 IF(SENSESWITCH2)11,411
   11 PRINT134
  411 WRITEOUTPUTTAPE2,134
  412 DO413I=1,6
S 413 STZ NOT(I)
   12 READ105,(BK(I,1),I=1,NOS)
   13 READ107,(RRT(I),I=1,NOS)
   14 READ107,(TC(I),I=1,NOS)
   15 READ105,(DT(I),I=1,NOS)
   17 NO=NO+1
   18 READ108,NUM(NO),CRT,CT(NO),(DATA(I,NO),I=1,6),(IDC(I),I=1,6)
   36 IF(NUM(NO))37,201,37
S  37 STZ NATE
   38 DO97I=1,NOS
S  39 STZ NOTE(I,NO)
S  40 STZ LOC(I,NO)
   41 IF(IDC(I)-1)69,45,42
S  42 STZ NOT(I)
   43 IF(IDC(I)-3)51,60,44
   44 IF(IDC(I)-5)56,62,444
  444 IF(IDC(I)-7)95,445,445
  445 NOTE(I,NO)=IDC(I)
  446 GOTO70
S  45 STZ NOT(I)
   46 BK(I,NO)=BK(I,1)-BK(I,1)*BKW+DATA(I,NO)*BKW/CT(NO)
   48 BK(I,1)=BK(I,NO)
   49 GOTO94
   51 BK(I,NO)=DATA(I,NO)/CT(NO)
   53 BK(I,1)=BK(I,NO)
   54 GOTO94
   56 NOT(I)=1
   57 GOTO95
   60 NATE=1
   61 GOTO70
```

```
   62 LOC(I,NO)=NO
   63 GOTO70
   69 IF(NOT(I))70,70,94
   70 IF(DC(I))570,96,570
  570 BK(I,NO)=BK(I,1)
  571 IF(DC(I)-2.)370,96,370
  370 DATC=D*DATA(I,NO)
  470 DAT=DT(I)/CT(NO)
   71 DATR=DATC+A*DAT*DATC**2+B*DAT**2*DATC**3+C*DAT**3*DATC**4
  471 DATB=DATR-D*BK(I,NO)*CT(NO)
  472 IF(DC(I)-1.)72,473,72
S 473 STZ SACT(I,NO)
S 474 STZ X
S 475 STZ Y
  476 DO486JK=1,NOS
  477 IF(DC(JK)-2.)486,478,486
  478 IF(IDC(JK)-6)479,486,479
  479 IF(DATA(JK,NO))486,486,480
  480 DATM=D*DATA(JK,NO)
  481 DATN=DT(JK)/CT(NO)
  482 DATO=DATM+A*DATN*DATM**2+B*DATN**2*DATM**3+C*DATN**3*DATM**4
  483 DATP=DATO-D*BK(JK,1)*CT(NO)
  484 X=X+1.
  485 Y=Y+DATB/DATP
  486 CONTINUE
  487 SACT(I,NO)=Y/X
  488 GOTO83
   72 IF(I-1)75,75,73
   73 IF(DC(I-1)-DC(I))75,773,75
  773 KMN=I-1
   74 IF(SACT(KMN,NO))75,75,82
S  75 STZ TJ
   76 TA=0.0-DC(I)*TC(I)-DC(I)*CRT
   77 TB=TA-DC(I)*RRT(I)
   78 TF=EXPF(TA)-EXPF(TB)
   79 TG=DC(I)*CT(NO)
   80 TH=EXPF(TG)-1.0
   81 TJ=EFC(I)*TF*TH
   82 SACT(I,NO)=DATB/TJ
S  83 STZNIL(I,NO)
   84 IF(SENSESWITCH6)85,97
   85 WRITEOUTPUTTAPE3,135,NO,NUM(NO),I,NIL(I,NO),SACT(I,NO),BK(I,NO),DA
     XTC,DAT,DATR,DATB,TA,TB,TF,TG,TH,TJ
   86 GOTO97
   94 NOTE(I,NO)=1
   95 NIL(I,NO)=NOT(I)
S  96 STZ SACT(I,NO)
   97 CONTINUE
```

```
  497 IF(SENSESWITCH2)498,499
  498 PRINT133,NO,NUM(NO),(SACT(I,NO),I=1,NOS)
  499 WRITEOUTPUTTAPE2,133,NO,NUM(NO),(SACT(I,NO),I=1,NOS)
   98 IF(NATE)17,17,403
  201 DO260I=1,NOS
 4201 IF(DC(I)-2.)202,260,202
  202 IF(DC(I))203,260,203
S 203 STZ J
  204 K=1
  205 IF(SENSESWITCH3)207,209
  207 READ120,(W(N),WE(N),N=1,4)
  208 LN=1
  209 DO259M=1,NO
S 210 STZ SPA(I,M)
  211 IF(NO-M)221,221,212
  212 IF(NIL(I,M))213,213,4228
  213 IF(SACT(I,M))259,259,214
  214 EA=(D*DATA(I,M))+(D*BK(I,M)*CT(M))
  215 EB=(D*DATA(I,M))-(D*BK(I,M)*CT(M))
 4215 IF(SENSESWITCH3)216,4216
 4216 EC=EA/EB**2
 4217 ER(I,M)=SQRTF(EC)
 4218 SPA(I,M)=SACT(I,M)
 4219 GOTO259
  216 EC=EA/EB**2+WE(LN)**2
  217 ER(I,M)=SQRTF(EC)
  218 SPA(I,M)=SACT(I,M)/W(LN)
  219 LN=LN+1
  220 IF(LN-4)259,259,4221
 4221 READ120,(W(N),WE(N),N=1,4)
 4222 LN=1
 4223 GOTO259
 4228 KMN=M-1
 4229 IF(NIL(I,KMN))221,221,259
  221 J=J+1
  222 IF(J-M)224,228,228
  224 IF(J-LOC(I,J))221,226,221
  226 LOK=J
  227 GOTO4233
  228 BIGA=SPA(I,K)
  229 DO233L=K,M
  230 IF(BIGA-SPA(I,L))231,233,233
  231 BIGA=SPA(I,L)
  232 LOK=L
  233 CONTINUE
 3233 IF(K-2)4233,235,3234
 3234 IF(KM-20)3235,4233,4233
 3235 IF(KM-5)235,3236,3236
```

```
 3236 IF(SENSESWITCH2)3237,3238
 3237 PRINT121
 3238 WRITEOUTPUTTAPE2,121
 3239 KM=KM+M-K
 3240 GOTO235
 4233 IF(SENSESWITCH2)4234,4235
 4234 PRINT 1031,(TITLE(I),I=1,12)
 5234 PRINT 121
 4235 WRITEOUTPUTTAPE2,1031,(TITLE(I),I=1,12)
 4236 WRITEOUTPUTTAPE2,121
 4237 KM=M-K
  235 DO243KI=K,M
S5235 STZ CACT(KI)
  236 IF(SPA(I,KI))243,243,237
  237 ERS=ER(I,KI)**2+ER(I,LOK)**2
  238 ERR=SQRTF(ERS)
  239 CACT(KI)=SPA(I,KI)/SPA(I,LOK)
  240 IF(SENSESWITCH2)241,242
  241 PRINT123,KI,NUM(KI),SACT(I,KI),SPA(I,KI),ER(I,KI),CACT(KI),ERR,
     XBK(I,KI),I,DATA(I,KI)
  242 WRITEOUTPUTTAPE2,123,KI,NUM(KI),SACT(I,KI),SPA(I,KI),ER(I,KI),
     XCACT(KI),ERR,BK(I,KI),I,DATA(I,KI)
  243 CONTINUE
  244 IF(SENSESWITCH4)257,3245
 3245 IF(KM-20)4246,4246,4245
 4245 WRITEOUTPUTTAPE2,1031
      GOTO245
 4246 KM=KM*2+2
  245 WRITEOUTPUTTAPE2,132,K,NUM(K),M,NUM(M),I
  246 DO256 IK=K,M
  247 IF(NIL(I,IK))4247,4247,4250
 4247 IF(CACT(IK)-1.)4252,4252,4248
 4248 CAC=1.
 4249 GOTO248
 4250 KM=KM-1
 4251 GOTO256
 4252 CAC=CACT(IK)
  248 IF(NOTE(I,IK)-1)254,4250,249
  249 IF(NOTE(I,IK)-8)253,252,250
  250 CALLGRAPH(XFIXF(200.*CAC),2,1HX)
  251 GOTO256
  252 WRITEOUTPUTTAPE2,139
 4253 KM=KM+1
  253 WRITEOUTPUTTAPE2,139
 4254 KM=KM+1
  254 WRITEOUTPUTTAPE2,138,IK,NUM(IK),CACT(IK)
  255 CALLGRAPH(XFIXF(200.*CAC),2,1H*)
  256 CONTINUE
```

```
4256 WRITEOUTPUTTAPE2,136
 257 IF(SENSESWITCH5)4257,258
4257 IF(KM-38)3257,3257,4258
4258 WRITEOUTPUTTAPE2,1031,(TITLE(I),I=1,12)
     GOTO3258
3257 WRITEOUTPUTTAPE2,1030,(TITLE(I),I=1,12)
3258 WRITEOUTPUTTAPE2,140,I,K,M,NUM(K),NUM(M)
3259 DO3263KL=K,M
4259 IF(NIL(I,KL))3260,3260,4260
4260 KM=KM-1
4261 GOTO3263
3260 INCR=NOTE(I,KL)-5
3261 INCR=XMAXOF(INCR,1)
3262 WRITEOUTPUTTAPE2,102,NUM(KL),INCR,SPA(I,KL),ER(I,KL)
3263 CONTINUE
 258 K=M
 259 CONTINUE
 260 CONTINUE
 261 PRINT 137
 268 PAUSE6
 269 IF(SENSESWITCH1)18,2
 102 FORMAT(1HP,I4,I2,2E24.8)
 103 FORMAT(12A6)
1030 FORMAT(1H0,12A6)
1031 FORMAT(1H1,12A6)
1032 FORMAT(1HP,12A6)
 104 FORMAT(I2,5F8.4)
 105 FORMAT(6E12.6)
 107 FORMAT(6F12.3)
 108 FORMAT(I5,F6.0,F5.0,6F8.0,I3,5I1)
 120 FORMAT(8E9.4)
 121 FORMAT(111H  NO. CARD    COR.ACT.     SPA(SENSESW3)   REL.DEV.
    X NORM. ACT.    NET DEV.    BCKGR,CPS SCALER SCALER DATA )
 123 FORMAT(I4,I6,2E15.7,E12.4,E15.7,E12.4,E13.5,I4,F12.0)
 132 FORMAT(31H PLOT OF TRAVERSE STARTING SEQ.,I3,9H, CARD NO,I5,12H EN
    XDING SEQ.,I3,9H  CARD NO,I5,8H  SCALER,I2/120H                  0
    X         10         20         30         40         50         60
    X  70         80         90         100/120H  SEQ. CARD  N.ACT +    +
    X  +    +    +    +    +    +    +    +    +    +    +    +    +
    X +    +    +    +    +    +)
 133 FORMAT(I4,I8,6E15.7)
 134 FORMAT(119H SEQ  CARD NO    SCALER 1       SCALER 2       SCALER 3
    X       SCALER 4       SCALER 5       SCALER 6       (CORRECTED)  )
 135 FORMAT(I4,I8,I3,I15,6E15.7/30H SEQ,CARD,SC,SACT,BK,NIL,T-TJ ,6E15.
    X7)
 136 FORMAT(120H                          +    +    +    +    +    +    +    +
    X    +    +    +    +    +    +    +    +    +    +    +    +    +/
    X120H                  0         10         20         30         40
```

```
      X       50         60         70         80         90        100/)
  137 FORMAT(112H END OF DECK-START NEXT DATA DECK WITH SSW-1 UP UNLESS
      XREQUESTED. SSW-1 DN RETAINS CONSTANTS FROM PRECEDING DECK/1H/)
  138 FORMAT(I4,I7,F7.4,102H +
      X                                                               +)
  139 FORMAT(120H                  +
      X                                                                      +)
  140 FORMAT(99H+
      X                 -CARDS PUNCHED FOR TRAVERSE/8HP-SCALER,I2,6H,  SEQ
      X,I6,3H TO,I6,7H,  CARD,I6,3H TO,I6)
  142 FORMAT(31HOPLOT OF TRAVERSE STARTING SEQ.,I3,9H, CARD NO,I5,12H EN
      XDING SEQ.,I3,9H  CARD NO,I5,8H  SCALER,I2/120H                  0
      X        10         20         30         40         50         60
      X  70         80         90        100/120H  SEQ. CARD  N.ACT +    +
      X  +    +    +    +    +    +    +    +    +    +    +    +    +
      X +    +    +    +    +    +)
  131 FREQUENCY10(1,5),38(5),41(10,1,1),69(0,1,1),70(0,1,1),472(5,1,1),4
      X76(5),477(5,1,1),478(1,1,1),479(0,1,1),72(0,1,3),73(5,1,5),84(1,9)
      X,497(1,9),98(0,5,1),201(6),205(1,9),209(50),211(0,1,50),212(0,1,1)
      X,213(0,1,1),4215(1,9),220(3,1,1),4229(0,1,1),222(9,1,0),224(9,1,0)
      X,229(25),230(1,1,3),4233(1,5),236(0,1,1),240(1,5),257(1,1),244(1,5
      X),246(25),247(0,1,1),249(5,1,1),3259(25),74(0,1,50),3233(1,1,9),32
      X34(9,1,2),3235(3,1,9),3236(1,5),3244(3,1,9),3245(9,1,1),4247(9,1,0
      X),4257(9,1,1),4259(0,1,1),404(1,5),412(5),43(1,1,5),44(1,1,3),444(
      X1,1,1),571(5,1,1),269(0,1),4201(5,1,1),202(0,1,5),235(25),248(1,1,
      X1),36(0,1,50)
       END(0,1,0,0,1)
```

Table II

INPUT DATA FOR RUN OF AUGUST 24, 1960

```
AUG 24, 1960 DY TRAVERSES SC1,2,4                                              8-24 C-1
4    .2000   1.0000   1.5000   3.7500   2.0000                                 8-24 C-2
.829909E-04 .829909E-04 .000000E-00 .829909E-04 .000000E-00 0000000E-008-24 C-3
.100000E 01 .100000E 01 .100000E 01 .100000E 01 .100000E 01 .100000E 018-24 C-4
.100000E 01 .030000E 01 .100000E 01 .300000E 00 .500000E 00 .300000E 008-24 C-5
   1200.000    1200.000    1200.000    1200.000    1200.000    1200.0008-24 C-6
   1800.000    1800.000    1800.000    1800.000    1800.000    1800.0008-24 C-7
.500000E-05 .500000E-05 .500000E-05 .500000E-05 .500000E-05 .500000E-058-24 C-8
0148 12843 0200   001939   006837   000000   016799   000001          004044 8-24 DY
0149 13061 0200   002477   008318   000000   017432   000001          000000 8-24 DY
0150 13279 0200   003155   009980   000000   016575   000001          000000 8-24 DY
0151 13497 0200   003818   011025   000000   014550   000001          000000
0152 13715 0200   004652   011584   000000   011587   000001          000000
0153 13933 0200   006040   012380   000000   006832   000001          000000
0154 14151 0200   007473   013195   000000   002117   000000          000000
0155 14369 0200   008520   013718   000000   001882   000000          000000
0156 14587 0200   0101 4   014542   000000   00607    000000          000000
0157 14806 0200   011561   014575   000000   010164   000000          000000
0158 15024 0200   011499   015221   000000   012744   000000          000000
0159 15242 0200   011801   014309   000000   014771   000000          000000
0160 15460 0200   011652   015090   000000   015732   000000          000000
0161 15678 0200   010336   014340   000000   015769   000000          000000
0162 15896 0200   008390   014160   000000   015505   000000          000000
0163 16114 0200   005369   013099   000000   013354   000000          000000
0164 16332 0200   001491   013290   000000   011396   000000          000000
0165 16551 0200   001375   012650   000000   008259   000000          000000
0166 16769 0200   004556   011245   000000   004499   000001          000000
0167 16987 0200   007460   010406   000000   001330   000001          000000
0168 17205 0200   009619   009526   000000   001803   000001          000000
0169 17423 0200   010887   008596   000000   005441   000001          000000
0170 17641 0200   011905   007621   000000   008025   000000          000000
0171 17859 0200   012342   006220   000000   009973   000001          000000
0172 18077 0200   011398   005148   000000   010302   000000          000000
0173 18295 0200   010384   004024   000000   010166   000001          000000
0174 18513 0200   008581   003009   000000   009862   000001          000000END2,4
0175 19272 0300   008789   000058   000000   000093   000001          040400
0176 19771 0300   005298   000072   000000   000103   000000          030000 CH 2-6
AUG 24,1960 DY TRAVERSE 1,2,3,4,5,6                                            8-24AC-1
6    .2000   1.0000   1.5000   3.7500   2.0000                                 8-24AC-2

.829909E-04 .829909E-04 .829909E-04 .829909E-04 .829909E-04 .829909E-048-24AC-3
.100000E 01 .100000E 01 .100000E 01 .100000E 01 .100000E 01 .100000E 018-24AC-4
.100000E 01 .030000E 01 .100000E 01 .300000E 00 .500000E 00 .300000E 008-24AC-5
   1200.000    1200.000    1200.000    1200.000    1200.000    1200.0008-24AC-6
   1800.000    1800.000    1800.000    1800.000    1800.000    1800.0008-24AC-7
.500000E-05 .500000E-05 .500000E-05 .500000E-05 .500000E-05 .500000E-058-24AC-8
0177 20087 0300   001591   000135   000107   000143   000161   025010   022220 8-24 DY
0178 20403 0300   001799   025042   001939   022146   016766   002482   000000
0179 20719 0300   005707   023649   002477   015816   017432   002471   000000
0180 21035 0300   008454   021344   003155   008944   016575   002436   000000
0181 21352 0300   009460   019511   003818   002644   014550   002428   000000
0182 21668 0300   010525   017742   004652   003367   011587   002458   000000
0183 21984 0300   010689   016137   006040   010670   006832   002301   000000
0184 22301 0300   009982   014140   007473   015495   002117   002167   000000
0185 22618 0300   007660   011663   008520   019345   001882   002199   000000
0186 22935 0300   007924   009484   010194   019744   006079   002234   000000 END 6
0187 23252 0300   006388   007560   011561   019775   010164   000265   000001END2-5
0188 23569 0300   005158   000070   000000   000099   000000            044444
0189 23885 0300   003884   000063   000000   000098   000000            000000
0190 24202 0300   003032   000069   000000   000090   000001            000000
0191 24518 0300   002343   000074   000000   000102   000000            000000
0192 24835 0300   001775   000065   000000   000094   000001            000000
0193 25152 0300   001320   000071   000000   000108   000000            000000
0194 25469 0300   000988   000074   000000   000094   000000            000000 END 1
                                                                           BLANK CD
```

Table III

PROCESSED DATA FOR RUN AUGUST 24, 1960

A - Decay Corrected Data

AUG 24, 1960 DY TRAVERSES SC1,2,4

SEQ	CARD NO	SCALER 1	SCALER 2	SCALER 3	SCALER 4	SCALER 5	SCALER 6	(CORRECTED)
1	148	0.7391149E 07	0.2881063E 08	0.	0.7119694E 08			
2	149	0.9854719E 07	0.3575029E 08	0.	0.7524068E 08			
3	150	0.1302299E 08	0.4373306E 08	0.	0.7283165E 08			
4	151	0.1623653E 08	0.4922512E 08	0.	0.6506136E 08			
5	152	0.2034488E 08	0.5268061E 08	0.	0.5269433E 08			
6	153	0.2717693E 08	0.5734992E 08	0.	0.3151509E 08			
7	154	0.3446589E 08	0.6226259E 08	0.	0.9745199E 07			
8	155	0.4014941E 08	0.6592540E 08	0.	0.8789352E 07			
9	156	0.4866964E 08	0.7118188E 08	0.	0.2952781E 08			
10	157	0.5685767E 08	0.7265273E 08	0.	0.5056295E 08			
11	158	0.5757956E 08	0.7727411E 08	0.	0.6464107E 08			
12	159	0.6019877E 08	0.7394826E 08	0.	0.7634768E 08			
13	160	0.6051006E 08	0.7942860E 08	0.	0.8282402E 08			
14	161	0.5453075E 08	0.7683995E 08	0.	0.8453537E 08			
15	162	0.4486149E 08	0.7725583E 08	0.	0.8463096E 08			
16	163	0.2882625E 08	0.7274291E 08	0.	0.7416647E 08			
17	164	0.7329618E 07	0.7515669E 08	0.	0.6439119E 08			
18	165	0.6793347E 07	0.7283044E 08	0.	0.4741903E 08			
19	166	0.2564836E 08	0.6587943E 08	0.	0.2613680E 08			
20	167	0.4353401E 08	0.6204766E 08	0.	0.7613064E 07			
21	168	0.5751764E 08	0.5780396E 08	0.	0.1063949E 08			
22	169	0.6645639E 08	0.5307408E 08	0.	0.3345203E 08			
23	170	0.7411939E 08	0.4786780E 08	0.	0.5042649E 08			
24	171	0.7829201E 08	0.3970743E 08	0.	0.6391131E 08			
25	172	0.7351980E 08	0.3339428E 08	0.	0.6723907E 08			
26	173	0.6807969E 08	0.2649058E 08	0.	0.6755704E 08			
27	174	0.5704441E 08	0.2006633E 08	0.	0.6672010E 08			
28	175	0.4084803E 08	0.	0.	0.			
29	176	0.2506372E 08	-0.9024774E 05	0.	0.			

AUG 24,1960 DY TRAVERSE 1,2,3,4,5,6

SEQ	CARD NO	SCALER 1	SCALER 2	SCALER 3	SCALER 4	SCALER 5	SCALER 6	(CORRECTED)
30	177	0.6645261E 07	0.	0.	0.	0.	0.1283716E 09	
31	178	0.7920997E 07	0.1317144E 09	0.9680597E 07	0.1163461E 09	0.8778717E 08	0.1263995E 08	
32	179	0.2933458E 08	0.1276461E 09	0.1285648E 08	0.8505887E 08	0.9373648E 08	0.1291614E 08	
33	180	0.4541752E 08	0.1181836E 09	0.1697415E 08	0.4902182E 08	0.9144977E 08	0.1306443E 08	
34	181	0.5238274E 08	0.1108409E 09	0.2121774E 08	0.1429899E 08	0.8229907E 08	0.1336695E 08	
35	182	0.6002897E 08	0.1033915E 09	0.2667740E 08	0.1892285E 08	0.6708186E 08	0.1389823E 08	
36	183	0.6261280E 08	0.9645841E 08	0.3575144E 08	0.6344412E 08	0.4019966E 08	0.1332151E 08	
37	184	0.5990592E 08	0.8666536E 08	0.4557190E 08	0.9500514E 08	0.1209923E 08	0.1284768E 08	
38	185	0.5945678E 08	0.7323286E 08	0.5343884E 08	0.1220141E 09	0.1092929E 08	0.1339340E 08	
39	186	0.4971743E 08	0.6096927E 08	0.6578362E 08	0.1278712E 09	0.3858974E 08	0.1397864E 08	
40	187	0.4075714E 08	0.4970956E 08	0.7669344E 08	0.1314877E 09	0.6697487E 08	0.	
41	188	0.3338830E 08	0.	0.	0.	0.	0.	
42	189	0.2528575E 08	0.	0.	0.	0.	0.	
43	190	0.1978799E 08	0.	0.	0.	0.	0.	
44	191	0.1519039E 08	0.	0.	0.	0.	0.	
45	192	0.1125927E 08	0.	0.	0.	0.	0.	
46	193	0.7993512E 07	0.	0.	0.	0.	0.	
47	194	0.5535377E 07	0.	0.	0.	0.	0.	

Table III

B - Traverse of Scaler #1

AUG 24,1960 DY TRAVERSE 1,2,3,4,5,6

NO.	CARD	COR.ACT.	SPA(SENSESW3)	REL.DEV.	NORM. ACT.	NET DEV.	BCKGR,CPS	SCALER	SCALER DATA
1	148	0.7391149E 07	0.7391149E 07	0.1881E-01	0.9440490E-01	0.1990E-01	0.10000E 01	1	1939.
2	149	0.9854719E 07	0.9854719E 07	0.1607E-01	0.1258713E-00	0.1734E-01	0.10000E 01	1	2477.
3	150	0.1302299E 08	0.1302299E 08	0.1386E-01	0.1663387E-00	0.1532E-01	0.10000E 01	1	3155.
4	151	0.1623653E 08	0.1623653E 08	0.1239E-01	0.2073843E-00	0.1400E-01	0.10000E 01	1	3818.
5	152	0.2034488E 08	0.2034488E 08	0.1106E-01	0.2598590E-00	0.1284E-01	0.10000E 01	1	4652.
6	153	0.2717693E 08	0.2717693E 08	0.9565E-02	0.3471226E-00	0.1158E-01	0.10000E 01	1	6040.
7	154	0.3446589E 08	0.3446589E 08	0.8516E-02	0.4402223E-00	0.1073E-01	0.10000E 01	1	7473.
8	155	0.4014941E 08	0.4014941E 08	0.7936E-02	0.5128162E 00	0.1027E-01	0.10000F 01	1	8520.
9	156	0.4866964E 08	0.4866964E 08	0.7247E-02	0.6216426E 00	0.9750E-02	0.10000E 01	1	10104.
10	157	0.5685767E 08	0.5685767E 08	0.6750E-02	0.7262257E 00	0.9386E-02	0.10000E 01	1	11561.
11	158	0.5757956E 08	0.5757956E 08	0.6769E-02	0.7354462E 00	0.9400E-02	0.10000E 01	1	11499.
12	159	0.6019877E 08	0.6019877E 08	0.6677E-02	0.7689005E 00	0.9334E-02	0.10000E 01	1	11801.
13	160	0.6051006E 08	0.6051006E 08	0.6722E-02	0.7728766E 00	0.9366E-02	0.10000E 01	1	11652.
14	161	0.5453075E 08	0.5453075E 08	0.7161E-02	0.6965047E 00	0.9686E-02	0.10000E 01	1	10336.
15	162	0.4486149E 08	0.4486149E 08	0.8002E-02	0.5730022E 00	0.1032E-01	0.10000E 01	1	8390.
16	163	0.2882625E 08	0.2882625E 08	0.1021E-01	0.3681889E-00	0.1211E-01	0.10000E 01	1	5369.
17	164	0.7329618E 07	0.7329618E 07	0.2252E-01	0.9361898E-01	0.2345E-01	0.10000E 01	1	1491.
18	165	0.6793347E 07	0.6793347E 07	0.2388E-01	0.8676936E-01	0.2476E-01	0.10000E 01	1	1375.
19	166	0.2564836E 08	0.2564836E 08	0.1119E-01	0.3275987E-00	0.1296E-01	0.10000E 01	1	4556.
20	167	0.4353401E 08	0.4353401E 08	0.8524E-02	0.5560467E 00	0.1073E-01	0.10000E 01	1	7460.
21	168	0.5751764E 08	0.5751764E 08	0.7439E-02	0.7346553E 00	0.9893E-02	0.10000E 01	1	9619.
22	169	0.6645639E 08	0.6645639E 08	0.6967F-02	0.8488273E 00	0.9543E-02	0.10000E 01	1	10887.
23	170	0.7411939E 08	0.7411939E 08	0.6647E-02	0.9467044E 00	0.9312E-02	0.10000E 01	1	11905.
24	171	0.7829201E 08	0.7829201E 08	0.6522E-02	0.1000000E 01	0.9223E-02	0.10000E 01	1	12342.
25	172	0.7351980E 08	0.7351980E 08	0.6800E-02	0.9390460E 00	0.9422E-02	0.10000E 01	1	11398.
26	173	0.6807969E 08	0.6807969E 08	0.7143E-02	0.8695612E 00	0.9673E-02	0.10000E 01	1	10384.
27	174	0.5704441E 08	0.5704441E 08	0.7906E-02	0.7286109E 00	0.1025E-01	0.10000E 01	1	8581.
28	175	0.4084803E 08	0.4084803E 08	0.7941E-02	0.5217395E 00	0.1028E-01	0.10000E 01	1	8789.
29	176	0.2506372E 08	0.2506372E 08	0.1059E-01	0.3201313E-00	0.1243E-01	0.10000E 01	1	5298.
30	177	0.6645261E 07	0.6645261E 07	0.2382E-01	0.8487790E-01	0.2469E-01	0.10000E 01	1	1591.
31	178	0.7920997E 07	0.7920997E 07	0.2161E-01	0.1011725E-00	0.2257E-01	0.10000E 01	1	1799.
32	179	0.2933458E 08	0.2933458E 08	0.1014E-01	0.3746817E-00	0.1205E-01	0.10000E 01	1	5707.
33	180	0.4541752E 08	0.4541752E 08	0.8114E-02	0.5801041E 00	0.1041E-01	0.10000E 01	1	8454.
34	181	0.5238274E 08	0.5238274E 08	0.7626E-02	0.6690688E 00	0.1003E-01	0.10000E 01	1	9460.
35	182	0.6002897E 08	0.6002897E 08	0.7195E-02	0.7667318E 00	0.9711E-02	0.10000E 01	1	10525.
36	183	0.6261280E 08	0.6261280E 08	0.7135E-02	0.7997343E 00	0.9667E-02	0.10000E 01	1	10689.
37	184	0.5990592E 08	0.5990592E 08	0.7406E-02	0.7651601E 00	0.9868E-02	0.10000E 01	1	9982.
38	185	0.5945678E 08	0.5945678E 08	0.7539E-02	0.7594233E 00	0.9969E-02	0.10000E 01	1	9660.
39	186	0.4971743E 08	0.4971743E 08	0.8411E-02	0.6350256E 00	0.1064E-01	0.10000E 01	1	7924.
40	187	0.4075714E 08	0.4075714E 08	0.9499E-02	0.5205786E 00	0.1152E-01	0.10000E 01	1	6388.
41	188	0.3338830E 08	0.3338830E 08	0.1075E-01	0.4264585E-00	0.1258E-01	0.10000E 01	1	5158.
42	189	0.2528575E 08	0.2528575E 08	0.1276E-01	0.3229672E-00	0.1433E-01	0.10000E 01	1	3884.
43	190	0.1978799E 08	0.1978799E 08	0.1494E-01	0.2527460E-00	0.1630E-01	0.10000E 01	1	3032.
44	191	0.1519039E 08	0.1519039E 08	0.1779E-01	0.1940223E-00	0.1895E-01	0.10000E 01	1	2343.
45	192	0.1125927E 08	0.1125927E 08	0.2184E-01	0.1438112E-00	0.2279E-01	0.10000E 01	1	1775.
46	193	0.7993512E 07	0.7993512E 07	0.2790E-01	0.1020987E-00	0.2865E-01	0.10000E 01	1	1320.
47	194	0.5535377E 07	0.5535377E 07	0.3689E-01	0.7070168E-01	0.3746E-01	0.10000E 01	1	988.

Table III

C - Punched-Card Output of Scaler #1

AUG 24,1960 DY TRAVERSE 1,2,3,4,5,6 -CARDS PUNCHED FOR TRAVERSE

-SCALER 1, SEQ 1 TO 48, CARD 148 TO -0

P 148	1	0.73911492E 07	0.18805756E-01
P 149	1	0.98547193E 07	0.16067420E-01
P 150	1	0.13022988E 08	0.13860336E-01
P 151	1	0.16236534E 08	0.12388576E-01
P 152	1	0.20344885E 08	0.11063441E-01
P 153	1	0.27176928E 08	0.95645479E-02
P 154	1	0.34465889E 08	0.85163599E-02
P 155	1	0.40149406E 08	0.79363335E-02
P 156	1	0.48669644E 08	0.72473176E-02
P 157	1	0.56857669E 08	0.67497946E-02
P 158	1	0.57579563E 08	0.67689197E-02
P 159	1	0.60198767E 08	0.66772600E-02
P 160	1	0.60510062E 08	0.67220150E-02
P 161	1	0.54530755E 08	0.71607132E-02
P 162	1	0.44861493E 08	0.80019839E-02
P 163	1	0.28826249E 08	0.10208620E-01
P 164	1	0.73296180E 07	0.22523224E-01
P 165	1	0.67933474E 07	0.23882919E-01
P 166	1	0.25648360E 08	0.11194844E-01
P 167	1	0.43534010E 08	0.85243792E-02
P 168	1	0.57517635E 08	0.74389875E-02
P 169	1	0.66456392E 08	0.69668461E-02
P 170	1	0.74119391E 08	0.66465454E-02
P 171	1	0.78292007E 08	0.65219605E-02
P 172	1	0.73519800E 08	0.68004255E-02
P 173	1	0.68079693E 08	0.71431788E-02
P 174	1	0.57044412E 08	0.79060789E-02
P 175	1	0.40848032E 08	0.79412070E-02
P 176	1	0.25063723E 08	0.10585349E-01
P 177	1	0.66452610E 07	0.23817957E-01
P 178	1	0.79209972E 07	0.21611732E-01
P 179	1	0.29334582E 08	0.10135786E-01
P 180	1	0.45417517E 08	0.81136741E-02
P 181	1	0.52382736E 08	0.76263096E-02
P 182	1	0.60028973E 08	0.71950801E-02
P 183	1	0.62612801E 08	0.71349402E-02
P 184	1	0.59905921E 08	0.74055739E-02
P 185	1	0.59456778E 08	0.75394353E-02
P 186	1	0.49717430E 08	0.84109230E-02
P 187	1	0.40757143E 08	0.94985757E-02
P 188	1	0.33388295E 08	0.10753361E-01
P 189	1	0.25285748E 08	0.12761826E-01
P 190	1	0.19787993E 08	0.14940213E-01
P 191	1	0.15190393E 08	0.17793657E-01
P 192	1	0.11259269E 08	0.21837455E-01
P 193	1	0.79935122E 07	0.27902450E-01
P 194	1	0.55353765E 07	0.36885399E-01
P -0	1	0.	0.

Figure 10. Processed Data Plot for Run of August 24, 1960
(Scaler 1 only)

PLOT OF TRAVERSE STARTING SEQ. 1, CARD NO 148 ENDING SEQ. 48 CARD NO -0 SCALER 1

SEQ.	CARD	N.ACT
1	148	0.0944
2	149	0.1259
3	150	0.1663
4	151	0.2074
5	152	0.2599
6	153	0.3471
7	154	0.4402
8	155	0.5128
9	156	0.6216
10	157	0.7262
11	158	0.7354
12	159	0.7689
13	160	0.7729
14	161	0.6965
15	162	0.5730
16	163	0.3682
17	164	0.0936
18	165	0.0868
19	166	0.3276
20	167	0.5560
21	168	0.7347
22	169	0.8488
23	170	0.9467
24	171	1.0000
25	172	0.9390
26	173	0.8696
27	174	0.7286
28	175	0.5217
29	176	0.3201
30	177	0.0849
31	178	0.1012
32	179	0.3747
33	180	0.5801
34	181	0.6691
35	182	0.7667
36	183	0.7997
37	184	0.7652
38	185	0.7594
39	186	0.6350
40	187	0.5206
41	188	0.4265
42	189	0.3230
43	190	0.2527
44	191	0.1940
45	192	0.1438
46	193	0.1021
47	194	0.0707
48	-0	0.

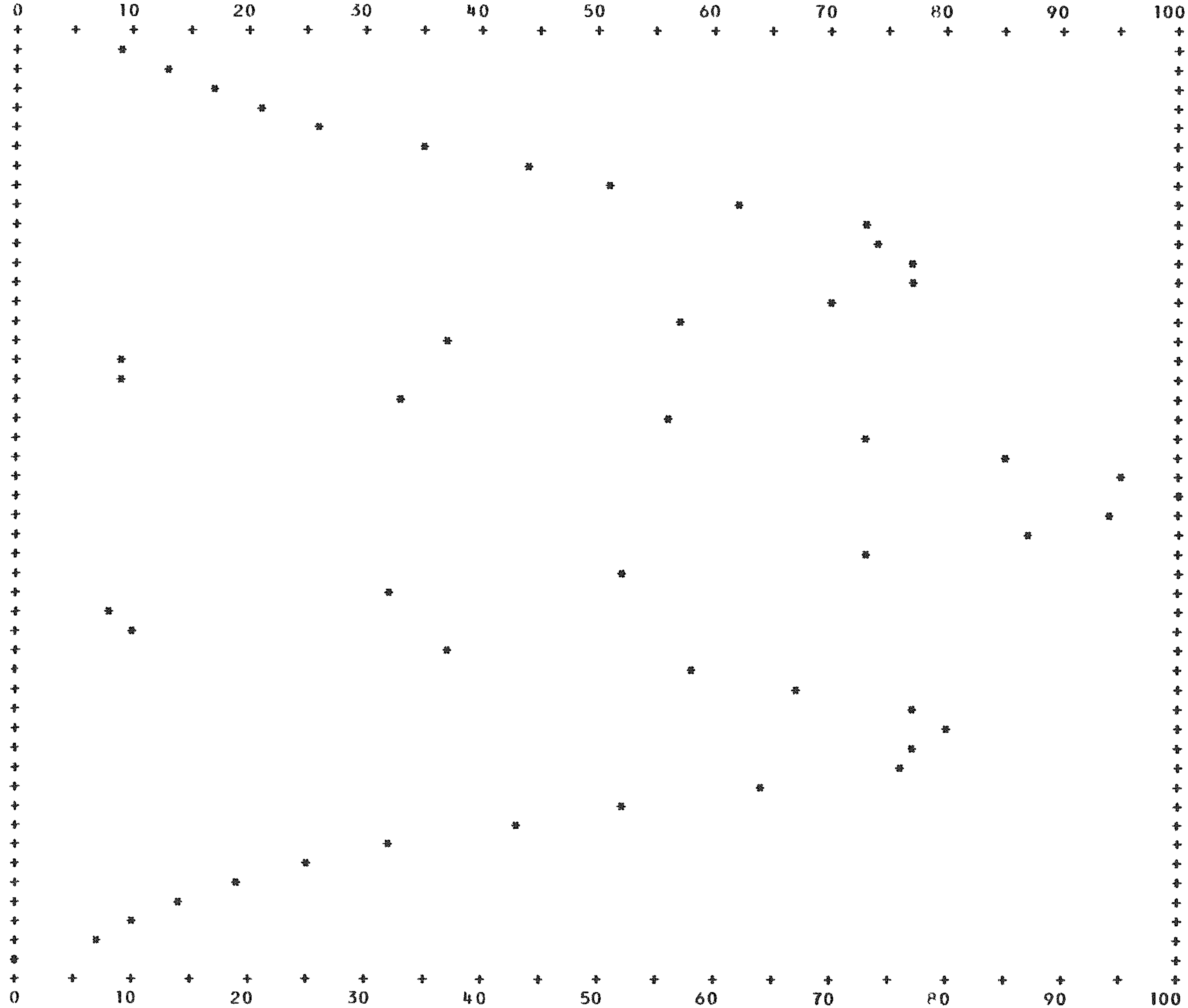


Table IV

COMPARISON OF CONCURRENT FOIL NORMALIZATION WITH COMPUTER DECAY REDUCTION

Scaler Data	Concurrent Normalized	Computer Decay Corr.	Per Cent Deviation
94,228	1.000	0.995	+0.5
92,412	0.981	0.979	+0.3
89,988	0.955	0.960	-0.5
94,102	0.999	1.000	-0.1
90,736	0.963	0.968	-0.5
82,784	0.879	0.886	-0.8
77,220	0.819	0.817	+0.2
71,280	0.756	0.758	-0.3
60,904	0.646	0.650	-0.6
50,940	0.541	0.538	+0.6
37,384	0.397	0.396	+0.2
27,884	0.296	0.296	0.0

Normalizing Foil Counted: 80,000 counts/interval

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