1961

The simulation of an automatic punch press line

David Litchfield Wood
Lehigh University

Photoduplication Service
Lehigh University
Bethlehem, Pa.

Job No. 2-10-3

REQUISITION FOR PHOTODUPLICATION SERVICES

Item No.	Type of Reproduction	Complete Description	Unit Price	Item Price
1	Microfilm (negative)	Wood, David Litchfield. The simulation of an automatic punch press line. Thesis (M.S.) L.U.-Dept. of Industrial Engineering.		

Microfilm reel and box _____
Microfilm minimum charge _____
Postage, as required _____

TOTAL CHARGE _____

This work is done under the conditions stated on the back of this sheet, to which I agree.

Authorized Signature _____ Department _____

Account Number _____ Date _____

Personal payment _____ (PREPAYMENT WILL NOT BE ACCEPTED. Applicant will be billed by the University on completion of work.)

If non-Lehigh request, name and address of institution:

_____

_____

Is copyright agreement on file? _____

THE SIMULATION

OF AN AUTOMATIC PUNCH PRESS LINE

by

David Litchfield Wood

A THESIS

Presented to the Graduate Faculty

of Lehigh University

in Candidacy for the Degree of

Master of Science

Lehigh University

1961

This thesis is accepted and approved in partial fulfillment of the requirements for the degree of Master of Science.

May 17, 1961
(Date

Clifton F. Gower
Professor in Charge

Clifton F. Gower
Head of the Department

ACKNOWLEDGEMENTS

This thesis could not have been prepared without the assistance and patience of my wife Elisabeth, and it is to her that this thesis is dedicated.

TABLE OF CONTENTS

LIST OF CHARTS

LIST OF TABLES

OBJECTIVES

The objectives of the development of the simulation described in this thesis are the following:

a. To develop a model for the operation of an existing automatic punch press line to include consideration of work load, equipment capacities, materials, and personnel.

b. To write a program for the LGP-30 Digital Computer to enable this model to be investigated.

c. To analyze the program and the model to determine if the model accurately represents the real-life punch press line.

INTRODUCTION

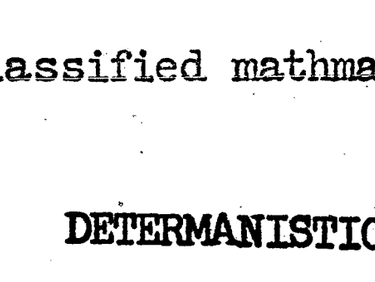
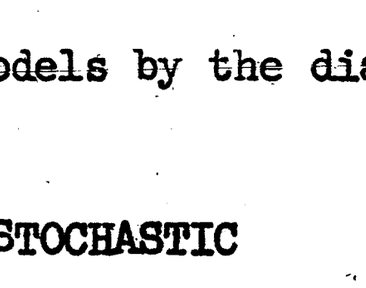
The analysis of a situation with the objective of learning the characteristics of the system is undertaken by the development of a model of the system. A model can be anything which permits the recognition of the characteristics of the system. Some characteristics would be the relationship between the inputs to the system and the outputs from the system, or the stability of the results from the system when the same inputs are entered over and over again.

One type of model in a Gantt Chart. Here the activity on a number of facilities is plotted against time. This type of model is useful when machine loading must be performed for a series of parts which must be combined into an assembly by a given date. Many types of situations require a pilot plant before all necessary characteristics of a system are known. This is common in the chemical industry where systems for the production of chemicals or chemical products must be tested by actual operation. Here information concerning the properties of the product at each step of the operation is checked to determine if each sub-process is of the correct nature to produce the finished product as it should be.

The mathmatical model is important to the Industrial Engineer because the outputs from the model can be analyzed by statistical methods as the inputs or parameters of the situation are varied. The chart type models such as the Gantt Charts picture a static situation and can not represent all the interactions which occur in the system

once any one variable has been changed. The pilot plant is a dynamic model because if one parameter changes in magnitude the pilot plant will show the affect of this change on all variables in the model. However a scaled down construction of the entire system can be very expensive. The mathmatical model does not require construction expenses and it also is a dynamic model.

Goode[1] has classified mathmatical models by the diagram which follows.

	DETERMANISTIC	STOCHASTIC
ANALYTIC	$F = (M)(a)$	$p(k) = \frac{e^{-m} m^k}{k!}$
NUMBERICAL	 Numerical Intergration	 Curve Fitting

"Deterministic" is defined as a model where no deviation from the relation is permitted while "Stochastic" represents a situation where deviation is expected, but is controlled by some probability function. In an "Analytic" model the process underlying the situation being simulated must be completely defined, but in a "Numerical" model the process underlying the situation does not need to be defined completely.

The Numerical Stochastic model is best suited to the use of a high speed digital computer as a means of analysis. In this model

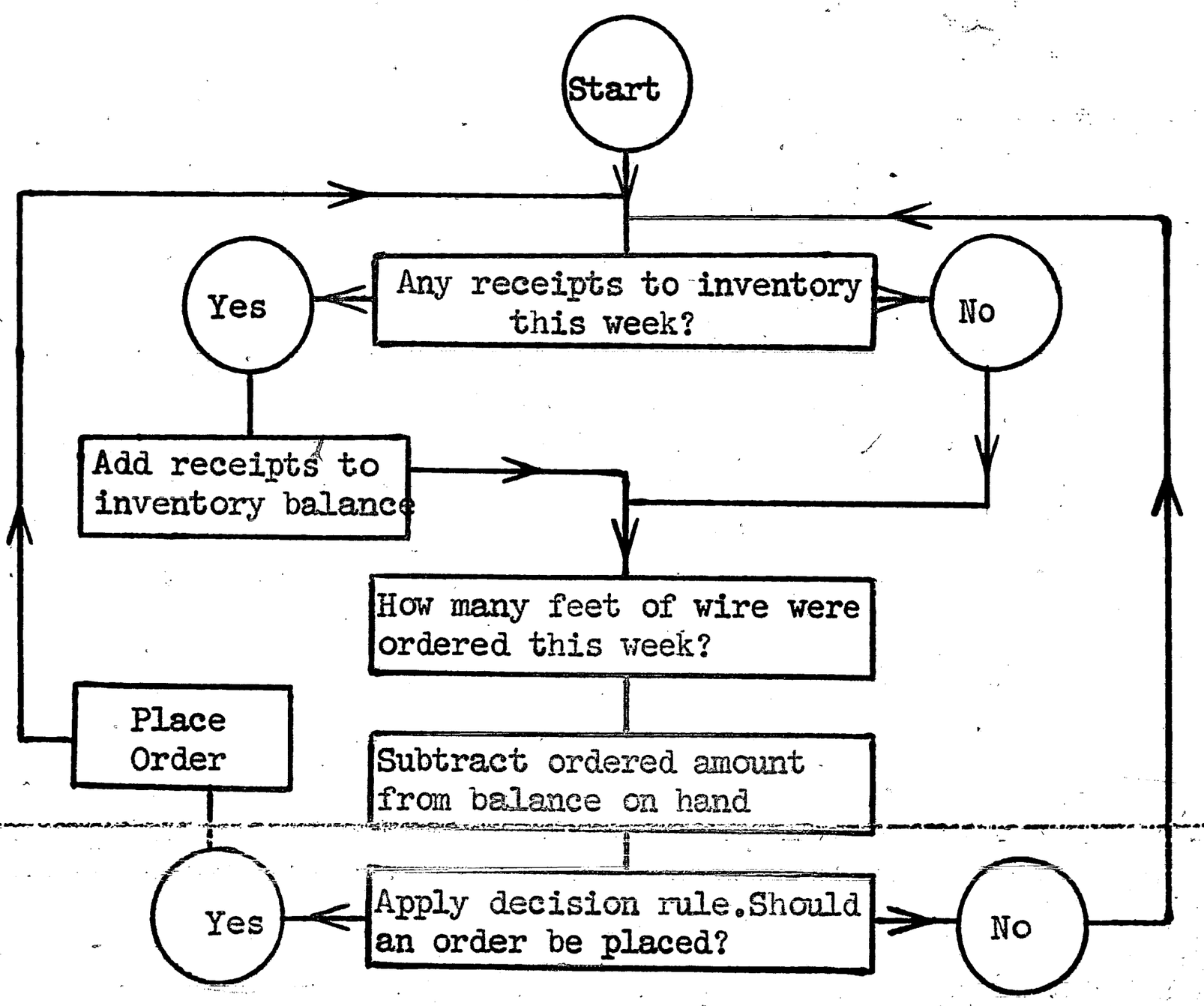
---

1. Goode, Harry H. "The Application of a High Speed Computer to the Definition and Solution of Vehicular Traffic Problems," Journal of Operations Research, December 1959.

a stochastic or conditional probability model of a situation is setup and sampling experiments are preformed on the model.

An example will clarify the above definition.[1] Suppose is was desired to evaluate inventory level decision rules in a wire manufacturing establishment. A model was developed which showed the effect of receipts and issues from the inventory on the inventory level in the plant of this manufacturer. Shown in chart number 1 is a quantitative analysis of the factors which cause the fluctuations in the inventory each week.

CHART 1



1. This model was developed and programmed at Lehigh University to be used as a teaching aid for Industrial Engineering students studying Operations Research.

The analysis above was made from a study of the existing situation. It is to be noted that the information listed below must be obtained by the model in order for it to function.

1. The number of receipts to inventory which arrive in a given week.
2. The number of feet of wire ordered during the week.
3. The number of feet of wire to be requisitioned by the decision rule.

This list of information comprises the parameters of the inventory situation and must be determined from the real situation. Many times the values of these parameters can be found from a past history of the operation being investigated. For example, the probability of an order taking six weeks, five weeks, or seven weeks to be filled can be determined from an analysis of past ordering and receiving documents. These probabilities can be used to determine in advance when an order will arrive in the plant. The number of units required per week can be determined by analyzing the job orders that were processed in the past. A distribution can be obtained showing the probability that any given length of wire might be ordered from inventory in any give week. Either economic order quantities or the decision rule itself will specify the number of units ordered each time the decision to replenish stock is made.

When the model has been specified and the data used to make the decisions developed, experiments can be performed. One decision rule can be used over a period of weeks and the resulting weekly level of inventory observed. If this level falls below the minimum allowed by management, the reasons for this situation can be observed from

the number of units required over past weeks and the number and frequency of units ordered. In this way the best decision rule can be developed.

The model in this example was a Numberical Stochastic model for the following reasons:

1. The situation was described, but the underlying function or relationship controlling the process was not defined mathematically.
2. The parameters were allowed to vary by means of the sampling of probability distributions.

The model described above can be investigated by hand by the use of random number tables. It must be observed that for this model it is a simple task, although very repetitious. The model described above can also be analyzed by a digital computer which would provide the results more quickly. It is estimated that one week's operation of the model by hand would take about two minutes if the decision rule employed was not complex. The same amount of work would take a computer a maximum of thirty seconds. Different decision rules can be evaluated with only minor changes in the program for the computer. There will be little chance of error in the computer runs, while with the hand operation the probability of error is high and would rise if the decision rule studied was more complex. A digital computer can undertake problems of greater complexity than the example given here. All Numerical Stochastic models may be investigated with a digital computer except where the time required to program the model or the cost of operating the computer prohibits the use of the machine.[1]

---

1. Malcome, Donald G, "System Simulation-A Fundamental Tool of Industrial Engineering," Journal of Industrial Engineering, pp 177-187, May-June 1958.

Once a model is transferred to a computer, the model can be analyzed more easily than if the model was analyzed by manuel methods, except where the model is extremely simple, By varying the magnitude of one parameter at a time and running the model for a number of cycles, the relationship between the variables output and the parameter can be defined. To do such an operation for a complex model by hand would take a prohibitively long time and probably induce many errors in the final results.

Numerical Stochastic models, which have been analyzed by digital computer methods, have been developed in a number of areas of interest to Industrial Engineers.[1,2] Industrial models have been investigated which range from the simple inventory problem described earlier in this thesis to models of the operation of an entire job shop. In these situations the objective of the simulation has been to determine the affect of changes in parameters such as scheduling rules, personnel availability, work load, etc., on the resulting production and the cost of operations.

Models for analysis by digital computer have been developed that portray the effect of operating decisions made by the management of a firm on the firm's profits in a given type of economy. Here the objective is to teach individuals to be executives by having them operate the business being simulated. The inputs to the model are the decisions made by the students. These would cover such areas as budgeting for expansion, advertising, and R & D; the number of salesmen to hire and

---

1. ----- "The Use of Simulation in Management Analysis," Journal of Operations Research, Vol 8 No. 2, 1960.

2. Malcome, Donald G., op. cit.

train, or the inventory level for each product being handled. The output from the model is the affects of these decisions on the business in the form of fiscal, production, and sales reports.

A third area where models have been developed and evaluated by means of digital computers has been in the areas of "war gaming." Here models of military systems have been developed which compete against each other to determine the required characteristics of the system so that it may best perform its assigned mission. An example of this type would be a model portraying a battle between aerial bombers and land based defensive forces. Here the characteristics needed by the bombers to have the best chance of victory against different forms of defense could be learned.

THE AREA INVESTIGATED

This study was conducted on an automatic punch press line of a manufacturer of five products for the appliance industry. All the presses are fed from coil stock and have a relatively constant work load.

The information used to develop the model described in this thesis was taken from a thesis titled "Preliminary Investigation of the Problems in Simulating a Metal Parts Press Shop" by Malcolm Scott Inglis which was written at Lehigh University in 1959. All information concerning the situation being simulated, and the data from which the probability distributions were developed for use by the model were taken from this thesis.

Listed below are the operations performed to complete an order on the automatic punch press line.

1. A schedulegraph showing the production for the next five weeks is rescheduled each week.
2. The foreman responsible for the automatic punch press line assigns the jobs to the presses at the time shown on the schedulegraph, and assigns a setupman to each job.
3. When the setup of a job has been completed, the initial pieces produced are sent to the inspection department to be checked against the parts specifications. If the parts do not pass inspection, the die on the press is adjusted until the parts produced are passed.
4. When the parts are approved by the inspection department,

the foreman assigns an operator to supervise the press while it is operating. Supervision consists of watching the presses to assure that they are operating and feeding correctly. The operator stands at a control panel where he may control the various presses he is supervising.

5. If the press needs adjustment during a run, the press is stopped and the adjustment made. If the operator is supervising more than one press at this time, these presses are also stopped while the adjustment is made.
6. If a die breaks during a run, it is taken off the press and repaired. When the repair is completed, the job is rescheduled on the schedulegraph.
7. The die for a completed run is left on the idle press until a new job is setup.

Analysis of Inglis's thesis brought out the following relationships which exist between the personnel, machines, and jobs run on the automatic punch press line.

1. The automatic punch press line consists of nine presses divided into three groups by size and speed.(See Appendix 1 for the characteristics of the presses used in this study.) Group one which has the smallest and fastest presses includes the presses numbered one, two, three, and four. Group two includes the presses numbered five, six and seven. Group three, the largest and slowest presses, includes presses numbered eight and nine.

2. The rate of strokes per minute for each press is fixed and does not vary from job to job. (See Appendix 1)
3. Although the presses are called automatic, they require the supervision of an operator while running.
4. An operator can supervise more than one press at a time if the presses are adjacent and of the same class. One man can supervise a maximum of three presses in group one, and two presses in group two. It is preferred that one man supervise only one press in group three, but if no men are free, one man can supervise both presses in this group.
5. A specially trained setupman is required to setup the press for each run which requires a die change.
6. A setupman can act as an operator when he is not doing a setup.
7. After a press is setup, the parts initially produced are inspected by the inspection department.
8. During a run it is probable that the press will be stopped from time to time for adjustment of the die.
9. During a run a die may break which will require a long delay while the die is being repaired.
10. A job is considered completed when the ordered amount has been made and the press or operator is needed for another job; otherwise production is continued until the coil of metal feeding the press is exhausted.
11. A job being setup or run on a press can be bumped by another job if the priority of the second is higher

than that of the first.

12. An operator or setupman who is supervising one or more jobs can be bumped to supervise another job if the priority of the new job is considered greater by the punch press line supervisor than the priority of all jobs being supervised by the operator or setupman.

13. A setupman who is working on a setup can be bumped to setup another job if the priority of the new job is higher than that of the origional job being setup.

Once the area to be simulated has been defined and all relationships in the situation have been isolated the basic question of control must be resolved. For this simulation, what must be decided is how the model will control the movement of a job as it is scheduled, setup, started into production, and completed. The model must have some way of knowing when a job should be setup, when it should go into production, and when the job has been completed.

One method of control, the "observer" method can be thought of as an observer who looks in on the punch press line at fixed intervals and observes what is going on at each press.[1] When he finds a job on a press that needs an operator he tells the supervisor to assign one, or when he finds that the production for a job has reached the ordered amount he reminds the supervisor that this job should be removed from the press if the press or operator is needed for a new job. The type of work being performed by the press may not change during the interval since the observer last looked at the press, but he must check

---

1. Malcome, Donald G., op. cit.

each one every period, since the activity could change at any time.

From the point of view of developing a model, the "observer" method for control has the following important disadvantages.

1. The model must be checked for the state (i.e. what is going on at the press; a setup, operation, or being idle) of each press in order to determine if this state has changed since the previous check of the press. Many times the state will not change, therefore the model is doing some unnecessary work when it checks those presses where there has been no change.
2. If the "observer" method of timing was used, the probabilities of occurance of such events as a die breakdown or a die adjustment would have to be based upon the probability of either event occurring in some small time increment, the interval between observations. These probabilities cannot be obtained from the past history of a situation unless production records are kept by time period rather than by job. This is rarely the case.

A second method, the "forecaster" method, can be described as a method which predicts when the state of a press is going to change, thereby eliminating any unnecessary checks of the state of the presses.[1] Using Monte Carlo sampling methods, the prediction is made by selecting from a table the total setup time for a job and by calculating an expected completion time using the rates of the punch presses.

---

1. R. W. Conway, B. M. Johnson, W. L. Maxwell, The Cornell Research Simulator, A description of a digital computer program for the simulation of job shop operations, Department of Industrial Engineering, Cornell University.

The primary advantage of this method is that the model need only check the system when it knows the state of a press is going to change. This will reduce the total time required to complete a given simulation run. A disadvantage of this method is that the possibility of a die adjustment or breakage occurring can only be considered at the time that an operator is assigned to the press, since the model does not look at the press again until the ordered amount has been completed. An alternative would be to have an independent sequencing system which would look at the model periodically to determine if a die will need adjustment or will break during the next interval. An approach of this nature would not only complicate the model greatly by requiring two sequencing systems, one for the jobs and one for the dies, but also bring up the same problems that were noted in the "observer"method, that is, that the data required to base the probabilities of die adjustment or breakdown are difficult to obtain.

The model for this simulation used the "forecaster" method for its control with the possibility of the die breaking or needing adjustment being considered at the time the setup is completed and the operator is assigned to the job. The reasons for this decision were the increased speed of operation of the model that would result, and the lack of probability data based upon time interval. The increased speed is obtained because the model does not spend any time checking the situation except when it knows that the state of a press will change.

The control proceedure used by this simulation program requires that the simulation function in the following sequence.

1. A clock is associated with each of the nine presses.

This clock contains the time at which the state of the press will change and a code to indicate what is the current state of the press.

2. All the clocks are searched to determine which has the minimum time.

3. The code associated with the clock which has the minimum time is analyzed to determine which of the following states of the press it represents:

   a. A job is to be setup.

   b. The setup and inspection of a job have been completed.

   c. The production of the ordered amount or maximum amount has been finished.

4. All necessary actions are taken to assign the proper personnel to the job associated with the minimum clock and to update all necessary records.

5. The time that the new state will change is predicted and stored in the clock associated with the press along with the code to show the new state of the press.

6. The clocks are again searched for the minimum time and the sequence of steps (2 to 5) are repeated.

Once the timing method for this simulation was determined, a detailed analysis was begun to determine the logical decisions that must be made by the model at each step as it processes jobs through the simulated punch press line. The particular information needed by the model to make each decision was also obtained from this analysis.

The files described below were designed to store all information needed by the model to process the jobs through the shop and to provide

the model this information in its most useable form.

1. Events File: The Purpose of this file is to record the state of each press and the time the state will change.
   a. This file contains nine records, one for each press, of three elements each.
   b. The elements of each record are defined as follows.
      1. A code indicating the state of the press
         a. 1: Job being setup
         b. 2: Job being operated
         c. 4: Press free
      2. The time the state of the press will change.
      3. The total time the press is occupied.
2. Production File: The purpose of this file is to record the details of the jobs currently assigned to the presses.
   a. This file contains nine records, one for each press, of ten elements each.
   b. The elements of each record are defined as follows.
      1. Job number (input)
      2. Units ordered (input)
      3. Maximum units to make (calculated)
      4. Preferred and alternate press numbers (input)
      5. Free
      6. Priority of job (input)
      7. Units produced so far (calculated)
      8. Time when production last started (calculated)
      9. Free
      10. Free

3. **Action File:** The purpose of this file is to record the details of the jobs that are not on the presses.

   a. This file contains 33 records of ten elements each.

   b. The elements of each record are defined as follows.

      1. The elements of this file are the same as those in the Production File with the following exceptions.

         a. Element number 8 A code indicating why the job is in the Action File

            1* 1: Job is awaiting setup

            2* 2: Job is awaiting operating

            3* 3: Job is awaiting a die repair

         b. Element number 9 If this job was run previously to storage in this file, the press number this job was last on is stored in this location

4. **Setupman File:** The purpose of this file is to record the activity of every setupman.

   a. This file contains two records, one for each setupman of three elements each.

   b. The elements of each record are defined as follows.

      1. A code which shows what the setupman is doing and the press or presses he is working on. The codes used are defined below.

         a. 0: Man is free, no press numbers will follow.

         b. 1: Man is doing a setup, one press

number will follow

c. 2: Man is operating, from one to three press numbers will follow.

2. The time this man has spent doing setups.

3. The time this man has spent supervising the operation of each press.

5. Operator File: The purpose of this file is to record the activity of each operator.

a. This file contains two records, one for each operator, of three elements each.

b. The elements of each record are defined as follows.

1. A code which shows what the man is doing and the press or presses he is working on. The codes used are defined below.

a. 0: Man is free, no press numbers will follow.

b. 2: Man is operating, from one to three press numbers will follow.

2. The time this man has spent supervising the operation of each press.

6. Schedule File: The purpose of this file is to store the details of the jobs to be setup at the beginning of the simulation.

a. This file contains ten records of ten elements each, one for each press and one for the job details as they are read in.

b. The elements of this file are the same as those

in the Production File.

7. Schedule Clocks: The purpose of this file is to record the time when each job in the Schedule File should be setup.

   a. This file contains nine records, one for each press, of two elements each.

   b. The elements of this file are defined as follows.

      1. The initial location in the Schedule File of the job to be setup on this press. The address is stored in the address portion of the instruction.

      2. The time when the job should be setup.

8. Special Clocks: The purpose of this file is to record the time that special events in the simulation will occur.

   a. This file contains 14 records of two elements each.

   b. The elements of this file are defined as follows.

      1. A code indicating what the event is.

         a. 3: Time when a die will be finished repair.

         b. 4: Time when this run of the simulation program will be completed.

         c. 5: Time when a printout of results will be made.

      2. The time that each event indicated by the code will occur.

9. Assist File: The purpose of this file is to reduce the searching time when a job record has to be stored in a free record in the Action File.

a. This file contains the locations of the last five records in the Action File that were freed.

The relationships that exist in the automatic punch press line being sumulated, as listed earlier in this thesis, were studied to determine the logical steps required to incorporate each characteristic into the model. The manner in which the model incorporates each of these characteristics is shown in the numbered paragraphs below. The numbers correspond to the numbered relationships that begin on page 10 of this thesis.

1. All the information used to assign jobs to presses and determine the production is classified by press group. This includes the following information:
   a. Distribution of setup times.
   b. Distribution of inspection times.
   c. Distribution for maximum production.
   d. Distribution of down time due to press adjustment.
   e. Distribution of down time due to die breakdown.
   f. Probabilities of die adjustment and die breakdown.
   g. Distribution showing the percentage of the job completed when a die breakdwon occurs.
2. A table containing the strokes per time period for each press is maintained. (Appendix I)
3. The number of the press an operator is assigned to is stored in the Operator File.
4. Before an operator or setupman is assigned to supervise a press, the numbers of the presses that this man is

running are compared to a table of admissable combinations of presses for the press group the man is working. If the presses the man is already operating plus the press that the program intends to assign to the man make up a combination that is not admissable the new press is not assigned.

5. The press number of the press which the setupman is assigned to setup is stored in the Setupman File. The code is stored to indicate that the setupman is doing a setup.

6. When a man is needed to supervise a press, and there are no operators available, the Setupman File is checked to see if a setupman is free. If one is free he is assigned to supervise the job on the press and the appropriate code and press number are stored in the Setupman File.

7. After a setupman has been assigned to a press both the setup time and inspection time are determined by random sampling of the appropriate tables for the particular press group involved. A constant tear down time is also added to the total time which is used as the estimate of when the press will be ready for operation.

8 & 9. After the setup for a job has been completed and an operator is assigned to the job, the computer predicts whether a die breakdown will occur or a die adjustment will be required during the time that the press will run. If a die adjustment will occur, the time that the

press will be down is determined by a random sampling of the Die Adjustment Down Time Distribution for the appropriate press group. This time is added to the estimated completion time of the run which is stored in the Events File. In this manner the predicted time when the job will be completed is delayed by the amount of the die adjustment time. When the computer discovers that a die will break during the run, the repair time and percentage completion before the breakdown occurs are selected. The production for the time the press was operating up to the time of the break is calculated. When the die breaks the particular run is considered complete, so the results of the run are printed and the ordered amount is reduced by the amount produced. The information on the job is moved to the Action File and a code is stored to indicate that the job is in the Action File because of die breakage. The time when the repairs will be completed and a code number is stored in the Special Clock File. This will indicate when the job which was shifted to the Action File can be rerun.

10. When the computer determines that the ordered amount for the job has been made, it selects by random selection the percentage increase over the ordered amount that will be considered the maximum production for this job. (The Distribution for Maximum Production was determined from past history by the increases that occurred over the ordered amount in actual runs.) If the total production

does not exceed the maximum production, the computer checks for the following two situations:

a. The press this job is now on is needed by another job and a setupman is available to setup the new job on the press.

b. The man operating the job which was completed is needed to operator or setup another job.

If neither of these conditions are met, the computer allows the job to be run until the maximum amount has been produced.

11. When a setupman or operator is available to work on a job, the job with the highest priority is selected from the Action File. If neither the preferred nor the alternate press is free, the priority of the new job is compared with the priority of the job on the press and if the priority of the new job is twice that of the job already on either press, this job is bumped and the new job is assigned to the freed press. When a job is bumped, the job records are shifted to the Action File.

12. When a job is assigned to a press, but a setupman or operator is not free to supervise the job, a man may be bumped if the priority of the new job requiring the man is twice that of the total priority (arithmetic sum) of all jobs presently being operated by the man.

13. When a job is to be setup and no setupman is free, a setupman may be bumped if the priority of the new job requiring the setupman is greater than the priority

of the job the setupman was originally working on.

Charts 2, 3 & 4 on the following pages picture the logical decisions that are made to assign a job to a press, assign a setupman to setup the job, assign a operator to supervise the operation of the press, and determine when a job has been completed. It must be noted that the flow charts shown are only a summary of the logic necessary to portray the operation of the automatic punch press line being simulated. The purpose of these flow charts is to give the reader an overall picture of the sequence of the logical decisions necessary to simulate the line. The flow charts for Subroutines 10, 11, and 12 in Appendix 2 which is a complete program description show the detailed logic of the simulation.

The time required to develop the model in a form detailed enough, so that the programming of the model for the LGP-30 digital computer could begin is shown below. This time does not include the time spent in the study of the techniques used in other digital computer programs for the simulation of shop operations.

1. Analysis and study of Inglis"s thesis to determine the relationships that exist in the punch press line. 10 hrs.
2. Preparation of flow charts of the model. 20 hrs.

CHART 2

SETUP OF A NEW JOB

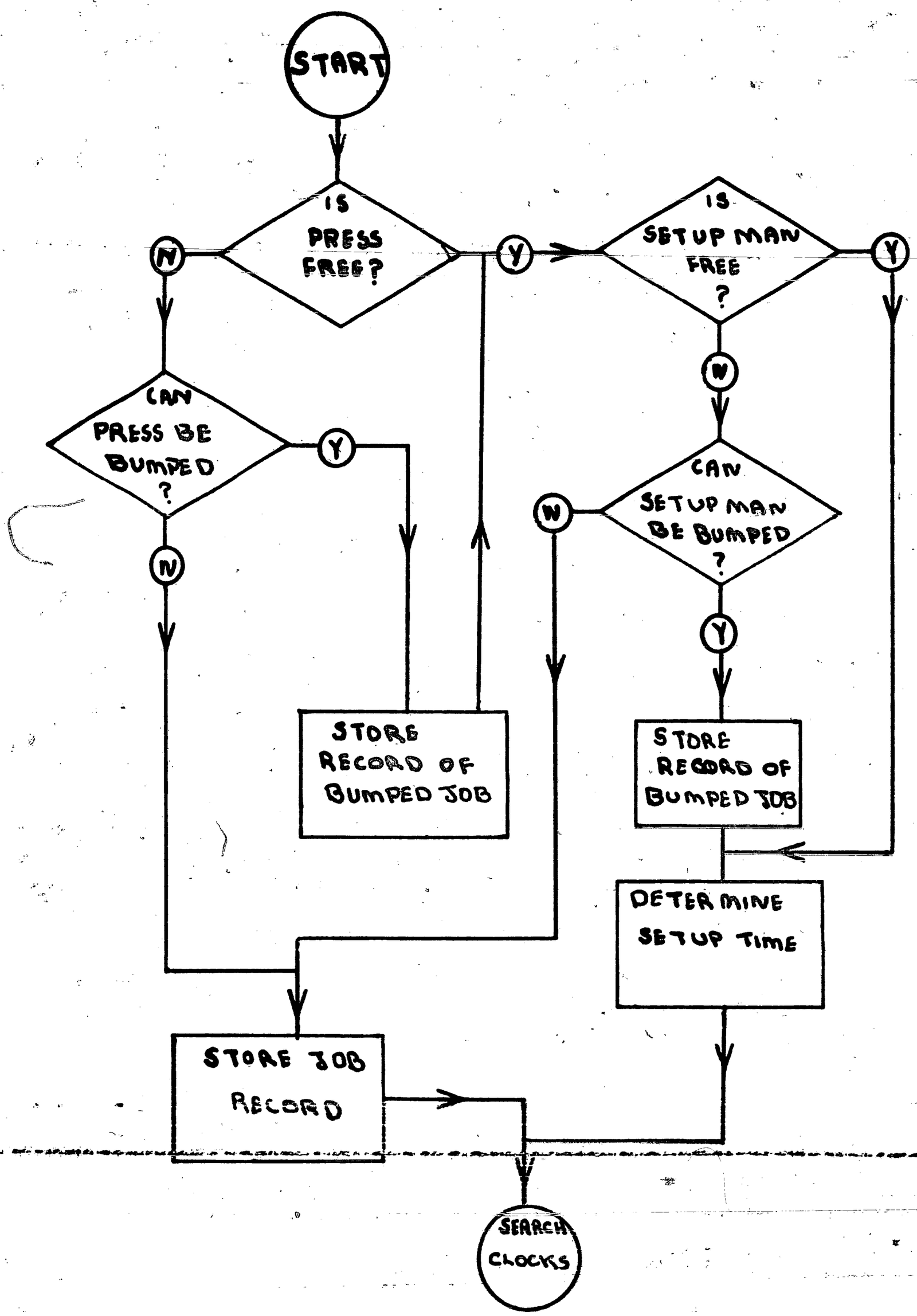


CHART 3

ASSIGNMENT OF AN OPERATOR

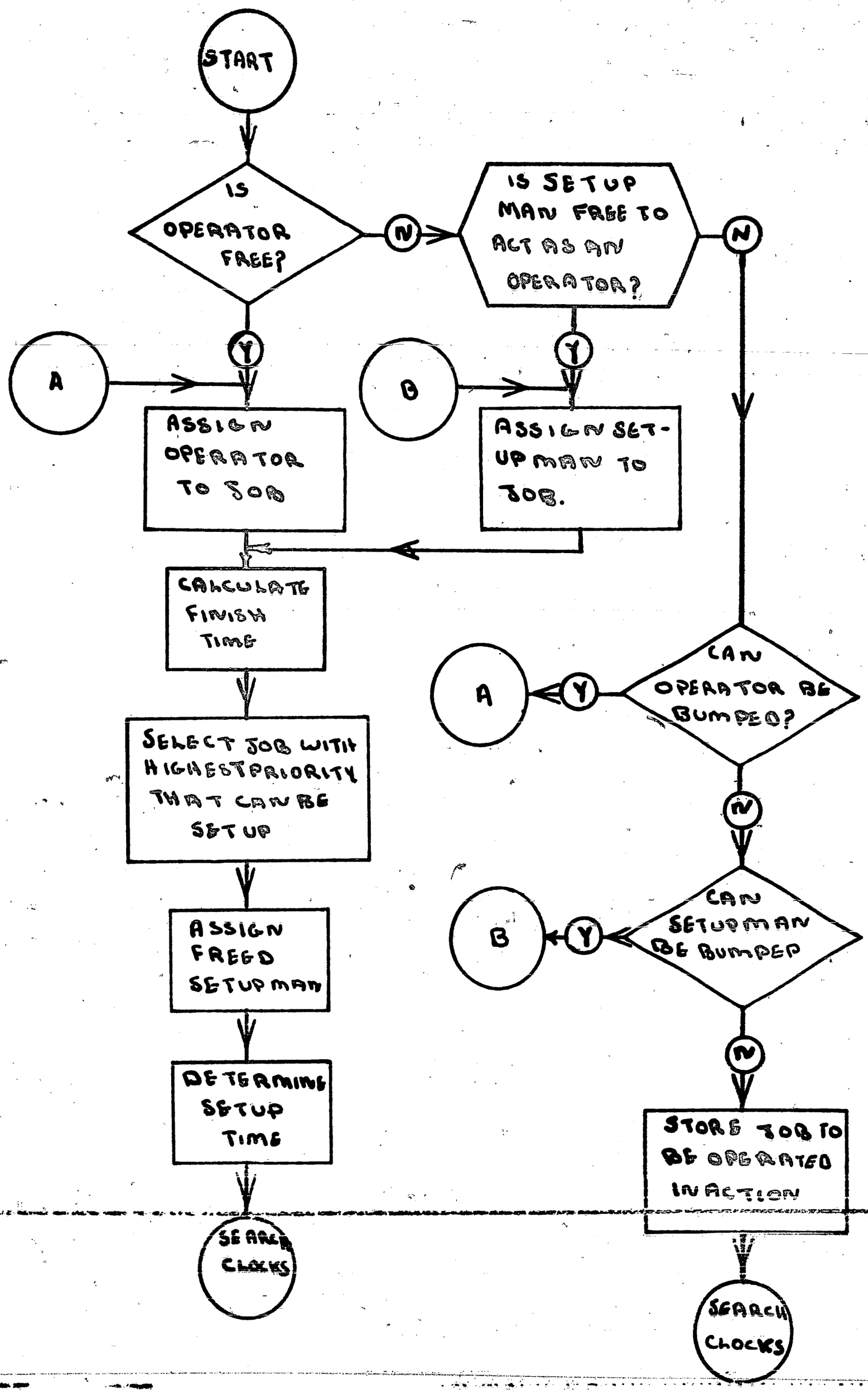
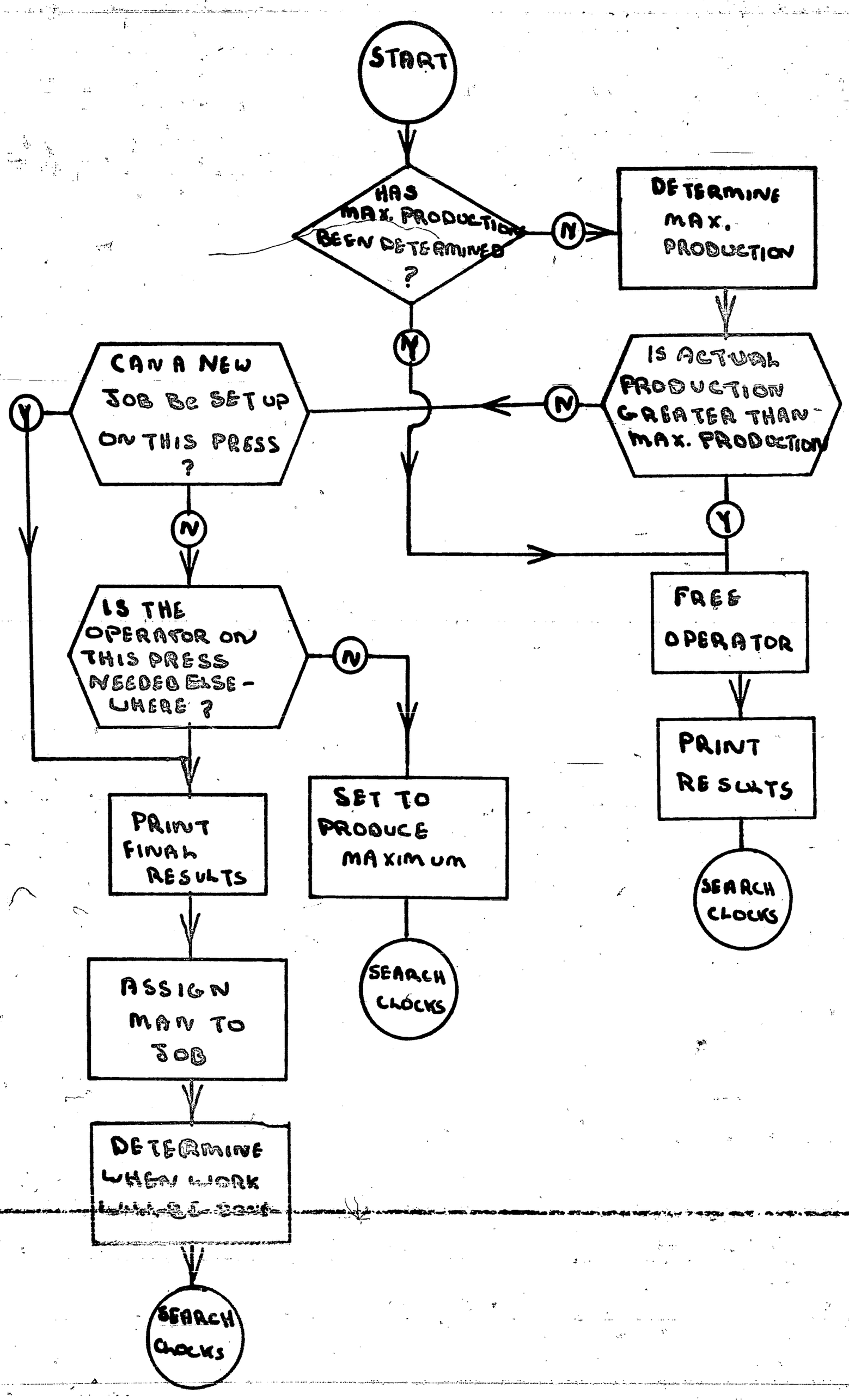


CHART 4

PRODUCTION COMPLETED



THE PROGRAMMING OF THE MODEL

The present state of the programming art has given the programmer many aids in his programming.[1] These aids may be classified as follows:

1. Compilers: Digital computer programs written in machine language which receive a program expressed in a non-machine language and translate the program into the language of the computer on which the program is to be run.
2. Interpreters: Digital computer programs written in machine language which receive a program written in a non-machine language and interpret this language to cause the computer to perform at that time the appropriate operation called for by the program.
3. Assembly programs: A digital computer program written in machine language which receives a program written in the form of the machine language but with symbols representing each storage location rather than numerical addresses in the instructions. The assembly program will replace the symbols with appropriate numerical addresses thus reducing some possibility for clerical errors.

The LGP-30 is classified as a "small" digital computer. The small

---

1. McCracken, Daniel D., Weiss, Harold, Lee, Tsai-Hwa, Programming Business Computers, pp 260-297, Wiley, 1960.

Digital computer manufacturers such as IBM, Remington Rand, and Burroughs all publish literature on these types of programs.

refers not only to the physical space required for the machine but also to its purchase price and operating cost. The LGP-30 is a stored program computer, and is therefore able to handle all types of problems that are handled by the larger computers. One of the abilities of a stored program computer is that it can make logical decisions. It does this by selecting which sequence of instructions it will execute from the value of any given program parameter. Appendix 3 contains a diagram which summarizes the characteristics of this computer.[1]

The relatively large memory of the LGP-30 allows the complex relationships that exist in many situations to be included in the logical model of the system. The principle disadvantage of the LGP-30 is its slow calculating speed. Due to this fact a program must be written so that unnecessary operations are at a minimum.

All three of the aforementioned types of programs were available for the LGP-30 at the time this simulation program was written.[2] This program however was written completely in the basic machine language of the computer for the following reasons:

1. The program for the simulation was felt to be too complex and used too many non-standard subroutines to be easily written in the compiler language for the LGP-30, Act I. The program for the model was visualized as a series of subroutines using common constants and common temporary storage. Due to the size of this program

---

1. Royal McBee Corporation, distributer of the LGP-30, will provide a detailed description of the computer upon request.

2. Royal McBee Corporation distributes detailed program descriptions on all programs mentioned. Additional information may be obtained from POOL, the LGP-30 Users Organization.

and of the program for Act I, each subroutine would have to be translated separately, and with the present version of ACT I, it is not possible to preserve the assigned data and constant storage locations from one compiling run to another.

2. All the interpretive programs presently available for the LGP-30 (Floating Point, and DICTATOR for example) perform the computations in floating point format. In a simulation such as the one to be programmed where the range of all numbers is known, and the computations are not complex, this number format is not necessary and just takes extra time to execute the calculations.

3. The present assembly routines for the LGP-30 (SATRAP, LGPSAP) could have been used to assist the programmer in writing the program for this simulation. The use of these programs would most likely have reduced debugging time due to the reduction of clerical type errors made by the programmer in the assignment of addresses. The problem of constant addresses for constants and for temporary storage of results can be handled in these programs. However, to use the assembly programs, each subroutine must be entered into the computer twice during the operation of the Assembly program. It was felt that the time lost by this operation would not compensate for the time lost in the tracking down of clerical errors made in the program.

An additional general comment which applies to any of the programs discussed above is that for complex programs, it has been the author's

experience with the LGP-30 that the problems generated through the use of any of these type programs were greater than any benefits obtained. These problems may be grouped as follows:

1. The increased probability of errors in the simulation program due to malfunctions which occurred in storing not only the simulation program but also the compiler or assembly program into memory.
2. The added time required to store the compiler or assembly program in the computer and to punch out the completed simulation program.
3. The difficulty involved in checking the compiled subroutines for the simulation when the coding sheets were written in the machine language. (i.e. the coding sheets would be written in the language of the compiler or assembly program and it would be difficult to relate addresses of the machine language program to the program on the coding sheets.)

Listed below are the basic concepts used in the organization of the program for the model of the automatic punch press line.

1. A series of three "control" programs were written to control the program through the basic parts of the simulation model. These were described by the flow charts shown earlier in this thesis. The control programs would include calling sequences to allow the program to use subroutines to perform any actions common to more than one "control" program or common to more than one place in any one control program.

2. The control programs are entered from a subroutine designed to search all clocks for the minimum time, and all control programs will exit back to this same subroutine to search the clocks again.
3. There is a common storage area for all constants and for all intermediate results. These areas are used by both the subroutines and the control programs.
4. The input of data is controlled by a special clock. It would be possible to allow jobs to enter the punch press line either daily or weekly by changing this clock. The format for the input data was kept simple so that the data would be recognizeable to management personnel.
5. The output was put in a form readily adaptable to statistical analysis.
6. Each subroutine was written so that all parts could be tested on the computer to assure that the subroutine would work properly before it was used in conjunction with any other subroutines or control programs.

The distributions used by the simulation program to obtain such information as the setup time, inspection time, and the time required to repair a die, etc., were developed from frequency distributions provided in Inglis's thesis . To provide an adequate range for the values of all parameters, it was decided to make the tables for each press class consist of twenty elements. The value of each element was selected in such a way that the value of each element had a probability of occurance of 5%.(See Appendix 4 for sample calculations) The tables constructed in this manner allowed for easy sampling, as a

random number between 0 and 19 need only be selected and the value of this number would define the position of the element in the table to be selected. For example, if the random number 16 was generated, the 16th element in the table being sampled would be selected as the value of the variable sought.

The time required to program the model is summarized below.

1.	Time required to develop detailed flow charts for the subroutines and control programs	25 hrs.
2.	Time required to code the flow charts	55 hrs.
3.	Time required to develop the distributions	6 hrs.
4.	Time required to develop test data	20 hrs.
5.	Time required to punch programs for input and check these tapes	30 hrs.
6.	Time required to debug programs on the computer	160 hrs.
	Total	296 hrs.

Table 1 shows the portion of the available memory of the LGP-30 used by different components of this program.

TABLE 1

Component of Program	Number of Locations	Percentage of total Locations Available
1. Coded instructions	2573	67
2. Distributions and Probabilities	375	9
3. Constants	242	6

4.	Locations for files	559	14
5.	Temporary storage	116	3
6.	Locations not used	51	1

One error in the concept of the programming for the model was discovered during the debugging phase of the development of the program. This error caused many errors in the coding of the control programs. The error was the use of the same area in the memory for the storage of intermediate values by both the control programs and the subroutines. Many times the control program would store a value in a particular intermediate storage location and then enter a subroutine. The subroutine would also use this location thereby changing the value stored by the control program. When these errors were discovered, it required a considerable amount of checking and recoding before all the errors were corrected. The best way to eliminate this problem is to have common intermediate storage for all subroutines, but use a different area for the storage of all intermediate results used by the control programs.

The proceedure used to debug the program must be stressed. In theory for each subroutine tested, data is developed to test every logical branch of the subroutine. Every branch is tested by developing combinations of data to force the computer to execute all the program steps in every loop. The random number generator is set to a known initial value so that the numbers generated are predictable and can be used to predict the results from the computer in areas where random numbers are used. For checking out the control programs forms are developed which list the value of all variables for a particular test and the expected results after each loop of the program has been tested.

In the debugging of this program the above proceedure was not used to the fullest extent. If it had been, the debugging time would have been reduced substantially. At least one-fourth of the time used to debug this program was spent hunting for minor errors in subroutines which developed during the running of the entire simulation program. More thorough use of the debugging proceedure would have eliminated these errors.

ANALYSIS OF RESULTS

A simulation, no matter whether it is analyzed by a mathmatical, mechanical, or stochastic model, must have three characteristics before useful information can be obtained.

The simulation must be reliable, discrete, and accurate.[1] By reliable is meant that if the simulation is run with the same data for a number of trials, comprised of a number of runs, the resulting distribution of answers for each trial can be shown to come from the same statistical population. The simulation must also be discrete in that if in a trial, one parameter or one characteristic of the model is changed, the resulting distribution of answers must come from a different statistical population than answers from the trial in which the parameter or characteristic was not changed. When the input data which occurred in the actual situation is employed for a number of runs of the simulation, a range of results is obtained for each one of the variables output. For the model to be accurate the resulting values from the actual situation must be included in each distribution determined by the simulation.

The first and second characteristics can be determined directly from the results of the simulation, but the greatest difficulty arose

---

1. The criteria for a simulation was based upon the criteria established for psychological tests as described in basic psychological texts such as Wickens & Meyer, Psychology, pp 316-7, The Dryden Press, 2nd Printing, 1955.

in proving the simulation was accurate. Accuracy was a problem because the data available from the automatic punch press line was not easily adaptable to analysis and comparison with the results obtained from the simulation. The only data available was a history of previous runs which showed only the total units produced for each particular job that had been run. (See Appendix 5 for a partial listing of this data) No information concerning labor or machine utilization was available.

The simulation provided the following results for every job that was completed:

1. Job number
2. Units ordered
3. Units produced

The computer printed for each week simulated the total time units that each press was operating, the total time units that each setupman worked as a setupman and supervised the operation of presses, and the total time units that each operator supervised the presses he was assigned. Also the job number, units ordered, and units produced for each job left in the Action File at the end of each run was printed. Shown on the following page in Table 2 is part of the output from one run of the simulation. Additional space between the printouts and titles has been added so that the significance of each number output can be better understood. A copy of the complete output of every run analyzed in this thesis is given in Appendix 6.

TABLE 2

Job Number	Units Ordered	Units Produced
5435267' /////////*	60000'	36000' **
4175154' /	120000'	35150'
5435331' //	80000'	72150'
•	•	•
•	•	•
•	•	•
5435068' /////***	16000'	18000'

Press Number	Time Units Press Run
1'	91'
2'	48'
3' ****	
4'	197'
5'	148'
6'	121'
7'	197'
8'	149'
9'	137'

Setupman Number	Time Doing Setup	Time Supervising Presses	Setupman Number	Time Doing Setup	Time Supervising Presses
1'	284'	16'	2'	249'	21'

Operator Number	Time Supervising Presses	Operator Number	Time Supervising Presses
1'	365'	2'	193'

Job Number	Units Ordered	Units Produced *****
4175149'	40000'	'
5435382'	45000'	'

TABLE 2 Cont.

* Each slash indicates one search of all clocks was completed.

** The results of production are printed every time a job is completed or a die breakdown occurs.

*** The clock selected at this point was the Special Clock which indicated that the run was complete and that final printout should begin.

**** The apostrophe for this press indicates there was no activity on this press.

***** The jobs printed at this point were those that were left in the action file at the end of the run.

For the simulation to be reliable, it is necessary to show that for a series of runs, each output variable forms its own statistical population. The data showing press utilization was grouped by press group in this analysis since all the factors that affect the press utilization are either constant (the production time for a given press) or are developed from a common table used by all presses in the group. The data on employee utilization cannot be grouped, therefore each employee in each activity must be treated separately. An analysis to determine reliability can be made by using a modified Chi Square test as shown in Appendix 7.

The simulation was shown to be discrete by varying one parameter between two trials each consisting of a number of runs. The variables output from the second trial were then compared with those from the first trial to determine if both sets of results were from the same distribution. If the simulation is reliable, the data showing press

utilization can be analyzed by either a "t" test or by establishing a confidence interval. Since the data was grouped, the Central Limit Theorum was applicable and one sample per run was obtained. The data showing personnel utilization should not be analyzed in this manner, for a large number of runs would be required before the Central Limit Theorum could be applied. This was because each sample would require at least four runs.

With the limited amount of data available from the actual situation the only analysis that could be made to determine whether the simulation was accurate was a comparison of the results as given by the simulation and the actual production that occurred on the automatic punch press line. The number of runs necessary to determine the probability that at least a fraction of the population lies between the extreme values of the range of results from the simulation for any one of the completed jobs can be determined from the following equation.[1]

$$p = 1 - nh^{(n-1)} + (n-1)h^{n}$$

where:

n = the number of runs necessary

h = the fraction of the population values lying within the range of a sample of size "n"

p = the probability that a fraction "h" of the population values lies within the range of a sample of size "n".

The results of calculations to show that the simulation is reliable are shown in Table 3. See Appendix 7 for sample calculations.

---

1. Burlington and May, Handbook of Probability and Statistics with Tables, p 168, Handbook Publishers, Inc., 1953.

TABLE 3

Summary of Chi Square Calculations to show the Simulation was Reliable

	Number of Intervals Established	Total Number of Elements	Chi Square	Epsilon*
Press Group 1	2	15	1.607	0.807
Press Group 2	2	15	1.607	0.807

* Epsilon equals the probability that the data is from the same distribution

It must be noted that the number of elements used per interval was below ten, the minimum number prescribed when comparisons with the Chi Square Distribution are made. Data from the other press groups and from the employee utilizations should also be analyzed in this manner, but there was not enough data available from the simulation to perform this computation validly. The number of runs that could be made for this thesis was limited due to the unexpected amount of checkout time that was required to complete the simulation program. It is assumed that further runs of the simulation will verify the indication that the simulation is reliable.

Tables 4, 5, and 6 show a summary of the calculations performed to show that the simulation was discrete. The tests were applied to data showing press utilization.

TABLE 4

Confidence Limits Established from Trial 1*

	Number of Elements in Sample	Number of Samples	Two Sigma Control Limits	
			Lower Control Limit	Upper Control Limit
Press Group 1	4	5	78.8	119.3
Press Group 2	3	5	138.0	190.4
Press Group 3	2	5	143.1	184.7

*See Appendix 8 for Calculations.

TABLE 5

A comparison of the Results of Three Runs from Trial 2 with the Confidence Limits Established from Trial 1*

	Run 1		Run 2		Run 3	
	$\bar{X}$	Control?	$\bar{X}$	Control?	$\bar{X}$	Control?
Press Group 1	122	Out	128	Out	117	In
Press Group 2	173	In	152	In	174	In
Press Group 3	138	Out	125	Out	117	Out

*See Appendix 9 for Calculations.

TABLE 6

Summary of Calculations for "t" Test Using Data from Trial 1 and Trial 2*

	"t"	Probability that the two samples are from the same distribution
Press Group 1	2.56	0.045
Press Group 2	0.22	0.833
Press Group 3	4.42	0.007

*See Appendix 10 for Calculations

The parameter changed between Trial 1 and Trial 2 was the method used to determine the priority of the job. In Trial 1 the priority was calculated as shown below:

$$\text{Priority} = \frac{\text{total units ordered}}{\text{strokes/time period for the preferred press}}$$

In Trial 2 the priority was determined as follows:

$$\text{Priority} = \frac{\text{total units ordered}}{1000}$$

The priority in Trial 1 can be seen to be highest for jobs run on Group 3 presses, since the strokes per time period for these presses was the lowest of the three groups. The priority used in Trial 2 eliminates this condition by assigning the higher priority to the jobs with the greater number of units to be produced. We would assume that the utilization of the presses in Group 3 would be reduced and the utilization of the presses in Group 1 increased. The simulation indicated this fact as shown in Tables 4, 5, and 6. It is to be noted that both the confidence limits and the "t" test showed this change. Although the confidence interval method is easier to calculate it does not give a numerical measure for the test while the "t" test does. To determine if the simulation is sensitive to changes in personnel, two trials of at least ten runs each should be made where in one trial there is a change in the number of setupmen or operators used. The data resulting should be analyzed by using the modified Chi-Square test as shown in Appendix 7.

A comparison of results from the automatic punch press line and the range of results obtained from eight runs of the simulation does not yield any conclusive information concerning the accuracy of the simulation. The probability is only 0.498 that at least 80% of

the distribution would be contained within the range of the units produced for each job. To assure there is a 95% probability that 90% of the population for each job lies within the range determined by the results of the simulation would require at least 47 runs of the simulation. (See Appendix 11 for calculations) The distribution of production for each job should also be compared with the classical type distributions such as the normal, binomial, poisson, etc. by the Chi-Square Test to determine if confidence limits can be calculated to show the interval within which the actual production should lie. If this is possible the number of runs required to prove the accuracy of the simulation would be reduced. Runs should also be made with different sets of data and the same analyses performed.

Analysis of the results from the simulation of each job is summarized in Table 7 below.

TABLE 7

A Comparison of the Results from Two Trials of the Simulation Program and the Actual Production from the Automatic Punch Press Line

	Number of Runs	A (Within Range)	B (Below Range)	C (Above Range)	D (Not Run)
Trial 1	5	43%	39%	15%	46%
Trial 2	3	18%	56%	22%	22%

A equals the percentage of jobs in which the actual results were within the range of results obtained from the simulation.

B equals the percentage of jobs where the actual production was below the range of results obtained from the simulation.

C equals the percentage of jobs where the actual production was above the range of results obtained from the simulation.

D equals the percentage of jobs where the simulation did not run the job more than one-half the number of runs.

Columns B and C show that for a majority of the jobs that were not within the range of results produced by the distribution, the actual production was below the range produced by the simulation. This indicates that on the jobs that were not completed on the automatic punch press line, probably due to a die breakage, the jobs were not resetup and run during that week. An analysis was made of the actual production for one month on the automatic punch press line and it bears out this deduction. Column D shows the number of jobs which were not set up by the model but were run in the actual automatic punch press line. The change made in the priority rule as shown by Trial 2 seems to improve this situation. This rule should be further investigated. The elimination of the jobs which had a die breakage from further work will also free both setupmen and operators so more work can be completed in the week.

Since the jobs are assigned to the presses from a schedulegraph, a priority rule might be tested which gives a higher priority to the jobs scheduled on the first day of the week and a decreasing priority to the jobs scheduled for succeeding days. This could be implemented by assigning the priority as follows:

Priority equals a number of the form XY.

X equals the day number. The first day of the week has a day number equal to 7 and each succeeding day reduces the day number by 1.

Y equals the units ordered divided by 10,000. For any runs of 90,000 units or greater use Y equal to 9.

Round all fractions up.

The suggested changes in the program and changes in the priority

rule were developed from an analysis of preliminary runs of the simulation. Any other changes or modifications should be made after further analysis of the results from the simulation. In this manner the accuracy of the simulation can continuously be improved until it reaches the desired level.

SUMMARY AND CONCLUSIONS

The model and program as written does simulate the operation of an automatic punch press line. The preliminary results show that the simulation can be made to accurately duplicate the conditions that exist in the automatic punch press line from which the data for the distributions and probabilities was obtained.

To as great an extent as possible the program was written so that the internal characteristics of the situation being simulated can be changed. Table 8 shows those characteristics that can be changed.

TABLE 8

Characteristic	Variability Possible	Modification Required
1. Presses	There can be less than 9, but there must be at least one per press group.	Changes in the Output Subroutine.
2. Press groups	none	
3. Setupmen	There can be from one to five.	Reset last location of file and change Output Subroutine.
4. Operators	There can be from one to five	Reset last location of file and change Output Subroutine.
5. Records per File	Variable	Change initial and final locations of files.
6. Elements per Table	Variable	Change initial and final locations of tables and the random number generator.
7. Probabilities	Variable	Change value in program

The time required to simulate one weeks operation of the punch press line averaged 30 minutes. Each week's simulation required an average of 66 searches of the clocks.

Once the accuracy of the simulation has been proved, experiments can be performed involving the analysis of the effects upon employee utilization and output when different work loads are placed on the shop or the internal parameters such as the number of setupmen are changed. The cost of each experiment can be determined from the average time per run given above and the hourly operating cost of the LGP-30 at the installation making the study.

The analysis of a model such as the one developed in this paper could be performed on a larger computer in a much shorter time. The time involved to program a model of this complexity would be equal to or less than the time required on the LGP-30. The programming and debugging time could be reduced by the use of compilers or assembly programs which might prove more economical to use on the larger computers.

The decision on the size of the computer to use to investigate a given situation through the development and analysis of a model must be based upon the actual costs involved in operating the contemplated program on whatever computers are available and the state of the training of the programmers available to write the program for the computer.

It is hoped that this thesis can be used to assist in the decisions involved in developing a model and programming the model for a digital computer.

APPENDIX 1

The Nine Presses Studied in this Simulation

No	Type	SH Height	Bolster	Speed/min	Speed/Simulation Time Unit
1.	19½ Bliss	7"	20" x 12½"	147	2200
2.	19½ Bliss	6½"	24" x 12"	176	2625
3.	3¼ V & O	10"	26½" x 15½"	100	1500
4.	3½ V & O	10"	26½" x 15½"	100	1500
5.	21 Bliss	9"	30" x 19"	131	1950
6.	21 Bliss	9"	27½" x 18 3/4"	131	1950
7.	A3½ Niagera	10½"	27" x 17½"	124	1850
8.	23M Bliss	11½"	32" x 24"	51	750
9.	23M Bliss	12"	32" x 24"	90	1350

APPENDIX 2

Program Description

I. DESCRIPTION

A. General Method: This program simulates the flow of jobs through a production line performing a single operation. The simulation assigns the jobs to the machines that can perform the operation required, and assigns a setupman and an operator to the machine. The simulation program accumulates data on the utilization of each machine and each operator and setupman. In the text that follows the nomanclature used will be for the simulation of an automatic punch press line.

B. Method for decisions: Random number generation proceedures are used to determine all variable parameters. All other decisions are based upon internally programmed decision rules as shown below.

1. The available presses are divided into three groups according to capacity.
2. The production rate for each press is constant and is stored in the Strokes per Time Period Table.
3. A numerical priority is input with each job. The higher the number, the higher the priority.
4. A job may be run on either the preferred or the alternate press. Both press numbers are input.
5. A setupman may setup only one press at a time. (Subroutine 4) Both the setup and the inspection time is selected by

random sampling. (Subroutine 7-1) A constant tear down time for the die which is already on the press is also included.

6. An operator may supervise the operation of only certain combinations of presses at any one time. (Subroutine 4 and 4A) A setupman may also supervise the operation of presses if he is not doing any setups. (Subroutine 4)

7. A press may be stopped during operation to make required adjustments or to repair a broken die. The probability and duration of a stoppage is determined by random sampling. (Subroutine 3-1)

8. The amount produced for any job is equal to the amount originally ordered plus an additional amount determined by random sampling of the Distribution for Maximum Production. This additional amount will not be produced if either the press being used or the operator supervising the press is needed elsewhere. (Subroutine 12)

9. When a setupman or operator is available to work on a job, the job with the highest priority is selected. If neither the preferred nor the alternate press for this job is free, the priority of the new job is compared with the priority of the job on the press and if the priority of the new job is twice that of the job already on either press, this job is bumped and the new job is assigned to the freed press. (Subroutine 6-1 and 7)

10. When a job is assigned to a press, but a setupman or

operator is not free to supervise the job, a man may be bumped to supervise the operation of the press if the priority of the new job requiring the man is twice that of the total priority (arithmetic sum) of all jobs presently being operated by the man. (Subroutine 6-2)

11. When a job is to be setup and no setupman is free, a setupman may be bumped if the priority of the new job requiring the setupman is greater than the priority of the job the setupman was originally setting up.

C. Method of Operation: The simulation is sequenced through the time period being simulated by the following proceedure.

1. A clock in the Events File is associated with each of the presses. This clock contains the time (in simulator time units) at which the state of the press will change. The state of the press is whether it is free, it is being setup, or it is being operated. A code is also stored in each record of the Events File to show the current state of each press.

2. All the clocks are searched to determine which has the minimum time.

3. The code associated with the clock which has the minimum time is analyzed to determine the state of the press.

4. The appropriate subroutine is entered so that all necessary actions may be taken to prepare the press for its next state.

5. The time that this new state will change is predicted

and stored with the code to indicate the new state in the record of the Events File for the given press.

6. The clocks are again searched for the minimum time, and the sequence of steps (2 to 5) is repeated.

II PROGRAM ORGANIZATION

A. General: The necessary actions to be taken when the state of a press changes are controlled by Subroutines 10, 11, and 12, Job Setup, Job Operation, and Job Completion respectively. The detailed logic for operations that are used by more than one subroutine is found in Subroutines 1 through 8. Subroutine 9 controls the sequencing of the simulation. Subroutine 13 controls input and initialization, and Subroutine 14 controls final output.

B. Constant and Temporary Storage: Track 61, locations 00 through 31, contains the initial locations of all tables used by the program. The second half of this track, locations 32 to 63, contains temporary storage locations. Track 62 contains common storage of all constants used by all subroutines.

C. Description of Files: See pages 16 through 19.

D. Description of Tables:

1. Distribution of Setup Time: This table stores a range of setup times for each press group. The data for these tables was obtained from production records from the situation being simulated.

a. This distribution presently consists of three tables one for each group of twenty elements each. The elements are stored in ascending order.

b. Each element of this table is a positive number stored at a "q" of 29.

c. The initial locations for the three tables for press groups 1, 2, and 3 are stored in locations 3058, 3059, and 3060 respectively.

2. Distribution of Inspection Time: This table stores a range of inspection times for each press group. The data for these tables was obtained from inspection records of the actual production line.

a. This distribution presently consists of three tables, one for each press group, of twenty elements each. The elements are stored in ascending order.

b. Each element of the table is a positive number stored at a "q" of 29.

c. The initial location for the three tables for press groups 1, 2, and 3 are stored in locations 3061, 3062, and 3063 respectively.

3. Distribution of down time due to press adjustment: This table stores a range of down times for each press group. The data for these tables was obtained from records of the actual production line.

a. This distribution presently consists of three tables, one for each press group, of twenty elements each. The elements are stored in ascending order.

b. Each element of the table is a positive number stored at a "q" of 29.

c. The initial location for the three tables for press groups 1, 2, and 3 is stored in locations 2928, 2929, and 2930 respectively.

4. Distribution of down time due to press breakdown: This table stores a range of down times for each press group. The data for these tables was obtained from records of die repair times of the actual production lines.

   a. This distribution presently consists of three tables, one for each press group, of twenty elements each, The elements are stored in ascending order.

   b. Each element of the table is a positive number stored at a "q" of 29.

   c. The initial location for the three tables for press groups 1, 2, and 3 is stored in locations 2925, 2926, and 2927 respectively.

5. Distribution for maximum production: This table stores a range of percentages of the ordered amount for each press group. Elements in this table range from 110% to 185%. The data for these tables was obtained from an analysis of those actual production records which showed production greater than the ordered amount.

   a. This distribution presently consists of three tables, one for each press group, of twenty elements each. The elements are stored in ascending order.

   b. Each element of the table is a positive number stored

at a "q" of 29.

c. The initial location for the three tables for press groups 1, 2, and 3 is stored in locations 2222, 2223, and 2224 respectively.

6. Distribution showing the percentage of the job completed when a die breakdown has occurred. This table stores a range of percentages of the ordered amount. The data for these tables was obtained from actual production records that showed production which was less than the ordered amount.

a. This distribution presently consists of three tables one for each press group, of twenty elements each. The elements are stored in ascending order.

b. Each element of the table is a positive number stored at a "q" of 29.

c. The initial location for the three tables for press groups 1, 2, and 3 is stored in locations 2961, 2962, and 2963 respectively.

7. Jump table: This table stores the beginning locations of the subroutines that take all necessary actions for each of the codes used in the Events File and Special Clocks.

a. This table consists of six instructions of the form "UXXXX" with the beginning location of each subroutine in the address portion of the subroutine. The instructions are stored in ascending order by the code.

b. This table begins at location 3421.

8. **Strokes per time period table:** This table stores the production rate for each press. The data for this table was obtained from the production rates of the actual presses.

   a. This table consists of nine elements stored in ascending order by press number.

   b. Each element of the table is a positive number stored at a "q" of 16.

   c. The beginning location of this table is 3523.

9. **Proper assignment table for press group 1:** This table gives for each press number in group 1 the combinations of presses that the man can already be supervising and also supervise the operation of the new press.

   a. This table consists of four groups of locations, one for each press number in group 1. In the last location in each group is a -1.

   b. The format for each element (other than the -1's) consists of a 2 at a "q" of 7, and the appropriate press numbers stored at "q"s of 11 and 15.

   c. This table begins in location 4630. The proper entrances to this table for each press number are stored in locations 4626 through 4629.

E. Description of Constants

1. Probability of die adjustment: This is the probability of one adjustment being necessary during the operation of a press on each job. The probability was obtained from an analysis of the actual production records.

a. There is a different probability of die adjustment for each press group.

b. Each probability is a positive number stored at a "q" of 29.

c. The probabilities of die adjustment for press groups 1, 2, and 3 are stored in locations 2916, 2917, and 2918 respectively.

2. Probability of die breakdown: This is the probability of the occurrance of a die breakdown during the operation of the press on each job. The probability was obtained from the analysis of actual production records where breakdowns occurred.

   a. There is a different probability of die breakdown for each press group.

   b. Each probability is a positive number stored at a "q" of 29.

   c. The probabilities of die breakdown for press groups 1, 2, and 3 are stored in locations 2919, 2920, and 2921 respectively.

3. The number of time units between printouts of press and employee utilization.

   a. The time is a positive number stored at a "q" of 29 in location 6249.

III. PROGRAM FLEXIBILITY

A. One of the objectives inherent in the logical development and programming of this simulation was to make it adaptable to as great a range of simulation problems as possible.

In the discussion below each characteristic that is flexible is listed with the amount of variability allowed and the changes in the program necessary to allow this variability.

1. The number of presses.

   a. The number of presses can be reduced, but there must be at least one press per press group. Neither the number of presses per group nor the number of press groups can be increased without extensive reprogramming.

   b. A reduction in the number of presses will require changes in the printout controls in Subroutine 14.

2. The number of setupmen or operators.

   a. The number of setupmen or operators can range from one to five. There must be at least one operator and setupman.

   b. The only change necessary to vary the number of personnel is to reset the last location of the file involved. These constants are stored in the 1st half of track 61.

3. The number of records per file.

   a. The number of records can be either increased or decreased with only two restrictions.

   1. All files are necessary, and all available memory is in use, therefore if the number of records in one file is increased, there must be a reduction in the number of records in another file.

2. Some of the files must have one record for each press used and since there is a minimum number of presses that can be simulated, some files have a minimum number of records that must be maintained.

b. The only change required is the storage of the new beginning and ending locations for each file in the appropriate locations in the 1st half of track 61.

4. The number of elements in the distributions.

a. The number of elements in distributions may be reduced or increased. But if an increase is contemplated, the same considerations as discussed in 3,a, 1 and 2 must be evaluated. All distributions that are to be sampled must have the same number of elements.

b. To change the number of elements in a distribution the appropriate beginning location of each distribution must be changed. Also the random number generator (Subroutine 5) must be modified to generate random numbers with a range equal to the number of elements in each distribution.

5. Changes in the value of constants such as the probability of die adjustment or the time between printouts can be made by just inserting the new value in the proper location.

B. The organization of this program into common subroutines and control programs facilitates any changes that require programming.

An example of this type of flexibility is the elimination of the provisions for production greater than what was ordered. The only change in the program required would be minor reprogramming in the control subroutine that handles this area, Subroutine 12. The change discussed on page of this thesis which was to consider a job completed if the press on which it was running had a breakdown could be implemented by changing only Subroutine 3-1.

IV PROGRAM TAPES

A. The program tape can be prepared by punching the instructions for each subroutine, as shown in the coding sheets, with the standard program input codes. The tape is loaded into the computer using the conventional program input program. The Proper Assignment Table for Press Group 1 should be input in hex with the programs. The data for the six distributions and the tables can be loaded using a data input subroutine stored in track 3 through 5.

V. OPERATING PROCEEDURE AND INPUT FORMAT

A. To start the simulation program transfer to location 1518. This is the beginning of Subroutine 13. This subroutine will set to zero the entire data storage area which has its beginning location stored in 6128 and its ending location stored in 6129. As the program is presently written, this initialization will destroy the contents of all locations from 0000 to 0941. If it is necessary to re-enter the program once this initialization has taken place, the "bootstrapping" process must be used.

B. When the initialization has been completed, the flexowriter input light will glow thus indicating input is ready. This first input is the number of time units to be simulated. The format for this number is as follows:

XXXXX'

This is a positive number and is stored at a "q" of 29. It has a range of from 1 to 9,999,999. This number is stored in the 1st element in the 1st special clock.

C. The data on each job to be simulated should follow.

1. The format shown below is that used for the data analyzed by this author. The actual range of each element of the job record is given in the discussion that follows.

AAAAAAA'BBBBB'C'D'EEE'

a. AAAAAAA' is a seven digit job number. This is a positive number which can range from 1 to 9999999. For all data input leading zeroes do not need to be punched.

b. BBBBB' is the units ordered. This is a positive number which can range from 1 to 9999999.

c. C' is the preferred press that the job can be run on. This is a positive number which can range from 1 to 32767.

d. D' is the alternate press that the job can be run on. This is a positive number which can range from 0 to 32767.

e. EEE' is a priority number that establishes the

priority of the job in relation to other jobs input. Priority is determined by a simple comparison. The job with the highest priority number has the highest priority.

2. As the data files are presently laid out, a maximum of 42 jobs may be loaded at one time if at least one job is assigned to every press. If 42 jobs are input, each press will be scheduled with the job with the highest priority, and the remaining 33 jobs will be stored in the Action File to await setup. The last job record input must be followed by a -1. The last record loaded would look as follows.

AAAAAAA'BBBBB'C'D'EEE'

-0000001'

D. The input of the jobs listed in Table 9 will require a data tape punched as in Table 10. The simulation period is 100 time units.

TABLE 9

Job Number	Units Ordered	Preferred Press	Alternate Press	Priority
4175149	40000	6	5	21
5435205	30000	9	8	40
5435604	50000	4	0	34
5435659	30000	2	1	12
5435653	30000	6	5	16

TABLE 10

100'

4175149'40000'6'5'21'

5435205'30000'9'8'40'

5435604'50000'4''34'

5435659'30000'2'1'12'

5435653'30000'6'5'16'

-0000001'

When the input is completed, the jobs would be scheduled for setup on the following presses:

Job Number	Press Number
4175149	6
5435205	9
5435604	4
5435659	2
5435653	5

VI OUTPUT

A. Periodically throughout the simulation the program will print the number of time units each press has been utilized to either setup or operate a job, the number of time units that each setupman has been doing setups, and the number of time units that each setupman and operator has spent supervising the operation of the presses up to the time of the printout. In the latter case if one man supervised three presses for four time periods, twelve time units would be added to this man's accumulated work time.

B. A slash (/) is printed every time the clocks are searched and a minimum clock is selected.

C. The simulation program is presently programmed to print the results of production whenever a job has been completed or whenever a job that was in production has to be stopped due to die breakage. In this instance the amount of production up to the breakdown is output. The ordered amount is reduced by the printed amount, and the amount produced is reset to zero. When the die has been repaired, the job is considered a new job by the simulation.

D. Sample Output. (see page 38)

VII. MEMORY LAYOUT FOR THE PROGRAM WITH THE PRESENT FILE AND DISTRIBUTION ORGANIZATION

Location	Description
0000 - 0026	Events File (9 Records)
0027 - 0152	Production File (9 Records)
0153 - 0206	Schedule Clocks (9 Records)
0207 - 0216	Operator File (5 Records)
0217 - 0231	Setupman File (5 records)
0232 - 0259	Special Clocks (14 Records)
0260 - 0805	Action File (33 Records)
0806 - 0941	Schedule File (10 Records)
0942 - 0961	Distribution of Setup Times for Press Group 1
0961 - 1017	Distribution of Setup Times for Press Group 2
1018 - 1037	Distribution of Setup Times for Press Group 3
1038 - 1057	Distribution of Inspection Times for Press Group 1
1058 - 1113	Distribution of Inspection Times for Press Group 2

Location	Description
1114 - 1133	Distribution of Inspection Times for Press Group 3
1134 - 1153	Distribution for maximum production, Press Group 1
1154 - 1209	Distribution for Maximum Production, Press Group 2
1210 - 1229	Distribution for Maximum Production, Press Group 3
1230 - 1249	Distribution of Down Time due to Press Adjustment, Press Group 1
1250-1305	Distribution of Down Time Due to Press Adjustment, Press Group 2
1306 - 1325	Distribution of Down Time due to Press Adjustment, Press Group 3
1326 - 1345	Distribution of Down Time Due to Die Breakage, Press Group 1
1346 - 1401	Distribution of Down Time due to Die Breakage, Press Group 2
1402 - 1421	Distribution of Down Time due to Die breakage, Press Group 3
1422 - 1441	Distribution for Percentage of Job Completion, Press Group 1
1442 - 1461	Distribution for Percentage of Job Completion, Press Group 2
1462 - 1517	Distribution for Percentage of Job Completion, Press Group 3
1518 - 1645	Subroutine # 13, Input data and load Schedule Clocks.
1646 - 1826	Subroutine # 14, Analysis of Special Clocks and Printer.
1827 - 2221	Subroutine # 12, Analysis of Code 2 (Job Completion)
2222 - 2224	Beginning locations of Distribution for Maximum Production.
2225 - 2302	Subroutine # 12 (continued)
2303 - 2602	Subroutine # 11, Analysis of Code 1 (Assign Operator)
2603 - 2763	Subroutine # 10, Analysis of Code 0 (Assign Setupman)
2800 - 2913	Subroutine # 3-1, Check for Die Adjustment or Breakdown
2914 - 2915	Locations of Probabilities of Die Breakdown and Adjustment
2916 - 2918	Probabilities of Die Adjustment.
2919- 2921	Probabilities of Die Breakdown.

Location	Description
2922 - 2924	Location of beginning locations for Distributions of Die Breakdown and Die Adjustment
2925 - 2927	Beginning Locations of Distribution of Die Breakdown
2928 - 2930	Beginning Locations for Distribution of Die Adjustment
2931 - 2959	Subroutine # 3-1 (Continued)
2960 -	Location of beginning location of the Percentage of the Job Completed Distribution
2961 - 2963	Beginning locations of the Distribution Showing the Percentage of the Job Completed.
3000 - 3043	Subroutine # 7-1, Accumulate Setup Time
3044 - 3055	Free
3056 - 3057	Location of Beginning locations of the Distributions for Setup Time and Inspection Time
3058 - 3060	Beginning locations of the Distribution of Setup Time
3061 - 3063	Beginning Locations of the Distribution of Inspection Time
3100 - 3261	Subroutine # 7, Shift Records of Bumped Job to Action
3300 - 3420	Subroutine # 9, Select Minimum Clock
3421 - 3426	Jump Table
3427 - 3439	Subroutine # 9 (Continued)
3440 - 3449	Subroutine # 13 (Patch)
3450 - 3463	Subroutine 14 (Patch)
3500 - 3522	Subroutine # 8, Calculate Units Produced
3523 -3531	Strokes per Time Period Table
3532 - 3555	Subroutine # 13 (Patch)
3556 - 3558	Subroutine # 14 (Patch)
3559 - 3562	Subroutine 13 (Patch)
3563	Free
3600 - 3663	Subroutine # 6-1, Check Presses to see if a new Job can be run

Location	Description
3700 - 3934	Subroutine # 6-2, See if any personnel can be bumped
3935 - 3941	Subroutine 4-1 (Patch)
3942 - 3952	Subroutine 14 (Patch)
3953 - 3957	Subroutine # 13 (Patch)
3958	Free
3959 - 3963	Assist File
4000 - 4038	Subroutine # 5 Sample Distribution or Test Probability
4039 - 4063	Subroutine # 4-1 (Patch)
4100 - 4463	Subroutine # 4, Check for Availability of Press, Setupman or Operator
4500 -4626	Subroutine # 4-1, Search Action File for Codes
4627 - 4647	Proper Assignment Tables for Press Group 1
4648 - 4660	Subroutine # 4 (Patch)
4661 - 4663	Free
4700 - 4849	Subroutine # 4-2, Find Man Running Given Press
4850 - 4854	Subroutine # 4 (Patch)
4855 - 4863	Subroutine # 4-4 (Patch)
4900 - 4918	Subroutine # 4-3, Initialize Schedule Clocks
4919 - 4921	Subroutine # 13 (Patch)
4922 - 4932	Subroutine # 3-1 (Patch)
4933 - 4942	Subroutine # 11 (Patch)
4943 - 4963	Subroutine # 4-4, Correct Accumulated Operate Time
5000 - 5060	Subroutine # 3, Time Production Finished
5061 - 5063	Free
5100 - 5612	Subroutine # 2, Store Codes
5613 - 5620	Subroutine # 12 (Patch)
5621 - 5648	Subroutine # 14 (Patch)

Location	Description
5649 - 5655	Subroutine # 4-3 (Patch)
5656 - 5663	Subroutine # 14 (Patch)
5700 - 5842	Subroutine # 1, Shift Data
5843 - 5846	Subroutine # 3-1 (Patch)
5847 - 5848	Subroutine # 1 (Patch)
5849 - 5850	Subroutine # 3-1 (Patch)
5851 - 5853	Subroutine # 13 (Patch)
5854 - 5860	Subroutine # 14 (Patch)
5861	Free
5862 - 5863	Subroutine # 14 (Patch)
5900 - 5963	Print Number, ACT I Fixed Point Output, Programmed 7/30/59
6000 - 6063	Read Number, ACT I Fixed Point Input, Programmed 7/30/59
6100 - 6131	Symbol Table
6132- 6163	Working Storage Table
6200 - 6256	Constant Table
6257 - 6263	Free
6300 - 6363	Working Storage

VIII. SUMMARY OF ERROR STOPS

Location	Subroutine Number in which Error Occurred	Page where Error is Explained
5842	1	78
5646	14	265
5533	2	89
5531	2	88
5460	2	88
5436	2	88
5207	2	88
4849	4-2	154
4754	4-2	154
3918	6-2	180
2307	11	220

IX. ELEMENTS OF ALL DISTRIBUTIONS

1. Distribution of Setup Time

Press Group 1	Press Group 2	Press Group 3
6	6	10
8	8	12
8	10	12
8	10	12
8	10	14
8	12	16
8	12	16
8	12	16
10	12	16
10	12	16
10	12	16
10	12	16
12	12	16
12	12	16
12	12	16
12	12	18
12	12	18
12	12	20
12	14	20
15	18	22

Elements of this distribution are given in simulation time units. Four simulation time units equals one hour.

2. Distribution of Inspection Times

Press Group 1	Press Group 2	Press Group 3
1	1	2
1	2	3
2	2	3
2	4	3
2	4	3
2	4	4
3	4	4
3	4	4
3	4	4
3	4	5
4	4	5
4	4	5
4	5	5
5	5	6
5	5	6
6	6	7
7	6	8
8	8	9
10	10	10
14	12	18

Elements of this distribution are given in simulation time units. Four simulation time units equals one hour.

3. Distribution of Down Time Due to Press Adjustment

Press Group 1	Press Group 2	Press Group 3
2	2	2
2	2	2
2	2	2
2	2	4
2	4	4
2	4	4
4	4	4
4	4	6
4	4	6
4	4	6
4	6	6
4	6	6
5	6	6
8	6	8
10	8	8
10	8	10
10	10	12
11	14	12
14	14	14
18	16	18

Elements in this distribution are given in simulation time units. Four simulation time units equals one hour.

4. Distribution of down time due to Press Breakdown.

Press Group 1	Press Group 2	Press Group 3
12	12	8
24	24	16
24	32	16
24	32	24
32	40	32
32	48	40
37	56	48
42	56	84
48	68	48
56	64	48
56	72	56
64	80	56
72	80	72
72	88	80
80	96	100
96	112	120
108	128	176
128	160	192
140	204	300
208	320	320

Elements in this distribution are given in simulation time units. Four simulation time units equal one hour.

5. Distribution for Maximum Production

Press Group 1	Press Group 2	Press Group 3
110	110	110
110	110	110
110	110	110
110	110	110
110	110	110
110	110	110
110	110	110
120	110	110
120	110	110
130	110	110
130	120	120
140	120	120
140	120	120
150	120	120
150	130	120
160	135	130
160	140	130
170	150	150
185	160	159

Elements of this distribution are percentages.

6. **Distribution Showing the Percentage of the Job Completed When a Die Breakdown Has Occurred.**

Press Group 1	Press Group 2	Press Group 3
0	3	0
10	15	6
10	15	10
25	15	20
25	30	20
40	30	25
50	45	30
50	45	35
60	45	50
60	60	50
70	60	60
70	68	65
70	68	70
80	80	70
80	80	80
80	80	80
90	90	80
90	90	90
90	90	90
90	90	90

Elements of this table are percentages

SUBROUTINE 1

PURPOSE To shift data in blocks of ten locations as shown below:

1. From Schedule File to Production File
2. From Action File to Production File
3. From Schedule File to Action File
4. From Production File to Action File
5. From the input record to Schedule File

CALLING SEQUENCES

1. Schedule File to Production File

   BXXXX press number

   XR5823

   XU5700

2. Action File to Production File

   BXXXX press number

   XR5823

   XU5702

3. Schedule File and Production File to Action File

   XR 5823

   XU5722

4. Input block to Schedule File

   XBXXXX location to store lst record in Schedule File

   XR5823

   XU5819

AREA USED

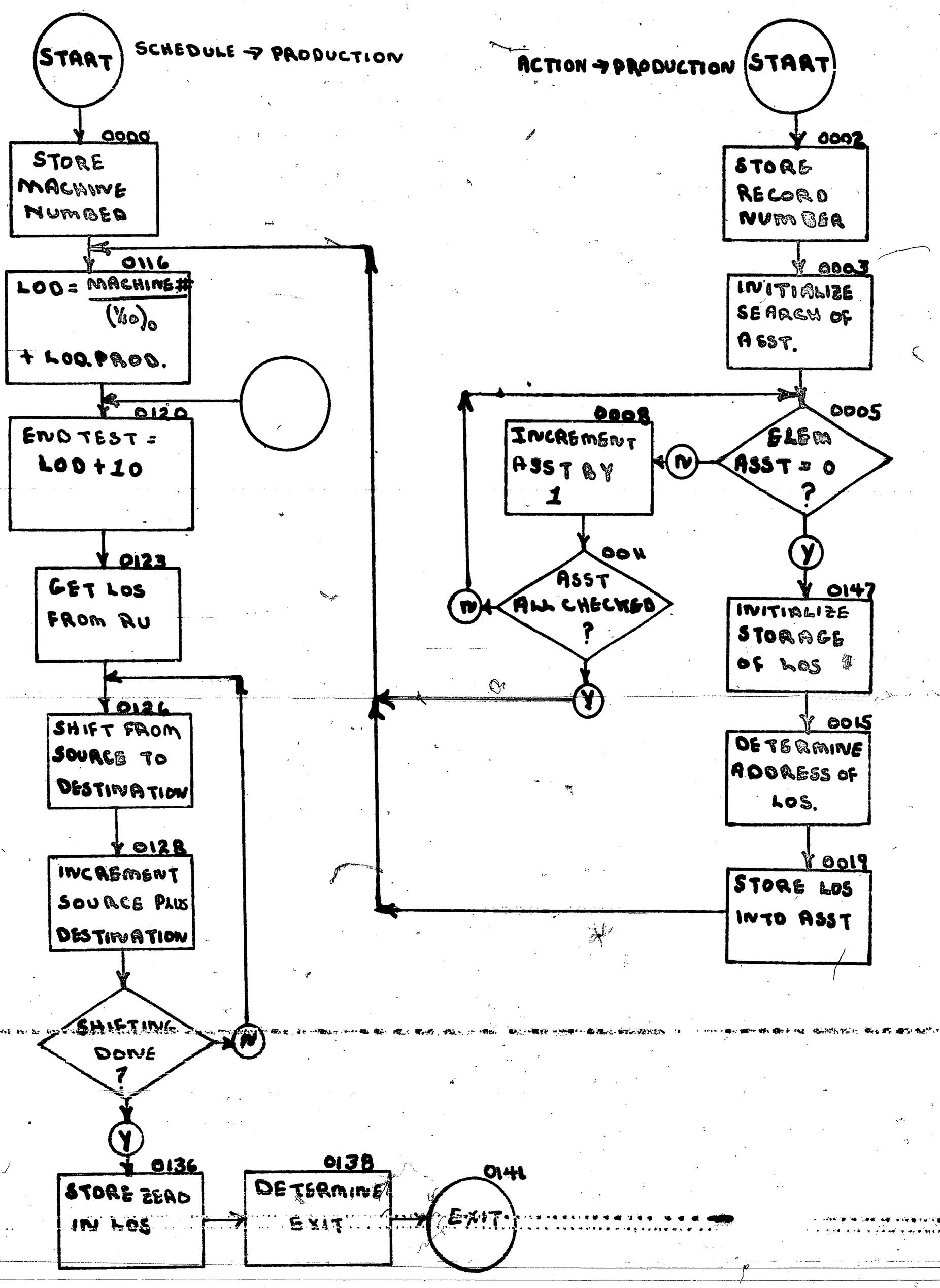
5700 to 5842

5847 to 5848

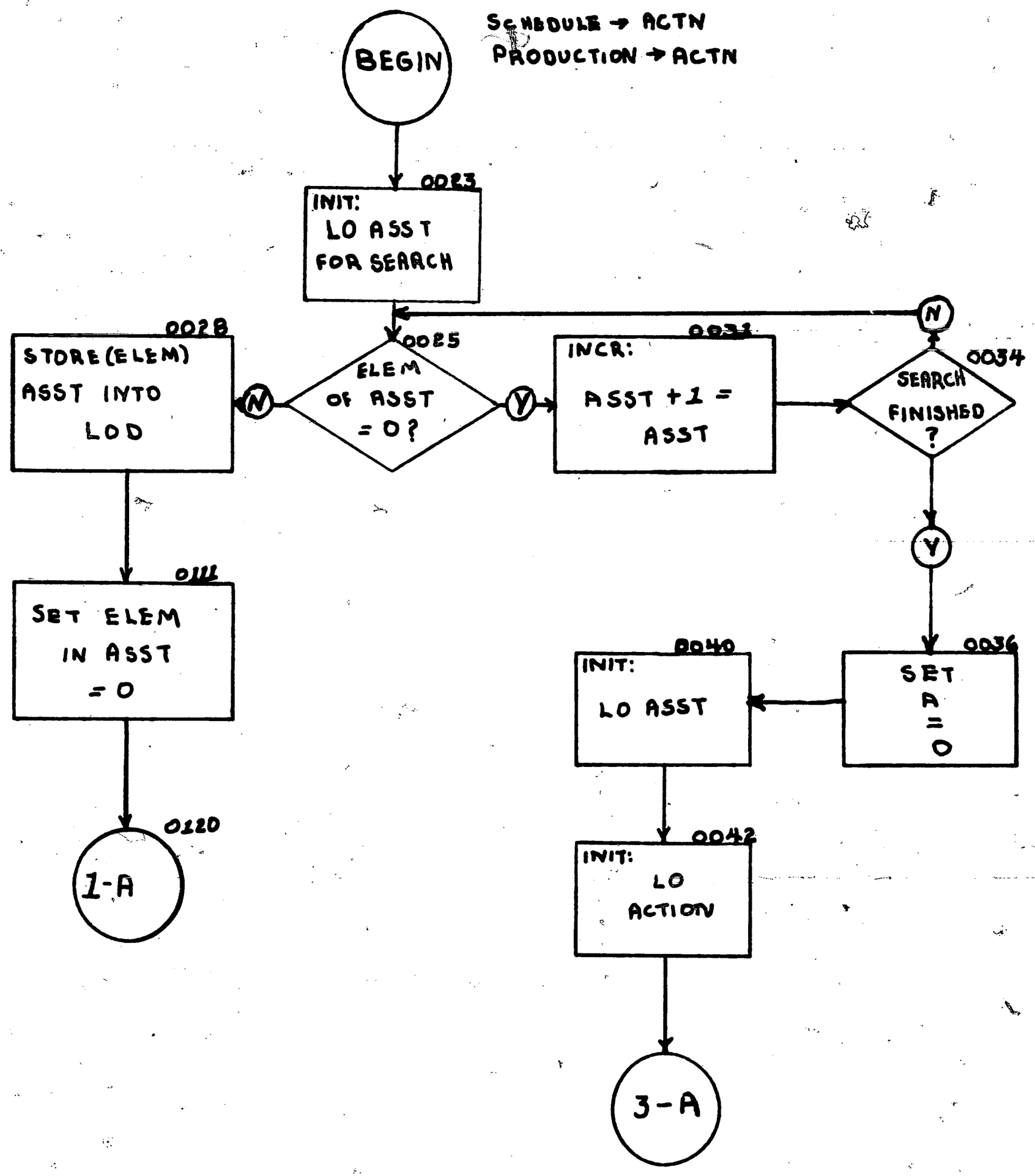
ERROR STOPS

1. 5842 The Action File is full and this record cannot be stored in the file. Depression of "Start Compute" will cause the computer to jump into another subroutine so this MUST NOT BE DONE.

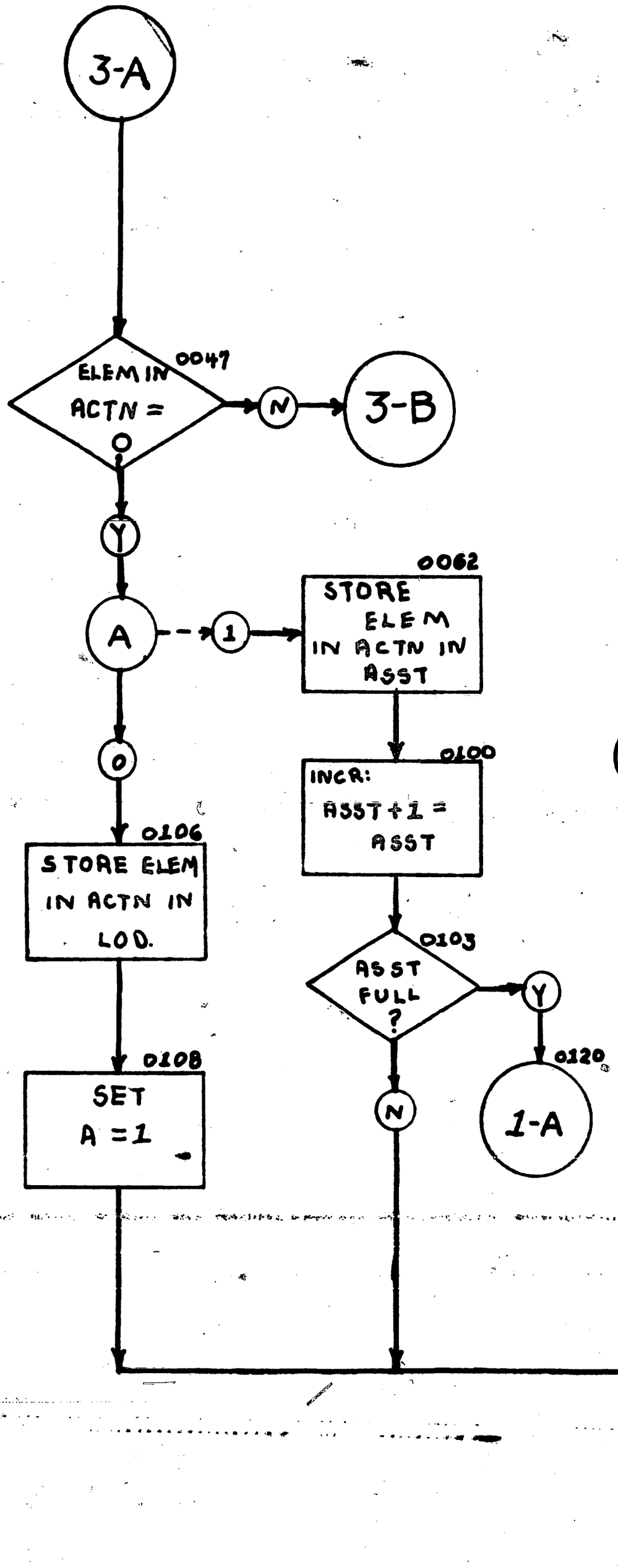
SUBROUTINE 1



SUBROUTINE 1



SUBROUTINE 1



PUNCH PRESS SIMULATION

Subroutine No. 1 **Track No. 57**

Title: Shift Data

```
0000   xh6132'    Machine No.                    Enter for SCHED to PROD
0001    u0116'    Transfer to shifter
0002   xh6132'    Machine No.                    Enter for ACTION to PROD
0003   xb6100'    Lo Assist file
0004    y0005'
0005   xb3961'    Contents of Assist
0006   xs6200'    1 at 30
0007    t0147'    Transfer if 0
0008    b0005'
0009   xa6201'    1 at 29
0010    h0005'
0011   xs6107'    B(last location + 1)
0012    t0005'    Transfer if not finished checking Action
0013    u0116'    Transfer to set LOD
0014    y0020'                                   EF  0148
0015    b0123'    B(LOS)
0016    y0019'
0017    u0019'
0018    y0019'    free
0019   xb2360'    Contents of LOS
0020   xh3961'    Action/Title Assist file
0021    u0116'    Transfer to set LOD
0022    u0023'                          Enter SCHED and PROD
0023   xb6100'     Lo Assist file           to ACTION
0024    y0025'
0025   xb3963'    Contents of Assist file
0026   xs6200'    1 at 30
0027    t0031'    Transfer if 0
0028   xa6200'    1 at 30
0029    y0127'    LOD
0030    u0111'    Transfer to set 0 in Assist file
0031    b0025'
```

PUNCH PRESS SIMULATION

Subroutine No. 1 **Track No. 57**

Title: Shift Data

```
0032   xa6201'     1 at 29
0033    h0025'
0034   xs6107'     B(last loc of Assist file)
0035    t0025'     Transfer if not finished
0036   xb6203'     0
0037    u0039'     skip
0038    z0000'     free
0039   xh6135'     Switch A
0040   xb6100'     Initial location of Assist file
0041    y0063'
0042    u0045'     skip
0043    z0000'     free
0044    z0000'     free
0045   xb6101'     Lo Action file
0046    y0047'
0047   xb0348'     Contents of Action file
0048   xs6200'     1 at 30
0049    t0059'     transfer if 0
0050    b0047'
0051   xa6204'     10 at 29
0052    h0047'
0053   xs6108'     B(last location + 1 of Action)
0054    t0047'     transfer if not done
0055   xb6135'     Switch A
0056   xs6201'     1 at 29
0057    t0142'     transfer if 0   ERROR
0058    u0120'     transfer to shifter
0059   xb6135'     Switch A
0060   xs6201'     1 at 29
0061    t0106'     transfer if 0
0062    b0047'
0063   xy4000'     variable address
```

PUNCH PRESS SIMULATION

Subroutine No. 1 Track No. 58

Title: Shift Data

```
0100    b0063'
0101    xa6201'     1 at 29
0102    h0063'
0103    xs6109'     H(last location of Assist file)
0104    t0050'      TRAnsfer if not finished
0105    u0120'      transfer to shifter
0106    b0047'
0107    y0127'      LOD
0108    xb6201'     1 at 29
0109    xh6135'     Switch A
0110    u0050'
0111    b0025'      B(location in assist)
0112    y0114'
0113    xb6203'     0
0114    xh3963'     variable address
0115    u0120'      transfer to shifter
0116    xb6132'     machine number at 29
0117    xd6205'     1/10 at 0
0118    xa6102'     Lo Production file
0119    y0127'      LOD
0120    b0127'      LOD
0121    xa6204'     10 at 29
0122    xh6300'     end test
0123    xb2109'                          R TO HERE
0124    y0126'
0125    y0137'
0126    xb0318'     LOS
0127    xh0153'     LOD
0128    b0126'
0129    xa6201'     1 at 29
0130    h0126'
0131    b0127'
```

PUNCH PRESS SIMULATION

Subroutine No. 1 **Track No. 58**

Title: Shift Data

```
0132   xa6201'      1 at 29
0133    h0127'
0134   xs6300'      H(LOD + 10)
0135    t0126'      transfer if not finished
0136   xb6203'      0
0137   xh0308'      variable address
0138    b0123'
0139   xa6201'      1 at 29
0140    y0141'
0141   xu2110'                                  EXIT
0142    z0000'      error stop
0143   xb2215'      address amt. prod           EF 4932  PATCH SUB 3-1
0144    y0149'
0145   xb6203'      0
0146    u0149'      skip
0147    b0005'                                  EF  0007  PATCH
0148    u0014'
0149   xh4900'      Amt prod so far
0150   xu2832'      Exit
0151   xb6203'      0                           Patch
0152   xh6143'      minimum clock
0153   xu1529'      Exit patch
0154   xb3541'      add. time end run     PATCH SUB 14
0155    u0156'      skip
0156    y0159'
0157   xb3562'      No time units between printouts
0158   xa6143'      minimum clock
0159   xh0000'      variable address
0160   xu3300'      Exit patch
0161   xz0000'      free
0162   xh6146'                                  EF 3949  PATCH
0163   xu1740'      Exit patch
```

SUBROUTINE 2

PURPOSE To store codes in the following files:

1. Events File
   a. Codes indicate that the press is being setup, being operated, or is free.
2. Operator File
   a. Codes indicate that the operator is free or is running machines.
3. Setupman File
   a. Codes indicate that the setupman is free, is doing a setup, or is operating presses.
4. Action File
   a. Codes indicate the reason that the record is stored in the Action File. The job was waiting for a press, an operator, or a die to be repaired.

CALLING SEQUENCES

1. Code to Events File. The press number of the press involved must be stored in location 6132.

   XR5214

   XU5209

   XZ000Y Y is the code to be stored.

2. Code to Operator File

   XBXXXX Man number involved

   XR5124

   XU5100

   XZ000Y Y is the code to be stored

3. Code to Setupman File

BXXXX	man number involved
XB5309	
XU5232	
XZ000Y	Y is the code number to be stored

4. Code to Action File

BXXXX	Initial location of the record in Action File
XR5225	
XU5220	
XZ000Y	Y is the code number to be stored

INTERNAL SUBROUTINES

1. Subroutine 2A-1

   a. Purpose: To eliminate from the Operator of Setupman Files the press number stored in location 6132, and shift any other press numbers in the record to the left to fill the gap.

   b. Calling Sequence

      R0421

      U0342

2. Subroutine 2A-2

   a. Purpose: To store in a record of the Operator or Setupman files, the press number stored in location 6132.

   b. Calling Sequence

      R0441

      U0422

AREA USED

1. Code to Operator File (Subroutine 2-A) 5100 to 5208

2.	Code to Events File	5209 to 5219
3.	Code to Action File	5220 to 5231
4.	Code to Setupman File (Subroutine 2-B)	5232 to 5441
5.	Subroutine 2A-1	5442 to 5521
6.	Subroutine 2A-2	5522 to 5541
7.	Patches from "Code to Events"	5542 to 5612

ERROR STOPS

1. 5207 The code in the record of the Operator File or the code to be stored in the Operator File is not correct. Depression of "Start Compute" will cause the next instruction, XU0000,to be executed.

2. 5436 The code in the record of the Setupman File or the code to be stored in the Setupman File is not correct. Depression of "Start Compute" will cause the next instruction, XU0000, to be executed.

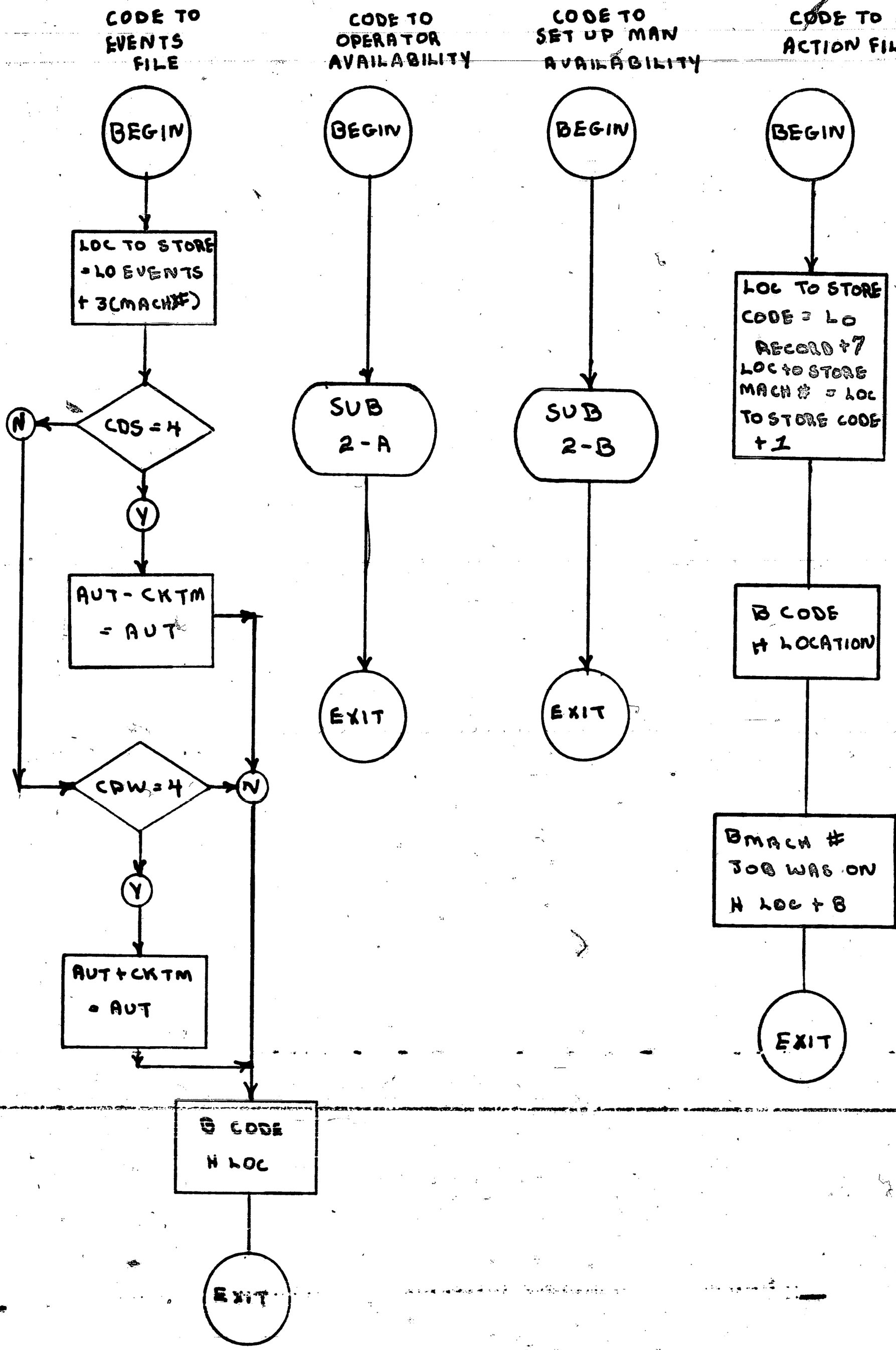
3. 5460 The press to be removed from either the Setupman or the Operator Files was not assigned to the given operator or setupman. Depression of "Start Compute" will cause the computer to stop again. The next depression will cause the computer to enter another subroutine. THIS MUST NOT BE DONE

4. 5531 The operator or setupman assigned to operate the given job is already operating three jobs. Depression of "Start Compute" will cause the computer to execute a "stop" instruction for the next three depressions. The fourth depression will cause the computer to exit from the subroutine with the contents of the element

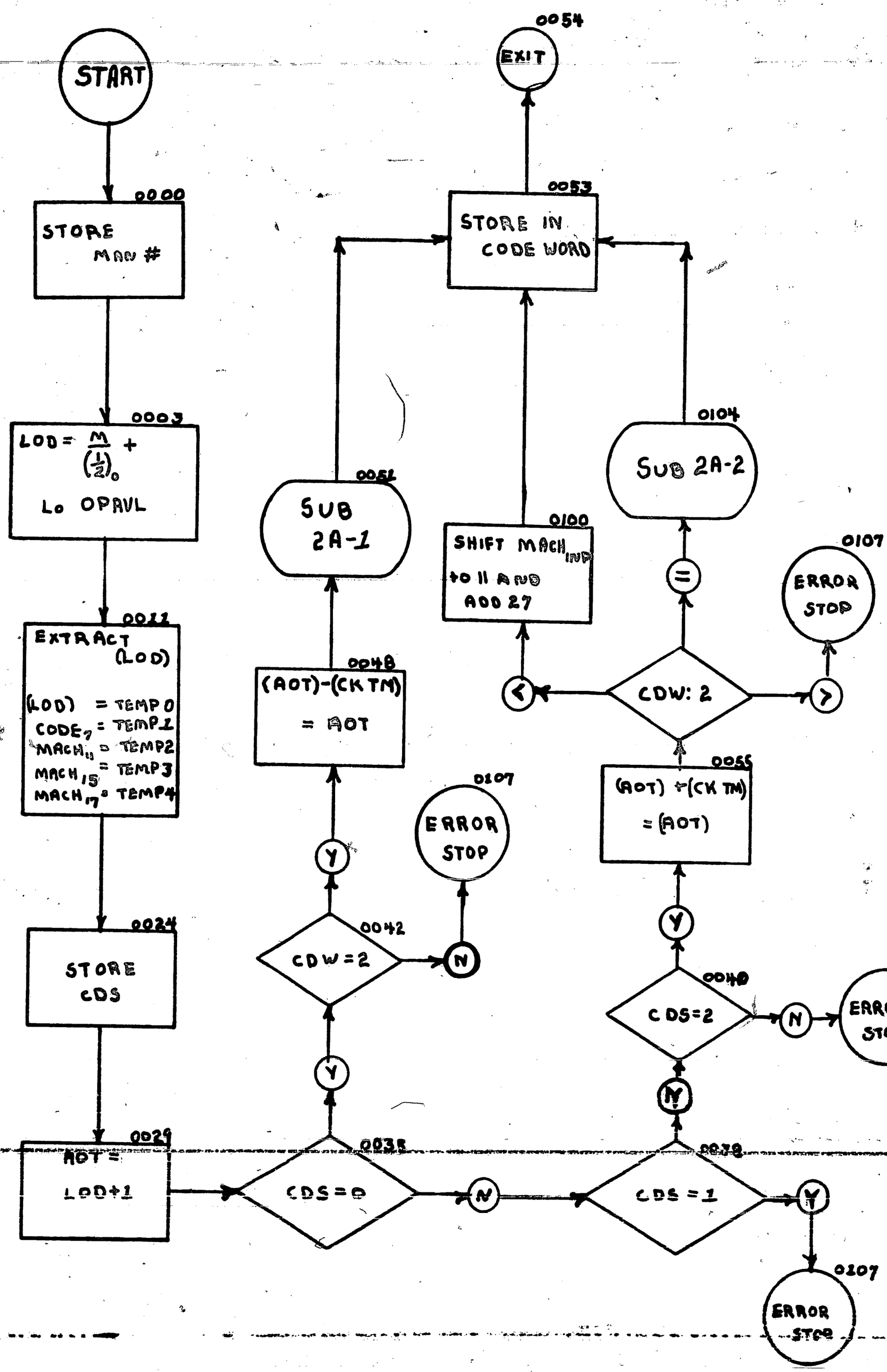
of the record showing the previous press assignments plus the new press at a "q" of 15.

5. 5533 The operator or setupman being checked is not operating any presses and the code for the man indicates that he should be operating at least one job. The results of depressing the "Start Compute" are the same as shown above (4), but the routine will exit after two depressions of the button.

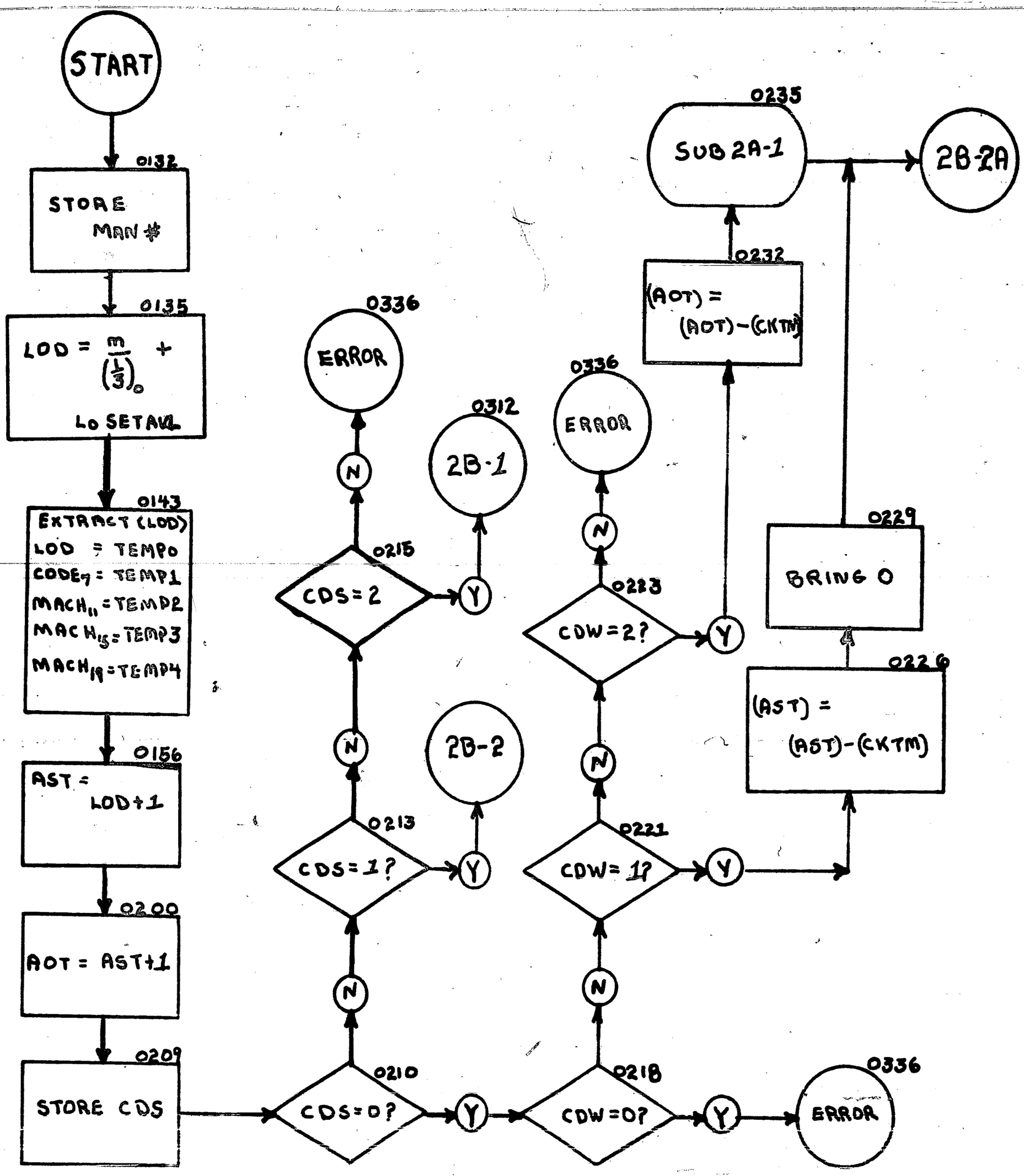
SUBROUTINE E



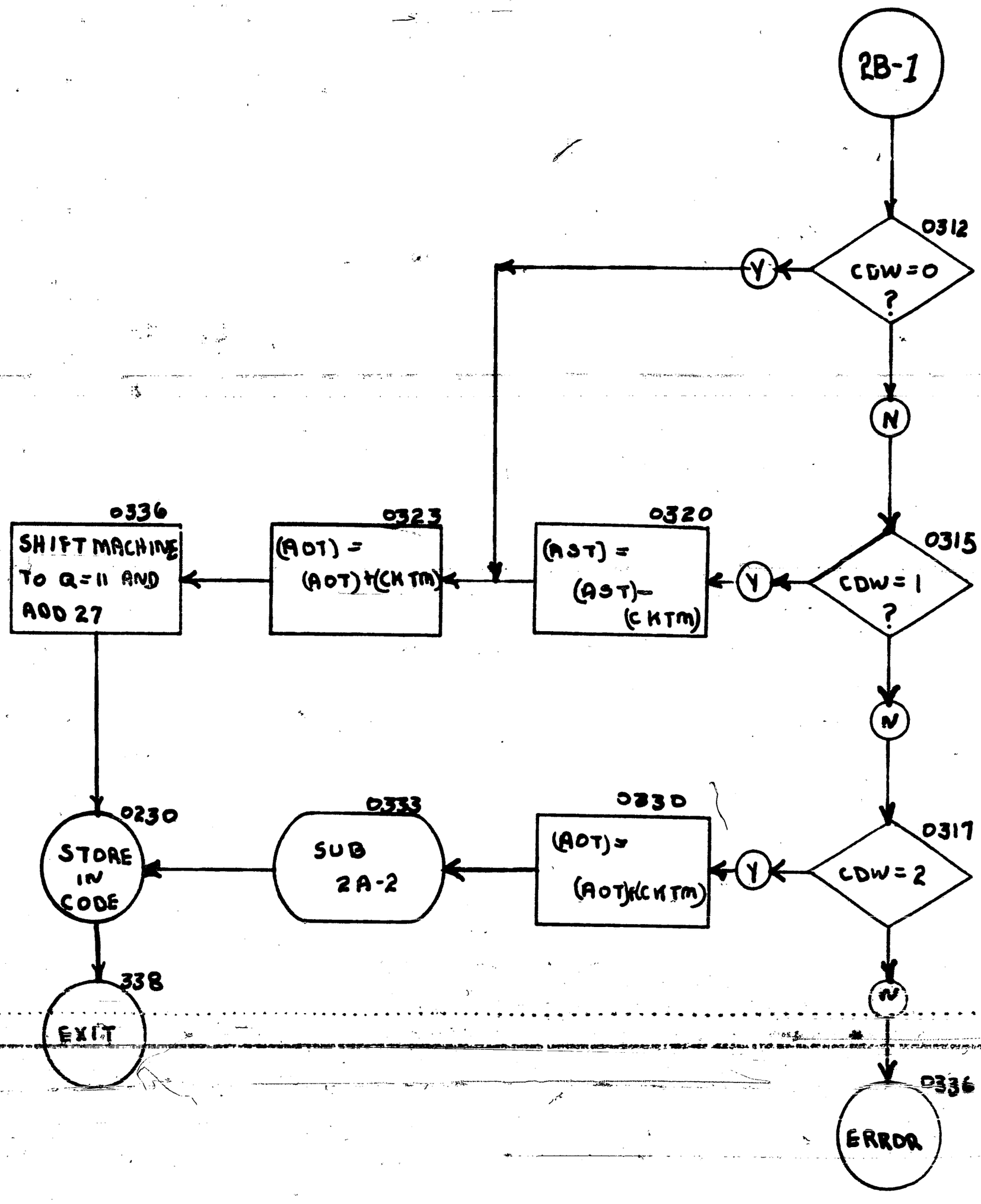
SUBROUTINE 2A



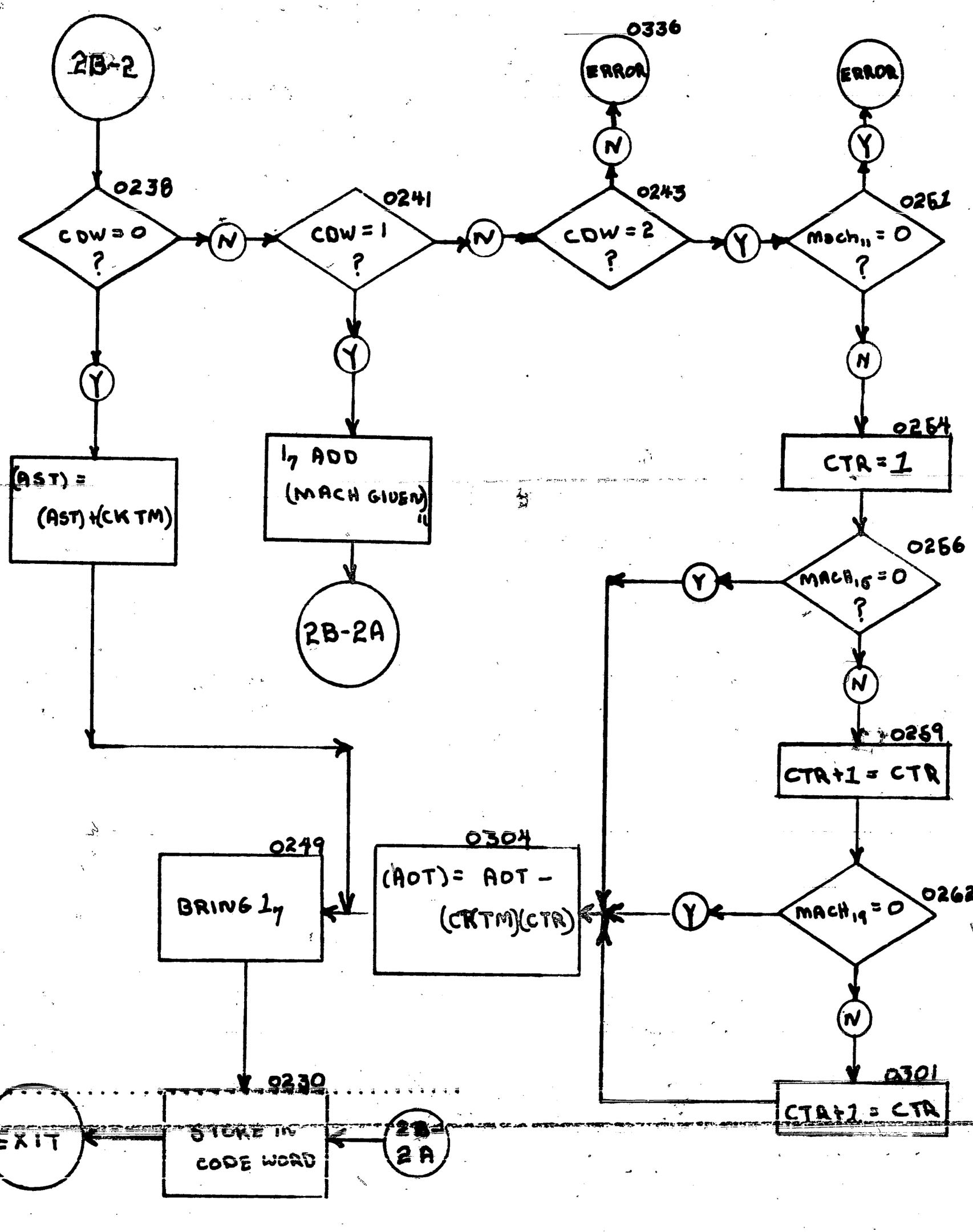
SUBROUTINE 2B



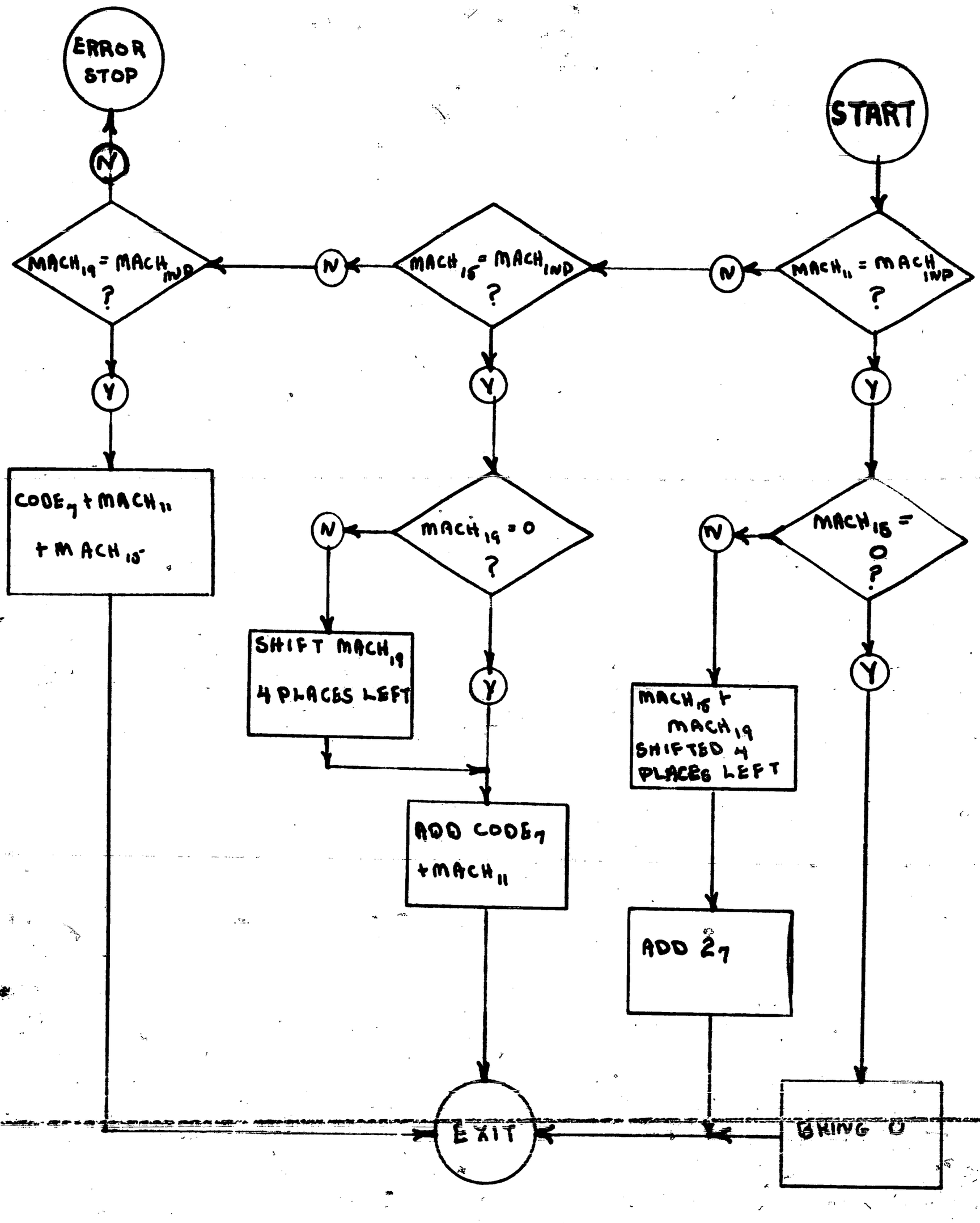
SUBROUTINE 2B



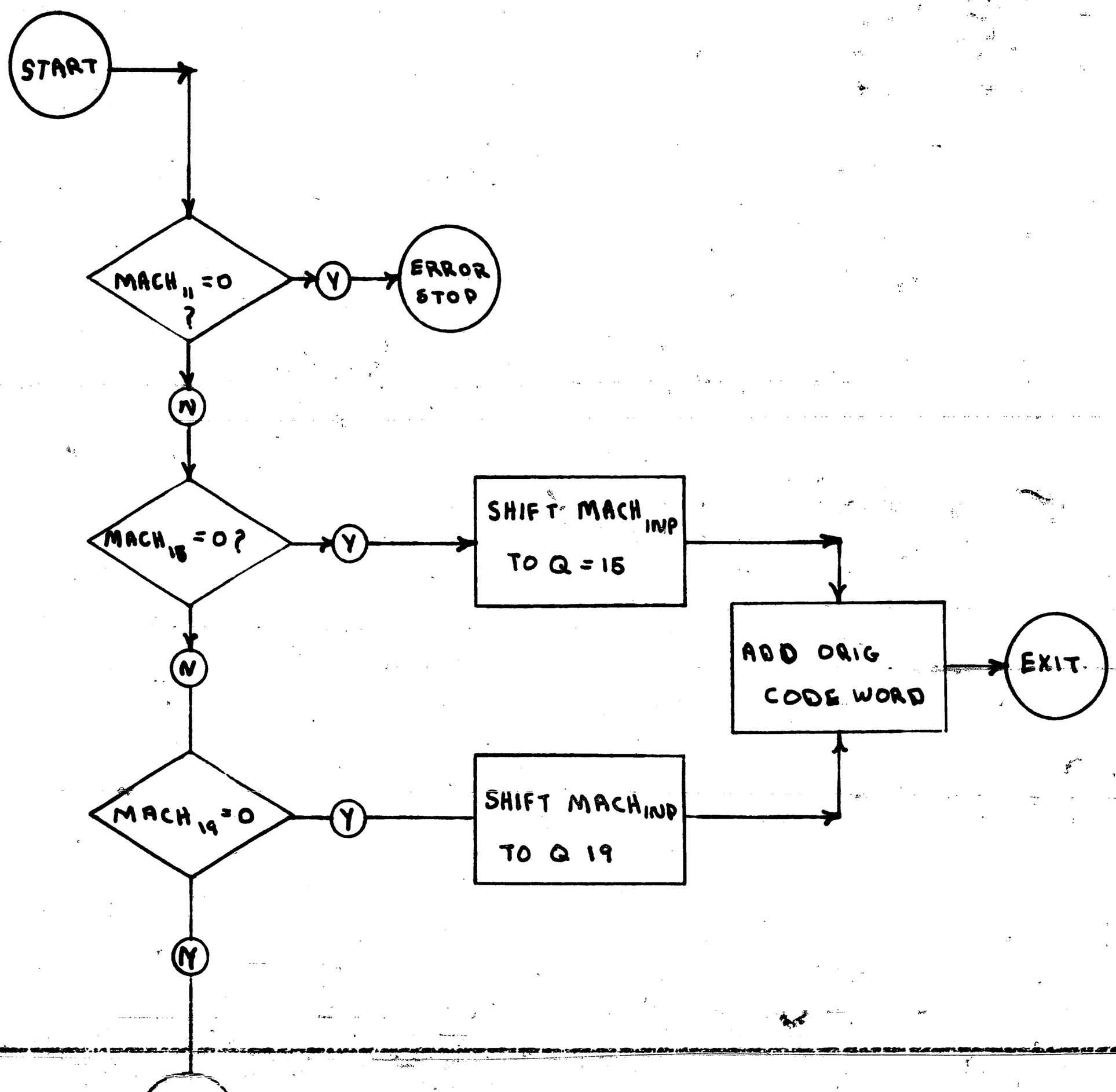
SUBROUTINE 2B



SUBROUTINE 2A-1



SUBROUTINE 2A-2



Subroutine No. 2 Track No. 51

Title: Store Codes

0000	xh6136'	man number	ENTER
0001	u0003'	skip	
0002	xm6212'	free	
0003	xh6137'	man number	
0004	xd6213'	1/2 at 0	
0005	xa6123'	Lo Operator Avail. - 2	
0006	y0011'		
0007	y0015'		
0008	y0018'		
0009	y0021'		
0010	y0053'		
0011	xb0209'	variable address	
0012	xh6138'	temp 0	entire code word
0013	xe6214'	w000000	
0014	xh6139'	temp 1	code at 7
0015	xb0209'	variable address	
0016	xe6215'	w00000	
0017	xh6140'	temp 2	machine at 11
0018	xb0209'	variable address	
0019	xe6216'	w0000	
0020	xh6141'	temp 3	machine at 15
0021	xb0209'	variable address	
0022	xe6217'	w000	
0023	xh6142'	temp 4	machine at 19
0024	xb2409'	variable address	R TO HERE
0025	xh6300'	CDS	
0026	b0024'		
0027	xa6201'	1 at 29	
0028	y0054'	exit	
0029	b0011'	B(location of code word)	
0030	xa6201'	1 at 29	
0031	y0048'		Address of accumulated operate time

PUNCH PRESS SIMULATION

Subroutine No. 2 Track No. 51

Title: Store Codes

```
0032    y0050'
0033    y0055'
0034    y0057'
0035    xb6300'    CDS
0036    xs6201'    1 at 29
0037     t0443'    transfer if CDS is 0
0038    xs6201'    1 at 29
0039     t0107'    transfer if CDS is 1   ERROR
0040    xs6201'    1 at 29
0041     t0055'    transfer if CDS is 2
0042     u0442'    error
0043    xs6210'    2 at 7
0044     t0107'    transfer if CDW ####d less 2
0045    xs6218'    1 at 7
0046     t0048'    transfer if CDW is 2
0047     u0107'    transfer if CDW GREATER than 2  ERROR
0048    xb0210'    AOT
0049    xs6143'    current clock
0050    xh0210'    AOT
0051     r0421'    eliminate mach. no.  Sub 2A-1
0052     u0342'
0053    xh0209'    EXIT location of code word
0054    xu2410'    EXIT
0055    xb0210'    AOT
0056    xa6143'    current clock
0057    xh0210'    AOT
0058    xb6139'    temp 1
0059    xs6210'    2 at 7
0060     t0100'    transfer if CDW less 2
0061    xs6218'    1 at 7
0062     t0104'    transfer if CDW = 2
0063     u0107'    transfer if CDW greater 2   ERROR
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 52**

Title: Store Codes

```
0100   xb6132'      machine number
0101   xm6219'      1 at 13   machine number shifted to 11
0102   xa6210'      2 at 7
0103    u0053'      transfer to store code
0104    r0441'      store code                Sub 2A-2
0105    u0422'
0106    u0053'      transfer to exit
0107   xz0400'      error stop  code input or code stored
0108   xu0000'                      not correct
0109   xb6132'      machine no.                ENTER TO STORE CODE IN
0110   xd6223'      1/3 at 0                         EVENTS
0111   xa6106'      Lo Events
0112    y0115'
0113    u0453'      transfer to patch
0114   xb2158'      code word
0115   xh0000'      CDW
0116    b0114'
0117   xa6201'      1 at 29
0118    y0131'      exit
0119    u0131'      transfer to exit
0120   xh6144'      Lo of record in Action     ENTER TO STORE CODE
0121   xa6229'      7 at 29                      IN ACTION
0122    y0127'
0123   xa6201'      1 at 29
0124    y0129'
0125   xb2756'      CDS
0126    u0127'      SKIP
0127   xh0355'      variable address
0128   xb6132'      machine number
0129   xh0356'      variable address
0130    u0445'      transfer to patch
0131   xu2159'      EXIT
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 52**

Title: Store Codes

```
0132   xh6136'     man number              ENTER TO STORE CODE IN
0133    u0135'     skip                     SETUPMAN AVAILABILITY
0134   xm6222'     free
0135   xh6137'     man number
0136   xd6223'     1/3 at 0
0137   xa6124'     Lo Setupman Availability
0138    y0143'
0139    y0147'
0140    y0150'
0141    y0153'
0142    y0230'
0143   xb0220'     code word for man
0144   xh6138'     temp 0                  store entire word
0145   xe6214'     w000000
0146   xh6139'     temp 1                  code at 7
0147   xb0220'
0148   xe6215'     w00000
0149   xh6140'     temp 2                  machine at 11
0150   xb0220'
0151   xe6216'     w0000
0152   xh6141'     temp 3                  machine at 15
0153   xb0220'
0154   xe6217'     w000
0155   xh6142'     temp 4                  machine at 19
0156    b0143'
0157   xa6201'     1 at 29
0158    y0226'     AST                     loc. of accum. setup
0159    y0228'                                  time
0160    y0246'
0161    y0248'
0162    y0320'
0163    y0322'
```

PUNCH PRESS SIMULATION

Subroutine No. 2 Track No. 53

Title: Store Codes

```
0200   xa6201'      1 at 29
0201    y0232'      AOT                    loc. of accum. operate
0202    y0234'                                 time
0203    y0308'
0204    y0310'
0205    y0323'
0206    y0325'
0207    y0330'
0208    y0332'
0209   xb2100'                          R TO HERE
0210   xh6300'      CDS
0211   xs6201'      1 at 29
0212    t0218'      transfer if CDS equals 0
0213   xs6201'      1 at 29
0214    t0238'      transfer if CDS is 1
0215   xs6201'      1 at 29
0216    t0312'      transfer if CDS is 2
0217    u0336'      transfer if CDS greater 2    ERROR
0218   xb6139'      temp 1   CDW          HERE IF CDW IS 0
0219   xs6218'      1 at 7
0220    t0336'      transfer if CDW is 0   ERROR
0221   xs6218'      1 at 7
0222    t0226'      transfer if CDW is 1
0223   xs6218'      1 at 7
0224    t0232'      transfer if CDW is 2
0225    u0336'      transfer if CDW is greater 2    ERROR
0226   xb0221'      AST                    HERE IF CDS=0,CDW=1
0227   xs6143'      current minimum clock
0228   xh0221'      AST
0229   xb6203'      0
0230   xh0220'      location of code
0231    u0338'      transfer to exit
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 53**

Title: Store Codes

```
0232   xb0222'     AOT                          CDS=0,CDW=2
0233   xs6143'     current clock
0234   xh0222'     AOT
0235    r0421'     eliminate mach no.    Sub 2A-1
0236    u0342'
0237    u0230'     transfer to store code
0238   xb6139'     CDW                          CDS=1
0239   xs6218'     1 at 7
0240    t0246'     transfer if CDW = 0
0241   xs6218'     1 at 7
0242    t0449'     transfer if CDW = 1
0243   xs6218'     1 at 7
0244    t0251'     transfer if CDW = 2
0245    u0336'     transfer if CDW greater 2    ERROR
0246   xb0221'     AST                          CDS=1,CDW=0
0247   xa6143'     current clock
0248   xh0221'     AST
0249   xb6218'     1 at 7
0250    u0449'     transfer to store code
0251   xb6140'     temp 2  mach at 11   CDS=1, CDW=2
0252   xs6224'     1 at 11
0253    t0336'     transfer if mach. = 0    ERROR
0254   xb6225'     1 at 3
0255   xh6300'     counter
0256   xb6141'     temp 3   mach at 15
0257   xs6226'     1 at 15
0258    t0304'     transfer if mach at 15 = 0
0259   xb6300'     counter
0260   xa6225'     1 at 3
0261   xh6300'     counter
0262   xb6142'     temp 4    mach. at 19
0263   xs6227'     1 at 19
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 54**

Title: Store Codes

```
0300    t0304'      transfer if mach at 19 = 0
0301   xb6300'      counter
0302   xa6225'      1 at 3
0303   xh6300'      counter
0304   xb6143'      current clock
0305   xn6211'      1 at 28
0306   xm6300'      counter at 3
0307   xh6300'      counter
0308   xb0222'      AOT
0309   xs6300'      counter
0310   xh0222'      AOT
0311    u0246'      transfer to update AST
0312   xb6139'      temp 1  code at 7    CDS=2
0313   xs6218'      1 at 7
0314    t0323'      transfer if CDW=0
0315   xs6218'      1 at 7
0316    t0320'      transfer if CDW=1
0317   xs6218'      1 at 7
0318    t0330'      transfer if CDW=2
0319    u0336'      transfer if CDW greater than 2    ERROR
0320   xb0221'      AST
0321   xs6143'      currrent clock
0322   xh0221'      AST
0323   xb0222'      AOT
0324   xa6143'      current clock
0325   xh0222'      AOT
0326   xb6132'      machine at 29
0327   xn6219'      1 at 13
0328   xa6210'      2 at 7
0329    u0230'      transfer to store  code
0330   xb0222'      AOT                          CDS=2,CDW=2
0331   xa6143'      current clock
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 54**

Title: Store Codes

```
0332   ~~x0000'~~ hzzzz'      AOT
0333   ~~x4004'~~ r0441'      STORE mach no. in file      Sub 2A-2
0334   ~~x6147'~~ u0422'
0335   ~~x4003'~~ u0230'      transfer to store code
0336   xz0800'          error stop   code input or code stored not
0337   xu0000'                                correct
0338    b0209'
0339   xm6201'      1 at 29
0340    y0341'
0341   xu2101'      EXIT]                                          -
0342   xb6140'      temp 2  mach at 11     START SUB 2A-1
0343   xm6206'      1 at 18
0344   xs6132'      mach no. input
0345    t0348'      transfer if not equal
0346   xs6201'      1 at 29
0347    t0362'      transfer if equal
0348   xb6141'      temp 3 mach at 15
0349   xm6207'      m at 14
0350   xs6132'      mac h no. input
0351    t0354'      transfer if not equal
0352   xs6201'      1 at 29
0353    t0408'      transfer if equal
0354   xb6142'      temp 4 mach no. at 19
0355   xm6208'      1 at 10
0356   xs6132'      mach no. input
0357    t0360'      transfer if not equal
0358   xs6201'      1 at 29
0359    t0418'      transfer if equal
0360   xz0000'      ERROR STOP  mach to be eliminated not in file
0361    z0342'      free
0362   xb6141'      mach at 15              mach at 11 = mach input
0363   xs6201'      1 at 29
                    ~~transfer if not equal~~
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 55**

Title: Store Codes

```
6800    t0406'    transfer if mach at 15 = 0
0401    xb6141'   mach at 15
0402    xa6142'   mach at 19
0403    xn6209'   1 at 27
0404    xa6210'   2 at 7
0405     u0421'   transfer to exit
0406    xb6203'   0
0407     u0421'   transfer to exit
0408    xb6142'   mach at 19                    mach at 15 = mach input
0409    xs6201'   1 at 29
0410     t0416'   transfer if 0
0411    xb6142'   mach at 19
0412    xn6209'   1 at 27
0413    xa6139'   code word at 7
0414    xa6140'   mach at 11
0415     u0421'   transfer to exit
0416    xb6139'   temp 1,code at 7
0417     u0414'
0418    xb6139'   temp 1 code at 7              mach at 19 = mach input
0419    xa6140'   mach at 11
0420    xa6141'   mach at 1ø5
0421     u0053'   EXIT
0422    xb6140'   temp 2 mach at 11     START SUB 2A-2
0423    xs6201'   1 at 29
0424     t0433'   transfer if mach at 11 = 0
0425    xb6141'   temp 3 mach at 15
0426    xs6201'   1 at 29
0427     t0435'   transfer if mach at 15 = 0
0428    xb6142'   temp 4 mach at 19
0429    xs6201'   1 at 29
0430     t0438'   transfer if mach at 19 = 0
0431    xz1600'   ERROR STOP   attempting to operate 4 machines
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 55**

Title: Store Codes

```
0432    z0342'   free
0433    xz3200'  ERROR STOP  man operating no presses and CDW=2
0434     z0342'  free
0435    xb6132'  mach input at 29
0436    xn6220'  1 at 17
0437     u0440'  transfer to exit
0438    xb6132'  mach input at 29
0439    xn6221'  1 at 21
0440    xa6138'  temp 0 complete code word
0441     u0106'  EXIT
0442     u0107'  transfer if error      EF  0042
0443    xb6139'  temp 1    code at 7
0444     u0043'
0445     b0125'                         EF  0130
0446    xa6201'  1 at 29
0447     y0131'
0448     u0131'  transfer to exit
0449    xb6132'    machine input at 29    EF  0242
0450    xd6206'    1 at 18
0451    xa6218'    1 at 7
0452     u0230'    transfer to store code and exit
0453     y0502'                           EF  0113
0454    xa6211'    2 at 29
0455     y0462'
0456     y0500'
0457    xb2158'    CDS
0458    xs6209'    4 at 29
0459     t0502'    transfer if ∅CDS LESS 4
0460     b0511'    S(minimum clock)
0461     h0463'
0462    xb0002'    AUT
0463    xs6143'    S or A  (minimum clock)
```

Subroutine No. 2

Track No. 56

Title: Store Codes

```
0500   xh0002'    AUT
0501    u0508'
0502   xb0000'    CDW
0503   xs6209'    4 at 29
0504    t0508'    transfer if CDW less 4
0505    b0512'    A(minimum clock)
0506    h0463'
0507    u0462'
0508    b0457'    address of CDS
0509    y0114'
0510    u0114'    exit to store code
0511   xs6143'    constant
0512   xa6143'    constnat
0513   xb1905'    loc of max prod     PATCH   SUB 12
0514    y0515'
0515   xb0029'    max production
0516   xs6201'    1 at 29
0517    t0519'    transfer if max prod not setup
0518   xu2112'    transfer if max prod setup
0519   xb6149'    machine number
0520   xu1844'    exit
0521   xb6103'    Lo schedule file    PATCH   SUB  14    EF  3426
0522    y0524'
0523   xb6203'    0
0524   xh0942'    element of schedule file
0525    b0524'
0526   xa6201'    1 at 29
0527    h0524'
0528   xs6130'    H(last loc Sched file + 1)
0529    t0523'    trnasfer if not finished
0530   xu1544'    transfer if finished
0531   xb6101'    Lo Action           PATCH   SUB 14    EF   1822
```

PUNCH PRESS SIMULATION

Subroutine No. 2 **Track No. 56**

Title: Store Codes

```
0532    y0534'
0533    u0534'      skip
0534    xb0752'     lst location of record
0535    xs6201'     1 at 29
0536     t0540'     transfer if 0
0537     b0534'
0538    xr2220'     print contents of location
0539    xu2202'
0540     b0534'
0541    xa6204'     1 at 29
0542     h0534'
0543     u0544'     skip
0544    xs6115'     B(last location of Action file + 1)
0545     t0534'     transfer if not finished
0546    xz1600'     BP stop for completion of printout
0547    xu5854'     transfer to initialize for next run
0548    xu1518'     transfer to initialize for new run
0549    xh4906'                          PATCH SUB 4-3  EF 4918
0550    xs6127'     B(last loc of sched. file + 1)
0551    xt4906'     transfer if not finished
0552    xu4900'     EXIT
0553    xb6239'     large + no.
0554    xh4900'     2nd element of schedule clock record
0555    xu4909'     exit
0556    xb6143'     current clock        PATCH SUB 14  ef 1823
0557    xd6213'     1/2 at 0
0558     u0560'
0559    xb6143'     current clock        EF 1821
0560    xh6363'     temp 1
0561    xu3450'
0562    xb6203'     0                    EF  1819
0563     u0560'
```

SUBROUTINE 3

PURPOSE To calculate the time when it is estimated production will be completed.

CALLING SEQUENCE

1. The calculation is based on the maximum amount to be produced.

   BXXXX press number

   XR5048

   XU5000

2. The calculation is based on the ordered amount to be produced.

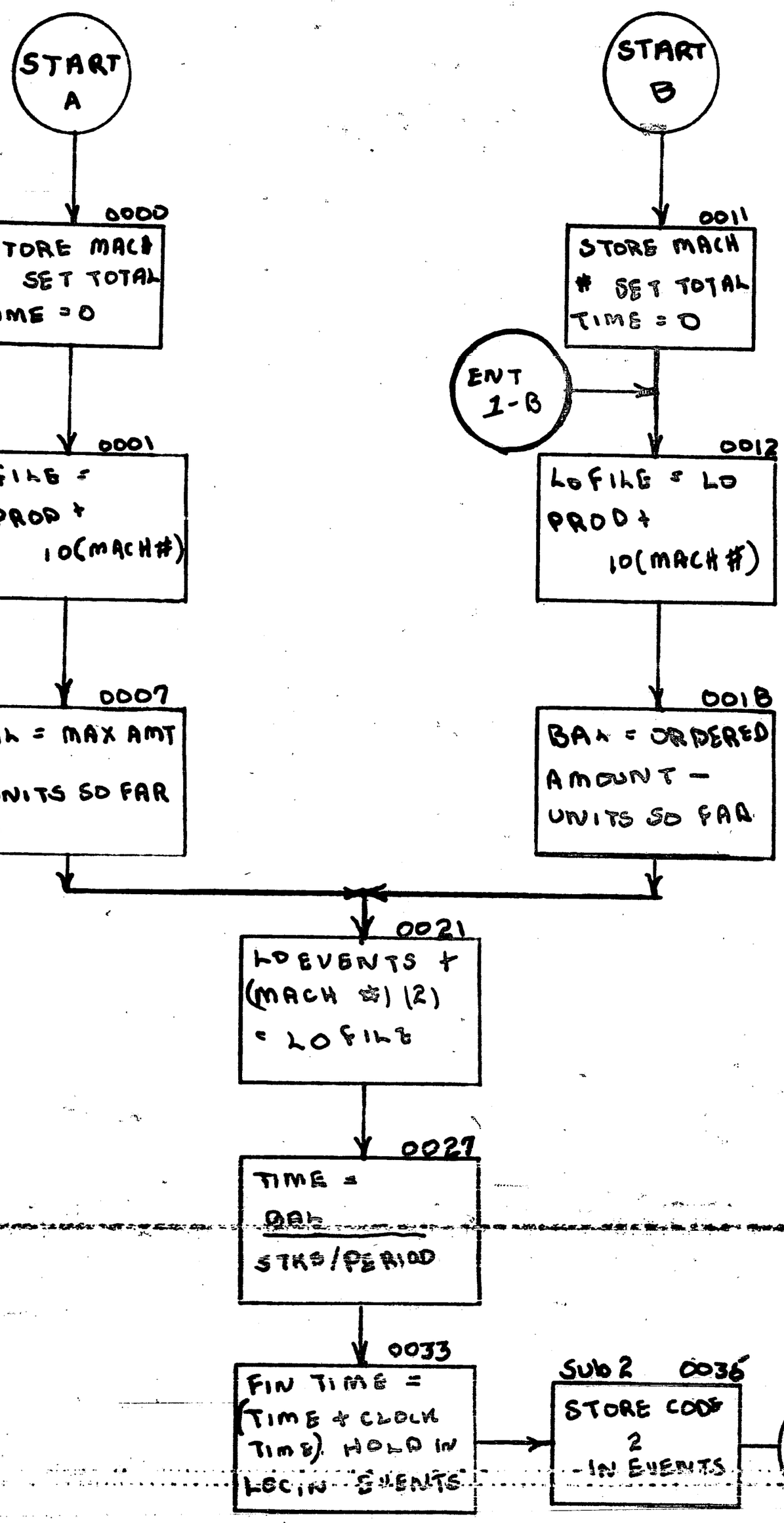
   BXXXX press number

   XR5048

   XU5011

AREA USED 5000 to 5060

SUBROUTINE 3



PUNCH PRESS SIMULATION

Subroutine No. 3 Track No. 50

Title: Time Production Finished

```
0000    u0049'                          ENTRANCE A
0001    xd6205'     1/10 at 0       -
0002    xa6102'     Lo Production - 10
0003    xa6211'     2 at 29
0004     y0009'
0005    xa6209'     4 at 29
0006     y0010'
0007    xa6201'     1 at 29
0008     y0044'
0009    xb0059'     max amount
0010    xs0063'     units produced so far
0011    xh6145'
0012     u0025'
0013     u0053'                         ENTRANCE B
0014    xd6205'     1/10 at 0       -
0015    xa6102'     Lo PROduction - 10
0016    xa6201'     1 at 29
0017     y0022'
0018    xa6202'     5 at 29
0019     y0023'
0020    xa6201'     1 at 29
0021     y0044'
0022    xb0114'     units ordered
0023    xs0119'     units produced so far
0024    xh6145'     balance to produce
0025    xb6132'     mach. no.
0026    xd6223'     1/3 at 0        -
0027    xa6106'     Lo Events - 3
0028     u0029'     skip
0029    xa6201'     1 at 29
0030     y0041'
0031    xb6110'     Lo strokes per ##### time period
```

PUNCH PRESS SIMULATION

Subroutine No. 3 Track No. 50

Title: Time Production Finished

```
                0032    xa6132'         mach no.
                0033     y0035'
                0034    xb6145'         balance to ~~run~~ make
                0035    xd3528'         strokes per time period at 16
                0036    xa6219'         1 at 13                 round up by 1/2
                0037    xm6220'         1 at 17
                0038    xd6213'         1 at 1
                0039    xa6143'         clock time
                0040    xa6152'         adjustment time
                0041    xh0016'         location of clock in events
                0042    xb6143'         clock time
                0043    xa6152'         adjustment time
                0044    xh0120'         start time in production
                0045    xr5557'         store code 2 in EVENTS    Sub 2
                0046    xu5209'
                0047    xz0002'
                0048    xu2413'         EXIT
                0049    xh6132'         mach no.
                0050    xb6203'         0
                0051    xh6152'         adjustment time
                0052     u0059'
                0053    xh6132'         mach no.
                0054    xb6203'         0
                0055    xh6152'         adjustment time
                0056     u0057'
                0057    xb6132'         mach no.
                0058     u0014'
                0059    xb6132'         mach no.
                0060     u0001'
,0000001'       0061 00086j84'          free
                0062     z0034'         free
                0063     u0032'         free
```

SUBROUTINE 3-1

PURPOSE To determine whether a die adjustment will be required or whether a die breakdown will occur while a press is operating. If a die adjustment occurs the time that the press will be down for adjustment is selected and the beginning and finish time for the job is adjusted accordingly. If a die breakage occurs, the following actions will take place: The time the press goes down and the amount of production completed before the breakdown are selected. The job on the press is moved to the Action File and a Special Clock is setup to control when the job can come back into production. The Events File is adjusted to indicate that the press is free.

CALLING SEQUENCE

XB 6132 press number

XR5048

XU2800

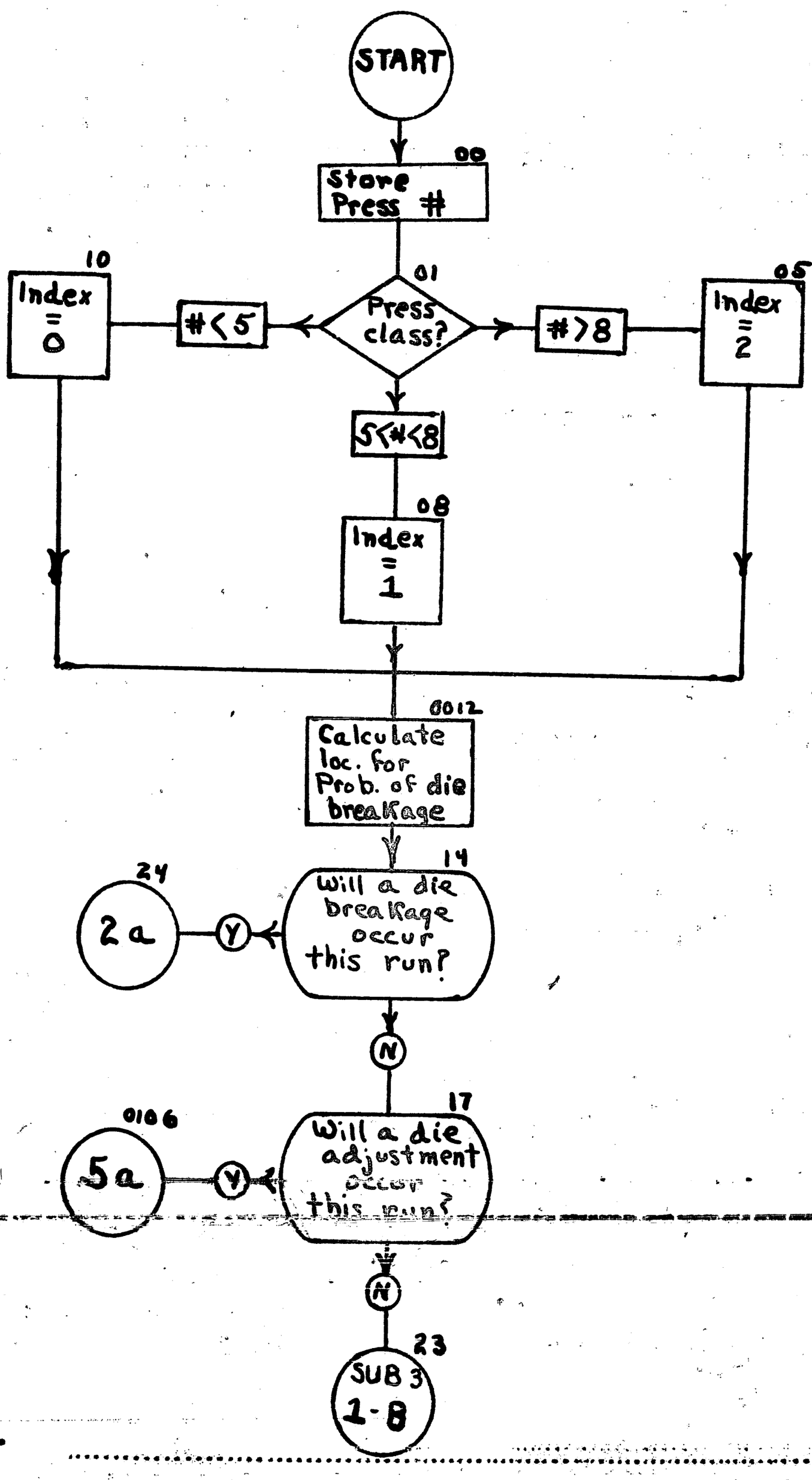
SUBROUTINES USED

1. Subroutine 1 Shift Data
2. Subroutine 2 Store Codes
3. Subroutine 3 Time Production Finished
4. Subroutine 4-2 Find Run Running a given Machine
5. Subroutine 5 Sample Distribution or Test Probability
6. Subroutine 8 Calculate Units Produced
7. Subroutine 12a Print Results

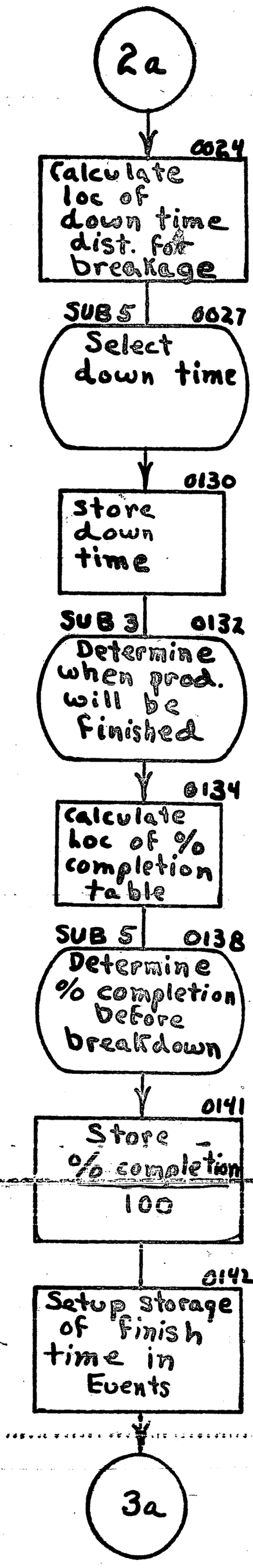
AREA USED

2800	to 2913	2932	to 2959
4922	to 4932	5843	to 5850

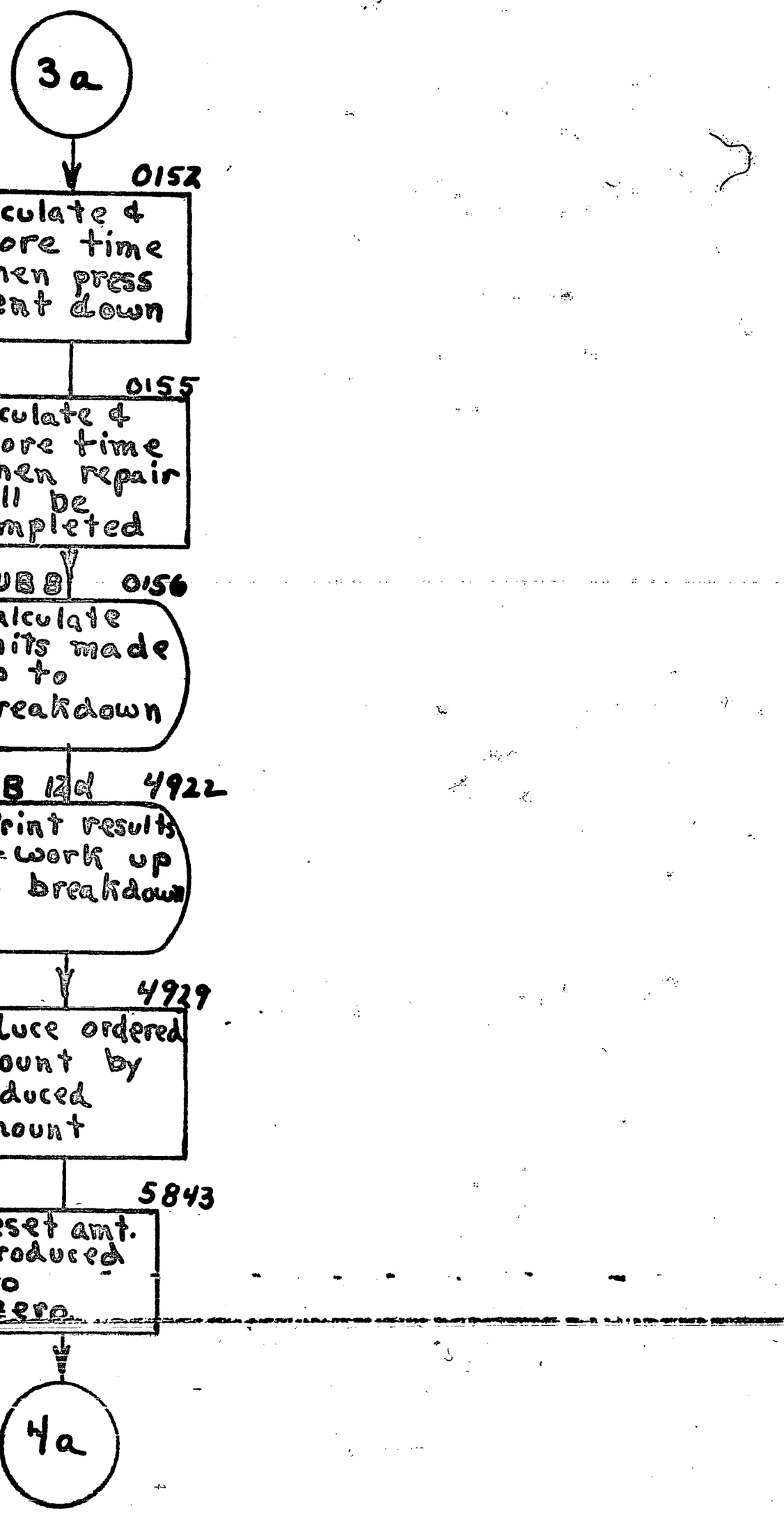
SUBROUTINE 3-1



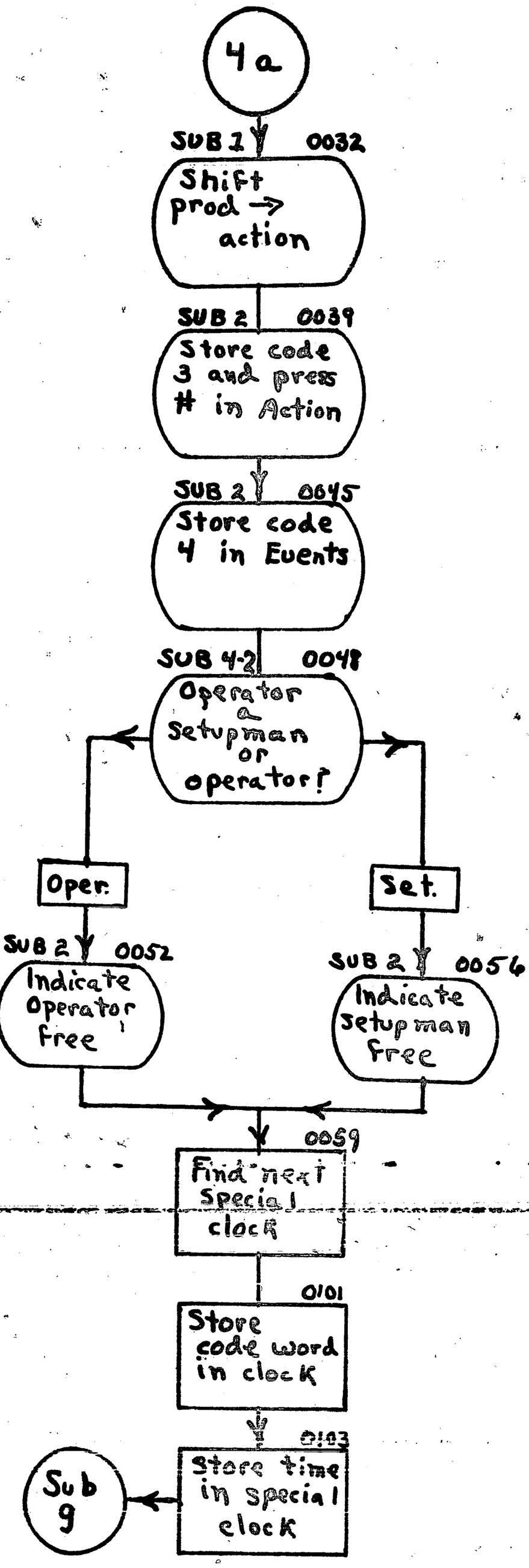
SUBROUTINE 3-1



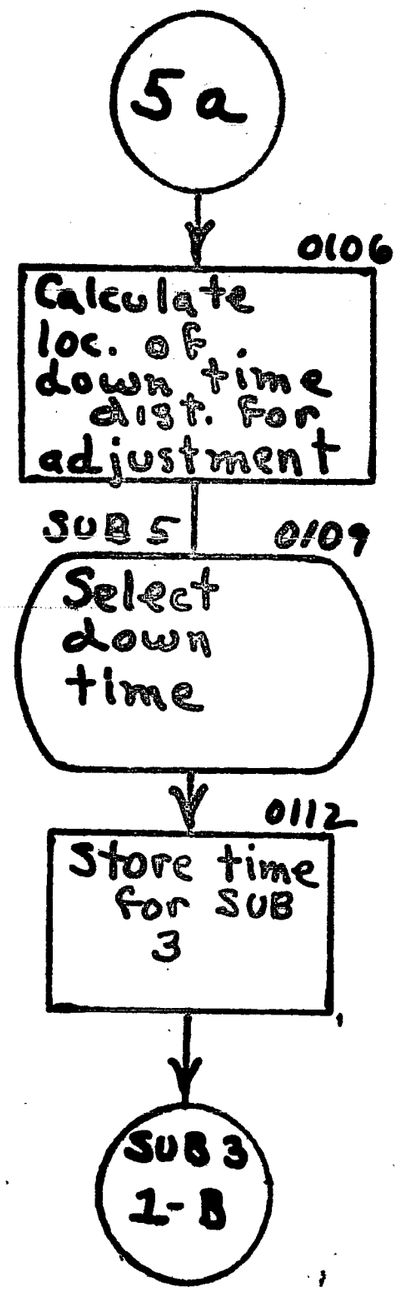
SUBROUTINE 3-1



SUBROUTINE 3-2



SUBROUTINE 3-I



PUNCH PRESS SIMULATION

Subroutine No. 3-1 **Track No. 28**

Title: Check for die adjustment or breakage

```
0000   xh6132'     Machine No
0001   xs6202'     5 at 29
0002    t0010'     transfer if Class 1
0003   xs6231'     3 at 29
0004    t0008'     transfer if Class 2
0005   xb6211'     2 at 29
0006   xh6151'     index
0007    u0012'     jump
0008   xb6201'     1 at 29
0009    u0006'
0010   xb6203'     zero
0011    u0006'
0012    b0114'     Location of 1st probability for die breakage
0013   xa6151'     index
0014   xr4029'     Test Probability            SUB 5
0015   xu4007'
0016    u0024'     transfer if die breakage will occur
0017    b0115'     location of 1st probability for die adjustment
0018   xa6151'     index
0019   xr4029'     test probability            SUB 5
0020   xu4007'
0021    u0106'     transfer if adjustment will occur
0022   xb6132'     machine number
0023   xu5013'     transfer to ENTRANCE B SUB 3
0024    b0123'     beginning location of table of die breakage dist.
0025   xa6151'     index
0026    y0027'
0027    b0127'     beginning location of distribution
0028   xr4029'     sample distribution         SUB 5
0029   xu4000'
0030    u0131'
0031    u0131'     not used
```

PUNCH PRESS SIMULATION

Subroutine No. 3-1 **Track No. 28**

Title: Check for Die Adjustment or Breakdown

```
0032   xb6132'    mach no.                              EF 5850
0033   xd6205'    1/10 at 0
0034   xa6102'    Lo Production - 10
0035    y0038'
0036   xr5823'    Shift Data                            SUB 1
0037   xu5722'
0038   xz0143'
0039   xb5827'    LOD plus 10 at 29
0040   xs6204'    10 at 29
0041    y0122'
0042   xr5225'    Store Code                            SUB 2
0043   xu5220'
0044   xz0003'    code to indicate die repair
0045   xr5557'    Store Code                            SUB 2
0046   xu5209'
0047   xz0004'    CODE TO indicate press free
0048   xb6132'    mach no.
0049   xr4845'    Identify man running press  SUB 4-2
0050   xu4700'
0051    u0056'    transfer if setupman running press
0052   xr5124'    Store Code                            SUB 2
0053   xu5100'
0054   xz0000'    Indicates operator not running this press
0055    u0059'
0056   xr5309'    Store Code                            SUB 2
0057   xu5232'
0058   xz0000'    Indicates setupman not running this press
0059   xb6121'    Last loc. plus 1 of Special Clocks
0060    y0102'    location of new code in file
0061   xa6201'    1 at 29
0062    y0104'    location of ~~~~ time in file
0063   xa6201'    1 at 29
```

PUNCH PRESS SIMULATION

Subroutine No. 3-1 **Track No. 29**

Title: Check for die adjustment or breakdown

```
0100   xh6121'      new last loc. plus 2 of Special Clocks
0101    b0122'      3(    )
0102   xh0236'      Location of code
0103   xb6153'      time
0104   xh0237'      Location of time when repair finished
0105   xu4999' 3300'  Transfer to search clocks  SUB 9
0106    b0124'      Beg. location of table of loc's for die adjust.
0107   xa6151'      index
0108    y0109'
0109    b0129'      beg. loc. of dist.
0110   xr4029'      Sample distribution          SUB 5
0111   xu4000'
0112   xh6152'      down time due to die adjustment
0113   xu5057'      transfer to ENTRANCE B SUB 3
0114    z0119'      loc. of 1st probability of die breakage
0115    z0116'      loc. of 1st probability of die adjustment
0116   xz0020'      probability of die adjustment 1st group of presses
0117   xz0018'            "    "   "    "        2nd   "   "     "
0118   xz0030'            "    "   "    "        3rd   "   "     "
0119   xz0028'      probability of die breakage 1st group of presses
0120   xz0043'            "    "   "    "        2nd   "   "     "
0121   xz0052'            "    "   "    "        3rd   "   "     "
0122   xr0308'      code word for special clocks
0123    z0125'      loc. of beginning loc. of tables for die breakage
0124    z0128'      loc. of beginning loc. of tables for die adjust.
0125   xz1326'      beg. loc. die breakage distribution group 1
0126   xz1346'       "    "    "     "          "      "   2
0127   xz1402'       "    "    "     "          "      "   3
0128   xz1230'      beg. loc. die adjustment distribution group 1
0129   xz1250'       "    "    "     "          "      "   2
0130   xz1306'       "    "    "     "          "      "   3
0131   xh6153'      ~~0000~~  actual repair time
```

PUNCH PRESS SIMULATION

Subroutine No. 3-1 **Track No. 29**

Title: Check for die adjustment or breakdown

```
0132   xr5048'     Find time when prod.        SUB 3
0133   xu5054'         is finished
0134    b0160'     loc. of beginning loc. of tables of % Comp
0135   xa6151'     index
0136    y0137'
0137    b0163'     initial loc. of dist to be sampled
0138   xr4029'     sample distribution         SUB 5
0139   xu4000'
0140   xd6248'     100 at 26
0141   xh6300'     temp
0142   xb5041'     H(loc. of time for press in Events)
0143    y0144'
0144   xb0025'     time
0145   xs6143'     current clock time
0146   xs6152'     any die adjustment time  result is actual prod.
0147   xd6212'     1 at 2                                  time
0148   xm6300'     temp
0149   xn6200'     1 at 30
0150   xa6143'     clock time
0151   xa6152'     adjustment time
0152   xh6143'     actual time press went down
0153   xa6153'     repair time
0154    u0155'
0155   xh6153'     time when press will be free to ru n job again
0156   xb6132'     press no.
0157   xr3522'     Calcualte units produced    SUB 8
0158   xu3506'
0159   xu4922'     transfer to print job and reduce ordered amt.
0160    z0161'     beginning loc. of initial loc's for tables of %
0161   xz1422'     beginning loc. of % Completion table -- 1.  comp.
0162   xz1442'        "       "   "  "     "       "      2
0163   xz1462'        "       "   "  "     "       "      3
```

SUBROUTINE 4 AND 4a

PURPOSE

1. Subroutine 4: To determine if a press is free, a setupman is free to setup a job, or an operator is free to supervise the operation of a press.

2. Subroutine 4a: To determine if a setupman can supervise the operation of a press.

CALLING SEQUENCES

1. To determine if a press is free.

   BXXXX press number

   XR4239

   XU4100

   UXXXX exit to this instruction if press not free (a + 2 exit)

   XXXXX exit to this insturction if press is free (a + 3 exit)

2. To determine if a setupman is free to setup a job

   XR4239

   XU4115

   UXXXX exit to this instruction if there are no free setupmen

   XXXXX exit to this instruction with the number of the free setupman in the accumulator.

3. To determine if an operator is free to supervise the operation of a press

   BXXXX press number of job

   XR4239

   XU4134

   UXXXX exit here if there are no operators who can supervise the job on the given press.

XXXXX exit to this instruction with the man number of the operator who can supervise the given job.

4. To determine if a setupman can supervise the operation of a given press.

BXXXX press number of job

XR4335

XU4362

UXXXX exit to this instruction if there are no setupmen who can supervise the operation of the given press.

XXXXX exit to this instruction with the man number of the setupman who can supervise the given job in the accumulator.

INTERNAL SUBROUTINES

1. Subroutine 4 Alpha

a. Purpose: To determine by comparison with a table, if the present combination of group 1 presses assigned to an operator or setupman will allow the additional assignment of the given press to this operator.

b. Calling Sequences

1. Presses assigned to an operator

BXXXX location of code word of operator

R0338

U0245

UXXXX exit to this instruction if the press cannot be assigned.

UXXXX exit to this instruction if the press can be assigned.

2. Presses assigned to a setupman.

BXXXX location of code word from Setupman

R0338

U0328

UXXXX exit to this instruction if the press cannot be assigned.

UXXXX exit to this instruction if the press can be assigned.

c. Area used

1. 4428 to 4446

2. Subroutine 4 Beta

a. Purpose: To determine for presses in group 2 if the one press already assigned the operator or setupman in question is adjacent to the given press.

b. Calling Sequence

1. Presses assigned to a operator

BXXXX location of code word from Operator File

R0363

U0144

UXXXX exit to this instruction if the press cannot be assigned

UXXXX exit to this instruction if the press can be assigned.

2. Presses assigned to a setupman.

BXXXX location of code word from Setupman File

R0363

U0347

UXXXX exit to this location if press cannot be assigned.

UXXXX exit to this instruction if press can be assigned.

c. NOTE: The following coding error was found during the preparation of this program description. If press number 7 is assigned to an operator or setupman in question, and the given press number is 5; this program will assign press number 5 to the operator or setupman.

d. Area used

1. 4447 to 4463

3. Subroutine 4 Gamma

a. Purpose: To determine if a group three press is assigned to the operator or setupman being considered to supervise another group 3 press.

b. Calling Sequences

BXXXX code word for man

XR4648

XU4649

UXXXX exit to this instruction if press not assigned to man.

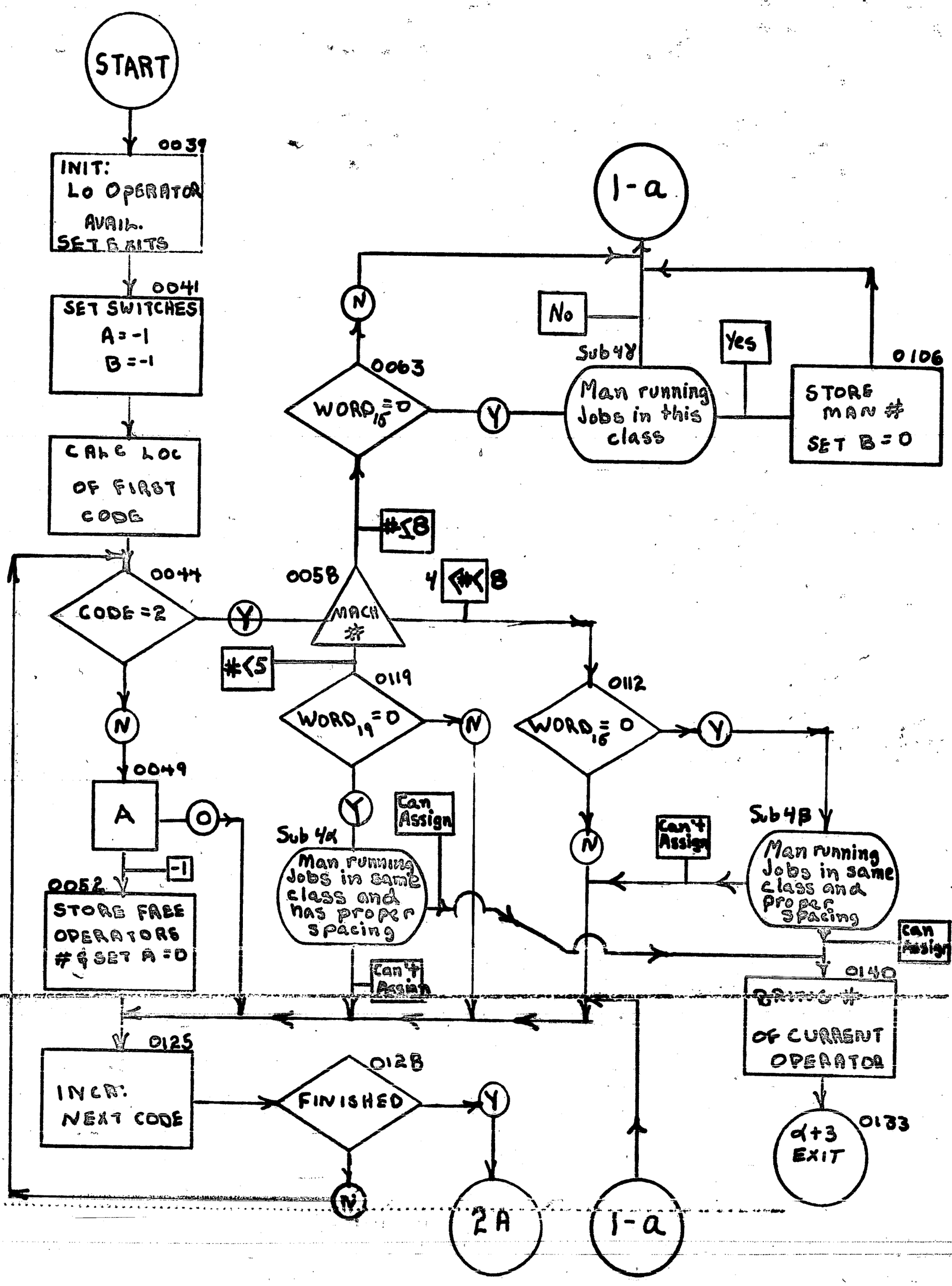
UXXXX exit to this instruction if press assigned to man.

AREA USED

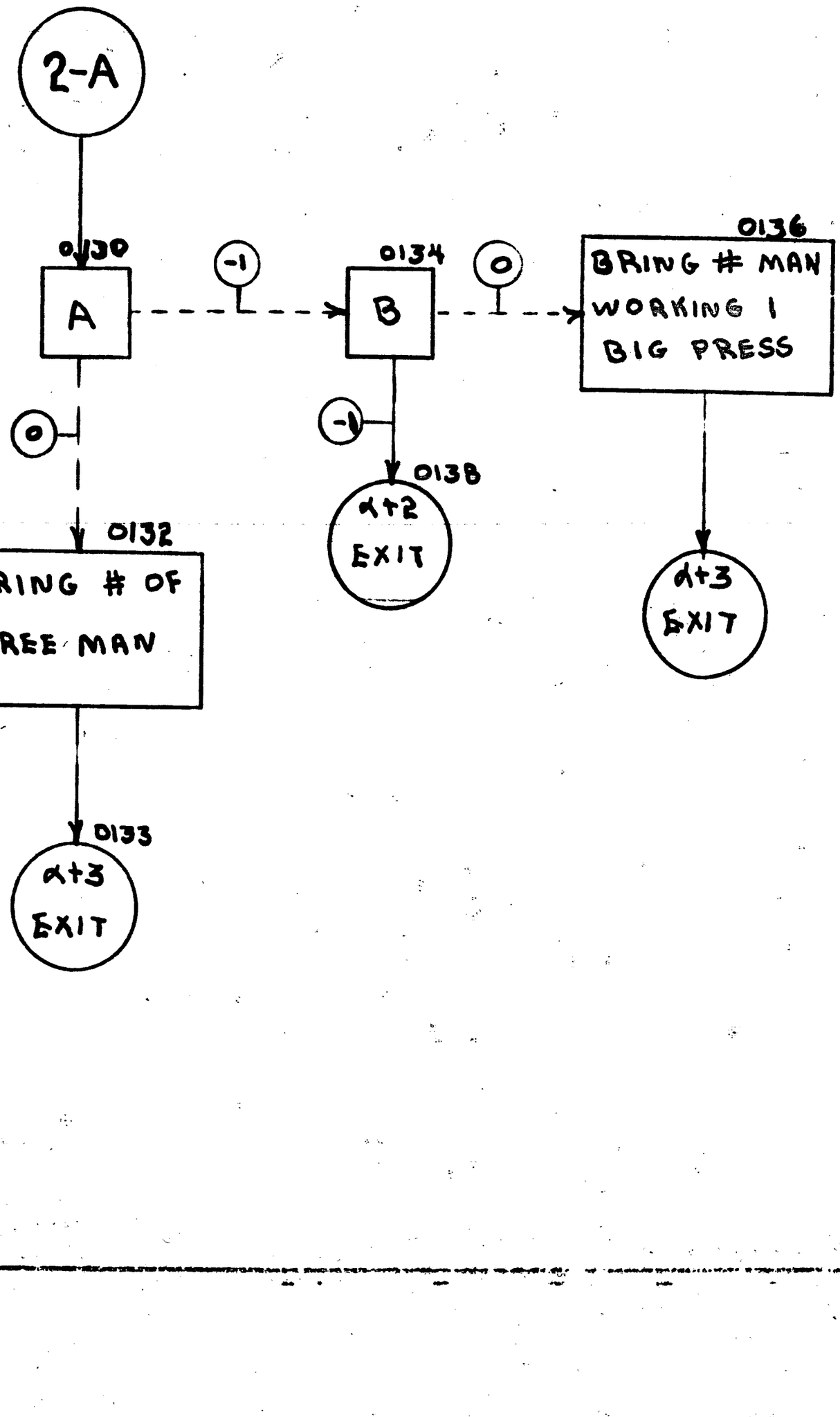
1.	Subroutine 4	4100 to 4246
2.	Subroutine 4a	4247 to 4407
3.	Internal subroutines	4408 to 4463
4.	Patches	4648 to 4660
5.	Patch	4850 to 4854

SUBROUTINE 4

OPERATOR FREE

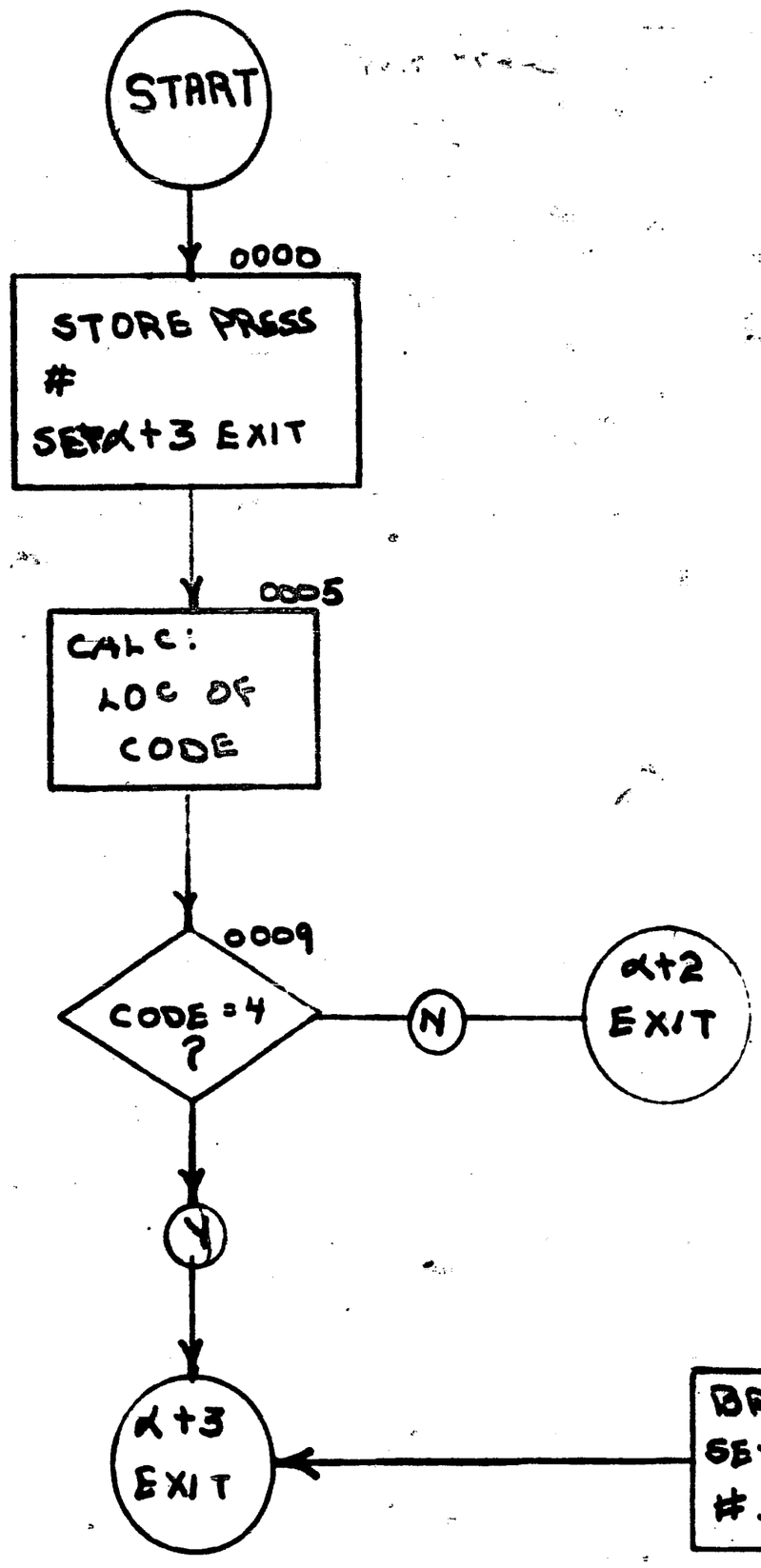


SUBROUTINE 4

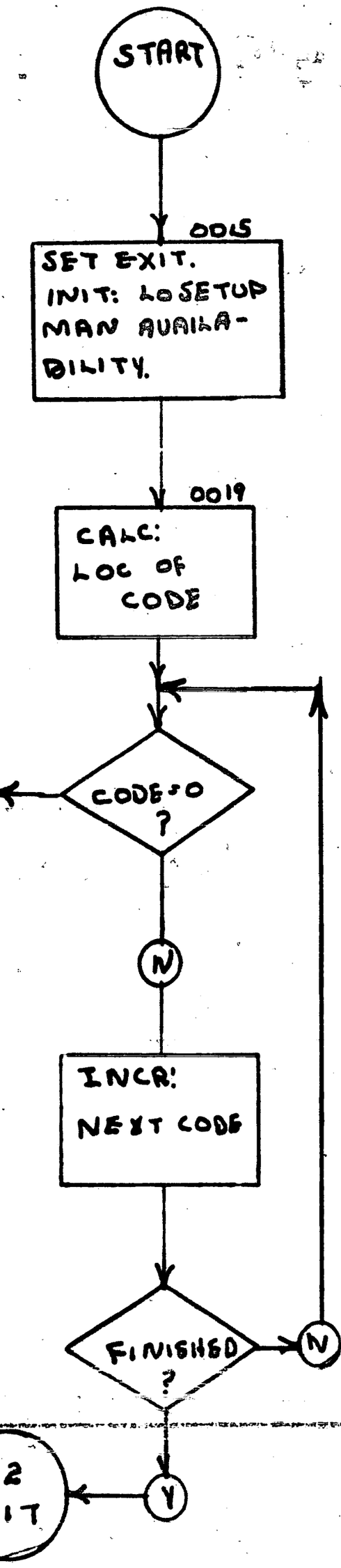


SUBROUTINE 4

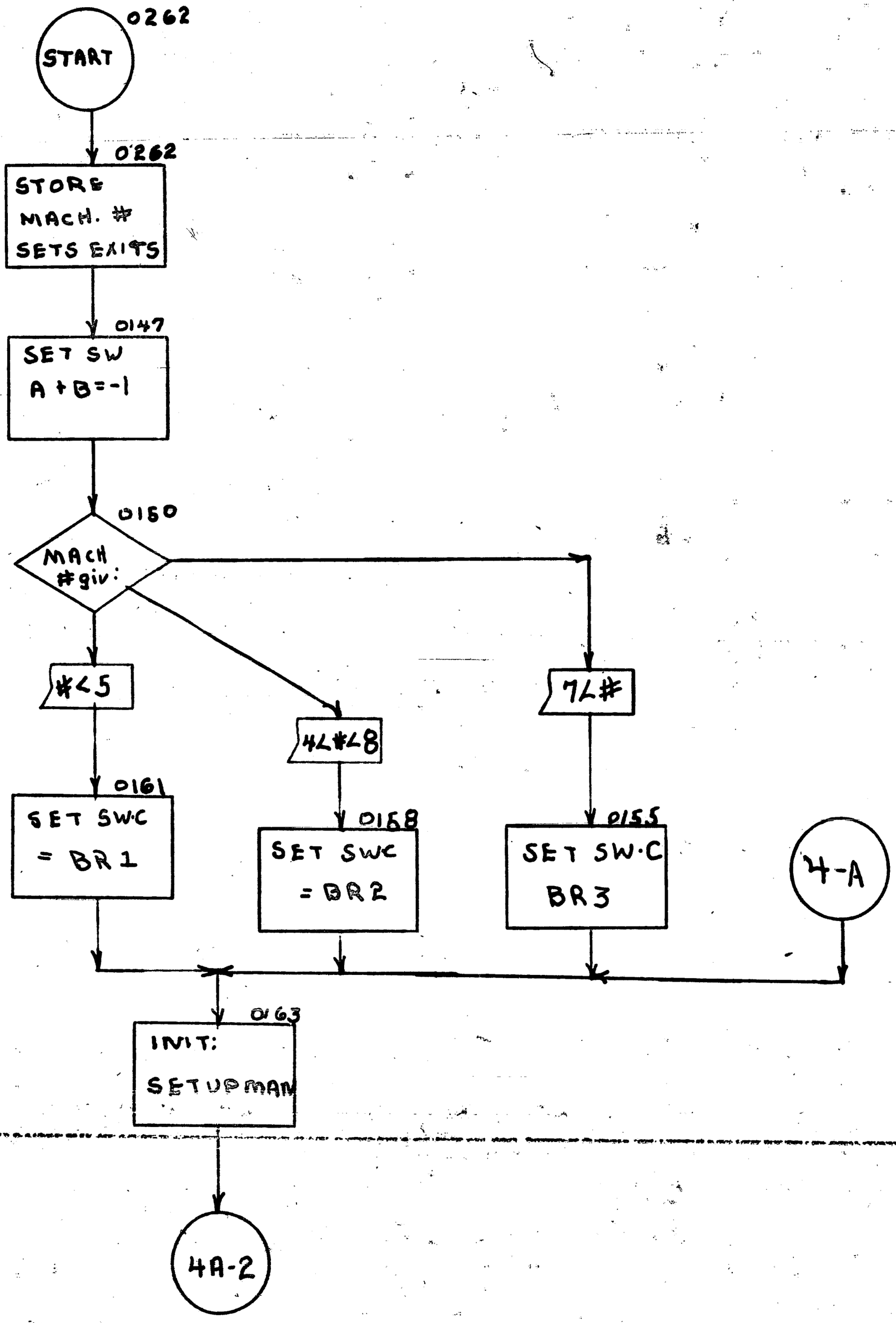
PRESS FREE



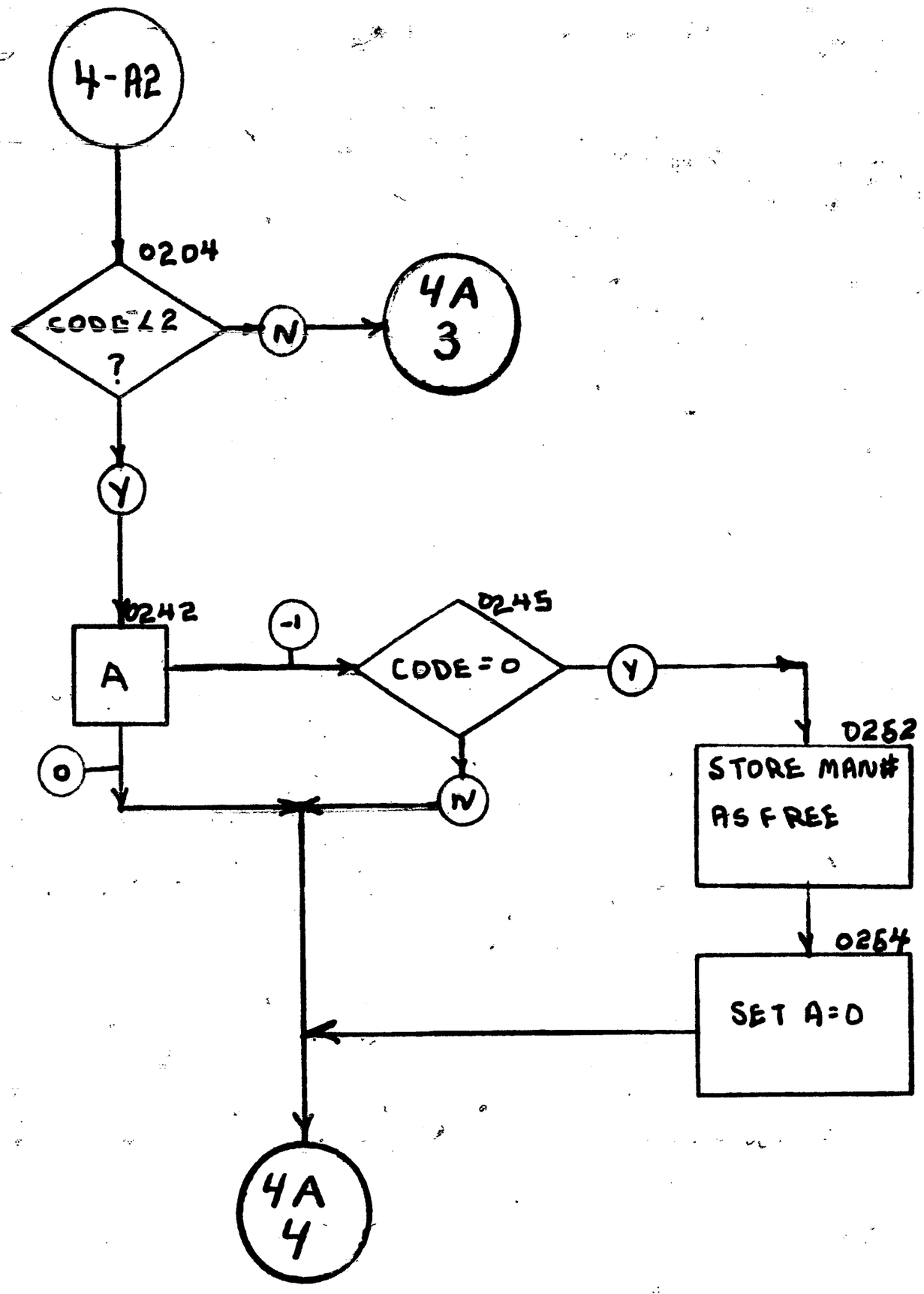
SETUPMAN FREE



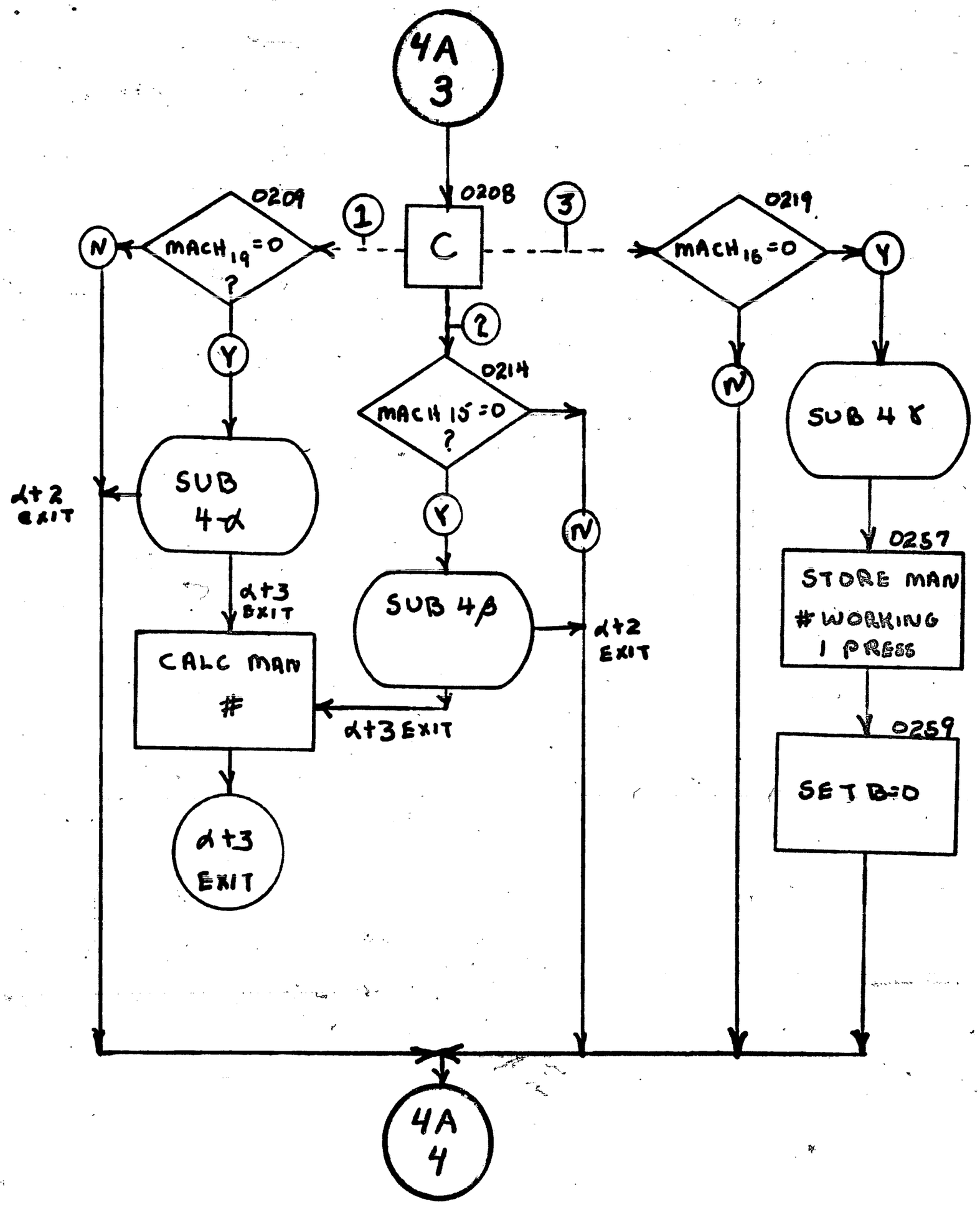
SUBROUTINE 4A



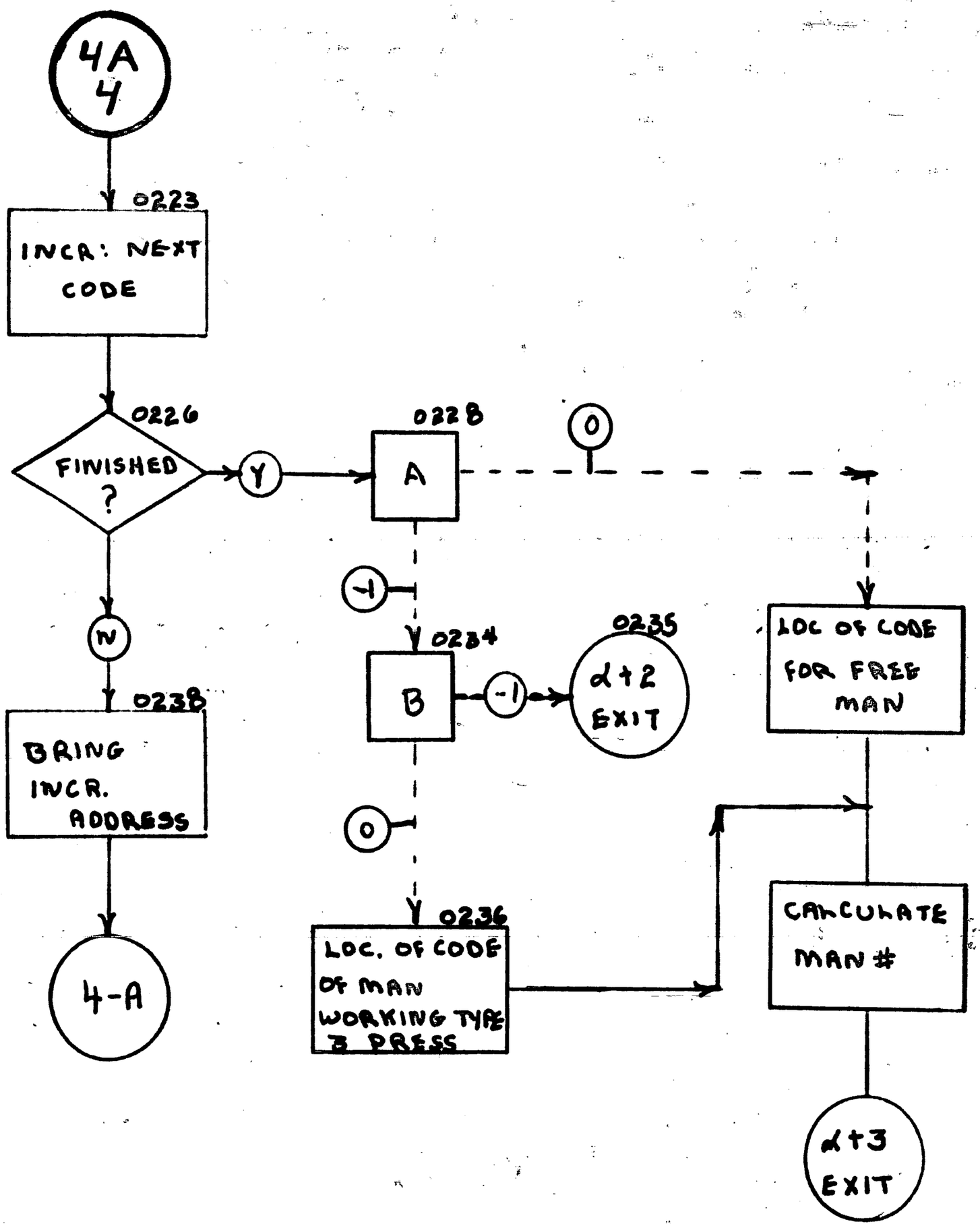
SUBROUTINE 4A



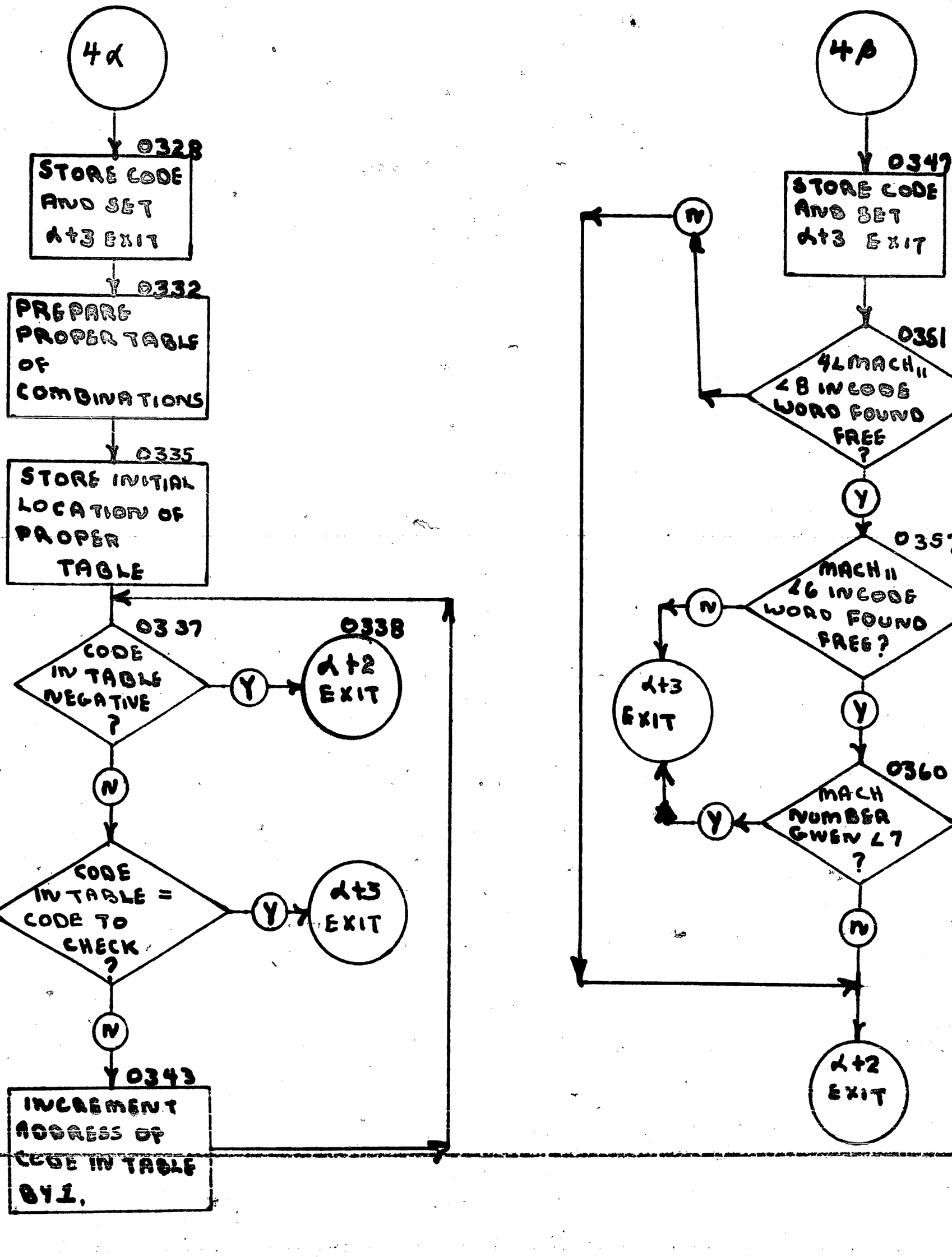
SUBROUTINE 4-A



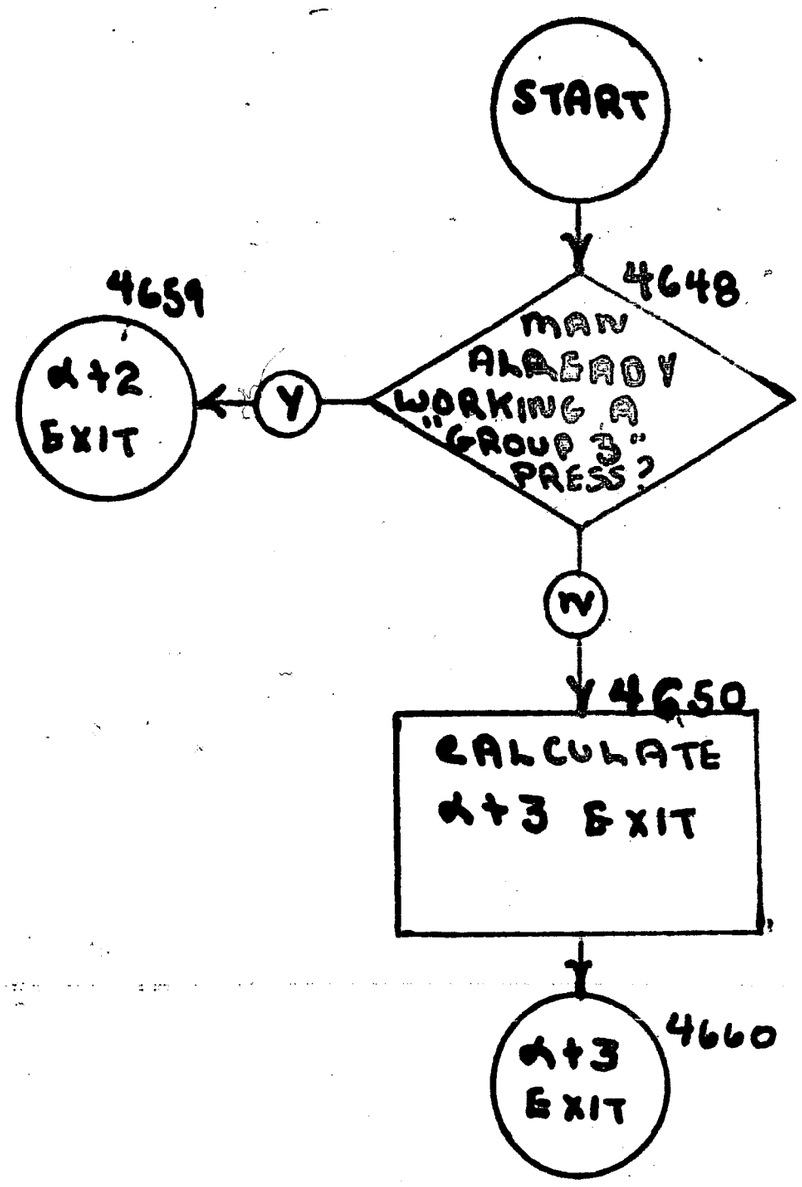
SUBROUTINE 4A



SUBROUTINE 4α AND 4β



SUBROUTINE 4-8



PUNCH PRESS SIMULATION

Subroutine No. 4 Track No. 41

Title: Check for availability of press, setupman or operator

```
0000   xh6132'     press no.                          ENTER TO FIND FREE PRESS
0001    b0139'     exit
0002    y0138'     no exit
0003   xa6201'     1 at 29
0004    y0133'     yes exit
0005   xb6132'     press no.
0006   xd6223'     1/3 at  0
0007   xa6106'     Lo Events file
0008    y0009'
0009   xb0024'     code from events
0010   xs6209'     4 at 29
0011    t0138'     transfer if code not 4
0012   xs6201'     1 at 29
0013    t0133'     transfer if code is 4
0014    u0138'     transfer if code is not 4
0015    b0139'     exit                               ENTER TO FIND FREE
0016    y0138'     no exit                                 SETUPMAN
0017   xa6201'     1 at  29
0018    y0133'     yes exit
0019   xb6105'     Lo Setupman File
0020    y0021'
0021   xb0223'     code from Setupman file
0022   xs6201      1 at 29
0023    t0030'     transfer if code is 0
0024    b0021'
0025   xa6231'     3 at 29
0026    h0021'
0027   xs6111'     B(Last loc Setupman File plus 1)
0028    t0021'     transfer if not finished
0029    u0138'     transfer to no exit
0030    b0021'
0031   xs6112'     B(1st loc. Setupman File)
```

PUNCH PRESS SIMULATION

Subroutine No. 4 **Track No.** 41

Title: Check for availability of press, setupman, or operator

```
0032   xm6223'    1/3 at 0                          man no. at 29
0033    u0133'    transfer to yes exit
0034   xh6132'    press no                          ENTER TO FIND FREE
0035    b0139'    exit                                      OPERATOR
0036    y0138'    no exit
0037   xa6201'    1 at 29
0038    y0133'    yes exit
0039   xb6104'    Lo Operator File
0040    y0044'
0041   xb6232'    -1 at 29
0042   xh6146'    Switch A
0043   xh6147'    Switch B
0044   xb0209'    code from Operator File
0045   xs6210'    2 at 7
0046    t0049'    transfer if less than 2
0047   xs6218'    1  at 7
0048    t0058'    transfer if 2
0049   xb6146'    Switch A
0050    t0052'    transfer if lst code is 0
0051    u0125'    transfer to incrementor
0052    b0044'    address of code
0053   xs6113'    B(Lo Operator)
0054   xm6213'    1/32at  0
0055    c0306'    free operators number
0056   xh6146'    Switch A                          set Switch A to 0
0057    u0125'    transfer to incrementor
0058   xb6132'    mach no.
0059   xs6202'    5 at 29
0060    t0119'    transfer if mach no. less than 4
0061   xs6231'    3 at 29
0062    t0112'    transfer if no. greater than 3 but less than 7
0063    b0044'    address of code from Operator   PRESS NO 7 or 8
```

PUNCH PRESS SIMULATION

Subroutine No. 4 Track No. 42

Title: Check for availability of press, setupman, or operator

```
0100   y0102'
0101   xb6216'     W0000
0102   xe0209'     code word from Operator
0103   xs6201'     1 at 29
0104   xt4654'     transfer if no. at 15 is 0
0105    u0125'     transfer to incrementor
0106    b0044'     B(address of code from Operator)
0107   xs6113'     B(Lo Operator)
0108   xm6213'     1/2 at 0
0109    c0307'     no. of operator on press 7 or 8
0110   xh6147'     Switch B                    set Switch B to 0
0111    u0125'     transfer to incrementor
0112    b0044'     address of code from Oper. Press NO. 4, 5, OR 6
0113    y0115'
0114   xb6216'     W0000
0115   xe0209'     code  word from Operator
0116   xs6201'     1  at 29
0117    t0313'     transfer if no. at 15 is 0
0118    u0125'     transfer to incrementor
0119    b0044'     code word address from Operator
0120    y0122'
0121   xb6217'     W000
0122   xe0209'     code word from Operator
0123   xs6201'     1 at 29
0124    t0308'     transfer if no. at 19 is 0
0125    b0044'     address of code from Oper.  INCREMENTOR
0126   xa6211'     2 at  29
0127    h0044'     address of next code in Operator File
0128   xs6114'     B(Last loc. of  Operator File plus 1)
0129    t0044'     transfer if not finished
0130   xb6146'     Switch A
0131    t0134'     transfer if no free Operators
```

PUNCH PRESS SIMULATION

Subroutine No. 4 **Track No. 42**

Title: Check for availability of press, setupman, or operator

```
0132    b0306'      Free man's no.
0133    xu2061'     Yes, Exit
0134    xb6147'     Switch B                        NO FREE OPERATORS
0135     t0138'     transfer if press no. not 7 or 8
0136     b0307'     no. of man working press 7 or 8
0137     u0133'     transfer to yes exit
0138    xu2060'     no exit
0139    xz2060'                                     R TO HERE
0140     b0044'     address of code from Operator
0141    xs6113'     B(Lo of Operator File)
0142    xm6213'     1/2 at 0
0143     u0133'     transfer to yes exit
0144     y0145'                                     PATCH  EF 0315
0145    xb0209'
0146     u0347'
0147    xb6232'     -1 at 29                        EF 0302
0148    xh6146'     Switch A
0149    xh6147'     Switch B
0150    xb6132'     press no. given
0151    xs6202'     5 at 29
0152     t0161'     transfer if no. less than 5
0153    xs6231'     3 at 29
0154     t0158'     transfer if no 4, 5, or 6
0155     b0303'     Branch 3
0156     h0208'     Switch C
0157     u0163'
0158     b0304'     Branch 2
0159     h0208'     Switch C
0160     u0163'
0161     b0305'     Branch 1
0162     h0208'     Switch C
0163    xb6105'     Lo Setupman File
```

PUNCH PRESS SIMULATION

Subroutine No. 4 Track No. 43

Title: Check for availability of press, setupman, or operator

```
0200   y0201'   code word from Setupman File
0201   xb0223'  code word from Setupman File
0202   xh6138'
0203    u0204'
0204   xb6138'  code word                                    4
0205   xe6214'  W000000
0206   xs6210'  2 at 7
0207    t0242'  transfer if code less than 2
0208    u0219'  SWITCH C
0209   xb6138'  code word from Setupman     BRANCH 1 SWITCH C
0210   xe6217'  W000Ø
0211   xs6227'  1 at 19
0212    t0318'  transfer  to SUB 4 ALPHA
0213    u0223'  transfer to incrementor
0214   xb6138'  code word from Setupman     BRANCH 2 SWITCH C
0215   xe6216'  W0000
0216   xs6226'  1 at 15
0217    t0323'  transfer to SUB 4 BETA
0218    u0223'  transfer to incrementor
0219   xb6138'  code word from Setupman     BRANCH 3 SWITCH C
0220   xe6216'  W0000
0221   xs6226'  1 at 15
0222   xt4850'  transfer to SUB 4 GAMMA
0223    b0201'  address of code word         INCREMENTOR
0224   xa6231'  3 at 29
0225    h0201'  new address of code word
0226   xs6111'  B(last loc. of Setupman plus 1)
0227    t0201'  transfer if not finished
0228   xb6146'  Switch A
0229    t0234'  transfer if no setupmen free to operate
0230    b0306'  Code word ØØ of free setupman
0231   xs6112'  B(Lo Setupman)
```

PUNCH PRESS SIMULATION

Subroutine No. 4 **Track No.** 43

Title: Check for availability of press, setupman, or operator

0232	xm6223'	1/3 at 0
0233	xu2418'	YES EXIT
0234	xb6147'	Switch B
0235	xt2417'	NO EXIT R HERE
0236	b0307'	code word for setupman on press 7 or 8
0237	u0231'	
0238	xb0209'	code word PATCH EF 0246
0239	u0328'	
0240	b0201'	EF 0212,0217
0241	u0231'	
0242	xb6146'	Switch A EF 0207
0243	t0247'	transfer if first free man
0244	u0223'	transfer to SUB 4 ~~ALPHA~~ BETA
0245	y0238'	PATCH EF 0310
0246	u0238'	
0247	xb6138'	code word from Setupman
0248	xe6214'	W000000
0249	xs6218'	1 at 7
0250	t0252'	transfer if code is 0
0251	u0223'	transfer to incrementor
0252	b0201'	address of code word
0253	h0306'	location of code for free man
0254	xb6203'	zero
0255	xh6146'	Switch A
0256	u0223'	transfer to incrementor
0257	b0201'	loc. of code for man working press 7 or 8 EF 0222
0258	h0307'	
0259	xb6203'	zero
0260	xh6147'	Switch B
0261	u0223'	transfer to incrementor
0262	xh6132'	press no. START TO FIND IF SETUPMAN CAN
0263	b0235'	no exit OPERATE

PUNCH PRESS SIMULATION

Subroutine No. 4 Track No. 44

Title: Check for availability of press, setupman, or operator

```
0300   xa6201'      1 at 29
0301    y0233'      yes exit
0302    u0147'
0303    u0219'      constant  for SWITCH C
0304    u0214'      constant   "    "     "
0305    u0209'      constant   "    "     "
0306   xz0002'      code for free man
0307   xb0806'      loc of code for man working presses 7 or 8
0308    b0044'      loc. of code                    CALLING SEQUENCE
0309    r0338'                                      SUB 4 ALPHA
0310    u0245'
0311    u0125'      transfer to incrementor
0312    u0140'      transfer to yes exit
0313    b0044'      loc of code                     CALLING SEQUENCE
0314    r0363'                                      SUB 4 BETA
0315    u0144'
0316    u0125'      transfer to incrementor
0317    u0140'      transfer to yes exit
0318   xb6138'      code from Setupman              CALLING SEQUENCE
0319    r0338'                                      SUB 4 ALPHA
0320    u0328'
0321    u0223'      transfer to incrementor
0322    u0240'      transfer to yes exit
0323   xb6138'      code from Setupman              CALLING SEQUENCE
0324    r0363'                                      SUB 4 BETA
0325    u0347'
0326    u0223'      TRANSfer to incrementor
0327    u0240'      transfer to yes exit
0328   xh6138'      code word                       START SUB 4 ALPHA
0329    b0338'      incrementor exit
0330   xa6201'      1 at 29
0331    y0342'      yes exit
```

PUNCH PRESS SIMULATION

Subroutine No. 4 Track No. 44

Title: Check for availability of press, setupman, or operator

```
0332   xb6245'   Lo of table of initial loc's of combinations
0333   xa6132'   mach no. at 29
0334    y0335'
0335   xb4629'   initial location of  proper table
0336    y0337'
0337   xb4647'   code to check
0338    t0311'   transfer if finished and exit to incrementor
0339   xs6138'   code word
0340    t0343'   transfer if not equal
0341   xs6201'   1 at 29
0342    t0312'   transfer if equal    YES EXIT
0343    b0337'   B(loc of code to check)
0344   xa6201'   1 at 29
0345    h0337'
0346    u0337'   transfer back to check next code
0347   xh6138'   code word                    START SUB 4 BETA
0348    b0363'   incrementor exit
0349   xa6201'   1 at 29
0350    h0359'   yes exit
0351   xb6138'   code word
0352   xs6243'   2 at 7 plus 5 at 11
0353    t0363'   transfer to incrementor exit
0354   xs6244'   3 at 11
0355    t0357'   transfer to yes exit
0356    u0363'   transfer to incrementor exit
0357   xa6208'   2 at 11
0358    t0360'   transfer if code is a 5
0359    u0317'                                 YES EXIT
0360   xb6132'   press no.
0361   xs6229'   7 at 29
0362    t0359'   transfer to yes exit
0363    u0316'   transfer to Incrementor exit
```

SUBROUTINE 4-1

PURPOSE

1. Search the Action File for a job with the same code as that given.
2. If ties occur in the selection of codes, the record with the maximum priority is selected. If ties in maximum priority occur, the record with the higher beginning address is selected.
3. It is also possible when ties occur in selection of codes to select the record which has a priority equal to or less than the priority in any given record.
4. When ties occur in the selection of the code and when the priority is equal to or less than the given priority, the press number that the job was assigned to may be compared with a given press number.

CALLING SEQUENCES

1. Check for priority equal to or less than the maximum allowable priority and for jobs that were assigned to a given press.

```
BXXXX press number
XH6132
BXXXX 1st location of record which contains the maximum
      allowable priority.
XH4622
BXXXX code
XR4545
XU4500
UXXXX exit to this location if no records are found which meet
      the requirements.
XXXXX exit to this location if a record is found. 1st loc. in
      accumulator.
```

2. Check for only jobs assigned to a given press.

BXXXX press number

XH6132

BXXXX code

XR4545

XU4508

UXXXX exit to this location if no record meets the requirements.

XXXXXX exit to this location with the 1st location of the record selected in the accumulator.

3. Check only for equal codes.

BXXXX code

XR4545

XU4522

UXXXX exit to this location if no record meets the requirements.

XXXXX exit to this location with the 1st location of the record selected in the accumulator.

4. Check for priority equal to or less than the maximum allowable priority for all presses.

BXXXX 1st location or record which has the maximum allowable priority.

XH4622

BXXXX code

XR4545

XU4514

UXXXX exit to this location if no record meets the requirements.

XXXXX exit to this location with the 1st location of the record selected in the accumulator.

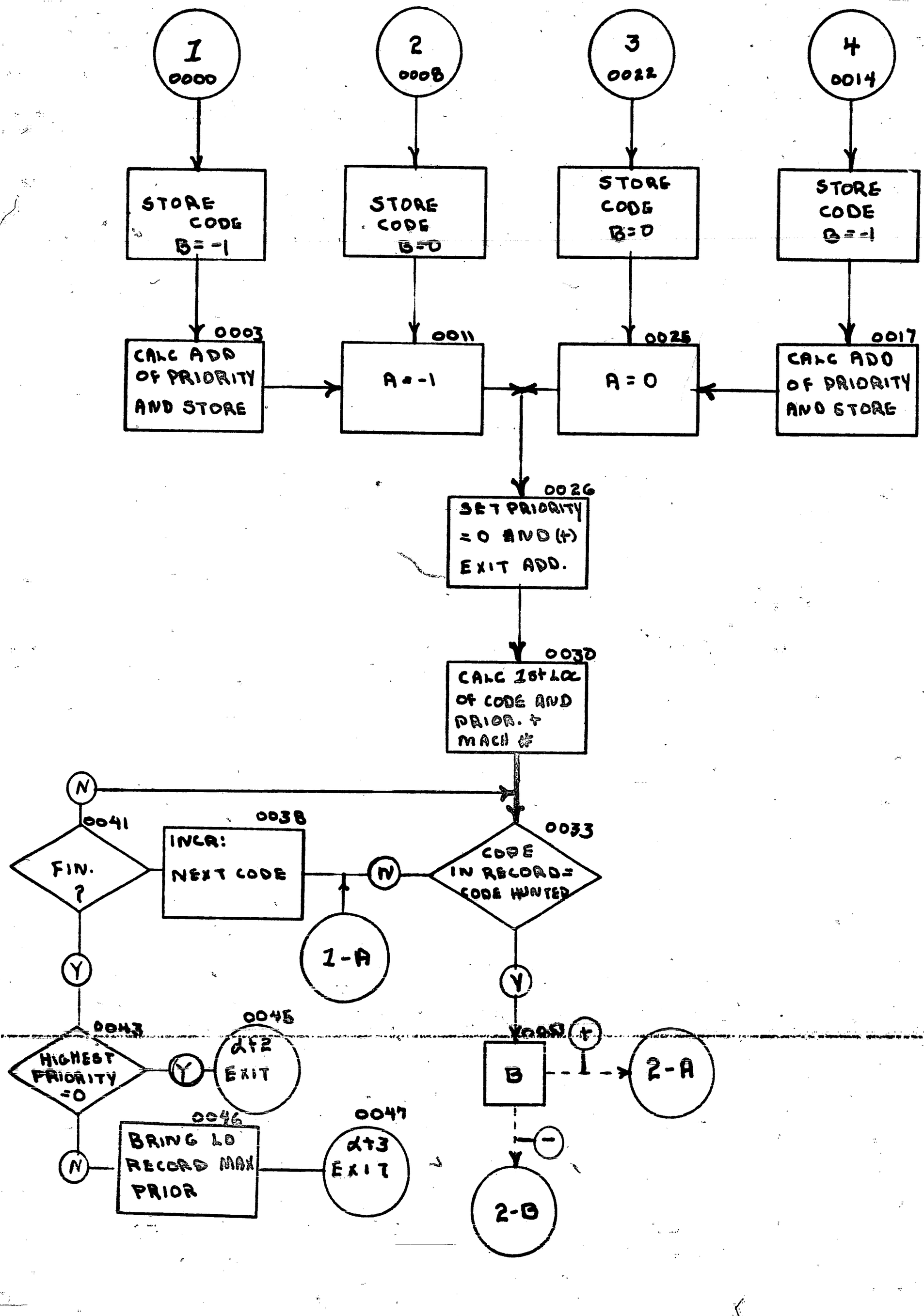
AREA USED

4500 to 4626

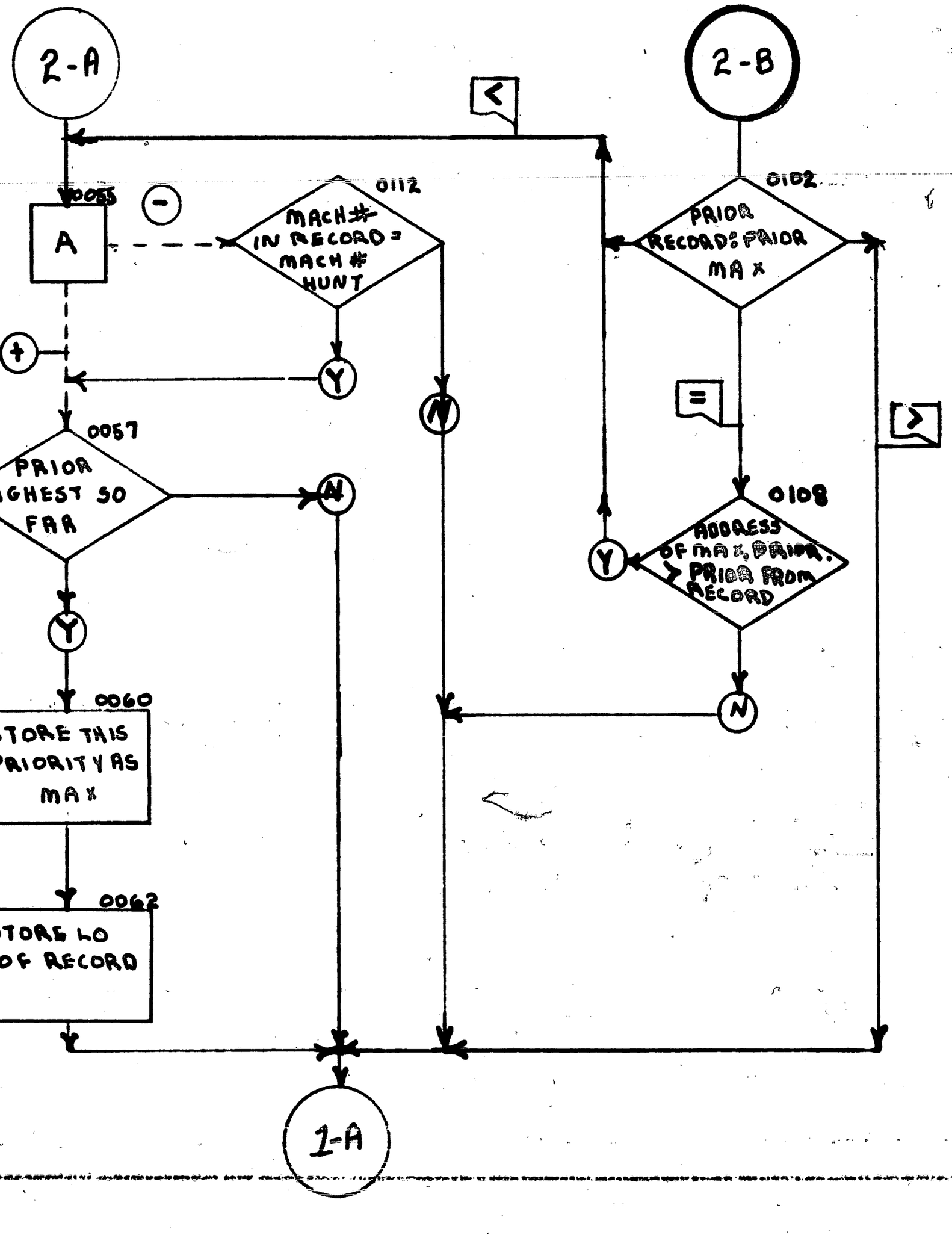
4039 to 4063

3935 to 3941

SUBROUTINE 4-1



SUBROUTINE 4-1



PUNCH PRESS SIMULATION

Subroutine No. 4-1 Track No. 45

Title: Search Action File for code

```
0000    h0121'    code hunted                              ENTRANCE 1
0001    xb6232'   -1 at 29
0002    xh6147'   Switch B
0003    b0122'    Lo of record to check priority against
0004    xa6202'   5 at 29
0005    h0123'    Location of priority to check
0006    y0103'
0007    u0011'
0008    h0121'    code hunted                              ENTRANCE 2
0009    xb6203'   zero
0010    xh6147'   Switch B
0011    xb6232'   -1 At 29
0012    xc6146'   Switch A
0013    u0026'
0014    h0121'    code hunted                              ENTRANCE 4
0015    xb6232'   -1 at 29
0016    xh6147'   Switch B
0017    b0122'    B(lo record to check priority against)
0018    xa6202'   5 at 29
0019    y0103'    loc. of priority to check
0020    c0123'    address of priority to check
0021    u0025'
0022    h0121'    code hunted                              ENTRANCE 3
0023    xb6203'   zero
0024    xh6147'   Switch B
0025    xh6146'   Switch A
0026    h0124'    maximum priority
0027    b0045'    no exit
0028    xa6201'   1 at 29
0029    y0047'    yes exit
0030    xu3935'   transfer to check the 1st loc. of record for zero.
0031    xa6229'   7 at 29
```

PUNCH PRESS SIMULATION

Subroutine No. 4-1 Track No. 45

Title: Search Action File for code

```
                0032    y0033'
                0033   xb0325'    code from record
                0034    s0121'    code sought
                0035    t0038'    transfer if codes not equal
                0036   xs6201'    1 at 29
                0037    t0048'    transfer if codes equal
                0038   xb3937'    Lo of record in Action
                0039   xa6204'    10 at 29
                0040   xh3937'    Lo of next record in Action
                0041   xs6115'    B(Last loc. of Action plus 10)
                0042   xt3937'    transfer if not finished all records
                0043    b0124'    maximum priority
                0044   xs6201'    1 at 29
                0045   xt2049'    NO EXIT                    R HERE
                0046    b0125'    Lo of record with max priority
                0047   xu2050'    YES EXIT
                0048    b0033'    loc of code
                0049   xs6211'    2 at 29
                0050    y0057'    address of priority in record
                0051    y0060'
                0052    y0102'
                0053   xb6147'    Switch B
                0054    t0102'    transfer if priorities are to be compared
          0055 xb6146'            Switch A
                0056   xt4039'    transfer if machine no's. are to be compared
                0057   xb0323'    priority from record
                0058    s0124'    maximum priority so far
                0059    t0038'    transfer to incrementor
                006    xb0323'    new maximum priority
          0061  h0124'            maximum priority so far
                0062    b0057'    address of priority form record
                0063   xs6202'    5 at 29
```

PUNCH PRESS SIMULATION

Subroutine No. 4-1 Track No. 46

Title: Search Action File for code

```
0100    h0125'      Lo of record with maximum priority
0101    u0038'      transfer to incrementor
0102   xb0323'      priority form record          CHECK PRIORITIES
010;   xs0825'      priority that is to be compared, maximum allowable
0104    t0055'      transfer to check Switch A
0105   xs6201'      1 at 29
0106    t0108'      transfer if priorities are equal
0107    u0038'      transfer to incrementor
0108    b0102'      B(address of priority from record)
010x    s0123'      B(address of maximum allowable priority)
0110    t0055'      transfer to check Switch A
0111    u0038'      transfer to incrementor
0112    b0033'      B(Code in recofd)             CHECK MACH. NOS.
0113   xa6201'      1 at 29
0114    y0115'
0115   xb0828'      Mach no. job was assigned to
0116   xs6132'      mach no being checked
0117    t0038'      transfer to incrementor
0118   xs6201'      1 at 29
0119    t0057'      transfer to check for maximum priority
0120    u0038'      transfer to incrementor
0121   xz0000'      the codo hunted--a constant
0122   xb0820'      constant--B(Lo record to check priority against)
0123   xb0825'      constant--B(loc of priority to check)
0124   xz0040'      constant--maximum priority so far
0125   xb0308'      constant--B(Lo of record with maximum priority)
0126    b0130'      INIT. loc. mach. giv. is 1-SUB 4 ALPHA
0127    z0134'       "    "    "    "   "  2-TABLES OF PROPER
0128    z0139'       "    "    "    "   "  3     COMBINATIONS
0129    z0144'       "    "    "    "   "  4
,0000009' 0130 02200000'  TABLE WHEN MACHINE GIVEN IS 1
          0131 02230000'
```

PUNCH PRESS SIMULATION

Subroutine No. 4-1 Track No. 46

Title: Search Action File for codes

```
                0132 02320000'
                0133 wwwwwwwq'
                0134 02100000'    TABLE WHEN MACH GIVEN IS 2
                0135 02300000'
                0136 02340000'
                0137 02430000'
                0138 wwwwwwwq'
,0000009'       0139 02400000'    TABLE WHEN MACH GIVEN IS 3
                0140 02200000'
                0141 02120000'
                0142 02210000'
                0143 wwwwwwwq'
                0144 02300000'    TABLE WHEN MACH GIVEN IS 4
                0145 02320000'
                0146 02230000'
                0147 wwwwwwwq'
                0148   xs6246'    2 at 7 plus 8 at 11          SUBROUTINE 4 GAMMA
                0149    t0159'    transfer to no exit
                0150    b0149'
                0151   xa6201'    1 at 29
                0152    y0153'
                0153   xu4854'    transfer to yes exit
                0154   xb4144'    loc of code                  PATCH SUB 4  EF 4204
                0155    y0156'
                0156   xb0209'    code in record
                0157    r0149'                                 SUB 4 GAMMA
                0158    u0148'
                0159   xu4225'    transfer if no assignment
                0160   xu4206'    transfer if assignment
,0000003'       0161 4020q40j'    free
                0162 8j10f4g4'    free
                0163 w4445494'    free
```

SUBROUTINE 4-2

PURPOSE: To determine the man number of the operator or setupman setting up or operating a given press.

CALLING SEQUENCES

1. Check for an operator or setupman supervising the operation of a press.

   BXXXX press number

   XR4845

   XU4700

   UXXXX exit at this location with the man number in the accumulator if the man is a setupman.

   XXXXX exit at this location with the man number in the accumulator if the man is an operator.

2. Check for an operator supervising the operation of a press.

   BXXXX press number

   XH6132

   XR4845

   XU4818

   XXXXXX free

   XXXXX exit at this location with the man number in the accumulator.

INTERNAL SUBROUTINES

1. Subroutine 4-2 alpha

   a. Purpose: To check the presses assigned to a man to see if the press number being searched for is among them.

   b. Calling Sequences

      1. When the man being checked is supervising the operation

of the presses

R0051

U0059

UXXXX exit at this location if the press was not being worked by this man.

XXXXX exit at this location if the press was being worked by this man.

2. When the man being checked is performing a setup.

R0051

U0063

UXXXX exit at this location if the press was not being setup by this man.

XXXXX exit at this location if the press was being setup by this man.

c. Area used: 4721 to 4801

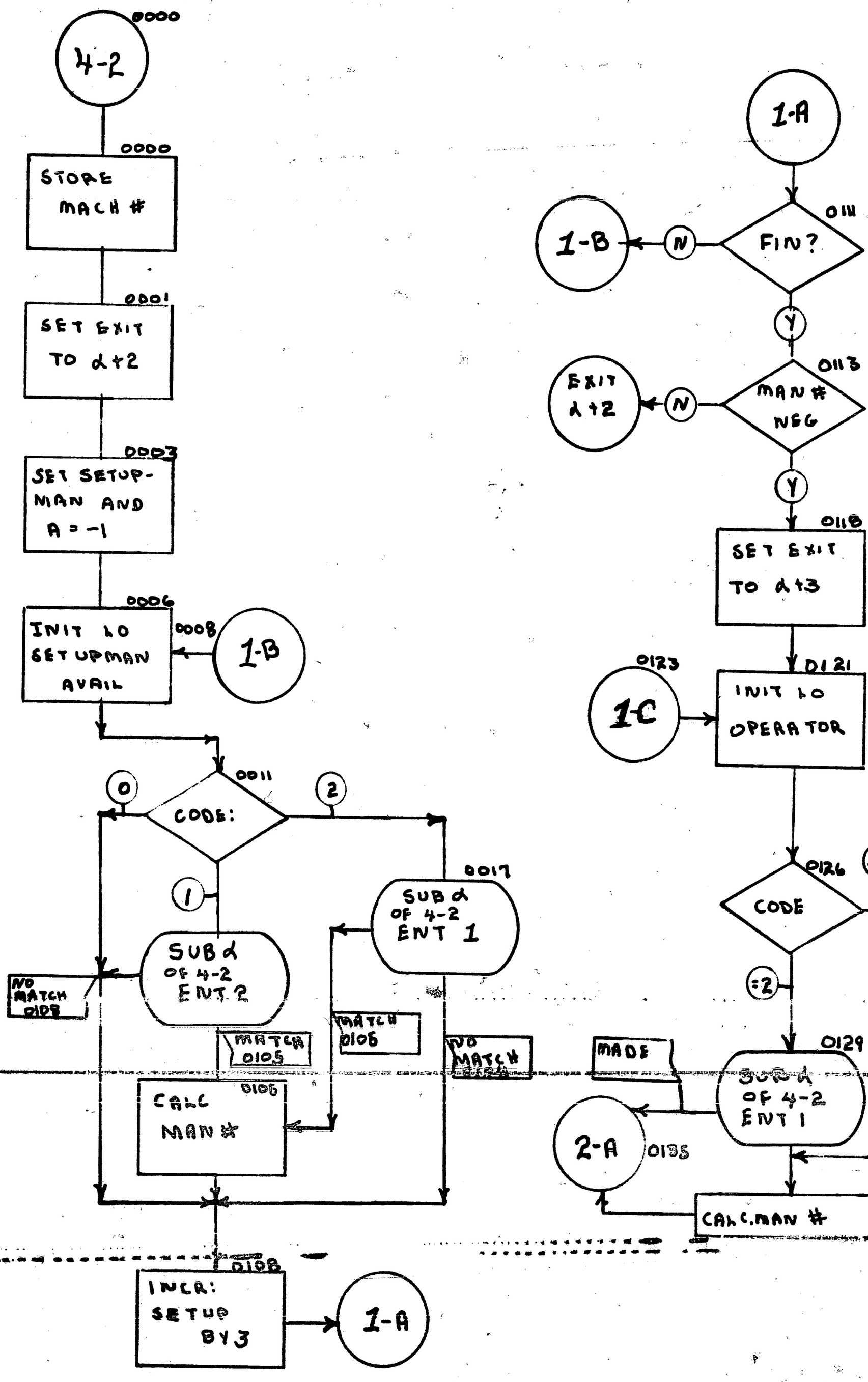
AREA USED 4700 to 4849

ERROR STOPS

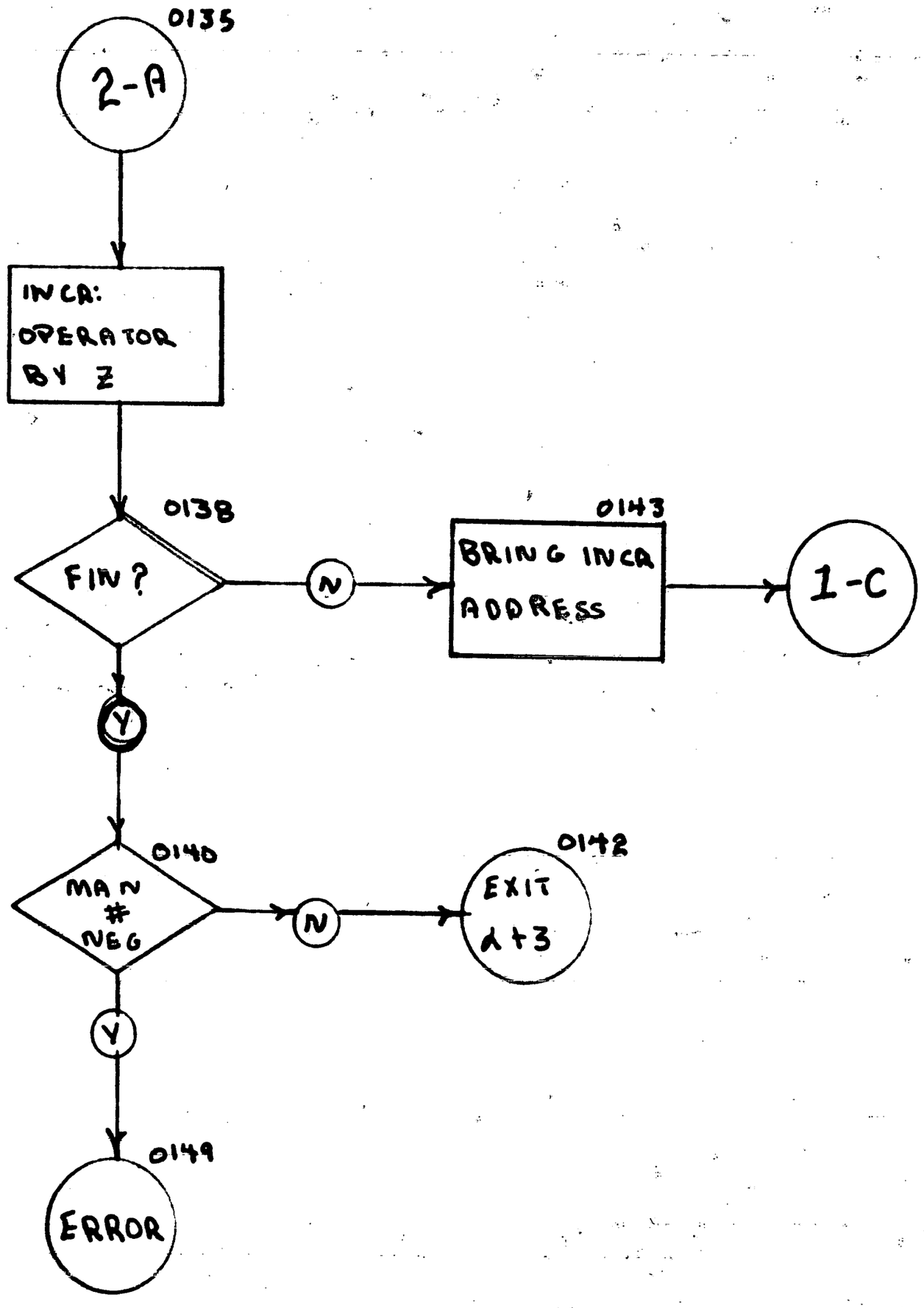
1. 4849 No man is assigned to the given press. DO NOT PRESS the "Start Compute".

2. 4754 There is more than one man assigned to the given press. Depression of "Start Compute" will cause the last man number assigned to the press to be stored as the only man assigned to the press.

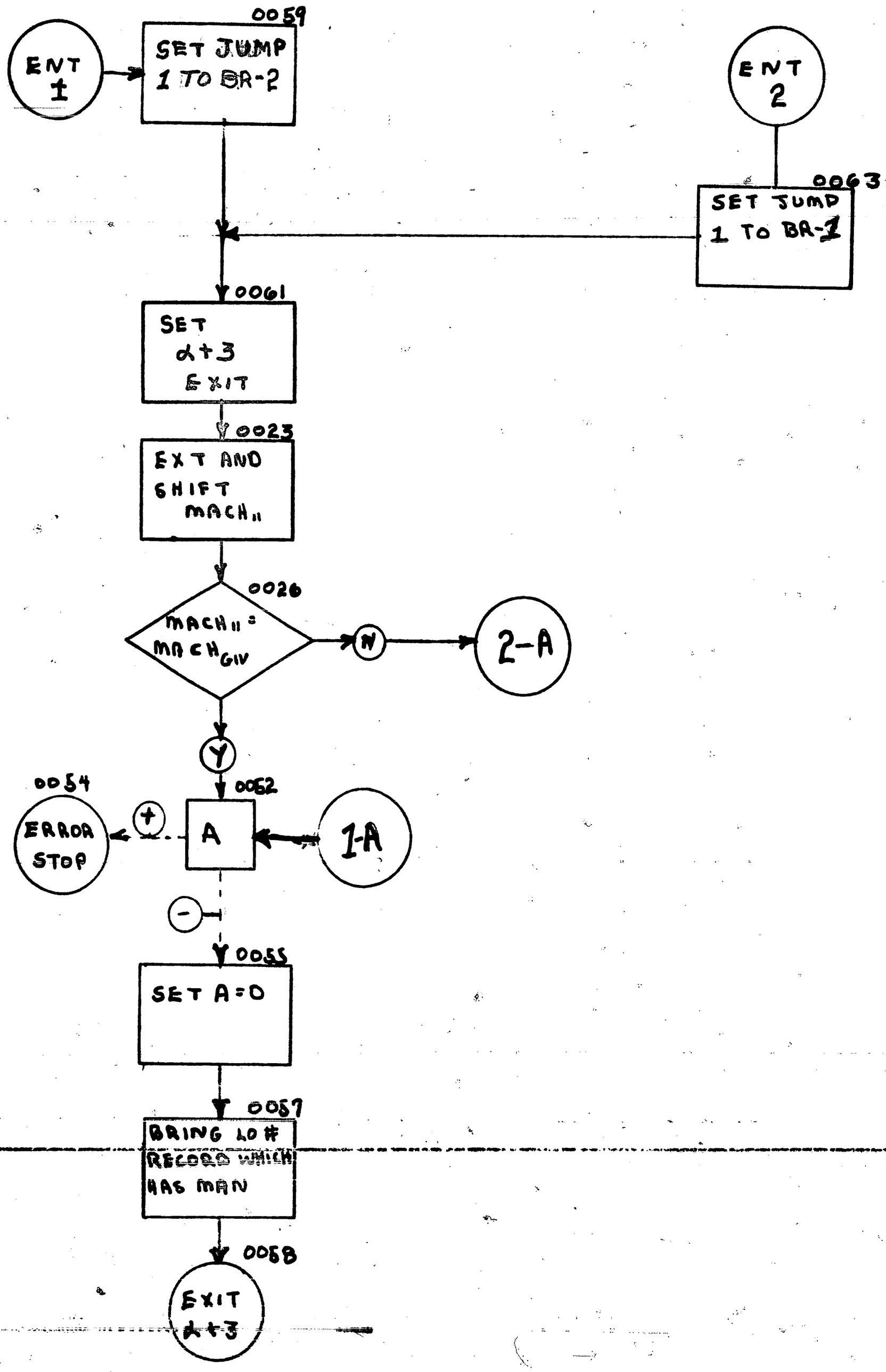
SUBROUTINE 4-2



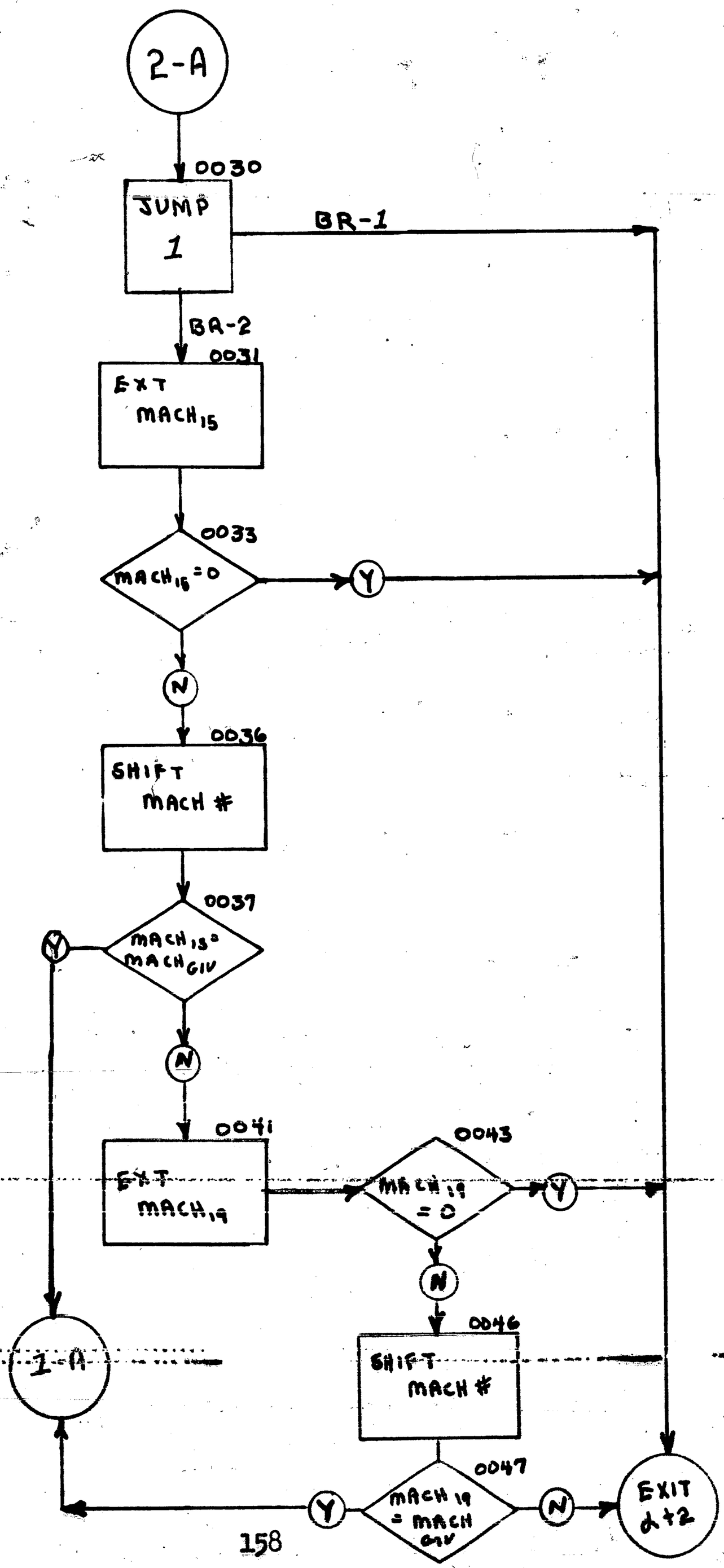
SUBROUTINE 4-2



SUBROUTINE 4-2 SUBα



SUBROUTINE 4-2 SUB d



PUNCH PRESS SIMULATION

Subroutine No. 4-2 **Track No.** 47

Title: Find man running given machine

```
0000   xh6132'    press no.                                  START
0001    b0145'    exit
0002    y0115'    setupman exit
0003   xb6232'    -1 at 29
0004    h0146'    man no. on given machine
0005   xh6146'    Switch A
0006   xb6105'    Lo Setupman
0007    y0041'
0008    y0031'
0009    y0023'
0010    y0011'
0011   xb0220'    code word from Setupman
0012   xe6214'    code at 7
0013   xs6218'    1 at 7
0014    t0108'    transfer if code is 0
0015   xs6218'    1 at 7
0016    t0102'    transfer if code is 1
0017    r0051'    check presses assigned          SUB 4-2 ALPHA
0018    u0059'
0019    u0108'    transfer if none of the presses agreed
0020    u0105'    transfer if man was on given press
0021   xa6201'    1 at 29                      SUB 4-2 ALPHA EF0062
0022    h0058'    operator exit if match made
0023   xb0209'    code word for man
0024   xe6215     press at 11
0025   xm6206'    1 at 18
0026   xs6132'    press given
0027    t0030'    transfer if not equal
0028   xs6201'    1 at 29
0029    t0052'    transfer if equal
0030    u0031'    Jump 1
0031   xb0209'    code word                          Branch 2 JUMP 1
```

PUNCH PRESS SIMULATION

Subroutine No. 4-2 Track No. 47

Title: Find man running given machine

```
0032   xe6216'    W0000
0033   xs6226'    1 at 15
0034    t0051'    transfer if no press at 15
0035   xa6226'    1 at 15
0036   xm6207'    1 at 14
0037   xs6132'    press given
0038    t0041'    transfer if not equal
0039   xs6201'    1 at 29
0040    t0052'    transfer if equal
0041   xb0211'    code
0042   xe6217'    W000
0043   xs6227'    1 at 19
0044    t0051'    transfer if no press at 19
0045   xa6227'    1 at 19
0046   xm6208'    1 at 10
0047   xs6132'    press given
0048    t0051'    transfer if not equal
0049   xs6201'    1 at 29
0050    t0052'    transfer if equal
0051    u0131'    exit if no match                    BRANCH 1 JUMP 1
0052   xb6146'    Switch A
0053    t0055'    transfer if no other matches made
0054   xz0000'    ERROR STOP--MORE THAN ONE OPERATOR ASSIGNED TO PRESS
0055   xb6203'    0
0056   xh6146'    Switch A
0057    b0041'    address of code
0058    u0132'    exit if match found
0059    b0148'    U0051      ENTRANCE 1 SUB 4-2 ALPHA
0060    h0030'
0061    b0051'    no match exit
0062    u0021'
0063    b0147'    U0031      ENTRANCE 2 SUB 4-2 ALPHA
```

PUNCH PRESS SIMULATION

Subroutine No. 4-2 Track No. 48

Title: Find man running given machine

```
0100   h0030'   Jump 1
0101   u0061'
0102   r0051'   check presses assigned          SUB 4-2 ALPHA
0103   u0063'
0104   u0108'   transfer if no match
0105   xs6112'  B(Lo Setupman File)
0106   xm6223'  1/3 at 0
0107   h0146'   man no. who is assigned to press
0108   b0011'   loc. of code word in Setupman file
0109   xa6231'  3 at 29
0110   h0041'
0111   xs6111'  B(Last loc of Setupman plus 1)
0112   t0116'   transfer if not finished
0113   b0146'   man no. who is assigned to press
0114   t0118'   transfer if man not found yet
0115   xu2306'  PROGRAM EXIT WHEN MAN WAS A SETUPMAN
0116   b0041'   location of new code
0117   u0008'
0118   b0145'
0119   xa6201'  exit                              ENTRANCE 2
0120   y0142'   1 at 29                          CHECK OPERATORS
0121   xb6104'  exit if man was an operator
0122   y0041'   Lo Operator file
0123   y0031'
0124   y0023'
0125   y0126'
0126   xb0209'  code word from Operator
0127   xs6210'  2 at 29
0128   t0135'   transfer if code less than two
0129   r0051'   check presses assigned          SUB 4-2 ALPHA
0130   u0059'
0131   u0135'   transfer if match not made
```

PUNCH PRESS SIMULATION

Subroutine No. 4-2 **Track No.** 48

Title: Find man running given machine

```
                0132   xs6113'    B(Lo Operator File)
                0133   xm6213'    1/2 at 0
                0134    h0146'    man no.operating given press
                0135    b0041'    loc. of code
                0136   xa6211'    2 at 29
                0137    h0041'    loc of next code
                0138   xs6114'    B(last location plus 1 of Operator)
                0139    t0143'    transfer if not finished
                0140    b0146'    man no. on given press
                0141    t0149'    transfer if ERROR--NO ONE ASSIGNED TO PRESS
                0142   xu2307'    PROGRAM EXIT WHEN MAN WAS AN OPERATOR
                0143    b0041'    loc. of code
                0144    u0123'
                0145   xz2306'    exit location                    R TO HERE
,0000001'       0146 wwwwwwj'     constant--MAN NO. ON GIVEN PRESS
                0147    u0051'    constant
                0148    u0031'    constant
                0149   xz0000'    ERROR STOP--NO MAN ASSIGNED TO PRESS
                0150   xb6138'                                     PATCH SUB 4  EF 4322
                0151   xr4649'    check assignment                 SUB 4 GAMMA
                0152   xu4648'
                0153   xu4323'    transfer if assignment cannot be made
                0154   xu4357'    transfer if assignment all right.
                0155   xb6143'    Clock Time                       PATCH SUB 4-4  EF 4957/8
                0156   xz0000'    D(1/3 at 0) or D(1/2 at 0)
                0157   xh6300'
                0158   xb0000'    Accumulated Operate Time
                0159   xs6300'
                0160   xh0000'    Accumulated Operate Time
                0161   xb6203'    zero
                0162   xh0000'    code
                0163   xu0000'    exit
```

SUBROUTINE 4-3

PURPOSE: At the beginning of a simulation run to initialize the Schedule Clocks for those presses where a job is to be setup.

CALLING SEQUENCE

XR5652

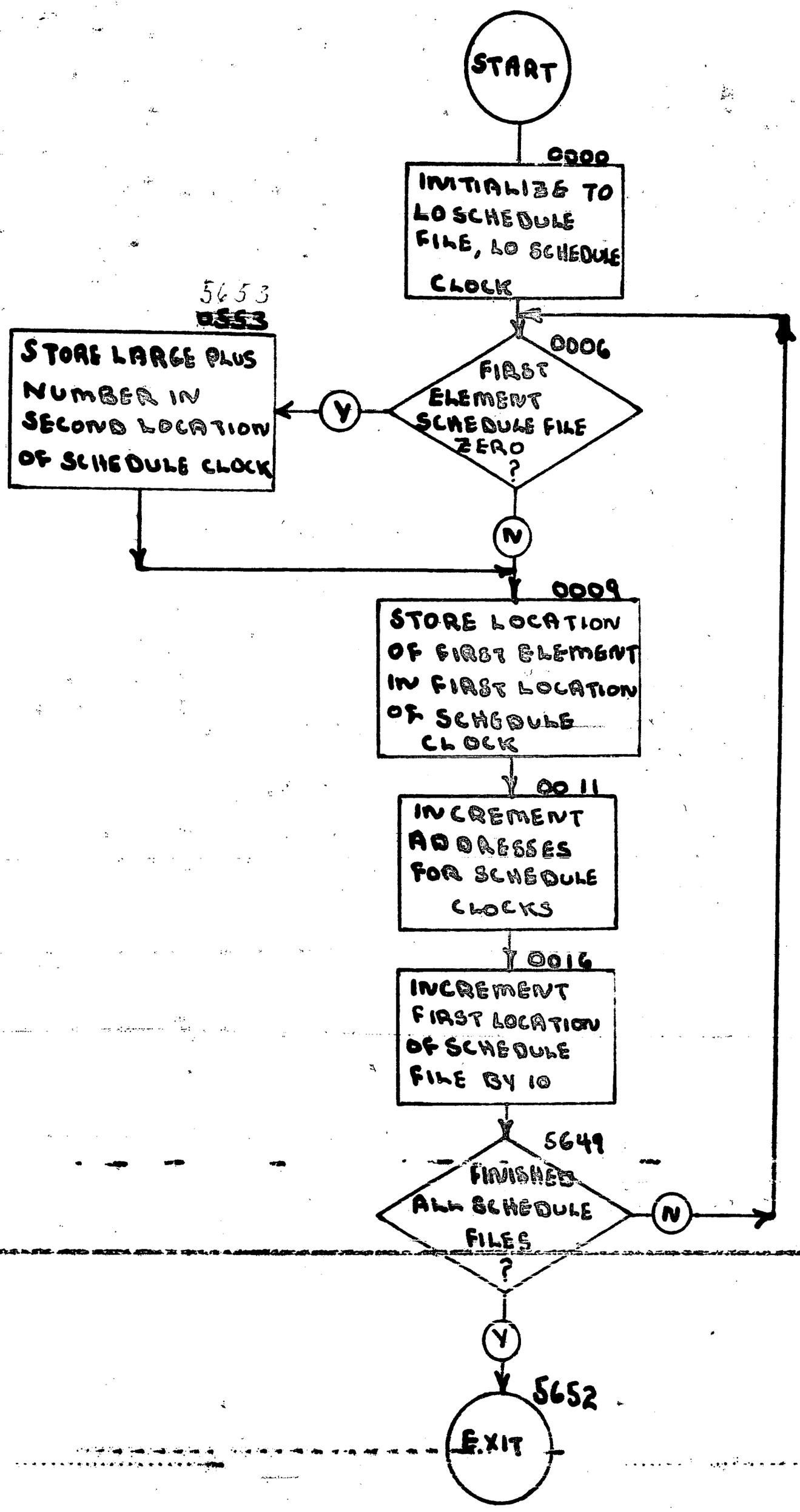
XU4900

AREA USED

4900 to 4918

5649 to 5655

SUBROUTINE 4-3



SUBROUTINE 4-4

PURPOSE: To reduce the accumulated operate time for a setupman or operator who is operating more than one press so that the accumulated operate time will reflect the total of the time the man has spent running each press.

CALLING SEQUENCE

XR4863

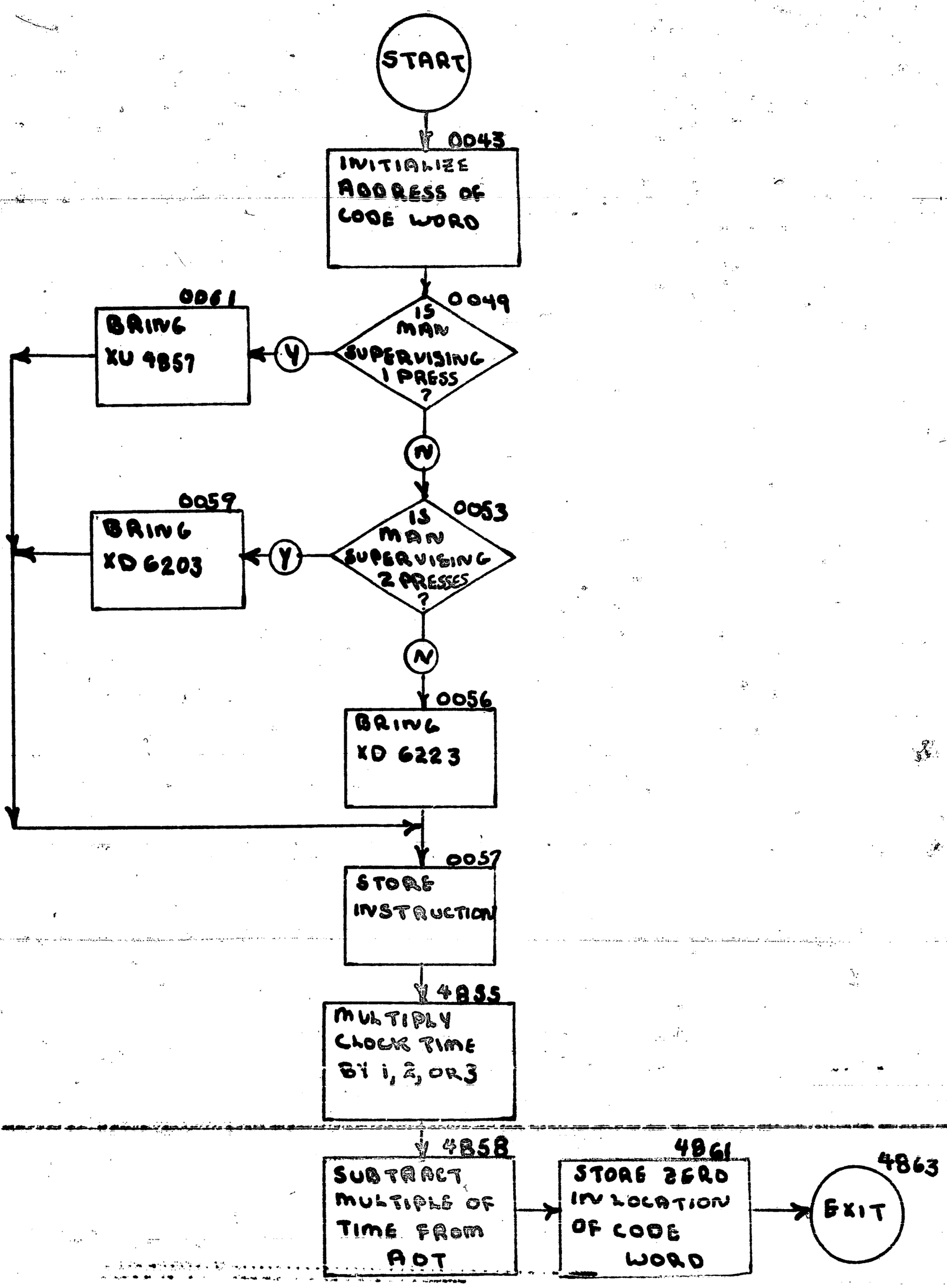
XU4943

AREA USED

4943 to 4963

4855 to 4863

SUBROUTINE 4-4



PUNCH PRESS SIMULATION

Subroutine No. 4-3,4-4 Track No. 49
T
Title: Shout utility programs

```
                0000    xb6103'     Lo Schedule File    ENTRANCE SUB 4-3
                0001     y0006'
                0002    xb6118'     Lo Schedule Clocks
                0003     y0010'
                0004    xa6201'     1 at 29
                0005    xy5654'
                0006     b0000'     Lst Element of Schedule File
                0007    xs6201'     1 at 29
                0008    xt5653'     transfer if 0
                0009     b0006'     loc. of lst element of record
                0010     y0000'
                0011    b0010'
                0012    xa6211'     2 at 29
                0013     y0010'
                0014    xa6201'     1 at 29
                0015    xy5654'
                0016     b0006'     loc. of lst element of record
                0017    xa6204'     10 at 29
0018    xu5649'                     transfer to patch to check if finished
                0019    xr5652'     load unused schedule        PATCH SUB 13  EF 1554
                0020     u0000'       clocks                    SUB 4-3
                0021    xu3549'     transfer to set up next input
                0022    xh6300'     temp--units produced        PATCH SUB 3-1  EF 2959
                0023    xb6132'     press no.
                0024    xr2220'                                 PRINT RESULTS
                0025    xu2200'
                0026    xb2212'     address of ordered amount
                0027     y0029'
                0028     y0031'
                0029     b0000'     ordered amount
                0030    xs6300'     produced amount
                0031     h0000'     ordered amount
```

PUNCH PRESS SIMULATION

Subroutine No. 4-3, 4-4 Track No. 49

Title: Short utility programs

```
0032   xu5843'
0033   xr5309'   store codes                          PATCH  SUB 11 EF 2506
0034   xu5232'                                       SUB 2
0035   xz0000'   indicate setupman free
0036   xb6149'   press no.
0037   xu2401'
0038   xr4239'   Setupman Free  SUB 4                PATCH SUB 11 EF 2400
0039   xu4115'                                                 2413, 2448
0040   xu3300'   transfer if none free
0041   xh6136'   free man no.
0042   xu2309'
0043   xb6150'   address of code word                START SUB 4-4
0044    y0049'
0045   xy4862'
0046   xa6201'   1 at 29
0047   xy4858'   address of Accumulated Operate Time
0048   xy4860'
0049    b0000'   code word of man
0050   xe6253'   WWWWQ
0051   xs6226'   1 at 15
0052    t0061'   transfer if man supervising only one press
0053   xe6254'   WWWQ
0054   xs6227'   1 at 19
0055    t0059'   transfer if man supervising two presses
0056    b0063'   D(1/3 at 0)
0057   xh4856'
0058   xu4855'
0059   xb6255'   D(1/2 at 0)
0060    u0057'
0061   xb6256'   XU4857
0062    u0057'
0063   xd6223'   constant
```

SUBROUTINE 5

PURPOSE:

1. To generate a random number between 0 and 99, and determine if it is greater or less than some given probability.
2. To generate a random number between 0 and 99, to divide this number by 5, and add the result to the initial location of a given distribution.

CALLING SEQUENCES

1. When a probability is to be tested.

   BXXXX location of the probability to be tested.

   XR4029

   XU4007

   UXXXX exit at this location if the random number was less than the given probability.

   XXXXX exit at this location if the random number was equal to or greater than the given probability.

2. When a distribution is to be sampled.

   BXXXX Initial location of the distribution.

   XR4029

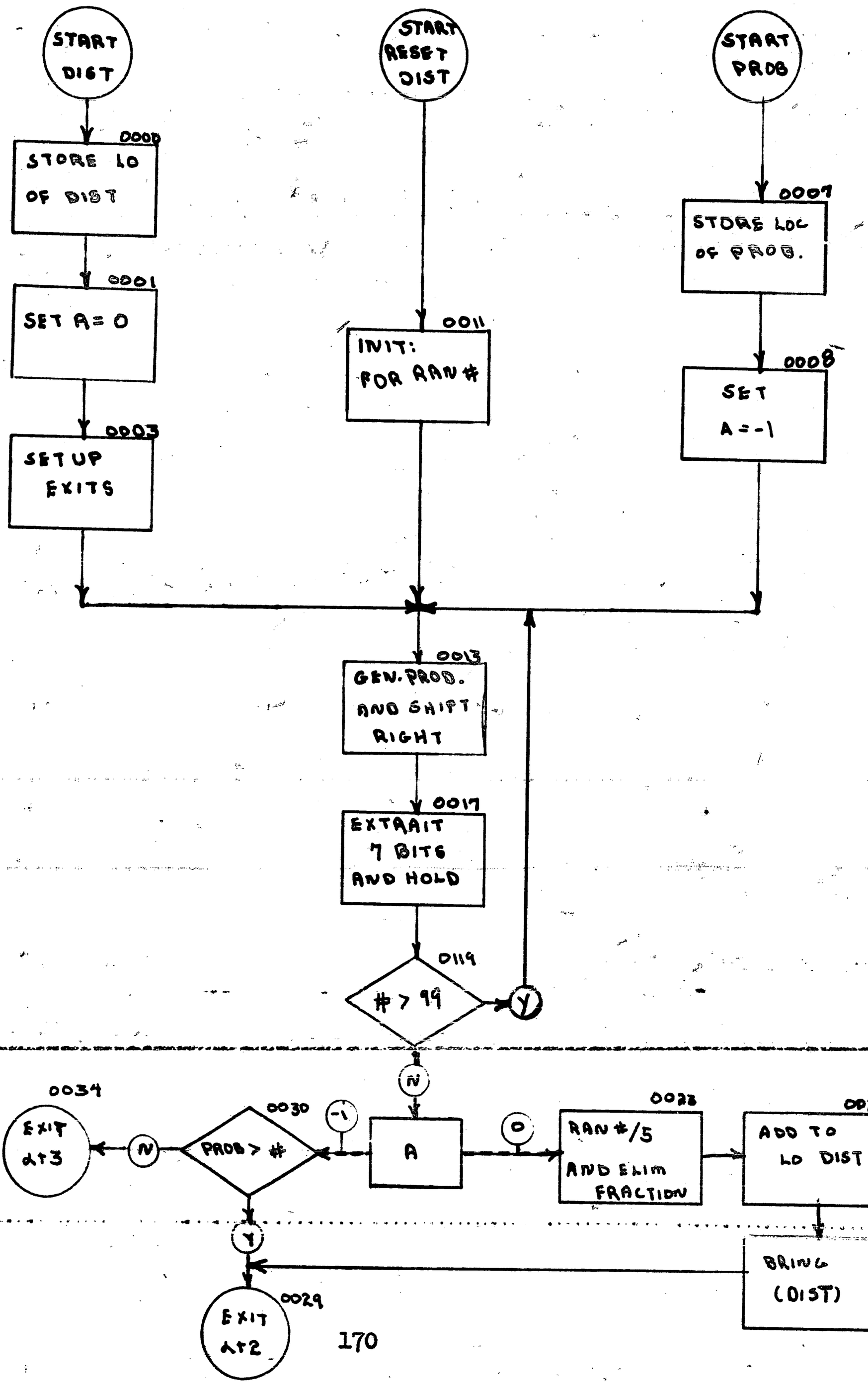
   XU4000

   XXXXX Exit at this location with the contents of the element chosen in the accumulator.

AREA USED

1. 4000 to 4038

SUBROUTINE 5



PUNCH PRESS SIMULATION

Subroutine No. 5 Track No. 40

Title: Sample distribution or test probability

```
                0000    xh6159'     Store Lo of Dist    START DIST
0001    xb6203'                     zero
                0002    xh6146'     Switch A
                0003     b0029'     U(no exit)
                0004    xa6201'     1 at 29
                0005     y0034'     U(yes exit)
                0006     u0013'
                0007     y0032'     Store Loc. of Prob  START PROB
                0008    xb6232'     -1 at 29
                0009    xh6146'     Switch A
                0010     u0003'
                0011    xb6233'     Random # Seed       START TO INITIALIZE GENERATOR
                0012     h0035'     bringer
                0013     b0035'     #
                0014    n6233'      Random # seed
                0015    xm6212'     1 at 2
                0016     h0035'     new # to multiply
                0017    xe6234'     3W800                7 bits at 20
                0018     h0036'     temp.
                0019    xs6235'     32000                100 at 20
                0020     t0037'     transfer if # less than 99
                0021     u0013'     transfer if # greater than 99
                0022     t0030'     transfer if # probability        EF 0022
                0023     b0036'     random # at 200
                0024    xm6236'     1/5 at 9
                0025    xe6237'     1WJ                  drop bit at 30
                0026    xa6159'     Lo of Dist
                0027     y0028'
                0028    xb1127'     address of dist selected
                0029    xu3025'     no exit
                0030     b0036'     random # at 20
                0031    xm6230'     1 at 9
```

PUNCH PRESS SIMULATION

Subroutine No. 5 **Track No. 40**

Title: Sample distribution or test probability

```
                0032   xs2920'     probability
                0033    t0029'     transfer if probability greater than random #
                0034   xu3026'     transfer if prob. less than ran. #  YES EXIT
,0000001'       0035  w7qf2170'     constant--new # to be multiplied
                0036   xy3200'     constant--temp.
                0037   xb6146'     Switch A
                0038    u0022'
                0039   xb4621'     code                        PATCH SUB 4-1 EF 4556
                0040   xs6201'     1 at 29
                0041    t0043'     transfer if 0
                0042   xu4612'
                0043   xb4533'     B(code in record)  EF 4045
                0044   xs6209'     4 at 29
                0045    y0047'
                0046    y0054'
                0047   xb0321'     press numbers
                0048   xe6216'     W0000                       preferred press
                0049   xm6207'     1 at 14
                0050   xs6132'     press given
                0051    t0054'     transfer if press #'s not equal
                0052   xs6201'     1 at 29
                0053   xt4557'     transfer if press #'s equal
                0054   xb0321'     press numbers
                0055   xe6240'     3J                          Alternate press
                0056   xs6201'     1 at 29
                0057   xt4538'     transfer if 0
                0058   xa6201'     1 at 29
                0059   xs6132'     press given
                0060   xt4538'     transfer if press #'s not equal
                0061   xs6201'     1 at 29
                0062   xt4557'     transfer if press #'s equal
                0063   xu4538'     transfer if press #'s not equal
```

SUBROUTINE 6-1

PURPOSE

1. To determine if the preferred and alternate presses given in the record whose beginning location is in the accumulator are free.
2. If neither press is free, the priority of the jobs on the presses are compared with the priority of the job in the given record. If the priority of the job in the given record is twice that of the job on either press, the new job can bump the job off the press.

CALLING SEQUENCE

BXXXX initial location of record

XR3633

XU3600

UXXXX exit at this location if neither press is free and neither can be bumped.

UXXXX exit at this location with the press number in the accumulator of the free press.

XXXXX exit at this location with the press number in the accumulator of the job that can be bumped.

INTERNAL SUBROUTINES

1. Subroutine 6-1 Alpha

   a. Purpose: To determine if a given press is free.

   b. Calling Sequence

      BXXXX press number

      R0040

      U0034

c. Area used: 0034 to 0042

2. Subroutine 6-1 Beta

a. Purpose: To determine if the job on a given press can be bumped and replaced with the job being checked.

b. Calling Sequence

EXXXX press number

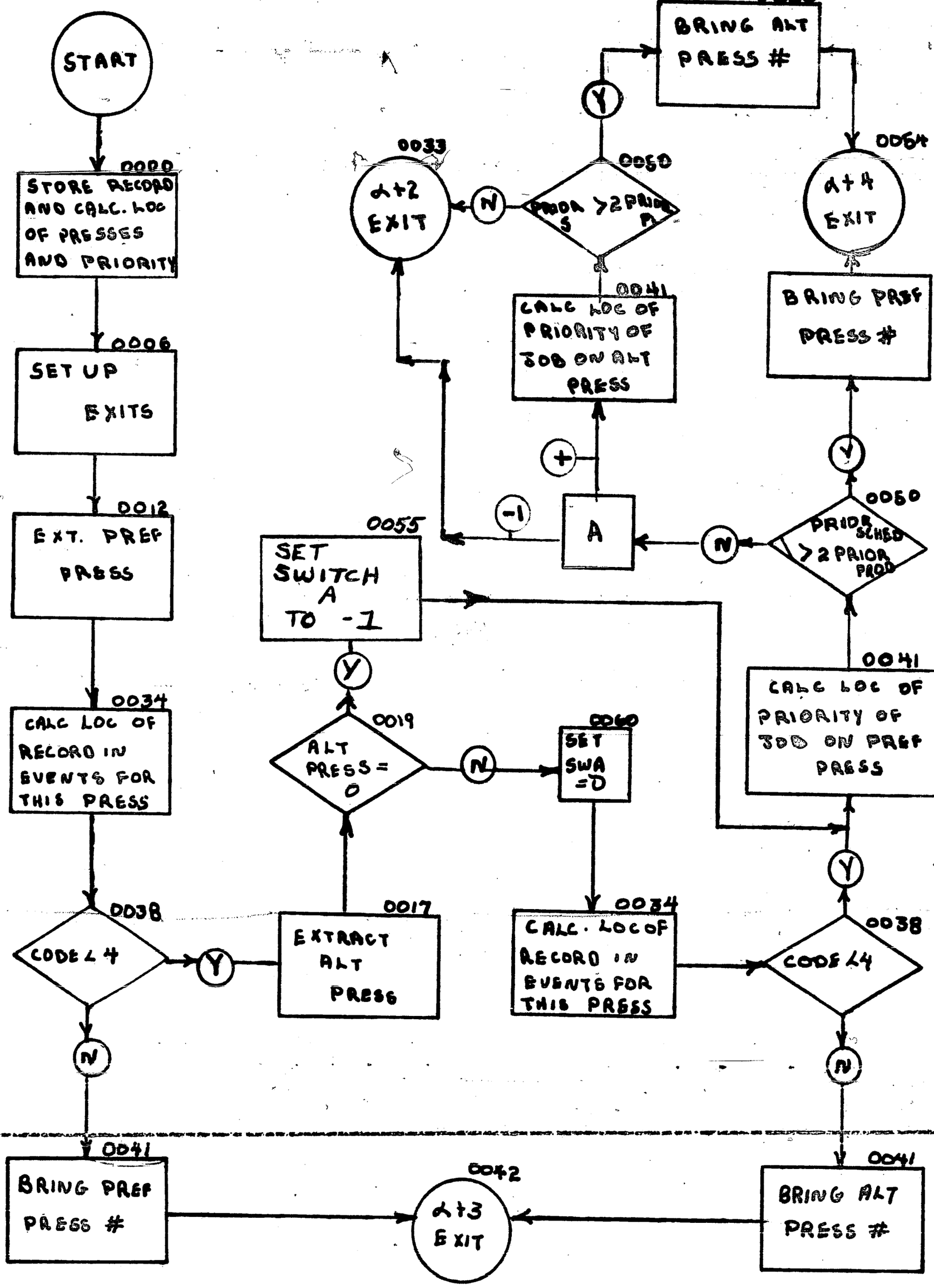
R0052

U0043

c. Area used 0043 to 0054

AREA USED 3600 to 3663

SUBROUTINE 6-1



PUNCH PRESS SIMULATION

Subroutine No. 6-1 Track No. 36

Title: Check presses to see if new job can be run

```
0000  xh6363'    Lo Record
0001  xa6231'    3 at 29
0002   y0011'    address of press #'s
0003   y0017'
0004  xa6211'    2 at 29
0005   y0050'    address of priority
0006   b0033'    no exit
0007  xa6201'    1 at 29
0008   y0042'    yes exit press free
0009  xa6201'    1 at
0010   y0054'    yes exit press bumped
0011  xb0351'    preferred and alternate press #'s
0012  xe6216'    W0000                preferred press
0013  xm6207'    1 at 14
0014   h0058'    preferred press at 29
0015   r0040'    is press free?     SUB 6-1 ALPHA
0016   u0034'
0017  xb0351'    preferred and alternate press #'s
0018  xe6240'    3J                   alternate press
0019  xs6201'    1 at 29
0020   t0055'    transfer if 0
0021  xa6201'    1 at 29
0022   u0060'    transfer to set Switch A to zero
0023   r0040'    is press free?     SUB 6-1 ALPHA
0024   u0034'
0025   b0058'    preferred press at 29
0026   r0052'    can job be bumped? SUB 6-1 BETA
0027   u0043'
0028  xb6146'    Switch A
0029   t0033'    transfer if alternate press is 0
0030   b0059'    Alternate press at 29
0031   r0052'    can job be bumped? SUB 6-1 BETA
```

PUNCH PRESS SIMULATION

Subroutine No. 6-1 **Track No. 36**

Title: Check presses to see if a new job can be run

```
0032    u0043'
0033   xu2316'    NO EXIT                          R HERE
0034   xh6362'    temp                             START SUB 6-1 ALPHA
0035   xd6223'    1/3 at 0
0036   xa6106'    LO Events -3
0037    y0038'
0038   xb0012'    code for press
0039   xs6209'    4 at 29
0040    t0025'    transfer if press not free   EXIT
0041   xb6362'    temp   press # free
0042   xu2317'    YES EXIT -- PRESS FREE
0043   xh6362'    temp                         START SUB 6-1 BETA
0044   xd6205'    1/10 at 0
0045   xa6102'    Lo Prod -10
0046   xa6202'    5 at 29
0047    y0048'
0048   xb0032'    Priority of job on press
0049   xd6213'    1/2 at 0
0050   xs0353'    Priority of job be ing checked
0051    t0053'    transfer if job can be bumped
0052    u0033'    transfer if press can not be bumped   EXIT
0053   xb6362'    temp-- press # that can be bumped
0054   xu2318'    YES EXIT -- PRESS BUMPED
0055   xb6232'    -1 at 29
0056   xh6146'    Switch A
0057    u0025'
0058   xz0006'    constant--preferred press at 29
0059   xz0005'    constant-- alternate press at 29
0060    c0059'
0061   xh6146'    Switch A
0062    b0059'    alternate press at 29
0063    u0023'
```

SUBROUTINE 6-2

PURPOSE

1. To determine if the priority of the job in the given record is twice the total priority of all the jobs being supervised by any setupman or operator. The man supervising the jobs with the minimum priority will be bumped if more than one man's jobs meet the criteria stated above.
2. To determine if the priority of the job in the given record is less than or equal to the priority of the job being setup by a setupman. If there is more than one setupman who meets the above criteria, the job with the minimum priority will be bumped.

CALLING SEQUENCES

1. Check all setupmen doing setups.

```
BXXXX  initial location of record to be checked.
XR3831
XU3700
UXXXX  exit at this location if no job can be bumped.
XXXXX  exit at this location with the man number in the
       accumulator of the man who is to be bumped. The
       code word for this man is stored in 6150.
```

2. Check all setupmen supervising the operation of presses.

```
BXXXX  initial location of record to be checked.
XR3831
XU3706
UXXXX  exit at this location if no job can be bumped.
XXXXX  exit at this location with the man number in the
```

accumulator. The code word for this man is stored in 6150.

3. Operator supervising the operation of presses.

BXXXX 1st location of record to check

XR3831

XU3850

UXXXX exit at this location if no job can be bumped.

XXXXX exit at this location with the man number in the accumulator of the man who is to be bumped. The code word for this man is stored in 6150.

INTERNAL SUBROUTINES

1. Subroutine Alpha

a. Purpose: To accumulate the priority on all jobs being supervised by a man, multiply this priority by two, and compare this total priority with the given priority and with the minimum total priority found so far.

b. Calling Sequences

1. Accumulate priority and make comparisons.

R0119

U0034

2. Obtain priority of job being setup and make comparisons.

R0119

U0139

c. Area used 0034 to 0119

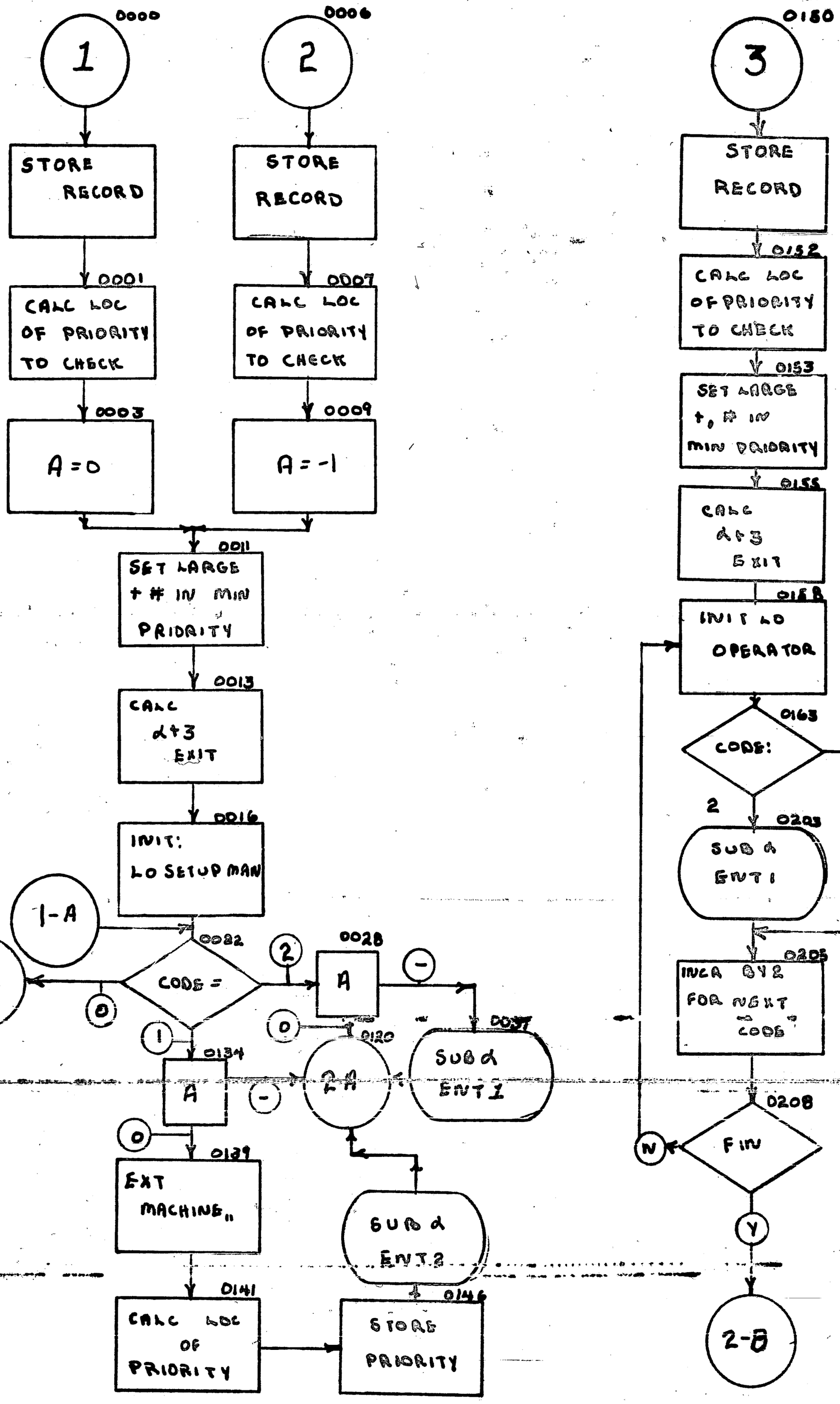
0139 to 0149

AREA USED 3700 to 3934

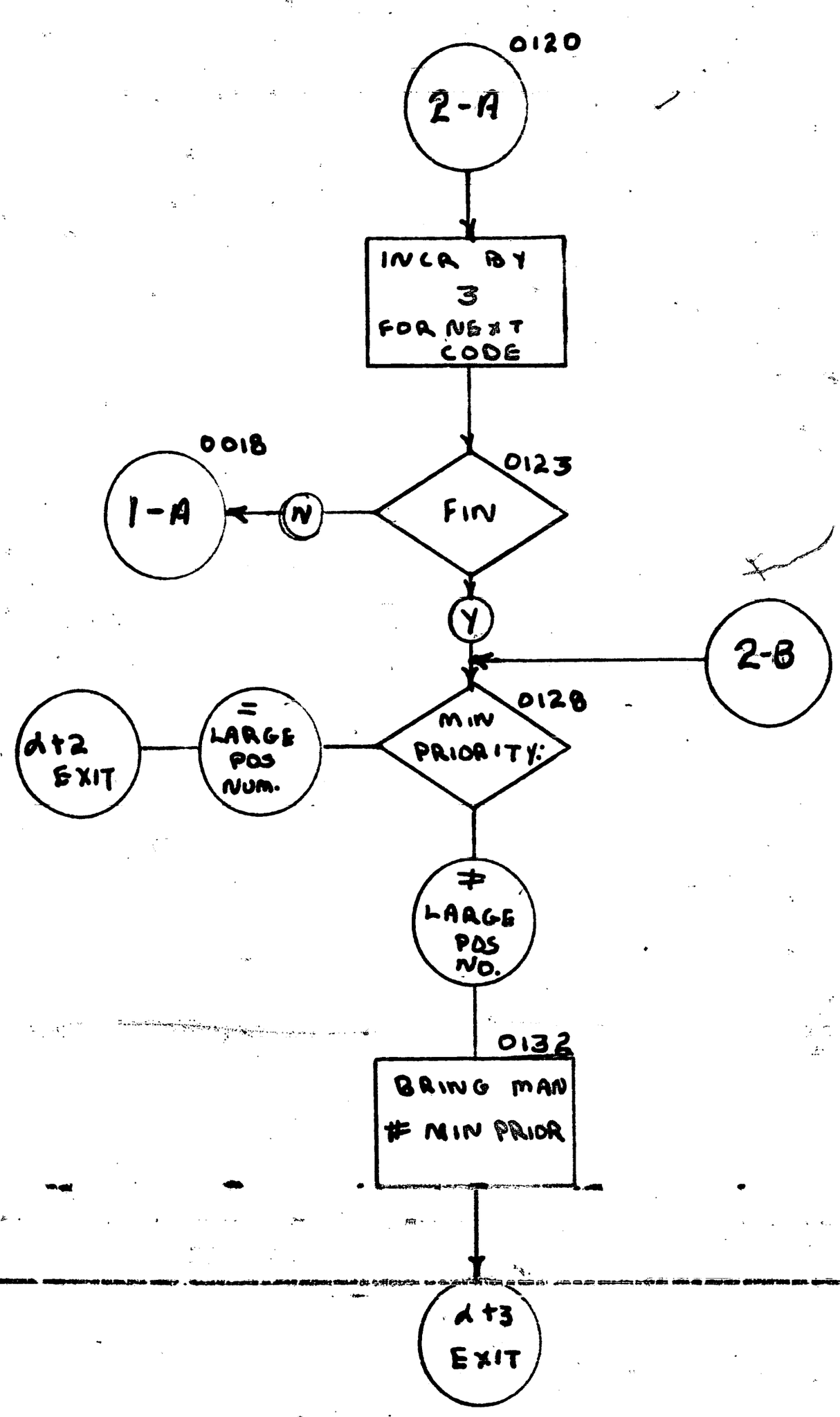
ERROR STOPS

3918 **No press is assigned to the operator when a code indicates that there should be one assigned. DO NOT PRESS "Start Compute."**

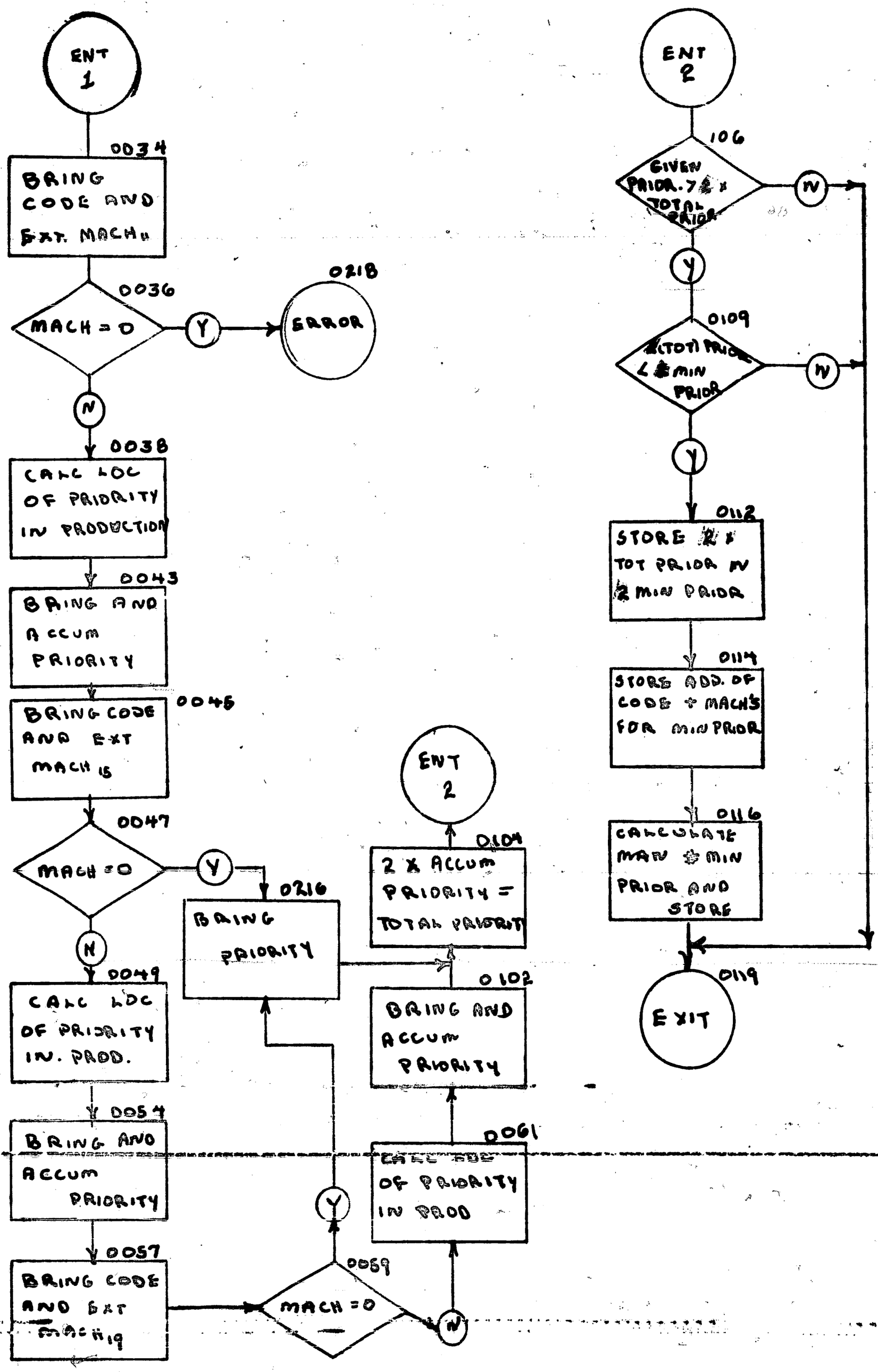
SUBROUTINE 6-2



SUBROUTINE 6-2



SUBROUTINE 6-2 SUB α



PUNCH PRESS SIMULATION

Subroutine No. 6-2 Track No. 37

Title: See if any personnel can be bumped

```
0000   xh6350'      Lo Record                    START--SETUPMEN DOING SETUPS
0001   xa6202'      5 at 29
0002    y0106'      address of priority to check
0003   xb6203'      zero
0004   xh6146'      Switch A
0005    u0011'
0006  xh6350'       Lo Record                    START--SETUPMAN SUPERVISING
0007   xa6202'      5 at 29                                 OPERATION
0008    y0106'      address of priority to check
0009   xb6232'      -1 at 29
0010   xh6146'      Switch A
0011   xb6239'      Large plus #
0012    h0213'      minimum priority to check
0013    b0131'      no exit
0014   xa6201'      1 at 29
0015    y0133'      yes exit
0016   xb6105'      Lo Setupman Available
0017    y0022'
0018    y0034'
0019    y0045'
0020    y0057'
0021    u0219'      transfer to setup more locations
0022   xb0223'      code in Setupman
0023   xe6214'      W000000              code at 7
0024   xs6218'      1 at 7
0025    t0120'      transfer if man free     Code is 0
0026   xs6218'      1 at 7
0027    t0134'      transfer if man doing setup      Code is 1
0028   xb6146'      Switch A       Code is 2--man is supervising
0029    t0031'      transfer to check bumping                operation
0030    u0120'      TRANSFER to incrementor
0031    r0119'      check for bumping  SUB 6-2 ALPHA ENTRANCE 1
```

PUNCH PRESS SIMULATION

Subroutine No. 6-2 **Track No. 37**

Title: See if any personnel can be bumped

```
0032   u0034'
0033   u0120'    transfer to incrementor    no bump
0034   xb0220'   code from setupman START SUB 6-2 ALPHA  ENT. 1
0035   xe6215'   W00000                press at 11
0036   xs6224'   1 at 11
0037    t0218'   transfer if 0   ERROR
0038   xm6206'   1 at 13
0039   xd6205'    1/10 at 0
0040   xa6102'   Lo Prod.
0041   xa6240'   15 at 29     to get address of correct priority
0042    y0043'   priority
0043   xb0148'   priority
0044    h0214'   accumulated priority
0045   xb0220'   code word
0046   xe6216'   W0000                press # at 15
0047   xs6226'   1 at 15
0048    t0216'   transfer if 0      no other presses assigned
0049   xm6207'   1 at 14
0050   xd6205'   1/10 at 0
0051   xa6102'   Lo Prod
0052   xa6240'   15 at 29    to get address of correct priority
0053    y0054'
0054    b0000'   priority
0055    a0214'   accumulated priority
0056    h0214'   accumulated priority
0057   xb0220'   code word
0058   xe6217'   W000                press # at 19
0059   xs6227'   1 at 19
0060    t0216'   transfer if 0      no other presses assigned
0061   xm6208'   1 at 10
0062   xd6205'   1/10 at 0
0063   xa6102'   Lo Prod
```

PUNCH PRESS SIMULATION

Subroutine No. 6-2 Track No. 38

Title: See if any personnel can be bumped

```
0100   xa6240'        15 at 29
0101    y0102'
0102    b0000'        priority
0103    a0214'        accumulated priority
0104   xd6213'        1/2 at 0
0105    h0214'        2(accumulated priority)
0106   xs0755'        given priority      SUB 6-2 ALPHA  ENT. 2
0107    t0109'        transfer to check if this is min. priority
0108    u0119'        transfer to exit                    so far
0109    b0213'        2(minimum priority)
0110    s0214'        2(accumulated priority)
0111    t0119'        transfer if min. still min.
0112    b0214'        2(accumulated priority)
0113    h0213'        2(minimum priority)
0114    b0034'        address of code of man bumped
0115   xh6150'
0116   xs6112'        B(Lo Setupman o/r Lo Operator)
0117   xm6223'        1/3 at 0 or 1/2 at 0
0118    h0215'        man # with min priority to be bumped
0119    u0138'        transfer to exit
0120    b0034'        address of code    Incrementor for Setupman
0121   xa6231'        3 at 29
0122    h0022'        temp
0123   xs6111'        B(Last loc. plus 1 of Setupman)
0124    t0126'        transfer if not finished
0125    u0128'        transfer if finished
0126    b0022'        temp
0127    u0018'
0128    b0213'        minimum priority
0129   xs6239'        large positive #
0130    t0132'        transfer if minimum priority found
0131   xu2649'        transfer if no man can be bumped  NO EXIT  R HERE
```

PUNCH PRESS SIMULATION

Subroutine No. 6-2 Track No. 38

Title: See if any personnel can be bumped

0132	b0215'	man # minimum priority
0133	xu2650'	YES EXIT
0134	xb6146'	Switch A Code is 1
0135	t0120'	transfer to incrementor
0136	r0119'	check for bumping SUB 6-2 ALPHA Ent. 2
0137	u0139'	
0138	u0120'	transfer to incrementor
0139	xb0220'	code word ~~START/SUB/6-2/ENT/2~~
0140	xe6215'	W0000 press at 11
0141	xm6206'	1 at 18
0142	xd6205'	1/10 at 0
0143	xa6102'	Lo Prod
0144	xa6202'	5 at 29
0145	y0146'	location of priority
0146	xb0128'	priority
0147	u0148'	
0148	h0214'	2(accumulated priority)
0149	u0106'	transfer to SUB 6-2 ALPHA ENT. 2
0150	xh6350'	Lo record START--OPERATOR SUPERVISING
0151	xa6202'	5 at 29 OPERATION
0152	y0106'	
0153	xb6239'	large plus #
0154	h0213'	minimum priority to check
0155	b0131'	no exit
0156	xa6201'	1 at 29
0157	y0133'	yes exit
0158	xb6104'	Lo Operator
0159	y0034'	
0160	y0045'	
0161	y0057'	
0162	u0225'	set up more locations
0163	b0000'	code word

PUNCH PRESS SIMULATION

Subroutine No. 6-2 Track No. 39

Title: See if any personnel can be bumped

```
                0200    xe6214'     W000000             code at 7
                0201    xs6210'     2 at 7
                0202     t0205'     transfer if operator free
                0203     r0119'     check for bumping  SUB 6-2 ALPHA ENT. 1
                0204     u0034'
                0205     b0163'     loc of code         incrementor
                0206    xa6211'     2 at 29
                0207     h0034'
                0208    xs6114'     B(Least loc. plus 1 of Operator)
                0209     t0211'     transfer if not finished
                0210     u0128'     transfer if finished
                0211     b0034'
                0212     u0160
,0000001'       0213 01000000'      constant--minimum priority to check
                0214    xz0202'     constant--accumulated priority
                0215    xz0002'     constant--man # minimum priority
                0216     b0214'     accumulated priority
                0217     u0104'
                0218    xz0000'     ERROR STOP--NO PRESS AT 11
                0219     y0139'
                0220     b0231'     S6112
                0221     y0116'
                0222     b0234'     M6223
                0223     y0117'
                0224     u0022'
                0225     y0163'
                0226     b0232'     S6115
                0227     y0116'
                0228     b0233'     M6213
                0229     y0117'
                0230     u0163'
                0231    xs6112'     constant  Lo Setupman-3
```

Subroutine No. 6-2 Track No. 39

Title: See if any personnel can be bumped

```
0232   xs6113'     constant--Lo Operator-2
0233   xm6213'     constant--1/2 at 0
0234   xm6223'     constant--1/3 at 0
0235   xb6101'     Lo Action              PATCH SUB 4-1  EF 4530
0236    y0237'
0237   xb0752'     contents of 1st Loc of record      EF 4542
0238   xs6201'     1 at 29
0239   xt4538'     transfer if record empty
0240    b0237'     Lo Action
0241   xu4531'
0242   xt3456'                            PATCH SUB 14 EF 1710
0243   xs6201'     1 at 29
0244   xt3461'
0245   xa6201'     1 at 29
0246   xs6143'     current clock
0247   xu3456'
0248    b0251'     XU3452                 EF 1702
0249   xh1710'
0250   xu1705'
0251   xu3452'     constant
0252    u0242'
0253   xb6302'     Alt press #            PATCH SUB 13  EF 1619
0254   xs6201'     1 at 29
0255   xt1628'     transfer if 0
0256   xa6201'     1 at 29
0257   xu1620'
0258   xu3455'
0259   xz0338'                            ASSIST FILE
0260   xz0328'                                 "
0261   xz0348'                                 "
0262   xz0000'                                 "
0263   xz0000'                                 "
```

SUBROUTINE 7

PURPOSE: To shift all the records of jobs contained in the code word for a setupman or an operator to the Action File. The units produced are calculated and the Events File is updated for each job.

CALLING SEQUENCES

1. Code word is for a setupman

   BXXXX man number

   XR3233

   XU3100

2. Code word is for an operator

   BXXXX man number

   XR3233

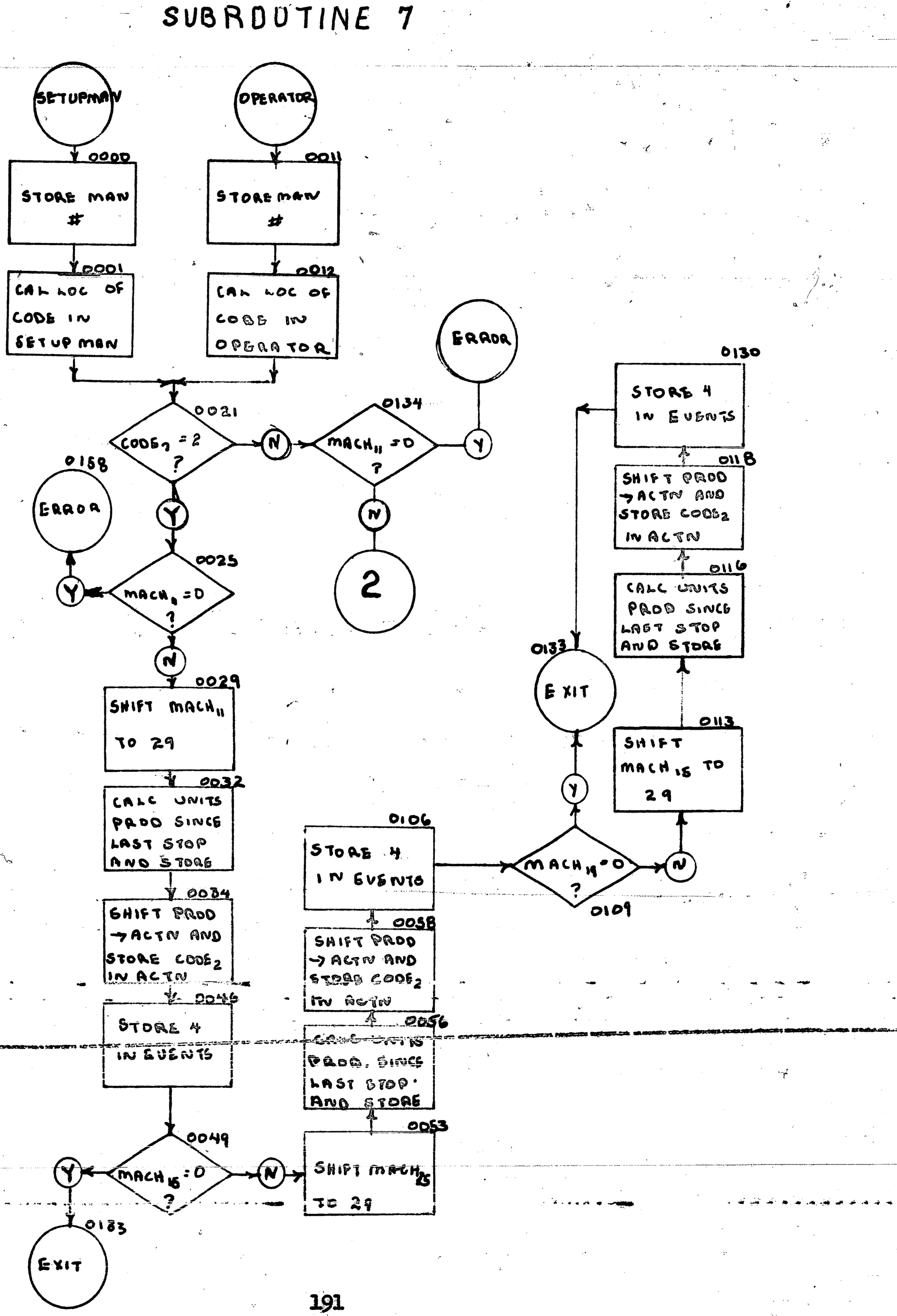
   XU3111

SUBROUTINES USED

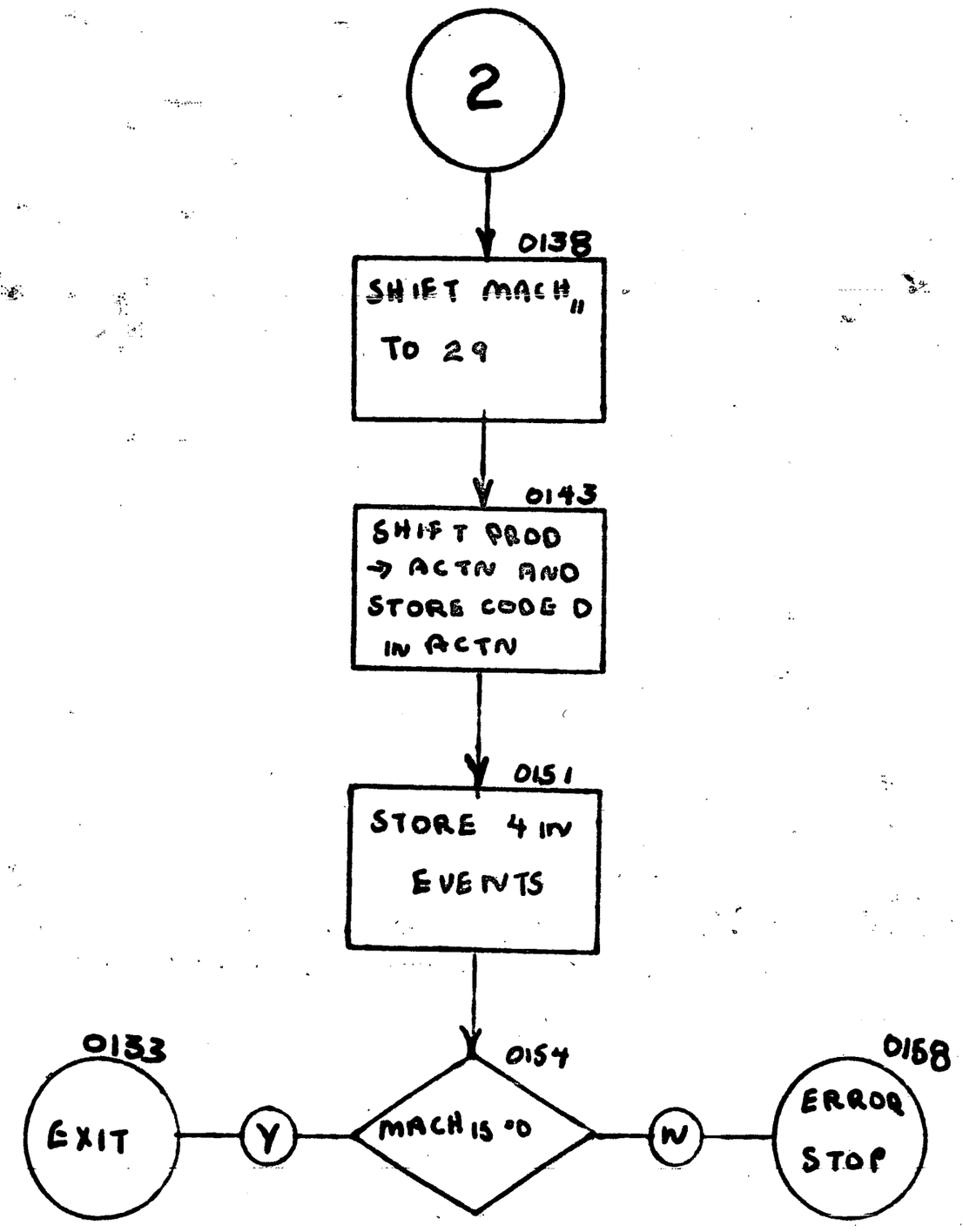
1. Subroutine 1 Shift Data
2. Subroutine 2 Store Codes
3. Subroutine 8 Calculate Units Produced

AREA USED 3100 to 3261

SUBROUTINE 7



SUBROUTINE 7



PUNCH PRESS SIMULATION

Subroutine No. 7 **Track No. 31**

Title: Shift records of bumped jobs to Action File

```
0000   xh6300'    man #                          START IF SETUPMAN
0001   xd6223'    1/3 at 0
0002   xa6124'    Lo Setupman -3
0003    y0021'
0004    y0049'
0005    y0025'
0006    y0109'
0007    y0134'
0008    y0154'
0009   xh6301'    temp
0010    u0021'
0011   xh6300'    man #                          START IF OPERATOR
0012   xd6213'    1/2 at 0
0013   xa6123'    Lo Operator -2
0014    y0021'
0015    y0049'
0016    y0025'
0017    y0109'
0018    y0134'
0019    y0154'
0020   xh6301'    temp
0021   xb0220'    code word
0022   xe6214'    W000000                        code at 7
0023   xs6210'    2 at 7
0024    t0134'    transfer if man not operating  code less 2
0025   xb0220'    code word
0026   xe6215'    W00000                         press # at 11
0027   xs6224'    1 at 11
0028   t0158'     X/X/X/X  transfer if zero      ERROR
0029   xa6224'    1 at 11
0030   xm6206'    1 at 18
0031   xh6132'    press #
```

PUNCH PRESS SIMULATION

Subroutine No. 7 **Track No. 31**

Title: Shift records of bumped jobs to Action File

```
                0032    xr3522'     Calculate units prod.      SUB 8
                0033    xu3500'
                0034    xb6132'     press #
                0035    xd6205'     1/10 at 0
                0036    xa6102'     Lo Prod -10
                0037     y0040'
                0038    xr5823'     Shift data to Action       SUB 1
                0039    xu5722'
                0040     z0000'     Lo  of Source record
                0041    xb5827'     Lo of Destination plus 10
                0042    xs6204'     10 at 29
          0043  xr5225'             Store Code          SUB 2
                0044    xu5220'
                0045    xz0002'     Indicate why ~~pres~~ record was in Action
                0046    xr5557'     Store Code          SUB 2
                0047    xu5209'
                0048    xz0004'     Indicate press is free  code 4 to events
                0049    xb0220'     code word
                0050    xe6216'     W0000
                0051    xs6226'     1 at 15
                0052     t0133'     transfer if no more presses
                0053    xa6226'     1 at 15
                0054    xm6207'     1 at 14
                0055    xh6132'     press #
                0056    xr3522'     Calculate units pred.      SUB 8
                0057    xu3500'
                0058    xb6132'     press #
                0059    xd6205'     1/10 at 0
                0060    xa6102'     Lo Prod - 10
                0061     y0100'
                0062    xr5823'     Shift data to Action       SUB 1
                0063    xu5722'
```

PUNCH PRESS SIMULATION

Subroutine No. 7 Track No. 32

Title: Shift records of bumped jobs to Action File

```
0100    xz6237'     Lo of Source record
0101    xb5827'     Lo of Destination plus 10
0102    xs6204'     10 at 29
0103    xr5225'     Store Code          SUB 2
0104    xu5220'
0105    xz0002'     Indicate why record is in Action
0106    xr5557'     Store Code          SUB 2
0107    xu5209'
0108    xz0004'     Indicate press free
0109    xb0220'     code word
0110    xe6217'     W000
0111    xs6227'     1 at 19
0112     t0133'     transfer ifno more presses
0113    xa6227'     1 at 19
0114    xm6208'     1 at 10
0115    xh6132'     press #
0116    xr3522'     Calculate units prod      SUB 8
0117    xu3500'
0118    xb6132'     press #
0119    xd6205'     1/10 at 0
0120    xa6102'     Lo Prod -10
0121     y0124'
0122    xr5823'     Shift data          SUB 1
0123    xu5722'
0124    xz0000'     Lo of Sourze record
0125    xb5827'     Lo of Destination plus 10
0126    xs6204'     10 at 29
0127    xr5225'     Store Code          Sub 2
0128    xu5220'
0129    xz0002'     Indicate why record is in Action
0130    xr5557'     Store Code          SUB 2
0131    xu5209'
```

PUNCH PRESS SIMULATION

Subroutine No. 7 **Track No. 32**

Title: Shift records of bumped jobs to Action File

```
0132    xz0004'     Indicate press free
0133    xu2653'     EXIT                    R HERE
0134    xb0220'     code word               CODE LESS THAN 2
0135    xe6215'     W00000                  press at 11
0136    xs6224'     1 at 11
0137     t0158'     transfer if no press    ERROR
0138    xa6224'     1 at 11
0139    xm6206'     1 at 18
0140     u0159'     transfer to pateh
0141    xa6102'     Lo Prod -10
0142     y0145'
0143    xr5823'     Shift data              SUB 1
0144    xu5722'
0145    xz0037'     Lo of Source Record
0146    xb5827'     Lo of Destination plus 10
0147    xs6204'     10 at 29
0148    xr5225'     Store Code              SUB 2
0149    xu5220'
0150    xz0000'     Indicate why record is in Action
0151    xr5557'     Store Code              SUB 2
0152    xu5209'
0153    xz0004'     Indicate press free
0154    xb0220'     code word
0155    xe6216'     W0000
0156    xs6226'     1 at 15
0157     t0133'     transfer if finished
0158    xz0000'     ERROR STOP
0159    xh6132'     press #
0160    xd6205'     1/10 at 0
0161     u0141'
0162    xh6348'     free
0163    xu3300'     free
```

SUBROUTINE 7-1

PURPOSE: To sample the Setuptime Distribution and the Distribution of Inspection Times and accumulate the total setup time. A constant tear down time is added to the total setup time, and the result is added to the current clock time. (the time in the minimum clock) This value, the time when the setup will be completed, is stored in the proper clock in the Events File.

CALLING SEQUENCE

EXXXX press number on which job is to be setup

XR3038

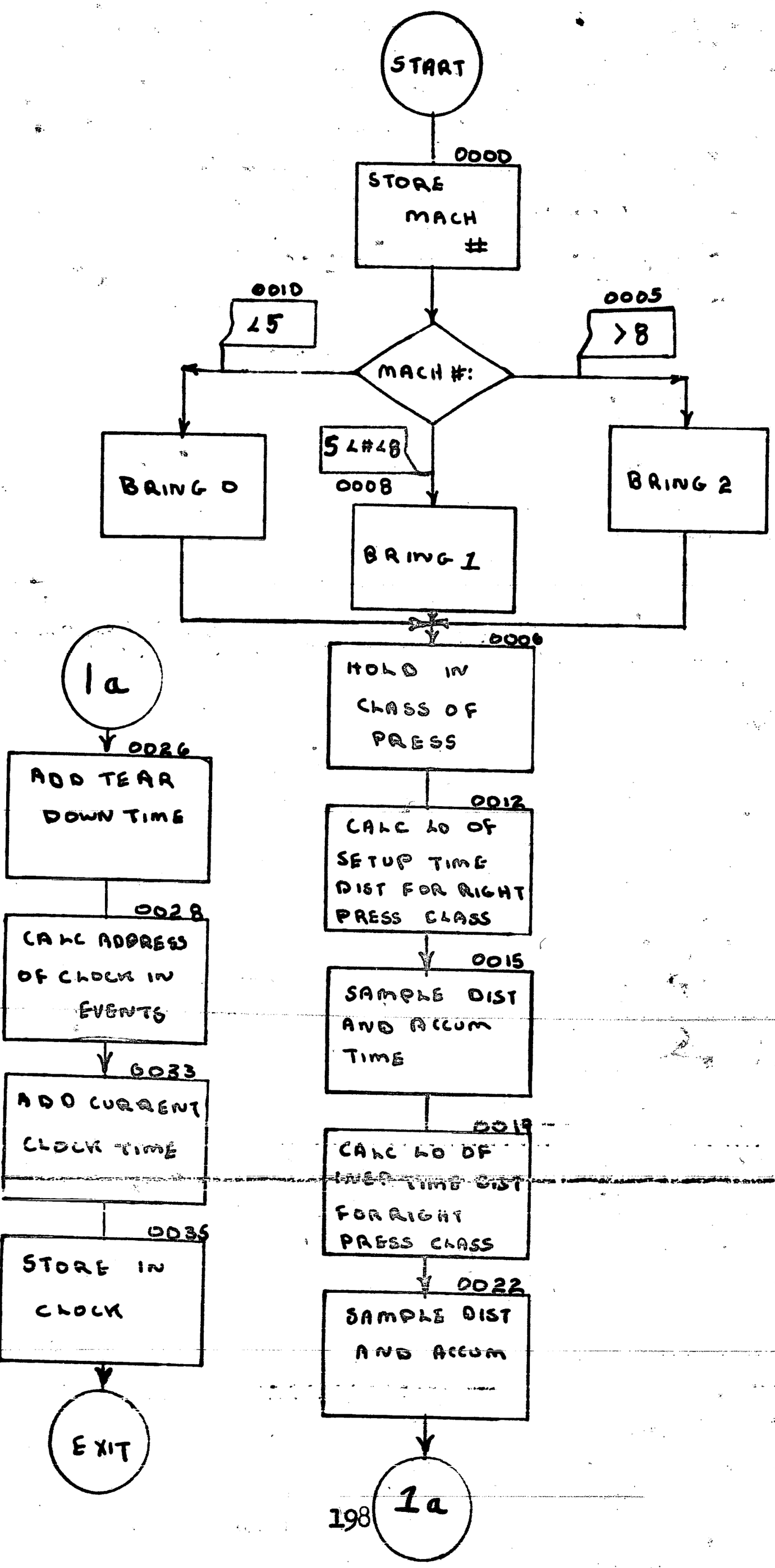
XU3000

SUBROUTINES USED

1. Subroutine 2 Store Codes
2. Subroutine 5 Sample Distribution

AREA USED 3000 to 3043

SUBROUTINE 7-1



PUNCH PRESS SIMULATION

Subroutine No. 7-1 Track No. 30

Title: Accumulate setup time

```
0000   xh6132'      press #
0001   xs6202'      5 at 29
0002    t0010'      transfer if press in group 1
0003   xs6231'      3 at 29
0004    t0008'      transfer if press in group 2
0005   xb6211'      2 at 29                PRESS IN GROUP 3
0006   xh6151'      press group #
0007    u0012'
0008   xb6201'      1 at 29                PRESS IN GROUP 2
0009    u0006'
0010   xb6203'      zero                   PRESS IN GROUP 1
0011    u0006'
0012    b0056'      loc of beginning loc of Setup dist for group 1
0013   xa6151'      press group #
0014    y0015'
0015    b0060'      Lo Setup dist for correct press group
0016   xr4029'      Sample Distribution    SUB 5
0017   xu4000'
0018    h0039'      Accumulated setup time
0019    b0057'      loc of beginning loc of Inspection dist
0020   xa6151'      press group #                  for group 1
0021    y0022'
0022    b0063'      Lo Inspection dist for correct press group
0023   xr4029'      Sample Distribution    SUB 5
0024   xu4000'
0025    a0039'      Accumulated Setup time
0026   xa6209'      4 at 29  Constant tear down time
0027    h0039'      Total setup time
0028   xb6132'      press #
0029   xd6223'      1/13 at 0
0030   xa6106'      Lo Events -3
0031   xa6201'      1 at 29
```

PUNCH PRESS SIMULATION

Subroutine No. 7-1 **Track No. 30**

Title: Accumulate setup time

```
                0032    y0035'      Loc of time in events
                0033    b0039'      Total setup time
                0034    xa6143'     currentclock
                0035    xh0025'     time setup finished in Events
                0036    xb6201'     1 at 29
                0037     u0040'     patch
                0038    xu2104'     EXIT          R HERE
                0039    xz0032'     constant--accumulated setup time
                0040    xr5557'     Store Code          SUB 2
                0041    xu5209'
                0042    xz0001'     Indicate press being setup
                0043     u0038'
                0044    xb6125'     free
                0045     y0046'      "
                0046    xb0027'      "
                0047    xr6360'      "
        0048    xu5900'              "
                0049     b0046'      "
                0050    xa6201'      "
                0051     h0046'      "
                0052    xs6116'      "
                0053     t0046'      "
                0054    xu3410'      "
                0055     z0000'      "
                0056     z0058'     constant--beginning loc of Setup dist group 1
                0057     z0061'     constant--beginning loc of Inspection dist group 1
                0058    xz0942'     constant--beginning loc of Setup dist group 1
                0059    xz0962'        "                 "  "   "    "    "    "   2
                0060    xz1018'        "                 "  "   "    "    "    "   3
                0061    xz1038'     constant--loc of Inspection dist group 1
                0062    xz1058'        "      "  "       "      "    "    "   2
                0063    xz1114'        "      "  "       "      "    "    "   3
```

SUBROUTINE 8

PURPOSE: To calculate the units produced on a press during the period since the press was last stopped and the current minimum clock time.

CALLING SEQUENCE

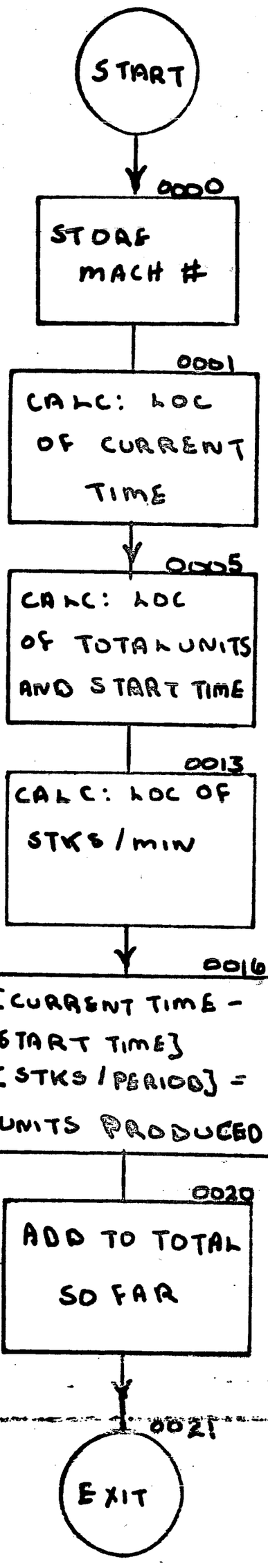
BXXXX press number of press that job was run on

XR3522

XU3500

AREA USED 3500 to 3531

SUBROUTINE 8



PUNCH PRESS SIMULATION

Subroutine No. 8 **Track No. 35**

Title: Calculate units produced

```
                0000    xh6132'    press #
                0001     u0006'    skip
                0002
                0003
                0004
                0005
                0006    xd6205'    1/10 at 0
                0007    xa6102'    Lo Prod -10
                0008    xa6238'    6 at 29
                0009     y0020'    loc. of units produced so far
                0010     y0021'
                0011    xa6201'    1 at 29
                0012     y0017'    loc. of time started
                0013    xb6110'    Lo of Strokes per time period Distribution
                0014    xa6132'    press #
                0015     y0019'
                0016    xb6143'    time minimum clock
                0017    xs0034'    start time
                0018    xd6241'    1 at 16
                0019     m0023'    proper strokes per time period at 16
                0020    xa0033'    units produced so far at 29
                0021    xh0033'    total units produced
                0022    xu1830'    EXIT                R HERE
,0000009'       0023 044j0000'     Strokes per Time Period Distribution at 16
                0024  05208000'
                0025  02qq0000'
                0026  02qq0000'
                0027  03jw0000'
                0028  03jw0000'
                0029  039k0000'
                0030  02f30000'
                0031  01770000'
```

SUBROUTINE 9

PURPOSE: To determine which of the clocks in the Events File, the Schedule File, or the Special Clocks has the minimum time. The code accompanying the minimum clock is analyzed and the program exits to the appropriate subroutine.

CALLING SEQUENCE

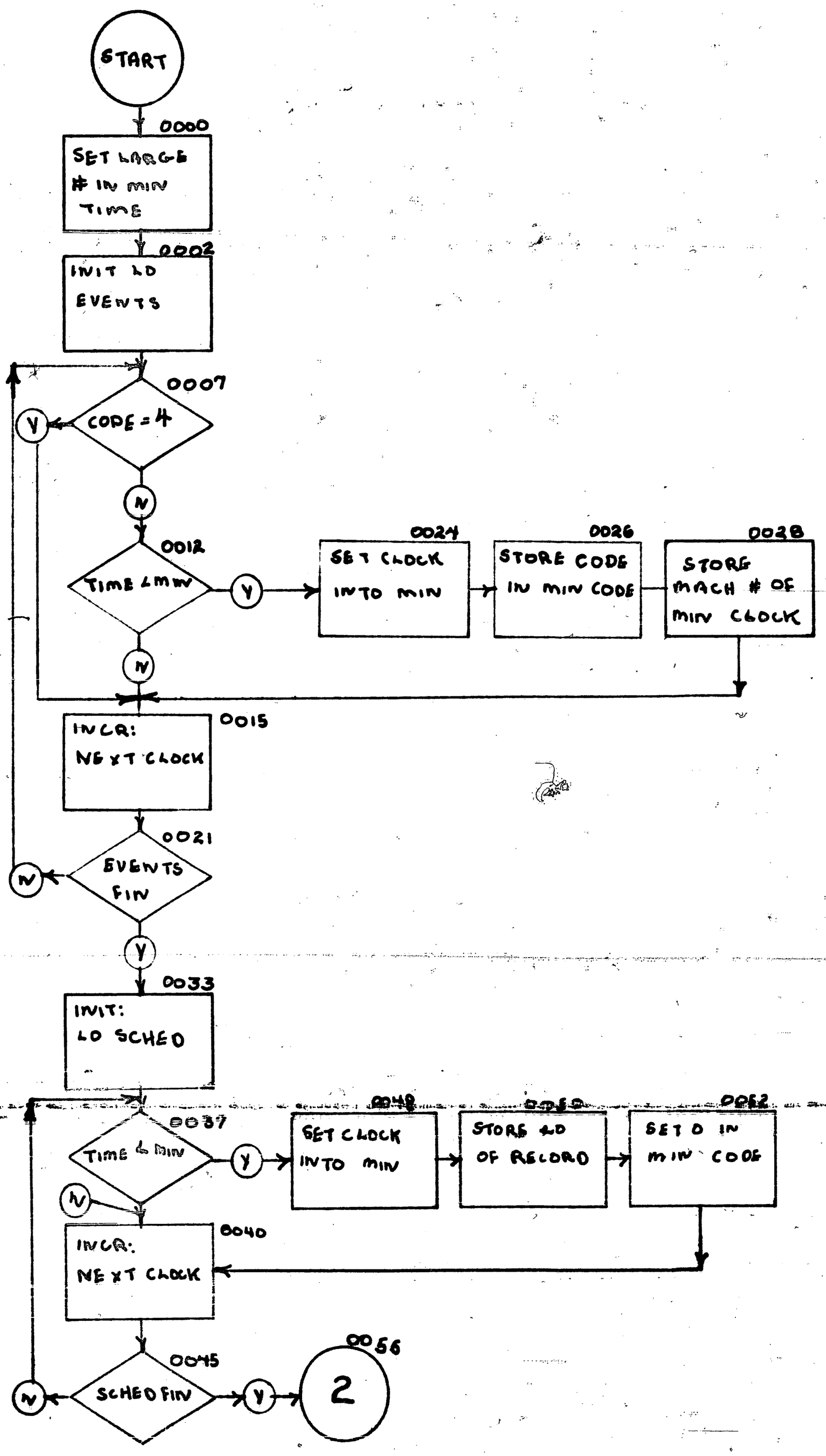
1. The program is entered by a XU3300 and exits to the appropriate subroutine.

AREA USED

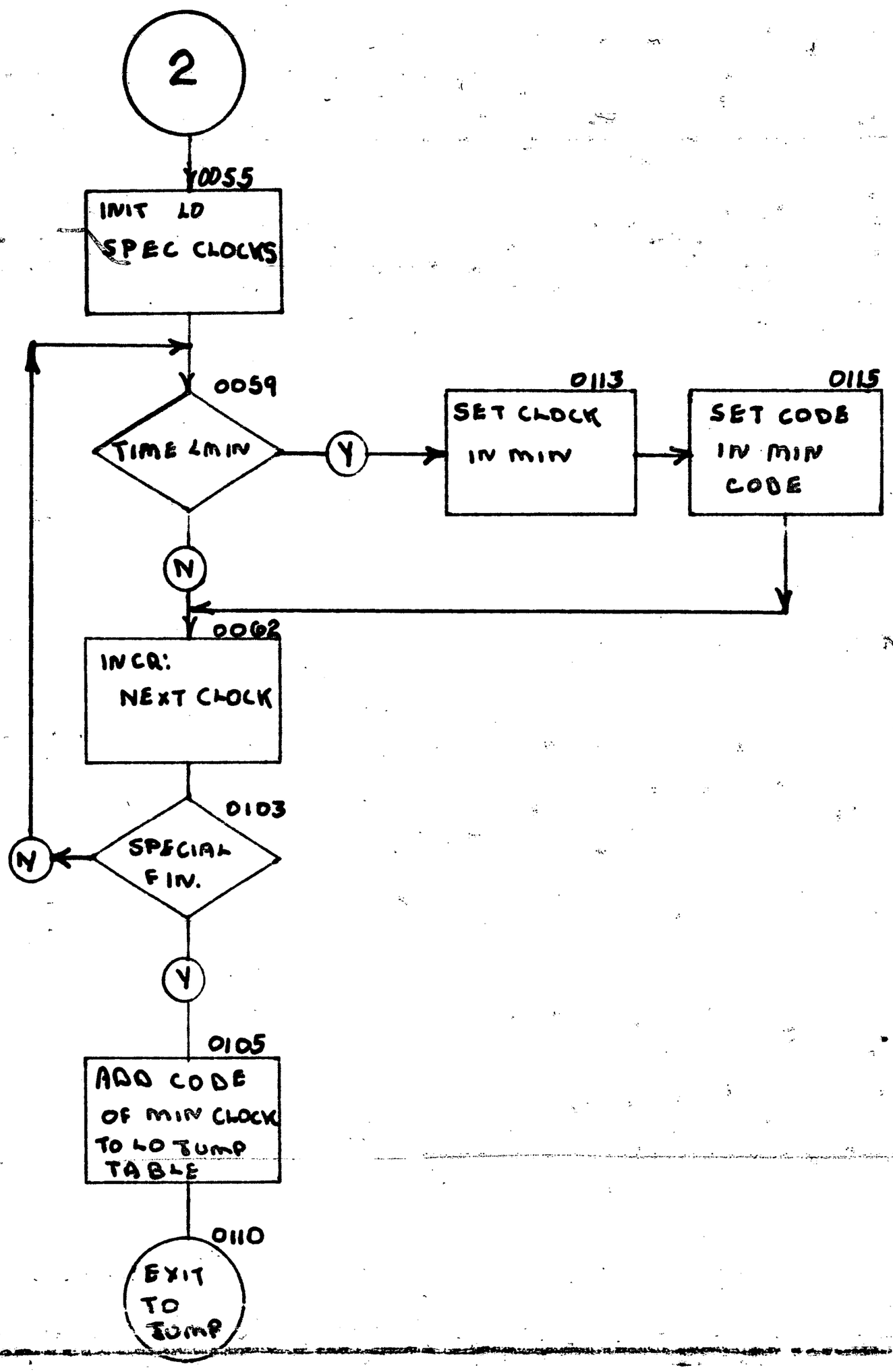
3300 to 3420

3427 to 3439

SUBROUTINE 9



SUBROUTINE 9



PUNCH PRESS SIMULATION

Subroutine No. 9 Track No. 33

Title: Select minimum clock

```
0000   xb6239'    lar go plus #      START
0001   xh6143'    minimum time
0002   xb6125'    Lo Events
0003    y0007'
0004    y0026'
0005   xa6201'    1 at 29
0006    y0012'
0007   xb0027'    code from Events
0008   xs6209'    4 at 29
0009    t0012'    transfer if press not free
0010   xs6201'    1 at 29
0011    t0015'    transfer if press free
0012   xb0028'    time from Events
0013   xs6143'    minimum time
0014    t0024'    transfer if this time less than minimum
0015    b0007'    address of code from Events
0016   xa6231'    3 at 29
0017    y0007'
0018    y0026'
0019   xa6201'    1 at 29
0020    y0012'
0021   xs6116'    B(last loc. of events plus 1)
0022    t0007'    transfer if all presses not checked
0023    u0033'    transfer if finished all presses
0024   xa6143'    minimum time
0025   xh6143'    minimum time
0026   xb0027'    code from Events
0027   xh6148'    code of minimum clock
0028    b0026'    address of code for minimum clock
0029   xs6117'    B(Lo of Events)
0030   xm6223'    1/3 at 0
0031   xh6149'    press # of minimum clock
```

PUNCH PRESS SIMULATION

Subroutine No. 9 Track No. 33

Title: Select minimum clock

```
0032   u0015'
0033   xb6118'   Lo Schedule Clocks
0034   y0050'    address of record to be setup
0035   xa6201'   1 at 29
0036   y0037'
0037   xb0208'   time from schedule clock
0038   xs6143'   minimum time
0039   t0048'    transfer if time less than minimum
0040   b0050'    address of job record to be setup (Loc. of)
0041   xa6211'   2 at 29
0042   y0050'
0043   xa6201'   1 at 29
0044   y0037'
0045   xs6119'   B(Last loc of Schedule Clocks plus 2)
0046   t0037'    transfer if all Schedule Clocks not checked
0047   u0055'    transfer if all Schedule clocks checked
0048   xa6143'   minimum time
0049   xh6143'   minimum time
0050   xb0207'   Lo of record to be setup
0051   xh6149'   Lo of record of minimum clock
0052   xb6203'   zero
0053   xh6148'   code of minimum clock
0054   u0127'    patch
0055   xb6120'   Lo of Special Clocks
0056   y0115'
0057   xa6201'   1 at 29
0058   y0059'
0059   xb0239'   time from Special Clocks
0060   xs6143'   minimum time
0061   t0113'    transfer if time less than minimum time
0062   b0115'    beginning location of record from Special Clocks
0063   xa6211'   2 at 29
```

PUNCH PRESS SIMULATION

Subroutine No. 9 Track No. 34

Title: Select minimum clock

```
0100   y0115'
0101   xa6201'      1 at 29
0102   y0059'
0103   xs6121'      B(Last Location of Special Clocks plus 1)
0104   t0059'       transfer if not finished
0105   u0133'       transfer to test if all clocks equal
0106   xa6122'      Lo Jump Table
0107   y0110'
0108   xy////' p1900'  Print Slash
0109   xz0000'
0110   b0122'       Location from jump table
0111   y0112'
0112   xu2303'      EXIT TO PROPER CONTROL PROGRAM
0113   xa6143'      minimum time
0114   xh6143'      minimum time
0115   xb0238'      code of special clock and address
0116   xy6149'      ////////////////  Lo of record min. clock
0117   xe6216'      W0000                code at 1/5
0118   xm6207'      1 at 14
0119   xh6148'      code of minimum clock
0120   u0130'       patch
0121   xu2603'      Code 0  job setup          JUMP TABLE
0122   xu2303'      Code 1  job operated        "    "
0123   xu1827'      Code 2  job finished       "    "
0124   xu1646'      Code 3  die repaired       "    "
0125   xu1656'      Code 4  run completed      "    "
0126   xu1518'      Code 5  initialize         "    "
0127   b0050'       address of record in Schedule Clock
0128   xh6162'
0129   u0040'
0130   b0059'       address of time in Special Clock
0131   xh6162'
```

PUNCH PRESS SIMULATION

Subroutine No. 9 Track No. 34

Title: Select minimum clock

```
0132    u0062'
0133    xb6143'     minimum time
0134    xs6239'     large positive number
0135    t0138'      transfer if there was a minimum time
0136    xz0000'     ERROR  NO MINIMUM TIME
0137    u0000'
0138    xb6148'     code from minimum clock
0139    u0106'
0140    xb6100'     Lo Assist   PATCH  SUB 13  EF 1526
0141    y0143'
0142    xb6203'     zero
0143    xh4000'     element of Assist File
0144    b0143'      address of element of Assist File
0145    xa6201'     1 at 29
0146    h0143'
0147    xs6251'     H(Lo Assist plus 5)
0148    t0142'      transfer if not finished
0149    xu5851'
0150    xb0210'     AOT         PATCH    SUB 14  EF 1710
0151    u0155'
0152    t0156'      free
0153    xs6143'     free
0154    u0156'      free
0155    xs6363'     Temp
0156    xc6350'                          complement #
0157    xs6350'
0158    xr6360'     print #
0159    xu5900'
0160    xu1807'     EXIT
0161    xp3200'     stop code
0162    xz0133'
0163    u0160'
```

SUBROUTINE 10

PURPOSE: To determine if the job which is scheduled to be setup can be setup. If the job can be setup, the time when the setup will be completed is determined. If necessary a job which is already in the process of being setup or is being operated will be bumped in favor of the scheduled job. If the scheduled job cannot be setup, the job record is shifted to the Action File.

ENTRANCE:

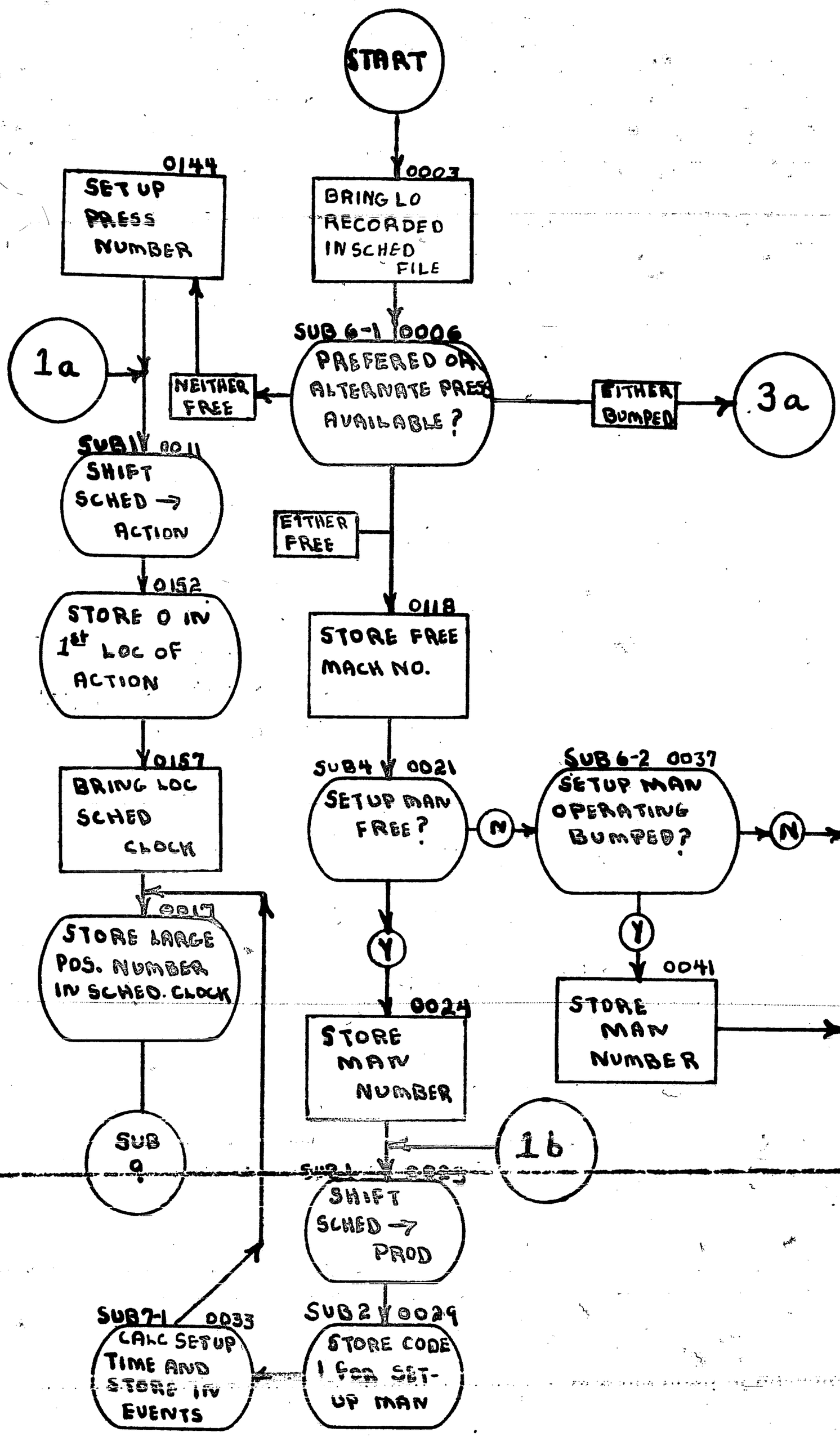
1. The subroutine is entered from location 3412 in Subroutine 9. The jump instruction to perform this exit is stored in location 3421.
2. This subroutine is entered when the code in the record from the Events File which has the minimum clock is a zero.

SUBROUTINES USED

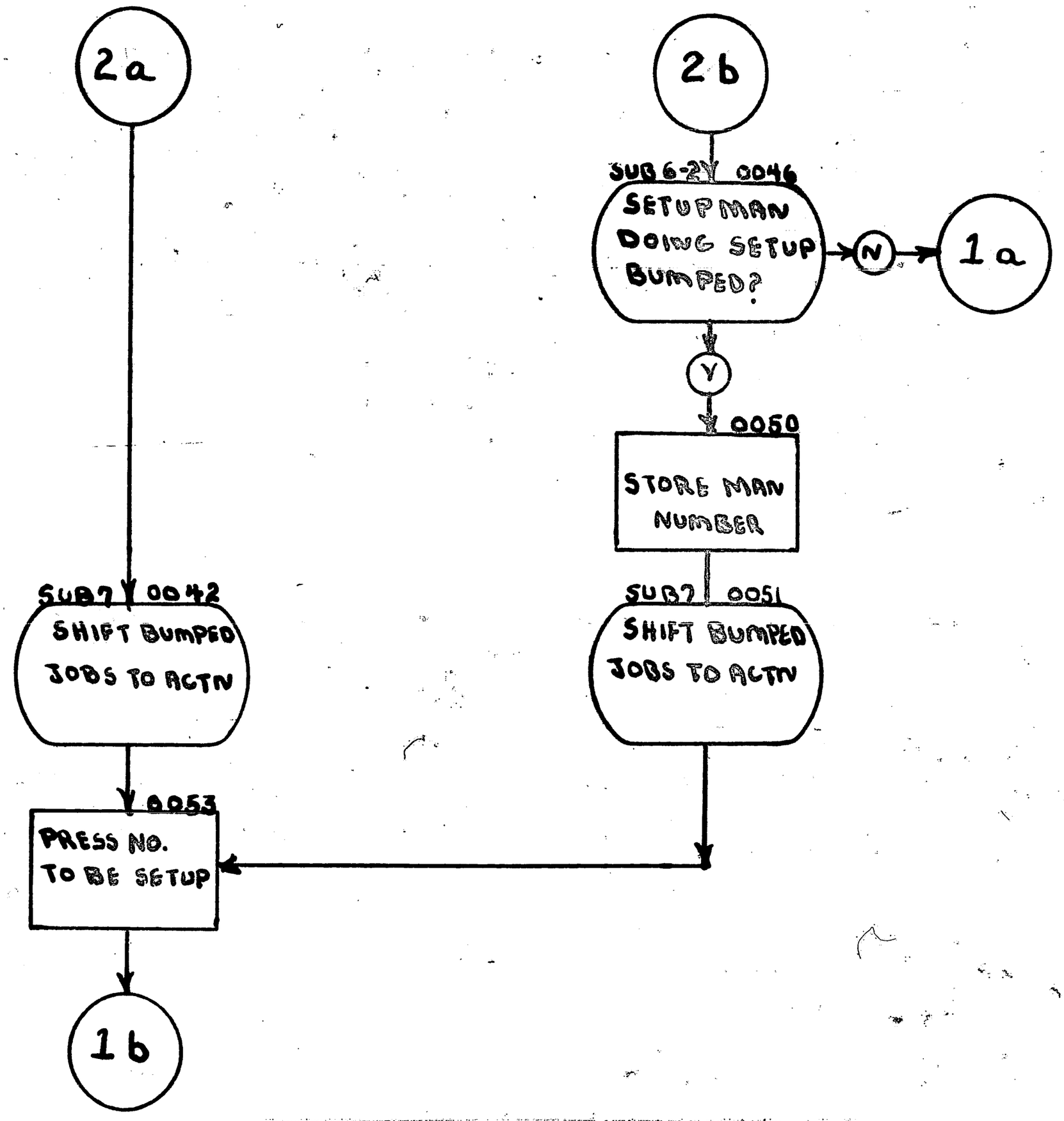
1. Subroutine 1 Shift Data
2. Subroutine 2 Store Codes
3. Subroutine 4 Check for availability of press, setupman or operator.
4. Subroutine 4-2 Find man operating given machine.
5. Subroutine 6-1 Check presses to see if a new job can be run.
6. Subroutine 6-2 See if personnel can be bumped.
7. Subroutine 7 Shift records of bumped jobs to Action File.
8. Subroutine 7-1 Accumulate Setup Time.

AREA USED 2603 to 2763

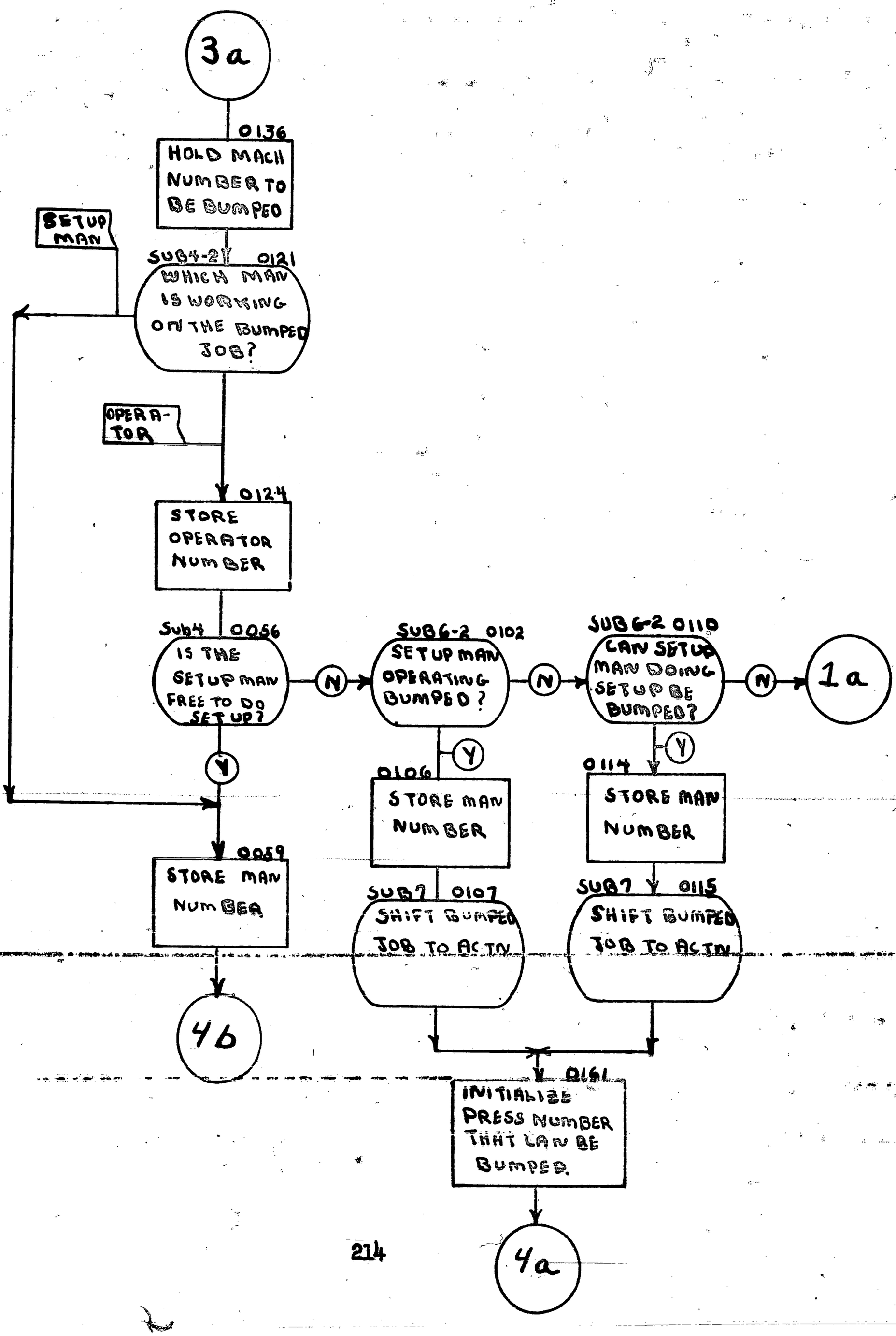
SUBROUTINE 10



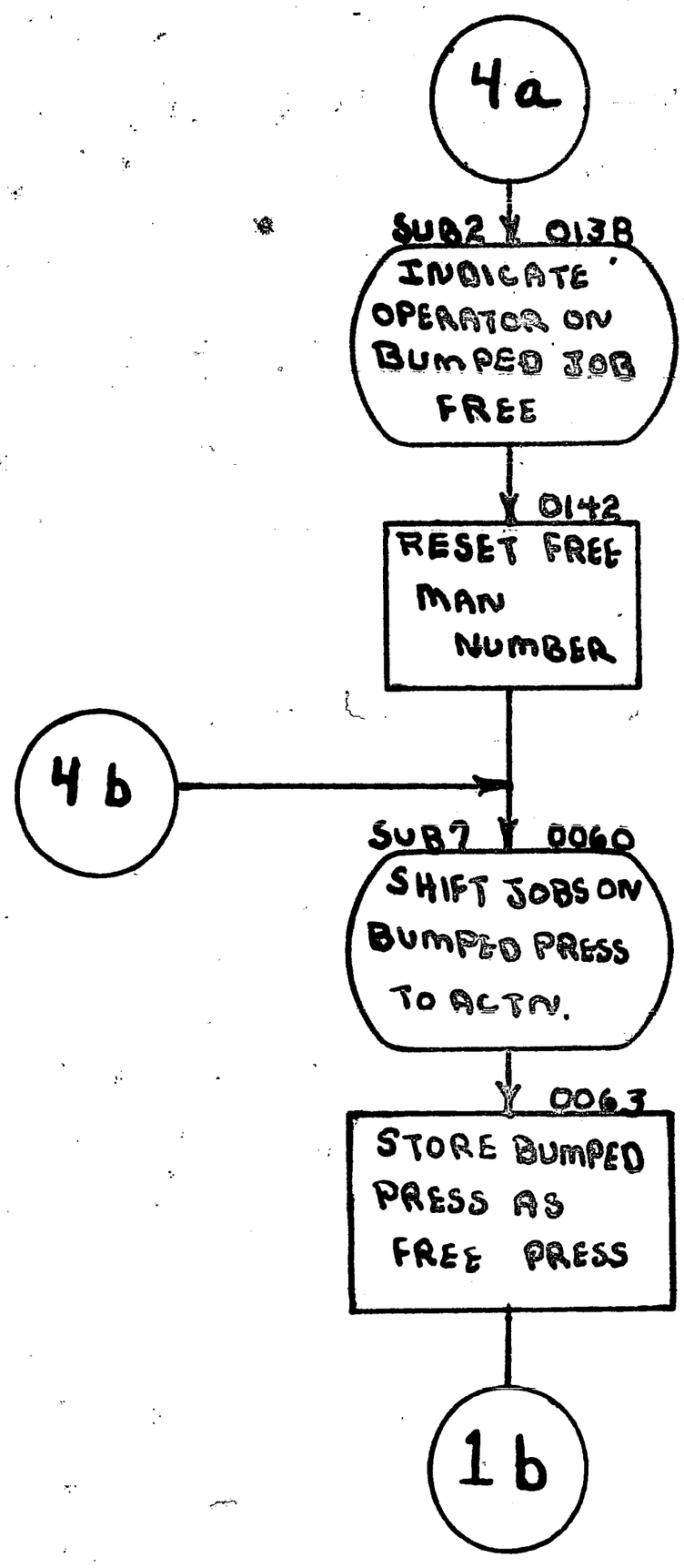
SUBROUTINE 10



SUBROUTINE 10



SUBROUTINE 10



PUNCH PRESS SIMULATION

Subroutine No. 10 Track No. 26

Title: Analysis of Code 0

```
0003   xb6149'     Lo of record to be setup          START
0004    y0028'
0005    y0013'
0006   xr3633'     see if job can be setup           SUB 6-1
0007   xu3600'
0008    u0144'     transfer if neither press free
0009    u0118'     transfer if either press free
0010    u0136'     transfer if either press can be bumped
0011   xr5823'     shift schedule to action          SUB 1   EF 0049
0012   xu5722'
0013   xz0750'     Lo of Source record
0014    u0152'     transfer to store code in Action
0015   xa6201'     1 at 29
0016    y0018'
0017   xb6239'     large plus #
0018   xh0756'
0019   xu3300'     transfer to search clocks         SUB 9
0020   xh6132'     free press #
0021   xr4239'     setupman free to setup?           SUB 4
0022   xu4115'
0023    u0037'     transfer if no setupmen free
0024   xh6136'     free man #
0025   xb6132'     free press #
0026   xr5823'     shift schedule to production      SUB 1
0027   xu5700'
0028   xz0750'     Lo of source record
0029   xb6136'     free man #
0030   xr5309'     store code in setupman            SUB 2
0031   xu5232'
```

PUNCH PRESS SIMULATION

Subroutine No. 10 Track No. 26

Title: Analysis of Code 0

```
0032   xz0001'   code to indicate setupman doing setup
0033   xb6132'   press # free
0034   xr3038'   accumulate setup time                    SUB 7-1
0035   xu3000'
0036    u0157'
0037   xb6149'   Lo record to be setup        SETUPMAN NOT FREE
0038   xr3831'   Setupman supervising operation   SUB 6-2
0039   xu3706'       bumped?
0040    u0046'   transfer if no man can be bumped
0041   xh6136'   freed setupman
0042   xr3233'   shift records of bumped jobs      SUB 7
0043   xu3100'       to Action
0044    u0053'
0045    u0025'   free
0046   xb6149'   Lo record to be setup
0047   xr3831'   Setupman doing setup bumped?      SUB 6-2
0048   xu3700'
0049    u0011'   transfer if no man can be bumped
0050   xh6136'   freed setupman
0051   xr3233'   shift records of bumped jobs      SUB 7
0052   xu3100'       to Action
0053   xb6305'   press # job is to be assigned to
0054   xh6132'
0055    u0026'   transfer to assign setupman
0056   xr4239'   setupman free to setup?    SUB 4     EF 0125
0057   xu4115'
0058    u0102'   transfer if none free
0059   xh6136'   free man #                                EF 0126
0060   xb6305'   press # job is to be assigned to
0061   xr3233'   shift record of bumped job to     SUB 7
0062   xu3215'       Action
0063   xb6305'   press # job is to be assigned to
```

PUNCH PRESS SIMULATION

Subroutine No. 10 **Track No. 27**

Title: Analysis of Code 0

```
0100   xh6132'
0101    u0025'    transfer to assign setupman
0102   xb6149'    Lo of record to be setup          EF00 59
0103   xr3831'    setupman operating bumped?        SUB 6-2
0104   xu3706'
0105    u0110'    transfer if no man bumped
0106   xh6312'    freed setupman                    SUB 7
0107   xr3233'    Shift records of bumped job
0108   xu3100'        to Action
0109    u0161'    transfer to setup press #
0110   xb6149'    Lo Record to be shifted           EF 0105
0111   xr3831'    setupman doing setup bumped?      SUB 6-2
0112   xu3700'
0113    u0011'    transfer if no man bumped
0114   xh6312'    freed setupman
0115   xr3233'    shift record of bumped job        SUB 7
0116   xu3100'        to Action
0117    u0161'    transfer to setup press #
0118   xh6305'    free press #                      EF 0009
0119    u0020'    transfer to see if setupman free
0120   xb6132'    press #                           EF 0137
0121   xr4845'    Find man supervising given        SUB 4-2
0122   xu4700'        press
0123    u0059'    transfer if setupman supervising this press
0124   xh6310'    free operator #
0125    u0056'    transfer to check for free setupman
0126    z0003'    free
0127    z0003'    free
0128   xr5309'    store code in setupman file   SUB 2  EF 012
0129   xu5232'
0130   xz0000'    indicates setupman free
0131    u0025'    transfer to assign job to press
```

PUNCH PRESS SIMULATION

Subroutine No. 10 Track No. 27

Title: Analysis of Code 0

```
0132   xb6162'   free
0133   xr4948'   free
0134   xu4900'   free
0135   xu3300'   free
0136   xh6305'   press # that can be bumped      EF 0010
0137    u0121'   transfer to free man on press
0138   xb6310'   free operator #                 EF 0163
0139   xr5124'   store code in Operator          SUB 2
0140   xu5100'
0141   xz0000'   indicates operator is free
0142   xb6312'   free setupman #
0143    u0159'   transfer to store man #
0144   xb6149'   Lo of record to be setup        EF 0008
0145   xa6231'   3 at 29
0146    y0147'
0147   xb0763'   press # of job to be setup
0148   xe6216'   W0000                           preferred press
0149   xm6207'   1 at 14
0150   xh6132'
0151    u0011'   transfer to shift schedule to action
0152   xb5827'   Lo of destination plus 10       EF 0014
0153   xs6204'   10 at 29
0154   xr5225'   store code in Action            SUB 2
0155   xu5220'
0156   xz0000'   indicate record in Action has not been setup
0157   xb6162'   Location of Schedule Clock
0158    u0015'   transfer to store large plus # in clock
0159   xh6136'                                   EF 0143
0160    u0060'
0161   xb6305'   press # that can be bumped      Ef 0109 0117
0162   xh6132'
0163    u0138'
```

SUBROUTINE 11

PURPOSE To assign an operator to a job that has been setup. If an operator is available the estimated time when the job will be completed is determined. If necessary a job which is already in the process of being operated or being setup will be bumped in favor of the job which has just finished being setup. The setupman who was setting up the job is assigned to setup a new job if possible.

ENTRANCE:

1. The subroutine is entered from location 3412 in Subroutine 9. The jump instruction to perform this exit is stored in location 3422.
2. This subroutine is entered when the code in the record from the Events File which has the minimum clock is a one.

SUBROUTINES USED

1.	Subroutine 1	Shift Data
2.	Subroutine 2	Store codes
3.	Subroutine 3	Time production finished
4.	Subroutine 4	Check for availability of press, setupman, or operator.
5.	Subroutine 4-1	Search Action for code.
6.	Subroutine 4-2	Find man running a given machine
7.	Subroutine 4-4	Utility program
8.	Subroutine 6-1	Check presses to see if a new job can be run.
9.	Subroutine 6-2	See if personnel can be bumped.
10.	Subroutine 7	Shift records of bumped job to Action File.
11.	Subroutine 7-1	Accumulate setup time.

AREA USED

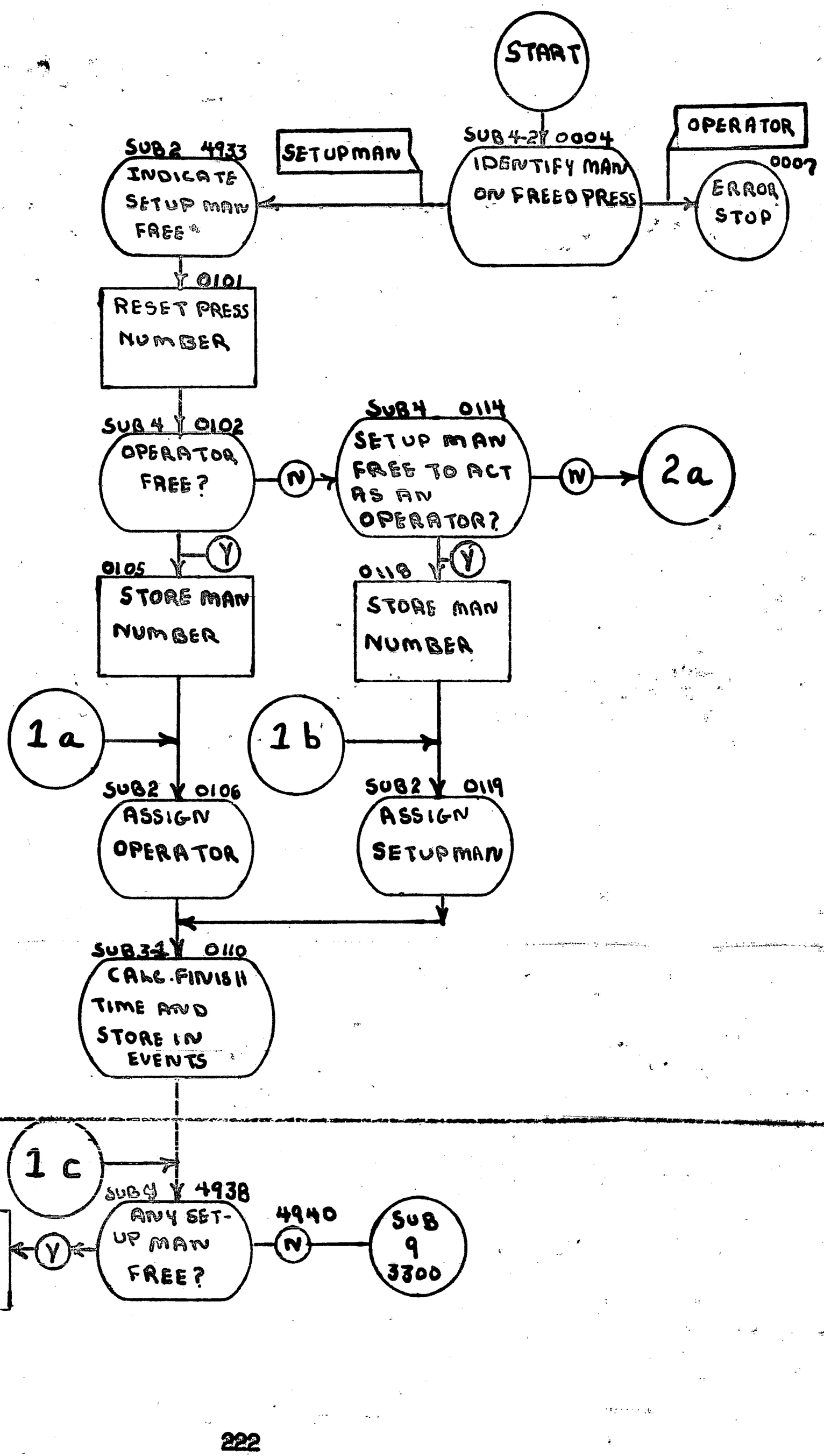
2303 to 2602

4933 to 4942

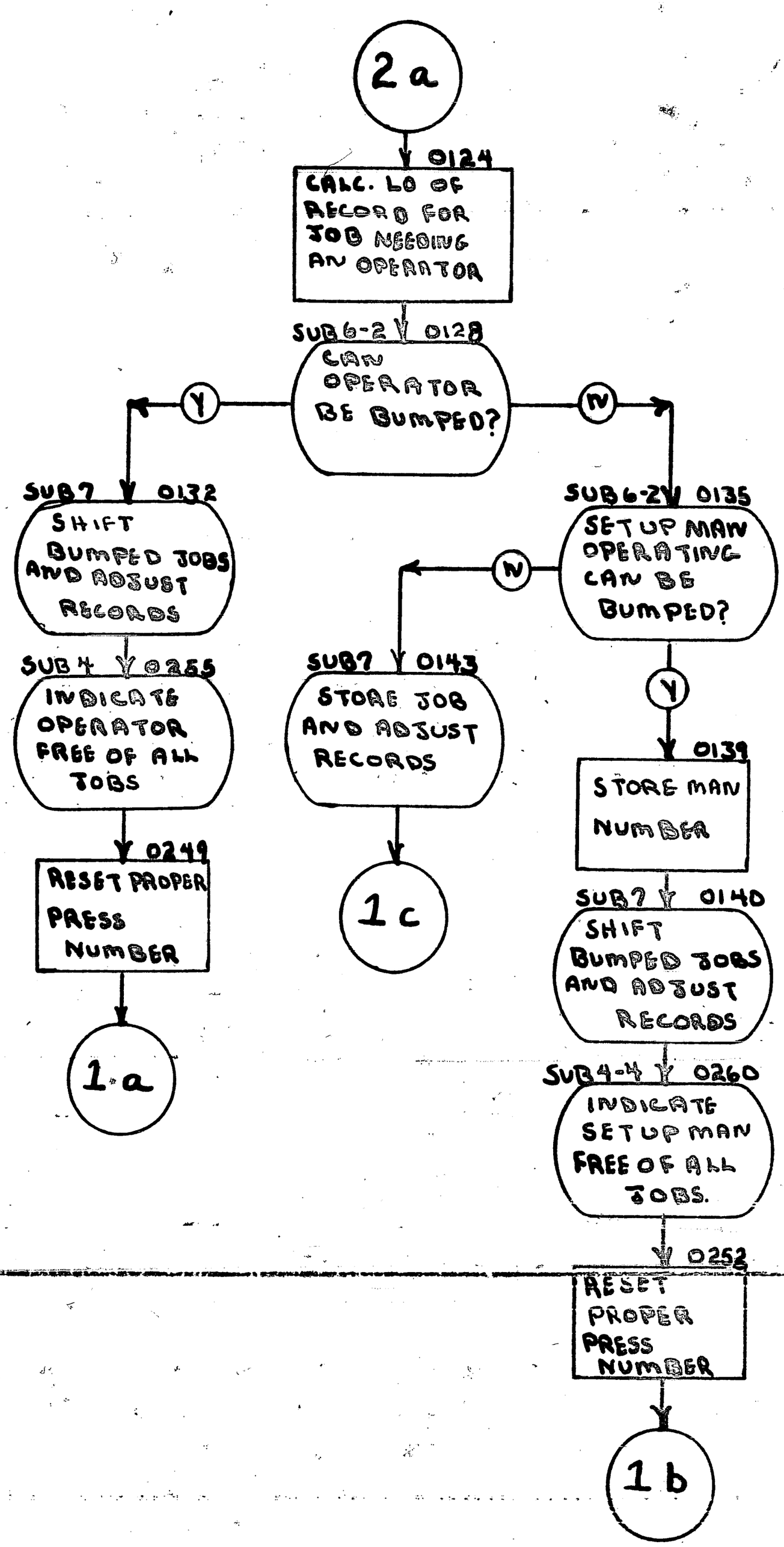
ERROR STOPS

1. 2307 Operator is doing a setup..Depression of "Start Compute" will cause additional errors.

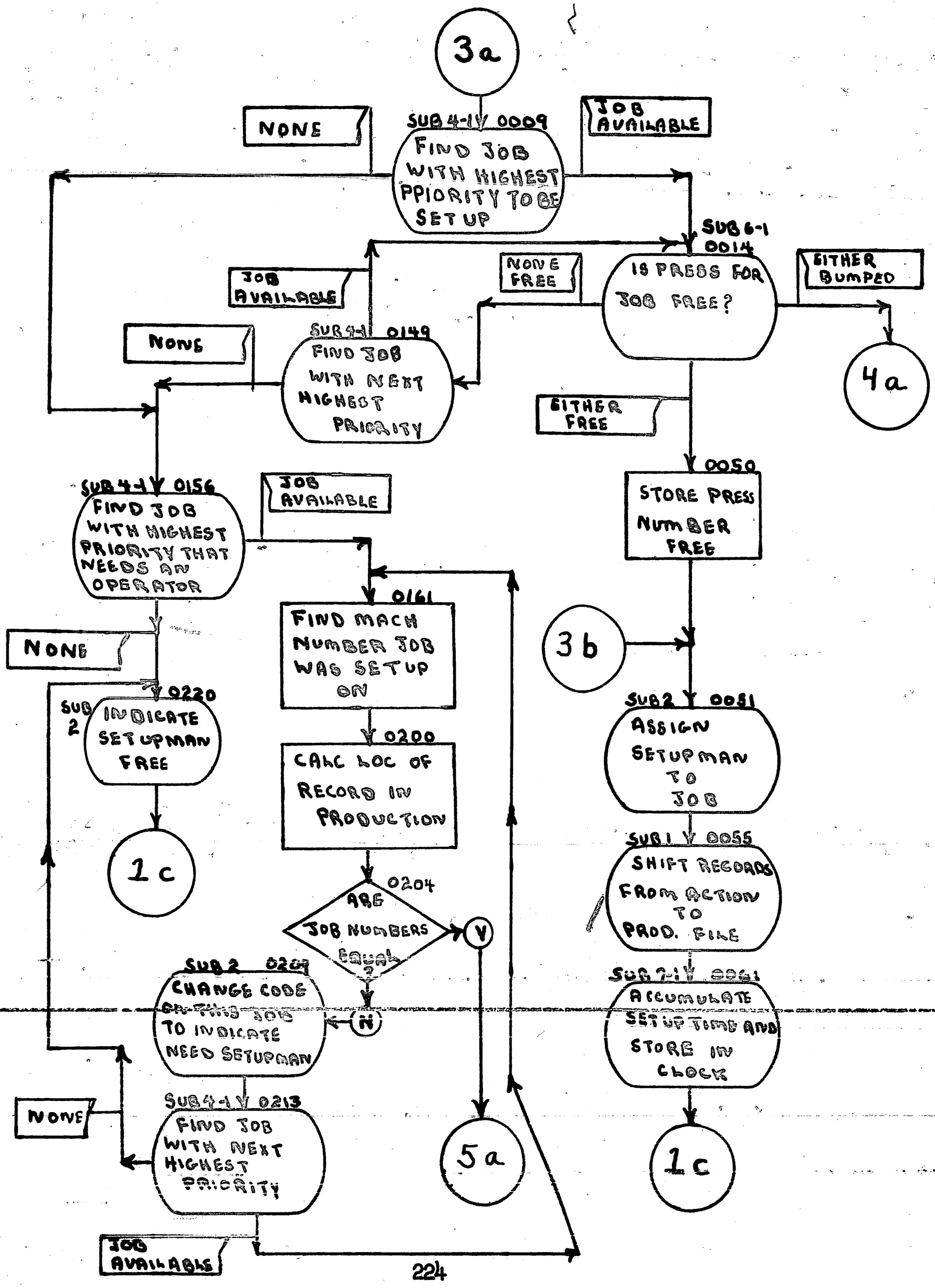
SUBROUTINE 11



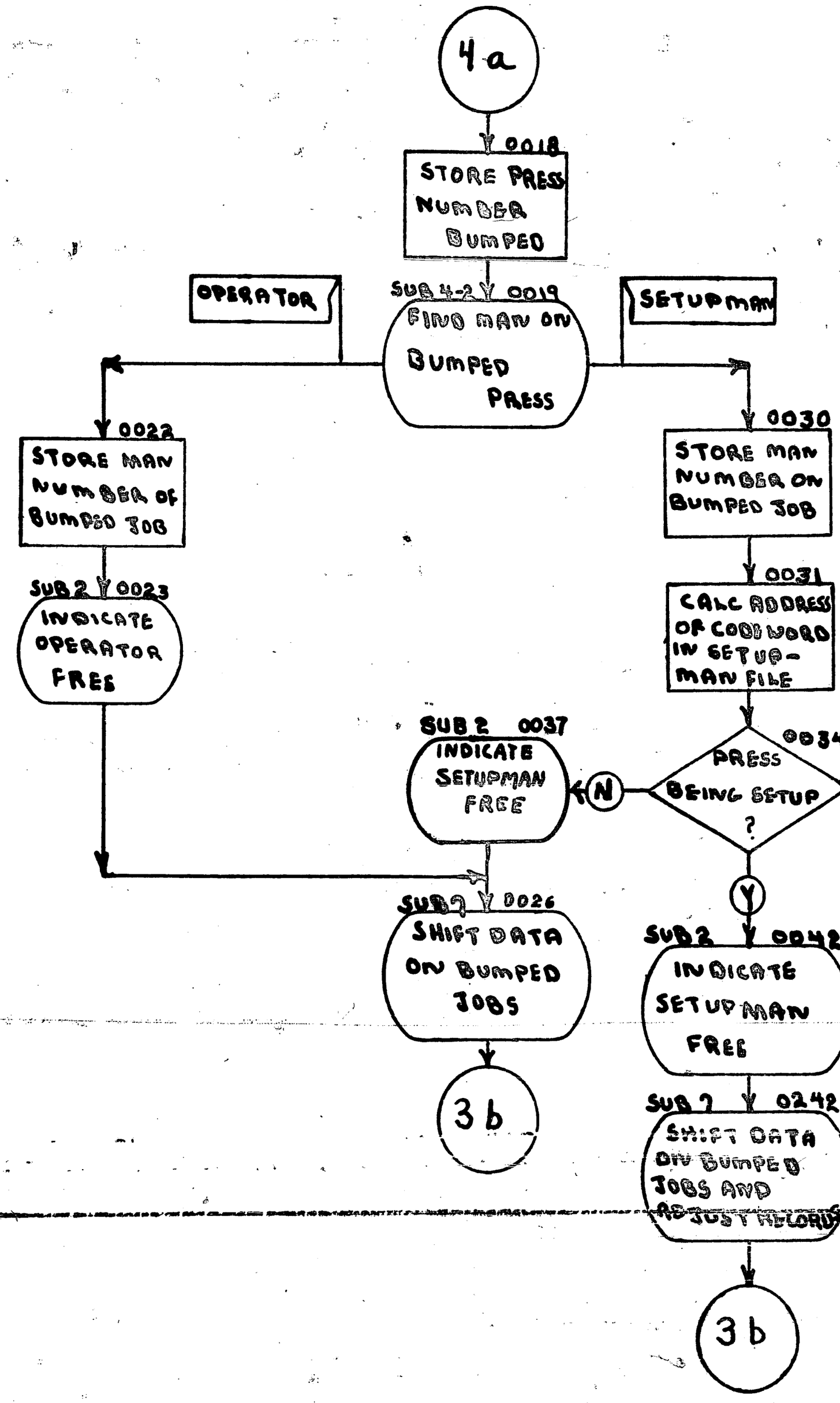
SUBROUTINE 11



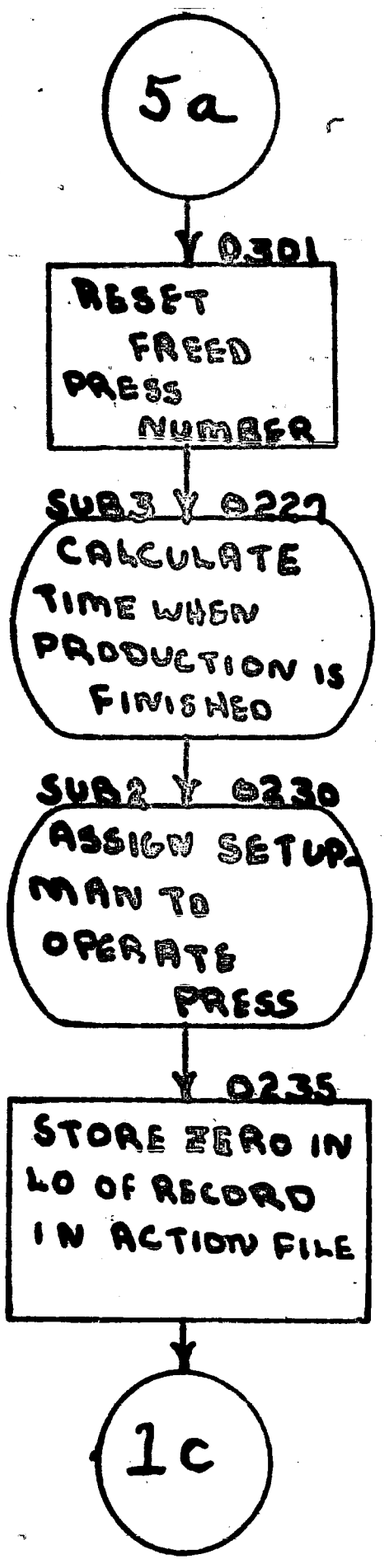
SUBROUTINE 11



SUBROUTINE 11



SUBROUTINE 11



PUNCH PRESS SIMULATION

Subroutine No. 11 Track No. 23

Title: Analysis of Code 1

```
0003   xb6149'   press # minimum clock                    START
0004   xr4845'   find man supervising given               SUB 4-2
0005   xu4700'       press
0006   xu4933'   transfer if operator a setupman
0007   xz6237'   operator doing setup   ERROR
0008   xh6136'   freed setupman
0009   xb6203'   zero
0010   xr4545'   search Action for job with               SUB 4-1
0011   xu4522'       maximum priority to be setup
0012    u0156'   transfer if no jobs to be setup
0013    h0246'   Lo record of job with maximum priority  EF 0158
0014   xr3633'   presses for job free?                    SuB 6-1
0015   xu3600'
0016    u0149'   transfer if neither press free
0017    u0050'   transfer if either press free
0018   xh6132'   press # of press which can be bumped
0019   xr4845'   find man running press                   SUB 4-2
0020   xu4700'
0021    u0030'   transfer if man a setupman
0022    h0247'   man # of operator on job
0023   xr5124'   store code in Operator                   SUB 2
0024   xu5103'
0025   xz0000'   Indicates man free
0026   xb6132'   press # which can be bumped              EF0041
0027   xr3233'   shift data on bumped jobs                SUB 7
0028   xu3215'       to Action
0029    u0051'   transfer to assign freed setupman
0030    h0247'   man # of setupman on job                 EF 0021
0031   xd6223'   1/3 at 0
```

PUNCH PRESS SIMULATION

Subroutine No. 11 Track No. 23

Title: Analysis of Code 1

```
0032   xa6124'   Lo Setupman -3
0033    y0034'
0034    b0003'   code word from Setupman file
0035   xs6210'   2 at 7
0036    t0042'   transfer if press was being setup
0037    b0247'   man # who was on bumped press
0038   xr5309'   store code in Setupman              SUB 2
0039   xu5235'
0040   xz0000'   indicate man free from this job
0041    u0026'   transfer to shift data
0042    b0247'   man # who was on bumped press      EF 0036
0043   xr5309'   store code in Setupman              SUB 2
0044   xu5235'
0045   xz0000'   indicate man free from job
0046    u0242'   patch
0047   xr3233'   free/press/# shift record on       EF 0245
0048   xu3260'   bumped job to Action    SUB 7
0049    u0051'
0050   xh6132'   free press #                       EF 0017
0051   xb6136'   free man #
0052   xr5309'   store code to Setupman             SUB 2
0053   xu5232'
0054   xz0001'   indicates man is doing setup
0055    b0246'   Lo record which is to be setup
0056    y0060'
0057   xb6132'   press # freed
0058   xr5823'   shift Action to Production         SUB 1
0059   xu5702'
0060   xz0348'   location of record in Action
0061   xb6132'   press # freed
0062   xr3038'   accumulated setup time             SUB 7-1
0063   xu3000'
```

PUNCH PRESS SIMULATION

Subroutine No. 11 Track No. 24

Title: Analysis of Code 1

```
0100   xu4938'   transfer to see if a setupman is free
0101   xh6132'   press #                                  EF 4937
0102   xr4239'   operator free?                           SUB 4
0103   xu4134'
0104    u0114'   transfer if operator not free
0105   xh6136'   man # free
0106   xb6136'   man # free                               EF 0251
0107   xr5124'   store code in Operator file              SUB 2
0108   xu5100'
0109   xz0002'   indicates operator supervising this press
0110   xb6132'   press #                                  EF 0123
0111   xr5048'   time production finished                 SUB 3
0112   xu2800'
0113   xu4938'   transfer to see if a setupman is free
0114   xb6132'   press #                                  EF 0104
0115   xr4335'   Setupman free to operate?                SUB 4
0116   xu4362'
0117    u0124'   transfer if setupman not free
0118   xh6136'   man # freed
0119   xb6136'   man # freed                              EF 0254
0120   xr5309'   store code in Setupman file              SUB 2
0121   xu5232'
0122   xz0002'   indicates setupman supervising press
0123    u0110'
0124   xb6132'   press #                                  EF 0117
0125   xd6205'   1/10 at 0
0126   xa6102'   Lo Prod -10
0127    h0248'   Lo of record tested
0128   xr3831'   can operator be bumped?                  SUB 6-2
0129   xu3850'
0130    u0135'   transfer if man cannot be bumped
0131   xh6136'   man # bumped
```

PUNCH PRESS SIMULATION

Subroutine No. 11 Track No. 24

Title: Analysis of Code 1

```
0132   xr3233'    shift records of bumped jobs     SUB 7
0133   xu3111'        to Action
0134    u0255'    transfer to free all jobs man was running
0135    b0248'    Lo record to compare              EF 0130
0136   xr3831'    setupman operating bumped?        SUB 6-1
0137   xu3706'
0138    u0143'    transfer if no man can be bumped
0139   xh6136'    man # bumped
0140   xr3233'    shift records of bumped jobs     SUB 7
0141   xu3100'        to Action
0142    u0260'    transfer to free all jobs man was running
0143    b0007'    constant--XZ6232                  EF 0138
0144   xy3254'
0145   xb6132'    press #
0146   xr3233'    shift job on press to Action     SUB 7
0147   xu3219'
0148   xu4938'    transfer to see if setupman free
0149    b0246'    Lo record of highest priority    EF 0016
0150   xy4622'
0151   xb6203'    zero
0152   xr4545'    search Action for record with    SUB 4-1
0153   xu4514'        next highest priority
0154    u0156'    transfer if no more jobs with given code
0155    u0013'    transfer if record found
0156   xb6211'    2 at 29                           EF 0012, 0154
0157   xr4545'    search Action for record with    SUB 4-1
0158   xu4522'        highest priority that needs an operator
0159    u0220'    transfer if no jobs need an operator
0160    h0246'    Lo record with maximum priority EF 0219
0161    y0205'
0162   xa6247'    8 at 29
0163    y0200'
```

####

PUNCH PRESS SIMULATION

Subroutine No. 11 Track No. 25

Title: Analysis of Code 1

```
0200    b0003'      press # from record job was last on
0201    xd6205'     1/10 at 0
0202    xa6102'     Lo prod =10
0203     y0204'     job
0204     b0003'     ////# from Prod file
job  0205     s0003'     ////# from Action file
0206     t0209'     transfer if # not equal
0207    xs6201'     1 at 29
0208     t0301'     transfer if job still set up on press
0209     b0246'     Lo record with max priority      EF 0206
0210    xr5225'     store code in Action             SUB 2
0211    xu5220'
0212    xz0000'     indicates job must be resetup
0213     b0246'     Lo record with max priority
0214    xy4622'
0215    xb6211'     2 at 29
0216    xr4545'     search Action for record with    SUB 4-1
0217    xu4514'          next highest priority
0218     u0220'     transfer if no more jobs needing operator
0219     u0160'     transfer to check to see if job is still setup
0220    xb6136'     freed # of setupman              EF 0159, 0218
0221    xr5309'     store code in Setupman           SUB 2
0222    xu5232'
0223    xz0000'     indicate setupman is free
0224     u0100'     transfer to see if operater free
0225     y0227'     freed ////# press #              EF 0302
0226     u0227'     skip
0227     b0003'     press # from record job was last on
0228    xr5048'     time production finished         SUB 3
0229    xu5013'
0230    xb6136'     man #
0231    xr5309'     indicate setupman operating      SUB 2
```

PUNCH PRESS SIMULATION

Subroutine No. 11 **Track No. 25**

Title: Analysis of Code 1

```
0232   xu5232'
0233   xz0002'   code to indicate setupman operating
0234    u0235'   skip
0235    b0246'   Lo record max priority
0236    y0238'
0237   xb6203'   zero
0238    h0003'   store 1st location of record in Action
0239    u0100'   transfer to see if Operator free
0240    z0003'   free
0241    z0003'   free
0242    b0007'   XZ6237                                  EF 0046
0243   xy3254'
0244   xb6132'   press #
0245    u0047'   transfer to shift bumped jobs
0246   xb0348'   constant--Lo record max priority
0247    z0003'   constant--man # bumped
0248    z0003'   constant--Lo record of job needing operator
0249   xb6149'   press # of job ready to be supervised  EF 0257
0250   xh6132'   press #
0251    u0106'   transfer to assign operator
0252   xb6149'   press # of job ready to be supervised  EF 0262
0253   xh6132'   press #
0254    u0119'   transfer to assign setupman to operate
0255   xr4863'   free all men                           SUB 4-4
0256   xu4943'
0257    u0249'
0258   xz0000'   free
0259    u0249'   free
0260   xr4863'   free all men                           SUB 4-4
0261   xu4943'
0262    u0252'
0263   xz0000'   free


0300    u0252'   free
0301    b0200'   loc of press job was last on           EF 0208
0302    u0225'
```

SUBROUTINE 12

PURPOSE: To determine if all production for a given job has been completed. If all production for a job has been completed, the job with the highest priority that can be setup on this press is selected for setup, if a setupman is available. If in the process an operator is freed, he is assigned a new job if possible. The results of production for the completed job are printed.

ENTRANCE:

1. This subroutine is entered from location 3412 in Subroutine 9. The jump instruction to perform this exit is stored in location 3423.
2. This subroutine is entered when the code in the record from the Events File with the minimum clock is a two.

SUBROUTINES USED

1.	Subroutine 1	Shift data.
2.	Subroutine 2	Store Codes.
3.	Subroutine 3	Time production finished.
4.	Subroutine 4	Check for availability of press, setupman or operator.
5.	Subroutine 4-1	Search Action for code.
6.	Subroutine 4-2	Find man running a given machine.
7.	Subroutine 5	Sample distribution or test probability.
8.	Subroutine 7	Shift records of bumped job to Action File.
9.	Subroutine 7-1	Accumulate Setup time.
10.	Output	Print number.

INTERNAL SUBROUTINES

1. Subroutine 12 alpha

   a. Purpose: To control the printing of the job number, units ordered, and units produced for completed jobs.

   b. Calling Sequence

      R0420

      U0400

   c. Subroutine Used

      1. Output Print number

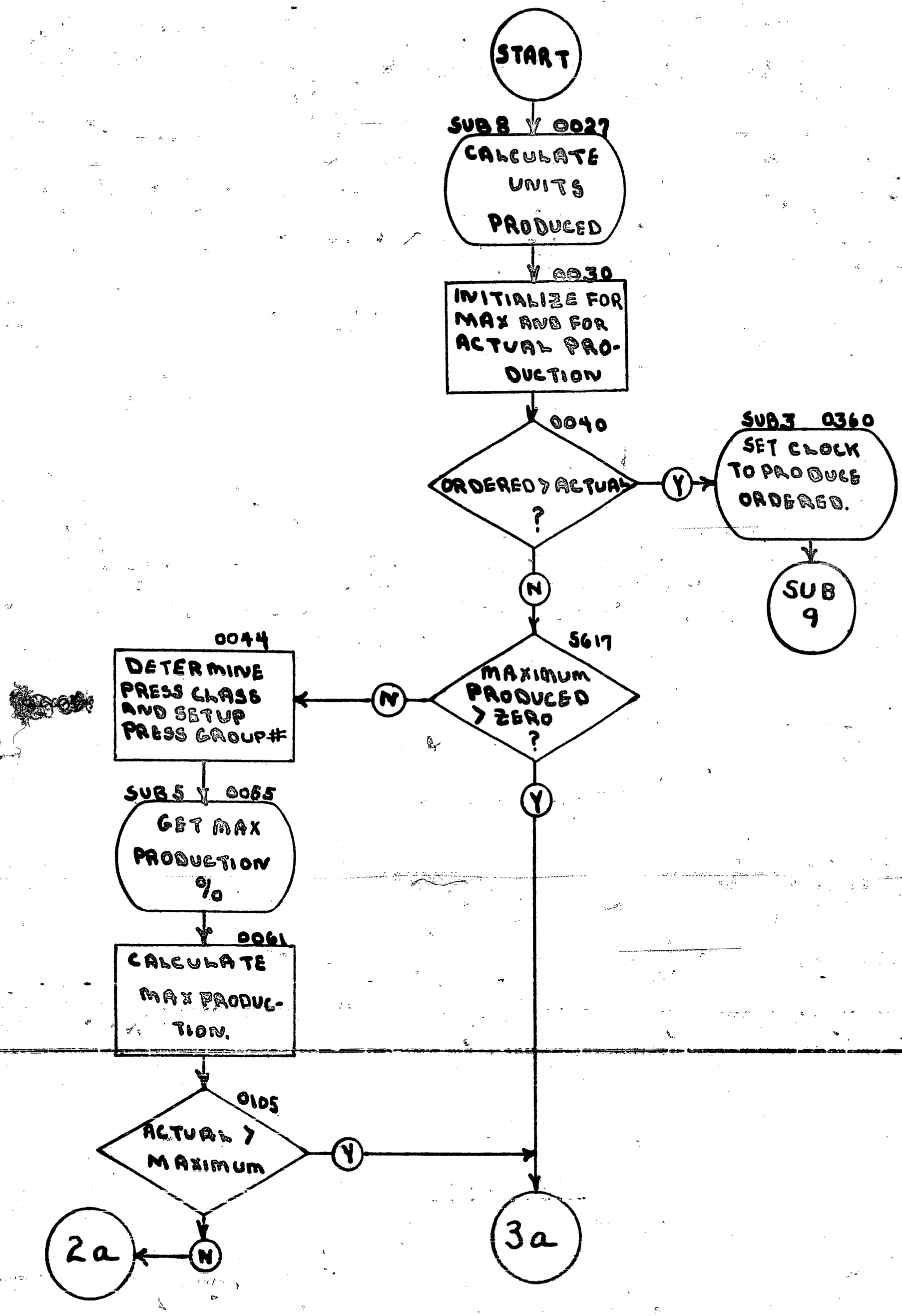
   d. Area used 0400 to 0420

AREA USED

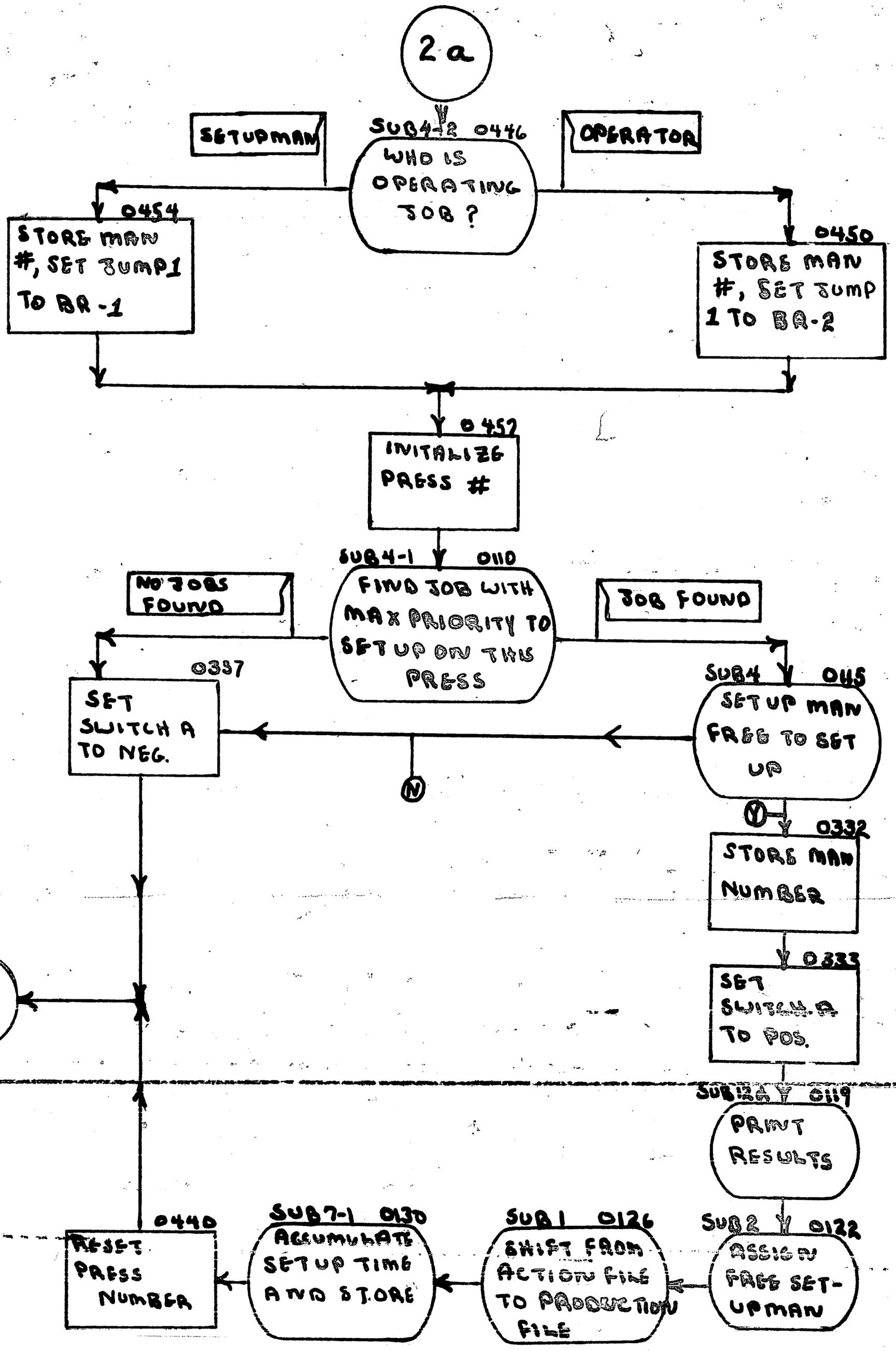
1827 to 2302

5613 to 5620

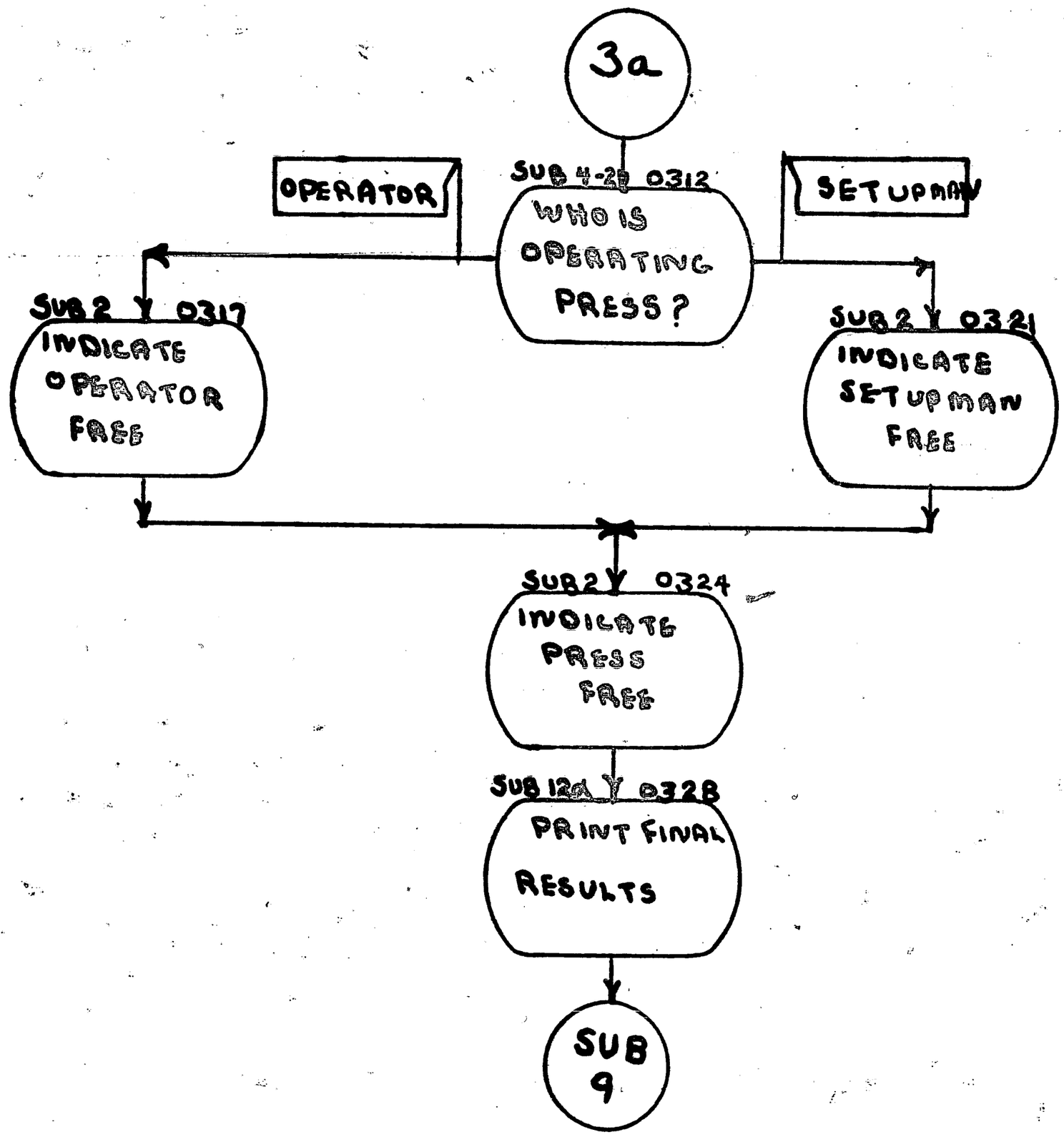
SUBROUTINE 12



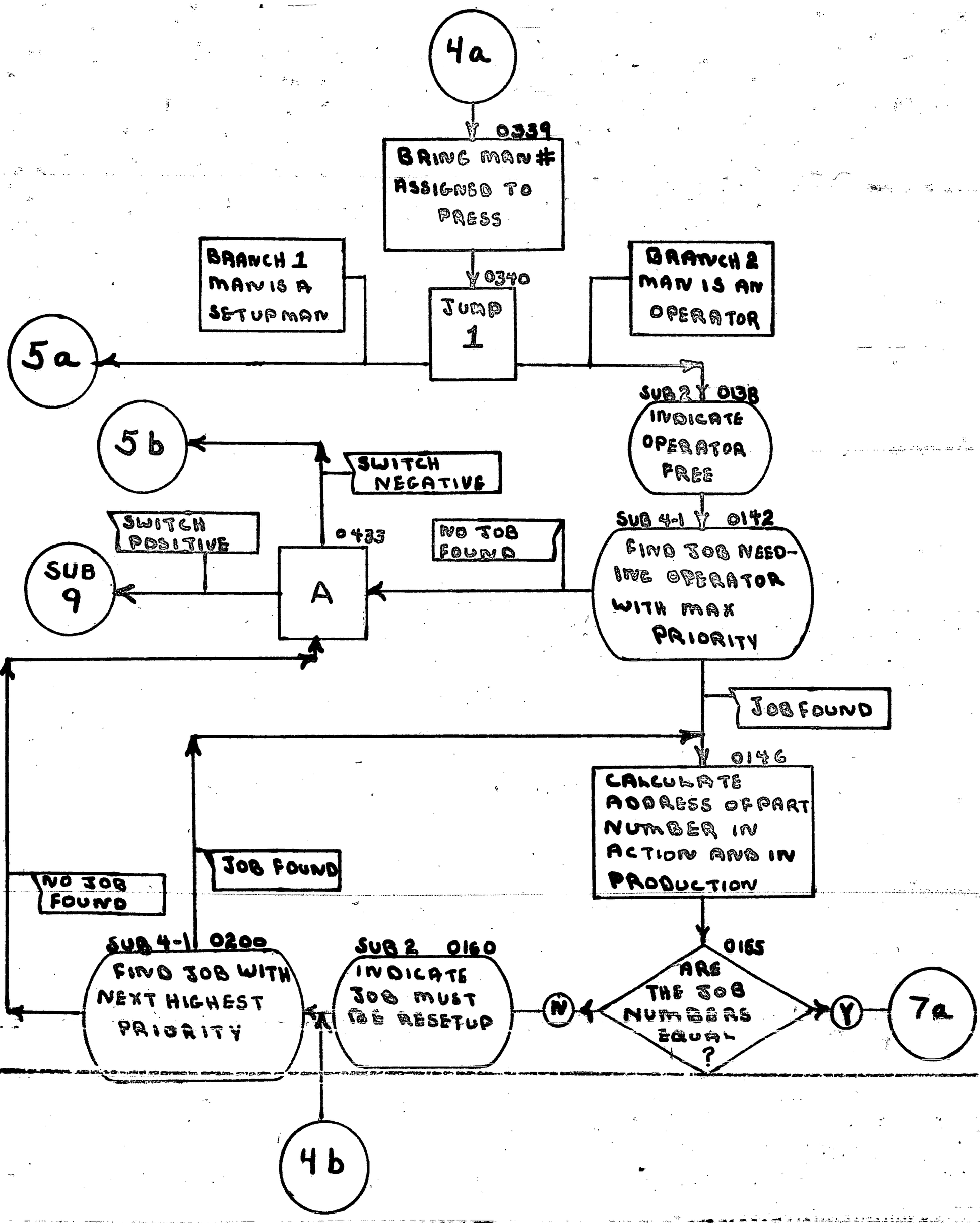
SUBROUTINE 12



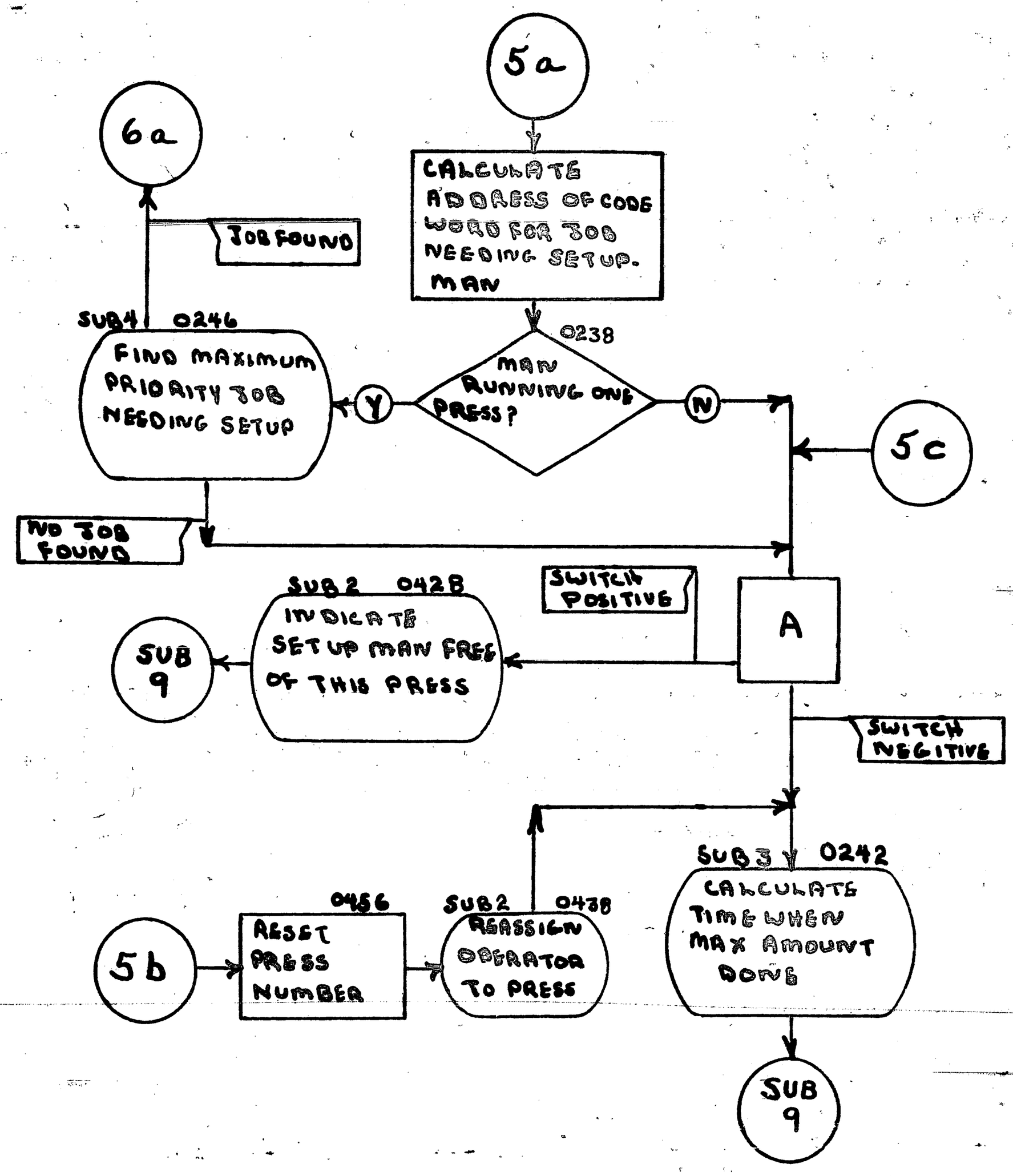
SUBROUTINE 12



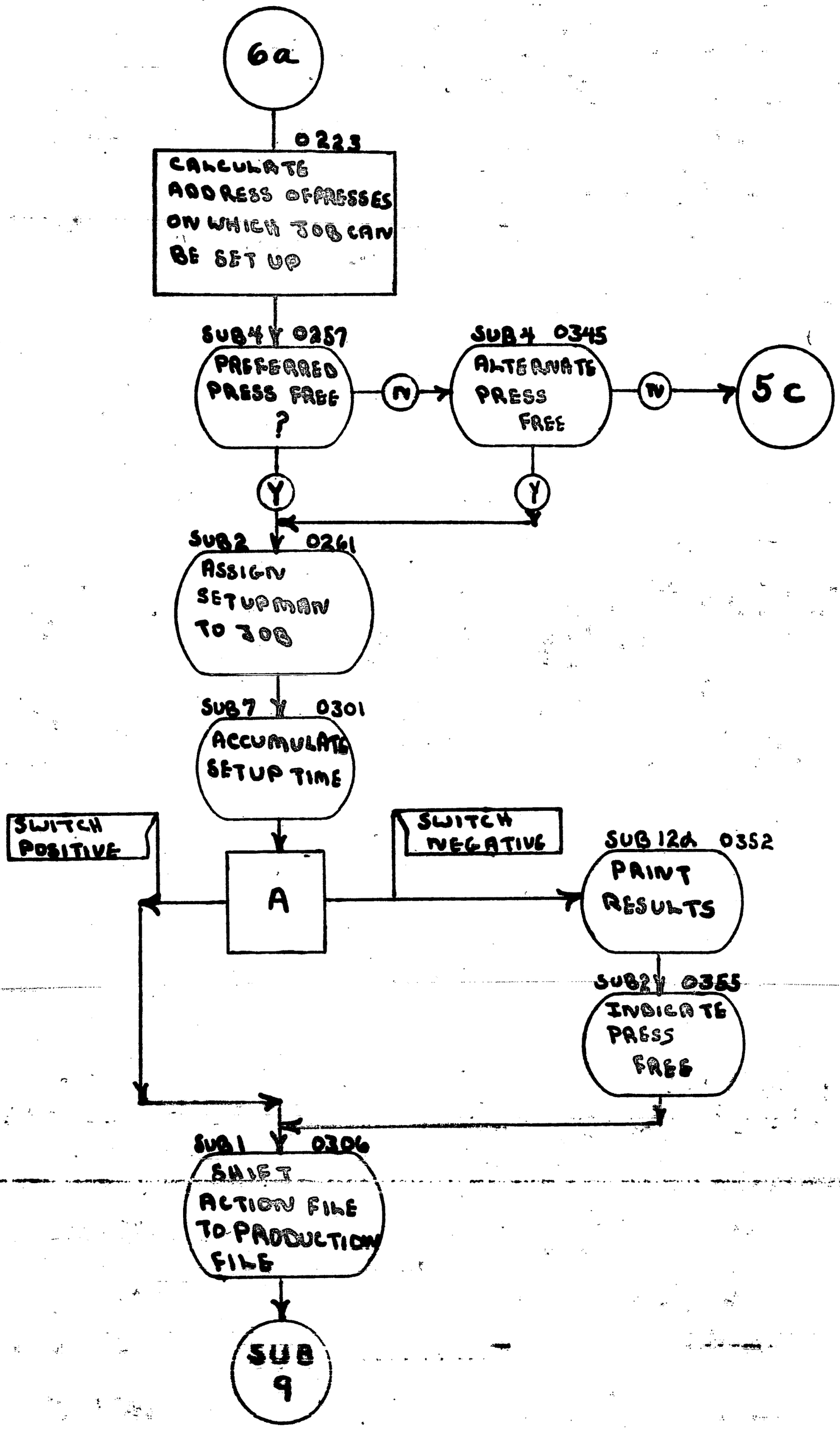
SUBROUTINE 12



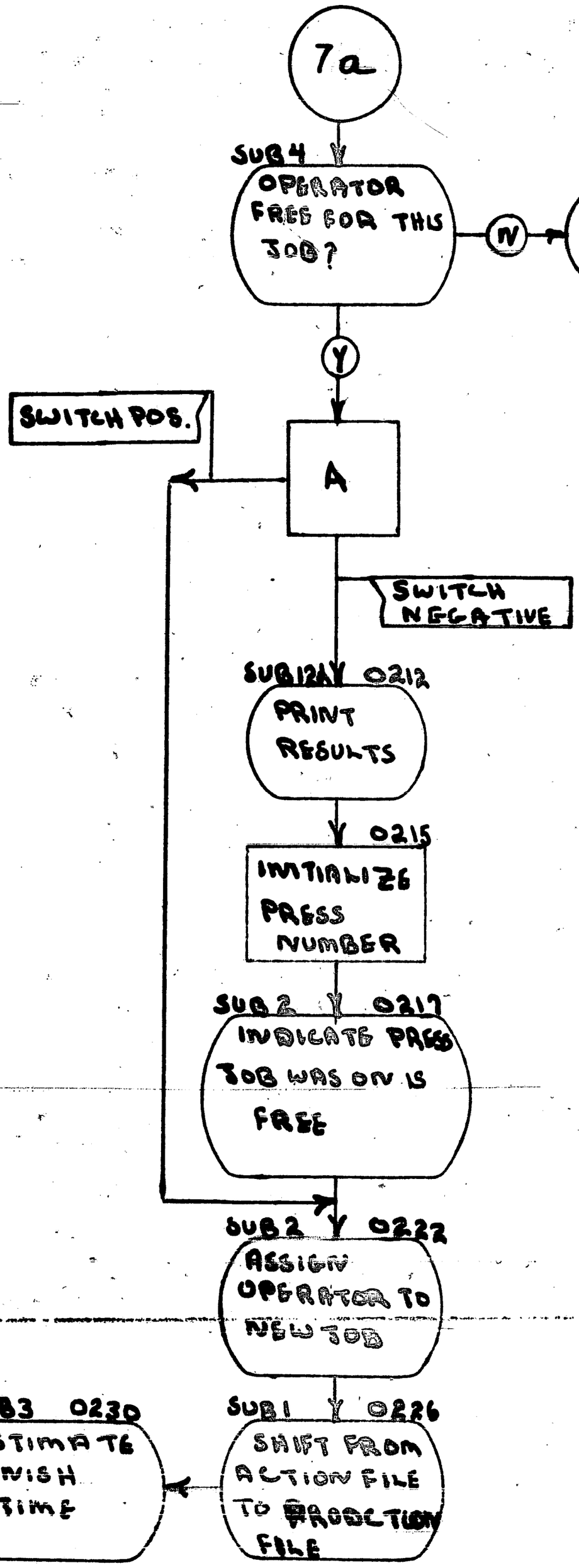
SUBROUTINE 12



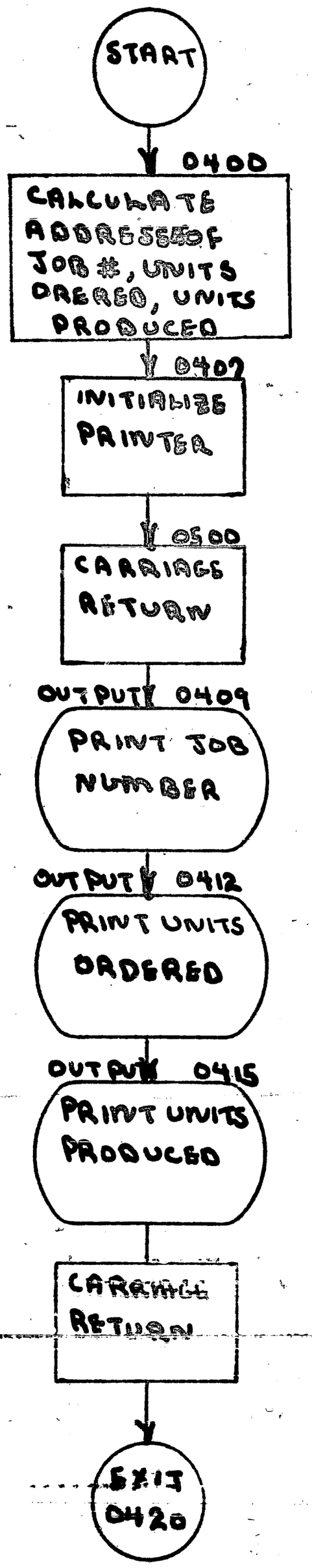
SUBROUTINE 12



SUBROUTINE 12



SUBROUTINE 12 α



PUNCH PRESS SIMULATION

Subroutine No. 12 Track No. 18

Title: Analysis of Code 2

```
0027    xb6149'    press # min clock                    START
0028    xr3522'    calculate units produced             SUB 8
0029    xu3500'
0030    xb6149'    press # min clock
0031    xd6205'    1/10 at 0
```

PUNCH PRESS SIMULATION

Subroutine No. 12 Track No. 18

Title: Analysis of Code 2

```
                0032    xa6102'     Lo Prod -10
                0033    xa6201'     1 at 29
                0034     y0041'     ordered amount
                0035    xa6201'     1 at 29
0036    y0105'                      maximum amount
                0037    xa6209'     4 at 29
                0038     y0040'     actual amount
                0039     y0106'     actual amount
                0040    xb0033'     actual amount
                0041    xs0028'     ordered amount
                0042     t0360'     transfer if ordered greater than actual
                0043    xu5613'     transfer to see if maximum amount calculated
                0044    xs6202'     5 at 29                          EF 5620
                0045     t0053'     transfer if press in group 1
                0046    xs6231'     3 at 29
0047    t0051'                      transfer if press in group 2
                0048    xb6211'     2 at 29                press in group 3
                0049    xh6151'     press group #
                0050     u0055'     transfer to calculate maximum amount
                0051    xb6201'     1 at 29                          EF 0047
                0052     u0049'
                0053    xb6203'     0 at 29                          EF 0045
                0054     u0049'
                0055     b0421'     Lo of beginning address of max amount dist.
                0056    xa6151'     press group #
0057    y0058'
                0058     b0422'     Lo maximum amount dist for press class
                0059    xr4029      sample distribution              SUB 5
                0060    xu4000'
                0061    xd6248'     100 at 26
                0062    xh6300'     temp
                0063     b0041'     ordered amount at 29  (address of)
```

PUNCH PRESS SIMULATION

Subroutine No. 12 **Track No. 19**

Title: Analysis of Code 2

```
                0100    y0101'
                0101    xb0028'     units ordered
                0102    xd6212'     1 at 2
                0103    xm6300'     factor increased at 3
                0104    xn6200'     1 at 30
                0105    xh0029'     maximum amount at 29
                0106    xs0033'     actual amount at 29
                0107     t0312'     transfer if actual greater than maximum
                0108     u0446'     transfer to determine who man on press was
                0109    xh6132'     press # minimum clock              EF 0458
                0110    xb6203'     zero
                0111    xr4545'     fimd job with maximum priority     SUB 4-1
                0112    xu4508'          in Action to be setup
                0113     u0337'     transfer if no jobs need to be setup
                0114     y0129'     Lo record of job to be setup
                0115    xr4239'     setupman free to setup?            SUB 4
                0116    xu4115'
                0117     u0337'     setupman not free
                0118     u0332'     transfer to set Switch A to zero
                0119    xb6132'     press # finished job               EF 0335
        0120    r0420'              print results                      SUB 12 ALPHA
                0121     u0400'
                0122    xb6154'     man # to do setup
                0123    xr5309'     store code in setup file
                0124    xu5232'
                0125    xz0001'     indicate man doing setup
                0126    xb6132'     press # to be setup
                0127    xr5823'     shift Action to Production         SUB 1
                0128    xu5702'
                0129    xz0318'     Lo of record shifted
                0130    xb6132'     press # to be setup
                0131    xr3038'     accumulate setup time              SUB 7-1
```

PUNCH PRESS SIMULATION

Subroutine No. 12 **Track No. 19**

Title: Analysis of Code 2

```
                0132    xu3000'
                0133     u0440'     transfer to setup press #
                0134     u0234'     constant
                0135     u0138'     constant
                0136     z0027'     free
                0137     z0027'     free
                0138    xh6136'     man # running press                EF 0340
                0139    xr5124'     store code in Operator             SUB 2
                0140    xu5100'
                0141    xz0000'     indicate operator free
                0142    xb6211'     2 at 29
                0143    xr4545'     find job with max priority in      SUB 4-1
                0144    xu4522'          Action needing operator
                0145     u0433'     transfer if operator not needed
                0146     y0229'     Lo record of job to check to see is still EF 0206
                0147     y0156'        setup
                0148    xa6247'     8 at 29
0149    y0150'
                0150     b0027'     press # job was setup on
                0151    xh6155'     press # job was setup on
                0152     u0443'     transfer to store job # in working storage
                0153    xa6102'     Lo Prod -10                             EF 0445
                0154     y0155'
                0155     b0027'     job # from production file
                0156     s0027'     job # from Action file
                0157     t0160'     transfer if job not still setup on press
                0158    xs6201'     1 at 29
                0159     t0207'     transfer if job still setup on press
                0160     b0229'     Lo record                               EF 0157
                0161    xr5225'     store code in Action                    SUB 2
                0162    xu5220'
                0163    xz0000'     indicates job must be resetup
```

PUNCH PRESS SIMULATION

Subroutine No. 12 **Track No. 20**

Title: Analysis of Code 2

```
0200    b0229'      Lo record with maximum priority  EF 0210
0201    xy4622'
0202    xb6211'     2 at 29
0203    xr4545'     find record with next highest    SUB 4-1
0204    xu4514'         priority in Action that needs an operator
0205     u0433'     no more jobs in Action that need an operator
0206     u0146'     transfer to see if job still setup
0207    xb6155'     press # job to be operated on EF 0159
0208    xr4239'     operator available to operate? SUB 4
0209    xu4134'
0210     u0200'     no operator available
0211     u0341'     transfer to test Switch A
0212    xb6149'     press # minimum clock            EF 0343
0213     r0420'     print results                    SUB 12 ALPHA
0214     u0400'
0215    xb6149'     press # minimum clock
0216    xh6132'
0217    xr5557'     store code in Events             SUB 2
0218    xu5209'
0219    xz0004'     indicates press is now free
0220    xb6155'     press # man assigned to          EF 0344
0221    xh6132'
0222    xb6154'     man #
0223    xr5124'     store code in operator file      SUB 2
0224    xu5100'
0225    xz0002'     indicates man assigned to operate job
0226    xb6132'     press # man assigned to
0227    xr5823'     shift data Production to Action SUB 1
0228    xu5702'
0229     z0027'     Lo of source record
0230    xb6132'     press # man assigned to
0231    xr5048'     time production finished         SUB 3
```

PUNCH PRESS SIMULATION

Subroutine No. 12 Track No. 20

Title: Analysis of Code 2

```
0232   xu5013'
0233   xu3300'
0234   xh6136'    exit to search clocks
0235   xd6223'    man # of setupman operating      EF 0340
0236   xa6124'    1/3 at 0
0237    y0238'    Lo Setupman -3
0238   xb0217'
0239   xe6216'    code word from setupman file     EF/0340
0240   xs6226'    W0000
0241    u0425'    1 at 15
0242   xb6149'    transfer to determine the jobs man is running
0243   xr5048'    press # minimum clock            EF 0462, 0427
0244   xu5000'    time production of max           SUB 3
0245   xu3300'          finished
0246   xb6203'    transfer to search clocks
0247   xr4545'    zero                             EF 0425
0248   xu4522'    find record with maximum         SUB 4-1
0249    u0426'        priority which needs a setupman from Action
0250    y0309'    transfer if no setupman needed
0251   xa6231'    Lo record of job with maximum priority
0252    y0254'    3 at 29
0253    y0345'    loc. preferred and alternate presses
0254   xb0311'
0255   xe6216'    preferred and alternate presses
0256   xm6207'    W0000
0257   xh6132'    1 at 14
0258   xr4239'    preferred press at 29
0259   xu4100'    is preferred press free?         SUB 4
0260    u0345'
0261   xb6136'    press not free
0262   xr5309'    man # free setupman              EF 0351
0263   xu5232'    store code in setupman file      SUB 2
```

PUNCH PRESS SIMULATION

Subroutine No. 12 **Track No. 21**

Title: Analysis of Code 2

```
                0300    xz0001'     code indicates setupman doing setup
                0301    xb6132'     press # to be setup
                0302    xr3038'     accumulate setup time                SUB 7
                0303    xu3000'
                0304     b0311'     Switch A
                0305     t0352'     transfer to branch 1
                0306    xb6132'     press # to be setup                  EF 0359
                0307    xr5823'     shift Action to Production
                0308    xu5700'
                0309    xz0308'     Lo record in Action
                0310    xu3300'     transfer to search clocks
,0000001'       0311 wwwwwwj'       constant--Switch A
                0312    xb6149'     press # minimum clock                EF 0107
 0313   xh6132'
                0314    xr4845'     find man running press               SUB 4-2
                0315    xu4700'
                0316     u0321'     man running press a setupman
                0317    xr5124'     store code in Operator file          SUB 2
                0318    xu5100'
                0319    xz0000'     indicates operator free
                0320     u0324'     transfer to free press
                0321    xr5309'     store code in Setupman file          SUB 2 EF 0316
                0322    xu5232'
                0323    xz0000'     indicates setupman free
                0324    xb6132'     press # completed job                EF 0320
                0325    xr5557'     store code in Events file            SUB 2
                0326    xu5210'
                0327    xz0004'     indicates press free
                0328    xb6132'     press # completed job
                0329     r0420'     print results                        SUB 12 ALPHA
                0330     u0400'
                0331    xu3300'     transfer to search clocks
```

PUNCH PRESS SIMULATION

Subroutine No. 12 **Track No. 21**

Title: Analysis of Code 2

```
0332   xh6154'   man # free setupman                    EF 0118
0333   xb6203'   zero
0334    h0311'   Switch A
0335    u0119'
0336    z0027'   free
0337   xb6232'   -1 at 29  (BR 1)                      EF 0113, 0117
0338    h0311'   Switch A
0339   xb6160'   man # on given press                   EF 0442
0340    u0238'   JUMP 1  BR 1-U0234   BR 2-U0138
0341   xh6154'   man # of operator free                 EF 0211
0342    b0311'   Switch A
0343    t0212'   transfer to BR 1
0344    u0220'   transfer to BR 2
0345   xb0311'   preferred and alternate press          EF 0260
0346   xe6240'   3J
0347   xh6132'   alternate press # at 29
0348   xr4239'   press free?                            SUB 4
0349   xu4100'
0350    u0426'   transfer if alternate press not free
0351    u0261'   transfer to assign job to press
0352   xb6149'   press # minimum clock                  EF 0305
0353    r0420'   print results                          SUB 12 ALPHA
0354    u0400'
0355   xb6149'   press # minimum clock
0356   xr5557'   store code in Events                   SUB 2
0357   xu5210'
0358   xz0004'   indicates press free
0359    u0306'   transfer to shift data to production
0360   xb6149'   press # minimum clock                  EF 0042
0361   xr5048'   time production finished               SUB 3
0362   xu5013'
0363   xu3300'   transfer to search clocks
```

PUNCH PRESS SIMULATION

Subroutine No. 12 **Track No. 22**

Title: Analysis of Code 2

```
0400   xd6205'    1/10 at 0                          START SUB 12 ALPHA
0401   xa6102'    lo Prod -10
0402    y0409'
0403   xa6201'    1 at 29
0404    y0412'
0405   xa6202'    5 at 29
0406    y0415'
0407   xb6203'    zero
0408    u0463'    transfer to do carriage return
0409   xb0318'    job #                                    EF 0502
0410   xr6360'    print #                            SUB   OUTPUT
0411   xu5900'
0412   xb0319'    units ordered
0413   xr6360'    print #                            SUB   OUTPUT
0414   xu5900'
0415   xb0324'    units produced
0416   xr6360'    print #                            SUB   OUTPUT
0417   xu5900'
0418   xp1600'    carriage return
0419   xz0000'
0420   xu5640'    EXIT SUB 12 ALPHA
0421    z0422'    constant--Lo of initial loc. max. prod. dist.
0422   xz1134'    constant--Lo max prod dist group 1
0423   xz1154'    constant--Lo max prod dist group 2
0424   xz1210'    constant--Lo max prod dist group 3
0425    t0246'    transfer if man on just 1 job      EF 0241
0426    b0311'    Switch A                           EF 0249, 0350
0427    t0242'    transfer to BR 1
0428   xb6136'    man #                              BR 2
0429   xr5309'    store code in Setupman file        SUB 2
0430   xu5232'
0431   xz0000'    indicates setupman free
```

PUNCH PRESS SIMULATION

Subroutine No. 12 Track No. 22, 23

Title: Analysis of Code 2

0432	xu3300'	transfer to search clocks	
0433	b0311'	Switch A	EF 0145
0434	t0436'	transfer to BR 1	
0435	xu3300'	transfer to search clocks	
0436	xb6149'	press # minimum clock	EF 0434
0437	xh6132'		
0438	xb6136'	man # to be assigned	
0439	u0459'	transfer to assign man	
0440	xb6149'	press # minimum clock	EF 0133
0441	xh6132'		
0442	u0339'	transfer to JUMP 1	
0443	xh6132'		EF 0152
0444	xd6205'	1/10 at 0	
0445	u0153'		
0446	xb6149'	press # minimum clock	EF 0108
0447	xr4845'	find man running press	SUB 4-2
0448	xu4700'		
0449	u0454'	transfer if man running press is setupman	
0450	xh6160'	man # who is operator	
0451	b0135'	U0138	
0452	h0340'	JUMP 1	
0453	u0457'		
0454	xh6160'	man # who is setupman	EF 0449
0455	b0134'	U0234	
0456	h0340'	JUMP 1	
0457	xb6149'	press # minimum clock	EF 0455
0458	u0109'		
0459	xr5124'	store code in Operator File	SUB 2 EF 0439
0460	xu5100'		
0461	xz0002'	code indicates man is operating	
0462	u0242'		
0463	xh6312'	constant for output	EF 0408

0500	xp1600'	carriage return	
0501	xz0000'		
0502	u0409'		

SUBROUTINE 13

PURPOSE:

1. To perform the following initialization.
   a. Set the entire data storage area to zero.
   b. To set the area for the Assist File to zero.
   c. To store zero in the location for the minimum clock.
   d. To store four (4) in the location of the code for each record in the Events File.
2. To input the time for the end of run and store it in the first Special Clock.
3. To initialize the second Special Clock by storing the time when the first simulated reporting period will end.
4. To input and store either in the Schedule File or the Action File the information for each job to be simulated. The jobs with the highest priority for each press will be stored in the Schedule File and the appropriate Schedule Clock will be setup. all other job records will be stored in the Action File.

ENTRANCES:

1. This subroutine is entered at location 1518.
2. To start this simulation program control must be transferred to the beginning location of this subroutine.
3. This subroutine is also entered by the execution of a jump instruction stored in location 5648. This instruction may be executed at the completeion of the end of a reporting period printout by the execution of a "Six Button Sequence" after the computer stops.

SUBROUTINES USED

1. Subroutine 1 — Shift data.
2. Subroutine 4-3 — Utility program.
3. Input — Read number.

AREA USED

1518 to 1645

3440 to 3449

3532 to 3555

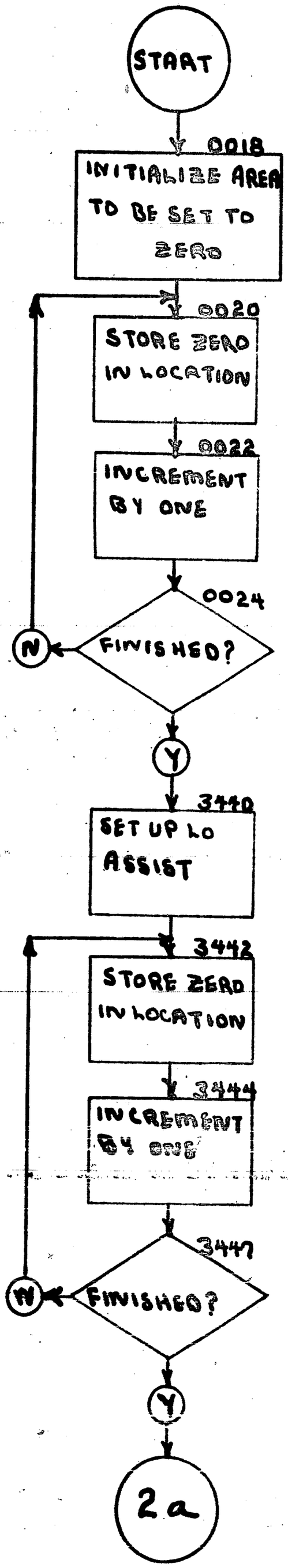
3559 to 3562

3953 to 3957

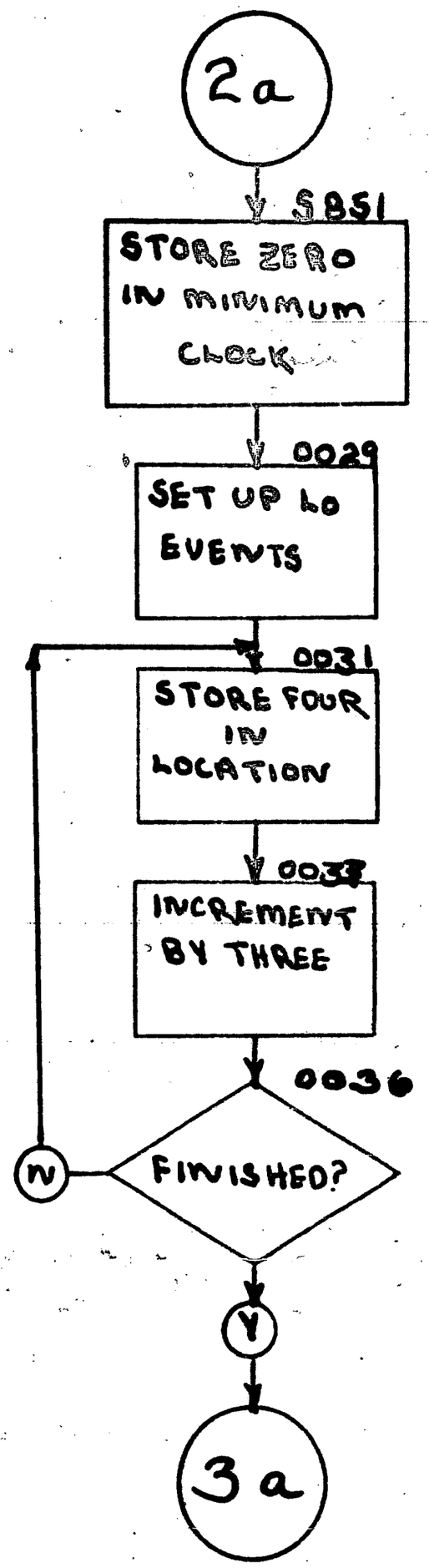
4919 to 4921

5851 to 5853

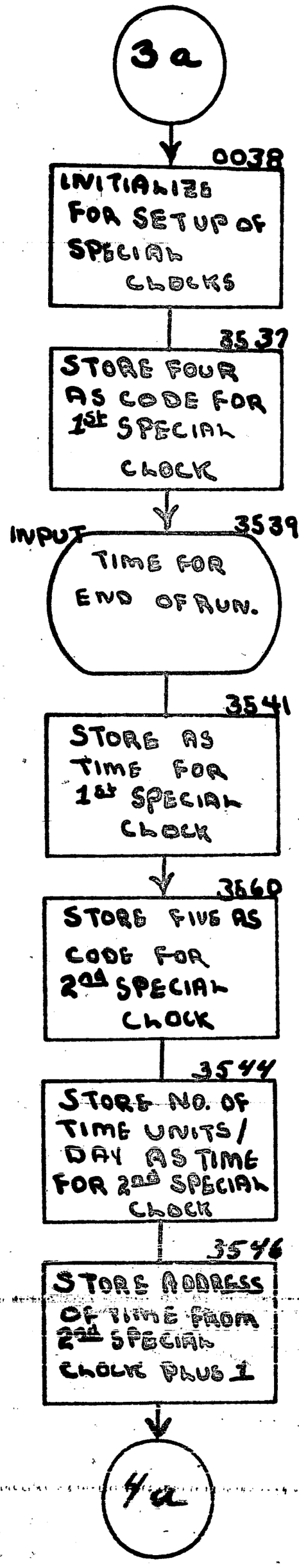
SUBROUTINE 13



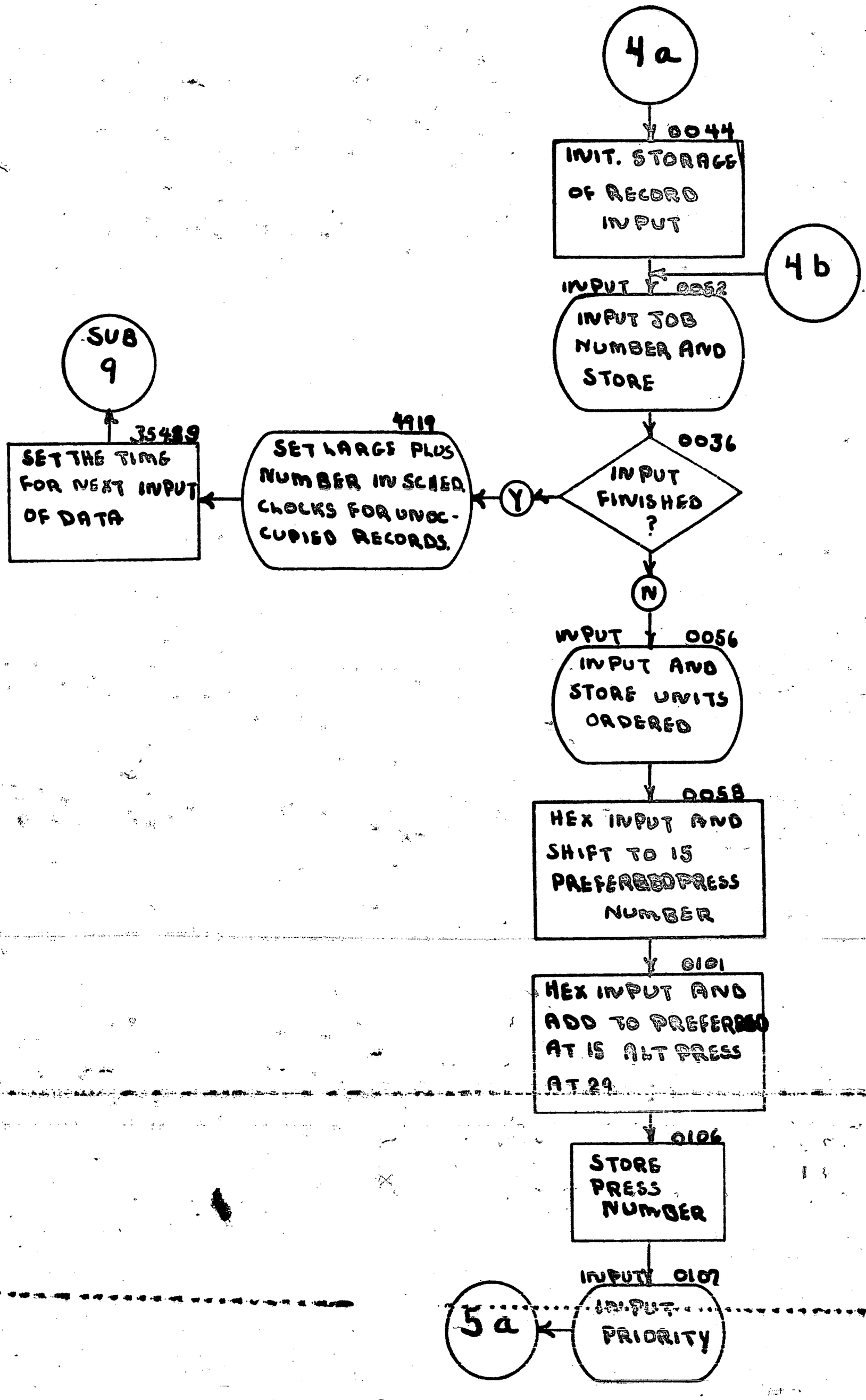
SUBROUTINE 13



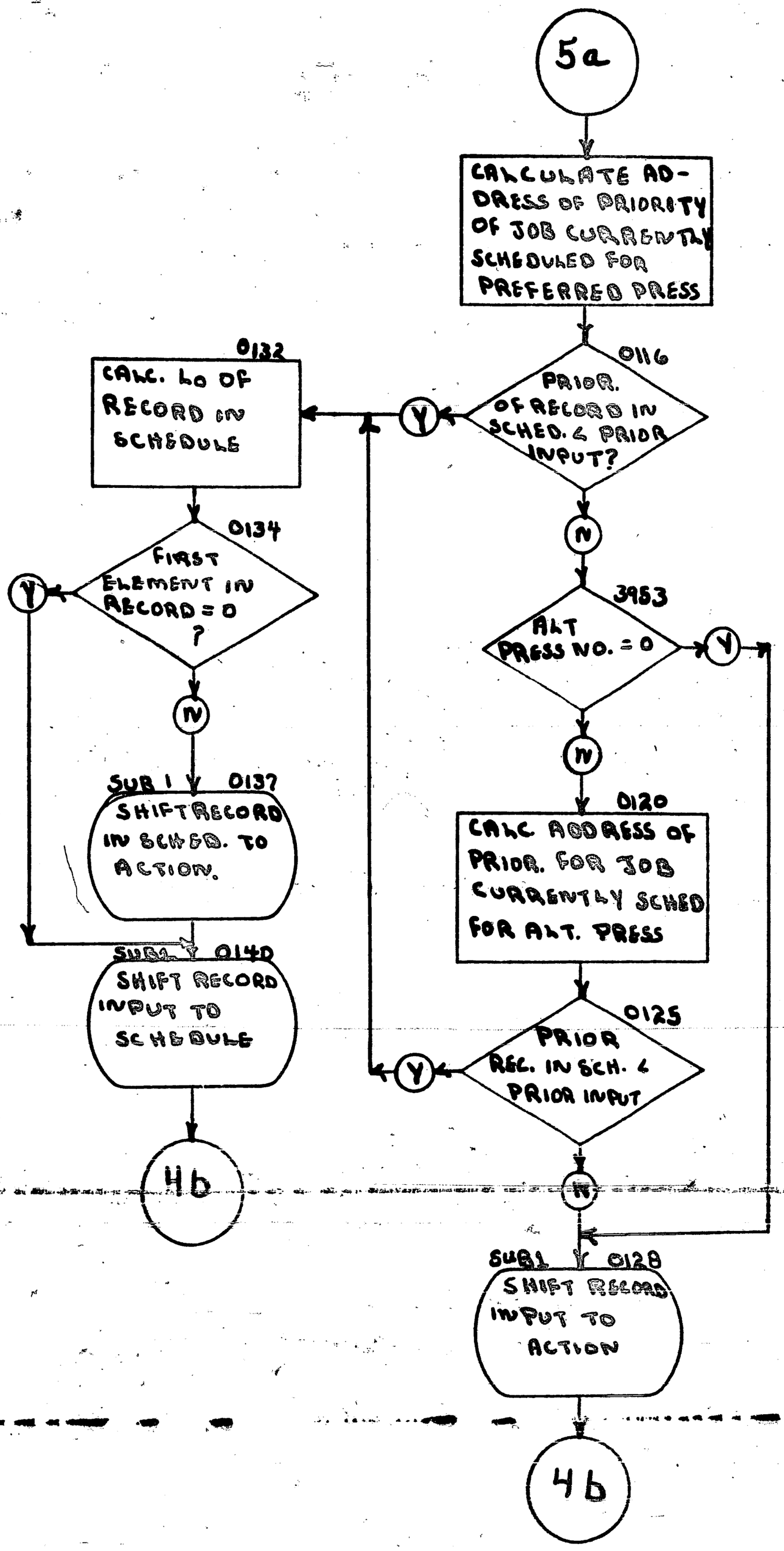
SUBROUTIN 13



SUBROUTINE 13



SUBROUTINE 13



PUNCH PRESS SIMULATION

Subroutine No. 13 Track No. 15

Title: Input data and load schedule clocks

```
0018   xb6128'   Lo area to be set equal to zero   START
0019    y0021'
0020   xb6203'   zero
0021   xh0941'   location to be zeroed
0022    b0021'
0023   xa6201'   1 at 29
0024   xs6129'   H(last loc plus 1)
0025    t0027'   transfer if not finished
0026   xu3440'   transfer to set Assist equal to zero
0027   xa6129'   H(last loc plus 1)                  EF 0025
0028    u0019'
0029   xb6125'   Lo Events                           EF 5853
0030    y0032'
0031   xb6209'   4 at 29
```

PUNCH PRESS SIMULATION

Subroutine No. 13 **Track No. 15**

Title: Input data and load schedule clocks

```
                0032    xh0027'         set 4 into beginning loc of records
                0033     b0032'                 in Events
                0034    xa6231'         3 at 29
                0035     h0032'
                0036    xs6131'         H(last loc sched clocks plus 1)
                0037     t0031'         transfer if not finished
                0038    xb6120'         Lo Special clocks
                0039    xy3538'
                0040    xa6201'         1 at 29
                0041    xy3541'
                0042    xa6201'         1 at 29
                0043    xu3532'         transfer to set up special clocks
                0044     b0130'         Lo temporary storage              EF 3548
                0045     y0055'         job #
                0046    xa6201'         1 at 29
                0047     y0058'         ordered amount
                0048    xa6211'         2 at 29
                0049     y0106'         press numbers
                0050    xa6211'         2 at 29
                0051     y0109'         priority
                0052    xr6360'         read job #          EF 0131   SUB INPUT
                0053    xu6000'                              0144
                0054    xt4919'         transfer if all input finished
                0055    xh0000'         job #
          0056  xr6360'                 read ordered amount           SUB INPUT
                0057    xu6000'
                0058    xc0000'         ordered amount
                0059    xp0000'         input preferred press #
                0060    xi0000'
                0061    xn6201'         1 at 29
                0062    xh6300'         temp
                0063    xn6220'         1 at 17
```

PUNCH PRESS SIMULATION

Subroutine No. 13 **Track No. 16**

Title: Input data and load schedule clocks

```
0100   xc6301'      temp 1 press # at 15
0101   xp0000'      input alternate press #
0102   xi0000'
0103   xm6201'      1 at 29
0104   xh6302'      temp 2 press # at 29
0105   xa6301'      temp 1 preferred press # at 15
0106   xh0000'      loc. of press nos.
0107   xr6360'      input priority                    SUB INPUT
0108   xu6000'
0109    h0018'      priority
0110   xb6300'      temp   preferred press # at 29
0111   xd6205'      1/10 at 0
0112   xa6108'      Lo Schedule file -10
0113    y0139'      temp 3  Lo record to shift
0114   xa6202'      5 at 29
0115    y0116'
0116    b0018'      priority of job in schedule file
0117   xs0811'      priority of job input
0118    t0132'      transfer if priority of job input
0119   xu3953'      check 0 Alt. press greater than job scheduled
0120   xd6205'      1/10 at 0                          EF 3957
0121   xa6108'      Lo Schedule
0122    y0139'      temp 3   Lo record to shift
0123   xa6202'      5 at 29
0124    y0125'
0125    b0018'      priority of job in schedule
0126   xs0811'      priority of job input
0127    t0132'      transfer if job input greater job schedule
0128   xr5823'      shift input to Action              SUB 1
0129   xu5723'
0130   xz0806'      Lo input record
0131    u0052'      transfer to read next record
```

PUNCH PRESS SIMULATION

Subroutine No. 13 **Track No. 16**

Title: Input data and load schedule clocks

```
0132    b0139'      temp 3 Lo record to shift
0133    y0134'
0134    b0018'      contents lst loc to shift
0135    xs6201'     1 at 29
0136     t0140'     transfer if zero
0137    xr5823'     shift sched. to Action          SUB 1
0138    xu5723'
0139    xz0000'     Lo record in schedule   temp 3
0140     b0139'
0141    xr5823'     shift Input to Schedule         SUB 1
0142    xu5819'
0143    xz0806'     Lo input record
0144     u0052'     transfer to read next record
0145    xu3549'     free
```

PUNCH PRESS SIMULATION

Subroutine No. 13, 14 — Track No. 35

Title: Patches

```
3532    y3543'                                  PATCH SUB 13  EF 1643
3533    xa6201'    1 at 29
3534     y3545'
3535    xa6201'    1 at 29
3536    xy6163'
3537    xb6219'    4 at 15
3538    xh0232'    code for 1st special clock
3539    xr6360'    input time for endo f run    SUB INPUT
3540    xu6000'
3541    xh0233'    time 1st special clock
3542     u3559'    transfer to initialize next clock
3543    xh0233'    code 2nd special clock       EF 3561
3544    xb6249'    # time units per day
3545    xh0235'    time 2nd special clock
3546    xb6163'    last loc plus 1 special Clocks
3547    xy6121'
3548    xu1544'    transfer to initialize for input
3549    xb6120'          PATCH SUB 13 --FOR PRINTOUT EACH DAY
3550    xa6231'    3 at 29
3551     y3554'
3552    xb6143'    minimum clock
3553    xa6249'    time units per day
3554    xh0235'    next input time
3555    xu3300'    transfer to search clocks
3556    xb6143'    time minimum clock   PATCH SUB 14  EF 1826
3557    xd6223'    1/3 at 0
3558    xu5660'
3559     h3562'    # time units per printout   EF 3542
3560    xb6250'    5 at 15
3561     u3543'
3562    xu3956'    temporary storage
3563
```

SUBROUTINE 14

PURPOSE:

1. To indicate that a job on a press which has had a die breakage, can be resetup.
2. Printout the report of operations at the end of the reporting period.
3. Initialize to begin a new reporting period.

ENTRANCE

1. 1646 The subroutine is entered at this location from Subroutine 9. The jump instruction to perform this exit is stored in location 3423. This entrance is used when the code found in record from the Special Clocks File with the minimum clock is a three.
2. 1656 The subroutine is entered at this location from Subroutine 9. The jump instruction to perform this entrance is stored in location 3424. This entrance is used when the code found in the record from the Special Clocks File with the minimum clock is a four.

SUBROUTINES USED

1. Output print number.

INTERNAL SUBROUTINES

1. Subroutine 14 Alpha

a. Purpose: To print the correct total operate time for each press.

b. Calling Sequences.

1. When press is free.

XR3460

XU3942

2. When press is not free.

XR3460

XU3452

c. Area used

3942 to 3947

3452 to 3460

3461 to 3463

2. Subroutine 14 Beta

a. Purpose: To print the correct accumulated operate time for each operator and setupman.

b. Calling Sequence

XR3460

U0217

c. Area used

0217 to 0226

3450 to 3460

3556 to 3558

AREA USED

1646 to 1826

3450 to 3463

3556 to 3558

3942 to 3952

5632 to 5648

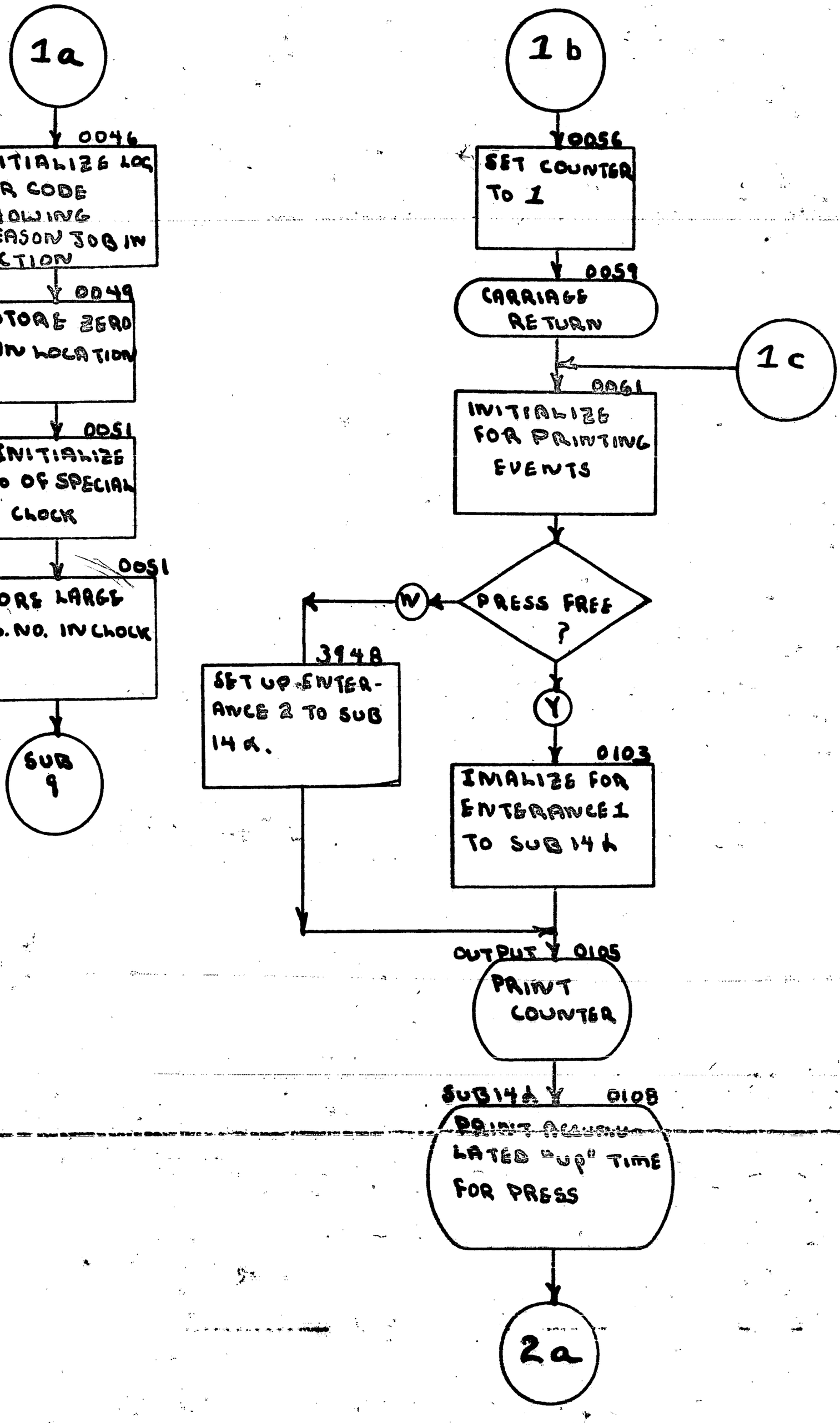
5656 to 5663

5854 to 5863

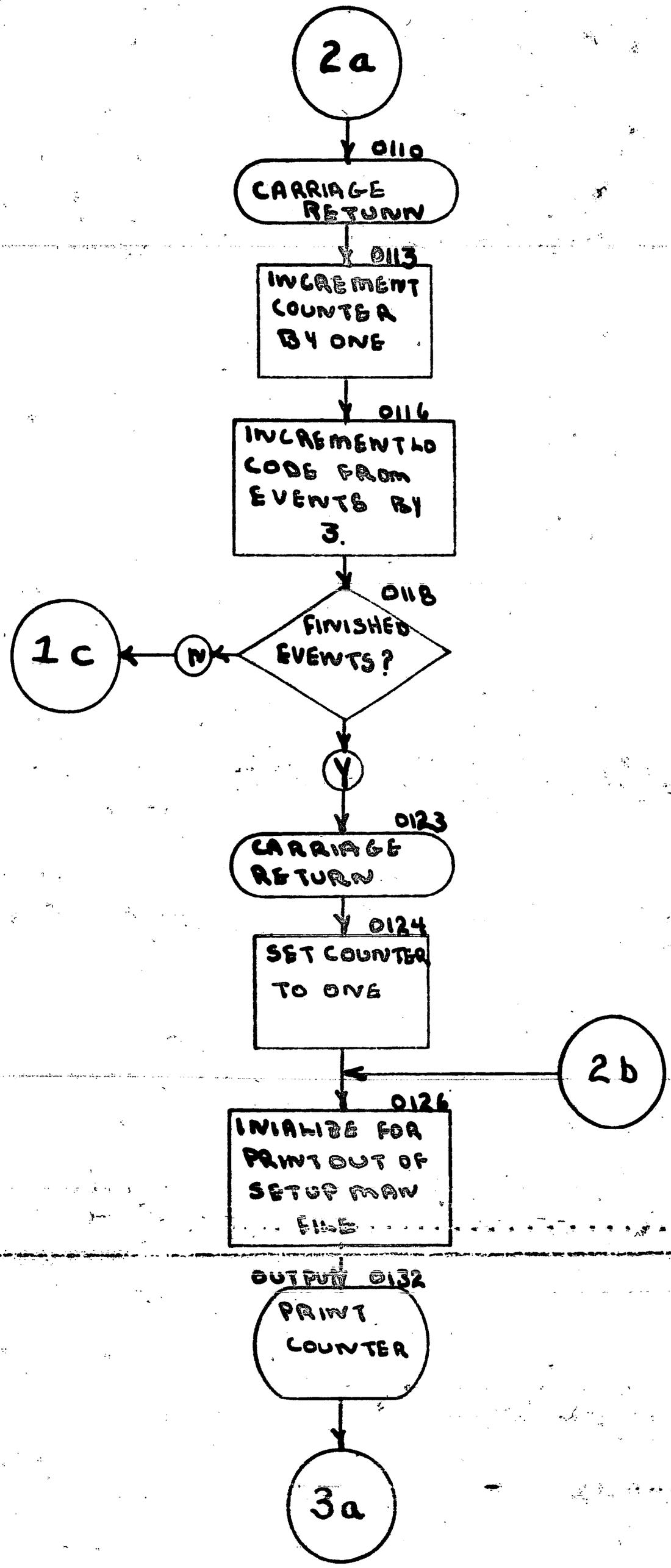
STOPS

5646 XZ1600 The printout at the end of the reporting period is completed. Depression of the "Start Compute" will cause the computer to initialize for the next reporting period and continue the simulation. Execution of the "Six Button Sequence" will cause the computer to reinitialize for the rerunning of the simulation.

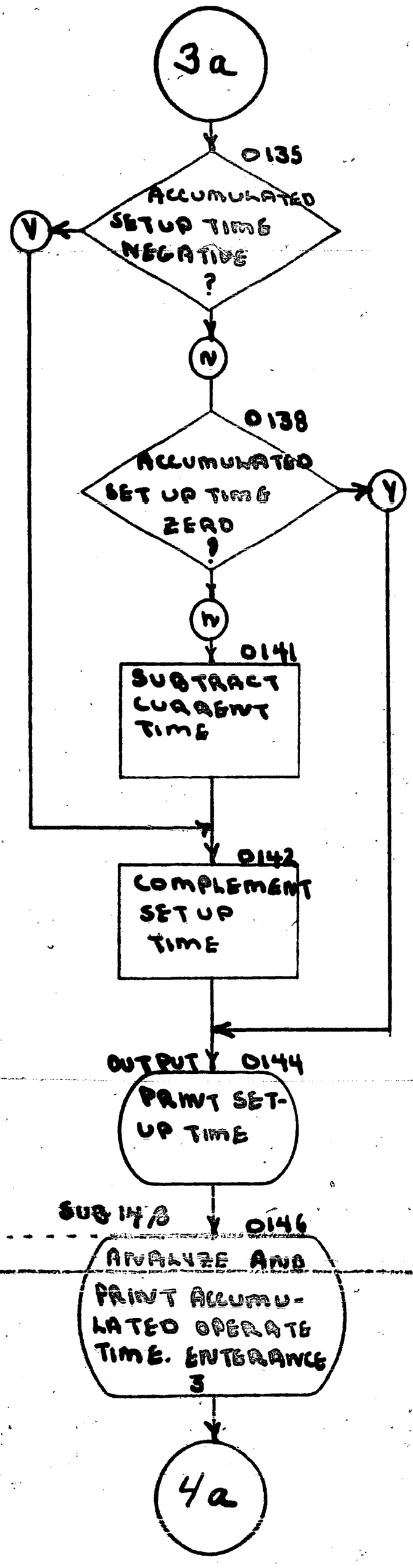
SUBROUTINE 14



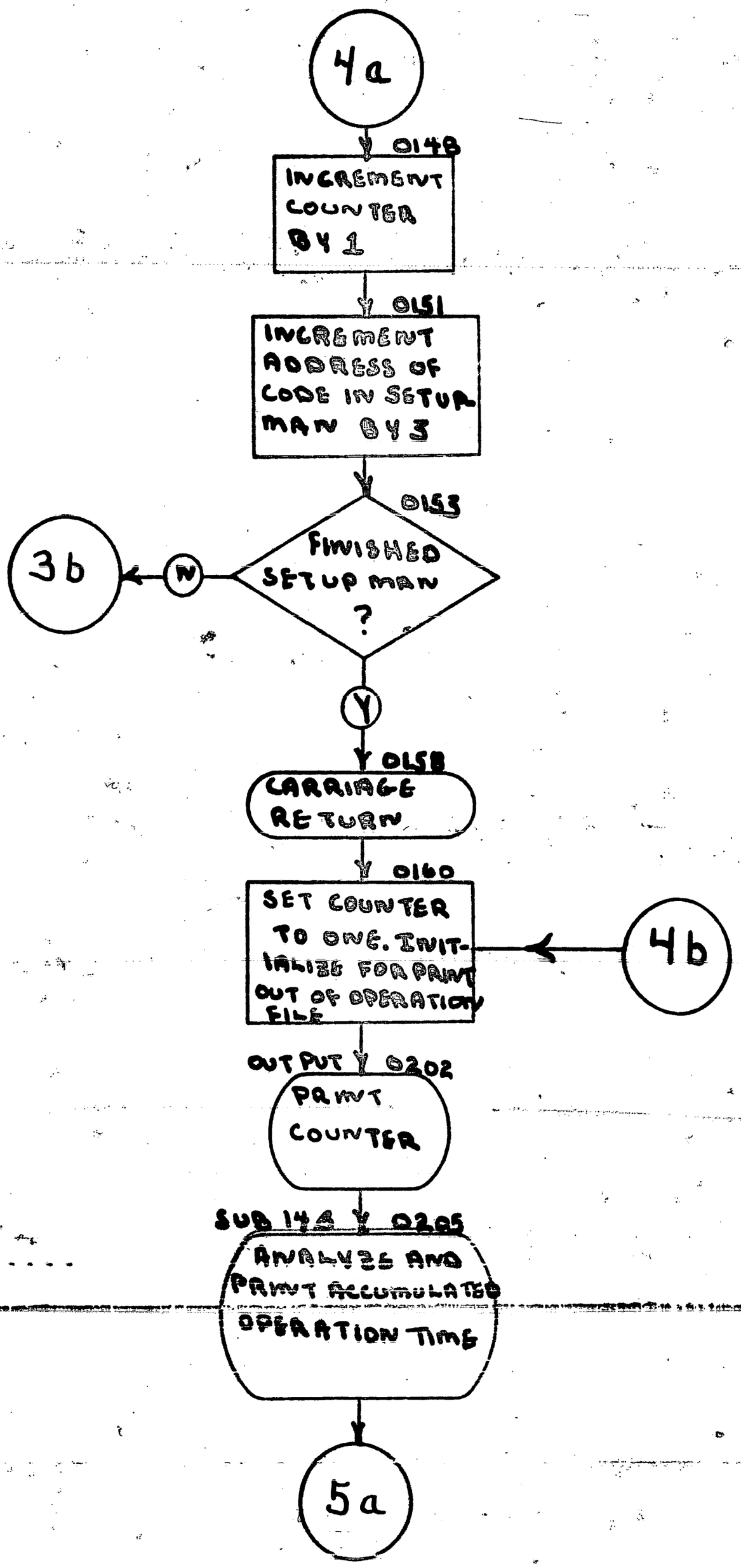
SUBROUTINE 14



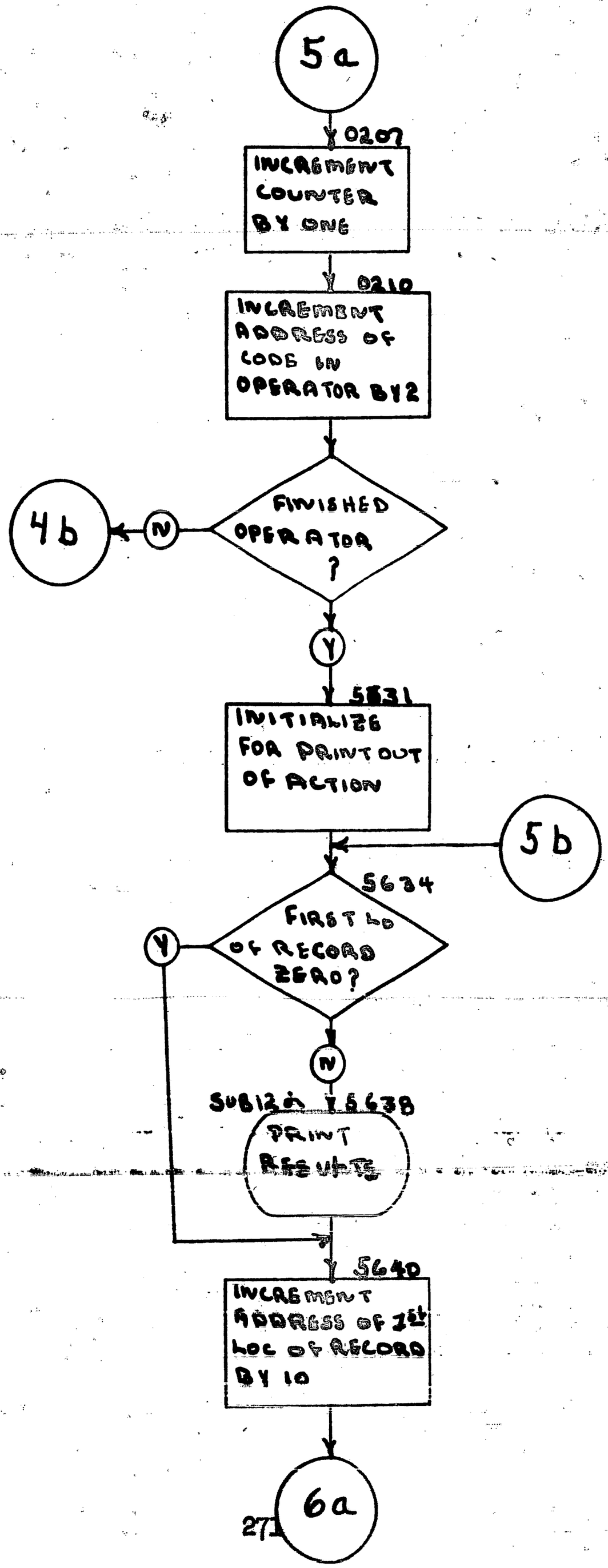
SUBROUTINE 14



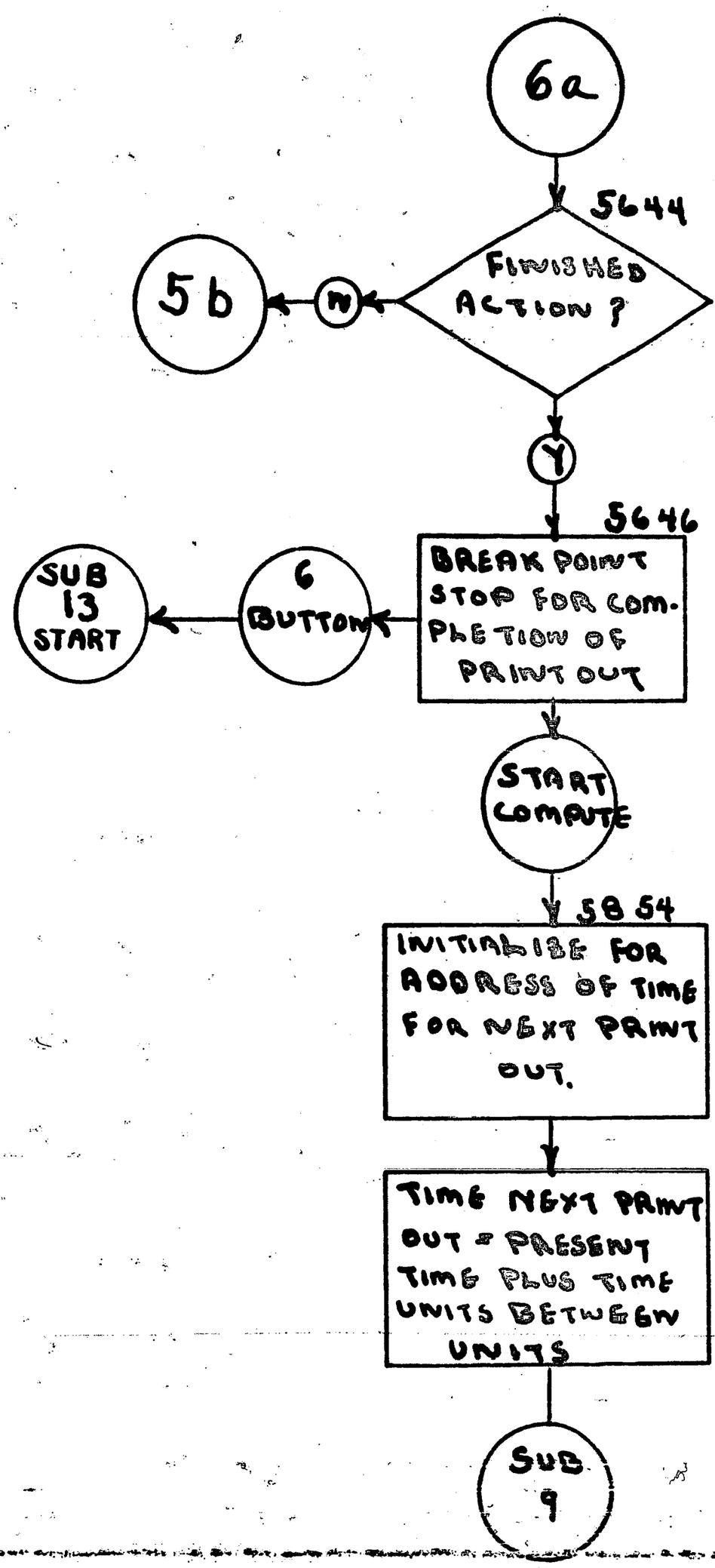
SUBROUTINE 14



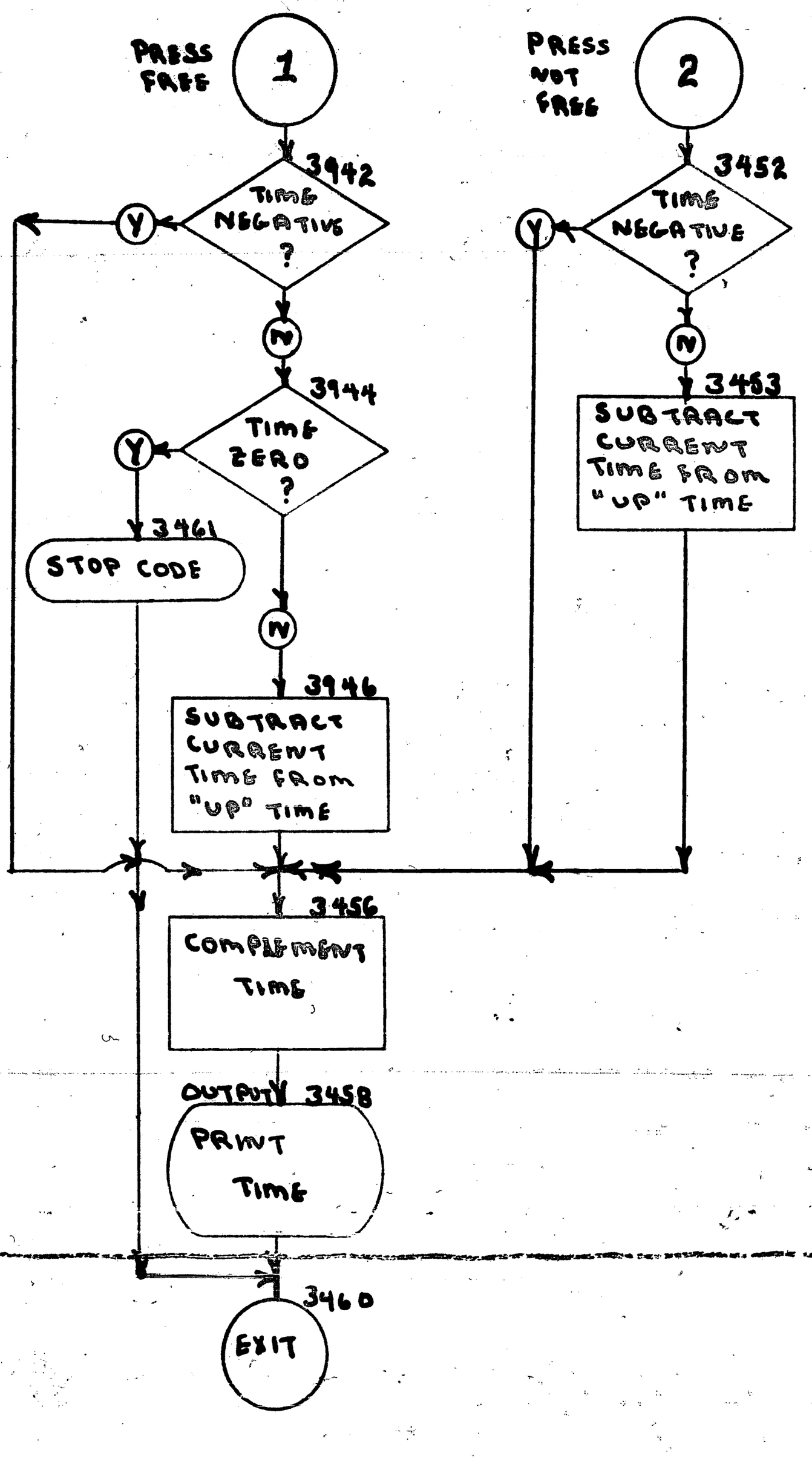
SUBROUTINE 14



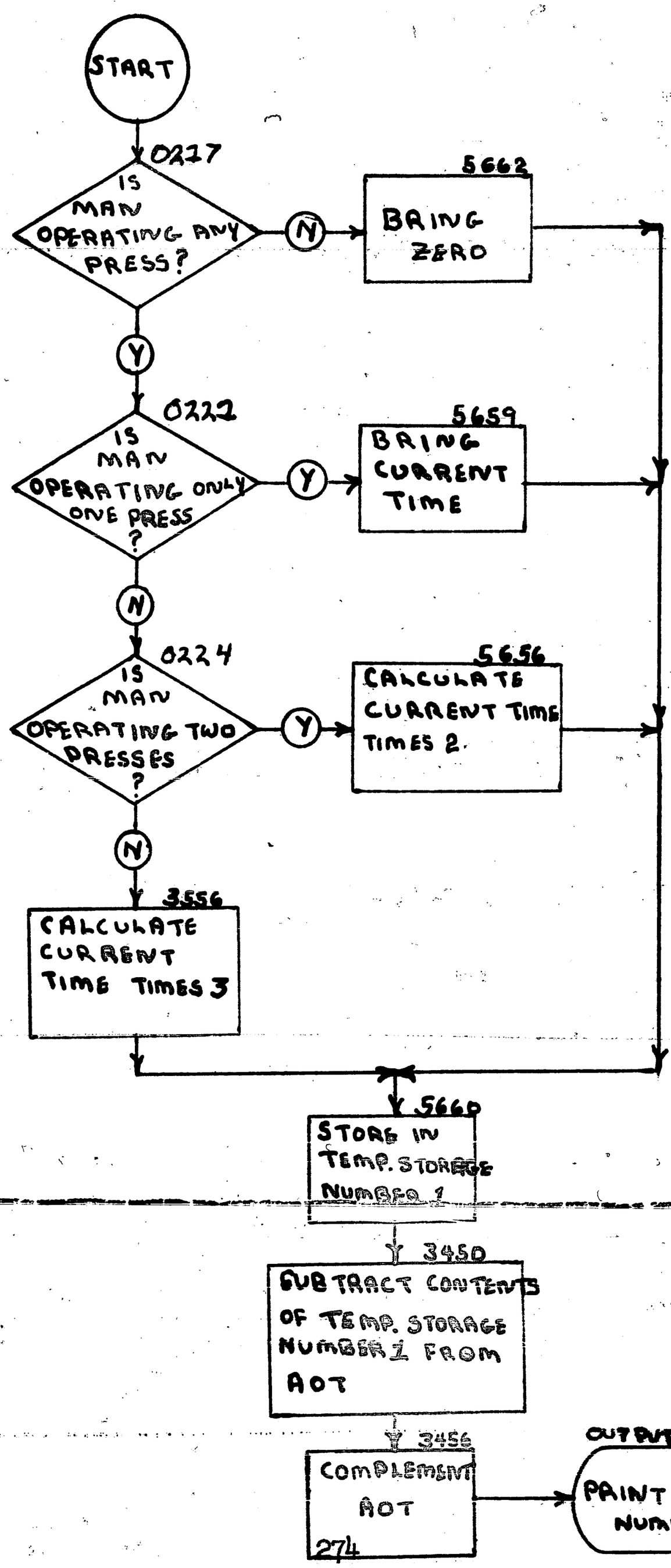
SUBROUTINE 14



SUBROUTINE 14 α



SUBROUTINE 14B



PUNCH PRESS SIMULATION

Subroutine No. 14 Track No. 16

Title: Analysis of special clocks and output printer

```
0046   xb6149'    Lo record minimum clock          START
0047   xa6229'    7 at 29                          SPECIAL CLOCK
0048    y0050'
0049   xb6203'    zero
0050   xh0315'    code to indicate job can be setup
0051   xb6162'    lo minimum clock
0052    y0054'
0053   xb6239'    large plus #
0054   xh0237'    lo minimum clock
0055   xu3300'    transfer to search clocks
0056   xb6201'    1 at 29          START OUTPUT PRINTER
0057   xh6161'    counter
0058   xb6125'    Lo Events
0059   xp1600'    carriage return
0060   xz0000'
0061    y0100'                                     EF 0122
0062   xa6211'    2 at 29
0063    y0108'
```

PUNCH PRESS SIMULATION

Subroutine No. 14 Track No. 17

Title: Analysis of special clocks and output printer

```
                0100    xb0024'     code from Events file
                0101    xs6209'     4 at 29
                0102    xt3948'     transfer if press not free
                0103    xb3952'     U394∅2
                0104     h0110'
                0105    xb6161'     counter
                0106    xr6360'     print #                          SUB OUTPUT
                0107    xu5900'
                0108    xb0026'     time from events
                0109    xr3460'     print time from Events,          SUB 14 ALPHA
                0110    xu3942'
                0111    xp1600'     carriage return
                0112    xz0000'
                0113    xb6161'     counter
                0114    xa6201'     1 at 29
                0115    xh6161'     counter
0116            b0100'              Lo record
                0117    xa6231'     3 at 29
                0118    xs6116'     B(last loc Events plus 1)
                0119     t0121'     transfer if not finished
                0120     u0123'     transfer if finished all Events
                0121    xa6116'     B(last loc Events plus 1)        EF 0119
                0122     u0061'     transfer for next record
                0123    xp1600'     carriage return
                0124    xb6201'     1 at 29
                0125    xh6161'     counter
                0126    xb6105'     Lo Setupman File
                0127     y∪217'                                      EF 0157
                0128    xa6201'     1 at 29
                0129     y0135'     Accumulated Setup Time
                0130    xa6201'     1 at 29
                0131    xy3450'     Accumulated Operate time
```

PUNCH PRESS SIMULATION

Subroutine No. 14 Track No. 17

Title: Analysis of special clocks and output printer

```
                0132    xb6161'     counter
                0133    xr6360'     print #                                 SUB OUTPUT
                0134    xu5900'
                0135    xb0221'     accumulated setup time
                0136     t0142'     transfer if negative
                0137     u0138'     skip
                0138    xs6201'     1 at 29
0139            t0144'              transfer if time is zero
                0140    xa6201'     1 at 29
                0141    xs6143'     minimum clock
                0142    xc6350'     temp      complement #                  EF 0136
                0143    xs6350'
                0144    xr6360'     print accumulated setup time          SUB OUTPUT
                0145    xu5900'
                0146    xr3460'     analyze and print accumulated operate time
                0147     u0217'                                           SUB 14 BETA
                0148    xb6161'     counter
                0149    xa6201'     1 at 29
                0150    xh6161'     counter
                0151     b0217'     B(address of code in setupman)
                0152    xa6231'     3 at 29
                0153    xs6111'     B(last loc Setupman File plus 1)
                0154     t0156'     transfer if all setupmen done not done
                0155     u0158'     transfer if all setupmen done
                0156    xa6111'     B(last loc Setupman File plus 1)      EF 0154
                0157     u0127'     transfer to setup next record
                0158    xp1600'     carriage return                       EF 0155
                0159    xz0000'
                0160    xb6201'     1 at 29
                0161    xh6161'     counter
                0162    xb6104'     Lo Operator File
                0163     y0217'                                           EF 0216
```

PUNCH PRESS SIMULATION

Subroutine No. 14 Track No. 18

Title: Analysis of special clocks and output printer

```
0200   xa6201'      1 at 29
0201   xy3450'
0202   xb6161'      counter
0203   xr6360'      print #                                  SUB OUTPUT
0204   xu5900'
0205   xr3460'      analyze and print accumulated operate time
0206    u0217'                                              SUB 14 BETA
0207   xb6161'      counter
0208   xa6201'      1 at 29
0209   xh6161'      counter
0210    b0217'      B(address of code in Operator)
0211   xa6211'      2 at 29
0212   xs6114'      B(last loc of Operator plus 1)
0213    t0215'      transfer if all records not done
0214   xu5631'      transfer if finished to print Action File
0215   xa6114'      B(last loc of Operator plus 1)    EF 0213
0216    u0163'      transfer to set up next record
0217   xb0209'      address of code in file   START SUB 14 BETA
0218   xs6252'      2 at 7 plus 1 at 11          no
0219   xt5662'      transfer if man operating ~~one~~ jobs
0220   xe6253'      WWWWQ
0221   xs6226'      1 at 15                      one
0222   xt5659'      transfer if man operating ~~two~~ jobs
0223   xe6254'      WWWQ
0224   xs6227'      1 at 19                      two
0225   xt5656'      transfer if man operating ~~three~~ jobs
0226   xu3556'      transfer if man operating ~~no~~ three jobs
```

PUNCH PRESS SIMULATION

Subroutine No. none Track No. 61

Title: Symbol table

```
                6100    z3959'      Lo Assist File
                6101    z0260'      Lo Action File
                6102    z0017'      Lo Production File -10
                6103    z0816'      Lo Schedule File
                6104    z0207'      Lo Operator File
                6105    z0217'      Lo Setupman File
,0000001'       6106 wwwwwww4'      Lo Events File -3     (0 - 3) is -3
                6107    b4000'      Lo Assist File plus 5
                6108    b0806'      last location of Action File plus 1
                6109    y4000'      Lo Assist File puls 5
                6110    z3522'      Lo Strokes per time period file -1
                6111    b0223'      Last location of Setupman File plus 1
                6112    b0214'      Lo Setupman File -3
                6113    b0205'      Lo Operator File -2
                6114    b0211'      Last location of Operator File plus 1
                6115    b0806'      Last locationof Action File plus 1
                6116    b0027'      Last location of Events File plus 1
,0000001'       6117 0000www4'      Lo Events File -3
                6118    b0153'      Lo Schedule Clocks
                6119    b0207'      Last location Schedule Clocks plus 1
                6120    b0232'      Lo Special Clocks
                6121    b0000'      Last location Special Clocks
                6122    z3421'      Lo jump table                plus 1 (Setup by program)
                6123    z0205'      Lo Operator File -2
                6124    z0214'      Lo Setupman File -3
                6125    z0000'      Lo Events File
                6126    z0151'      Lo Schedule Clocks -2
                6127    b0942'      Last Loc Schedule File plus 1
                6128    z0000'      Beginning location of Files
                6129    h0942'      Last location of files plus 1
                6130    h0942'      Last location Schedule File plus 1
                6131    h0027'      Last location Events File plus 1
```

PUNCH PRESS SIMULATION

Subroutine No. none

Track No. 61

Title: Working Storage table

6132	(	)	press #
6133	(	)	i
6134	(	)	j
6135	(	)	a
6136	(	)	man #
6137	(	)	m
6138	(	)	temp 0 entire code word
6139	(	)	temp 1 code at 7
6140	(	)	temp 2 press # at 11
6141	(	)	temp 3 press # at 15
6142	(	)	temp 4 press # at 19
6143	(	)	minimum clock time
6144	(	)	job space #
6145	(	)	balance
6146	(	)	Switch A
6147	(	)	Switch B
6148	(	)	code of minimum clock
6149	(	)	press # of minimum clock or Lo of record in clock
6150	(	)	address of code and press # which has min. prior.
6151	(	)	class of press
6152	(	)	time added to clock for die adjustment
6153	(	)	time when die can be resetup after breakage
6154	(	)	man # to do setup on press
6155	(	)	press # being checked
6156	(	)	maximum priority used to search Schedule File
6157	(	)	minimum start time used in searching Schedule File
6158	(	)	location of minimum start time
6159	(	)	Lo of distribution to be sampled
6160	(	)	
6161	(	)	printout counter
6162	(	)	location of minimum clock
6163	(	)	current last loc plus 1 of Special Clocks

PUNCH PRESS SIMULATION

Subroutine No. none

Track No. 62

Title: Constant table

,0000032	6200	00000002	1 at 30
	6201	00000004	1 at 29
	6202	00000014	5 at 29
	6203	00000000	zero
	6204	00000028	10 at 29
	6205	0JJJJJJJ	1/10 at 0
	6206	00002000	1 at 18
	6207	00020000	1at 14, 2 at 15
	6208	00200000	1 at 10, 2 at 11
	6209	00000010	1 at 27, 4 at 29
	6210	02000000	2 at 7
	6211	00000008	1 at 28, 2 at 29
	6212	20000000	2 at 3, 1 at 2
	6213	40000000	1/2 at 0, 1 at 1
	6214	0W000000	mask -- code word at 7
	6215	00W00000	mask -- press # at 11
	6216	000W0000	mask -- press # at 15
	6217	0000W000	mask -- press # at 19
	6218	01000000	1 at 7
	6219	00040000	1 at 13
	6220	00004000	1 at 17
	6221	00000400	1 at 21
	6222	30000000	3 at 3
	6223	2FFFFFGG	1/3 at 0
	6224	00100000	1 at 11
	6225	10000000	1 at 3
	6226	00010000	1 at 15
	6227	00001000	1 at 19
	6228	50000000	10 at 4
	6229	0000001J	7 at 29
	6230	00400000	1 at 9
	6231	0000000J	3 at 29

PUNCH PRESS SIMULATION

Subroutine No. none Track No. 62

Title: Constant table

,0000032	6232	WWWWWWWJ	-1 at 29
	6233	4FJKQ986	Random Number Seed
	6234	0005W800	mask -- 7 bits at 20
	6235	00032000	100 at 20
	6236	000JJJJQ	1/5 at 9
	6237	000001WJ	mask -- 7 bits at 29
	6238	00000018	6 at 29
	6239	01000000	large positive number
	6240	0000003J	15 at 29
	6241	00008000	1 at 16
	6242	04000000	4 at 7, 2 at 6, 1 at 5
	6243	02500000	2 at 7 plus 5 at 11
	6244	00300000	3 at 11
	6245	00002Q64	XZ4625 Lo codes to check for proper press
	6246	02800000	2 at 7 plus 8 at 11 assignment
	6247	00000020	1 at 26, 8 at 29
	6248	00000J80	100 at 26
	6249	0000063J	# time units between printouts (set for 1 week)
	6250	00050000	5 at 15
	6251	000H2800	H4000 -- Lo Assist File plus 5
	6252	02100000	2 at 7 plus 1 at 11
	6253	000WWWWQ	mask
	6254	000CWWWQ	mask
	6255	000D3Q34	XD6213
	6256	000U30Q4	XU4857
	6257		
	6258		
	6259		
	6260		
	6261		
	6262		
	6263		

APPENDIX 3

CHARACTERISTICS OF THE LGP-30

MEMORY

1. Magnetic drum
2. 4096 Locations
3. Access time 16 milliseconds

ARITHMETIC & CONTROL

1. 16 single address instructions
2. Includes division
3. Addition time 1 millisecond

INPUT & OUTPUT

1. Flexowriter with paper tape reader and punch. Other devices available.

APPENDIX 4

The Preparation of a Sampling Table

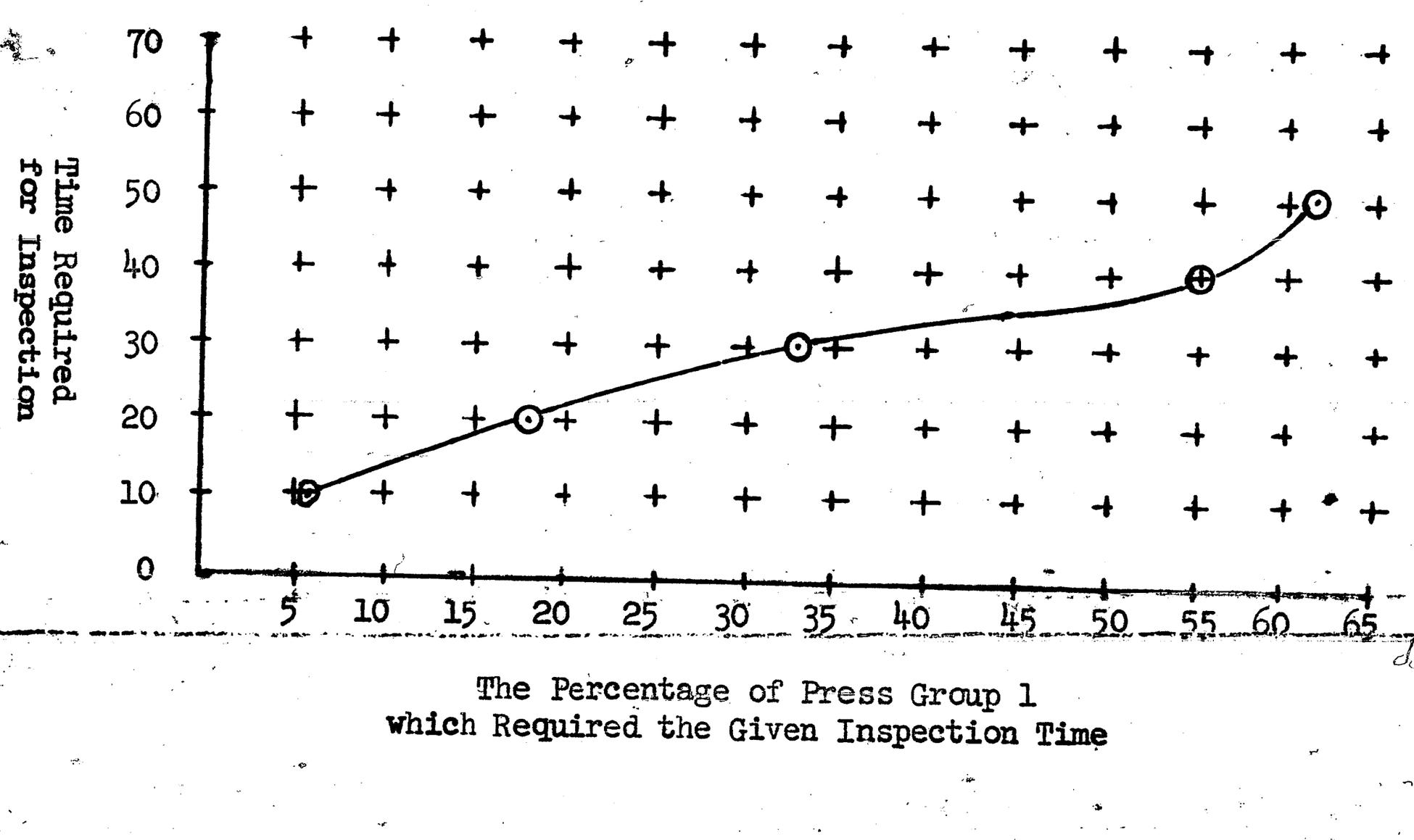
from a Frequency Distribution

1. Given a frequency distribution table of the form

Distribution of Inspection Times
(Partial Table)

Time required for Inspection (Minutes)	10	20	30	40	50	60	70	80	90
The Percentage of Press Group 1 which required the given inspection time	6	12	15	12	7	8	3	5	4

2. The data from the distribution is plotted on the graph below.



2. In the table below is shown the time at which the given percent of the jobs will be completed inspection. This table may also be used as a discrete distribution showing the time required to inspect a given part of all jobs run. A table of this form can be used to select inspection times by randomly selecting the position in the table containing the time to be used.

Element Number	Percentage	Time from the graph Measured in Minutes	Time as shown the Distribution*
1	5	10	1
2	10	12	1
3	15	18	1
4	20	21	1
5	25	28	2
6	30	29	2
7	35	30	2
8	40	32	2
9	45	34	2
10	50	37	2
11	55	40	3
12	60	45	3
•	•	•	•
•	•	•	•
•	•	•	•

APPENDIX 5

A History of One Weeks Runs Made on

The Actual Automatic Punch Press Line

Job Number	Units Ordered	Units Produced
5435267	60,000	76,834
5175494	120,000	111,690
5435205	30,000	30,900
5435331	80,000	26,940
5435683	90,000	104,075
4175275	60,000	85,800
5435373	40,000	38,618
5435617	50,000	67,600
5435606	50,000	50,150
5435610	50,000	10,455
5435609	45,000	45,320
4175494	60,000	48,300
5435078	40,000	69,200
4175289	30,000	47,000
5435261	50,000	81,180
4175152	40,000	29,600
4175149	40,000	52,400
5435613	50,000	30,900
5435653	30,000	29,050
5435382	45,000	45,550
5435056	25,000	41,900
5435659	50,000	46,740
	286	

APPENDIX 6

Printouts of all runs made

by the Simulation

1. **Trial 1:** The priority of the jobs input for the five runs in this trial was calculated as follows:

$$\text{Priority} = \frac{\text{Units ordered}}{\text{Strokes per time period for the preferred press}}$$

The input for all five runs of this trial is the same and is shown below. On the following pages is the printout of the output from each of the five runs in Trial 1.

```
399'
4175149'40000'6'5'21'
5435205'30000'9'8'40'
5435604'50000'4''34'
5435659'30000'2'1'12'
5435653'30000'6'5'16'
4175154'120000'7'4'65'
4175275'60000'4''40'
5435331'80000'6'5'41'
5435261'50000'1'2'23'
5435267'60000'9'8'80'
5435382'45000'1''21'
4175494'60000'2'1'23'
5435613'50000'2'1'20'
5435609'45000'5'6'24'
5435659'30000'2'1'11'
5435056'25000'6'5'13'
5435068'40000'4''27'
5435683'90000'1'2'41'
5435373'40000'8''30'
5435606'50000'7''27'
5435610'50000'5''26'
4175289'30000'8'9'23'
4175152'40000'5'6'21'
5435617'50000'7''27'
-0000001'
```

Trial 1 Run 1

5435267'	60000'	36000'
4175154'	120000'	35150'
5435331'	80000'	72150'
5435205'	30000'	21500'
5435683'	90000'	101200'
4175275'	60000'	67500'
5435373'	40000'	8100'
5435617'	50000'	'
5435606'	50000'	2200'
5435267'	24000'	36750'
5435331'	7850'	1950'
5435610'	50000'	44850'
5435604'	50000'	70500'
5435609'	45000'	40950'
5435373'	31900'	35100'
4175154'	84850'	57350'
4175494'	60000'	68250'
5435068'	40000'	24000'
5435331'	5900'	7800'
5435617'	50000'	40700'
5435610'	5150''	5850'
4175289'	30000'	17550'
5435068'	16000'	18000'

Trial 1 Run 1

1'	91'
2'	48'
3'	'
4'	197'
5'	148'
6'	121'
7'	197'
8'	149'
9'	137'

1'	284'	16'	2'	249'	21'
1'	365'	2'	153'		

4175149'	40000'	'
5435382'	45000'	'
5435659'	30000'	'
5435653'	30000'	'
5435659'	30000'	'
5435056'	25000'	'
4175152'	27500'	'
5435606'	27800'	'
4175289'	12450'	'
5435205'	8400'	'

Trial 1 Run 2

5435267'	60000'	12000'
5435683'	90000'	79200'
5435205'	30000'	24000'
4175154'	120000'	133200'
5435331'	80000'	128700'
5435373'	40000'	28350'
5435683'	10800'	13200'
4175275'	60000'	97500'
5435267'	48000'	53250'
5435205'	6000'	4050'
5435617'	50000'	55500'
5435373'	11650'	'
5435604'	50000'	70500'
5435610'	50000'	56550'
5435609'	45000'	40950'
5435606'	50000'	51800'
5435068'	40000'	36000'
5435373'	11650'	2700'
4175494'	60000'	84000'
4175289'	30000'	17550'
5435609'	4050'	5850'
5435261'	50000'	44000'
4175152'	40000'	5850'
5435068'	4000'	7500'

Trial 1 Run 2

1'	148'				
2'	51'				
3'	'				
4'	213'				
5'	78'				
6'	151'				
7'	204'				
8'	167'				
9'	188'				
1'	262'	3'	2'	277'	36'
1'	364'	2'	258'		
5435659'	30000'	'			
5435613'	50000'	'			
5435653'	30000'	'			
5435659'	30000'	'			
5435059'	25000'	'			
4175152'	34150'	'			
4175289'	12450'				
5435261'	6000'	'			
5435205'	1950'	'			

Trial 1 Run 3

5435267'	60000'	'
5435331	80000'	48750'
5435683'	90000'	90200'
4175154'	120000'	133200'
4175275'	60000'	61500'
5435267'	60000'	48000'
4175494'	60000'	96800'
5435205'	30000'	33750'
5435331'	31250'	44850'
5435267'	1200'	3000'
5435604'	50000'	51000'
5435373'	40000'	1350'
5435068'	40000'	45000'
5435373'	38650'	27000'
5435617'	50000'	51800'
5435267'	9000'	6000'
5435606'	50000'	55500'
4175289'	30000'	24300'
5435609'	45000'	46800'
5435610'	50000'	56550'
5435261'	50000'	77000'
4175152'	40000'	48750'
5435613'	50000'	'
4175149'	40000'	48750'
5435653'	30000'	17550'
5435382'	45000'	46200'

Trial 1 Run 3

1'	224'				
2'	40'				
3'	'				
4'	168'				
5'	105'				
6'	216'				
7'	185'				
8'	167'				
9'	176'				
1'	336'	18'	2'	241'	120'
1'	348'	2'	218'		
5435653'	12450'	'			
5435267'	3000'	'			
5435613'	50000'	'			
4175289'	5700'	'			
5435373'	11650'	'			

Trial 1 Run 4

//////////		
5435331'	80000'	72150'
/		
5435683'	90000'	90200'
//		
4175154'	120000'	144300'
///		
5435205'	30000'	10800'
//		
5435267'	60000'	66750'
/		
5435617'	50000'	29600'
/		
5435331'	7850'	3900'
//		
4175275'	60000'	78000'
///		
5435373'	40000'	9450'
///		
5435606'	50000'	66600'
//		
5435610'	50000'	39000'
/		
5435331'	3950'	3900'
//		
5435604'	50000'	66000'
//////		
5435617'	20400'	24050'
/		
4175494'	60000'	52500'
/		
5435609'	45000'	50700'
/		
5435068'	40000'	40500'
/////		
5435331'	50'	1950'
/		
4175289'	30000'	24300'
/		
5435610'	11000'	
/		
4175494'	7500'	5250'
////		
4175152'	40000'	11700'
//		
4175149'	40000'	5850'
/		
5435373'	30550'	33750'
//		
5435261'	50000'	57200'
///		
4175289'	5700'	4500'
/		

Trial 1 Run 4

1'	117'				
2'	48'				
3'	'				
4'	197'				
5'	137'				
6'	147'				
7'	228'				
8'	173'				
9'	146'				
1'	276'	37'	2'	303'	44'
1'	308'	2'	225'		
4175289'	1200'	'			
5435659'	30000'	'			
5435653'	30000'	'			
5435659'	30000'	'			
5435056'	25000'	'			
4175152'	28300'	'			
5435610'	11000'	'			
4175494'	2250'	'			
5435205'	19200'	'			
4175149'	34150'	'			

Trial 1 Run 5

5435267'	60000'	54000'
5435683'	90000'	44000'
4175154'	120000'	133200'
5435267'	6000'	'
5435205'	30000'	24000'
4175275'	60000'	78000'
5435683'	46000'	46200'
5435331'	80000'	97500'
5435373'	40000'	44550'
5435267'	6000'	6750'
5435205'	6000'	750'
5435610'	50000'	29250'
5435617'	50000'	61050'
5435604'	50000'	66000'
5435609'	45000'	62400'
4175289'	30000'	5400'
4175494'	60000'	84000'
5435068'	40000'	40500'
5435606'	50000'	55500'
4175149'	40000'	17550'
5435261'	50000'	57200'
4175152'	40000'	44850'
5435653'	30000'	17550'
5435613'	50000'	55125'
5435382'	45000'	50600'
5435610'	20750'	17550'
5435056'	25000'	15600'

Trial 1 Run 5

1'	159'
2'	97'
3'	'
4'	184'
5'	121'
6'	227'
7'	198'
8'	87'
9'	249'

1'	296'	5'	2'	273'	50'
1'	388'	2'	310'		
5435659'	30000'	'			
5435653'	12450'	'			
5435659'	30000'	'			
5435610	3200'	'			
5435056'	9400'	'			
5435205'	5250'	'			

2. Trial 2: The priority of the jobs input for the three runs in this trial was calculated as follows:

$$\text{Priority} = \frac{\text{Units Ordered}}{1000}$$

The input for all three runs of this trial is the same and is shown below. On the following pages is the printout of the output from each of the three runs in Trial 2.

```
399'
4175149'40000'6'5'40'
5435205'30000'9'8'30'
5435604'50000'4''50'
5435659'30000'2'1'30'
5435653'30000'6'5'30'
4175154'120000'7'4'120'
4175275'60000'4''60'
5435331'80000'6'5'80'
5435261'50000'1'2'50'
5435267'60000'9'8'60'
5435382'45000'1''45'
4175494'60000'2'1'60'
5435613'50000'2'1'50'
5435609'45000'5'6'45'
5435659'30000'2'1'30'
5435056'25000'6'5'25'
5435068'40000'4''40'
5435683'90000'1'2'90'
5435373'40000'8''40'
5435606'50000'7''50'
5435610'50000'5''50'
4175289'30000'8'9'30'
4175252'40000'5'6'40'
5435617'50000'7''50'
-0000001'
```

Trial 2 Run 1

5435267'	60000'	48000'
5435683'	90000'	110000'
4175494'	60000'	68250'
5435331'	80000'	89700'
4175154'	120000'	168350'
5435610'	50000'	50700'
5435617'	50000'	35150'
5435261'	50000'	44000'
4175275'	60000'	67500'
5435267'	12000'	8250'
5435613'	50000'	55125'
5435606'	50000'	61050'
5435604'	50000'	55500'
5435382'	45000'	50600'
5435261'	6000'	5250'
5435609'	45000'	46800'
5435617'	14850'	3700'
4175152'	40000'	35100'
5435267'	3750'	6000'
5435068'	40000'	31500'
5435373'	40000'	60750'
5435261'	750'	'
4175289'	30000'	18900'
4175149'	40000'	48750'

Trial 2 Run 1

1'	179'				
2'	142'				
3'	'				
4'	167'				
5'	151'				
6'	133'				
7'	235'				
8'	114'				
9'	163'				
1'	271'	95'	2'	290'	64'
1'	273'	2'	291'		
5435068'	8500'				
4175152'	4900'	'			
4175289'	11100'	'			
5435056'	25000'	'			
5435261'	750'	'			
5435617'	11150'	'			

Trial 2 Run 2

4175154'	120000'	9435'
5435683'	90000'	136400'
5435331'	80000'	89700'
4175494'	60000'	68250'
4175275'	60000'	61500'
5435610'	50000'	60450'
5435261'	50000'	50600'
5435617'	50000'	75850'
5435613'	50000'	36750'
5435606'	50000'	35150'
4175154'	25650'	34500'
5435267'	60000'	78000'
5435609'	45000'	50700'
5435382'	45000'	50600'
5435604'	50000'	51000'
5435613'	13250'	2625'
5435373'	40000'	60750'
5435613'	10625'	10500'
4175152'	40000'	60450'
5435068'	40000'	40500'
4175149'	40000'	35100'
5435606'	14850'	3700'
5435659'	30000'	23625'
4175289'	30000'	21600'

Trial 2 Run 2

1'	166'
2'	146'
3'	'
4'	204'
5'	147'
6'	120'
7'	189'
8'	113'
9'	136'

1'	255'	130'	2'	239'	71'	
1'	316'	2'	210'			
4175149'	4900'	'				
5435205'	30000'	'				
4175289'	8400'	'				
5435659'	6375'	'				
5435056'	25000'	'				
5435613'	125'	'				
5435606'	11150'	'				

Trial 2 Run 3

5435331'	80000'	11700'
5435267'	60000'	48000'
5435683'	90000'	136400'
5435610'	50000'	29250'
4175494'	60000'	78750'
4175154'	120000'	133200'
4175275'	60000'	15000'
5435261'	50000'	81400'
5435617'	50000'	55500'
5435613'	50000'	94500'
5435610'	20750'	29250'
5435331'	69300'	76050'
5435606'	50000'	51800'
5435604'	50000'	51000'
5435267'	12000'	13500'
5435609'	45000'	50700'
5435382'	45000'	46200'
4175275'	45000'	46500'
5435373'	40000'	4050'
5435068'	40000'	24000'
4175149'	40000'	5850'
4175152'	40000'	44850'
4175289'	30000'	2700'
5435659'	30000'	47250'
4175149'	34150'	19500'
5435373'	35950'	17550'

Trial 2 Run 3

1'	164'
2'	146'
3'	'
4'	157'
5'	169'
6'	162'
7'	191'
8'	94'
9'	140'

1'	289'	55'	2'	253'	133'
1'	266'	2'	227'		

5435205'	30000'	'
5435373'	18400'	'
5435056'	25000'	'
5435068'	16000'	'
4175149'	14650'	'

APPENDIX 7

Sample Calculations to shown that the Simulation is Reliable

1. Definitions

s = the number of runs

n_s = the size of run "s"

n = the total number of all elements in all samples

$$n = \sum_{j=1}^{s} n_j$$

r = the number of class intervals

p_i = the estimated population relative frequency for the "i"th class interval.

v_{ij} = the observed sample frequency for the "i"th class interval from the "j"th sample

$$p_i = \frac{1}{n}\sum_{j} v_{ij}$$

$$= \sum_{ij} (v_{ij} - n_j p_i)^2 / n_j p_i$$

2. The data below represents the utilization of the group 1 presses for the five runs of trial 1.

	Run 1	Run 2	Run 3	Run 4	Run 5
Press 1	91	148	117	224	159
Press 2	48	51	48	40	97
Press 3	0	0	0	0	0
Press 4	197	213	197	168	184

3. In all calculations that follow, Press 3 has been eliminated since the utilization for all runs was zero.

4. Frequency Table

Class interval	25 to 149	150 to 224
Run 1	////	/
Run 2	////	/
Run 3	////	/
Run 4	////	//
Run 5	/	//
	305	

4. Calculations

$s = 5$

$n = 15$

$r = 2$

$$p_1 = \frac{1}{n}\sum v_{ij} = \frac{8}{15}$$

$$p_2 = \frac{1}{n} \quad v_{ij} = \frac{7}{15}$$

$$\chi^2 = \sum_{ij} (v_{ij} - n_j p_i) / n_j p_i$$

$$= 3[2 - 3(8/15)]^2/3(8/15) + 2[1 - 3(8/15)]^2/3(8/15) +$$

$$3[1 - 3(7/15)]^2 /3(7/15) + 2[2 - 3(7/15)]^2/3(7/15)$$

$$\chi^2 = 1.607$$

degrees of freedom df = $(s - 1)(r - 1) = 4$

5. The probability "e" that all runs are from the same population is found from the Chi Square Table

"e" was found to be 0.807.

APPENDIX 8

Calculations of Confidence Intervals

Press #	Run 1	Run 2	Run 3	Run 4	Run 5	$\bar{\bar{X}}$	$\frac{\bar{X}^2}{N}$	$\bar{X}^2$	LCL	UCL
1.	91	148	111	224	159					
2.	48	51	48	40	97					
3.	0	0	0	0	0					
4.	197	213	197	168	184					
MEAN	84	103	90.5	108	110	99.1	9,938	9,820	78.8	119.3
						sigma = 10.11				
5.	148	78	137	105	121					
6.	121	151	147	216	227					
7.	197	204	228	185	198					
MEAN	155.3	144.3	170.7	168.7	182	164.2	27,132	26,961	138.0	190.4
						sigma = 13.07				
8.	149	167	173	167	87					
9.	137	188	146	176	249					
MEAN	143	177.5	159.5	171.5	168	163.9	26,972	26,868	143.1	184.7
						sigma = 10.43				

APPENDIX 9

Calculation of Sample Means for Trial 2

Press #	Run 1	Run 2	Run 3
1.	179	166	164
2.	142	146	146
3.	0	0	0
4.	167	204	157
MEAN	122	128	117
5.	151	147	169
6.	133	120	162
7.	235	189	191
MEAN	173	152	174
8.	114	113	94
9.	163	136	140
MEAN	139.5	124.5	117

APPENDIX 10

Calculations Showing the "T" Test for the Difference Between Two Samples

1. Definitions

   a. $\bar{\bar{X}}_1$ and $\bar{\bar{X}}_2$ are the means of the means of the running time for each press in group 1 for Trial 1 and Trial 2.

   b. S_1^2 and S_2^2 are the variances in press utilization for group 1 from Trial 1 and Trial 2.

   c. N_1 and N_2 are the number of runs in Trial 1 and Trial 2.

   d. $$\text{"T"} = (\bar{\bar{X}}_1 - \bar{\bar{X}}_2)\left[(N_1 + N_2 - 2)(N_1 N_2)\right]^{\frac{1}{2}} / \left[N_1 + N_2)(N_1 S_1^2 + N_2 S_2^2)\right]^{\frac{1}{2}}$$

2. Data

	$\bar{\bar{X}}_1$	$\bar{\bar{X}}_2$	S_1^2	S_2^2	N_1	N_2
Press Group 1	99.1	122.0	118	102	5	3
Press Group 2	164.2	166.5	171	48	5	3
Press Group 3	163.9	127.0	104	88	5	3

3. Calculations for Press Group 1

$$\text{"T"} = (99.1 - 122)\left[(6)(15)\right]^{\frac{1}{2}} / \left[(5 + 3)(5 \cdot 118 + 3 \cdot 102)\right]^{\frac{1}{2}}$$

$$= (-22.9)(9.49)/84.7 = 2.56$$

APPENDIX 11

Calculations to show the Probability that at least a Fraction of the Population lies within the range of the Sample

1. Definitions

   a. n = the number of runs necessary

   b. h = the fraction of the population values lying within the range of a sample of size "n".

   c. p = the probability that a fraction "h" of the population values lies within the range of a sample of size "n".

$$p = 1 - nh^{(n-1)} + (n-1)h^{n}$$

2. To determine the probability, "p" that at least 80% ("h") of the distribution would be contained within the range of the units produced for each job when the number of runs equals 8 ("n"), the calculations would be as follows.

$$p = 1 - 8(.80)^{7} + 7(.80)^{8}$$

$$= 0.498$$

3. To determine the number of runs ("n") necessary so that there is a 95% probability ("p") that 90% ("h") of the population for each job would lie within the range determined by the results of the simulation, will require a trial and error type solution.

   1. Rearranging the equation for "p" and substituting the values shown above we have:

$$0.95 = 1 - n(.9)^{n-1} + (n-1)(.9)^{n} \qquad (1)$$

$$0.05 = n(.9)^{n-1} - (n-1)(.9)^{n} \qquad (2)$$

   2. Different values of "n" are tried in (2) until the right side of the equation equals 0.05. The table below shows the different values tried.

right side of the
equation

n	Right Side of the equation
30	0.290
35	0.122
40	0.078
60	0.017
50	0.033
45	0.054

BIBLIOGRAPHY

1. Goode, Harry H. "The Application of a High Speed Computer to the Definition and Solution of Vehicular Traffic Problems," Journal of Operations Research, December 1959.

2. Malcome, Donald G, "System Simulation - A Fundamental Tool of Industrial Engineering," Journal of Industrial Engineering, pp 177-187, May-June 1958.

3. -----"The Use of Simulation in Management Analysis, A Survey and Bibliography," Journal of Operations Research, Vol 8 No 2, 1960.

4. R. W. Conway, B. M. Johnson, W. L. Maxwell, The Cornell Research Simulator, Department of Industrial Engineering, Cornell University.

5. McCracken, Daniel D., Weiss, Harold, Lee, Tsai-Hwa, Programming Business Computers, pp 260-297, Wiley, 1960.

6. Wickens and Meyer, Psychology, pp 316-17, The Dryden Press, 2nd Printing, 1955.

VITA

Date of Birth:	20 September 1936
Place of Birth:	New York City, New York
Father:	Charles Arthur Wood
Mother:	Eleanor Litchfield Wood
Education:	Massapequa Grade School (1941 - 1950)
	Haverford Junior and Senior High School (1950 - 1954)
	The Pennsylvania State University (1954 - 1958)
	Lehigh University (1958 - 1960)
Degrees:	Bachelor of Science in Industrial Engineering
Marriage:	28 November 1959 to Elisabeth L. Braithwaite