NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
8310-12-8818	October 13, 1958	6015

A SYSTEM PROGRAMMER AND DATA COMMUTATOR

L. E. Gatterer

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
BOULDER LABORATORIES
Boulder, Colorado

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF DRAWINGS

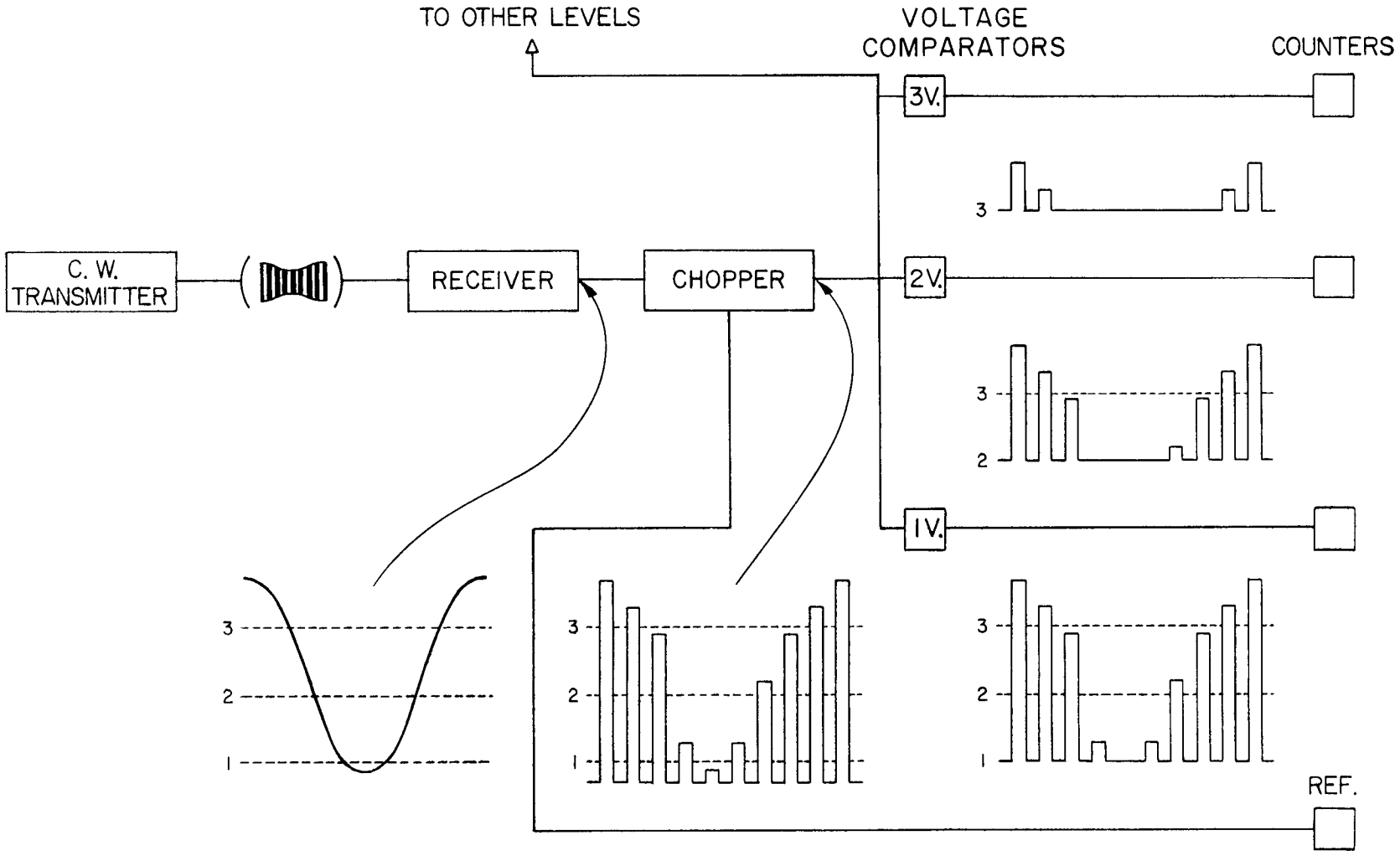
FOREWORD

One of the frequently required types of analysis performed in the Radio Propagation Engineering Division is that of the cumulative distribution of radio field strength. This involves the manual scaling of charts and the subsequent reduction of data thus obtained, or the use of an analog-to-digital converter which comprises a manually operated chart follower and an IBM card punch machine: the IBM 650 Digital-computer is then used to perform the analysis.

In order to improve data taking and analysis procedures the use of automatic distribution analyzing and recording systems has been under investigation. The SYSTEM PROGRAMMER AND DATA COMMUTATOR described in this report has been designed to be used with N.B.S. FIVE LEVEL COMPARATOR UNITS and N.B.S. FIVE-CHANNEL IMPULSE COUNTER UNITS as a fully automatic system for the field and laboratory recording of data in decimal form on paper tape. The device is versatile in nature being adaptable for use with equipment which, like the IMPULSE COUNTER units, employs circuit closures for the electrical read-out of decimal-digital counters.

Walter E. Johnson
Chief, Data Reduction Instrumentation Section

K. A. Norton
Chief, Radio Propagation Engineering Division



BLOCK DIAGRAM OF AMPLITUDE DISTRIBUTION ANALYSIS SYSTEM

Figure 1

A SYSTEM PROGRAMMER AND DATA COMMUTATOR

L. E. Gatterer

ABSTRACT

A fully automatic device controls counter-type equipment and records information contained there-in. The capacity of the device is fifty 5-digit counters. It is designed for use with decimal counters whose electrical read-out comprises circuit closures.

In a typical data analysis system now being used at the Boulder Laboratories the SYSTEM PROGRAMMER AND DATA COMMUTATOR complements the NBS 5 LEVEL COMPARATOR to form a cumulative distribution analysis system.

GENERAL DESCRIPTION

The device is described as it is used in an amplitude distribution analysis system. The operation of the system is demonstrated in Figures 1 and 2. Referring to Figure 1, a fading CW signal after being picked up by a receiver goes through a synchronous chopper and then to the input of a group of voltage comparators set for succeedingly higher levels. Those pulses which are higher than a given amplitude advance the counter associated with the voltage comparator set for that amplitude. This sampling is allowed to go on for some interval of time, and the amounts by which the numbers in the various counters increase during the interval are noted. If these numbers are compared with

BLOCK DIAGRAM REPRESENTATION OF
SYSTEM PROGRAMMER AND DATA COMMUTATOR

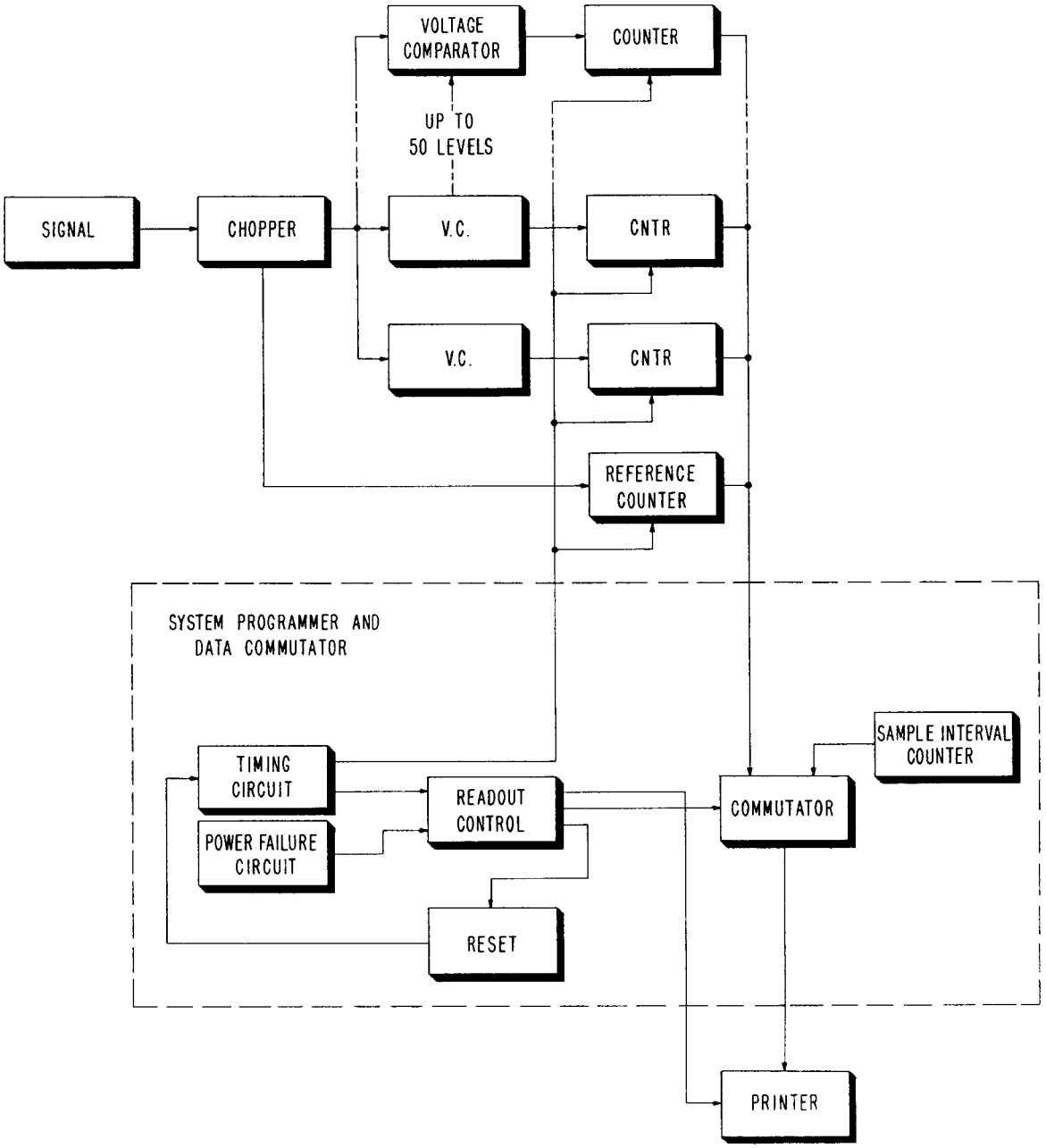


Figure 2

the increase of the number in a reference counter which counts the samples taken by the chopper, the percentages of time for which the signal exceeded the levels associated with the respective counters are obtained.

Circuits for activating the counters, controlling the sample time, and recording the information are shown schematically in Figure 2.

The timing circuits can be programmed for three basic types of operation:

(1) Single: a single sample of preset length is automatically taken and recorded.

(2) Manual: a sample is started, timed, and stopped manually. Simultaneous with the stopping of the sampling the automatic recording operation is begun.

(3) Repeat: a sample of preset length is automatically taken and recorded after which another is taken and recorded, the sequence continuing automatically until stopped manually.

In all cases the sampling is initiated manually--on "automatic" all samples but the first are started automatically.

On completion of the preset sample interval the timing circuits remove power from the counters and activate the readout control circuits.

The readout control causes the commutator to scan the counters and channel the data into the printer. Also scanned by the commutator is the sample interval counter. The sample interval number is

99463
13707
67800
58354
35970

69051
46978
86377
91418
24752

99471
13776
67809
58302
35978

69059
46987
80317
91427
24761

1

99485
13791
67824
58376
35993

69073
47002
80330
91442
24775

2

99613
13920
67952
58504
36121

69200
47130
80458
91570
24903

3

FIG. 3 – SECTION OF READOUT TAPE SHOWING A REFERENCE PRINT AND THREE DATA SAMPLES

printed after the data sample. (See Fig. 3.) This counter is automatically reset to zero each time the chassis power is turned on.

When the commutator has completed its cycle all circuits are reset and the preset program continues.

Circuits are included to initiate a readout cycle whenever power is applied. Thus when the system is first turned on a reference print of the numbers registered in the data counters is obtained, and in the event of a power failure the system will resume the programmed operation when the power comes back on.

The composite system consists of

1. The system Programmer and Data Commutator
2. A Clary Model 1900 Numerical Data Printer
3. 1-10 Five-Level Comparator units.
4. A Five-Channel Impulse Counter for each Comparator unit.

The Programmer operates on 115 volts at 60 c.p.s. It is slide mounted for installation in a 19" cabinet type relay rack and requires a vertical space of 12-1/4". The printer unit uses standard adding machine paper rolls 2-1/4" in width.

The Comparator units require a 45 minute warm-up period.

A complete ten level amplitude distribution analysis system is shown pictorially in Fig. 6. The SYSTEM PROGRAMMER AND DATA COMMUTATOR is immediately above the Clary printer.

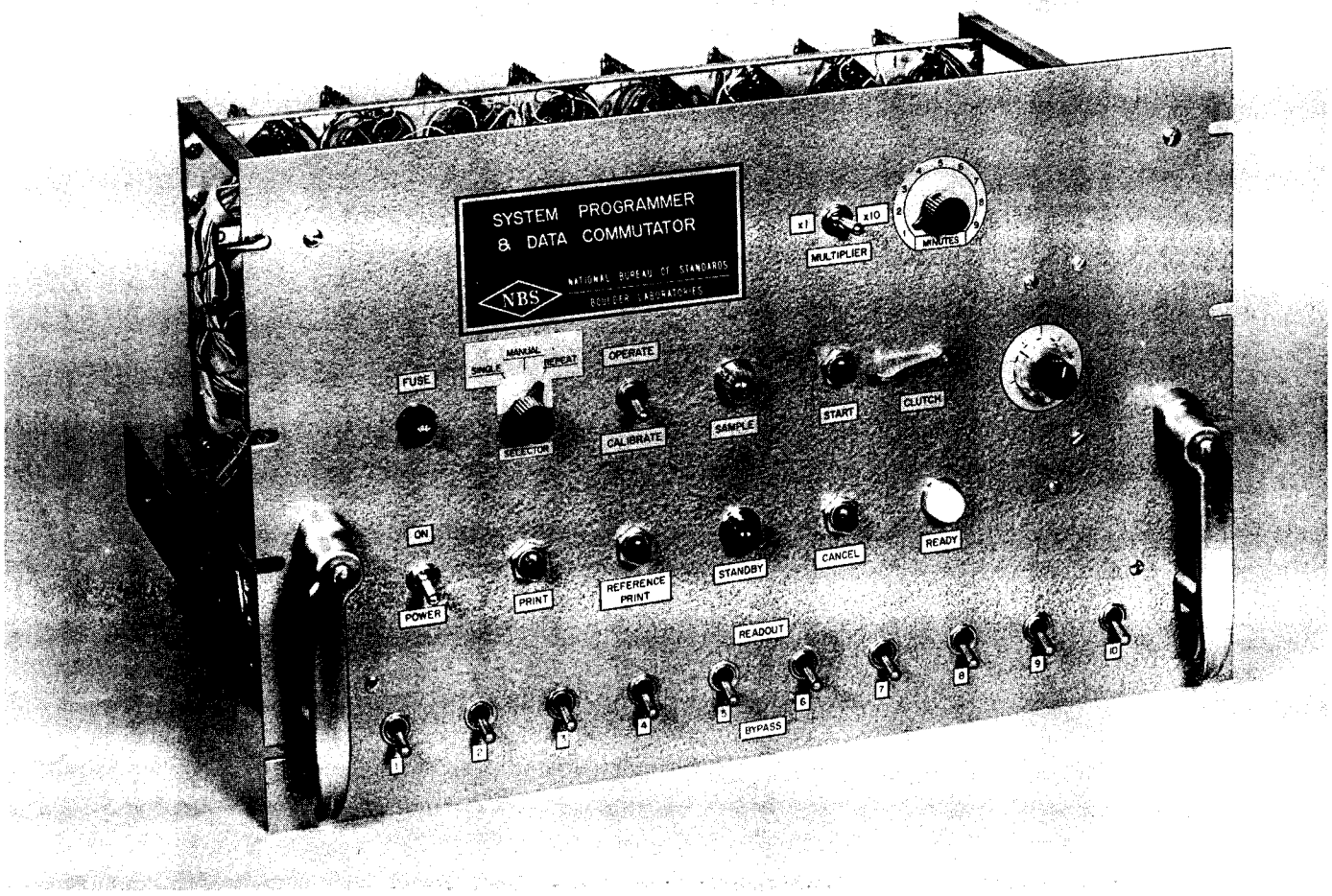


FIG.4 – SYSTEM PROGRAMMER AND
DATA COMMUTATOR

METHOD OF OPERATION

The device is designed for three modes of operation as controlled by the SELECTOR switch settings--SINGLE, MANUAL, or REPEAT. With the switch on SINGLE, one sample is taken, the timing and control being automatic. With the switch on MANUAL a sample is started, timed, and stopped by the operator. If the switch is on REPEAT the device will automatically take and record samples of desired duration, continuing to do so until stopped by the operator.

Procedure

Turn SELECTOR switch to manual. (See Fig. 4.)

Determine which COMPARATOR units (1-10) are to be used in the sample: for those units which are to be used, set the corresponding READ-OUT/BY-PASS switches on the PROGRAMMER to READ-OUT; for those units which are not to be used set the switches to BY-PASS.

Set the READ-OUT/CALIBRATE switches on the COMPARATOR units to READ-OUT. (See. Fig. 5.)

Set the OPERATE/CALIBRATE switch on the PROGRAMMER to OPERATE.

Turn on the POWER switches of those comparator units which are to be used.

Turn on the POWER switch of the PROGRAMMER. The numbers registered in the counters are now automatically printed. This provides numbers to which the readings of the first sample can be referred.

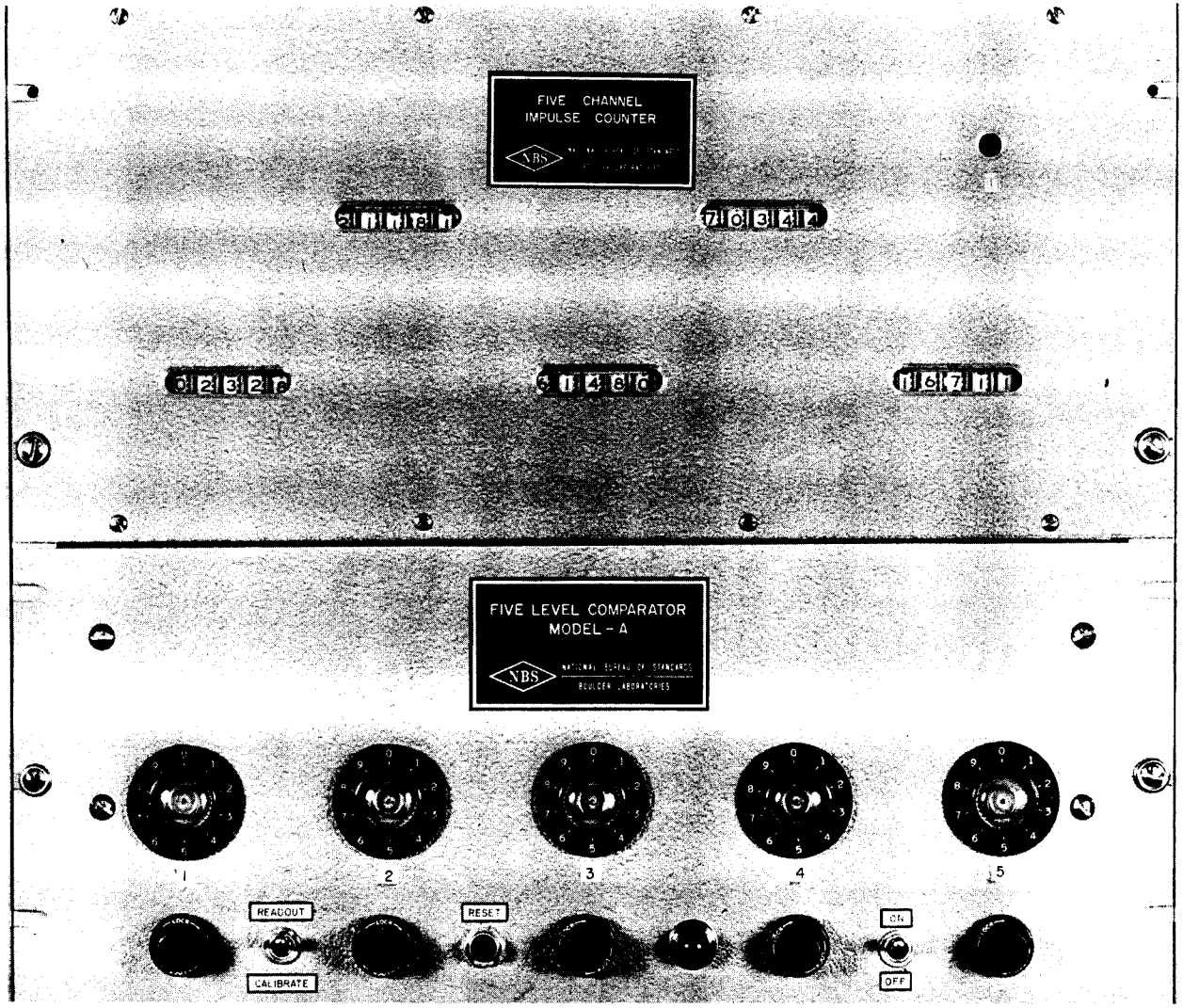


FIG. 5 – FIVE CHANNEL IMPULSE COUNTER AND
FIVE LEVEL COMPARATOR

The three modes of operation will now be considered:

1. SELECTOR switch on SINGLE.

When the SELECTOR switch is turned to SINGLE, the TIMING MOTOR automatically goes to its home position (pointer straight up) if it is not already there. When the motor is at home position, the READY light goes on; this light should always be on before a sample is started.

The timing motor is a 1 RPM synchronous motor which drives, through suitable gearing, two cams--one at 1 RPM and one at 1/10 RPM. These cams close micro-switches once each revolution. Two concentric, counter-rotating dials show the positions of the cams. A clutch is provided which when released (by depressing the CLUTCH lever on the front panel) allows the position of either cam to be changed manually by turning the center (1 RPM) dial on the TIMING MOTOR. The outside (1/10 RPM) dial should not be used for this purpose because the high gear ratio will place too heavy a load on the gear train. In advancing a cam to home position it can be moved most of the way manually, but the motor should be used to complete the movement in order to remove slack from the gear train.

The sample interval is set by use of the MINUTES and MULTIPLIER switches--the number (1 through 9) selected by the MINUTES switch multiplied by the number (1 or 10) selected by the MULTIPLIER switch will be the length of the sample in minutes.

With the READY light on, the sample is started by depressing the START button: the STAND-BY light goes off, the SAMPLE light comes on, and the sample begins. The elapsed fraction of sample time is shown by the TIMING MOTOR dial. When the preset time interval has passed the sampling stops; the numbers registered in the counters are printed; and the device is left on STAND-BY, ready for a new sample. If for some reason it is desired to stop a sample in progress the CANCEL button is depressed; the machine is again put on STAND-BY, ready for another sample. Depressing the REFERENCE PRINT button will start a print cycle, recording a new set of reference numbers.

2. SELECTOR switch on MANUAL.

The timer does not function in this mode of operation: to start and stop the sample the START and PRINT buttons respectively are used. As before the CANCEL button will nullify the sample, and the REFERENCE PRINT button will record a new set of reference numbers.

3. SELECTOR switch on REPEAT.

With the sample interval set and the READY light on, depressing the START button causes the sample to begin. On completion of a sample the numbers in the counters are printed and a new sample begins automatically. This sequence continues until the operation is stopped by turning the SELECTOR switch off REPEAT.

The timing motor runs continuously in this mode of operation so as to remain in phase with local time: since the printing operation takes place with the motor running, the actual sample interval will be shorter than programmed. A reference counter counts the cycles of the chopper so that the exact sample time is recorded.

Calibration Provision

With the device on REPEAT operation it is possible to calibrate the voltage comparators without interrupting the operation. If the OPERATE/CALIBRATE switch is thrown to CALIBRATE the timing motor will continue to run but the sampling will cease. Depressing the REFERENCE PRINT button will record the information obtained in the elapsed fraction of sample time and will provide a set of reference numbers for whatever fraction of time remains in the sample after the calibration is completed. Should the end of the sample interval arrive with the device still on CALIBRATE the sample interval counter will advance as usual so as to stay in phase with local time. When the calibration is completed and the switch thrown back to OPERATE a sample will be taken for the remainder of the interval in progress, the appropriate sample interval number will be printed, and REPEAT operation will be resumed.

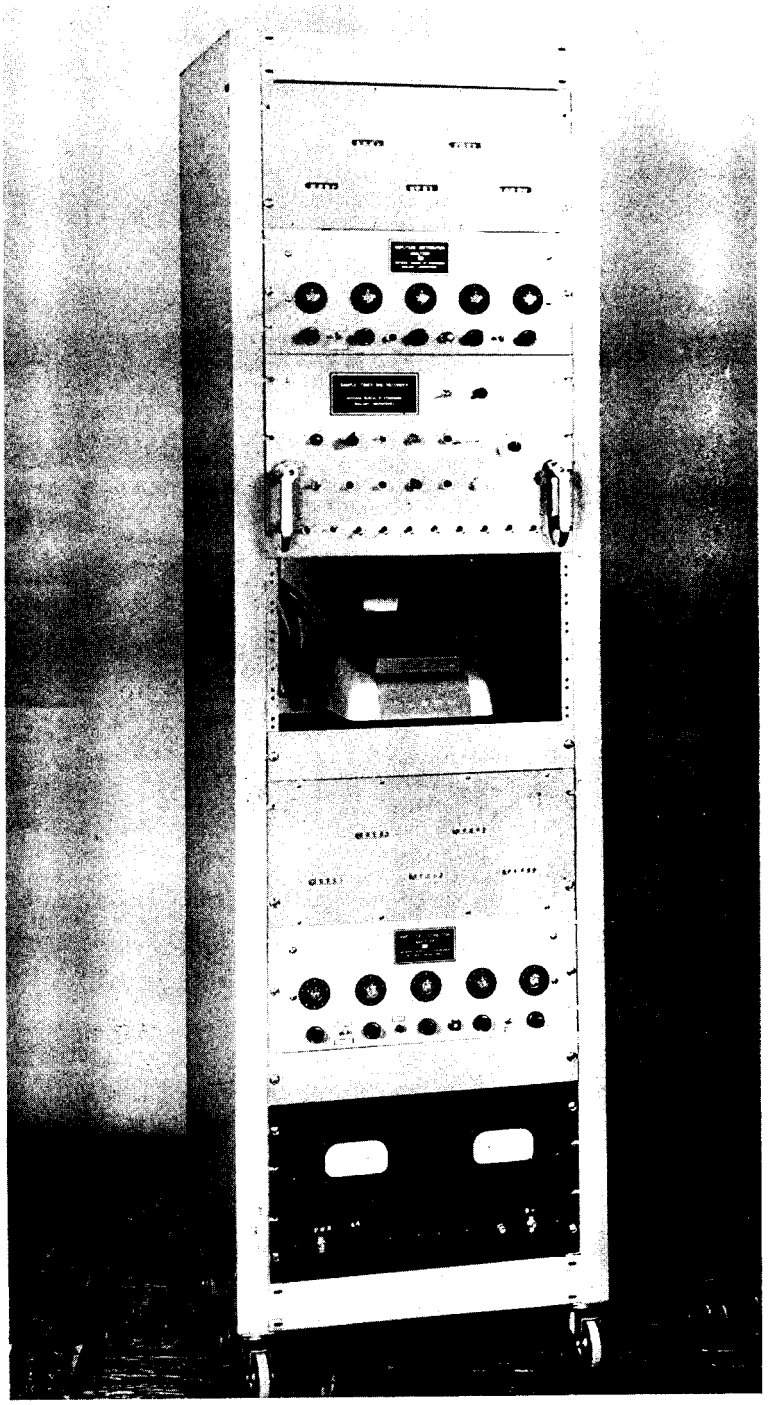


FIG. 6 – A COMPLETE AMPLITUDE DISTRIBUTION ANALYSIS SYSTEM

OPERATIONAL FEATURES

Sample Interval Counters

After all the information in the counters has been printed a number which identifies the sample interval is printed. The counter is automatically reset each time the power is turned on.

Test Circuitry

Because of the speed at which the device operates it is difficult to check the functioning of the various circuits. For this reason a test circuit has been built into the machine to stop it at any time during its cycle: the controls for this circuit have been put on the floor of the chassis to avoid complicating the front panel.

When the OPERATE/TEST #1 Switch is thrown from OPERATE to TEST the printer becomes inoperative. The START lamp is lighted whenever a voltage is applied which would normally start the printer on its cycle. Depressing and releasing the MICRO SWITCH button corresponds to the operation of the printer micro-switch during the print cycle.

When the OPERATE/TEST #2 Switch is on TEST the commutator (stepping switch #1) will not advance in response to an applied voltage unless the "ADVANCE" button is depressed.

Timer

The synchronous timing motor drives two outputs, 1 RPM and 1/10 RPM, through a clutch system. The outputs employ cams to close roller micro-switches once each revolution and drive concentric counter-rotating pointers which show the phase of the cams and the elapsed sample time. With the CLUTCH lever depressed the 1 RPM (inside) pointer can be turned to change the phase of the cams.

The clutch unit comprises a differential, internal-tooth planetary gear system which couples the sun gear to the motor and the planet gear to the outputs. The central pinion, locked by the brake, causes the motor to drive the outputs. Depressing the CLUTCH lever releases the brake, interrupting the driving couple; the motor will idle and the cam phase can be adjusted.

Power Failure

The device is designed so that it will not be jammed by a failure and subsequent restoration of power. When power is applied to the chassis the numbers in the counters are printed; the sample interval counter is reset; and with the SELECTOR switch set on REPEAT, that mode of operation is resumed, the sample interval numbering again beginning with 1. If there should be one (and only one) power failure during a period of REPEAT operation the time and duration of the failure can be ascertained from the record: the highest sample interval

number in the first group multiplied by the sample time gives the time elapsed prior to the power failure and the time at which the failure occurred; similarly the time elapsed after the restoration of power can be obtained from the highest sample interval number in the second group.

By-Pass

The device has been designed to handle up to fifty levels in ten banks of five levels each. If fewer than ten banks are used it is not necessary that any particular group of bank input plugs be used. When the device is going through its read-out operation it will automatically stop printing when it comes to a bank not in use (or set for BY-PASS) and advance rapidly through that bank. This cuts down the read-out time and reduces the amount of blank recording tape.

Slide Mount (Fig. 7)

To provide for the maximum ease in testing and maintenance the unit is mounted on chassis slides of the type which allow for rotation in a plane parallel to the front panel.

Cover and Shock Mounting

The device is enclosed in a cork-lined sheet-metal cover to keep out dust and to suppress both mechanical and electrical noise. To further quiet the device stepping switches are shock mounted.

Over each of the 104 pin AMPLITUDE DISTRIBUTION ANALYZER plugs is a jack-cover to protect the plug from dust and physical damage. (Fig. 8)

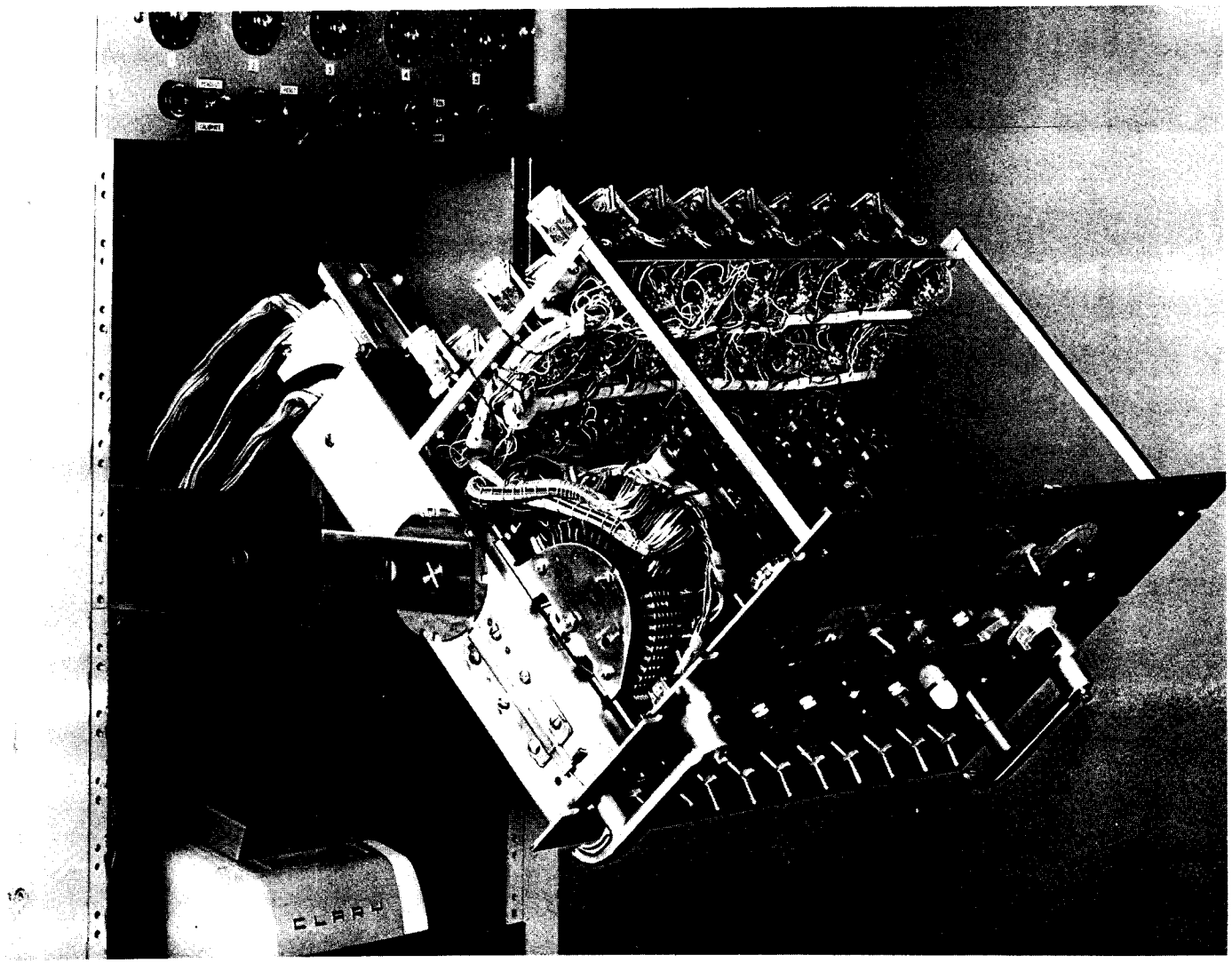


FIG. 7 – SYSTEM PROGRAMMER AND DATA COMMUTATOR WITH CHASSIS SLIDES EXTENDED

Plug-In Relays (Fig. 8)

Plug-in relays are used where possible to facilitate testing and replacement. An extruding tool is supplied to force the relays out of their sockets.

Acknowledgment

Credit for lay-out and much of the construction of the final model goes to Donald V. Glen.

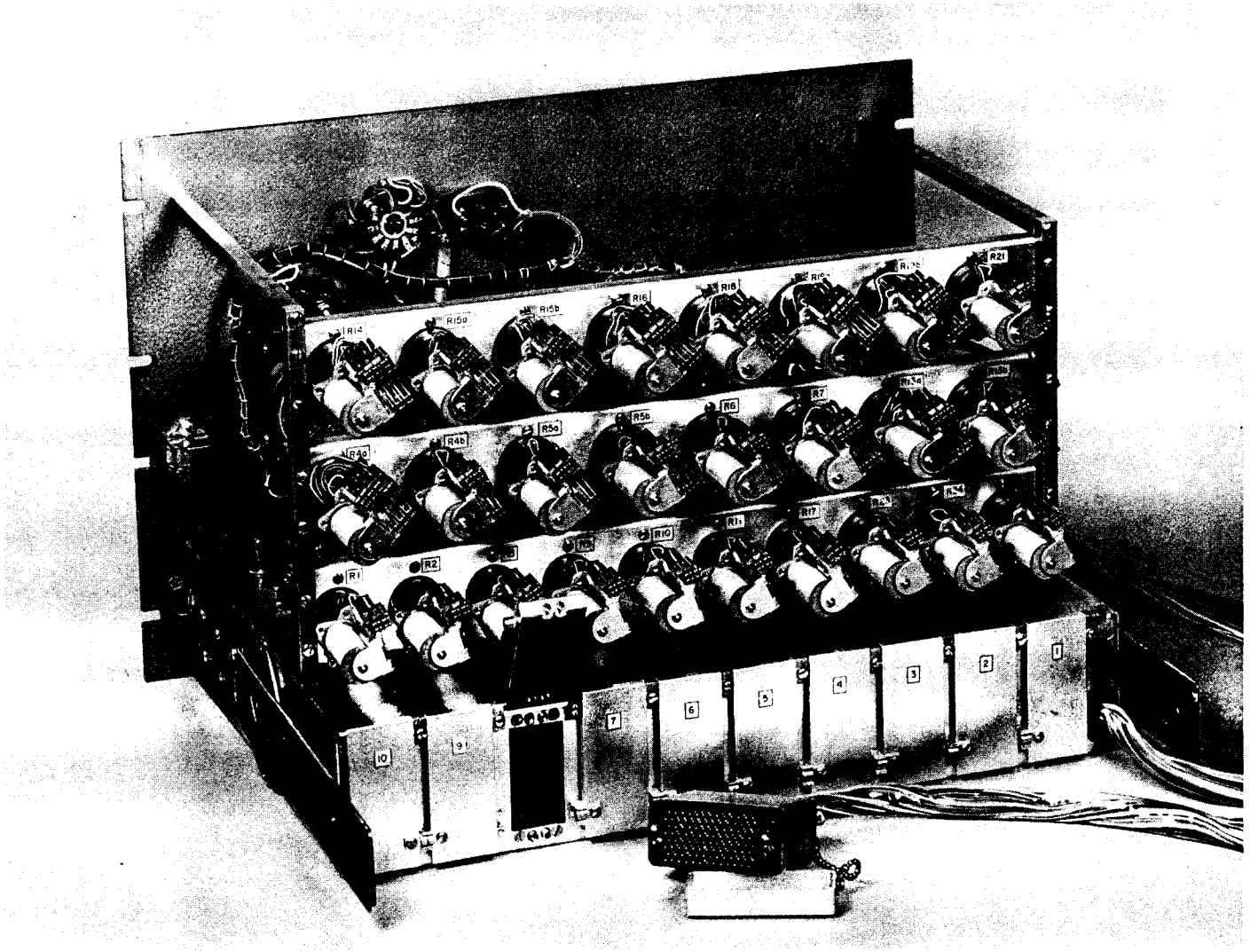


FIG. 8 – SYSTEM PROGRAMMER AND
DATA COMMUTATOR REAR VIEW