EUR 2702.e

EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

DECIMAL SCANNER FOR THE MODULAR CHAIN

by

N. COPPO and L. STANCHI

1966

Joint Nuclear Research Center
Ispra Establishment - Italy

Engineering Department
Technology Service

This report is on sale at the addresses listed on cover page 4.

at the price of FF 2.50	FB 25,–	DM 2.–	Lit. 310	Fl. 1.80

When ordering, please quote the EUR number and the title, which are indicated on the cover of each report.

Printed by SMEETS
Brussels, January 1966

EUR 2702.e

DECIMAL SCANNER FOR THE MODULAR CHAIN
by N. COPPO and L. STANCHI

European Atomic Energy Community - EURATOM
Joint Nuclear Research Center
Ispra Establishment (Italy)
Engineering Department - Technology Service
Brussels, January 1966 - 12 Pages - 7 Figures - FB 25

A decimal scanner which is used to perform the step by step variation of a voltage is described. There is a series of resistors connected in such a way that if a current is sent to them it is possible to obtain a voltage scanned step by step in 101 channels. Five modes of operation are foreseen : 1) upward scanning and stop, 2) downward scanning and stop,

EUR 2702.e

DECIMAL SCANNER FOR THE MODULAR CHAIN
by N. COPPO and L. STANCHI

European Atomic Energy Community - EURATOM
Joint Nuclear Research Center
Ispra Establishment (Italy)
Engineering Department - Technology Service
Brussels, January 1966 - 12 Pages - 7 Figures - FB 25

A decimal scanner which is used to perform the step by step variation of a voltage is described. There is a series of resistors connected in such a way that if a current is sent to them it is possible to obtain a voltage scanned step by step in 101 channels. Five modes of operation are foreseen : 1) upward scanning and stop, 2) downward scanning and stop.

3) upwards and downwards and stop, 4) upwards and downwards indefinitely, 5) upwards with fast flyback indefinitely.

Suitable circuits for external controls are included.

3) upwards and downwards and stop, 4) upwards and downwards indefinitely, 5) upwards with fast flyback indefinitely.

Suitable circuits for external controls are included.

EUR 2702.e

EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

DECIMAL SCANNER FOR THE MODULAR CHAIN

by

N. COPPO and L. STANCHI

1966

Joint Nuclear Research Center
Ispra Establishment - Italy

Engineering Department
Technology Service

CONTENTS

1. Introduction 3

2. General description 3

3. Principle of operation 5

4. Description of the circuits 6

1) Scalers 6

2) Relays control and display 6

3) Dc - dc converter 6

4) Scanned bleeder 7

5. Results 7

Acknowledgement 8

SUMMARY.

A decimal scanner which is used to perform the step by step variation of a voltage is described. There is a series of resistors connected in such a way that if a current is sent to them it is possible to obtain a voltage scanned step by step in 101 channels. Five modes of operation are foreseen : 1) upward scanning and stop, 2) downward scanning and stop, 3) upwards and downwards and stop, 4) upwards and downward indefinitely, 5) upwards with fast flyback indefinitely.

Suitable circuits for external controls are included.

Decimal scanner for the modular chain

1. Introduction

The scanner is an instrument used for varying step by step an electrical quantity following an external control. The electrical quantity which is scanned is in the majority of the cases a dc voltage. The stepping can be obtained by :

a) moving a center tap on a resistive bleeder
b) adding or substracting resistances from a bleeder - (this is a particular case of the preceeding one)
c) connecting in series some reference elements in order to obtain standardized quantities

Since one of the most typical applications of the scanner is to vary step by step the threshold of a single-channel analyzer, each step of the scanner is normally called "channel". The number of channels is in general less than that of modern multichannel analyzers, but it can be concentrated in a reduced region of the quantity to be scanned.

There is a biunivocal correspondence between the electrical quantity Q and the channel number n which can be expressed in general by the equation :

$$Q = f(n)$$

This equation can be theoretically satisfied by any function. For practical uses a proportionality law or more generally a linear or a logarithmic law is normally sufficient.

2. General description

The scanner model SC2 gives a proportionality law between the channel number and the electrical quantity which is in this case a dc voltage scanned in 100 steps corresponding to 101 channels (from channel 0 to channel 100). The 100 steps of the scanning can be concentrated in one half or in one fourth of the total range of the useful voltage increasing thus the actual number of steps up to 200 or 400.

The working is entirely automatic and is controlled by external driving

Manuscript received on November 22, 1965.

pulses (in general the pulses are given by a timer which controls all the operations of a chain of instruments). The output scanned voltage can be utilized as a threshold voltage for discriminators or as a voltage reference for high voltage power supplies or for other uses.

The scanner model SC2 is composed of a resistive bleeder and the circuits necessary to control the movement step by step of a tap on the bleeder. A voltage scanned in 101 channels can be obtained from the center tap if a prefixed current is sent to the bleeder.

The bleeder has a total resistance of 500 Ohms and the 100 steps are obtained with successive variations of 5 Ohms. Adding in series and in parallel other resistors of the same quality, the scanning is concentrated in a half or in a fourth of the total range. The voltage is taken between the center tap and one terminal of the divider : the circuit connected to these terminals must have an impedance sufficiently high so that load effect on the divider will affect in a negligible manner the linearity of the divider.

The useful range can be scanned in unidirectional or bidirectional sense. Five different modes of working are foreseen :

A) Scanning from a minimum to a maximum and stop.
B) Scanning from a maximum to a minimum and stop.
C) Scanning from a minimum to a maximum and back from the maximum to the minimum and stop.
D) Triangular scanning from a minimum to a maximum and back from the maximum to the minimum, indefinitely.
E) Sawtooth scanning from a minimum to a maximum with fast flyback to the minimum and recycling indefinitely.

Starting and stopping channels (minimum and maximum) can be preset on the positions 0 - 20 - 40 - 60 - 80 - 100. The progression can be fixed in 1 or 2 or 10 steps per input pulse ; the total scanning is thus made with 100 or 50 or 10 steps. A pulse counter provides for the advancement step by step of the channel number.The counter consists of 9 binary dividers ; two groups of four binaries with direct feed-back constitute the two decades of the counter and the last binary is used only for the channel number 100. Using a binary-to-decimal decoder the channel number is displayed in a decimal form by means of two decimal indicator tubes and a neon lamp.

For an eventual utilization of the channel number (as for printing that number together the corrisponding measurements) all the collectors of the binaries are wired to a multiple connector on the rear panel. The code of the decade is 1 - 2 - 4 - 2.

3. Principle of operation

The block diagram is reported in Fig. 1. The driving pulses are sent through a gate and a shaper to the counter. The shaper is also connected to a push-botton for manual advance. A diode matrix decoder controls a series of relays which in turns controls a series of resistors. In the same time the decoder controls the display of the channel number. A set-reset flip-flop controls the counting upwards and downwards. A second matrix of diodes connected to the counter allows to preset the start and stop channel for the scanning. The signal coming from the matrix in correspondence to the end of the scanning switches the UP-DOWN flip-flop from one to the other state and presets the counter for the scanning in the opposite direction ; in addition this signal may or not close the input gate depending on the preselected mode of operation. When this gate is closed a second gate is opened in turns so the next input pulse gives an output signal for stopping the timer (or other instrument) which drives the scanner. The input gate can also be closed by an external signal in order to allow automatic controlling of the scanning. There is in addition a provision for the stop of the operation and a sudden return to zero channel in case of the presence of a special signal used as alarm signal. The five modes of operation preselected by the mode selector are listed below, where it is made reference to a complete scanning from the channel 0 to the channel 100. For a limited range the operation is the same.

1 - Mode A. The range is scanned upwards. A push-button presets the counter to the starting (zero) channel and the up-down flip-flop for upward operation. The driving pulses pass through the gate (if it is not closed by the external control) and control step by step the counting scalers. When channel 100 is reached there is a positive step (from -6 V to ground) coming out from line 100 of the diode matrix. This step resets the flip-flop for downward operation ; passing through the mode selector this step closes the gate and stops the operation giving also an output stop pulse.

2 - Mode B. This mode is analogous to the preceding one. The starting position is preselected on channel 100 by means of a push button for downward operation. When channel 0 is reached there is the same step as for channel 100 in the mode A operation, which stops the operation.

3 - Mode C. This mode is the composition of modes A and B. The push-button for upward operation has a second section, connected with the mode selector, which controls a second flip-flop which opens the input gate. When channel 100 is reached the positive step through the mode selector, switches the up-down flip-flop for downward operation. When channel 0 is reached the

positive step switches the second flip-flop which closes the input gate.

4 - Mode D. It is a composition of mode A and B without the stop of the operation because the mode selector breaks the inhibiting signal for the input gate. The cycle continues up and down indefinitely.

5 - Mode E. It is similar to the preceding mode up to the arrival of the 101^{st} driving pulse. This pulse should drive the counter from number 100 to number 99 so that, the ground voltage on the line corresponding to channel 100 disappears. Thus a negative step comes out from the diode matrix . This step is inverted and through the mode selector resets the counter to zero. The cycle retakes the upward operation and continues indefinitely because also in this mode the inhibiting signal is breaked.

4. Description of the circuits

1) Scalers

Two cascaded decades with direct feedback and a 1 - 2 - 4 - 2 code are used for the channel numbers from 0 to 99. A final binary is used for the position 100. Fig. 2 , a) and b) shows the principle of operation and the succession of the states of the flip-flops of an up and down decade in correspondence to a series of ten pulses. In Fig. 3 the complete schematic of the decade scaler is reported.

2) Relays control and display

Fig. 4 shows the schematic of one of the circuits which control the relays and the display. Each circuit, corresponding to a digit, is connected through the decoder to the collectors of the transistors of the binaries in such a way that there is a negative output (-6 V) in the line corresponding to the stored number ; all the other lines are at a voltage level near the ground. The negative voltage drives transistors T_1 and T_2 into saturation so the relay and the corresponding figure in the numerical indicator tube are energized. The indicator tube is a nixie tube of the miniature type. Two tubes are used for the display of units and tens and a simple neon lamp for the display of the 1 for the channel 100.

3) Dc - dc converter

The indicator tubes are supplied at a voltage of 180 V and the neon lamps for the front panel indications at a voltage of 140 V. These voltages are obtained by means of the dc dc converter reported in Fig. 5. There is a double blocking oscillator working at a supersonic frequency in order to avoid the annoying whistle of similar dc - dc converters. The magnetic core is made of ferrite material of commercial type. All the circuit is contained in an iron box connected with the other circuits only by the leads for the - 24 V and for the output voltages filtered inside. That allows to eliminate the perturbances caused by the square wave oscillator.

4) Scanned bleeder

The contacts on the bleeder are accomplished by a series of relays driven as in Fig.4. The general outline of operation of the scanned bleeder is reported in Fig. 6 where the contacts are actually made by the relays contacts. Auxiliary resistors, suitably connected to the bleeder are used for concentrating the 100 steps of the scanner in a restricted range of the voltage to be scanned. The contact resistance is 12 mOhm max. The total number of contacts through which the current flows is always two ; by thus the linearity of the instruments is affected only by the variation of the contact resistance of the relays in one configuration in respect of another one.

5. Results

The maximum variation of the contact resistance of a relay in respect of another resulted 10 mOhm. This corresponds to a maximum error in respect to a channel (differential linearity) of 0.2 % . This error is increased by the tolerance of the resistors which is 0.1 %. The maximum differential error is by thus 0.3 % . The integral linearity is practically depending only on the precision of the resistors, that is 0.1 %. The error related to the contact resistances is an absolute error which does not vary with the position of the voltage divider so it becomes negligible.

The tests in respect of the temperature gave a correct operation in the range - 30°C to + 50°C. All the instruments fail for a temperature of 52 - 54°C. This is due to the fact that the transistors are germanium types. The linearity of the voltage divider is not seriously affected by the temperature changes because the resistors are all wirewound of the same type and manufacturer. In any case the maximum temperature coefficient is $2 \cdot 10^{-5}/°C$.

Throughout the instrument only one type of transistor was used except the nixie and neon lamp drivers which are the silicon types 2N1990. We will apologize for the use of germanium transistors and diodes types 2G526 and respectively 1G26. This was for economical reasons and for the fact that when the instrument was developed the delivery of germanium types was easier.

The instrument is contained in an ESONE plug-in unit of 2 modular units. In Fig. 7 a view of the instrument is reported.

Acknowledgement

Some circuits of the instrument are derived from a preceding binary scanner. The first design of that instrument was due to J. Eder.

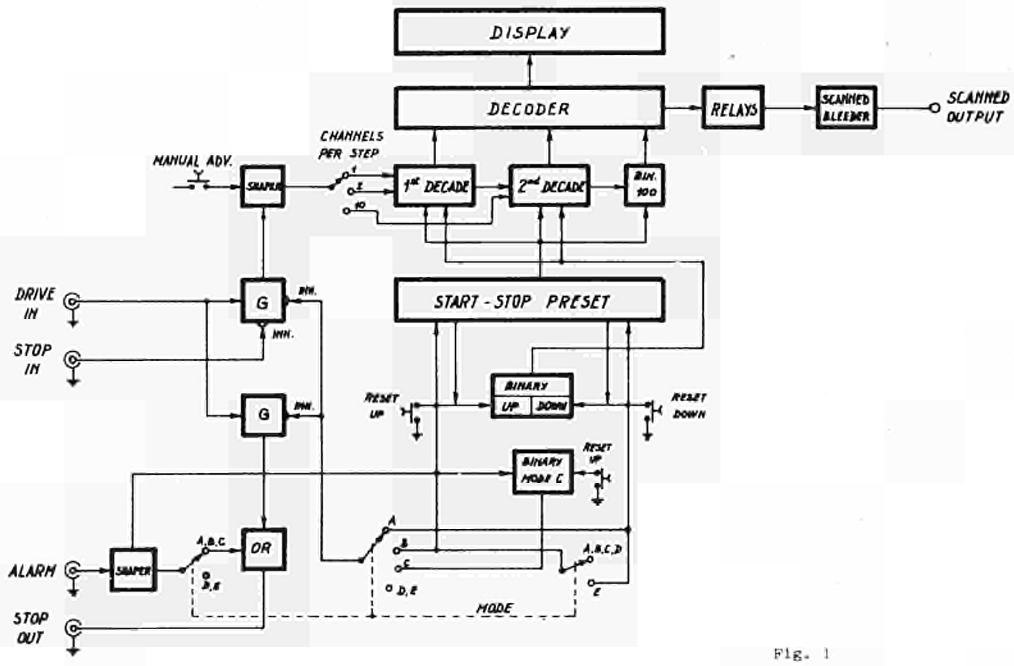

DISPLAY
DECODER
RELAYS
SCANNED BLEEDER
SCANNED OUTPUT
CHANNELS PER STEP
MANUAL ADV.
SHAPER
1st DECADE
2nd DECADE
BIN. 100
DRIVE IN
G
INH.
STOP IN
START - STOP PRESET
RESET UP
BINARY
UP
DOWN
RESET DOWN
BINARY MODE C
ALARM
SHAPER
OR
MODE
STOP OUT

Fig. 1

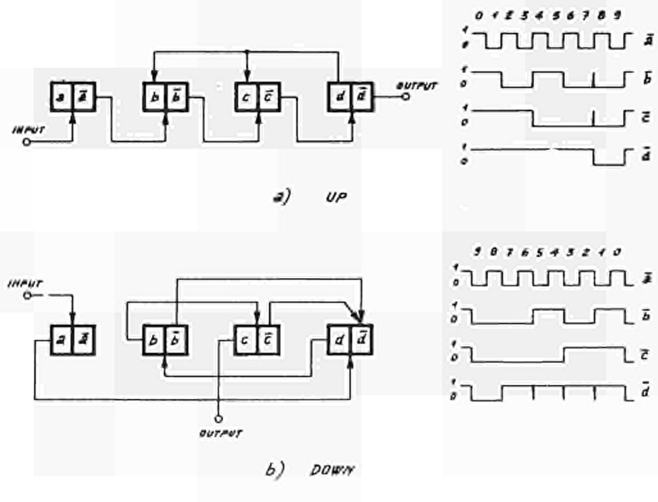
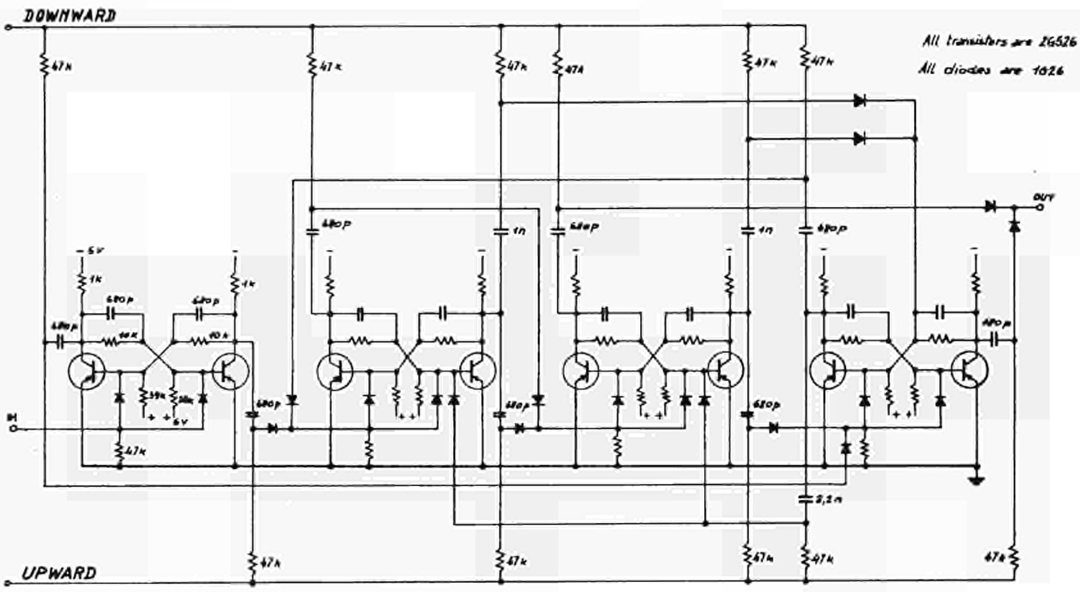
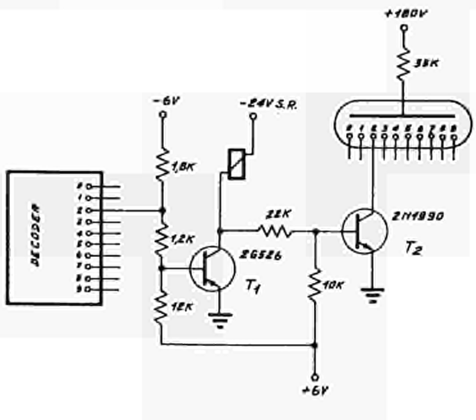

INPUT
OUTPUT
a) UP
INPUT
OUTPUT
b) DOWN

Fig. 2



DOWNWARD
UPWARD
IN
OUT
All transistors are 2G526
All diodes are 1G26

Fig. 3



+180V
33K
-6V
-24V S.R.
1,8K
1,2K
12K
22K
10K
2G526
T1
2N1890
T2
DECODER
+6V

Fig. 4

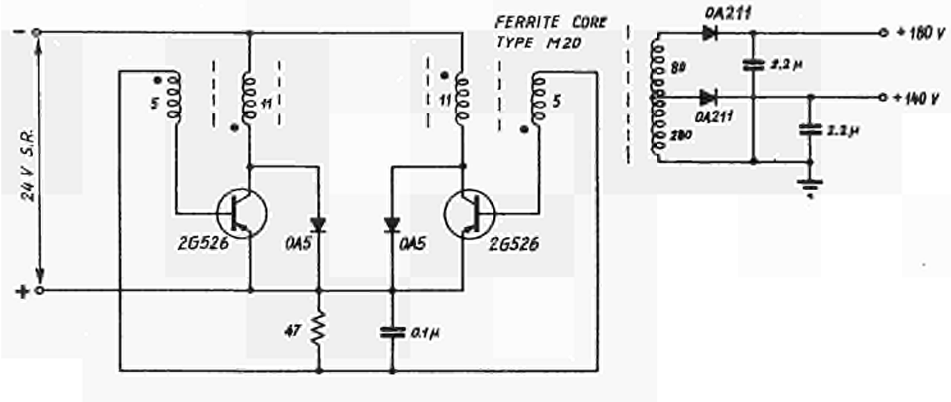

FERRITE CORE
TYPE M20
0A211
+180 V
+140 V
2.2 μ
80
280
5
11
24 V S.R.
2G526
0A5
47
0.1 μ

Fig. 5

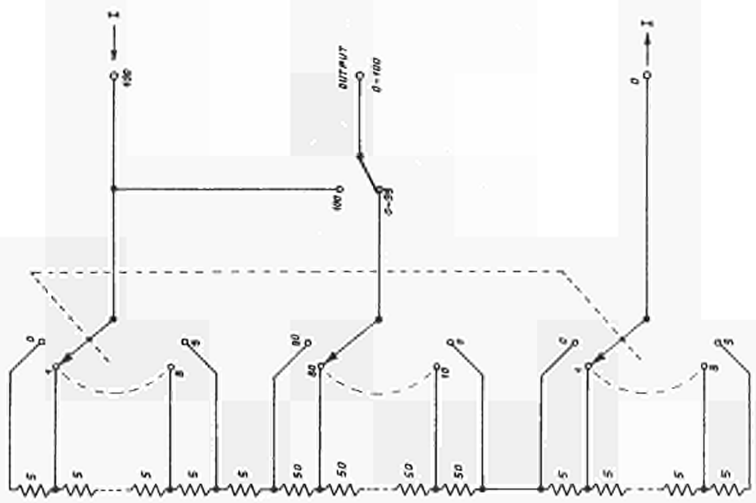
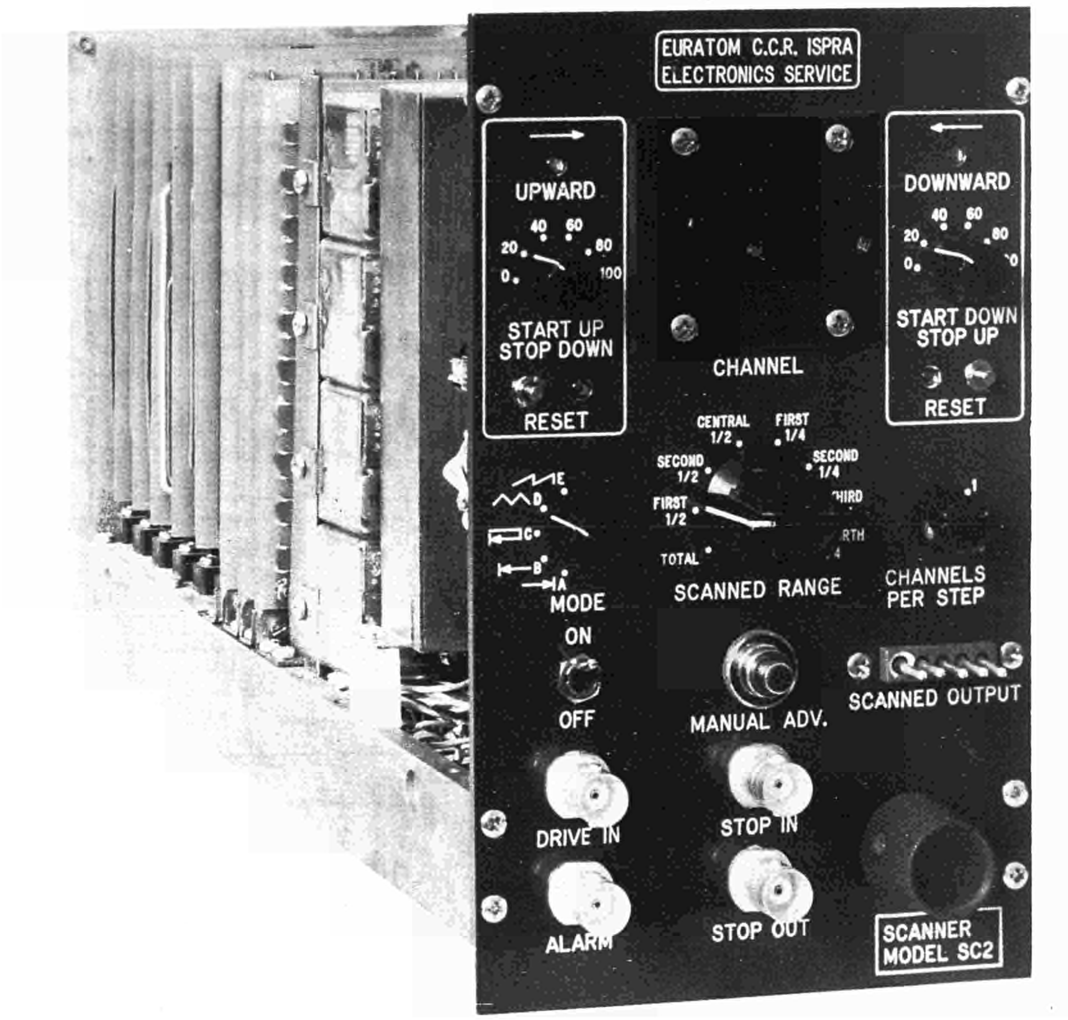

I
OUTPUT
0-100
0-99
100
5
50

Fig. 6


EURATOM C.C.R. ISPRA
ELECTRONICS SERVICE
UPWARD
START UP
STOP DOWN
RESET
CHANNEL
DOWNWARD
START DOWN
STOP UP
RESET
MODE
SCANNED RANGE
CHANNELS
PER STEP
ON
OFF
MANUAL ADV.
SCANNED OUTPUT
DRIVE IN
STOP IN
ALARM
STOP OUT
SCANNER
MODEL SC2

To disseminate knowledge is to disseminate prosperity — I mean general prosperity and not individual riches — and with prosperity disappears the greater part of the evil which is our heritage from darker times.

Alfred Nobel

SALES OFFICES

All Euratom reports are on sale at the offices listed below, at the prices given on the back of the cover (when ordering, specify clearly the EUR number and the title of the report, which are shown on the cover).

PRESSES ACADEMIQUES EUROPEENNES
98, Chaussée de Charleroi, Bruxelles 6

Banque de la Société Générale - Bruxelles
compte N° 964.558,

Banque Belgo Congolaise - Bruxelles
compte N° 2444.141,

Compte chèque postal - Bruxelles - N° 167.37,

Belgian American Bank and Trust Company - New York
compte No. 22.186,

Lloyds Bank (Europe) Ltd. - 10 Moorgate, London E.C.2,

Postcheckkonto - Köln - Nr. 160.861.

OFFICE CENTRAL DE VENTE DES PUBLICATIONS DES COMMUNAUTES EUROPEENNES
2, place de Metz, Luxembourg (Compte chèque postal N° 191-90)

BELGIQUE — BELGIË
MONITEUR BELGE
40-42, rue de Louvain - Bruxelles
BELGISCH STAATSBLAD
Leuvenseweg 40-42 - Brussel

DEUTSCHLAND
BUNDESANZEIGER
Postfach - Köln 1

FRANCE
SERVICE DE VENTE EN FRANCE DES PUBLICATIONS DES COMMUNAUTES EUROPEENNES
26, rue Desaix - Paris 15e

GRAND-DUCHE DE LUXEMBOURG
OFFICE CENTRAL DE VENTE DES PUBLICATIONS DES COMMUNAUTES EUROPEENNES
9, rue Goethe - Luxembourg

ITALIA
LIBRERIA DELLO STATO
Piazza G. Verdi, 10 - Roma

NEDERLAND
STAATSDRUKKERIJ
Christoffel Plantijnstraat - Den Haag

EURATOM — C.I.D.
51-53, rue Belliard
Bruxelles (Belgique)