Large storage binary-to-decimal converter

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Abstract

An accurate binary-to-decimal converter is described capable of dealing with numbers up to 2^{24}. *The instrument is designed for manual input with display on dekatron indicators, and a speed of operation of four bits per second.*

Introduction

THERE are many instruments using a display in the binary system, and several methods have been described for converting this display into the more familiar decimal system.[1,2] However, where complete accuracy, speed of operation and large capacity are required, it was felt necessary to use a digital computer design. The method described fulfils these requirements, and some features may have other applications where very high speed is not essential.

General principles

The basis of the design is the pulse source of separate but synchronized groups of 1, 2, 3 . . . 9 pulses, which are permanently connected to the requisite contacts of seven banks of a 25-way uniselector. The banks correspond to powers of ten up to 10^6 and successive wiper positions correspond to successively higher powers of two. Thus the $(n + 1)^{th}$ wiper position relates to $2^n = \ldots dcba$, and the first bank contact would be connected to the source of *a* pulses and so on, as illustrated by Fig. 1 for the first few banks and contacts. From the wipers the pulses are fed to the corresponding dekatron stage of the seven-decade display.

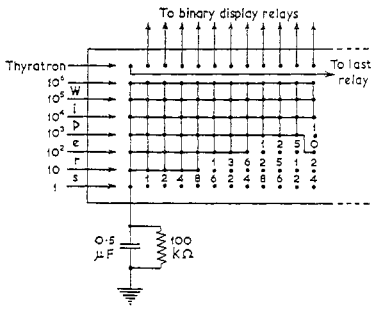

Fig. 1. Connexions of pulse sources to the first few banks and contacts

Outline of the design

The block diagram is shown in Fig. 2. The input is by a pair of push-buttons *A* and *B*, the operation of which corresponds to the addition, or not, of the particular power of two into the storage display.

Button *A* operates a scale-of-two gate which in turn opens a suppressor-gated amplifier allowing pulses from a continuously running multivibrator to pass through. The pulses

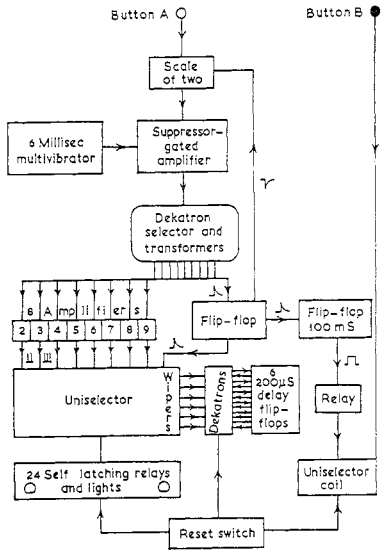

Fig. 2. Block diagram of the circuit

V_1, V_3 = ECC91 (6J6 CV858)
V_9 = 1/2 CV858
V_2 = CV329
V_4 = GS126 dekatron selector
V_5 = 1/2 ECC81 (12AT7 CV455)
V_6, V_7 = ECC81
V_8 = EN91 (2D21) thyratron
V_{10} = GC10B/5 (CV2271)
V_{11} = ECC83 (12AX7 CV492)

D_1 = EA50 (CV1092) hot diode
All other diodes crystal diodes CV448

R_1, R_3, R_4, R_{16}, R_{32}, R_{47}, R_{61}, R_{70}, R_{79}, R_{80} = 470 kΩ
R_2, R_{48} = 15 kΩ
R_{84} = 1·5 MΩ
R_5, R_{11}, R_{18}, R_{22} = 560 kΩ
R_6, R_{10}, 3 W., R_{67} = 33 kΩ
R_7, R_8 = 330 kΩ
R_9 3 W., R_{26}, R_{46}, R_{72} = 22 kΩ
R_{12}, R_{13}, R_{37}, R_{40}, R_{49}, R_{60}, R_{77} = 1 MΩ
R_{14}, R_{41} = 68 kΩ
R_{15} = 50 Ω
R_{17}, R_{19}, R_{21}, R_{28}, R_{30}, R_{31}, R_{32}, R_{33}, R_{34}, R_{35}, R_{36}, R_{38}, R_{54}, R_{58} = 100 kΩ
R_{24}, R_{25}, R_{27}, R_{55}, R_{59}, R_{64}, R_{65} = 47 kΩ
R_{29}, R_{43} = wire wound potentiometer
R_{51} = wire wound potentiometer
R_{66} = 10 kΩ
R_{20}, R_{62}, R_{81} = 39 kΩ
R_{23}, R_{63}, R_{71} = 150 kΩ
R_{53} = 3·9 MΩ
R_{57} 6X6 W.12 Ω = 72 Ω
R_{74} wire wound potentiometer = 5 kΩ
R_{69} = 82 kΩ
R_{39}, R_{42}, R_{50} = 330 Ω
R_{45} = 820 k
R_{56} = 3·9 k
R_{68}, R_{75} = 680 k
R_{76} 3 W. wire wound = 50 k
R_{73} = 6·8 kΩ
R_{78} = 56 kΩ
R_{82} = 18 kΩ
R_{83}, R_{84} = 100 Ω
R_{44}, R_{52} 6 W. wire wound = 3 k
M_1, M_2, M_3 = metrosils 110 V, 1 W.
R_{85}, 1 kΩ in series with 1 kΩ relay coil
T_1–T_9 intervalve transformers 5 : 1
S_1 button *A* (yes), S_2 button *B* (no)
RS, reset switch

C_1, C_6, C_7 C_{16}, C_{19}, C_{27}, C_{35}, C_{38} = 0·01 μF
C_2, C_5, C_8, C_{10}, C_{11}, C_{17}, C_{18}, C_{21}, C_{22}, C_{39}, C_{40}, C_{41} = 0·1 μF
C_9, C_{20}, C_{31}, C_{32} = 0·02 μF
C_3 = 0·005 μF
C_{13} = 0·05 μF
C_{33} = ~200 μμF
C_{24} = 0·05 μF
C_{28} = 0·25 μF
C_{34} = 1500 μμF
C_{23} = 1 μF (electrolytic)
C_4, C_{30} = 100 μμF
C_{12} = 2000 μμF
C_{14}, C_{36} = 1000 μμF
C_{25}, C_{26} = 0·5 μF
C_{29} = 680 μμF
C_{15} = 100–300 μμF

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have a period of 6 ms and a mark-to-space ratio of 1 : 2. These pulses are fed into a twelve-position dekatron selector tube (type GS12C by Ericsson Telephones Ltd.) which is the pulse source. As the method of obtaining the requisite numbers of pulses is novel, it is best described in some detail, with reference to Fig. 3. The first ten separate cathodes of the tube are connected to the primaries of a chain of nine small transformers (Radiospares intervalve type, ratio 1 : 5), and one end of the chain is earthed. One side of each secondary is earthed, the output being taken from the other. Diodes can be used across the primaries to eliminate unwanted pulses and the associated ring of the transformer, but this was only found to be necessary with the last one in the chain (the unit pulse transformer).

As the discharge invests cathode x from the second guide electrode, current flows through the primaries of the x transformers up to this point in the chain, producing pulses in each of these x secondaries. When the discharge leaves this cathode, a pulse of the same size but of opposite sign is produced at the same secondaries. The glow moves around the nine cathodes in the chain, the first transformer giving nine pulses, the second eight, and so on; the pulses are, of course, synchronized and the single pulse from the last transformer coincides with the last pulse in each group. The

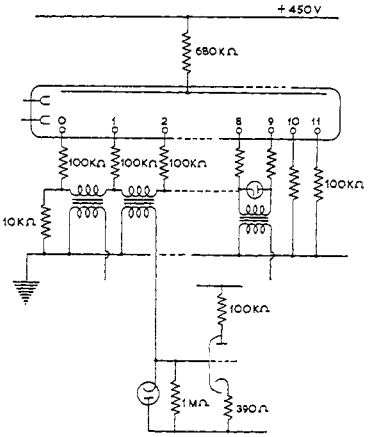

Fig. 3. Pulse source and amplifier

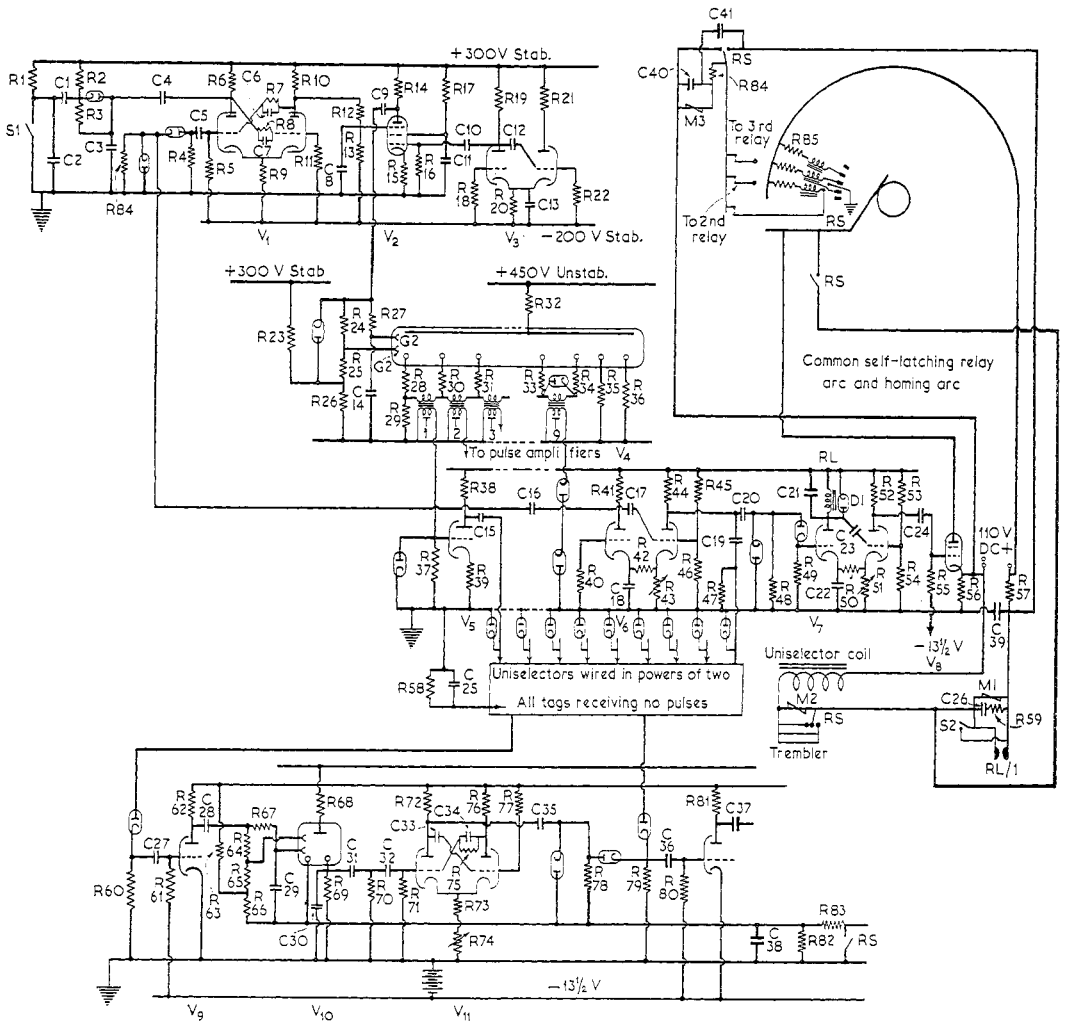

Fig. 4. Circuit diagram

positive pulse from the last transformer triggers a univibrator,[3] from which are taken a negative pulse to close the gate and a positive pulse to trigger a second univibrator (having a relay coil as anode load) for the purpose of resetting and moving the uniselector on. From the other eight transformers negative pulses (about 8 V high) are fed into amplifiers. The outputs from these, together with a positive pulse from the first univibrator, are fed into the uniselector as described above, and from there into the dekatron display. Thus at each operation of button *A*, separate groups of 9, 8, 7 . . . 1 pulses are produced and fed into the appropriate dekatron.

A miniature thyratron (type 2D21) and self-latching relays are used to give an indication, by light bulb, of the addition of this binary digit, so that there are always equivalent binary and decimal displays. An eighth bank of the uniselector is used for the relays.

If button *B* is pressed, the uniselector is simply moved to its next position, and no change is made in the displays.

In order to avoid difficulties from the coincidence of pulses fed into a dekatron stage, and the carry pulses from the previous one, a univibrator is used to delay the carry pulses by a time of about 200 μs.

Speed of operation is limited, by resetting and uniselector time constants, to about five bits per second. If greater speed were required, an increase by a factor of ten could be achieved by another dekatron drive circuit, and by using larger current pulses with shorter time constants for the relays.

A switch is provided in order to reset the instrument to zero. For this the dekatrons are reset in the usual manner; the uniselector has a homing arc (making nine banks required in all) and trembler, and the binary display circuit of self-latching relays and lights is opened.

Details of circuits and construction

The circuit diagram is given in Fig. 4. It should be noted that the complications in the binary display circuit are due to the same uniselector bank being used for the homing arc as for the binary display relays. The supplies required are 450 V, 5 mA, unstabilized, 300 V, 100 mA and −200 V, 10 mA stabilized, with 50 V, 2 A for the uniselector and relays, and 6·3 V, 8 A for heaters and lights. A low impedance bias supply of $-13\frac{1}{2}$ V is best supplied by dry batteries.

The input push-buttons are micro-switches for positive action. These and the reset switch are conveniently mounted in a small unit which can be close to the binary display being read. Connexion to the main converter is by twelve-core cable.

In order to avoid spurious pulses, it is necessary to earth all unused uniselector tags, to magnetically isolate the uniselector from the transformers and to use Metrosil spark suppression on the uniselector operating contacts.

Acknowledgements

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Growth of single crystals of anthracene

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Abstract

Single crystals of anthracene have been grown from melts of zone-purified material, in an all-glass oven. The important factors which governed the successful growth of single crystals by the moving-vessel technique have been investigated, viz. the purity of the anthracene, the temperature gradient, the shape of the growth vessel and the growth rate.

Introduction

GROWTH of organic crystals from the vapour phase usually results in slow growth of very thin crystals.[1–5] Thus, when large single crystals are required, these must be grown from the melt, or from saturated solution. In the case of anthracene, the latter method is of doubtful applicability, because the limiting factor in growth from solution[6] is solubility. Solubilities of 20–50% by weight are required for tolerable growth rates, and anthracene solubilities are much lower. There is also the disadvantage of possible solvent occlusion.

Growth from the melt has none of these disadvantages and reports[7–13] are available on the growth of anthracene crystals by this method. Though the Kyropoulos procedure[14, 15] may not be used because of the volatility of anthracene, and the likelihood of atmospheric oxidation, the moving-vessel[13, 16–19] and the stationary-vessel techniques[16, 20, 21] can be used. These have the advantage that crystals can be grown from highly purified material in an inert atmosphere. The moving-vessel technique was chosen for the present study. The investigation is concerned with several important criteria to be observed before crystals can be grown successfully, namely, the purity of materials, the temperature gradient, the rate of crystal growth, and the shape of the growth vessel.