1. The function of the pulse generator is to supply suitable trains of pulses to the transfer units, carry units, sending store, receiving store, translator and register. These trains of pulses are initiated by the pulse generator control circuit shown on C 47927. The dekatron tubes are operated by pulses applied in sequence to the two guide electrodes. In this computer the guide electrodes are normally at +60 and a negative square pulse of 120 V amplitude and 1.5 m sec duration is applied to guide 1 (A pulse) and then to guide 2 (B pulse) followed by an interval of 1.5 m sec before the next A pulse. There is a slight overlap between the A and B pulses.

To enable an arithmetical operation to be performed trains of these pulses are needed as follows:

1. Train of 10 A pulses for operating the
SK 10 sending store (max. load 19 dekatrons)

2. Train of 10 B pulses for operating the
SK 21 sending store (max. load 17 dekatrons)

3. Train of 10 B pulses at a different mean
SK 20 D.C. level for application to the cathodes of the double triodes in the transfer units (Transfer Pulses). (Constant load, 16 transfer units).

4. B Pulses at all times except the "Transfer
SK 19 Pulse" period for application to the cathodes of the double triodes in the carry units (Carry Pulses). (Constant load 16 carry units)

5. Train of 9 A pulses (omitting the A pulse
SK 12 preceding the first of the 10 B pulses) followed by additional A pulses during the period when carry-over is taking place, for connection to guide 1 in the receiving store. (Max. load 16 dekatrons)

6. One B pulse (the first of the train of
SK 17 10 B pulses) to move one digit of the register store forward one step during multiplication or division. (Constant load when used 10 dekatrons)

7. Nine B pulses (the last nine of the train
SK 18 of 10 B pulses) to move one digit of the register store back one step during multiplication or division. (Constant load when used 10 dekatrons)

√8. A switched anode supply for the cold cathode trigger tubes in the transfer units such that they are extinguished outside the transfer and carry periods.

√9. A switched anode supply for the cold cathode trigger tubes in the carry units such that they are extinguished at the beginning of each carry B pulse; and outside the transfer and carry periods.

10. A train of A pulses for recycling the translator to zero, available at all times other than transfer periods.
5K13
(TWO CARRYA)

11. A waveform simulating the output from a dekatron standing at 9 or 8 for rounding off.

2. The pulse generator circuit can be sub-divided into the following units:

(a) A control circuit (see C 47927)

(b) A continuously running oscillator producing positive and negative going A pulses and positive going B pulses.

(c) An A pulse switching circuit producing trains of 10 A, 9 A and carry, and translator recycling A pulses.

(d) A B pulse switching circuit producing positive going trains of 10 B pulses and carry B pulses.

(e) A B pulse switching circuit dividing the train of 10 B pulses into 1 B and 9 B.

(f) Output stages for the Transfer, carry and 10 B pulse supplies.

(g) Trigger valve anode waveform generator.

(h) Round-off waveform generator.

These individual circuits will now be described separately.

3. The Oscillator

This consists of valves V 8, V 9 and V 10 and operates continuously irrespective of the remainder of the computer. V 9 and V 10 are a conventional multivibrator with screen to grid coupling. The anodes are free to give outputs. The time constant on V 10 grid is double that on V 9 so that V 10 conducts for one-third of each cycle. The screen waveform from V 9 is applied to V 8, which is cut-off for the first half of the period during which V 9 is conducting. The three condensers C 14, C 15, C 19 each consist of several components chosen to give A and B pulse widths of exactly 1.5 m sec and a cycle time of 4.5 m sec. Switch S 1 raises the potential of the line to which the grids of the oscillator are returned and provides 1 m sec pulses for test purposes.

The outputs from the oscillator are:

(1) Positive going B pulses from anode and screen circuit of V 8.

(2) Positive going A pulses from anode of V 9.

(3) Negative going A pulses from anode of V 10.

4. A pulse switching circuit

The negative A pulses from the anode of V 10 are applied to the cathodes of two double triode switches V 11 and V 12. The grids of V 11 are controlled by the W and X waveforms generated by V 5 and V 6 in the control circuit. Waveform W is more positive than X during the transfer period and negative 10A pulses appear at the SK10 left hand anode of V 11. Waveform X is more positive than W at all other times and A pulses then appear at the right hand anode of V 11 for recycling the trans- SK13 lator. The time for which W is more positive than X is controlled by the dekatron V 7 so that the left hand anode of V 11 delivers 10 A pulses. (SOCKET 10)

The grids of V 12 are controlled by the Y and Z waveforms, whose generation is described later. Waveform Z is more positive than Y while carry B pulses are returned to the control circuit so that the A pulses are directed to the right hand anode of V 12. Waveform Y becomes more positive than Z after the first B pulse and subsequent A SK12 pulses appear at the left hand anode of V 12 until waveform Z becomes most positive after the carry B pulses are once again returned to the control circuit. The excursions of the anodes of V 11 and V 12 are limited by rectifiers. 9A + CARRY from SK 12 to ONE

5. 10 B and carry B pulse switching

Positive B pulses from the screen of V 8 are inverted by V 13 and applied to the cathode of a double triode switch V 14. The grids of V 14 are controlled by the W and X waveforms and consequently 10 B pulses appear at the right hand anode and carry B pulses at all other times from the left hand anode. These negative pulses are again inverted by the two halves of V 15.

6. B pulse output stages

SK 19
2 CARRY B
-125 — -250V

Positive going Carry B pulses from the left hand half of V 15 drive the output stage V 17. The anode of V 17 normally rests at -100 volts. When the grid potential is raised by a carry B pulse the anode falls until the rectifier W 19 conducts, and then negative feedback is applied to limit any further fall of anode potential. RV 4 adjusts the potential at which this limiting operates. Similarly 10 B pulses from the right hand half of V 15 drive the output stage V 18 and also V 19.

SK 20
10B -125 to -250V

SK 21
10B +55 to -60V

The anode potential of V 19 normally rises until caught by the diode V 25 at +60 V. When the grid potential is raised by one of the 10 B pulses the anode falls until, through the A.C. coupling, C 25, the rectifier W 23 conducts and limits the fall in anode potential. RV 6 determines the voltage from which the negative going waveform applied to W 23 starts, and hence controls the amplitude of the anode waveform.

7. 1 B and 9 B switching circuit

Waveforms Y and Z are used to control the division of the 10 B pulse train into 1 B and 9 B pulses. Returned carry B pulses appearing at the anodes of V 2 in the control circuit (SK6) are differentiated by a 4700 pF condenser, the negative pulse from the leading edge of the carry pulse is removed by rectifier W 6 and the positive pulse from the trailing edge applied to the grid of V 4. The positive pulse, decaying with a time constant of about 18 m sec appears at the cathode of V 4 and is applied through W 16 to the left hand grid of V 26. These carry pulses are maintained throughout the period between transfers and hold the potential of the left hand cathode of V 26 (waveform Z) ('Z' SK9) above that of the right hand cathode (waveform Y). This condition still exists when the first of the train of 10 B pulses is applied to the cathode of V 16. The first B pulse therefore appears at the left hand anode of V 16. (SK 17) The positive trailing edge of this pulse is applied to the right hand grid of V 26, raising the potential of Y above ('Y' SK 11) that of Z. Since no further carry pulses are returned via V 2 until the end of the transfer and carry period the potential of Y stays above that of Z and the remaining 9 B pulses appear at the right hand anode of V 16. (SK 18) The first returned carry pulse raises the potential of Z again.

8. Trigger Valve Anode Waveform Generator

V 20 in this circuit is a double triode whose grids are controlled by the Y and Z waveforms so that the left hand side is conducting during the transfer and carry period and the right hand side during the remainder of the time. If controlled only by Y and Z the changeover would occur after the first B pulse, but rectifier W 29 allows the first of the 10 B pulses to advance the changeover by one pulse width. The potential of the right hand anode of V 20 is normally caught at -60 volts by W 9, but during transfer and carry periods rises to a potential determined by R 58 and R 61 (approximately +130 V).

Between Transfers and First B pulse 'Z' more positive than 'Y'

During Transfer 'W' is more positive than 'X'.

This waveform controls the left hand grid of V 21 (45 V to 105 volts) and appears at the left hand cathode (SK 3) as the Transfer unit anode waveform. This waveform controls a cathode follower in the stabilizer unit.

Positive going carry B pulses from the left hand anode of V 15 are inverted by V 27, differentiated by C 28, the positive pulse from the trailing edge removed by the diode V 28 and the negative pulses (time constant .75 m secs) from the leading edge drives the right hand grid of V 29. Negative pulses, coincident with the leading edge of the carry pulses, ~~coincident with the leading edge of the carry pulses~~, appear at the left hand anode of V 29 and are combined with the Transfer anode waveform and applied to the right hand grid of V 21. The waveform at the right hand cathode of V 21 +90 — -60V (SK 2) is the Carry unit anode waveform, and provides for extinguishing the carry trigger valves outside the transfer and carry period and also at the beginning of each carry B pulse.

9. Round-off waveform generator

G1/370K

V 22 and V 23 are a conventional cold cathode scale-of-two counting down positive A pulses from the anode of V 9 in the oscillator independently of arithmetical operations. When the first of the 10 B pulses is produced for any transfer there is a substantially equal probability that V 22 or V 23 will be conducting. Square waves from the cathodes of V 22 and V 23 control the grids of the double triode V 24 and 10 B pulses are applied to its cathode. There is therefore an equal probability that the first of the 10 B pulses will appear at the left hand or right hand anode of V 24. An output is taken from the right hand anode of V 24 and, when random round off is required, is taken to the input of transfer unit No.8. Thus this transfer unit may receive the first pulse of the train (equivalent to the output from a dekatron circulating from cathode 9) or the first pulse may go to the left hand anode of V 24 and the second pulse go to the transfer unit (equivalent to the output from a dekatron circulating from cathode 8). The transfer unit therefore behaves as though it has received the complement of 1 or 0 with equal probability. The remaining transfer units are fed with a waveform (generated in unit GA) simulating the complement of 0.