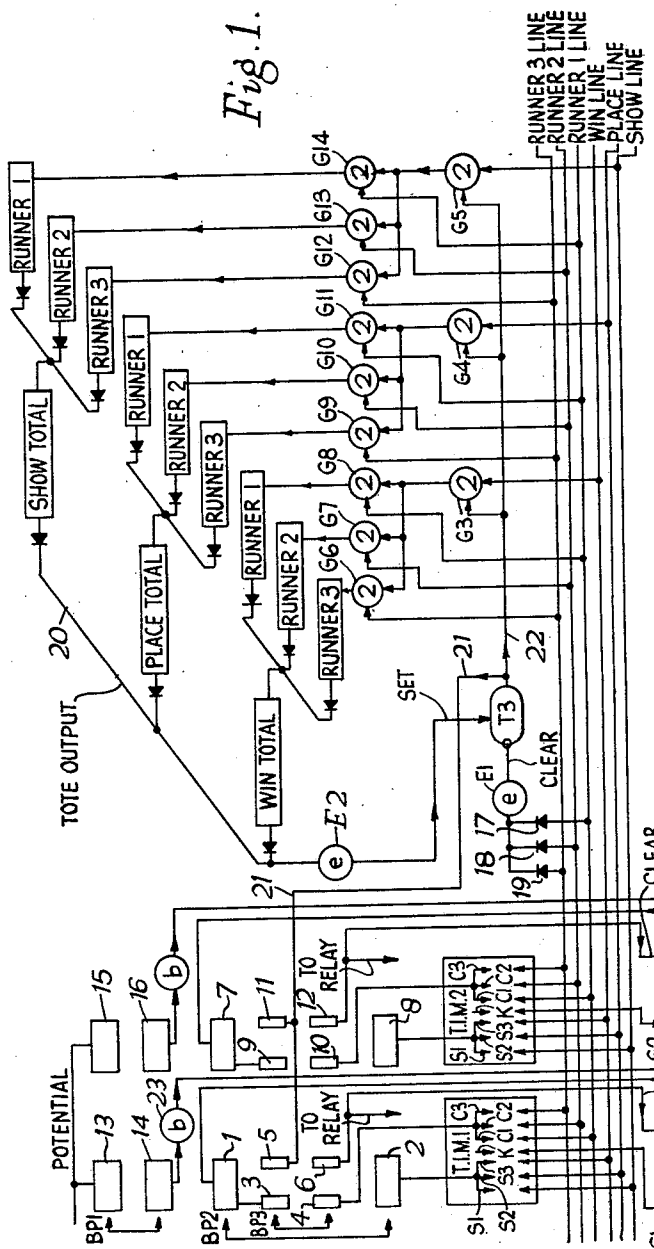
May 7, 1963 J. H. CONDY ETAL 3,089,058

TOTALISATOR SYSTEM

Filed Sept. 9, 1957 5 Sheets-Sheet 1

Fig. 1.



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TOTALISATOR SYSTEM

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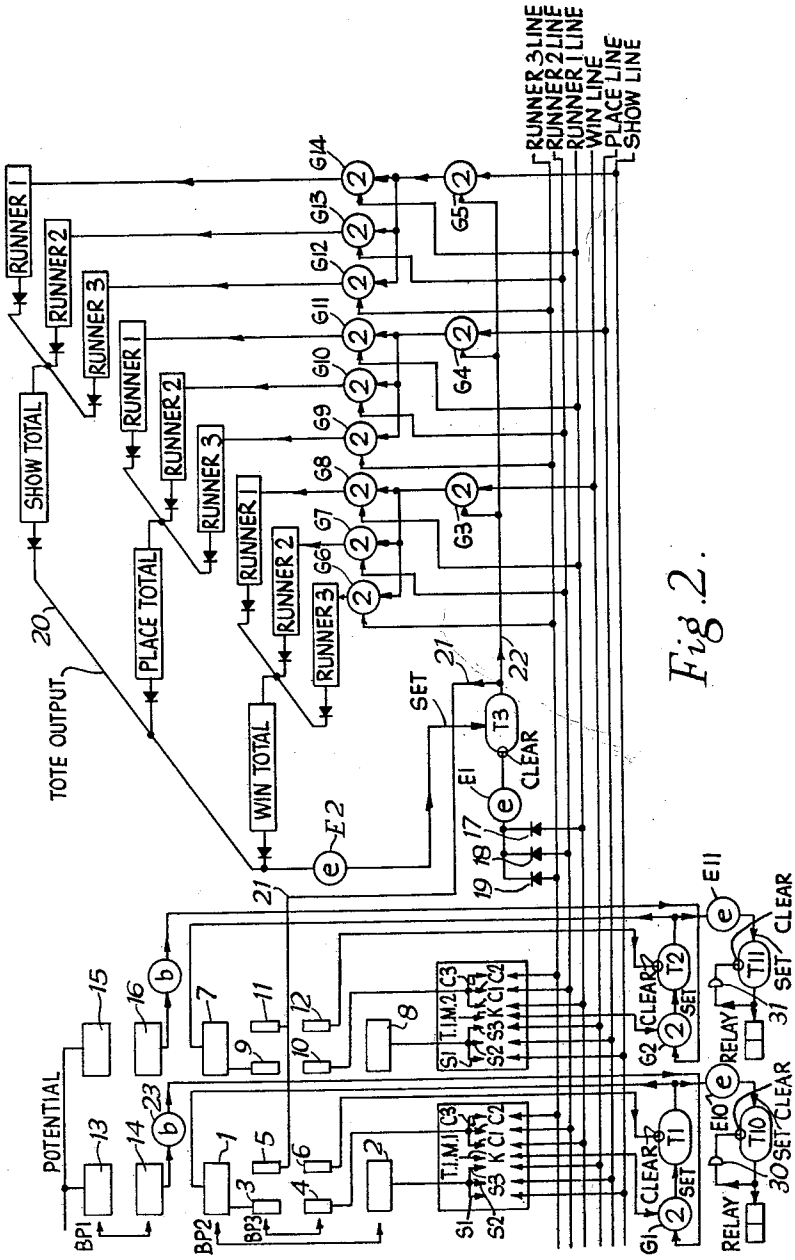


Fig 2.

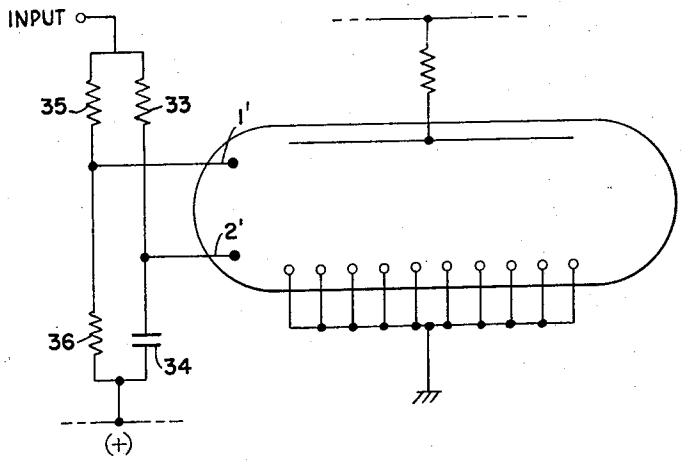
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TOTALISATOR SYSTEM

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Fig. 3.



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TOTALISATOR SYSTEM

Filed Sept. 9, 1957 5 Sheets-Sheet 4

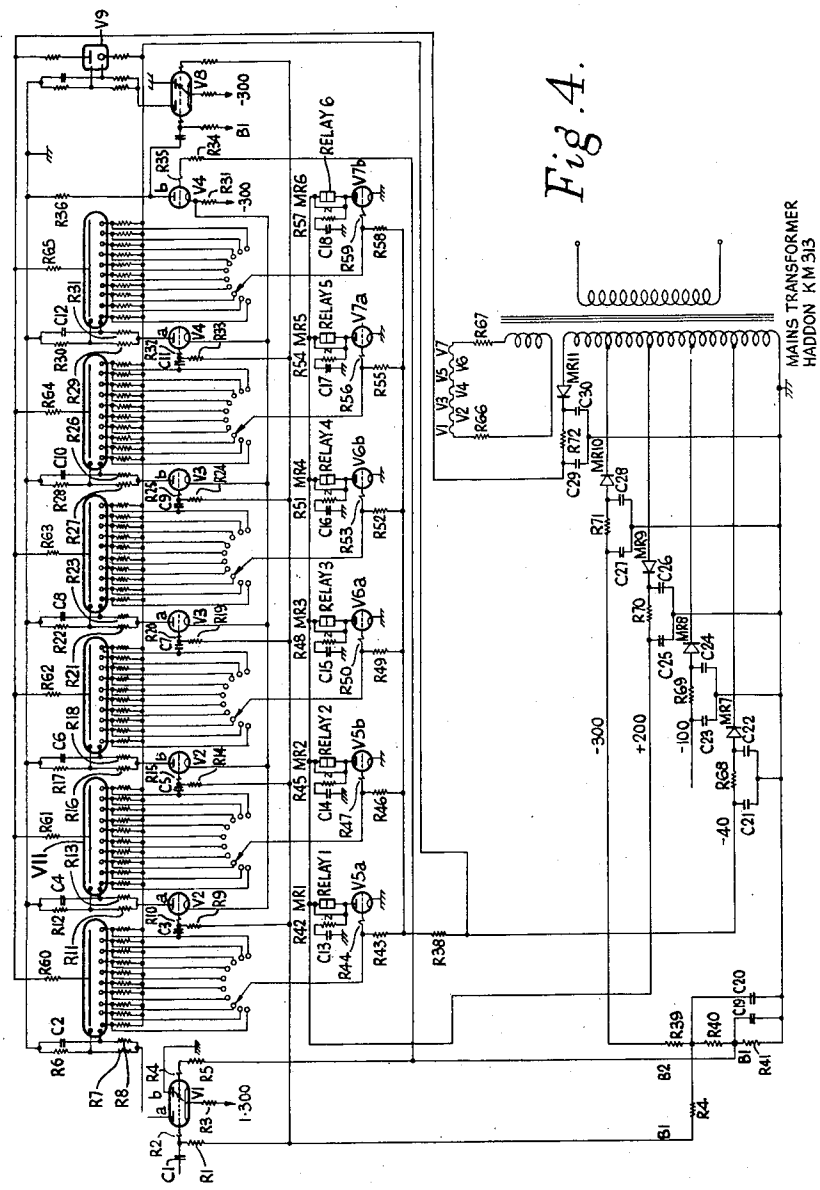


Fig. 4.

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TOTALISATOR SYSTEM

Filed Sept. 9, 1957 5 Sheets-Sheet 5

RESISTORS

R1		R37	10K WIRE WOUND
R2	47K (T)	R38	47Ω
R3		R39	8·2K
R4	47K (T)	R40	2·2K
R5		R41	2·2K
R6	5·6K	R42	2·2K
R7	"	R43	2·2M
R8	47K	R44	47K (T)
R9	560K (T)	R45	2·2K
R10	47K (T)	R46	2·2M
R11	5·6K	R47	47K (T)
R12	"	R48	2·2K
R13	47K	R49	2·2M
R14	560K (T)	R50	47K (T)
R15	47K (T)	R51	2·2K
R16	5·6K	R52	2·2M
R17	"	R53	47K (T)
R18	47K	R54	2·2K
R19	560K (T)	R55	2·2M
R20	47K (T)	R56	47K (T)
R21	5·6K	R57	2·2K
R22	"	R58	2·2M
R23	47K	R59	47K (T)
R24	560K (T)	R60	820K (T)
R25	47K (T)	R61	" "
R26	47K	R62	" "
R27	5·6K	R63	" "
R28	"	R64	" "
R29	"	R65	" "
R30	"	R66	" WIRE WOUND
R31	47K	R67	BRIMISTER TYPE CZ6
R32	47K (T)	R68	1K
R33	560K (T)	R69	
R34	" "	R70	
R35	47K (T)	R71	
R36	4·7K	R72	10K

ALL DEKATRON CATHODE RISISTORS = 220K TYPE T

RECTIFIERS

MR1	S.T.C.	Q33
MR2	"	"
MR3	"	"
MR4	"	"
MR5	"	"
MR6	"	"
MR7	S.T.C.	Q82
MR8	WESTINGHOUSE	CONTACT COOLED 18 R.A. 1-1-8-1
MR9	TWO 18 R.A. 1-1-16-1	
MR10	TWO 18 R.A. 1-1-16-1	
MR11	S.T.C. K8/25	

ALL VALVES E90CC
DEKATRONS GS 10C

Fig. 4a.

CAPACITORS

C1	470 PF	C17	0·1 uf
C2	0·01 uf	C18	"
C3	470 PF	C19	"
C4	0·01 uf	C20	"
C5	470 PF	C21	50uf 50V
C6	0·01 uf	C22	" "
C7	470 PF	C23	8 uf 450V HUNTS JF55375
C8	0·01 uf	C24	"
C9	470 PF	C25	"
C10	0·01 uf	C26	"
C11	470 PF	C27	"
C12	0·01 uf	C28	"
C13	0·1 uf	C29	8 uf 50V DUBILIER BR850
C14	"	C30	"
C15	"	C31	
C16	"	C32	

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United States Patent Office

3,089,058
Patented May 7, 1963

3,089,058
TOTALISATOR SYSTEM

John H. Condy and Norbert Kitz, London, England, assignors to Bell Punch Company Limited, London, England, a British company

Filed Sept. 9, 1957, Ser. No. 682,839
Claims priority, application Great Britain Sept. 11, 1956
13 Claims. (Cl. 315—84.6)

This invention is for improvements in or relating to totalisators.

It is well known that electronic devices can perform their functions at a greater speed than mechanical devices are capable of doing and the principal object of the present invention is to provide a construction of totalisator which is considerably more rapid in operation and less susceptible to error than those conventional totalisators employed at the present time.

A further object of the present invention is to provide a construction of totalisator the speed of operation of which, in connection with the acceptance and registration of bets, renders unnecessary the provision of temporary bet storage facilities in the aggregating equipment.

Other important objects and advantages sought to be achieved by the present invention will become apparent from the ensuing particular description.

The present invention will hereinafter be more particularly described with reference to the accompanying drawings, in which:

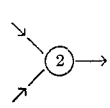
FIGURE 1 illustrates diagrammatically a totalisator system constructed in accordance with the present invention;

FIGURE 2 illustrates diagrammatically the circuit illustrated in FIGURE 1 modified in accordance with an alternative embodiment of the present invention;

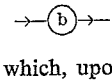
FIGURE 3 represents a ten cathode stepping tube marketed under the name Dekatron; and

FIGURES 4 and 4*a* comprise, respectively, a circuit diagram of the aggregators employed in the said totalisator, and a chart setting out the values of the various components employed.

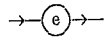
It is considered desirable to describe, at the outset, certain symbols employed in FIGURE 1 in order that the said figure may be readily understood when the detailed description starts. Thus,



represents a "gating device" or "gate" which is capable of transmitting an output pulse only when it receives two simultaneous input pulses;

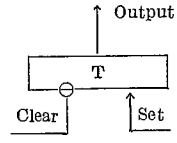


represents an element which, upon receiving an impulse, transmits a very narrow pulse at the beginning, only, of the said impulse;



represents an element which, upon receiving an impulse,

transmits a very narrow pulse at the end, only, of the said impulse; and



represents a "trigger" or "bi-stable device" which, once it has been set, applies voltage until it is cleared. It is set by a pulse on the line marked Set and is cleared by a pulse on the line marked Clear.

In addition to the symbols set out above, rectangular blocks are employed to denote electronic multi-stage counters or aggregators, ticket-issuing machines and commutator segments. A detailed description of the construction and mode of operation of the ticket issuing machines thus diagrammatically illustrated is believed to be unnecessary since a ticket issuing machine of the kind intended to be employed is fully described and illustrated in United States Patents Nos. 1,886,626; 1,886,769 and 2,020,594.

The following description relates to a totalisator which has been limited as regards the number of component parts in the interests of simplicity and in the belief that a person skilled in the art will be readily capable of applying the general principles of the invention explained herein to a considerably larger installation if required.

Therefore, referring to FIGURE 1 it will be noted that there are illustrated therein two ticket-issuing machines T.I.M.1 and T.I.M.2 each capable of dealing with three runners, 1, 2, and 3, and three categories of stake, namely, "win," "place" and "show." The machine T.I.M.1 is associated with a set of commutator segments **1** to **6** and the machine T.I.M.2 is associated with a set of commutator segments **7** to **12**. The commutator segments **1**, **2** and **7**, **8** are so arranged as to be swept by a pair of shorting brushes BP2 and the commutator segments **3**, **4**, **5**, **6** and **9**, **10**, **11**, **12** are so arranged as to be swept by a pair of shorting brushes BP3. Further, the machine T.I.M.1 is associated with a pair of commutator segments **13** and **14** and the machine T.I.M.2 is associated with a pair of commutator segments **15** and **16**, the said commutator segments **13**, **14** and **15**, **16** being so arranged as to be swept by a pair of shorting brushes BP1.

It will be convenient to point out at this juncture that the segments **1** to **6** and **13**, **14** associated with the machine T.I.M.1 and the segments **7** to **12** and **15**, **16**, associated with the machine T.I.M.2 will, in practice, be disposed in a plurality of concentric circles, the pairs of shorting brushes BP1, BP2 and BP3 all being carried by one rotating arm and being so aligned as to sweep on the same radial line. The commutator segments will preferably consist of metallic segments set in insulating material, the insulating material being formed as a circular disc in which all those segments which, in the drawing, are disposed in the same horizontal line are disposed in the same circular track. The disc, herein after referred to as the commutator disc, and the metallic segments may be made in accordance with printed circuit techniques.

Reverting to FIGURE 1, it will be noticed that the

segments 1, 2 and 7, 8 swept by the brush BP2 are wider than the segments 3, 4, 5, 6 and 9, 10, 11, 12 swept by the brush BP3 and for this reason the pulses generated by the segments 1, 2 and 7, 8 being swept by the brush BP2 will be called wide pulses whilst the pulses generated by the segments 3, 4, 5, 6 and 9, 10, 11, 12 being swept by the brush BP3 will be called narrow pulses.

The commutator segments 13 and 15 have voltage permanently connected to them and thus the pairs of segments 13, 14 and 15, 16 generate wide impulses, known as "clock" impulses, for synchronising purposes when they are swept sequentially by the brush BP1. The impulse generated, for example, by the sweeping of the segments, 13 14 is applied to one input of a gate G1, the impulse generated by the sweeping of the segments 15, 16 being applied to a gate G2.

The output of a bi-stable device T1 is applied to the segment 1 and, by way of the pair of shorting brushes BP2, to the segment and a set of three stake switches, S1, S2 and S3. The segment 1 is connected to the segment 3 so that the output of the bi-stable device T1 is also applied to a set of three runner switches C1, C2 and C3 when the pair of shorting brushes BP3 sweeps the segments 3, 4.

The segments 7, 8, 9, 10 and the bi-stable device T2 are similarly connected.

A set of three runner lines and a set of three stake lines are common to the machines T.I.M.1 and T.I.M.2, the stake switches S1, S2, S3, and the runner switches C1, C2, C3 in each machine being connected to the appropriate lines as indicated in FIGURE 1.

The runner lines are connected by means of buffer diodes to an element E1, the switches C1, C2 and C3 being, therefore, connected when closed to the element E1 by the buffer diodes 17, 18 and 19, respectively. The output of the element E1 is applied to the bi-stable device T3 at the input marked "Clear." The output of T3 is applied to or removed from:

(*a*) One input of each of three gates G3, G4 and G5, and
(*b*) The commutator segments 5 and 11.

according to the state thereof during the preceding interval of time.

The stake lines are connected to the gates G3, G4 and G5, the stake switches S1, S2 and S3 being connected, respectively to G5, G4 and G3. The output of gate G3 is connected to one input of each of three gates G6, G7 and G8, the outputs of the gates G4 and G5 being connected to one of the inputs of the gates G9, G10, G11 and G12, G13, G14, respectively. The second input of each of the gates G6, G9, G12 is connected to the line associated with runner 3 (namely the line connected to the runner switch C3), the second input of each gate G7, G10, G13 is connected to the line associated with runner 2 and the second output of each gate G8, G11, G14 is connected to the line associated with runner 1.

The output of each gate G6 to G14 is connected to an aggregator,

(*a*) Gates G6, G7, G8 being connected to aggregators labelled, respectively, runner 3, runner 2, runner 1. Each runner aggregator is connected, by means of a buffer diode, to an aggregator labelled Win Total;
(*b*) Each gate G9, G10, G11 being connected, as in (*a*) above, to an aggregator, each aggregator being connected, via a buffer diode, to an aggregator labelled Place Total; and
(*c*) The arrangement being similar to that in (*a*) and (*b*), the final aggregator being labelled Show Total.

The Show Total, Place Total and Win Total aggregators are each connected to a Tote Output line 20 by means of a buffer diode. The line 20 is connected to the input of an element E2, the output of which is applied to the device T3 at the input marked Set.

The issue of a ticket will now be described in connection with T.I.M.1:

It should be noted at the outset that the bi-stable devices T1 and T2 are normally "off" or do not apply voltage at the outputs thereof whilst the device T3 is normally "on" or applies voltage to the two lines 21 and 22.

In order to issue a ticket on a particular runner, the operator first conditions the machine for the kind of stake required (namely, win, place or show), thereby causing, for example, the switch S2 to close. Assuming that the person placing the stake has chosen runner 3, the operator depresses a runner key associated with that particular runner, thereby closing the switch C3. The switch K is automatically closed shortly after closure of the switch C3, thereby calling the machine T.I.M.1 into action by applying a voltage to gate G1.

When the brushes BP1 short the segments 13, 14, voltage is applied to an element 23 which sends an extremely narrow pulse to gate G1, this pulse being timed to occur at the beginning of the first "clock" pulse to be generated by the sweeping of the segments 13, 14 after the switch K in T.I.M.1 has closed. The gate G1, having voltage applied thereto through the switch K and having received a pulse from the element 23, sends a pulse which triggers T1, thereby causing T1 to apply voltage to the segment 1. Since segment 3 is connected to segment 1, voltage is also applied to segment 3.

It is necessary to point out here that the segments 1 and 2 are greater in width than the combined widths of segments 3 and 5, for example. Further, the segments 1 and 2 are so disposed relatively to the two pairs of segments 3, 4 and 5, 6 that the brushes BP2 contact segments 1, 2 before contacting segments 3, 4 and also fall off segments 5, 6 before falling off segments 1, 2. Further, segments 3, 4 are separate from segments 5, 6. Similar remarks apply to the segments 7, 8, 9, 10, 11 and 12 associated with T.I.M.2.

When brushes BP2 short segments 1, 2 voltage is applied via the said brushes, segment 2, and switch S2 to the line which represents the type of stake involved; in this case, a "place" stake. The place line, as it will hereafter be called, is connected to one input of gate G4. Since the output of the device T3 is applying a voltage to one of the inputs of each of the gates G3, G4, G5, the gate G4 will now have voltage applied at both inputs and will, as a result, transmit a pulse to the line which commons the gates G9, G10 and G11.

Shortly after the brushes BP2 contact segments 1, 2, the brushes BP3 contact and short-circuit segments 3, 4, as a result of which an impulse is sent via the said brushes BP3, the segment 4 and the switch C3 to the line which represents the runner involved, namely, "runner 3." "Runner 3" line is connected (*a*) via buffer diode 19 to the element E1, and (*b*) to one input of each of the gates G6, G9, G12, and therefore the impulse generated by the brushes BP3 sweeping segments 3, 4 is simultaneously applied to the element E1 and the said gates G6, G9 and G12. By definition, the element E1 transmits a very narrow pulse at the end of the impulse generated by the brushes BP3 sweeping the segments 3, 4 and, therefore, just before the brushes BP3 fall off the segments 3, 4 the element E1 emits a pulse which clears T3, thereby cutting off the supply of voltage to the lines 21 and 22.

Reverting to the gate G4, it will be remembered that this gate transmitted a pulse to the line which commons one of the inputs of each of the gates G9, G10, G11. Moreover, the "runner 3" line is connected to one of the inputs of each of the gates G6, G9, G12 and thus the impulse generated by the brushes BP3 shorting the segments 3, 4 is applied to the said inputs of gates G6, G9, G12. It will, therefore, be appreciated that gate G9 receives two overlapping impulses at its two inputs, this causing G9 to transmit an impulse to the "runner 3" aggregator.

When "runner 3" aggregator has recorded the fact that a bet has been placed in respect of "runner 3," the said ag-

gregator transmits a pulse to the "place total" aggregator. When the "place total" aggregator has recorded the fact that a "place" bet has been staked the said aggregator transmits an impulse to the tote output line **20** and, via the line **20**, to the element E2 which, at the end of the impulse transmitted by the "place total" aggregator, transmits a narrow impulse to the device T3. The device T3 is set by this narrow return impulse and thereby voltage is applied once again to the lines **21** and **22**.

It will be convenient to note, at this juncture, that when the device T3 is cleared, thereby removing voltage from the lines **21** and **22**, voltage is not applied any longer to one input of each of the gates G3, G4 and G5. Until the device T3 is set by a narrow impulse being transmitted by the element E2, the totalisator is not able to accept and register any further bets.

When the device T3 is set and re-applies voltage to the lines **21** and **22**, voltage is applied to the segments **5** and **11** associated, respectively, with T.I.M.1 and T.I.M.2. After the brushes BP3 fall off segments **3, 4** and after a further short interval of time, the said brushes short-circuited the segments **5, 6**, the segment **6** of which is connected to a self-holding relay and to the "clear" input of the device T1. Thus, when the brushes BP3 short-circuit the segments **5, 6**, an impulse is sent both to the self-holding relay and to the device T1.

Operation of the said relay (*a*) breaks the line connecting the K contacts of T.I.M.1 to the gate G1 and (*b*) initiates the ticket issuing cycle. The impulse which operates the said relay also clears T1, thereby removing potential from the segments **1** and **3**, and, since the brushes BP3 fall off the segments **5, 6** before the brushes BP2 fall off the segments **1, 2**, the potential is removed from the segments **1, 2** whilst the brushes BP2 are short-circuiting them.

When the ticket has been issued, T.I.M.1 releases those keys of the machine which have been depressed, the self-holding relay falls off and thereby T.I.M.1 is re-connected to G1 in readiness for the next cycle.

The above detailed description of the operation of the totalisator in connection with T.I.M.1 applies also to T.I.M.2 and, therefore, the sequence of operations as applied to T.I.M.2 will be deemed to be understood.

Additional safeguards against the undesired issue, by any ticket issuing machine in the system, of a ticket may be added and one such preferred safeguard is illustrated in FIGURE 2 in which only those parts of FIGURE 1 which are directly associated with T.I.M.1 and which are modified have been illustrated. It will be remembered that the brushes BP3 short-circuit the segments **5, 6**, of which the segment **5** has potential applied thereto by T3. When the brushes BP3 short-circuit the segments **5, 6**, an impulse is sent to clear the device T1, thereby removing potential from the segments **1** and **3**. Towards the end of the pulse generated by the device T1 being turned off, an element E10 (FIGURE 2) sends a narrow pulse to a device T10, the output of which is connected (*a*) to a self-holding relay and (*b*) to a delay **30**. The arrangement is such that when T10 is turned on or set an impulse is sent to the self-holding relay which breaks the line connecting the K contacts to the gate G1 and which initiates the ticket issuing cycle. The said relay then falls off, as hereinbefore described, and by this time the delay **30** sends a pulse to clear or turn off the device T10.

It will be appreciated that T.I.M.2 is provided with an element E11, a device T11, a delay **31** and a self-holding relay, the operation of all of which is as described above, and it will further be appreciated that each ticket issuing machine in or associated with a totalisator system is provided with such a safeguard circuit as that described above.

Each of the aggregators illustrated in FIGURES 1 and 2 consists of a plurality of ten cathode stepping tube counters, marketed under the name Dekatron and hereinafter referred to as such, interconnected by a novel type of carry-over circuit. A mathematical check on the performance of each aggregator unit as a whole is provided, both the carry-over circuit and the checking circuit having been introduced to minimise the risk of misfunction on the part of any aggregator unit passing unnoticed.

Before the circuit illustrated in FIGURE 4 is described in detail, the manner of operation of a Dekatron will be considered very carefully.

A Dekatron is a gas-filled cold-cathode stepping tube which usually has ten electrodes known as cathodes. A glow can be maintained between a common anode and any one, and only one, of the above-mentioned cathodes and the glow can be transferred from one cathode to another by suitable pulsing. By referring to a particular cathode as the 0 cathode, to the one next to it as the 1 cathode and so on, decimal counting is possible or indeed counting in any notation is possible dependent upon the number of cathodes with which the tube is provided.

Before the carry-over system which it is proposed to employ between successive Dekatrons can be discussed it becomes necessary to consider the manner in which the glow is transferred from one cathode to the next adjacent cathode:

In the Dekatron assembly there are two electrodes between each pair of adjacent cathodes, these electrodes being known as guides **1'** and guides **2'**, respectively. All guides **1'** are commoned and similarly all guides **2'** are commoned. Normally the voltage difference between each of the cathodes and the common anode is kept greater than the voltage difference between each of the guides and the anode, so that the glow must reside on a particular cathode.

When it is desired to step the glow from one cathode to the next adjacent cathode the voltage difference between guides **1'** and the anode is made greater than that between the anode and cathode on which the glow resides (that is, guide **1'** is driven negative compared with the said cathode) so that the glow jumps from the said cathode to the nearest guide **1'**. After a predetermined interval of time the guides **2'** are driven negative compared with the cathode and the glow is shared by the adjacent guides **1'** and **2'** because the negative voltage reading of all guides **1'** and **2'** is the same. After a further predetermined interval of time, all guides **1'** are restored to the normal "at rest" voltage and guide **2'** will take over the whole glow. When finally the guides **2'** are restored to the normal "at rest" voltage the glow jumps to the nearest cathode (which is nearer to guide **2'** than the cathode from which is started) because, in order to go back to the cathode from which it started, the glow would have to jump over guide **1'**.

It now becomes important to discuss how the pulses on the guides **1'** and **2'** are derived. These are normally derived by means of a single pulse which is applied through a voltage divider **35, 36** to guide **1'** and, via an integrating circuit **33, 34**, to guide **2'**. It will be seen from FIGURE 3 that the integrating circuit to guide **2'** merely consists of a resistor **33** and capacitor **34** and that the delay required between switching off the pulses to guide **1'** and guide **2'** is simply provided by the charge stored in the capacitor **34**.

A very important point arises in this connection and this is the fact that, after the drive pulse has disappeared, the glow resides on guide **2'** until such time as the charge on the capacitor **34** has dropped sufficiently to allow it to step to the next cathode.

It is a feature of Dekatron circuitry that the amplitude of the carry-over pulse obtained when a Dekatron passes through the zero position, is insufficient, without amplification, to step the Dekatron in the next higher order and, therefore, a carry-over amplifier is always provided.

The output of the zero cathode of a Dekatron is usually connected to the input of the carry-over amplifier via a conventional resistance/capacity coupling.

It is common practice to make the carry-over amplifiers independent self-contained circuits. These sometimes take the form of a simple amplifier, cut off until a carry-over pulse occurs, which the amplifier magnifies sufficiently to drive the next stage.

Sometimes the carry-over pulse is used to trigger off a pulse shaping circuit of conventional design which produces a pulse of predetermined amplitude or width or indeed both, which pulse is used once more to drive the next stage.

All the above carry-over amplifier units suffer from the following disadvantages:

(1) Being separate units, the failure of one of them may pass undetected for a long time;
(2) Each unit uses its own supply of current, with consequent increase in power requirement where there is a plurality of units;
(3) The fluctuations in load on the power unit may be violent in the case of amplifiers being turned on from a cut-off condition, so that stabilisation of the power unit may be essential.

The carry-over circuitry illustrated in FIGURE 4 and employed in the aggregators illustrated in FIGURES 1 and 2 is a variation of the "long-tailed pair" circuit well known in the art.

Referring to FIGURE 4, the triode V4*b* always forms one of the valves of the pair and the grid potential of V4*b* is normally higher than that of V2*a*, V2*b*, V3*a*, V3*b* and V4*a* so that V4*b* is normally conductive. Accordingly, current flows through R36 and R31 and voltage is developed across R31 which is sufficient to prevent V2*a*, V2*b*, V3*a*, V3*b*, V4*a* from conducting.

However, if, for example, V2*a* is pulsed by either an input or carry-over pulse, it will be made conductive so that current will flow through its anode circuit and R31. This additional current through R31 will cause an increased voltage drop across it, with the result that V4*b* will become non-conductive. The current through the anode circuit of V2*a* will cause pulses to be applied to the guides of the second Dekatron V11 to step it and increase its setting by unity. At the end of the input or carry-over pulse, V2*a* will become non-conductive and V4*b* will again become conductive.

A single current can be used for all the carry-over circuits because it has already been established that, after a drive pulse has been applied to a carry-over amplifier, the glow in the driven Dekatron will not settle on a cathode until some time after the drive pulse has disappeared, with the consequence that while the drive pulse is "on" another stage is not capable of producing a carry-over pulse and the same source of common current can be safely used for all the carry-over amplifiers.

It will be appreciated that the circuit described above with reference to FIGURE 4 possesses the following advantages:

(I) Only one current is required for all the carry-over amplifiers;
(II) The drain on the power supply is a minimum;
(III) All stages of the counter are driven by a current pulse and are independent of valve characteristics;
(IV) The load on the power supply is virtually constant as the same amount of current is taken from it at all times;
(V) The use of suitable time constants enables all stages to operate with identical height and width pulses;
(VI) All carry-over amplifiers are connected to the same source of current so that many faults (such, for example, as one of the carry-over amplifiers being permanently "on") are readily detected in that they are of the catastrophic type rather than of the intermittent type.

A further degree of security is achieved by connecting all the heaters of the carry-over valves in series so that heater failure in one valve puts the whole circuit out of action.

The novel feature of the above circuit compared with a conventional long-tailed pair lies in the fact that, in the conventional circuit, two triodes share a common cathode load and according to the grid setting current (the same current) will flow through one valve or the other; whereas, in the carry-over circuit described above, the current is absorbed by whichever valve happens to be "carrying" and the long-tailed "pair" may be formed by V.4*b* and any other valve according to the previous history of the counting circuit.

Another novel feature of the circuit of the present invention is the design of a carry-over circuit for Dekatrons on similar counting tubes which is based on the realisation that a delay (in the case of the Dekatron, the delay forms part of the drive circuit) introduced at a suitable point in the circuit will cause only one carry-over amplifier to be operative at a given time. One result of this is that a common source of current may be used, with what may be regarded as the consequent advantages of long-tailed pair technique which make it possible, as already explained, to make all stages of the counter or aggregator operate with standardised identical pulses, a condition most likely to lead to absolute reliability.

Even with the carry-over circuit described with reference to FIGURE 4 and the connection of all valves in that circuit in the series heater manner a further check on the correcter correct functioning of the aggregator is desirable.

It will be realised that one of the properties of the carry-over circuit illustrated in FIGURE 4 is the fact that every time one of the various carry-over amplifiers "carries," current is taken away from V.4*b*, so that every time a carry occurs V.4*b* gives out a pulse from its anode circuit. These pulses from V.4*b* are reshaped by a conventional pulse shaper V.8 which is similar to V.1 and the reshaped pulses are used to drive another Dekatron V.9.

It follows that, at the end of a count V.9 will register (modulo 10) the total number of carries that have occurred during that count. Suppose, for example, that 5336 impulses have been sent into the counter or aggregator there will have been the following carries:

From units to tens	533
From tens to hundreds	53
From hundreds to thousands	5
	591

and V.9 will therefore read: 1.

If all the figures standing in the aggregator (except the units) are added up (modulo 10) they should give 1 as the answer:

$$5+3+3=11$$
$$11 \text{ (modulo } 10)=1$$

Therefore, all that it is necessary to do at the end of a count is to add up (modulo 10) all figures except the units figure standing in the aggregator and compare them with the check figure standing in V.9. If there is a discrepancy, there has been a miscount.

The above check will pick up a miscount provided that the number of impulses missed is not a multiple of 10 and therefore an accuracy of 90% can be claimed for the checked result.

In the system described above, units readings are ignored. The checking system can be extended to the units readings simply by replacing V.1 by a circuit identical with V.2*a*, V.2*b*, V.3*a*, V.3*b* and V.4*a* joined to the same source of current. Under these new conditions V.4*b* will send out a pulse for every pulse sent into the counter, namely, including the units stage, as well as for every carry. Assuming that the number of pulses sent into the

counter is the same as in the preceding example, V.9 would receive the following number of pulses:

Input pulses	5336
Carries:	
From units to tens	533
From tens to hundreds	53
From hundreds to thousands	5
	5927

and V.9 will therefore read: 7. The check figure being 7, the result of adding together (modulo 10) the figures standing in the aggregator, units included, should be 7:

$$5+3+3+6=17$$
$$17 \text{ (modulo 10)}=7$$

Suppose that on one occasion the carry-over between the hundreds and the thousands had failed to step the thousands Dekatron in spite of the fact that a drive pulse had been generated. The final count would be 4336, the figures of which when added together (modulo 10) would give 6. However V.9 would still in these circumstances read 7 and therefore the fact that an error or miscount had occurred in some stage would be detected.

The carry-over circuit described above suffers from certain drawbacks which are not of any significance in totalisator work but which should be mentioned. Owing to the common current source, the circuit illustrated in FIGURE 4 would not work at the maximum speed of which Dekatrons are capable if ten stages of counting were used instead of six, because, as the carry propagates from stage to stage at the same speed as the Dekatron in stage 1 steps, it follows that all propagation must be completed before stage 1 has stepped through another complete cycle and has generated yet another carry if the best use is to be made of the Dekatrons. Naturally, though, if stage 1 is stepped at a slower speed than the rate of carry-over propagation, more than ten stages of Dekatrons can be used.

The complete checking circuit, units included, proposed above can, for the same reasons, only be used at the expense of Dekatron counting speed because, in using the complete checking circuit, it becomes necessary to limit the rate at which pulses are fed into stage 1 to 1 to 6 to allow the carry-over sufficient time to propagate.

The maximum speed of counting of the type of Dekatron employed in FIGURE 4 is 4000 counts per second. If this is the speed used in carry-over propagation, the rate of input to stage 1 must be limited to:

$$\frac{4000}{6}=666 \text{ pulses per second}$$

Of course, such a counting speed is still well over five times as fast as the totalisator requirement so that, despite the above so-called drawbacks, the completely checked circuit would almost certainly be used in totalisator work.

It should be emphasized that there is associated with each Dekatron a visual display from which the contents of a Dekatron may be read. The display consists, in one embodiment, of a numeral wheel which automatically adjusts the setting of itself so as to indicate visually the setting of the Dekatron. Such a construction has been described in United States patent applications Serial Nos. 682,376, 682,394 and 682,396, all filed September 6, 1957, and basically comprises a numeral wheel, a series of contacts each connected to a cathode of the associated Dekatron and a relay-operated arresting device. Whilst the Dekatron is being pulsed the numeral wheel "hunts," thus rotating constantly, but when the Dekatron is not being pulsed any longer the numeral wheel, upon which there is disposed a pair of wiper contacts, bridges the "live" contact connected to the cathode on which the glow is residing. The relay hereinbefore referred to operates and the numeral wheel is arrested, displaying the amount recorded by the Dekatron.

Valves V.5*a*, V.5*b*, V.6*a*, V.6*b*, V.7*a* and V.7*b* are employed as amplifiers to operate the arresting relays of the visual display by means of which the "hunting" numeral wheel is caused to display visually the amount standing in the associated Dekatron.

The power unit illustrated in FIGURE 4 is conventional and of a simplicity rendered possible by the type of circuits used.

It will be appreciated and it is to be understood that a trigger circuit consisting of a pair of valves may either consist of that pair of valves within one and the same glass envelope or consist of each valve of the pair being enclosed within a separate glass envelope.

We claim:

1. An electronic aggregator including a plurality of multi-cathode gas-filled electron discharge glow tubes coupled by carry-over amplifiers to form a counting chain, wherein each carry-over amplifier comprises a trigger circuit which has two conduction phases and which draws substantially the same current in each of its two conduction phases.

2. An electronic aggregator as claimed in claim 1, wherein each trigger circuit comprises a pair of valves.

3. An electronic aggregator as claimed in claim 2, wherein the two valves are cathode-coupled.

4. An electronic aggregator as claimed in claim 3, wherein each carry-over amplifier comprises a long-tailed pair.

5. An electronic aggregator as claimed in claim 2, wherein one valve of each pair is common to a plurality of carry-over amplifiers.

6. An electronic aggregator as claimed in claim 5, wherein one valve of each pair of valves is common to all carry over amplifiers.

7. An electronic aggregator comprising a plurality of multi-cathode gas-filled electron discharge glow tubes, a plurality of first electronic valves operatively connected each between two of said multi-cathode tubes to form a counting chain, a second electronic valve, each of said valves having an anode, a cathode, and a control electrode, a common cathode load for said second valve and at least some of said first valves, and means for applying a constant potential to the control electrode of said second valve.

8. An electronic aggregator as claimed in claim 7, wherein said first valves and said second valve are hard valves.

9. An electronic aggregator comprising a series of multi-cathode gas-filled electron discharge glow tubes, a plurality of first electronic valves each operatively connected between the tubes of a separate pair of said multi-cathode tubes to form said multi-cathode tubes into a counting chain, a second electronic valve, each of said valves having an anode, a cathode, and a control electrode, a cathode load common to all said valves, and means for applying a constant potential to the control electrode of said second valve, whereby only one of said valves can be conductive at a time.

10. An electronic aggregator comprising a plurality of multi-cathode gas-filled electron discharge glow tubes each including an anode, a plurality of cathodes, and a plurality of guide electrodes between adjacent of said cathodes, said aggregator further comprising a plurality of first electronic valves each including an anode, a cathode, and a control grid, each of said valves being disposed in circuit between the tubes of a separate pair of said tubes with a cathode of one tube of such pair coupled to the control grid of that valve and with the anode of that valve coupled to the guide electrodes of the other tube of such pair, a second electronic valve including an anode, a cathode and a control grid, a cathode load common to all of said valves, and bias means to cause said second valve to conduct except when one of said first valves is conducting.

11. An electronic aggregator comprising a plurality of

multi-cathode gas-filled electron discharge glow tubes, carry-over amplifiers operatively connected between adjacent ones of said multi-cathode tubes to form said multi-cathode tubes into a counting chain, an electronic valve, a common power supply for all said amplifiers and said valve, and means for ensuring that said valve is conductive except when one of said carry-over amplifiers is operating to pass a carry from one of said multi-cathode tubes to the next tube in the chain.

12. An electronic aggregator as claimed in claim 11, including means for counting the number of times said valve is rendered non-conductive.

13. An electronic aggregator comprising a plurality of multi-cathode gas-filled electron discharge glow tubes, carry-over amplifiers operatively connected between said multi-cathode tubes to form a counting chain, an electronic valve, means for ensuring that said valve is conductive except when one of said carry-over amplifiers is passing a carry, means for deriving a pulse from said valve whenever it is rendered non-conductive, and means for counting said pulses.

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