

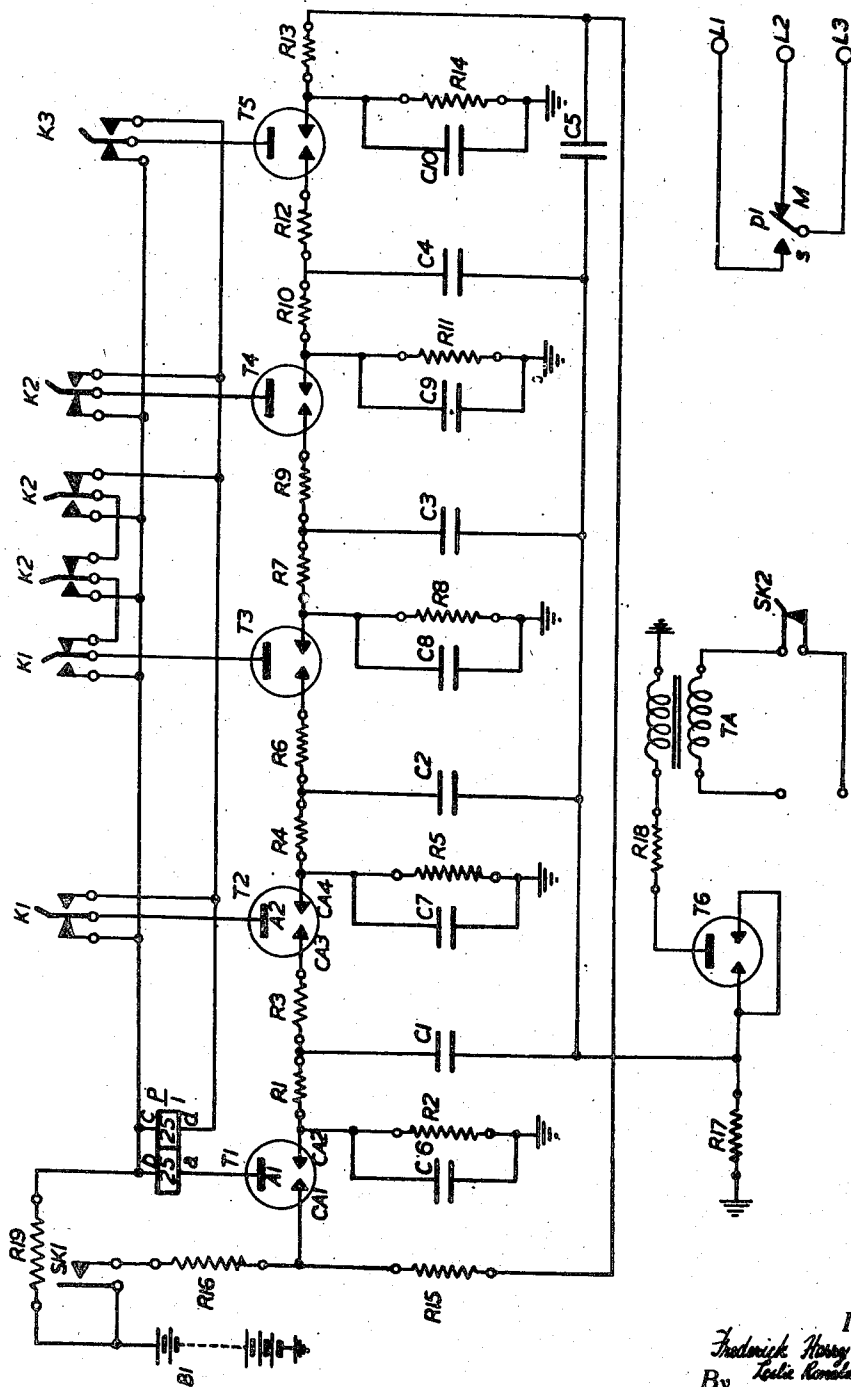
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CIRCUIT FOR COUNTING ELECTRICAL IMPULSES

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CIRCUIT FOR COUNTING ELECTRICAL IMPULSES

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This invention relates to a circuit arrangement for counting electrical impulses comprising a chain of electronic devices. This arrangement may be used for counting directly impulses from the dial of a subscriber's station in an automatic telecommunication system or from a revertingly controlled switch in such a system or may be used for generating electrical impulses by causing it to count the number of cycles of an applied alternating current and to generate one impulse for each n cycles. Used in this last mentioned way the arrangement according to the invention may be used as the source of impulses which is required in the register controllers of step-by-step telecommunication exchange systems, and may thus be common to a plurality of such register controllers, in replacement of the mechanical operation of a plurality of impulse springs at present used for that purpose.

Circuit arrangements comprising a chain of electronic devices for counting electrical impulses are already known. One such arrangement described in British Patent No. 436,420 comprises two electronic devices in the chain for each impulse to be counted, one such device being rendered conducting when an impulse is applied and the next in the chain when such impulse is removed. Thus two electronic devices were required to count each impulse. The electronic devices were however adapted to be arranged in a closed chain and the arrangement could be used to count the number of cycles of an alternating current and to generate an impulse each n cycles. In British Patent No. 555,392 there is described and claimed an impulse counting device differing from that described in British Patent No. 436,420 in that one electronic device per impulse was all that was necessary. The electronic devices and the manner in which each such device is connected to the next in the chain are generally similar to those described in the embodiment described later in this specification.

The invention will be better understood from the following description of one embodiment thereof taken in conjunction with the accompanying drawing.

The drawing shows a circuit arrangement for counting the alternations of a source of alternating current of 50 cycles per second and for producing therefrom impulses at the standard rate of dialling impulses used in automatic telephone systems, viz, 10 impulses per second. The circuit uses a series of five cold cathode gas filled tubes $T1 \dots T5$ for counting the cycles of the alternating current and a sixth tube $T6$ for converting the alternating current into steep fronted surges at the rate of 50 surges per second.

Each of the gas filled tubes is of a well known type comprising a control gap between two control electrodes and a main gap between a main

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electrode and one of the control electrodes. Either of the control electrodes may function as the cathode, but for the sake of clearness of description of the operation of the circuit one will be referred to as the cathode and the other as the control electrode, whilst the main electrode is referred to as the anode. When the control gap ionises and becomes conducting the main gap thereupon becomes conducting.

The five tubes $T1 \dots T5$ are arranged in a closed chain. The cathode of tube $T1$ is connected through resistances $R1$ and $R3$ to the control electrode of tube $T2$ and to ground through a condenser $C6$ and resistance $R2$ in parallel. The cathode of tube $T2$ is similarly connected to the control electrode of $T3$ and to ground and so on, the cathode of tube $T5$ being connected to complete a closed chain to the control electrode of tube $T1$ over resistances $R13$ and $R15$.

The anodes of tubes $T1 \dots T5$ are connected to a battery $B1$ of 150 volts in a manner presently to be explained. The anode of the sixth tube $T6$ is connected over a resistance $R18$ of 5,000 ohms and the secondary of a transformer TA to ground. The primary of transformer TA is connected over normally closed contacts $SK2$ of a start key to a source of alternating current of 50 cycles per second and 200 volts peak value. The cathode and control electrode of tube $T6$ are connected together and through a resistance $R17$ of 5,000 ohms to ground.

The operation of the device is as follows: In order to start the circuit into operation it is necessary to operate and release a start key, the contacts of which are shown at $SK1$ and $SK2$. Operation of the key closes contacts $SK1$ and opens contacts $SK2$.

On closure of contacts $SK1$ positive voltage of 150 volts is applied from battery $B1$ over resistance $R16$ to the control electrode of tube $T1$. The cathode is connected over resistance $R2$ and condenser $C6$ in parallel to ground. The potential across the control gap rises from zero to about 100 volts, causing the control gap to ionise, and, since the anode of the tube is connected to battery $B1$ over resistance $R19$ and one winding of relay P the main gap also ionises. Current therefore flows through the left-hand winding of relay P and the main gap of tube $T1$. Relay P is a polarised relay and operates its contacts $p1$ into the position shown if they were not previously in that position. The main gap current of tube $T1$ passes also through resistance $R19$ across which the voltage drop is of the order of 30 volts and through resistance $R2$ of 6,000 ohms across which the voltage drop is about 40 volts. This last mentioned voltage is applied to the control electrode of tube $T2$.

So long as the start key is held operated, nothing further happens. When the start key is released, alternating current passes through the

primary of transformer TA. Assuming that a positive half cycle is commencing, the voltage across the main gap of tube T6 increases until it is about 180 volts. The main gap ionises and the voltage across the tube falls to between 70 and 80 volts, which is characteristic of the tube used. Thus about 100 volts are left to be divided between the two resistances R17 and R18 of 5,000 ohms each. The voltage across R17 is thus suddenly increased from zero to about 50 volts and is applied through condensers C1 . . . C5 respectively to a control electrode of each of the tubes T2, T3, T4, T5 and T1.

The voltage across the control gap of tube T2 is raised from 40 volts, which is insufficient to ionise the gap, to about 80 volts at which the gap ionises and the main gap of tube T2 also ionises. A current flows from battery B1 through resistance R19 and the main gap of tube T2 and begins to charge condenser C7. The current through resistance R19 and thus the voltage drop across it is increased. The increase in the voltage drop across R19 is sufficient to decrease the voltage applied to the anode of tube T1 to de-ionise the main gap of that tube. The main gap of tube T2, however, remains ionised, since although the potential of its anode is decreased to the same value as that of tube T1, the cathode is at ground potential whilst the cathode of tube T1 is at about 40 volts positive (condenser C6 being fully charged and just beginning to discharge).

The voltage across resistance R5 and condenser C7 begins to increase as the condenser C7 charges, but this does not take place sufficiently rapidly for the control gap of tube T3 to be ionised by the same surge of voltage as that which ionised the control gap of tube T2. Thus tube T2 remains ionised until the next surge.

During the negative half cycle of alternating current in transformer TA the tube T6 is de-ionised and remains de-ionised.

On the next following positive half cycle, tube T3 is ionised in the same way as tube T2, and in succeeding positive half cycles the ionisation of one tube and de-ionisation of the immediately preceding tube in the series continues, tubes T4, T5, T1 and so on ionising in succession.

The right hand winding of relay P can be inserted in the circuit of the main gap of any of the tubes T2 . . . T5 by means of the keys K1 . . . K3. Thus in the position of the keys shown, battery B1 is connected to the anode of tube T2 over the left hand contacts of key K1, and is connected over the right hand winding of relay P, two left-hand sets of contacts of key K2, right hand contacts of key K1 to the anode of tube T3. When the main gap of tube T3 ionises, therefore, relay P is operated over its right-hand winding and changes over its contacts p1 into alternate position. Battery B1 is connected to the anode of tube T4 over the right-hand contacts of key K2 and to the anode of tube T5 over contacts of key K3. Thus make and break impulses are sent into a circuit connected to terminals L2 and L3 with 40% make, 60% break. The total time for one cycle of operation being 100 milliseconds, ten impulses are sent per second.

If key K1 be actuated, then battery B1 is connected over the right-hand winding of relay P and left-hand contacts K1 to the anode of tube T2. Battery B1 is connected to the anode of tube T3 independently of relay P over the right-

hand contacts K1. The impulses are 20% make, 80% break.

In a similar manner actuation of keys K2 and K3 connect battery over the right-hand winding of relay P to the anodes of tubes T4 and T5 respectively and the impulses are 60% and 80% make respectively.

The impulses produced in a circuit connected to terminals L1 and L2 are reversed as regards the periods of make and break with respect to those produced in a circuit connected to terminals L2 and L3.

Although the circuit arrangement has been described for the purpose of generating impulses of ten per second from 50 c. p. s. alternating current, it will be seen that it could be used for counting impulses applied to the tubes through condensers C1 . . . C5 and that a counting relay could be connected in the anode circuit of each of the tubes. It is also clear that, by altering the number of tubes in the series the ratio of the number of impulses produced to the period of the alternating current could be altered. If tubes T1 . . . T5 be of the three-electrode gas-filled type indicated and containing neon, impulses up to and including at least 100 per second can be accurately counted, whilst if tubes containing argon be used, the speed of counting can be still further increased.

What is claimed is:

1. An impulse counting system including a chain of gas-filled tubes, each tube having a cathode, anode and auxiliary discharge initiating electrode, a pair of series-connected resistances coupling the cathode of one tube to the auxiliary electrode of the next tube in the chain, a condenser between the junction of said two resistances and a common terminal, a resistance and condenser in shunt between each cathode and ground, a source of direct current potential having its negative terminal grounded and its positive terminal connected to each anode, a load resistance connected between said common terminal and ground, an electron discharge device having cathode and anode with said cathode connected to said common terminal, a source of sinusoidal alternating current connected between ground and anode of said electron discharge device and means for establishing a discharge through said electron discharge device at a predetermined time during the positive portion of each alternating current cycle to generate a voltage surge between ground and said common terminal, said counting system being adapted to operate on a predetermined number of said alternating current cycles.

2. The system of claim 1 wherein switching means are provided in the anode circuit of said gas tubes for altering the counting ratio.

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