A Transistorized Dekatron Scaler

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Received July 15, 1959

As an attempt to transistorize the scaling circuit, a Dekatron scaling circuit has been transistorized by the use of all home-made products. Performance and operation of this new circuit are presented, although some improvement seems to be necessary.

INTRODUCTION

With the development of transistors and semiconductor diodes, these elements are recently replacing vacuum-tubes in many electronic circuits, since they have the advantages of smaller size, cooler operation and some increased reliability. In the field of nucleonic instruments many works on the transistorization of the circuit have already been reported[1]; especially, Goulding and his group at Chalk River have been working to open the new field of application of transistors in radiation measuring instruments.[2]

The present work was undertaken in an attempt to assemble a Dekatron scaling unit using all home-made products of transistors and germanium diodes available on the market in this country. All Dekatron scalers commercially available in this country are using vacuum-tubes to drive Dekatrons. As the Dekatron is the cold-cathode gas-discharge tube, it seems to be simpler if a cold-cathode tube will be used in the driving circuit, however, at present in our country we can not find a cold-cathode tube with good characteristics applicable for this purpose. From this reason the application of transistors becomes favorable; the transistorization of the circuit facilitates lesser imput power, simpler construction, cooler operation, smaller size, resulting in increased reliabllity and cutting down the cost of the unit.

Our circuit is essentially the same as that reported by Kandiah[3] except a few points are modified, while Chaplin and Williamson made some modification in its trigger circuit.[4] This paper gives a few accounts on our transistorized Dekatron scaler.

DEKATRON DRIVING CIRCUIT

For driving a Dekatron by trigger action there are few circuit systems, blocking oscillator and monostable multivibrator system. Since, in general, due to smaller value of supplied voltage to a transistor a generated pulse from a transistor is not sufficient to drive a Dekatron, it should be necessary to step

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up this pulse by a transformer. By the use of such a transformer as an element of the blocking oscillator, getting sufficient oscillation and step up, is possible to build a driving circuit with only one transistor for the it Dekatron scaling unit. In Fig. 1 the circuit diagram of the intermediate stage is shown.

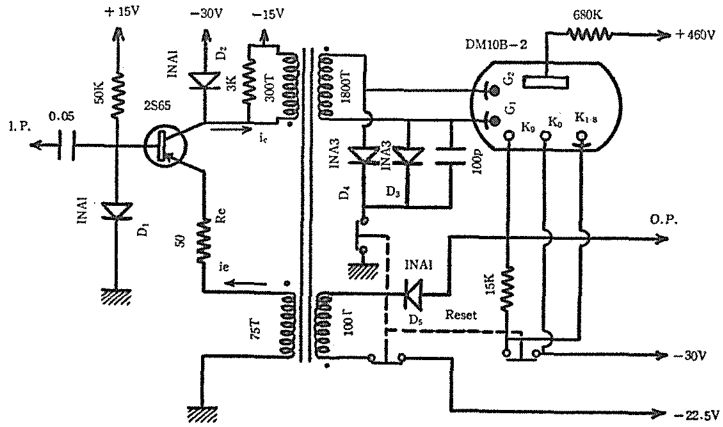

Fig. 1. Intermediate stage of the Dekatoron scaler driven by a transistor.

The transistor is normally at the "off" state, as its base potetial is positive by a current through D_1. By applying a trigger pulse (negative) to the input, the base potential of the transistor becomes negative, resulting in the "on" state, and the initial current i_e of the emitter grows to be $i_c=\alpha i_e$ from a collector and then flows into the primary side of the transformer. It appears as $K\alpha i_e$ in the secondary side, where K is a transformer ratio and α is a current transmission factor of the transistor. When $K\alpha>1$, i_e and i_c increase and the collector potential bottoms for a time $L\left(\alpha-\frac{1}{K}\right)/KR_e$, and then the primary voltage of the transformer becomes 15 V while an emitter current $i_e=15/K\times50\fallingdotseq75$ mA. L is the inductance of the primary coil. A magnetizing current through the primary coil then increases, at a rate 15/L, until i_c reaches αi_e. Then the system operates reversibly; i_e is cut off, V_c falls to -30 V by the action of D_2, and the magnetizing current decreases, at a rate 15/L, until it reaches zero. Waveforms of the system are shown in Fig. 2.

The high tension winding of the tranaformer gives a negative pulse to G_1 of the Dekatron when the blocking oscillator generates a positive pulse, while the fransformer gives a negative pulse to G_2 when a negative pulse produced in the oscillator system, resulting in transfer of a glow in the Dekatron. However, in practice, to achieve reliable transfer of the glow these two pulses to G_1 and G_2 must be adequately overlapped by distorting the pulse-forms such as shown in Fig. 2, by the insertion of a small capacitor of 100 pF.

In general, to trigger the next stage the positive edge of a output pulse at K_0 of a Dekatron is used, but in the present circuit the negative edge of an output pulse at K_9 is supplied to the next stage. By this modification the time

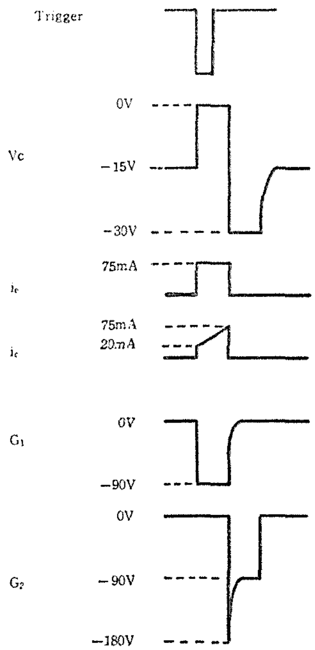

Fig. 2. Waveforms of the transistorized Dekatron scaler.

delay for pulse generation at each stage is made much smaller than that at an ordinary circuit, being very advantageous for the scale-down purpose. However, since the amplitude of the pulse at K_9 is insufficient for this purpose, we use the 4th winding of the blocking transformer, with which it is possible to flow larger trigger current by discharging the input condenser of the next stage suddenly, stimulated by a negative pulse generated in this extra-winding through D_5 at the instance when a glow is leaving the electrode K_0.

PRE-STAGE CIRCUITS

Pre-stage circuits, shown in Fig. 3, are composed of the phase invertor, discriminator and differentiator circuits. The circuits have a simple phase

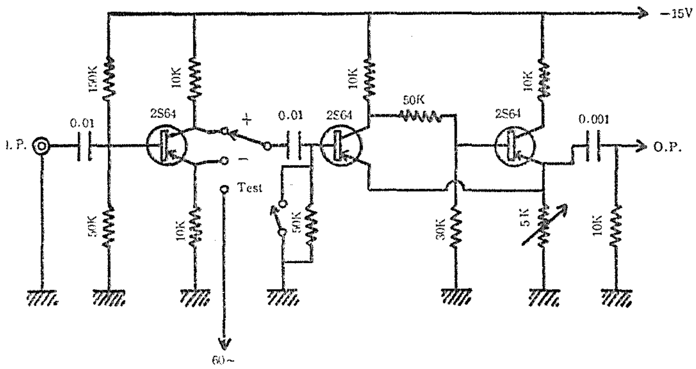

Fig. 3. Transistorized pre-stage circuit for the Dekatron scaler.

invertor, being able to receive either positive or negative input pulses. For a discriminator the Schmitt trigger circuit is applied, followed by a simple differentiator as broad pulses may be produced through the Schmitt circuit.

DISCUSSION

The transformer used in the present circuit has a ferrite core, TDK EI-20, with four windings. Distortion of waveforms was observed, because of appearance of big under-shoot due to the large self-capacitance resulting from too much number of turns of the high tension winding. On this point further improvements seems to be necessary.

All transistors and germanium diodes are commercially available products of th Kobe Kogyo Corp. As the resolving time of the Dekatron, JRC DM1OB-2, is about 200μ sec, even the audio-frequency transistors are shown to be available for this purpose.

The present circuit has the resolving time of about 400 μsec seems to be limited by that of the Dekatron used as well as by some defect of the transformer used. It is thought that by more elaborate version of a transformer design we would be able to obtain the resolving time nearly equal to that of the Dekatron.

The authors are grateful to Professor S. Shimizu for his generous stimulation throughout the work.

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