The Experimental Results of the Blocking Oscillator

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This paper describes the analysis and the experimental results of the blocking oscillator with the pulse transformer. The analysis and the experiments are in good agreement with each other.

1. Introduction

The application of the pulse transformer to an electronic circuit is able to simplify the circuit configuration, and it is possible to compose the electronic circuit which is essential to use the transformer in consequence. In this paper, the blocking oscillator that is the typical example of the wave generation circuit by means of the transformer being adopted, we attend to the roles of the transformer, and examine the pulse wave.

2. The equivalent Circuit [2)]

The pulse transformer is a kind of a wide band device which has the object in transmit the wave. In the case of the preparation of the equivalent circuit for the analysis of the transformer, it is impossible for us to determine the circuit entirely. As the method which was done for a long time relatively, the lumped circuit for that of approximation was used. Recently the method as the distributed circuit is held. For usual electronic circuit, lumped one is better for the reason of a simple and easy way. Thus we shall use the theories introduced by the lumped circuit. The circuit as was mentioned above is shown in Fig. 1.

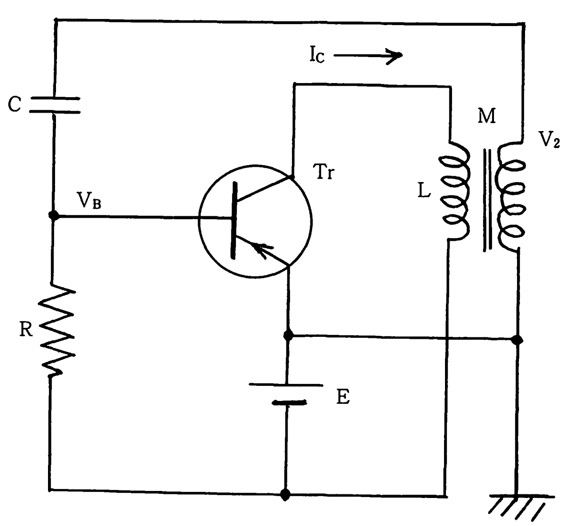

Fig. 1 Blocking Oscillator

3. The Oscillators[2)]

Since being the most simplicity, the transistor circuit is used under the condition of the saturation. The kind of circuit we mention here will be in common with a transistor saturation type, and a clamp.

3・1 Common-emitter connection

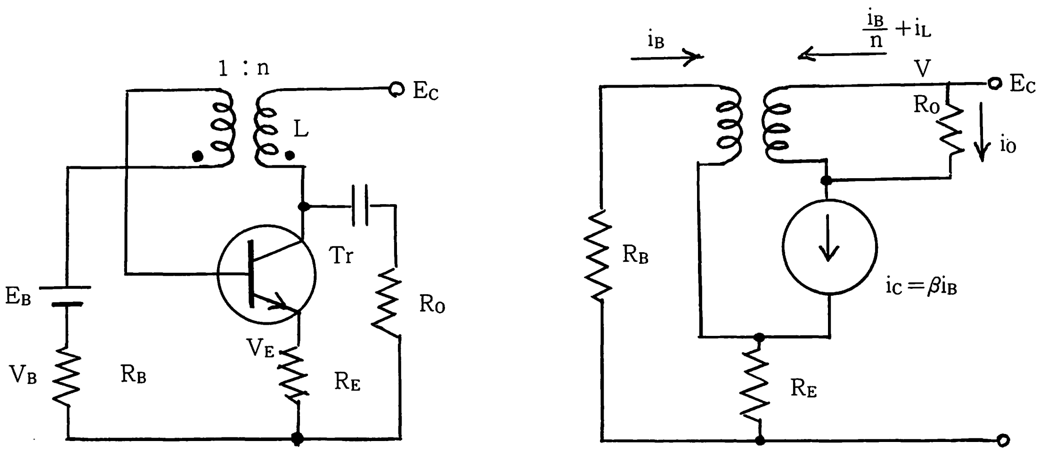

Fig. 2 Common-emitter connection and the equivalent circuit

This circuit is named β limit type, and is shown in Fig. 2. Although it may be correct that the internal. resistance of a transistor is contained to that of the outer circuit, since we give the enough larger one as the outer, the internal is canceled out. We assume that the pulse width τ is wider enough than the transistor storage time. Then

$$i_B=\frac{v/n}{R_B+R_E(1+\beta_s)} \quad (1)$$

where β_S = the value at the bottom condition when the transistor characteristics get out from the saturation region, that is, the value at the point which causes the reverse regeneration.

The primary voltage of the transformer is

$$v=L\frac{di_L}{dt} \quad (2)$$

where i_L = exciting current on the transformer
We can take the first approximation, if the exciting current increases linearly. Using the above condition,

$$v=L\frac{i_L}{t} \quad (3)$$

Reffering to the above equation, for the pulse width

$$i_L=\frac{v\tau}{L} \quad (4)$$

Since the bottoming is when the collector current i_C is equal to the $\beta_S i_B$,

$$i_C=\beta_S i_B=\frac{i_B}{n}+i_L+i_O \quad (5)$$

Substituting above two equations (3) and (4) into the equation (5),

$$\frac{\beta_S v/n}{R_B+R_E(1+\beta_S)}=\frac{v/n^2}{R_B+R_E(1+\beta_S)}+v\frac{\tau}{L}+\frac{v}{R_O},\qquad \tau=L\left\{\frac{1}{n^2}\cdot\frac{n\beta_S-1}{R_B+R_E(1+\beta_S)}-\frac{1}{R_O}\right\} \quad (6)$$

Consequently above equation does not contain v_1 and have no connection with the source voltage. More we can now find the pulse width depends on the load. Output voltage at the collector side equals v, when the negative pulse appears. The voltage is then

$$v=E_C-i_E R_E-V_{CE(S)} \qquad (7)$$

Still more the output at the emitter is

$$V_E=i_E R_E$$

The voltage is here positive pulse. About the output of collctor side, in general, since the ringing oscillation by the leakage inductance and equivalent capacitance of the transformer will superpose on the output, it is desirable to use the output at the emitter terminal. In the above case, R_O in the equation (6) has only meaning of the dumping resistance. And we may cancel out this term, if it is not necessary to keep the dumping phenomena on the primary.

In practice, the quantities used in the blocking oscillator are

$L=16.7^{mH}$, $E_C=8.5V$, $E_B=2.5V$, $R_E=20\Omega$, $R_B=1K\Omega$, $R_O=3K\Omega$, $n=2$, $\beta_B\cong 100$

As stated, according to the experimental results, collctor voltage E_C little affected to the pulse width, but base voltage gives some influence on the width. More experimental pulse width is shown in reasonably good agreement with that of the equation (6) : theoretical value $\tau=0.27$ms, and the experimental $\tau=0.3$ms.

3・2 Common-base connection

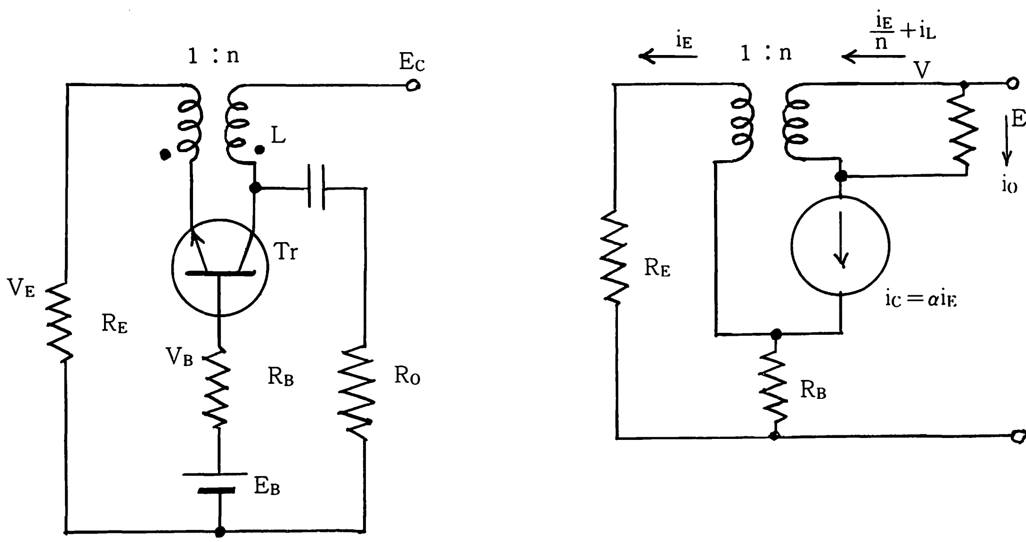

Fig. 3 Common-base connection and the equivalent circuit

This circuit is also called alpha limit. This connection being shown in Fig. 3, the analytical method is similar to that of the common emitter. The transistor casts off the saturation, emitter current decreasing gradually, and at last reverse regeneration will occur. If we put α_s as the h_{fb}, forward current gain parameter, in which comes about the regeneration, we have

$$i_E = \frac{v/n}{R_E + R_B(1-\alpha_S)} \quad (8) \qquad i_C = \alpha_S i_E = \frac{i_E}{n} + i_L + i_O$$

Using the equations (4) and (8), the pulse width is determined simply as

$$\tau = L\left\{\frac{1}{n^2}\cdot\frac{n\alpha_S - 1}{R_E + R_B(1-\alpha_S)} - \frac{1}{R_O}\right\} \quad (9)$$

The good agreement is also easily obtained in above case similarly to the common emitter. As the experiment,

$L = 16.7^{mH}$, $E_C = 9.5V$, $E_B = 4.0V$, $R_E = 30\Omega$, $R_B = 500\Omega$, $R_O = 3K\Omega$, $n = 2$, $\alpha_S \cong 0.9$, $\alpha_S = 0.99$ and the theoretical $\tau = 111.3\mu s$ and the experimental $\tau = 115\mu s$.

3・3 Common-collector connection

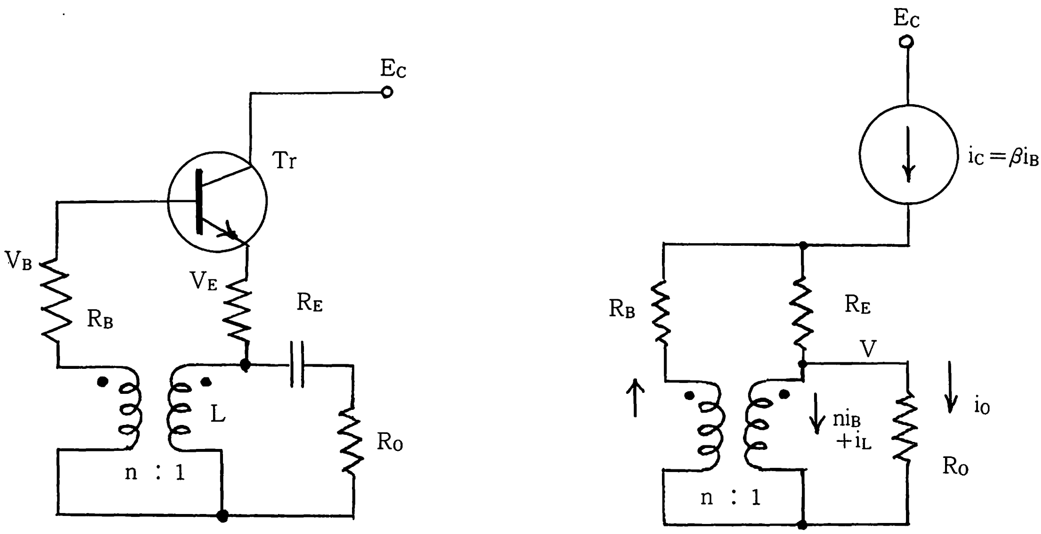

Fig. 4 Common-collector connection and the equivalent circuit

In the circuit shown in Fig. 4, taking the same method as was previously, it is found that

$$i_B = \frac{(n-1)v}{R_B + R_E(1+\beta_S)} \quad (10) \qquad i_E = (1-\beta_S)i_B = n i_B + i_L + i_O$$

Making the substitution of the equations (4) and (10) into the above equation, we have

$$\tau = L\left\{(n-1)\frac{\beta s + 1 - \frac{1}{n}}{R_B + R_E(1+\beta_S)} - \frac{1}{R_O}\right\} \quad (11)$$

We have not always the good agreement on the pulse width given by the theoretical and experimental value in the case : the value of the former is 0.499^{mS}, while the latter is 0.22^{mS}.

4 . Acknowledgement

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References

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2 . 小柴典居 “パルストランスと応用回路” 産報 (1973)