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Oscillation circuit and oscillator for use therein

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None

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Selected US
specifications from
IPC sub-class H03B

FIG. 1

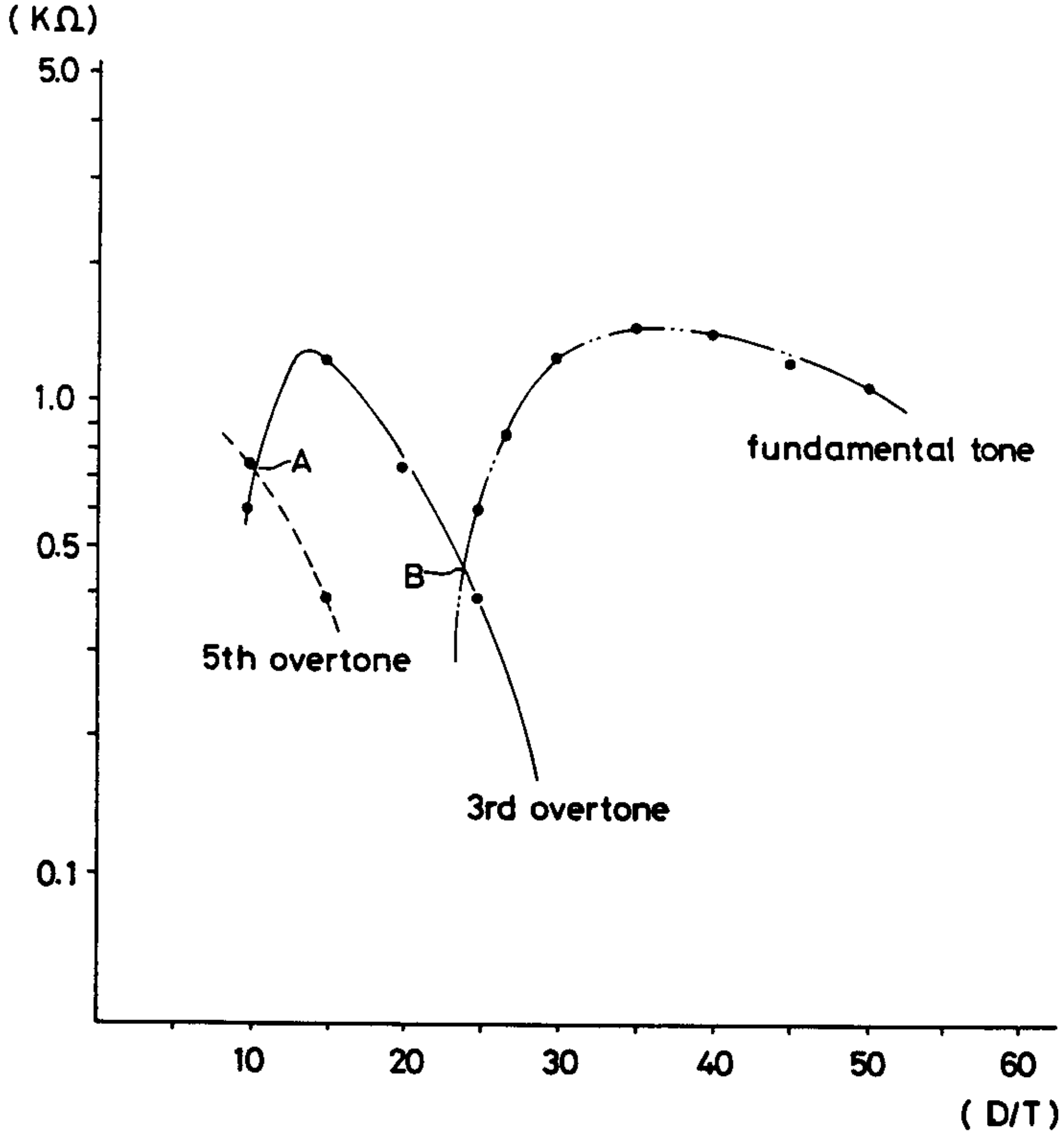


FIG.2

FIG.3

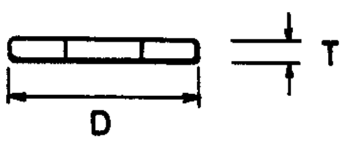


FIG.4

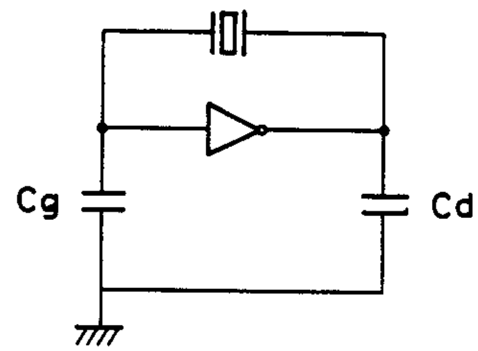

Cg
Cd

FIG.5

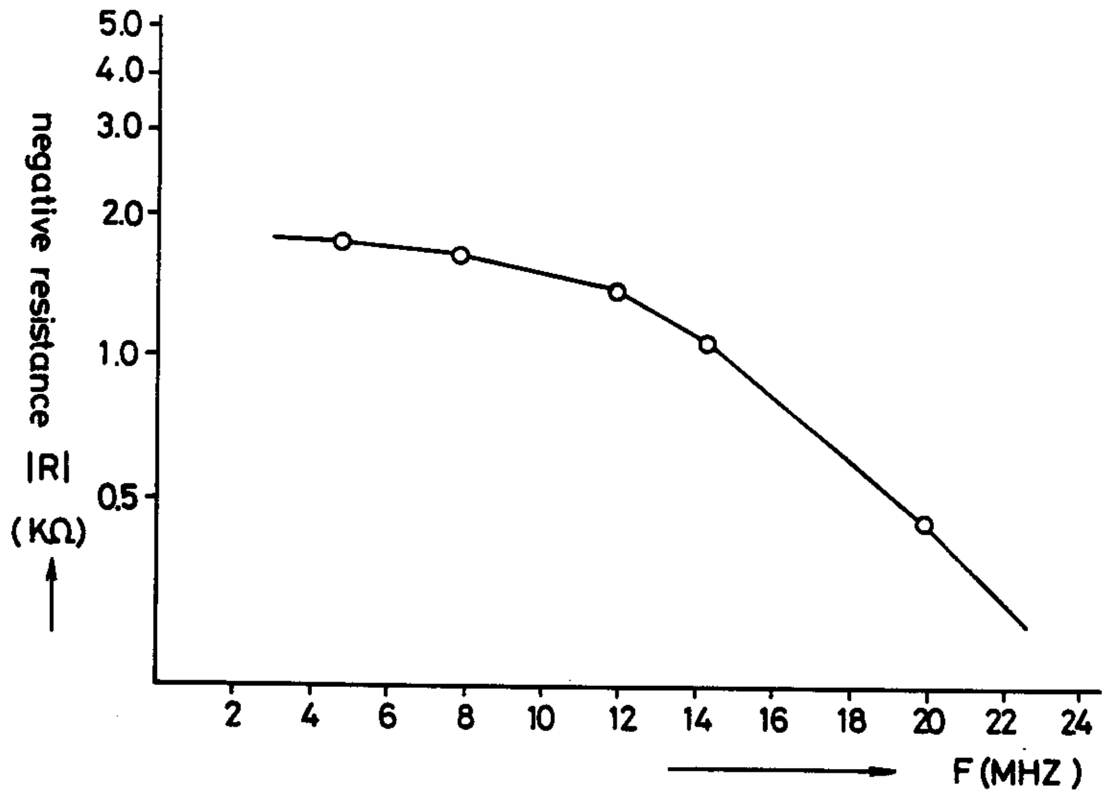

5.0
4.0
3.0
2.0
1.0
0.5
negative resistance |R| (KΩ)
2
4
6
8
10
12
14
16
18
20
22
24
F (MHZ)

FIG. 6

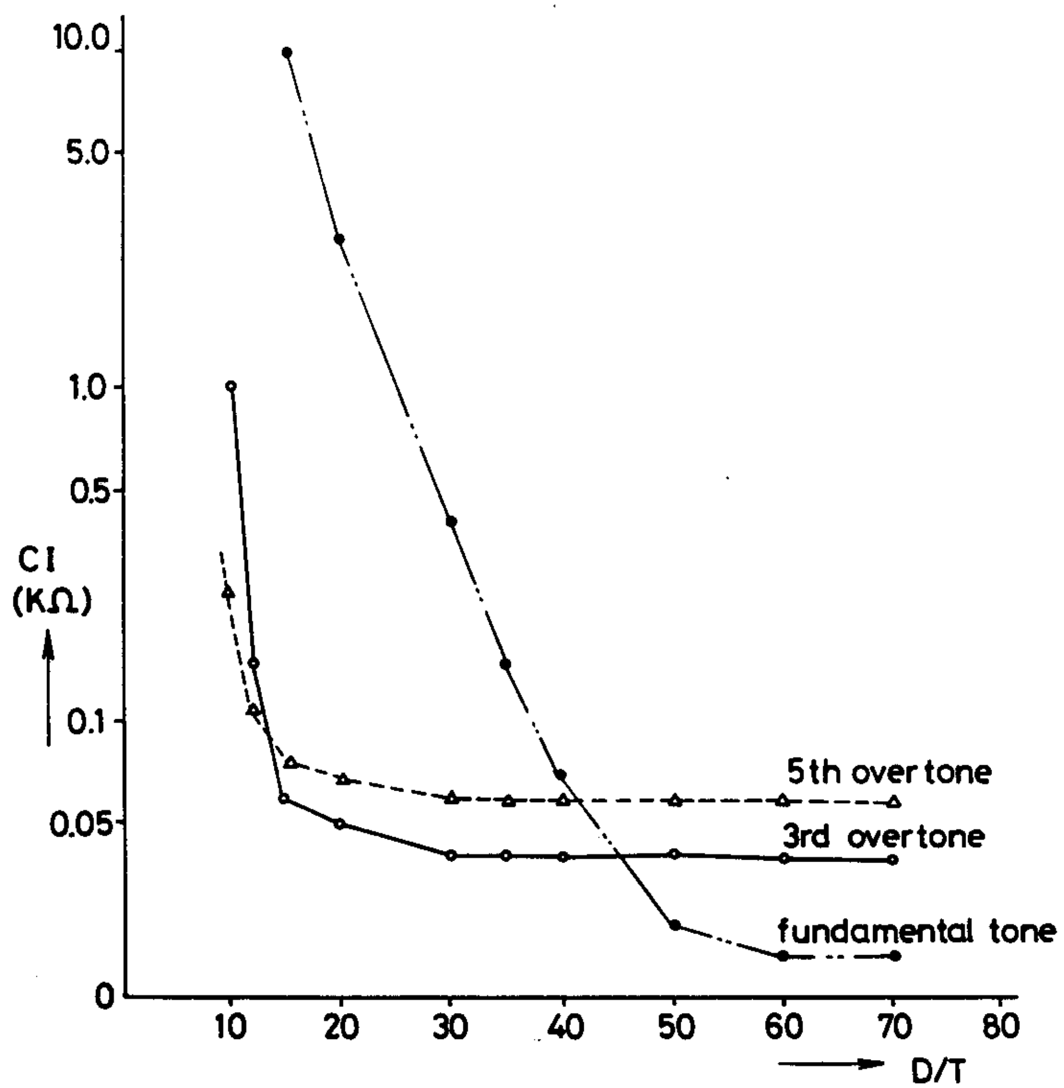

10.0
5.0
1.0
0.5
CI
(KΩ)
0.1
0.05
0
10
20
30
40
50
60
70
80
D/T
5th over tone
3rd over tone
fundamental tone

FIG. 7

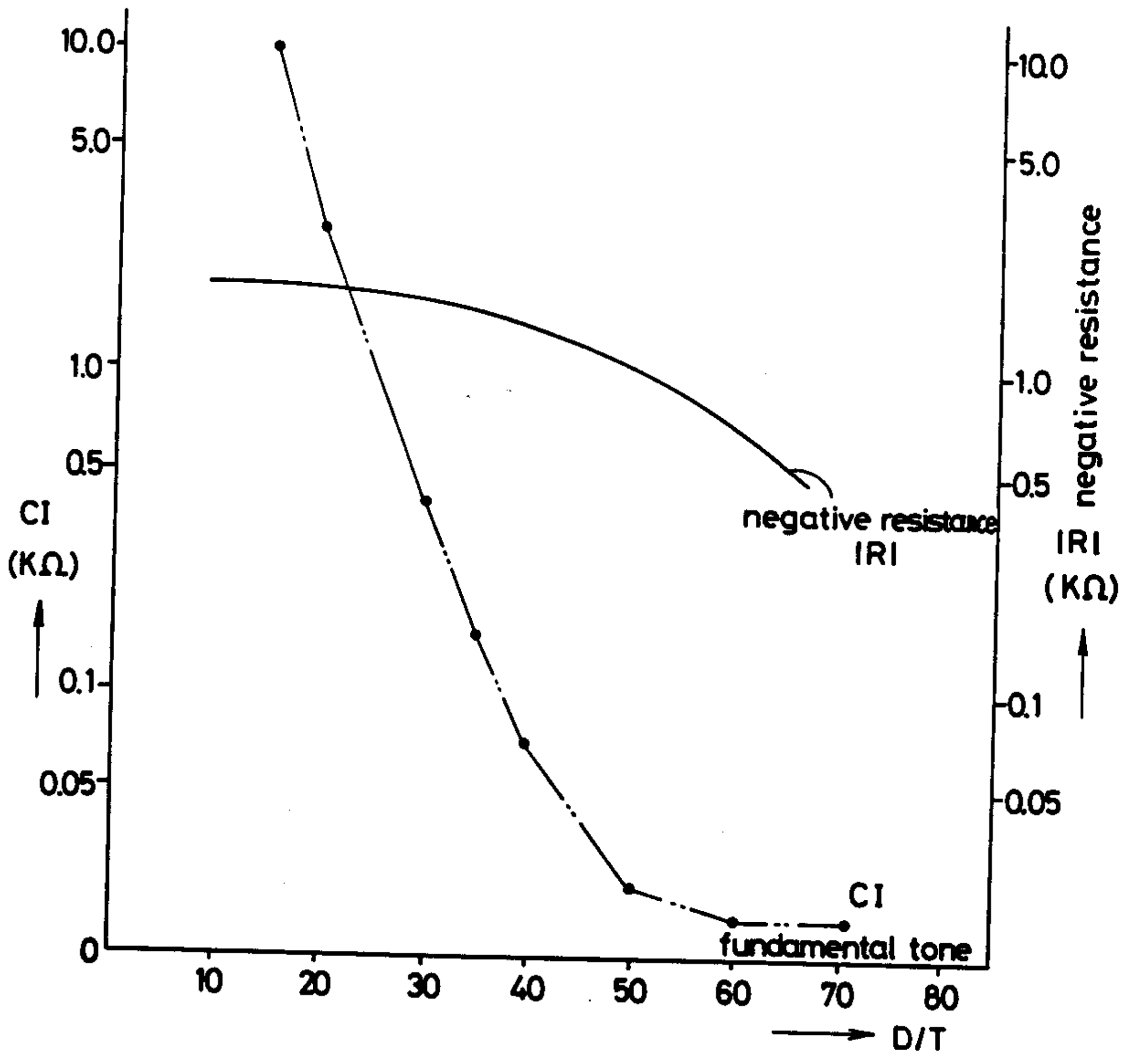

10.0
5.0
1.0
0.5
0.1
0.05
0
CI
(KΩ)
10.0
5.0
1.0
0.5
0.1
0.05
negative resistance
IRI
(KΩ)
negative resistance
IRI
CI
fundamental tone
10
20
30
40
50
60
70
80
D/T

FIG. 8

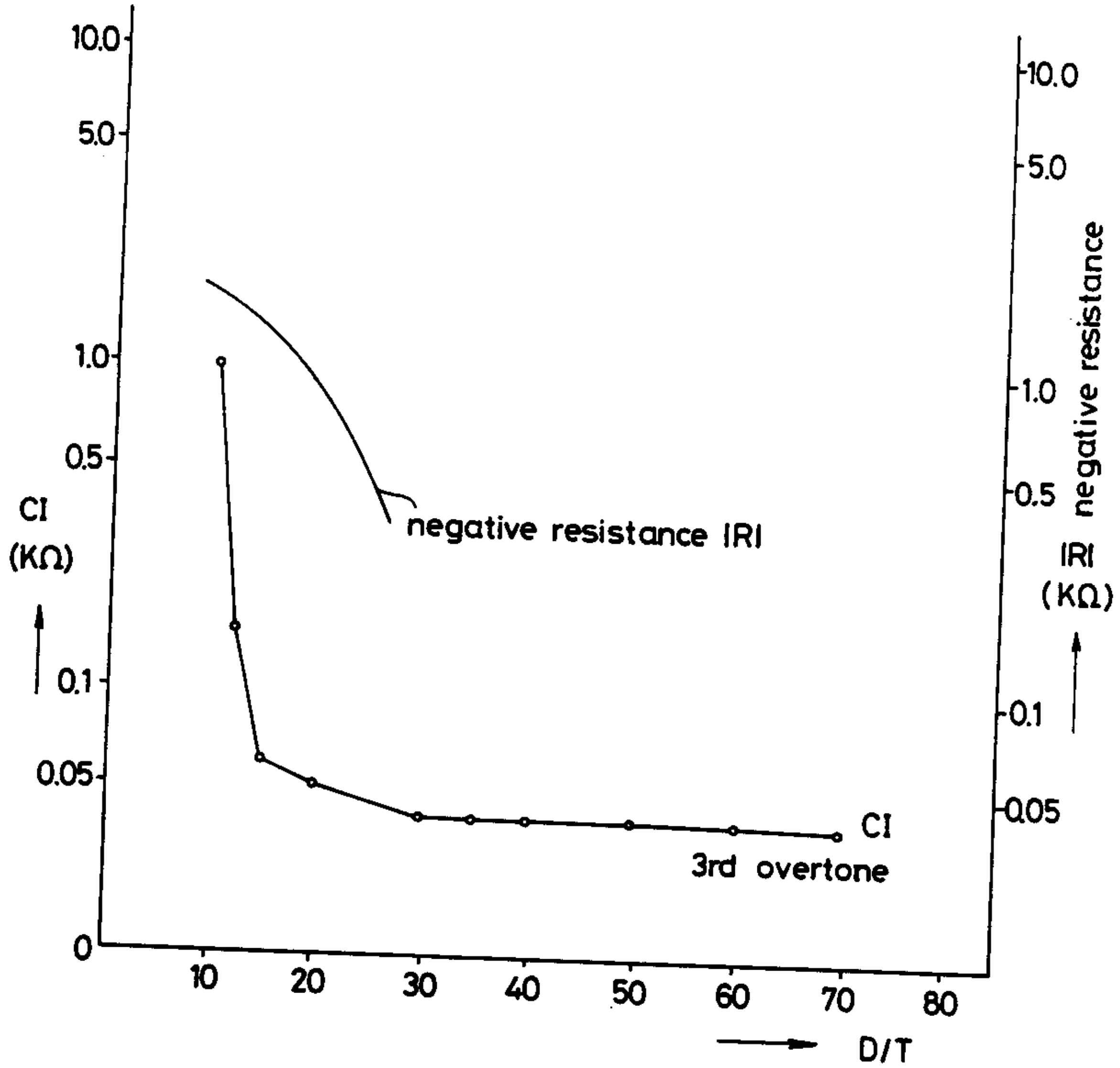
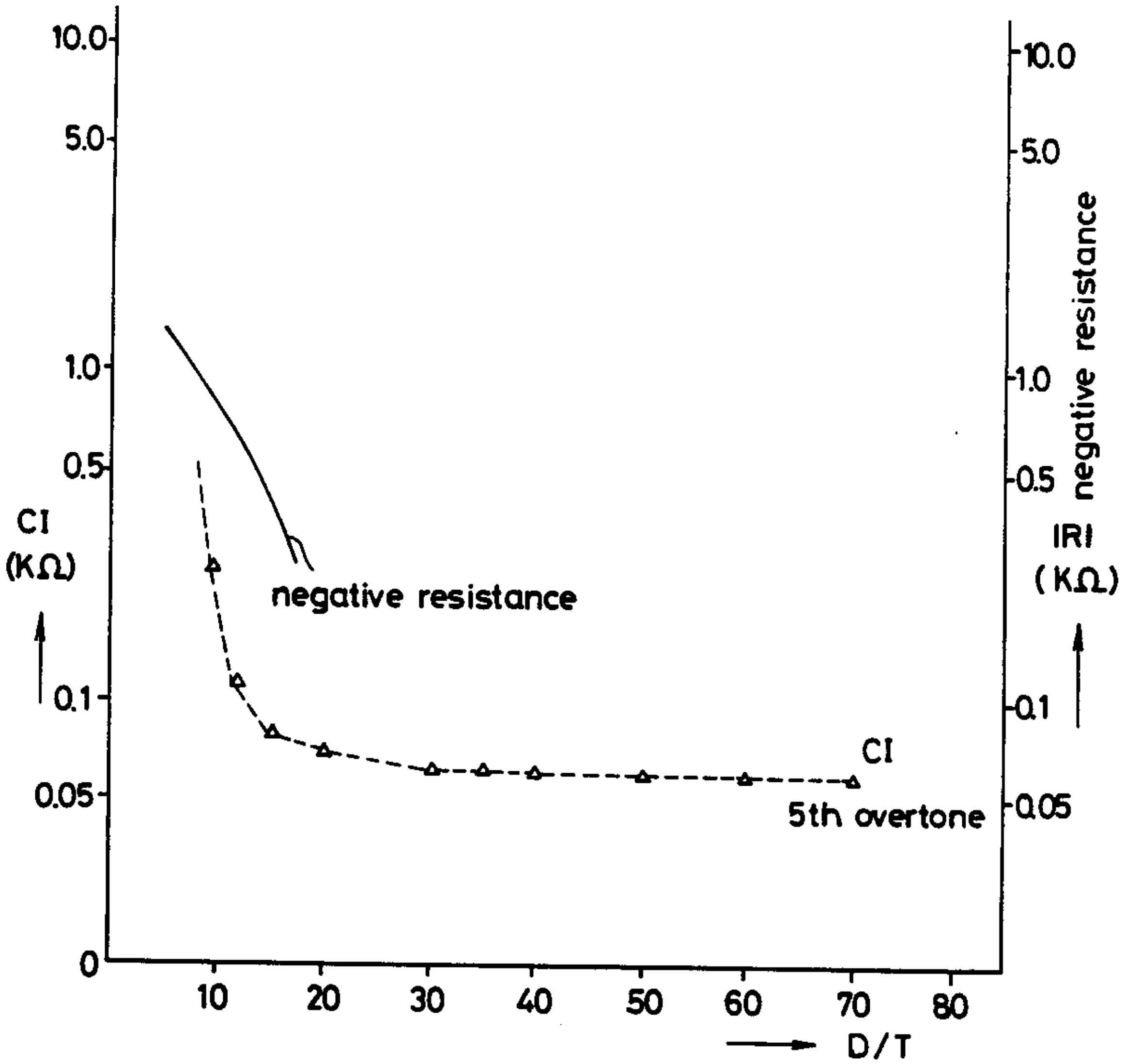

10.0
5.0
1.0
0.5
0.1
0.05
0
CI
(KΩ)
negative resistance IRI
negative resistance
IRI
(KΩ)
CI
3rd overtone
10
20
30
40
50
60
70
80
D/T

FIG.9


10.0
5.0
1.0
0.5
CI
(KΩ)
0.1
0.05
0
negative resistance
CI
5th overtone
10
20
30
40
50
60
70
80
D/T
10.0
5.0
1.0
0.5
0.1
0.05
negative resistance
IRI
(KΩ)

"OSCILLATION CIRCUIT AND OSCILLATOR FOR USE THEREIN"

This invention relates to an oscillation circuit in which is connected a planar thickness shear mode oscillator, such, for example, as an AT-cut quartz crystal oscillator, which is adapted to oscillate in the third overtone. The invention also relates to an oscillator for use in the said oscillation circuit.

It has been usual for a planar type thickness shear mode quartz crystal oscillator to have a relationship between its diameter (D) and its thickness (T) such that it oscillates at a fundamental tone or frequency. Commonly, this relationship ranges from D/T=50 to D/T = 100. The reason is as follows. The oscillation of a quartz crystal oscillator is determined by the difference between the negative resistance of an oscillation circuit in which the oscillator is connected and the crystal impedance of the quartz crystal oscillator, and the quartz crystal oscillator oscillates in an oscillation mode in which this difference is at its greatest. The negative resistance of the oscillation circuit tends to decrease as the frequency increases. In other words, the negative resistance decreases as the ratio D/T increases. On the other hand, the impedance of a quartz crystal oscillator shows a sharp decline as the ratio D/T increases, and, so far as impedances in all oscillation modes near or above D/T=45 are concerned, the impedance of the oscillator is at its lowest when it oscillates at its fundamental frequency. The characteristic curve of the negative resistance of an oscillation circuit varies according to the IC (integrated circuit) used in the oscillation circuit and the impedance of a quartz crystal oscillator changes with its diameter and other factors. The factors discussed above, however, exist fundamentally and the ratio D/T is usually arranged to be in the range from 50 to 100 so as to get stable oscillation at the fundamental frequency. Some known planar type quartz crystal oscillators are driven in the third overtone, but in such a case, their oscillation circuits are provided with tuning circuits composed of coils (L) and condensers (C).

In the prior art, as described above, very thin quartz plates having a diameter/thickness ratio $D/T=50 \sim 100$ are employed, but the oscillation of such quartz crystal oscillators is affected by the nature of their supporting means and it has been difficult to achieve high stable oscillation due to a decrease in the quality factor (Q). Further, such quartz crystal oscillators are so thin that their shock resistance is poor and they are liable to break. Further, in an oscillation device which is provided with a tuning circuit which employs L and C components for getting the third overtone, it is inevitable that the size of the device is large due to the tuning circuit, and especially because of the size of its coil (L), while the structure of the device is complex due to its large number of parts.

The object of the present invention is to provide a planar thickness shear mode oscillator which can be used in an oscillation circuit which does not comprise an L, C tuning circuit.

According to the present invention, there is provided an oscillation circuit in which is connected a planar, thickness shear mode oscillator which is adapted to oscillate in the third overtone, the ratio D/T of the diameter D to the thickness T of the oscillator being such that the difference between the impedance of the oscillator and the negative resistance of the oscillation circuit is greater in the third overtone than in other oscillation modes.

Preferably, the oscillator is a quartz crystal oscillator, e.g. an AT cut quartz crystal oscillator.

The oscillator may be substantially disc shaped. Moreover, an arcuate portion of the disc may be removed to lower its impedance in overtone oscillations.

The oscillator may be such that

$10 \leq D/T < 24$.

The invention also comprises a planar, thickness shear mode oscillator which is adapted to oscillate in the third overtone and which is adapted for use in the above-mentioned oscillation circuit, the ratio D/T of the diameter D of the oscillator to its thickness T being in accordance with the expression

$$10 < D/T < 24.$$

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a graph showing the relationship between the ratio D/T of a quartz crystal oscillator and the difference between the negative resistance of an oscillation circuit and the impedance of the quartz crystal oscillator in each oscillation mode,

Figure 2 is a plan view of a quartz crystal oscillator according to the present invention,

Figure 3 is an elevation of the quartz crystal oscillator of Figure 2,

Figure 4 is a diagram of an oscillation circuit which incorporates the oscillator of Figures 2 and 3 but which is not provided with an L, C tuning circuit,

Figure 5 is a grap showing the relationship between the frequency and the negative resistance of the oscillation circuit,

Figure 6 is a graph showing the relationship between a stable third overtone oscillator can therefore be obtained by arranging that the ratio D/T avoids such unstable regions.

The present invention thus enables the oscillation circuit to be composed of a small number of parts since it does not require an L, C tuning circuit, and the oscillation circuit can therefore be made small. SInce the quartz crystal oscillator oscillates in the third overtone, the capacitance of motion (Cm) can be made low and the influence of stray capacitance can be made small. Further, the quality factor Q can be made large and the oscillator can be arranged to perform high stable oscillation with excellent ageing characteristics. Furthermore, the oscillator can be made thicker than conventional oscillators so as to improve its shock resistance.

CLAIMS

1. An oscillation circuit in which is connected a planar, thickness shear mode oscillator which is adapted tc oscillate in the third overtone, the ratio D/T of the diameter D to the thickness T of the oscillator being such that the difference between the impedance of the oscillator and the negative resistance of the oscillation circuit is greater in the third overtone than in other oscillation modes.

2. An oscillation circuit as claimed in claim 1 in which the oscillator is a quartz crystal oscillator.

3. An oscillation circuit as claimed in claim 2 in which the oscillator is an AT cut quartz crystal oscillator.

4. An oscillation circuit as claimed in any preceding claim in which the oscillator is substantially disc shaped.

5. An oscillation circuit as claimed in claim 4 in which an arcuate portion of the disc shaped oscillator has been removed to lower its impedance in overtone oscillations.

6. An oscillation circuit as claimed in any preceding claim in which the oscillator is such that

$$10 < D/T < 24.$$

7. An oscillation circuit substantially as hereinbefore described with reference to the accompanying drawings.

8. A planar, thickness shear mode oscillator which is adapted to oscillate in the third overtone and which is adapted for use in the oscillation circuit claimed in claim 1, the ratio D/T of the diameter D of the oscillator to its thickness T being in accordance with the expression

$$10 < D/T < 24.$$

9. An oscillator as claimed in claim 8 in which the oscillator is a quartz crystal oscillator.

10. An oscillator as claimed in claim 9 in which the oscillator is an AT cut quartz crystal oscillator.

11. An oscillator as claimed in any of claims 8-10 in which the oscillator is substantially disc-shaped.

12. An oscillator as claimed in claim 11 in which an arcuate portion of the disc shaped oscillator has been removed to lower its impedance in overtone oscillations.

13. An oscillator substantially as hereinbefore described with reference to and as shown in Figures 2 and 3 of the accompanying drawings.

14. Planar type thickness shear mode quartz oscillator in which the proportion between the diameter and the thickness of the quartz oscillator is so designed that difference between impedance of the quartz oscillator and negative resistance of oscillation circuit for the quartz oscillator is greater in the third overtone than those in other oscillation modes.

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Oscillation circuit and oscillator for use therein

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