Douglas, Alan
The electronic musical instrument manual. Bl. 1-

Vorl. (MwJ.k.: Ds 54)

~~1954 London~~, 2. Aufl., S. 34-35.



if it were, i.e. if it contained exactly similar positive and negative loops, it could not contain even harmonics. The addition of the second harmonic has caused the centre of the wave to move slightly

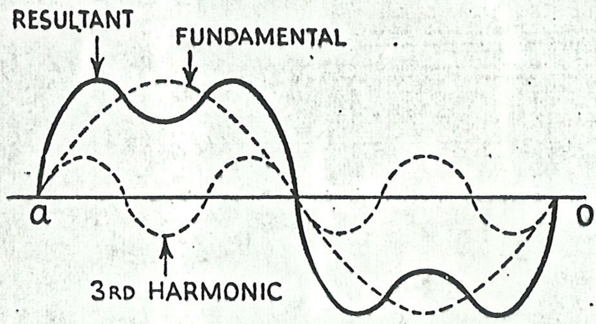


FIG. 21. ADDITION OF THIRD HARMONIC

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to the left, because this is the middle of a loop at second harmonic frequency.

Let us now see what happens if we add a third harmonic only

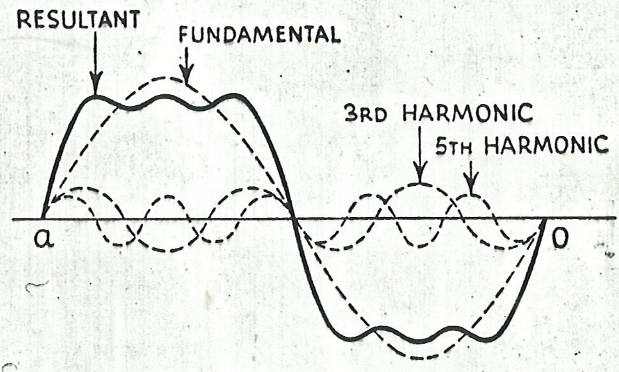


FIG. 22. ADDITION OF FIFTH HARMONIC

to the sine wave. The effect of this is shown in Fig. 21, from which it can be seen that the composite wave is now symmetrical in each half, and clearly this is because the third harmonic has a node at this point on the time base instead of a loop. The further effect of adding a fifth harmonic can be seen in Fig. 22.

If now we take a case where the frequency difference is much greater, and extend it to cover a series of waves, we can see the effect more clearly. Fig. 23 shows the composite wave form resulting



* bei Sign.-Änderungen auch Bl. für 1/32 berücksichtigen

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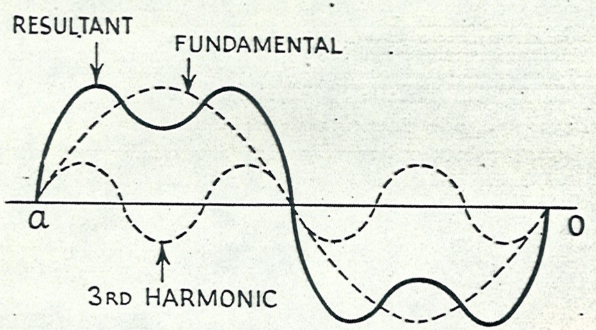


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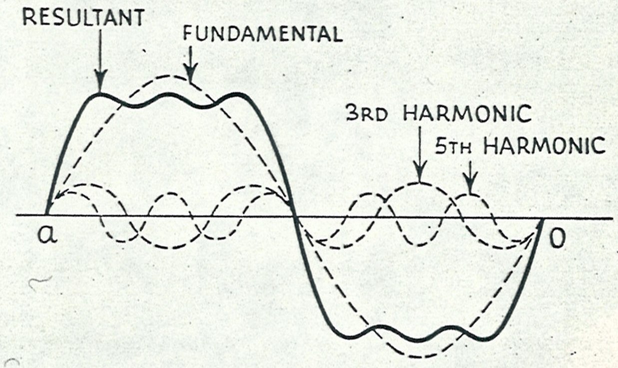


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from the addition of a fundamental frequency and another frequency of ratio $6\frac{1}{4}$ to 1. This is not a particularly musical sound.

It has previously been stated that the very rapid steeply fronted characteristic of a transient sound contains a wide band of frequencies. Such a wave form, if sustained for a time, might be

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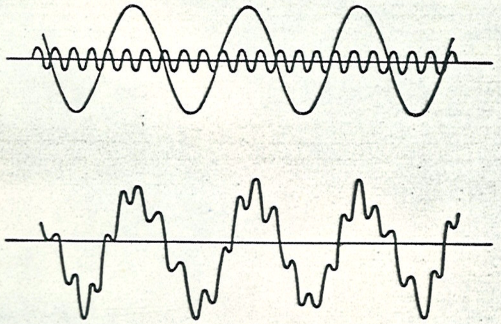

1 : 6

1 : 6¼
= 4 : 25

FIG. 23. ADDITION OF TWO WAVES OF WIDELY DIFFERING FREQUENCIES

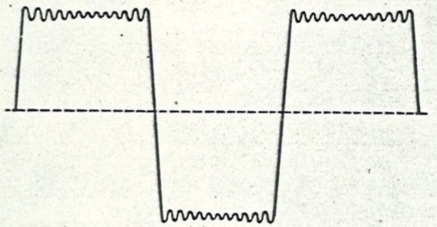

FIG. 24. FORMATION OF SQUARE WAVE FROM ODD HARMONICS

represented by Fig. 24. When the form shown is symmetrically repeated, this is known as a square wave. Its special property is that it contains only *odd* harmonics in addition to the fundamental. The square wave is exceedingly useful in musical synthesis, as all "hollow" sounding tones consist principally of odd harmonics. Several circuits for producing such wave forms either directly or from some other kind of wave are shown later in this chapter. The harmonic intensity of a symmetrical square wave is shown in Fig. 25.

A special case is shown in Fig. 26. If the mid-point of a string is stretched we obtain a "curve" with approximately straight sides. Nevertheless this can be resolved into its constituent harmonics and the analysis is shown in the figure. The height of the wave crests is exaggerated for clearness. As we have already seen, if the