April 19, 1932. W. A. FITCH 1,854,986

METHOD AND MEANS FOR PRODUCING HIGH FREQUENCIES

Filed May 17, 1930

Fig. 1.

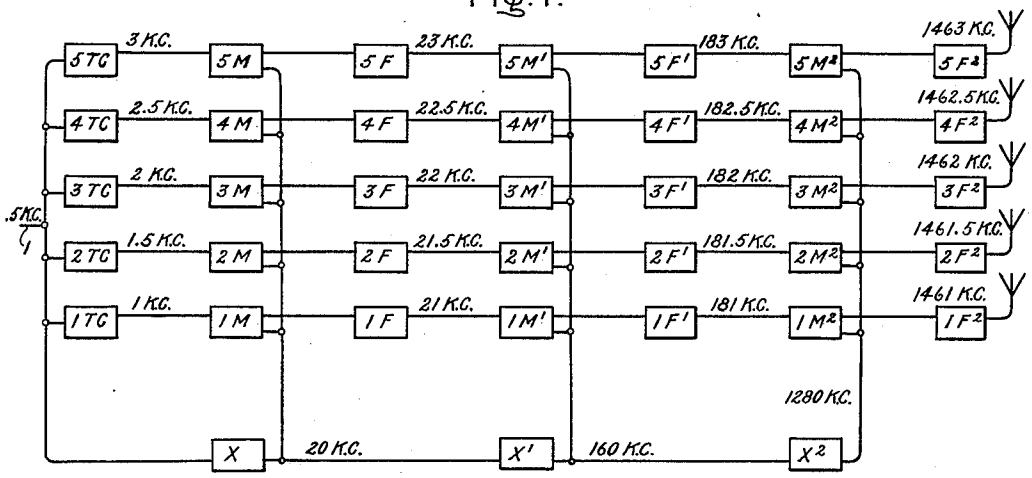
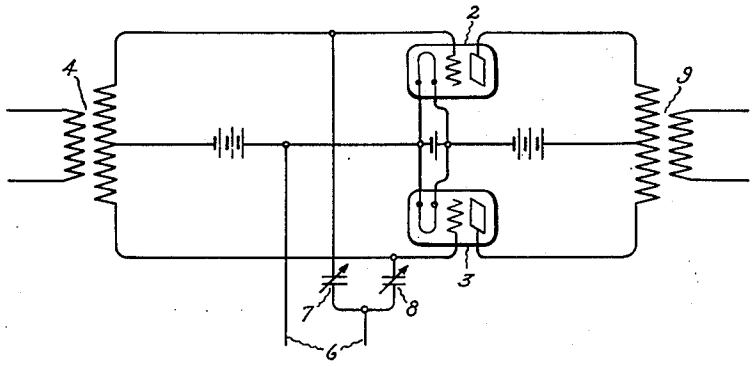


Fig. 2.



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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR PRODUCING HIGH FREQUENCIES

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My invention relates to a method and means for producing a plurality of high frequencies which are spaced apart in the frequency spectrum by fixed intervals and it has for one of its objects to produce an improved method and means whereby a plurality of fixed high frequencies may be produced, all of which may be included in a narrow portion of the frequency spectrum.

Another object of the invention is to provide a method and means whereby a plurality of frequencies spaced apart in a narrow range of the frequency spectrum may be produced from a common low base frequency without necessitating the use of expensive or sharply selective filters.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which Fig. 1 shows, by means of a single line diagram, an arrangement embodying my invention, and Fig. 2 represents a type of modulating means which may be advantageously employed.

In accordance with my invention, a source of low frequency oscillations, which I shall hereinafter term the base frequency, is employed as a means for synchronizing or maintaining the spacing in the frequency spectrum of the various high frequency waves which are to be produced. The desired high frequency waves are in fact developed from this common base frequency.

The system whereby the desired high frequency oscillations are thus developed comprises, briefly, a plurality of channels, corresponding in number to the number of different frequencies which are to be produced, these channels being indicated in the drawings by the coefficients of the legends applied to the rectangles thereof. Each channel is initiated by a low harmonic of the common base frequency, which frequency is modulated, in the first stage of the system upon a high harmonic of the base frequency and a desired side band selected. In the succeeding stage the selected side band in each channel is in turn modulated upon a higher harmonic of the base frequency and a side band is again selected, this process being repeated in successive stages until the desired frequencies are produced. Reference may be had to these stages of the system by the exponents of the legends applied to the drawings.

In the one line diagram shown in Fig. 1 it may be assumed that the low, or base, frequency source is connected to the conductor 1. The rectangles 1TC, 2TC, . . . 5TC represent a plurality of tuned circuits which operate in the nature of band pass filters to select from the oscillations supplied to the conductor 1 various low harmonics, or multiples, of the base frequency supplied to this conductor. Thus for example, if the base frequency is assumed to be 500 cycles or .5 K. C., as indicated in the drawings, the tuned circuit 1TC may be assumed to pass currents corresponding to the second harmonic of this frequency or currents of a frequency of 1 K. C. Similarly the circuits 2TC, 3TC, 4TC, 5TC pass frequencies of 1.5 K. C., 2 K. C., 2.5 K. C. and 3 K. C. respectively.

At X, X′ and X^2 I have represented a plurality of frequency multipliers, or harmonic generators, connected in cascade. These multipliers may be of any suitable construction, such for example as an electron discharge device having tuned grid and anode circuits, and having its grid and anode voltages so adjusted that it operates on a curved portion of the characteristic. These multipliers are so adjusted as to produce in their output circuits certain high harmonics of the base frequency. The fundamental frequency of .5 K. C. is supplied to the input of the first multiplier X. If we assume that this multiplier is arranged to produce the fortieth harmonic of the input frequency, oscillations will be produced in the output circuit having a frequency of 20 K. C. I have shown a plurality of modulators 1M, 2M, . . . 5M etc. connected to the output of the multiplier X, each of these modulators also being connected to a corresponding tuned

circuit TC. Thus the first high multiple of the base frequency is modulated by each of the low multiples of this base frequency.

These modulators, may of course, be of any suitable well known construction but advantageously are of the type shown in Fig. 2, comprising push pull connected electron discharge devices 2 and 3. In this modulator the low frequency multiple of the base frequency is supplied to the grids of discharge devices in opposed phase, as by means of the transformer 4, and the high frequency multiples are supplied to the grids in like phase, as by means of conductors 6 and coupling condensers 7 and 8. In the output circuit will appear oscillations having a frequency corresponding to the side bands, or to the sum of the two input frequencies and also oscillations corresponding to the difference of the two input frequencies. The high multiple frequency, or oscillations of the 20 K. C. frequency, will be eliminated in the primary winding of the output transformer 9.

I have shown a filter 1F, 2F, . . . 5F, etc., connected in each of the output circuits of the various modulators 1M, 5M, etc. These filters may be of any suitable low pass or high pass type but in conformance with the legends applied to the drawings these filters may be assumed to be of the high pass type and are so adjusted as to eliminate the lower side band or difference frequency which appears in the output circuit of each of the modulators. Thus in the output circuit of the different filters F will appear respectively, oscillations having the frequency 21 K. C., 21.5 K. C., 22 K. C., 22.5 K. C. and 23 K. C.

The multiplier X′ may be assumed to produce in its output circuit the eighth harmonic of the input frequency or 160 K. C. This frequency may then be modulated with each of the side band frequencies which appear in the output circuit of the filters F by means of modulators 1M′, . . . 5M′, etc. The filters F′ then again eliminate the lower side band or difference frequency resulting from this modulation, thereby producing in the output circuits oscillations having the frequencies 181 K. C., 181.5 K. C., 182 K. C., 182.5 K. C., 183 K. C., etc., respectively.

If we assume now that the multiplier X^2 produces the eighth harmonic of the input frequency, it will be seen that a frequency of 1280 K. C. is produced in its output circuit. This frequency may then be modulated by means of modulators M^2 with the frequencies appearing in the output circuits of the filters F′. In the output circuit of the modulators M^2 are shown filters F^2 which similarly eliminate the lower side band frequency. Thus in the output circuits of these filters are produced oscillations having frequencies of 1461 K. C., 1461.5 K. C., 1462 K. C., 1462.5 K. C., 1463 K. C., etc., respectively. These oscillations may then be supplied to suitable load circuits, which are indicated in the drawing as antennæ or employed in any manner desired.

While in the description given the filters F, F′ and F^2 are indicated as being adjusted to eliminate the lower side band frequency, it will of course be apparent that these filters may be arranged to eliminate the upper side band frequency, or a part of them may be adjusted to eliminate one side band and another part the other side band, as is desired in accordance with the frequencies which are to be produced. Further, while I have shown an arrangement which is particularly adapted for producing a plurality of frequencies relatively closely and equally spaced in the frequency spectrum, it will of course be apparent that by proper selection of the side band frequencies and the harmonic frequencies generated by the multipliers X, X′ and X^2, any desired frequency may be produced and these frequencies may be spaced apart in the frequency range as desired. Similarly if desired oscillations may be supplied from any stage of the system to suitable load circuits.

My invention possesses the advantage that notwithstanding the frequencies produced are relatively close together, the arrangement is such that the filters F, F′ and F^2 may be of any convenient construction and need not be of a kind which is sharply selective to certain frequencies to the exclusion of others. Thus for example in the output circuit of the filter 1M appear the two side band frequencies which are respectively 21 K. C. and 19 K. C. These frequencies are sufficiently spaced apart to be readily separable by means of an inexpensive filter. On the other hand were the 1 K. C. frequency modulated upon the 160 K. C. harmonic, an expensive filter would be required to separate the side bands. The side bands produced by the modulators 2M, 3M, 4M and 5M are still more widely spaced apart than those produced by modulator 1M. For the same reason the filters F′ and M^2 may be of a very inexpensive construction.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since many modifications may be made both in the circuit arrangement and in the instrumentalities employed. I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The method of producing a plurality of high frequency oscillations spaced apart in the frequency range by fixed intervals which includes producing oscillations having a low base frequency corresponding to the minimum interval between frequencies to be produced, producing a plurality of low

harmonics of said base frequency, producing a plurality of high harmonics of said base frequency spaced apart in the frequency range by wide intervals, modulating the lowest of said high harmonics with each of said low harmonics, selecting a side band frequency produced by modulating said lowest high harmonic with each of said low harmonics, modulating a higher one of said high harmonics with each of said side band frequencies and supplying to load circuits frequencies corresponding to the side band frequencies produced by said last modulation.

2. The method of producing a plurality of oscillations having different high frequencies spaced apart in the frequency range by fixed intervals which includes producing a plurality of oscillations having frequencies corresponding to certain low multiples of a common base frequency, producing a plurality of oscillations having frequencies corresponding to certain high multiples of said common base frequency, modulating oscillations having a frequency corresponding to the lowest of said high multiple frequencies with each of said oscillations having said low multiple frequencies, selecting desired side band frequencies resulting from said modulation and modulating oscillations having frequency corresponding to a higher multiple of said base frequency with each of said side band frequencies, whereby oscillations having frequencies corresponding to desired side band frequencies resulting from said last modulation are produced, said high multiple frequencies being so chosen with respect to said low multiple and side band frequencies as to permit efficient selection of desired side band frequencies resulting from each modulation.

3. The method of producing a plurality of oscillations spaced apart in the frequency spectrum by fixed intervals which includes producing a plurality of low harmonics of a base frequency, and a plurality of high harmonics of said base frequency, modulating the lowest of said high harmonics with each of said low harmonic, selecting desired side bands, and modulating each of the higher harmonics in succession with a side band produced by modulation of the next lower of said high harmonics, said high harmonic frequencies being so chosen with respect to said low harmonic and side band frequencies as to permit efficient selection of desired side bands resulting from the different modulations.

4. The combination, in a system for producing oscillations having a plurality of frequencies spaced apart in the frequency spectrum by fixed intervals, of a source of base frequency oscillations, means for producing a plurality of low harmonics, and a plurality of high harmonics of said base frequency, means for modulating the lowest of said high harmonics with each of said low harmonics, filtering means for selecting desired side band frequencies resulting from said modulation, means for modulating the next higher of said high harmonics with the selected side band frequencies and filtering means for selecting desired side bands resulting from said last modulation, the ratio between the frequency of each of said high harmonics and the frequencies with which it is modulated being sufficiently great to permit efficient selection of desired side bands by said filtering means.

In witness whereof, I have hereto set my hand this 16th day of May, 1930.

WILLIAM A. FITCH.