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ELECTRICAL WAVE PRODUCTION

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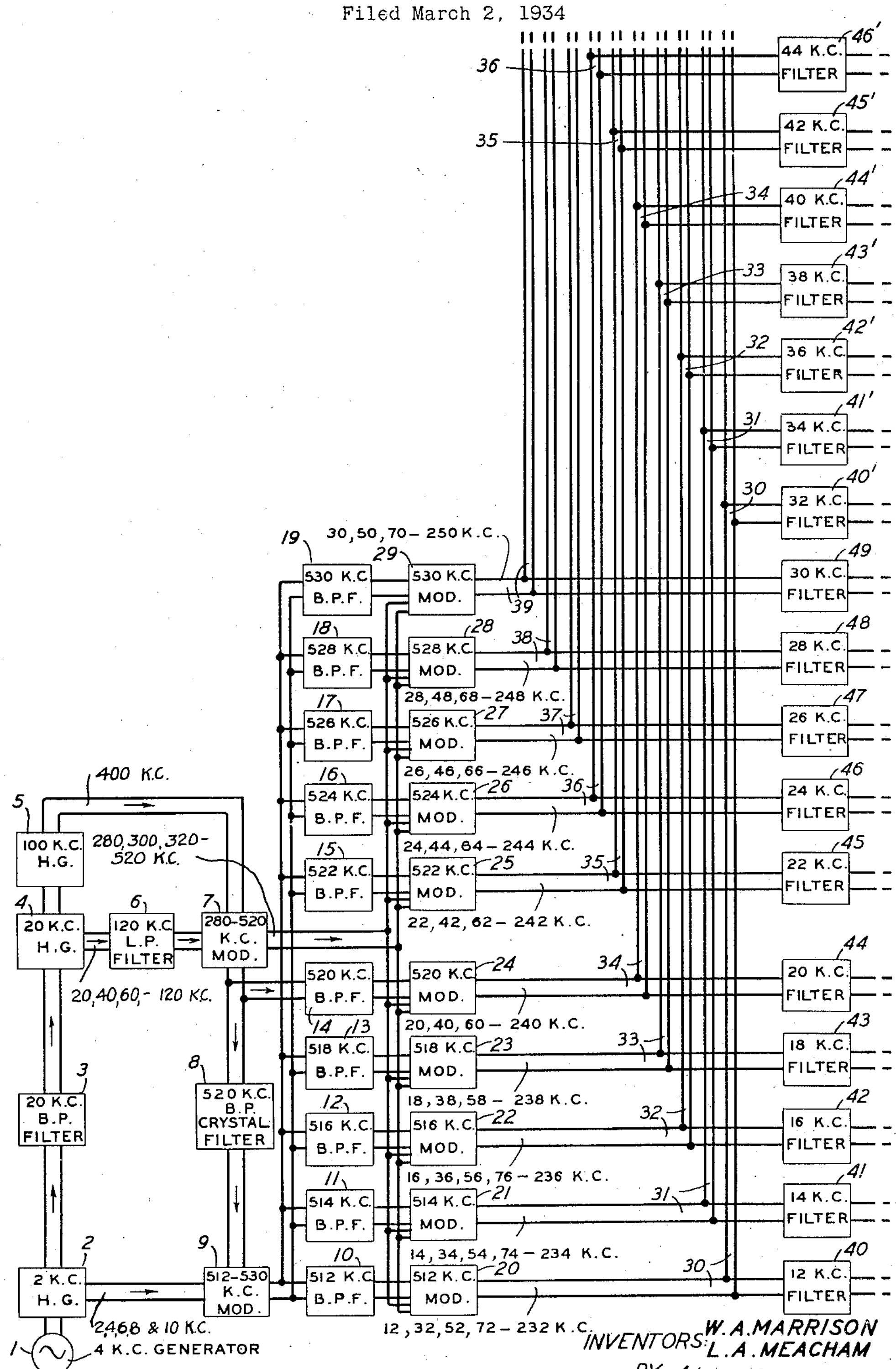

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ELECTRICAL WAVE PRODUCTION

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5 Claims. (Cl. 250—36)

The present invention relates to the production of a plurality of waves spaced in frequency and suitable for use, for example, as carrier waves in a multiplex signaling system although, of course, capable of other uses.

An object of the invention is the production of a large number of waves spaced in frequency with an economy in filtering circuits necessary for separation of the various wave components.

A further object is the production of a large number of waves spaced in frequency with a minimum production of spurious or unwanted frequencies.

A feature of the present invention is a circuit structure in which the waves as finally produced appear in a number of separate circuits with a frequency spacing sufficiently large to enable them to be separated readily. The final output waves which are close together in frequency are produced in different output circuits and do not need to be separated from one another by filtering means.

A more complete understanding of the invention together with its various objects and features will be had from the following detailed description when read in connection with the accompanying drawing in which the single figure shows in block diagram the circuit structure of a system according to the invention by which a large number of waves closely spaced in frequency are produced.

While the invention is of general application, its mode of application will be readily understood by considering a specific problem as outlined in the accompanying drawing. It is assumed for illustrative purposes that the problem is to produce a series of electrical waves with a spacing of 2 kilocycles beginning with a lower frequency of 12 kilocycles and extending to an upper frequency of 250 kilocycles per second, as indicated by the final output filters 40, 41, 42, 43, etc. shown at the right-hand side of the figure. It is further assumed that these waves are to be produced from a single originating source shown at 1 in the lower left corner of the figure, this source comprising a 4 kilocycle generator of any suitable type for delivering a constant frequency wave.

The source of constant 4 kilocycle frequency waves 1 leads to a harmonic generator 2 which may be conveniently of the multi-vibrator type of circuit well known in the art and which produces in its two output circuit branches a 2 kilocycle frequency and multiples thereof. The tenth multiple or 20 kilocycles is selected by filter 3 and impressed on the harmonic generator 4 which is shown provided with two output branches, one leading to harmonic generator 5 and delivering thereto a wave of 100 kilocycles, the fourth multiple of which is supplied to one input branch of modulator 7. The other branch from harmonic generator 4 delivers multiples of 20 kilocycles up to and including 120 kilocycles through the low pass filter 6 to the second input branch of the modulator 7. Modulator 7 produces upper and lower sidebands resulting from the modulation of the 400 kilocycle component with the 20, 40–120 kilocycle components from filter 6, these sidebands representing components extending from 280 to 520 kilocycles with a 20 kilocycle spacing between components. The output of this modulator 7 is supplied in multiple to each of the ten modulators 20 to 29 inclusive.

Another branch from the output of modulator 7 supplies a 520 kilocycle component to each of two filters 8 and 14. Filter 8 is preferably a band pass filter of the crystal type with a highly selective narrow band characteristic such that the 520 kilocycle component is effectively separated from all of the other components and applied to the modulator 9 where it is combined with multiples of 2 kilocycles from the harmonic generator 2. The resulting 512, 514–530 kilocycle components are utilized. These are supplied in multiple to the ten filters 10 to 19 inclusive, which are sharply selective band pass filters preferably of the type including a crystal so that each of the ten 512, 514–530 kilocycle component is effectively isolated from all of the others present. The filters 10 to 19 which have to meet the most rigid requirements that are placed on any of the filters of the system do not need to be as complicated as might be expected. For example, applicants have found that a filter comprising one crystal in series in the circuit with a shunt arm on one or both sides of the crystal, comprising a condenser, is capable of discriminating between 520 and 522 kilocycle waves with a discrimination of the order of 20 or 25 decibels. Each of the modulators 20 to 29, inclusive, is therefore supplied with a substantially pure wave of a single frequency, namely 512 kilocycles, 514–530 kilocycles, respectively.

Consider now the modulator 23, by way of example. This modulator has applied to it a substantially pure wave component of 518 kilocycles together with thirteen different frequency components extending from 280 to 520 kilocycles inclusive with a spacing of 20 kilocycles, these components being derived, as previously stated, from modulator 7. Considering only the lower sideband components resulting from the action of modulator 23, the highest of these output components is obtained by subtracting 280 from 518 kilocycles which gives 238 kilocycles. The lowest of the output components (neglecting the 2 kilocycle component which is not used) is found by subtracting 500 from 518 kilocycles making an 18 kilocycle component. Other components between these extremes are obtained at frequency intervals of 20 kilocycles. The output leads from modulator 23 are shown multipled to two filters 43 and 43', the former of which is selective to the 18 kilocycle component and the latter to the 38 kilocycle component. It will be understood that these leads are multipled to other filters similar to 43 and 43', but not shown in the drawing, these other filters being selective, respectively, to 58, 78–238 kilocycles, respectively.

In similar manner modulator 24 has applied to it a 520 kilocycle component from filter 14 (in this case) and a series of waves from the output of modulator 7 comprising components 280 to 520 kilocycles with 20 kilocycle spacing. The lower sideband components in the output of modulator 24 comprise, therefore, the components 20, 40, 60–240 kilocycles which appear in the output leads 34. These leads are shown multipled to a 20 kilocycle filter 44 and a 40 kilocycle filter 44' and it will be understood that they are also multipled to other filters not shown in the drawing but selective to the other frequencies present in these leads.

In similar manner each of the modulators 20 to 29, inclusive, has applied to its input a single high frequency component and a series of lower frequency components whereby there are produced in the output of each modulator a series of wave components 20 kilocycles apart. It will be noted that the filters connected to any one modulator output branch such as 33 have a very low requirement placed upon them since they only need to separate between frequencies 20 kilocycles apart, the highest of which is 250 kilocycles. In the most severe case this represents a separation between components that are spaced apart by about 10% of the frequencies in question, a requirement easily met by a simple and economical type of filter design. Thus, in the example given 120 wave components extending from 12 to 250 kilocycles with a 2 kilocycle spacing are obtained by a circuit arrangement in which the minimum frequency separation required by the final output filters is 20 kilocycles.

The ten filters 10 to 19, inclusive, which are required to have high discrimination are few in number, representing in the illustration given less than 10% of the number of the final output filters.

By utilizing only the lower frequency sideband resulting from each of the modulators 20 to 29, inclusive, all interference from harmonics of the input waves is avoided. For example, the lowest input component frequency is 280 kilocycles, whereas it will be noted that the highest frequency utilized is 250 kilocycles so that no interference from the 280 kilocycle wave or a harmonic of it or any other input component is possible.

It will be obvious from the example that has been given that the principle of the invention can be extended to cover widely different frequencies and arrangements from those illustrated and described. The magnitudes given are typical and practicable for supplying carrier waves to an actual carrier signaling system such as a carrier telephone system, but it will be understood that the specific frequencies mentioned and also the actual number of filters, modulators, etc. to be employed in any given system can be varied widely to suit requirements and the values that have been given are to be taken as illustrative and not as limiting.

What is claimed is:

1. The method of producing a number of waves spaced in frequency comprising producing a series of waves with a greater frequency interval than that of the desired waves, producing a second series of waves of higher frequency than the first series and with the desired frequency spacing, and modulating each of the latter waves by a plurality of the former to produce waves of the desired frequencies.

2. The method of producing a number of waves spaced in frequency comprising producing a series of waves with a greater spacing than that of the desired waves, producing a second series of waves of higher frequency than the first series and with the desired frequency spacing, separating the latter waves into separate circuits, modulating each of the waves so separated by a plurality of waves of the first mentioned series to produce lower sideband waves of the desired frequencies, and separating the resulting waves.

3. In a system for producing waves of spaced frequencies, means to produce a first series of waves with a greater frequency spacing than that of the desired waves, means to produce a second series of waves of higher frequency than the first series and with the desired frequency spacing, and means to modulate each of the latter waves with a plurality of the waves of the first series to produce resultant waves of the desired frequency and frequency spacing.

4. In a wave producing system, a plurality of modulators, circuits applying to one modulator a high frequency wave and a series of lower frequency waves spaced in frequency to produce resultant lower sideband waves of the same frequency spacing but lower than said high frequency, circuits supplying to a second modulator said series of waves and a second high frequency wave spaced in frequency from said first high frequency wave by less than the spacing of said series of waves to produce resultant lower sideband waves overlapping in frequency the first mentioned lower sideband waves, and means on the output side of each modulator for selecting the different resultant waves.

5. In a wave producing system, a master source of waves of given frequency, a first wave translating circuit for producing under control of said source a certain series of waves spaced in frequency, a second wave translating circuit for producing under control of said source a second series of waves more closely spaced and of higher frequency than the first series, and means to modulate each of said latter waves by a plurality of said first series of waves to produce waves having frequencies lower than either series and with the spacing of said second series.

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