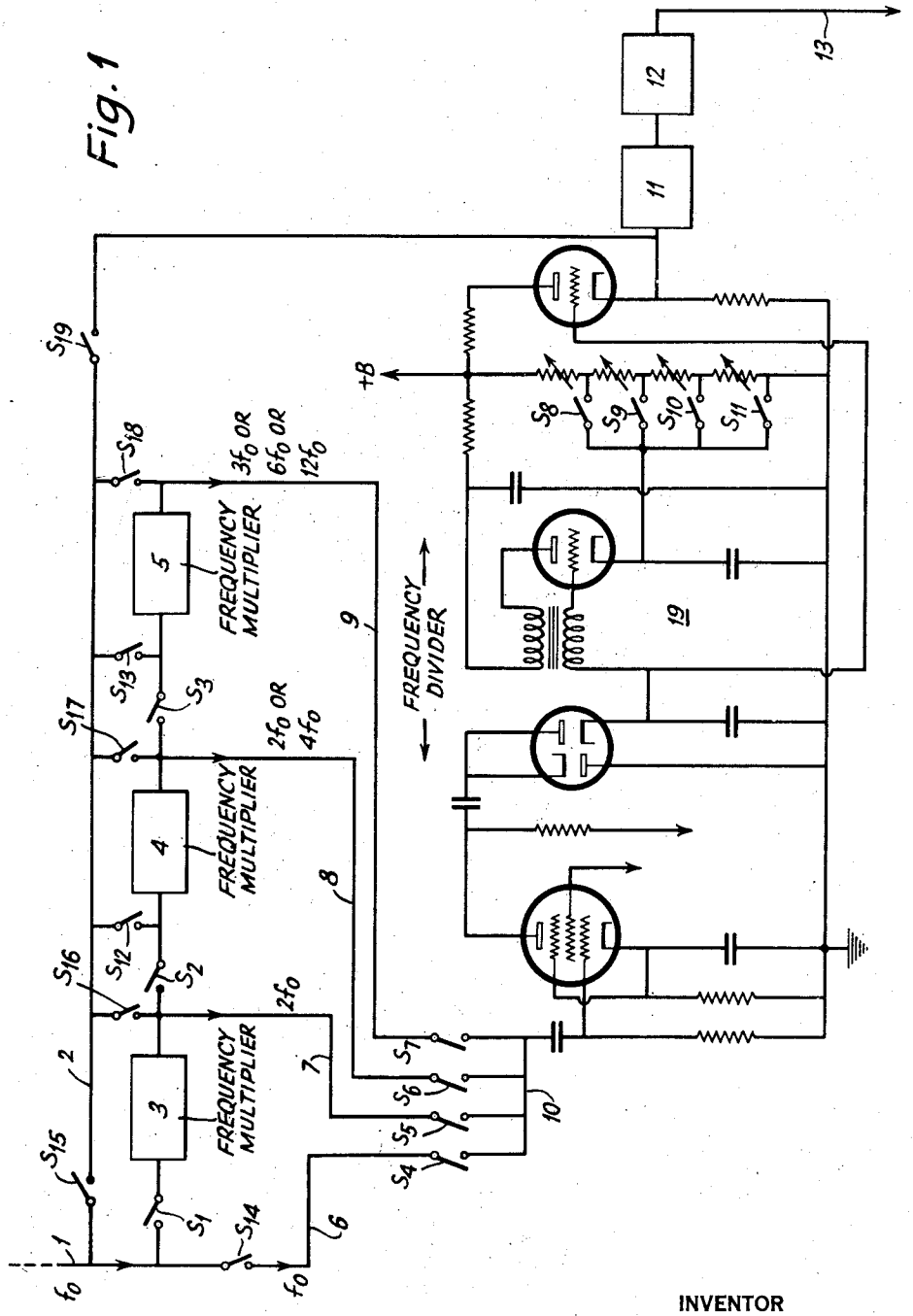
Aug. 1, 1944. H. B. DEAL 2,354,800

MULTIPLE FREQUENCY SOURCE

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Fig. 1




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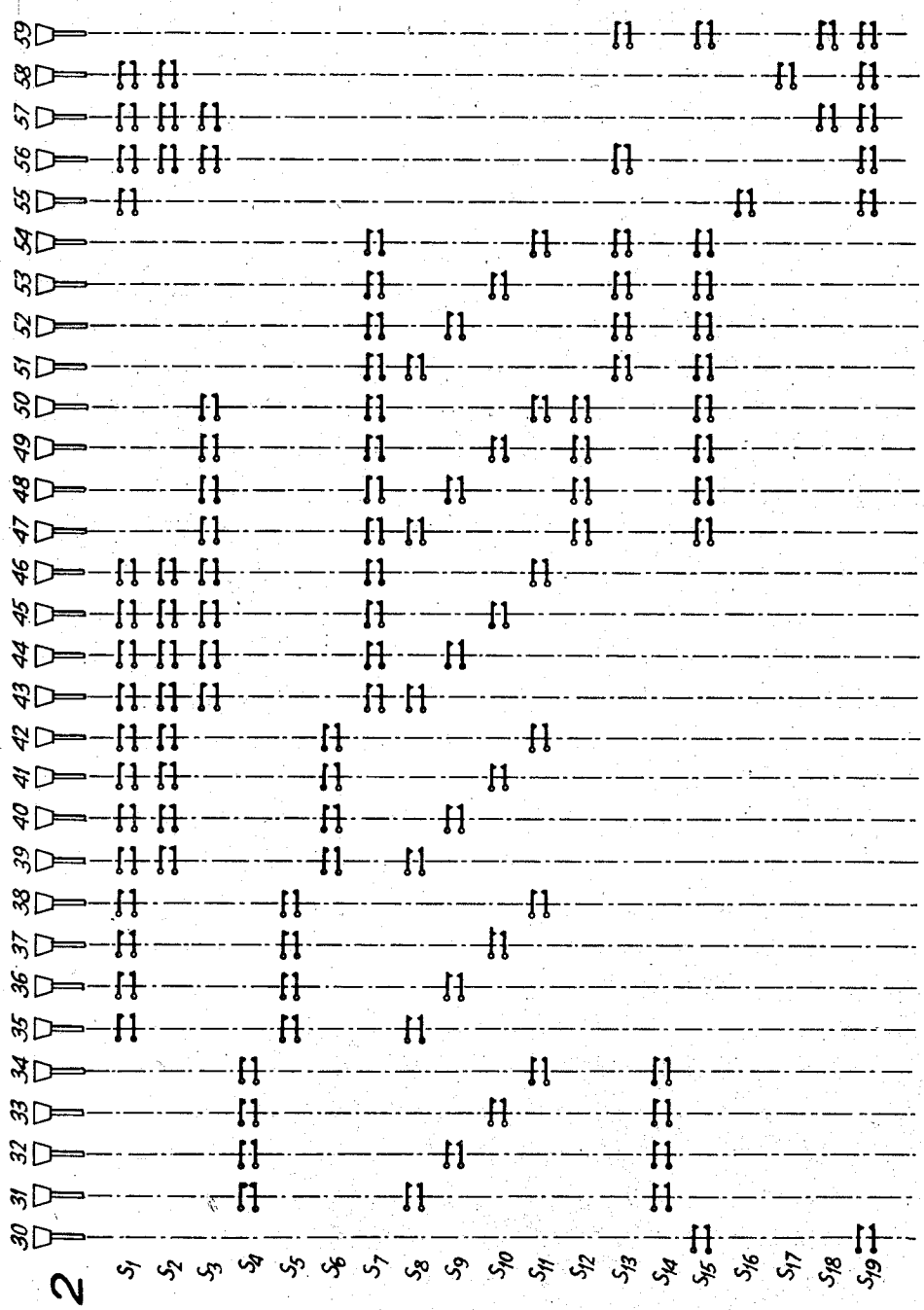



Fig. 2

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# UNITED STATES PATENT OFFICE

2,354,800

## MULTIPLE FREQUENCY SOURCE

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Application August 7, 1941, Serial No. 405,758

1 Claim. (Cl. 250—36)

The present invention relates generally to an arrangement for producing a plurality of different frequencies from a single master frequency.

More particularly, the invention provides means for producing a plurality of stable frequencies from a standard frequency which may be a crystal controlled oscillator or the sixty-cycle current which is usually available in a commercial light and power supply network. In the latter case it is possible to take advantage of the frequency constancy of the usual commercially available light and power supply current and to utilize it for producing various control frequencies.

It is often desirable and sometimes essential to be able to generate or produce one or more stable control frequencies for use in controlling the operation of one or more remotely situated devices. One such instance arises in the type of systems shown and described in my United States Patent 2,340,798, which was granted February 1, 1944, wherein there is described a system for controlling the operation of a radio receiver and/or the operation of an alarm device by means of control frequencies which are used to modulate the carrier of a broadcasting station and are thereby transmitted to the remote point.

Briefly, according to the present invention, there is obtained from a single master frequency, a plurality of frequencies by acting upon the master frequency by multiplication and/or division and thereby produce frequencies which may or may not be integrally related to the master frequency. This object of the invention may be attained by utilizing through the operation a selectively operable device combination of a relatively few multiplication values and/or a relatively few division values and obtaining therefrom a relatively large number of frequencies. The various frequencies are selected preferably by changing one or more of the multiplication ratios and/or one or more of the division ratios. A particularly important feature of the invention is that the various different frequencies may be obtained without the use of selective circuits.

The invention may be more readily understood and carried into effect by considering the following detailed description thereof and the accompanying drawings.

In the drawings:

Figure 1 illustrates in schematic form a preferred circuit arrangement for producing a plurality of different frequencies from a single master frequency in accordance with the present invention; and

Figure 2 illustrates in diagrammatic form a push button manual for the arrangement shown in Figure 1.

Referring more particularly to Figure 1 of the drawings, the standard frequency is referred to as $f_0$ and may be impressed upon the line 1 by connection of line 1 to any suitable source such as to a commercially available sixty-cycle current power supply network or a crystal controlled oscillator. Line 1 may be connected to line 6 through a circuit including an operable switch $s_{14}$ which, when closed, connects line 1 to line 6. Line 1 is also connected to the input of a frequency multiplier 3, which may be a frequency doubler, through an operable switch $s_1$ arranged so that when switch $s_1$ is closed, the standard frequency on line 1 is fed to the input of frequency multiplier 3. Also, a connection including switch $s_{15}$ is provided between line 1 and an auxiliary line 2. The output of frequency multiplier 3 is connected to line 2 through a switch $s_{16}$ and to the input of a second frequency multiplier 4 which may also be a frequency doubler, if desired, through an operable switching device $s_2$. The input of frequency multiplier 4 may be connected also to line 2 through an operable switch $s_{12}$. It is seen, therefore, that the frequency multiplier 4 may have impressed upon its input, either the output from frequency multiplier 3 by closing switches $s_1$ and $s_2$, or the standard frequency energy from the line 1 by closing switches $s_{15}$ and $s_{12}$. The output of the frequency multiplier 4 is connected to the input of a third frequency multiplier 5 which, if desired, may be a frequency tripler, through an operable switch $s_3$. In addition, the input of the frequency multiplier 5 may be connected to line 2 through an operable switching device $s_{13}$. Accordingly, the input of frequency multiplier 5 may be connected to either the output of frequency multiplier 4 or to the line 1 depending upon whether switch $s_3$ is closed or switches $s_{13}$ and $s_{15}$ are closed.

The output of frequency multiplier 3 may be also connected to line 10, the latter connection being made through an operable switching device $s_5$. In addition, the output of frequency multiplier 4 may be connected to line 10, through an operable switching device $s_6$. The output of frequency multiplier 5 may be connected also to line 10 through an operable switching device $s_7$.

An operable switching device $s_4$ is provided between line 6 and line 10 and acts when closed to connect line 6 to line 10.

Furthermore, line 10 is coupled to the input of a frequency divider network 19. While any type of frequency divider network may be uti-

lized, I have found that a divider of the type disclosed in White, U. S. Patent No. 2,113,011, is admirably adapted for the present purposes. In view of the fact that the frequency divider is described in the above referred to patent, a detailed description thereof will not be given herein except to state that various divider ratios may be obtained with such a device by simply changing the ratio of impedances shown connected thereto through the selective operation of switches $S_8$, $S_9$, $S_{10}$, and $S_{11}$. These impedances are shown variable to permit adjustments. It is to be understood that other types of impedance elements may be employed if desired. The output of frequency divider **19** is connected to an amplifier **12** and, if desired, the connection may be made through a filter **11** which may be a low pass filter if it is desired, adjusted to prevent the passage of frequencies to the amplifier which are above a certain predetermined frequency.

A few of the various frequencies obtainable by an arrangement such as described above, assuming that frequency multipliers **3** and **4** are frequency doublers and that frequency multiplier **5** is a frequency tripler, are referred to below in connection with the operation of the switching devices.

Closure of switch $S_{14}$ impresses frequency $f_0$ on line **6**. Closure of switch $S_1$ makes available energy of double the standard frequency $f_0$ across the output of frequency multiplier **3**. This double frequency may be fed to the frequency divider network **19** by closing switches $S_1$ and $S_5$. Closure of switches $S_1$ and $S_2$ makes available across the output of frequency multiplier **4** energy having a frequency four times the standard frequency and this energy will be present on line **8** so that it may be fed to the frequency divider network **19** by closure of switch $S_6$. Closure of switches $S_1$, $S_2$ and $S_3$ makes available upon line **9** energy having a frequency which is twelve times the standard frequency. This frequency may be impressed upon the line **10** through closure of switch $S_7$. Closure of switches $S_{13}$ and $S_{15}$ impresses upon line **9** energy having a frequency which is three times the standard frequency. This energy may be impressed upon the line **10** by closure of switch $S_7$. To obtain energy having a frequency which is six times the standard frequency, it is simply necessary to close switches $S_{15}$, $S_{12}$ and $S_3$ and such frequency will be available upon line **9**, whereupon it may be fed to line **10** by closing switch $S_7$. The frequency of any energy impressed upon line **10** may be divided by the frequency divider **19**, the divider ratio being dependent upon which one of the switches $S_8$, $S_9$, $S_{10}$ and $S_{11}$ is closed. It should be understood that while only four of such switches have been shown, any number thereof may be provided and arranged so as to vary the ratio of the impedances and thereby adjust the divider **19** to produce substantially any desired divider ratio.

In the event that the arrangement herein described is to be used for signalling purposes such as described in my aforementioned Patent 2,340,798, line **13** may be connected through suitable circuits to a transmitter and the carrier of the transmitter may be modulated in accordance with any one of the control frequencies.

In arrangements of this type it is convenient to provide a push button manual arranged so that there will be a distinct selectively operable device for each particular frequency capable of being produced by the system and desired to be utilized. One such arrangement is shown in Figure 2 of the drawings wherein for purposes of illustration a plurality of selectively operable push buttons **30–59** inclusive, have been provided. As illustrated, push button **30** when depressed, closes switches $S_{15}$ and $S_{19}$. This will permit the standard frequency $f_0$ to be fed directly into the input of filter **11**. Depression of push button **31** causes closure of switches $S_{14}$, $S_4$, and $S_8$ thereby feeding the fundamental frequency or standard frequency through the frequency divider network **19** which is adjusted by closure of switch $S_8$ to provide a particular fraction of the standard frequency and feed it to the input of filter network **11**. Push button **32** when depressed, closes switches $S_{14}$, $S_4$ and $S_9$ which means that the fundamental frequency is fed to the frequency divider **19** and a fraction thereof determined by closure of switch $S_{19}$ is fed to filter network **11**. Depression of switch **33** closes switches $S_{14}$, $S_4$, and $S_{10}$ while closure of switch **34** closes switches $S_{14}$, $S_4$, and $S_{11}$. It is believed that the operation of the other push buttons shown in Figure 2 is self-explanatory. Considering Figure 1 again, it should be understood that any one of the switches shown therein may comprise, in fact, a plurality of switches in parallel so that closure of any one of the group produces the same effect as is produced by closure of any other of that group. For example, the switch $S_1$ shown in Figure 1 may comprise sixteen switches (as shown in Figure 2) all connected in parallel. Thus, in Figure 2 depression of any one of push buttons **35–46** and **55–58** all numbers inclusive, causes the closure of switch $S_1$ in Figure 1 thereby feeding the standard frequency to frequency multiplier **3**.

While the invention has been described in connection with a particular number of frequency multipliers and frequency dividers, it should be understood that their number and construction may be varied in any suitable manner within the scope of the appended claim.

What I claim is:

A multiple frequency source comprising a single master frequency source, a plurality of frequency multiplier circuits, an adjustable frequency divider circuit, and manipulative switching means including push buttons singly operable to control a plurality of switch points for adjusting said frequency divider circuit and for selecting a predetermined path through at least one of said multiplier circuits, thereby to obtain any one of a large number of output frequencies, said path being caused to extend from said master source through those of the multiplier and/or divider circuits which are to be utilized and to bypass the other circuits in accordance with the output frequency which is desired.

HARMON B. DEAL.