

April 30, 1940.

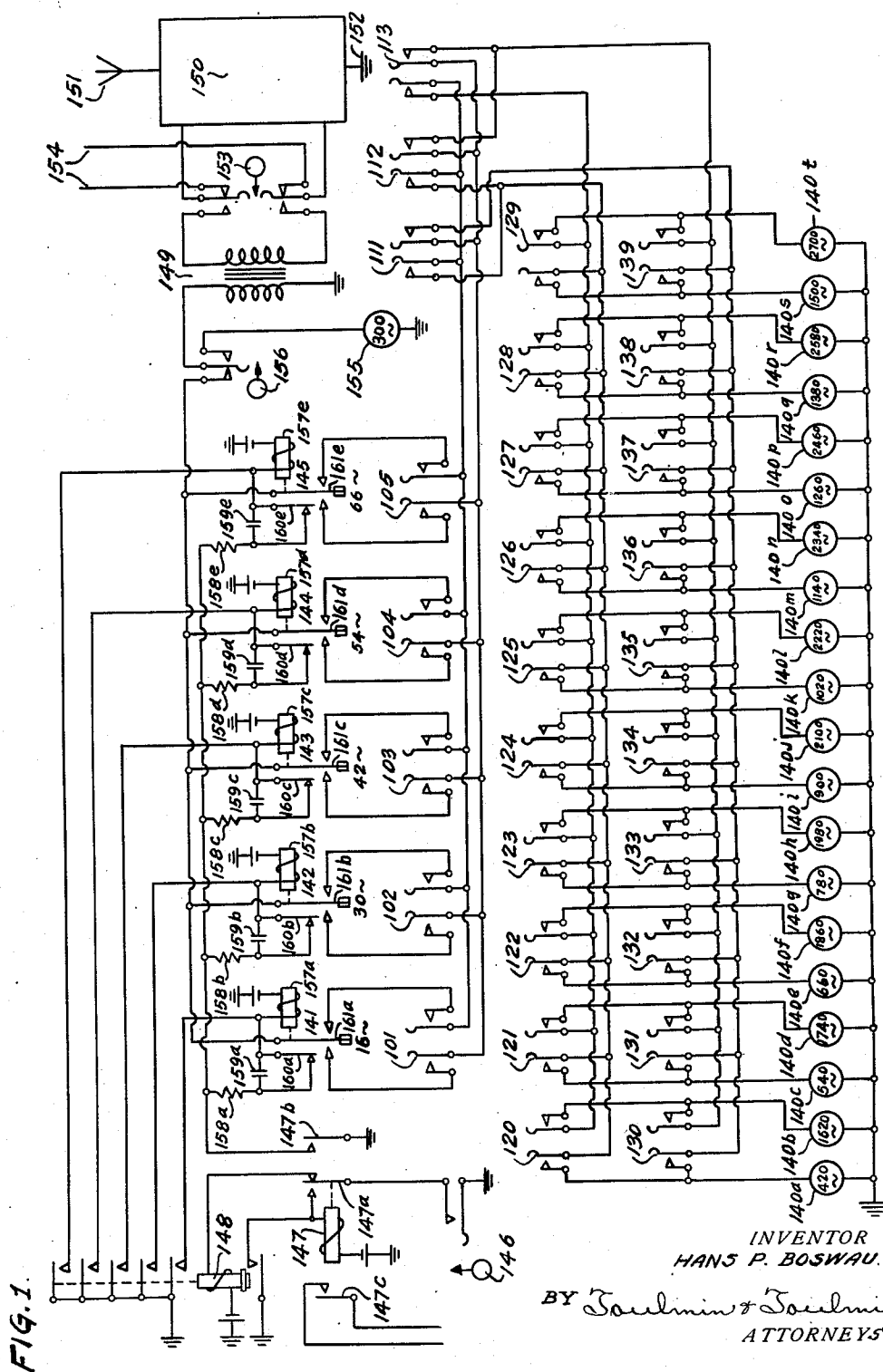
H. P. BOSWAU

2,198,901

SIGNALING SYSTEM

Filed March 17, 1938

3 Sheets-Sheet 1



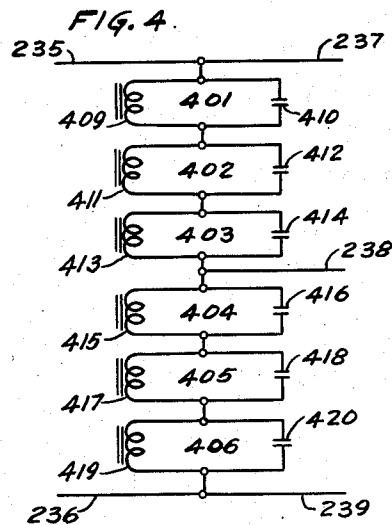
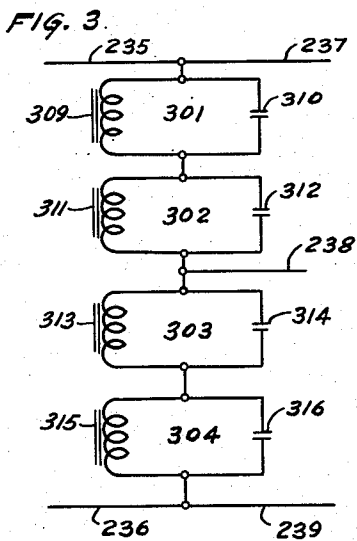
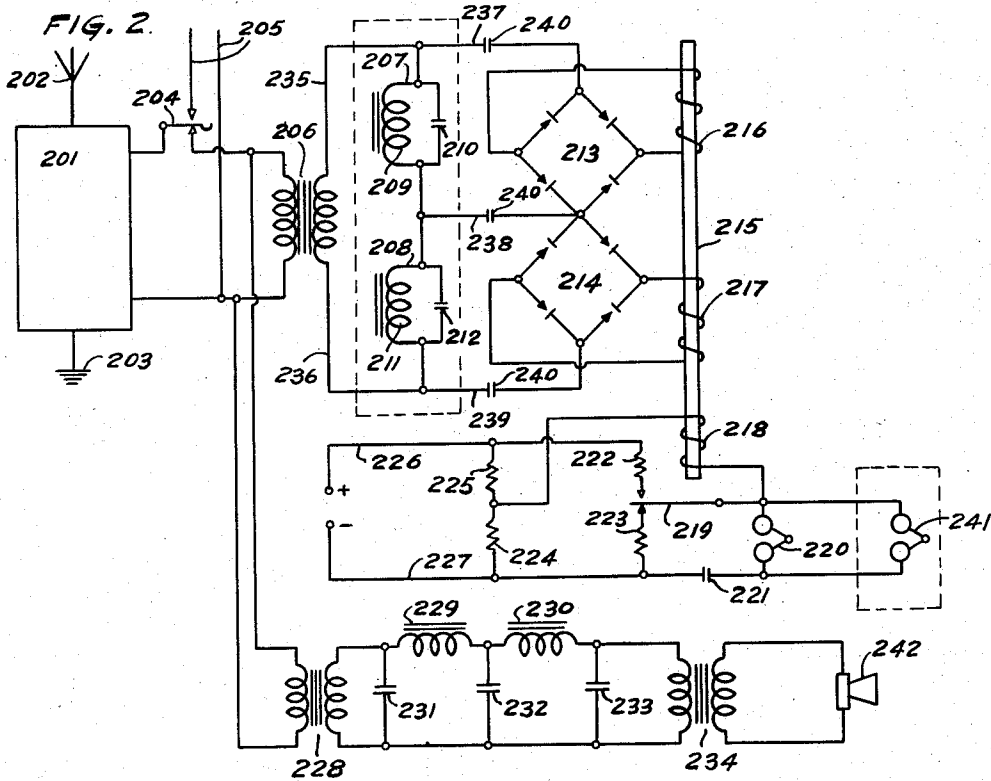
April 30, 1940.

H. P. BOSWAU
SIGNALING SYSTEM

2,198,901

Filed March 17, 1938

3 Sheets-Sheet 2



INVENTOR
HANS P. BOSWAU.

BY *Toulmin & Toulmin*
ATTORNEYS

April 30, 1940.

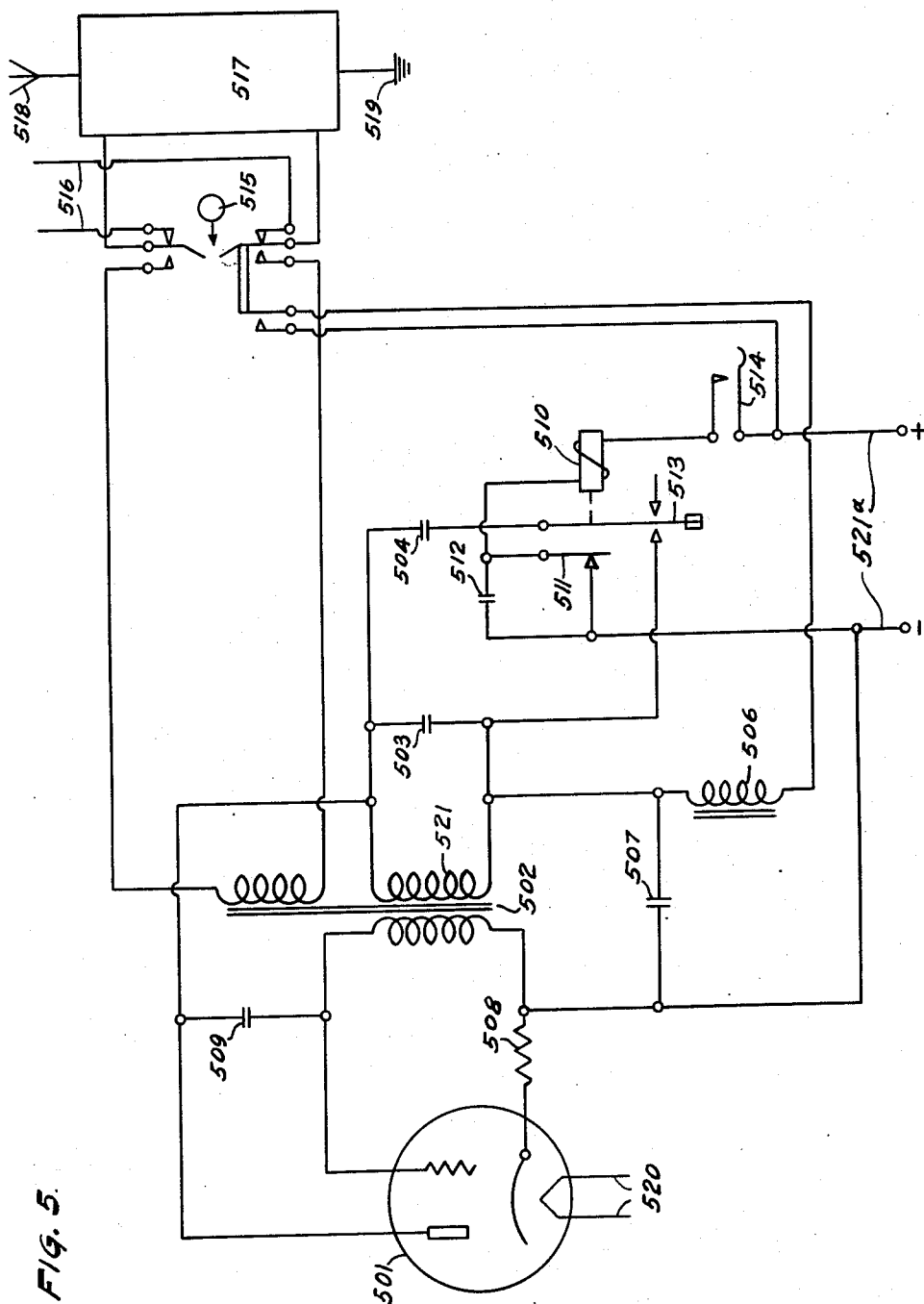
H. P. BOSWAU

2,198,901

SIGNALING SYSTEM

Filed March 17, 1938

3 Sheets-Sheet 3



INVENTOR
HANS P. BOSWAU.

BY *Saulmin & Saulmin*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,198,901

SIGNALING SYSTEM

Hans P. Boswau, Lorain, Ohio, assignor to The
Lorain Telephone Company, Lorain, Ohio, a
corporation of Ohio

Application March 17, 1938, Serial No. 196,467

7 Claims. (Cl. 177—341)

This invention relates to signaling systems, and in particular, to selective signaling systems for selective communication between one or more master stations and a large number of subsidiary stations.

One object of this invention is to provide a selective signaling system for signaling between one or more master stations and a large number of subsidiary stations, such as ship radio stations or way stations on long telephone lines in a rapid, simple and dependable selective arrangement.

Another object is to provide a selective telephonic signaling system, giving substantially instantaneous selection and response of the calling device at the called station, thereby eliminating the delay resulting in prior systems from the employment of long and extended trains of selecting impulses, and at the same time enabling the employment of code ringing signals for transmitting additional information with the calling signal.

Another object is to provide a selective telephonic signaling system, wherein receiving stations are enabled to use standard telephone devices without the necessity for the provision of special selector mechanisms of a costly, intricate and delicate nature.

Another object is to provide a selective telephonic signaling system giving means for making general calls to groups of subsidiary stations of a selected common character, such as to all ships of one particular fleet, or for making general calls to all subsidiary stations.

Another object is to provide a selective telephonic signaling system, as described above, wherein the subsidiary stations are provided with simple and inexpensive circuits for facilitating calls from one subsidiary station to another subsidiary station.

In the drawings:

Figure 1 is a wiring diagram of the sending circuit at the master station.

Figure 2 is a wiring diagram of the receiving equipment at ship stations, or other subsidiary stations.

Figure 3 is a modified subcircuit applicable to Figure 2, showing a modified filter circuit adapted for ship call and fleet call, or ship call and general call purposes.

Figure 4 is a modified subcircuit applicable to Figure 2, showing another modified filter circuit adapted for ship, fleet and general call purposes.

Figure 5 is a wiring diagram of the sending equipment at the ship stations, or other subsidiary stations.

General nature

In general, the radio signaling system of the present invention consists of a master circuit and a plurality of subsidiary circuits arranged for intercommunication. For calling purposes in this signaling system, the carrier wave of the radio transmitter is modulated by a selective ringing signal consisting of alternate impulses of two different audio frequencies, alternating at suitable harmonic or synchrononic ringing frequencies. According to this arrangement one of the audio frequencies is transmitted during one-half of the period of the ringing frequency corresponding, for example, to the positive half cycle and the other audio frequency is transmitted during the second half period corresponding, for example, to the negative half cycle.

The system is arranged so that any one of a large number of subsidiary stations may be called selectively. In particular, assuming the possibility of twenty audio frequencies for transmission upon one voice channel and segregated from each other by suitable filters at the receiving station, a total of 190 different combinations of two of these twenty frequencies may be obtained, as found from the simple computation:

$$\frac{1}{2}(20 \times 19) = 190$$

Furthermore, as each of these 190 combinations may be alternated at one of the five customary harmonic or synchrononic ringing frequencies, the product of these numbers gives a total of 950 different calling signals available for the selective calling of any one of 950 stations.

In setting forth the invention, the equipment at each station will first be described, and then the operation of the system as a whole. The reference numerals in each figure are numbered in hundreds according to the particular figure. That is, all reference numerals in Figure 1 are numbered between 100 and 199, Figure 2 between 200 and 299, etc.

Master station arrangement

The master station is provided with sending equipment, as shown in the wiring diagram of Figure 1. This sending equipment includes five keys 101, 102, 103, 104 and 105 for selecting the ringing frequency. Ten additional keys 120 to 129, inclusive, are provided for selecting the first audio frequency of the desired combination of frequencies. Ten more keys 130 to 139, inclusive, are provided for selecting the second audio frequency of the desired combination. Three

keys 111, 112 and 113 are likewise provided for shifting the selection of frequencies from the first ten audio frequencies to the second ten audio frequencies in various combinations of such frequencies.

In order to provide the variety of audio frequencies necessary for the operation of the circuit, twenty audio frequency generators 140^a to 140^t, inclusive, are connected respectively in circuit with the two banks of keys 120 to 129, inclusive, and 130 to 139, inclusive. These audio frequency generators may be of any suitable type for providing such oscillations such as, for example, a rotating machine used for voice frequency telegraph systems or vacuum tube oscillators.

In order to provide the ringing frequencies employed in the system, five ringing frequency generators 141 to 145, inclusive, are connected in circuit with the ringing frequency selecting keys 101 to 105, inclusive. These ringing frequency generators are shown for purposes of illustration to consist of mechanically tuned vibrators operated electrically, in the manner in which such devices are employed in wired telephone exchanges. It will be obvious to those skilled in the art, however, that five motor-driven commutators could be employed in place of the five ringing frequency generators 141 to 145.

Also provided in the circuit of Figure 1 is a starting key 146 and two starting relays 147 and 148, these being employed for the purpose of starting the ringing frequency generators 141 to 145 in vibration. A transformer 149 inductively couples the signal and ringing frequency circuits to the radio transmitter, generally designated 150, the latter being connected to an antenna 151 and ground 152. Arranged between the transformer 149 and radio transmitter 150 is a ringing key 153, the purpose of which is to disconnect the radio transmitter 150 from the telephone circuit 154 and to connect it to the transformer 149. Additionally provided in the circuit of Figure 1 is a low audio frequency generator 155, together with a tone key 156 connected thereto for the purpose subsequently to be described.

Ship receiving arrangement

The receiving circuit at the ship or subsidiary station (Figure 2) consists of a radio receiver 201, connected to an antenna 202 and a ground 203. The switch hook 204 serves to switch the output of the radio receiver 201 from the signaling apparatus to the telephone circuit 205, the latter being connected to a signal indicator, such as a telephone receiver or loud speaker.

The signal-selecting apparatus in the subsidiary station receiving equipment includes an input transformer 206 connected to two audio frequency filters, generally designated 207 and 208, by way of the conductors 235 and 236. The filters 207 and 208 include inductances 209 and 211, coupled to capacities 210 and 212, respectively. The audio voltage arising at the filters 207 and 208 is transmitted to other lines 237, 238 and 239, and rectified by the rectifiers, generally designated 213 and 214. Beyond these it is fed to the windings 216 and 217 of a polarized relay, generally designated 215, the latter having a holding winding 218 and an armature 219 with associated contacts. A ringer 220 of the usual harmonic or synchromonic type is operated from the power supply of the station over the lines 226 and 227, the circuit including resistances 222 and 223, a condenser 221 and resistances 224 and 5 cooperating with the holding winding 18

of the polarized relay 215. Optionally provided in the receiving circuit of Figure 2 is an additional signaling device connected between the radio receiver 201 and the transformer 206. This includes the transformers 228 and 234, the filter inductances 229 and 230 and condensers 231, 232 and 233. A signaling device 242, such as a loud speaker, may be optionally provided, as set forth more fully below. Optionally connected beyond the first ringer 220 and in parallel therewith is a second ringer 241, for purposes set forth more fully below.

The circuit shown in Figure 2 includes a filter system composed of filters 207 and 208, adapted to handle the ship call only. Figure 3, however, shows a filter system adapted to handle either a ship call and a fleet call, or a ship call and a general call. This filter system is adapted to be substituted for the filter system inclosed in the dashed lines in Figure 2, and for that purpose is connected between the junction of the lines 235 and 237 and the junction of the lines 238 and 239. The line 238, as before, leads from the midportion of the filter system. The filter system of Figure 3 includes two pairs of filters 301 and 303, and 302 and 304. The filters, as before, include inductances 309, 311, 313 and 315 in circuit with capacities 310, 312, 314 and 316.

Figure 4 shows a filter system arranged for substitution in the dashed inclosure of Figure 2, and adapted for handling ship, fleet and general calls. This filter system of Figure 4 includes three pairs of filters 401 and 404, 402 and 405, and 403 and 406, connected in a similar manner to those of Figure 3 between the junction of the lines 235 and 237 and the junction of the lines 238 and 239. These filters 401 to 406, inclusive, likewise consist of inductances 409, 411, 413, 415, 417 and 419, connected in circuit with capacities 410, 412, 414, 416, 418 and 420, respectively.

Ship sending arrangement

The ship sending circuit for use in the radio signaling system of this invention is shown in Figure 5. This circuit includes an audio frequency oscillator consisting of a vacuum tube 501 connected to a transformer 502, the latter being further connected to tuning condensers 503 and 504. Also included in the circuit of Figure 5 is a choke 506, a by-pass condenser 507, a cathode bias resistance 508 and a by-pass condenser 509. A ringing frequency vibrator 510 is connected in this circuit and provided with an interrupting contact 511 and an associated spark quenching condenser 512, likewise an operating contact 513.

The ringing frequency vibrator 510 is started by means of the switch hook 514, whereas the audio frequency oscillator is started by closing a ringing key 515, thereby closing the plate voltage circuit of the audio frequency oscillator and switching the input circuit of the radio transmitter, generally designated 517, from the microphone circuit 516 to the output of the audio frequency oscillator. The radio transmitter 517 is connected to an antenna 518 and a ground 519. The filament or heater of the vacuum tube 501 is energized from a heater supply circuit 520. A power supply circuit 521^a, of any suitable voltage such as 110 volts, is connected to the ringing frequency vibrator 510 in the manner shown in Figure 5.

The ringing vibrators 141 to 145 may be arranged to vibrate at any desired series of frequencies. Similarly, the audio frequency generators 140^a to 140^t, inclusive, may be arranged

in any desired series of frequencies. In Figure 1, for purposes of exemplification, the ringing frequency generators 141 to 145 have been indicated as having frequencies of 16, 30, 42, 54 and 66 cycles per second, respectively. Similarly, the audio frequency generators 140 have been designated with audio frequencies extending from 420 to 2700 cycles per second. Placing definite values for these respective frequencies enables a clearer showing to be made, but it is understood that the invention is not limited to the particular numbers of cycles described.

Each of the ringing frequency generators 141 to 145 is provided with a vibrator 161^a to 161^e, respectively, and also with operating coils 157^a to 157^e, respectively. Each ringing frequency generator 141 to 145 is further provided with a normally closed contact 160^a to 160^e, inclusive, likewise a condenser 159^a to 159^e, inclusive, and a resistance 158^a to 158^e, inclusive. For purposes of illustration, the signal tone generator 155 is designated as having a frequency of 300 cycles per second.

Operation

If the operator at the master station wishes to call a particular ship of the system, he first operates the starting key 146 (Figure 1) to start the ringing frequency generators 141 to 145. When the key 146 is closed it operates the relay 148 through a break contact 147^a of the relay 147. When the relay 148 is thus energized, it closes individual circuits to operating coils 157^a to 157^e of the ringing frequency generators 141 to 145, and these, when energized, attract their reed armatures 161^a to 161^e, inclusive.

When the relay 148 closes it likewise operates the relay 147, which locks itself to a contact of the key 146 and opens the circuit of the relay 148. The latter, however, is a slow release relay and remains operated for a predetermined time after it has become deenergized. During this time lag interval the coils 157^a to 157^e attract the armatures 161^a to 161^e. When the relay 148 releases its contacts after this predetermined time, the coils 157^a to 157^e thenceforth receive current through the contacts 160^a to 160^e, resistances 158^a to 158^e and the make contact 147^b of the relay 147, causing the reed armatures 161^a to 161^e to vibrate in the manner of an ordinary electric bell. The reed armatures 161 are tuned mechanically so that they vibrate at predetermined desired frequencies, such as the frequencies 16, 30, 42, 54 and 66 cycles per second shown in Figure 1. The starting relay 148 is provided to produce a strong initial pull upon the reed armatures 161^a to 161^e by means of the coils 157^a to 157^e, thereby insuring starting at full amplitude of vibration. Condensers 159^a to 159^e are provided for spark protection to the contacts 160^a to 160^e, inclusive. The left-hand contact 147^c is a make contact which may be used to energize the circuit starting audio frequency generators 140^a to 140^t, inclusive.

In the signaling system of the present invention each ship is assigned a call number consisting of four digits. The first digit indicates one of the keys 101 to 105, the second digit one of the keys 111 to 113, the third digit one of the keys 120 to 129, and the fourth digit one of the keys 130 to 139. The numerals of the call number for the particular ship, therefore, correspond to the last digits of the key numbers. For example, to call the ship having the call number 4237, the operator at the master station operates

keys 104, 112, 123 and 137. If desired, each of the four groups of keys mentioned above may be equipped with a mechanical interlocking arrangement so that the operation of any one key will restore any previously operated key in the same group to its inoperative position.

The equipment is now ready for signaling, and the operator now signals the desired ship by means of the ringing key 153 (Figure 1). The latter connects the radio transmitter 150 through the transformer 149 to the vibrating reeds 161^a to 161^e, inclusive, of all five ringing frequency generators 141 to 145, inclusive. As the contact circuits associated with the reeds 161^a, 161^b, 161^c and 161^e are opened at the contacts of the keys 101, 102, 103 and 105 only the contact circuits of the ringing frequency generator 144 are closed through the operated key 104.

When thus energized, the vibrating reed armature 161^d connects the transformer 149 alternately to the left and right-hand contacts of the generator at a frequency, for example, of 54 cycles per second. When the right-hand contact of the ringing frequency generator 144 is closed the transformer 149 is connected through the contacts of the keys 112 and 123 to the audio frequency generator 140^e for an audio frequency of 780 cycles. On the other hand, when the left-hand contact thereof is closed, the circuit is completed through the contacts of the keys 112 and 137 to the audio frequency generator 140^b for an audio frequency of 2460 cycles.

As a result of these connections, signal impulses consisting of fifty-four impulses per second of 780 cycles, interspersed by fifty-four impulses per second of 2460 cycles are impressed upon the radio transmitter 150, which radiates a signal modulated in a corresponding manner. By using any one of the ringing frequencies and any two of the audio frequencies in a different combination, any other combination of operated selection keys will transmit a corresponding signal. For example, when the key 111 is operated the right and left-hand contacts of the ringing frequency generators 141 to 145 are both associated with the ten audio frequencies ranging from 420 to 1500 cycles per second. Since any one of these ten frequencies can be combined with any one of the nine remaining frequencies, a total number of combinations of 90 is achieved. Since, however, the frequency combinations composed of the same number of cycles in reverse arrangement cannot be distinguished from one another, only half of the 90 combinations or 45 combinations are distinct from each other. Thus, for example, the frequency combination of 420 cycles with 540 cycles would be indistinguishable from the combination of 540 cycles with 420 cycles.

If, however, the second key 112 is operated instead of the first key 111, the right-hand contact of the vibrators 141 to 145 is connected to become associated with the ten audio frequencies ranging from 420 to 1500 cycles per second, and the left-hand contact with the ten audio frequencies of 1620 to 2700 cycles per second, thereby giving one hundred distinct combinations. If the third key 113 is operated it associates both vibrator contacts with the ten audio frequencies of 1620 to 2700 cycles per second so that similar considerations apply as in the case of key 111, making 45 distinct combinations available. The total number of audio frequency combinations for a given ringing frequency, therefore, amounts to 190. The call numbers corresponding to these different audio frequency combinations obtained

by operating the first ringing frequency key 101 are given in the following table:

	1101-1109	1200-1209	1301-1309
5	1112-1119	1210-1219	1312-1319
	1123-1129	1220-1229	1323-1329
	1134-1139	1230-1239	1334-1339
	1145-1149	1240-1249	1345-1349
	1156-1159	1250-1259	1356-1359
10	1167-1169	1260-1269	1367-1369
	1178-1179	1270-1279	1378-1379
	1189	1280-1289	1389
		1290-1299	

By using the other four ringing frequencies a similar table will be obtained, having the numbers 2, 3, 4 or 5 for the first digit of the call number instead of the No. 1. These other ringing frequencies add 760 distinctive signals to those obtained by the first ringing frequency, giving a total of 950 distinctive call numbers obtainable with the equipment shown in Figure 1.

At the receiving stations (Figure 2) the modulated radio signal is received by the antenna 202 and is amplified and converted by the radio receiver 201 into an audio frequency signal exactly corresponding to the audio signal impressed upon the transmitter 150 at the master station (Figure 1). The audio output of the receiver 201 is connected, through the switch hook 204 and transformer 206, to the two audio filters 207 and 208 in series. On any particular ship one of these filters is tuned to one of the two audio frequencies used for calling this ship, and the other filter is tuned to the other audio frequency. The output of these filters passes through the condensers 240 to the full wave rectifiers 213 and 214. In these rectifiers audio frequencies are rectified and the resulting rectified current is fed to the windings 216 and 217 of the polarized relay 215. The connections between the rectifiers 213 and 214 and the relay windings 216 and 217 are made in such a manner that an audio frequency signal of the frequency to which the filter 207 is tuned operates the relay 215 in one direction, whereas a signal of the frequency to which the filter 208 is tuned operates the relay 215 in the opposite direction. The additional winding 218 of the relay 215 in cooperation with the resistances 224 and 225, provides a direct current bias which reverses with the reversal of the relay armature 219, thereby tending to hold the armature 219 against the contact to which it was last moved.

Assuming that the ringing frequency selected is that of the ringing frequency generator 144 with a frequency of 54 cycles per second, the alternating impulses in the windings 216 and 217 of the relay 215 move the armature 219 thereof back and forth fifty-four times per second. This action alternately charges and discharges the condenser 221 through the winding of the harmonic ringer 220 and resistances 222 and 223. The effect of this action is to produce an alternating current of fifty-four cycles flowing through the ringer 220. The latter, however, is mechanically tuned to respond only to impulses of alternate direction at a predetermined single frequency. Thus the ship being called, in the particular example, has its ringer 220 mechanically tuned to respond to 54 cycles per second when the ringer will ring in response to the arrival of the call through the ship's receiving set, shown in Figure 2.

It will be evident that the same combination of the two identical audio frequencies may be used for calling four other ships of the same sys-

tem because their ringers 220 are not tuned to 54 cycles, and therefore do not respond to the signal even though it is received and rectified and operates the relay 215. One or the other of the two audio frequencies will be used for calling a number of other ships, thereby causing the armature 219 of the relay 215 to move on the first impulse of the signal unless it is already engaged with the corresponding contact. The other audio frequency on these ships, however, will differ, that is, their second filter is not tuned to the other audio frequency used for the call directed to the first ship, as described above. These two filters 207 and 208 have the effect that any audio frequency to which they are not tuned passes through them in approximately equal amounts and is therefore substantially balanced out in the relay 215, since the rectified currents from the two rectifiers 213 and 214 produce the magnetic flux of opposing directions in the relay.

In this manner the relay 215 is not affected by the impulses of the second audio frequency, with the result that the armature 219 remains against the contact to which it was first moved. A single impulse will not operate the ringers 220 on these ships even when they receive such a single impulse because several cycles are required to swing the clapper of the ringer a sufficient amount to hit and sound the gongs. In all other ships, whose filters 213 and 214 are tuned to neither of the two audio frequencies above mentioned, the relay 215 will not be affected at all.

Noise or static interference will also leave the relay 215 substantially unaffected because it will pass through both filters in approximately equal amounts and balance out in the relay 215. If, however, occasional interference or static should contain one of the audio frequencies, the ringers 220 will not be affected, because their mechanical tuning requires the reception of several impulses at the proper ringing frequency before they begin to ring. Similarly, the signal on the ship being called will not be affected materially by static or interference as this can have no worse effect than to obliterate the signal during a few cycles of the ringing frequency. As the mechanical inertia of the vibrating system of the ringer easily carries it over such brief interruptions, no effect will ordinarily be detected. Even if the noise or static interferences are long enough to break the swing of the ringer 223, the result will simply be a somewhat uneven ring.

In the prior so-called "selector system" of selective calling, however, one missing impulse will spoil the call. The superiority of the present system over the prior system is therefore self-evident. Therefore, in summation, it will be seen that in order to call a particular ship of the system, it is necessary not only to transmit to it the two audio frequencies to which its two audio filters are tuned, but also to alternate these two frequencies at the frequency to which the ringer of the ship is tuned. The system of the present invention is adapted to call a large number of ships in a very small period of time, because the ringer 220 of each called ship responds almost instantly to the calling signal, and does not require the time-consuming operation of step-by-step relays, etc.

To provide a common calling signal for an entire fleet of ships, the filter arrangement of Figure 3 may be employed in the circuit of Figure 2. In this modified circuit the ringing frequency is the same for all ships of the fleet, but a second set of audio filters 302 and 304 is pro-

vided. These two additional filters are tuned to the same two audio frequencies on all ships of the particular fleet, thereby making it possible to call the entire fleet at the same time. As neither of the two audio frequencies of such a fleet call can be used for other calls on the same ringing frequency, the number of calling code signals is reduced by $19+18=37$ for each fleet called. If this were not so the filters 301 and 304 or 302 and 303 might respond to other signals.

As a further modification, by omitting the filter 304, one common audio frequency may be used for fleet and individual calls in a certain fleet. This arrangement provides for one fleet call and eighteen individual calls with the same ringing frequency of the ringers 220, but with different audio frequencies. If the fleet has more than eighteen ships, the other ships of the fleet may be called by using the same audio frequencies, and one or more additional ringing frequencies, that is with ringers 220 tuned to different ringing frequencies. This arrangement allows large fleets of ships to be called in groups of eighteen ships merely by employing a few successive ringing signals.

To make a general call to all ships in the system, two separate audio frequencies not used for any other calls may be reserved for this purpose. All ships in the system may then be signaled by employing these two reserved audio frequencies in combination with all five of the ringing frequencies in succession. In this manner all of the ships in the system may be called in approximately five seconds. Similarly fleet calls may be provided by using individual code ringing signals for each fleet, and a simple code ringing signal, such as three long rings, for the general call. With the modification shown in Figure 4, fleet calls can be combined with a general call by providing three pairs of audio frequency filters. If, however, the fleet calls use an audio frequency in common with the individual calls of that fleet, one of the filters, such as the filter 405, may be omitted in a manner analogous to that previously described in connection with Figure 3. The filter circuit in Figure 4 is, of course, to be substituted for the filters 207 and 208 in Figure 2.

The use of the polarized relay 215 is for the purpose of permitting the ringer 220 to respond solely to the proper ringing frequency. If the ringer 220 were provided with two windings connected directly to the output of the rectifiers 213 and 214, the ringer 220 would respond not only to its assigned signal, but also to any signal containing one of its two audio frequencies at the proper ringing frequency. The reason for this behavior arises from the fact that the ringer 220 responds not only to impulses of alternate polarity, but also to pulsating current of one polarity at the proper frequency. This is caused by the inertia and elasticity of the mechanically tuned armature of the ringer 220, which tend to restore this armature to normal after each impulse. The polarized relay 215, however, because of its bias winding 218, remains in the last position to which it is moved until an opposite impulse is received. The possibility exists of providing the ringer with three windings and relay contacts, but the provision of a separate relay and ringer also requires much less energy for their operation, so that they can be operated directly from the output circuit of the radio receiver. A combined ringer and relay, however, would require additional amplification, hence, the advantage of simplification in one respect would be offset by the

greater complexity of the amplification system required.

For ship-to-ship calling the master station calling equipment described above would be unnecessarily elaborate and expensive, except for possibly the largest ships. Any suitable system of ship-to-ship calling may therefore be employed, for example, the low tone audio frequency calling system using the code ringing principle as disclosed in my copending application, Ser. No. 130,943, filed March 15, 1937. For this purpose the subcircuit shown at the bottom of Figure 2 is provided. In this subcircuit the receiver 201 feeds a second transformer 228, which transmit the received signal through a low pass filter consisting of the inductances 229 and 230 and the condensers 231, 232 and 233. The energy passing through this system is transformed by the transformer 234 and passes to a signal indicator, such as the loud speaker 242.

The tone frequency used for ship-to-ship calling in this arrangement is lower than any of the selective audio frequencies, and hence, will not affect the selective calling apparatus. The selective audio frequencies are likewise kept from the speaker 242 by the low pass filter system 229 to 233. In order to improve the signal reception, the speaker 242 is arranged to have its peak at the signal tone frequency. If, however, there is provided a speaker or "howler" 242, which is mechanically tuned to the signal tone frequency, the low pass filter system 229 to 233 may be omitted, if desired. Optionally, in place of this simple low pass filter system, a band pass filter or a more elaborate low pass filter may be employed. Similarly, the audio frequency filter systems 207, 208, etc. may be replaced by more complex or improved forms of filters, such as differential band pass filters. Signal tone calling may be enabled by providing the master stations with a signal tone generator, such as the signal tone generator 155 and its associated key 156 (Figure 1). This may be employed when the ships are equipped for signal tone calling in addition to selective calling.

For ship-to-ship calls one common pair of audio frequencies and one ringing frequency only may be used. In this arrangement only two audio frequency generators and one ringing frequency generator or one audio frequency generator furnishing two alternate audio frequencies under the control of a ringing vibrator would be required on the ships, as shown in Figure 5. In order to avoid complications, the ringing frequency in such an arrangement should not be used for selective calling from master stations, thereby making it necessary to connect a second harmonic ringer 241 in series or parallel with the ringer 220 on each ship. The ships then call each other by means of code ringing on the separate ringer 241. In an obvious manner, the ship-to-ship ringing signal may likewise be used for fleet and general calls from master stations by using appropriate code ringing signals.

In the operation of the transmitting equipment for ships, as shown in Figure 5, when the telephone is lifted from the switch hook 514 the latter energizes the ringing frequency generator 510 by way of its interrupter contact 511, causing the armature 513 to vibrate at the desired ringing frequency. Instead of using the switch hook 514, the ringing frequency generator 510 may be started by other suitable means, such as a separate switch. In order to call another ship the ringing key 515 is operated in accordance

with the code ringing signal assigned to the ship being called. The closing of the key 515 starts the audio frequency oscillator of Figure 5 by closing its plate supply circuit. The audio frequency generated by this system is determined mainly by the inductance of the plate winding 521 of the transformer 502 and the capacity 503 in parallel therewith.

When the ringing frequency generator vibrator 513 is in open circuit, as shown in Figure 5, the condenser 503 is arranged in parallel with the plate winding 521, thereby generating a certain audio frequency. At intervals corresponding to the ringing frequency developed by the period of vibration of the armature 513, the latter closes its contacts, thereby connecting the condenser 504 in parallel with the condenser 503 and lowering the audio frequency generated by the system. The output of the audio oscillator of Figure 5, therefore, provides for two audio frequencies alternating with each other at the ringing frequency of the armature 513. The audio output is connected to the radio transmitter 517 whenever the key 515 is operated, thus modulating the carrier wave of this transmitter with the desired calling signal at intervals controlled by the operation of the key 515. The latter may be replaced, if desired, by the dial controlled code sending means shown in my co-pending application, Ser. No. 130,943, filed March 15, 1937, as previously referred to. Similarly, any other type of audio frequency or ringing frequency generators may be employed in place of those shown, or two separate audio frequency generators may be used instead of the single audio frequency generator 510. The customary means for stabilizing the audio frequencies may likewise be added, such as voltage stabilizers, temperature compensators, etc.

Additional information may be transmitted by this code ringing system in connection with the calling signals, because the ringers 220 and 241 respond to the calling signal almost instantly. For example, the channel on which a master station is calling may be identified by the use of one, two or more rings in the calling signal, and other codes may be employed in an obvious manner to distinguish urgent calls from ordinary calls, or for any other purpose. In this manner the calling system of the present invention is much more flexible in meeting the varying signaling requirements than the previously known so-called selector system.

The harmonic ringers 220 and 241 at the receiving stations may be replaced by any other type of device which responds only to the predetermined ringing frequencies. In place of the electrical audio filters shown at the receiving station in Figure 2, any other suitable means responding only to predetermined audio frequencies may be employed, such as acoustic filters, mechanically tuned reed relays, etc.

Selective calling system for land lines

The calling system of the present invention may be employed in connection with land telephone lines, such as train dispatching lines. Under these circumstances, a relatively large number of way stations connected to the same line must be called selectively. In this case the radio transmitter 150 and receiver 201 are omitted. The transformer 149 is then connected over a telephone line to the transformers 206 at the way stations. If additional energy is required, a simple audio amplifier may be interposed in the

circuit at some point between the telephone line and the relay 215. The present system, moreover, is practically instantaneous, requires no delicate selector mechanism at the way stations and permits the use of code ringing signals to transmit additional information. Accordingly, it is decidedly superior to the previously known type of selective calling by means of train dispatching selectors. It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a signaling system, a sending station, a plurality of receiving stations, means at said sending station for producing a plurality of paired sets of electrical oscillations of different frequencies, means at said sending station for transmitting said different frequency oscillation sets to said receiving stations, means at said sending station for alternating the transmission of said sets of oscillations at a plurality of predetermined rates of alternation, a signal indicator at each of said receiving stations, and means associated with said signal indicator for rendering one of said signal indicators operative solely in response to the arrival at said receiving stations of two sets of electrical oscillations of the same frequencies as those transmitted from the sending station and alternating at the same rate of transmission alternation.

2. In a signaling system, a sending station, a plurality of receiving stations, means at said sending station for producing a plurality of paired sets of electrical oscillations of different frequencies, means at said sending station for transmitting said different frequencies to said receiving stations, means at said sending station for alternating the transmission of said plurality of paired sets of oscillations at a plurality of predetermined rates of alternation, a signal indicator at each of said receiving stations, said indicators being adapted to respond to alternations of said paired sets of oscillations, and a filter system at said receiving station responsive solely to the same frequencies as said frequencies transmitted by said sending station for causing said signal indicator to respond to the alternations of said paired sets of oscillations.

3. In a signaling system, a sending station, a plurality of receiving stations, means at said sending station for producing a plurality of paired sets of electrical oscillations of different frequencies, means at said sending station for transmitting said different frequencies to said receiving stations, means at said sending station for alternating the transmission of said plurality of paired sets of oscillations at a plurality of predetermined rates of alternation, a signal indicator at each of said receiving stations, said indicators being adapted to respond to the alternations of said paired sets of oscillations, a filter system at said receiving station capable solely of passing the same frequencies as said frequencies transmitted by said sending station, and means responsive solely to the transmitted rate of alternation for causing said signal indicator to respond to the alternations of said paired sets of oscillations.

4. In a signaling system, a sending station, a receiving station, means at said sending station for producing two sets of electrical oscillations of different frequencies, means at said sending sta-

tion for transmitting said different frequencies to said receiving station, means at said sending station for alternating the transmission of said two sets of oscillations at a predetermined rate of alternation, a signal indicator including a polarized relay at said receiving station, and a filter system associated with said signal indicator and polarized relay for rendering said signal indicator operative solely in response to the arrival at said receiving station of two sets of electrical oscillations of the same frequencies as the two sets of electrical oscillations transmitted from said sending station, said polarized relay being adapted to remain in the last position to which it has been moved, said filter system being connected to said relay so that one set of alternations will move the relay to one of its positions and the other set to its other position and said indicator being of a character as to respond only when the polarized relay is moved back and forth at a predetermined rate of alternation of the two sets of oscillations.

5. In a signaling system, a sending station, a receiving station, means at said sending station for producing two sets of electrical oscillations of different frequencies, means at said sending station for transmitting said different frequencies to said receiving station, means at said sending station for alternating the transmission of said two sets of oscillations at a predetermined rate of alternation, a signal indicator at said receiving station, and a filter system associated with said signal indicator for rendering said signal indicator operatively solely in response to the arrival at said receiving station of two sets of electrical oscillations of the same frequencies as the two sets of electrical oscillations transmitted from said sending station and alternating at the same rate as the transmission alternation.

6. In a signaling system, a sending station, a receiving station, means at said sending station

for producing a plurality of paired sets of electrical oscillations of different frequencies, means at said sending station for transmitting said different frequencies to said receiving station, means at said sending station for alternating the transmission of said two sets of oscillations at a plurality of predetermined rates of oscillation, a signal indicator at said receiving station, a polarized relay for energizing said signal indicator, and means at said receiving station responsive to the plurality of predetermined rates of oscillation for operating said relay, said indicator being responsive only when the polarized relay is moved back and forth at the predetermined rate of alternation of the two sets of oscillations.

7. In a signaling system, a sending station, a receiving station, means at said sending station for producing a plurality of paired sets of electrical oscillations of different frequencies, means at said sending station for transmitting said different frequencies to said receiving station, means at said sending station for alternating the transmission of said two sets of oscillations at a plurality of predetermined rates of oscillation, a signal indicator at said receiving station, a polarized relay for energizing said signal indicator, means at said receiving station responsive to the plurality of predetermined rates of oscillation for operating said relay, and means associated with said relay for holding said relay in one of two positions corresponding to a set of electrical oscillations of one frequency until the arrival of a set of electrical oscillations of the other frequency whereupon said relay moves to the other of said positions, said indicator being of such character and so connected to the relay that it will respond only when the indicator is intermittently energized by the relay at the predetermined rate of alternation of the two sets of oscillations.

HANS P. BOSWAU.