June 20, 1933.

C. S. DEMAREST

1,914,407

SIGNALING SYSTEM

Filed Oct. 1, 1932

4 Sheets-Sheet 1

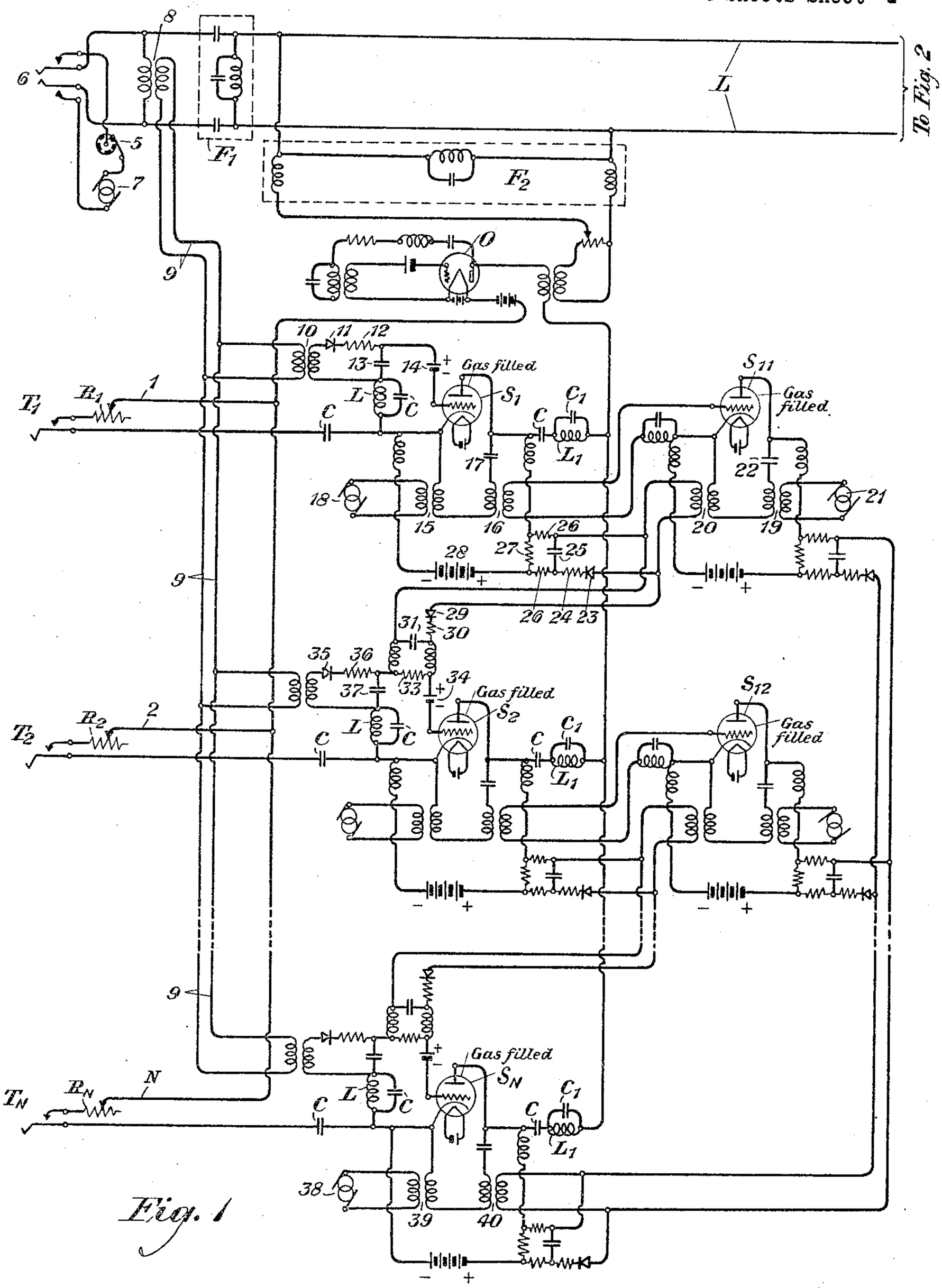

Fig. 1

INVENTOR

C. S. Demarest

BY

ATTORNEY

June 20, 1933. C. S. DEMAREST 1,914,407

SIGNALING SYSTEM

Filed Oct. 1, 1932 4 Sheets-Sheet 2

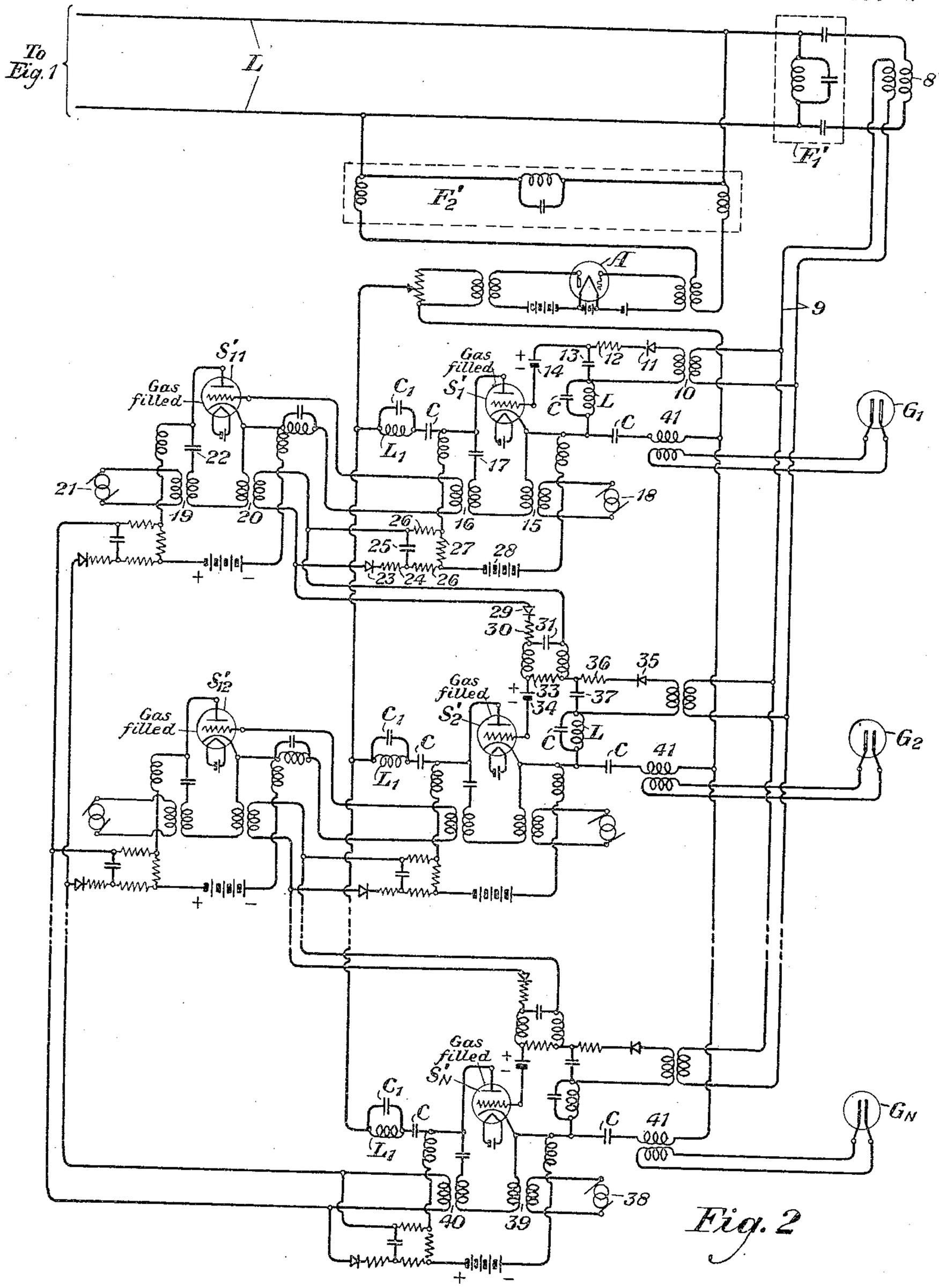

Fig. 2

INVENTOR
C. S. Demarest
BY
ATTORNEY

June 20, 1933. C. S. DEMAREST 1,914,407

SIGNALING SYSTEM

Filed Oct. 1, 1932 4 Sheets-Sheet 3

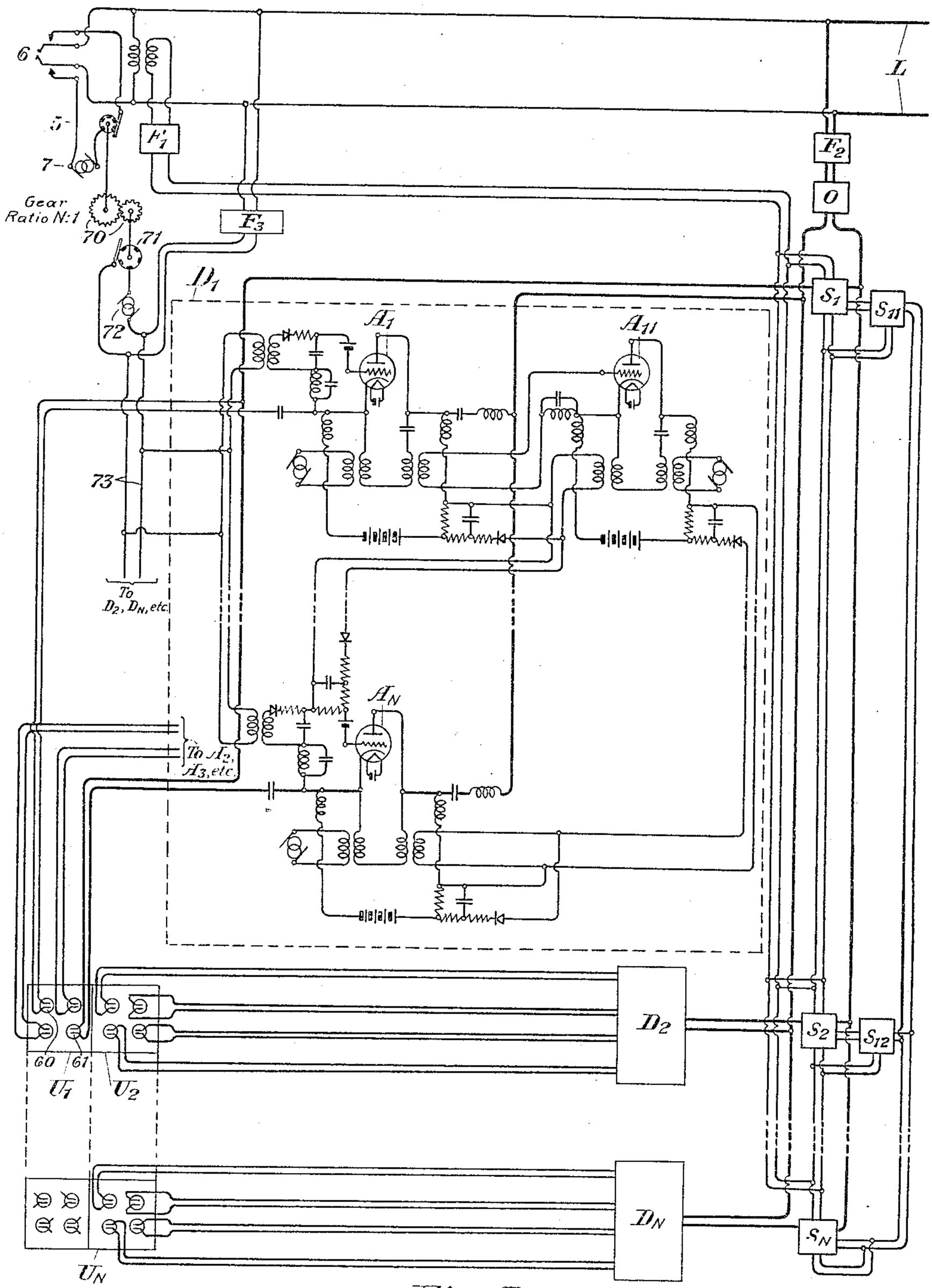

Fig. 3

INVENTOR
C. S. Demarest
BY
ATTORNEY

June 20, 1933. C. S. DEMAREST 1,914,407

SIGNALING SYSTEM

Filed Oct. 1, 1932 4 Sheets-Sheet 4

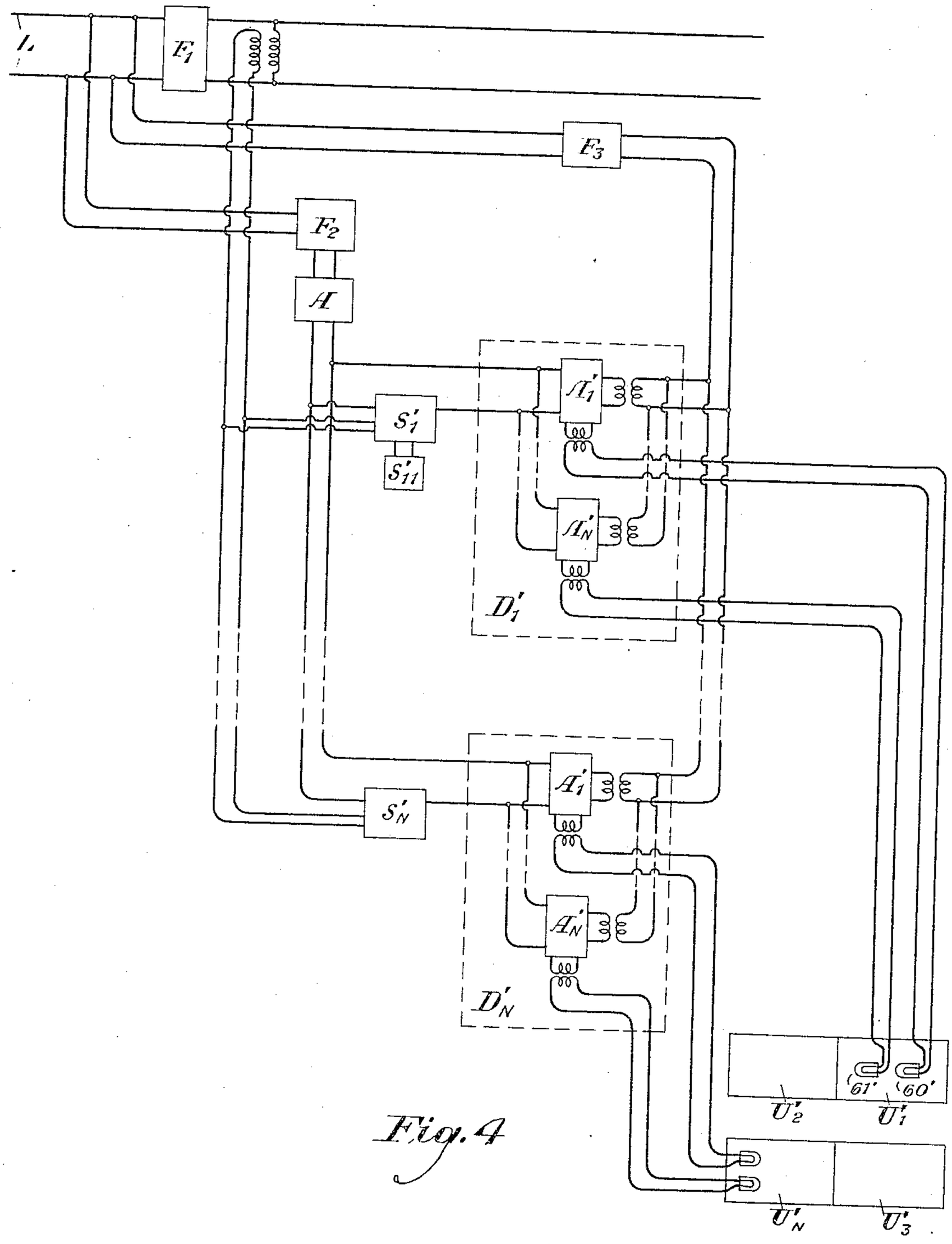

Fig. 4

INVENTOR
C. S. Demarest
BY
ATTORNEY

Patented June 20, 1933 1,914,407

UNITED STATES PATENT OFFICE

CHARLES S. DEMAREST, OF RIDGEWOOD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

SIGNALING SYSTEM

Application filed October 1, 1932. Serial No. 635,834.

This invention relates to signaling systems and more particularly to visual signaling systems such as picture transmission or television systems.

In visual signaling systems the three dimensions of length, breadth and light intensity are required to be converted into two dimensions, current strength and time in order to be transmitted over a line circuit. This conversion is accomplished by "scanning." The process of scanning consists of effectively dividing the picture into a large number of elements arranged in two dimensional rows or strips which are exposed consecutively to the light sensitive transmitting device, thus sending a series of signals of varying current intensity over the line circuit. At the receiving station these signals are rearranged in rows or strips by the receiving apparatus operating in synchronism with the transmitting apparatus, thus regaining the three dimensions of the original picture.

The scanning devices used at both transmitting and receiving stations for television have usually employed mechanical means such as large, spirally-perforated discs through which the various elements of the picture are illuminated or viewed. A high degree of synchronism is required with such devices in order to avoid distortion or displacement of the image. For slower picture transmission or telephotography, other devices may be used such as a light-sensitive transmitting device, synchronously rotating films and light values operated by the received currents.

In the arrangements disclosed in this invention the mechanical devices heretofore used are replaced by gas-filled tubes to provide for closer synchronism, more rapid scanning, and the elimination of moving parts in the system. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2, 3 and 4 of which the invention is illustrated. Figs. 1 and 2 are circuit diagrams showing respectively transmitting and receiving arrangements of the invention suitable for television or picture transmission systems. Figs. 3 and 4 are transmitting and receiving arrangements for scanning large areas in telephoto or television systems. Similar reference characters have been used to denote like parts in all of the figures.

As the various transmission paths shown in Fig. 1 are closed consecutively through tubes $S_1, S_2, \ldots S_N$ the condition of switches $T_1, T_2, \ldots T_N$ and the values of resistances $R_1, R_2, \ldots R_N$ will determine the intensity of the signaling current transmitted over the line circuits. At the receiving station, as shown in Fig. 2, the varying currents are distributed to the signaling devices, such as glow lamps $G_1, G_2, \ldots G_N$, in the proper time relation and produce the degree of illumination determined by the value of resistances at the transmitting station. Where variations in illumination are not required, these resistances may be of the same value or omitted.

The arrangements of the invention, as illustrated, might be used for a variety of purposes requiring instantaneous remote control of visual signals, such as bulletin boards, or advertising signs, each light element of which corresponds to one of the lamps G_1, G_2, etc. By the proper operation of keys $T_1, T_2, \ldots T_N$ to form letters, numbers, etc., such signals might be displayed and changed at will. Some uses of such remote control are for dial call announcing systems, advertising sign displays, brokers' bulletin boards, display boards on signal towers for the crews of moving trains, etc. The principles of this invention may also be applied to non-visual signaling systems. It is particularly adapted to use with printing telegraph systems, as will be explained more fully hereinafter.

By the combination of groups of such tube arrangements, each group for one section of the picture, large areas may be covered. Also by employing different frequencies for synchronizing and signaling in the two directions, simultaneous transmission and reception may be obtained.

Fig. 1 shows the arrangement of the transmitting station. Filters F_1 and F_2 are provided to separate the synchronizing and signaling frequencies. An interrupted synchronizing signal is transmitted to the input circuits of tubes S_1, S_2 . . . S_N and simultaneously through filter F_1 and over line L to the corresponding units such as tubes S_1', S_2', . . . S_N', at the receiving station. As these tubes are successively operated and quenched, thus closing and opening transmission paths, 1, 2 . . . N, the output of oscillator O is transmitted over the line L in varying intensity, amplified by the common amplifier A at the receiving station and distributed to the proper transmission paths and glow tubes. The keys and resistances at the transmitting station may be replaced by photoelectric cells or other devices whose resistance varies with the intensity of light falling upon them, thus controlling the output of oscillator O.

The detailed operation of the system is as follows: When key 6 is closed energy from source 7 is transmitted through interrupter 5 and key 6, transformer 8 and over leads 9 to the input rectifier circuits of all the tubes S_1, S_2, . . . S_N. At the same time this frequency is transmitted through filter F_1 to the line L and thus to the receiving station where a corresponding filter F_1' and transformer 8' are provided. The signals are then applied to the input rectifier circuits of receiving tubes S_1', S_2', . . . S_N' operating these in synchronism with those at the transmitting station.

At the transmitting station tubes S_2 and all succeeding tubes are provided with two input rectifier circuits in series which are so arranged that each of these tubes requires energy to be supplied from the preceding auxiliary tubes S_{11}, S_{12}, etc., in addition to the synchronizing voltage from source 7, in order to be operated. Tube S_1, however, is operated at the first spurt of synchronizing voltage transmitted from source 7 by interrupter 5. The alternating current voltage is transmitted over leads 9, through transformer 10, rectified by rectifier 11 and causes condenser 13 to be charged through resistance 12. The voltage across condenser 13 is opposite in polarity to that of battery 14 and causes the grid potential to become more positive until the voltage is reached at which ionization occurs in tube S_1, establishing an arc between anode and cathode and closing the plate circuit of oscillator O through key T_1, resistance R_1, condensers C and tuned circuit L_1C_1. The value of resistance R_1 will determine the output of oscillator O which is transmitted through filter F_2 and over line L during the time that tube S_1 is operated. When the arc is established in tube S_1 the circuit through transformers 15 and 16 and condensers 17 is also closed and attenuating current voltage from source 18 is then transmitted to the grid-cathode circuit of tube S_{11} causing it to ionize and close the circuit through transformers 19 and 20 and condenser 22. Voltage from source 21 is then applied through these transformers to the rectifier circuit comprising rectifier 23, resistance 24, condenser 25, and resistances 26 and 27, charging condenser 25 and causing current to flow through resistances 26 and 27. The voltage drop across resistance 27 is opposed to the voltage of battery 28 and when the resultant anode potential is sufficiently reduced the arc in the tube S_1 is quenched, opening the plate circuit of oscillator O and cutting off the current transmitted over line L. The values of resistances 24, 26 and 27 and condenser 25 are so chosen that tube S_1 is quenched before the next spurt of synchronizing current is received from source 7. Energy from source 21 is also transmitted to the rectifier circuit associated with tube S_2 consisting of rectifier 29, resistance 30, condenser 31, and resistances 32 and 33. A voltage drop is produced across resistance 33 in the same manner as described above for resistance 27. The voltage drop across resistance 33 is controlled, however, to be not sufficient in itself to cause ionization of S_2. When the second spurt of synchronizing voltage is impressed on the input rectifier circuit of tube S_2 the voltage produced across condenser 37 by rectifier 35 supplies the additional voltage necessary to operate tube S_2 which closes the plate circuit of oscillator O through key T_2, resistance R_2, condensers C and tuned circuit L_1C_1. The output of oscillator O then depends on the value of resistance R_2. The operation of tube S_2 causes the operation of tube S_{12} in a manner similar to that described above for tubes S_1 and S_{11} and tube S_2 is quenched in like manner before the next spurt of synchronizing voltage. The closing of the succeeding paths occurs similarly, each path being closed only at the application of successive spurts of synchronizing voltage, and being opened by the action of the preceding auxiliary tube before the next tube operates. Since the auxiliary tubes S_{11}, S_{12}, etc., remain operated, tubes S_1, S_2, etc., are prevented from operating more than once in a cycle of operations. When tube S_N is operated, voltage is applied from source 38 through transformers 39 and 40 to the rectifier circuits associated with the anode circuits of all the auxiliary tubes S_{11}, S_{12}, etc. These are then quenched simultaneously in a manner similar to that described above for tube S_1. Voltage from source 38 is also applied to the rectifier associated with the anode circuit of tube S_N itself, which is quenched after all the auxiliary tubes but before the next spurt of synchronizing voltage. Tube S_1 is now ready to be operated by the next spurt and the cycle will be repeated as

described above, successive tubes operating on successive spurts.

At the receiving station the synchronizing signals are transmitted through filter F_1' and transformer 8' and are applied to the input rectifier circuits of tubes S_1', S_2', . . . S_N' causing these tubes to operate in synchronism with the corresponding tubes at the transmitting station. As the successive transmission paths are closed, the varying signals of frequency transmitted through filters F_2 and F_2' from oscillator O are amplified by the common amplifier A whose output passes through transformers 41 into transmission paths including signal devices G_1, G_2, . . . G_N, such as lamps or glow tubes, which are then operated with intensities depending on the values of the corresponding resistances R_1, R_2, . . . R_N at the transmitting station.

In Figs. 3 and 4, with Fig. 4 placed to the right of Fig. 3, are shown arrangements of the invention for scanning large areas as in telephoto or television use. In the arrangement of Fig. 3 auxiliary distributors D_1, D_2, . . . D_N are provided each one scanning individual areas, such as U_1, U_2, . . . U_N, covering the total area desired to be scanned. Each of the auxiliary distributors, such as D_1, would comprise a combination of gas-filled tubes A_1, A_{11}, . . . A_N similar in arrangement respectively to the set of gas-filled tubes shown in Fig. 1 and designated S_1, S_{11}, . . . S_N. Instead of the tubes in auxiliary distributor D_1 being adapted to close circuits through the switches T_1, T_2, etc., these tubes would each close circuits for photoelectric cells or light responsive devices. For example, the tubes of D_1 would close circuits for the photoelectric cells, such as 60, 61, etc., of individual area U_1. The tubes of distributor D_2 would close circuits through the light responsive devices of area U_2. At the transmitting station there would be provided arrangements identical with those of Fig. 1 except that the operation of tube S_1 would extend the operating circuit of the oscillator O to the distributor D_1. The oscillator circuit would then be completed by the operation of the tubes, such as A_1, etc., through the various light responsive devices. Depending upon the operation of these light responsive devices the strength of the current transmitted out over the line from oscillator O would be varied. The tubes, A_1, A_2, . . . A_N of the distributor D_1 would operate through one complete cycle under control of current from source 72 and interrupter 71. After the completion of the cycle of operations of D_1 the area U_1 will have been scanned. The tube S_1 will be adjusted to their release and S_2 will operate. This will connect the oscillator O to the distributor D_2 which will be similar to D_1 and the area U_2 will be scanned. This process will continue until all of the individual areas have been scanned. Obviously to effect the various light responsive devices in the various areas the image of the whole area may be focused or reflected on these cells.

At the receiving end of the system as shown in Fig. 4 there would be provided arrangements such as those shown in Fig. 2. For example, there would be provided a filter F_2 transmitting current from the distant oscillator O to the common amplifier A. The output circuit of the amplifier would be extended through a series of tubes such as S_1' . . . S_N', operated in synchronism with the tubes S_1 . . . S_N in Fig. 3 by the synchronizing current transmitted through filters F_1 from source 7 and interrupter 5 of Fig. 3. The cathode-anode circuit of each of the tubes S_1' . . . S_N' would be extended or completed through the tubes of the distributors D_1' . . . D_N' respectively. Each of these distributors would comprise a set of tubes corresponding in action to the tubes of the corresponding distributors D_1 . . . D_N of Fig. 3. For example, tubes A_1' . . . A_N' of distributor D_1' would correspond to tubes A_1 . . . A_N of distributor D_1. The individual tubes of each of the distributors D_1' will have their circuits completed through individual glow tubes in the area U_1' . . . U_N' corresponding to areas U_1 . . . U_N of the area scanned. In this manner the effect of the oscillator current controlled by the light responsive devices in the total area scanned will be reproduced by the glow tubes at the receiving station and the image will be thereupon reproduced.

Obviously it will be necessary for the individual tubes of each of the distributors D_1' . . . D_N' to operate in synchronism with the tubes of the corresponding distributors D_1 . . . D_N. The operation of the tubes of distributors D_1 . . . D_N is controlled by pulses of current applied to leads 73 from the source 72 and interrupter 71. Interrupter 71 may be connected by shafts and gears 70 to interrupter 5. The gear ratio will be N to 1. N will represent the number of elements in each of the individual areas to be scanned, such as area U_1, or in other words the total number of tubes such as A_1 . . . N_N in each of the distributors. Current from source 72 and interrupter 71 is transmitted through filters F_3 and over the line and applied to the grid circuits of the individual tubes of each of the distributors D_1' . . . D_N' in a manner similar to that shown in Fig. 3. With such an arrangement the tubes of corresponding distributors will operate in synchronism with each other. As heretofore pointed out current from source 7 and interrupter 5 transmitted through filters F_1 keeps tubes S_1 . . . S_N and tubes S_1' . . . S_N' in synchronism. Other means

for keeping the tubes operating in synchronism may be used if desired.

This invention also provides a means for operating printing telegraph apparatus without requiring a mechanically moving rotary distributor of the type heretofore employed. Referring to Fig. 1, key 6 may be used as the starting key, while contacts T_1, T_2 . . . T_N represent the contacts in a tape transmitter, of the type well known in the art, which is ordinarily used to transmit printing telegraph signals from perforated tape. In the ordinary case of 5-unit Baudot code N would therefore be five. At the receiving station, as shown in Fig. 2, the lamps G_1 to G_N would be replaced by the electromagnets of the receiving teletypewriter, rectifiers of a suitable type being provided to convert the alternating current to direct current adapted to operate the electromagnets. It is at once apparent that the arrangements shown in Figs. 1 and 2 are readily applicable to the printing telegraph art and enable a group of gas-filled discharge tubes to replace the mechanically operated rotating distributors heretofore employed.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A signaling system comprising a line extending from a transmitting station to a receiving station, an oscillator associated with said line at said transmitting station, means for applying a synchronizing current to said line at said transmitting station, a series of gas-filled discharge tubes at said transmitting station adapted to be operated in sequence by said synchronizing current, means for causing each of said tubes to release before the succeeding tube of the series is operated, means controlled by each of said tubes for closing individual operating circuits for said oscillator, means for varying the resistance of each of said individual operating circuits of said oscillator, a series of gas-filled discharge tubes at said receiving station corresponding to said series of tubes at said transmitting station and sequentially operated by said synchronizing current in synchronism with the tubes at said transmitting station, signaling means individual to each of said tubes at said receiving station, and means controlled by each of the tubes at said receiving station for operatively connecting its individual signaling means to said line.

2. A signaling system comprising a line, transmitting apparatus associated with said line, said transmitting apparatus comprising, an oscillator associated with said line, means for applying pulses of synchronizing current to said line, a series of gas-filled discharge tubes, means for applying said pulsating synchronizing current to said tubes, the first tube of said series being adjusted so that it will normally be operated by the voltage of the first pulse of said synchronizing current and the other tubes being adjusted so that they normally will not be operated by the voltage of said synchronizing current, auxiliary gas-filled discharge tubes individual to the tubes of said series and adapted to be operated thereby, means controlled by each of said auxiliary tubes when operated for releasing its operating tube before the next succeeding pulse of synchronizing current has been transmitted, and for adjusting the next succeeding tube in the series so that it will be operated on the voltage of the next succeeding pulse of said synchronizing current, means controlled by each of the tubes of said series for closing individual operating circuits for said oscillator, means for varying the resistance of each of said individual operating circuits of said oscillator, and receiving apparatus associated with said line, said receiving apparatus comprising a series of gas-filled discharge tubes corresponding to the tubes of said transmitting apparatus and operated by said synchronizing current in synchronism with the tubes of said transmitting apparatus, and receiving circuits controlled by said series of tubes in said receiving apparatus.

3. A signaling system comprising a line extending from a transmitting station to a receiving station, a series of gas-filled discharge tubes at said transmitting station, signaling circuits individual to each of the tubes of said series and each adapted to be operatively associated with said line by the operation of each of the tubes of said series, signal transmitting devices in each of said individual signaling circuits, means for operating and releasing the tubes of said series sequentially, a series of gas-filled discharge tubes at said receiving station corresponding to the tubes of said series at said transmitting station, means for operating the tubes of said series at said receiving station in synchronism with the tubes of said series at said sending station, and signal responsive means individual to and controlled by each of the tubes of said series at said receiving station.

4. A signaling system comprising a line extending from a transmitting station to a receiving station, an oscillator associated with said line at said transmitting station, means for applying a synchronizing current to said line at said transmitting station, a series of gas-filled discharge tubes at said transmitting station adapted to be operated in sequence by said synchronizing current, means for causing each of said tubes to release before the succeeding tube of the series is oper-

ated, means controlled by each of said tubes for closing individual operating circuits for said oscillator, individual light responsive devices for varying the resistance of each of said individual operating circuits of said oscillator, a series of gas-filled discharge tubes at said receiving station corresponding to said series of tubes at said transmitting station and sequentially operated by said synchronizing current in synchronism with the tubes at said transmitting station, visual signaling means individual to each of said tubes at said receiving station, and means controlled by each of the tubes at said receiving station for operatively connecting its individual visual signaling means to said line.

5. A signaling system comprising a line, transmitting apparatus associated with said line, said transmitting apparatus comprising an oscillator associated with said line, a series of gas-filled discharge tubes, means for operating and releasing the tubes of said series in sequence, means for extending the operating circuit of said oscillator over the cathode-anode circuits of each of the tubes of said series when operated, a distributor associated with each of the tubes of said series, each of said distributors comprising a series of gas-filled discharge tubes adapted to be operated and released in sequence, means for extending the operating circuit of said oscillator from the cathode-anode circuits of each of the tubes of said first series over the cathode-anode circuits of the series of tubes when operated in the distributor associated therewith, signaling circuits individual to each of the tubes of each of said distributors for completing the cathode-anode circuits of each of said tubes, receiving apparatus associated with said line, said receiving apparatus comprising a plurality of gas-filled tubes associated with said line and corresponding in number and arrangement and operating in synchronism with the gas-filled tubes of said transmitting apparatus, and signal responsive circuits controlled by the tubes at said receiving station.

6. A signaling system comprising a line, transmitting apparatus associated with said line, said transmitting apparatus comprising an oscillator associated with said line, a master series of gas-filled discharge tubes, means for applying to said line and to said master series of tubes a synchronizing current of a first frequency for operating and releasing the tubes of said series in sequence, means for extending the operating circuit of said oscillator over the cathode-anode circiuts of each of the tubes of said master series when operated, a distributor associated with each of the tubes of said master series, each of said distributors comprising a series of gas-filled discharge tubes, means for applying to said line and to each of said distributors a synchronizing current of a second frequency whereby the tubes of each series in each distributor may be operated in sequence and so that each series of tubes will complete one cycle of operations while individual ones of the tubes of said master series are operated, means for extending the operating circuit of said oscillator from the cathode-anode circuits of each of the tubes of said master series over the cathode-anode circuits of the series of tubes when operated in the distributor associated therewith, signaling circuits individual to each of the tubes of each of said distributors for completing the cathode-anode circuits of each of said tubes, a receiving circuit associated with said line, a second master series of gas-filled discharge tubes corresponding to the tubes of said first master series, means for applying to the tubes of said second master series the synchronizing current of said first frequency to cause said tubes to operate and release in synchronism with the tubes of said first master series, means for extending said receiving circuit over the cathode-anode circuits of each of the tubes of said second master series when operated, a distributor associated with each of the tubes of said second master series, each of said distributors comprising a series of gas-filled discharge tubes similar to the series of tubes in the corresponding distributors of said transmitting apparatus, means for applying to each of said last mentioned distributors said synchronizing current of said second frequency whereby the tubes of said distributors will operate in synchronism with the tubes of said distrbutors of said transmitting apparatus, means for extending said receiving circuit from the cathode-anode circuits of each of the tubes of said second master series over the cathode-anode circuits of the series of tubes when operated in the distributor associated therewith, and signaling circuits individual to and controlled by each of the tubes of each of said distributors of said receiving apparatus.

In testimony whereof, I have signed my name to this specification this 29th day of September 1932.

CHARLES S. DEMAREST.