Oct. 6, 1936. C. S. DEMAREST 2,056,346

SIGNALING SYSTEM

Filed Feb. 1, 1935 10 Sheets-Sheet 1

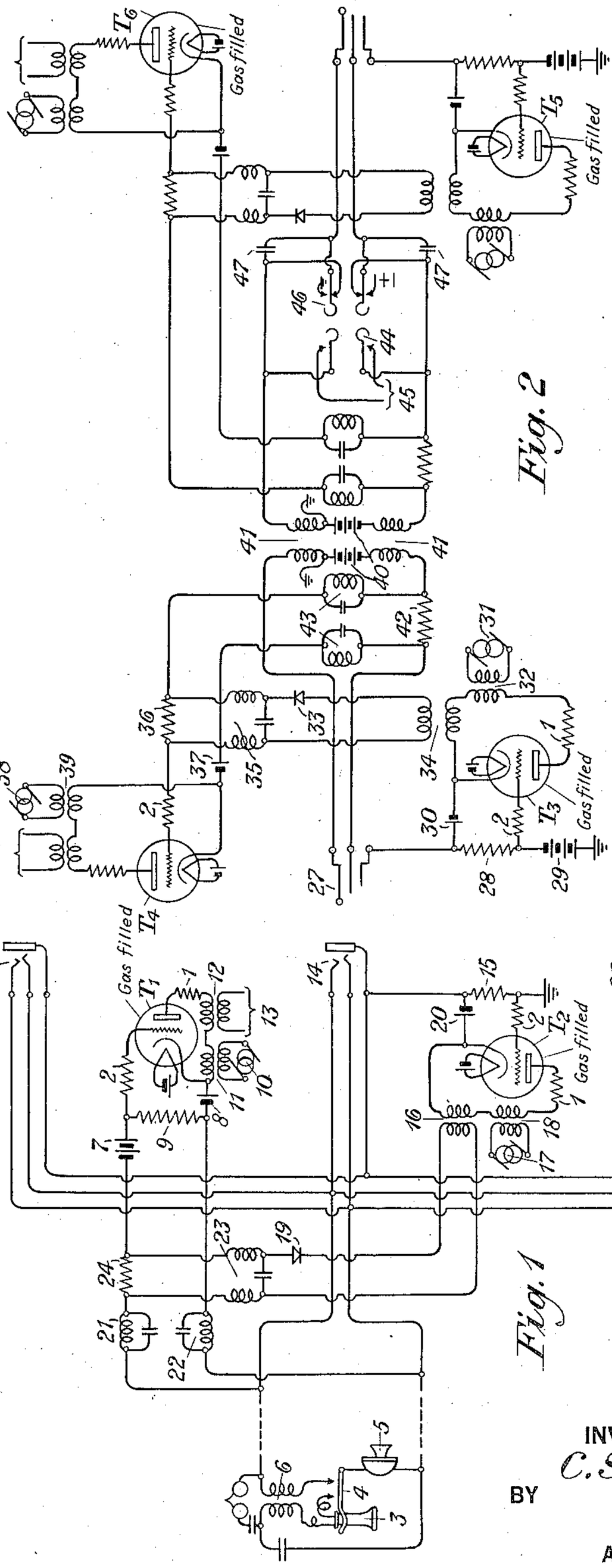

Fig. 2

Fig. 1

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SIGNALING SYSTEM

Filed Feb. 1, 1935 10 Sheets-Sheet 2

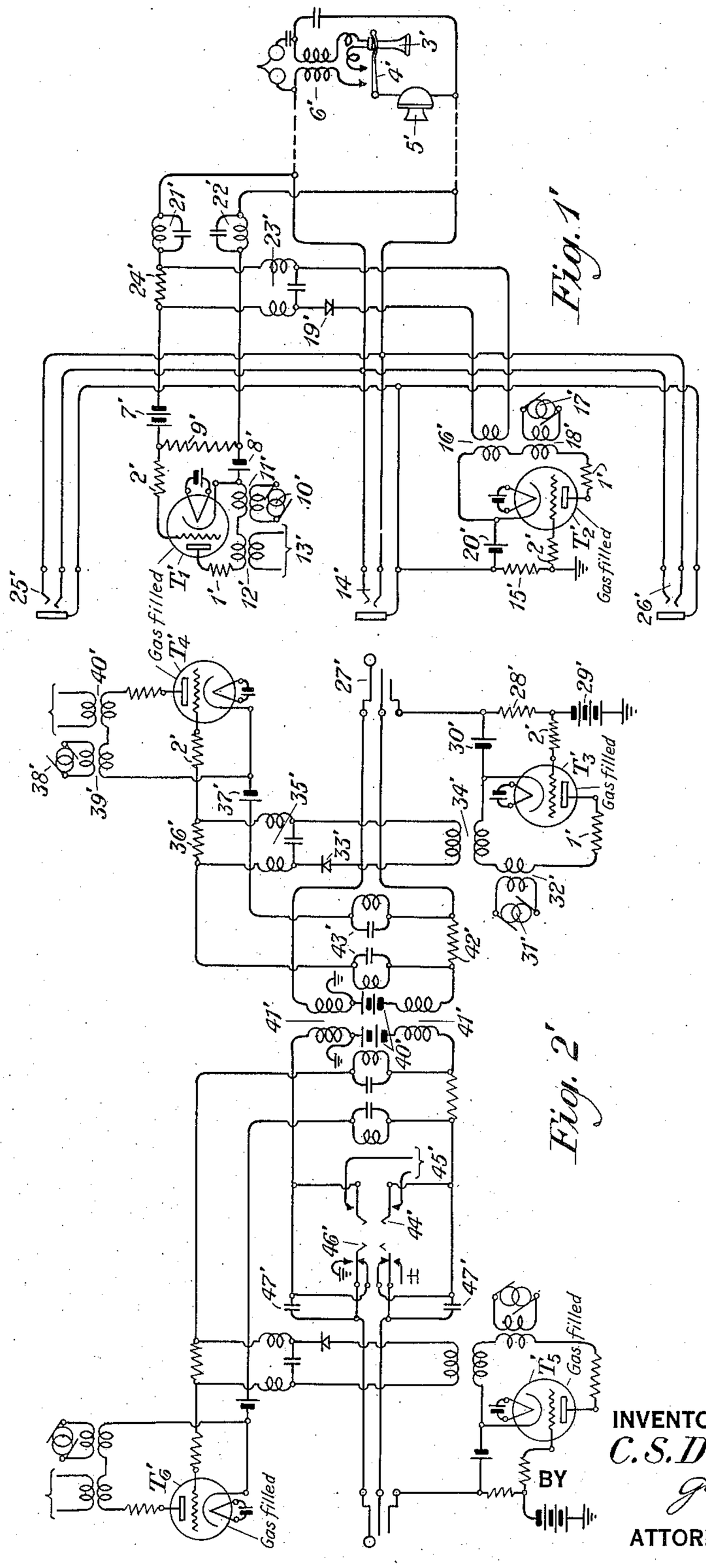

Fig. 1'

Fig. 2'

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SIGNALING SYSTEM

Filed Feb. 1, 1935 10 Sheets-Sheet 3

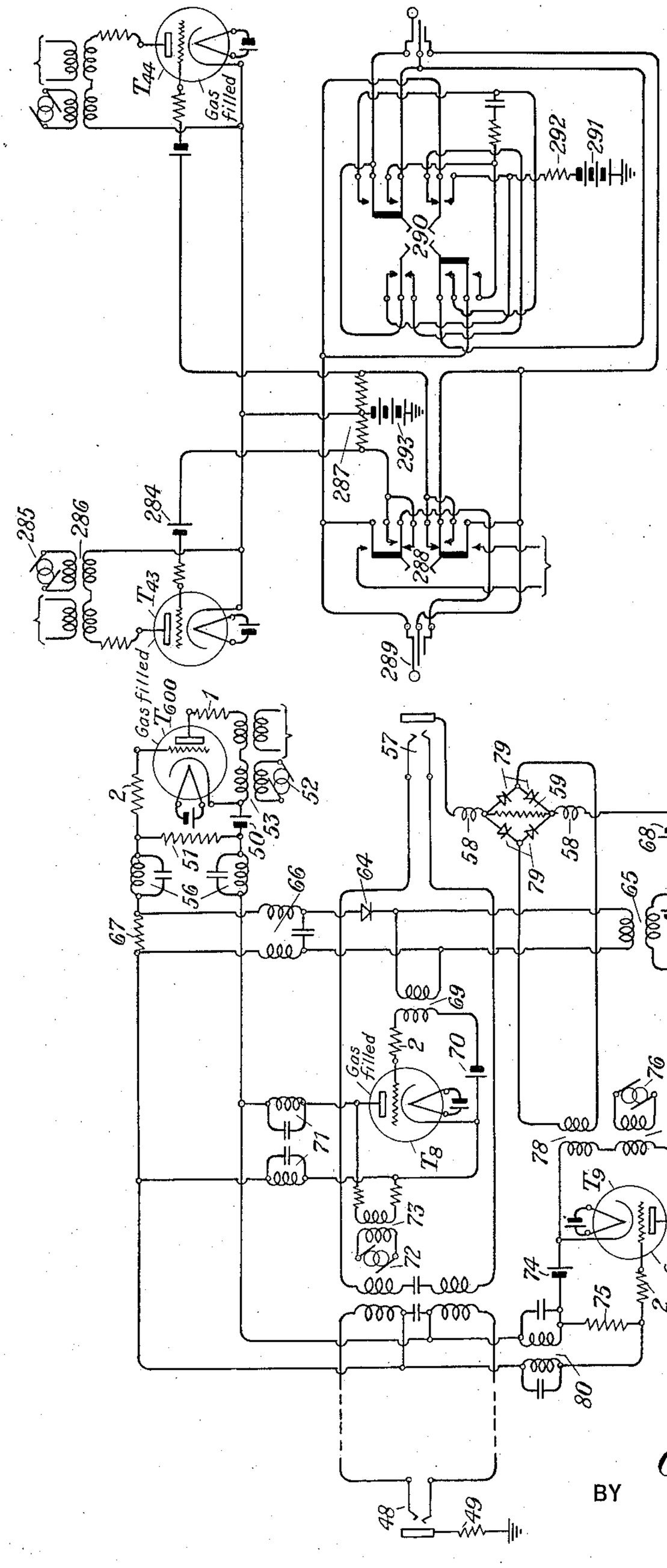

Fig. 6.

Fig. 3

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SIGNALING SYSTEM

Filed Feb. 1, 1935 10 Sheets-Sheet 4

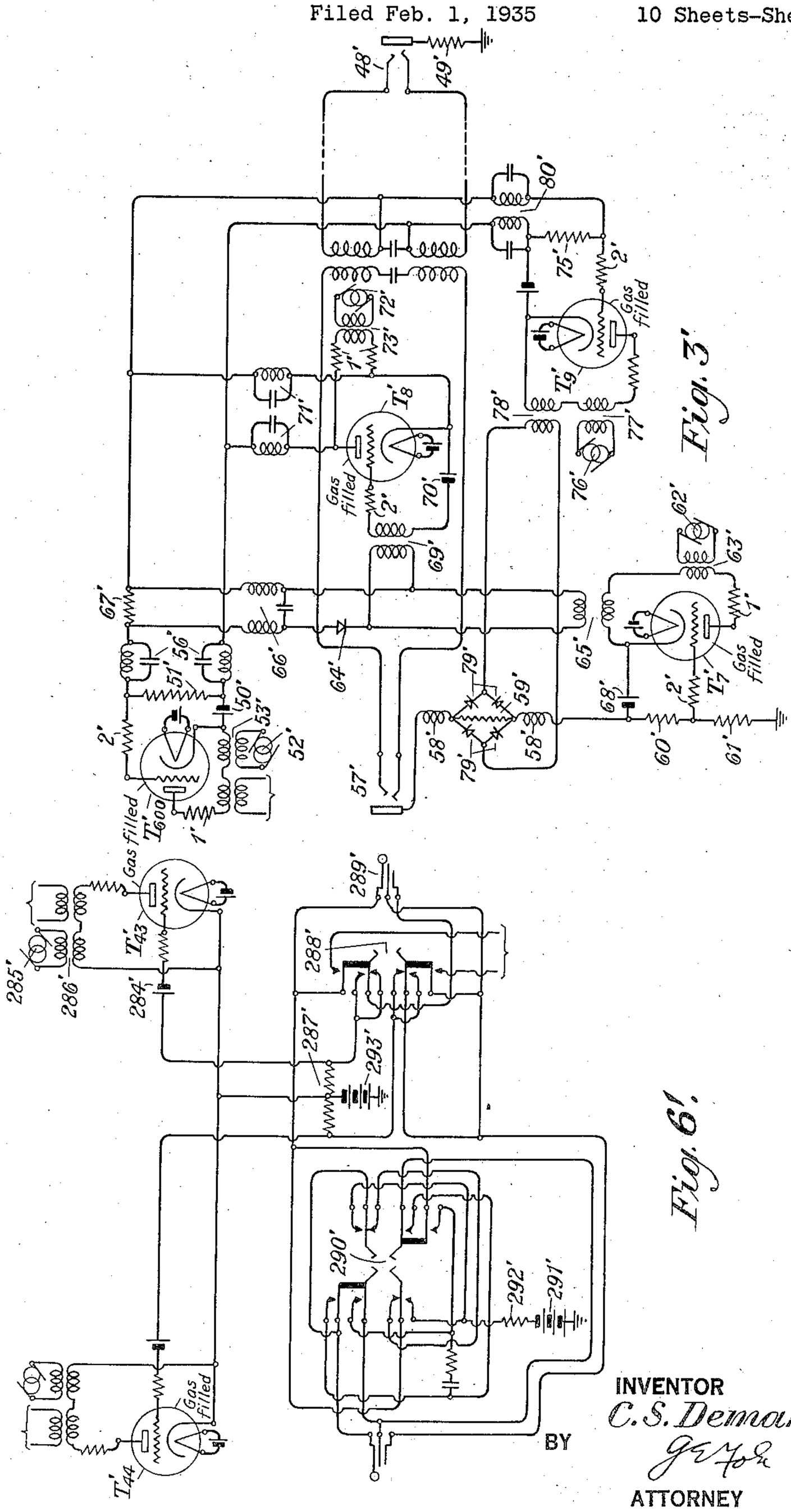

Fig. 3.

Fig. 6.

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SIGNALING SYSTEM

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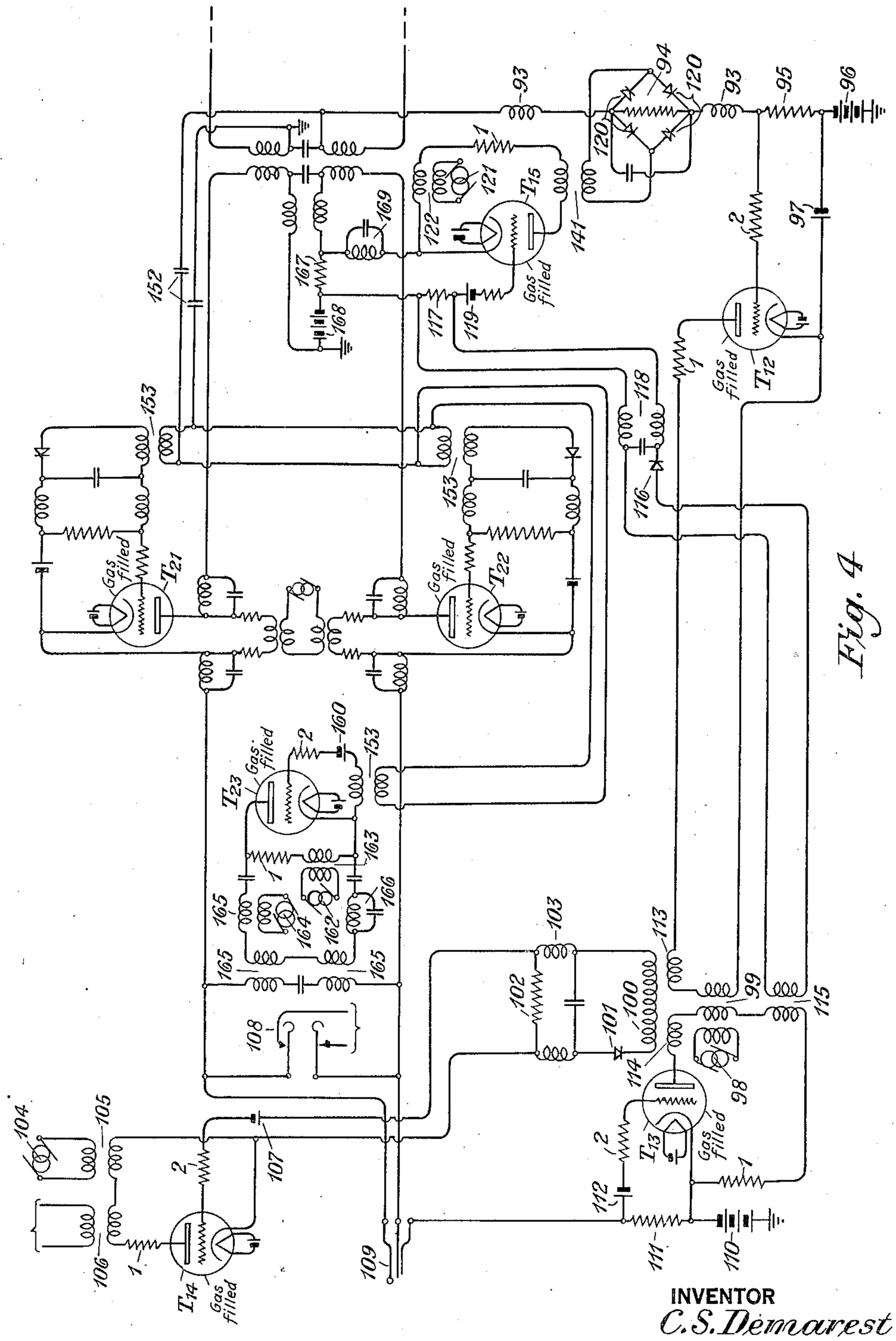

Fig. 4

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SIGNALING SYSTEM

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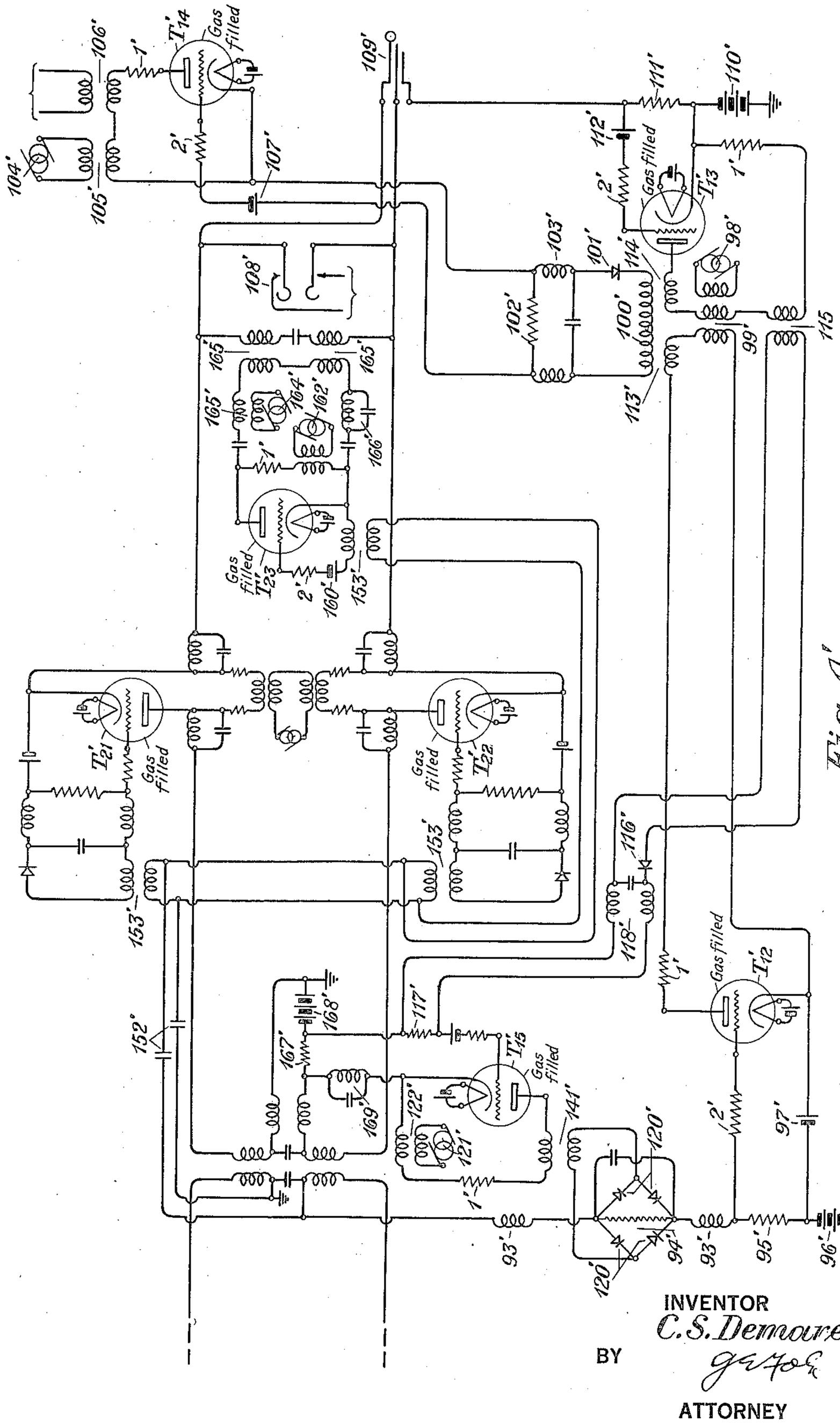

Fig. 4'

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SIGNALING SYSTEM

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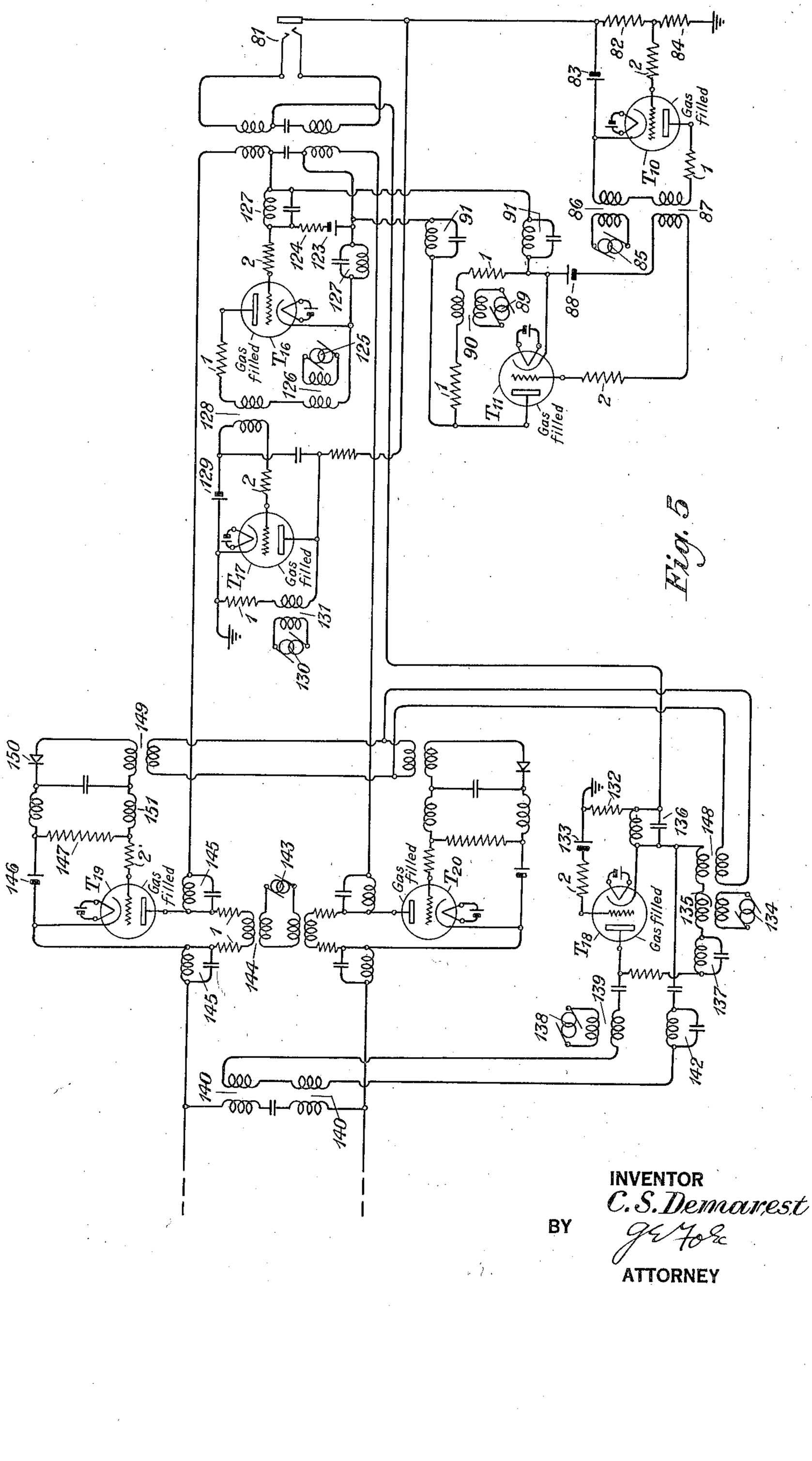

Fig. 5

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SIGNALING SYSTEM

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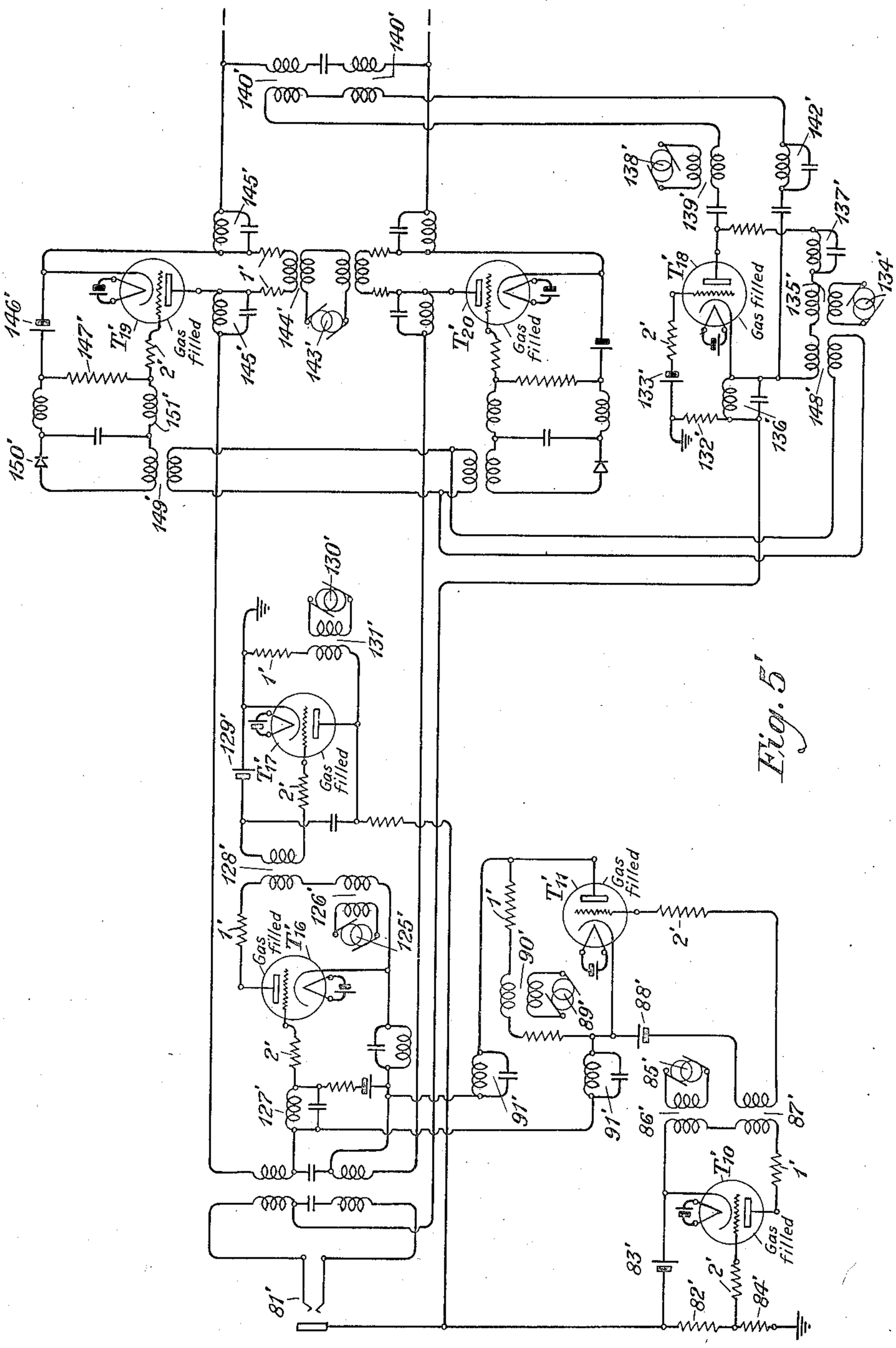

Fig. 5'

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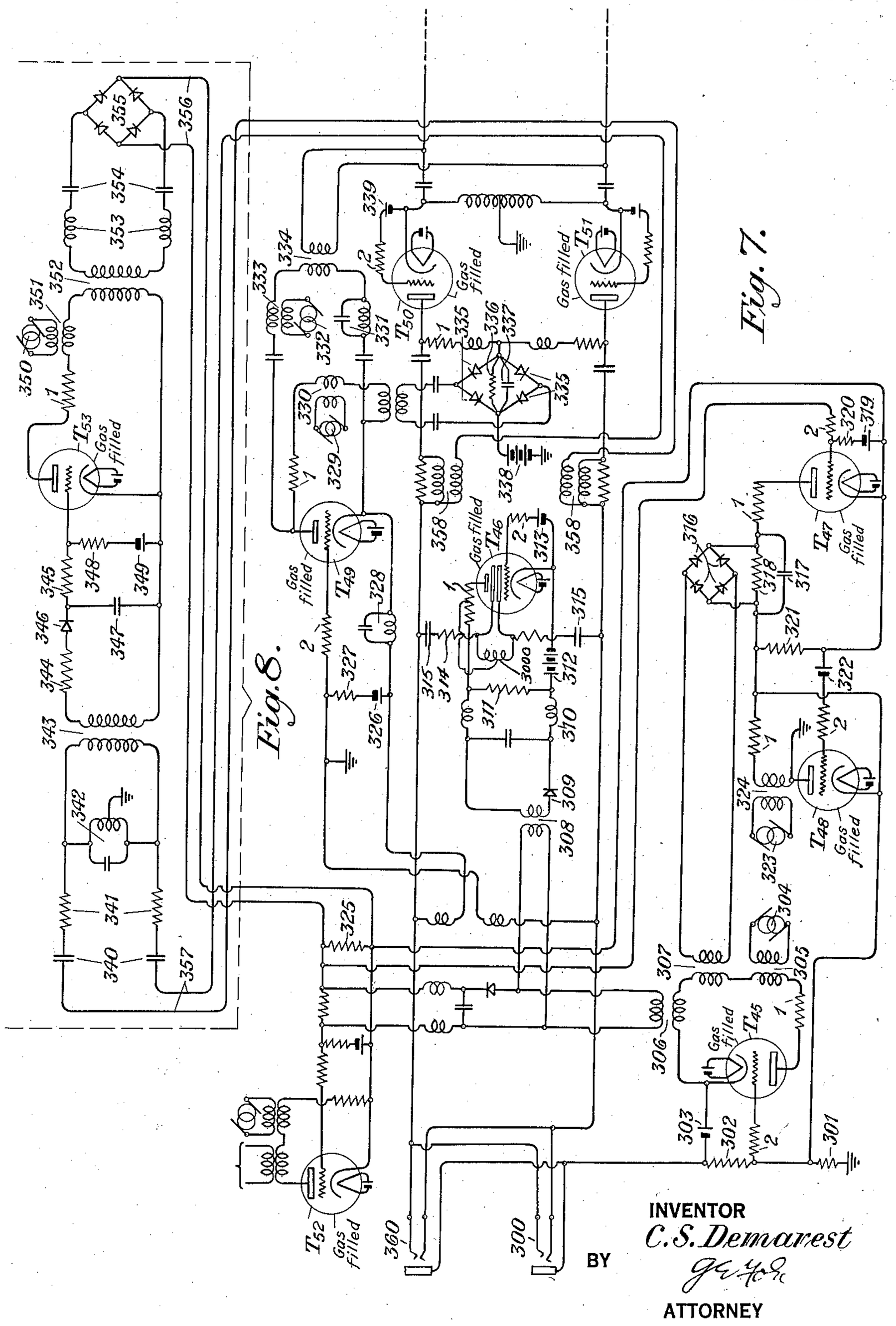

Fig. 8.

Fig. 7.

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SIGNALING SYSTEM

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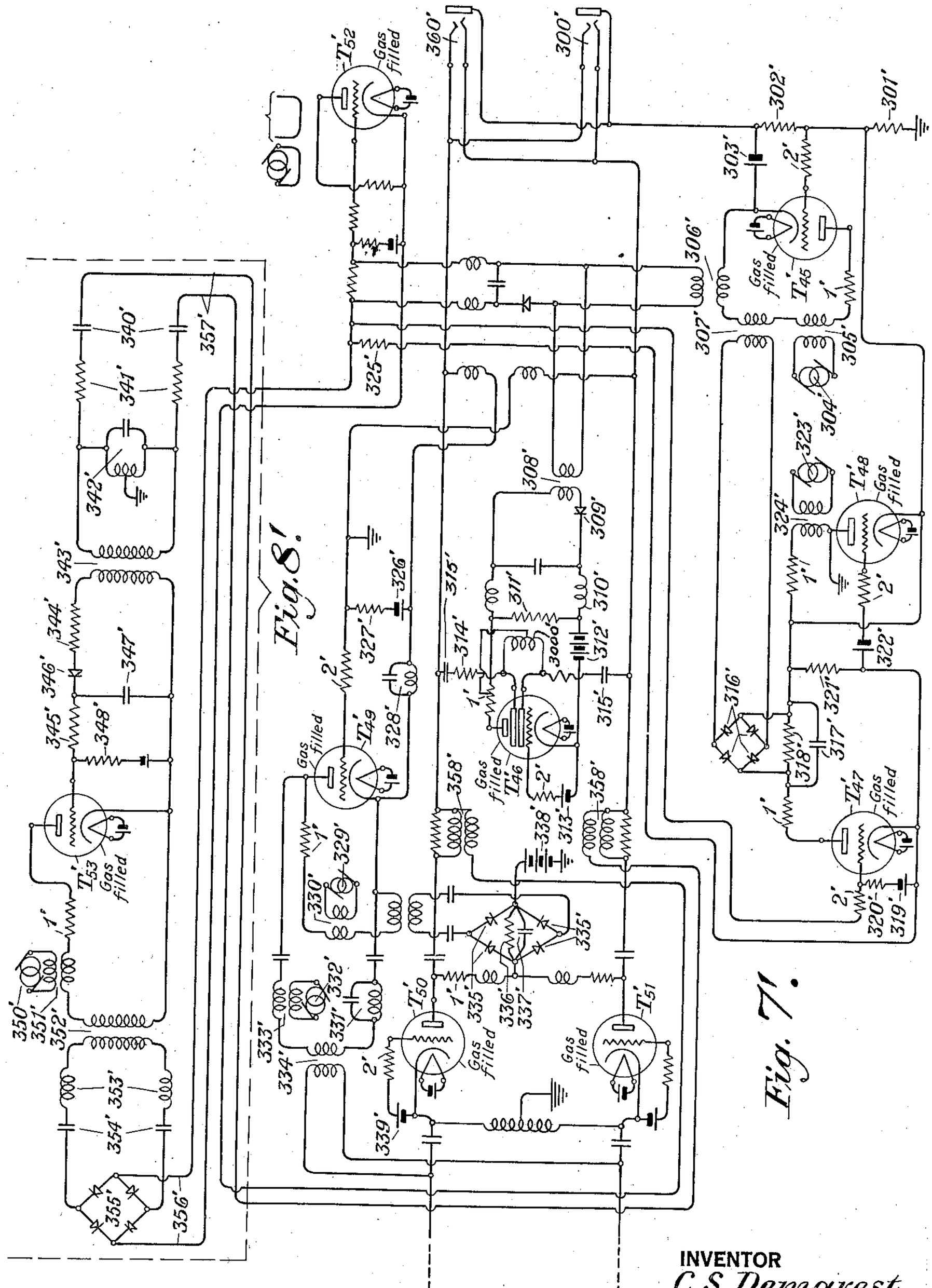

Fig. 8.

Fig. 7.

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Patented Oct. 6, 1936 2,056,346

UNITED STATES PATENT OFFICE

2,056,346

SIGNALING SYSTEM

Charles S. Demarest, Ridgewood, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application February 1, 1935, Serial No. 4,582

14 Claims. (Cl. 179—45)

This invention relates to transmission systems and more particularly to improved means for signaling over such systems.

As the invention is particularly adapted for use in signaling over certain types of long distance telephone circuits, it will be specifically described herein with respect to the type of toll circuit termed a ring-down toll circuit. In the ring-down type of toll circuit, the outgoing toll operator has direct supervision of the calling party only, whereas the distant or incoming toll operator retains the supervision of the called party. While the invention is described with respect to this type of toll circuit, it is understood that it is for the purpose of illustration only and that the arrangements of the invention may be used with other types of transmission systems.

The signaling and control arrangements in toll circuits heretofore used employ direct current, low-frequency alternating current, or voice-frequency alternating current or any combination of these which may be necessary to operate electromagnetic relays and other devices requiring mechanically moving parts for contact-making and contact-breaking devices either directly or with the aid of associated apparatus. Such apparatus requires mechanical adjustment which sometimes necessitates considerable maintenance in practice. The speed of operation of mechanical devices is limited by the weight of the moving parts or by the time required to build up a magnetic field in the electromagnetic field. This may limit the application of such devices because of the slowness of operation. In some cases, marginal operation is employed to perform certain operations. The number of margins which are permissible when electromagnetic devices are employed is limited. It is difficult to devise electromagnetic devices which will operate successfully at any but relatively low frequencies. This factor limits the possible uses of various frequencies as means of signaling over telephone circuits. The signaling and control arrangements now available for telephone systems, therefore, are somewhat limited in the number of variables which may be employed to perform various necessary functions.

In the arrangements of this invention, gas-filled discharge tubes together with circuits designed therefor are utilized to replace all electromagnetic devices. Gas-filled discharge tubes are capable of response to currents of relatively high frequencies as well as low frequencies and direct current. Accordingly, the combination of gas-filled tubes and circuit arrangements therefor result in a signaling system applicable to transmission circuits which is superior to the relay arrangements of the prior art, since the number of frequencies which may be employed and, consequently, the variety of functions obtainable is greatly increased. Moreover, in accordance with this invention, the gas-filled tubes and circuit arrangements therefor are of such design that the tube can be caused to operate or release as the circuit may require by means of the application of carrier frequency, alternating current, alternating currents of lower frequency or direct currents of the proper polarity. The direct current may be supplied by either the primary or secondary cells through resistance units or alternating current which has been rectified by means of rectox units, vacuum tube or gas-filled rectifiers or by any other rectifying device, several of which are well known in the art. Furthermore, in accordance with the arrangements of this invention, more precise and constant specific time of operation is obtained through the use of gas-filled tubes and their associated circuits than can be obtained by using a system of electromagnetic relays. Also, the gas-filled tube circuits are capable of being faster acting than the electromagnetic equipment. The gas-filled tube, and circuit therefor, adapts itself readily to marginal operation.

The invention may be more fully understood from the following description together with the accompanying drawings, in the Figures 1, 2, 3, 4, 5, 6, 7, 8, 1′, 2′, 3′, 4′, 5′, 6′, 7′ and 8′ of which are shown circuit diagrams embodying one form of the invention. Fig. 1 is a circuit diagram showing a local subscriber's line connecting the subscriber to a local office. In the drawings, Fig. 2 should be placed to the right of Fig. 1. Fig. 2 shows a cord circuit for the operator at the local office. In the drawings, Fig. 3 is placed to the right of Fig. 2. Fig. 3 shows a recording trunk for interconnecting the local office with a toll office. In the drawings, Fig. 6 is placed to the right of Fig. 3. Fig. 6 shows a cord circuit for the operator at the toll office. In the drawings, Figs. 7 and 8 are placed to the right of Fig. 6. Figs. 7 and 8 show the terminal apparatus associated with the toll line at one office. Figs. 4 and 5 show a toll switching trunk when Fig. 5 is placed on the right of Fig. 4. This toll switching trunk may be used to establish a connection between a local subscriber's line such as shown in Fig. 1 and a toll operator's cord cir-

cuit such as shown in Fig. 6. At the distant end of the line, the Figs. 7′ and 8′ show terminal equipment associated with the toll line at the distant station. Fig. 6′ is placed to the right of Fig. 7′ and illustrates a cord circuit for the toll operator at the distant toll station. Figs. 4′ and 5′ with 4′ placed to the right of Fig. 5′ illustrate a toll switching trunk for establishing a connection from the distant toll office to the local office. Fig. 3′ is placed to the right of Fig. 6′ and shows a recording trunk for connecting the toll operator's cord circuit to the local office. Fig. 2′ is placed to the right of Fig. 3′ and shows the local operator's cord. Fig. 1′ is placed to the right of Fig. 2′ and shows the subscriber's circuit at the distant end of the connection. As Figs. 1′, 2′, 3′, 4′, 5′, 6′, 7′, and 8′ are identical with Figs. 1, 2, 3, 4, 5, 6, 7 and 8, respectively, similar reference characters with the added designation of prime have been utilized to denote like parts in corresponding figures.

While this invention has been described in one particular form, it is understood that the invention is not limited to the particular arrangement here described, but includes other and similar arrangements within the spirit and scope of the claims hereinafter made.

A brief description of the general operation of the circuits shown will now be given. When the subscriber lifts his receiver from the hook, a lamp appears at the local "A" operator's position. The operator plugs into the subscriber's line jack and determines the destination of the call. If the call is to be a toll call and is to pass over a ringdown toll line, the operator plugs into the proper two-wire recording trunk to the nearest toll office. This lights a lamp in front of the toll operator. She plugs into the recording trunk with a toll cord and determines the destination of the call. Then the toll operator plugs into the proper ringdown toll line with another toll cord and also plugs into a ringdown toll switching trunk back to the "B" board at the local office of the calling subscriber. This lights a lamp in front of the "B" operator. The toll operator instructs the local "B" operator to go into the subscriber's line jack over the busy test. The subscriber is now connected to the toll operator by means of the ringdown toll switching trunk and the toll operator pulls down from the two-wire recording trunk, thus giving a disconnect signal to the local "A" operator who disconnects the subscriber's cord from both the subscriber's line and the two-wire recording trunk. The toll operator must ring the distant toll operator by operating her ringing key in the proper direction. When she does this, a lamp appears in front of the distant toll operator, who answers by plugging a toll cord into the line jack. The distant operator, after learning the destination of the call, plugs into the proper ringdown toll switching trunk. This lights a lamp in front of the local "B" operator who answers the call. The called number is passed from the toll operator to the local "B" operator who connects the called party's line to the ringdown toll switching trunk. The toll operator receives an indication that the subscriber's line has been reached and then rings the subscriber.

When the calling subscriber hangs up, a disconnect lamp appears before the outward toll operator. She then disconnects from the toll switching trunk, causing a lamp to light in front of the local "B" operator who disconnects from the subscriber's line. At the called end, a lamp appears before the toll operator, indicating that the called party has hung up. She also disconnects from the toll switching trunk and a signal appears before the "B" operator who pulls down from the called subscriber's line. If the toll call has passed over more than one toll link, it is the duty of the outward toll operator to clear the circuit by ringing the various intermediate points. In doing so, a lamp appears before the intermediate operator and she is instructed to clear the circuit.

In the following detailed description of the invention the word "operate" or derivatives thereof will be used hereafter to indicate the process which takes place within the gas-filled tube when the gas contained inside the bulb ionizes and an arc is established from the cathode to the anode. The word "release" or derivatives thereof will be used hereafter in the description of this invention to indicate the extinction of the arc and the return of the gas to a deionized condition. Each of the gas-filled tubes in this invention has a protective resistance **1** in the plate circuit of the tube. This protective resistance is used to limit the current in the plate circuit to a suitable or a safe value. Furthermore, each gas-filled tube has a protective resistance **2** in the grid circuit in order to prevent the grid current of the tube from becoming excessive. Since these resistances are to be found associated with every tube, no further mention will be made of their purpose.

The type of gas-filled tube illustrated herein is of the heater type and the heater power is shown supplied by means of direct current. It is understood in this invention that the cathode is not necessarily of the heater type and the power supply is not limited to direct current. Furthermore, the gas-filled tube may be of the cold cathode type, under which conditions no heater or heater power would be required.

The types and characteristics of the gas-filled tubes used in this invention will be varied and numerous and each gas-filled tube employed will be of the type and have the characteristics which are essential and necessary to perform the functions which are required of the tube by the use to which it is specifically put.

One type of tube is of such physical dimensions that it is capable of being mounted in the switchboard in front of the operator. The gas content of this tube is of such a nature and pressure that a visual glow is present when the tube is operating. However, this type of tube may be used not only to give a visual indication but also perform some electrical function such as the completion of a circuit. For example, an electromagnetic relay might have its winding included in the plate circuit of the tube in place of the protective resistance **1** heretofore referred to and might be utilized under control of the tube for any desired purpose. This type of gas-filled tube will be referred to in this description as a "combined lamp and relay".

Another type of tube has five electrodes contained within the envelope. The cathode, grid and anode perform the same functions as in the three-element tube. In addition to these elements are two probes or plates. When the tube is in the non-operate or release condition, the resistance between these two probes or plates is very high but when the tube operates the resistance between these two probes or plates is relatively low. Hence, by properly connecting such

a tube in the circuit, the circuit may be completed through these probes or plates. This type of tube will be referred to in this description as a "five-element tube".

The other types of tubes employed in this invention are of such physical characteristics and have such gas and gas pressure within the envelope as to meet the requirements which are set up by the circuit conditions.

In the embodiment of the invention described herein, certain gas-filled tubes are arranged for self-quenching by means of an alternating potential applied to the anode circuit from a separate source of alternating current. It is of course, within the scope of this invention to apply other quenching means to such tubes as may require the same in the practice of this invention. For example, the aforesaid tubes may be arranged to oscillate in such a manner that the plate current is interrupted once for each cycle of the operation. It would also be possible to provide auxiliary quenching tubes in such a manner that the discharge would be transferred from one of the main tubes to the auxiliary tube when required.

Certain gas-filled tubes described in this invention are so connected as to be associated with an auxiliary circuit. Connection is made to these auxiliary circuits through a transformer connected in the plate circuit of certain gas-filled tubes. The words "auxiliary circuit" are taken to mean such equipment as may not be required if the telephone circuit is to include the connections required for connecting together and giving service to only two subscribers, one at each end of the toll connection or local connection. This auxiliary circuit equipment would be necessary if more than the above mentioned subscribers were to be served. It is proposed in this description to indicate a method or methods of connecting such auxiliary equipment to the herein described telephone circuit.

Figure 1 is the subscriber's line circuit. Gas-filled tube T_1 is a combined lamp and relay. The operation of tube T_1 is under the control of the subscriber's switchhook and tube T_2, which is controlled by the sleeve circuit of jack **14**, **25** or **26**. When the subscriber lifts the receiver **3** from the switchhook **4**, the subscriber's line is short-circuited through one of the coils of the induction coil **6** and the telephone transmitter **5**. This short-circuit on the line applies the positive potential of battery **7** to the grid of tube T_1. The applied potential is of such a polarity as to cause the tube to operate. Tube T_1 is normally held released by the negative potential of battery **8** applied to the grid of tube T_1 through the resistance **9**. The plate of tube T_1 is supplied with an alternating potential by generator **10** through transformer **11**. The operation of the tube T_1 gives a visual signal to the operator and also allows plate current to flow in the plate circuit of the tube. This current induces a voltage in the secondary of transformer **12** which supplies an auxiliary circuit **13**, the purpose of which has been discussed previously. Anti-resonant circuits **21** and **22** consisting of suitable coils and condensers are placed in the input circuit of tube T_1 to prevent the alternating current which is supplied to the plate of the tube from being fed back into the telephone line. When the local "A" operator answers the call, she plugs into the subscriber's line jack **14**. This applies negative battery to the sleeve of the jack. The potential drop across resistance **15** in the sleeve circuit is such that tube T_2 operates. When tube T_2 operates, potential is supplied to rectifier **19** by transformer **16**. The plate supply of tube T_2 is supplied by alternator **17** through transformer **18**. Tube T_2 is held normally unoperated by a negative potential supplied by battery **20**. Unidirectional current supplied by rectifier **19** flows through filter **23** to resistance **24**. The potential drop across resistance **24** is in such a direction as to apply the proper polarity to the grid of tube T_1 to cause it to release, thus extinguishing the visible glow. Whenever a cord is plugged into any of the subscriber's line jacks, **14**, **25** or **26**, switchhook signals from the subscriber are transferred to the cord circuit and do not cause tube T_1 to operate. Jacks **25** and **26** are at inward positions or at the local "B" operator's position and the insertion of a plug in these jacks causes tube T_2 to operate and function in the circuit as described above. When the subscriber hangs the receiver **3** on hook **4**, the short circuit is removed from the subscriber's line and the potential of battery **7** is removed from the grid of tube T_1. Hence, when the cord is pulled out of either jack, **14**, **25** or **26**, tube T_1 will not operate and no visible signal is given to the local "A" operator by tube T_1. Should a cord be pulled out of either jack **14**, **25** or **26**, before the subscriber has placed his receiver on the hook, tube T_1 would operate and a visual signal would appear before the local "A" operator.

Figure 2 is the local operator's cord circuit which is available to the local "A" operator. The subscriber's cord circuit is used to answer calls from the calling subscriber and connect the subscriber to the toll operator if the call is to be a toll call. Incoming calls are answered by inserting plug **27** into the subscriber's line jack. This operation completes the sleeve circuit of the plug, thus allowing a current to flow from battery **29** through resistance **28**. The completion of the sleeve circuit applies a negative potential to the grid of tube T_3 of such a value that the tube is released. Tube T_3 is normally held operated by the positive potential of battery **30** being applied to the grid of the tube. Alternating potential from generator **31** is applied to the plate of tube T_3 through transformer **32**. When tube T_3 is operated, an alternating potential is applied to rectifier **33** through transformer **34**. The unidirectional voltage from rectifier **33** passes through filter **35** and is applied to resistance **36**. The potential applied across resistance **36** is in such a direction as to oppose the potential supplied by battery **37** to the grid of tube T_4. The potential supplied to the grid of tube T_4 from battery **37** is applied thereto through resistances **42** and **36**. Tube T_4 is accordingly normally released. When the subscriber's cord is plugged into a line jack tube T_3 will release as heretofore pointed out and this will tend to cause tube T_4 to operate. However, this operation of tube T_4 at this time will be prevented if the subscriber's receiver is off the hook as will be pointed out hereinafter. The tube T_4 is a combined lamp and relay and is so placed as to be visible to the operator. The alternating potential for tube T_4 is supplied by generator **38** through transformer **39**. Another transformer is used to connect the subscriber's cord circuit shown to auxiliary apparatus, the purpose of which has been discussed above. When the subscriber's receiver is off the hook, current from battery **40** is supplied to the subscriber's line through the repeating coil **41**. This current flows through resistance **42** in such a direction that the potential drop across this

resistance is in opposition to the potential applied to the grid by battery **37** and hence will cause a negative potential to be applied to the grid of tube T_4 thus releasing the tube. Anti-resonant circuits **43** are employed to prevent the alternating potential which is applied to the plate of tube T_4 from feeding back into the subscriber's line circuit. When the subscriber places the receiver on the hook, current ceases to flow through resistance **42** and tube T_4 will operate, thus giving a visual signal to the operator that the subscriber has completed the call. When the operator pulls plugs **27** out of the line jack, tube T_3 operates due to the ceasing of the current flow through resistance **28**. When tube T_3 operates, a potential is applied across resistance **36** in such a direction as to cause tube T_4 to be released. The tubes T_5 and T_6 and the equipment associated with them perform in a manner substantially similar to that described immediately above for tubes T_3 and T_4. This will be pointed out in more detail hereinafter. Key **44** is the key by which the operator can connect her telephone to the line circuit. The operator's telephone set and associated equipment are connected at **45**. Key **46** is a ringing key to apply ringing current to the subscriber's line should the "A" operator desire to call a subscriber. Condensers **47** are used to send audible ringing current back to the calling subscriber.

Figure 3 is the two-wire recording trunk which connects the local "A" operator to the toll operator. This is the trunk over which information is passed from the calling subscriber through the local operator to the toll operator. The trunk is not used to complete the call but the toll operator reaches the calling subscriber over a different type of trunk and the calling subscriber communicates with the called subscriber over the last mentioned trunk but not over a two-wire recording trunk. Signals are transmitted over this trunk only from the local "A" operator to the toll operator.

The local "A" operator reaches the toll operator by inserting the plug of the subscriber's cord circuit into jack **48**. Resistance **49** completes the sleeve circuit of this jack to ground. The plug of a subscriber's cord circuit is so wired that the tip has a positive and the ring a negative potential on it. The positive potential applied to the tip of the trunk places a positive potential on the grid of tube T_{600} causing it to operate. Tube T_{600} may be the type of combined lamp and relay which has been referred to previously. Tube T_{600} is normally held released by the potential of battery **50** applied to the grid of the tube through resistance **51**. The plate potential of tube T_{600} is supplied by generator **52** through transformer **53**. A transformer is used to connect this circuit with auxiliary apparatus. Anti-resonant circuits **56** prevent the alternating potential applied to the plate of the tube from going out to the line. When tube T_{600} operates, there is a visual indication to the toll operator that a call is waiting on that trunk. She inserts the plug of a toll cord into the jack **57**.

The sleeve circuit of jack **57** contains inductances **58** and resistances **59**, **60** and **61**. When the plug of the toll operator's cord circuit of Fig. 9 is inserted into the line jack **57**, current flows from battery **293** through resistance **60** in such a direction as to apply a positive potential to the grid of tube T_7, causing it to operate. Tube T_7 is held normally released by the negative potential supplied to the grid of this tube by battery **68**. Generator **62** supplies the alternating plate potential of the tube through transformer **63**. When the tube operates, alternating current is applied to rectifier **64** through transformer **65**. The unidirectional current from rectifier **64** flows through the filter **66** into the resistance **67**. The resulting potential across resistance **67** is in such a directon as to oppose the potential applied to the tip and ring of the line circuit by the subscriber's cord circuit. This releases tube T_{600}. When tube T_7 operates, alternating potential is applied to the grid of tube T_8 through transformers **65** and **69**. The tube T_8 is held normally released by the negative potential supplied by battery **70**. When tube T_8 operates, it applies a relatively low impedance across the tip and ring of the two-wire recording trunk through the anti-resonant circuits **71**. The placing of this low impedance across the tip and ring conductors of the recording trunk will allow current to flow from battery **40** through a resistance in the local A operator's cord circuit similar to resistance **42**, which in a manner similar to that described with respect to resistance **42** will apply a potential to tube T_6 so as to extinguish or release it. These anti-resonant circuits are placed in the leads to the trunk to prevent the alternating potential supplied to the tube by generator **72** through transformer **73** from being fed back into the trunk. When the toll operator has received the instructions concerning the call, she pulls down from the line jack **57**. This removes battery **293** from the sleeve of the jack and thus removes the potential drop across resistance **60**. Tube T_7 releases and removes the potential drop from across resistance **67** and also removes the voltage from the grid of tube T_8 causing it to release. The removal of the potential drop across resistance **67** will cause tube T_{600} to operate at this time and it will remain operated until the jack is removed from plug **48**. The release of tube T_8 removes the low impedance from across the two-wire recording trunk. This gives a visual indication to the local operator to remove her plug from the line jack of the recording trunk. When the local operator removes the subscriber's cord from the recording trunk, tube T_{600} is extinguished as referred to above.

The operation of tube T_9 will now be described. When the local operator inserted the subscriber's cord in the jack of the two-wire recording trunk, a positive potential was placed on the grid of tube T_9, causing it to operate. Tube T_9 is normally held released by the negative potential supplied by battery **74** through resistance **75**. The plate potential of tube T_9 is supplied by the generator **76** through transformer **77**. When an alternating current flows in the plate circuit of tube T_9, an alternating potential is applied to rectifier unit **79** by transformer **78**. The unidirectional current from rectifier **79** flows through resistance **59** in such a direction as to oppose the flow of current caused by the battery **293** in the sleeve circuit. The value of this potential, however, is not sufficiently great to prevent the operation of tube T_7, but it is of a sufficient value to make the sleeve circuit appear as a very high impedance circuit to the toll cord. Should the local operator remove the plug from jack **48** before the toll operator removes the plug from jack **57**, tube T_9 would be released, the counter voltage set up by the rectifier unit **79** would be removed, and the sleeve circuit would appear as a low impedance circuit. This would cause a visual signal at the toll operator's position in the toll cord circuit due to the operation of tube T_{43} as hereinafter de-

scribed. Anti-resonant circuits 80 are placed in the input circuit of tube T_9 to prevent the alternating potential supplied to the plate of that tube from feeding back into the two-wire recording trunk.

Figures 4 and 5 are the tool switching trunk circuits which are used to complete an outgoing or incoming call which is to be made over a ring-down toll line. These switching trunks are so designed that the supervision of the subscriber is transferred to the toll operater at the outward position. As has been heretofore pointed out the toll operator has connected her cord circuit, shown in Fig. 6, with the recording trunk of Fig. 3. When she ascertains what the long distance call is to be she will now plug into a toll switching trunk, such as shown in Figs. 4 and 5, with another toll cord circuit identical with that of Fig. 6. Instead of illustrating an additional cord circuit reference will be had to that shown in Fig. 6. Considering Figure 5, when the toll operator plugs into the line jack 81 with a plug such as 289 of toll cord such as shown in Fig. 6, battery 293 is supplied to the sleeve circuit such that the potential drop across resistance 82 is in the proper direction to cause tube T_{10} to operate. Tube 10 is normally held unoperated by the negative potential supplied by battery 83 to the grid of the tube. Resistance 84 in the sleeve circuit is a protective resistance. Alternating potential is supplied to the plate of tube T_{10} by the generator 85 through transformer 86. When tube T_{10} operates, an alternating potential is supplied to the grid of tube T_{11} by means of transformer 87. Tube T_{11} is held normally released by the negative potential supplied by battery 88 to the grid of the tube. Alternating potential is supplied to the plate of tube T_{11} by generator 89 through transformer 90. When tube T_{11} operates, a short circuit is applied to the tip and ring of the toll switching trunk through anti-resonant circuits 91. These anti-resonant circuits are used to prevent the alternating potential from generator 89 from being fed to the tip and ring of the trunk.

Referring to Fig. 4, the short circuit applied to the tip and ring of toll switching trunk by the operation of tube T_{11} causes the current from battery 96 to flow through inductances 93, resistances 94 and 95. When current flows through resistance 95, the potential drop across the resistance is in such a direction as to cause the operation of tube T_{12}. Tube T_{12} is held normally released by the potential supplied by battery 97. Alternating potential is applied to the plate of tube T_{12} by generator 98 through the three-winding transformer 99. This transformer also supplies the plate potential of tube T_{13}. When tube T_{12} operates, an alternating current flows through the plate circuit. This causes current to flow through the primary winding 113 of the three-winding transformer 100. Alternating potential from the secondary of this transformer is applied to rectifier unit 101 and a unidirectional potential results across resistance 102 which is supplied from this rectifier through filter 103. The unidirectional potential resulting across resistance 102 is in such a direction as to cause the operation of tube T_{14}. Tube T_{14} is a combined lamp and relay of the type which has been described above. Generator 104 supplies the alternating potential for the plate of tube T_{14} through transformer 105. Transformer 106 is inserted in the plate circuit of the tube T_{14} for the purpose of relaying signals to auxiliary apparatus. Tube T_{14} is held normally unoperated by the negative potential supplied to the grid of the tube by battery 107.

When tube T_{14} operates, it gives a visual indication to the local "B" operator that there is a call on that particular toll switching trunk. The local "B" operator connects her telephone set to the trunk by means of key 108. After she has been instructed as to the number called, she inserts plug 109 into the proper subscriber's line jack. This completes the sleeve circuit of plug 109. Battery 110 causes current to flow through resistance 111. The potential drop across resistance 111 is in such a direction as to cause the operation of tube T_{13}. This tube is held normally released by the negative potential supplied to the grid of the tube by battery 112. When tube T_{13} operates, current is caused to flow through primary winding 114 of the three-winding transformer 100. Since the plate potential of tube T_{13} is supplied by generator 98, the relative phases of the currents flowing through windings 113 and 114 are so adjusted as to result in no potential across the secondary of this transformer when current is flowing in both primary windings. When there is no alternating potential across the secondary of transformer 100, tube T_{14} is released.

Transformer 115 located in the plate circuit of tube T_{13} supplies an alternating potential to rectifier 116. This causes a unidirectional potential across resistance 117 of such a polarity as to cause tube T_{15} to operate. Filter 118 is inserted between the rectifier and the resistance 117. Tube T_{15} is held normally released by the negative potential supplied to the grid of the tube by battery 119. When tube T_{15} operates, an alternating potential is supplied by transformer 141 to rectifier 120. This is in such a direction as to add to the potential supplied to the tip and ring of the toll switching trunk by battery 96. Generator 121 supplies the plate potential of tube T_{15} through transformer 122.

Returning to Fig. 5, tube T_{16} is so adjusted as to remain unoperated until the added potential supplied by rectifier 120 increases the potential difference between the tip and ring of the toll switching trunk to such a value that tube T_{16} operates. This tube is normally held unoperated by the potential of battery 123 applied to the grid of the tube through resistance 124 to the grid of the tube. Generator 125 supplies the plate potential for tube T_{16} through transformer 126. Anti-resonant circuit 127 is inserted in the input circuit of tube T_{16} to prevent the alternating potential applied to the plate from being applied to the toll switching trunk. When tube T_{16} operates, an alternating potential is applied to the grid of tube T_{17} through transformer 128. Tube T_{17} is normally held released by the negative potential of battery 129. Alternating potential is supplied to the plate of tube T_{17} by generator 130 through transformer 131. The purpose of tube T_{17} is to change the sleeve impedance of the toll cord. This sleeve impedance is changed from a high value to a low value by the operation of tube T_{17}. This causes a visual signal to appear before the toll operator in a manner to be pointed out in more detail hereinafter. This signal is an indication that the subscriber's line has been reached.

The subscriber's bell is rung by the toll operator. She does this by pulling a ringing key in the toll cord circuit which applies a negative potential to the tip of the toll cord and the toll

switching trunk. When the toll operator pulls the ringing key, a current flows through resistance 132 in such a direction as to cause the operation of tube T_{18}. Tube T_{18} is normally held released by the negative potential supplied by battery 133. Tube T_{18} is supplied with plate potential by generator 134 through transformer 135. Anti-resonant circuit 136 prevents the alternating current supplied to the plate of tube T_{18} from being fed back into the talking circuit. Anti-resonant circuit 137 is resonant to the ringing frequency which is used to ring over the toll switching trunk. When the tube T_{18} operates, ringing current supplied by generator 138 through transformer 139 is applied to the line through coils 140. Circuit 142 is an anti-resonant circuit, resonant to the frequency of the alternating potential supplied by generator 134 to the plate of the tube.

When tube T_{18} operates it not only supplies ringing current to the line but it also extinguishes tubes T_{19} and T_{20}. These tubes cut off the toll operator while ringing current is being sent out over the line. Since both of these tubes operate in the same manner, the operation of only one will be described. Considering tube T_{19}, alternating current is supplied to the plate of this tube by generator 143 through transformer 144. Anti-resonant circuits 145 are inserted in the tip and ring of the toll switching trunk to prevent the alternating current of the frequency supplied to the plate from getting out on the line. Tube T_{19} is normally held operative by the positive potential of battery 146 applied to the grid through resistance 147. When tube T_{18} supplies alternating current through transformer 148 to transformers 149, tubes T_{19} and T_{20} are extinguished. Alternating potential is applied to rectifier unit 150 and unidirectional potential is applied to resistance 147 through filter 151. The potential drop across this resistance is in such a direction as to cause tubes T_{19} and T_{20} to release. The release of these tubes breaks the toll switching trunk at this point.

When the ringing current passes over the toll switching trunk, it passes through condensers 152 and through transformers 153, causing the release of tubes T_{21} and T_{22} and the operation of tube T_{23}. The circuits of tubes T_{21} and T_{22} are identical with those of tubes T_{19} and T_{20} and the operation will be omitted as it is described in detail for tube T_{19}. Tube T_{23} is caused to operate by the application of an alternating potential to the grid of that tube due to the ringing current from source 138. The tube T_{23} is held normally released by the negative potential supplied by battery 160. Generator 162 supplies plate potential to tube T_{23} through transformer 163. When tube T_{23} operates, ringing current supplied by generator 164 is applied to the subscriber's line through transformers 165. Anti-resonant circuit 166 prevents the alternating current of the generator 162 from being applied to the subscriber's line.

When the subscriber lifts the receiver from the switchhook, a short circuit is applied to the subscriber's line and this short circuit causes a current to flow from battery 168 through resistance 167. The potential drop across resistance 167 is of such a polarity as to cause the release of tube T_{15} which had been caused to operate by the operation of tube T_{13} which in turn resulted from the operator inserting the plug of the toll switching trunk into the subscriber's line circuit. Anti-resonant circuit 169 prevents the alternating potential from the generator 121 from entering the talking circuit. The release of tube T_{15} will cause the release of tubes T_{16} and T_{17} and will allow the sleeve circuit of the trunk to resume its initial high impedance, thereby releasing tube T_{43}.

When the subscriber completes the conversation and places his receiver on the hook, the short circuit is removed from the subscriber's line and current ceases to flow through resistance 167. Since plug 109 is still inserted in the line jack, tube T_{13} is operated and hence tube T_{15} will again operate due to the potential drop across resistance 117. When tube T_{15} operates, the added potential set up by rectifier 120, as explained above, is applied to the potential of battery 96. This increase in potential results in the operation of tube T_{16} in Fig. 5. The operation of tube T_{16} reduces the resistance in the sleeve circuit of jack 81 and causes a visual signal to be given in the toll cord circuit to the toll operator indicating that the subscriber has hung up. When the toll operator pulls down from jack 81, tube T_{10} releases, and, in doing so, releases tube T_{11} which removes the low resistance circuit from the toll switching trunk. This causes the release of tube T_{12} of Fig. 4. When tube T_{12} releases, no current flows through winding 113 of transformer 100. Since the plug 109 is still inserted in the subscriber's line jack, tube T_{13} is operated and current flows through winding 114 of transformer 100. With this condition of currents in transformer 100, namely, only current flowing through one primary, tube T_{14} operates, giving a visual signal to the local "B" operator and instructing her to pull down from the subscriber's line circuit. When the local "B" operator disconnects the plug 109 from the line jack, tube T_{13} releases. This removes all the potential from the secondary of transformer 100, thus releasing tube T_{14}. The circuit as a whole is then restored to its normal condition.

Fig. 6 is a circuit diagram of a toll cord used by the toll operator to complete toll connections. Tubes T_{43} and T_{44} are combined lamp and relays. Since these tubes are identical in operation, only tube T_{43} will be described. Tube T_{43} is held normally released by the negative potential of battery 284 which is applied to the grid. Generator 285 supplies the alternating potential for this tube through transformer 286. The toll cord is so arranged that an on-hook signal is transmitted to the toll cord as a high impedance sleeve. An off-hook signal is transmitted to the toll cord as a low impedance sleeve. A high impedance sleeve circuit will result in the flow of very little current through resistance 287 from battery 293. This will not cause tube T_{43} to operate. However, when the sleeve impedance is reduced, current flows from battery 293 through resistance 287 and the potential drop across this resistance is of such value and in such a direction as to cause the operation of tube T_{43}. Key 288 is used by the toll operator to connect her head set to the toll line. In operating from the normal to the operating condition this key momentarily breaks the sleeve circuit of plug 289. This is necessary to cause certain operations in associated equipment into which plug 289 may be inserted. Key 290 is a ringing key by means of which the toll operator may ring in either direction. This key applies a negative potential from batery 291 through resistance 292 to the tip of the toll cord.

Consideration will now be given to the description of the toll terminal equipment. Fig. 7 is a circuit diagram of the terminal equipment used to complete the type of call termed "ringdown" as previously described. This terminal equipment is so designed that the outward toll operator must ring the distant toll operator by operating the ringing key in the toll cord circuit. Incoming calls from the distant end are received by the ringer shown in Fig. 8 (enclosed in dotted lines) and detected therein. The detected ring is transferred to the equipment shown in Fig. 7 and results in a visual signal being given by the combined lamp and relay T_{52}. After a toll connection has been established between two toll operators all subsequent rerings appear in the toll cord circuits such as shown in Figs. 6 and 6'. In this type of circuit, there is no automatic signal which indicates that either operator has pulled down from the circuit but one operator must ring the other stating her intention to pull down.

When the toll operator at the toll office at which the cord of Fig. 6 is located desires to make a call over the ringdown toll line she inserts the plug of the toll cord into a jack such as **300**. This completes the sleeve circuit of the jack. The resulting potential drop across resistance **302** is of such a value and in such a direction as to cause the operation of tube T_{45}. This tube is held normally released by the negative potential supplied by battery **303** to the grid of the tube. Generator **304** supplies an alternating potential to the plate of tube T_{45} through transformer **305**. When tube T_{45} operates voltage is applied through transformers **306** and **308** to the rectifier circuit consisting of rectifier **309**, filter **310** and resistance **311**. The unidirectional potential drop across resistance **311** is of such a value and in such a direction as to make the resulting voltage on the plate of tube T_{46} insufficient to maintain the tube operated. Battery **312** supplies the normal plate potential to the anode of tube T_{46} and the potential to the probes of said tube through the inductance **3000** which is of a sufficient value to cause the line to be essentially opened at such time as the said tube is unoperated. The tube is held normally operated by the positive potential of battery **313** applied to the grid. This tube is of the five-element type referred to heretofore. One of the probes or plates is connected to one side of the line through resistance **314** and condenser **315** and the other probe is connected to the other side of the line through a similar resistance and condenser. When tube T_{46} is operated, the toll line is terminated by the aforementioned resistances and condensers and when the tube is released the termination is removed. It is the practice in telephony to terminate ringdown toll lines in a network comprising resistance and capacitance for well known transmission purposes.

When the toll operator rings out over the toll line, she does so by pulling the ringing key in the toll cord circuit. This applies a negative potential to the tip of the toll line. This operation causes the operation of tube T_{49} which applies signaling current to the toll line and causes the release of tubes T_{50} and T_{51} which disconnect the toll line from the toll operator during the ringing period. Tube T_{49} is normally held released by the negative potential of battery **326** applied to the grid of the tube through resistance **327**. Generator **329** supplies alternating potential to the plate of the tube through transformer **330**. Anti-resonant circuits **328** and **331** prevent alternating current of the frequency applied to the plate from being fed into the toll line. When tube T_{49} operates ringing current is supplied to the toll line from generator **332** through transformers **333** and **334**.

When tube T_{49} operates an alternating potential is supplied to rectifier **335** which applies a unidirectional potential across resistance **336** of such a value and in such a direction as to result in the direction of the plate potential of tube T_{50} below that value which will maintain the operation of the tube. Battery **338** normally supplies the plate potential of tube T_{50}. The positive potential of battery **339** applied to the grid of the tube keeps it normally operated. Tube T_{51} operates in an identical manner and the method of operation will not be repeated. The transmission of ringing current over the toll line will result in the operation at the distant end of ringing equipment similar to that of Fig. 8 and shown at Fig. 8' at the distant end of the line. This will result in the operation of tube T_{52}' of Fig. 7' which is similar to tube T_{52} of Fig. 7. This will tell the inward operator that there is a call on the line.

Tube T_{52} is a combined lamp and relay which operates when potential of the correct polarity is supplied across resistance **325** by circuit **356** which goes to the output circuit of Fig. 8. Tube T_{52} gives a visual indication to the toll operator that the distant toll operator is calling her on that particular ringdown toll line. She answers the call by inserting the plug of a toll cord into a jack such as **360**. The method of operation and release of this tube will not be described here since the tube operates in a manner similar to that described previously for tube T_1, Fig. 1 of the subscriber's line circuit.

Fig. 8 is a circuit diagram of the ringer associated with the ringdown toll equipment. The ringer is used to detect incoming rings from the distant end of the toll line. The input circuit **357** of Fig. 8 is connected to the directional selection circuits **358** well known in the art and shown on Fig 7.

After the incoming signal passes through the directional selection circuits **358** of Fig. 7, it passes through condensers **340** and resistances **341** of Fig. 8 to the input transformer **343**. The primary of this transformer is tuned to the carrier frequency of the impressed ringing frequency by the resonant circuit **342**. The voltage of the incoming signal is impressed on the grid of the tube T_{53} through the slow operate and release circuit consisting of resistances **344** and **345**, rectifier **346** and condenser **347**. Tube T_{53} is held normally released by the negative potential of battery **349** applied to the grid through resistance **348**. Plate potential is supplied to the tube by generator **350** through transformer **351**. When the tube operates an alternating potential is supplied to the rectifier unit **355** by transformer **352** through the tuned circuit consisting of inductances **353** and condensers **354** which is made resonant to the modulation frequency of the incoming ringing signal. The output circuit **356** of Fig. 8 supplies a unidirectional potential of the proper value and polarity to resistance **325** of Fig. 7.

When a plug of a toll cord is inserted in jack such as **300** the circuit of tube T_{47} is put in the proper operating condition to care for rerings from the distant toll operator. Whenever the plug of a toll cord is in jack **300**, potential is

supplied to the plate of tube T_{47} by the plate circuit of tube T_{45} through transformer **307** and rectifier **316**. Condenser **317** is a filter condenser in parallel with resistance **318** across which the output of the rectifier is applied. The potential drop across resistance **318** supplies the plate voltage of tube T_{47}. Should the distant toll operator rering, a potential of such a value and polarity is supplied across resistance **325** by the associated ringer over leads **356** that tube T_{47} operates. Since the plate of this tube is supplied with direct current, the tube remains operated even after the incoming ring has been removed. Tube T_{47} is kept released before the incoming ring causes it to operate by the negative potential of battery **319** applied to the grid through resistance **320**. When tube T_{47} operates current flows through resistance **321** in such a direction that the potential drop across the resistance is of the correct polarity to cause tube T_{48} to operate. This tube is held normally released by the negative potential of battery **322**. The plate of tube T_{48} is supplied with an alternating potential from generator **323** through transformer **324**. When tube T_{48} operates, high resistance **301** is short-circuited and the sleeve circuit becomes one of low impedance to ground through the operated tube T_{48}. This change in the sleeve circuit from a high to a low impedance will serve to operate tube T_{44} in the toll operator's cord circuit. This will give a visual signal to the toll operator. When the toll operator answers the visual indication which is thus given in the toll cord circuit by the rering signal, she operates a key which not only connects her headset to the line but also momentarily breaks the sleeve circuit. In breaking the sleeve circuit, tube T_{45} is momentarily released and hence the plate potential is removed from tube T_{47} and this tube is released thus releasing tube T_{48} and removing the low impedance ground from the sleeve and extinguishing the lamp in the toll cord circuit.

As has been heretofore pointed out, when the toll operator at the toll office where the cord circuit of Fig. 6 is located operates her ringing key and transmits ringing current over the toll line, the tube T'_{52} at the distant end of the toll line will be operated and will give a visual signal to the toll operator at that end of the line. The apparatus shown in Figs. 7′ and 8′ at the distant end of the toll line is identical with that shown in Figs. 7 and 8 and accordingly no detailed description of its operation will be given. In response to the operation of the visual signal T'_{52}, the toll operator at the distant end of the line will connect her cord circuit shown in Fig. 6′ with the toll line and will ascertain the called number. Fig. 6′ is identical with Fig. 6 and no further description thereof will be given. The toll operator will then connect the toll line through her cord circuit of Fig. 6′ with a toll switching trunk such as that shown in Figs. 4′ and 5′. As Figs. 4′ and 5′ are identical with Figs. 4 and 5, no detailed description of their operation will be given. The toll operator will now transmit a ringing signal over the toll switching trunk of Figs. 4′ and 5′. This will cause the operation of the tube T'_{14} of Fig. 4′ and will give a visual signal to the local operator. The local operator may then ascertain the called number and will then connect the toll switching trunk of Figs. 4′ and 5′ with the subscriber's line such as shown in Fig. 1′, which is identical with that of Fig. 1.

Obviously, when a call originates at the distant end of the line the toll switching trunk and the local operator's cord circuit shown in Figs. 3′ and 2′ would be utilized. These figures are identical with Fig. 3 and Fig. 2, and no detailed description of their operation will be given.

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. In a telephone system including a subscriber's circuit and a local operator's cord circuit, the combination of signaling means including a first gas-filled discharge tube (T_1—Fig. 1) normally released and located in said subscriber's circuit, means operative when the subscriber seizes the line for use for operating said first tube, a second gas-filled discharge tube (T_2—Fig. 1) in said subscriber's circuit normally unoperated and adapted to be operated when said subscriber's circuit is connected with said cord circuit, means controlled by the operation of said second tube for releasing said first tube, a third gas-filled discharge tube (T_3—Fig. 2) located in said cord circuit, normally operated and adapted to be released when said cord is connected to said subscriber's line, signaling means comprising a fourth gas-filled discharge tube (T_4—Fig. 2) located in said cord circuit and normally released, means controlled by said third tube when operated for maintaining said second tube released, means operative when said cord circuit is connected to said subscriber's line for releasing said third tube, and means operative when a talking circuit is completed over said subscriber's line and said cord circuit for maintaining said fourth tube released.

2. In a telephone system including a subscriber's circuit, a toll switching trunk, a toll operator's cord circuit, the combination of a supervisory gas-filled discharge tube (T_{14}—Fig. 4) capable of giving a visual signal and located in said toll switching trunk at the subscriber's end thereof, a first gas-filled discharge tube (T_{10}—Fig. 5) in said trunk normally released and controlled by the connection of said toll cord to said trunk, means controlled by the operation of said first tube for closing a low impedance path across the talking conductors of said trunk, a second gas-filled discharge tube (T_{12}—Fig. 4) in said trunk normally released, means operable when said low impedance path is closed for operating said second tube, and means controlled by the operation of said second tube for operating said supervisory tube.

3. In a telephone system including a subscriber's circuit, a toll switching trunk, a toll operator's cord circuit, the combination of a supervisory gas-filled discharge tube (T_{14}—Fig. 4) capable of giving a visual signal located in said toll switching trunk at the local office end thereof, a plurality of gas-filled discharge tubes and circuit arrangements therefor associated with said previously mentioned circuits and operative when said toll cord is connected to said switching trunk to exclusively cause the initial operation of said supervisory tube, and a plurality of gas-filled discharge tubes and circuit arrangements therefor associated with said previously mentioned circuits and operative when said subscriber's line is connected to said switching trunk to cause the subsequent release of said supervisory signal.

4. In a telephone system including a subscriber's circuit, a toll switching trunk, a toll oper-

ator's cord circuit, the combination of a supervisory gas-filled discharge tube (T_{43}—Fig. 6) capable of giving a visual signal located in said toll operator's cord circuit, a plurality of gas-filled discharge tubes and circuit arrangements therefor associated with said previously mentioned circuits and operative when a connection is established between all of said circuits for causing said supervisory tube to give a signal, the type of signal given by said supervisory tube being determined by the condition of the switchhook in said subscriber's line.

5. In a telephone system including a subscriber's circuit, a toll cord having a supervisory gas-filled tube (T_{43}—Fig. 6) capable of operating a visual signal associated with the sleeve circuit thereof, a toll switching trunk including a first gas-filled discharge tube (T_{13}—Fig. 4) normally released and operated when said trunk is connected to said subscriber's line, a second gas-filled discharge tube (T_{15}—Fig. 4) normally released and conditioned for operation by the operation of said first tube, means controlled by operation of the subscriber's switchhook for operating said second tube, a chain of gas-filled tubes in said trunk controlled by the operation of said second tube, means controlled by said chain of gas-filled tubes for varying the characteristics of the sleeve circuit of said toll cord when connected to said trunk whereby said supervisory tube may be controlled.

6. In a telephone system the combination of a toll operator's cord circuit, means in said cord circuit for applying a potential to the tip conductor of said cord, a toll switching trunk including a gas-filled discharge tube (T_{18}—Fig. 5) normally unoperated and operated by the potential applied to the tip conductor of said toll cord when connected to said trunk, means for applying ringing current over said trunk controlled by the operation of said first tube, second and third gas-filled discharge (T_{19}—T_{20}—Fig. 5) tubes normally operated and connected serially in the tip and ring conductors of said trunk at the toll operator's end thereof, and means controlled by the operation of said first tube for releasing said second and third tubes.

7. In a telephone system including a calling operator's toll cord, a toll line and a called operator's toll cord, the combination of a supervisory gas-filled discharge tube (T'_{52}—Fig. 7') located in said toll line at the called operator's position, and being capable when operated to act as a visual supervisory signal itself, and a plurality of gas-filled discharge tubes and circuit arrangements therefor associated with said toll line and started in operation by the application to said toll line of ringing current by the calling operator, said plurality of gas-filled tubes being arranged to cause the operation of said supervisory tube.

8. In a telephone system including a calling operator's toll cord, a toll line and a called operator's toll cord, the combination of a supervisory gas-filled discharge tube (T'_{52}—Fig. 7') capable of operating a visual signal located in said toll line at the called operator's position, a first chain of gas-filled discharge tubes and circuit arrangements therefor associated with said toll line and controlled by the application to said line of ringing current by the calling operator, means controlled by said first chain of tubes for applying ringing current over said toll line to the called operator's end thereof, means controlled by said first chain of tubes for opening said toll line at the calling operator's end thereof, and a second chain of gas-filled discharge tubes and circuit arrangements therefor associated with the called operator's end of said toll line and operated by the ringing current transmitted thereover for controlling said supervisory tube.

9. In a telephone system including a calling operator's toll cord, a toll line and a called operator's toll cord, the combination of a supervisory gas-filled discharge tube (T_{44}—Fig. 6) capable of giving a visual signal located in said calling operator's toll cord, a sleeve circuit for said toll line at the calling toll operator's end thereof having its characteristics so adjusted that when the calling operator's toll cord is initially connected therewith said supervisory tube will be held unoperated, and a plurality of gas-filled discharge tubes and circuit arrangements therefor associated with said toll line and started in operation by the application of ringing current to said toll line by said called toll operator for changing the characteristics of said sleeve circuit whereby said supervisory tube may be operated.

10. In a telephone system including a calling operator's toll cord, a toll line and a called operator's toll cord, the combination of a supervisory gas-filled discharge tube (T_{44}—Fig. 6) capable of operating a visual signal located in said calling operator's toll cord, a sleeve circuit for said toll line at the calling operator's end thereof having its characteristics so adjusted that when the calling operator's toll cord is initially connected therewith said supervisory tube will be held unoperated, a second gas-filled tube (T_{45}—Fig. 7) located in said toll line at the calling operator's end thereof and operated when said calling operator's cord is connected to said toll line, a first chain of gas-filled discharge tubes (T_{47}—T_{48}—Fig. 7) associated with said toll line and conditioned for operation by the operation of said second tube, a second chain of gas-filled discharge tubes associated with said toll line and operated by the application to said line of ringing current by said called operator for operating said first chain of tubes previously conditioned for operation, and means controlled by the operation of said first chain of tubes for changing the characteristics of said sleeve circuit of said toll line whereby said supervisory tube will be operated.

11. In a telephone system including a subscriber's circuit, a toll switching trunk, a toll operator's cord circuit, the combination of supervisory signaling means located in said toll switching trunk at the subscriber's end thereof, a first gas filled discharge tube (T_{10}—Fig. 5) in said trunk normally released and controlled by the connection of said toll cord to said trunk, means controlled by the operation of said first tube for closing a low impedance path across the talking conductors of said trunk, a second gas filled discharge tube (T_{12}—Fig. 4) in said trunk normally released, means operable when said low impedance path is closed for operating said second tube, and means controlled by the operation of said second tube for operating said supervisory signaling means.

12. In a telephone system including a subscriber's circuit, a toll cord having supervisory signaling means associated with the sleeve circuit thereof, a toll switching trunk including a first gas filled discharge tube (T_{13}—Fig. 4) normally released and operated when said trunk is connected to said subscriber's line, a second gas filled discharge tube (T_{15}—Fig. 4) normally released and conditioned for operation by the operation of said first tube, means controlled by the

operation of the subscriber's switchhook for operating said second tube, a chain of gas filled tubes in said trunk controlled by the operation of said second tube, means controlled by said chain of gas filled tubes for varying the characteristics of the sleeve circuit of said toll cord when connected to said trunk whereby said supervisory signaling means may be controlled.

13. In a telephone system including a calling operator's toll cord, a toll line and a called operator's toll cord, the combination of supervisory signaling means located in said toll line at the called operator's position, a first chain of gas filled discharge tubes and circuit arrangements therefor associated with said toll line and controlled by the application to said line of ringing current by the calling operator, means controlled by the said first chain of tubes for applying ringing current over said toll line to the called operator's end thereof, means controlled by said first chain of tubes for opening said toll line at the calling operator's end thereof, and a second chain of gas filled discharge tubes and circuit arrangements therefor associated with the called operator's end of said toll line and operated by the ringing current transmitted thereover for controlling said supervisory signaling means.

14. In a telephone system including a calling operator's toll cord, a toll line and a called operator's toll cord, the combination of supervisory signaling means located in said calling operator's toll cord, a sleeve circuit for said toll line at the calling operator's end thereof having its characteristics so adjusted that when the calling operator's toll cord is initially connected therewith said supervisory signaling means will be held unoperated, a first gas filled tube (T_{45}—Fig. 10) located in said toll line at the calling operator's end thereof and operated when said calling operator's cord is connected to said toll line, a first chain of gas filled discharge tubes (T_{47}, T_{48}—Fig. 10) associated with said toll line and conditioned for operation by the operation of said first tube, a second chain of gas filled discharge tubes associated with said toll line and operated by the application to said line of ringing current by said called operator for operating said first chain of tubes previously conditioned for operation, and means controlled by the operation of said first chain of tubes for changing the characteristics of said sleeve circuit of said toll line whereby said supervisory signaling means will be operated.

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