Sept. 25, 1923. 1,468,687

H. A. AFFEL

TRANSMISSION REGULATION

Filed May 4, 1922 2 Sheets-Sheet 1

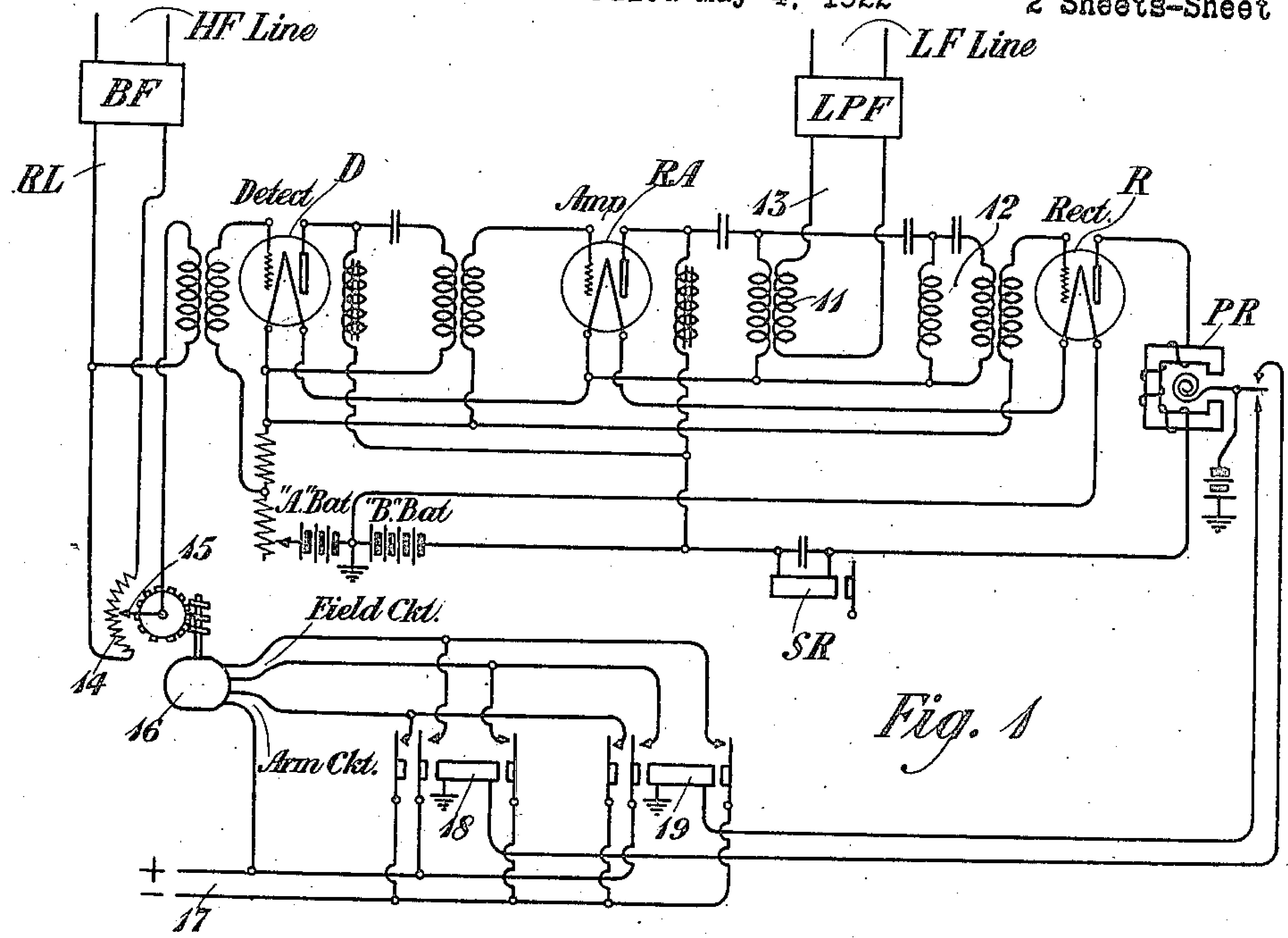

Fig. 1

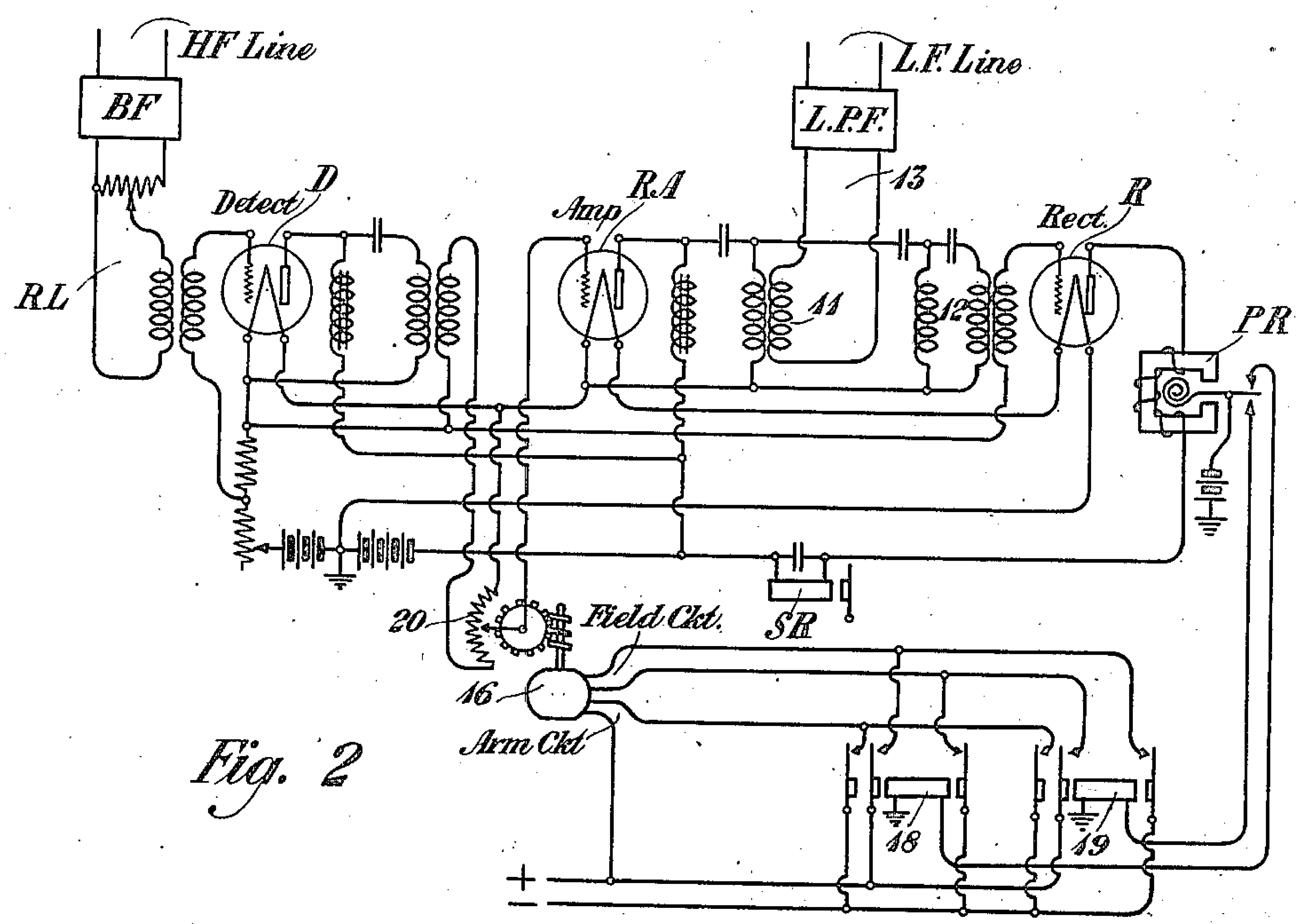

Fig. 2

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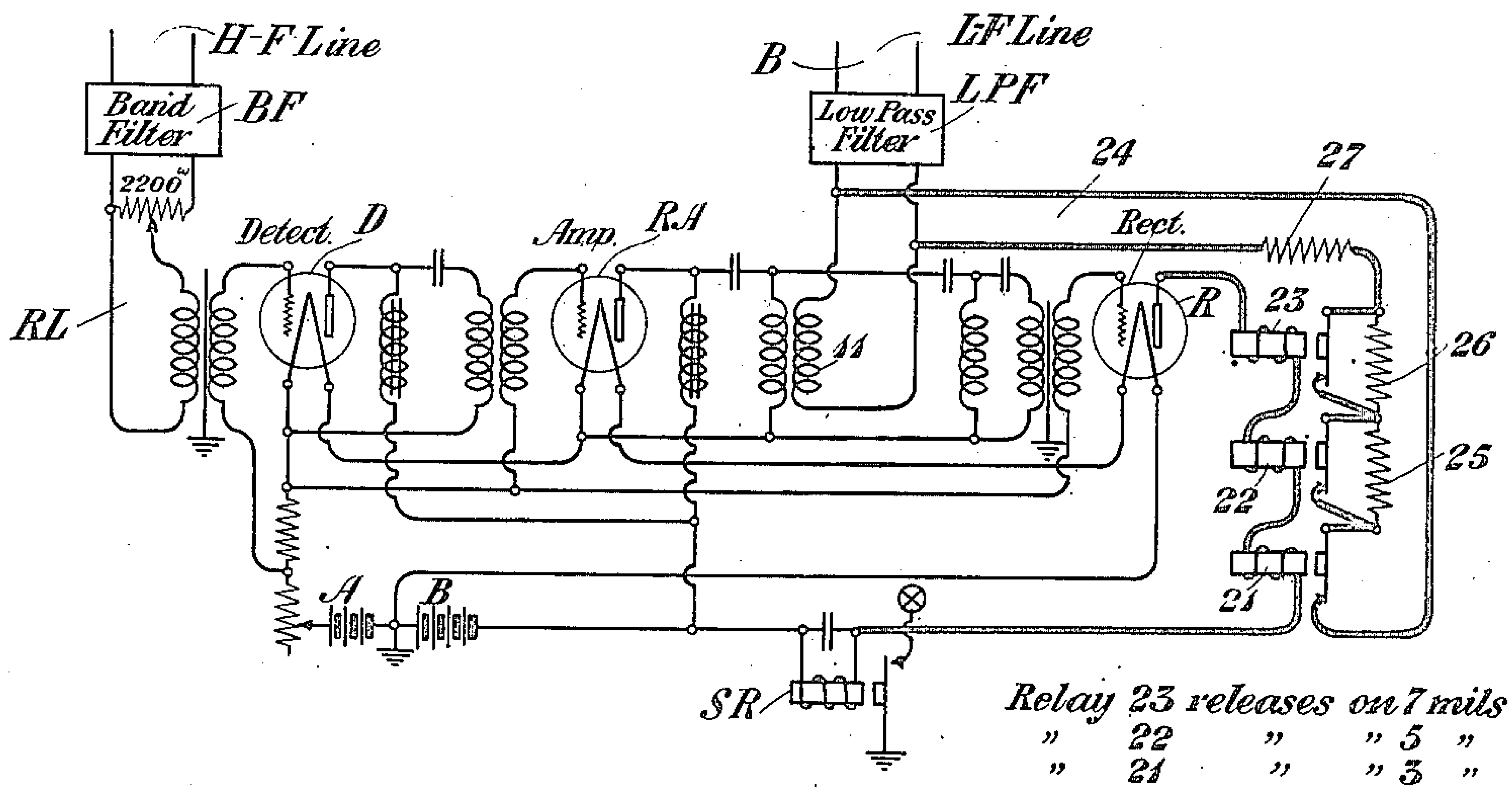

Fig. 3

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Patented Sept. 25, 1923. 1,468,687

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TRANSMISSION REGULATION.

Application filed May 4, 1922. Serial No. 558,447.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Transmission Regulations, of which the following is a specification.

This invention relates to multiplex signaling circuits, and more particularly to methods and arrangements for controlling the transmission over such circuits.

In a wire carrier or radio telephone system, the fluctuations in attenuation of the transmission medium or line produce corresponding variations in the over-all transmission equivalent of the voice circuit. In one well known type of carrier system, the carrier frequency itself is suppressed at the modulator end in connection with each channel, and the fundamental frequency, which is relatively low, is transmitted to the receiving end of the circuit, and by harmonic regeneration, caused to produce a synchronous carrier supply for the respective demodulators. The carrier supply in this case is transmitted at a frequency which is substantially independent of ordinary line attenuation fluctuations and the variation in line attenuation at the side band frequency causes a directly proportional variation in the over-all equivalent, there being substantially no fluctuation of the equivalent of the circuit due to the carrier component itself.

With the type of carrier system, however, in which a carrier frequency is transmitted along with the side band of each individual channel, the transmission fluctuations may be even more serious, since in demodulation the resultant voice output may, for normal operation of the demodulator, be proportional to the product of the carrier and the modulated side band. If, therefore, the attenuation of the intervening line or other transmission medium varies, approximately the same variation will take place for both the carrier and the modulated side band, and the resultant voice circuit variation, being proportional to the product of these two factors, will be approximately double that of the line attenuation itself.

In accordance with the present invention, it is proposed to overcome the difficulties encountered in connection with transmission fluctuations in the type of circuit in which the carrier frequency is transmitted along with the side band, by controlling some element of the transmission channel or circuit to vary the transmission of such element in accordance with the amplitude of the carrier frequency of the channel. Preferably, the control thus exercised will be applied to an element in the receiving channel at a receiving station by selecting the carrier frequency component, rectifying the selected component to produce a direct current whose amplitude will depend upon the transmission conditions to which the carrier has been subjected, and controlling the transmission element by the rectified current. The control exercised by the rectified current may be effected either electrically or mechanically, but in the preferred form herein disclosed, a mechanical system is illustrated.

The invention may now be more fully understood from the following description, when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which show circuit diagrams illustrating three different forms of the invention.

Referring to Fig. 1, so much of a carrier system is shown as is necessary to an understanding of the present invention. In this figure, RL designates a receiving channel of one transmission circuit of a carrier telegraph system, said channel being connected, together with other similar channels (not shown) to a common transmission line (not shown) over which carrier frequencies are transmitted. The corresponding transmitting channel is not illustrated, as it is not involved in the present invention. The receiving channel RL includes a band filter RF for selecting the desired side band and the corresponding carrier, a detector D and a receiving amplifier RA. The detector D may be of any well known type, such as a vacuum tube detector, and is adapted to detect the voice currents corresponding to the side band by beating the side band with the carrier. The receiving amplifier RA may be any well known type of amplifier, but is illustrated as being a vacuum tube amplifier and is arranged to amplify the detected voice currents as well as the unmodulated carrier appearing in the output circuit of the detector. The output circuit of the receiving amplifier RA includes a transformer 11 by which the low frequency circuit 13 (which may be associated with a low frequency transmission line) is connected to the receiving channel.

The circuit 13 includes a low-pass filter LPF by which voice frequency currents are selected into said circuit to the exclusion of the higher frequency components such as the unmodulated carrier. The carrier frequency component may be selected by means of a tuned circuit or filter 12 through which the carrier frequency is impressed upon a rectifier R. The rectifier may be of any well known type but is illustrated as a vacuum tube arrangement adapted to translate the selected carrier component into a direct current. In systems of this type, this direct current is ordinarily used to control the operation of a signal relay SR which is illustrated as being included in the output circuit of the rectifier. This signal relay is adapted to operate a ringing signal when the carrier is interrupted at the sending station, the interruption of the carrier (which is normally transmitted) resulting in the cessation of the flow of direct current in the output circuit of the rectifier.

In the present invention, this circuit is also utilized to control the transmission efficiency of the receiving channel RL and for this purpose a polar relay PR is included in the output circuit of the rectifier R. The polar relay PR may be arranged with its armature so biased that the direct current flowing in the output circuit of the rectifier R, when the transmission efficiency of the transmitting medium is normal, will be just sufficient to hold the armature at a neutral point against the tension of the biasing means. An increase or decrease in the direct current, in response to an increase or decrease in the efficiency of the transmitting medium, will therefore result in shifting the armature to its upper or lower contact.

In order to adjust the transmission efficiency of the receiving channel RL, the potentiometer 14 is included in the receiving channel upon the input side of the detector D. This potentiometer may be adjusted by means of an arm 15 which may be rotated by a motor 16. The motor 16 may be energized from the power mains 17 and its circuits are controlled by means of relays 18 and 19, so that when either of these relays is operated, the armature circuit is closed, and when one of the relays is operated, the field circuit is completed in one direction, while when the other relay is operated, the field circuit is completed in the opposite direction. These relays are controlled by the contacts of the polar relay PR, so that if the armature of the polar relay is shifted to one contact, the motor 16 will rotate in one direction and adjust the potentiometer to increase the transmission, while if the armature is shifted to the other contact of the polar relay, the motor rotates in the opposite direction and adjusts the potentiometer to decrease the transmission.

Assuming that the carrier frequency, together with the side band, is being transmitted over some transmitting medium whose transmission efficiency varies under different conditions, the side band and carrier frequency assigned to the receiving channel RL will be selected by the band filter BF and will be transmitted from the potentiometer 14 to the input circuit of the detector D. The detector D detects the voice currents corresponding to the side band by beating the side band with the carrier, and the detected voice currents, together with the unmodulated carrier component, are impressed upon the amplifier RA. When these currents are amplified the low frequency voice currents pass through the transformer 11 and the low-pass filter LPF to the low frequency line. The carrier frequency component, however, is selected by the filter or selecting device 12 and impressed upon the rectifier R. The carrier frequency is transmitted at all times, regardless of whether or not a side band is being transmitted, and the output direct current of the rectifier R will correspond in amplitude to the amplitude of the carrier. The amplitude of the carrier will in turn depend upon the transmitting conditions of the transmitting medium so that the rectified current flowing through the polar relay PR will fluctuate in amplitude as the efficiency of the transmitting medium fluctuates.

If the efficiency of the transmitting medium is decreased, the armature of the polar relay PR will be shifted to one of its contacts, say the lower contact, thereby energizing the relay 19 which completes the field and armature circuits of the motor 16 to cause the motor to rotate in one direction and adjust the potentiometer 14 to gradually increase the transmission to the detector, until a condition is reached such that the amplitude of the carrier frequency will be sufficient to produce a rectified current in the rectifier R, whose strength will be of such value as to again shift the armature of the polar relay PR to neutral position, whereupon the operation of the motor will cease. The adjustment of the transmission of the receiving channel RL is now such that the change in transmission of the transmitting medium has been compensated for, and the low frequency voice currents detected by the detector will be of normal amplitude.

If the efficiency of the transmitting medium is increased, the unmodulated carrier component would increase in amplitude, thereby causing a greater direct current to flow through the polar relay PR and this would shift the armature to the other contact and energize the relay 18, causing the motor 16 to rotate in the opposite direction and adjust the potentiometer 14 so that the transmission efficiency to the receiving channel RL is gradually decreased. This results in a gradual decreasing of the amplitude of the carrier frequency until a point is reached where the direct current flowing through the polar relay PR will be reduced to its normal value, so that the armature of the polar relay is shifted to neutral and the motor 16 stops rotating. The voice frequency currents transmitted to the circuit 13 will now have a normal amplitude.

Instead of using the motor 16 to adjust the potentiometer on the input side of the detector D, it may be arranged to adjust a potentiometer 20 included between the detector D and the receiving amplifier RA, as shown in Fig. 2. The net result will be the same as in the case of Fig. 1, and in this case, the adjustment of the potentiometer, instead of affecting the carrier and the side band before detection, produces a change in the amplitude of the unmodulated carrier component of the detector, and of the low frequency voice signal. The change in the amplitude of the unmodulated carrier component in the detector, in response to adjustment of the potentiometer, causes the current through the relay PR to vary in amplitude until the current becomes normal, after which the adjustment ceases. The amplitude of the low frequency voice current component is adjusted by the potentiometer at the same time, so that when the final adjustment is reached, the amplitude of the voice current will be normal.

Instead of arranging the circuit so that the rectified direct current will be automatically restored to its normal value by the adjusting means, the system may be so arranged that the direct current will at all times depend in amplitude upon the amplitude of the carrier frequency, and the value of this current may be utilized to adjust the transmission efficiency of the circuit for the low frequency voice currents only. Such an arrangement is illustrated in Fig. 3. In this case, the output circuit of the rectifier R, instead of including a polarized relay PR, includes a series of marginal relays 21, 22 and 23. The contacts of these relays are arranged to control a shunt circuit 24 including resistances 25, 26 and 27 bridged across the low frequency circuit 13. When the rectified current in the output circuit of the rectified R falls below a certain minimum value, which for purposes of illustration may be taken as 3 mils, none of the relays 21, 22 and 23 is energized. If the rectified current has a value between 3 mils and say 5 mils, only the relay 21 is energized. If the rectified current has a value between 5 mils and say 7 mils, relays 21 and 22 are energized, and for a value of rectified current greater than 7 mils, all three relays will be energized.

Suppose now the transmitting efficiency of the transmitting medium is so low that the rectified carrier component flowing through the relays 21, 22 and 23 is less than 3 mils. All three relays 21, 22 and 23 will be deenergized and the shunt path 24 will be opened at the contact of the relay 21, so that the full energy of the detected voice currents will be transmitted through the low-pass filter LPF into the circuit 13. If the transmission efficiency of the medium is increased, so that the rectified carrier component attains a value of over 3 mils but less than 5 mils, relay 21 will be energized and relays 22 and 23 deenergized. Under these conditions, the bridge 24 will be closed at the contact of relay 21 and resistances 25, 26 and 27 will be included in the bridge. This will shunt a certain proportion of the energy of the low frequency voice currents into the bridge, thereby reducing the voice energy transmitted to the circuit 13 to the normal value.

If the efficiency of the transmitting medium is still further increased, so that the rectified current attains a value between 5 mils and 7 mils, relays 21 and 22 will be actuated and relay 23 will be deenergized. Relay 22 short-circuits resistance 25, so that the bridge 24 will now be closed through resistances 26 and 27 in series. Under these conditions, a still greater proportion of the voice current energy will be shunted through the bridge, so that the voice current energy transmitted to the circuit 13 will be substantially normal. If the amplitude of the carrier frequency is still further increased by an increase in efficiency of the transmitting medium, the rectified current may attain a value of 7 mils or over, in which case the relay 23 will be energized, in addition to relays 21 and 22. Both resistances 25 and 26 will now be short-circuited and the bridge circuit 24 will include only the resistance 27, thereby shunting a still greater proportion of the voice energy into the bridge and maintaining the energy transmitted to the circuit 13 substantially normal.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the folowing claims.

What is claimed is:

1. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the side band and carrier may be simultaneously impressed to detect the low frequency signaling currents represented by the side band, means to select from the output of the detector the unmodulated carrier frequency current, means to produce from the selected carrier component a current having characteristics depending upon the transmission conditions to which the carrier has been subjected, and a mechanical switching device operated by the current thus produced to adjust a circuit element of the receiving channel in accordance with the characteristics of the current thus produced to compensate for the change in efficiency of the transmitting medium.

2. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the side band and carrier may be simultaneously impressed to detect the low frequency signaling currents represented by the side band, means to select from the output of the detector the unmodulated carrier frequency component, means to produce from the selected carrier component a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and mechanical switching means operated by the direct current for adjusting a circuit element of the receiving channel in accordance with the amplitude of said direct current to compensate for the change efficiency of the transmitting medium.

3. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the carrier and side band may be simultaneously impressed, means for selecting the carrier, means for producing from the carrier a current whose characteristics depend upon the transmission conditions to which the carrier has been subjected, a circuit element in said receiving channel, and mechanical switching means controlled in accordance with the characteristics of said current to adjust said circuit element to compensate for the change in efficiency of the transmitting medium.

4. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel upon which the carrier and side band may be impressed, means for selecting the carrier, a rectifying device to rectify the selected carrier to produce a direct current having an amplitude depending upon the transmission conditions to which the carrier has been subjected, a circuit element in said receiving channel, and mechanical switching means controlled in accordance with the amplitude of the rectified current to adjust said circuit element to compensate for the change in efficiency of the transmitting medium.

5. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the carrier and side band may be impressed, means for selecting the carrier, means for producing from the selected carrier a current whose characteristics depend upon the transmission conditions to which the carrier has been subjected, a potentiometer in said receiving channel, and means for adjusting said potentiometer in accordance with the characteristics of the current produced from the selected carrier to compensate for the change in transmission efficiency of the transmitting medium.

6. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmisson efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the carrier and side band may be impressed, means for selecting the carrier, a rectifying device to rectify the selected carrier to produce a direct current having an amplitude depending upon the transmission conditions to which the carrier has been subjected, a potentiometer in said receiving channel, and means to adjust said potentiometer in accordance with the amplitude of the rectified current to compensate for the change in efficiency of the transmitting medium.

7. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the side band may be impressed together with the carrier to detect

the low frequency signaling currents represented by the side band, means to select the unmodulated carrier component from the output of said detector, means to produce from said selected carrier component a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, a potentiometer in said receiving channel, and means to adjust said potentiometer in accordance with the amplitude of said direct current to compensate for the change in transmission efficiency of said transmitting medium.

In testimony whereof, I have signed my name to this specification this 3rd day of May, 1922.

HERMAN A. AFFEL.