

Nov. 10, 1931.

A. WEAVER

1,830,864

ELIMINATION OF RADIO INTERFERENCE DUE TO PRINTING TELEGRAPH

Filed March 9, 1929

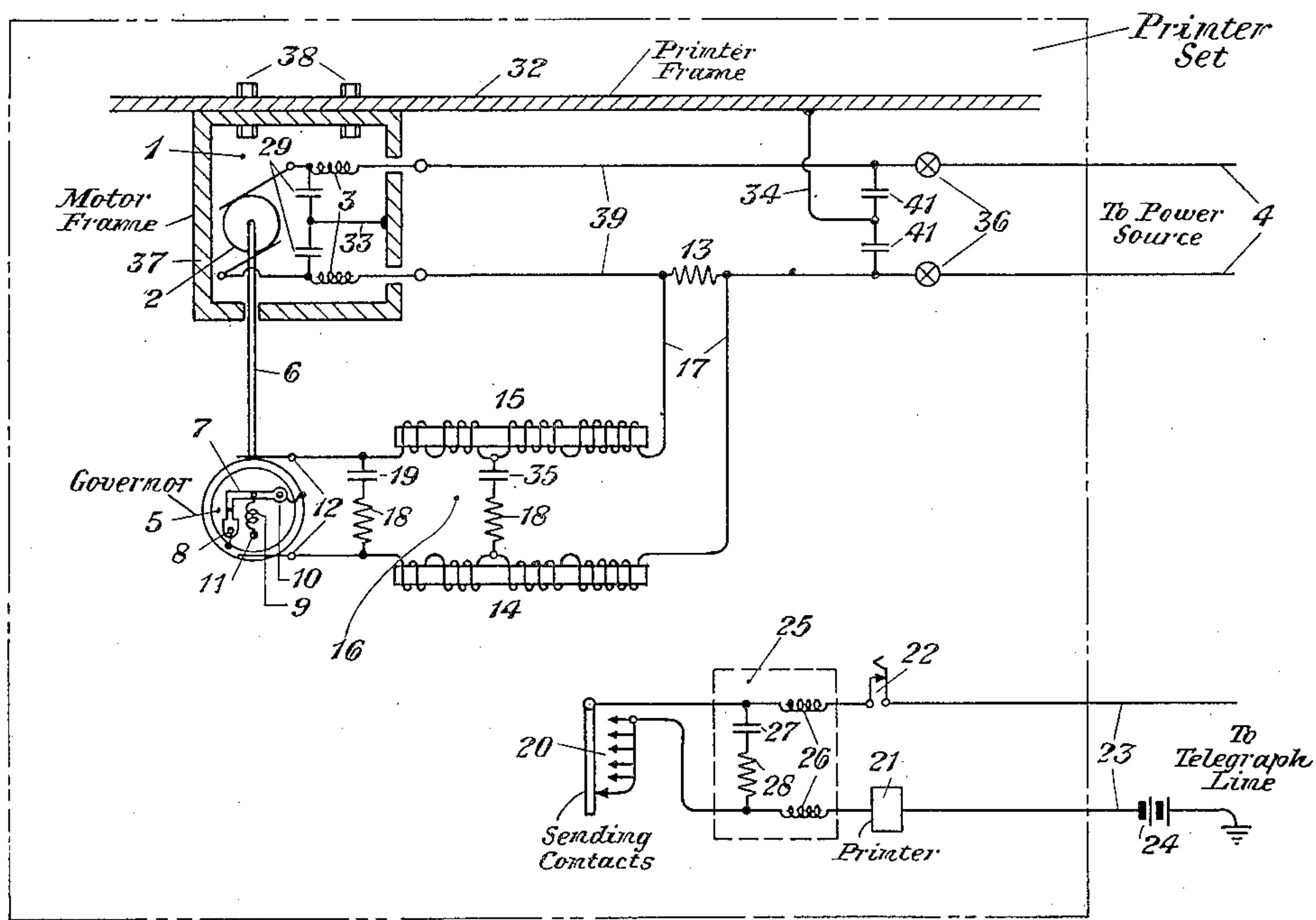


Fig. 1

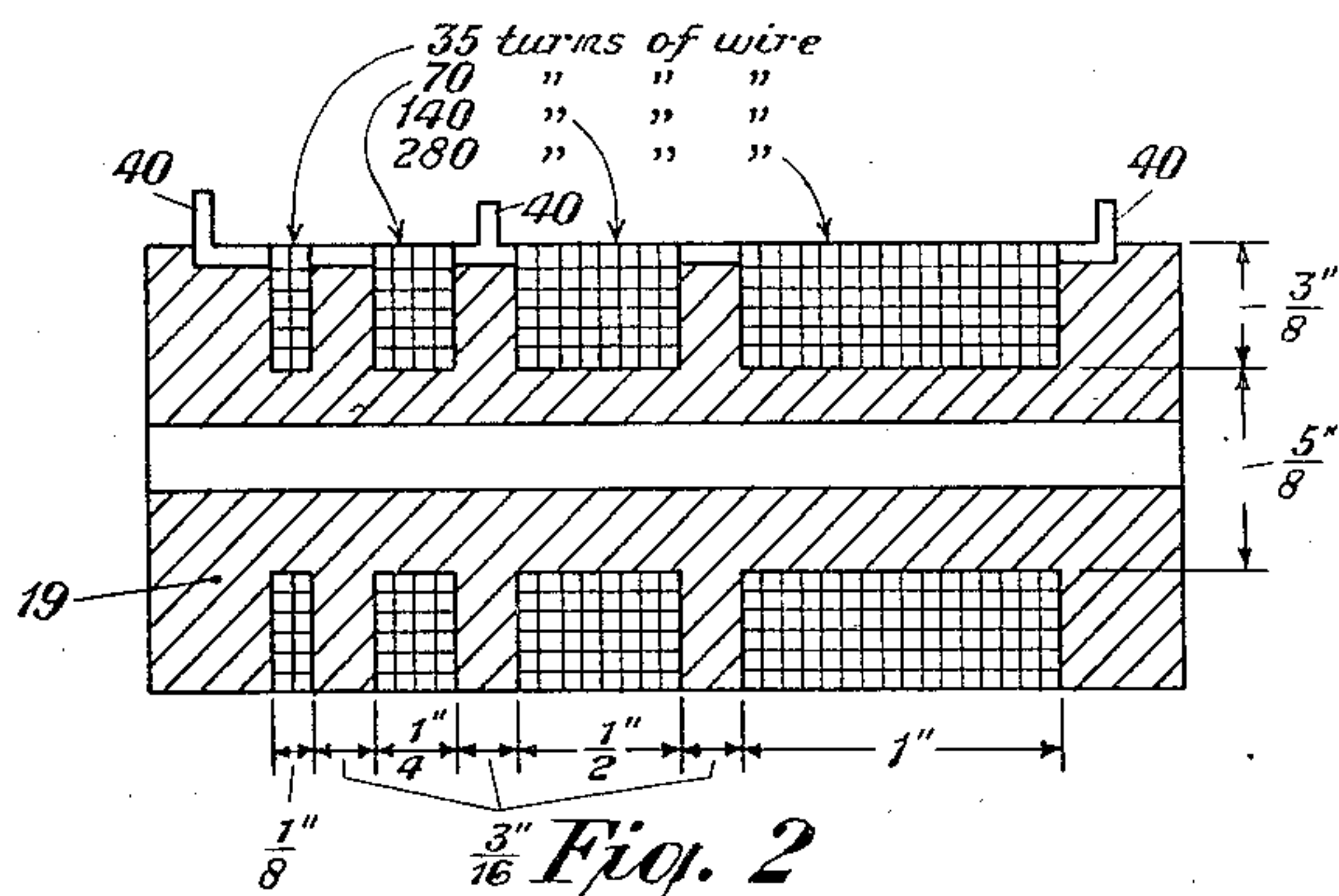


Fig. 2

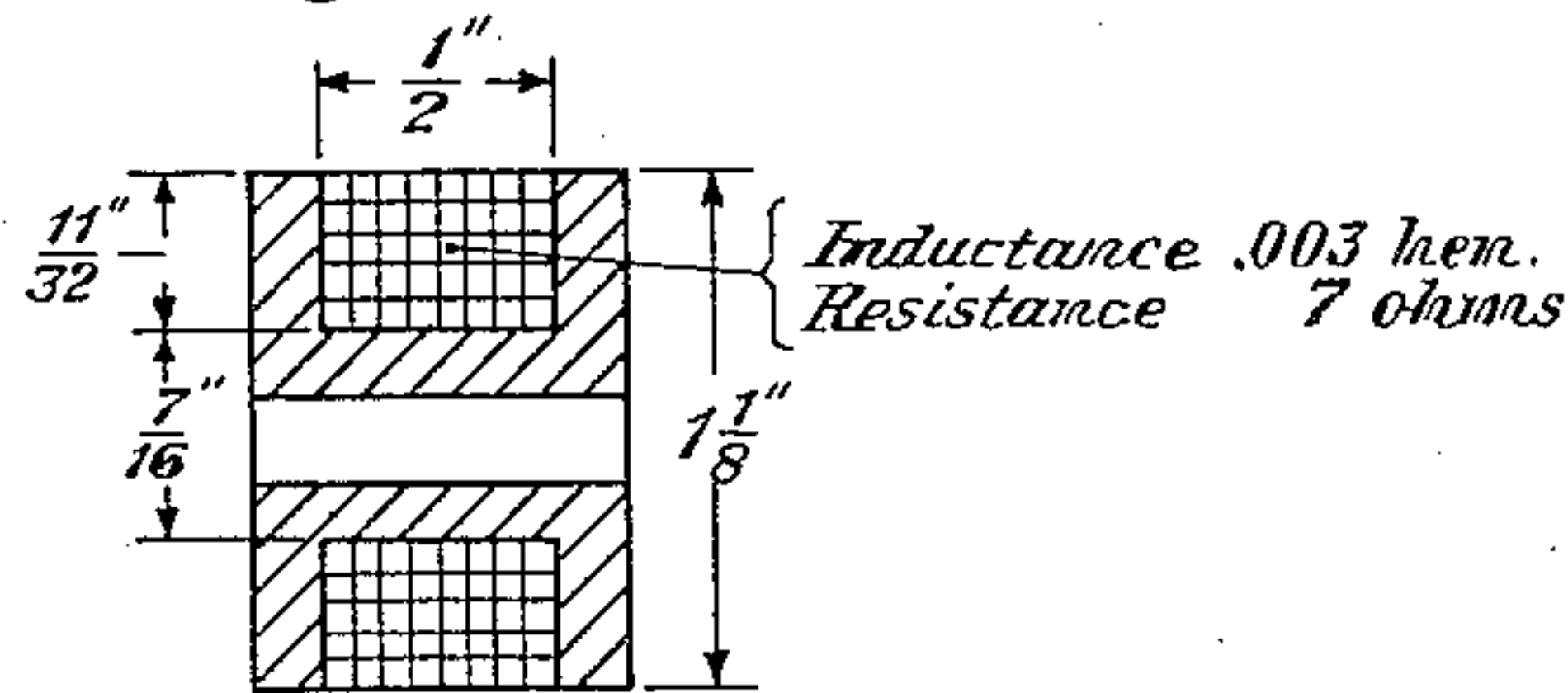


Fig. 3

INVENTOR
A. Weaver
BY
J. E. 409
ATTORNEY

UNITED STATES PATENT OFFICE

ALLAN WEAVER, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE
AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

ELIMINATION OF RADIO INTERFERENCE DUE TO PRINTING TELEGRAPH

Application filed March 9, 1929. Serial No. 345,701.

This invention relates to telegraph circuits and discloses means for eliminating the interference to radio receiving stations due to the operation of the printing telegraph sets in the vicinity thereof. The interference caused by the printer is due chiefly to the operation of the sending contacts, the governor contacts and to sparking at the brushes of the printer motor. In the present disclosure, the interference effects are eliminated or at least greatly reduced by the use of certain specially designed filter circuits comprising choke coils, condensers and resistance elements.

As is well known, when a message is transmitted from a printer telegraph set, the operation of the sending contacts thereof interrupts the flow of current in the loop circuit. This continual interruption of the direct current flow causes a series of miniature arcs to be set up at the sending contacts upon each opening or closure thereof. Each such arc comprises a train of transient high frequency oscillations which flow through the conductive portions of the printer circuit and cause energy of a radio frequency to be radiated from all portions of the printer unit as well as from the wiring connected thereto, including the power leads as well as the loop circuit. As a result of this condition, it will be obvious that a radio receiving station operating in the vicinity of the printer unit will pick up these high frequency oscillations in its antenna circuit and cause them to be transmitted to the radio receiving unit, thus producing interfering noises therein. In some instances these interfering noises have been so great as to completely drown out the radio signals.

The governor which regulates the speed of the printer set motor is controlled through contacts which open and close a current regulating circuit. Each time this circuit is opened or closed, a miniature arc occurs at the governor contacts, which causes energy to be radiated at radio frequency in the manner described above for the sending contacts. In a similar manner, any arcing which occurs at the brushes associated with the printer set motors causes energy of radio

frequency to be radiated from the printer set and its associated wiring.

In accordance with one feature of the invention, the radiation of energy at radio frequencies from the sender contacts and also the governor contacts is greatly reduced by the interposition of a filter circuit between the contacts in question and the remainder of the printer circuit. These filter circuits comprise special choke coils in series with the contact leads and condenser and resistance elements connected across the contacts. The choke coils act to prevent the high frequency current from getting into other conductive portions of the printer circuit and being radiated therefrom. The shunt arms which include the condenser and resistance elements aid the choke coils in preventing the high frequency current from getting into other conductive portions of the printer set and at the same time serve to quench the spark.

In accordance with a second feature of the invention, the interfering effects due to arcing at the brushes of the printer motor are minimized by connecting a pair of condensers across the power input leads with the midpoints between condensers connected to the frame of the printer motor, with possibly a second similarly connected condenser pair having the midpoint connected to the frame of the printer set.

A typical instance of a situation in which the interference to radio reception caused by the operation of a printer unit is apt to be most troublesome, occurs where a radio receiving station is used as a relay point for transmitting by wire to other points messages received via radio. In such a case, a printer telegraph set is located at the radio receiving desk and an operator thereat, equipped with a head-set, types on the printer unit the messages as they come in on the radio circuit. The printer unit is, of course, connected by means of telegraph lines to other printer units at distant points which thus type up the received radio messages. Since the lead-in wire from the antenna circuit and the radio receiving equipment is located very close to the printer unit for this situation, interfer-

ing currents radiated from the printer, due to arcing, are easily picked up by the radio circuit and produce very troublesome interfering noises in the operator's headset.

5 Having explained above the general nature of the problem involved and outlined means used for eliminating the troublesome conditions, a detailed explanation will now be given with reference to the drawings of the
10 devices used for eliminating the interfering effects discussed above. In this connection, Figure 1 of the drawings shows in diagrammatic form the essential portions of a printer telegraph circuit embodying the circuit ar-
15 rangements utilized for eliminating the interfering currents. Figs. 2 and 3 furnish detailed information on the special choke coils used in the filter circuits.

Referring to Fig. 1, all the apparatus
20 shown within the dashed-line rectangle is associated with a given printer unit. The driving motor 1 comprises the armature 2, the field structure 3 and the metallic frame or housing 37. The motor elements are, of
25 course, shown in very schematic form. The motor is affixed to the supporting structure or metallic frame 32 of the printer by means of bolts 38. Power for driving the printer is supplied over leads 4, which are connected to
30 terminals 36, which terminals are affixed to the frame 32 of the printer but insulated therefrom in a manner not shown. Leads 39 connect the motor 1 to the power terminals 36.

The governor 5 for regulating the motor
35 speed is connected mechanically to the armature 2 of motor 1 by means of shaft 6. The governor comprises a disk which is affixed to the shaft 6 and rotates in unison with the armature of the motor. It is equipped with
40 a pair of insulated slip rings having brushes 12 bearing thereon respectively as shown in the drawings. Affixed to the disk is the conductive segment 8 which is connected to the inner slip ring as shown. A second element
45 comprising an arm of conductive material 7 is pivoted at 10, as shown, and connected to the outer slip ring. A tension spring 9 having one end affixed to the disk 5 by means of screw 11 has the other end connected to seg-
50 ment 7 and normally holds segment 7 against segment 8, thus completing a conductive path between the brushes 12. If the motor rotates above a certain speed, the centrifugal force pulls segment 7 away from segment 8 against
55 the tension of spring 9 and thus opens the conductive path between the brushes 12.

As was mentioned above, the source of power to drive motor 1 is supplied over leads
60 4. Assuming that the current from the power source comes in over the lower conductor of leads 4, the circuit is traced in over the lower lead and through the shunt path connected across resistance 13 comprising the windings of choke coils 14, the lower brush 12, contacts
65 8 and 7, respectively, of the governor and out

over the upper brush 12, through the wind-
ings of the upper choke coil 15, through lower field winding 3 of the motor 1, through the armature 2 and the upper field winding 3 and out over the upper conductor of power leads
70 4. This presents the condition when the motor is running at its normal speed. If, now, the motor speeds up beyond a certain value, the arm 7 on the governor will be thrown out of contact with segment 8 due to the centrif-
75 ugal force of rotation overcoming the tension of spring element 9. This opens up the circuit connected in shunt with resistance 13 and forces the current from the power source supplied over leads 4 to flow through resist-
80 ance 13 in series with the field and armature of the motor 1. The resistance 13 is of such value that it reduces the current flowing in the armature of the motor to a low value and causes it to slow down. As soon as the motor
85 speed falls below a certain value, however, spring 9 forces arm 7 of the governor back into contact with segment 8, thus shunting out the resistance 13 and allowing the motor to speed up again.

It will thus be seen that as contacts 7 and 8 alternately open and close due to variation in speed of the motor, current from the power source normally flowing through these con-
90 tacts is interrupted and restored. Each time the contacts open or close, a miniature arc occurs at contacts 7 and 8. This arc contains transient high frequency components in the radio range which normally, in the absence of the filter device 16, cause high frequency
95 currents to flow through leads 17 into the power circuit and other conductive portions of the printer system, from which elements the radio frequency currents are radiated into space. It will be seen, of course, that the
100 total radiating surface comprising the printer unit and the leads connected thereto constitute quite an appreciable antenna system from which energy may be radiated to any radio receiving stations in the vicinity
105 thereof. The energy radiated directly into space from the arc is small in comparison with that radiated from the printer set and its associated wiring. This suggests the possibility of eliminating or at least greatly
110 reducing the radiation of energy from the arc by interposing between the governor 5 and the leads 17 some sort of a filter circuit such as indicated by 16. This method was tried
115 and it was found that with a filter suitably designed, as now to be described, the energy radiated with the filter inserted was only about 1/100 to 1/10,000 of that radiated with the filter omitted.

The filter 16 comprises choke coils 14 and
120 15 connected in the lower and upper conductors, respectively, of leads 17 extending to the governor contacts. Connected directly across the governor contacts is the series circuit comprising condenser 19 and resistance
130

18. Each choke coil 14 or 15 comprises four windings placed on the same spool, as described below. Between the second and third windings of each coil, a shunt path is connected across the line comprising a condenser 35 in series with a resistance 18. The choke coils 14 and 15 prevent the high frequency currents generated at the contacts 7 and 8 of the governor from traversing leads 17 and thus being radiated from the conductive portions of the printer circuit. The shunt circuits comprising the condenser element 19 or 35 and resistances 18 serve the dual function of by-passing the high frequency currents directly across the circuit and of quenching the arc.

The condenser elements 19 and 35 offer low impedance shunt paths to the high frequency currents generated by the arc, and thus aid the choke coils in preventing these currents from flowing over leads 17. If the condenser elements alone were connected in the shunt paths when a direct current power source is used, currents of large magnitude would flow through them due to the negligible impedance offered, which currents would be damped out slowly. The resistances 18 are therefore inserted in series with the condensers to limit the current magnitude and also to quench the arc quickly by dissipating the energy generated.

In a specific design which has been found successful for eliminating interferences, the condenser elements 19 and 35 had capacities of 1 mf. and .1 mf., respectively, while the resistance elements 18 were 75 ohms each. The details of the special choke coils 14 and 15 successfully used are shown in Fig. 2. Referring to Fig. 2, the coil comprises four windings connected series aiding and wound in suitable slots on the wooden spool 19. The spool contains four slots, as shown, for the reception of the windings. As indicated in Fig. 1, the number of turns per slot increases from left to right. Specifically referring to Fig. 2, each slot, from left to right, in order, contains the following number of turns: 35, 70, 140 and 280. The wire used was No. 20 gauge, silk, enamelled covered. In Fig. 1, the choke coils 14 and 15 are so connected that the thirty-five-turn winding was connected directly to the brushes of the governor while the 280-turn windings were connected to leads 17, as indicated.

Referring again to Fig. 1, the printing elements of the printer set comprise the printer unit 21, the sending contacts 20 and the "break" key 22 connected in series to the telegraph line 23. Current supplied from battery 24 normally flows through the sending contacts 20 and out over the telegraph line to the distant point and thence to ground. When a message is being transmitted, however, the operation of the sending contacts 20 interrupts this current flow and thus pro-

duces arcing at the sender contacts. The high frequency currents thus generated normally flow out over the telegraph line 23 and through conductive portions of the printer set and are radiated therefrom, as was described above for arcing at the governor contacts. To minimize this radiation, the filter circuit 25 is inserted between the sender contacts 20 and the rest of the sending circuit. The filter circuit 25 comprises special choke coils 26 for preventing the high frequency currents generated at the arcing contacts from getting out into the telegraph line. The shunt circuit connected across the line comprising condenser 27 in series with resistance 28 serves the purpose of quenching the arc and by-passing the high frequency currents. In a specific design of the filter circuit which was found to be successful, the condenser had a capacity of .1 mf. while the element 28 comprises a resistance of 300 ohms. The detailed information on the special high frequency choke coils 26 are given in Fig. 3. These coils are wound on wooden spools having the dimensions indicated.

It would seem off-hand that the same type of filter circuit which was successful for the sending contacts would also be successful when applied to the governor contacts. When, however, a filter such as 25 was connected in place of filter 16, the results were not nearly so successful as those obtained with the arrangement of Fig. 1. The difficulty apparently lay in the design of the choke coil. As is well known, any choke coil has distributed capacity between the turns of the winding, and this distributed capacity has much the same effect as a condenser connected in shunt with the coil inductance. At a certain frequency, the coil thus becomes anti-resonant and above this frequency the distributed capacity acts as a by-pass around the coil and thus prevents its inductance from being effective at such frequencies.

Now the coil of Fig. 2 is wound in four slots separated, as shown, to cut down the distributed capacity per unit inductance. For this reason, the coil of Fig. 2 will resonate at a much higher frequency than the coil of Fig. 3, and hence the inductance of the former coil will be effective in suppressing radio frequency currents over a much wider range of wave lengths than the latter.

Using the above facts as a basis of deduction, the probable reason why the special type of choke coil shown in Fig. 2 is required for the governor contacts while that shown in Fig. 3 is satisfactory for the sending contacts, lies in the different system of frequency spectra of the arcs generated at that governor and sending contacts. If it is assumed that the frequency spectrum for an arc generated at the governor contacts contains components of much higher frequency than are present in the sender contact arcs, it of course be-

comes apparent why the coil of Fig. 3 is not satisfactory when applied to the governor contacts while that of Fig. 2 is effective. The former type of choke coil would merely by-
 5 pass these high frequency currents via its distributed capacity and permit them to be radiated as described above, while the coil of Fig. 2 suppresses them. Regardless of
 10 the correctness of the above reasoning, however, there is no doubt as to the effectiveness of the circuit arrangements described.

Another reason for the need of more elaborate suppressing arrangements for the governor contacts is this. The current broken by
 15 the governor contacts is many times greater (about $\frac{1}{2}$ amp. as compared to .06 amp.) which therefore causes a greater amount of interference. Consequently, the reduction needed is greater.

20 The detailed data on the coil of Fig. 2 is shown on the drawings. The four windings are connected series aiding with terminals 40 brought out for connecting the coil in a filter circuit.

25 A method which has been found effective for eliminating interference to radio reception due to arcing at the brushes of the motor 1, comprises connecting a pair of equal capacities 29 in series between the brush terminals
 30 of motor 1, as shown, and connecting the midpoint between the condensers to the motor frame, as shown by lead 33. It is important to have all leads to the condensers 29 as short as possible and for this reason, it is
 35 advisable to mount the condensers on the motor frame. Capacities of 1 mf. each have been successfully used for the condensers 29.

If the printer set and the radio receiving station are run from different power sources,
 40 the above precaution is in general all that is required. If, however, the same power source is used for both, interfering currents may nevertheless find their way from the printer set to the radio circuit. In such a case, the
 45 interference may be further reduced by connecting an additional pair of condensers 41 in series between the power input terminals 36 to the printer set, and connecting the midpoint between said condensers to the printer
 50 frame as shown by lead 34. In this case again the leads to the condensers should be made as short as possible so that best results are obtained by locating the condensers 41 adjacent terminals 36 and connecting the mid-
 55 point to the printer frame thereat.

What is claimed is:

1. Means for preventing interference to radio reception caused by printing telegraph operation, comprising in combination with a
 60 printing telegraph set equipped with a sender circuit including sending contacts, a filter circuit for suppressing radio frequency currents interposed in said sender circuit adjacent said sending contacts, said filter comprising series arms of non-magnetic core
 65

inductances and shunt arms of resistance and capacity in series.

2. Means for preventing interference to radio reception caused by printing telegraph operation, comprising in combination with a
 70 printing telegraph set equipped with a sender circuit including sending contacts, a filter circuit for suppressing radio frequency currents interposed in said sender circuit adjacent said sending contacts, said filter comprising a radio frequency choke coil serially
 75 connected in the sender circuit on each side of said sender contacts, with resistance and capacity in series connected directly across said sender contacts. 80

3. Means for preventing interference to radio reception caused by printing telegraph operation, comprising in combination with a
 85 printing telegraph set equipped with a sender circuit including sending contacts, a filter circuit for suppressing radio frequency currents interposed in said sender circuit adjacent said sending contacts, said filter comprising non-magnetic core coils of substantially 3 millihenries inductance and substantially 7 ohms resistance serially connected
 90 in said sender circuit on each side of said contacts and a capacity of substantially .1 mf. in series with substantially 300 ohms resistance connected directly across said sender
 95 contacts.

4. Means for minimizing interference to radio reception due to printing telegraph operation, comprising in combination with a
 100 printing telegraph set equipped with a driving motor and a speed governor therefor, said governor having associated therewith a pair of electrical contacts with leads extending therefrom to a regulating circuit, a filter
 105 circuit for suppressing radio frequency oscillations situated adjacent said contacts and interposed in the leads extending thereto, said filter comprising shunt arms containing resistance and capacity in series, and series arms comprising radio frequency choke
 110 coils.

5. Means for minimizing interference to radio reception due to printing telegraph operation, comprising in combination with a
 115 printing telegraph set equipped with a driving motor and a speed governor therefor, said governor having associated therewith a pair of electrical contacts with leads extending therefrom to a regulating circuit, a filter circuit for suppressing radio frequency
 120 oscillations situated adjacent said contacts and interposed in the leads extending thereto, said filter comprising specially wound choke coils as described serially connected in each said lead, with capacity and resistance
 125 in series connected directly across said contacts, and with capacity and resistance in series connected between said choke coils at intermediate tapping points thereon.

6. Means for minimizing interference to 130

radio reception due to printing telegraph operation, comprising in combination with a printing telegraph set equipped with a driving motor and a speed governor therefor, said governor having associated therewith a pair of electrical contacts with leads extending therefrom to a regulating circuit, a filter circuit for suppressing radio frequency oscillations interposed in said leads adjacent said contacts, said filter comprising a plurality of mutually coupled radio frequency choke coils connected series aiding in one said lead, and a similar device connected in the other said lead, resistance and capacity in series connected directly across said contacts, and resistance and capacity in series from a point between a pair of said choke coils in one said lead to a corresponding point between said choke coils in the opposite lead.

7. Means for preventing interference to radio reception caused by printing telegraph operation, comprising in combination with a printing telegraph set having a driving motor and a governor therefor with a pair of electrical contacts on said governor connected by a pair of leads to regulating means, means for suppressing radio frequency currents interposed in said leads adjacent said contacts, said means comprising a choke coil serially connected in each said lead, each coil comprising a plurality of windings spaced apart on a non-magnetic core with the windings connected series aiding and with successively increasing turns per winding from a minimum winding adjacent said contacts, capacity and resistance in series connected directly across said contacts, and capacity and resistance in series connected between said choke coils at intermediate tapping points thereon.

8. Means for preventing interference to radio reception caused by printing telegraph operation, comprising in combination with a printing telegraph set having a driving motor and a governor therefor with a pair of electrical contacts on said governor connected by a pair of leads to regulating means, means for suppressing radio frequency currents interposed in said leads adjacent said contacts, said means comprising a choke coil serially connected in each said lead, each coil comprising a plurality of windings spaced apart on a non-magnetic core with the windings connected series aiding and with the turns per winding increasing successively in geometric progression from a minimum winding adjacent said contacts, capacity and resistance in series connected between said contacts, and capacity and resistance in series connected between said choke coils at intermediate tapping points thereon.

9. In a combination as set forth in claim 8, choke coils therefor having four windings each with a minimum winding for each of

35 turns, a capacity of substantially .1 mf. in series with substantially 75 ohms connected directly across said governor contacts, a capacity of substantially .1 mf. in series with substantially 75 ohms connected from a point between the second and third windings of one said choke coil to a point between the second and third windings of the other said choke coil.

10. In a printing telegraph set including telegraph sending contacts with leads connected thereto, a driving motor, a governor therefor including a pair of electrical contacts operable in accordance with the motor speed, speed regulating means controlled through said contacts, a metallic framework for retaining all elements aforesaid, and power leads for said printer set connected to a pair of insulated terminals on said framework, means for preventing interference to radio reception caused by said printer operation comprising in combination, a filter circuit adapted to suppress radio frequency oscillations inserted adjacent said sending contacts in the leads extending thereto, a filter inserted adjacent said governor contacts in the leads extending thereto and including an inductance element in each of said governor leads comprising a plurality of windings connected series aiding and spaced apart with successively increasing turns per winding from a minimum winding adjacent said governor contacts, a pair of equal capacities situated adjacent said motor and connected in series between the brushes thereof with the midpoint between said capacities connected to the motor framework, and a pair of equal capacities situated adjacent said power terminals and connected in series between the same with the midpoint between said capacities connected to said printer framework.

11. Inductance means comprising a plurality of windings connected series aiding and spaced apart on a core with successively increasing turns per winding, said core being adapted to have a rapid rate of magnetization and demagnetization.

12. An inductance element comprising a plurality of windings connected series aiding and spaced apart on a non-magnetic core with the turns per winding increasing successively in geometric progression.

13. An inductance element comprising in combination a non-magnetic core having a plurality of slots therein spaced apart, a plurality of windings arranged in said slots and connected series aiding, the number of turns per winding increasing successively in geometric progression, and a plurality of terminals for said windings, two of said terminals being connected to the first and last windings, respectively, and at least one of said terminals being connected between a pair of the intermediate windings.

14. A filter circuit for suppressing radio frequency currents, comprising in combination a plurality of radio frequency choke coils and a plurality of shunt arms containing capacity and resistance in series, certain of said shunt arms being connected across the terminals of said choke coils and the remainder of said shunt arms being connected between said choke coils at intermediate tapping points thereon.

10 15. A filter circuit for suppressing radio frequency currents, comprising in combination a pair of choke coils, each coil comprising a plurality of windings spaced apart on
15 a non-magnetic core with the windings connected series aiding and with successively increasing turns per winding, a shunt arm containing resistance and capacity in series connected across the terminals of said choke coils
20 adjacent the minimum winding, and a second shunt arm containing resistance and capacity in series connected from a point between a pair of said windings in one choke coil to a corresponding point in the other choke coil.

25 16. In a printing telegraph system including telegraph sending contacts with leads connected thereto, a motor governor including a pair of electrical contacts operable in accordance with the motor speed and speed
30 regulating means controlled through said contacts, means for preventing interference to radio reception caused by said printer operation, comprising in combination a filter circuit for said sending contacts comprising
35 a pair of radio frequency choke coils connected serially in the leads extending to said sending contacts and a shunt arm containing resistance and capacity in series connected across said leads adjacent said sending contacts, and a filter circuit for said governor
40 comprising a pair of choke coils connected serially in the leads extending to said governor, each of said choke coils including a plurality of windings spaced apart on a non-
45 magnetic core with windings connected series aiding and with successively increasing turns per winding from a minimum winding adjacent said governor, a shunt arm containing resistance and capacity in series connected di-
50 rectly across said governor means, and a second shunt arm containing resistance and capacity in series connected from a point between a pair of said windings in one choke
55 coil to a corresponding point in the other choke coil.

17. Means for preventing interference to radio reception caused by printing telegraph operation, comprising, in combination with a
60 printing telegraph set equipped with sending and receiving contacts and a sending and receiving circuit, filter means interposed in said circuit adjacent said contacts for suppressing radio frequency currents, said filter
65 means comprising series arms of non-mag-

netic core inductances and shunt arms of resistance and capacity.

In testimony whereof, I have signed my name to this specification this 8th day of March, 1929.

ALLAN WEAVER.