

May 3, 1932.

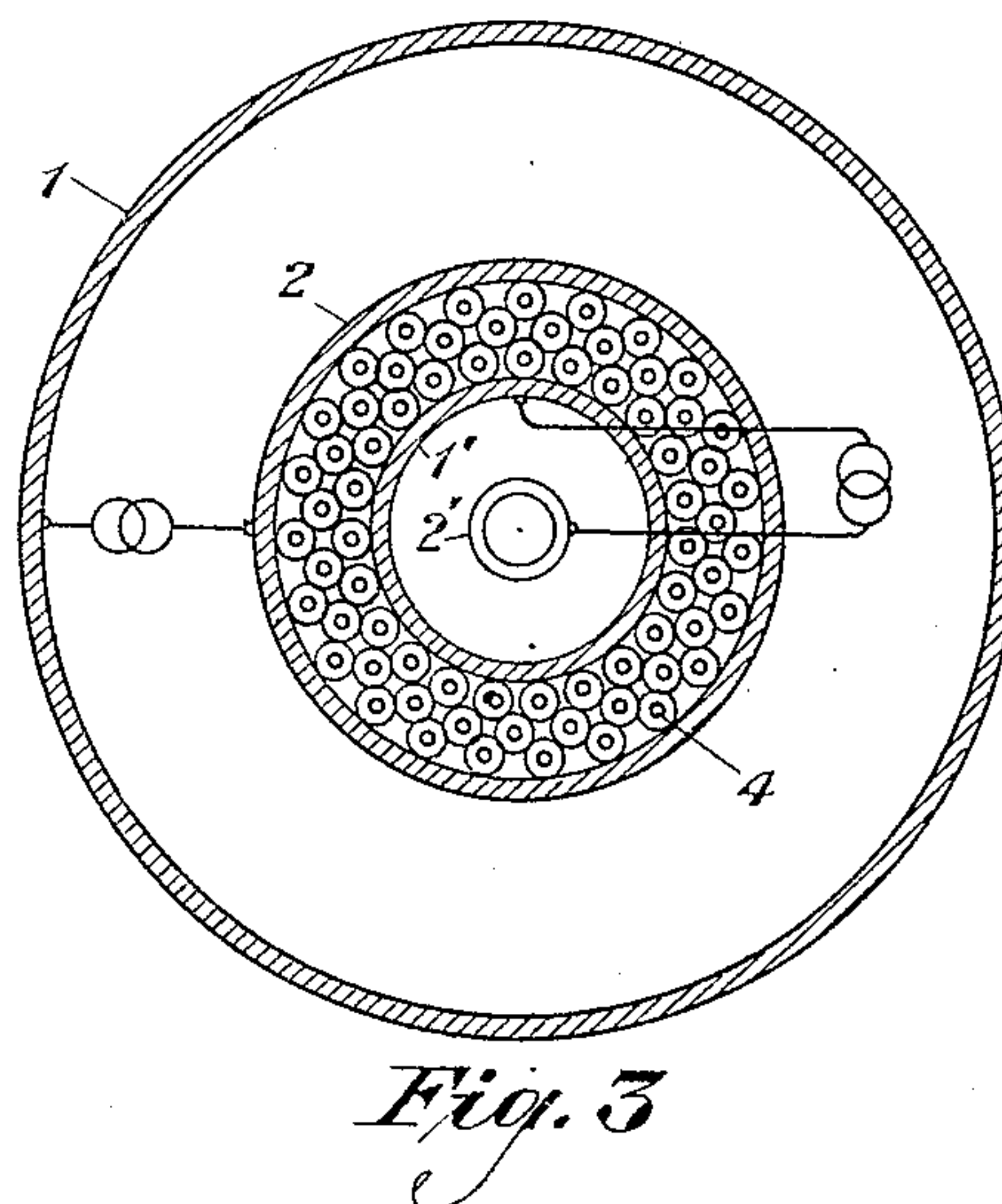
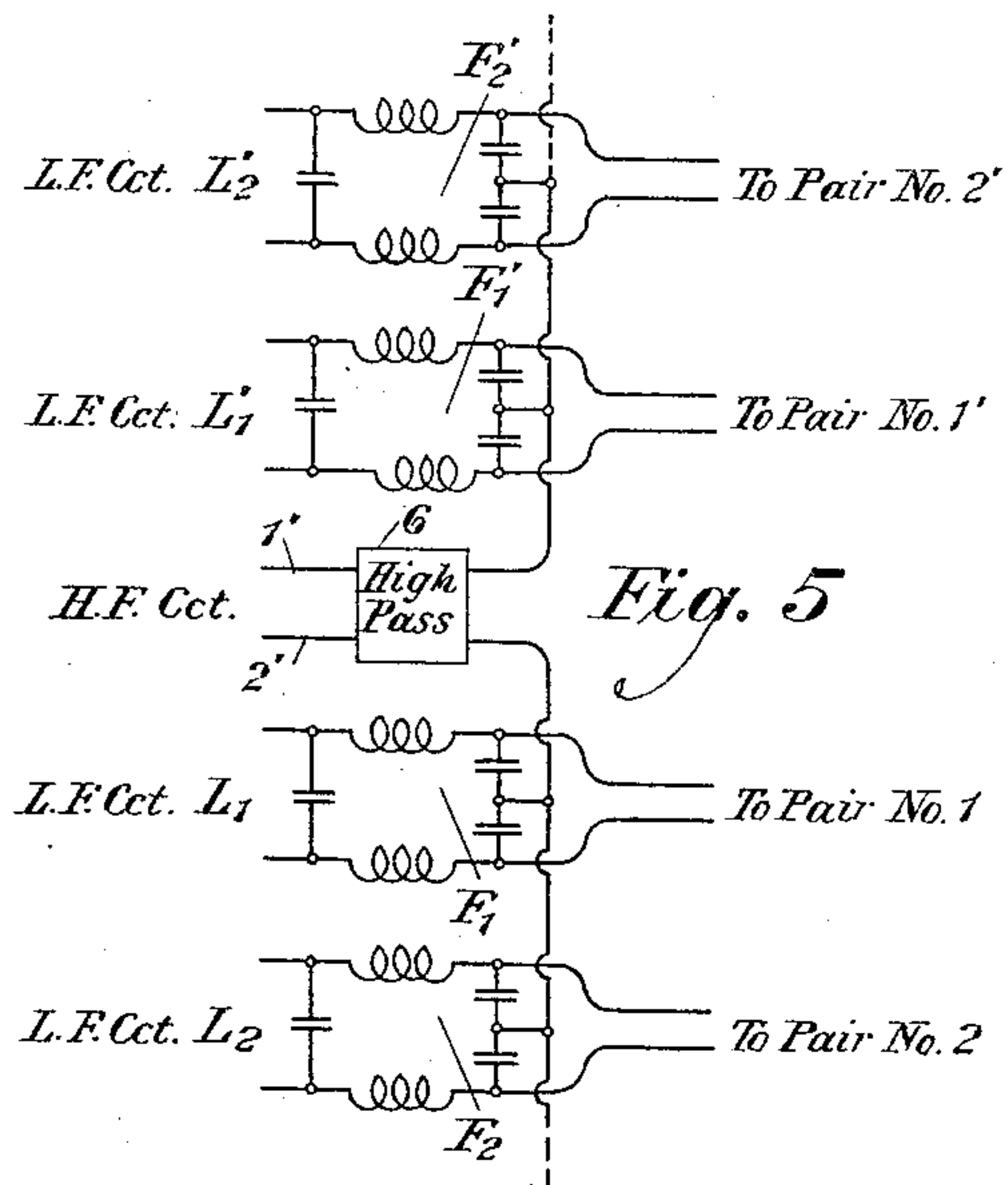
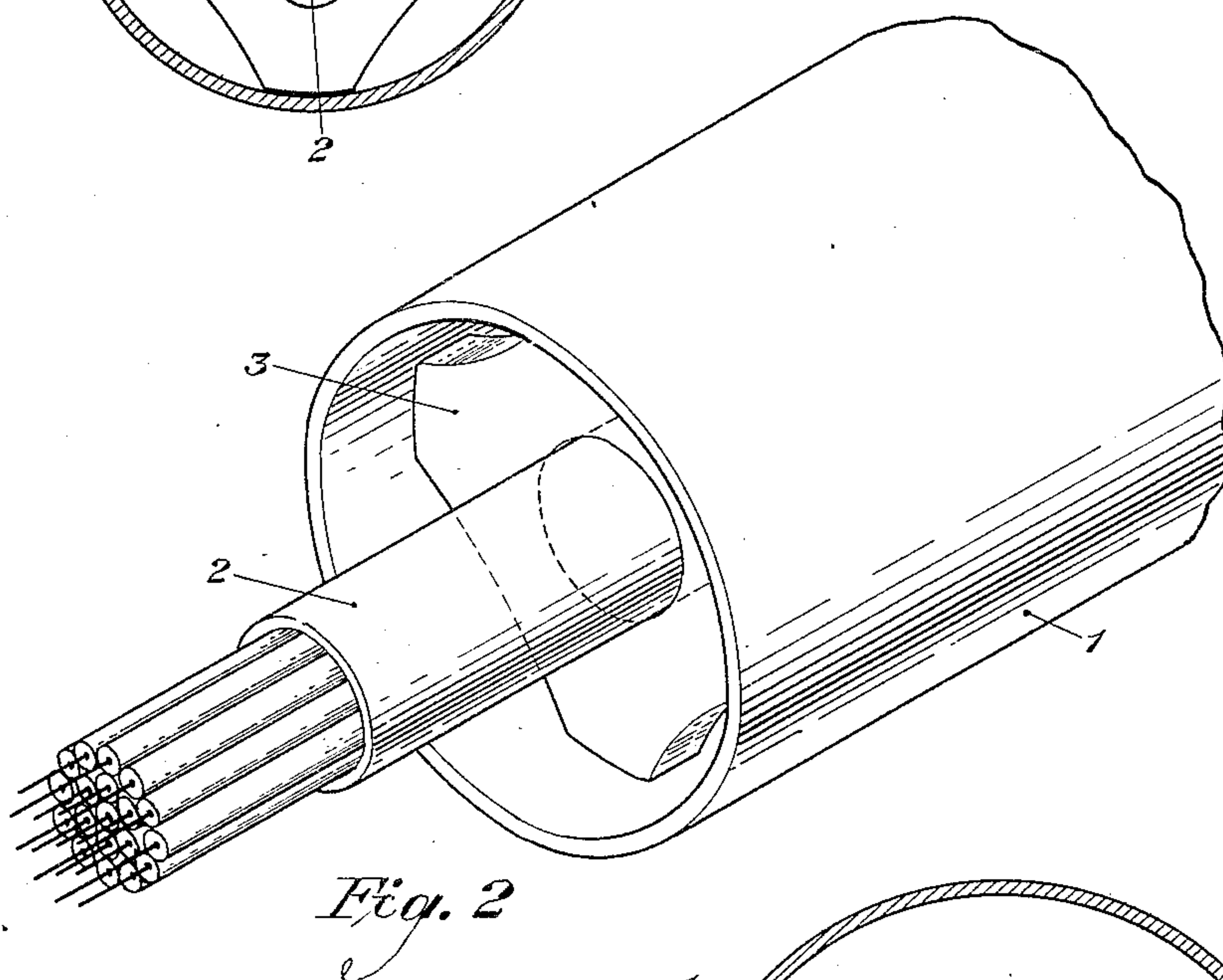
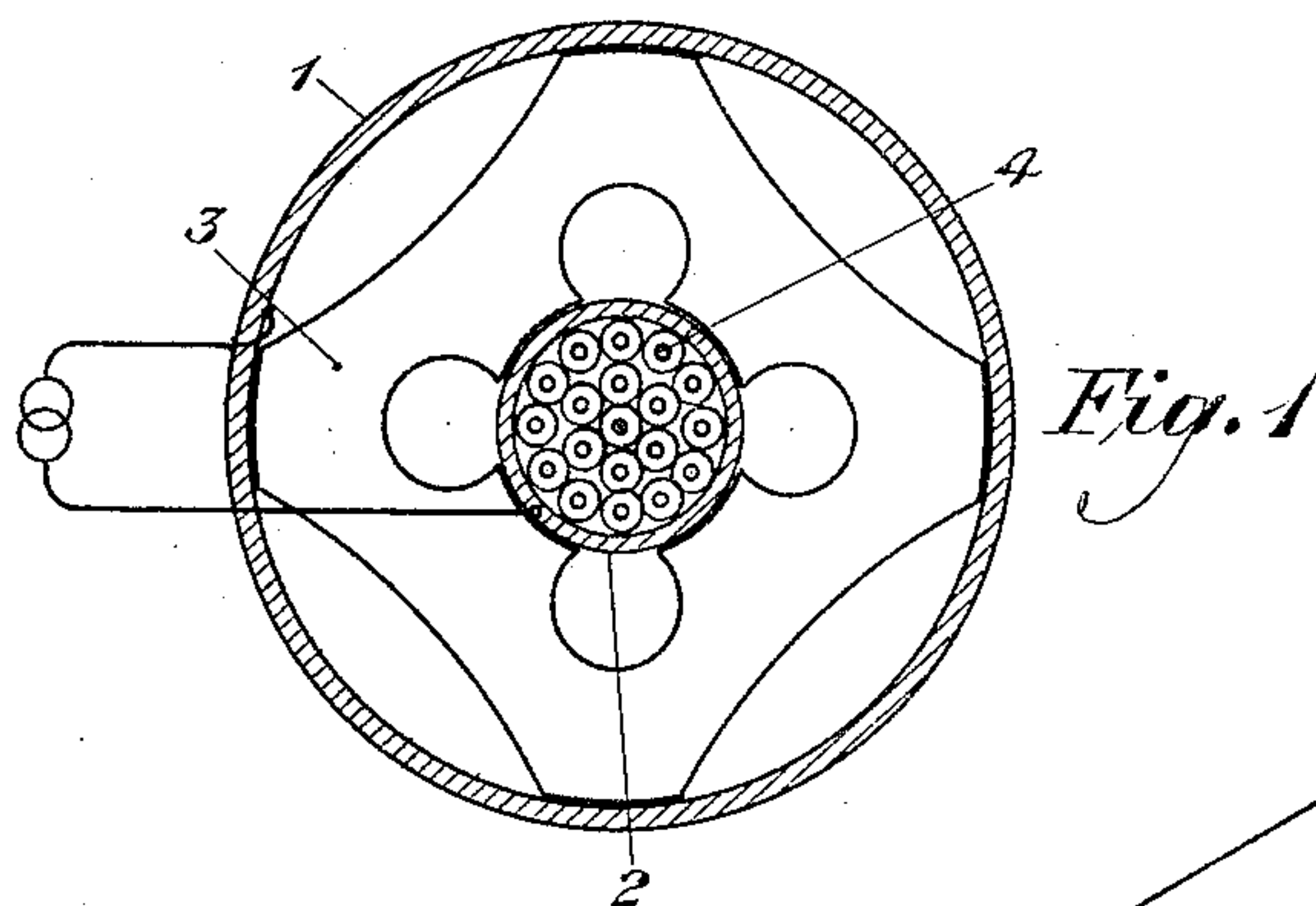
H. A. AFFEL ET AL

1,856,204

COAXIAL CONDUCTOR SYSTEM

Filed May 24, 1930

2 Sheets-Sheet 1



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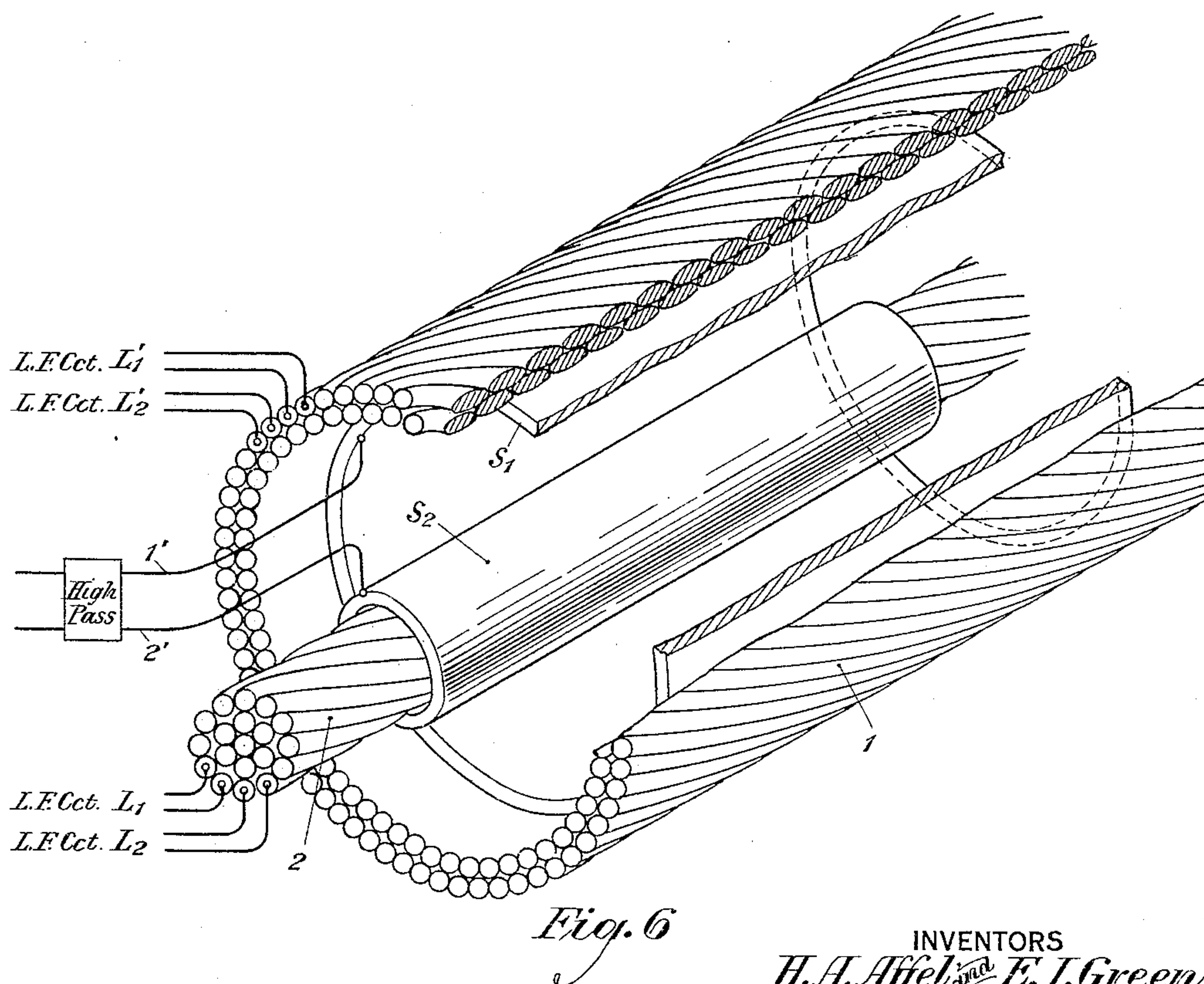
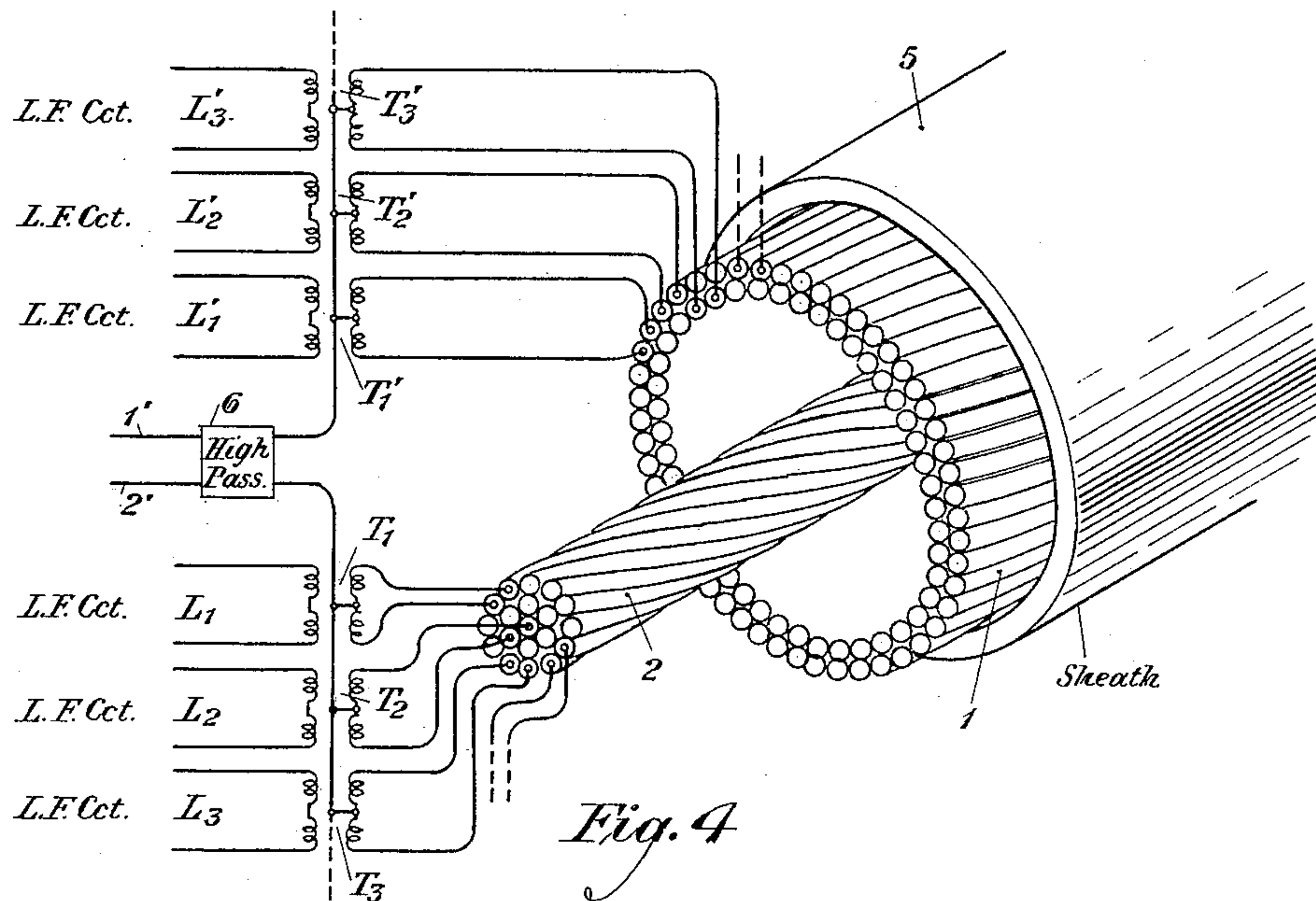
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COAXIAL CONDUCTOR SYSTEM

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2 Sheets-Sheet 2



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COAXIAL CONDUCTOR SYSTEM

Application filed May 24, 1930. Serial No. 455,328.

This invention relates to concentric conductor systems, and more particularly to arrangements for providing spare conductors for special services.

5 In a concentric conductor system comprising two tubular conductor arrangements arranged concentrically one within the other, and the one acting as a return for the other, a large number of channels of communication
10 may be provided between terminal points connected by the concentric conductor system. Service to or between intermediate points, however, would be difficult to obtain from such a system due to the expense of
15 providing the necessary filter and other apparatus for picking off channels at intermediate points. In accordance with the present invention it is, therefore, proposed to utilize the space inside the inner conductor by filling
20 it with ordinary cable pairs, these pairs being utilized to give service between intermediate points along the concentric conductor system. Such additional cable pairs will serve the useful purpose of providing spare channels
25 to give temporary service in case the concentric conductor system is disabled. The spare conductors within the interior of the inner conductor will be shielded from external interference due to the surrounding concentric
30 conductor and will, indeed, be shielded from the concentric conductor transmission itself due to the fact that such transmission tends to take place along the outer skin of the inner conductor.

35 The invention will now be more fully understood when read in connection with the accompanying drawings in which Figure 1 is a transverse section showing how the spare cable pairs are mounted within the interior
40 of the concentric conductor; Fig. 2 is a perspective view of a portion of the conductor system; Fig. 3 is a cross-section of a modified arrangement in which two separate concentric conductor systems are mounted one
45 within the other, with the extra cable pairs located in the space between the outer conductor of the inner system and the inner conductor of the outer system; and Figs. 4, 5 and 6 are views showing modified arrangements
50 in which both the inner and outer con-

centric conductors are formed of pairs of insulated conductors, which are connected to serve as independent transmission paths.

Referring to Figs. 1 and 2, a concentric conductor system comprising an outer conductor 1 of copper or other suitable material, is arranged to concentrically surround an inner conductor 2, and the two conductors are maintained in proper spaced relation by means of insulating members 3 of suitable
55 insulating material, spaced at intervals along the inner conductor. The spacing elements 3 are cut away in order to reduce the amount of dielectric material between the two conductors and are, of course, spaced as far apart
60 as is possible for the same reason. If the conductors are arranged one as a return for the other, the system will have relatively low attenuation at very high frequencies and may be used to effectively transmit communication channels of frequencies much higher
65 than are possible in ordinary open wire circuits. In such a system the current flows at the outer surface of the inner conductor and at the inner surface of the outer conductor, and the field is practically confined within
70 the space between the two conductors. Substantially no field due to the current flow over the concentric conductor system exists in the space within the inner conductor. Also, this space will be free from external interference due to the shielding effect of the concentric conductors surrounding it. Accordingly, it is proposed to utilize this space
75 by locating therein a plurality of insulated wires, such as 4. These wires may preferably be ordinary cable pairs which may be used as separate channels of communication without interfering with the concentric conductor system. It will be noted that the concentric
80 conductor system replaces the usual cable sheath.

In a concentric conductor system the immediate realization of partial service in case the system is disabled is of primary importance, and by utilizing the space within the inner conductor for additional cable pairs, as illustrated in Figs. 1 and 2, a limited number of channels for emergency service will be provided. The scheme has several advantages
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among which may be noted the following:
 (1) It provides additional circuits at very small cost; (2) it offers means of obtaining short haul circuits without the necessity of deriving them from the wide frequency band on the main circuit; (3) it offers a means of obtaining some service in emergencies inasmuch as there will be little likelihood of the pairs within the inner conductor being affected by an interruption of the main circuit.

An arrangement such as above described will also be useful in providing connections for service between points located intermediate the main centers which are connected by the concentric conductor system. In order to supply service to the intermediate points from the main concentric conductor system, it would be necessary to pick off channels by providing expensive filters and other associated equipment similar to that which would be provided at the terminals. The cable pairs located within the interior conductor will, therefore, be very useful to provide communication channels for wayside points independently of the main system.

A modified arrangement is shown in Fig. 3 in which one concentric conductor system is located within the other. An outer conductor system is shown comprising an outer conductor 1 and an inner conductor 2, concentrically arranged. The conductors 1 and 2 will, of course, be connected so that the one acts as a return for the other. A second concentric conductor system of smaller diameter is also provided, this system comprising an outer conductor 1' and an inner conductor 2', these conductors also being connected so that one acts as a return for the other. The transmission for the inner system will take place along the outer surface of conductor 2' and the inner surface of conductor 1', while that for the outer conductor system will take place along the outer surface of conductor 2 and the inner surface of conductor 1. Therefore, the space between conductors 1' and 2 may be utilized for spare insulated cable pairs 4. These pairs will not be subject to interference due to the current flow in the two concentric conductor systems, and the pairs will also be shielded from external interference due to the surrounding conductors 2 and 1.

The principles of the invention may also be applied to a system of concentric conductors in which either the inner or the outer coaxial conductor, or both, may consist of a number of pairs of insulated wires. The wires of each pair may be connected in series to form an independent low frequency circuit, and the wires of all the pairs forming one side of the coaxial conductor system are connected in parallel for high frequency transmission. As a result of such an arrangement the coaxial conductors would be of stranded formation, and the individual

wires or strands may, if desired, be interwoven or interchanged so as to reduce the skin effect resistance at high frequencies.

One such an arrangement is illustrated in Fig. 4. Here, the outer concentric conductor 1 comprises a large number of individual pairs of insulated wires. The pairs are twisted helically to form a hollow cylinder, as shown, and if desired the individual wires of each pair may be twisted about each other, as is the usual telephone practice. So, also, the inner concentric conductor 2 is made up of a number of pairs of insulated wires twisted about each other to form a more or less solid cylinder arranged concentrically with the outer shell 1. The different pairs of the inner cylinder 2 are connected through transformers T_1, T_2, T_3 , etc. to individual low frequency terminal circuits numbered L_1, L_2 and L_3 . Similarly, the pairs forming the outer hollow cylinder 1 are connected through transformers T'_1, T'_2 and T'_3 to individual low frequency terminal circuits L'_1, L'_2, L'_3 , etc. Each of the pairs making up the concentric conductor arrangement, therefore, acts independently to form a separate low frequency transmission path.

The high frequency concentric conductor system is provided by utilizing a connection similar to that used for phantoming ordinary telephone circuits. In other words, from the midpoint of the primaries of each of the transformers T_1, T_2 , etc., a connection is made to a common conductor 2' so that all of the pairs forming the cylindrical conductor 2 are effectively connected in parallel and form one side of the concentric conductor system. Likewise, the midpoints of each of the transformers T'_1, T'_2 , etc., are connected to the conductor 1' so that all of the pairs of the outer concentric shell are connected in parallel to form the return path of the high frequency concentric conductor system. If desired, the outer shell may be encased in a suitable sheath 5 for purposes of protection. A high-pass filter 6 may also be included in the circuit formed by the conductors 1' and 2' to prevent low frequency currents from the individual pairs from passing into the high frequency terminal.

Instead of using the phantom connection of Fig. 4, the connection shown in Fig. 5 may be employed. Here, each of the low frequency terminal circuits such as L_1, L_2 or L'_1, L'_2 , etc., includes a low-pass filter; that is to say, a filter whose section is made up of a series inductance and a shunt capacity. The shunt capacity at the terminal adjacent the concentric conductor is split, as shown, and the midpoint is connected to the conductor 1' or 2', as the case may be, so that the pairs of wires making up the concentric conductors are connected in two parallel groups to form the two sides of the high frequency concentric transmission path.

Still another arrangement by which the pairs forming the individual low frequency transmission circuits may be effectively connected in parallel to form the high frequency concentric conductor system is illustrated in Fig. 6. Here, the capacity of a conductive sheath adjacent to the twisted pairs is used as a means for coupling the high frequency circuit. As shown at the terminal of the inner concentric conductor 2, a short section of conductive sheath S_2 surrounds the cylindrical member 2 and is connected to the wire 2' forming one side of the high frequency system. A similar conductive shield S_1 is arranged along the inner surface of the outer shell 1 near the end thereof, and this shell is likewise connected to the conductor 1' of the high frequency system. The capacity between these two shells and the ends of the adjacent conductors effectively couples the conductors in parallel to form the high frequency transmission path. As in Figs. 3 and 4, the individual pairs are brought out to separate terminal circuits so they are connected in series for ordinary transmission purposes.

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 following claims.

What is claimed is:

1. A concentric conductor system comprising an outer tubular conductor and an inner tubular conductor concentrically arranged and connected so that one acts as a return for the other, and a plurality of independent conductor wires located in the space surrounded and bounded by the outer surface of the inner conductor.

2. A concentric conductor system comprising an outer tubular conductor and an inner tubular conductor concentrically arranged and connected so that one acts as a return for the other, and a plurality of independent insulated wires located within the space surrounded and bounded by the outer surface of the inner concentric conductor, said independent wires constituting independent transmission channels.

3. A concentric conductor system comprising an outer tubular conductor and an inner tubular conductor concentrically arranged and connected so that one acts as a return for the other, and a plurality of insulated cable pairs located within the space surrounded and bounded by the outer surface of the inner tubular conductor, said pairs serving as spare or additional circuits independent of the transmission channels provided by the concentric conductor system itself.

4. A cable comprising a plurality of coaxial conductors forming means for high

frequency transmission, and a plurality of pairs of insulated wires occupying certain portions of the cable not occupied by the coaxial conductors and substantially free from induction from said coaxial conductors.

5. In a transmission system, a group of pairs of conductors, each conductor of a pair connected as a return for the other, and the group of pairs being arranged to form a stranded cylindrical cable-like structure, a second group of pairs of conductors, each conductor of a pair connected as a return for the other, said second group of conductors being arranged to form a hollow cylinder concentric with said first group, and means to connect conductors of said first group in multiple so that the outer conductors thereof constitute effectively one conductor of a concentric conductor system, and means to connect conductors of said second group in multiple so that they constitute in effect the return concentric conductor for the concentric conductor formed by the first group.

6. In a transmission system, a group of insulated conductors connected in parallel and forming a stranded cylindrical cable, a second group of insulated conductors forming a hollow cylindrical structure concentric with said cable and connected in parallel to form a cylindrical return path for the transmission path formed by said first group, and means to connect the conductors of each group in pairs to form a plurality of transmission circuits independent of the concentric conductor system.

In testimony whereof, we have signed our names to this specification this 16th day of May, 1930.

HERMAN A. AFFEL.
ESTILL I. GREEN.