

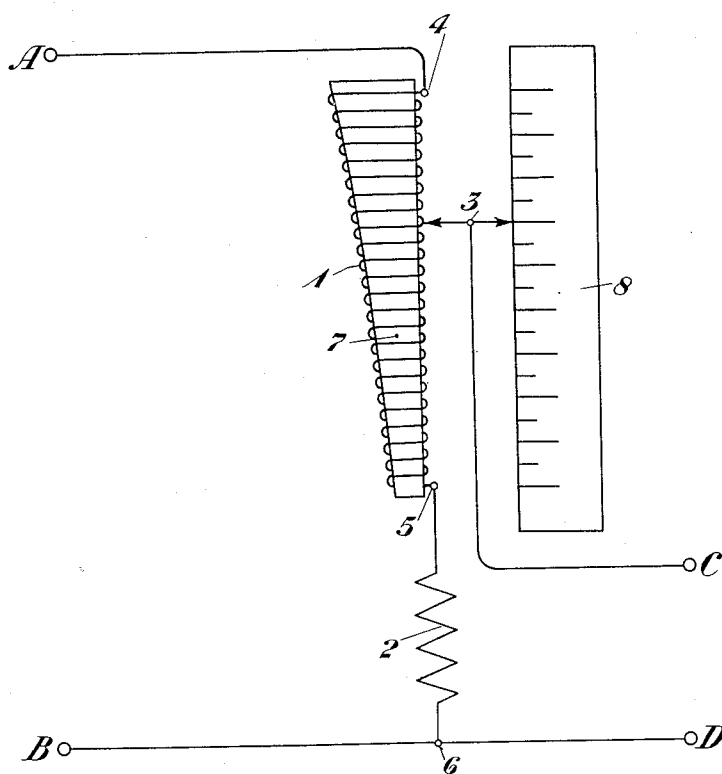
Jan. 1, 1924

1,479,051

F. H. BEST

ARTIFICIAL LINE

Filed May 14, 1920



INVENTOR

F. H. Best

BY

g e 4 o h

ATTORNEY

UNITED STATES PATENT OFFICE.

FRED H. BEST, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

ARTIFICIAL LINE.

Application filed May 14, 1920. Serial No. 381,480.

To all whom it may concern:

Be it known that I, FRED H. BEST, residing at Westfield, in the county of Union and State of New Jersey, have invented certain

Improvements in Artificial Lines, of which the following is a specification.

This invention relates to artificial lines and particularly to lines of the potentiometer type.

It proposes to employ as the shunt resistance element, a device whose resistance per unit length is so graded, that the transmission equivalent of the line varies substantially directly as the distance of movement of the contact which co-operates with this resistance, so that for reasons explained hereinafter, the scale employed to indicate the number of miles of actual line to which the artificial line is equivalent, may be provided with divisions of substantially uniform lengths. The invention proposes as a resistance device of the above-defined character, a wire wound on a core of graded cross section, and provided with a contact which co-operates with the turns and is movable transversely with respect thereto.

A good understanding of the invention may now be had from the following description thereof having reference to the accompanying drawing showing one form and arrangement of apparatus embodying the invention in diagrammatic view.

In this drawing, reference characters AB designate the input terminals of the line and CD the output terminals thereof. Resistances 1 and 2, of which 1 is of a special type of construction described in detail herein below, are bridged across terminals A and B, and a variable contact 3 is provided to co-operate with the resistance 1 so as to connect a variable portion thereof in series with the resistance 2 between the terminals CD. It will be observed that the voltage CD may be adjusted, within limits, to any desired fraction of AB, from a maximum when contact 3 is at the upper terminal 4 of resistance 1, to a minimum when the same is at the lower terminal 5 thereof.

For any position of contact 3 the length of actual line to which the artificial line is equivalent depends upon the ratio of the voltage CD to AB. This follows from the fact well known in the telephone art, that when a wave of voltage E_1 travels along a uniform

line it shrinks or attenuates by the factor $e^{-\alpha}$ in each unit of length of the line, where alpha is a constant dependent on the particular line under consideration, and e is the base of the Naperian logarithms. (See page 71 of textbook by A. E. Kennelly on "The Application of Hyperbolic Functions to Electrical Engineering Problems" published by the University of London Press, Ltd. London 1912.) The value E_2 of the voltage wave as it arrives at a point L units of length remote from the starting point is therefore:

$$E_2 = E_1 e^{-L\alpha}$$

whence

$$L = \frac{1}{\alpha} \log \frac{E_1}{E_2}$$

In the present case E_1 = voltage AB and E_2 = voltage CD. The voltage E_1 may be taken as a constant. The length of actual line L, therefore, which is simulated by the device of my invention is a logarithmic or exponential function of the voltage CD, and consequently, likewise of the resistance included between contact 3 and the terminal 6 of resistance 2. The latter resistance is of such value relatively to resistance 1 that the transmission loss in the line is the same as that of a cable having a length of, say, 10 miles, although any other length may be chosen, this value being used herein only for sake of illustration. To simulate a cable of 10 miles, the contact 3 is placed at the terminal 5 of resistance 1 and to simulate a cable of less length, the contact is moved upwardly on the resistance, to include a greater portion thereof between terminals CD. Because of the inverse logarithmic relation between the voltage CD and the number of miles simulated, the resistance included between 3 and 6, as the contact 3 is moved to terminal 4, has to be increased in accordance with an exponential function of the miles simulated. This means that when the resistance 1 is of the form of a slide-wire, the length of resistance wire per unit length of cable simulated increases as contact 3 approaches terminal 4. The present invention proposes to construct the resistance 1 of a wire wound on a tapered core, the taper of the core being such that when the resistance is connected as in the drawing, and contact

3 is moved longitudinally between 4 and 5, equal distances of movement of the contact will cause substantially equal changes in the transmission equivalent of the line, no matter at what part of the resistance this movement takes place. A scale 8 may therefore be placed adjacent resistance 1 and the contact may be provided with an index which cooperates with the scale. The same may then be calibrated to read miles loss of transmission according to the position of the contact point. With the resistance constructed in the manner described, the scale divisions will be of substantially uniform length throughout the scale, so that equal accuracy may be attained in the use of the instrument, no matter what part of the scale is being used. This would not be the case if the resistance were of the ordinary uniform slide wire type, for then the divisions close to terminal 5 would be very much smaller than those close to terminal 4, i. e., the length of the divisions would vary in a logarithmic or exponential order. The impedance of the circuit connected to terminals CD should be large with respect to that of the artificial line so that the voltage across AB remains constant as the position of contact 3 is varied.

Although I have herein shown and described only one form and arrangement of apparatus embodying the invention, it is readily understood that various changes and modifications may be made therein within the scope of the following claims without departing from the spirit and scope of the invention.

What I claim is:

1. An artificial line having input and output terminals and comprising an impedance connected between said input terminals, adjustable means to include any desired part thereof between the output terminals, an indicator to show the adjustment of said means, and a scale for said indicator, said impedance being graduated and said scale being marked so that the indication on the latter is in terms of length of a transmission line having the same attenuation as the artificial line at the corresponding adjustment.

2. An artificial line having input and out-

put terminals and comprising an impedance connected between said input terminals, adjustable means to include any desired part thereof between the output terminals, an indicator to show the adjustment of said means, and a scale for said indicator, said impedance being graduated and said scale being marked in uniform divisions, so that the indication on the latter is in terms of and proportional to the length of a transmission line having the same attenuation as the artificial line at the corresponding adjustment.

3. An artificial line having input and output terminals and comprising a resistance across the input terminals, a movable contact to include a part of said resistance across the output terminals, an indicator associated with said contact, and a scale adjacent to said indicator with equal scale divisions marked in miles of transmission line, said resistance being graduated as an exponential function of the scale divisions so as to make the indicator read correctly on the scale.

4. An artificial line having input and output terminals and comprising a resistance coil across the input terminals, a sliding contact to include a part of said coil across the output terminals, an indicator carried by said contact, and a scale adjacent to said indicator with equal scale divisions marked in miles of transmission line, said coil being wound with turns of progressively increasing length so as to make the indicator read correctly on the scale.

5. An artificial line having input and output terminals and comprising an impedance across the input terminals, a movable member to include a part of said impedance across the output terminals, an indicator associated with said member, and a scale adjacent to said indicator marked in miles of transmission line, said impedance being graduated and said scale being marked to make the indicator read correctly on the scale.

In testimony whereof, I have signed my name to this specification this 13th day of May, 1920.

FRED H. BEST.