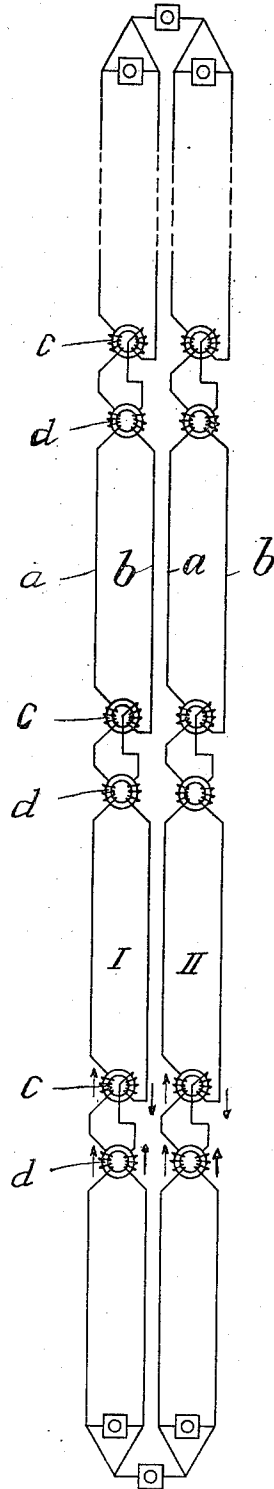


A. W. EBELING.
 DIPLEX TELEPHONE CONNECTION.
 APPLICATION FILED JULY 7, 1909.

960,856.

Patented June 7, 1910.



Witnesses
~~W. H. Knight~~
 Ray J. Ernst.

Inventor
 August Wilhelm Ebeling
 by his attorneys *Smith, & B. O.*

UNITED STATES PATENT OFFICE.

AUGUST WILHELM EBELING, OF CHARLOTTENBURG, GERMANY, ASSIGNOR TO SIEMENS & HALSKE A. G., OF BERLIN, GERMANY, A CORPORATION OF GERMANY.

DIPLEX TELEPHONE CONNECTION.

960,856:

Specification of Letters Patent.

Patented June 7, 1910.

Application filed July 7, 1909. Serial No. 506,380.

To all whom it may concern:

Be it known that I, AUGUST WILHELM EBELING, a subject of the German Emperor, and residing at Charlottenburg, near Berlin, Germany, have invented certain new and useful Improvements in Diplex Telephone Connections, of which the following is a specification.

The subject-matter of my invention is a diplex telephone connection having self-induction load according to the Pupin system.

It has become known through Pupin to weaken the injurious effect of the capacity of telephone lines by interpolating inductance coils in the same at definite intervals which are as uniform as possible. In this manner it is possible to make telephone lines cheaper or to connect telephonically places separated by materially greater distances.

Endeavors are constantly being made to make telephonic working more profitable over long distances, this being still relatively expensive. One way of doing this is afforded by the well-known diplex telephone

connection. The use of the diplex telephone connection in the case of double lines equipped with Pupin coils is connected with certain difficulties however. For equipping double lines with Pupin coils so-called

double coils have been used, in general, heretofore, *i. e.* coils having two windings on a common iron core, of which the one winding is always interpolated in the one branch and the other winding in the other branch of the double line. If double lines equipped in this manner were employed in diplex telephone connections, as will be readily understood the effect intended by the inductance coils for the combined double line would not

occur, since, in consequence of the deranged current in this event, the self-induction coils wound on common cores would reciprocally cancel one another in their effect. If instead of double coils single coils were employed, the use of lines equipped in such manner would indeed be possible in the diplex telephone connection, but these coils present great difficulties inasmuch as it is very difficult in practice to make single coils

which possess and retain exactly equal electrical values which is absolutely necessary in order that the currents in the lead and return of a double line may be as exactly

equal as possible. If the currents are not exactly tuned, very disturbing cross-talk is met with in diplex working.

Now a primary object of my invention is to remove these defects; making use of the materially more advantageous double coils, I attain this object by interpolating a special set of double coils in each double line for each mode of working these lines, namely in such manner that they take into account the different directions of current.

In order that my invention may be clearly understood I will now describe the same with reference to the accompanying drawing in which one embodiment is diagrammatically represented by way of example.

Referring to the drawing, I and II denote two double lines, whose branches *a*, *b* are equipped with double coils *c* and *d*. To the standard equipment of the two double lines the double coils *c* would solely belong which are distributed along the entire double line at definite, but preferably uniform intervals and whose windings, as shown, are arranged on common cores. The direction in which the windings *c* are wound and the interpolation of the windings *c* in the branches of the double lines must be such that, having regard to the direction of current occurring during normal working, which direction will always be opposite in the two windings, the iron core is magnetized in the same sense. If it were wished to unite such double lines equipped only with coils *c* in the diplex telephone connection, in this event, as will be readily understood, the self-induction of the windings of the individual coils would reciprocally cancel one another for the combined double line, since then both the branches of each double line would conduct the current in the same direction at any time. If each double line be provided, however, with a second set of self-induction coils *d* in such manner that account is taken of the flow of current occurring in the diplex connection, *i. e.* by the core being magnetized only in the same sense by the two windings when the branches of the double line are traversed by current in the same sense, it is possible to obtain the Pupin effect in the diplex connection also. As is clear, it is only necessary to reverse the connection of the one

winding of the double coil *d* so that the current traverses this in the reverse direction.

It will be readily understood that for the combined double line the coils *c* do not operate in the normal sense, but that these windings traversed simultaneously now by current of the same direction cancel one another reciprocally in their action. The double lines are therefore loaded by self-induction in the diplex connection solely by the set of coils *d*. Owing to the employment of two sets of coils increased resistance of the telephone circuit has to be reckoned with. But since, as described, only one set of coils is operative simultaneously, only the pure, direct current resistances come into question which can be kept very small by selecting suitable coils. Practical tests have shown that the influence of the coils which are inoperative at any time is practically unnoticeable or only so to a small extent according to the kind of the coils in each instance. In order to maintain the Pupin effect correct, of course the values of the self-inductions of the coils must be selected suitably, the capacity of the kind of conductor and the effective value of the self-induction having to be taken into consideration.

It is obviously not necessary that the two double coils *c* and *d* be always located in the lines as closed together in pairs as shown in the drawings, but that the additional coils *d* may be distributed over the lines at any suitable intervals, however, always alternating with the double coils *c*. It is only necessary that the single coils of the two sets of double coils are all traversed by the cur-

rent in series in the same sense in one of the two lines (for instance in line *a* as shown) and that the single coils of the two sets located in the other line (*b*) are traversed by the current in series, but alternately in the opposite sense.

In the event of an additional telephone circuit being made by further combination of two double lines, which might have a certain importance in cables, the operative coils of the first combination would have to be considered as simple coils. Consequently, it would always be possible to make a further combination beyond that of two double lines to form a third telephone circuit in case of need.

I claim:

In a diplex telephone connection the combination with the double lines, having a set of double coils forming the self-induction load according to the Pupin system; of an additional set of double coils alternating with the double coils of said first named set along the lines at suitable intervals, the single coils of the two sets of double coils in one of the two lines being all traversed by the current in series and in the same sense and the single coils of the two sets located in the other line being traversed by the current in series but alternately in the opposite sense, for the purpose set forth.

In testimony whereof I have signed my name to this specification in the presence of two witnesses.

AUGUST WILHELM EBELING.

Witnesses:

HENRY HASPER,
WOLDEMAR HAUPT.