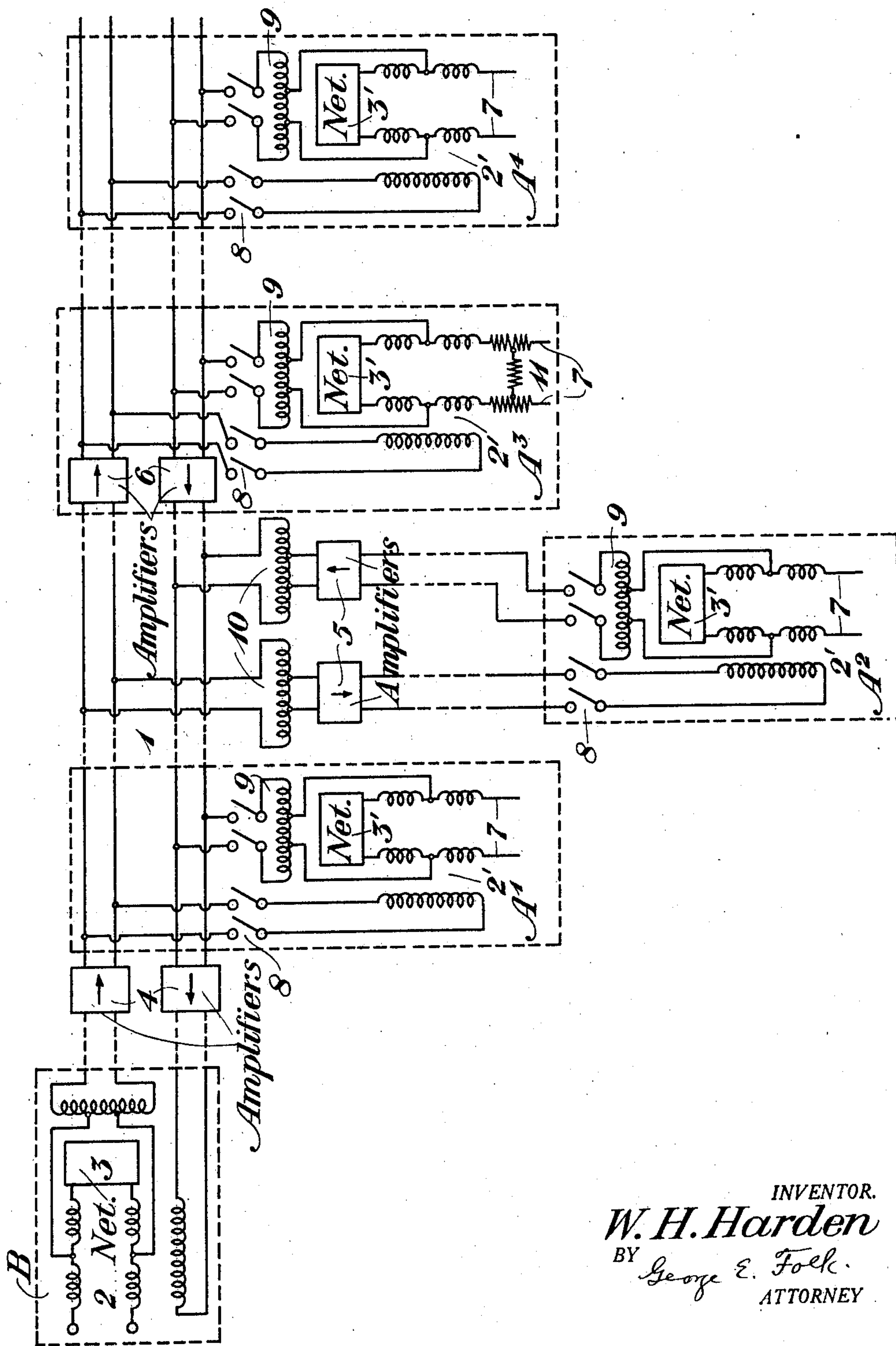


W. H. HARDEN.
 MULTIPLE STATION TRANSMISSION CIRCUITS.
 APPLICATION FILED DEC. 13, 1918.

1,392,152.

Patented Sept. 27, 1921.



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MULTIPLE-STATION TRANSMISSION-CIRCUITS.

1,392,152.

Specification of Letters Patent. Patented Sept. 27, 1921.

Application filed December 13, 1918. Serial No. 266,636.

To all whom it may concern:

Be it known that I, WILLIAM H. HARDEN, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Multiple-Station Transmission-Circuits, of which the following is a specification.

This invention relates to systems for transmitting telephonic or telegraphic signals, and its object is to provide a system of this character giving improved service to a number of stations bridged across the line at various points. This is accomplished by a novel arrangement of circuits and apparatus for equalizing the transmission from the more distant stations to make it substantially as effective as from the nearer stations.

The invention is applicable to a variety of situations in which it is desirable that a station, say at one end of the line, have ready and effective communication with all of the other stations bridged upon the line at varying distances away, as for instance in train despatching systems or the like, and is especially valuable for the order or "call" circuits used by the operators in multi-office exchange areas.

In the latter case the circuit terminates in the telephone set of a "B" operator whose duty it is to complete, by the use of trunks, calls originating at various other stations or exchanges and directed to subscribers associated with her exchange. To do this she must be informed by the "A" operator at the other exchange, of the number wanted and the exchange from which the call comes, and must in return advise the A operator which trunk running to her exchange shall be used to complete the connection. This information is exchanged over a call circuit. Such a circuit may extend from the B operator's set through a number of exchanges or stations, all of the A operators at each station having access to the line upon depression of their call-circuit buttons. There is therefore a possibility of a number of A operators coming onto the line at once when the apparatus of each being bridged across the circuit, cuts down the effectiveness of the connection between the others and the B operator. Moreover in large cities the stations may be widely separated and those more remote electrically from the B operator in question may easily be drowned out

by the nearer stations because of the greater volume of transmission from the latter.

The present invention remedies difficulties of the character indicated. It is here illustrated as embodied in a telephone call circuit and will be more fully understood by reference to the following description and the accompanying drawing which shows diagrammatically a circuit embodying the invention.

Instead of the ordinary two wire circuit for connecting the various stations I use a four wire circuit indicated on the drawing generally at 1. It is shown terminating at one end in a "B" operator's station, B, where it may be changed into a two wire line by means of the usual three limbed transformer, 2. This permits the circuit to be connected to the standard two wire instrument, which may then be used interchangeably between this circuit and others of a different character. The net-work 3 is provided to balance the operator's set (not shown) as is customary in using transformers of this kind.

A¹, A², A³ and A⁴ indicate other exchanges or stations located at varying distances from the exchange B and all having access thereto by being bridged across the line 1, in the manner shown. One way amplifiers, 4, 5, 6, of any approved type are introduced into the respective sides of the four wire circuit at suitable points, their location being determined by the extent and arrangement of the particular circuit in which they are to be placed. In the circuit shown they have been located adjacent stations A¹ and A³ and in the branch leading to station A². It will be unnecessary under usual conditions to insert them at every station. And in general they will not need to be inserted in any of the bridged circuits.

At each station or exchange the four wire circuit is preferably converted into a two wire circuit 7 by a transformer 2' similar to the transformer 2 at station 3, and employed for like reasons. Also, as at station B, net-works 3' are provided to balance the operators' instruments.

Inasmuch as there are several operators at each of the A stations any number of whom may chance to come onto the call circuit simultaneously, the net-work 3' at each station should be designed to give the best average balance under the conditions likely

to occur at that station. Experience indicates that a sufficiently good balance may be had for these stations by the use of non-inductive resistances.

5 Switching arrangements 8 are provided between the four wire circuit and each A station or exchange. These have their con-
tacts normally open as shown, and are
closed, preferably automatically, only upon
10 the depression by an operator of the call-
circuit button which connects her instru-
ment to the two wire line 7, so that unless a
station is actually using the line the trans-
formers or other apparatus of the station
15 will not form a shunt for the talking cur-
rents from other stations. Without provid-
ing a means for removing the bridges from
the main circuit when they are not in use a
very bad condition of unbalance would exist
20 in the three limbed transformers 2' since
normally no operator's instrument is con-
nected to the lines 7 to balance the net-work.

Auto-transformers 9 are placed in the line
at each station. The impedance ratio of
25 these transformer coils is high so that the
loss to the transmission on the main circuit,
due to the bridges is small. The loss, inci-
dent to the coil, in the station with which it
is associated is made up by the amplifiers.
30 It will be observed that for all the stations
except station A² the auto-transformer is
shown in one side only of the four-wire
bridge, the right-hand side. The three-
limbed transformer acts as a high impedance
35 ratio repeating coil and therefore the left-
hand side of each of the four-wire bridges
shown connected to the repeating coil side
of the three-limbed transformer does not
need to be provided with auto-transformers.

40 Station A² represents a special case in this
connection in that the three-limbed trans-
former is located at some distance from the
main four-wire circuit. The auto-trans-
former 9 and the three-limbed transformer
45 2' have ratios such that reflection losses
where these connect to the branch circuits
will be small. The auto-transformers 10
have high impedance ratios such that the
bridged losses caused by these branch cir-
50 cuits will be small. The presence of the
amplifiers 5 and the length of the circuits
between these and station A² prevent the
use of high impedance ratio transformers
at station A² to accomplish this result.

55 An artificial line 11 is shown in the two
wire leads of station A³. This device is use-
ful for cutting down the number of ampli-
fiers necessary. In the example given, for
instance, the amplifiers 6 are designed to
60 give the proper transmission from the more
distant station, A⁴, and the artificial line is
then added to the line at station A³ to
make it the equivalent in transmission of the
line running to station A⁴. The losses inci-
65 dent to the artificial line, as well as those due

to the auto-transformers, are unobjection-
able because of the peculiar properties of
the four wire circuit whereby they can be
efficiently compensated by the amplifiers.

It may be desirable in certain instances to 70
have the circuit at station B somewhat un-
balanced. In the case illustrated in the
drawing, for instance it will be noticed that,
because of the one way repeaters in the
branch leading to station A², the operators 75
at that station will be unable to hear the
operator at stations A³ and A⁴ if they happen
to be using the line and, similarly those at
the latter stations cannot hear those at sta-
tion A², unless the B operator's set and the 80
net-work 3 are sufficiently out of balance to
repeat the talk back from the B station
along the other side of the line from the
one upon which it enters. The same unbal-
ance will be necessary for this purpose, if 85
the A stations use four wire instruments con-
nected directly to the four-wire circuit, in-
stead of the arrangement shown, as may be
done, for instance, in a train despatching
system. It may be noted here that if it 90
were desired also to use a four wire instru-
ment at the station B no opportunity for
this unbalance would be present since the
transformer 2 and net-work 3 would be omit-
ted. In such a case the bridged stations 95
would be isolated from each other and to
prevent interference a separate signal or lock-
out device of any approved type could be
employed. By using four-wire instruments
all limitations due to effects of unbalance 100
are avoided, and lower equivalents between
the B station and the various A stations are,
therefore, possible, in general.

By the use of a circuit of the character
here disclosed it is possible to render the 105
transmission to all of the bridged stations
equally effective, however widely they may
be separated, and by reason of the peculiari-
ties of the four wire line employed the
losses incident to the longer circuits and to 110
the apparatus used in connection with the
invention may be adequately compensated by
the use of amplifiers, without the danger of
"singing" which limits the degree of ampli-
fication practicable in the ordinary circuit. 115
It will be understood however that the in-
vention contemplates the use of sections of
two wire circuit to complete the connections
wherever found desirable, and the means
shown at each station for converting the 120
four wire line into a two wire line makes
obvious the manner in which such an ar-
rangement may be set up.

What I claim is:

1. In combination, a circuit comprising a 125
section having separate lines for transmit-
ting signals in opposite directions respec-
tively, a plurality of stations some of which
are bridged across said section of the circuit
at various points and means associated with 130

the circuit for substantially equalizing the transmission from a selected one of said stations to each of the others.

2. In combination, a circuit comprising a section having separate lines for transmitting signals in opposite directions respectively, a number of stations bridged across the circuit at various points, one-way amplifiers so distributed in the opposite sides of the circuit that the effectiveness of the communication between a given station and each of the others is substantially the same.

3. The combination with a circuit having separate lines for transmitting signals in opposite directions respectively, of a number of stations bridged across the circuit, means associated with the circuit for compensating the transmission losses from a given point thereon to the various stations to substantially equalize facility of communication with all stations, and means at each station for minimizing the transmission losses incident to bridging in on the circuit.

4. The combination with a circuit having separate lines for transmitting signals in opposite directions respectively, of a number of stations bridged across the circuit at various points, means associated with the circuit to compensate the unequal transmission losses from a given point on the circuit to the various stations, means whereby each bridged station may be disconnected from the circuit when not in use and means at each station for minimizing the circuit transmission losses due to the shunt formed by bridging in any station.

5. The combination of a telephone circuit having separate lines for transmitting sound in opposite directions respectively, a number of telephone stations bridged across the circuit, one-way amplifiers in the circuit located and distributed to compensate the unequal transmission from the various stations

to a given point, auto-transformers interposed between the stations and the main circuit and switches whereby each bridged station may be disconnected from the circuit when not in use.

6. The combination with a main circuit having separate lines for transmitting signals in opposite directions, of a number of stations bridged across the circuit at various points, transforming apparatus at each station for converting the circuit into one communicating in both directions over the same conductors and means associated with said main circuit for substantially equalizing the transmission from a given one of said stations to each of the others.

7. The combination with a main circuit having separate lines for transmitting signals in opposite directions, of a number of stations bridged across the circuit at various points, transforming apparatus at each station for locally changing the circuit into one communicating in both directions over the same conductors, the transforming apparatus of one station being unbalanced to cause signals received over one side of the main circuit to be repeated back over the other side.

8. The combination with a four-wire transmission circuit having a number of bridged stations, of amplifiers distributed in the circuit and located adjacent certain of the stations, means for converting the four-wire circuit in each of the bridges into a two-wire circuit and artificial lines in the two-wire circuits of the stations adjacent the amplifiers for rendering them the equivalent in transmission of the stations more remote from the amplifiers.

In testimony whereof, I have signed my name to this specification this 11th day of December 1918.

WILLIAM H. HARDEN.