We, INTERNATIONAL STANDARD ELECTRIC CORPORATION of 320 Park Avenue, New York 22, State of New York, United States of America, hereby apply for the grant of a Patent for an invention, entitled, "CONTINUITY TEST CIRCUIT"

which is described in the accompanying complete specification. This application is a Convention application and is based on the application numbered P 27 35 341.9 for a patent or similar protection made in Germany on 5 August, 1977.

Our address for service is:

PATENT DEPARTMENT,
STANDARD TELEPHONES AND CABLES PTY. LIMITED,
232-280 BOTANY ROAD,
ALEXANDRIA, N.S.W. 2015,
AUSTRALIA.

Dated the twenty-sixth day of July 1978.

INTERNATIONAL STANDARD ELECTRIC CORPORATION

Authorized Signatory
To: The Commissioner of Patents.
In support of the convention application made for a patent or a patent of addition for an invention entitled

"CONTINUITY TEST CIRCUIT"

I, CONWAY WALTER WADHAM,
of Standard Telephones and Cables Pty. Limited, 252-280 Botany Road, Alexandria, 2015, N.S.W., Australia, do solemnly and sincerely declare as follows:-

1. I am authorised by INTERNATIONAL STANDARD ELECTRIC CORPORATION the applicant for the patent or a patent of addition to make this declaration on its behalf.
2. The basic application as defined by Section 141 of the Act was made in Germany on 5 August, 1977 by STANDARD ELEKTRIK LORENZ AKTIENGESELLSCHAFT.
3. HEINZ BRAND of Walter-Flex-Str. 44, 7000 Stuttgart, Germany.

I am the actual inventor of the invention, and the facts upon which the Applicant is entitled to make the application are as follows:-

INTERNATIONAL STANDARD ELECTRIC CORPORATION is the Assignee of STANDARD ELEKTRIK LORENZ AKTIENGESELLSCHAFT who are the Assignees of THE SAID INVENTOR.

4. The basic application referred to in paragraph 2 of this Declaration was the first application in a Convention country in respect of the invention the subject of the application.

Declared at Sydney this 26th day of July 1978.

INTERNATIONAL STANDARD ELECTRIC CORPORATION

Declarant

To: The Commissioner of Patents
Claim

1. A continuity test arrangement to test a two-wire analog line connected to a time-division multiplex network bus via a hybrid, an analog-to-digital converter in the transmit direction and a digital-to-analog converter in the receive direction, the arrangement comprising a voice-frequency transmitter connectable via the bus and the digital-to-analog converter to the hybrid receive side in the receive time slot allotted to the line and a voice-frequency receiver connectable via the bus and the analog-to-digital converter to the hybrid transmit side and control means to control the connection of the transmitter and receiver to the bus.
The following statement is a full description of this invention, including the best method of performing it known to us...
When a connection is established in modern switching systems with analog switching networks, the paths through the switching network are tested. In digital switching systems, e.g., in transit exchanges, such a continuity test is made with digital test signals.

It is also known to successively select the transistor gains of test subscribers in each subgroup by means of permanently programmed procedures. Test connections are thus established via all multiplex highways and links, and the switches of the switching network are checked for short and open circuits.

The object of the present invention is to provide an arrangement for making continuity tests on connection to two-wire analog lines connected to a time-division multiplex switching network via a hybrid, in telecommunication systems, which requires no special test subscribers.

There is described a system in which a voice-frequency transmitter and a voice-frequency receiver are provided which are connectable to a time-division multiplex bus by means of a control circuit, and that the control circuit connects the transmitter at the receive time slot, and the receiver at the transmit time slot, of the line to be tested. This has the advantage that the test may be made prior to the establishment of each connection to ensure that there is no fault.

In a development of this system, means associated with the lines are provided which, during the continuity test, are controllable from a central unit for short times and, in the "on" state, change the transfer characteristic of the connection to the line to be tested. This has the added advantage of ensuring that the tested line is identified; thus no unwanted tests of other lines are possible.

An embodiment of the invention will now be explained in greater detail with reference to the accompanying drawing, in which only one subscriber connected to a time switch is shown for simplicity.

The subscriber Tln is connected via his two-wire line to a hybrid G which interfaces the two-wire line with a four-wire line. An analog-to-digital converter W2 converts the analog signals to digital signals and passes them on to the connection unit AT of the subscriber. Analogously, a digital-to-analog converter W1 converts the digital signals provided by the connection unit AT into analog signals.
In the connection unit AT, the subscriber Tin is connected, in a known manner, to the time-division multiplex bus ZS in the time switch ZSt. Any further time and space switches that may be present are not shown in the drawing for simplicity.

When a subscriber removes the handset, this is detected in a central unit ZE in a known manner. A path is completed to the time switch ZSt, and the subscriber is allotted the necessary time slots. At the same time, the control of the time switch Sz is instructed to connect a voice-frequency transmitter S at the receive time slot tx of the subscriber, and a voice-frequency receiver E at the transmit time slot ty, to the time-division multiplex bus ZS.

The transmitter and the receiver may be equipment already present in modern switching systems or equipment specifically developed for this purpose. For example, use can be made of:

- MFC transmitter and receiver
- transmitter and receiver for frequency of push-button dialling
- dial tone transmitter and dial tone receiver
- transmitter and receiver for frequencies or frequency combinations not used for signalling within the exchange
- the frequency or frequency combination may be applied in keyed fashion
- in the receiver, all known methods of signal recognition may be used, e.g. level comparison, frequency recognition, mark/space detection, correlation calculus.

The transmitter S and the receiver E, too, are connected to the time-division multiplex bus via connection units AS and AE respectively. To simplify the representation, transmitters and receivers are assumed here which can transmit and receive digital signals, i.e. the interface circuitry between the transmitter and receiver and the bus has not been shown.

The signal transmitted by the voice-frequency transmitter S via the time switch ZS is applied to the hybrid G, reduced in power by the transhybrid loss, and applied to the outgoing arm of the four-wire line. This signal is then received by the voice-frequency receiver E and evaluated as the result of the continuity test.

Such a continuity test may also be made prior to the connection of ringing tone to the called subscriber.

For testing purposes, connections to all inactive subscribers may be established and then tested in like manner. In this way, all connections can be tested.
To ensure that the test connection to the desired subscriber has been established, the central unit ZE may carry out a special test step whereby a contact \( u \) associated with the subscriber to be tested is operated for a short time. The embodiment shows different possibilities of placing this contact \( u \).

When the contact \( u_1 \) is operated, the converter \( W_2 \) is blocked, and the receiver \( E \) receives no signal during the operation. This short-time interruption of the received signal is interpreted as a confirmation that the correct subscriber has been tested.

It is also possible to briefly disconnect the balancing network \( N \) in the hybrid \( G \) by means of the contact \( u_2 \). The disconnection of the balancing network changes the transhybrid loss and, consequently, the signal received in the receiver. This short-time change is also interpreted as a confirmation.

Another possibility is to open the contact \( u_3 \) for a short time and thus influence the transhybrid loss. This contact \( u_3 \) may be, for example, a ringing contact associated with the subscriber.

If the hybrid \( G \) contains active elements, an amplifier \( V \) in the hybrid may be so influenced by means of a contact \( u_4 \) for a short time that the transhybrid loss is reduced. If the transhybrid loss is reduced to the value 0, it is possible to identify the subscriber and check the operation of the D/A and A/D converters \( W_1 \) and \( W_2 \) if tones of different level are transmitted by the voice-frequency transmitter \( S \), thereby covering the whole converter characteristic, for at higher transhybrid losses the characteristic in the range of the maximum levels cannot be tested.

The contacts shown may, of course, be replaced by transistors or other switching means.
The claims defining the invention are as follows:

1. A continuity test arrangement to test a two-wire analog line connected to a time-division multiplex network bus via a hybrid, an analog-to-digital converter in the transmit direction and a digital-to-analog converter in the receive direction, the arrangement comprising a voice-frequency transmitter connectable via the bus and the digital-to-analog converter to the hybrid receive side in the receive time slot allotted to the line and a voice-frequency receiver connectable via the bus and the analog-to-digital converter to the hybrid transmit side and control means to control the connection of the transmitter and receiver to the bus.

2. An arrangement as claimed in claim 1 in which switching means are provided to alter the transfer characteristic between the transmitter and the receiver for a predetermined period during the test.

3. An arrangement as claimed in claim 2 in which the switching means are adapted to either block the digital-to-analog or analog-to-digital converter associated with the line or disconnect the balancing network in the hybrid associated with the line or open the line to the calling subscriber.

4. An arrangement as claimed in claim 3 in which the switching means adapted to open the subscriber line comprise a ringing switch.

5. An arrangement as claimed in claim 2 or claim 3 in which the hybrid comprises active elements and the switching means are co-operable with the active elements to alter the transhybrid loss.

6. An arrangement as claimed in claim 5, wherein the transhybrid loss is reduced to zero and wherein test means are provided whereby the operation of the digital-to-analog and analog-to-digital converters are tested by transmitting tones of different levels from the transmitter.

7. A continuity test arrangement substantially as herein described with reference to the accompanying drawing.

DATED THIS TWENTY-SIXTH DAY OF JULY 1978.

INTERNATIONAL STANDARD ELECTRIC CORPORATION.