

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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International Classification: —H 04 m 13/00

COMPLETE SPECIFICATION

A Telephone System

5 We, SUPERIOR CONTINENTAL CORPORATION, of P.O. Box 489, 1928 Main Avenue, S.E., Hickory, North Carolina, United States of America, a corporation organised and existing under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to telephone communication systems, and more particularly to apparatus for use in combination with existing telephone systems which facilitates the addition of a second subscriber telephone circuit to each cable transmission pair normally providing a single one-party subscriber telephone circuit.

20 With the rapid growth in population, a problem arose in telephone communication systems of providing for subscriber circuit expansion in areas where the subscriber exchange plant was already congested without the necessity of adding cable reinforcement. In other words, the problem was that of furnishing a second listed telephone for a business or residence. This problem became especially critical in many so-called "dedicated plant" areas where only one cable pair was allotted per residence address in building development areas.

35 The present invention relates to improvements in, or modifications of, the invention of our copending Patent Application No. (Serial No. 1185678) 19926/67 which is concerned with the general question of providing a practical, efficient and economical solution to the above problem.

40 Claim 1 of our said copending application provides a telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from the central office to a remotely

located subscriber station and connected to a first telephone set to form a non-carrier subscriber circuit, a power supply in the central office for supplying power to the transmission pair, and a carrier circuit providing an additional subscriber facility for the same transmission pair, wherein a central office terminal unit having carrier transmitter and receiver sections is connected to the central office and to the transmission pair, a subscriber terminal unit also having carrier transmitter and receiver sections is connected to the transmission pair at the subscriber station, a second telephone set is connected to the subscriber terminal unit, and a rechargeable battery is provided in the subscriber terminal unit for supplying power to operate the subscriber terminal unit sections, the battery being connected to the transmission pair through charging control means for recharging by the power supply of the central office.

65 Further, claim 18 of the said copending application provides a subscriber terminal unit for use in a telephone system to provide service via a carrier derived circuit to an additional telephone set at a subscriber station, which station includes a first telephone set connected by a cable transmission pair to a central office to constitute a non-carrier subscriber circuit, the transmission pair being supplied with power from a power supply in the central office, such subscriber terminal unit comprising carrier transmitter and receiver sections having a first pair of terminals for connection to the transmission pair and a second pair of terminals for connection to the additional telephone set, a rechargeable battery for supplying power to operate the transmitter and receiver sections, and charging control means connected to the battery and adapted to be connected to the transmission pair, whereby the battery is rechargeable from the transmission pair under the control of the charging control means.

[Price 5s. 0d.] Price 25p

An object of a first aspect of the present invention is to provide an improved telephone system or subscriber terminal unit therefor, wherein the subscriber terminal unit employs an A.C. bell ringer.

Accordingly, in this aspect, the present invention provides a telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from the central office to a remotely located subscriber station and connected to a first telephone set to form a non-carrier subscriber circuit, a power supply in the central office for supplying power to the transmission pair, and a carrier circuit providing an additional subscriber facility for the same transmission pair, wherein a central office terminal unit having carrier transmitter and receiver sections is connected to the central office and to the transmission pair, a subscriber terminal unit also having carrier transmitter and receiver sections is connected to the transmission pair at the subscriber station, a second telephone set is connected to the subscriber terminal unit, a rechargeable battery is provided in the subscriber terminal unit for supplying power to operate the subscriber terminal unit sections, the battery being connected to the transmission pair through charging control means for recharging by the power supply of the central office, and a ringing control circuit provided in the subscriber terminal unit includes a ringing oscillator for providing an A.C. voltage output and an A.C. bell ringer connected to the oscillator for operation by the oscillator output.

The invention further provides, in this first aspect, a subscriber terminal unit for use in a telephone system to provide service via a carrier derived circuit to an additional telephone set at a subscriber station, which station includes a first telephone set connected by a cable transmission pair to a central office to constitute a non-carrier subscriber circuit, the transmission pair being supplied with power from a power supply in the central office, such subscriber terminal unit comprising carrier transmitter and receiver sections having a first pair of terminals for connection to the transmission pair and a second pair of terminals for connection to the additional telephone set, a rechargeable battery for supplying power to operate the transmitter and receiver sections, charging control means connected to the battery and adapted to be connected to the transmission pair, whereby the battery is rechargeable from the transmission pair under the control of the charging control means, and a ringing control circuit which includes a ringing oscillator for providing an A.C. voltage output and an A.C. bell ringer connected to the oscillator for operation by the oscillator output.

An object of a second aspect of the inven-

tion is to provide an improved telephone system or subscriber terminal unit therefor, wherein the subscriber terminal unit has improved charging control means for the battery.

Accordingly, in this second aspect, the present invention provides a telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from the central office to a remotely located subscriber station and connected to a first telephone set to form a non-carrier subscriber circuit, a power supply in the central office for supplying power to the transmission pair, and a carrier circuit providing an additional subscriber facility for the same transmission pair, wherein a central office terminal unit having carrier transmitter and receiver sections is connected to the central office and to the transmission pair, a subscriber terminal unit also having carrier transmitter and receiver sections is connected to the transmission pair at the subscriber station, a second telephone set is connected to the subscriber terminal unit, and a rechargeable battery is provided in the subscriber terminal unit for supplying power to operate the subscriber terminal unit sections, the battery being connected to the transmission pair through charging control means for recharging by the power supply of the central office, such charging control means being adapted to derive a battery charging current from the transmission pair regardless of the battery polarity relative to the transmission pair.

The invention further provides in this second aspect, a subscriber terminal unit for use in a telephone system to provide service via a carrier derived circuit to an additional telephone set at a subscriber station, which station includes a first telephone set connected by a cable transmission pair to a central office to constitute a non-carrier subscriber circuit, the transmission pair being supplied with power from a power supply in the central office, such subscriber terminal unit comprising carrier transmitter and receiver sections having a first pair of terminals for connection to the transmission pair and a second pair of terminals for connection to the additional telephone set, a rechargeable battery for supplying power to operate the transmitter and receiver sections, and charging control means connected to the battery and adapted to be connected to the transmission pair, whereby the battery is rechargeable from the transmission pair under the control of the charging control means which is adapted to derive a battery charging current from the transmission pair regardless of the battery polarity relative to the transmission pair.

In order that the invention may be more clearly understood embodiments thereof will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a combined block and circuit

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diagram showing a modified form of the subscriber station shown in Figure 5 of our copending Application No. (Serial No. 1185678) 19926/67 with a modified battery charging circuit;

FIGURE 2 is a combined block and circuit diagram showing another embodiment of a subscriber station with a further modified form of battery charging circuit;

FIGURE 3 is a circuit diagram of the battery charging component shown in Figure 2;

FIGURE 4 is a combined block and circuit diagram showing a modified subscriber station for the system utilizing a ringing inverter; and

FIGURE 5 is a detailed diagram of the ringing control circuit for the subscriber terminal unit shown in Fig. 4.

Figure 1 of the drawings illustrates a subscriber terminal unit 28a with an alternative form of battery control circuit 90a to that shown in Fig. 5 of our copending Application No. (Serial No. 1185678) 19926/67 which may be connected to a pair of input leads 98 and 112 without regard to the battery polarity. In the control circuit 90 of Fig. 5 of our said copending Application, it is possible to connect the battery improperly and cause it to discharge eventually. In this alternate arrangement which eliminates the problem, the leads 98 and 112 are provided with current limiting and isolation resistors 306 and 308, respectively, and are connected to the input terminals 310 and 312 of a diode bridge circuit 314 which provides complete independence of polarity. In other words, whether a positive or negative voltage appears on an input lead, or an AC voltage, the DC output of the bridge circuit at its output terminals 316 and 318 will always be the same. The bridge circuit 314 may be of the conventional type and comprises four diodes 320, 322, 324, and 326 which are connected, as shown, between its input and output leads. A capacitor 328 is connected across the input leads to serve as an RF by-pass, and another capacitor 330 is connected across the output leads to provide filtering. A pair of leads 332 and 334 containing resistors 336 and 338, respectively, are connected between the bridge output terminals and the terminals of the battery 88a. So long as the voltage apparent across the cable transmission pair 16 at terminals 94 and 96 is less than the voltage of the battery, plus the diode drops of the bridge circuit (e.g. nominal 7.2 volts), the diode bridge will no longer conduct. Therefore, the bridge circuit acting as a switch disconnects the charging circuit from the cable transmission pair 16. Thus, again the removal of the handset 114 from its hook cradle in the telephone set 18 interrupts the charging of the battery.

For some central office line circuits it is

necessary to minimize the charging current derived from the non-carrier circuit, so that sufficient line current is always available for operation of the standard equipment. This problem is overcome in another modified subscriber station 28b, shown in Figs. 2 and 3. Here, the leads 98 and 112 to the battery charging control circuit 90b from the terminals 94 and 96 are connected through a pair of resistors 340 and 342 to the input terminals 344 and 346 of a diode bridge circuit 348. The latter has a pair of output terminals 350 and 352 and connected between the input and output terminals are four diodes 354, 355, 356 and 358. Connected to the output terminals of the bridge circuit is a high frequency (e.g., 140 Khz) oscillator circuit which is comprised of a transistor 360, a transformer 362 and other associated components. The transistor 360 and the primary winding 364 of the transformer 362 are connected in a modified Hartley oscillator configuration. This includes a capacitor 366 connected from a centre tap 368 across one portion of the primary winding, whose inductance with the capacitor forms a resonant circuit which is connected to the collector of the transistor 360 by a lead 370. The transistor emitter is connected to one output terminal 350 of the bridge circuit and a lead 372 connects the other output terminal 352 to the center tap 368 on the primary winding 364.

The other section of the primary winding 364 provides a positive feedback to the base of the transistor 360 through a bias network comprised of a capacitor 374 and a resistor 376 in parallel therewith. So long as a negative voltage is applied to the emitter of the transistor and a positive voltage to the tap 368 of the primary winding 364, this circuit will operate at its resonant frequency. The secondary winding 378 of the transformer 362 is inductively coupled and connected as a standard full wave rectifier circuit through a pair of diodes 380 and 382 provided in a lead 384 which interconnects its end terminals. A capacitor 386 is connected in a lead between a centre tap 390 of the secondary winding 378 and a junction with the lead 384 between the diodes 380 and 382. A capacitor 392 connected between the input terminals of the bridge circuit serves as an RF by-pass. Between each of the input terminals 344 and 346 of the bridge circuit and a common terminal 394 are leads containing a pair of capacitors 396 and 398. A lead 400 connects this common terminal through a resistor 402 to the centre tap 390 of the secondary winding which in turn is also connected by a lead 404 with the plus terminal of the battery 88b. These latter capacitors 396 and 398 serve to provide and preserve a balanced condition between the carrier line and the electronic circuitry.

In some instances it may be desirable to

employ standard straight line ringers in our system of the type which are operable by an alternating (e.g., 20 cycle) ringing voltage rather than by a DC voltage as utilized in the ringing control circuit shown in Figure 6 of our said copending Application. In a block diagram of Fig. 4 an arrangement for accomplishing this modification is shown which includes a ringing inverter 410 connected to the output lead 236 of the ring control circuit 234 and having an output connected through a lead 412 to an input terminal of the telephone set 34. The inverter receives battery power through a pair of leads 414 and 416.

As illustrated in detail in Fig. 5, the inverter circuit 410 comprises a transformer 418 having first and second primary windings 420 and 422, a pair of transistors 424 and 426 and a diode 428. As previously described, a positive voltage is supplied to the ring control circuit 234 through the lead 252 and the lead 236. However, this lead 236 is now connected through a resistor 430 to a tap 432 on the second primary winding 422. A positive voltage is also supplied from the lead 245 to a tap 434 of the first primary winding 420 and by a lead 436 from the lead 245 to an end terminal 438 of the secondary winding 440.

A negative voltage supplied to the inverter circuit 410 through a lead 442 is connected to a junction 444 in a lead 446 connecting emitters of the transistors 424 and 426. The diode 428 is in a lead which extends from the junction 444 to the lead 236. From the end terminals of the first primary winding 420 a pair of leads 450 and 452 and connected to the collectors of the transistors 424 and 426, respectively, and from the ends of the second primary winding 422 a pair of leads 454 and 456 are connected to the transistor bases.

As stated, one end of the secondary winding 440 is connected to the positive voltage lead 436 at the end terminal 438. The other end 458 of the secondary winding is connected to one terminal 460 of a standard straight line ringer 238a whose other terminal 462 is connected by a lead 268 to the negative power lead 416.

The positive voltage through the resistor 430 applied to the diode 428 and the center tap 432 of the second primary winding 420 will, due to the potential drop across the diode, cause a turn-on bias to appear at the bases of the transistors 424 and 426, thereby causing a multi-vibrator action to commence, which may be described as follows.

Whichever transistor starts conduction first will draw increased current through its particular half of the winding. The windings are so fixed that such an increase in collector current of a specific transistor will cause an increased base voltage on the same transistor so that the current will continue to increase until such time as the magnetic core of the

transformer 418 saturates. At this time current in the conducting transistor will remain constant until no longer able to apply an increased current; the current will start to decrease on the conducting transistor and at the same time apply a turn-on bias to the non-conducting transistor, which will go through the same sequence. Therefore, with voltage applied and a turn-on bias present, the two transistors 424 and 426 will switch alternately from non-conduction to saturation at a rate determined by the magnetic time constant of transformer 418, in this case a nominal 20 Hz. The primary windings 420 and 422 of the transformer inductively coupled to the secondary winding 440 have a step-up ratio, so that the output voltage (e.g., approximately 100 volts) is applied through the terminal 460 to the standard straight line ringer 238a, such as is normally included in a standard telephone set.

WHAT WE CLAIM IS:—

1. A telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from the central office to a remotely located subscriber station and connected to a first telephone set to form a non-carrier subscriber circuit, a power supply in the central office for supplying power to the transmission pair, and a carrier circuit providing an additional subscriber facility for the same transmission pair, wherein a central office terminal unit having carrier transmitter and receiver sections is connected to the central office and to the transmission pair, a subscriber terminal unit also having carrier transmitter and receiver sections is connected to the transmission pair at the subscriber station, a second telephone set is connected to the subscriber terminal unit, a rechargeable battery is provided in the subscriber terminal unit for supplying power to operate the subscriber terminal unit sections, the battery being connected to the transmission pair through charging control means for recharging by the power supply of the central office, and a ringing control circuit provided in the subscriber terminal unit includes a ringing oscillator for providing an A.C. voltage output and an A.C. bell ringer connected to the oscillator for operation by the oscillator output.

2. A telephone system according to Claim 1, wherein the ringing oscillator comprises: a transformer having first and second portions of a primary winding; a pair of transistors connected to the said portions of the primary winding so as to produce a multi-vibrator action and thus an AC output on the secondary of the transformer connected to said AC bell ringer.

3. A telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from

employ standard straight line ringers in our system of the type which are operable by an alternating (e.g., 20 cycle) ringing voltage rather than by a DC voltage as utilized in the ringing control circuit shown in Figure 6 of our said copending Application. In a block diagram of Fig. 4 an arrangement for accomplishing this modification is shown which includes a ringing inverter 410 connected to the output lead 236 of the ring control circuit 234 and having an output connected through a lead 412 to an input terminal of the telephone set 34. The inverter receives battery power through a pair of leads 414 and 416.

As illustrated in detail in Fig. 5, the inverter circuit 410 comprises a transformer 418 having first and second primary windings 420 and 422, a pair of transistors 424 and 426 and a diode 428. As previously described, a positive voltage is supplied to the ring control circuit 234 through the lead 252 and the lead 236. However, this lead 236 is now connected through a resistor 430 to a tap 432 on the second primary winding 422. A positive voltage is also supplied from the lead 245 to a tap 434 of the first primary winding 420 and by a lead 436 from the lead 245 to an end terminal 438 of the secondary winding 440.

A negative voltage supplied to the inverter circuit 410 through a lead 442 is connected to a junction 444 in a lead 446 connecting emitters of the transistors 424 and 426. The diode 428 is in a lead which extends from the junction 444 to the lead 236. From the end terminals of the first primary winding 420 a pair of leads 450 and 452 and connected to the collectors of the transistors 424 and 426, respectively, and from the ends of the second primary winding 422 a pair of leads 454 and 456 are connected to the transistor bases.

As stated, one end of the secondary winding 440 is connected to the positive voltage lead 436 at the end terminal 438. The other end 458 of the secondary winding is connected to one terminal 460 of a standard straight line ringer 238a whose other terminal 462 is connected by a lead 268 to the negative power lead 416.

The positive voltage through the resistor 430 applied to the diode 428 and the center tap 432 of the second primary winding 420 will, due to the potential drop across the diode, cause a turn-on bias to appear at the bases of the transistors 424 and 426, thereby causing a multi-vibrator action to commence, which may be described as follows.

Whichever transistor starts conduction first will draw increased current through its particular half of the winding. The windings are so fixed that such an increase in collector current of a specific transistor will cause an increased base voltage on the same transistor so that the current will continue to increase until such time as the magnetic core of the

transformer 418 saturates. At this time current in the conducting transistor will remain constant until no longer able to apply an increased current; the current will start to decrease on the conducting transistor and at the same time apply a turn-on bias to the non-conducting transistor, which will go through the same sequence. Therefore, with voltage applied and a turn-on bias present, the two transistors 424 and 426 will switch alternately from non-conduction to saturation at a rate determined by the magnetic time constant of transformer 418, in this case a nominal 20 Hz. The primary windings 420 and 422 of the transformer inductively coupled to the secondary winding 440 have a step-up ratio, so that the output voltage (e.g., approximately 100 volts) is applied through the terminal 460 to the standard straight line ringer 238a, such as is normally included in a standard telephone set.

WHAT WE CLAIM IS:—

1. A telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from the central office to a remotely located subscriber station and connected to a first telephone set to form a non-carrier subscriber circuit, a power supply in the central office for supplying power to the transmission pair, and a carrier circuit providing an additional subscriber facility for the same transmission pair, wherein a central office terminal unit having carrier transmitter and receiver sections is connected to the central office and to the transmission pair, a subscriber terminal unit also having carrier transmitter and receiver sections is connected to the transmission pair at the subscriber station, a second telephone set is connected to the subscriber terminal unit, a rechargeable battery is provided in the subscriber terminal unit for supplying power to operate the subscriber terminal unit sections, the battery being connected to the transmission pair through charging control means for recharging by the power supply of the central office, and a ringing control circuit provided in the subscriber terminal unit includes a ringing oscillator for providing an A.C. voltage output and an A.C. bell ringer connected to the oscillator for operation by the oscillator output.

2. A telephone system according to Claim 1, wherein the ringing oscillator comprises: a transformer having first and second portions of a primary winding; a pair of transistors connected to the said portions of the primary winding so as to produce a multi-vibrator action and thus an AC output on the secondary of the transformer connected to said AC bell ringer.

3. A telephone system comprising a central office including switching and line finding circuits, a cable transmission pair extending from





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- 5 the central office to a remotely located sub-
scriber station and connected to a first tele-
phone set to form a non-carrier subscriber
circuit, a power supply in the central office for
supplying power to the transmission pair, and
10 a carrier circuit providing an additional sub-
scriber facility for the same transmission pair,
wherein a central office terminal unit having
carrier transmitter and receiver sections is con-
15 nected to the central office and to the trans-
mission pair, a subscriber terminal unit also
having carrier transmitter and receiver sec-
tions is connected to the transmission pair at
the subscriber station, a second telephone set
20 is connected to the subscriber terminal unit,
and a rechargeable battery is provided in the
subscriber terminal unit for supplying power
to operate the subscriber terminal unit sec-
25 tions, the battery being connected to the
transmission pair through charging control
means for recharging by the power supply
of the central office, such charging control
means being adapted to derive a battery charg-
ing current from the transmission pair regard-
less of the battery polarity relative to the
transmission pair.
- 30 4. A telephone system according to claim
3, wherein the charging control means in-
cludes: a charging circuit in which the battery
is connected; and a diode bridge which is
connected between the charging circuit and
the transmission pair and which will conduct
current only when the voltage apparent across
35 the transmission pair exceeds the voltage of
the battery.
- 40 5. A telephone system according to claim
3, wherein the charging control means in-
cludes: a diode bridge circuit connected to
the transmission pair; a high frequency oscil-
lator circuit connected to the bridge circuit
and including a transistor and a transformer
having first and second portions of a primary
winding, the first portion being connected to
45 the collector of the transistor in the oscilla-
tor circuit to provide a resonant circuit while
the second portion is connected through a
bias network to provide a feedback to the
base of the transistor; and an inductively
50 coupled secondary winding on said trans-
former connected as a full wave rectifier, the
oscillator circuit being operable at its reson-
ant frequency to provide power to the recti-
fier which is connected to said battery.
- 55 6. A subscriber terminal unit for use in a
telephone system to provide service via a
carrier derived circuit to an additional tele-
phone set at a subscriber station, which sta-
tion includes a first telephone set connected
60 by a cable transmission pair to a central office
to constitute a non-carrier subscriber circuit,
the transmission pair being supplied with
power from a power supply in the central
office, such subscriber terminal unit compris-
ing carrier transmitter and receiver sections
65 having a first pair of terminals for connec-
- tion to the transmission pair and a second
pair of terminals for connection to the addi-
tional telephone set, a rechargeable battery
for supplying power to operate the transmitter
and receiver sections, charging control means 70
connected to the battery and adapted to be
connected to the transmission pair, whereby
the battery is rechargeable from the trans-
mission pair under the control of the charg-
ing control means, and a ringing control cir- 75
cuit which includes a ringing oscillator for
providing an A.C. voltage output and an
A.C. bell ringer connected to the oscillator
for operation by the oscillator output.
- 80 7. A subscriber terminal unit according to
claim 6, wherein the ringing oscillator com-
prises: a transformer having first and second
portions of a primary winding; a pair of
transistors connected to the said portions of
the primary winding so as to produce a multi- 85
vibrator action and thus an AC output on
the secondary of the transformer connected
to said AC bell ringer.
- 90 8. A subscriber terminal unit for use in
a telephone system to provide service via a
carrier derived circuit to an additional tele-
phone set at a subscriber station, which sta-
tion includes a first telephone set connected
95 by a cable transmission pair to a central
office to constitute a non-carrier subscriber
circuit, the transmission pair being supplied
with power from a power supply in the cen-
tral office, such subscriber terminal unit com-
prising carrier transmitter and receiver sec-
100 tions having a first pair of terminals for con-
nection to the transmission pair and a sec-
ond pair of terminals for connection to the
additional telephone set, a rechargeable bat-
tery for supplying power to operate the trans-
mitter and receiver sections, and charging 105
control means connected to the battery and
adapted to be connected to the transmission
pair, whereby the battery is rechargeable
from the transmission pair under the control
of the charging control means, which is
110 adapted to derive a battery charging current
from the transmission pair regardless of the
battery polarity relative to the transmission
pair.
- 115 9. A subscriber terminal unit according to
claim 8, wherein the charging control means
includes: a charging circuit in which the
battery is connected; and a diode bridge
which is connected between the charging cir-
cuit and the transmission pair and which will
120 conduct current only when the voltage appar-
ent across the transmission pair exceeds the
voltage of the battery.
- 125 10. A subscriber terminal unit according to
claim 8, wherein the charging control means
includes: a diode bridge circuit connected
to the transmission pair; a high frequency
oscillator circuit connected to the bridge cir-
cuit and including a transistor and a trans-
former having first and second portions of a 130

- primary winding, the first portion being connected to the collector of the transistor in the oscillator circuit to provide a resonant circuit while the second portion is connected through a bias network to provide a feedback to the base of the transistor; and an inductively coupled secondary winding on said transformer connected as a full wave rectifier, the oscillator circuit being operable at its resonant frequency to provide power to the rectifier which is connected to said battery.
11. A telephone system substantially as hereinbefore described with reference to, and as illustrated in, Figure 1, Figures 2 and 3, or Figures 4 and 5 of the accompanying drawings.
12. A subscriber terminal unit substantially as hereinbefore described with reference to, and as illustrated in, Figure 1, Figure 2 and 3, or Figures 4 and 5 of the accompanying drawings.

FORRESTER, KETLEY & CO.,
Chartered Patent Agents,
Jessel Chambers, 88—90 Chancery Lane,
London, W.C.2, and
Rutland House, Edmund Street,
Birmingham, 3,
Agents for the Applicants.

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