

OPTICAL FIBRE COMMUNICATIONS SYSTEM

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This invention relates to an optical fibre communications system, and to a method of controlling the provision of services on such a system.

In optical transmission systems, the radiation used is not necessarily in the visible region of the electromagnetic spectrum, and so the words 'optical' and 'light' when used in this specification are not to be interpreted as implying any limitation to the visible spectrum. For example, the wavelengths preferred for transmission through silica optical fibres are in the infra red region, because the loss minima of silica fibres occurs at 1.3 and 1.5 microns.

Optical transmission systems may be utilised to distribute various services such as telephony, video channels, facsimile and data transmission. In general, the primary service, at least as presently measured in terms of subscriber lines, is telephony. Various techniques are available for separating lines from one another, and also for separation of different services, for example the transmitted signals may be time, wavelength or subcarrier frequency multiplexed.

A disadvantage of time division multiplexing is that it requires a very wide bandwidth. Moreover, expensive receivers and transmitters are required, together with a complex protocol for providing customers with a range of services. Therefore, it is not an attractive financial proposition for situations where, for example, only a telephony line is initially required and there is only a limited likelihood of additional services being required subsequently. Likewise, wavelength division multiplexing, with different services on different wavelengths, would

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also require additional optical transmitters and receivers to be installed for an expansion of services on additional channels.

There has been much recent interest in subcarrier frequency multiplexing for optical transmission systems, and in particular in subcarrier frequency multiplexing utilising microwave subcarrier frequencies. With such an arrangement, the electronics operating at the microwave subcarrier frequency are now of a proven reliability and low cost; and, with multiplexing possible, it has been proposed to utilise subcarrier multiplexing with the subscriber receiver tuned to a particular subcarrier frequency.

The basic starting point for a transmission network is usually the provision of a telephony link. Initially, supply of additional services over the link may not be required, even though optical fibre has a sufficiently larger bandwidth to provide more services. The invention relates to a flexible system which can expand services as demand arises, without the need for installation of additional transmitter and receiver equipment.

The present invention provides an optical fibre communications system in which a plurality of subscriber lines are connected to exchange apparatus capable of providing a range of services on different subcarrier frequencies, each of the subscriber lines being provided with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and the exchange apparatus being provided with control means for governing access of individual terminal apparatus to given subcarrier frequencies.

Advantageously, the control means is such that access of a given terminal apparatus to a given subcarrier frequency is governed by selectively enabling that



terminal apparatus to operate on the given subcarrier frequency.

The control means may also be such such that a predetermined subcarrier frequency is enabled for a restricted time period. Preferably, each terminal apparatus is provided with means for requesting the exchange apparatus for service frequency allocation.

The invention also provides a method of controlling the provision of services in an optical fibre communications network constituted by exchange apparatus and a plurality of subscriber lines, the method comprising the steps of providing a range of services of different subcarrier frequencies, providing each of the subscriber lines with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and tuning each terminal apparatus to govern access to said different subcarrier frequencies by control signals from the exchange apparatus.

The invention will now be described in greater detail by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a frequency diagram schematically illustrating the subcarrier frequency multiplexing scheme used in the system of Figure 2;

Figure 2 is a schematic diagram of an optical fibre communications system constructed in accordance with the invention;

Figure 3 is a flow diagram of a customer-initiated service request; and

Figure 4 is a flow diagram of an exchange-initiated service provision.

Referring to the drawings, Figure 1 shows a schematic subcarrier frequency diagram at a particular optical operating frequency in the 1300nm or 1500nm transmission windows of silica fibre. It will be realised that a



similar subcarrier multiplexing scheme can operate at other optical frequencies, thereby providing an enormous range of available channels. Initially, the service provided will be telephony, for example on a passive optical network (PON) such as that illustrated in Figure 2, in which 32 telephony subscriber lines 1 are provided from an exchange E. A single fibre 2 leaves the exchange E, and is split four ways at a cabinet 3, and eight ways at each of four distribution points 4 (only one of which is shown in Figure 2). Each of the 32 lines 1 terminates at a respective subscriber apparatus (transmitter /receiver) 5 which is tuned to a particular one of the subscriber telephony subcarrier frequencies 6, and also receives control signals on a common control frequency 7. The control signals address the subscriber apparatus 5, and tunes them to receive only their allocated subscriber frequencies. Return information, from the subscriber end to the exchange E (for example by automatic repeat request signalling), may also be given on a common control frequency, for example to indicate faults or tampering. At the same time, or subsequently, additional services such as video channels (CATV), high definition facsimile lines and data channels referenced respectively 8, 9 and 10, are provided from the exchange E on to the PON at their own unique subcarrier frequencies.

Requests for additional services can be made from any of the subscribers to the exchange E. Within the exchange E, the requests for service allocation are microprocessor controlled, so that the subscriber simply dials a request code, the microprocessor checks for service availability (for example whether there is a high definition facsimile line available), makes a service frequency allocation, and sends out the frequency enabling control signal addressed to the subscriber.



Figure 3 illustrates an additional service request procedure. When a subscriber wishes to receive an additional service, he or she makes a request for the service to the exchange E, the subscriber apparatus 5 signalling to the exchange. This signalling may be on the control frequency 7, or another control frequency. At the exchange E, a computer control 11 (see Figure 2) determines whether the requested service is one that is on a frequency that can be made generally available, such as reception of CATV, or whether the service requires a unique frequency such as a high definition facsimile service. Having established the type of service required, the computer control 11 allocates a carrier frequency, and a control signal is sent out on the control frequency that enables the subscriber apparatus 5 to access the frequency of the requested service. In some instances, when unique frequencies are required, there may not be a suitable frequency available, in which case the exchange E sends control signals to the subscriber apparatus 5 to retry.

Tuning to a new subcarrier frequency may also be initiated by the exchange E, for example to enable receipt of an incoming high definition facsimile service. The sequence is then as shown in Figure 4, the exchange E signalling to the subscriber apparatus 5 on the control frequency to tune to the correct frequency for the incoming service.

Access to a given frequency may be provided on a long term enabling basis, for a predetermined interval, or for the duration of a subsequent use. For example, for access to some or all of the video channels, it is envisaged that general access on a permanent basis would be preferred. However, for data transmission or high definition facsimile, it is envisaged that lines may be leased on a time basis, thereby enabling maximum usage of the channels



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and removing the need to provide a unique channel for each potential user.

In order that second order subcarrier intermodulation products do not interfere with the services provided, the services may all be provided within a single octave, so that the second intermodulation products fall out of band. Alternatively, the frequencies used for the services may be selected so that they interleave with the intermodulation products.

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CLAIMS

1. An optical fibre communications system in which a plurality of subscriber lines are connected to exchange apparatus capable of providing a range of services on different subcarrier frequencies, each of the subscriber lines being provided with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and the exchange apparatus being provided with control means for governing access of individual terminal apparatus to given subcarrier frequencies.
2. A system as claimed in claim 1, wherein the control means is such that access of a given terminal apparatus to a given subcarrier frequency is governed by selectively enabling that terminal apparatus to operate on the given subcarrier frequency.
3. A system as claimed in claim 1 or claim 2, wherein the control means is such that a predetermined subcarrier frequency is enabled for a restricted time period.
4. A system as claimed in any one claims 1 to 3, wherein each terminal apparatus is provided with means for requesting the exchange apparatus for service frequency allocation.
5. An optical fibre communications system substantially as hereinbefore described with reference to, and as illustrated by, the accompanying drawings.
6. A method of controlling the provision of services in an optical fibre communications network constituted by exchange apparatus and a plurality of subscriber lines,





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the method comprising the steps of providing a range of services of different subcarrier frequencies, providing each of the subscriber lines with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and tuning each terminal apparatus to govern access to said different subcarrier frequencies by control signals from the exchange apparatus.

7. A method as claimed in claim 6, wherein service request signals are made from the terminal apparatus to the exchange apparatus.

8. A method as claimed in claim 6 or claim 7, wherein terminal apparatus access to a particular subcarrier frequency is enabled for a restricted time period.

9. A method as claimed in claim 6 or claim 7, wherein terminal apparatus access to a particular subcarrier frequency is enabled on an unrestricted time basis.

10. A method of controlling the provision of services on an optical fibre transmission line substantially as hereinbefore described with reference to the accompanying drawings.

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OPTICAL FIBRE COMMUNICATIONS SYSTEM

ABSTRACT

An optical fibre communications system includes an exchange (E) and a plurality of subscriber lines (1). The exchange (E) provides a plurality of services in different subcarrier frequencies (6, 8, 9, 10). Each subscriber line (1) is provided with terminal apparatus (5) operable at different subcarrier frequencies, and a control (11) at the exchange (E) tunes the terminal apparatus to transmit and/or receive on a particular frequency in response to a request. The request may be a signal from the terminal apparatus (5), or an incoming service request addressed to the particular terminal apparatus.



Fig.1.

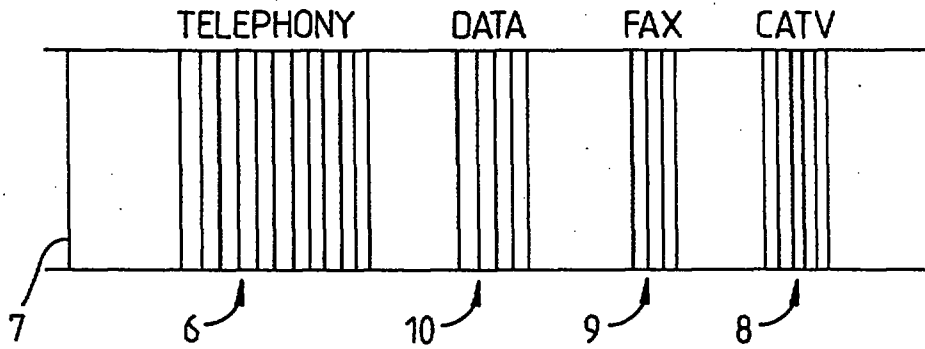
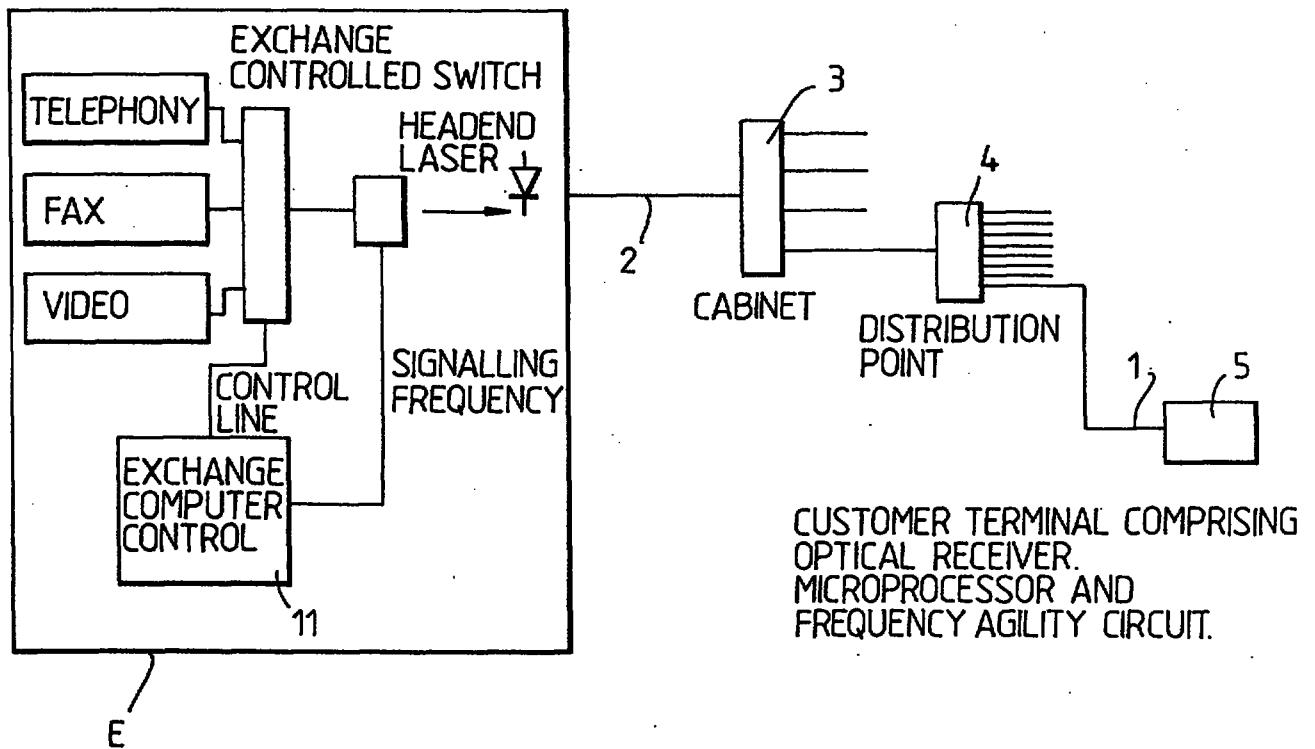


Fig.2.



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Fig.3.

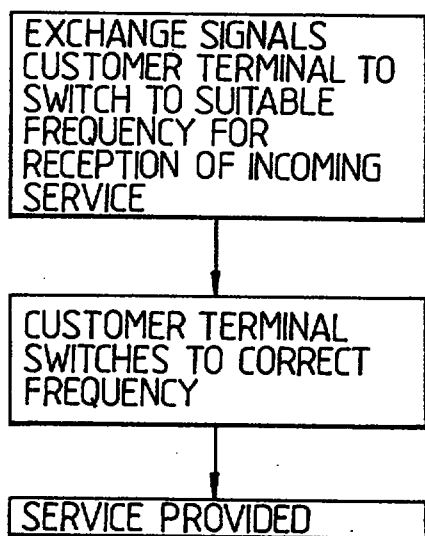
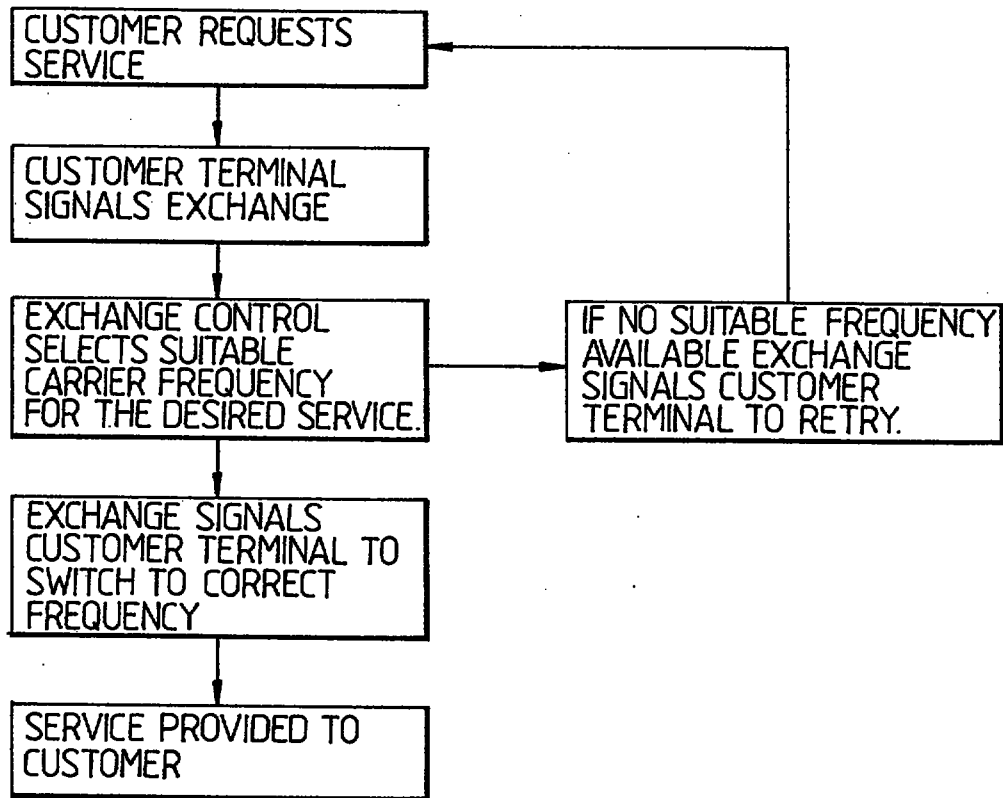
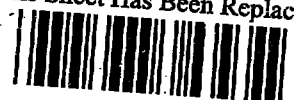


Fig.4.



REPLACEMENT SHEET

07 OCT 1996

- 1 -

OPTICAL FIBRE COMMUNICATIONS SYSTEM

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Optical transmission systems may be utilised to distribute various services such as telephony, video channels, facsimile and data transmission. In general, the primary service, at least as presently measured in terms of subscriber lines, is telephony. Various techniques are available for separating lines from one another, and also for separation of different services, for example the transmitted signals may be time, wavelength or subcarrier frequency multiplexed.

A disadvantage of time division multiplexing is that it requires a very wide bandwidth. Moreover, expensive receivers and transmitters are required, together with a complex protocol for providing customers with a range of services. Therefore, it is not an attractive financial proposition for situations where, for example, only a telephony line is initially required and there is only a limited likelihood of additional services being required subsequently. Likewise, wavelength division multiplexing, with different services on different wavelengths, would

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07 OCT 1996

- 2 -

also require additional optical transmitters and receivers to be installed for an expansion of services on additional channels.

There has been much recent interest in subcarrier frequency multiplexing for optical transmission systems, and in particular in subcarrier frequency multiplexing utilising microwave subcarrier frequencies. With such an arrangement, the electronics operating at the microwave subcarrier frequency are now of a proven reliability and low cost; and, with multiplexing possible, it has been proposed to utilise subcarrier multiplexing with the subscriber receiver tuned to a particular subcarrier frequency.

The basic starting point for a transmission network is usually the provision of a telephony link. Initially, supply of additional services over the link may not be required, even though optical fibre has a sufficiently larger bandwidth to provide more services. The invention relates to a flexible system which can expand services as demand arises, without the need for installation of additional transmitter and receiver equipment.

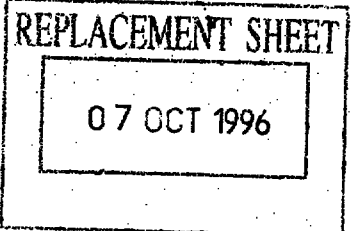
The present invention provides an optical fibre communications system in which a plurality of subscriber lines are connected to exchange apparatus capable of providing a range of services on different subcarrier frequencies, each of the subscriber lines being provided with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and the exchange apparatus being provided with control means for governing access of individual terminal apparatus to given subcarrier frequencies.

Advantageously, the control means is such that access of a given terminal apparatus to a given subcarrier frequency is governed by selectively enabling that

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- 3 -

terminal apparatus to operate on the given subcarrier frequency.

The control means may also be such such that a predetermined subcarrier frequency is enabled for a restricted time period. Preferably, each terminal apparatus is provided with means for requesting the exchange apparatus for service frequency allocation.

The invention also provides a method of controlling the provision of services in an optical fibre communications network constituted by exchange apparatus and a plurality of subscriber lines, the method comprising the steps of providing a range of services of different subcarrier frequencies, providing each of the subscriber lines with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and tuning each terminal apparatus to govern access to said different subcarrier frequencies by control signals from the exchange apparatus.

The invention will now be described in greater detail by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a frequency diagram schematically illustrating the subcarrier frequency multiplexing scheme used in the system of Figure 2;

Figure 2 is a schematic diagram of an optical fibre communications system constructed in accordance with the invention;

Figure 3 is a flow diagram of a customer-initiated service request; and

Figure 4 is a flow diagram of an exchange-initiated service provision.

Referring to the drawings, Figure 1 shows a schematic subcarrier frequency diagram at a particular optical operating frequency in the 1300nm or 1500nm transmission windows of silica fibre. It will be realised that a

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07 OCT 1996

- 4 -

similar subcarrier multiplexing scheme can operate at other optical frequencies, thereby providing an enormous range of available channels. Initially, the service provided will be telephony, for example on a passive optical network (PON) such as that illustrated in Figure 2, in which 32 telephony subscriber lines 1 are provided from an exchange E. A single fibre 2 leaves the exchange E, and is split four ways at a cabinet 3, and eight ways at each of four distribution points 4 (only one of which is shown in Figure 2). Each of the 32 lines 1 terminates at a respective subscriber apparatus (transmitter /receiver) 5 which is tuned to a particular one of the subscriber telephony subcarrier frequencies 6, and also receives control signals on a common control frequency 7. The control signals address the subscriber apparatus 5, and tunes them to receive only their allocated subscriber frequencies. Return information, from the subscriber end to the exchange E (for example by automatic repeat request signalling), may also be given on a common control frequency, for example to indicate faults or tampering. At the same time, or subsequently, additional services such as video channels (CATV), high definition facsimile lines and data channels referenced respectively 8, 9 and 10, are provided from the exchange E on to the PON at their own unique subcarrier frequencies.

Requests for additional services can be made from any of the subscribers to the exchange E. Within the exchange E, the requests for service allocation are microprocessor controlled, so that the subscriber simply dials a request code, the microprocessor checks for service availability (for example whether there is a high definition facsimile line available), makes a service frequency allocation, and sends out the frequency enabling control signal addressed to the subscriber.

07 OCT 1996

- 5 -

Figure 3 illustrates an additional service request procedure. When a subscriber wishes to receive an additional service, he or she makes a request for the service to the exchange E, the subscriber apparatus 5 signalling to the exchange. This signalling may be on the control frequency 7, or another control frequency. At the exchange E, a computer control 11 (see Figure 2) determines whether the requested service is one that is on a frequency that can be made generally available, such as reception of CATV, or whether the service requires a unique frequency such as a high definition facsimile service. Having established the type of service required, the computer control 11 allocates a carrier frequency, and a control signal is sent out on the control frequency that enables the subscriber apparatus 5 to access the frequency of the requested service. In some instances, when unique frequencies are required, there may not be a suitable frequency available, in which case the exchange E sends control signals to the subscriber apparatus 5 to retry.

Tuning to a new subcarrier frequency may also be initiated by the exchange E, for example to enable receipt of an incoming high definition facsimile service. The sequence is then as shown in Figure 4, the exchange E signalling to the subscriber apparatus 5 on the control frequency to tune to the correct frequency for the incoming service.

Access to a given frequency may be provided on a long term enabling basis, for a predetermined interval, or for the duration of a subsequent use. For example, for access to some or all of the video channels, it is envisaged that general access on a permanent basis would be preferred. However, for data transmission or high definition facsimile, it is envisaged that lines may be leased on a time basis, thereby enabling maximum usage of the channels

and removing the need to provide a unique channel for each potential user.

In order that second order subcarrier intermodulation products do not interfere with the services provided, the services may all be provided within a single octave, so that the second intermodulation products fall out of band. Alternatively, the frequencies used for the services may be selected so that they interleave with the intermodulation products.



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07 OCT 1996

- 7 -

CLAIMS

1. An optical fibre communications system in which a plurality of subscriber lines are connected to exchange apparatus capable of providing a range of services on different subcarrier frequencies, each of the subscriber lines being provided with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and the exchange apparatus being provided with control means for governing access of individual terminal apparatus to given subcarrier frequencies.
2. A system as claimed in claim 1, wherein the control means is such that access of a given terminal apparatus to a given subcarrier frequency is governed by selectively enabling that terminal apparatus to operate on the given subcarrier frequency.
3. A system as claimed in claim 1 or claim 2, wherein the control means is such that a predetermined subcarrier frequency is enabled for a restricted time period.
4. A system as claimed in any one claims 1 to 3, wherein each terminal apparatus is provided with means for requesting the exchange apparatus for service frequency allocation.
5. An optical fibre communications system substantially as hereinbefore described with reference to, and as illustrated by, the accompanying drawings.
6. A method of controlling the provision of services in an optical fibre communications network constituted by exchange apparatus and a plurality of subscriber lines,

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07 OCT 1996

- 8 -

the method comprising the steps of providing a range of services of different subcarrier frequencies, providing each of the subscriber lines with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and tuning each terminal apparatus to govern access to said different subcarrier frequencies by control signals from the exchange apparatus.

7. A method as claimed in claim 6, wherein service request signals are made from the terminal apparatus to the exchange apparatus.

8. A method as claimed in claim 6 or claim 7, wherein terminal apparatus access to a particular subcarrier frequency is enabled for a restricted time period.

9. A method as claimed in claim 6 or claim 7, wherein terminal apparatus access to a particular subcarrier frequency is enabled on an unrestricted time basis.

10. A method of controlling the provision of services on an optical fibre transmission line substantially as hereinbefore described with reference to the accompanying drawings.

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07 OCT 1996

- 9 -

OPTICAL FIBRE COMMUNICATIONS SYSTEM

ABSTRACT

An optical fibre communications system includes an exchange (E) and a plurality of subscriber lines (1). The exchange (E) provides a plurality of services in different subcarrier frequencies (6, 8, 9, 10). Each subscriber line (1) is provided with terminal apparatus (5) operable at different subcarrier frequencies, and a control (11) at the exchange (E) tunes the terminal apparatus to transmit and/or receive on a particular frequency in response to a request. The request may be a signal from the terminal apparatus (5), or an incoming service request addressed to the particular terminal apparatus.

FIGURE 2

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Fig.1.

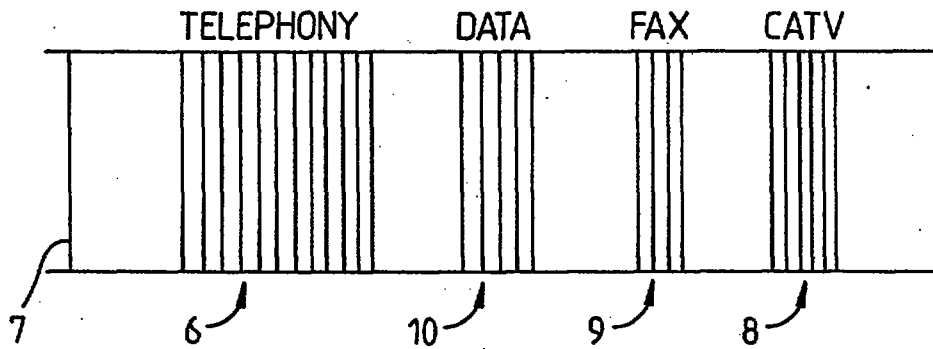
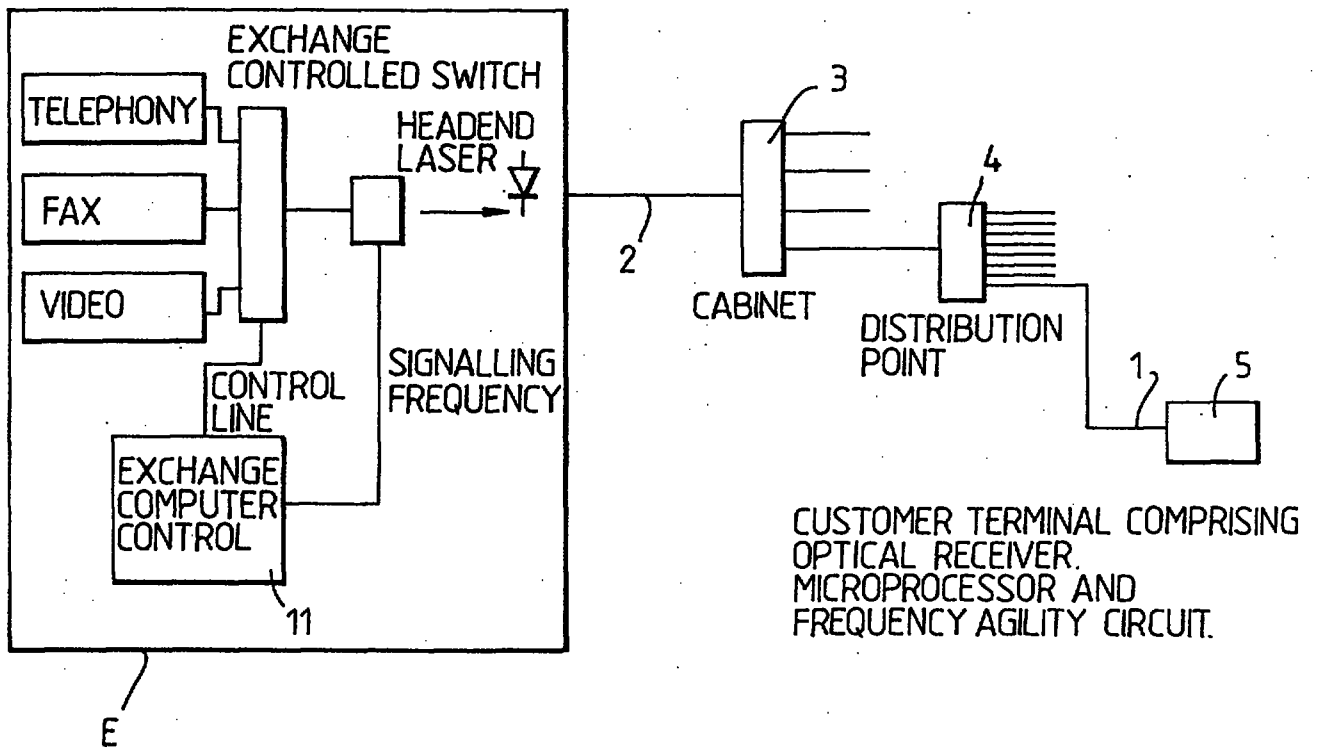


Fig.2.



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Fig.3.

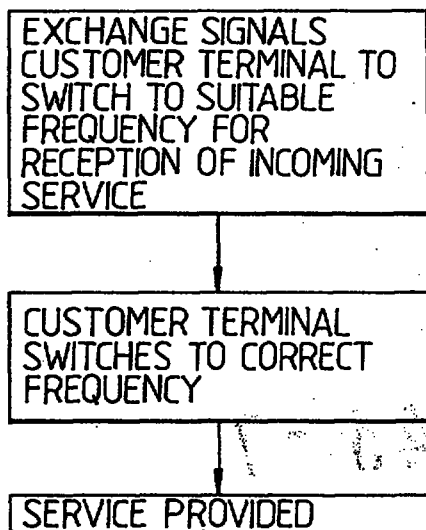
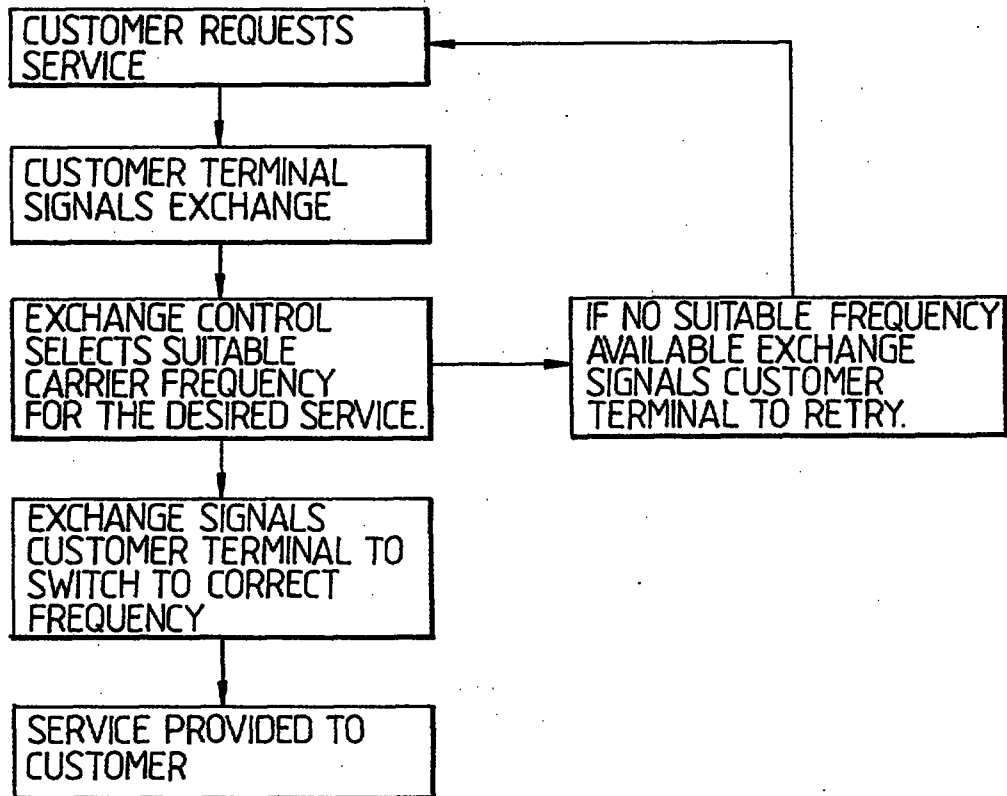


Fig.4.

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also require additional optical transmitters and receivers to be installed for an expansion of services on additional channels.

There has been much recent interest in subcarrier frequency multiplexing for optical transmission systems, and in particular in subcarrier frequency multiplexing utilising microwave subcarrier frequencies. With such an arrangement, the electronics operating at the microwave subcarrier frequency are now of a proven reliability and low cost; and, with multiplexing possible, it has been proposed to utilise subcarrier multiplexing with the subscriber receiver tuned to a particular subcarrier frequency.

The basic starting point for a transmission network is usually the provision of a telephony link. Initially, supply of additional services over the link may not be required, even though optical fibre has a sufficiently larger bandwidth to provide more services. The invention relates to a flexible system which can expand services as demand arises, without the need for installation of additional transmitter and receiver equipment.

The papers "Fiber Optic Digital Video Signals Transport For Broadband Subscriber Network" - Proceedings, the International Symposium on Subscriber Loops and Services, Boston, US, 11-16 September 1991, IEEE, pages 222-229, and "Coherent Multicarrier Techniques in Future Broadband Communications Networks" - Technical Digest, 13th European Conference on Optical Communication, Volume 3, 13-

17 September 1987, pages 78-87 disclose known communications systems.

The present invention provides an optical fibre communications system in which a plurality of optical fibre subscriber lines are connected to exchange apparatus capable of providing different subcarrier frequencies, each of the optical fibre subscriber lines being provided with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and the exchange apparatus being provided with downlink control means for governing access of each individual terminal apparatus to given subcarrier frequencies, for selectively allocating services to each individual terminal apparatus, characterised in that the downlink control means transmits control signals to each individual terminal apparatus on a separate common control channel.

Preferably, the common control channel is constituted by a predetermined one of the subcarrier frequencies.

Advantageously, the common control channel means is such that access of a given terminal apparatus to a given subcarrier frequency is governed by selectively enabling that terminal apparatus to operate on the given subcarrier frequency.

The control means may also be such that a predetermined subcarrier frequency is enabled for a restricted time period. Preferably, each terminal apparatus is provided with means for requesting the exchange apparatus for service frequency allocation.

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optical fibre subscriber lines, the method comprising the steps of providing a range of services on different subcarrier frequencies, providing each of the subscriber lines with a respective terminal apparatus operable at a plurality of said
5 different subcarrier frequencies, and tuning each terminal apparatus to govern access to said different subcarrier frequencies, for selectively allocating services to each terminal apparatus, by control signals from the exchange apparatus, characterised in that the control signals are
10 transmitted to each terminal apparatus on a separate common control channel.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:

15 Figure 1 is a frequency diagram schematically illustrating the subcarrier frequency multiplexing scheme used in the system of Figure 2;

Figure 2 is a schematic diagram of an optical fibre communications system constructed in accordance with the
20 invention;

Figure 3 is a flow diagram of a customer-initiated service request; and

Figure 4 is a flow diagram of an exchange-initiated service provision.

25 Referring to the drawings, Figure 1 shows a schematic subcarrier frequency diagram at a particular optical operating frequency in the 1300nm or 1500nm transmission windows of silica fibre. It will be realised that a



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CLAIMS

1. An optical fibre communications system in which a plurality of optical fibre subscriber lines (1) are
5 connected to exchange apparatus (E) capable of providing different subcarrier frequencies (6-10), each of the optical fibre subscriber lines being provided with a respective terminal apparatus (5) operable at a plurality of said different subcarrier frequencies, and the exchange
10 apparatus being provided with downlink control means (11) for governing access of each individual terminal apparatus to given subcarrier frequencies, for selectively allocating services to each individual terminal apparatus, characterised in that the downlink control means transmits
15 control signals to each individual terminal apparatus on a separate common control channel.

2. A system as claimed in claim 1, wherein the control means is such that access of a given terminal apparatus to
20 a given subcarrier frequency is governed by selectively enabling that terminal apparatus to operate on the given subcarrier frequency.

3. A system as claimed in claim 1 or claim 2, wherein
25 the control means is such that a predetermined subcarrier frequency is enabled for a restricted time period.

4. A system as claimed in any one claims 1 to 3, wherein each terminal apparatus is provided with means for
30 requesting the exchange apparatus for service frequency allocation.



5. A system as claimed in any one of claims 1 to 4, wherein the common control channel is constituted by a predetermined one of the subcarrier frequencies.

5

6. A system as claimed in any one of claims 1 to 5, wherein the subcarrier frequencies fall within a single octave.

10

7. A method of controlling the provision of services in an optical fibre communications network constituted by exchange apparatus and a plurality of optical fibre subscriber lines, the method comprising the steps of providing a range of services on different subcarrier frequencies, providing each of the subscriber lines with a respective terminal apparatus operable at a plurality of said different subcarrier frequencies, and tuning each terminal apparatus to govern access to said different subcarrier frequencies, for selectively allocating services to each terminal apparatus, by control signals from the exchange apparatus, characterised in that the control signals are transmitted to each terminal apparatus on a separate common control channel.

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8. A method as claimed in claim 6, wherein service request signals are made from the terminal apparatus to the exchange apparatus.

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9. A method as claimed in claim 7 or claim 8, wherein terminal apparatus access to a particular subcarrier frequency is enabled for a restricted time period.



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10. A method as claimed in claim 7 or claim 8, wherein terminal apparatus access to a particular subcarrier frequency is enabled on an unrestricted time basis.

5

11. A method as claimed in any one of claims 7 to 10, wherein the subcarrier frequencies fall within a single octave.