DECLARATION UNDER 37 CFR 1.131(a)

Application Serial Number: 15/283,881

Patent Number: 9,768,842

Filing Date: 10/3/2016

Inventor: Steve Shattil

Attorney Docket Number:

I, Steve Shattil, declare as follows:

1. I am the inventor of Patent No. 9,768,842 ('842).

2. This Declaration establishes constructive reduction to practice (and thus, invention) of the subject matter of each rejected claim prior to the effective date (under 35 U.S.C. 102(e)) of references on which the rejection is based.

3. I completed my invention as described and claimed in the subject patent 9,768,842 ('842) as evidenced by the following:

4. The subject matter of each of the rejected claims is disclosed in U.S. Patent appl. no. **60/163,141 ('141), filed Nov. 2, 1999**.

Re: Claim 1

5. With respect to claim 1, the figures and written description throughout '141 support the claimed invention of the instant patent. For the sake of brevity, FIG. 6A of '141 is shown below.

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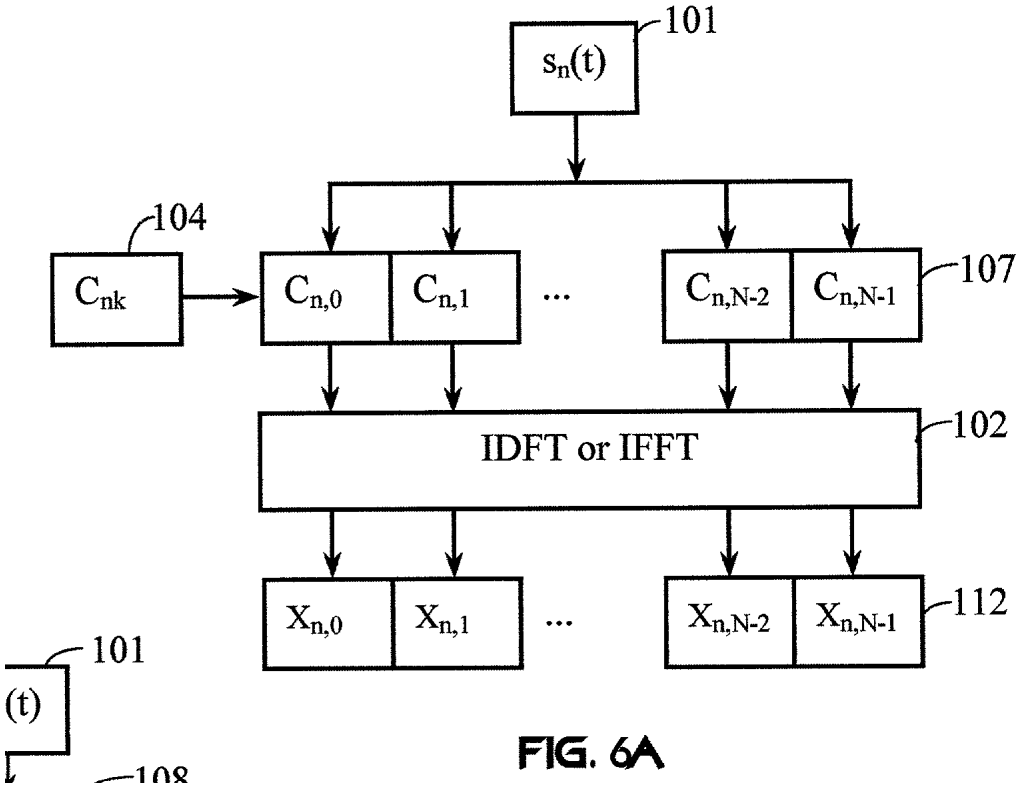

FIG. 6A

6. A portion of the written description (see '141, Page 24, third and fourth Pars.) pertaining to FIG. 6A, and corresponding features of Claim 1 (in parentheses) is shown below: (emphasis added)

"A code generator **104** [**OFDM spreader configured to spread a plurality of data symbols**] provides the N chips c_{kn} to a serial-to-parallel converter **107** [**mapper configured to map the DFT-spread data signal to a plurality of OFDM subcarriers**] that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator **102** [**OFDM modulator configured to modulate the DFT-spread data signal onto the plurality of OFDM subcarriers**]."

7. The features of claim 1 (with emphasis) and corresponding support in '141, by way of example, but without limitation, are shown as follows:

An OFDM transmitter

8. FIGs. 3A, 4A, 4B, and 5B are plots of OFDM transmission signals.

9. Written support in ’141 includes the following:

Page 43, third Par.: (emphasis added)

> “Redundantly modulated **multicarrier signals** may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers.”

Page 18, fourth Par.: (emphasis added)

> “The signal generator 102 produces a **multicarrier signal. A multicarrier signal is defined as a plurality of carrier signals having different orthogonalizing properties (also referred to as orthogonality parameters or diversity parameters), such as** time, differential power, location, mode, **frequency**, polarization, phase space, directivity, spread-spectrum code, or any combination of orthogonalizing properties. An orthogonalizing property (such as polarization) may not be completely orthogonal. For example, polarized signals having less than 90-degrees separation between them have cross-polarization (interference) terms. A multicarrier signal may be defined by any signal property that affects propagation characteristics, such as velocity, reflections, and refraction. Each multicarrier signal may be defined by a different propagation mode.

10. Thus, a person of ordinary skill in the art (POSITA) would understand “multicarrier signals” to include OFDM.

- **an OFDM spreader configured to spread a plurality of data symbols with Fourier coefficients to generate a discrete Fourier Transform (DFT)-spread data signal;**

11. Written support in ’141 includes the following:

Page 24, third Par. – Page 25, first Par. (emphasis added)

"FIG. 6A shows a multicarrier transmitter and transmission method of the present invention. **An nth information signal $s_n(t)$, such as for an nth user, is applied to an nth code c_n having N chips c_{kn} (k = 0 to N-1). The information signal $s_n(t)$ may modulate the code or it may be modulated by the code c_n.**

A code generator 114 provides the N chips c_{kn} to a serial-to-parallel converter 107 that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform. Each chip c_{kn} may be applied to a frequency bin of a transform process. **The chips c_{kn} may have** binary, real, or **complex values**. The modulated carriers are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown).

The code generator 114 can be used as an information-signal encoder or a carrier encoder. **An information signal may be used to modulate at least one code sequence.** The code generator 114 may be a multi-stage code generator. **Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT),** Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

12. The POSITA would understand that the claimed "**Fourier coefficients**" are the disclosed "**chips c_{kn}**" which are disclosed throughout '141, such as

Page 20, fifth Par.:

"Unlike a chip sequence in MC-CDMA (which uses binary values, such as ±1), CIMA signals use values of $e^{in\Delta\phi_k}$."

and on Page 25, first Par.: (emphasis added)

"Code generators may include one or more N-point transforms. N-point transforms include **Discrete Fourier Transforms (DFT)**"

13. The claimed "discrete Fourier Transform (DFT)-spread data signal" is produced when the disclosed "**n^{th} information signal $s_n(t)$, such as for an nth user, is applied to an nth code c_n having N chips c_{kn} (k = 0 to N-1)**". In the art of spread spectrum, the term "chip" refers to each value in a spread-spectrum code. By way of example,

Page 24, third Par.: (emphasis added)

> "**The information signal $s_n(t)$ may modulate the code or it may be modulated by the code c_n.**"

and the corresponding decoder is a spread-spectrum decoder, such as described in Page 37, first Par.: (emphasis added)

> "An **information decoder** decodes an encoded information signal. The decoder may provide encryption, error-correction, or **spread-spectrum decoding** (or any combination of decoding) **to decode an encoded information signal**."

Page 37, third Par.: (emphasis added)

> "A **spread-spectrum decoder** can be used as an information decoder or carrier decoder. The decoder may decode an information or multicarrier signal according to a code sequence generated by a code generator. The decoder may include a multi-stage decoder. **Decoders may generate one or more N-point transforms**. N-point transforms include DFTs, FFTs, WTs, HTs, RTs, PTs, **Inverse DFTs**, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

Page 55, fourth Par.: (emphasis added)

> "The **spread-spectrum signals** may be CDMA, Frequency Hopped, Time Hopped, hybrid spread spectrum, **N-point transform**, **or any type of multicarrier spread-spectrum signals**."

14. The POSITA would understand that "N-point transform" and "multicarrier spread-spectrum" includes the disclosed DFT-spread signals.

- **a mapper configured to map the DFT-spread data signal to a plurality of OFDM subcarriers;**

15. Written support in '141 includes the following:

Page 24, third Par. – Page 25, first Par.: (emphasis added)

> "FIG. 6A shows a multicarrier transmitter and transmission method of the present invention. An nth information signal $s_n(t)$, such as for an nth user, is applied to an nth code c_n having N chips c_{kn} (k = 0 to N-1). The information signal $s_n(t)$ may modulate the code or it may be modulated by the code c_n.
>
> A code generator 114 provides the N chips c_{kn} to **a serial-to-parallel converter 107 that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier signals** generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform. **Each chip c_{kn} may be applied to a frequency bin of a transform process**. The chips c_{kn} may have binary, real, or complex values. The modulated carriers are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown).
>
> The code generator 114 can be used as an information-signal encoder or a carrier encoder. An information signal may be used to modulate at least one code sequence. The code generator 114 may be a multi-stage code generator. Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

Upon reading the disclosure, the POSITA understands that the claimed "**map the DFT-spread data signal to a plurality of OFDM subcarriers**" is performed by the "**serial-to-parallel converter 107 that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier**

signals" or when each chip is "**applied to a frequency bin of a transform process**". The POSITA knows that in the field of OFDM, in an Inverse DFT or an Inverse FFT, each frequency bin corresponds to one of a plurality of OFDM subcarriers.

The POSITA would recognize that the recited "**plurality of OFDM subcarriers**" is the "**plurality of carrier signals**" disclosed in '141 corresponding to the frequency bins of the transform process to which the chips are applied. The transform process may be the disclosed "**inverse Discreet Fourier Transform**", which produces OFDM subcarriers.

- **an OFDM modulator configured to modulate the DFT-spread data signal onto the plurality of OFDM subcarriers…**

16. Written support in '141 includes the following:

Page 24, third Par. – Page 25, first Par.: (emphasis added)

> "FIG. 6A shows a multicarrier transmitter and transmission method of the present invention. An nth information signal $s_n(t)$, such as for an nth user, is applied to an nth code c_n having N chips c_{kn} (k = 0 to N-1). The information signal $s_n(t)$ may modulate the code or it may be modulated by the code c_n.
>
> A code generator 114 provides the N chips c_{kn} to a serial-to-parallel converter 107 that arranges the chips c_{kn} to **parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform.** Each chip c_{kn} may be applied to a **frequency bin of a transform process**. The chips c_{kn} may have binary, real, or complex values. **The modulated carriers** are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown).
>
> The code generator 114 can be used as an information-signal encoder or a carrier encoder. An information signal may be used to modulate at least one code sequence. The

code generator 114 may be a multi-stage code generator. Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

17. The POSITA is taught that the disclosed "**carrier-signal generator 102**" (e.g., "**a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform**") generates OFDM subcarriers. For example, in the carrier-signal generator 102 "each chip is applied to a frequency bin of a transform process".

- **to produce an OFDM transmission signal comprising a superposition of the OFDM subcarriers,**

18. Written support in '141 includes the following:

Page 43, third Par.: (emphasis added)

"Redundantly modulated multicarrier signals may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers."

Page 13, thirteenth and fourteenth Pars.: (emphasis added)

"FIG. 5A is a plot of relative amplitudes of a set of multi-frequency carriers that produce a composite signal 130 (shown in FIG. 5B) having time-domain characteristics of a direct-sequence CDMA signal.

FIG. 5B is a time-domain plot of a **superposition of the carrier signals** shown in FIG. 5A."

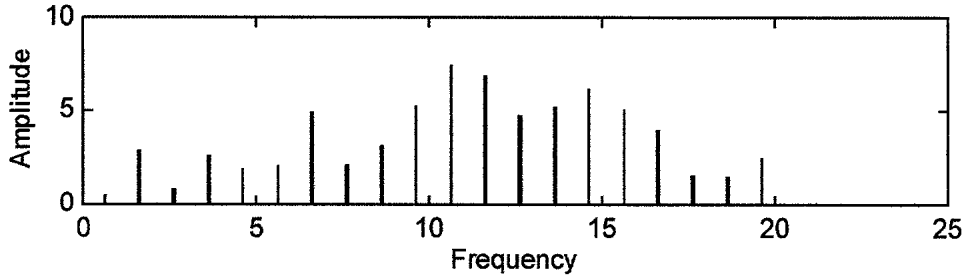

FIG. 5A

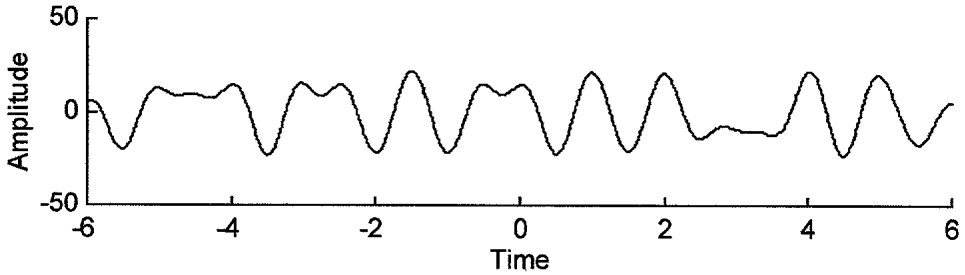

FIG. 5B

19. The disclosure informs the POSITA that FIG. 5B depicts a superposition of subcarriers in which the subcarriers bear DFT-spread data.

- **wherein the OFDM spreader is configured to provide the superposition with a reduced peak-to-average power ratio.**

20. It was well-known in the art that a single-carrier signal, such as the direct-sequence signal, has lower peak-to-average power ratio than a prior-art multicarrier signal (see Richard D.J . van Nee; "OFDM Codes For Peak-to-Average Power Reduction And Error Correction", Proceedings of GLOBECOM'96. 1996 IEEE Global Telecommunications Conference). FIG. 5B illustrates how the amplitude of the multicarrier signal produced by the invention has a reduced peak-to-average power ratio.

Page 23, third Par.: (emphasis added)

"The modulator 104 may provide weights to each of the carriers according to a predetermined code. **The coded weights may be applied to the carriers in order to generate a predetermined time-domain profile, such as a direct-sequence signal.** A preferred embodiment of the invention includes a process of **applying complex weights to a multicarrier signal in order to create a predetermined time-domain signal. A predetermined time-domain signal (or profile) is defined herein as a specific shape of at least one signal parameter, such as amplitude**, frequency, polarization, and phase in the time domain."

Page 13, thirteenth and fourteenth Pars. (emphasis added); and FIG. 5B depicts a single-carrier signal, i.e., a direct-sequence CDMA signal, with low PAPR.

"FIG. 5A is a plot of relative amplitudes of a set of multi-frequency carriers that produce a composite signal 130 (shown in FIG. 5B) **having time-domain characteristics of a direct-sequence CDMA signal**.

FIG. 5B is a time-domain plot of a superposition of the carrier signals shown in FIG. 5A."

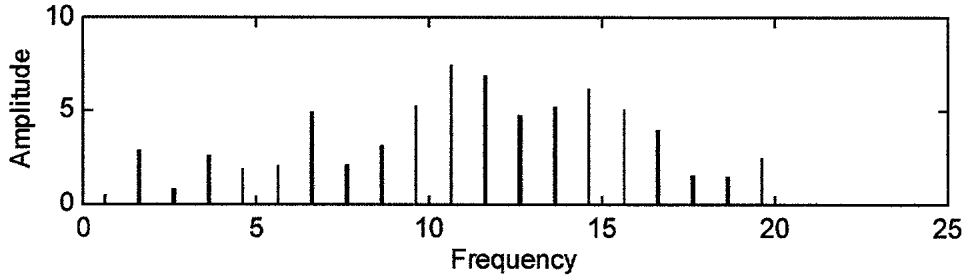

FIG. 5A

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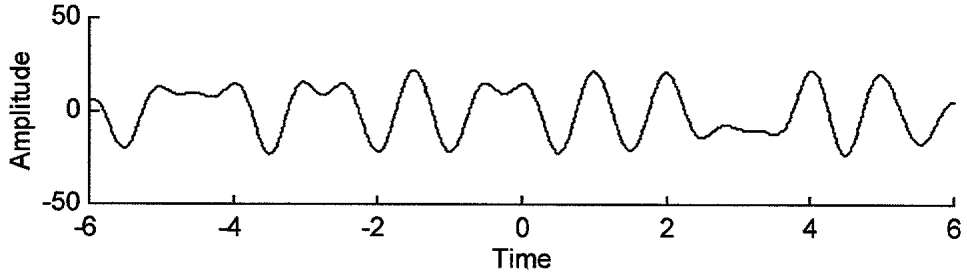


FIG. 5B

21. The POSITA would understand that a multicarrier signal with the time-domain characteristics of a direct-sequence CDMA signal has low peak-to-average power.

Claim 2: The OFDM transmitter recited in claim 1, wherein the OFDM spreader comprises an N-point DFT and the OFDM modulator comprises an M-point inverse discrete Fourier Transform, wherein M>N.

22. Written support in '141 includes the following:

Page 24, fifth Par. – Page 25, first Par.: (emphasis added)

> "Code generators may include one or more N-point transforms. N-point transforms include **Discrete Fourier Transforms (DFT)**, Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

Page 24, fourth Par. (emphasis added)

> "…the carrier-signal generator **102** may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an **inverse Discreet Fourier Transform** or an inverse Fast Fourier Transform."

23. M > N is depicted in several of plots of the digital transmission signals, such as FIG. 5B. M > N is required to produce a waveform with a mainlobe and sidelobes. For example, FIG. 5A shows 20 subcarrier amplitudes, but FIG. 5B shows many more than 20 samples, so M > N. The POSITA would know that in the case of M = N, there would be only 20 time-domain samples in FIG. 5B instead of 20 pulse waveforms, so FIG. 5B depicts the case of M > N.

24. Annotated FIG. 5B (below) in '141 is a plot of a digital time-domain signal produced by a computer that was programmed to generate digital transmission signals. A magnified portion of the plot in FIG. 5B depicts digital steps in the waveform, which indicates that there are a lot more than 20 (thus, M > N) digital samples in FIG. 5B.

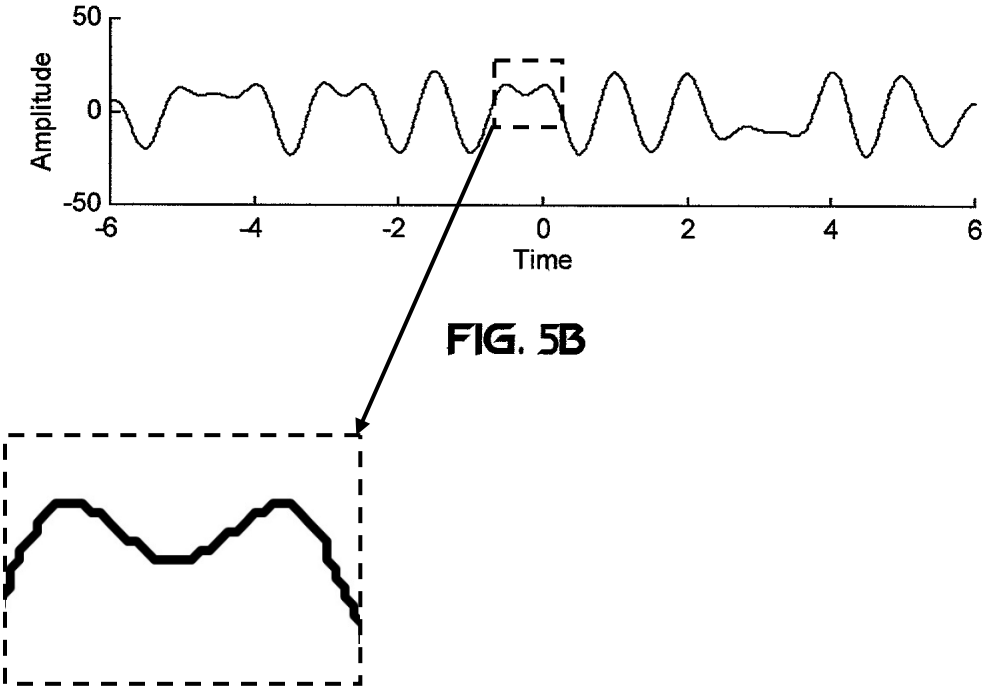


FIG. 5B

25. FIG. 3A (below) is a plot of a digital time-domain signal produced by a computer that was programmed to generate the disclosed digital transmission signals from a superposition of N = 5 sinusoids. Since each sinusoid depicts more than 5 sinusoid periods, it is clear that each sinusoid comprises more than N = 5 samples. FIG. 3A depicts a single time-domain pulse centered at time 0. Since the pulse envelope depicts an oscillating waveform therein, the

pulse comprises more than one sample point, and the depicted pulse waveform clearly comprises more than 5 samples. thereby illustrating M > N.

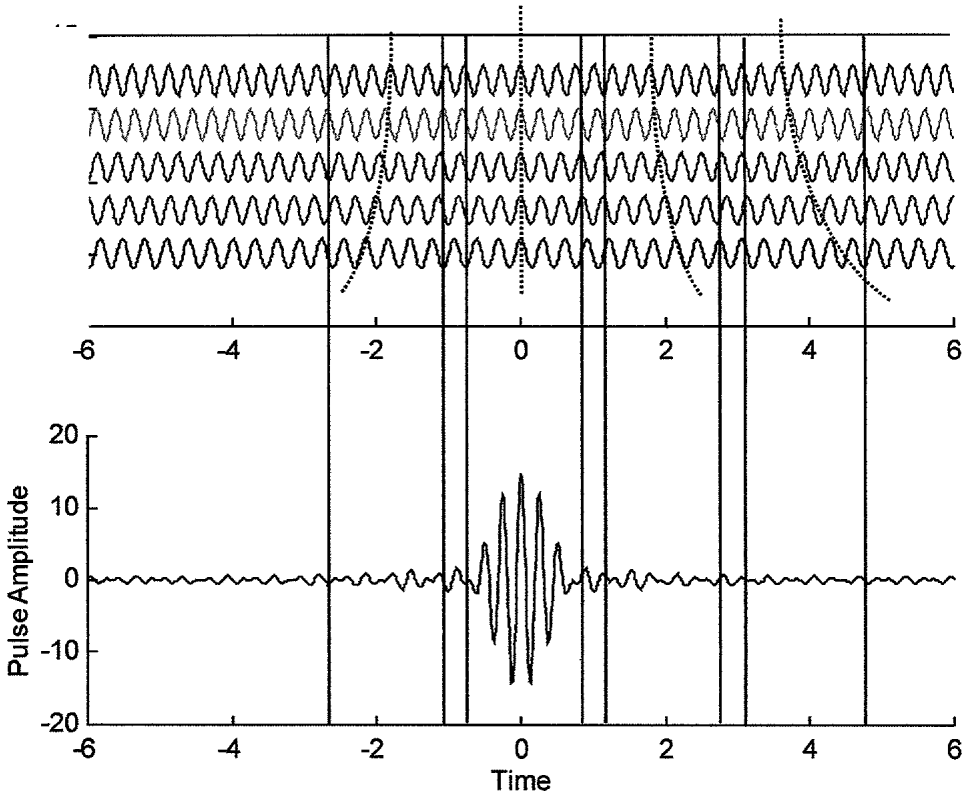


FIG.3A

Claim 3: The OFDM transmitter recited in claim 1, wherein the OFDM modulator comprises an inverse fast Fourier transform.

26. Written support in '141 includes the following:

Page 24, fourth Par.: (emphasis added)

"A code generator 114 provides the N chips c_{kn} to a serial-to-parallel converter 107 that arranges the chips c_{kn} to **parallel modulate each of a plurality of carrier signals** generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier

Transform or an **inverse Fast Fourier Transform**. Each chip c_{kn} may be applied to a frequency bin of a transform process."

27. The POSITA is instructed to implement the modulator with an inverse Fast Fourier Transform.

Claim 4: The OFDM transmitter recited in claim 1, wherein the data symbols comprise reference-signal symbols, which comprise at least one of known training symbols and synchronization symbols.

28. Written support in '141 includes the following:

Page 68, second Par.: (emphasis added)

"**Training sequencers** may be used in transmitters to transmit **training sequences consisting of predetermined signals**."

Page 67, second Par.: (emphasis added)

"The central unit or other transceiver may respond with **information indicating phase shifts or delays to be applied to the transmitted signals to synchronize the transmissions** with respect to other transmissions that the transceiver is receiving."

29. The POSITA is taught to employ training and/or synchronization signals. OFDM transceivers communicate by means of OFDM waveforms, thus the "**central unit or other transceiver"** communicates synchronization information to a different transceiver by means of OFDM transmission.

Claim 5: The OFDM transmitter recited in claim 1, wherein the plurality of OFDM subcarriers comprise at least one of contiguous OFDM subcarriers and equally spaced non-contiguous OFDM subcarriers.

30. Written support in '141 includes the following:

Page 21, first Par.: (emphasis added)

"A CIMA signal corresponding to the superposition on N carriers **uniformly spaced in frequency** by f_s has a waveform envelope according the equation:

$$E(t) = \left| \frac{\sin(N\pi f_s t)}{\sin(\pi f_s t)} \right|$$

The CIMA envelopes are periodic with a period of $1/f_s$."

Page 27, third Par.: (emphasis added)

"Information modulated onto carriers may be coded, such as according to a multiple-access, error-correction, or encryption code. **Interleaving** may be employed to reduce distortion effects caused by the channel **99**."

Page 21, last Par.: (emphasis added)

"CIMA signals may be **spaced in frequency by large amounts** to achieve a large system bandwidth relative to the coherence bandwidth. In this case, CIMA signals make use of the frequency diversity parameter to achieve uncorrelated fading."

31. The POSITA understands from the mathematical descriptions and other disclosure that the subcarriers can be contiguous (e.g., N carriers uniformly spaced in frequency by f_s) or non-contiguous (e.g., interleaved).

Claim 6: The OFDM transmitter recited in claim 1, further comprising a pulse-shaping module configured to provide the OFDM transmission signal with a predetermined pulse shape.

32. Written support in '141 includes the following:

Page 26, first Par.: (emphasis added)

"The signal generator **102** performs an inverse Fourier Transform, and may perform other digital processing methods, such as filtering and **pulse shaping**."

33. The POSITA is taught that the transmitter (e.g., signal generator) can perform pulse-shaping.

Claim 7: The OFDM transmitter recited in claim 1, further comprising a cyclic prefix appender configured to append at least one of a cyclic prefix, a postfix, and a guard interval to the OFDM transmission signal.

34. Written support in '141 includes the following: (emphasis added)

Page 43, third Par.:

> "Redundantly modulated multicarrier signals may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers."

35. Upon reading "OFDM", the POSITA would know to add a cyclic prefix, postfix, or guard interval, as such features were common in OFDM. The terms, "cyclic prefix", "postfix" (or suffix), and "guard interval", were common parlance in the field of OFDM.

36. In the art of OFDM, it was well-known that one **typically** adds extra samples to the transformed waveform produced by the Inverse Discrete Fourier Transform. For example, Cimini (US 6,891,792: col. 2 line 57 – col. 3, line 4) states (emphasis added):

> "**Typically**, the **OFDM** transmitter would be implemented by generating a series of complex numbers, representing the phase of the individual tones, and using the Inverse Discrete Fourier Transform (IDFT) to convert the series of tones into a time domain waveform. For practical reasons, in order to make the analog reconstruction and antialiasing filters realizable, the size of the IDFT (or more often the Inverse Fast Fourier Transform (IFFT)) is usually larger than the number of tones. In addition**, extra samples are prepended and appended to the transformed waveform. These "cyclic prefix" and "cyclic suffix" samples make the transmitted signal more robust against time dispersion and timing offset**—as long as the received signal, plus its various delayed copies, are sampled within the cyclic extension, **the constant amplitude of the received spectrum will be preserved**."

37. A POSITA would have known that the orthogonality of OFDM is maintained by appending

or prepending a guard interval, or cyclic prefix, between each symbol. This ensures that **the constant amplitude of the received spectrum will be preserved (see Cimini above)**, which enables the channel to be characterized by **flat fading**. Thus, a POSITA, upon reading OFDM, orthogonal multicarrier signals, and flat fading in the '141 would have directed the POSITA to append a cyclic prefix, postfix (i.e., cyclic suffix), or guard interval to the OFDM signal. For example,

Page 61, third Par. states: (emphasis added)

"Frequency diversity mitigates **flat fading**. Information signals $s_n(t)$ transmitted on different carriers are combined in the receiver 200 to generate a plurality of composite information signals $s'_n(t)$."

38. Cimini shows that knowledge of how the OFDM transmitter is "typically" implemented would guide the POSITA, upon reading "OFDM" or "flat fading" in '141, to append at least one of a cyclic prefix, a postfix, and a guard interval to the OFDM transmission signal.

Claim 8: The OFDM transmitter recited in claim 1, wherein the OFDM spreader is configured to provide channel precoding.

39. Written support in '141 includes the following: (emphasis added)

Page 26, first Par. states: (emphasis added)

"The modulated symbols are coupled to a **predistortion** device 111, which adjusts signal parameters (such as power, gain-profile, and phase) in order to **compensate for distortion** resulting from network components (such as the **channel**, amplifiers, and receivers). The predistortion device 111 is an optional part of the transmitter 100."

40. A POSITA would know that "predistortion" is a common name for "channel precoding", as channel precoding compensates for distortion resulting from the channel.

Claim 9: The OFDM transmitter recited in claim 1, wherein the plurality of data symbols

are at least one of time-multiplexed with reference-signal symbols, frequency-multiplexed with reference-signal symbols, and code-multiplexed with reference-signal symbols.

41. Written support in ’141 includes the following: (emphasis added)

Page 53, third Par.: (emphasis added)

> “…a known training sequence may be used to optimize the separation quality. **The training sequence may be performed in a predetermined orthogonal channel, such as a time interval, spread-spectrum code, frequency band**, directivity, phase space, or polarization.”

42. The POSITA knows that time multiplexing provides for transmitting different symbols or data channels in different time intervals. Frequency multiplexing provides for transmitting symbols on different frequencies. Code multiplexing provides for employing different spread-spectrum codes to encode different symbols. The POSITA would have known that a training sequence is a reference signal.

Claim 10: The OFDM transmitter recited in claim 1, further comprising a Cyclic Delay Diversity (CDD) module configured to provide CDD to the OFDM transmission signal.

43. The principle of CDD is to transmit different cyclic delayed versions of the original signal on different transmit antennas. In the case of OFDM transmission, a cyclic shift of the time-domain signal corresponds to a frequency-dependent phase shift before OFDM modulation (see US 6842487, Larsson).

44. The ’141 application incorporates by reference PCT Pat. Appl. No. WO99/41871 (‘871), which transmits a different frequency of an orthogonal multicarrier spread signal on each antenna. Specifically,

Page 70, second Par.: (emphasis added)

> “This invention claims the methods of controlling signal parameters in multiple diversity dimensions to achieve specific signal processing capabilities (such as diversity benefits and

capacity enhancement) in other diversity dimensions. For example, PCT Pat. Appl. No. WO99/41871 ('871) describes how **different-frequency carriers transmitted from different spatial locations cause a time-varying superposition beam pattern** (and a time-varying spatial gain distribution)."

45. Written support in '871 includes the following:

'871: Page 8, lines 26-35: (emphasis added)

"The separation d between the antenna elements 24n of the transmitter 70 (shown in FIG. 3) results in an **azimuthal variation** of the beam pattern produced by the array 24n due to the **time-dependent phase-space characteristic** of the CIMA signal. In other words, **as the phase space of the CIMA signals changes with time, the beam pattern of the array 24n scans**."

46. This causes cyclic shifts in the transmitted signal (depicted as near-vertical dotted lines in FIG. 3 of '871 below) due to the phase shifts between the frequencies.

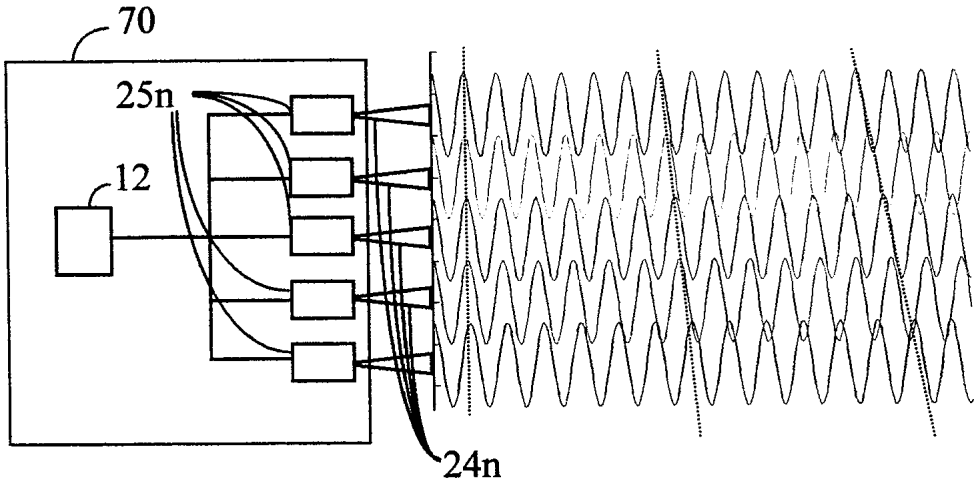


FIG. 3

47. Thus, the POSITA finds sufficient disclosure in the incorporate reference to make the claimed Cyclic Delay Diversity (CDD) module.

48. **Claims 11 and 22** recite similar features as those recited in claim 1.

Claim 22 recites a processor; and a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor.

49. By way of example, written support in '141 includes the following: (emphasis added)

Page 26, first Par.:

> "The modulated symbols may be processed in a carrier-signal generator 102, which may be a **digital signal processor**. The signal generator 102 performs an inverse Fourier Transform, and may perform other **digital processing methods**, such as filtering and pulse shaping."

Page 26, third Par.:

> "A combiner, such as the combiner 109 is any device or process that has an input of a plurality of signals and an output representing a superposition of the signals. A combiner may be a physical device, such as a wavelength multiplexer, splitter, voltage divider, a summer, or a difference amplifier. A combiner may be a combining process performed by a **computer processor**. A combiner may provide phase shifts to one or more input signals, filtering, inversion, interleaving, de-interleaving, or amplitude adjustment prior to combining the input signals."

Page 36, second Par.: (emphasis added)

> "A Fourier transform, as used herein is defined as any of the direct or inverse Fourier transform methods including Fourier transforms, Fourier series, discreet-time Fourier transforms, discreet Fourier transforms, and polynomial transforms. **Fourier transforms may be implemented using any number of computational techniques**, such as fast Fourier transforms, and they may be supported using additional mathematical relationships such as Laplace transforms."

50. **Claims 12 and 23** recite similar features as those in claim 5.

Claim 13: The method recited in claim 11, wherein the plurality of OFDM subcarriers is selected based on measured channel quality of the subcarriers.

51. Written support in '871 includes the following: (emphasis added)

Page 21, fourth and fifth Par.:

> "A CIMA signal **has a number of carrier signals that may each have a bandwidth that is less than the coherence bandwidth of the communication channel**. The coherence bandwidth is the bandwidth limit in which **correlated fading** occurs. The total bandwidth of the CIMA signal preferably exceeds the coherence bandwidth.
>
> **CIMA signals may be spaced in frequency by large amounts to achieve a large system bandwidth relative to the coherence bandwidth**. In this case, CIMA signals make use of the frequency diversity parameter to achieve **uncorrelated fading**."

Page 33, fourth Par.:

> "The process of providing the carrier-phase relationship may include providing at least one initial carrier-phase relationship between the carriers and **selecting the values of at least one carrier's orthogonalizing properties** (such as frequency and/or polarization) that affect **dispersion** of the signals in the channel 99."

Page 68, second Par.: (emphasis added)

> "The optimization process may be performed with respect to **signal-to-noise, signal-to-interference, signal-to-noise-plus-interference, bit-error rate, or any type of measurement or computation that indicates signal quality**."

Page 68, third Par.: (emphasis added)

> "FIG. 35 illustrates a method of adjusting reception parameters and **assigning transmissions to signal spaces in order to optimize system-operating parameters**. Signals are received in a first step 295. The signals may be information or training signals. The spatial gain(s) of the received signals are determined in a measurement step 296. **Signal parameters are**

optimized in an optimization step 297. The optimization step 297 includes optimizing signal parameters (such as SNR, signal power, and BER). A second optimization step 298 includes distributing signals into optimized signal spaces. The optimization is based on system parameters (such as power efficiency and system complexity)."

52. The POSITA would know that correlated fading, dispersion, and SNR are measured channel qualities of the subcarriers.

Claim 14: The method recited in claim 11, wherein the mapping is configured to provide the spread OFDM signal with reduced PAPR.

53. Written support in '871 includes the following: (emphasis added)

Page 21, first Par.:

"A CIMA signal corresponding to the superposition on **N carriers uniformly spaced in frequency by f_s** has a **waveform envelope** according the equation:

$$E(t) = \left| \frac{\sin(N\pi f_s t)}{\sin(\pi f_s t)} \right|$$

The CIMA envelopes are periodic with a period of $1/f_s$. The mainlobe of the envelope has a width of $2/Nf_s$, and the N-1 sidelobe widths are $2/Nf_s$. Applying a phase shift of $n\Delta\phi_k$ to each nth carrier shifts the CIMA envelope in time by $\Delta t = \Delta\phi_k/2\pi f_s$. Therefore **N signals can be positioned orthogonally in time**. The phase shifts provide the necessary phase relationships to create the desired timing of the information signal received by at least one receiver (not shown)."

54. The POSITA is taught how to configure mapping (e.g., select the number of carriers and frequency spacing) to produce a waveform envelope that allows N signals to be positioned orthogonally in time, which reduces PAPR (an example of such a low-PAPR signal is depicted in FIG. 5B above).

Claim 15: The method recited in claim 11, wherein at least one of the spreading matrix and

the mapping is configured to provide a spread reference signal comprising a coherent superposition of reference symbol components on different subcarriers.

55. Written support in '871 includes the following: (emphasis added).

Page 53, third Par.:

> "The training sequence may be performed in a predetermined orthogonal channel, such as a time interval, **spread-spectrum code**, frequency band, directivity, phase space, or polarization."

Page 24, last Par. – Page 25, first Par.:

> "Code generators may include one or more N-point transforms. N-point transforms include **Discrete Fourier Transforms** (DFT), Fast Fourier Transforms (FFT)…"

Page 21, first Par.:

> "A CIMA signal corresponding to the **superposition** on N carriers uniformly spaced in frequency by f_s has a **waveform envelope** according the equation:
>
> $$E(t) = \left| \frac{\sin(N\pi f_s t)}{\sin(\pi f_s t)} \right|$$
>
> The CIMA envelopes are periodic with a period of $1/f_s$. **The mainlobe of the envelope** has a width of $2/Nf_s$, and the N-1 sidelobe widths are $2/Nf_s$. Applying a phase shift of $n\Delta\phi_k$ to each nth carrier shifts the CIMA envelope in time by $\Delta t = \Delta\phi_k/2\pi f_s$. Therefore N signals can be positioned orthogonally in time. The phase shifts provide the necessary phase relationships to create the desired timing of the information signal received by at least one receiver (not shown)."

56. The training sequence can be in an orthogonal spread-spectrum channel, which is defined by a spread-spectrum code. As disclosed in '141, a DFT code produces a coherent superposition (e.g., the mainlobe of the envelope given by the formula in the first Par. of Page 21). The POSITA understands that both the disclosed DFT spreading and the IDFT modulation intrinsically employ coherent frequencies.

57. **Claim 16** recites similar features as those in claim 4.

58. **Claims 17 and 28** recite similar features as those in claim 7.

59. **Claims 18 and 25** recite similar features as those in claim 2.

60. **Claim 19** recites similar features as those in claim 10.

61. **Claims 20 and 27** recite similar features as those in claim 6.

Claim 21. A User Equipment configured to perform the method recited in claim 11.

62. Written support in '141 includes the following: (emphasis added)

Page 16, second to last Par.:

> "FIG. 1 shows the basic components of a high-capacity optical-fiber network that provides last-mile information delivery to **individual users** via wireless links."

Page 21, second Par.:

> "CIMA can support N orthogonal **users**."

63. The term, "User Equipment", is known in the art to mean any device used by an end user to communicate (see https://en.wikipedia.org/wiki/User_equipment):

> "In the Universal Mobile Telecommunications System (UMTS) and 3GPP Long Term Evolution (LTE), **user equipment** (**UE**) is any device used directly by an end-user to communicate."

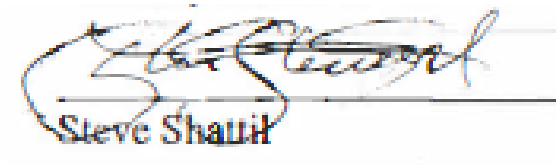
Thus, the POSITA would understand "users" to mean user equipment.

64. **Claim 24** recites similar features as those in claim 21.

65. **Claim 26** recites similar features as those in claim 3.

66. **Claim 29** recites similar features as those in claim 13.

DECLARATION

The declarant acknowledges that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issuing thereon. The declarant attests that all statements made of the declarant's own knowledge are true and that all statements made on information and belief are believed to be true.

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