IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the *Inter Partes* Review of U.S. Patent No. 7,639,982

Trial No.: Not Yet Assigned

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Inventors: Philip M. Wala

Assignee: COMMSCOPE TECHNOLOGIES LLC

Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

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PETITION FOR *INTER PARTES* REVIEW UNDER 37 C.F.R. § 42.100

On behalf of SOLiD, Inc. ("SOLiD" or "Petitioner") and in accordance with 35 U.S.C. § 311 and 37 C.F.R. § 42.100, *inter partes* review ("IPR") is respectfully requested for claims 11-24, 33, 36, and 52-74 of U.S. Patent No. 7,639,982 ("the '982 patent") (Ex. 1001).

The undersigned representative of Petitioner authorizes the Office to charge the Petition and Post-Institution Fees, and any additional fees, to Deposit Account 503013, ref: 428880-605001.

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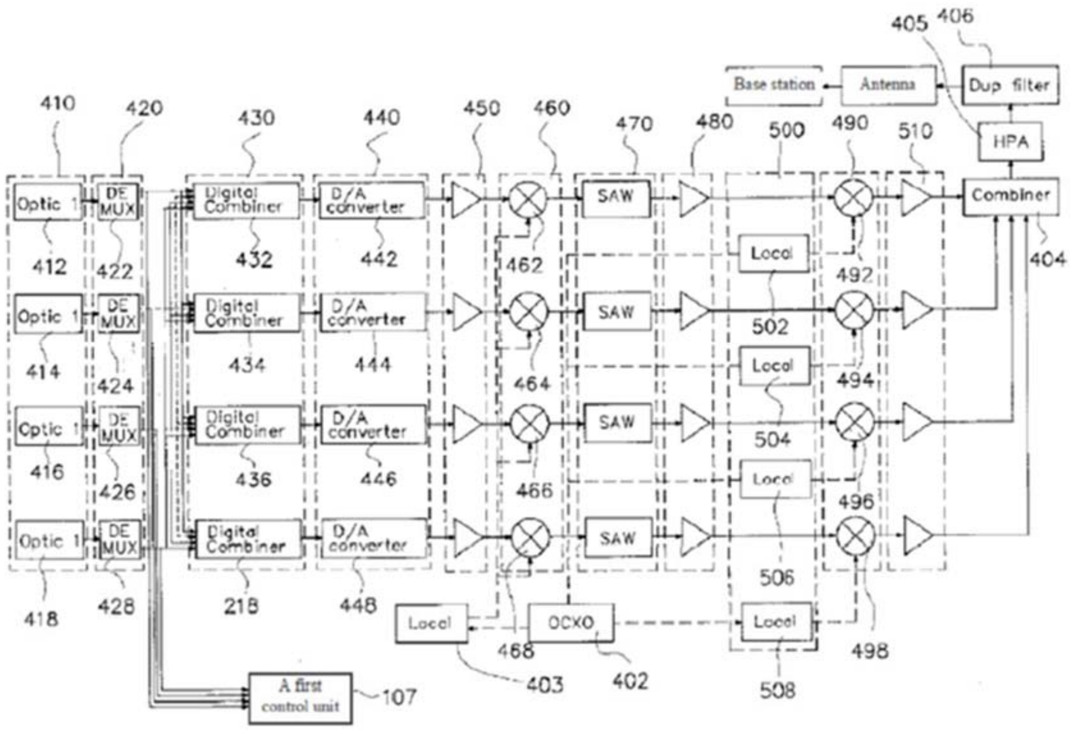
I. Introduction

U.S. Patent No. 7,639,982 (the ’982 patent) describes a digital antenna system that enables extension of radio frequency (RF) analog signals from base stations to areas (*e.g.*, inside of buildings) where access to such signals is inhibited. The ’982 patent systems include a digital host unit that communicates with a base station, and a plurality of remote units distributed within the hard to reach area. On the forward path, the ’982 patent digitizes analog signals received from the base station and transmits those digital signals to the remote units. The remote units then convert the digital signals back to analog and forward them to nearby wireless devices via their antennas. On the reverse path, the remote units sample and digitize analog RF signals received at the antennas and forward the digital data to the host unit. The host unit sums digital sample data received from multiple remote units and uses the summed data values to generate analog signals that are forwarded to the base station.

The ’982 patent was allowed in part based on claim features describing the digital host unit performing the digital summing operation on digitized radio frequency signals received at the host unit. *See*, Ex. 1001, claim 1. While the Examiner found the claims of the ’982 patent to be patentable, the Examiner did not have the benefit of the Oh reference (Ex. 1007) cited herein. The Examiner’s failure to find the Oh reference is understandable because Oh is a publication of a Korean patent application filed in April

1999 that was published in Korean in August 1999.

FIG. 5



Had the Examiner had access to the Oh reference during prosecution, the '982 patent would not have issued.

II. Grounds For Standing Pursuant To 37 C.F.R. § 42.104(a)

Petitioner certifies the '982 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR challenging the patent claims on the grounds identified herein.

III. Background Information For The '982 Patent

A. Overview Of The '982 Patent

The '982 patent is directed to a digital distributed antenna system illustrated in Fig. 1 having a host unit and multiple distributed remote antenna units.

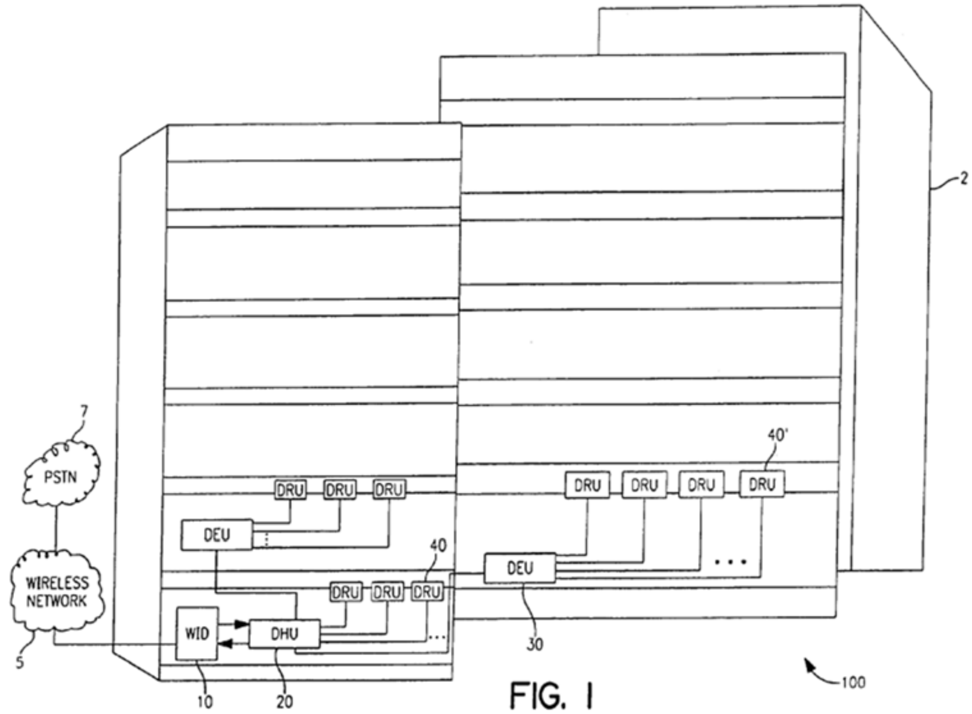
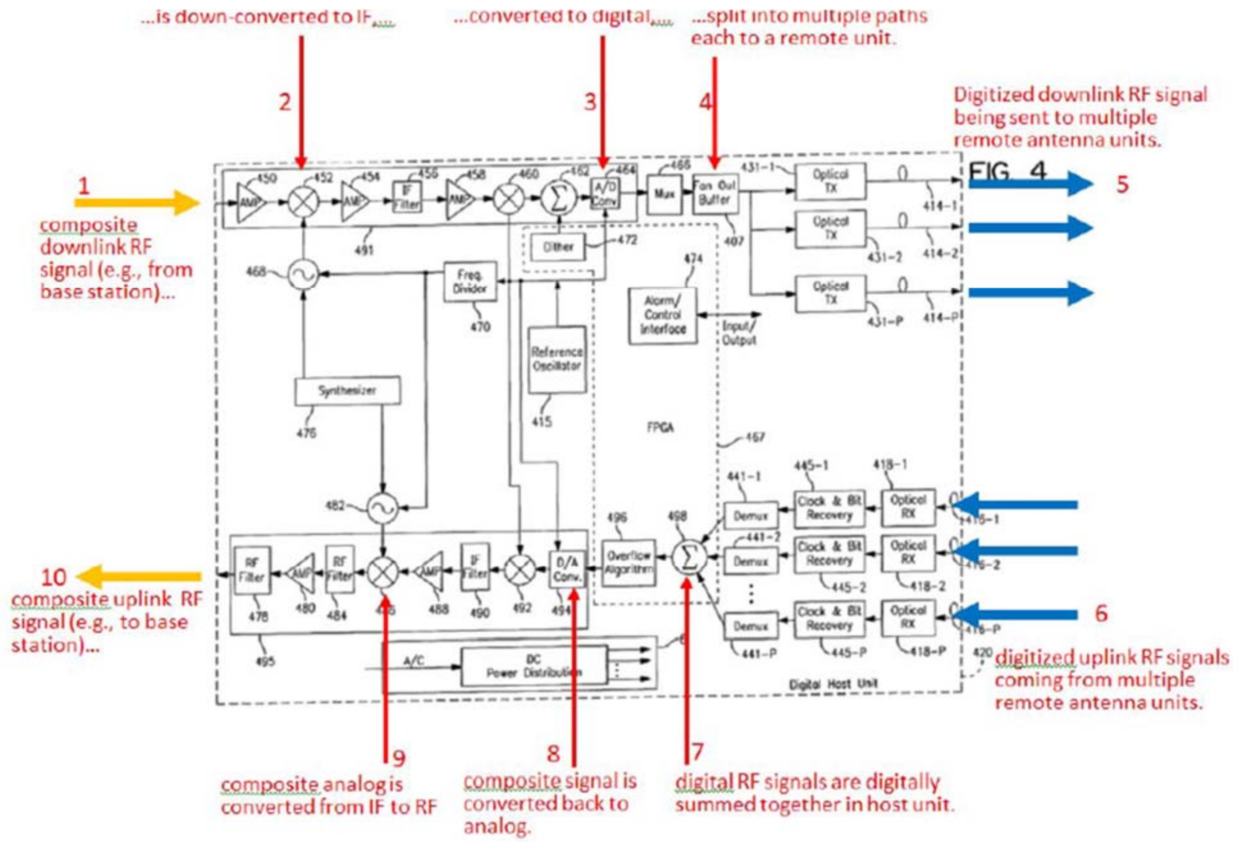


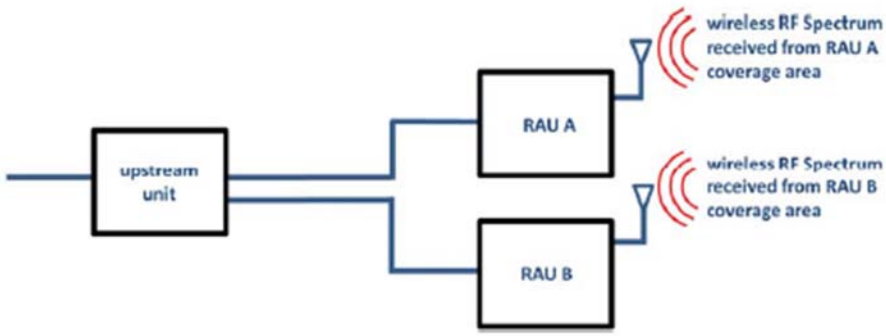
FIG. 1

Annotated Fig. 4 of the ’982 patent below illustrates a host unit that provides digitization of an RF signal received from a base station (top left) for distribution to multiple digital remote units (top right). Annotated Fig. 4 further illustrates creation of an uplink RF signal for transmission to the base station (bottom left) based on digital samples received from multiple digital remote units (bottom right).

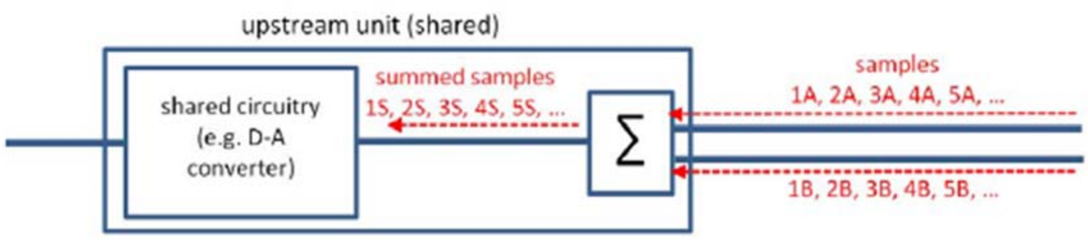


In the downlink direction, the host unit down-converts a composite downlink RF signal to an intermediate frequency, takes a sequence of digitized samples, and delivers a sequence of digitized samples over a fiber optic cable to each of several remote units. Ex. 1001,7:3-17. At each digital remote unit, the arriving stream of digital samples are converted back into the analog signal from which they are derived and then delivered to an antenna for transmission. *Id*., 9:5-20.

In the uplink direction, each digital remote unit receives the wireless RF spectrum from its coverage area and converts this to a sequence of digital samples that are sent over a fiber optic cable to the host unit.



Ex. 1001, 9:34-38 (drawing from Ex. 1008, ¶173, Patent Owner's background description of this patent family showing remote antenna units (RAU) relaying signals from wireless devices to an upstream unit, *e.g.*, a host unit). The upstream unit receives the sequence of samples from the respective remote units and digitally sums the corresponding digital samples from the respective remote units by summing corresponding digital values of the recorded samples.



Ex. 1001, 7:53-8:7; Ex. 1008, ¶177. The summed digital samples are then converted into an analog signal and converted to an RF signal for delivery to the base station. *Id.*; Ex. 1005, ¶¶59-63.

B. Overview Of The Prosecution History

The '982 patent issued after eight Office Actions and corresponding responses. The Applicant amended certain aspects of the claims (*e.g.*, claim 1) to recite that the digital host unit digitally sums the digitized radio frequency signals received at the digital host unit. Ex. 1006, 465. Applicant further differentiated the claims from the Examiner cited prior art based on the resolution of signals involved in digitally summing operations (*e.g.*, claim 37, Ex. 1006, 69-70), and the location of summing operations being at the host unit and not remote units (*e.g.*, claim 1, Ex. 1006, 72-73).

The Oh reference cited herein clearly discloses these features, where Oh's digital combiner unit 430 resides in master unit 20 and includes digital combiners 432, 434, 436, 438 that perform digital combining by "creating 14-bit intermediate frequency signals by combining four 12-bit intermediate frequency signals in the same frequency band." Ex. 1007, 5:16-17. Oh was not considered by the Examiner during prosecution of the '982 patent. Ex. 1005, ¶¶58, 64.

C. Level Of Skill In The Art

A person of ordinary skill in the art ("POSITA") as of July 2000 (the earliest patent filing date to which the '982 patent could claim priority) would have possessed at least a bachelor's degree in electrical engineering with at least two years of industry experience with data communications system (or equivalent degree or experience). Ex. 1005, ¶¶3-19, 28-30. A person could also have qualified as a POSITA with some combination of (1) more formal education (such as a master's of science degree) and less technical experience, or (2) less formal education and more technical or professional experience. *Id.*

IV. Identification Of Challenge Pursuant To 37 C.F.R. § 42.104(b)

A. 37 C.F.R. § 42.104(b)(1): Claims For Which IPR Is Requested

IPR is requested for claims 11-24, 33, 36, and 52-74 of the ’982 patent.

B. 37 C.F.R. § 42.104(b)(2): The Prior Art And Specific Grounds On Which The Challenge To The Claims Is Based

IPR is requested in view of the following references:

- Korean Laid-Open Disclosure No. KR1999-0064537 to Oh (“Oh”) (Ex. 1007). Oh is prior art to the ’982 patent at least under 35 U.S.C. § 102(a).
- U.S. Patent No. 5,883,882 to Schwartz (“Schwartz”). Schwartz is prior art to the ’982 patent under at least 35 U.S.C. §§ 102(a), (b), and (e).
- U.S. Patent No. 5,379,455 to Koschek (“Koschek”). Koschek is prior art to the ’982 patent under at least 35 U.S.C. §§ 102(a), (b), and (e).
- U.S. Patent No. 5,969,837 to Farber (“Farber”). Farber is prior art to the ’982 patent under at least §§ 102(a), (b), and (e).

The specific statutory grounds on which the challenge to the claims is based and prior art relied upon for each ground are as follows:

Ground 1a: Claims 65-69, and 74 are unpatentable under 35 U.S.C. § 103 over Oh;

Ground 1b: Claims 11-24, 33, and 36 are unpatentable under 35 U.S.C. § 103 over Oh in view of Schwartz; and

Ground 1c: Claims 52-64 and 70-73 are unpatentable under 35 U.S.C. over Oh in view of Koschek.

C. 37 C.F.R. § 42.104(b)(3): Claim Construction

The Board gives claims their ordinary and customary meaning, or "the meaning that the term would have to a [POSITA] at the time of the invention." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-13 (Fed. Cir. 2005) (en banc). Petitioner proposes no claim terms for construction at this time.

V. There Is A Reasonable Likelihood Claims 11-24, 33, 36, 52-69, and 70-74 Of The '982 Patent Are Unpatentable

A. Brief Overview Of The Prior Art

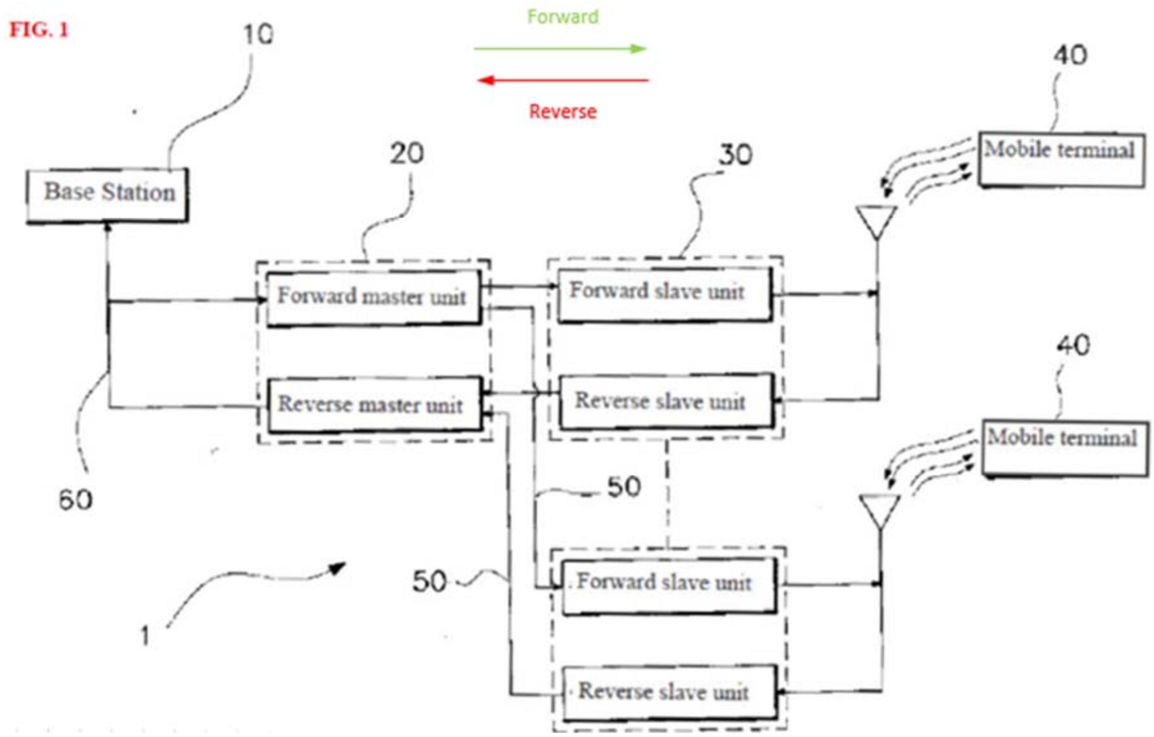
1. Overview Of Oh

Oh is a publication of a Korean patent application filed on April 3, 1999. Oh was published on August 5, 1999.

Oh discloses an optic repeater system that is installed to facilitate communications to and from "radio wave shadow area" where base station signals are unable to reach. Ex. 1007, 2:4-7. When a "base station is far away" or when the mobile terminal is "in the radio wave shadow area, the base station cannot perform streamlined transmission/reception to/from the mobile terminals." *Id.*, 2:11-13.

Optic repeater systems were used prior to Oh in an attempt to provide wireless access to mobile terminals in the radio wave shadow area. *Id.*, 2:16-19. In those historic systems, transmissions between the primary unit and the remote units across an optic line were analog. *Id.*, 2:20-22. But because "the RF signals transmitted/received to/from said first optic repeater and a second optic repeater [were] analog signals, the strength of the signals is greatly decreased during transmission through the optical line." *Id.*, 2:28-30. This analog signal attenuation required implementation of signal amplifiers in prior systems, which exacerbated signal-to-noise ratio issues. *Id.*, 2:30-33.

To address the analog signal attenuation issue, Oh "provide[s] a digital optical repeater that can maximize the efficiency of signal transmission in such a way that the optic repeater converts the intermediate frequency signals, analog signals, to the digital signals and transmits/receives them through the optical line." *Id.*, 2:36-39. An Oh optic repeater system includes a first optic repeater (master unit 20) that is in communication with the base station 10 and second optic repeaters (slave units 30) that are distributed within the radio wave shadow area. *Id.*, Abstract, 2:19-20.



On the forward path (left-to-right in Fig. 1), RF signals are received by the forward portion of master unit 20 from the base station 10 and are processed by the forward master unit 100. *Id.*, 2:72-73. The forward master unit 100 "converts RF signals, analog signals, transmitted from the base station 10 to the intermediate frequency signals; converts them to digital signals; and transmits them to the slave unit 30 through the optic line 50." *Id.*, 3:5-6. The forward portion of the slave units 30 (*e.g.*, forward slave unit 200) "converts digital signals to the intermediate frequency signals, analog signals; converts the intermediate frequency signals to RF signals; and transmits them to the mobile terminals 40. *Id.*, 3:1-4.

On the reverse path (right-to-left in Fig. 1), the reverse portion of slave unit 30 (*e.g.*, reverse slave unit 300) converts analog RF signals received from the mobile terminals 40 to digital signals and transmits them to master unit 20 through the optic line 50. *Id.*, 4:23-25. The reverse portion of master unit 20 (*e.g.*, reverse master unit 400) "converts the digital signals transmitted from the slave unit 30 through the optic line 50 to the intermediate frequency signals, analog signals, converts them to the RF signals, and transmits them to the base station 10." *Id.*, 4:62-64.

FIG. 2

Labels for 182, 184, 186, 188 fixed here. See Oh, 3:40 ("four A/D converters 182, 184, 186, and 188")

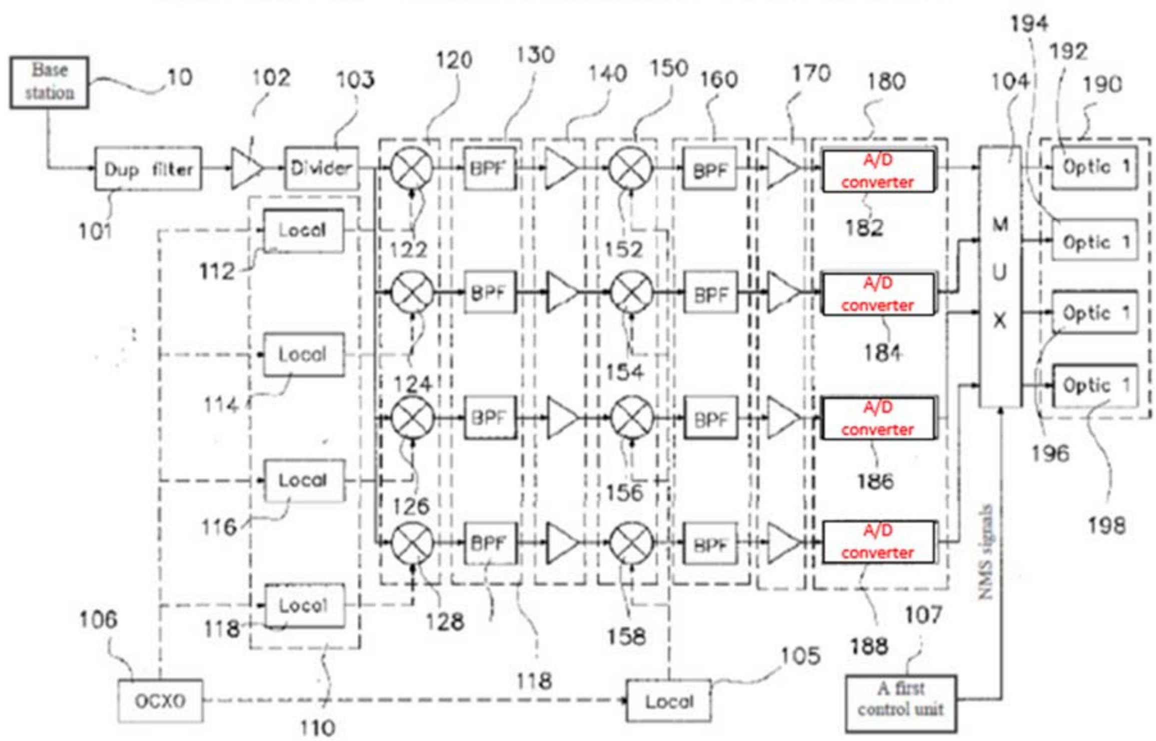


Fig. 2 provides example detail of the forward portion of Oh's master unit 20. The forward master unit receives RF signals from the base station 10 through a bi-directional filter 101. A divider 103 divides the RF signals into its component frequency bands (*i.e.*, the component frequency bands that make up the RF signal received from the base station 10), where each of those component band signals is processed in parallel through first mixer unit 120, band pass filter (BPF) 130, amplifier 140, second mixer unit 150, second BPF 160, and second amplifier 170 collectively to transition the signals from their band frequencies to baseband frequency close to DC. *Id.*, 3:6-14. Analog to Digital (A/D) converters 182, 184, 186, 188 sample the baseband signals to convert them to digital representations of the analog component frequency band signals. *Id.*, 3:14-16. Multiplexer 104 multiplexes the four 12-bit digital sample values with 4-bit network management system (NMS) control data from control unit 107 and applies that 52-bit (*i.e.*, the 4-12-bit words plus the 4-bit NMS control information) serial data stream to each of a plurality of optic converters 192, 194, 196, 198 for transmission across optic lines 50 to destination slave units. *Id.*, 3:38-44.

FIG. 3

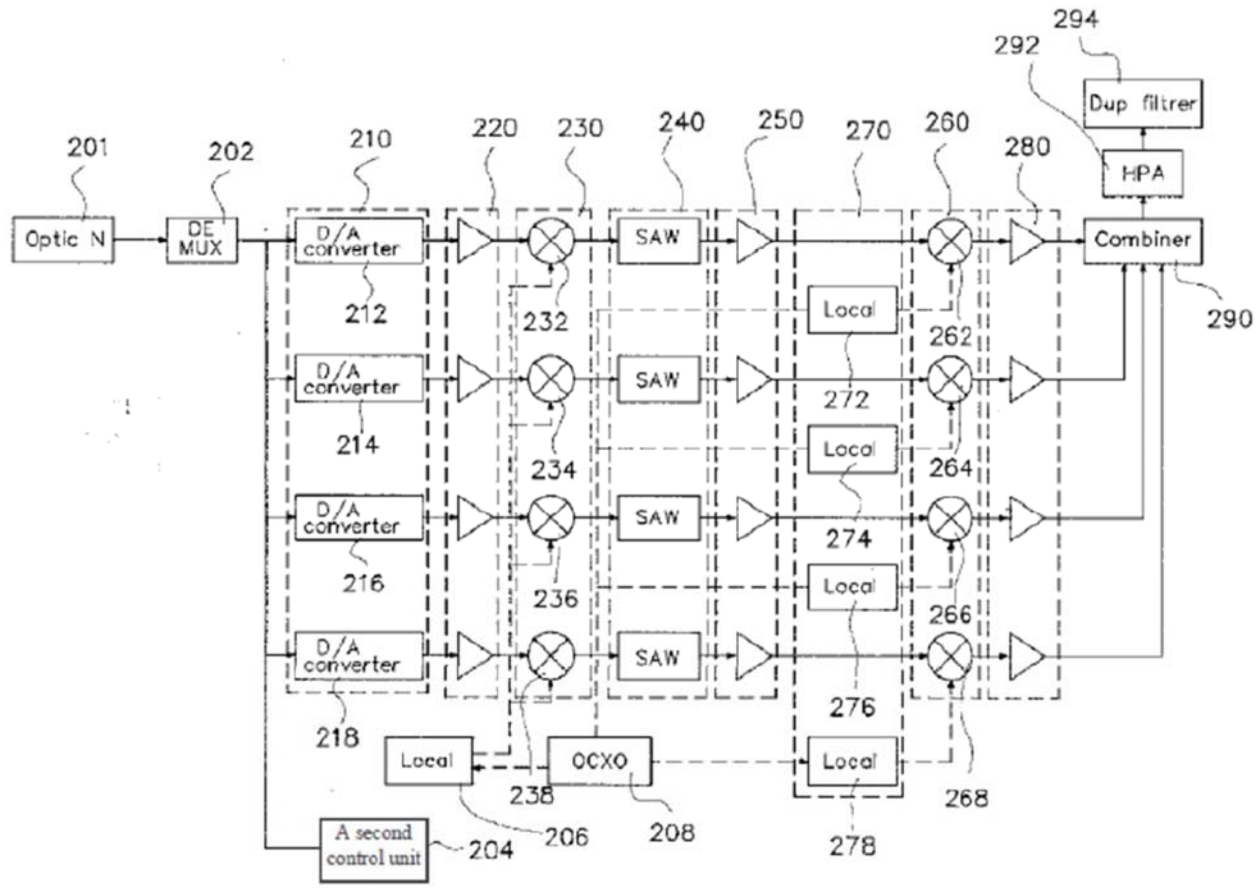


Fig. 3 provides example detail of the forward portion of one of Oh's slave units 30. The 52-bit digital signal transmitted on one of the optic lines 50 is received at a second optic converter unit 201. "[C]ombiner 290 [] combines the RF signals of four different frequency bands [*i.e.*, analog combining (Ex. 1005, ¶58)]… and transmits them to the mobile terminals 40 through a second power amplifier 292 and a second bi-directional filter 294." Ex. 1007, 3:59-61.

FIG. 4

Labels for 382, 384, 386, 388 fixed here. See Oh, 4:53-54 ("four A/D converters 382, 384, 386, 388")

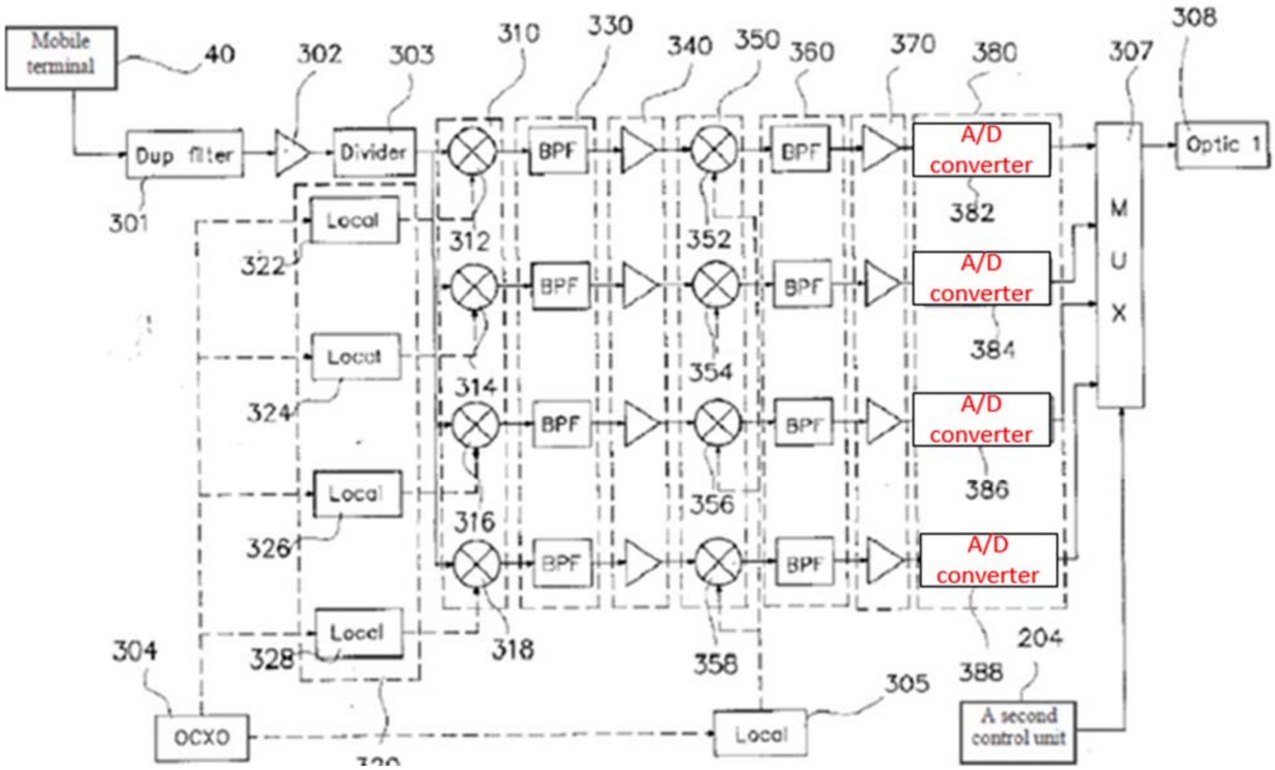


Fig. 4 illustrates example details of the reverse path at a slave unit 30 (*e.g.*, reverse slave unit 300). "RF signals transmitted from the mobile terminals 40 to the reverse slave unit 300 of the slave unit 30 through the antenna are converted to the intermediate frequency signals close to DC…, mixed with the NMS signals transmitted from a second control unit 204, and transmitted to the reverse master unit 400 through the optic line." *Id.*, 4:16-18.

FIG. 5

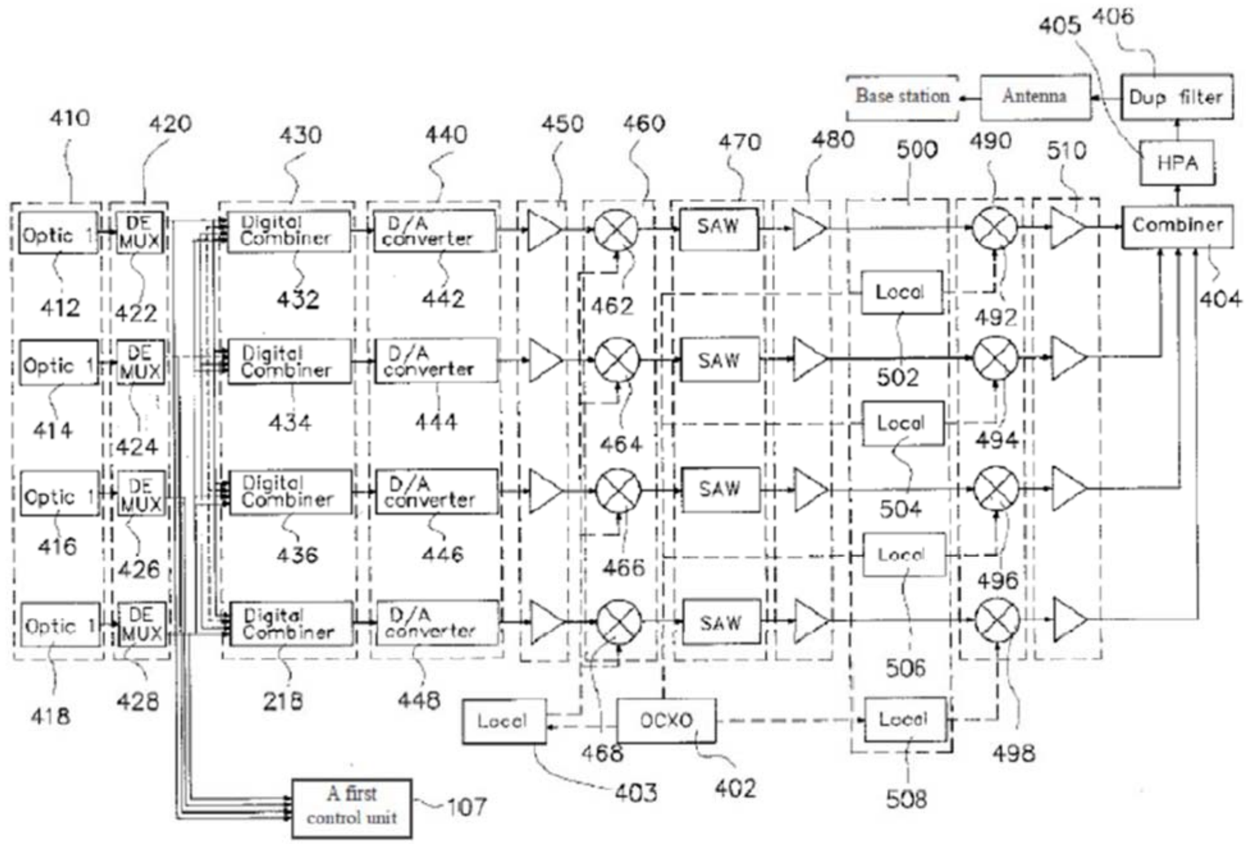


Fig. 5 illustrates example detail of the reverse path at the master unit 20 (*e.g.*, reverse master unit 400), which receives four streams of digital data from four slave units over optic lines (*i.e.*, digital data from a first slave unit at 412, a second slave unit at 414, a third at 416, and a fourth at 418). Each demultiplexer 422-428 is associated with a respective one of the remote slave units to route digital sample data to its respective frequency band path in the reverse unit. Each demultiplexer 422-428 receives digital sample data and control data from one slave unit 30 and separates that digital sample data according to frequency band. *Id.*, 5:4-10. In the example where the reverse master unit of Fig. 5 is connected to four slave units 30, the 52-bit data from the slave unit is demultiplexed at a first demultiplexer, with one 12-bit data sample being sent to each of four digital combiners and 4-bit control data to control unit 107. *Id.*, 5:11-12. Demultiplexer 422 sends a 12-bit sample associated with a first frequency band to first digital combiner 432, a 12-bit sample for second band to combiner 434, a 12-bit sample for third band to combiner 436, and a 12-bit sample for fourth band to combiner 438. Demultiplexers 424, 426, 428 similarly send 12-bit samples to each of the digital combiners 432, 434, 436, 438. *Id.*, 5:11-15.

Each digital combiner 432, 434, 436, 438 receives four digital samples associated with its band and "aggregates the same digital signals transmitted from each demultiplexer." Specifically, each digital combiner performs digital combining "by combining four 12-bit intermediate frequency signals in the same frequency band" to "creat[e] 14-bit intermediate frequency signals." *Id.*, 4:69; 5:16-17; Ex. 1005, ¶58. Those 14-bit digital signals are then applied to respective D/A converters 442, 444, 446, 448 to provide intermediate frequency signals. Ex. 1007, 5:18. The intermediate frequency signals are shifted to their respective band frequencies by being amplified at 450, mixed with a step up frequency at 460, filtered at 470, amplified again at 480, mixed with a respective frequency at 490 to recreate the radio frequency signals, and amplified again at 510. *Id.*, 4:73-5:2. "[C]ombiner 404 aggregates the RF signals in different frequency bands [*i.e.*, performs analog combining (Ex. 1005, ¶58)]… amplifies the strengths and level in a first power amplification unit 405, and transmits them to the base station 10 through a fourth bi-directional filter 406" such as via an antenna as depicted in Fig. 5 or an RF cable. Ex. 1007, 5:27-29.

Oh shows multiple, different example ways of communicating with a base station. For example, a wired connection (*e.g.*, RF cable 60) is illustrated in FIG. 1 between the base station 10 and master unit 20. Oh also illustrates a wireless connection (*e.g.*, antenna in Fig. 5) between the first bi-directional filter 406 of the master unit 20 and the base station 10.

Oh is analogous art to the '982 patent because it is in the same field of endeavor (RF data communications) and it is associated with the common problem of extending RF data communications into hard to reach areas. Ex. 1005, ¶¶70-85; Ex. 1007, 2:4-13.

2. Overview Of Schwartz

Like the '982 patent and Oh, Schwartz addresses expansion of RF signal coverage into hard to reach areas "especially within structures or around other obstacles, man-made or natural, which otherwise tend to block or disrupt radio waves." Ex. 1010, 1:26-30. Schwartz proposes a radio frequency transport system similar to the '982 patent and Oh, differing in that Schwartz propagates signals from its host unit (central station 20) to its remote units (remote stations 22) using analog signals. Oh recognized such analog RF distribution systems as state of the art prior to its invention of its digital relays. *See*, Ex. 1007, 2:28-30 (Conventional Technology–"Since the RF signals transmitted/received to/from said first optic repeater and a second optic repeater are analog signals, the strength of the signals is greatly decreased during transmission through the optical line.")

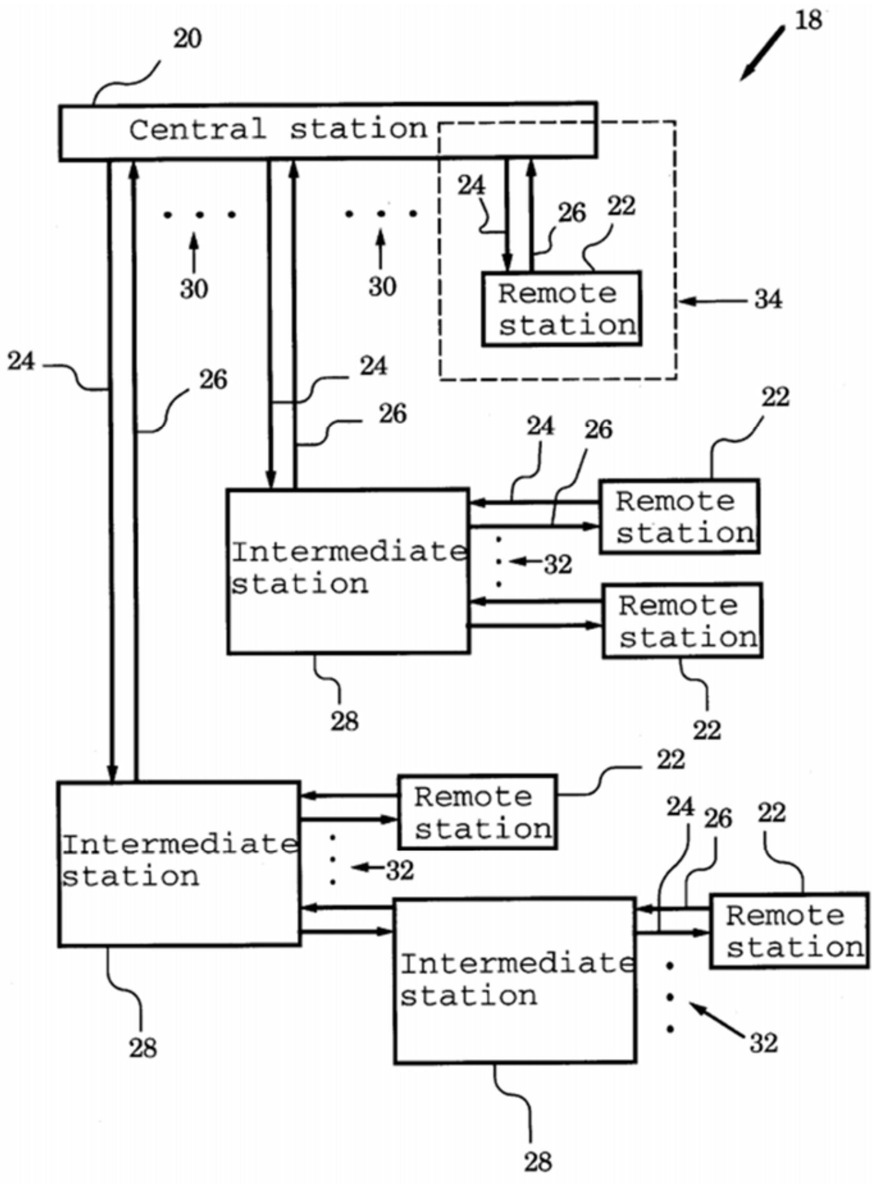


FIG. 1

While Schwartz discloses an analog RF signal distribution platform, the likes of which Oh improved upon via its relay digitization, Schwartz evidences that it was well known to implement RF signal distribution systems using topologies beyond the host↔remote unit arrangement of Oh. Schwartz, like Oh discloses implementations where some branches may contain remote units directly connected to the host unit, as illustrated at 34. Ex. 1010, 42-44.

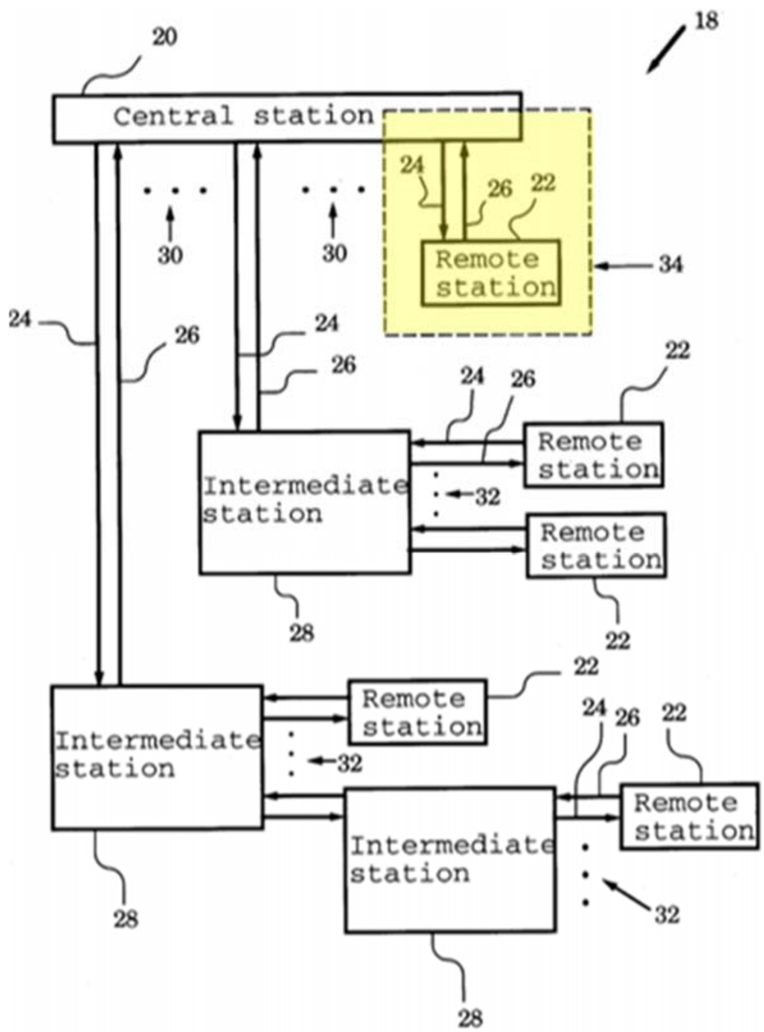


FIG. 1

Schwartz also discloses additional branches whereby intermediate stations 28 may be connected to the host central station 20, and even to other intermediate stations 28, so as to expand the number of remote stations 22 to which the central station is ultimately responsive.

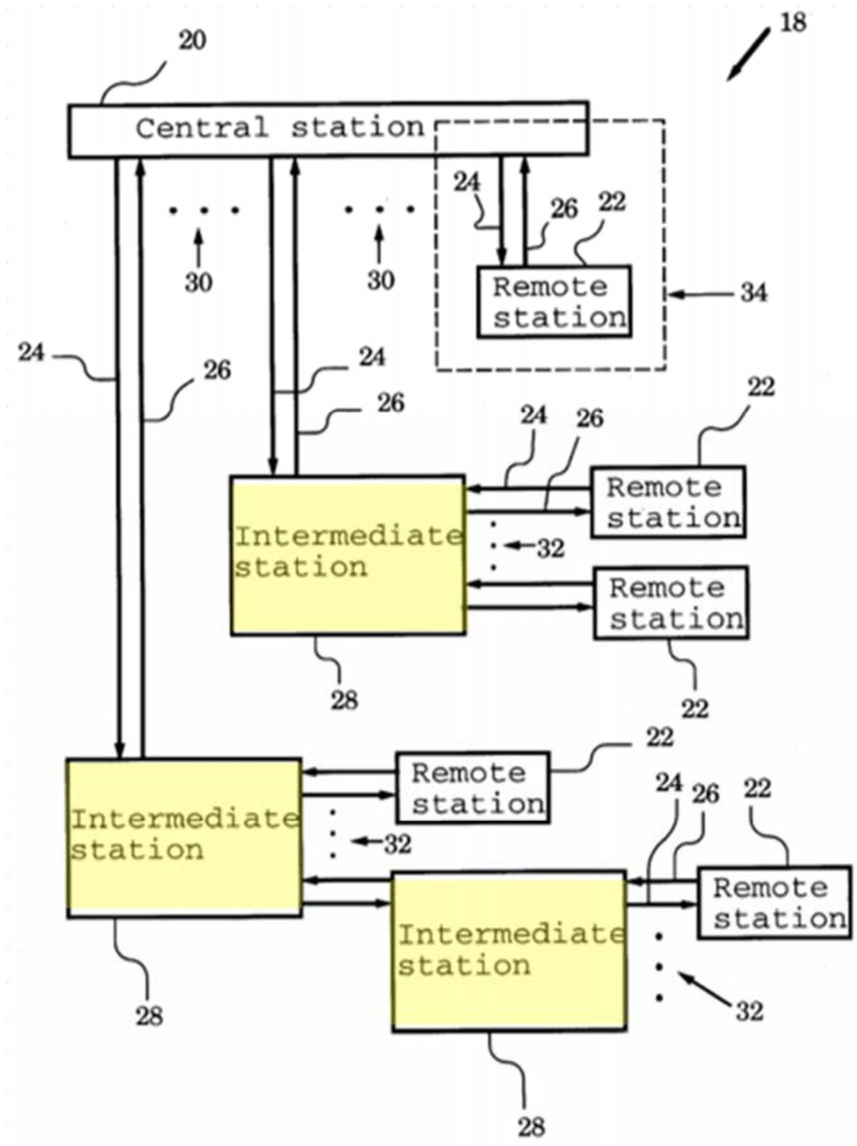


FIG. 1

Ex. 1010, 4:38-42 ("Intermediate stations 28, preferably are repeaters and likewise have pairs of downlink cable 24 and uplink cable 26 which in turn connect to any number of other intermediate stations 28 and/or remote stations 22.")

Schwartz's intermediate stations 28 "preferably are repeaters" (4:38-39), where example intermediate station 28 implementation details are shown in Fig. 7a. Ex. 1010, 10:13-15.

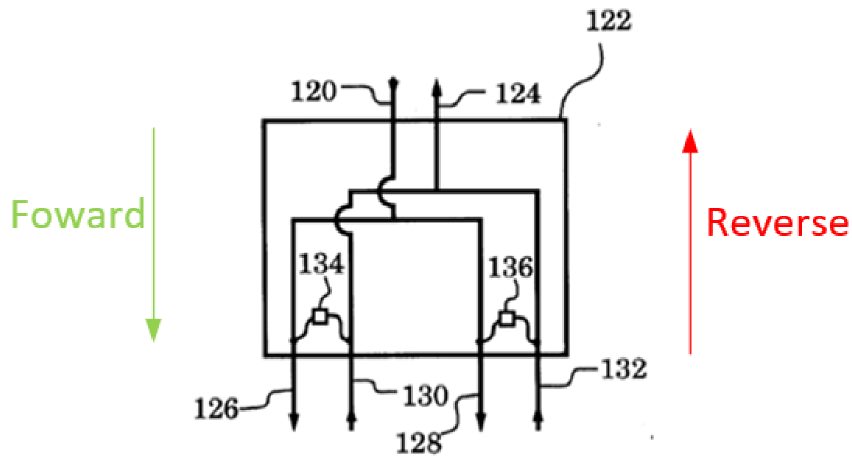


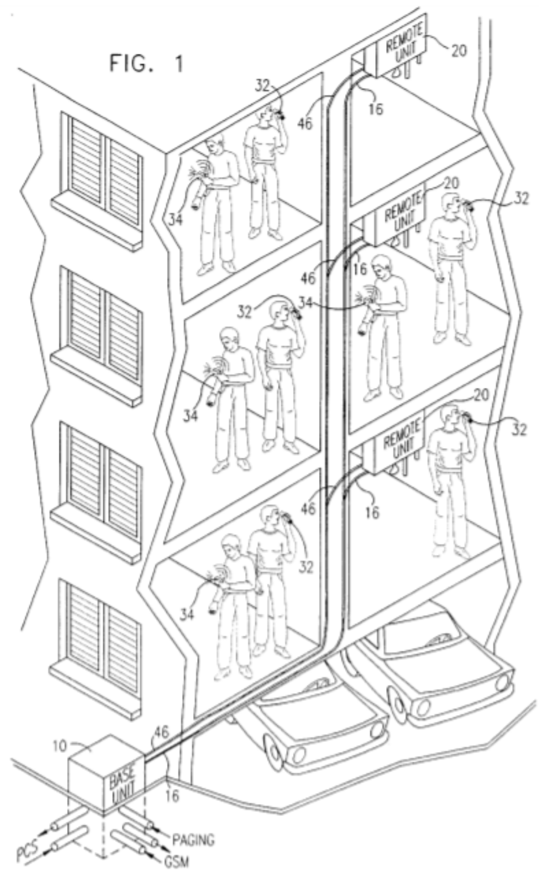
FIG. 7a

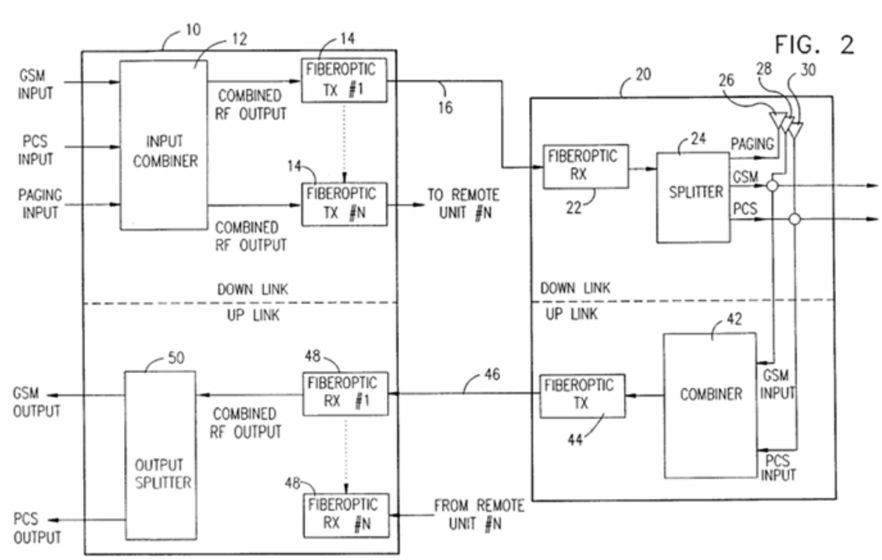
In the forward direction (top to bottom in the figure), "downlink connection 120 splits into two secondary downlink connections 126 and 128 before exiting station 122." Ex. 1010, 10:15-18. In the reverse direction (bottom to top in the figure), "uplink connection 124 is fed by two secondary uplink connections 130 and 132." *Id*., 10:19-20. In that uplink operation, signals from downstream units (*e.g.*, remote units) are received at 130, 132 and applied to a common uplink connection line 124, aggregating the analog signals received on those lines. Ex. 1005, ¶482.

Schwartz's RF signal distribution topology that supports intermediate expansion units enables a network where host central station 20 is connected to "any number of intermediate stations 28 and/or remote stations 22," providing an RF signal distribution platform that is customizable to the difficult RF environment into which the platform is installed. Ex. 1010, 4:34-38; 1:24-30 ("[I]ntermediate stations provide bi-directional branching points within the network. Such a system is highly advantageous for providing wireless two-way communication service especially within structures or around other obstacles, man-made or natural, which otherwise tend to block or disrupt radio waves.”). Ex. 1005, ¶¶89-92.

3. Overview of Farber

Farber describes a wireless communications station employing optical fibers. Ex. 1022, 1:4-6. Farber discloses the use of fiber in an antenna system for reaching difficult coverage areas such as buildings, as illustrated in Fig. 1, and other shadowed areas that is very similar to the digital system of Oh. *Id*., 4:30-33. Farber states that the optical fibers “may be single or multi mode.” *Id*., 2:59-60. With reference to Fig. 2, Farber describes that “[p]referably the fiberoptic transmitter employs a vertical cavity surface emitting laser or an edge emitting laser coupled to a single or multi mode fiber.” *Id*. 2:51-53, Ex. 1005, ¶88.





4. Overview Of Koschek

Like the ’982 patent and Oh, Koschek addresses expansion of radio frequency analog signal coverage into hard to reach areas, "such as a building or a tunnel." Ex. 1013, 1:12-16. Koschek proposes a radio frequency transport system similar to the '982 patent and Oh, whereby a terminal stage 102 with an antenna for broadcasting and receiving signals is connected to upstream units via a series of connecting stages, where each of those connecting stages may also include an antenna for receiving radio frequency signals in their vicinity.

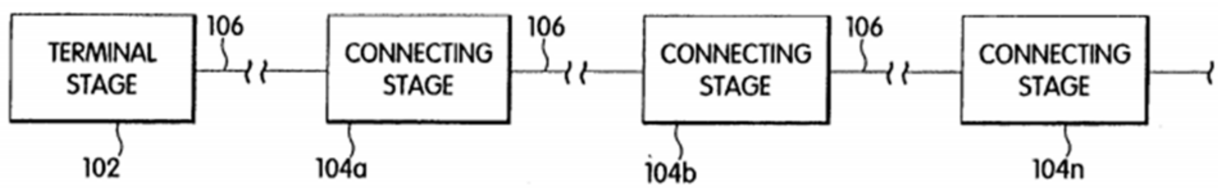


Fig. 1

Fig. 2 illustrates an upstream path in a terminal stage at 102, which includes an antenna 130, a filter 131, and an amplifier 132. Ex. 1013, 3:50-54. An example connecting stage includes its own antenna 134 and corresponding filter 135. A couple 136 receives filtered radio frequency signals from terminal stage 102's antenna and connecting stage 104's antenna and those signals "are combined into a single signal on line 140 by coupler 136" before propagation to further upstream stages. *Id.*, 4:8-10.

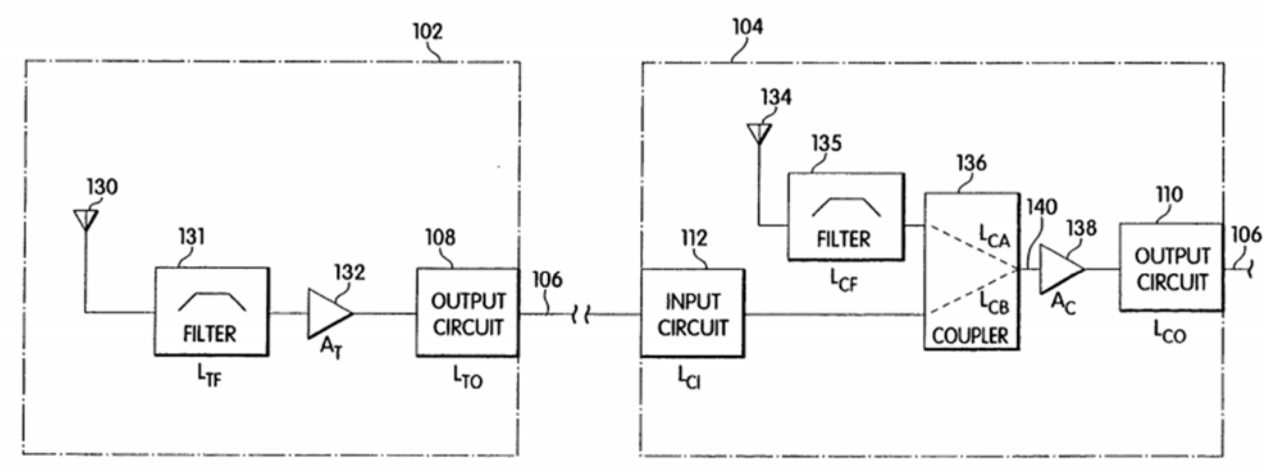


Fig. 2

The amplifiers (*e.g.*, 132, 138) of Koschek's stages may be powered in a variety of ways. In one example, "the amplifiers may be powered remotely, from power transmitted down the signal or other cables. In [that] configuration, a single, DC power supply may be located at any centrally convenient point in the system." *Id.*, 5:41-45.

The modular configuration of Koschek enables easy replacement of stages or changes to the configuration of the network without requiring redesign, calibration, or adjustment. Ex. 1005, ¶¶ 93-95; Ex. 1013, 5:17-20.

A. Ground 1a: Claims 65-69 and 74 Are Obvious Over Oh

1. Independent Claim 65

(a) Preamble and element 1: "A first unit comprising: an interface to communicatively couple the first unit to a plurality of second units using at least one communication medium, wherein the first unit uses the interface to communicate to the plurality of second units downstream digital RF samples produced from an original downstream analog radio frequency signal;"

Oh discloses master unit 20 is coupled to multiple remote slave units 30 via optic lines 50. That master unit 20 receives analog RF signals from base station 10 and digitizes that analog signal on a per frequency band basis at 180 for communications to slave units 30.

FIG. 1

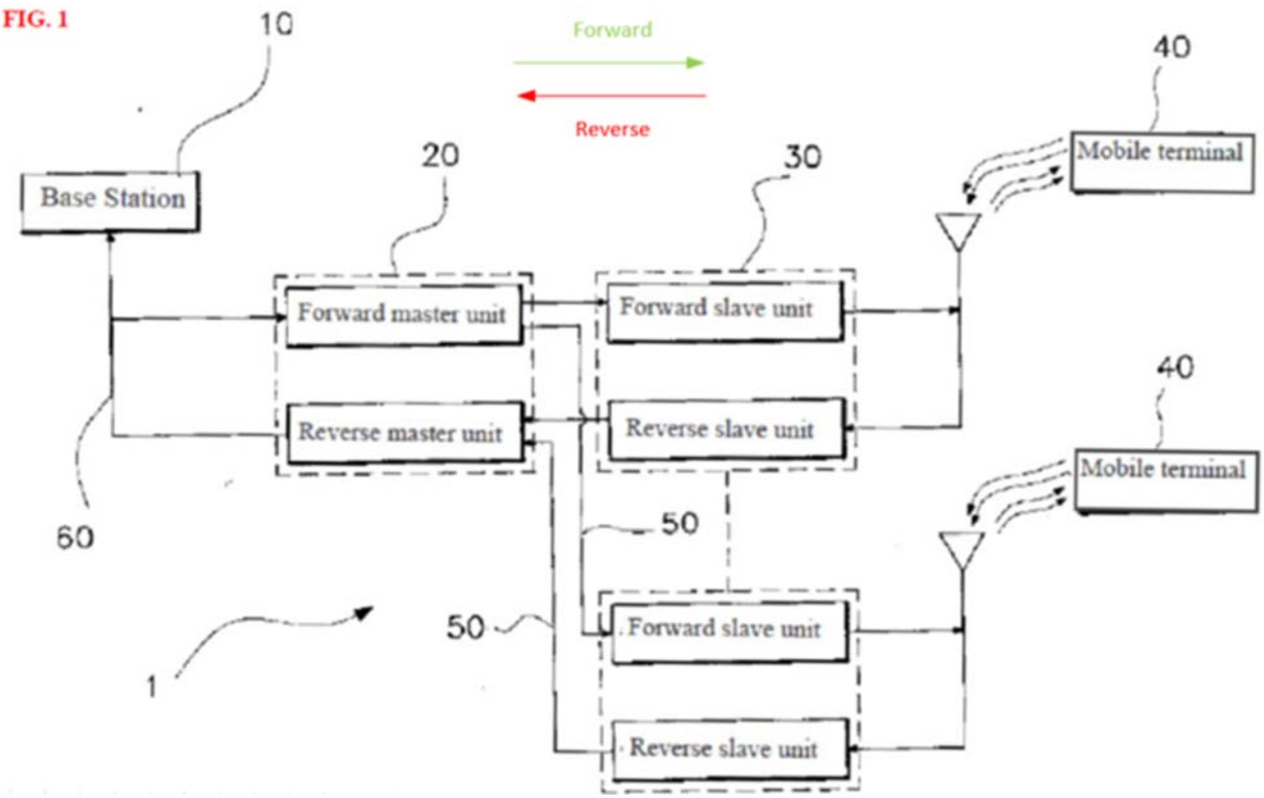
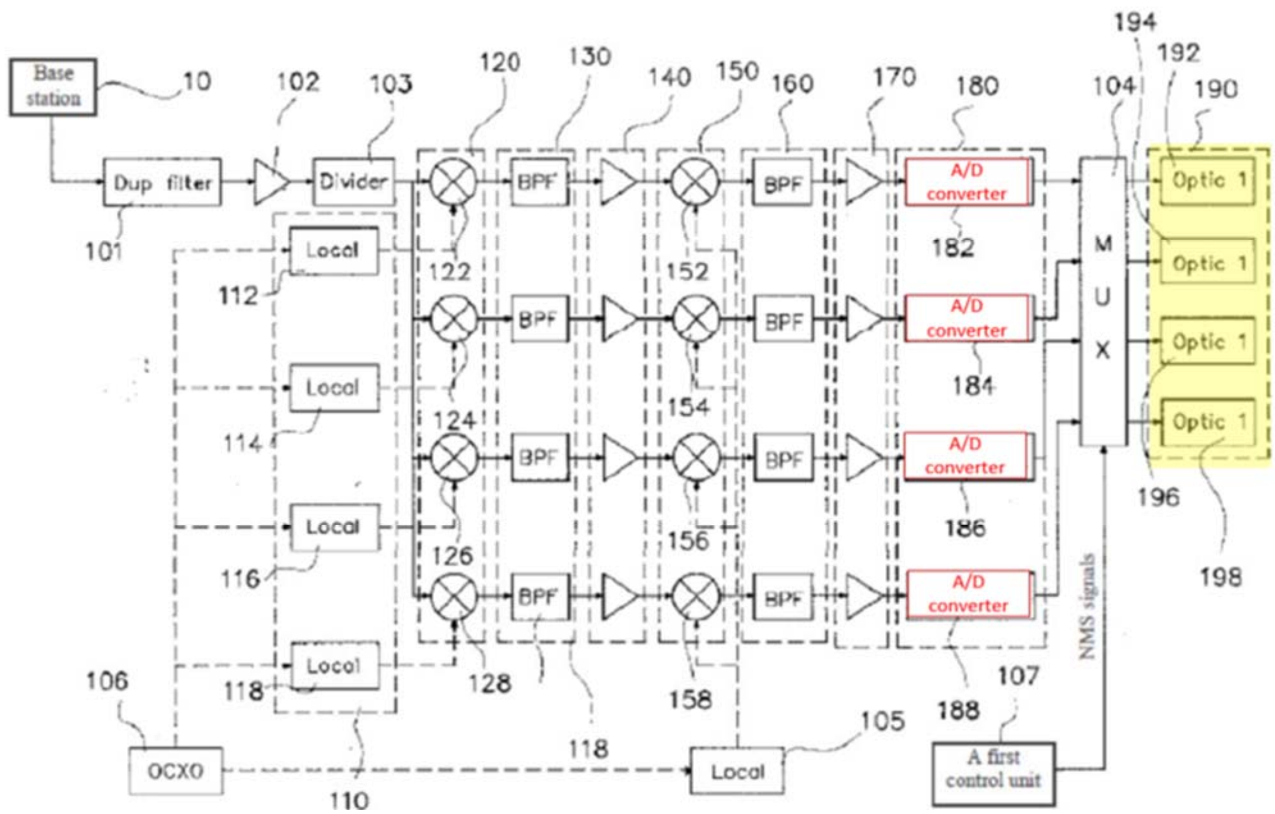


Fig. 2 of Oh depicts optic converter unit 190 that provides an interface between forward master unit 100 of master unit 20 and forward slave unit 200 of remote slave units 30.

FIG. 2

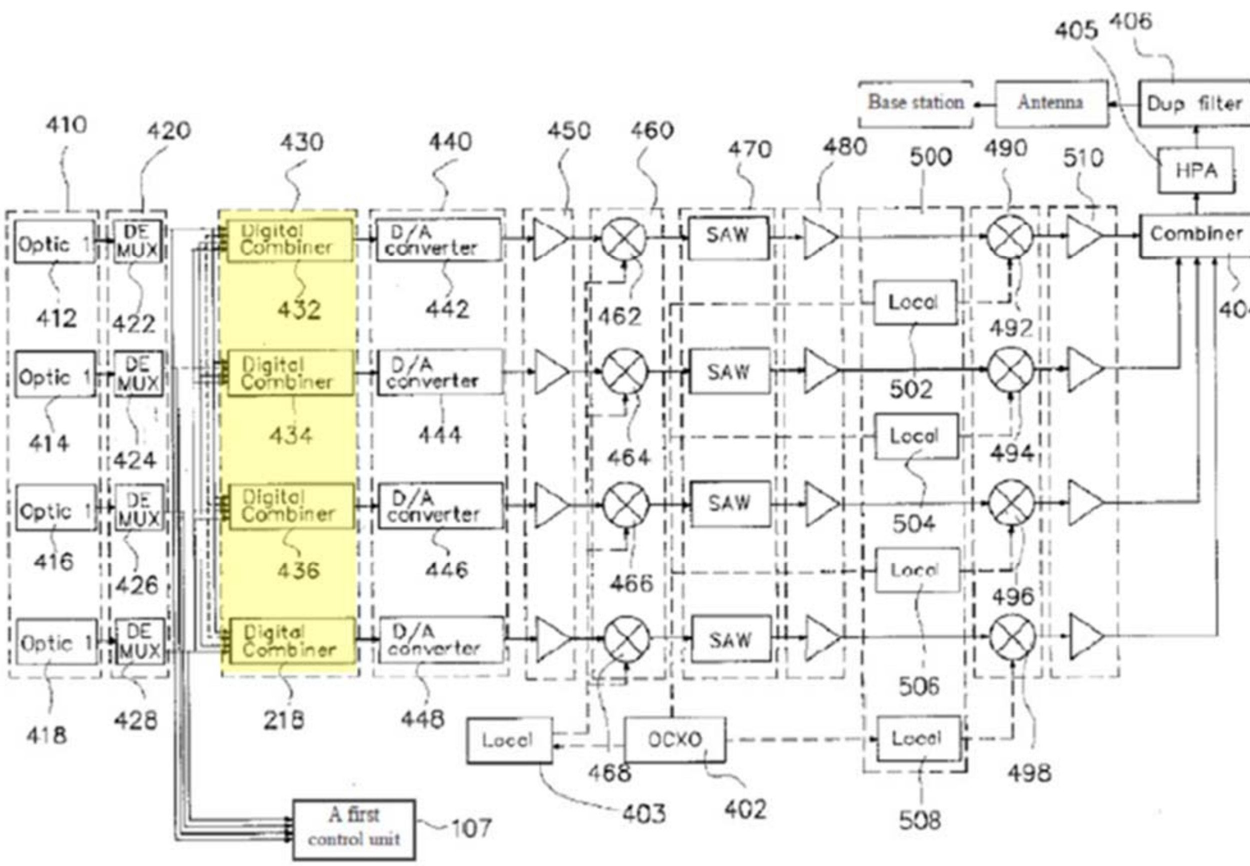


Oh renders obvious a first unit (20) comprising: an interface (190) to communicatively couple the first unit to a plurality of second units (30) using at least one communication medium (50), wherein the first unit uses the interface to communicate to the plurality of second units downstream digital RF samples (generated at 180) produced from an original downstream analog radio frequency signal (from base station 10). Ex. 1005, ¶¶251-253.

(b) Elements 2 and 3: "a digital-to-analog unit to convert a stream of summed upstream digital RF samples to a replicated upstream analog radio frequency; and wherein each of the summed upstream digital RF samples is produced by digitally summing respective upstream digital RF samples received from the plurality of second units;"

Oh's master unit 20 includes a digital combiner unit 430 that performs digital combining by aggregating digital signals transmitted from each demultiplexer 422, 424, 426, 428 of demultiplexer unit 420. Ex. 1007, 4:68-70; Ex. 1005, ¶58.

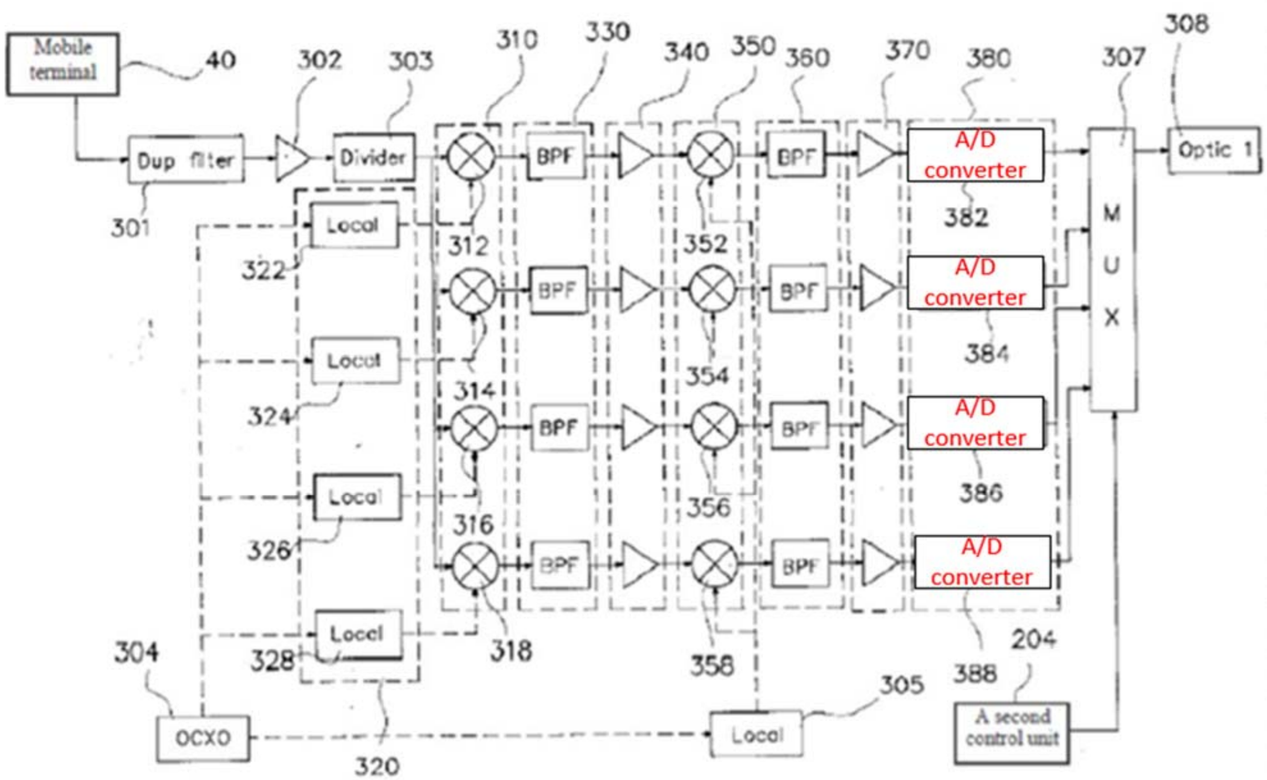
FIG. 5



Those demultiplexers at 420 receive data from individual remote slave units 30 at 410.

As depicted in Fig. 4, each slave unit 30 receives an analog signal from a mobile terminal 40, divides the received analog signal into its component frequency bands at 303 and downconverts the frequency band signals to near DC at 310-370. Ex. 1007, 4:26-34. The downconverted band signals are then sampled at 380 to create 12-bit digitized radio frequency signals. *Id.*, 4:56-61. The multiplexer 307 multiplexes the four 12-bit samples with 4 bits of control data from 204 to form 52-bit serial data signals that are forwarded to master unit 20. *Id.*

FIG. 4



Referring back to Fig. 5, each demultiplexer 422, 424, 426, 428 receives a 52-bit signal from its respective slave unit 30. Each demultiplexer forwards 12-bits of sample data to the appropriate digital combiner associated with the proper frequency band for that 12-bit sample and forwards its 4 bits of control data to control unit 107. Upon receiving four 12-bit signals (one from each of demultiplexer 422, 424, 426, 428), each digital combiner 432, 434, 436, 438 performs digital combining on those 12-bit signals to "creat[e a] 14-bit intermediate frequency signal[] by combining[1] four 12-bit intermediate frequency signals in the same frequency band." Ex. 1005, ¶80 (Dr. Baker testifying that whether referred to as "adding," "aggregating," or "combining," the result of digital combiners 432, 434, 436, 438 processing of the four 12-bit signals to create a 14-bit signal is a "digital sum:" *e.g.*, 1010 1010 1010 (2,730) + 1100 1100 1100 (3,276) + 1111 1111 1111 (4,095) + 0000 1100 1100 (204) = 10 1000 0100 0001 (10,305)); Ex. 1007, 5:16-17.[2] Those 14-bit signals are then converted to analog signals

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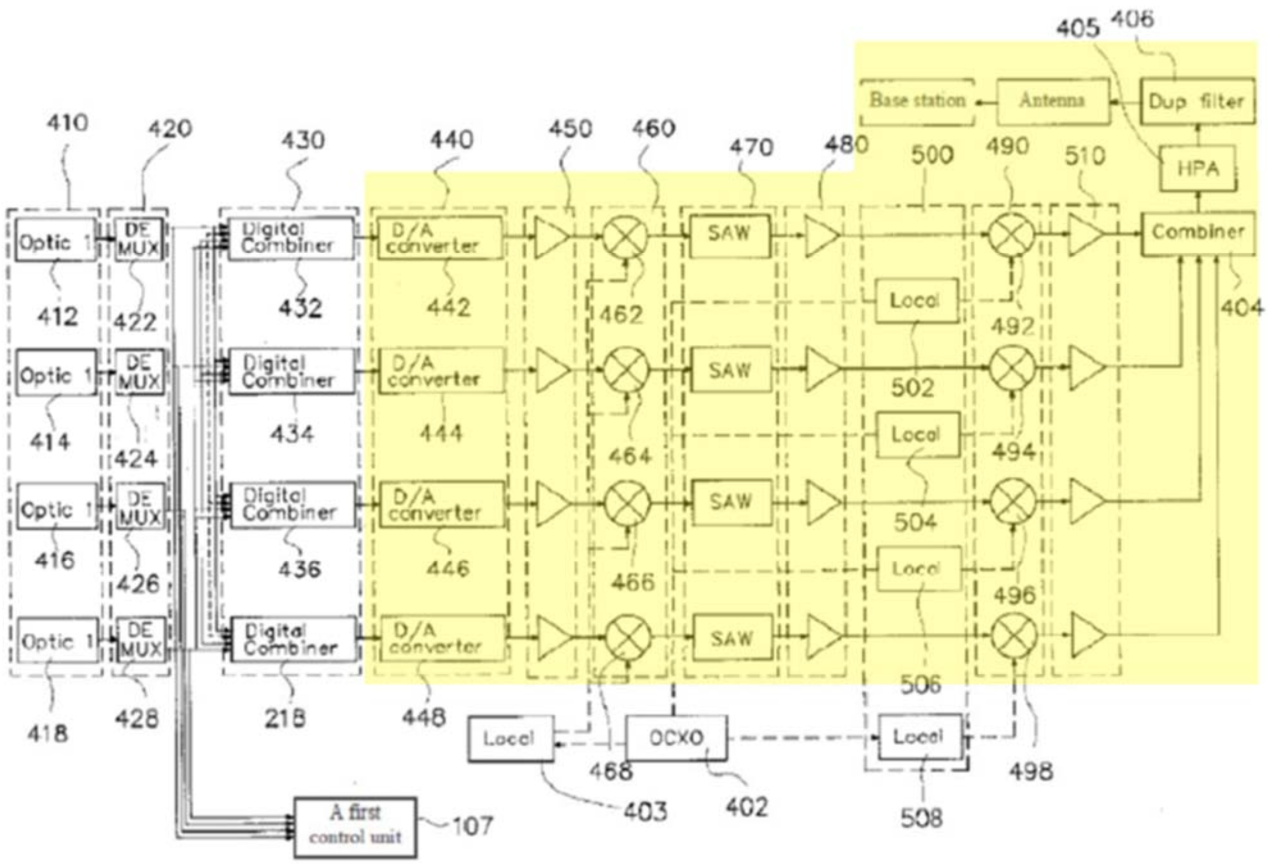
[1] The translation originally commissioned by SOLiD translated this word as "added." In parallel litigation in the UK, CommScope requested that it be translated as "combined." The translator is agreeable to using "combined," and that is reflected in Ex. 1007 submitted herewith.

[2] This is evidenced by the CommScope patents themselves referring to their "sum" operation as "combining." *See*, Ex. 1001, 4:67-5:16 ("Both DHU and DEU split signals in the forward path and **sum signals in the reverse path**…Splitting and **combining** the signals in a digital state avoids the combining and splitting losses experienced with an analog system.")

(*i.e.*, analog combining) at 440, upconverted, combined, and transmitted to the base station 10. *Id.*, 5:17-29; Ex. 1005, ¶58.

Following the digital summing operation of Element 5, the summed digital data values are converted to analog signals, up converted to the appropriate frequency signals associated with their particular bands to create component analog signals, that are then combined and transmitted to a base station via an antenna.

FIG. 5



Specifically Oh states:

After creating 14-bit intermediate frequency signals by combining four 12-bit intermediate frequency signals in the same frequency band, said

> digital combiner transmits them to a first D/A converter unit 440. Each D/A converter 442, 444, 446, and 448… transmits 1.23MHz or 1.5MHz intermediate frequency signals to… a third mixer unit 460 through a third amplification unit 450… The intermediate frequency signals outputted from said third mixer unit 460 are transmitted to a fourth mixer unit 490 through a first saw filter unit 470 and a fourth amplification unit 480. Said fourth mixer unit 490… transmits 800MHz RF signals in different frequency bands to a first combiner 404 through a fifth amplification unit 510.

Ex. 1007, 5:16-26. The analog signals are combined at 404 to "aggregate[] the RF signals in different frequency bands transmitted from four mixers 492, 494, 496, and 498," and are amplified at 510 and run through a bi-directional filter 406 to an antenna and a base station.[3]

Oh renders obvious a digital-to-analog unit (shown in Fig. 5 after digital combiners 432, 434, 436, 438) to convert a stream of summed upstream digital RF samples (from 432, 434, 436, 438) to a replicated upstream analog radio frequency (output from combiner 404 for transmission to the base station); wherein each of the summed upstream digital RF samples is produced by digitally summing (432, 434, 436, 438 each create 14-bit signals by combining four 12-bit signals) respective upstream digital RF samples (routed by demultiplexer unit 420 to digital combiners

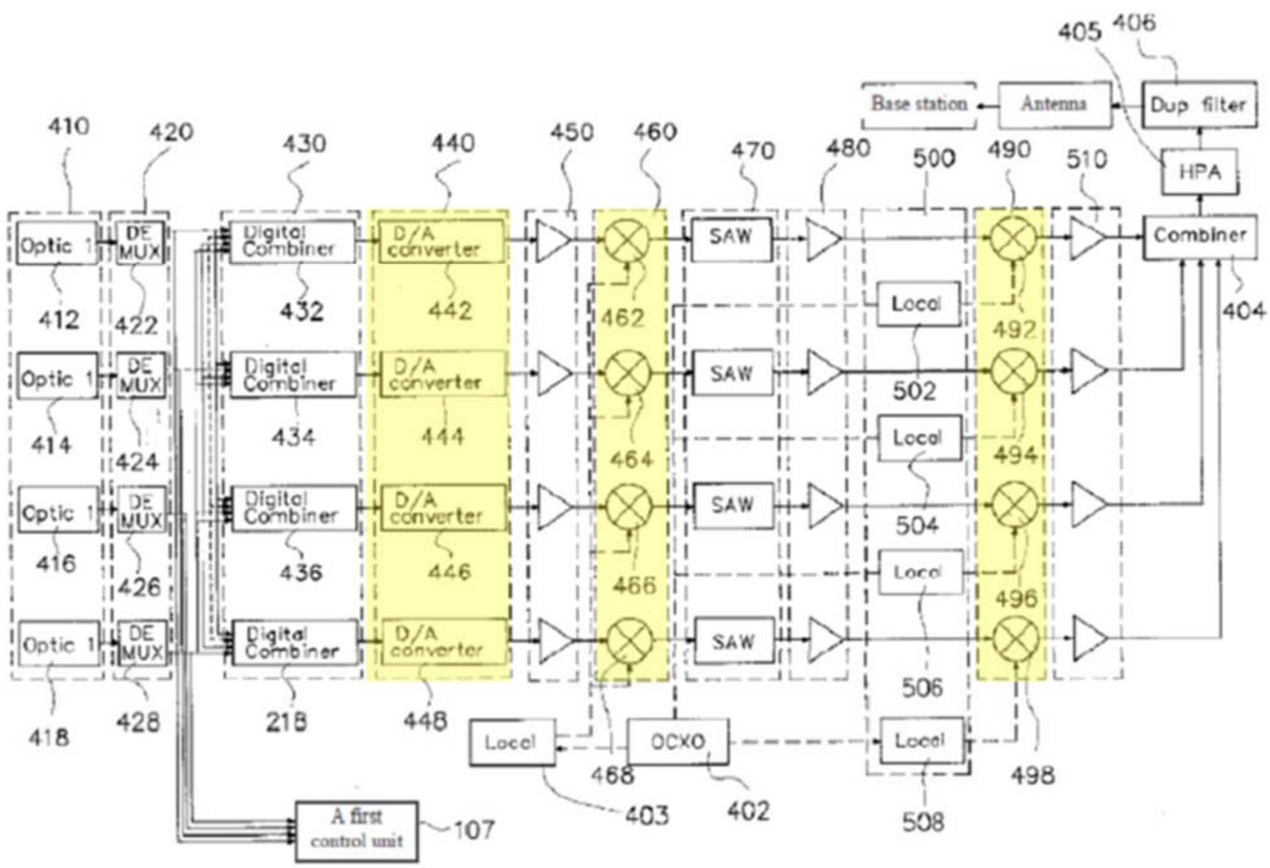
[3] Recall that '982 states that a wireless interface device may comprise a base station.

associated with the frequency band of each of four samples received from each slave unit 30) received from the plurality of second units (30). Ex. 1005, ¶¶254-258, 58.

(c) Element 4: "wherein the digital-to-analog unit comprises a digital-to-analog converter, a first mixer, and a second mixer"

Fig. 5 of Oh depicts the reverse master unit 400 includes D/A converter unit 440, third mixer unit 460, and fourth mixer unit 490 on the reverse path. Ex. 1007, 4:70-76.

FIG. 5



Oh renders obvious the digital-to-analog unit comprises a digital-to-analog converter unit (440), a first mixer (460), and a second mixer (490). Ex. 1005, ¶259.

(d) Element 5: "wherein the stream of summed upstream digital RF samples is converted to an analog signal by the digital-to-analog converter"

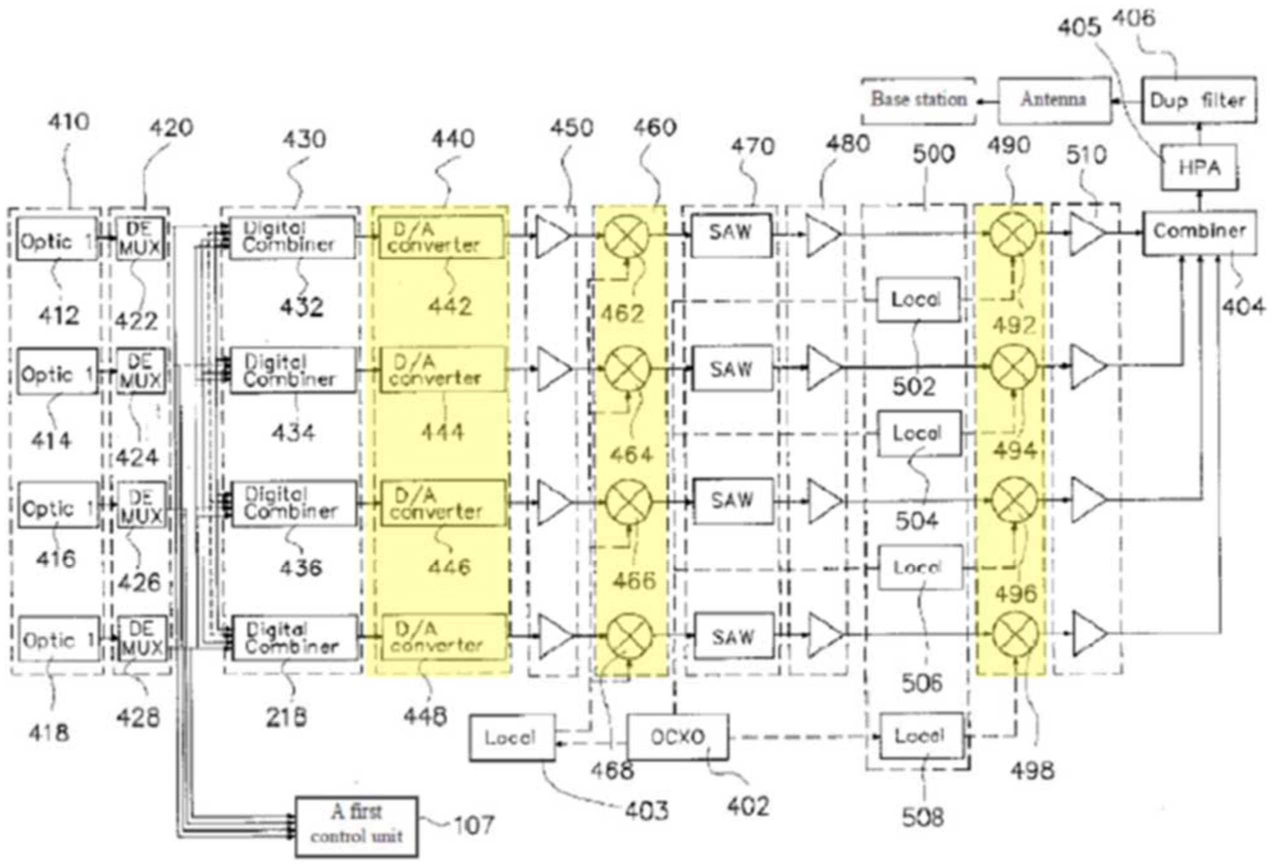
Oh discloses D/A converter unit 440 receiving the summed upstream digital RF samples from digital combiner unit 430. "D/A converter unit 440 that converts the digital signals transmitted from said digital combiner unit 430 to analog signals, respectively." Ex. 1007, 4:70-71.

Oh renders obvious the stream of summed upstream digital RF samples (from 430) is converted to an analog signal by the digital-to-analog converter unit (440). Ex. 1005, ¶260.

(e) Elements 6, 7: "wherein a signal derived from the analog signal is mixed with a first reference signal by the first mixer; wherein a signal derived from a signal output by the first mixer is mixed with a second reference signal by the second mixer;"

Oh discloses that its analog signals output from 440 are amplified at 450, mixed with a signal from local oscillator 403 at 460, filtered and amplified at 470, 480, and mixed with signals from local oscillators 502, 504, 506, 508 at 490. The signals mixed with the first reference signal from 403 at 460 are amplified versions of outputs from 440 and are thus "derived from the analog signal" produced at 440. Similarly, the signals mixed with the second reference signals from 500 at 490 are amplified/filtered signals from the first mixer at 460 and are "derived from a signal output by the first mixer."

FIG. 5

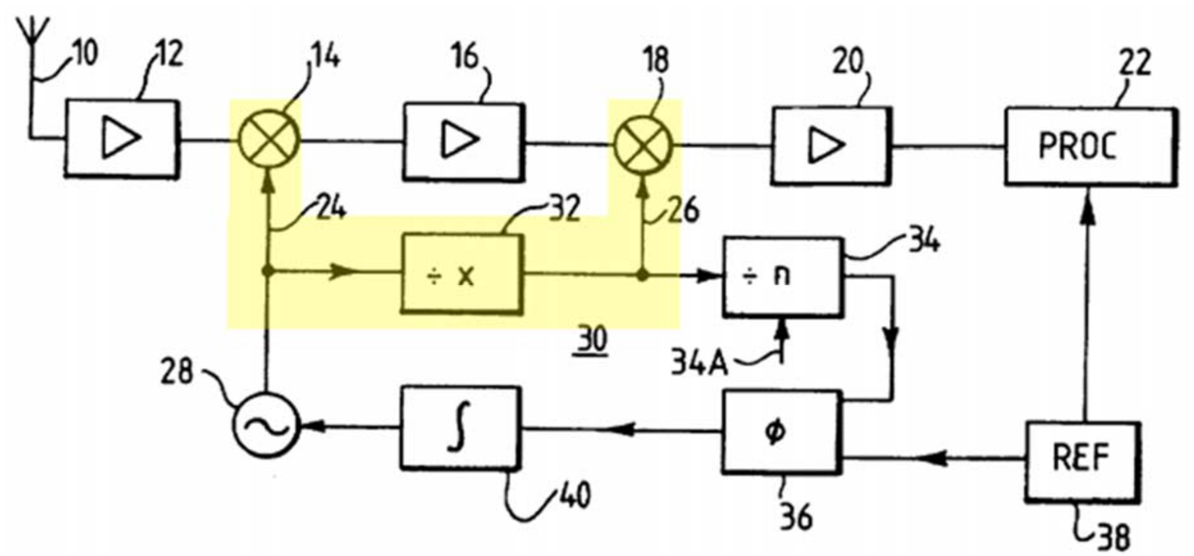


Oh renders obvious wherein a signal derived from the analog signal (output of 450 originating from 440) is mixed with a first reference signal (403) by the first mixer (460); wherein a signal derived from a signal output by the first mixer (output of 480 originating at 460) is mixed with a second reference signal (500) by the second mixer (490). Ex. 1005, ¶¶261-262.

(f) Element 8: "wherein the second reference signal is generated by frequency dividing the first reference signal."

The intermediate frequency selected in the translation of the near DC signals at 440 to the ~800MHz signals at 490 is a matter of design choice. If the frequency translation from DC to 800 MHz is performed as: DC→600 MHz→800 MHz, then Fig. 8 could be implemented with OCXO 402 = Local 403 = 600 MHz and Local 502, 504, 506, 508 = 200 Mhz. In such an instance, local oscillators 502, 504, 506, 508 would be generated by frequency dividing the first reference signal by a factor of about 3.

Such frequency dividing in generating oscillator signals for frequency translation in radio transmitter/receiver systems was well known many years prior to the ’982 patent as evidenced by Hasler (Ex. 1020), which utilizes the reference oscillator 28 frequency for a first frequency translation, and a divided frequency at 18 for a second frequency translation, reducing the number of local oscillators in the system by one, reducing cost and power consumption. Ex. 1005, ¶264.

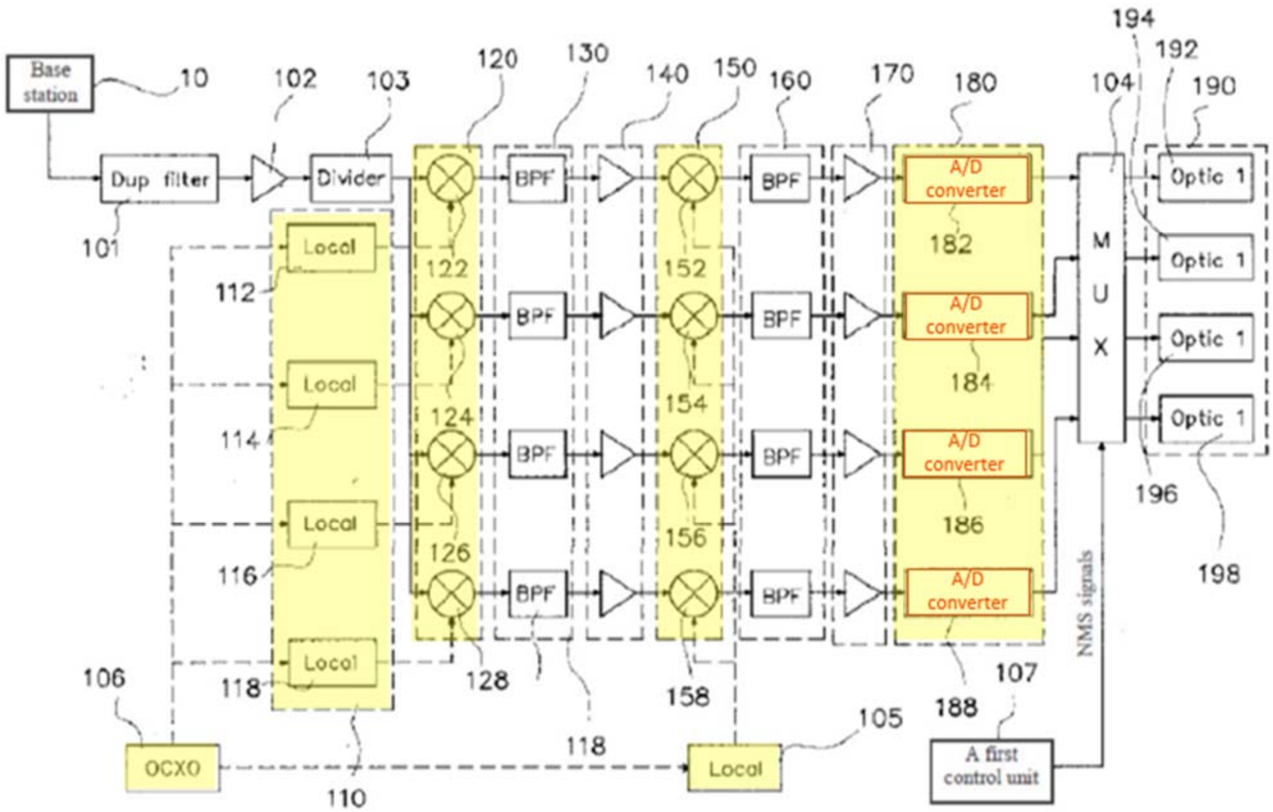


A POSITA would have considered it obvious to generate the second reference signals by frequency dividing the first reference signal. Ex. 1005, ¶¶263-264.

2. Dependent Claim 66

Oh's master unit 20 receives RF signals from a base station 10 and divides it into its component frequency bands at 103. Those frequency bands are downconverted to from around 800Mhz to about 70MHz by mixers at 120 that are controlled by local oscillators 110 deriving frequencies from oven controlled oscillator (OCXO) 106. Following filtering 130 and amplification, those intermediate frequency signals are further downconverted to near DC at 150 based on a signal from local oscillator 105, responsive to OCXO 106 before A/D conversion at 180. Ex. 1007, 3:19-39. Based on frequency shifting principles, where mixing a signal at a frequency of f_0 with a frequency of f_1 produces signals at $f_0 \pm f_1$, where an unwanted one of those signals is filtered out of the system, a same reference signal (*e.g.*, a 70MHz) is useful for upconverting from near DC to the intermediate frequency (70 MHz in Oh) on the reverse path (claim 65) at the host/master unit as is useful for downconverting from the intermediate frequency to near DC on the forward path (claim 66).

FIG. 2



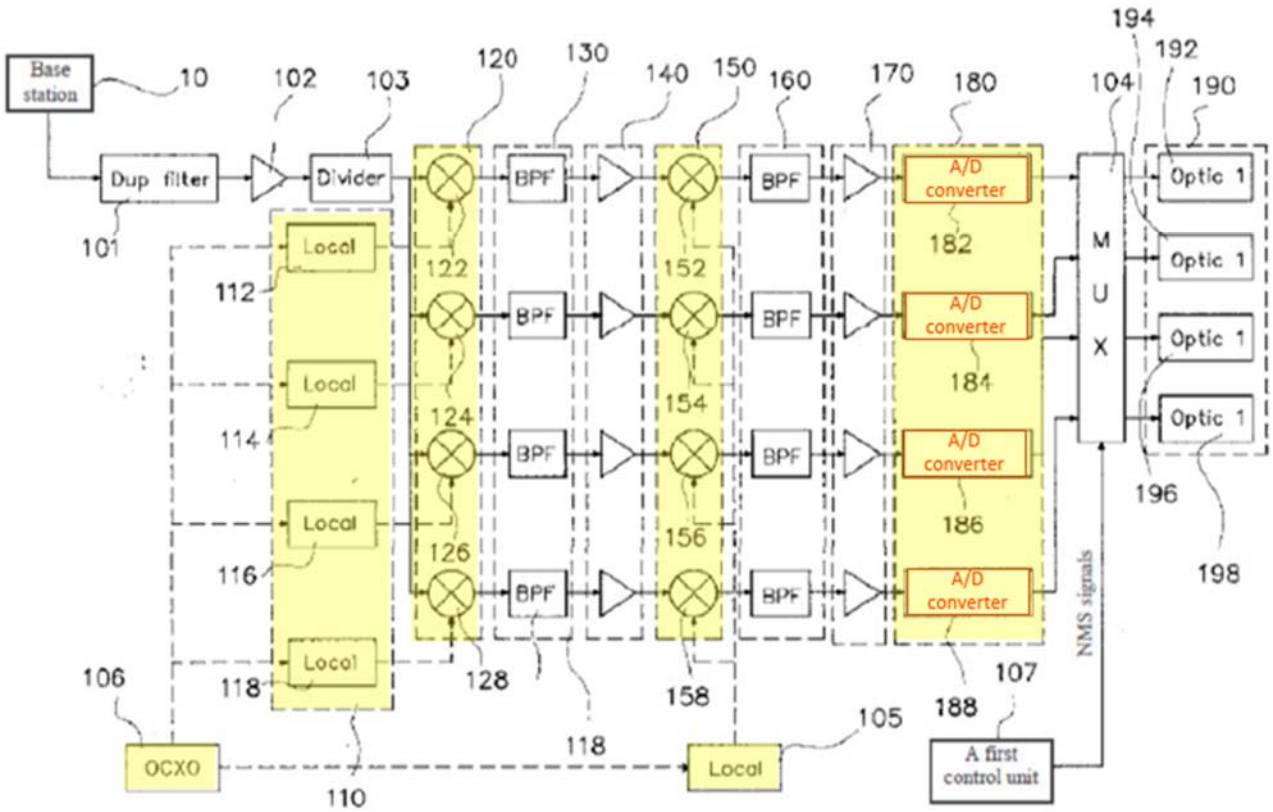
Oh renders obvious an analog-to-digital unit (depicted in Fig. 2) to digitize the original downstream analog radio frequency signal in order to produce the downstream digital RF samples, wherein the analog-to-digital unit comprises a third mixer (120), a fourth mixer (150), and an analog-to-digital converter unit (180); wherein a signal derived from the original downstream analog radio frequency signal is mixed with a third reference signal (from 110) by the third mixer; wherein a signal derived from a signal output by the third mixer is mixed with the first reference signal (from 105, a same frequency used for upconversion to the intermediate frequency in Fig. 5) by the fourth mixer; and wherein a signal derived from a signal output by the fourth mixer is digitized (at 180) to produce the downstream digital RF samples.

Claim 66 further recites wherein the third reference signal is generated by frequency dividing the first reference signal. The intermediate frequency selected in the translation of the ~800Mhz at 120 to near DC signals at 150 is a matter of design choice. If the frequency translation from 800MHz to DC is performed as: 800→600 MHz→DC, then Fig. 2 could be implemented with OCXO 106 = Local 105 = 600 MHz and Local 112, 114, 116, 118 ≈ 200 Mhz. In such an instance, local oscillators 112, 114, 116, 118 (operating at 200 Mhz) would be generated by frequency dividing the first reference signal (operating at 600 Mhz (*see*, claim 65 above)) by a factor of about 3. Because Oh's forward and reverse master units are components of the same master unit 20, a POSITA would have considered it obvious to generate the third reference signal by frequency dividing the first reference signal. Using a common oscillator to produce the first reference signal that is utilized in those forward and reverse master units would reduce power consumption and part count (compared to using multiple, separate oscillators, one in each of the forward and reverse sides of master unit 20), which provides a corresponding reduction in cost (component and power) as well as an increase in reliability. Ex. 1005, ¶¶265-268.

3. Dependent Claim 67

As discussed above with reference to claim 66, Oh discloses digitization of the output of the fourth mixer unit 150 at 180.

FIG. 2



A person of ordinary skill in the art would recognize that applying dither to a signal prior to digitization can reduce quantization error and that inclusion of a dither generator in an A/D converter (*e.g.*, A/D converter unit 180) would have been obvious. Ex. 1005, ¶¶269-270. To the extent that the limitation is not deemed obvious based on Oh, Curbelo evidences that the dither feature is obvious. Curbelo discloses an A/D converter whose resolution is improved through the use of a dither generator. Specifically, "[a]n analog signal to be digitized is combined with a dither signal, the resultant dithered signal is then sampled a plurality of times, and at least some of the sampled values are digitized (by the A/D converter). At least some of the digitized values are co-added (in effect averaged) to provide an output having a digitization error reduced by a factor of up to the square root of the number of values averaged." Ex. 1015, 3:35-42. A POSITA would be motivated to incorporate dither into Oh's A/D converter to reduce digitization error, as described by Curbelo. As further evidence of obviousness of applying dither to a signal prior to digitization, Noro discloses using a dither circuit "for improving linearity in analog-to-digital (A/D) or digital-to-analog (D/A) conversion of a signal" to address quantizing noise inherently generated in A/D or D/A conversion. Ex. 1023, 1:10-19. Specifically, "in the case of A/D conversion, as shown in FIG. 2, dither (digital signal) generated by a noise generator 10 is converted to an analog signal by a D/A converter 12 and the converted dither is superposed on an input analog signal by an adder 14. After the input signal superposed with dither is A/D-converted by an A/D converter 16." *Id.*, 1:33-39.

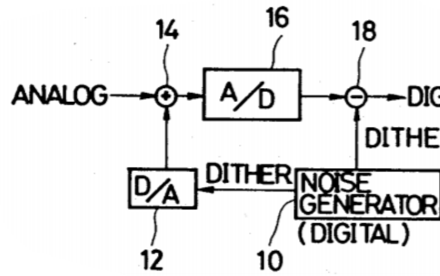


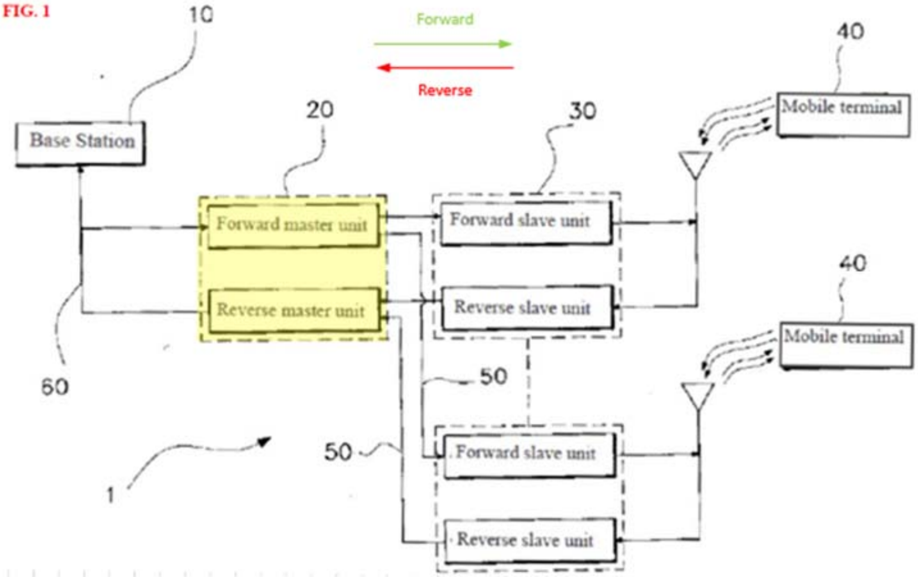
FIG.2

Oh, alone or in combination with Curbelo renders obvious the signal derived from the signal output by the fourth mixer (150) that is digitized (at 180) to produce the downstream digital RF samples is produced by adding dither to the signal output by fourth mixer (*e.g.*, as described by Curbelo). Ex. 1005, ¶¶269-271.

4. Dependent Claim 68

Oh's master unit 20 transmits/receives analog signals to/from the base station and relays digital samples of those analog signals to/from remote slave units 30 across optic lines 50. Ex. 1007, 2:70-3:1; 4:62-64.

FIG. 1



Oh's master unit 20 is analogous to the '982 patent's digital host unit (DHU) 20 which interfaces with a wireless interface device (WID) 10 that in embodiments comprises a base station (Ex. 1001, 4:28-29). And like Oh's master unit 20, on the forward path the '982 patent's DHU "receives RF signals from WID 10 [*i.e.*, base station] and converts the RF signals to digital RF signals. DHU 20 further optically transmits the digital RF signals to multiple DRUs 40."

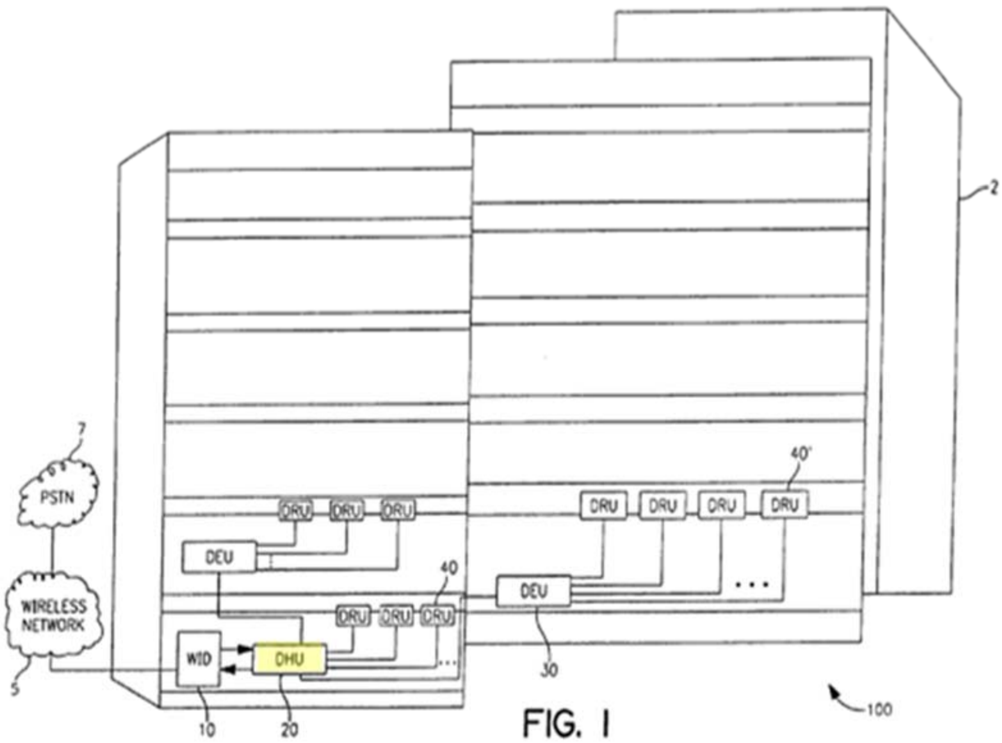
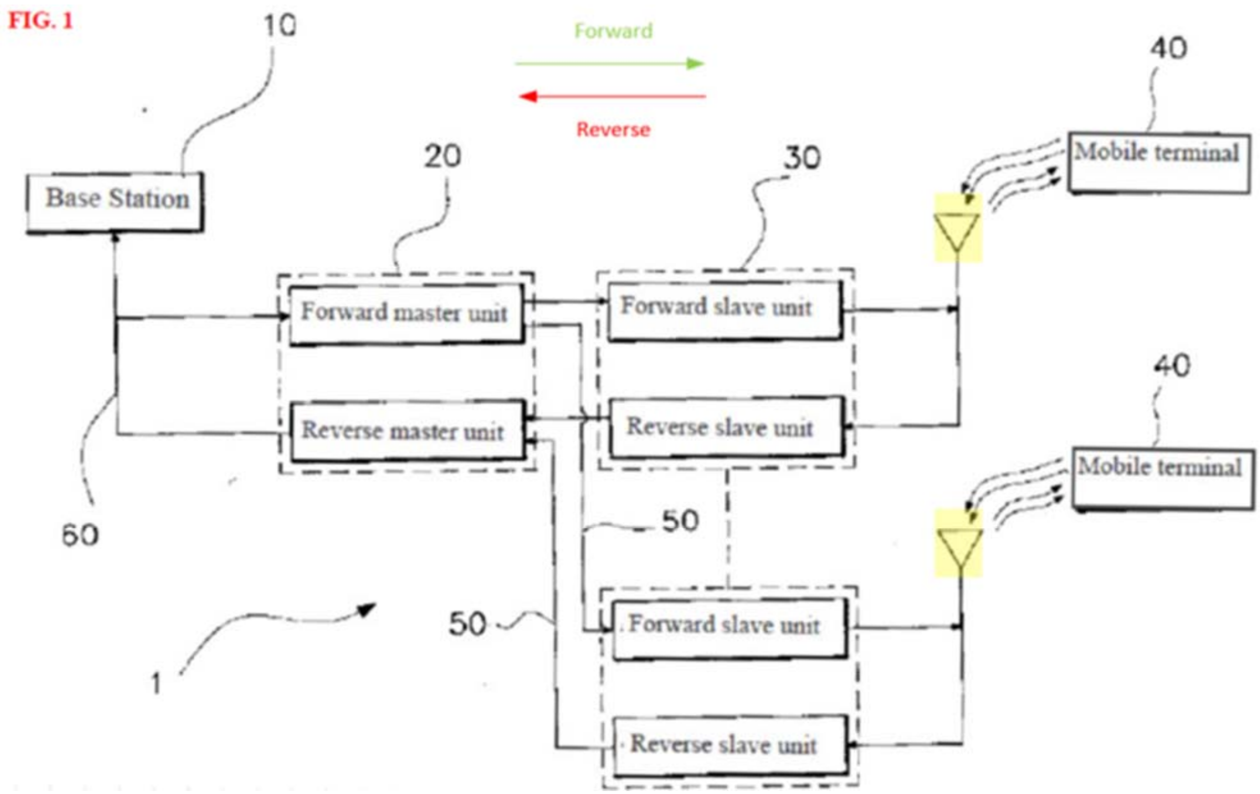


FIG. 1

Because Oh's master unit 20 communicates analog signals bi-directionally with a base station, and communicates digital signals bi-directionally with multiple remote units (slave units 30), it is analogous to the host unit described in the '982 patent. Oh renders obvious the first unit comprises at least one of a digital host unit (master unit 20) and a digital expansion unit. Ex. 1005, ¶¶272-274.

5. Dependent Claim 69

Oh discloses multiple remote slave units 30, each slave unit 30 including an antenna for communicating with mobile terminals 40. Because each slave unit 30 includes an antenna that is remote from master unit 20, those slave units 30 are "remote antenna units."



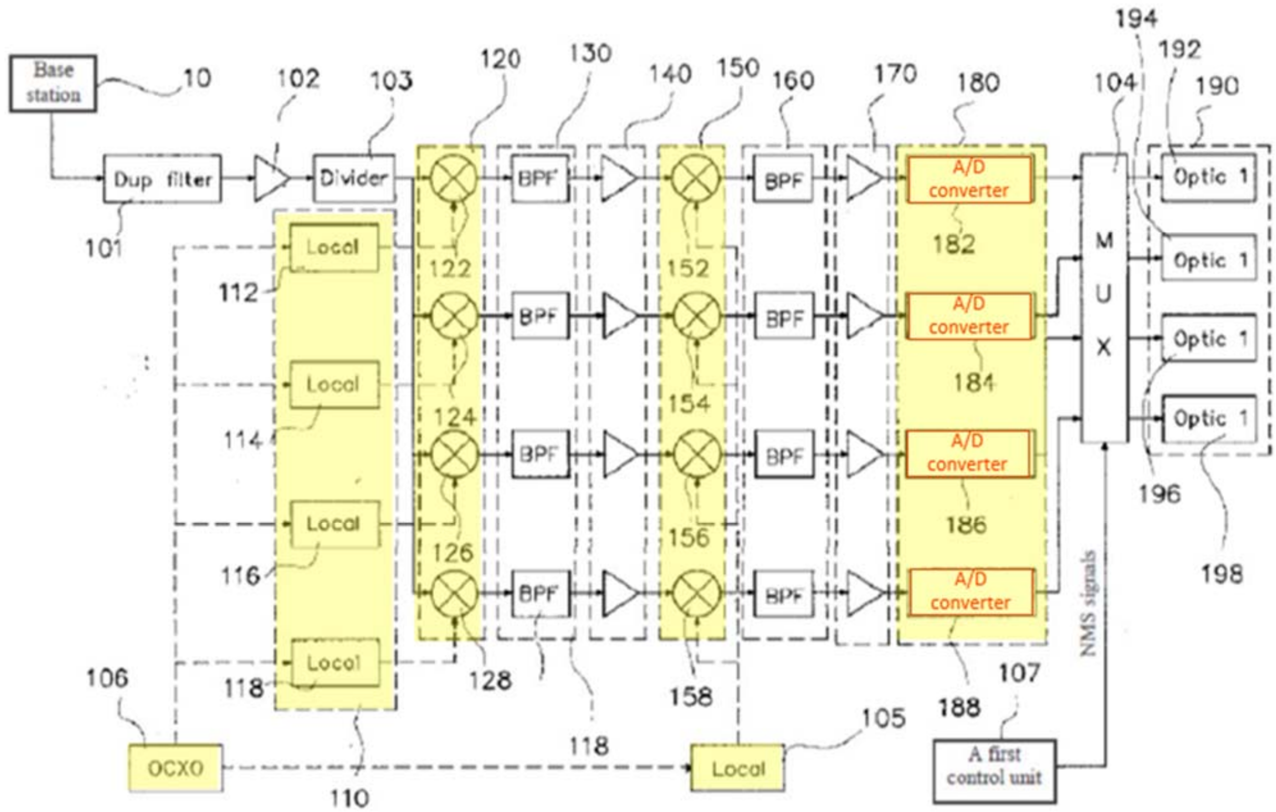
Oh renders obvious each of the plurality of second units (30) comprises at least one of a remote antenna unit (*i.e.*, a remote antenna unit) and a remote expansion unit. Ex. 1005, ¶¶275-276.

6. Independent Claim 74

The preamble of claim 74 is obvious based on Oh for the reasons noted above for the preamble and first element of claim 65.

The first element of claim 74 is disclosed for the reasons provided above for claim 66, where Oh's A/D converter unit 180 digitizes downstream an analog frequency signal from the base station 10.

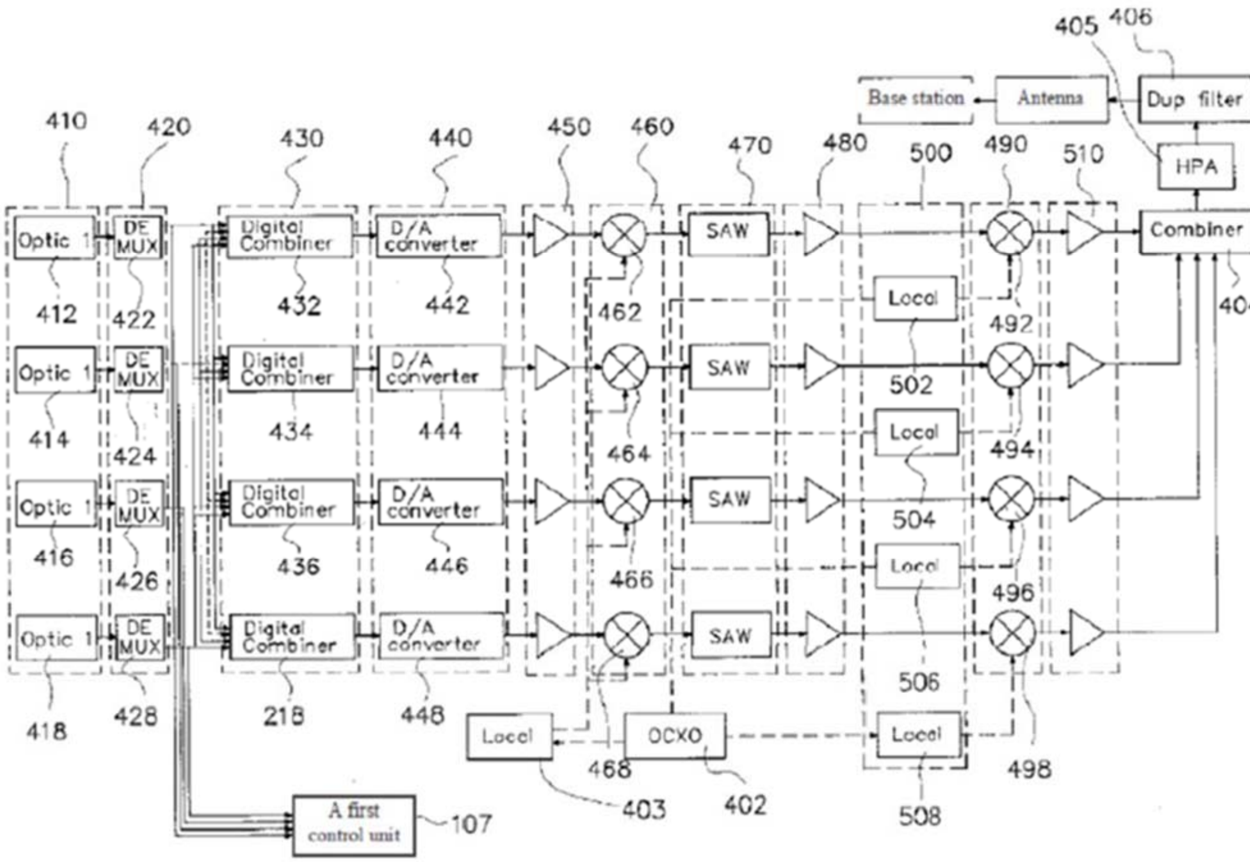
FIG. 2



Regarding the second element of claim 74, Oh renders that limitation obvious for the reasons provided for element 1 of claim 65, where optic converter unit 190 provide an interface for communicating digital samples to slave units 30.

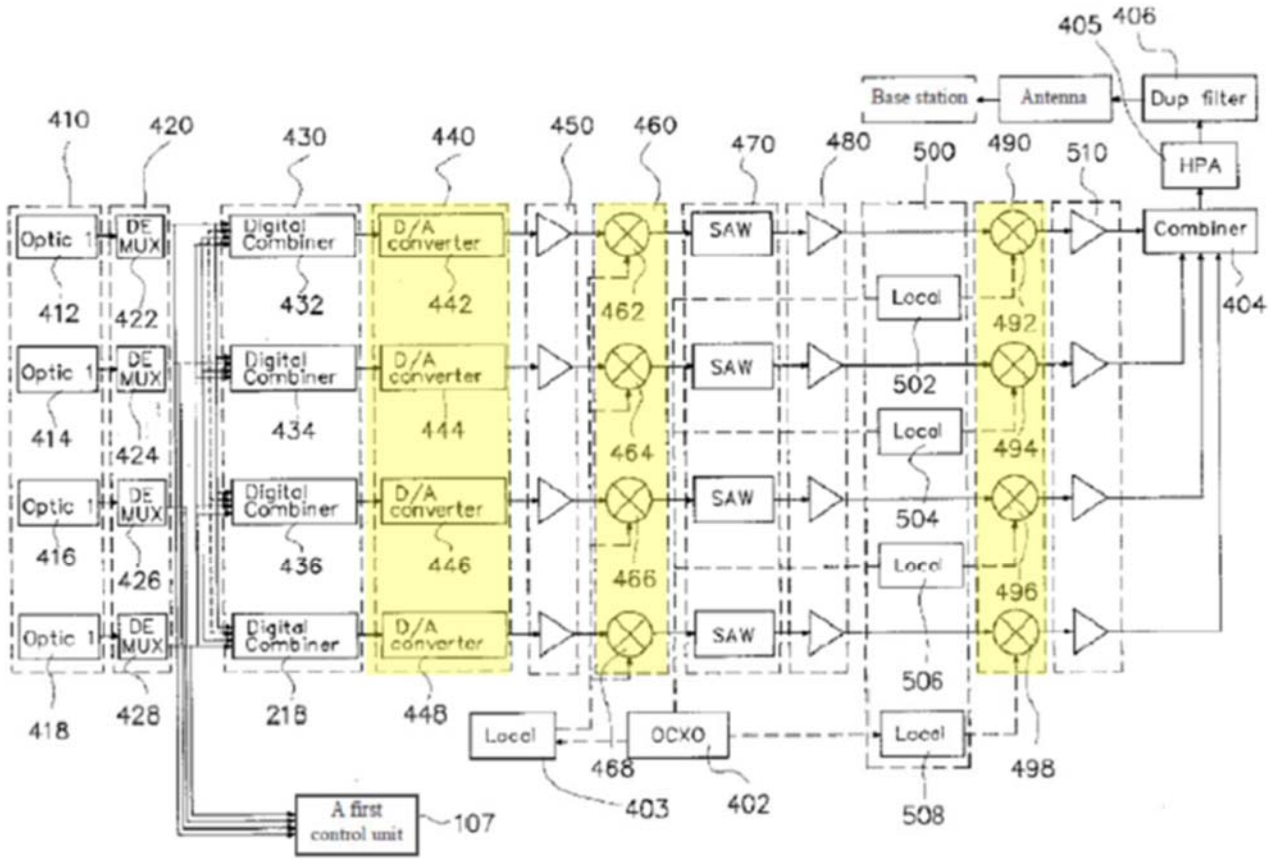
Regarding elements 3-5, Oh renders those limitations obvious for the reasons provided for 2 and 3 of claim 65, where optic converter unit 410 receives digital sample data from slave units 30, that digital sample data is unpacked and routed to the row associated with an appropriate frequency band at 420, and frequency band samples from the four slave units 30 connected to 412, 414, 416, 418 are summed at 432, 434, 436, 438 to produce summed upstream digital RF samples that are converted from digital to analog at 440.

FIG. 5



Regarding elements 6-8, those elements are rendered obvious by Oh for the reasons provided above for claim 65, elements 6-8, where outputs from the D/A converter at 440 are mixed for a first time at 460 and a second time at 490 with reference signals from local oscillators, 403, 502, 504, 506, 508. Ex. 1005, ¶¶277-280.

FIG. 5



B. Ground 1b: Claims 11-24, 33, and 36 Are Obvious Over Oh in view of Schwartz

1. Motivation to Combine

A person of ordinary skill in the art would be motivated to combine the disclosures of Oh and Schwartz for a variety of reasons. As an initial matter, Oh expressly mentions the types of all-analog RF distribution system described by Schwartz in its "Conventional Technology" section, where Oh notes that in those systems where "the RF signals transmitted/received to/from said first optic repeater and a second optic repeater are analog signals, the strength of the signals is greatly decreased during transmission through the optical line." Ex. 1007, 2:29-30. The resulting amplification can cause signal-to-noise ratio issues in the analog signals that ultimately reach destinations at the host or remote units. *Id*., 2:30-33. Because Oh expressly discusses the types of conventional, all-analog systems described in Schwartz, a POSITA would have recognized compatibilities in those systems and that Oh's digital relay improvements would have been applicable to Schwartz-type topologies (*i.e.*, topologies that incorporate intermediate stations 28 for distribution network expansion).

Additionally, a POSITA starting with Oh would have readily recognized a limitation in Oh's disclosure, where an RF distribution topology would have been limited to the number of remote slave units 30 corresponding to the number of master unit 20 optical ports (*i.e.*, four optic converters 192, 194, 196, 198 on the forward path and four optic converters 412, 414, 416, 418 on the reverse path limit master unit 20 to connection to four slave units 30). Schwartz's topology that supports intermediate stations 28 for RF distribution network expansion beyond the number of physical ports available at the host (*i.e.*, central station 20). Fig. 1 of Schwartz depicts the ability to daisy-chain intermediate stations 28 together such that a Schwartz network can be expanded to "any number of intermediate stations 28 and/or remote stations 22." Ex. 1010, 4:33-38. A POSITA starting with Oh but looking to provide a large RF distribution network (*e.g.*, in a large building, a sports arena) would be motivated to utilize Schwartz intermediate stations 28 to facilitate that expansion. Ex. 1005, ¶¶281-

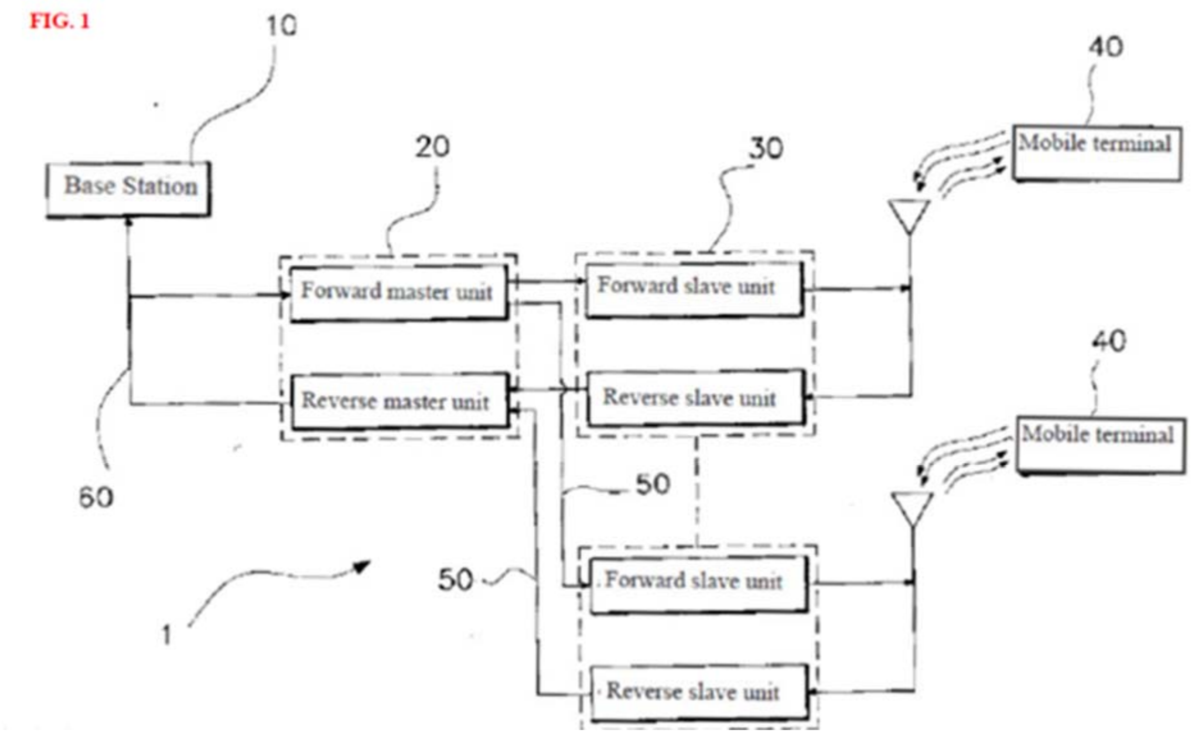
282.

2. Independent Claim 14

(a) Preamble

To the extent the preamble of claim 14 is limiting, it is rendered obvious by Oh.

As discussed above, Oh discloses a Digital Optic Repeater system that receives RF signals, from a base station 10 at a master unit 20 and from mobile terminals at remote slave units 30. The optic repeater 1 is installed in a radio wave shadow area and converts received analog signals to intermediate frequency signals (*e.g.*, close to DC in the example at 3:11-14) and then to digital signals for mutual transmission and reception to one another across optic lines 50. Ex. 1007, Abstract, Fig. 1. At a destination unit, the digital signals transmitted across the optic lines 50 are converted to analog signals, and upconverted to RF signals for transmission to their destination (*e.g.*, base station 10 or mobile terminals 40). *Id*.



Patent Owner has made clear in a prior litigation that "digital radio frequency (RF)" as that term is used in the '982 patent refers to sampling of any of baseband signals, intermediate frequency signals, or radio frequency signals. *See*, Ex. 1008, Acampora Report, ¶136 ("Accordingly, the baseband digital samples, any intermediate frequency digital samples, and any radio frequency digital samples are all referred to a[s] being digital RF.") Oh's disclosure of A/D conversion (*i.e.*, sampling) of intermediate frequency signals, including signals down converted to close to DC (*i.e.*, baseband signals) is disclosure of digital radio frequency data as that term is used in the '982 patent.

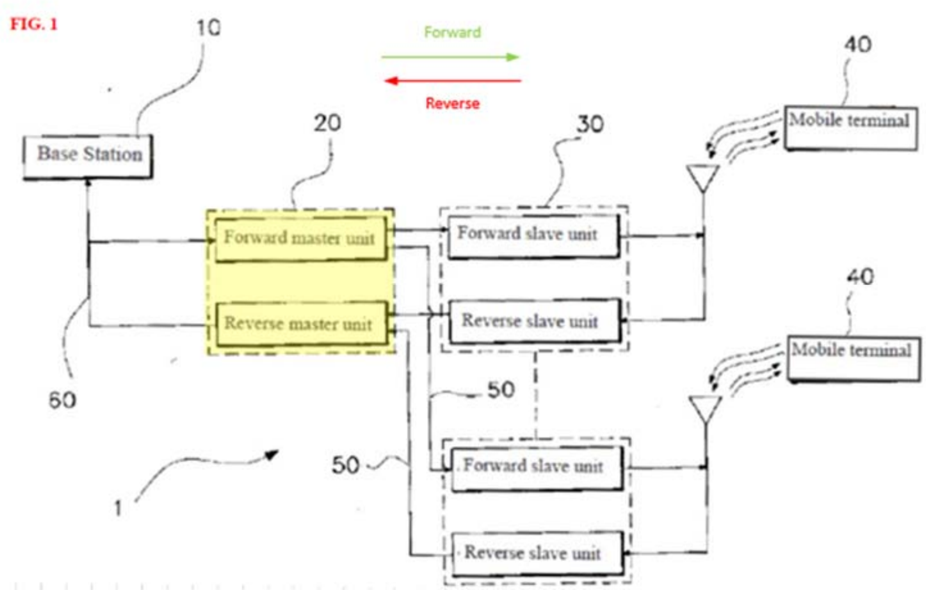
Oh therefore renders obvious each limitation recited in the preamble of claim

14 by disclosing a digital radio frequency (digital samples of intermediate frequency/baseband analog signals) transport system (transmission of those digital signals among the master 20 and slave units 30 across optic lines 50). Ex. 1005, ¶¶283-285.

(b) Element 1: "a digital host unit;"

Element 1 of claim 14 is rendered obvious by Oh.

As discussed above and as shown in Fig. 1, Oh's master unit 20 transmits/receives analog signals to/from the base station and relays digital samples of those analog signals to/from remote slave units 30 across optic lines 50. Ex. 1007, 2:70-3:1; 4:62-64.



Oh's master unit 20 is analogous to the '982 patent's digital host unit (DHU) 20 which interfaces with a wireless interface device (WID) 10 that in embodiments comprises a base station (Ex. 1001, 4:37-39). And like Oh's master unit 20, on the forward path the '982 patent's DHU "receives RF signals from WID 10 [*i.e.*, base station] and converts the RF signals to digital RF signals. DHU 20 further optically transmits the digital RF signals to multiple DRUs 40."

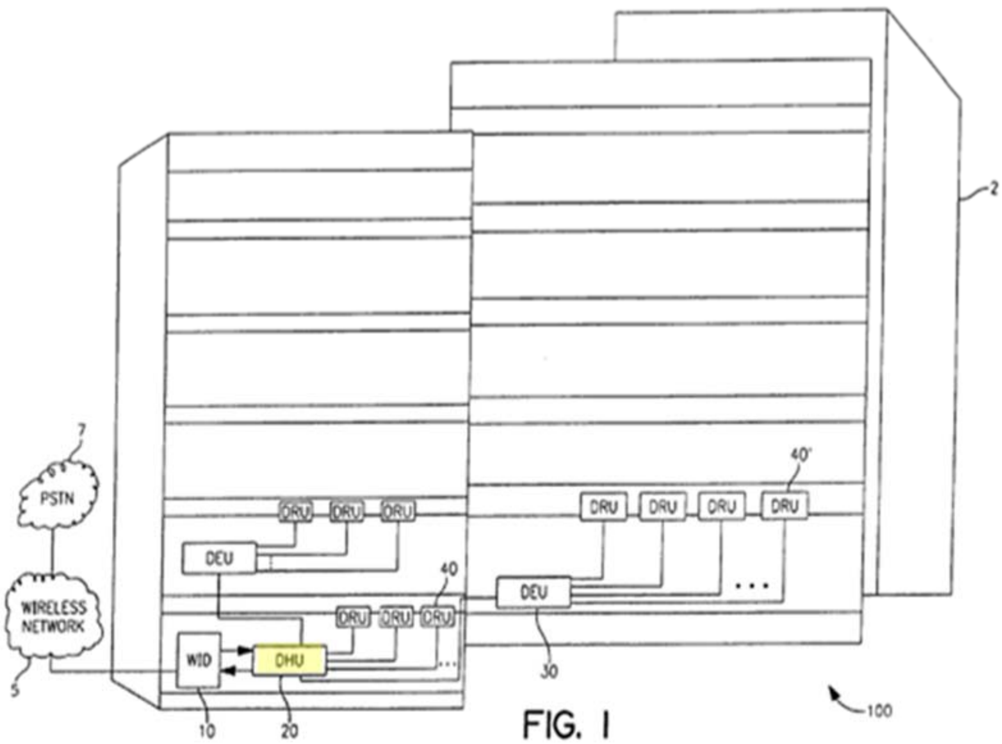


FIG. 1

Because Oh's master unit 20 communicates analog signals bi-directionally with a base station, and communicates digital signals bi-directionally with multiple remote units (slave units 30), it is analogous to the host unit described in the '982 patent. Oh renders obvious a digital host unit (master unit 20). Ex. 1005, ¶¶286-288.

(c) Element 2: "at least one digital expansion unit coupled to the digital host unit;"

Element 2 is rendered obvious by Oh in view of Schwartz.

Schwartz discloses an RF distribution network whereby external RF signals are transmitted to remote stations for wireless transmission via a central station 20. Schwartz discloses that remote stations may be directly connected to the central station 20 or through intermediate stations 28, where each intermediate station 28 may be connected to multiple remote stations 22. And further intermediate stations 28 may be connected to additional intermediate stations 28 to act as signal relays between central station 20 and remote stations 22. Such intermediate stations 28 enable topologies that "connect central station 20 directly to any number of intermediate stations 28 and/or remote stations 22." Ex. 1010, 4:33-38.

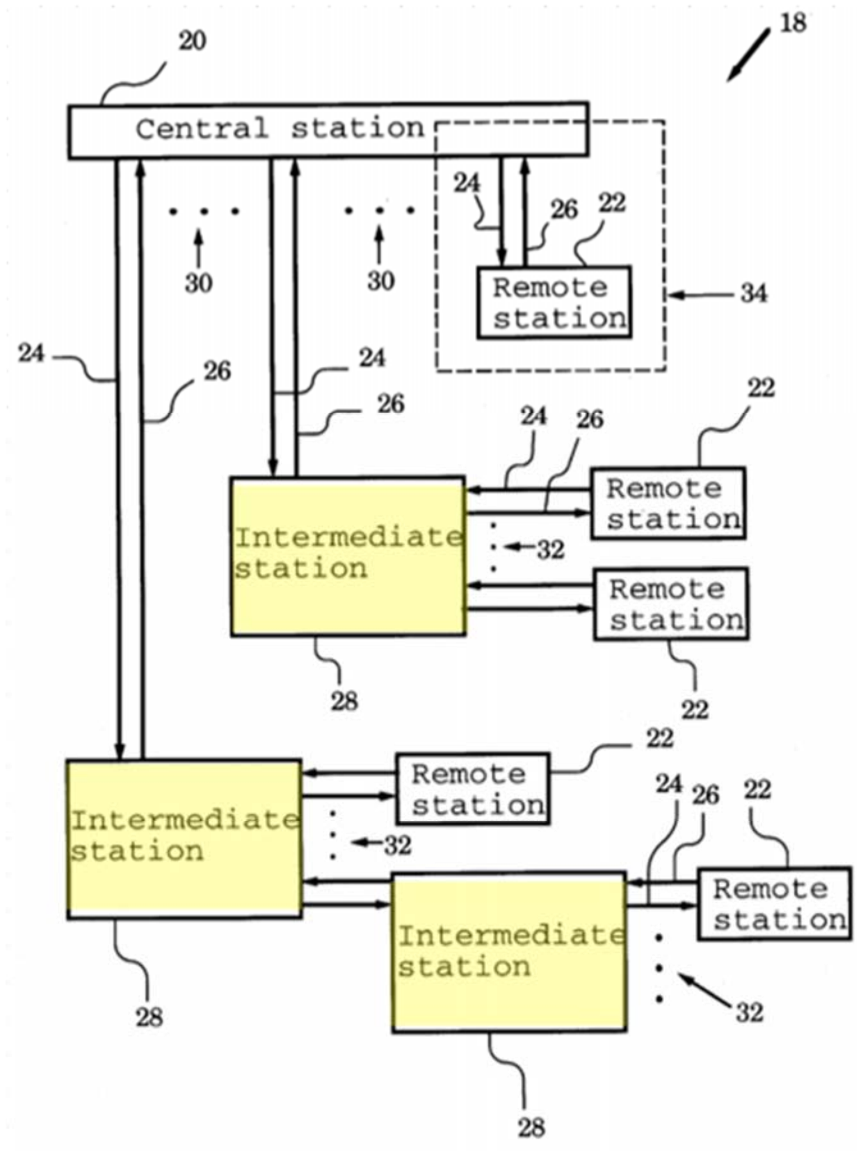


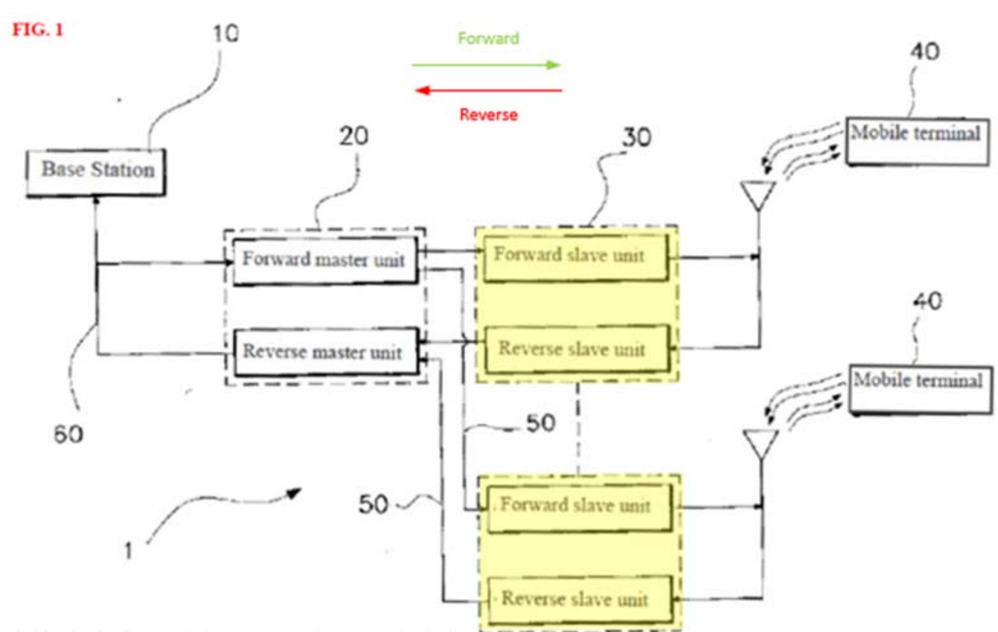
FIG. 1

As described above, a POSITA would have been motivated to incorporate Schwartz intermediate stations 28 into Oh's system to enable connection to more remote units (*e.g.*, slave units 30), where Oh's system was limited in the number of slave units 30 to which master unit 20 could be connected by master unit 20's optical ports (*e.g.*, four ports in Figs. 2 & 5). Oh in view of Schwartz renders obvious at least one digital expansion unit (Schwartz intermediate station 28) coupled to the digital host unit (Oh master unit 20). Ex. 1005, ¶¶289-290.

(d) Element 3a: "at least two digital remote units, each coupled to one of the digital host unit and the digital expansion unit,"

Element 3a is rendered obvious by Oh in view of Schwartz.

Oh's slave units 30 convert "the digital signals transmitted from the master unit 20 through the optic line 50 to intermediate frequency signals, analog signals; converts them to the RF signals and transmits them to the mobile terminals 40." Ex. 1007, 3:47-49. Oh's slave units 30 further convert analog signals from the mobile terminals 40 to digital signals and transmit them to master unit 20. *Id.*, 4:23-25.



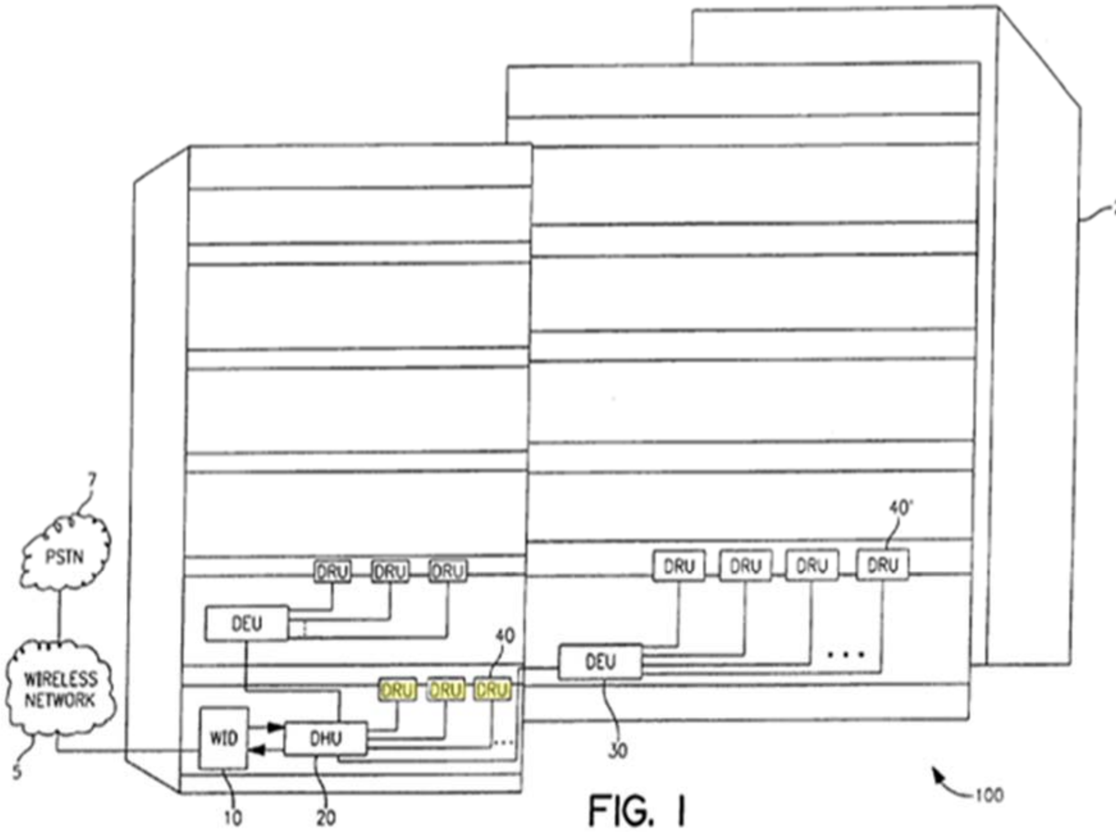


FIG. 1

Oh's slave units 30 are analogous to the '982 patent's digital remote units (DRUs) that digitally communicate with the DHU via optic cables (Ex. 1001, 3:61-64) and wirelessly communicate with devices in their area (*e.g.*, via antenna 599). Oh discloses remote units coupled directly to a host unit.

Schwartz Fig. 1 discloses remote stations 22 connected both directly to host central station 20 and expansion intermediate stations 28.

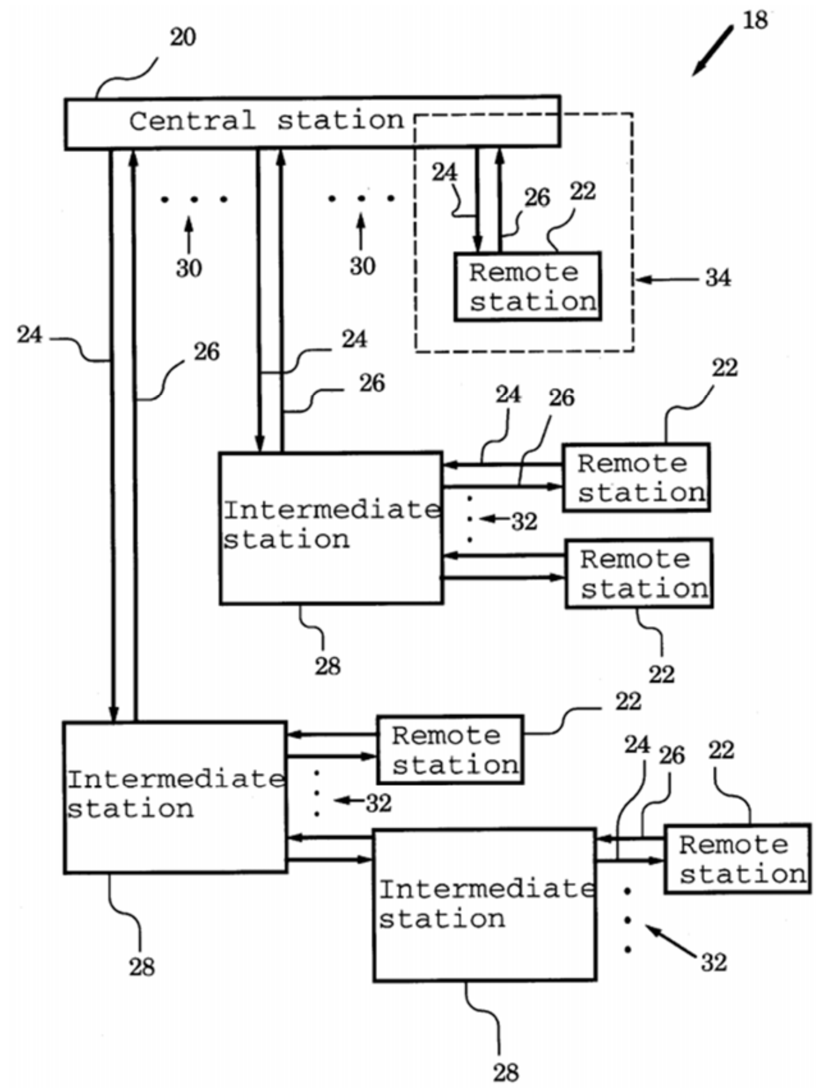


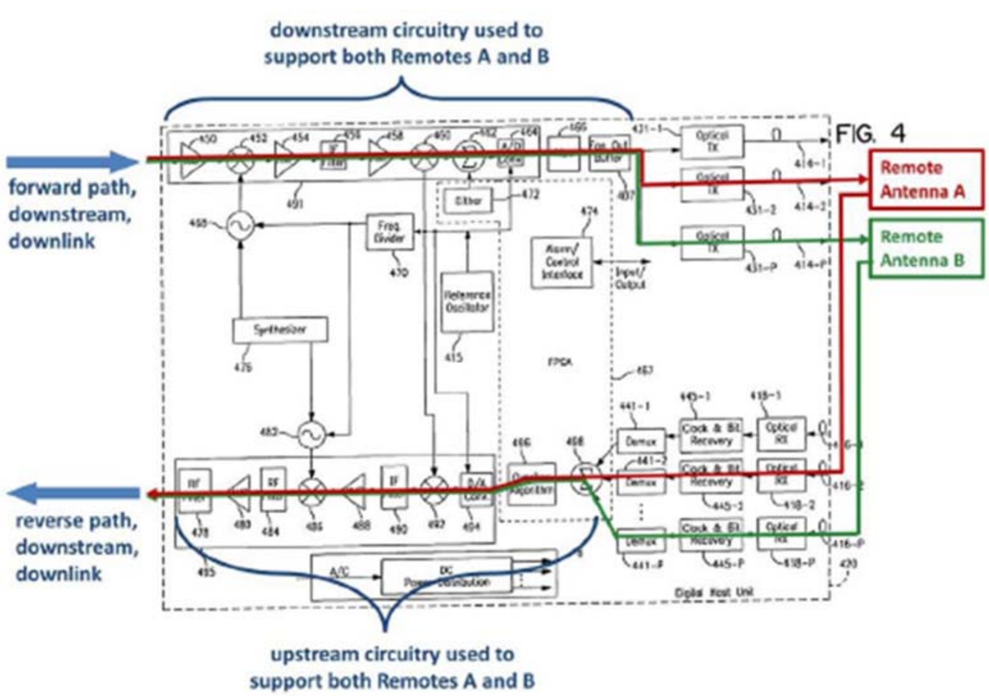
FIG. 1

Oh in view of Schwartz renders obvious at least two digital remote units (Oh slave units 30; Schwartz remote stations 22), each coupled to one of the digital host unit (Oh master unit 20; Schwartz central station 20) and the digital expansion unit (Schwartz intermediate station 28). Ex. 1005, ¶¶291-294.

(e) Element 3b: "wherein the digital host unit includes shared circuitry that performs bi-directional simultaneous digital radio frequency distribution of digitized radio frequency signals between the digital host unit and the at least two digital remote units;"

Element 3b is rendered obvious by Oh.

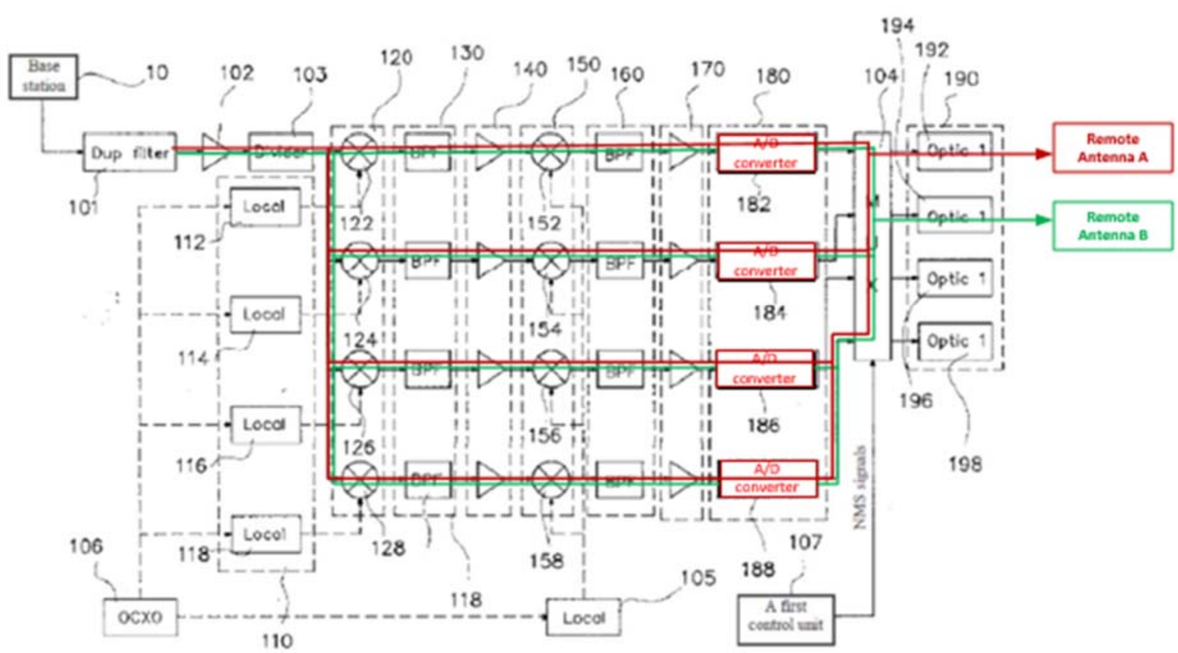
While the '982 patent's specification does not use the term "shared circuitry" beyond paraphrases of the claim language, in a prior litigation, Patent Owner has clarified their position that "'shared circuitry' was intended to mean circuitry that is used to support more than one remote unit." Ex. 1008, ¶316. In that same document, Patent Owner illustrated and discussed what it envisioned as the "shared circuitry" at paragraphs 323-324.



There it identified '982 patent's "circuitry in box 491, the mux 465, and fan out buffer 431" as the downstream shared circuitry for providing digital radio frequency distribution of digitized radio frequency signals, and "summing unit 498 of the FPGA, the overflow algorithm and circuits of box 495" as the upstream shared circuitry. *Id.*, ¶324.

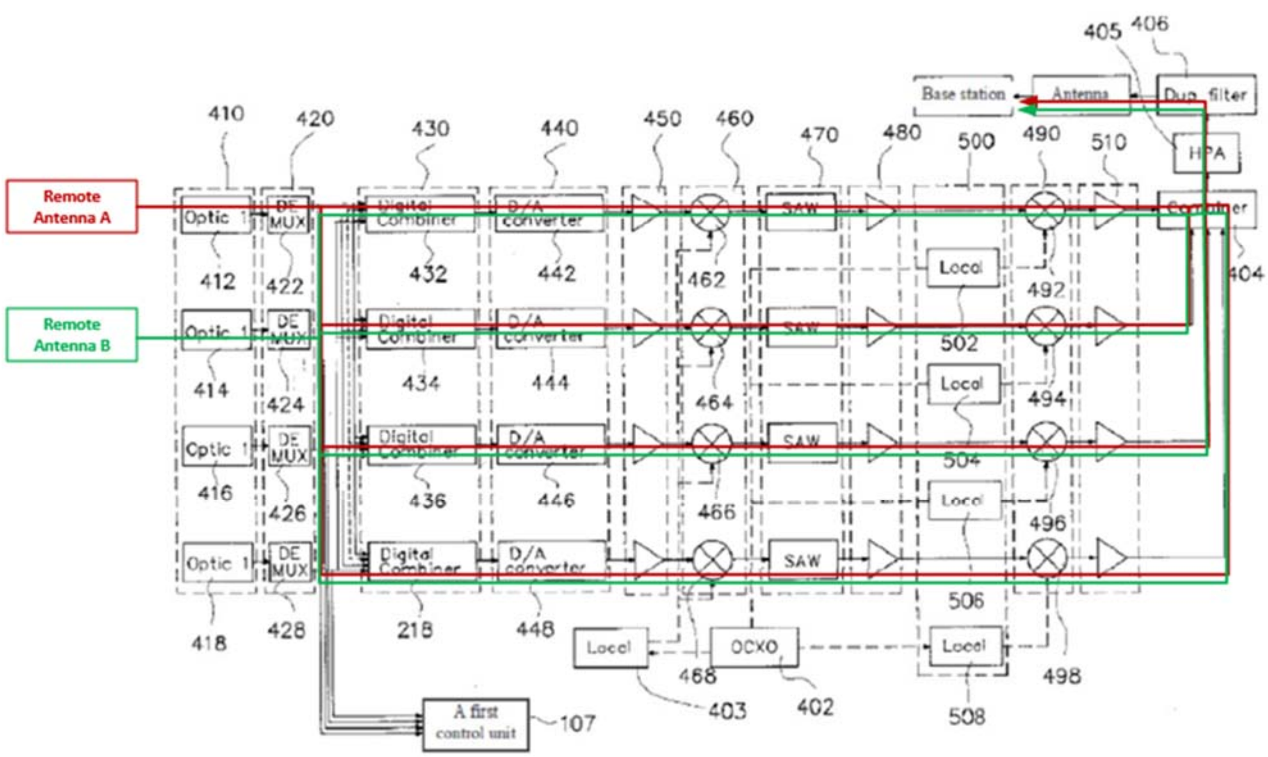
Oh discloses an analogous arrangement of components. On the downstream path of Fig. 2, Oh's circuitry at 120, 130, 140, 150, 160, 170, 180 down converts the analog signal received from the base station to near DC and samples that data, just like the '982 patent's "circuitry in box 491." Oh similarly includes a multiplexer 104 that serializes the digitized data and distributes it to the remote slave units.

FIG. 2



And on the reverse path, Oh's digital combiner unit 430 performs digital combining by aggregating (*i.e.*, digitally summing) digitized radio frequency signals received at master unit 20 from multiple slave units 30 (*see*, Ex. 1007, 4:68-70; 5:16-17; Ex. 1005, ¶58) and then converts the resulting sums to analog signals and processes those analog signals to generate a signal at 404 (*i.e.*, analog combining) that represents all of the data received from the multiple slave units 30 (*i.e.*, an output RF signal containing the same information contained in the '982 patent's RF signal output).

FIG. 5



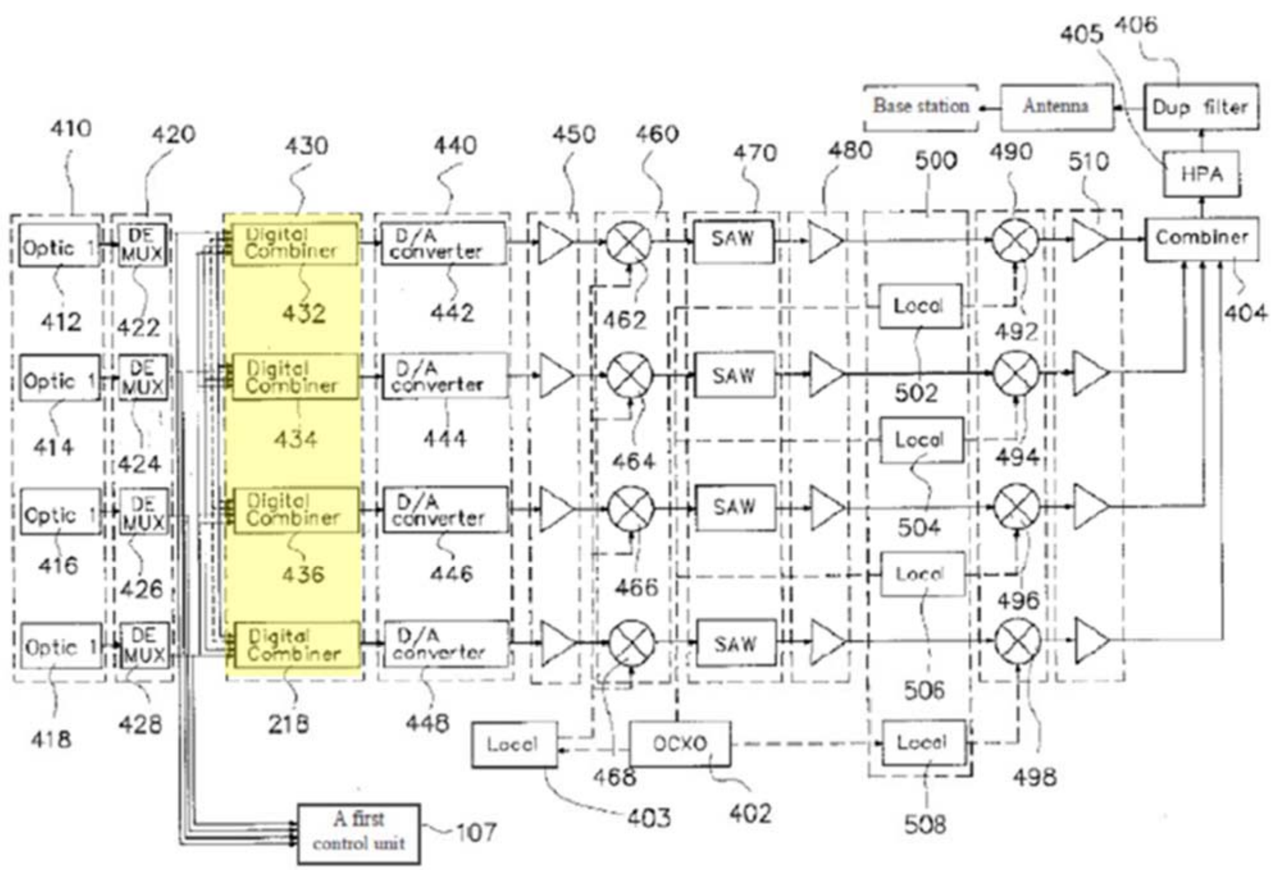
Oh renders obvious the digital host unit (master unit 20) includes shared circuitry (downstream 104, 120-190); upstream 420-510, 404) that performs bi-directional simultaneous digital frequency distribution (signals transmitted from 190 and at the same time, signals received at 430 at the same time) of digitized radio frequency signals (intermediate frequency signals sampled at the master unit at 180 and slave units at 380) between the digital host unit (master unit 20) and the at least two digital remote units (slave units 30). Ex. 1005, ¶¶295-299.

(f) Element 4: "wherein the digital host unit digitally sums the digitized radio frequency signals received at the digital host unit."

Element 4 of claim 14 is rendered obvious by Oh.

Oh's master unit 20 includes a digital combiner unit 430 that performs digital combining by aggregating digital signals transmitted from each demultiplexer sub-unit 422, 424, 426, 428 of demultiplexer unit 420. Ex. 1007, 4:68-70.

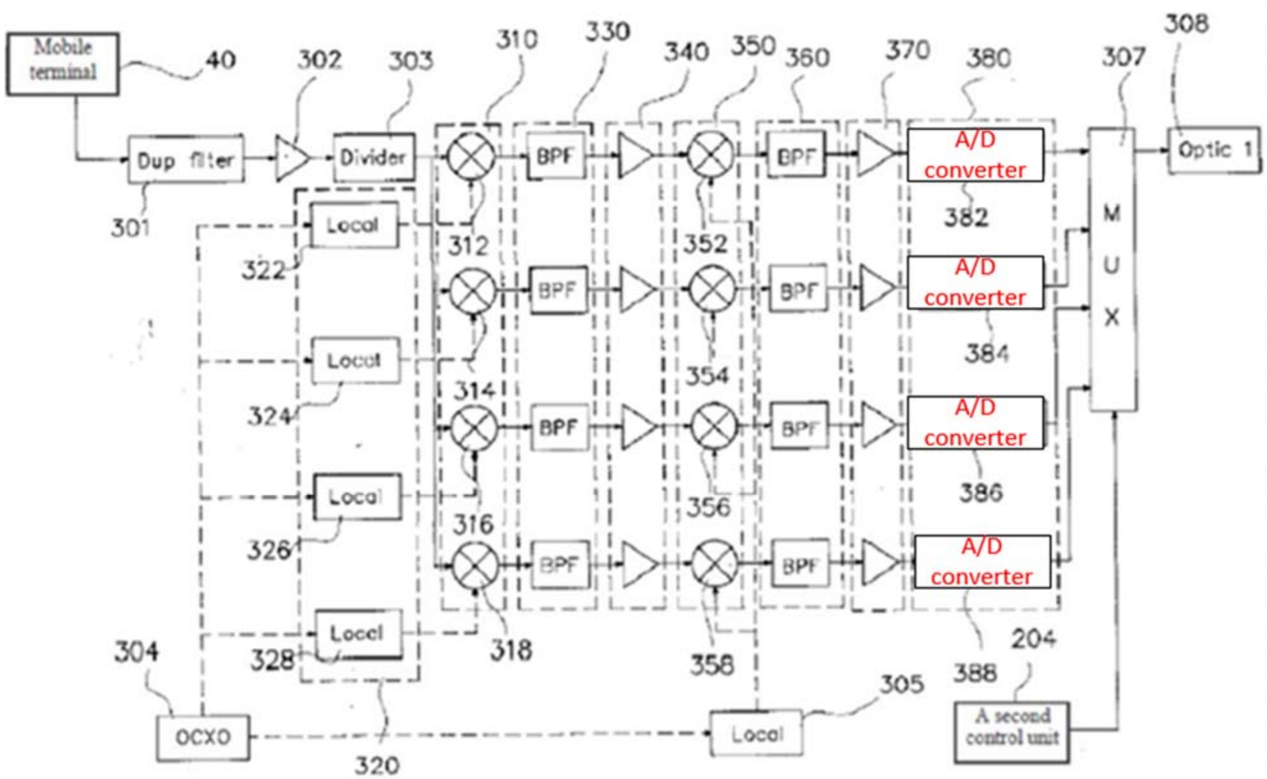
FIG. 5



Those demultiplexers at 420 receive data from individual remote slave units 30 at 410.

As depicted in Fig. 4, each slave unit 30 receives an analog signal from mobile terminals 40, divides the received analog signal into its component frequency bands at 303 and downconverts the frequency band signals to near DC at 310-370. Ex. 1007, 4:26-34. The downconverted band signals are then sampled at 380 to create 12-bit digitized radio frequency signals. *Id.*, 4:56-61. The multiplexer 307 multiplexes the four 12-bit samples with 4 bits of control data from 204 to form 52-bit serial data signals that are forwarded to master unit 20. *Id.*

FIG. 4



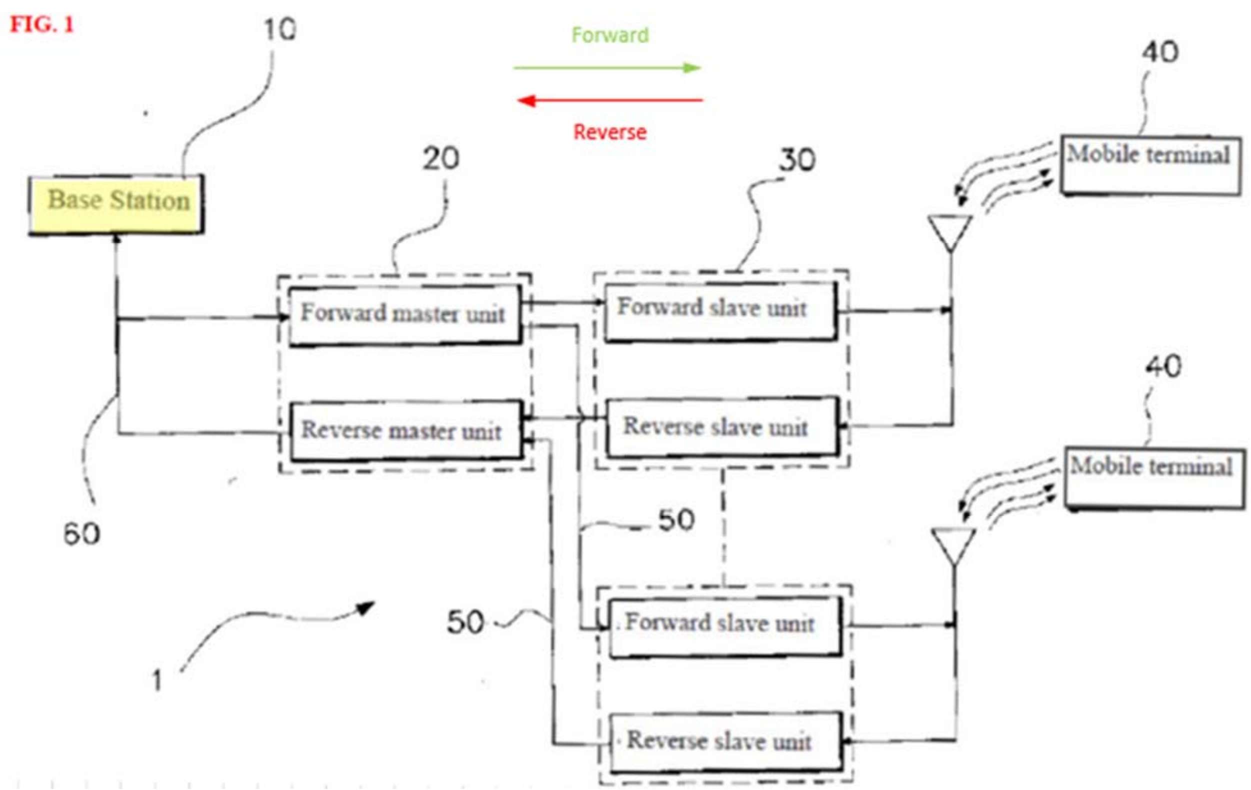
Referring back to Fig. 5, each demultiplexer sub-unit 422, 424, 426, 428 receives a 52-bit signal from its respective slave unit 30. Each demultiplexer forwards 12-bits of sample data to the appropriate digital combiner associated with the proper frequency band for that 12-bit sample and forwards its 4 bits of control data to control unit 107. Upon receiving four 12-bit signals (one from each of demultiplexer 422, 424, 426, 428), each digital combiner 432, 434, 436, 438 "creat[es a] 14-bit intermediate frequency signals by combining four 12-bit intermediate frequency signals in the same frequency band." Ex. 1005, ¶¶80, 58; Ex. 1007, 5:16-17. Those 14-bit signals are then converted to analog signals at 440, upconverted, combined, and transmitted to the base station 10. *Id.*, 5:17-29.

Oh renders obvious the digital host unit (master unit 20) digitally sums the digitized radio frequency signals (creates 14-bit signals by combining four 12-bit signals) received at the digital host unit.

Oh in view of Schwartz therefore renders obvious each limitation recited in claim 14. Ex. 1005, ¶¶300-303.

3. Dependent Claim 15

The '982 patent states that in one embodiment a wireless interface device comprises a base station. Ex. 1001, 4:28-30. Fig. 1 of Oh depicts a base station 10 coupled to master unit 20.



Oh renders obvious a wireless interface device (base station 10) coupled to the digital host unit (master unit 20). Ex. 1005, ¶¶304-305.

4. Dependent Claim 16

Oh discloses that RF signals are transmitted from base station 10 to master unit 20 through "RF cable." Ex. 1007, 2:71-72. A POSITA in July 2000 would have understood a reference to RF cable to mean coaxial cable. *See, e.g.,* Ex. 1025, 1:27-29.

Oh renders obvious the wireless interface device comprises a base station (10) that couples directly to the digital host (30) unit via coaxial cables (RF cable). Ex. 1005, ¶306.

5. Dependent Claim 17

Oh discloses that its master unit 20 bi-directionally communicates with base station 10. Figs. 2 and 5 illustrate that those bi-directional communications are via a bi-directional amplifier, where Oh's master unit 20 communicates with the base station 10 via a bi-directional filter 101, 406 connected to amplifiers 102, 405.

FIG. 2

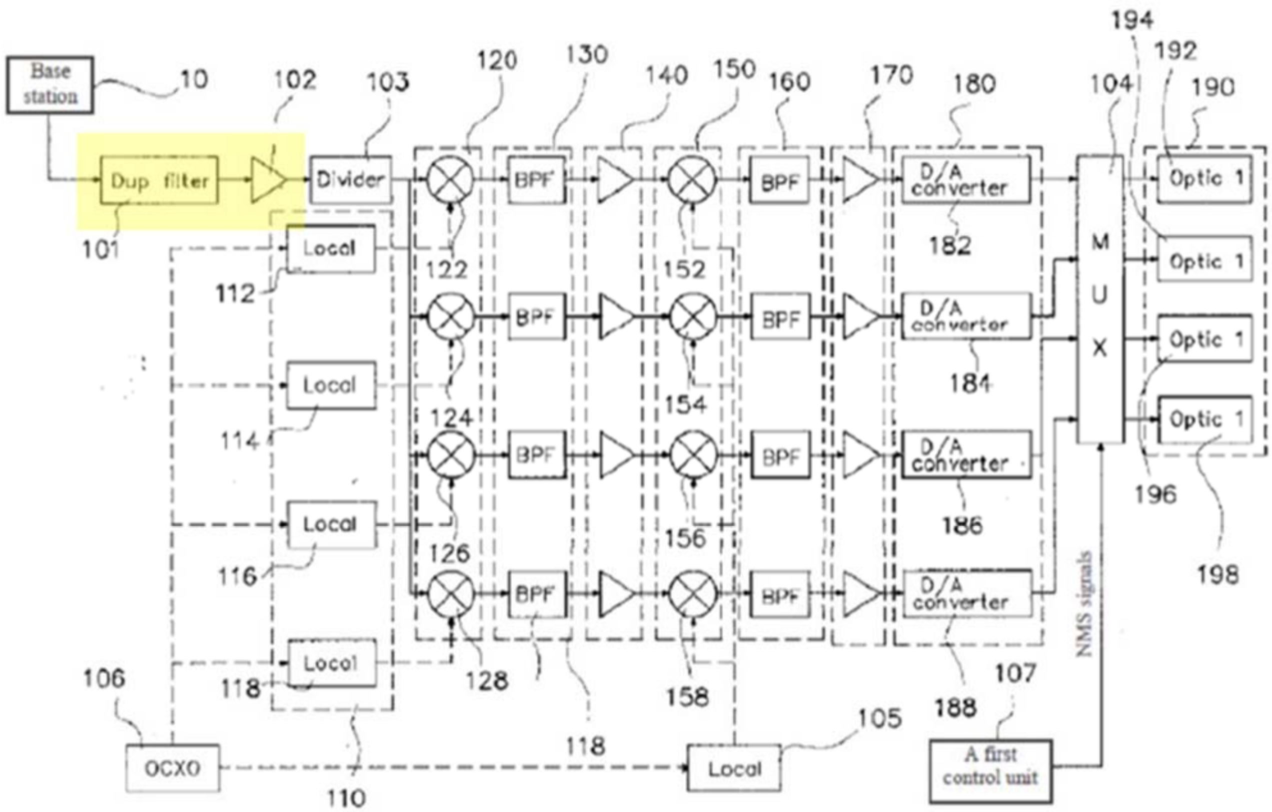
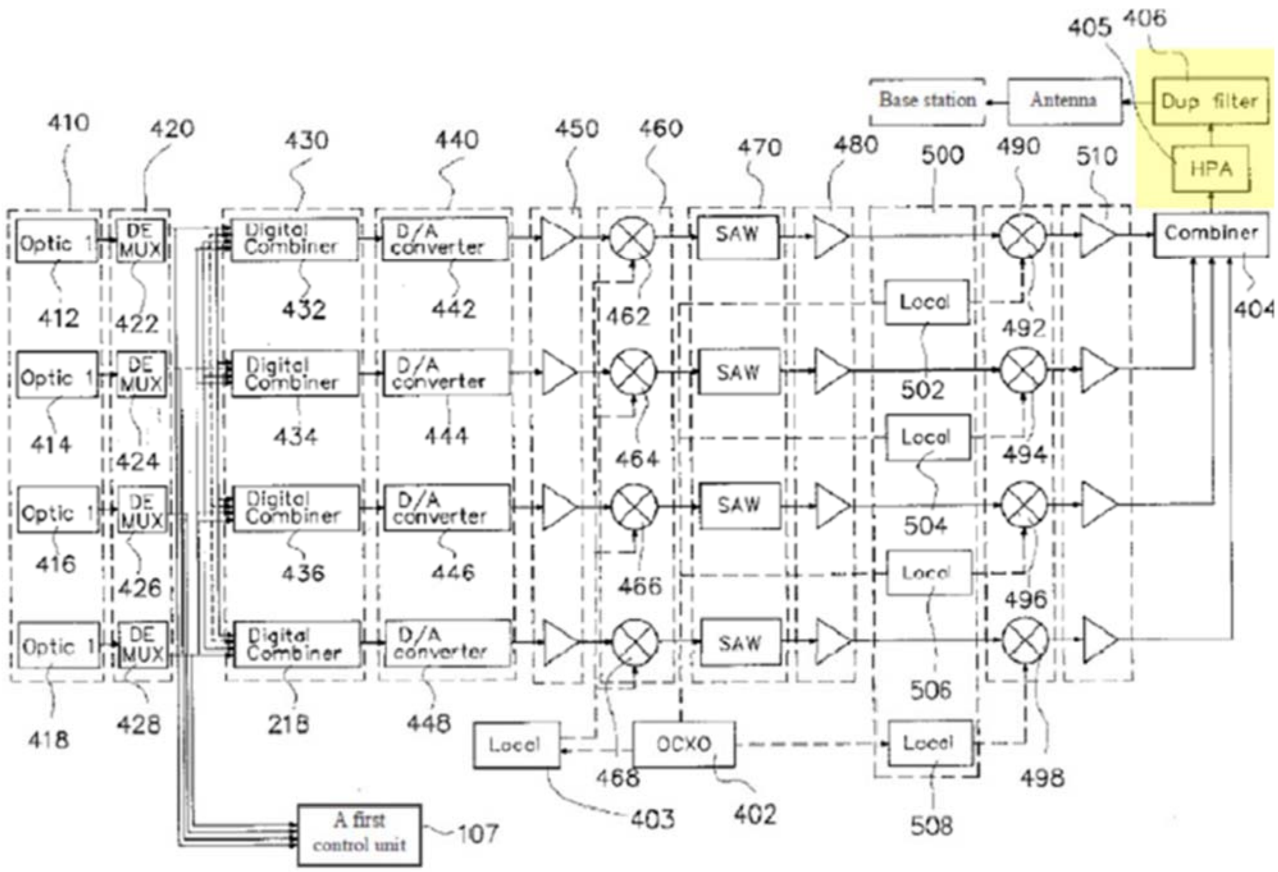


FIG. 5



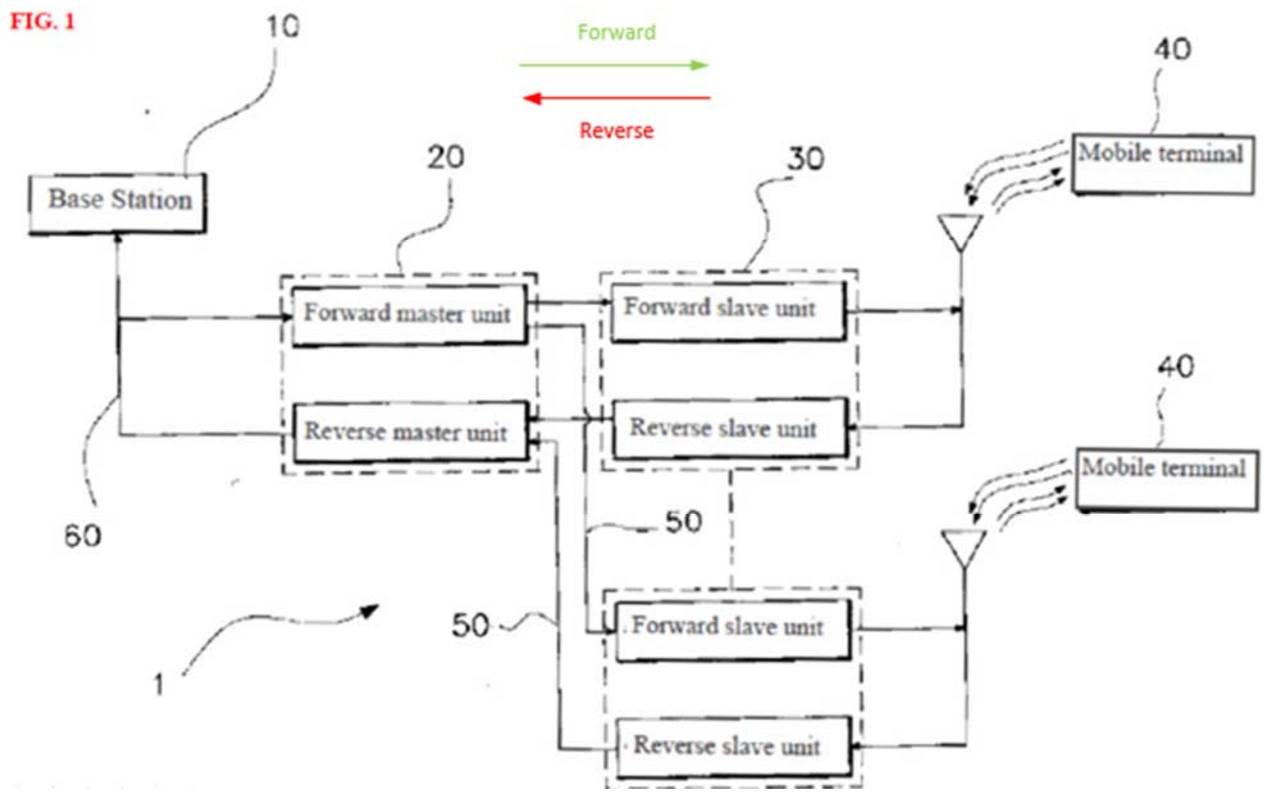
A POSITA understands that a bi-directional amplifier comprises a bi-directional duplex filter component to prevent the transmit signal from interfering with the receive channel and an amplifier component. Fig. 5 of Oh illustrates its bi-directional filter 406 being connected to an antenna for wireless communication with the base station 10.

Oh renders obvious the wireless interface device comprises a base station (10) that wirelessly connects (*see*, Fig. 5 Antenna) to the digital host unit (master unit 20) via a bi-directional amplifier (101, 102, 405, 406). Ex. 1005, ¶¶307-309.

6. Dependent Claim 18

Oh discloses multiple slave units 30 connected to master unit 20 via optic lines

50.



Oh renders obvious at least one of the at least two digital remote units (slave units 30) is coupled to the digital host unit (master unit 20). Ex. 1005, ¶¶310-311.

7. Dependent Claim 19

As noted above, a POSITA would have been motivated to incorporate Schwartz-type intermediate stations 28 to enable RF distribution network expansion. Schwartz discloses remote stations 22 that are connected directly to the central station 20 at 34, as well as several remote stations 22 connected to expansion intermediate stations 28.

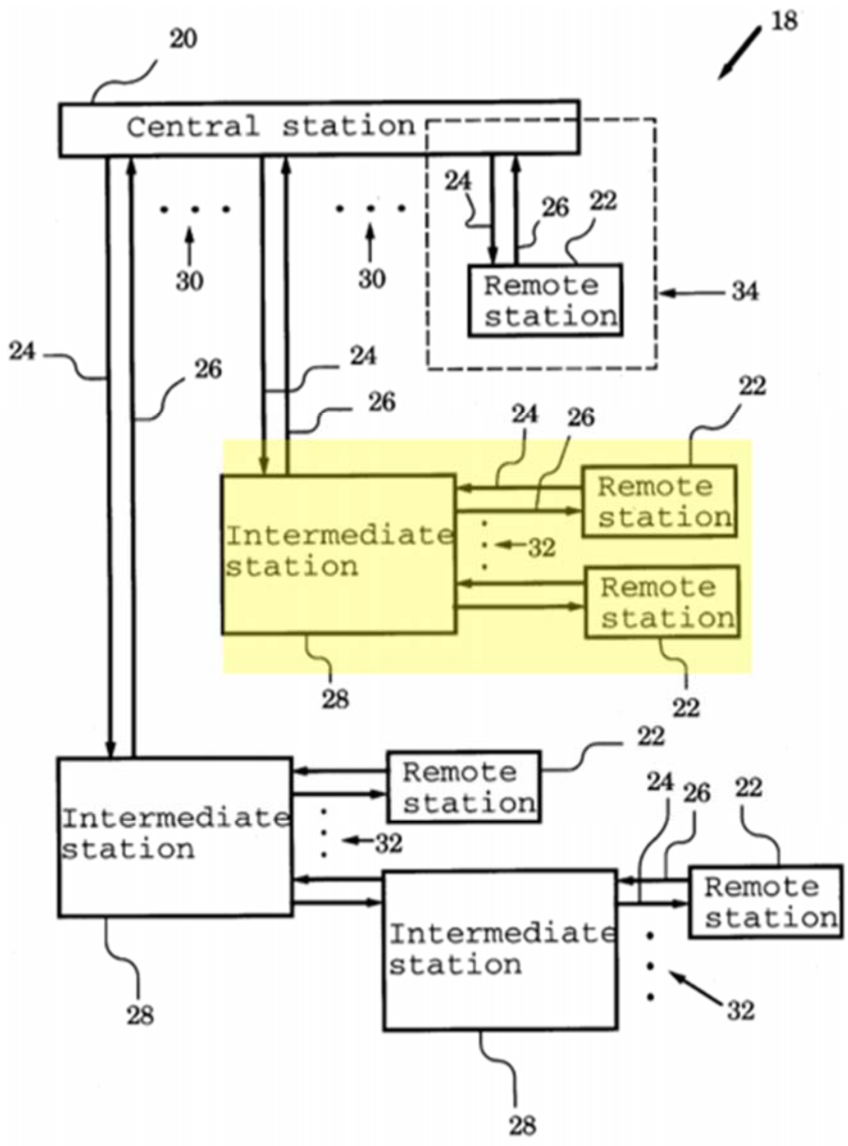
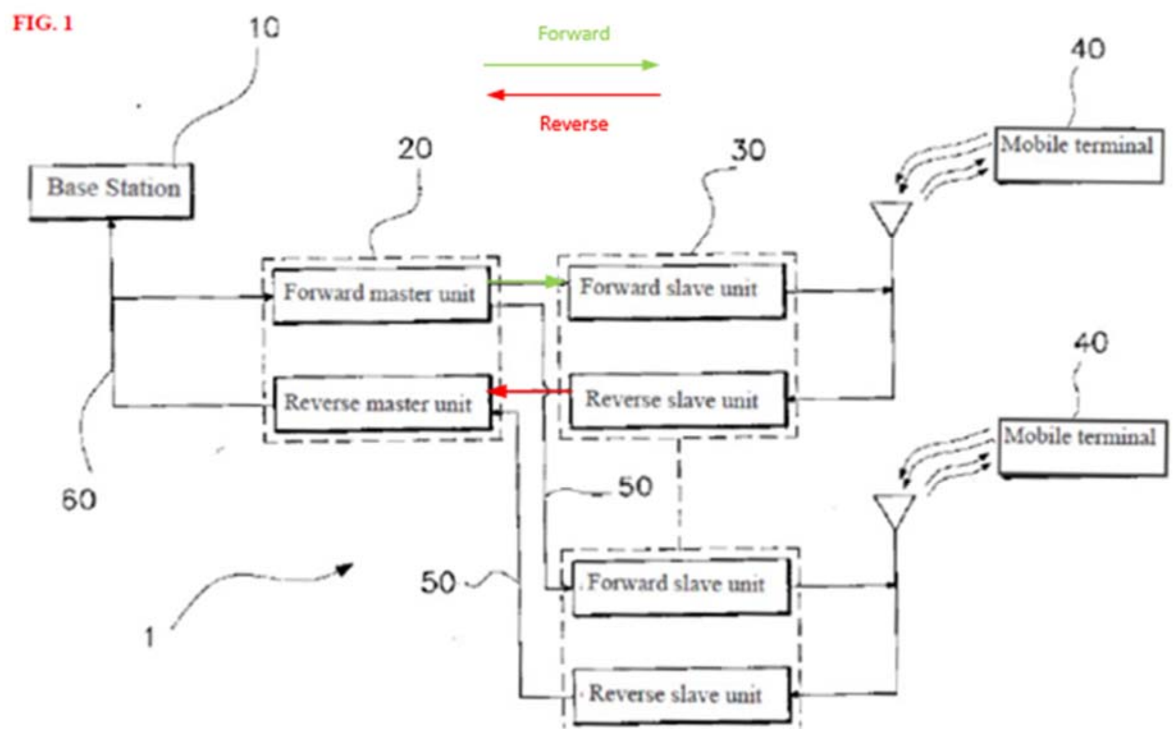


FIG. 1

Oh in view of Schwartz renders obvious at least one of the at least two digital remote units (remote station 22) is coupled to the at least one digital expansion unit (intermediate station 28). Ex. 1005, ¶312.

8. Dependent Claim 20

Schwartz Fig. 1 illustrates its intermediate stations 28 being coupled to central station 20 via separate downlink cable 24 and uplink cable 26, this is similar to Oh Fig. 1, which illustrates master unit 20 communicating in a forward direction with a slave unit 30 using one optic line 50, and in a reverse direction with that same slave unit 30 using a second optic line 50.



In an Oh-Schwartz system that communicates using optic lines, like in Oh, a POSITA would consider selection of multimode or single mode to be a matter of design choice. This is evidenced by Farber which describes the use of single or multimode fiber in an antenna system for reaching difficult coverage areas (*see*, Fig. 1) that is very similar to the digital system of Oh. Ex. 1022 ("Farber"), 4:30-33 ("Preferably the transmitter 14 employs a vertical cavity surface emitting laser or an edge emitting laser coupled to a single or multi-mode fiber 16."); Fig. 2. As further evidence of obviousness of using single or multimode fiber, Haas illustrates the cost-benefit analysis of selection of multimode or single mode fiber for an application. Ex. 1012, 1125. A POSITA would have been motivated to select multimode fiber as disclosed by Haas for communicating among a host and remote units when cost is a significant factor for the project. Additionally as disclosed by Haas, in some instances multimode fiber may already be installed in an area into which an RF distribution network is being implemented, making reuse of that multimode fiber an attractive option.

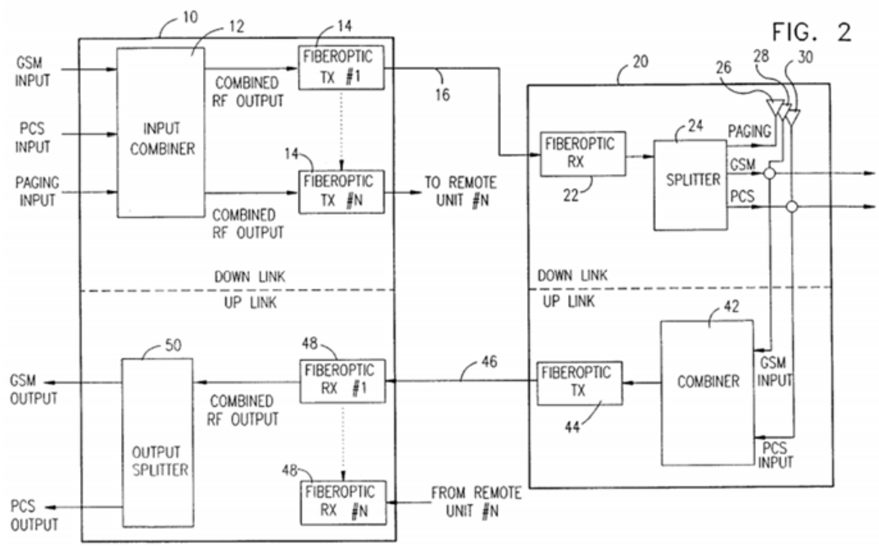


FIG. 2

Oh in view of Schwartz, or further in view of Farber to the extent that the cost-benefit analysis of single vs. multimode fiber was not background state of the art knowledge, renders obvious the at least one digital expansion units (intermediate station 28) are each coupled to the digital host unit (Oh master unit 20) by a multimode fiber pair (*e.g.*, as disclosed by Farber). Ex. 1005, ¶¶313-315.

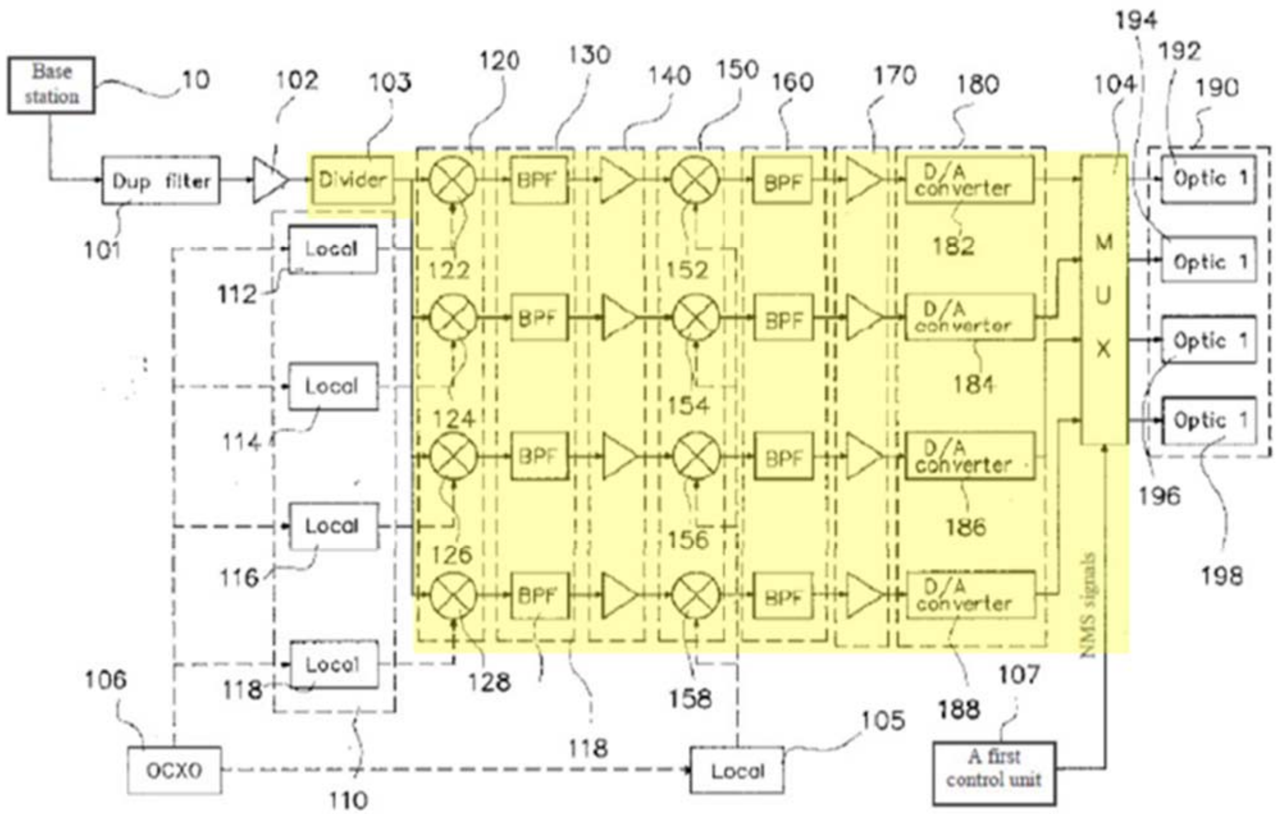
9. Dependent Claim 21

As noted above, where speed is a critical factor, single mode fiber was known to be an optimum choice. Ex. 1012, 1125. Oh in view of Schwartz, or further in view of Farber to the extent that the cost-benefit analysis of single vs. multimode fiber was not background state of the art knowledge, renders obvious the at least one digital expansion unit (intermediate station 28) is coupled to the digital host unit (Oh master unit 20) by single mode fiber (*e.g.*, as disclosed by Farber). Ex. 1005, ¶316.

10. Dependent Claim 22

Fig. 2 of Oh depicts the master unit 20 that receives a radio frequency signal and outputs digital representation of the received radio frequency signal.

FIG. 2



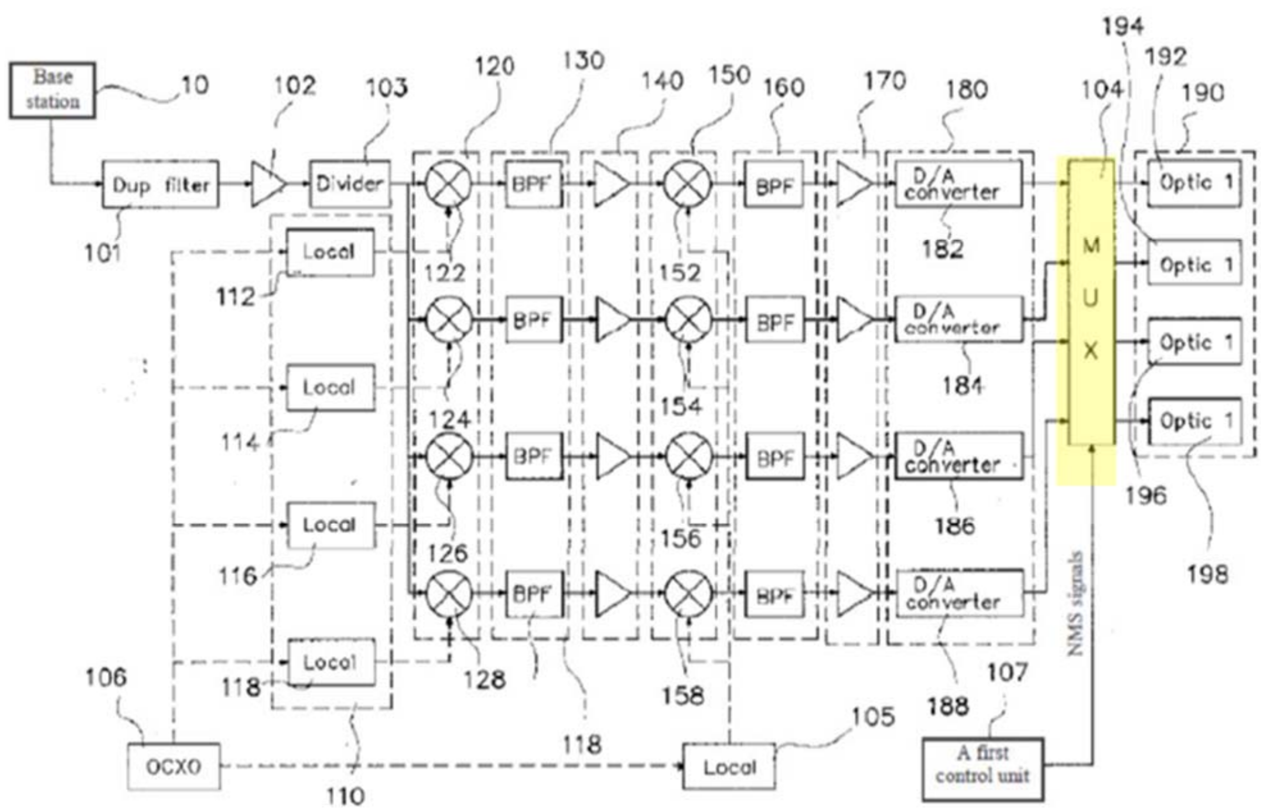
As described at 3:6-18, a first divider 103 divides the received RF signal among 4 rows of frequency band digitization circuitry. The frequency band signals from the divider are downconverted 120, filtered 130, amplified 140, further downconverted 150, further filtered 160, and further amplified 170 before being sampled at 180 to create a digital representation of the received main radio frequency signal in the form of four 12-bit samples, one from each frequency band path. The multiplexer 104 multiplexes those four 12-bit samples, which together represent the main radio frequency signal received from the base station 10, and 4 bits of control data 107 that is transmitted to the remote slave units 30.

Oh renders obvious the digital host unit (master unit 20) includes a radio frequency to digital converter (103, 120-180, 104) that converts a main radio frequency signal (received from base station 10) to at least a portion of the digitized radio frequency signals (output from mux 104 to remote slave units 30). Ex. 1005, ¶¶317-319.

11. Dependent Claim 23

Fig. 2 of Oh depicts master unit 20's multiplexer 104. Multiplexer 104 receives the 12-bit samples from the A/D converter unit 180 and multiplexes them along with the control data from 107 and outputs copies of those 52-bit signals to four remote slave units 30 via optical converters depicted at 190. Ex. 1007, 3:16-19.

FIG. 2

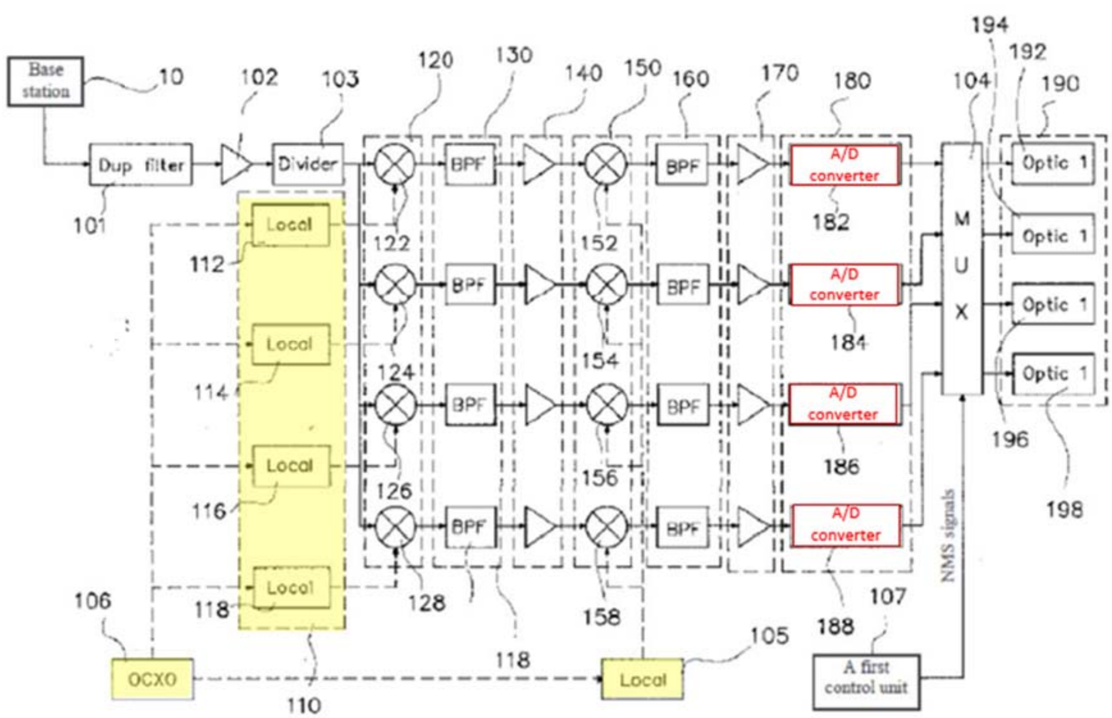


Oh renders obvious the digital host unit (master unit 20) further includes a multiplexer (104) which splits the digitized radio frequency signals (52-bit signals) into at least two digital signals (mux 104 splits for transmission on 192, 194, 196, 198) for optical transmission to the at least two digital remote units (remote slave units 30). Ex. 1005, ¶¶320-321.

12. Dependent Claim 24

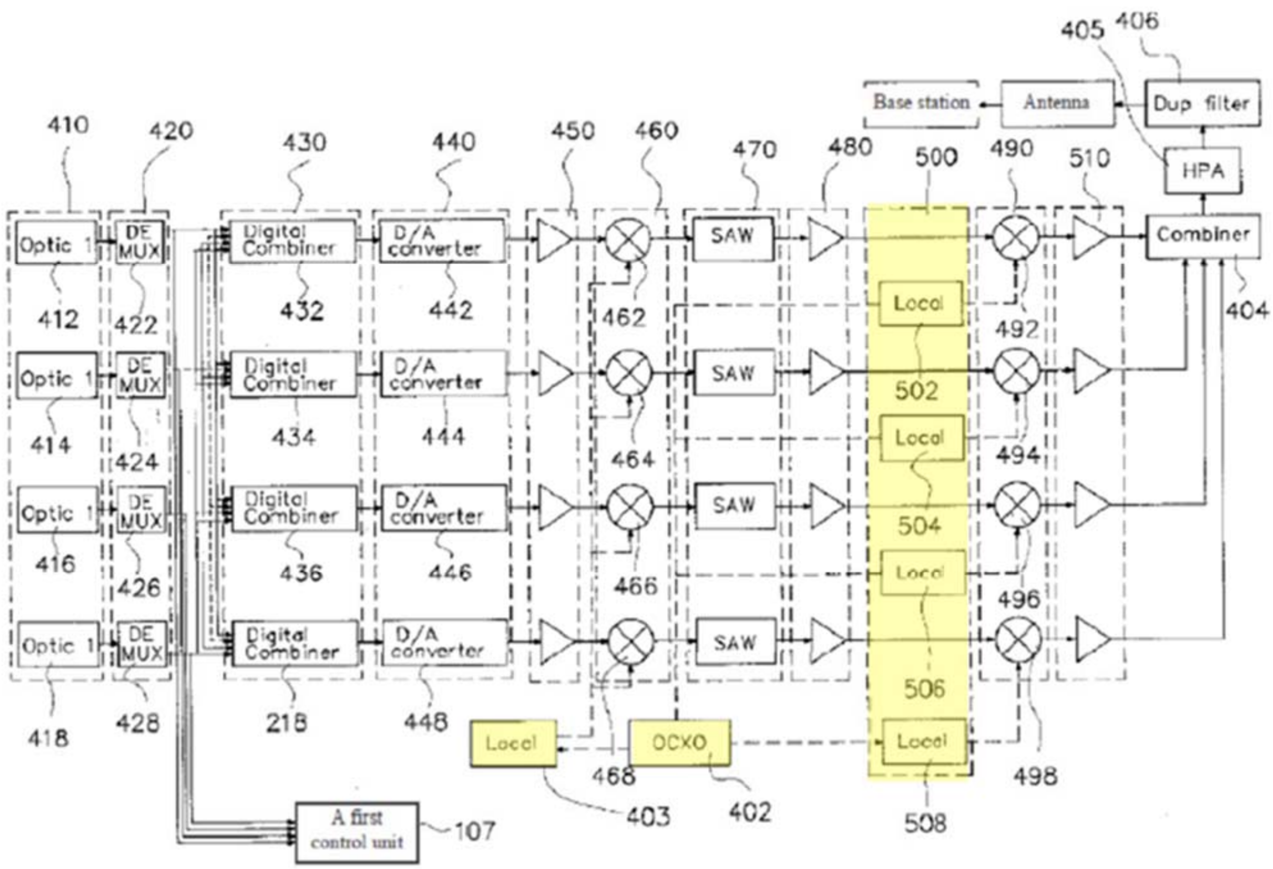
Oh discloses that the digital host unit discloses local oscillators 105 (for converting from 70MHz to near DC: Ex. 1007, 3:34-37), 112, 114, 116, 118 (for converting from 801.23, 803.69, 806.15, 808.61 to 70Mhz: Ex. 1007, 3:20-25) coupled to OCXO 106 in the forward direction of Fig. 2.

FIG. 2



And Oh discloses that the digital host unit discloses local oscillators 403 (for converting from near DC to 70 MHz: Ex. 1007, 5:19-22), 502, 504, 506, 508 (for converting from 70 to 801.23, 803.69, 806.15, 808.61 Mhz: Ex. 1007, 5:23-26) coupled to oven-controlled reference oscillator 402 in the forward direction of Fig. 2.

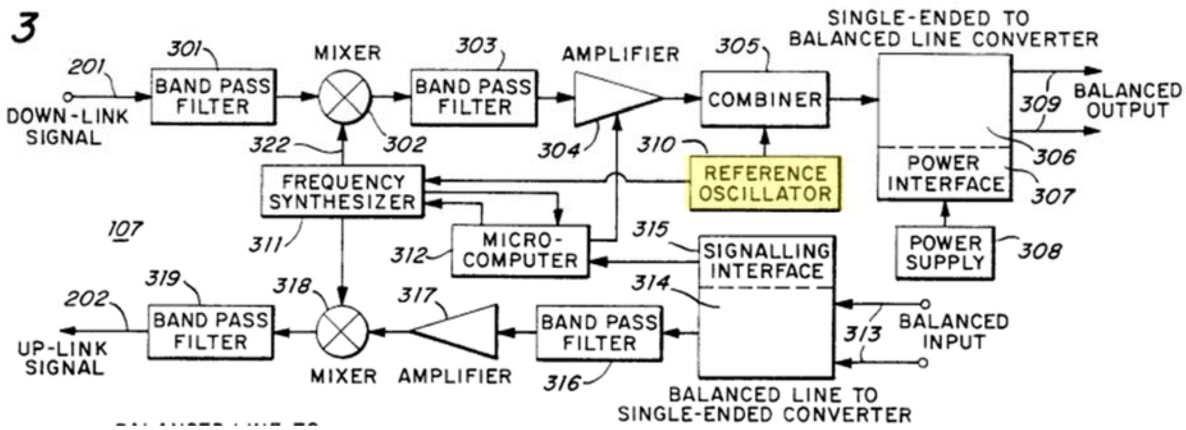
FIG. 5



Oh's disclosure of OCXO (106 in Fig. 2, 402 in Fig. 5) in host master unit 10 teaches the limitation. To the extent that Oh is not explicit that OCXO 106 in Fig. 2 and 402 in Fig. 5 are indicating the same reference oscillator, such an implementation would be obvious to a POSITA. Because the forward and reverse frequency translations are to the same frequencies (*i.e.*, 70MHz to/from about 800MHz; near DC to/from 70MHz), the local oscillators operating in Figs. 2 and 5 will be operating at about the same frequencies. Having those common local frequencies being generated in Figs. 2 and 5 using a single, common oven-controlled reference oscillator would have been an obvious design choice because using a single reference oscillator would have reduce part count, reduced power consumption, and reduced reliability concerns caused by additional moving parts that would be present if discrete reference oscillators were used. As illustrated in Figs. 2 and 5 already, a single reference oscillator can be used to generate several local frequency signals. Implementing master unit 30 with a single OCXO 106/402 would have been obvious.

To any extent that the use of a common reference oscillator is deemed not within the general skill of the art, a POSITA would have been motivated to implement a common reference oscillator for forward and reverse direction operations as disclosed in van der Kaay (Ex. 1019), where a common reference oscillator 310 is used to generate frequencies for frequency shifting operations in the forward and reverse directions. A POSITA would be motivated to combine the disclosures because use of a common reference oscillator would reduce part count (and associated cost), reduce power consumption, and reduce reliability concerns caused by additional moving parts that would be present if discrete reference oscillators were used. Further "[s]ince the same reference oscillator signal (representative of the output of the referenced oscillator 310) is used throughout the RF signal distribution system, frequency accuracy is maintained at a high level." Ex. 1019, 9:62-65.

FIG. 3



Oh renders obvious the digital host unit (30) includes local oscillators (105, 112, 114, 116, 118, 403, 502, 504, 506, 508 coupled to a reference oscillator (106/402) for synchronization of the radio frequency signal in the forward direction (Fig. 2) and the reverse direction (Fig. 5). Ex. 1005, ¶¶322-325.

13. Dependent Claim 11

Dependent claim 11 depends from claim 1. With regard to the features of claim 1, those features are rendered obvious by Oh for the reasons provided above for the preamble, and elements 1, 3a, 3b, and 4 of claim 14.

Claim 11 further recites "a digital expansion unit coupled to the digital host unit, wherein the digital expansion unit contains circuitry that performs bi-directional simultaneous digital radio frequency distribution between the digital host unit and the digital remote unit." As detailed above with reference to claim 14, a POSITA would have considered it obvious to use intermediate units, such as intermediate station 28 of Schwartz to provide expanded coverage of an RF distribution network like the one disclosed in Oh. As depicted in Fig. 7a of Schwartz, those intermediate stations 28 forward RF signals received from upstream (*e.g.*, at 120) to multiple downstream units (*e.g.*, remote stations 22 and/or other intermediate stations 28 via 126, 128). And those intermediate stations 28 further receive RF signals from multiple downstream units (*e.g.*, at 130, 132), combine those received RF signals, and forward the combined signal to an upstream unit (*e.g.*, at 124).

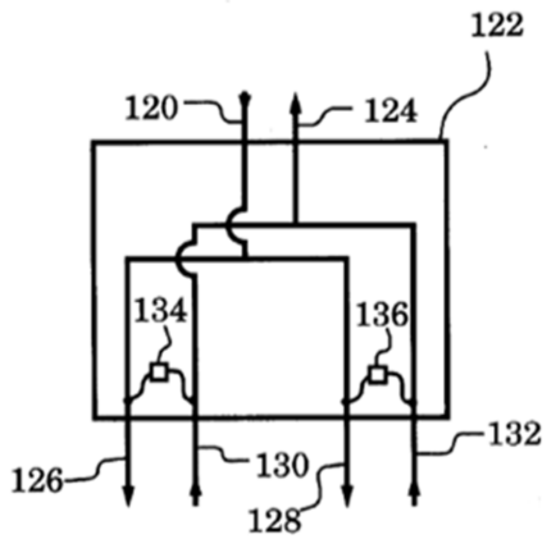


FIG. 7a

When connected between central station 20 two remote stations 22, as the highlighted intermediate station 28 is in Fig. 1 below, Oh in view of Schwartz renders obvious digital expansion unit (28) coupled to the digital host unit (20), wherein the digital expansion unit contains circuitry that performs bi-directional simultaneous digital radio frequency distribution (downstream from 120 to 126, 128; upstream from 130, 130 to 124) between the digital host unit and the digital remote unit. Ex. 1005, ¶¶326-328.

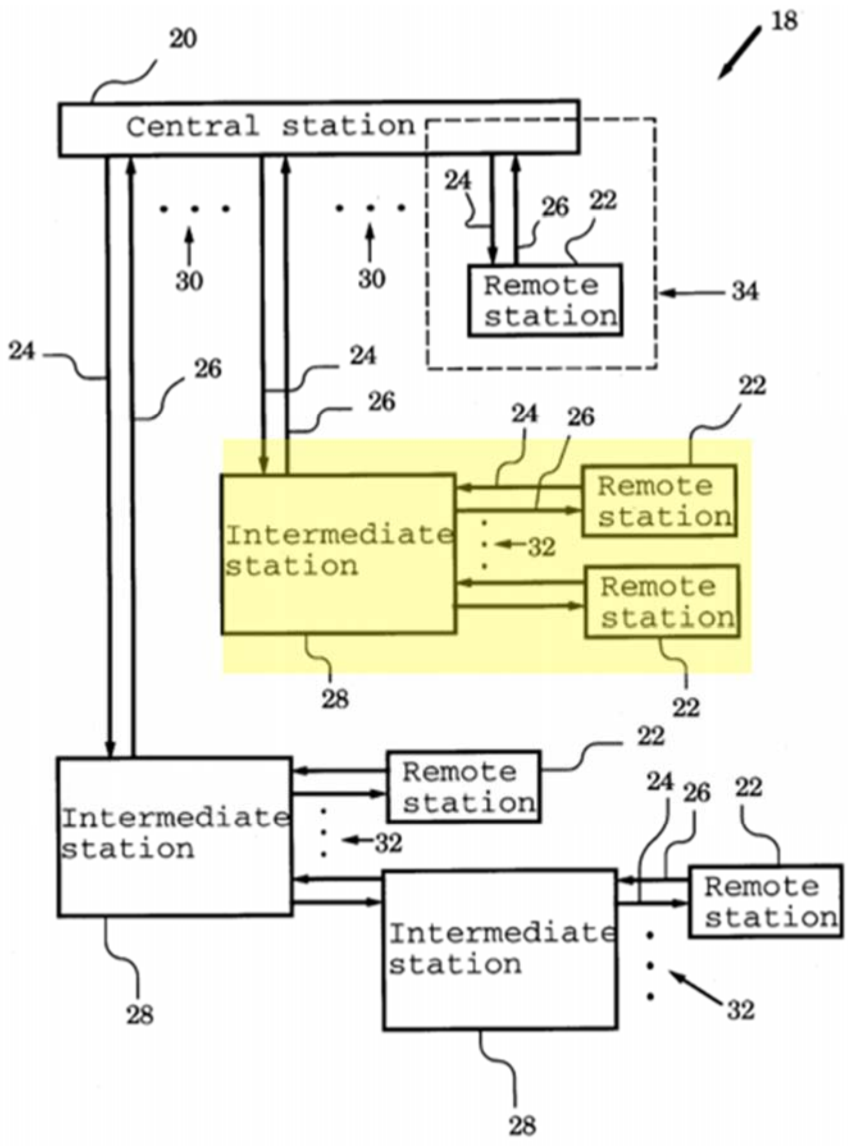


FIG. 1

14. Dependent Claims 12 and 13

Claims 12 and 13 recite features that are analogous to those recited in claims 20 and 21. The limitations of claims 12 and 13 are rendered obvious for the additional reasons provided in addressing claims 20 and 21, respectively. Ex. 1005, ¶329.

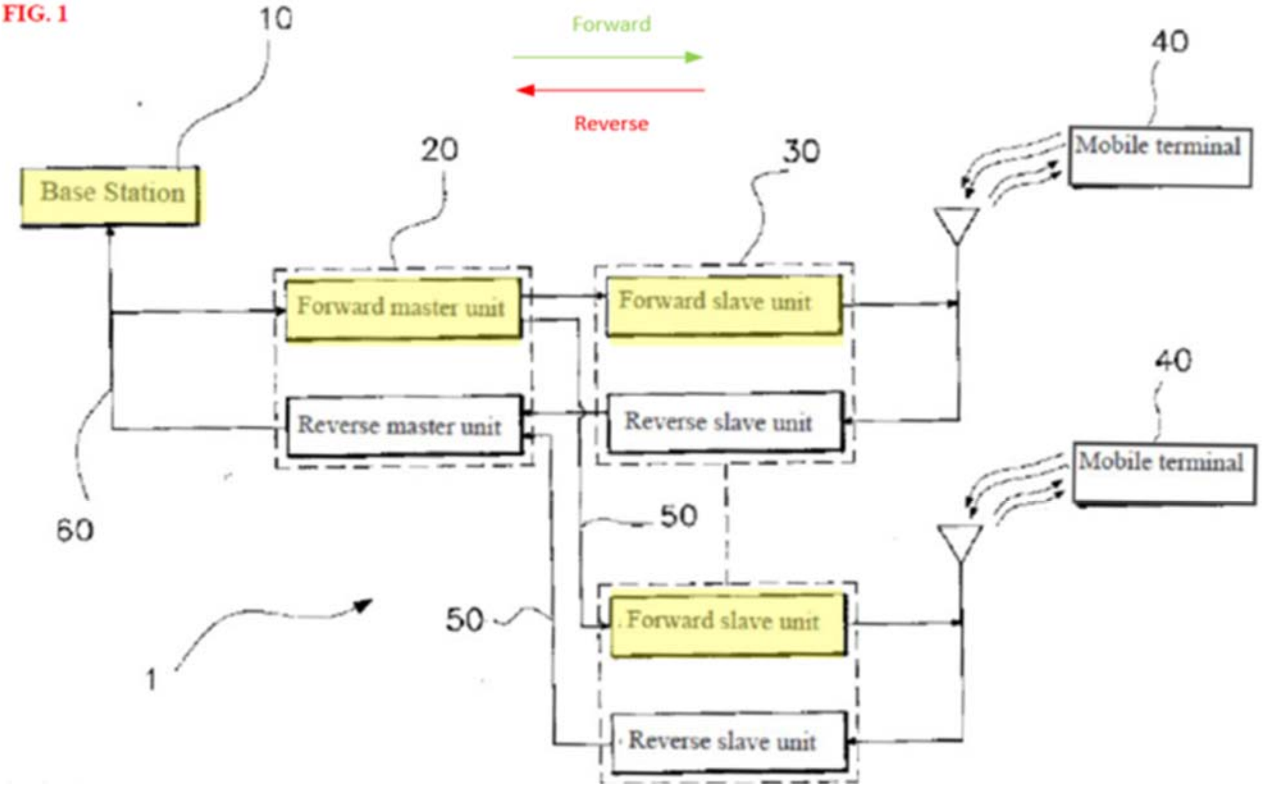
15. Independent Claim 33

(a) Preamble

To the extent the preamble of claim 33 is limiting, it is rendered obvious by Oh.

Oh discloses digital radio frequency transport for the reasons noted above in addressing the preamble of claim 14. Oh's disclosure of point-to-multipoint digital radio frequency transport is evidenced in FIG. 1, where the master unit 20 receives RF signals from base station 10.

FIG. 1



RF signals from base station 10 are downconverted and converted to digital representations at 180. The digital signals from A/D converter unit 180 are then transmitted from the forward master unit forward slave units of multiple slave units 30 via optic lines 50. Ex. 1007, 3:38-44.

Oh therefore renders obvious each limitation recited in the preamble of claim 28 by disclosing point (master unit 20) to multipoint (multiple slave units 30) digital radio frequency (digital samples of intermediate frequency/baseband analog signals from the base station 10) transport (transmission of those digital signals from the master unit 20 to the slave units 30 across optic lines 50). Ex. 1005, ¶¶330-332.

(b) Element 1

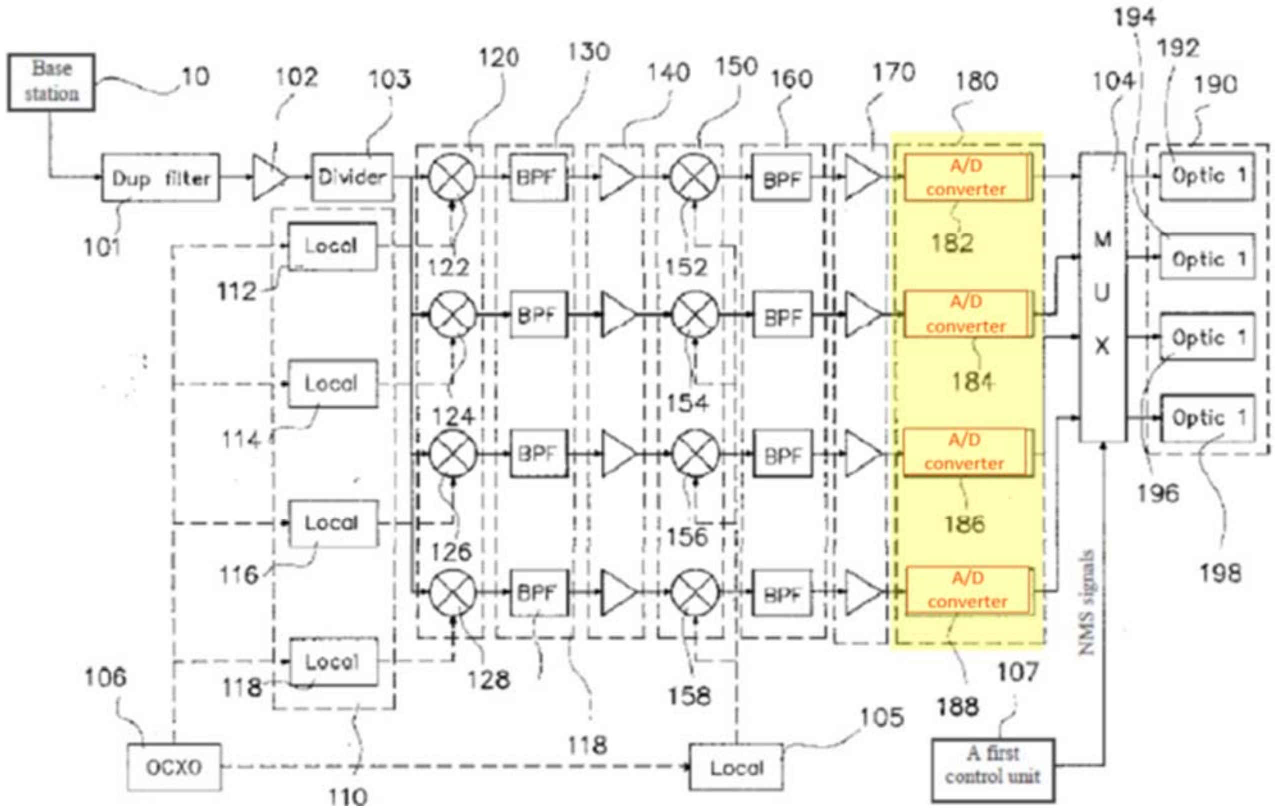
Oh states that the forward master unit 100 of the master unit 20 "executes a first means that converts RF signals, analog signals, transmitted from the base station 10 to the intermediate frequency signals; converts them to digital signals; and transmits them to the slave unit 30 through the optic line 50." Ex. 1007, 3:4-6.

Oh renders obvious receiving radio frequency signals (RF signals from base station 10) at a digital host unit (master unit 20). Ex. 1005, ¶333.

(c) Element 2

Following receipt from base station 10, Oh's forward master unit divides the received analog RF signal at 103 into its component frequency bands, downconverts those frequency band signals to near DC at 120-270, and digitizes those component band signals at A/D converter unit 180. Ex. 1007, 3:6-18.

FIG. 2

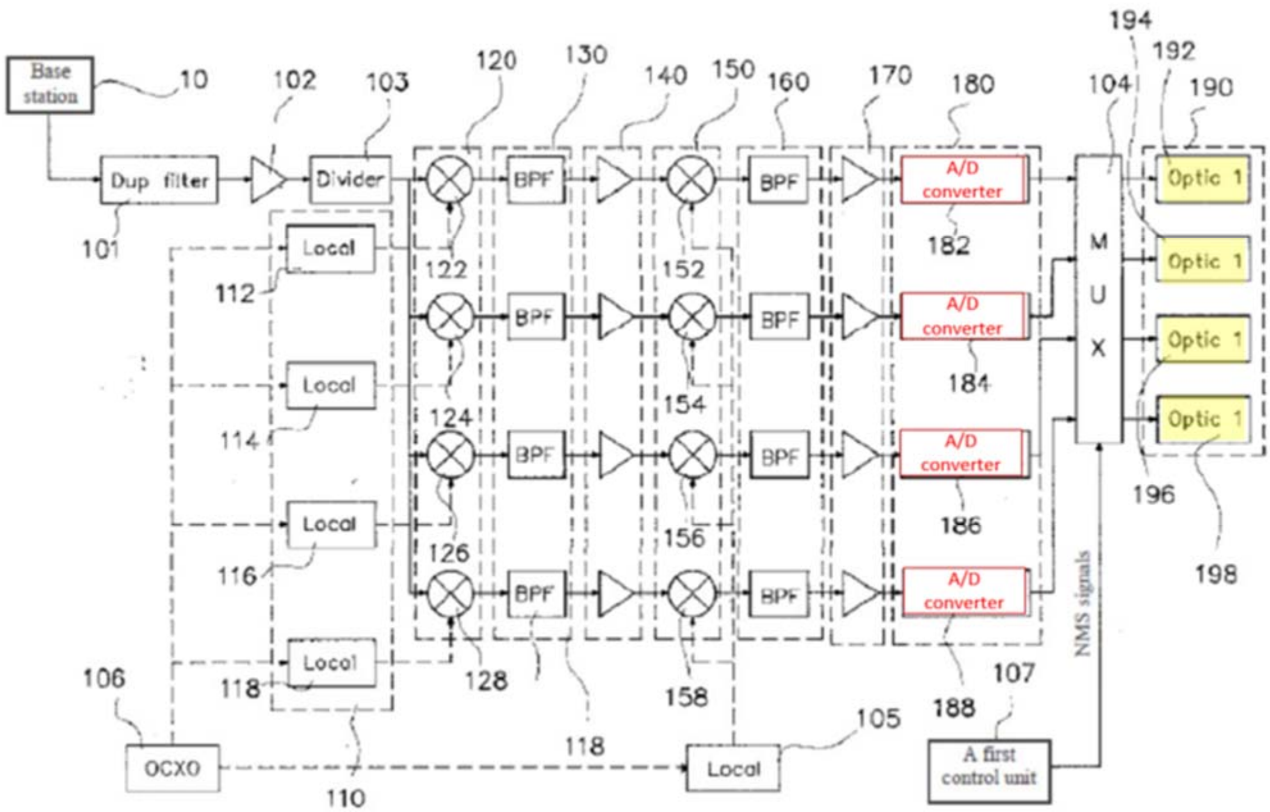


By disclosing an A/D converter unit 180 that digitizes the component analog signals for transmission of digital samples to multiple remote units, Oh renders obvious converting (at 180) the radio frequency signals to a digitized radio frequency spectrum. Ex. 1005, ¶¶334-335.

(d) Element 3

Oh discloses "a first MUX 104 that [multiplexes] all digital signals transmitted from said first A/D converter unit 180 with the NMS signals transmitted from a first control unit 107 and outputs the serial data signals to the forward slave unit 200 of the slave unit 30 through a first optic converter unit 190 and the optic line 50." Ex. 1007, 3:16-18; 38-44.

FIG. 2



Schwartz discloses transmitting forward path signals to multiple remote units and a digital expansion unit.

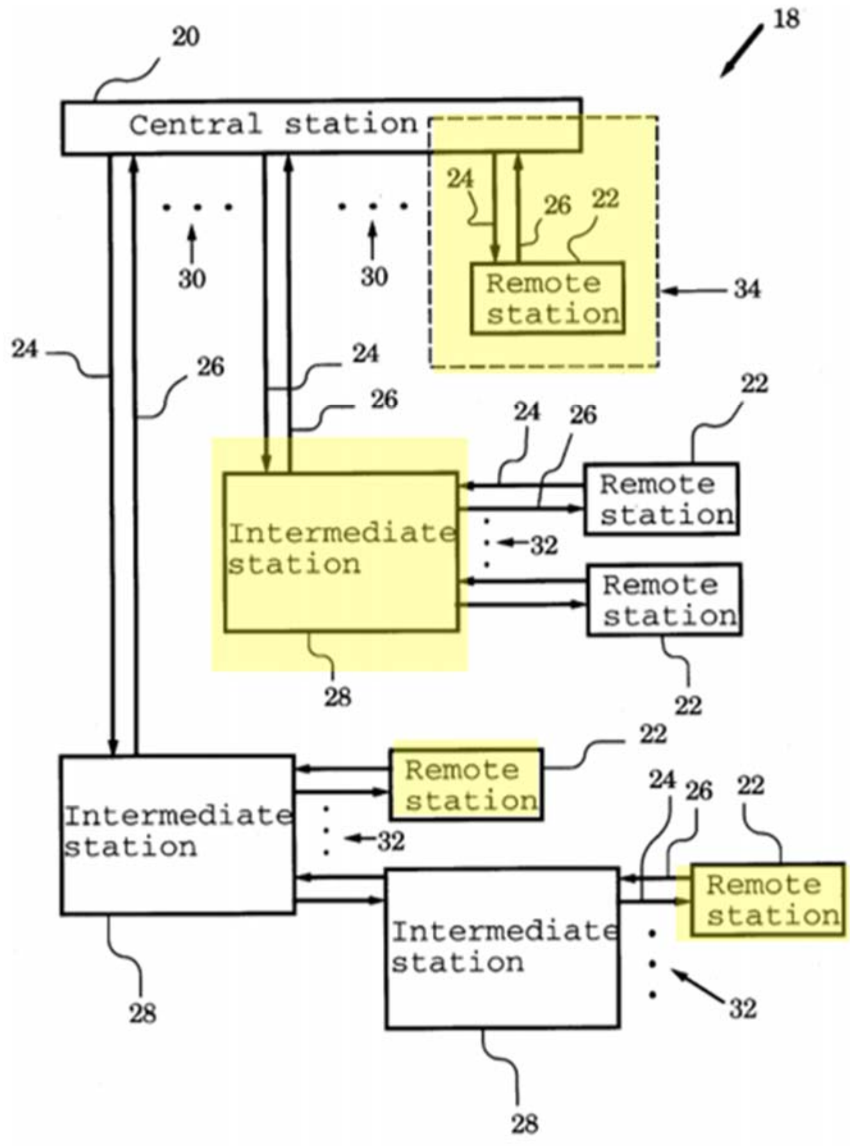
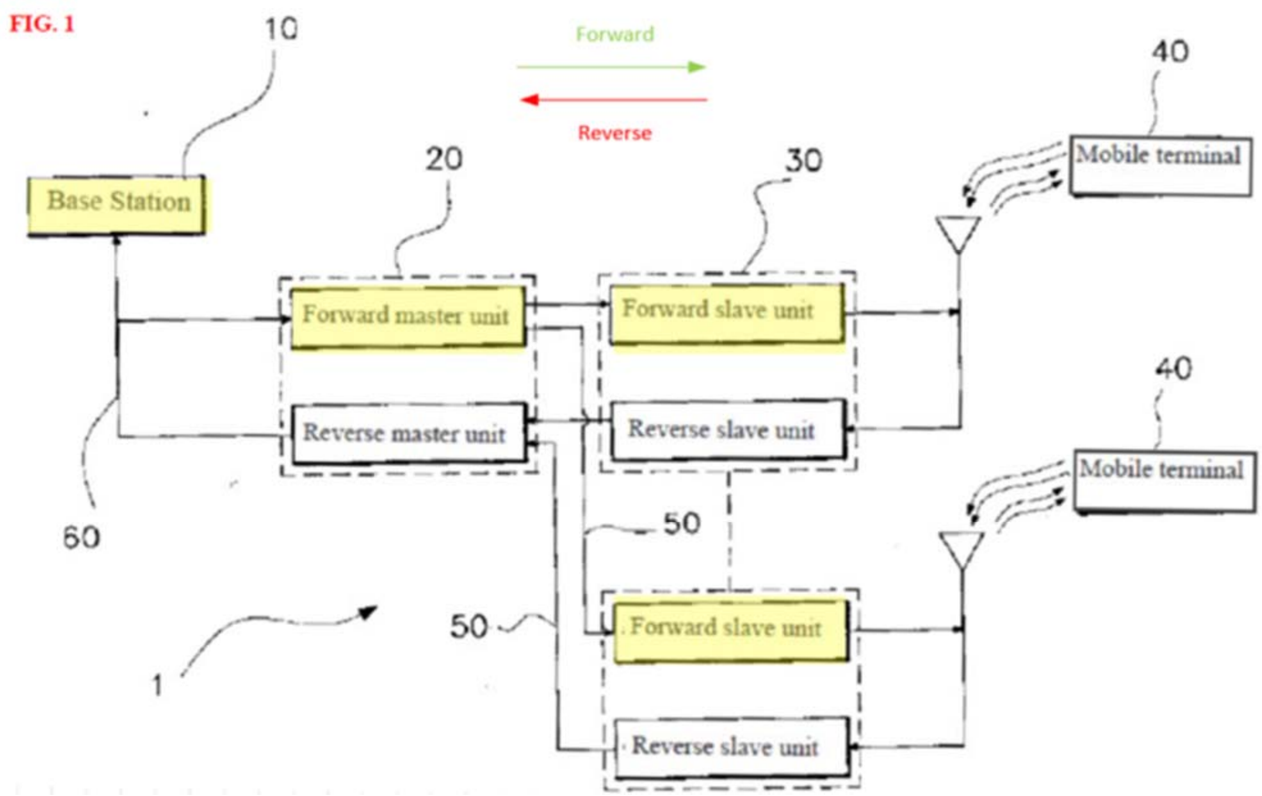


FIG. 1

Oh renders obvious optically transmitting (using optic converters 192, 194, 196, 198) the digitized radio frequency spectrum output by the shared analog-to-digital converter (A/D converter unit 180) to a plurality of digital remote units (slave units 30/remote stations 22) and at least one digital expansion unit (intermediate station 28). Ex. 1005, ¶¶336-337.

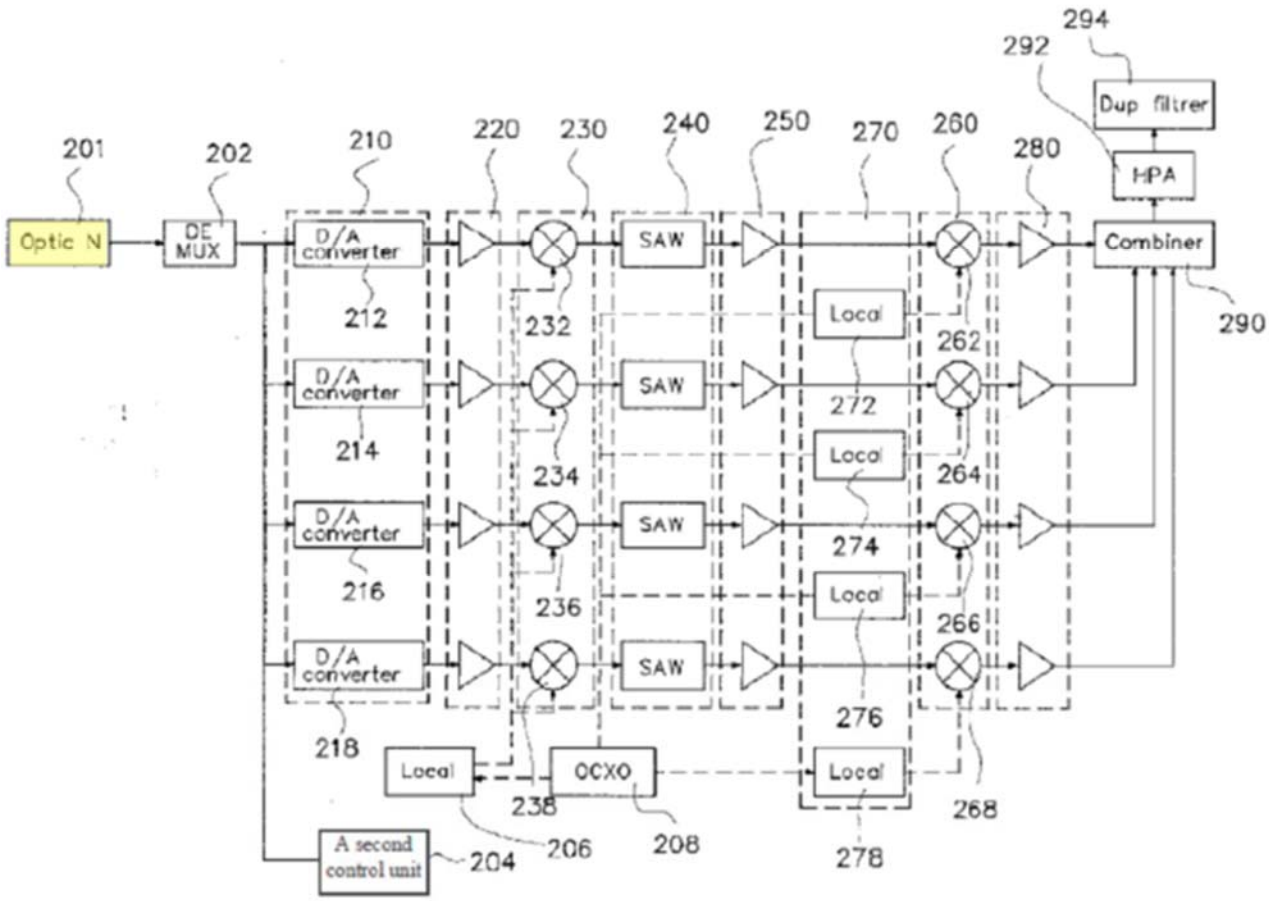
(e) Element 4

Oh discloses that the optic converter unit 190 transmits digitized radio frequency spectrum data to multiple slave units over optic line 50 as depicted in FIG. 1. Ex. 1007, 3:16-18; 38-44.



The forward slave unit 200 of the slave unit 30 "converts the digital signals transmitted from the master unit 20 through the optic line 50 to the intermediate frequency signals, analog signals; converts them to the RF signals and transmits them to the mobile terminals 40." Ex. 1007, 3:47-49.

FIG. 3

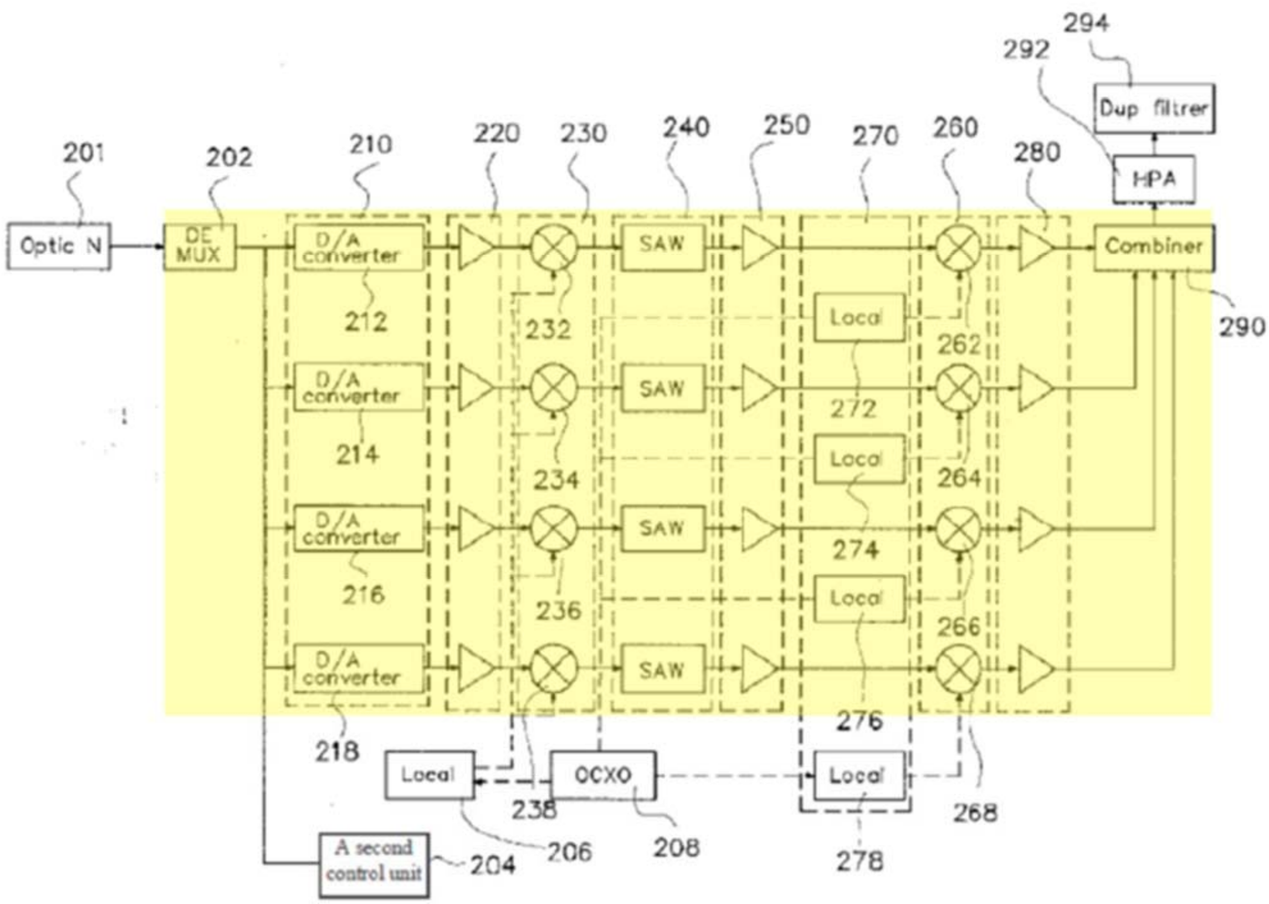


Oh in view of Schwartz renders obvious receiving the digitized radio frequency spectrum (digital samples from master unit 20) at the plurality of digital remote units (slave units 30 at 201 positioned at the locations of Schwartz remote stations 22 highlighted in referencing element 3 above). Ex. 1005, ¶¶338-340.

(f) Element 5

Oh discloses that the forward slave unit 200 of the slave unit 30 "converts the digital signals transmitted from the master unit 20 through the optic line 50 to the intermediate frequency signals, analog signals; converts them to the RF signals and transmits them to the mobile terminals 40." Ex. 1007, 3:47-49. That process is described in further detail at 3:50-61, where the digital samples from the master unit 20 are routed for recreation of the component analog band signals and upconverted to component analog radio frequency signals which are combined at 290 (*i.e.*, analog combining) prior to transmission to mobile terminals 40. Ex. 1005, ¶58.

FIG. 3



Oh renders obvious converting the digitized radio frequency spectrum (digital sample data received from master unit 20 at 201) to analog radio frequency signals (converting from digital to analog signals, upconverting the analog signals to their respective band frequencies, and analog combining to form analog radio frequency signals for transmission to mobile terminals 40) at each of the first plurality of digital remote units (slave units 30). Ex. 1005, ¶¶341-342, 58.

(g) Element 6

As noted above with reference to Element 3, in the Oh-Schwartz combination, digital RF data from the host unit (master unit 20) is transmitted to a digital expansion unit placed in an RF distribution network topology as Schwartz's intermediate station 28 is. That intermediate station 28 receives the digital RF data from the host unit.

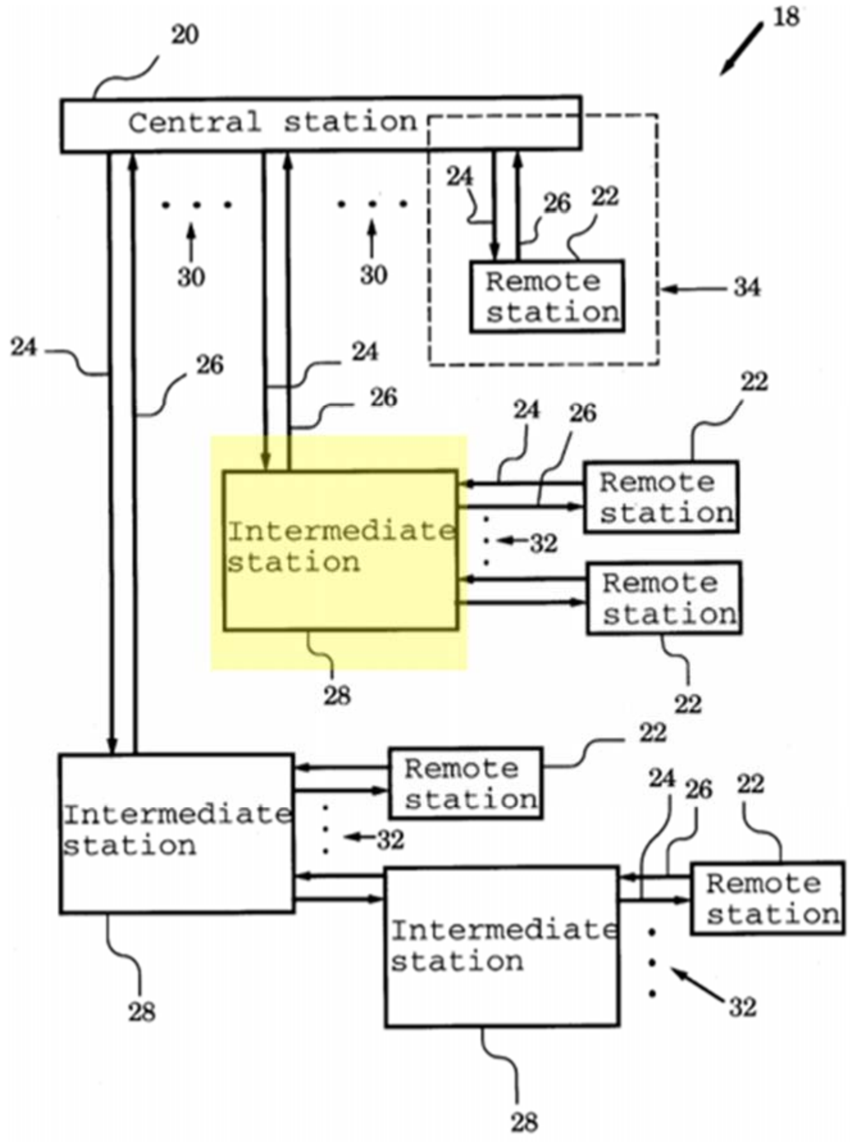


FIG. 1

Oh in view of Schwartz renders obvious receiving the digitized radio frequency spectrum at the at least one digital expansion unit (intermediate station 28). Ex. 1005, ¶¶343-344.

(h) Elements 7, 8: "optically transmitting a second digitized radio frequency spectrum to a second plurality of digital remote units; receiving the second digitized radio frequency spectrum at the second plurality of digital remote units;"

As illustrated below, the Schwartz intermediate station 28 highlighted in discussing element 6 forward its RF data to the two highlighted remote stations 22, which are different from the remote stations 22 highlighted in referencing element 4 above. In the Oh-Schwartz combination, that RF data would be digital sample data from Oh's master unit 20 transmitted across optic lines 50, which would be forwarded through intermediate station 28, similar to how intermediate station 28 forwards analog RF data in its prior art system.

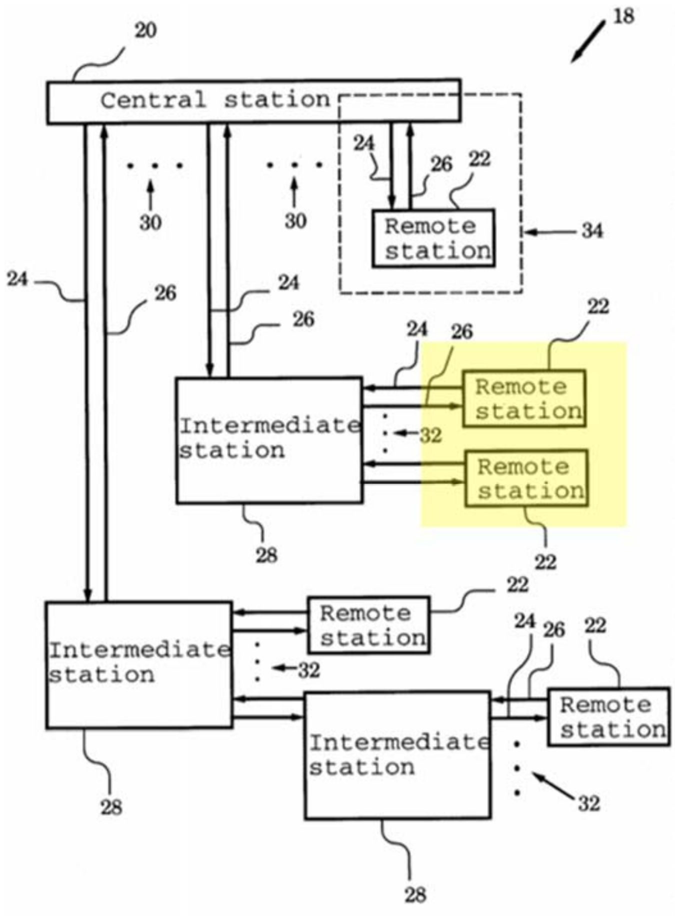


FIG. 1

Oh in view of Schwartz renders obvious optically transmitting a second digitized radio frequency spectrum to a second plurality of digital remote units (remote stations 22 highlighted above, which are different from those highlighted with reference to element 4 above); and receiving the second digitized radio frequency spectrum at the second plurality of digital remote units (22). Ex. 1005, ¶¶345-346.

(i) Element 9

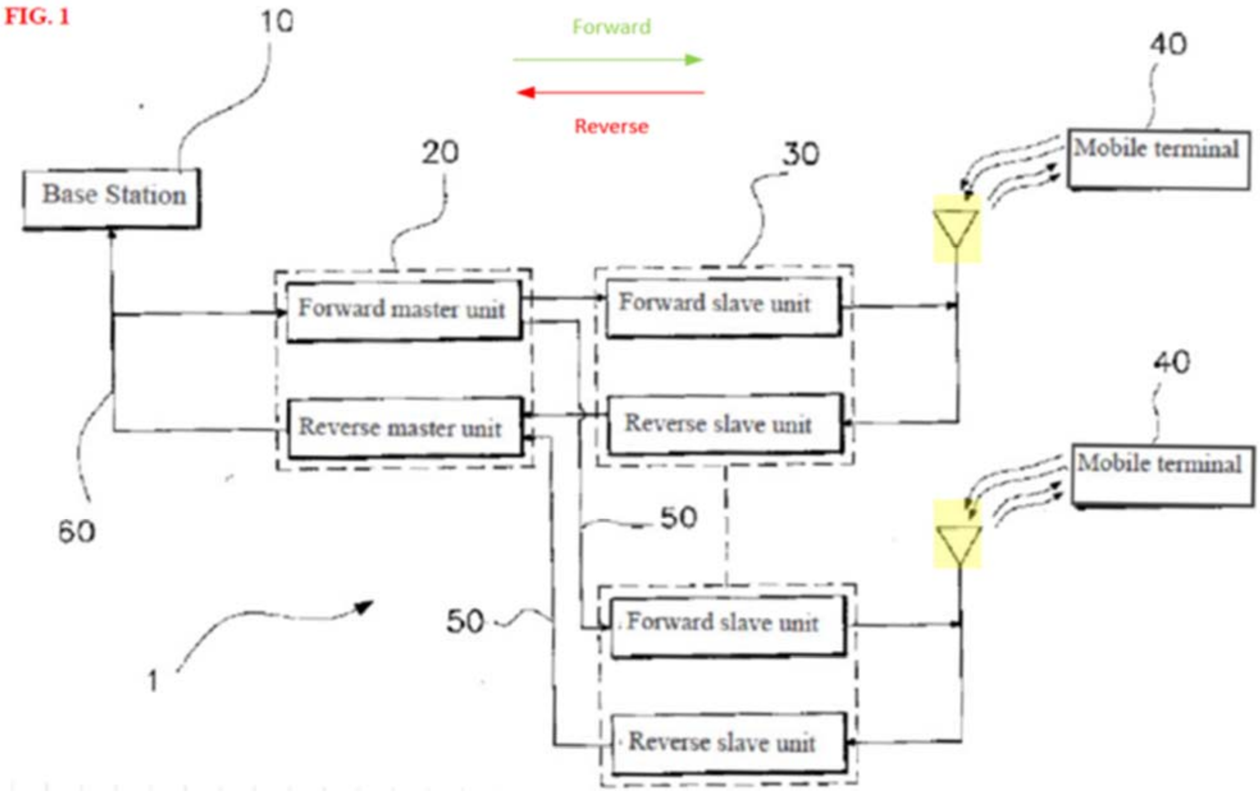
As discussed above with reference to element 5, all of the remote units in the Oh-Schwartz combination, including the two highlighted with reference to elements 8 and 9 above, convert digital RF data originating from the host unit (master unit 20) to analog radio frequency signals in preparation for transmission.

Oh in view of Schwartz renders obvious converting the second digitized radio frequency spectrum (digital sample data received from master unit 20 at 201) to analog radio frequency signals (converting from digital to analog signals, upconverting the analog signals to their respective band frequencies, and analog combining to form analog radio frequency signals for transmission to mobile terminals 40) at each of the second plurality of digital remote units (slave units 30 positioned at the positions of remote stations 22 highlighted with reference to elements 8 and 9). Ex. 1005, ¶¶347-348, 58.

(j) Element 10

Oh discloses that the digital signals from the master unit 20 are converted to analog, upconverted to RF, and transmitted to the mobile terminals 40. Ex. 1007, 3:47-49. Fig. 1 of Oh depicts the main frequency antenna associated with each slave unit 30 for bidirectional communications with the mobile terminals 40.

FIG. 1



Oh renders obvious transmitting the analog radio frequency signals (analog combined signals from combiner 290) via a main radio frequency antenna at each of the plurality of digital remote units (slave units 30 positioned, one each at the remote station 22 positions of Fig. 1 of Schwartz). Ex. 1005, ¶¶349-350.

16. Independent Claim 36

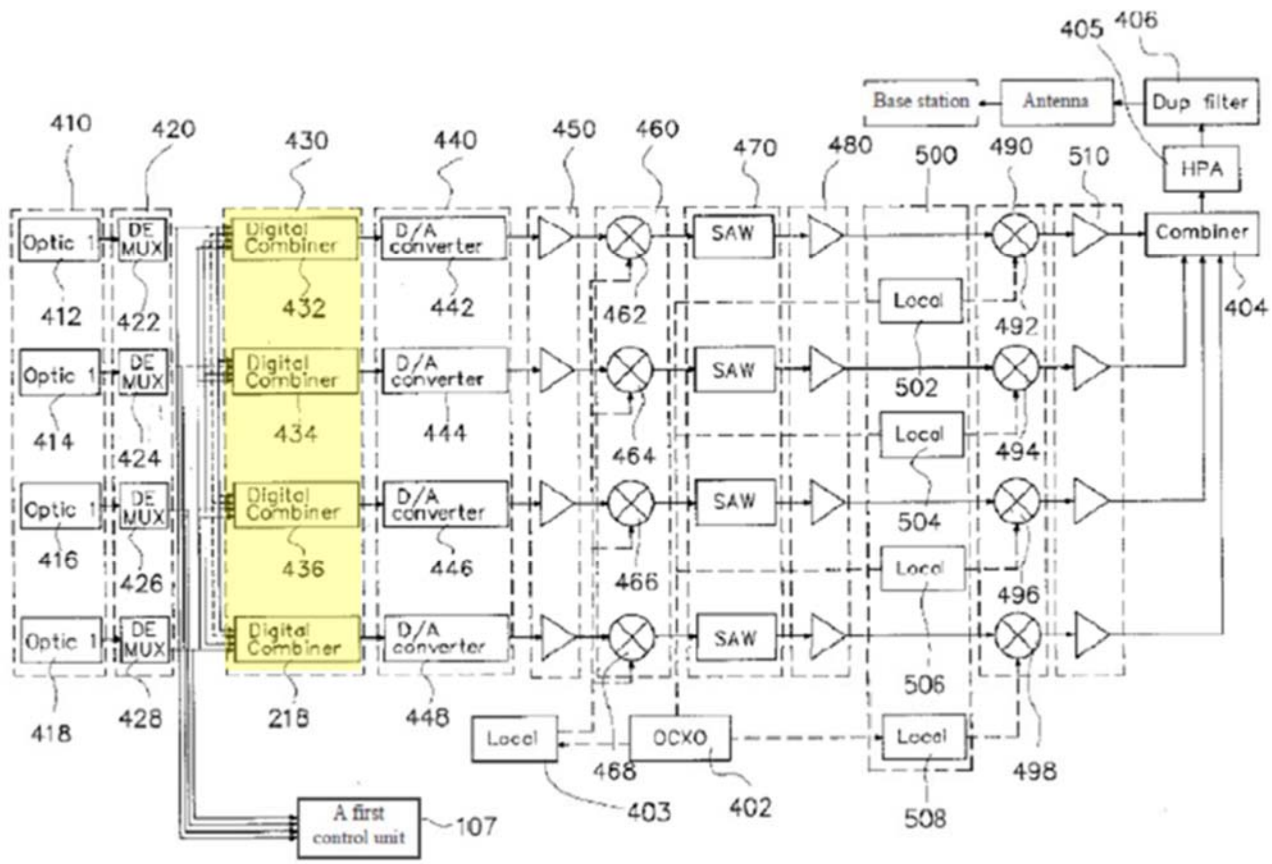
(a) Preamble and Element 1a

Claim 36's preamble recites "A digital radio frequency transport system." Element 1a recites "a digital host unit." Those elements are rendered obvious by Oh for the reasons noted above with respect to the preamble and element 1 of claim 14. Ex. 1005, ¶351.

(b) Element 1b: "wherein the digital host unit includes a channel summer to digitally sum digitized RF signals received at the digital host;"

As noted above with reference to claim 14, element 4, Oh's master unit 20 includes digital combiners 432, 434, 436, 438. Upon receiving four 12-bit signals (1 from each of demultiplexer 422, 424, 426, 428), each digital combiner 432, 434, 436, 438 performs digital combining by "creating 14-bit intermediate frequency signal by combining four 12-bit intermediate frequency signals in the same frequency band." Ex. 1007, 5:16-17; Ex. 1005, ¶58.

FIG. 5



Each Oh digital combiner is associated with a "frequency band" (Ex. 1007, 5:16-

17) (*i.e.*, a channel).

Oh renders obvious the digital host unit (master unit 20) includes a channel summer (any of 432, 434, 436, 438) to digitally sum digitized RF signals received at the digital host. Ex. 1005, ¶¶352-353.

(c) Elements 2 and 3

Elements 2 and 3 are rendered obvious by Oh in view of Schwartz for the reasons presented above in addressing claim 14, elements 2 and 3. Ex. 1005, ¶354.

C. Ground 1c: Claims 52-64 and 70-73 Are Obvious Over Oh in view of Koschek

1. Independent Claim 52

(a) Motivation to Combine

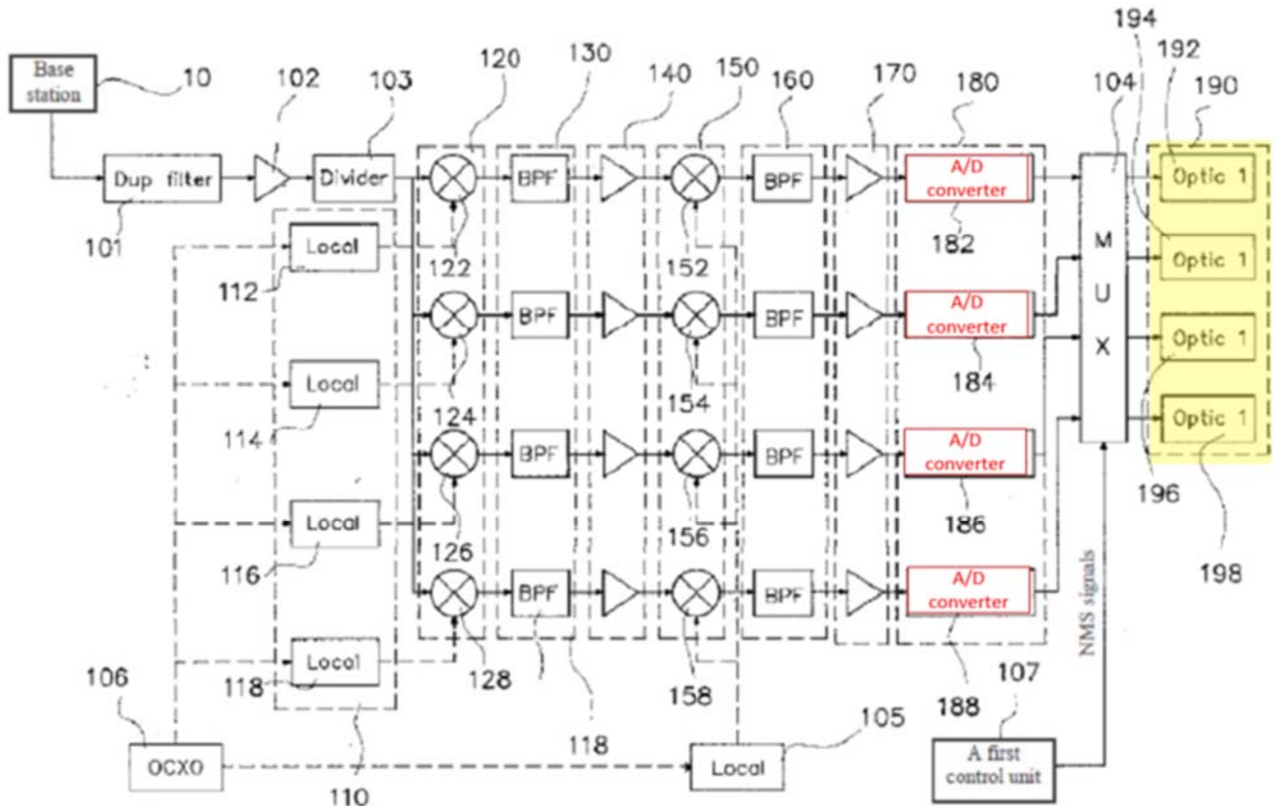
A POSITA would be motivated to combine Oh and Koschek for several reasons. First, the Oh and Koschek systems are highly compatible in that they both provide RF transport systems for extending RF communications into hard to reach areas, such as buildings and tunnels. *Compare* Ex. 1007, 2:4-13; Ex. 1013, 1:12-16. On a reverse path, both Oh and Koschek receive RF signals via an antenna at remote units, the remote units and send them to upstream units where those signals are combined with other received analog signals received at different remote units. *Compare* Oh combining at 430 with Koschek combining at 136 ("[s]ignals received by antenna 134 and input circuit 112 are combined" 4:8-10).

While Oh is silent as to powering of its remote slave units 30, Koschek states that remote unit power may be routed along with the signal cables, in the same or a co-located cable). Ex. 1013, 5:41-45. Providing power from a central location enables placement of remote units in locations where power may not be easily accessible (*e.g.*, at a point not near a wall power outlet). Because an installer will need to run signal lines when installing an Oh or Koschek system, it makes sense for them to provide power to remote units in the network at that time of installation, either using "power transmitted down the signal or other cables," where the added labor of such power during signal line installation is minimal. Ex. 1005, ¶¶355-356.

(b) Preamble and Element 1

The preamble and element 1 of claim 52 are rendered obvious by Oh for the reasons provided above for element 1 of claim 65, where Oh discloses optic converter unit 190 that provides an interface from master unit 20 to slave units 30 for transmission of the digitized RF samples that are used at the slave units 30 to reconstitute the RF signal received from the base station 10 for broadcast over the slave unit 30 antennas. Ex. 1005, ¶357.

FIG. 2



(c) Element 2

Oh is agnostic as to how its remote slave units 30 are powered. Koschek states that the amplifiers in its remote terminal/connecting stages may be powered in a variety of ways, including power from a central point in the network. Koschek states that "[e]ach amplifier may be powered … remotely, from power transmitted down the signal or other cables. In [that] configuration, a single, DC power supply may be located at any centrally convenient point in the system." Ex. 1013, 5:37-45. A POSITA would understand Oh's master unit 20 to be precisely such a "centrally convenient point in the system" from which it would be obvious to route power.

Oh in view of Koschek renders obvious a power distribution interface (to provide power from master unit 20) configured to provide power to at least one of the plurality of second units (remote slave units 30). Ex. 1005, ¶¶358-359.

(d) Elements 3 and 4

Elements 3, 4 of claim 52 is rendered obvious by Oh for the reasons provided for elements 2, 3 of claim 65, respectively. Ex. 1005, ¶360.

(e) Elements 5 and 6: "wherein the upstream digital RF samples received from the plurality of second units have an associated resolution; and wherein the upstream digital RF samples are digitally summed with a resolution that is greater than the resolution associated with the upstream digital RF samples being digitally summed."

Oh discloses that its A/D converters sample the downconverted analog signals at each frequency band at 12-bits of resolution. Ex. 1007, 3:38-39; 3:61-64; 4:16. On the reverse path at the master unit 20, each digital combiner 432, 434, 436, 438 performs digital combining to "creat[e] 14-bit intermediate frequency signals by combining four 12-bit intermediate frequency signals in the same frequency band." *Id.*, 5:16-17; Ex. 1005, ¶58.

Oh renders obvious wherein the upstream digital RF samples received from the plurality of second units have an associated resolution (12-bit resolution).

Oh further renders obvious wherein the upstream digital RF samples are digitally summed with a resolution (14 bits) that is greater than the resolution associated with the upstream digital RF samples being digitally summed (12 bits). Ex.

1005, ¶361.

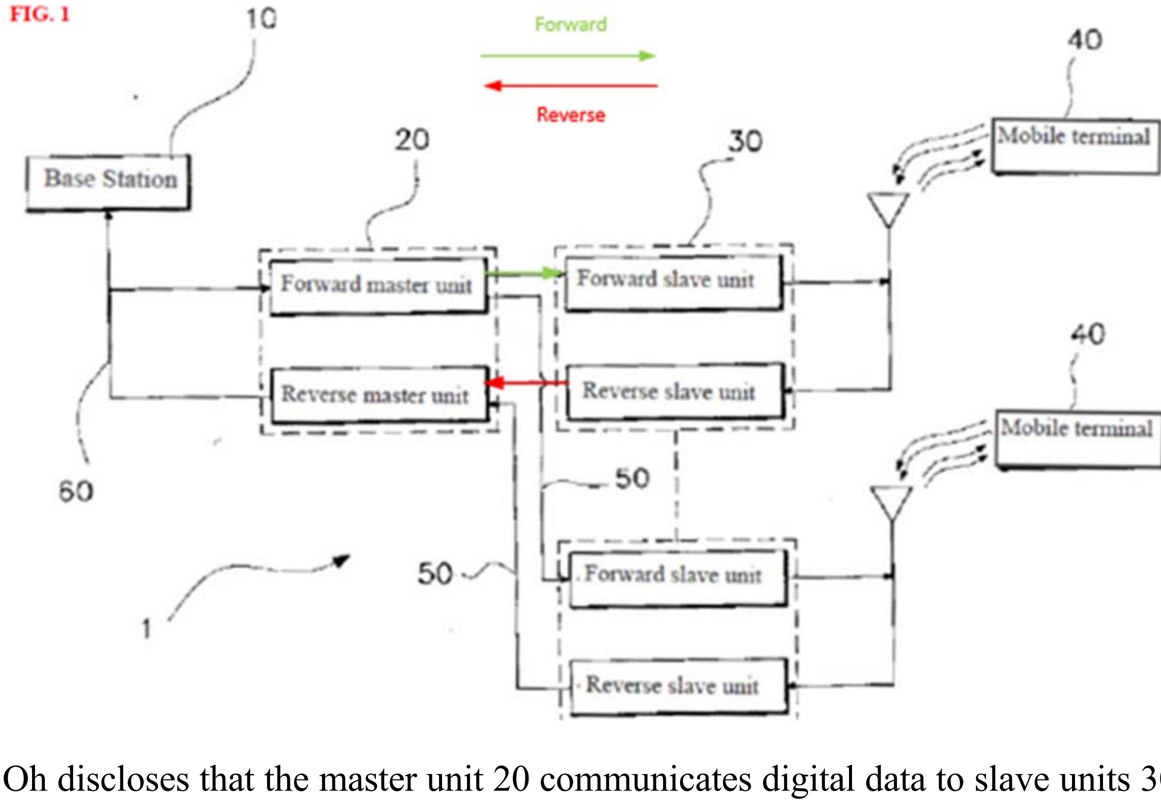
2. Dependent Claim 53

Claim 53 is rendered obvious by Oh for the reasons provided above for claim 66. Ex. 1005, ¶362.

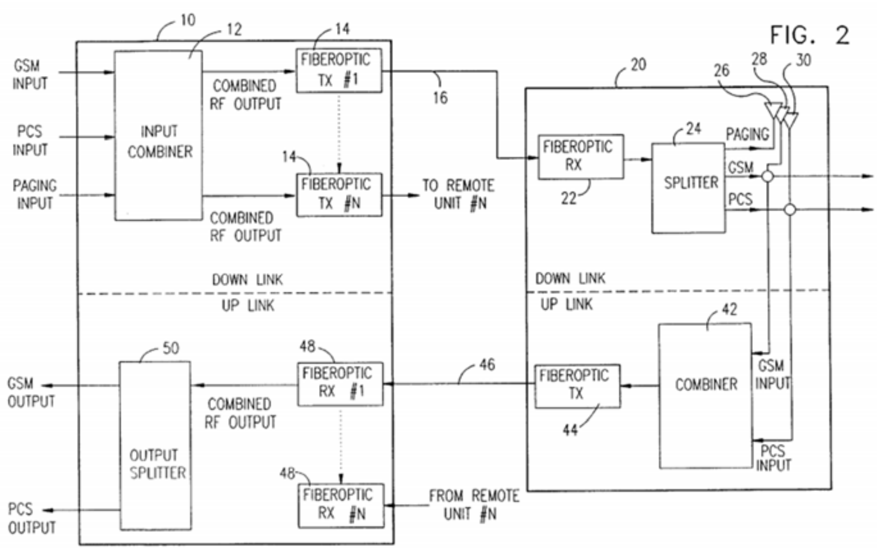
3. Dependent Claim 54

Oh Fig. 1 illustrates master unit 20 communicating in the forward direction to a slave unit 30 using a first optic line 50, highlighted in green, and in the reverse direction from a slave unit using a second optic line 50 highlighted in red. Oh discloses master unit 20 communicating with each slave unit 30 via fiber pairs.

FIG. 1



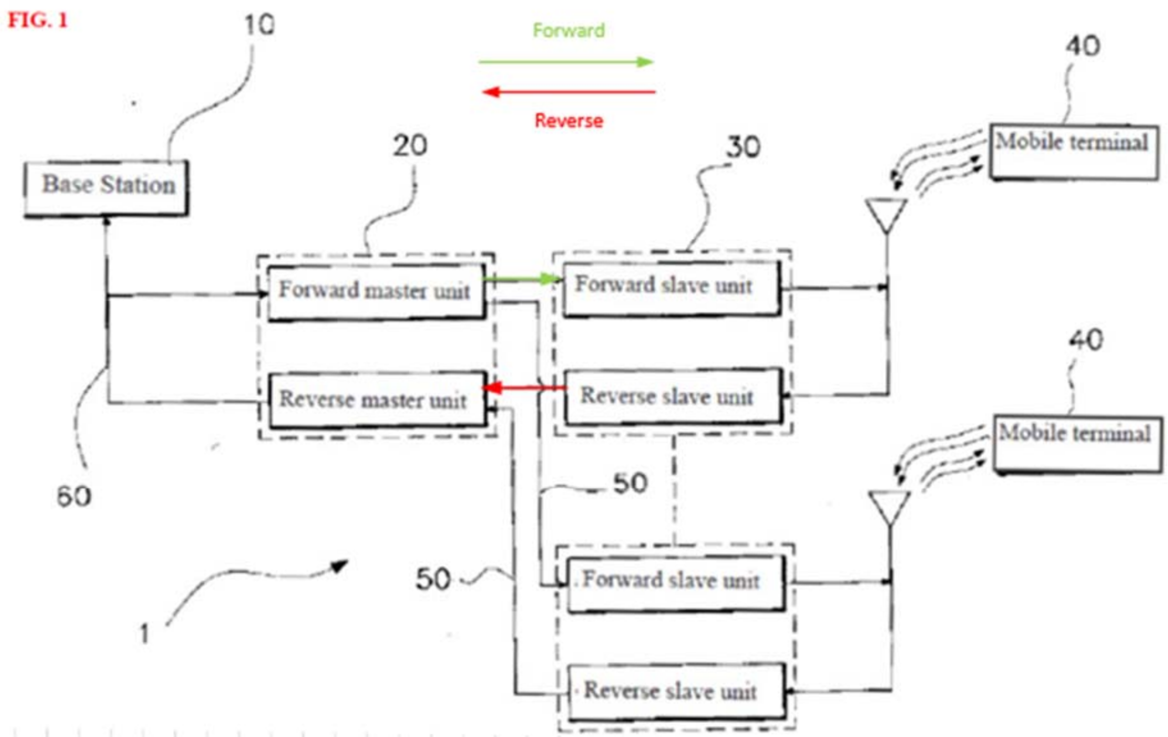
Oh discloses that the master unit 20 communicates digital data to slave units 30 via optic lines 50. Ex. 1007, 3:4-6. Oh is agnostic as to whether multimode or single mode fiber is used. A POSITA would consider selection of multimode or single mode to be a matter of design choice. This is evidenced by Farber which describes the use of single or multimode fiber in an antenna system for reaching difficult coverage areas (*see*, Fig. 1) that is very similar to the digital system of Oh. Ex. 1022 ("Farber"), 4:30-33 ("Preferably the transmitter 14 employs a vertical cavity surface emitting laser or an edge emitting laser coupled to a single or multi-mode fiber 16."); Fig. 2. As further evidence of obviousness of using single or multimode fiber, Haas illustrates the cost-benefit analysis of selection of multimode or single mode fiber for an application. Ex. 1012, 1125. A POSITA would have been motivated to select multimode fiber as disclosed by Haas for communicating among a host and remote units when cost is a significant factor for the project. Additionally as disclosed by Haas, in some instances multimode fiber may already be installed in an area into which an RF distribution network is being implemented, making reuse of that multimode fiber an attractive option.



A POSITA would have considered it obvious to select one of the two possible choices to implement optic lines 50, where the claim encompasses both possible choices. Ex. 1005, ¶¶363-366.

4. Dependent Claim 55

Oh Fig. 1 illustrates master unit 20 communicating in the forward direction to a slave unit 30 using a first optic line 50, highlighted in green, and in the reverse direction from a slave unit using a second optic line 50 highlighted in red.



Oh renders obvious the interface (Fig. 2, 190; Fig. 4 410) is operable to communicatively couple the first unit (20) to at least one second unit (30) using a pair of optical fibers, wherein a first optical fiber (50, green) included in the pair is used to communicate the at least a portion of the downstream digital RF samples to the at least one second unit and a second optical fiber (50, red) included in the pair is used to receive respective upstream digital RF samples from the at least one second unit. Ex. 1005, ¶¶367-368.

5. Dependent Claim 56 and 57

Dependent claims 56 and 57 are rendered obvious by Oh for the reasons provided above with reference to claims 68 and 69, respectively. Ex. 1005, ¶370.

6. Independent Claim 58

(a) Preamble and Elements 1-2

Oh renders obvious a system for bi-directional radio frequency distribution that includes a host unit (master unit 20) and a plurality of other units (remote slave units 30) coupled to the host unit using at least one communication medium (optic lines 50), wherein the plurality of other units are located remotely from the host unit. Ex. 1005, ¶371.

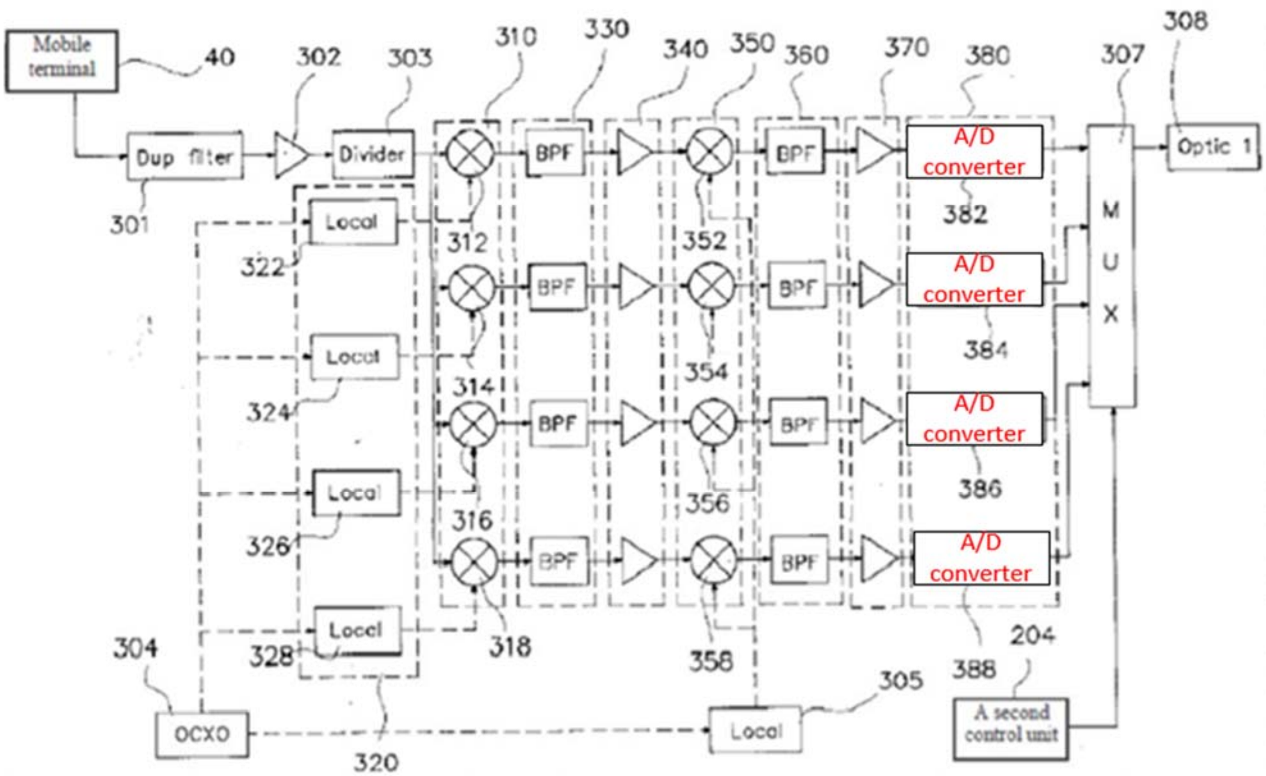
(b) Elements 3-6

Elements 3-6, describing host unit components, are rendered obvious by Oh in view of Koschek for the reasons provided above with reference to elements 1-4 of claim 52. Ex. 1005, ¶372.

(c) Element 7: "wherein each of the other units digitizes an original upstream analog radio frequency signal produced for radiation from a respective antenna in order to produce the upstream digital RF samples, at least a portion of which are communicated to the host unit, wherein the upstream digital RF samples have an associated resolution;"

Each Oh slave unit 30 receives an analog signal from a mobile terminal 40, divides the received analog signal into its component frequency bands at 303 and downconverts the frequency band signals to near DC at 310-370. Ex. 1007, 4:26-34. The downconverted band signals are then sampled at 380 to create 12-bit digitized radio frequency signals. *Id.*, 4:56-61. The multiplexer 307 multiplexes the four 12-bit samples with 4 bits of control data from 204 to form 52-bit serial data signals that are forwarded to master unit 20. *Id.*

FIG. 4



Oh renders obvious each of the other units (30) digitizes an original upstream analog radio frequency signal produced for radiation from a respective antenna (from mobile terminals 40) in order to produce the upstream digital RF samples, at least a portion of which are communicated to the host unit (20), wherein the upstream digital RF samples have an associated resolution (12 bit samples). Ex. 1005, ¶¶373-374.

(d) Elements 8-10

Element 8 is rendered obvious by Oh for the reasons provided above for element 6, where the summer resolution is 14 bits compared to the 12 bit resolution of the digital samples being summed.

Element 9 is rendered obvious by Oh for the reasons provided above for element 5 of claim 33.

Element 10 is rendered obvious based on Oh in view of Koschek for the reasons provided for claim 52, element 2, where amplifiers of the remote and intermediate stations are powered from a "DC power supply [that] may be located at any centrally convenient point in the system," such as at Oh's master unit 20. Ex. 1005, ¶375.

7. Dependent Claims 59-63

Dependent Claims 59-63 are rendered obvious by Oh in view of Koschek for the reasons provided above for claims 53-57, respectively. Ex. 1005, ¶376.

8. Independent Claim 64

(a) Preamble and Elements 1-6

Oh renders obvious the preamble and elements 1-2 of claim 64 for the reasons provided above for claim 52's preamble and element 1.

Elements 3-5 of claim 64 are rendered obvious by Oh for the reasons provided above for elements 3-6 of claim 52.

Element 6 of claim 64 regarding power distribution is rendered obvious by Oh in view of Koschek for the reasons provided above for claim 52, element 2. Ex. 1005, ¶377.

9. Independent Claim 70

(a) Preamble through Host Unit Limitations

Oh renders obvious the preamble of claim 70 through the initial host unit limitations (*i.e.*, through "wherein each of the summed upstream…") and further through the five limitations describing mixing operations at the host unit the reasons provided above for claim 65. Ex. 1005, ¶378.

(b) The Other Unit Limitations

Remote unit digitization of upstream data is disclosed by Oh for the reasons provided above for claim 58, limitation 7. Conversion of downstream digital data to analog for transmission is rendered obvious by Oh for the reasons provided above for claim 33, elements 4-5. Ex. 1005, ¶379.

(c) Remote Powering Of Other Units

The final limitation is disclosed by Oh in view of Koschek for the reasons provided for claim 52, element 2. Ex. 1005, ¶380.

10. Dependent Claims 71-73

Dependent claims 71 and 72 is rendered obvious by Oh for the reasons provided above for claims 66 and 67, respectively. Claim 73 is a broader form of claim 71 and is also rendered obvious by Oh for the reasons provided for claim 66 above. Ex. 1005, ¶381.

VI. Mandatory Notices Pursuant to 37 C.F.R. § 42.8(a)(1)

Pursuant to 37 C.F.R. § 42.8(a)(1), the mandatory notices identified in 37 C.F.R.

§ 42.8(b) are provided below as part of this petition.

A. 37 C.F.R. § 42.8(b)(1): Real Parties-In-Interest

SOLiD, Inc., SOLiD Gear, Inc., SOLiD Technologies, Inc., and SOLiD Gear Pte, Ltd. are the real parties-in-interest for Petitioner.

B. 37 C.F.R. § 42.8(b)(2): Related Matters

The '982 patent was the subject of litigation in *CommScope Technologies LLC v. SOLiD Gear, Inc. et al*., No. 3-20-cv-01285 (N.D. Tx.), filed on May 18, 2020. That litigation was dismissed without prejudice on January 6, 2021. IPR petitions for the remaining asserted patents of this litigation are being filed concurrently herewith. A second petition challenging claims of the '982 patent that are not addressed in this petition is also filed concurrently.

The '982 patent is also currently the subject of litigation in *CommScope Technologies LLC v. Dali Wireless Inc.*, No. 3-16-cv-00477 (N.D. Tx.), filed on February 1, 2016, now on appeal to the Federal Circuit in *CommScope Technologies LLC v. Dali Wireless Inc.*, 20-1817; -1818. Petitioner is uninvolved in that litigation.

CommScope Technologies LLC v SOLiD Technologies, Inc. High Court of Justice (Patents Court), Business and Property Courts of England & Wales, Claim number HP-2020-000017, is a further litigation involving the parties here.

C. 37 C.F.R. § 42.8(b)(3), (4): Lead And Back-Up Counsel And Service Information

Petitioner provides the following designation of counsel:

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Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this petition. Please address all correspondence to lead and back-up counsel at the addresses above. Petitioner also consents to electronic service by email at the email addresses listed above.

Dated: August 12, 2021 Respectfully submitted,

/s/ Matthew W. Johnson

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing petition for *Inter Partes* Review of U.S. Patent No. 7,639,982, including all Exhibits, was served on August 12, 2021 via Express Mail delivery directed to the attorney of record for the patent at the following address:

FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS MN 55435

Additionally, a courtesy copy of the foregoing petition for *Inter Partes* Review of U.S. Patent No. 7,639,982, and the accompanying Declaration of Dr. Jacob Baker, was sent on August 12, 2021 to CommScope's litigation counsel via email to the following addresses:

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Date: August 12, 2021

By: /s/ Matthew W. Johnson

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CERTIFICATE OF WORD COUNT UNDER 37 C.F.R. § 42.24(a)

I, the undersigned, do hereby certify that the attached petition contains 13,977 words, as measured by the Word Count function of Microsoft Word 2016. This is less than the limit of 14,000 words as specified by 37 C.F.R. § 42.24(a)(i).

Date: August 12, 2021

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APPENDIX OF EXHIBITS

EXHIBIT NO.	TITLE
1001	U.S. Patent No. 7,639,982 ("'982 patent")
1002	U.S. Patent No. 8,326,218 ("'218 patent")
1003	U.S. Patent No. 8,577,286 ("'286 patent")
1004	U.S. Patent No. 9,332,402 ("'402 patent")
1005	Declaration of Dr. R. Jacob Baker
1006	'982 Patent File History
1007	Korean Laid-Open Disclosure No: KR1999-0064537 ("Oh")
1008	Acampora Report
1009	Philip M. Wala, "A New Microcell Architecture Using Digital Optical Transport," 1993 43rd IEEE Vehicular Technology Conference, 585 (1993) ("Wala")
1010	U.S. Patent No. 5,883,882 ("Schwartz")
1011	K. Ishida et al., "A 10-GHz 8-b multiplexer/demultiplexer chip set for the SONET STS-192 system," IEEE J. Solid-State Circuits, 1936 (1991) ("Ishida")
1012	Zygmunt Haas, "A Mode-Filtering Scheme for Improvement of the Bandwidth-Distance Product in Multimode Fiber Systems," J.

	Lightwave Tech., Vol. 11, No. 7, 1125 (1993) ("Haas")
1013	U.S. Patent No. 5,379,455 ("Koschek")
1014	U.S. Patent No. 5,631,757 ("Bodeep")
1015	U.S. Patent No. 5,265,039 ("Curbelo")
1016	'218 Patent File History
1017	'286 Patent File History
1018	'402 Patent File History
1019	U.S. Patent No. 5,774,789 ("van der Kaay")
1020	U.S. Patent No. 5,606,736 ("Hasler")
1021	U.S. Patent No. 6,496,546 ("Allpress")
1022	U.S. Patent No. 5,969,837 ("Farber")
1023	U.S. Patent No. 4,812,846 ("Noro")
1024	CommScope Complaint
1025	U.S. Patent No. 4,779,064 ("Monser")
1026	Declaration of Maria P. Garcia
1027	U.S. Patent No. 3,783,385 ("Dunn")

1028	U.S. Patent No. 7,359,447 (“Sage”)