

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been
filed in the U.S. District Court Northern District of Texas on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO. 3:16-cv-00477-B	DATE FILED 2/19/2016	U.S. DISTRICT COURT Northern District of Texas
PLAINTIFF CommScope Technologies LLC		DEFENDANT Dali Wireless Inc
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 8,326,218	12/4/2012	CommScope Technologies LLC
2 7,639,982	12/29/2009	CommScope Technologies LLC
3 8,577,286	11/5/2013	CommScope Technologies LLC
4 7,848,747	12/7/2010	CommScope Technologies LLC
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☒ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 9,332,402	5/3/2016	CommScope Technologies LLC,
2 9,031,521	5/12/2015	Dali
3 9,531,473	12/27/2016	Dali
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK Karen Mitchell	(BY) DEPUTY CLERK s/Yolanda Pace	DATE 9/13/2017

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	05/03/2016	9332402	100.019US05	6118

135878 7590 04/13/2016
Fogg & Powers LLC/Commscope
4600 W 77th St
Suite 305
Minneapolis, MN 55435

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 31 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Philip M. Wala, Savage, MN;
CommScope Technologies LLC, Hickory, NC

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

Response to Rule 312 Communication	Application No. 14/054,223	Applicant(s) WALA, PHILIP M.
	Examiner DUC M. NGUYEN	Art Unit 2647

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☒ The amendment filed on 21 March 2016 under 37 CFR 1.312 has been considered, and has been:

a) ☒ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

4/4/16

/DUC M NGUYEN/
Primary Examiner, Art Unit 2647

Issue Classification 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.	
	Examiner DUC M NGUYEN	Art Unit 2647	

CPC						
Symbol					Type	Version
H04W		4		06	F	2013-01-01
H04B		10		25754	I	2013-01-01
H04W		88		085	A	2013-01-01
H04W		88		08	I	2013-01-01
Y10S		370		906	A	2013-01-01
Y10S		370		907	A	2013-01-01
H04B		7		2606	I	2013-01-01
H04L		65		1016	A	2013-01-01
H04L		51		28	I	2013-01-01
H04L		51		38	I	2013-01-01
H03M		7		4006	I	2013-01-01
H04L		51		04	A	2013-01-01
H04L		65		1006	I	2013-01-01
H04W		4		12	A	2013-01-01
H04W		4		14	I	2013-01-01
H04N		19		139	I	2014-11-01
H04N		19		109	I	2014-11-01
H04N		19		91	I	2014-11-01
H04N		19		625	I	2014-11-01

CPC Combination Sets							
Symbol				Type	Set	Ranking	Version

NONE		Total Claims Allowed:	
(Assistant Examiner)		57	
(Date)			
/DUC M NGUYEN/ Primary Examiner.Art Unit 2647		4/4/16	
(Primary Examiner)		(Date)	
		O.G. Print Claim(s)	O.G. Print Figure
		1	6

Issue Classification 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	19	17	35	33	51	49								
2	2	20	18	36	34	52	50								
3	3	21	19	37	35	53	51								
4	4	22	20	38	36	54	52								
5	5	23	21	39	37	55	53								
6	6	24	22	40	38	56	54								
7	7	25	23	41	39	57	55								
8	8	26	24	42	40	17	56								
9	9	27	25	43	41	18	57								
10	10	28	26	44	42										
11	11	29	27	45	43										
12	12	30	28	46	44										
13	13	31	29	47	45										
14	14	32	30	48	46										
15	15	33	31	49	47										
16	16	34	32	50	48										

NONE		Total Claims Allowed:	
		57	
(Assistant Examiner) /DUC M NGUYEN/ Primary Examiner.Art Unit 2647	(Date) 4/4/16	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant						☐ CPA		☒ T.D.		☐ R.1.47	
CLAIM		DATE									
Final	Original	04/22/2015	08/06/2015	12/16/2015	04/04/2016						
1	1	✓	=	=	=						
2	2	✓	=	=	=						
3	3	✓	=	=	=						
4	4	✓	=	=	=						
5	5	✓	=	=	=						
6	6	✓	=	=	=						
7	7	✓	=	=	=						
8	8	✓	=	=	=						
9	9	✓	=	=	=						
10	10	✓	=	=	=						
11	11	✓	=	=	=						
12	12	✓	=	=	=						
13	13	✓	=	=	=						
14	14	✓	=	=	=						
15	15	✓	=	=	=						
16	16	✓	=	=	=						
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31	29	✓	=	=	=						
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33	31	✓	=	=	=						
34	32	✓	=	=	=						
35	33	✓	=	=	=						
36	34	✓	=	=	=						
37	35	✓	=	=	=						
38	36	✓	=	=	=						

<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant						☐ CPA		☒ T.D.		☐ R.1.47	
CLAIM		DATE									
Final	Original	04/22/2015	08/06/2015	12/16/2015	04/04/2016						
39	37	✓	=	=	=						
40	38	✓	=	=	=						
41	39	✓	=	=	=						
42	40	✓	=	=	=						
43	41	✓	=	=	=						
44	42	✓	=	=	=						
45	43	✓	=	=	=						
46	44	✓	=	=	=						
47	45	✓	=	=	=						
48	46	✓	=	=	=						
49	47	✓	=	=	=						
50	48	✓	=	=	=						
51	49	✓	=	=	=						
52	50	✓	=	=	=						
53	51	✓	=	=	=						
54	52	✓	=	=	=						
55	53	✓	=	=	=						
56	54	✓	=	=	=						
57	55	✓	=	=	=						
17	56				=						
18	57				=						

Applicants	Wala	AMENDMENT UNDER 37 C.F.R. § 1.312
Serial No.	14/054,223	
Filing Date	10/15/2013	
Group Art Unit	2647	
Examiner Name	Duc M Nguyen	
Confirmation No.	6118	
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

OK TO ENTER: /D.M.N/

03/24/2016

The Applicants have reviewed the Notice of Allowance mailed on December 22, 2015. The Applicants respectfully request that the amendments presented below be entered in the previously allowed claims.

Amendments to the Claims are reflected in the listing of claims that begins on Page 2 of this paper.

Remarks begin on Page 13 of this paper.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

135878 7590 04/11/2016
Fogg & Powers LLC/Commscope
4600 W 77th St
Suite 305
Minneapolis, MN 55435

EXAMINER

NGUYEN, DUC M

ART UNIT	PAPER NUMBER

2647

NOTIFICATION DATE	DELIVERY MODE

04/11/2016

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@fogglaw.com

Supplemental Notice of Allowability	Application No. 14/054,223	Applicant(s) WALA, PHILIP M.	
	Examiner DUC M. NGUYEN	Art Unit 2647	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 3/21/16.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-57. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ____ 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date ____	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☒ Other <u>PTO-271</u> .

/DUC M NGUYEN/ Primary Examiner, Art Unit 2647	4/4/16

Applicants	Wala	AMENDMENT UNDER 37 C.F.R. § 1.312
Serial No.	14/054,223	
Filing Date	10/15/2013	
Group Art Unit	2647	
Examiner Name	Duc M Nguyen	
Confirmation No.	6118	
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

OK TO ENTER: /D.M.N/

03/24/2016

The Applicants have reviewed the Notice of Allowance mailed on December 22, 2015. The Applicants respectfully request that the amendments presented below be entered in the previously allowed claims.

Amendments to the Claims are reflected in the listing of claims that begins on Page 2 of this paper.

Remarks begin on Page 13 of this paper.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

135878 7590 03/30/2016
Fogg & Powers LLC/Commscope
4600 W 77th St
Suite 305
Minneapolis, MN 55435

EXAMINER

NGUYEN, DUC M

ART UNIT	PAPER NUMBER

2647

NOTIFICATION DATE	DELIVERY MODE

03/30/2016

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@fogglaw.com

Response to Rule 312 Communication	Application No. 14/054,223	Applicant(s) WALA, PHILIP M.
	Examiner DUC M. NGUYEN	Art Unit 2647

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☒ The amendment filed on 21 March 2016 under 37 CFR 1.312 has been considered, and has been:

- a) ☒ entered.
- b) ☐ entered as directed to matters of form not affecting the scope of the invention.
- c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

- d) ☐ disapproved. See explanation below.
- e) ☐ entered in part. See explanation below.

3/24/16

/DUC M NGUYEN/
Primary Examiner, Art Unit 2647



UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
14/054,223	10/15/2013	2647	5400	100.019US05	55	5

CONFIRMATION NO. 6118
CORRECTED FILING RECEIPT



135878
Fogg & Powers LLC/Commscope
4600 W 77th St
Suite 305
Minneapolis, MN 55435

Date Mailed: 03/23/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Philip M. Wala, Savage, MN;

Applicant(s)

CommScope Technologies LLC, Hickory, NC

Power of Attorney: The patent practitioners associated with Customer Number 135878

Domestic Priority data as claimed by applicant

This application is a CON of 13/662,948 10/29/2012 PAT 8577286
which is a CON of 12/617,215 11/12/2009 PAT 8326218
which is a CON of 10/740,944 12/19/2003 PAT 7639982
which is a CON of 09/619,431 07/19/2000 PAT 6704545

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/22/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/054,223**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Preliminary Class

455

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.



UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/054,223	10/15/2013	Philip M. Wala	100.019US05

135878
Fogg & Powers LLC/Commscope
4600 W 77th St
Suite 305
Minneapolis, MN 55435

CONFIRMATION NO. 6118
POA ACCEPTANCE LETTER



Date Mailed: 03/23/2016

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/21/2016.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/dfisher/



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/054,223	10/15/2013	Philip M. Wala	100.019US05

34206
FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS, MN 55435

CONFIRMATION NO. 6118
POWER OF ATTORNEY NOTICE



Date Mailed: 03/23/2016

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/21/2016.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/dfisher/

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

34206 7590 12/22/2015
FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS, MN 55435

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

TITLE OF INVENTION: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	03/22/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, DUC M	2647	455-016000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Fogg & Powers LLC

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

CommScope Technologies LLC

Hickory, NC

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☒ Payment by credit card. ~~XXXXXXXXXXXX~~
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 502432 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Wade A. Whisenant/

Date March 21, 2016

Typed or printed name Wade A. Whisenant

Registration No. 59593

Applicants	Wala	AMENDMENT UNDER 37 C.F.R. § 1.312
Serial No.	14/054,223	
Filing Date	10/15/2013	
Group Art Unit	2647	
Examiner Name	Duc M Nguyen	
Confirmation No.	6118	
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

The Applicants have reviewed the Notice of Allowance mailed on December 22, 2015. The Applicants respectfully request that the amendments presented below be entered in the previously allowed claims.

Amendments to the Claims are reflected in the listing of claims that begins on Page 2 of this paper.

Remarks begin on Page 13 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the Application.

Listing of Claims

1. (Previously Presented) A system for digital transport of a wireless spectrum, the system comprising:
 - a first unit; and
 - a plurality of second units communicatively coupled to the first unit using at least one wired communication link and remotely located from the first unit;
 - wherein each of the plurality of second units receives a respective analog wireless signal comprising the wireless spectrum and any transmissions from any wireless units within a respective coverage area associated with that second unit;
 - wherein each of the plurality of second units is configured to generate respective digital samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit;
 - wherein each of the plurality of second units is configured to communicate the respective digital samples generated by that second unit to the first unit using the at least one wired communication link;
 - wherein the first unit is configured to digitally sum corresponding digital samples derived from the digital samples received from the plurality of second units to produce summed digital samples; and
 - wherein the system is configured so that an input used for base station processing is derived from the resulting summed digital samples.
2. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

3. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.
4. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.
5. (Original) The system of claim 1, wherein the system includes base station signal processing functionality configured to perform base station processing.
6. (Original) The system of claim 5, wherein the base station processing functionality is at least one of: co-located with the first unit and remote from the first unit.
7. (Original) The system of claim 1, wherein the system comprises at least a portion of a base station for performing the base station processing.
8. (Previously Presented) The system of claim 1, wherein the system further comprises software configured to perform the base station processing using the input derived from the resulting summed digital samples.
9. (Previously Presented) The system of claim 8, wherein the first unit comprises the software configured to perform the base station processing using the input derived from the resulting summed digital samples.
10. (Previously Presented) The system of claim 1, wherein the system is configured to convert the summed digital samples to a replicated analog wireless signal.

11. (Previously Presented) The system of claim 10, wherein the system comprises a digital-to-analog converter to convert the summed digital samples to the replicated analog wireless signal.

12. (Previously Presented) The system of claim 1, wherein each of the plurality of second units comprises:

a respective analog-to-digital converter to digitize the respective analog wireless signal received at that second unit in order to produce the respective digital samples.

13. (Previously Presented) The system of claim 1, wherein each of the plurality of second units generates the respective digital samples indicative of the respective analog wireless signal received at that second unit by frequency shifting the respective analog wireless signal received at that second unit and digitizing the frequency-shifted analog wireless signal.

14. (Previously Presented) The system of claim 1, wherein each of the plurality of second units is configured to generate the respective digital samples indicative of the respective analog wireless signal received at that second unit by down converting the respective analog wireless signal received at that second unit and digitizing the down-converted analog wireless signal.

15. (Previously Presented) The system of claim 1, wherein the first unit is configured to digitally sum the corresponding digital samples derived from the digital samples received from the plurality of second units as a part of generating the summed digital samples at a resolution greater than a resolution of the digital samples being summed.

16. (Currently Amended) The system of claim 1, wherein the wireless spectrum comprises a cellular radio frequency spectrum and any modulated transmissions from the wireless units carried by the cellular radio frequency spectrum of the wireless spectrum.

and wherein the digital samples generated by and received from each of the second units comprise digital radio frequency samples in that the digital samples are indicative of the modulation of the transmissions carried by the cellular radio frequency spectrum of the wireless spectrum.

17. (Previously Presented) The system of claim 1, wherein the at least one wired communication link comprises at least one of: a single mode optical fiber, a multi-mode optical fiber, a coaxial cable, and a category cable.

18. (Previously Presented) A first unit used in digital transport of a wireless spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units receives a respective analog wireless signal comprising the wireless spectrum and any transmissions from any wireless units that are within a coverage area associated with that second unit and wherein each of the plurality of second units is configured to generate respective digital samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit, wherein the interface is used to receive the digital samples from the plurality of second units;

a digital summer to digitally sum corresponding digital samples derived from the digital samples received from the plurality of second units to produce summed digital samples; and

wherein the first unit is configured so that an input used for base station processing is derived from the resulting summed digital samples.

19. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface

configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

20. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

21. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

22. (Previously Presented) The first unit of claim 18, wherein the base station processing is at least one of: co-located with the first unit and remote from the first unit.

23. (Original) The first unit of claim 18, wherein the base station processing is performed by at least a portion of a base station.

24. (Previously Presented) The first unit of claim 18, wherein the first unit further comprises software configured to perform the base station processing using the input derived from the resulting summed digital samples.

25. (Previously Presented) The first unit of claim 18, wherein the first unit is configured to convert the summed digital samples to a replicated analog wireless signal.

26. (Previously Presented) The first unit of claim 25, wherein the first unit comprises a digital-to-analog converter to convert the summed digital samples to the replicated analog wireless signal.

27. (Previously Presented) The first unit of claim 18, wherein the first unit is configured to digitally sum the corresponding digital samples derived from the digital samples received from the plurality of second units in order to produce the summed digital samples at a resolution greater than a resolution of the digital samples being summed.

28. (Previously Presented) The first unit of claim 18, wherein the wireless spectrum comprises a cellular radio frequency spectrum.

29. (Previously Presented) A method for digital transport of a wireless spectrum used with a first unit and a plurality of second units, each of the plurality of second units being remotely located from the first unit, the method comprising:

at each of the plurality of second units:

receiving a respective analog wireless signal comprising the wireless spectrum and any transmissions from any of the wireless units that are within a coverage area associated with that second unit;

generating respective digital samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit; and

communicating the respective digital samples generated by that second unit to the first unit using at least one communication medium; and

at the first unit, digitally summing corresponding digital samples derived from the digital samples received from the plurality of second units to produce summed digital samples.

30. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

31. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.
32. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.
33. (Previously Presented) The method of claim 29, further comprising performing base station processing using an input derived from the resulting summed digital samples.
34. (Original) The method of claim 33, wherein the base station processing is at least one of: co-located with the first unit and remote from the first unit.
35. (Original) The method of claim 33, wherein the base station processing is performed by at least a portion of a base station.
36. (Previously Presented) The method of claim 29, further comprising converting the summed digital samples to a replicated analog wireless signal.
37. (Previously Presented) The method of claim 29, wherein the corresponding digital samples derived from the digital samples received from the plurality of second units are digitally summed at a resolution greater than a resolution of the digital samples being summed.
38. (Previously Presented) The method of claim 29, wherein the wireless spectrum comprises a cellular radio frequency spectrum.

39. (Previously Presented) The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital samples indicative of the at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit comprises:

frequency shifting the respective analog wireless signal received at that second unit; and

digitizing the frequency-shifted analog wireless signal.

40. (Previously Presented) The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital samples indicative of the at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit comprises:

down converting the respective analog wireless signal received at that second unit; and

digitizing the down-converted analog wireless signal.

41. (Previously Presented) A system for digital transport of a wireless spectrum, the system comprising:

a first unit; and

a plurality of second units communicatively coupled to the first unit using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit;

wherein each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless spectrum;

wherein each of the plurality of second units is configured to generate respective digital samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit;

wherein each of the plurality of second units is configured to communicate the respective digital samples generated by that second unit to the first unit using the at least one wired communication link;

wherein the first unit is configured to digitally sum corresponding digital samples derived from the digital samples received from the plurality of second units to produce summed digital samples; and

wherein the system is configured so that an input used for wireless protocol processing is derived from the resulting summed digital samples.

42. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

43. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

44. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

45. (Original) The system of claim 41, wherein the wireless protocol processing is at least one of: co-located with the first unit and remote from the first unit.

46. (Original) The system of claim 41, wherein the system comprises at least a portion of a base station for performing the wireless protocol processing.

47. (Previously Presented) The system of claim 41, wherein the system further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital samples.

48. (Previously Presented) The system of claim 47, wherein the first unit comprises the software configured to perform the wireless protocol processing using the input derived from the resulting summed digital samples.

49. (Previously Presented) A first unit for digital transport of a wireless spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless spectrum and wherein each of the plurality of second units is configured to generate respective digital samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit, wherein the at least one interface is configured to receive the digital samples from the plurality of second units at the first unit;

a digital summer to digitally sum corresponding digital samples derived from the digital samples received from the plurality of second units to produce summed digital samples; and

wherein the first unit is configured so that an input used for wireless protocol processing is derived from the resulting summed digital samples.

50. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface

configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

51. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

52. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

53. (Previously Presented) The first unit of claim 49, wherein the wireless protocol processing is at least one of: co-located with the first unit and remote from the first unit.

54. (Original) The first unit of claim 49, wherein the wireless protocol processing is performed by at least a portion of a base station.

55. (Previously Presented) The first unit of claim 49, wherein the first unit further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital samples.

56. (New) The system of claim 16, wherein each of the second units is configured to perform a down-conversion in connection with generating the digital radio frequency samples.

57. (New) The system of claim 56, wherein each of the second units is configured to perform a down-conversion of an analog signal in connection with generating the digital radio frequency samples.

REMARKS

The Notice of Allowance mailed December 22, 2015 has been reviewed. The Applicant thanks the Examiner for allowing claims 1-55. The Applicant requests entry of the claim amendments above to amend dependent claim 16 and add new dependent claims 56-57. The amendments to dependent claim 16 are at least supported by paragraphs [0024]-[0025], and [0034] (which describe DHU 20 and DRUs 40 being used in a wireless network) of the application as filed. Additionally, new dependent claims 56-57 are at least supported by paragraph [0049] (which describe down conversion and analog to digital conversion) of the application as filed. No new matter is being introduced by these amendments.

Request for Consideration and Allowance of Dependent Claims 16 and 56-57

Per 37 C.F.R. § 1.312:

No amendment may be made as a matter of right in an application after the mailing of the notice of allowance. Any amendment filed pursuant to this section must be filed before or with the payment of the issue fee, and **may be entered on the recommendation of the primary examiner**, approved by the Director, without withdrawing the application from issue.

37 C.F.R. § 1.312. Section 714.16 of the MPEP provides additional guidance to Examiners on consideration of new claims added by an amendment under 37 C.F.R. § 1.312, specifically (emphasis added):

As to amendments affecting the disclosure, the scope of any claim, or **that add a claim**, the remarks accompanying the amendment must fully and clearly state the reasons on which reliance is placed to show:

- (A) **why the amendment is needed;**
- (B) **why the proposed amended or new claims require no additional search or examination;**
- (C) **why the claims are patentable;** and
- (D) **why they were not presented earlier.**

MPEP § 714.16. Section 714.16 of the MPEP further describes with reference to dependent claims that:

Where **claims added** by amendment under 37 CFR 1.312 are **all of the form of dependent claims**, **some of the usual reasons for nonentry are less likely to**

apply although questions of new matter, sufficiency of disclosure, or undue multiplicity of claims could arise.

MPEP § 714.16, I.

Amended claim 16 and new claims 56-57 are needed to more completely claim features of embodiments of the invention. Amended claim 16 and new claims 56-57 require no additional search or examination because they are dependent claims that depend from previously allowed independent claims. Amended claim 16 and new claims 56-57 are patentable for at least the same reasons as the independent claims from which they depend. Amended claim 16 and new claims 56-57 were not presented earlier because the benefit of such amendment and new claims was not appreciated until after the filing of the amendments included with the RCE dated November 13, 2015.

Accordingly, applicant respectfully requests consideration and entry and allowance of all claims in the above claim set including amended claim 16 and new claims 56-57.

CONCLUSION

Applicant respectfully requests review and entry of the amendments presented herein. Excess claim fees for new claims 56-57 have been submitted herewith. If necessary, please charge any additional fees or credit overpayments to Deposit Account No. 502432.

If the Examiner has any questions or concerns regarding this application, please contact the undersigned at 952-465-0770.

Respectfully submitted,

Date: March 21, 2016

/Wade A. Whisenant/
Wade A. Whisenant
Reg. No. 59,593

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Applicants	Wala	Miscellaneous Communication
Serial No.	14/054,223	
Filing Date	10/15/2013	
Group Art Unit	2647	
Examiner Name	Duc M Nguyen	
Confirmation No.	6118	
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

On February 19, 2016, a complaint for patent infringement was filed against Dali Wireless, Inc. in the United States District Court for the Northern District of Texas, Civil Action No. 3:16-cv-477. The complaint alleges infringement of U.S. Patent Nos. 8,326,218; 7,639,982; 8,577,286; and 7,848,747. The first three of these patents are related to the present application.

If the Examiner has any questions or concerns regarding this Application, please contact the undersigned at 952-465-0770.

Respectfully submitted,

Date: March 21, 2016

/Wade A. Whisenant/
Wade A. Whisenant
Reg. No. 59,593

Attorneys for Applicants
Fogg & Powers LLC
4600 W 77th Street, Suite 305
Minneapolis, MN 55435
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Supplemental Application Data Sheet

PTO/AIA/14 (03-13)

Approved for use through 01/31/2014. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	<u>14054223</u>
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1					Remove		
Legal Name							
Prefix	Given Name		Middle Name		Family Name		Suffix
Mr.	Philip		M.		Wala		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service							
City	Savage		State/Province	MN	Country of Residence	US	
Mailing Address of Inventor:							
Address 1		14082 Toledo Court					
Address 2							
City	Savage			State/Province	MN		
Postal Code	55378		Country	US			
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.							
Add							

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	34206- <u>135878</u>		
Email Address			Add Email Remove Email

Application Information:

Title of the Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		
Attorney Docket Number	100.019US05	Small Entity Status Claimed ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	8	Suggested Figure for Publication (if any)	

Supplemental Application Data Sheet

PTO/AIA/14 (03-13)

Approved for use through 01/31/2014. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	<u>14054223</u>
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.			
Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	~~34206~~ <u>135878</u>		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.					
Prior Application Status	Pending		Remove		
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)		
	Continuation of	13662948	2012-10-29		
Prior Application Status	Patented		Remove		
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13662948	Continuation of	12617215	2009-11-12	8326218	2012-12-04
Prior Application Status	Patented		Remove		
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12617215	Continuation of	10740944	2003-12-19	7639982	2009-12-29
Prior Application Status	Patented		Remove		
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
10740944	Continuation of	09619431	2000-07-19	6704545	2004-03-09
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.					

Supplemental Application Data Sheet

PTO/AIA/14 (03-13)

Approved for use through 01/31/2014. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	100.019US05
	Application Number	14054223
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)¹ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐	This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

Authorization to Permit Access:

☒	Authorization to Permit Access to the Instant Application by the Participating Offices
If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application. In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application. In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.	

SOLID Ex. 1018

Page 38

Supplemental Application Data Sheet

PTO/AIA/14 (03-13)

Approved for use through 01/31/2014. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	100.019US05
	Application Number	14054223
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

☒ Assignee ☐ Legal Representative under 35 U.S.C. 117 ☐ Joint Inventor

☐ Person to whom the inventor is obligated to assign. ☐ Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☒

Organization Name ADC-Telecommunications, Inc. **CommScope Technologies LLC**

Mailing Address Information For Applicant:

Address 1	~~1167 Park Place~~ 1100 CommScope Place SE		
Address 2			
City	~~Shakopee~~ Hickory	State/Province	~~MN~~ NC
Country	US	Postal Code	~~55379~~ 28602
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Supplemental Application Data Sheet

PTO/AIA/14 (03-13)

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	14054223
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Assignee 1				
Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).				
If the Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information For Non-Applicant Assignee:				
Address 1				
Address 2				
City		State/Province		
Country ¹		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Assignee Data may be generated within this form by selecting the Add button.				

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.					
Signature	/Wade A. Whisenant/			Date (YYYY-MM-DD)	2016-03-21
First Name	Wade A.	Last Name	Whisenant	Registration Number	59593
Additional Signature may be generated within this form by selecting the Add button.					

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:



Practitioners associated with the Customer Number:

135878

OR



Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name Registration	Number	Name Registration	Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:



The address associated with Customer Number:

135878

OR

☐ Firm or Individual Name			
Address			
City	State	Zip	
Country			
Telephone	Email		

Assignee Name and Address:

CommScope Technologies LLC
1100 CommScope Place SE
Hickory, NC 28602

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on the behalf of the assignee.

Signature		Date	2-3-2016
Name	Laura Thomas	Telephone	828-324-2200
Title	Assistant Secretary, CommScope Technologies LLC		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

This Power of Attorney may be revoked at any time.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: CommScope Technologies LLC

Application No./Patent No.: 14/054,223 Filed/Issue Date: 10/15/2013

Titled: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Attorney 100.019US05
Docket No.

CommScope Technologies LLC, a Corporation _____,
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose one of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is _____ %. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose one of options A or B below):

- A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in United States Patent and Trademark Office at Reel/Frame _____, or for which a copy thereof is attached.
- B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:
1. From: Wala, Phil To: ADC Telecommunications, Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 031408, Frame 0325, or for which a copy thereof is attached.
2. From: ADC Telecommunications, Inc. To: Tyco Electronics Services GmbH
The document was recorded in the United States Patent and Trademark Office at
Reel 036908, Frame 0443, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)3. From: Tyco Electronics Services Gmb H To: CommScope EMEA LimitedThe document was recorded in the United States Patent and Trademark Office at
Reel 036956, Frame 0001, or for which a copy thereof is attached.4. From: CommScope EMEA Limited To: CommScope Technologies LLCThe document was recorded in the United States Patent and Trademark Office at
Reel 037012, Frame 0001, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.☐ Additional documents in the chain of title are listed on a supplemental sheet(s).☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Wade A. Whisenant/

Signature

March 21, 2016

Date

Wade Whisenant

Printed or Typed Name

59593

Title or Registration Number

[Page 2 of 2]

Electronic Patent Application Fee Transmittal

Application Number:	14054223			
Filing Date:	15-Oct-2013			
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT			
First Named Inventor/Applicant Name:	Philip M. Wala			
Filer:	Wade A. Whisenant/Danielle Suess			
Attorney Docket Number:	100.019US05			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Claims in Excess of 20	1202	2	80	160
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Utility Appl Issue Fee	1501	1	960	960
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1120

Electronic Acknowledgement Receipt

EFS ID:	25260871
Application Number:	14054223
International Application Number:	
Confirmation Number:	6118
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT
First Named Inventor/Applicant Name:	Philip M. Wala
Customer Number:	34206
Filer:	Wade A. Whisenant/Danielle Suess
Filer Authorized By:	Wade A. Whisenant
Attorney Docket Number:	100.019US05
Receipt Date:	21-MAR-2016
Filing Date:	15-OCT-2013
Time Stamp:	18:13:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$ 1120
RAM confirmation Number	5485
Deposit Account	502432
Authorized User	WHISENANT, WADE A.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 CFR 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 CFR 1.17 (Patent application and reexamination processing fees)

SOLID Ex. 1018

Charge any Additional Fees required under 37 CFR 1.19 (Document supply fees)

Charge any Additional Fees required under 37 CFR 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	00529530.PDF	1000745	no	1
			6445ce7da3ba2510b35aefc1d196f76cb1f3a7d3		

Warnings:

Information:

2		00540185.PDF	1052853	yes	14
			98c0f83d6cc69595adeebd6eb4ceceb9946050db		

Multipart Description/PDF files in .zip description

Document Description		Start	End
Amendment after Notice of Allowance (Rule 312)		1	1
Claims		2	12
Applicant Arguments/Remarks Made in an Amendment		13	14

Warnings:

Information:

3	Miscellaneous Incoming Letter	00540190.PDF	983385	no	1
			08a107723e12af73743620f9386367eccc2592f		

Warnings:

Information:

4	Application Data Sheet	00540228.PDF	1048737	no	6
			031f5ccc1c3c3ba5a0d00e813eb9ae32105471f51		

Warnings:

Information:

This is not an USPTO supplied ADS fillable form

5	Power of Attorney	00531205.PDF	401460	no	1
			d37f8ff3ba73856e3d515523190676f407d99b81		

Warnings:

Information:

6	Assignee showing of ownership per 37 CFR 3.73	00540222.PDF	588170 023931969c70163be751624a5723f7f849d3917a	no	2
Warnings:					
Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	32401 7c79990436fe6cc696ec8b4aa0d018e45085ecdb	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			5107751		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

UNITED STATES PATENT AND TRADEMARK OFFICE
COMMISSIONER FOR PATENTS
P.O.BOX 1450
ALEXANDRIA VA 22313-1451

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FIRST-CLASS MAIL
U.S. POSTAGE PAID
POSTEDIGITAL
NNNNN

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



**Courtesy Reminder for
Application Serial No: 14/054,223**

Attorney Docket No: 100.019US05
Customer Number: 34206
Date of Electronic Notification: 12/22/2015

This is a courtesy reminder that new correspondence is available for this application. If you have not done so already, please review the correspondence. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:

DAVID@FOGGLAW.COM
docketing@fogglaw.com

To view your correspondence online or update your email addresses, please visit us anytime at <https://sportal.uspto.gov/secure/myportal/privatepair>. If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov or call 1-866-217-9197.



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

34206 7590 12/22/2015
FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS, MN 55435

EXAMINER

NGUYEN, DUC M

ART UNIT

PAPER NUMBER

2647

DATE MAILED: 12/22/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.

14/054,223

10/15/2013

Philip M. Wala

100.019US05

6118

TITLE OF INVENTION: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	03/22/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

34206 7590 12/22/2015
FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS, MN 55435

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

TITLE OF INVENTION: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	03/22/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, DUC M	2647	455-016000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached. ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.	2. For printing on the patent front page, list (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____ (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____ 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted: ☐ Issue Fee ☐ Publication Fee (No small entity discount permitted) ☐ Advance Order - # of Copies _____	4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above) ☐ A check is enclosed. ☐ Payment by credit card. Form PTO-2038 is attached. ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

34206 7590 12/22/2015
FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS, MN 55435

EXAMINER

NGUYEN, DUC M

ART UNIT PAPER NUMBER

2647

DATE MAILED: 12/22/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/054,223	Applicant(s) WALA, PHILIP M.	
	Examiner DUC M. NGUYEN	Art Unit 2647	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 11/13/15.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-55. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____ 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____

/DUC M NGUYEN/ Primary Examiner, Art Unit 2647	12/16/15

Issue Classification 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.	
	Examiner DUC M NGUYEN	Art Unit 2647	

CPC						
Symbol					Type	Version
H04W		4		06	F	2013-01-01
H04B		10		25754	I	2013-01-01
H04W		88		085	A	2013-01-01
H04W		88		08	I	2013-01-01
Y10S		370		906	A	2013-01-01
Y10S		370		907	A	2013-01-01
H04B		7		2606	I	2013-01-01
H04L		65		1016	A	2013-01-01
H04L		51		28	I	2013-01-01
H04L		51		38	I	2013-01-01
H03M		7		4006	I	2013-01-01
H04L		51		04	A	2013-01-01
H04L		65		1006	I	2013-01-01
H04W		4		12	A	2013-01-01
H04W		4		14	I	2013-01-01
H04N		19		139	I	2014-11-01
H04N		19		109	I	2014-11-01
H04N		19		91	I	2014-11-01
H04N		19		625	I	2014-11-01

CPC Combination Sets							
Symbol				Type	Set	Ranking	Version

NONE		Total Claims Allowed:	
		55	
(Assistant Examiner)	(Date)		
/DUC M NGUYEN/ Primary Examiner.Art Unit 2647	12/16/15	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

Issue Classification 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17		33		49								
	2		18		34		50								
	3		19		35		51								
	4		20		36		52								
	5		21		37		53								
	6		22		38		54								
	7		23		39		55								
	8		24		40										
	9		25		41										
	10		26		42										
	11		27		43										
	12		28		44										
	13		29		45										
	14		30		46										
	15		31		47										
	16		32		48										

NONE		Total Claims Allowed: 55	
(Assistant Examiner)	(Date)		
/DUC M NGUYEN/ Primary Examiner.Art Unit 2647	12/16/15	O.G. Print Claim(s) 1	O.G. Print Figure 6
(Primary Examiner)	(Date)		

Search Notes 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

CPC- SEARCHED		
Symbol	Date	Examiner
H04B 3/36; 7/2606, 2609	4/22/15	DN
H04W 16/26	4/22/15	DN
Updated	8/6/15	DN
	12/16/15	DN

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	7, 14, 16, 20, 22, 560, 561	4/22/15	DN
Updated	same as aboves	8/6/15	DN
		12/16/15	DN

SEARCH NOTES		
Search Notes	Date	Examiner
see EAST search history	4/22/15	DN
	8/6/15	DN
	12/16/15	DN

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H04B	3/36; 7/2606, 2609	8/6/15	DN
H04W	16/26	8/6/15	DN
455	7, 14, 16, 20, 22, 560, 561	8/6/15	DN
Updated	same as aboves	12/16/15	DN

	/DUC M NGUYEN/ Primary Examiner.Art Unit 2647

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14054223
	Filing Date		2013-10-15
	First Named Inventor	Wala	
	Art Unit	2647	
	Examiner Name	Duc M. Nguyen	
	Attorney Docket Number	100.019US05	

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² i	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	11234200	JP		1999-08-27	Yoshihiro		☐

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NON-PATENT LITERATURE DOCUMENTS			Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	14054223
Filing Date	2013-10-15
First Named Inventor	Wala
Art Unit	2647
Examiner Name	Duc M. Nguyen
Attorney Docket Number	100.019US05

1	BRAZILIAN PATENT OFFICE, "Office Action for Brazil Application No. PI0112653-9", "from Foreign Countpart to U.S. Application No. 09/619,431", 04/08/2015, Page(s) 1-14, Published in: BR	☐

If you wish to add additional non-patent literature document citation information please click the Add button **Add**

EXAMINER SIGNATURE

Examiner Signature	/DUC M NGUYEN/	Date Considered	12/16/2015

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	14054223
Filing Date	2013-10-15
First Named Inventor	Wala
Art Unit	2647
Examiner Name	Duc M. Nguyen
Attorney Docket Number	100.019US05

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

- ☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

- ☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

- ☐ See attached certification statement.
- ☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.
- ☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2015-11-13
Name/Print	Wade A. Whisenant	Registration Number	59593

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	3379	H04B7/2606.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:25
L5	1749	H04W16/26.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:25
L6	12000	455/16 455/18 455/20 455/561	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:26
L7	513	H04B3/36.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:28
L8	202	H04B7/2609.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:28
L9	16531	4 5 6 7 8	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:29
L10	29	9 and (digital\$3 near2 sum\$4).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:29
L18	22	10 and wireless	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/12/16 17:38
L20	59	("20030143947" "4183054" "4611323" "4628501" "4654843" "4667319"	US-PGPUB;	OR	ON	2015/12/16 17:44

		"4691292" "4760573" "4999831" "5193109" "5243598" "5321736" "5321849" "5339184" "5499047" "5603080" "5621786" "5627879" "5642405" "5644622" "5657374" "5708961" "5715235" "5724385" "5765097" "5765099" "5774789" "5802173" "5809431" "5812605" "5852651" "5878325" "5946622" "5969837" "5978650" "6005884" "6112086" "6147786" "6181687" "6192216" "6198558" "6262981" "6275990" "6317884" "6337754" "6356374" "6362908" "6373611" "6374124" "6449071" "6466572" "6480551" "6486907" "6697603" "6771933" "6785558" "6801767" "7035671" "8326218").PN.	USPAT; USOCR			
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EAST Search History (I nterference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L11	2448	H04B7/2606.cpc.	US-PGPUB; USPAT	OR	ON	2015/12/16 17:36
L12	1254	H04W16/26.cpc.	US-PGPUB; USPAT	OR	ON	2015/12/16 17:36
L13	357	H04B3/36.cpc.	US-PGPUB; USPAT	OR	ON	2015/12/16 17:36
L14	176	H04B7/2609.cpc.	US-PGPUB; USPAT	OR	ON	2015/12/16 17:36
L15	12570	455/16 455/18 455/20 455/56 455/561	US-PGPUB; USPAT	OR	ON	2015/12/16 17:36
L16	15687	11 12 13 14 15	US-PGPUB; USPAT	OR	ON	2015/12/16 17:37
L17	31	16 and (digital\$3 near2 sum\$4).clm.	US-PGPUB; USPAT	OR	ON	2015/12/16 17:37
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12/ 16/ 2015 5:50:19 PM
C:\ Users\ dnguyen7\ Documents\ EAST\ Workspaces\ 4-26-14.wsp

<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant					☐ CPA					☒ T.D.					☐ R.1.47				
CLAIM		DATE																	
Final	Original	04/22/2015	08/06/2015	12/16/2015															
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<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant					☐ CPA					☒ T.D.					☐ R.1.47				
CLAIM		DATE																	
Final	Original	04/22/2015	08/06/2015	12/16/2015															
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL (Submitted Only via EFS-Web)

Application Number	14054223	Filing Date	2013-10-15	Docket Number (if applicable)	100.019US05	Art Unit	2647
First Named Inventor	WALA			Examiner Name	Duc M. Nguyen		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☐ Other _____

☒ Enclosed

☒ Amendment/Reply

☒ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

☒ The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to
Deposit Account No 502432

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

Signature of Registered U.S. Patent Practitioner			
Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2015-11-13
Name	Wade A. Whisenant	Registration Number	59593

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14054223	
	Filing Date		2013-10-15	
	First Named Inventor	Wala		
	Art Unit	2647		
	Examiner Name	Duc M. Nguyen		
	Attorney Docket Number	100.019US05		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14054223
	Filing Date		2013-10-15
	First Named Inventor	Wala	
	Art Unit	2647	
	Examiner Name	Duc M. Nguyen	
	Attorney Docket Number	100.019US05	

1	BRAZILIAN PATENT OFFICE, "Office Action for Brazil Application No. PI0112653-9", "from Foreign Countpart to U.S. Application No. 09/619,431", 04/08/2015, Page(s) 1-14, Published in: BR	☐
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Examiner Signature		Date Considered
*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.		
¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.		

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	14054223
Filing Date	2013-10-15
First Named Inventor	Wala
Art Unit	2647
Examiner Name	Duc M. Nguyen
Attorney Docket Number	100.019US05

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

- ☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

- ☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

- ☐ See attached certification statement.
- ☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.
- ☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2015-11-13
Name/Print	Wade A. Whisenant	Registration Number	59593

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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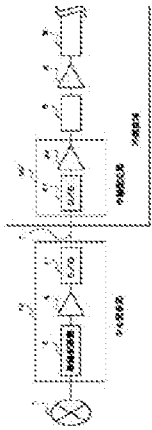
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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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(11)Publication number 11-234200
(43)Date of publication of application 27.08.1999
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H04B 3/58
H04B 7/15
H04H 1/00
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// H04B 10/22
H04B 10/00

(21)Application number 10-327014
(22)Date of filing 17.11.1998
(71)Applicant KOKUSAI ELECTRIC CO LTD
(72)Inventor IMASHIYOU YOSHIHIRO



(30)Priority

Priority number : 09327544 Priority date : 28.11.1997 Priority country : JP

(54)RELAY SYSTEM

(57)Abstract

PROBLEM TO BE SOLVED: To provide a relay system capable of relaying many kinds of signals by a simple constitution so as to solve a drawback in the conventional system that many kinds of signals can not be relayed by a simple constitution.
SOLUTION: A central fixed station 10 converts signals to be relayed inputted from a public line network 1 to high frequency signals by a radio modulator 2, converts the high frequency signals to optical signals and outputs them to plural relay fixed stations 30' distributed and arranged in a blind zone. Then, the relay fixed stations 30' covert the optical signals to the high frequency signals and emit them in the blind zone through a leakage coaxial cable 5.

(19)日本国特許庁 (J P)

(12) 公 開 特 許 公 報 (A)

(11)特許出願公開番号

特開平11-234200

(43)公開日 平成11年(1999) 8 月27日

(51)Int.Cl. ⁶	識別記号	F I
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	3/58	3/58
	7/15	H 0 4 H 1/00 U
H 0 4 H 1/00		H 0 4 M 3/00 B
H 0 4 M 3/00		H 0 4 B 7/15 Z
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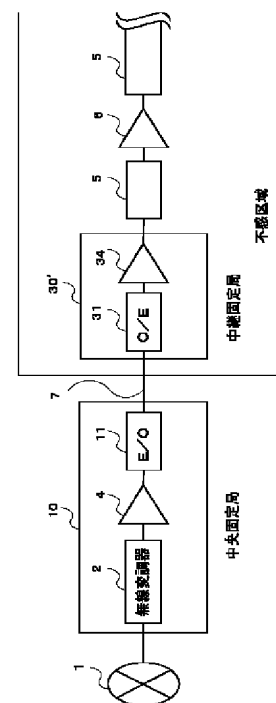
(21)出願番号	特願平10-327014	(71)出願人	000001122 国際電気株式会社 東京都中野区東中野三丁目14番20号
(22)出願日	平成10年(1998)11月17日	(72)発明者	今庄 義弘 東京都中野区東中野三丁目14番20号 国際 電気株式会社内
(31)優先権主張番号	特願平9-327544	(74)代理人	弁理士 船津 暢宏 (外1名)
(32)優先日	平9(1997)11月28日		
(33)優先権主張国	日本 (J P)		

(54)【発明の名称】 中継システム

(57)【要約】

【課題】 従来の中継システムでは、多種の信号を簡易な構成で中継できないという問題点があったが、本発明では、多種の信号を簡易な構成で中継できる中継システムを提供する。

【解決手段】 中央固定局10が無線変調器2により、公衆回線網1から入力を受けた中継すべき信号を高周波信号に変換し、当該高周波信号を光信号に変換して、不感区域に分散配置された複数の中継固定局30'に出力し、中継固定局30'が当該光信号を高周波信号に変換し、漏洩同軸ケーブル5を介して不感区域で放射する中継システムである。



【特許請求の範囲】

【請求項1】 中継すべき高周波信号を光信号に変換して、当該光信号を出力する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射する中継固定局とを備える中継システムであって、

前記中央固定局が、公衆回線網から入力を受けた信号で特定の周波数の搬送波を変調し、前記高周波信号を得る無線変調器を有する中央固定局であることを特徴とする中継システム。

【請求項2】 中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、

前記中央固定局が、公衆回線網から入力を受けた信号で特定の周波数の搬送波を変調し、前記高周波信号を得る無線変調器と、前記中継固定局から入力を受けた光信号を変換した高周波信号を復調して、前記公衆回線網に出力する無線復調器とを有する中央固定局であることを特徴とする中継システム。

【請求項3】 不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、

前記中央固定局が、アンテナと、無線部と、有線部とを備え、

前記無線部が、前記アンテナに到来した信号を高周波信号として出力すると共に、高周波信号の入力を受けて、当該入力された高周波信号を前記アンテナを介して外部に放射する無線部であり、

前記有線部が、外部から有線で入力される多種の信号で各々特定の周波数の搬送波を変調し、高周波信号を得る複数の無線変調器と、前記無線部から入力される高周波信号と前記複数の無線変調器から入力される高周波信号

とを合成して出力する合成器と、前記合成された高周波信号を光信号に変換して中継固定局に出力する電気／光変換器と、前記中継固定局から入力される光信号を高周波信号に変換する光／電気変換器と、前記光／電気変換器から入力される高周波信号を前記無線部のアンテナから放射すべき高周波信号と、外部に有線で出力すべき高周波信号とに分配する第1の分配器と、前記第1の分配器から入力される、外部に有線で出力すべき高周波信号を分配する第2の分配器と、前記第2の分配器からそれぞれ入力される高周波信号から多種の信号の各々を復調する複数の無線復調器とを有する有線部であることを特徴とする中継システム。

【請求項4】 不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、

前記中継固定局が、中央固定局から入力された光信号を高周波信号に変換する光／電気変換器と、前記高周波信号を分配する分配器と、前記分配された高周波信号の一方から中継固定局を制御する信号である制御信号を復調する復調器と、前記制御信号に従って中継固定局内の各部の制御を行う制御部と、前記分配された他方の高周波信号を漏洩同軸ケーブルに出力すると共に、漏洩同軸ケーブルに到来した高周波信号を出力する共用器と、前記共用器から入力された高周波信号を光信号に変換して中央固定局に出力する電気／光変換器とを有する中継固定局であることを特徴とする中継システム。

【請求項5】 不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、

前記中継固定局が、中央固定局から入力された光信号を高周波信号に変換する光／電気変換器と、前記高周波信号を漏洩同軸ケーブルに出力すると共に、漏洩同軸ケーブルに到来した高周波信号を出力する共用器と、中継固定局内の各部の動作状態を監視し、監視信号を出力する

制御部と、前記監視信号を高周波信号に変調する変調器と、前記変調器で変調された高周波信号と前記共用器から入力された高周波信号とを合成して出力する合成器と、前記合成器から入力された高周波信号を光信号に変換して中央固定局に出力する電気／光変換器とを有する中継固定局であることを特徴とする中継システム。

【請求項6】 不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、前記中継固定局が、中央固定局から入力された光信号を高周波信号に変換する光／電気変換器と、前記高周波信号を分配する分配器と、前記分配された高周波信号の一方から中継固定局を制御する信号である制御信号を復調する復調器と、前記制御信号に従って中継固定局の各部の制御を行うと共に、中継固定局の各部の動作状態を監視し、監視信号を出力する制御部と、前記分配された他方の高周波信号を漏洩同軸ケーブルに出力すると共に、漏洩同軸ケーブルに到来した高周波信号を出力する共用器と、前記監視信号を高周波信号に変調する変調器と、前記変調器で変調された高周波信号と前記共用器から入力された高周波信号とを合成して出力する合成器と、前記合成器から入力された高周波信号を光信号に変換して中央固定局に出力する電気／光変換器とを有する中継固定局であることを特徴とする中継システム。

【請求項7】 不感区域外に配置され、アンテナと、無線部と、有線部と、制御部とを備え、中継すべき高周波信号を光信号に変換し、当該光信号を光ファイバを介して不感区域に設置された中継固定局に出力すると共に、前記中継固定局から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局であって、前記無線部が、前記アンテナに到来した信号を高周波信号として出力すると共に、高周波信号の入力を受けて、当該入力された高周波信号を前記アンテナを介して外部に放射する無線部であり、前記有線部が、外部又は前記制御部から有線で入力される複数の信号で各々特定の周波数の搬送波を変調し、高周波信号を得る複数の無線変調器と、前記無線部から入力される高周波信号と前記複数の無線変調器から入力される高周波信号とを合成して出力する合成器と、前記合成された高周波信号を光信号に変換して中継固定局に出力する電気／光変換器と、前記中継固定局から入力される光信号を高周波信号に変換する光／電気変換器と、前

記光／電気変換器から入力される高周波信号を前記無線部のアンテナから放射すべき高周波信号と外部に有線で出力すべき高周波信号とに分配する第1の分配器と、前記第1の分配器から入力される、外部に有線で出力すべき高周波信号を分配する第2の分配器と、前記第2の分配器からそれぞれ入力される高周波信号から複数の信号の各々を復調する複数の無線復調器とを有する有線部であり、

前記制御部が、前記無線変調器と前記無線復調器とに接続され、前記無線復調器から入力される、前記中継固定局からの監視信号に基づいて、前記中継固定局の動作状態を認識し、前記動作状態に応じて前記中継固定局を制御する制御信号を前記無線変調器に出力する制御部であることを特徴とする中央固定局。

【請求項8】 制御部が、中継固定局の動作状態を示す信号を外部の上位監視局に出力すると共に、前記上位監視局からの指示信号に従って前記無線変調器に前記中継固定局を制御する制御信号を出力する制御部であることを特徴とする請求項7記載の中央固定局。

【請求項9】 制御部が、中継固定局からの監視信号に基づいて、前記中継固定局にて異常が発生したことを認識した場合に、無線変調器に前記中継固定局の正常化を図る制御信号を出力する制御部であることを特徴とする請求項7記載の中央固定局。

【請求項10】 請求項7記載の中央固定局を備えることを特徴とする請求項6記載の中継システム。

【請求項11】 請求項8記載の中央固定局を備えることを特徴とする請求項6記載の中継システム。

【請求項12】 請求項9記載の中央固定局を備えることを特徴とする請求項6記載の中継システム。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、移動体通信の不感区域をカバーするための中継システムに係り、特に複雑な形状の不感区域の全体で所望の通信品質での無線通信を行うことができ、かつ簡易な構成で複数の信号を中継でき、更にシステムの管理を容易にできる中継システムに関する。

【0002】

【従来の技術】自動車電話、携帯電話システム、簡易携帯電話（PHS）システム、無線呼出しシステム等の公衆移動体通信システム（以下、「移動通信システム」と略称する）では、公衆回線網（PSTN、ISDN）等より上位の回線網に有線接続されている移動体通信基地局（以下、「基地局」と略称する）を備え、基地局が携帯電話機等の移動局と無線通信を行うようになっている。

【0003】基地局は、例えば自動車電話や携帯電話システムの場合で無線通信可能なエリア（カバーエリア）が数kmから十数km程度となっている。また、周波数

を有効利用しつつ、より広いサービスエリアを確保するために、カバーエリアを細胞のように配置する、いわゆるセルラー方式が採用されている。

【0004】これらセルラー方式を採用する移動通信システムでは、普通、屋外の地上等では無線通信が良好に行えるが、基地局のカバーエリア内にあっても、トンネル、地下街、ビル地階、大規模なビルの地上階内部では、電波が到達し難くなって、これらの中に存在する移動無線端末との無線通信が行えないものである。

【0005】このような地域は、「不感区域」と称されており、不感区域は、移動通信システムに限らず、警察無線、消防無線、列車無線等の業務用無線や、テレビジョン放送、ラジオ放送等、電波を用いる無線通信に一般的に現われるものである。

【0006】これら不感区域における無線通信を可能にするための補助的な手段として、中継増幅装置と呼ばれる装置が用いられるのが普通である。すなわち基地局（放送等においては放送局）との間で良好な無線通信が行える地点に第1のアンテナを配置し、また、不感区域に第2のアンテナを配置して、第1のアンテナに到来した高周波信号を増幅し、不感区域に配置した第2のアンテナに有線にて伝送し、第2のアンテナを介して当該増幅した高周波信号を放射するものである。

【0007】このようにすることで、基地局から移動局への下り回線の通信を確保すると共に、移動局から基地局への上り回線の通信も、第2のアンテナでとらえた、移動局が放射する高周波信号を増幅し、第1のアンテナに有線にて伝送して、第1のアンテナを介して増幅した高周波信号を放射して、基地局に送信出力することで、不感区域における無線通信を可能とすることができるようにしている。

【0008】ここで、第2のアンテナとを配置する方法としては、現在、漏洩同軸を用いる方法と光ファイバを用いる方法とがあるが、これらを単に配置するだけでは、特に携帯電話等の移動通信システムに用いる場合には、不感区域から中継を受ける基地局のカバーエリアが広がるのと等価であるので、当該基地局が処理すべき通信の数が増大することになって、大都市等の通信需要の大きな地域においては当該基地局の収容能力を超えて、カバーエリア内の携帯局の発着信を処理できなくなる場合がある。

【0009】そこで、ISDN回線等の高品質な上位の有線回線の普及を背景として、特に通信需要の大きな不感区域に対しては、ISDN回線等の上位回線網に有線で直接接続した無線変復調器を設置することが考えられている。

【0010】このような無線変復調器は、上位回線網から入力を受けた信号で高周波信号を変調して、当該無線変復調器から不感区域に配置されたアンテナ（上記第2のアンテナ）に当該高周波信号を配信し、また、当該ア

ンテナを介して高周波信号を受信して、移動局からの信号を復調し、上位回線網に出力するものである。

【0011】かかる従来の中継システムについて図9と図10とを使って説明する。図9は、従来の漏洩同軸ケーブルを用いた中継システムの概念を表す説明図であり、図10は、従来の光ファイバを用いた中継システムの概念を表す説明図である。

【0012】図9に示す漏洩同軸ケーブルを用いた中継システムは、PSTNやISDN等の公衆回線網1と、公衆回線網1と有線接続されている無線変調器2と、同軸ケーブル3と、増幅器4と、漏洩同軸ケーブル5と、補助増幅器6とから構成されている。尚、図9と図10とでは、簡単のため、下り回線のみを図示している。

【0013】以下、各部を具体的に説明する。無線変調器2は、公衆回線網1から有線を介して着信した信号で搬送波を変調して高周波信号を得て、同軸ケーブル3を介して当該高周波信号を増幅器4に出力するものである。増幅器4は、同軸ケーブル3を介して入力を受けた高周波信号を増幅して、漏洩同軸ケーブル5に出力するものである。

【0014】漏洩同軸ケーブル5は、不感区域に線状に配置され、一端から入力された高周波信号を徐々に外部に漏洩しつつ他端に伝達するものであり、いわばアンテナの役割を果たすものである。補助増幅器6は、漏洩同軸ケーブル5の中間に挿入されているもので、漏洩同軸ケーブル5が伝送している高周波信号を増幅することで、漏洩同軸ケーブル5の延長距離を延ばすようにしている。

【0015】次に、図9に示す漏洩同軸ケーブルを用いた中継システムの動作について説明する。無線変調器2が、公衆回線網1を介して着信した信号で高周波信号を変調し、同軸ケーブル3を介して増幅器4に出力する。

【0016】すると、増幅器4が当該高周波信号を増幅して漏洩同軸ケーブル5に出力する。そして、漏洩同軸ケーブル5がアンテナのごとく、増幅器4から入力された高周波信号を外部に漏洩しつつ伝送し、補助増幅器6が、漏洩によって減衰した高周波信号を増幅して、さらに後続の漏洩同軸ケーブル5に出力し、当該後続の漏洩同軸ケーブル5が当該増幅された高周波信号を外部に漏洩するようになる。

【0017】このようにして、不感区域に存する移動局に対して公衆回線網1を介して高周波信号が伝達されるようになる。

【0018】また、図10に示す光ファイバを用いた中継システムは、公衆回線網1と、光ファイバ7と、中央固定局10と、光スターカプラ20と、複数の中継固定局30とから構成されている。また、中央固定局10は、図9の中継システムにおけるのと同様の無線変調器2及び増幅器4と、増幅器4が増幅した高周波信号を光信号に変換する電気／光変換器（E/O）11とから構

成されており、中継固定局30は、光信号を高周波信号に変換する光／電気変換器(O/E)31と、図9の中継システムにおける増幅器4と同様の増幅器34と、増幅器34が増幅した信号を放射するアンテナ32とから構成されている。

【0019】以下、各部を具体的に説明する。中央固定局10の無線変調器2は、公衆回線網1から入力された信号を高周波信号に変換して出力するものである。中央固定局10の増幅器4は、無線変調器2が出力する高周波信号を増幅して、出力するものである。

【0020】電気／光変換器11は、増幅器4が増幅した高周波信号を光信号に変換して、当該光信号を光スターカプラ20に出力するものである。

【0021】すなわち、中央固定局10は、公衆回線網1から入力された信号を高周波信号に変換して増幅し、当該増幅した高周波信号で光信号の搬送波を変調することで、信号を光信号に変換して、光スターカプラ20に出力するようになっている。光スターカプラ20は、入力された光信号を光ファイバ7を介して、複数の中継固定局30に分配して伝達するものである。

【0022】中継固定局30は、不感区域に複数設置されているものであり、光ファイバ7を介して入力を受けた光信号を光／電気変換器31によって高周波信号に変換して、増幅器34で増幅し、アンテナ32を介して外部に放射するものである。

【0023】尚、一般に、アンテナ32の利得、指向性及び高周波出力によって、アンテナ1つで、所望の通信品質にて無線通信が行えるエリアが限られるので、不感区域のどこでも所望の通信品質にて無線通信を行うことができるように、不感区域の広さに応じた数の中継固定局30を配置するようにしている。

【0024】次に、図10に示す従来の光ファイバを用いた中継システムの動作について説明する。まず、中央固定局10が公衆回線網1から入力された信号で搬送波を変調して高周波信号を得て、当該高周波信号を増幅し、さらに光信号に変換して、光スターカプラ20に出力する。

【0025】そして、光スターカプラ20が当該光信号を分配して、光ファイバ7を介して複数の中継固定局30に出力し、各々の中継固定局30が入力された光信号を高周波信号に変換し、増幅して、アンテナ32を介して放射することで、公衆回線網1から入力された信号を不感区域に伝達できるようになっている。

【0026】

【発明が解決しようとする課題】しかしながら、上記従来の漏洩同軸ケーブルを用いた中継システムでは、トンネルのように、不感区域が線状の場合に適するが漏洩同軸ケーブルが単位長さあたり一定の高周波電力を外部に電磁波として漏洩するため、近年携帯電話やPHSに割り当てられた1.5GHz帯や1.9GHz帯といった

高周波の帯域では、漏洩分以外の高周波信号の損失も大きくなって、不感区域において所望の通信品質を維持することが困難であるという問題点があった。

【0027】さらに、FPLMTSと呼ばれる次世代移動通信システムでは、世界共通に2GHz帯を割り当てることが予定されているおり、かかる高周波の帯域での信号伝送を行う場合、漏洩同軸ケーブルにおける高周波信号の損失に対応するため、補助増幅器を多数挿入する必要があると、その間隔は数100m程度になってしまう一方、接続できる補助増幅器および漏洩同軸ケーブルの数は、要求される歪み、雑音等の電波品質と、増幅器および補助増幅器において発生する歪みと雑音との大きさによって制限されることになるため、漏洩同軸ケーブルと補助増幅器の敷設工事が困難になると共に、不感区域が広い場合には、不感区域の全体をカバーできないという問題点があった。

【0028】さらに、高周波に対応するため、無線変調器と増幅器との間を有線接続する同軸ケーブルを大口径とする必要があり、そのために敷設工事が困難になるという問題点があった。

【0029】また、上記従来の光ファイバを用いた中継システムでは、光ファイバの外径が約125 μ mと細く、また柔軟、軽量であるため、敷設工事が容易になり、伝送距離1kmあたりの減衰量が0.5dB以下という低損失特性を備え、伝送帯域幅が伝送距離1kmあたり数THzと十分な帯域幅を有しているので、高周波に対応できると共に、十分な伝送距離を保持できるが、アンテナが放射する電波はスポット状に放射されるため、トンネル、地下道のように線状に広がる不感区域の全体で、所望の通信品質での無線通信を行うことができるようにするのは、困難であるという問題点があった。

【0030】そこで、これら漏洩同軸ケーブルを用いた中継システムと、光ファイバを用いた中継システムとの問題点を相互に補わせるべく、上記光ファイバを用いた中継システムを基本にして、アンテナの代わりに漏洩同軸ケーブルを配置することも考えられている。

【0031】かかる発明は例えば、特開平9-130322号の「移動体通信用中継増幅システム」に開示されているが、当該出願には、無線通信以外の公衆回線網を含む多種の信号の中継は考慮されておらず、多種の信号の中継したい場合には、各々の中継局を設ける必要があって、敷設工事が困難になるという問題点があった。

【0032】本発明は上記実情に鑑みて為されたもので、複雑な形状の不感区域の全体で、所望の通信品質での無線通信を行うことができ、かつ簡易な構成で多種の信号の中継でき、更にシステムの管理を容易にできる中継システムを提供することを目的とする。

【0033】

【課題を解決するための手段】上記従来例の問題点を解決するための請求項1記載の発明は、中継すべき高周波

信号を光信号に変換して、当該光信号を出力する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射する中継固定局とを備える中継システムであって、前記中央固定局が、公衆回線網から入力を受けた信号で特定の周波数の搬送波を変調し、前記高周波信号を得る無線変調器を有する中央固定局であることを特徴としており、公衆回線網から入力される信号を移動局が所望の通信品質で無線にて受信できる。

【0034】上記従来例の問題点を解決するための請求項2記載の発明は、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、前記中央固定局が、公衆回線網から入力を受けた信号で特定の周波数の搬送波を変調し、前記高周波信号を得る無線変調器と、前記中継固定局から入力を受けた光信号を変換した高周波信号を復調して、前記公衆回線網に出力する無線復調器とを有する中央固定局であることを特徴としており、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができる。

【0035】上記従来例の問題点を解決するための請求項3記載の発明は、不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、前記中央固定局が、アンテナと、無線部と、有線部とを備え、前記無線部が、前記アンテナに到来した信号を高周波信号として出力すると共に、高周波信号の入力を受けて、当該入力された高周波信号を前記アンテナを介して外部に放射する無線部であり、前記有線部が、外部から有線で入力される多種の信号で各々特定の周波数の搬送波を変調し、高周波信号を得る複数の無線変調器と、前記無線部から

入力される高周波信号と前記複数の無線変調器から入力される高周波信号とを合成して出力する合成器と、前記合成された高周波信号を光信号に変換して中継固定局に出力する電気／光変換器と、前記中継固定局から入力される光信号を高周波信号に変換する光／電気変換器と、前記光／電気変換器から入力される高周波信号を前記無線部のアンテナから放射すべき高周波信号と、外部に有線で出力すべき高周波信号とに分配し、前記無線部のアンテナから放射すべき高周波信号を前記無線部に出力する第1の分配器と、前記第1の分配器から入力される、外部に有線で出力すべき高周波信号を分配する第2の分配器と、前記第2の分配器からそれぞれ入力される高周波信号から多種の信号の各々を復調する複数の無線復調器とを有する有線部であることを特徴としており、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、多種の信号を簡易な構成で中継できる。

【0036】上記従来例の問題点を解決するための請求項4記載の発明は、不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、前記中継固定局が、中央固定局から入力された光信号を高周波信号に変換する光／電気変換器と、前記高周波信号を分配する分配器と、前記分配された高周波信号の一方から中継固定局を制御する信号である制御信号を復調する復調器と、前記制御信号に従って中継固定局内の各部の制御を行う制御部と、前記分配された他方の高周波信号を漏洩同軸ケーブルに出力すると共に、漏洩同軸ケーブルに到来した高周波信号を出力する共用器と、前記共用器から入力された高周波信号を光信号に変換して中央固定局に出力する電気／光変換器とを有する中継固定局であることを特徴としており、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、更に中継固定局に対するシステム設定を遠隔制御することができる。

【0037】上記従来例の問題点を解決するための請求項5記載の発明は、不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信

号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、前記中継固定局が、中央固定局から入力された光信号を高周波信号に変換する光／電気変換器と、前記高周波信号を漏洩同軸ケーブルに出力すると共に、漏洩同軸ケーブルに到来した高周波信号を出力する共用器と、中継固定局内の各部の動作状態を監視し、監視信号を出力する制御部と、前記監視信号を高周波信号に変調する変調器と、前記変調器で変調された高周波信号と前記共用器から入力された高周波信号とを合成して出力する合成器と、前記合成器から入力された高周波信号を光信号に変換して中央固定局に出力する電気／光変換器とを有する中継固定局であることを特徴としており、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、更に中継固定局の動作状態を遠隔監視することができる。

【0038】上記従来例の問題点を解決するための請求項6記載の発明は、不感区域外に配置され、中継すべき高周波信号を光信号に変換し、当該光信号を出力すると共に、不感区域から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局と、不感区域に複数分散配置され、前記中央固定局から光ファイバを介して入力された前記光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して当該高周波信号を不感区域で放射すると共に、前記漏洩同軸ケーブルを介して不感区域に存する移動局から受信した高周波信号を光信号に変換して前記中央固定局に出力する中継固定局とを備える中継システムであって、前記中継固定局が、中央固定局から入力された光信号を高周波信号に変換する光／電気変換器と、前記高周波信号を分配する分配器と、前記分配された高周波信号の一方から中継固定局を制御する信号である制御信号を復調する復調器と、前記制御信号に従って中継固定局の各部の制御を行うと共に、中継固定局の各部の動作状態を監視し、監視信号を出力する制御部と、前記分配された他方の高周波信号を漏洩同軸ケーブルに出力すると共に、漏洩同軸ケーブルに到来した高周波信号を出力する共用器と、前記監視信号を高周波信号に変調する変調器と、前記変調器で変調された高周波信号と前記共用器から入力された高周波信号とを合成して出力する合成器と、前記合成器から入力された高周波信号を光信号に変換して中央固定局に出力する電気／光変換器とを有する中継固定局であること

を特徴としており、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、更に中継固定局で異常が発生した際の修復やシステムの設定を遠隔制御することができる。

【0039】上記従来例の問題点を解決するための請求項7記載の発明は、不感区域外に配置され、アンテナと、無線部と、有線部と、制御部とを備え、中継すべき高周波信号を光信号に変換し、当該光信号を光ファイバを介して不感区域に設置された中継固定局に出力すると共に、前記中継固定局から光ファイバを介して入力された光信号を高周波信号に変換する中央固定局であって、前記無線部が、前記アンテナに到来した信号を高周波信号として出力すると共に、高周波信号の入力を受けて、当該入力された高周波信号を前記アンテナを介して外部に放射する無線部であり、前記有線部が、外部又は前記制御部から有線で入力される多種の信号で各々特定の周波数の搬送波を変調し、高周波信号を得る複数の無線変調器と、前記無線部から入力される高周波信号と前記複数の無線変調器から入力される高周波信号とを合成して出力する合成器と、前記合成された高周波信号を光信号に変換して中継固定局に出力する電気／光変換器と、前記中継固定局から入力される光信号を高周波信号に変換する光／電気変換器と、前記光／電気変換器から入力される高周波信号を前記無線部のアンテナから放射すべき高周波信号と外部に有線で出力すべき高周波信号とに分配する第1の分配器と、前記第1の分配器から入力される、外部に有線で出力すべき高周波信号を分配する第2の分配器と、前記第2の分配器からそれぞれ入力される高周波信号から多種の信号の各々を復調する複数の無線復調器とを有する有線部であり、前記制御部が、前記無線変調器と前記無線復調器とに接続され、前記無線復調器から入力される、前記中継固定局からの監視信号に基づいて、前記中継固定局の動作状態を認識し、前記動作状態に応じて前記中継固定局を制御する制御信号を前記無線変調器に出力する制御部であることを特徴としており、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、かつ1対の光ファイバを用いた簡易な構成で多種の信号を中継でき、更に中継固定局の動作状態を中央固定局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を遠隔制御することができる。

【0040】上記従来例の問題点を解決するための請求項8記載の発明は、請求項7記載の中央固定局において、制御部が、中継固定局の動作状態を示す信号を外部

の上位監視局に出力すると共に、前記上位監視局からの指示信号に従って前記無線変調器に前記中継固定局を制御する制御信号を出力する制御部であることを特徴としており、中継固定局の動作状態を上位監視局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を上位監視局から遠隔制御することができる。

【0041】上記従来例の問題点を解決するための請求項9記載の発明は、請求項7記載の中央固定局において、制御部が、中継固定局からの監視信号に基づいて、前記中継固定局にて異常が発生したことを認識した場合に、無線変調器に前記中継固定局の正常化を図る制御信号を出力する制御部であることを特徴としており、中継固定局の動作状態を中央固定局において監視して、中継固定局において異常が発生した場合に、迅速に中継固定局の正常化を図ることができる。

【0042】上記従来例の問題点を解決するための請求項10記載の発明は、請求項6記載の中継システムにおいて、請求項7記載の中央固定局を備えることを特徴としており、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、かつ1対の光ファイバを用いた簡易な構成で多種の信号を中継でき、更に中継固定局で異常が発生した際の修復やシステムの設定を遠隔制御することができる。

【0043】上記従来例の問題点を解決するための請求項11記載の発明は、請求項6記載の中継システムにおいて、請求項8記載の中央固定局を備えることを特徴としており、中継固定局の動作状態を上位監視局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を中央固定局から遠隔制御することができる。

【0044】上記従来例の問題点を解決するための請求項12記載の発明は、請求項6記載の中継システムにおいて、請求項9記載の中央固定局を備えることを特徴としており、中継固定局の動作状態を中央固定局において監視して、中継固定局において異常が発生した場合に、迅速に中継固定局の正常化を図ることができる。

【0045】

【発明の実施の形態】本発明の実施の形態について図面を参照しながら説明する。本発明の実施の形態に係る第1の中継システム（第1の本システム）は、公衆回線網から入力された信号で搬送波を変調し、高周波信号を得て、当該高周波信号を光信号に変換し、光ファイバを介して不感区域まで伝送し、不感区域において当該光信号を高周波信号に変換して、当該高周波信号を漏洩同軸ケーブルによって放射するもので、公衆回線網から入力される信号を不感区域全体に中継できるものである。

【0046】第1の本システムは、図1に示すように、

PSTNやISDN等の公衆回線網1に有線で直接接続され、公衆回線網1から入力された信号で副搬送波を変調し、高周波信号を得て増幅し、さらに当該増幅した高周波信号で光信号の主搬送波を変調することで、高周波信号を光信号に変換する中央固定局10と、中央固定局10が出力する光信号を伝達する光ファイバ7と、光ファイバ7を介して中央固定局10から入力された光信号を高周波信号に変換する中継固定局30'と、漏洩同軸ケーブル5と、補助増幅器6とから基本的に構成されている。図1は、第1の本システムの構成ブロック図である。

【0047】以下、各部を具体的に説明するが、中央固定局10と、光ファイバ7とは、図10に示した従来の中継システムのものと同様であり、漏洩同軸ケーブル5と、補助増幅器6とは、図9に示した従来の中継システムのものと同様であるので、説明を省略する。

【0048】中継固定局30'は、図10に示した従来の中継システムのものと同様に、光ファイバ7を介して入力される光信号を電気的な高周波信号に変換する光／電気変換器31と、増幅器34とを備えるものであるが、増幅器34によって増幅された高周波信号をアンテナではなく、漏洩同軸ケーブル5を用いて放射するところが異なっている。

【0049】すなわち、第1の本システムは、公衆回線網1から中央固定局10によって変換され、不感区域に導かれた光信号を中継固定局30'で高周波信号に変換し、漏洩同軸ケーブル5を用いて放射するもので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網1から入力される信号を所望の通信品質で無線にて受信できる効果がある。

【0050】また、図1に示した第1の本システムは、例えばページャのように公衆回線網から移動局に対する下り回線のみを用いる中継システムに好適なものであるが、携帯電話機等の双方向通信機器に用いるのに好適なように、本発明の実施の形態に係る第2の中継システム（第2の本システム）として、図2に示すように上り回線の信号を扱うようにしてあっても構わない。図2は、第2の本システムの構成ブロック図である。

【0051】第2の本システムは、図2に示すように、図1に示した第1の本システムと同様に公衆回線網1に有線で直接接続された中央固定局10と、下り回線と上り回線とにそれぞれ対応して敷設されている2の光ファイバ7と、中継固定局30'と、漏洩同軸ケーブル5と、補助増幅器6とから構成されているものであるが、中央固定局10と、中継固定局30'とが少々異なっている。

【0052】以下、各部を具体的に説明するが、漏洩同軸ケーブル5と、補助増幅器6とは、既に説明したものと同様のものであるので、説明を省略する。第2の本システムにおける中央固定局10は、公衆回線網1から入

力される信号で高周波を変調し、高周波信号として出力する無線変調器2と、無線変調器2から入力される高周波信号を増幅する第1の増幅器4aと、当該増幅された高周波信号を光信号に変換し、当該光信号を下り回線用に敷設されている光ファイバ7を介して中継固定局30'に伝達する電気/光変換器11と、下り回線用に敷設されている光ファイバ7を介して中継固定局30'から入力された光信号を高周波信号に変換する光/電気変換器31と、光/電気変換器31から入力される信号を増幅する第2の増幅器4bと、当該増幅された高周波信号の入力を受けて信号を復調し、出力する無線復調器8とから構成されている。

【0053】また、第2の本システムにおける中継固定局30'は、下り回線用の光ファイバ7を介して入力された光信号を電気的な高周波信号に変換する光/電気変換器31と、当該高周波信号を増幅して出力する第1の増幅器34aと、漏洩同軸ケーブル5に移動局から到来した高周波信号を増幅する第2の増幅器34bと、入力された高周波信号を光信号に変換し、上り回線用の光ファイバ7に出力する電気/光変換器11と、第1の増幅器34aから入力された下り回線の高周波信号を漏洩同軸ケーブル5に出力しつつ、漏洩同軸ケーブル5に移動局から到来した上り回線の高周波信号を第2の増幅器34bに出力する共用器33とから構成されている。

【0054】次に、第2の本システムの動作について説明する。まず、公衆回線網1から不感区域に存する移動局に対する信号が中央固定局10に出力されると、中央固定局10が無線変調器2によって当該信号で搬送波を変調して高周波信号を得て、第1の増幅器4によって当該高周波信号を増幅し、さらに電気/光変換器11で光信号に変換して、下り回線用の光ファイバ7に出力する。

【0055】すると、下り回線用の光ファイバ7を介して光信号の入力を受けた中継固定局30'が光/電気変換器31によって、当該光信号を電気的な高周波信号に変換し、第1の増幅器34aによって増幅して、共用器33を介して当該高周波信号を漏洩同軸ケーブル5に出力する。

【0056】そして、漏洩同軸ケーブル5から当該高周波信号が放射されるようになって、不感区域に存する移動局に信号が到来するようになる。

【0057】一方、漏洩同軸ケーブル5に到来した、移動局が送信出力する高周波信号は、中継固定局30'の共用器33によって、第2の増幅器34bに出力され、当該第2の増幅器34bで増幅され、電気/光変換器11によって光信号に変換されて、上り回線用の光ファイバ7に出力される。

【0058】すると、上り回線用の光ファイバ7を介して当該光信号の入力を受けた中央固定局10が当該光信号を光/電気変換器31で電気的な高周波信号に変換

し、第2の増幅器4によって、当該高周波信号を増幅し、無線復調器8によって、当該高周波信号から信号を復調して、公衆回線網1に出力する。

【0059】このような第2の本システムによれば、敷設工事の容易な光ファイバを用いて、下り回線の信号を不感区域全体に中継すると共に、不感区域のいずれの場所にある移動局から放射された上り回線の信号を公衆回線網に中継することができる効果がある。

【0060】第1の本システムと第2の本システムとは、本発明の基本的構成を表すものであり、例えば、漏洩同軸ケーブルでとらえられた目的外の電波の中央固定局の無線復調器に入力されるのを防ぐと共に、増幅器の非線形性等に起因する歪み成分によるスプリアス成分の漏洩同軸ケーブルからの輻射等を除くため、必要に応じて帯域フィルタ等が挿入される場合があるが、ここではかかる説明を省略している。

【0061】次に、不感区域に分岐がある場合に好適な本発明の第3の実施の形態に係る中継システム（第3の本システム）について図3を参照しつつ説明する。図3は、第3の本システムの構成ブロック図である。

【0062】尚、以下の第3の本システムは、簡単のため、第1の本システムと同様にページャ等の単方向の通信システムに適用する場合の例を示しているが、第2の本システムに対応した中継システムとしても構わない。

【0063】図3に示す第3の本システムは、不感区域が十字状に交差する場合を念頭に、交差点から4方向に漏洩同軸ケーブルを設置する場合の例である。すなわち、図3に示すように、第3の本システムは、公衆回線網1、中央固定局10と、光ファイバ7と、光スターカプラ20と、4つの中継固定局30'と、4つの漏洩同軸ケーブル5とから主に構成されている。

【0064】以下、各部を具体的に説明するが、中央固定局10は、第1の本システムにおけるものと同様のものであるので、説明を省略する。

【0065】光スターカプラ20は、従来技術における光スターカプラ20と同様のものであり、ここでは、中央固定局10から入力された光信号を、光ファイバ7を介して、複数の中継固定局30'に分配して伝達するものである。また、光スターカプラ20は、図3では、十字に広がる不感区域に対応するために、1対4の光スターカプラとしている。

【0066】中継固定局30'と漏洩同軸ケーブル5とは、第1の本システムにおけるこれらと同様のもので、それぞれ十字の各枝ごとに設置されている。尚、特に漏洩同軸ケーブル5は、十字の各枝に沿って敷設されていることが好適である。

【0067】すなわち、第3の本システムは、中央固定局10が出力する光信号を十字の各枝ごとに配置された中継固定局30'に光スターカプラ20によって分配して伝達し、各枝ごとの中継固定局30'が当該光信号を

高周波信号に変換し、各枝に沿って敷設された漏洩同軸ケーブル5を介して放射するようになっている。

【0068】このような第3の本システムによれば、敷設工事の容易な光ファイバを用いて、下り回線の信号を十字状に広がる不感区域全体に中継することができる効果がある。

【0069】また、光スターカプラ20を1対多のスターカプラとして、分岐した枝ごとに配置された中継固定局30'と、当該枝に沿って敷設された漏洩同軸ケーブル5とを用いて、分岐のあるトンネル等の不感区域全体をカバーするようにしてもよい。

【0070】さらに、各枝に沿って敷設された漏洩同軸ケーブル30'の中間に補助増幅器6を挿入して、補助増幅器6により漏洩同軸ケーブル5が伝送している高周波信号を増幅することで、漏洩同軸ケーブル5の延長距離を延ばすようにしても構わない。

【0071】次に、不感区域が非常に長い線上に広がる場合に好適な本発明の第4の実施の形態に係る中継システム(第4の本システム)について、図4を用いて説明する。図4は、第4の本システムの構成ブロック図である。

【0072】すなわち、第4の本システムでは、漏洩同軸ケーブルと中継増幅器とを多段に接続しただけでは、減衰、雑音、歪みの発生のために不感区域全体をカバーできないときに、光ファイバを不感区域全体に敷設し、適宜光分岐器で光信号を分岐して高周波信号に変換し、漏洩同軸ケーブルを介して当該高周波信号を放射するようにすることで、敷設工事の容易な光ファイバを用いて所望の通信品質を維持しつつ、不感区域全体をカバーできるものである。

【0073】第4の本システムは、図4に示すように中央固定局10と、不感区域全体に敷設された光ファイバ7と、複数の光分岐器21と、光分岐器21に対応して設けられた中継固定局30'と、各中継固定局30'に接続された漏洩同軸ケーブル5とから主に構成されている。

【0074】以下、各部を具体的に説明するが、中央固定局10と中継固定局30'とは、図2に示した第2の本システムのこれらと同様のものであるので、説明を省略する。光分岐器21は、上り回線用の1対2光カプラと、下り回線用の1対2光カプラとから主に構成され、不感区域全体に敷設された光ファイバ7の中間に挿入されており、光ファイバ7が伝達する光信号を特定の光強度の比率(光分岐比)で分岐して、対応する中継固定局30'に出力するものである。

【0075】尚、漏洩同軸ケーブル5は、光ファイバ7と略平行に多数敷設して、不感地帯全体を漏れなくカバーすることが望ましい。

【0076】すなわち、第4の本システムは、中央固定局10が出力する光信号を適宜光分岐器で分岐し、中継

固定局30'が当該分岐した光信号を高周波信号に変換して漏洩同軸ケーブル5を介して放射するようになっている。

【0077】また、光分岐比は、光ファイバを中継固定局30'の近傍で光信号を分岐する単芯多分岐型光伝送路を用いるものであるので、光分岐器21の光分岐比の設定方法等に関しては、例えば、「自動波長オフセット制御を適用した移動体通信用多分岐型光ファイバリンク」、垂澤他、電子情報通信学会技術研究報告RCS94-70(1994年9月)に従って、以下のように設定すればよい。

【0078】すなわち、下り回線用の光カプラの分岐比は、各中継固定局30'の光/電気変換器31に入力される光信号の強度Prが一定値であるようにすれば、各中継固定局30'の増幅器の利得等を共通に設計することができるため、経済的である。そこで、i番目の中継固定局の光カプラの分岐比(結合係数)Kiを、次の[数1]によって決定する。

【0079】

【数1】

$$K_i = \frac{K_L^{i-2}}{\sum_{i=1}^{N-2} K_L^i + 2}$$

【0080】ただし、KLは光ファイバの損失であり、iは3以上である。また、中央固定局に最も近い光カプラの結合係数KNは、次の[数2]に示されるようになる。

【0081】

【数2】

$$K_N = \frac{K_L^{N-2}}{\sum_{i=1}^{N-2} K_L^i + 2}$$

【0082】また、中央固定局10の電気/光変換器11の出力する光信号の強度をPsとすると、各中継固定局における受光レベルPrは、次の[数3]のようになる。

【0083】

【数3】

$$P_r = \frac{K_L^{N-1}}{\sum_{i=1}^{N-2} K_L^i + 2} \cdot P_s$$

【0084】上り回線の光カプラの結合係数に関しても、下り回線と同様に計算できる。

【0085】尚、これらの第1～第4の本システムを組

み合わせて、例えば図5に示すように、中央固定局10が出力する光信号を1対多の光スターカプラ20で分岐し、当該分岐した光信号を伝達する光ファイバ7を不感地帯に沿って敷設し、適宜光分岐器21によって分岐して、複数の中継固定局30'にそれぞれ光信号を伝達し、当該中継固定局30'において、当該光信号を高周波信号に変換して、各中継固定局30'に接続された漏洩同軸ケーブル5を介して当該高周波信号を放射するようにしても構わない。図5は、第1～第4の本システムを組み合わせた場合の中継システムの一例を表す構成ブロック図である。

【0086】このように第1～第4の本システムを組み合わせれば、複雑な形状に広がる現実の不感区域全体に信号を中継できる効果がある。

【0087】尚、上記第1～第4の本システムにおいて、光信号は、例えば、アナログ光変調された光信号であり、かかる変調方式としては、半導体レーザの直接強度変調が一般に用いられている。一般に、光通信用半導体レーザおよび光復調器として用いられるフォトダイオードは、数GHz程度の変調帯域（応答帯域）を有するので、周波数多重化された複数の信号を合成して光信号に変調することも考えられる。

【0088】つまり、ここでは、図面の煩雑さを避けるため無線変調器2と増幅器4とを1組しか記載していないが、無線変調器2と増幅器4とを複数組備え、各無線変調器2において用いられる搬送波（副搬送波）が互いに異なる複数の周波数であるとして、これらをそれぞれ変調して得た高周波信号を合成し、当該合成した信号で、光信号の搬送波（主搬送波）を変調することで、多種の高周波信号を一括して光信号に変換する、いわゆる副搬送波多重アナログ光伝送を行ってもよい。

【0089】このような多種の信号を一斉に中継し、更にシステム設定の制御及び監視を遠隔的に行うための本発明の第5の実施の形態に係る中継システム（第5の本システム）は、例えば、図6に示すように、中央固定局10が、アンテナ12と、共用器13と、第1の上り回線用フィルタ14aと、第1の下り回線用フィルタ14bと、第1の増幅器4aと、第2の増幅器4bとを具備する無線部40と、複数の無線変調器2と、合成器15と、第3の増幅器4cと、電気／光変換器11と、光／電気変換器31と、第4の増幅器4dと、第1の分配器16aと、第2の上り回線用フィルタ14cと、第2の下り回線用フィルタ14dと、第2の分配器16bと、無線復調器8とを具備する有線部41と、公衆回線網に接続し、中継固定局30'の制御及び監視を行う制御部43とを備えているものである。図6は、第5の本システムにおける中央固定局10の構成ブロック図である。

【0090】ここで、多種の信号とは、携帯電話、単方向無線呼出し、双方向無線呼出し、警察・消防等の業務用無線、テレビジョン放送波、ラジオ放送波、有線放

送、有線テレビジョン、本システムの中継固定局等を監視／制御する信号（監視信号又は制御信号）、データ通信信号等であることが考えられる。

【0091】以下、各部を具体的に説明する。無線部40は、基地局や放送局等からアンテナ12に到来した信号を共用器13と第1の下り回線用フィルタ14bとを介して、第2の増幅器4bで増幅して有線部41に出力するものであり、また、有線部41から分配された上り回線の信号を第1の増幅器4aで増幅し、第1の上り回線用フィルタ14aと共用器13とを介してアンテナ12に出力し、アンテナ12から送信出力するものである。

【0092】また、有線部41は、携帯電話システムや列車無線システム等各種の通信システムから有線でそれぞれの信号の入力を受けて、当該システムごとに対応して設けられた無線変調器2で、対応するそれぞれのシステムの信号で、当該それぞれの信号に応じて割り当てた搬送波信号を変調して、高周波信号を得て、これらと、上記の無線部40から入力された下り回線の信号とを合成器15で合成して、第3の増幅器4cで増幅して、電気／光変換器11によって光信号に変換して、光ファイバ7を介して中継固定局30'に出力するものである。

【0093】さらに有線部41は、中継固定局30'から入力される光信号を光／電気変換器31によって電気的な高周波信号に変換し、第4の増幅器4dで増幅して、第1の分配器16aによって、無線部40に出力する信号と、第2の分配器16bに出力する信号とに分配し、さらに、無線部40に出力する信号は、第2の上り回線用フィルタ14cによって、帯域制限されてから出力されるようになっている。

【0094】さらに有線部41は、第1の分配器16aによって第2の分配器16bに出力された信号を第2の分配器16bによって、上記の各システムに対応して設けられた複数の無線復調器8で、それぞれ復調し、上記の各システムにそれぞれ有線で出力するものである。

【0095】また、制御部43は、有線部41を介して下位の中継固定局30'から、各々の中継固定局30'の動作状態を示す監視信号の入力を受けて中継固定局30'の状態を認識し、動作状態に応じて中継固定局30'を制御する制御信号を有線部41を介して各中継固定局30'に出力するものである。

【0096】例えば、制御部43は、監視信号によって中継固定局30'に異常が発生したことを認識すると、当該中継固定局30'に対してシステムリセット、電源断、アラーム表示等の制御信号を出力したり、また、中継固定局30'の状態に応じて増幅利得の設定等を指示する制御信号を出力するものである。

【0097】ここで、制御部43が出力する制御信号は、他の各種通信システムの信号と同様に、制御部43に対応した無線変調器2において、特定周波数の搬送波

を制御信号にて変調することにより高周波信号に変換され、他の無線変調器2及び無線部40からの下り回線の信号と合成器15で合成された後、電気／光変換器11によって光信号に変換されるものである。

【0098】また、中継固定局30'からの監視信号は、多重化された状態で光／電気変換器31によって電気的な高周波信号に変換され、更に第1の分配器16a、第2の分配器16bによって分配され、制御部43に対応した無線復調器8によって復調されて監視信号が取り出され、制御部43に入力されるようになっている。

【0099】また、制御部43に、表示部を備えたモニターを接続して、モニターにおいて、中央固定局10自身及び中継固定局30'の動作状態を表示させることも可能である。モニターとしてはノート型パーソナルコンピュータ（PC）等が考えられる。

【0100】このように、中央固定局10が、複数の中継固定局30'の動作状態を監視して、中継固定局30'の動作状態に応じた制御信号を出力することにより、中央固定局10及びそれに接続される中継固定局30'から成るシステムの管理（House Keeping）を容易に及び適正に行うことができるものである。

【0101】更に、制御部43は、公衆回線又は専用線を介して上位の監視局（図示せず）と双方向に接続可能であり、監視局に対して、中央固定局10自身又は下位の中継固定局30'における重大アラーム発生時の報告や、システム動作状況の定期報告を行ったり、監視局からの指示信号を受けて制御信号として下位に伝達するものである。

【0102】例えば、中央固定局10自身又は下位の中継固定局30'において重大アラームが発生した場合には、中央固定局10が監視局に対して重大アラーム発生時の報告を自動的に発信し、上位の監視局においてこれを受信すると、監視局においてアラーム表示又はブリンク表示等を行い、更に、監視局が、中央固定局10に指示信号を出力し、中央固定局が指示信号に従って下位の中継固定局30'に制御信号を出力するようになっている。監視局からの指示信号としては、個々の中央固定局10及び中継固定局30'に対するシステムの設定を変更するシステム操作や、個別リセット、電源切断等の制御が考えられる。

【0103】また、システム動作状況の定期報告は中央固定局10が自発的に行ってもよいし、上位監視局からの要求に応じて中央固定局10が出力するようにしてもよい。更に、中継固定局30'からの定期報告も、中継固定局30'が自発的に行ってもよいし、中央固定局10又は上位監視局からの要求に応じて出力するようにしてもよい。

【0104】これにより、複数の中央固定局10及びそれに接続される中継固定局30'を含むシステムの管理

を、更に上位の監視局において遠隔管理することができるものである。

【0105】次に、第5の本システムにおける中継固定局30'について図7を用いて説明する。図7は、第5の本システムにおける中継固定局30'の一例を表す構成ブロック図である。中継固定局30'は、第2の本システムにおける中継固定局30'をそのまま用いてもよいが、図7に示すように、第1の増幅器34aの後段に、1本の入力信号を2本に分けて出力する分配器36と、分配された信号の一方を帯域制限して、中継固定局30'を制御するための制御信号を取り出す第1のフィルタ37aと、分配された他方の信号を帯域制限する第2のフィルタ37bと、第1のフィルタ37aを介して制御信号の入力を受けて、当該制御信号を復調して出力する復調器38と、制御信号の入力を受けて中継固定局30'内の制御を行うと共に装置内部の動作状態を監視して監視信号を出力する制御部17と、制御部17からの指示に従ってアラーム表示を行うアラーム表示器18と、第2のフィルタ37bを介して上記その他の信号の入力を受けて、当該信号を増幅する第3の増幅器34cと、当該増幅した信号を漏洩同軸ケーブル5に出力する共用器33と、共用器33から漏洩同軸ケーブル5に到来した信号の入力を受けて、帯域制限する第3のフィルタ37cと、当該第3のフィルタ37cから入力された信号を増幅する第4の増幅器34dと、中継固定局30'の状態を表す信号である監視信号を変調する変調器39と、上記第4の増幅器34dと変調器39とから入力された信号を合成して第2の増幅器34bに出力する合成器35とを備えるようにしてもよい。

【0106】上記構成の中継固定局30'においては、制御部17に、復調器38から制御信号が入力されると、制御部17は当該制御信号に従って中継固定局30'の各構成部を制御する。例えば、制御信号としてアラーム表示の指示が入力された場合には、制御部17は、アラーム表示器18に対してアラーム表示の指示を出力し、アラーム表示器18がアラーム表示を行うようになっている。また、指示信号又は制御信号によってリセット、電源断等を行い、更に増幅器における利得の設定等のシステム設定の変更を行うものである。

【0107】また、制御部17は、中継固定局30'内の動作状態を監視して、定期的に又は監視局又は中央固定局10からの要求により、変調器39に監視信号を出力する。監視局からの要求は、中央固定局10を介して制御信号として中継固定局30'に出力される。監視信号は、変調器39にて高周波信号に変調され、増幅器34dからの信号と合成された後、増幅器34bにて増幅され、電気／光変換器11にて光信号に変換されて、光ファイバー7を介して伝送され、上述した中央固定局10に入力されるようになっている。

【0108】このような第5の本システムによれば、敷

設の容易な光ファイバを用いて、複雑な形状の不感区域の全体をカバーして、所望の通信品質での無線通信を行うことができ、かつ1対の光ファイバを用いた簡易な構成で多種の信号を中継できる効果がある。

【0109】また、第5の本システムによれば、中継固定局30'の動作状態を、中央固定局10又は更に上位の監視局に対して報知して、中央固定局10及び監視局にて管理することができ、また、利得等の設定やその他システム操作を中央固定局10又は監視局から遠隔制御することができ、システム全体の管理を容易に且つ適正にできる効果がある。

【0110】また、この第5のシステムにおいて、例えば地下鉄等における列車運行指令等の列車無線のように沿線全線にわたってサービスエリアを必要とするものと、携帯電話、無線呼出し等のように、ホームやコンコース等でスポット的にしかサービスエリアを必要としない場合に図8に示すように、中継固定局30'がそれぞれ漏洩同軸ケーブル5とアンテナ32とのうち、好適なものを適宜選択して、中継固定局30'と、漏洩同軸ケーブル5と、光ファイバ7とを設置するようにしても構わない。図8は、第5の本システムの中継固定局30'の一例を表す構成ブロック図である。

【0111】尚、上記第1～第5のシステムにおいて、中継固定局30'の電源を中央固定局10から供給するようにしておいても構わない。また、この場合には、電源ケーブルと光ファイバ7とを一体とした複合ケーブルを用いるようにしても構わない。

【0112】

【発明の効果】請求項1記載の発明によれば、中央固定局が無線変調器により、公衆回線網から入力を受けた中継すべき信号を高周波信号に変換し、当該高周波信号を光信号に変換して、不感区域に分散配置された複数の中継固定局に出力し、中継固定局が当該光信号を高周波信号に変換し、漏洩同軸ケーブルを介して不感区域で放射する中継システムとしているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される信号を移動局が所望の通信品質で無線にて受信できる効果がある。

【0113】請求項2記載の発明によれば、中央固定局が無線変調器により、公衆回線網から入力を受けた中継すべき信号を高周波信号に変換し、当該高周波信号を光信号に変換して、不感区域に分散配置された複数の中継固定局に出力すると共に、中継固定局から入力された光信号を高周波信号に変換し、当該高周波信号を復調して公衆回線網に出力し、中継固定局が中央固定局から入力された光信号を高周波信号に変換し、不感区域に敷設された漏洩同軸ケーブルを介して放射すると共に、当該漏洩同軸ケーブルに到来した高周波信号を光信号に変換して中央固定局に出力する中継システムとしているので、トンネル、地下道のように線状に広がる不感区域におい

て、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができる効果がある。

【0114】請求項3記載の発明によれば、中央固定局がアンテナを備えて、当該アンテナに到来する無線信号と、外部から有線で入力される多種の信号を元に、複数の無線変調器によって得られる複数の高周波信号とを合成し、当該合成した高周波信号を光信号に変換して中継固定局に出力し、中継固定局から入力される光信号を高周波信号に変換して無線で放射する信号と有線で出力する信号とに分配し、無線で放射する信号はアンテナを介して放射すると共に、有線で出力する信号は、さらに信号の種類毎に分配し、各々復調して、外部に有線にて出力する中継システムとしているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、かつ1対の光ファイバを用いた簡易な構成で多種の信号を中継できる効果がある。

【0115】請求項4記載の発明によれば、中継固定局が中央固定局から入力された光信号を高周波信号に変換して漏洩同軸ケーブルを介して不感区域に放射すると共に、当該高周波信号から制御信号を復調し、制御部が当該制御信号に従って中継固定局の各部を制御し、また、漏洩同軸ケーブルに到来した信号を光信号に変換して中央固定局に出力する中継システムとしているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、更に中継固定局に対するシステム設定を遠隔制御できる効果がある。

【0116】請求項5記載の発明によれば、中継固定局が中央固定局から入力された光信号を高周波信号に変換して漏洩同軸ケーブルを介して不感区域に放射すると共に、制御部が中継固定局内の各部を監視して監視信号を出力し、また、漏洩同軸ケーブルに到来した信号と、監視信号を元に変調により得た高周波信号とを合成して光信号に変換して中央固定局に出力する中継システムとしているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、更に中継固定局の動作状態を遠隔監視できる効果がある。

【0117】請求項6記載の発明によれば、中継固定局が中央固定局から入力された光信号を高周波信号に変換して漏洩同軸ケーブルを介して不感区域に放射すると共

に、当該高周波信号から制御信号を復調し、制御部が当該制御信号に従って中継固定局の各部を制御し、更に制御部が中継固定局内の各部を監視して監視信号を出力し、また、漏洩同軸ケーブルに到来した信号と、監視信号を元に変調により得た高周波信号とを合成して光信号に変換して中央固定局に出力する中継システムとしているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、更に中継固定局の動作状態を遠隔監視して、中継固定局で異常が発生した際の修復やシステムの設定を遠隔制御することができる効果がある。

【0118】請求項7記載の発明によれば、アンテナに到来する無線信号と、有線で入力される複数の信号に基づいて複数の無線変調器によって得られる複数の高周波信号とを合成し、当該合成した高周波信号を光信号に変換して中継固定局に出力し、中継固定局から入力される光信号を高周波信号に変換して無線で放射する信号と有線で出力する信号とに分配し、無線で放射する信号はアンテナを介して放射すると共に、有線で出力する信号を信号の種類毎に分配し、各々復調して、有線にて出力し、更に、制御部が、中継固定局からの監視信号に基づいて、中継固定局の動作状態に応じて中継固定局を制御する制御信号を無線変調器に出力する中央固定局としているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、かつ1対の光ファイバを用いた簡易な構成で多種の信号を中継でき、更に中継固定局の動作状態を中央固定局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を遠隔制御することができる効果がある。

【0119】請求項8記載の発明によれば、制御部が、中継固定局の動作状態を示す信号を外部の上位監視局に出力すると共に、上位監視局からの指示信号に従って中継固定局を制御する制御信号を出力する請求項7記載の中央固定局としているので、中継固定局の動作状態を上位監視局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を上位監視局から遠隔制御することができる効果がある。

【0120】請求項9記載の発明によれば、制御部が、中継固定局からの監視信号に基づいて、中継固定局にて異常が発生したことを認識した場合に、無線変調器に中継固定局の正常化を図る制御信号を出力する請求項7記載の中央固定局としているので、中継固定局の動作状態を中央固定局において監視して、中継固定局において異常が発生した場合に、迅速に中継固定局の正常化を図ることができる効果がある。

【0121】請求項10記載の発明によれば、請求項7記載の中央固定局を備えた請求項6記載の中継システムとしているので、トンネル、地下道のように線状に広がる不感区域において、公衆回線網から入力される下り回線の信号を不感区域全体に中継すると共に、不感区域にある移動局から放射された上り回線の信号を公衆回線網に中継することができ、かつ1対の光ファイバを用いた簡易な構成で多種の信号を中継でき、更に中継固定局の動作状態を中央固定局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を遠隔制御することができる効果がある。

【0122】請求項11記載の発明によれば、請求項8記載の中央固定局を備えた請求項6記載の中継システムとしているので、中継固定局の動作状態を上位監視局において監視して、中継固定局で異常が発生した際の修復やシステムの設定を上位監視局から遠隔制御することができる効果がある。

【0123】請求項12記載の発明によれば、請求項9記載の中央固定局を備えた請求項6記載の中継システムとしているので、中継固定局の動作状態を中央固定局において監視して、中継固定局において異常が発生した場合に、迅速に中継固定局の正常化を図ることができる効果がある。

【図面の簡単な説明】

【図1】第1の実施の形態に係る中継システム（第1の本システム）の構成ブロック図である。

【図2】第2の本システムの構成ブロック図である。

【図3】第3の本システムの構成ブロック図である。

【図4】第4の本システムの構成ブロック図である。

【図5】第1～第4の本システムを組み合わせた場合の中継システムの一例を表す構成ブロック図である。

【図6】第5の本システムにおける中央固定局10の構成ブロック図である。

【図7】第5のシステムにおける中継固定局30'の一例を表す構成ブロック図である。

【図8】第5の本システムの中継固定局30'の一例を表す構成ブロック図である。

【図9】従来の漏洩同軸ケーブルを用いた中継システムの概念を表す説明図である。

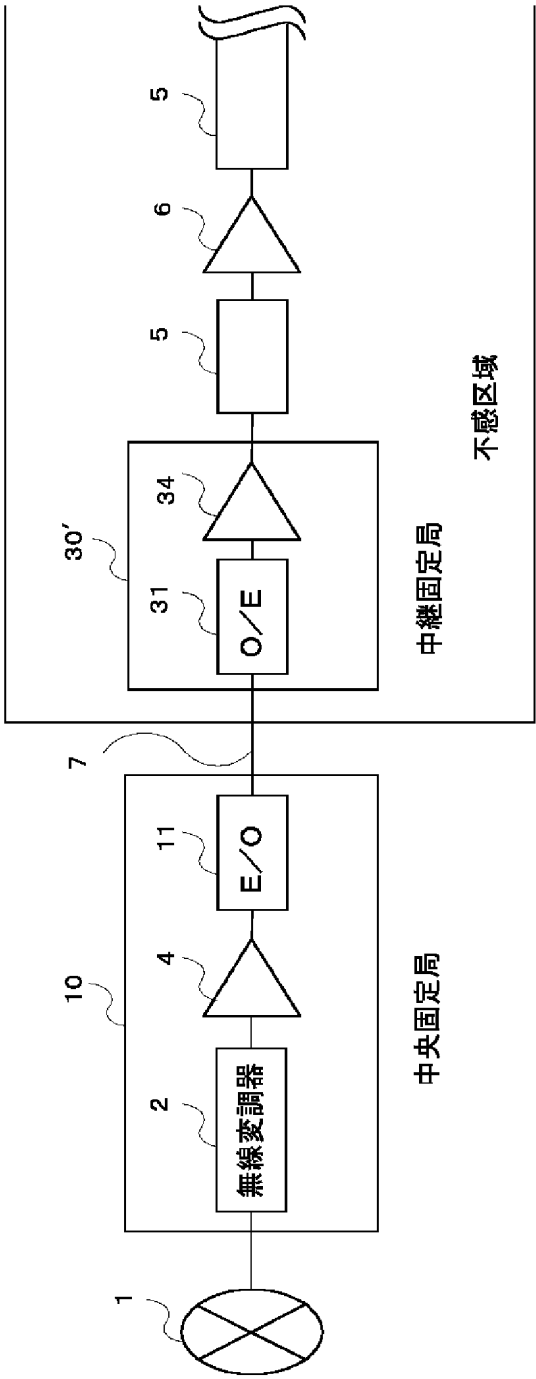
【図10】従来の光ファイバを用いた中継システムの概念を表す説明図である。

【符号の説明】

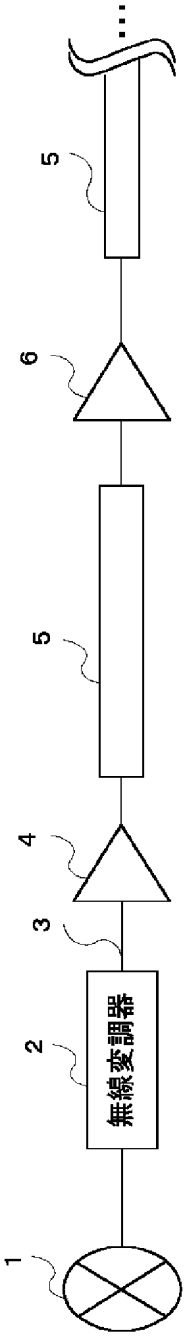
1…公衆回線網、 2…無線変調器、 3…同軸ケーブル、 4…増幅器、 5…漏洩同軸ケーブル、 6…補助増幅器、 7…光ファイバ、 8…無線復調器、 10…中央固定局、 11…電気／光変換器、 12…アンテナ、 13…共用器、 14…フィルタ、 15…合成器、 16…分配器、 17…制御部、 18…アラーム表示器、 20…光スターカプラ、 21…光分岐器、 30、 30'…中継固定局、 31…光／電気変換

器、 3 2…アンテナ、 3 3…共用器、 3 4…増幅部、 4 1…有線部、 4 3…制御部
器、 3 5…合成器、 3 6…分配器、 4 0…無線

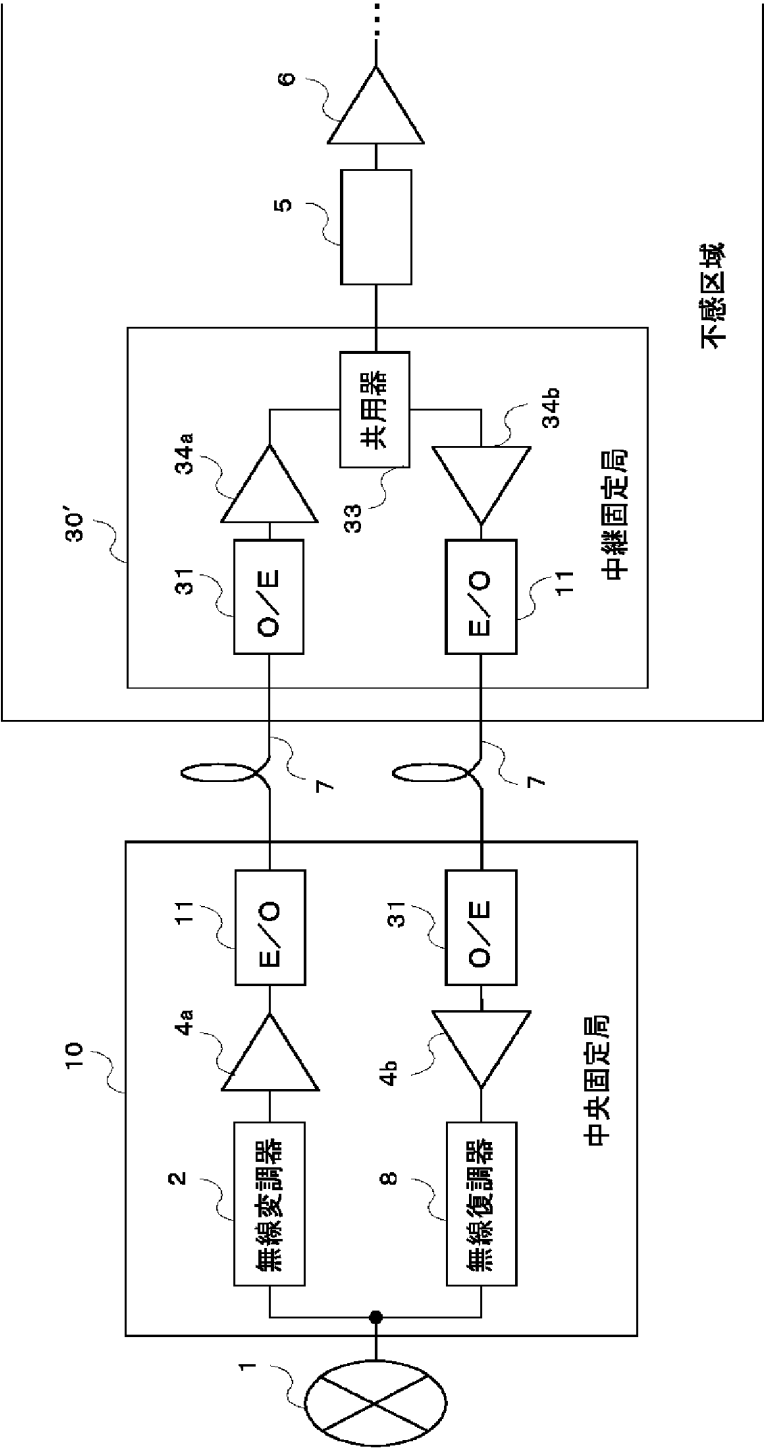
【図 1】



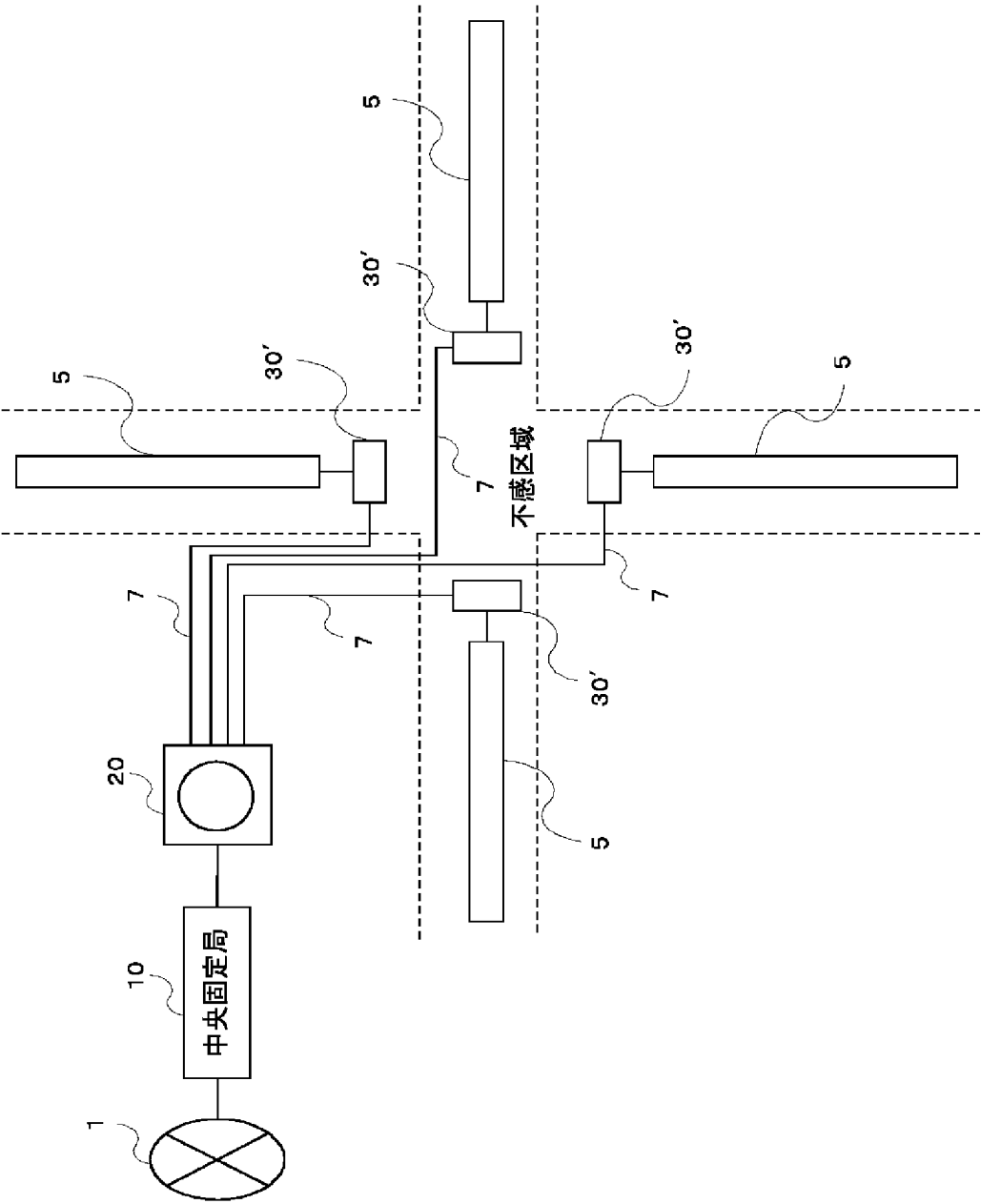
【図 9】



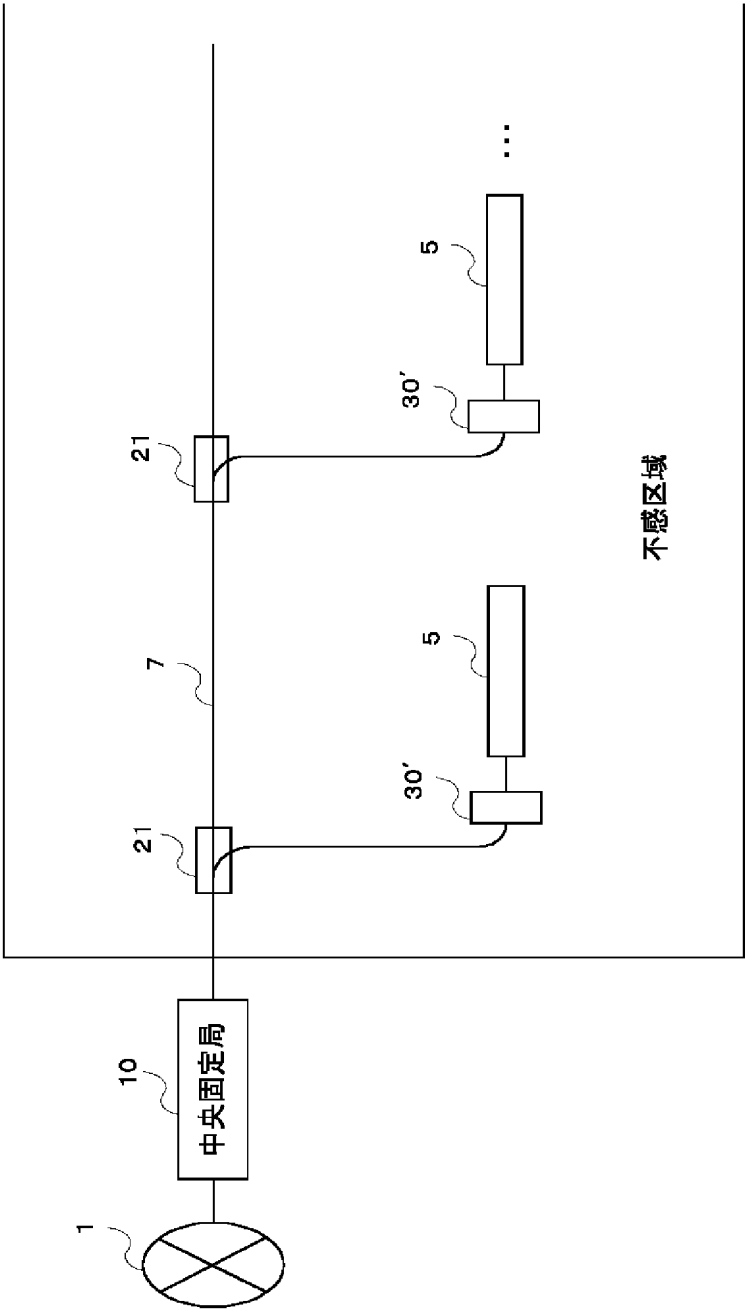
【図 2】



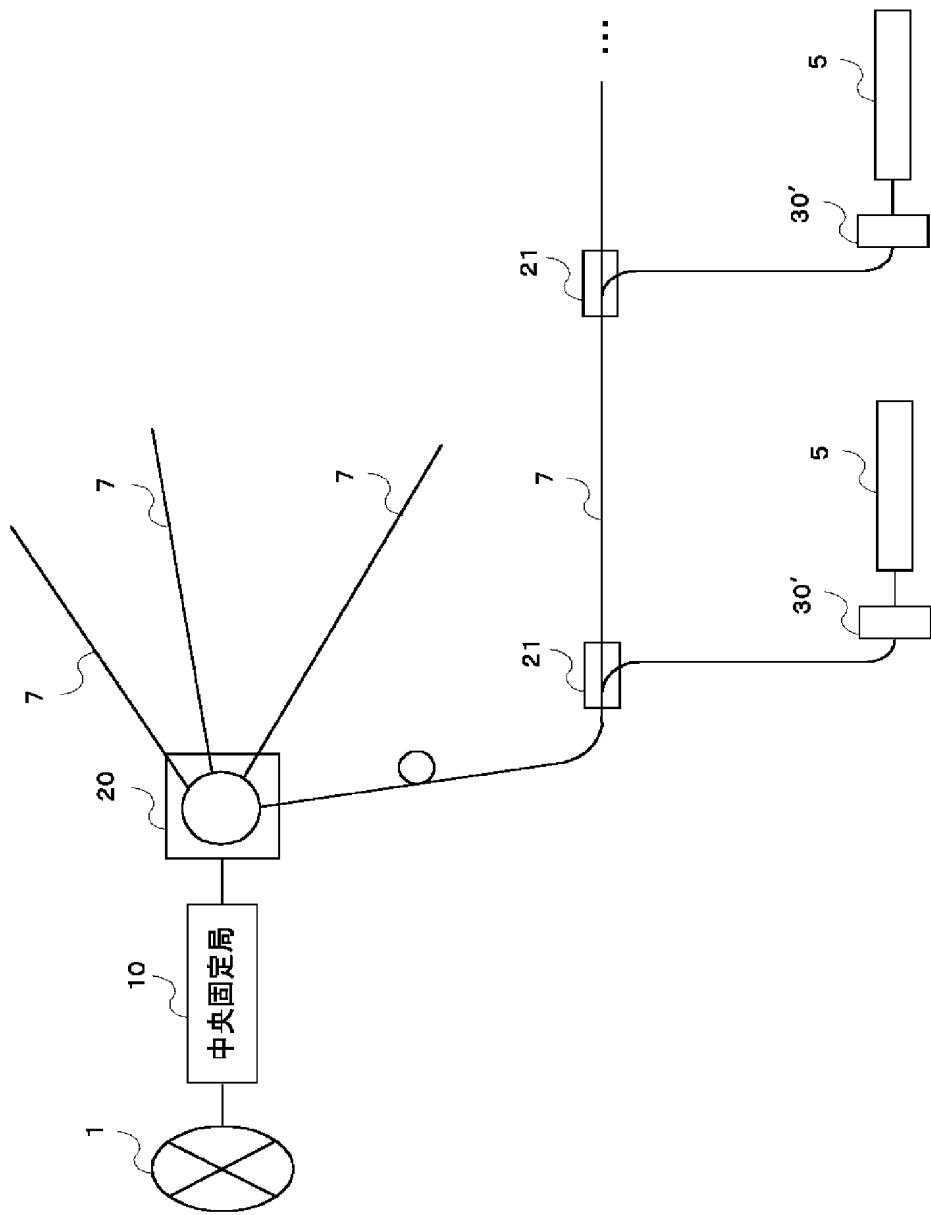
【 図 3 】



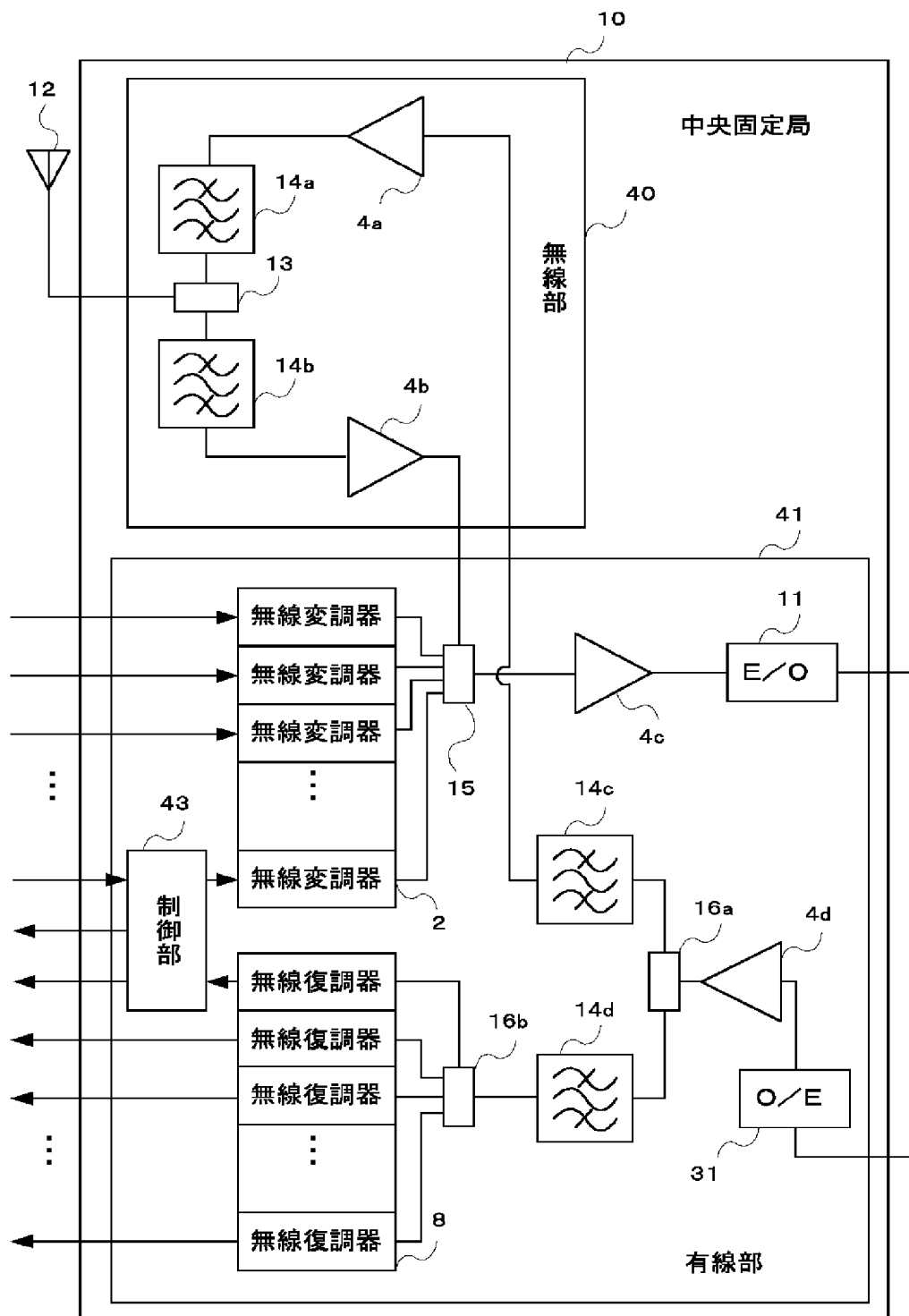
【図4】



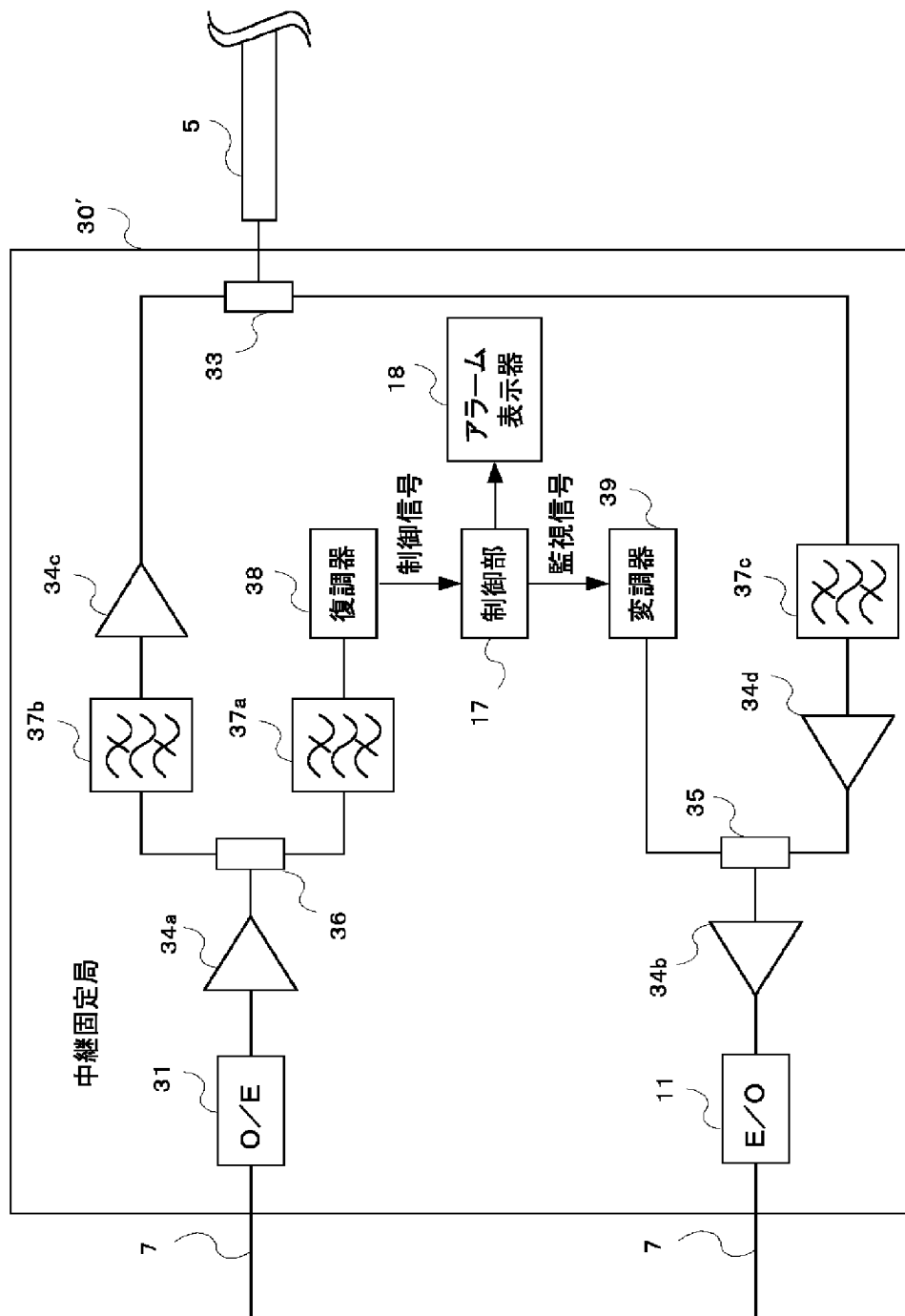
【図 5】



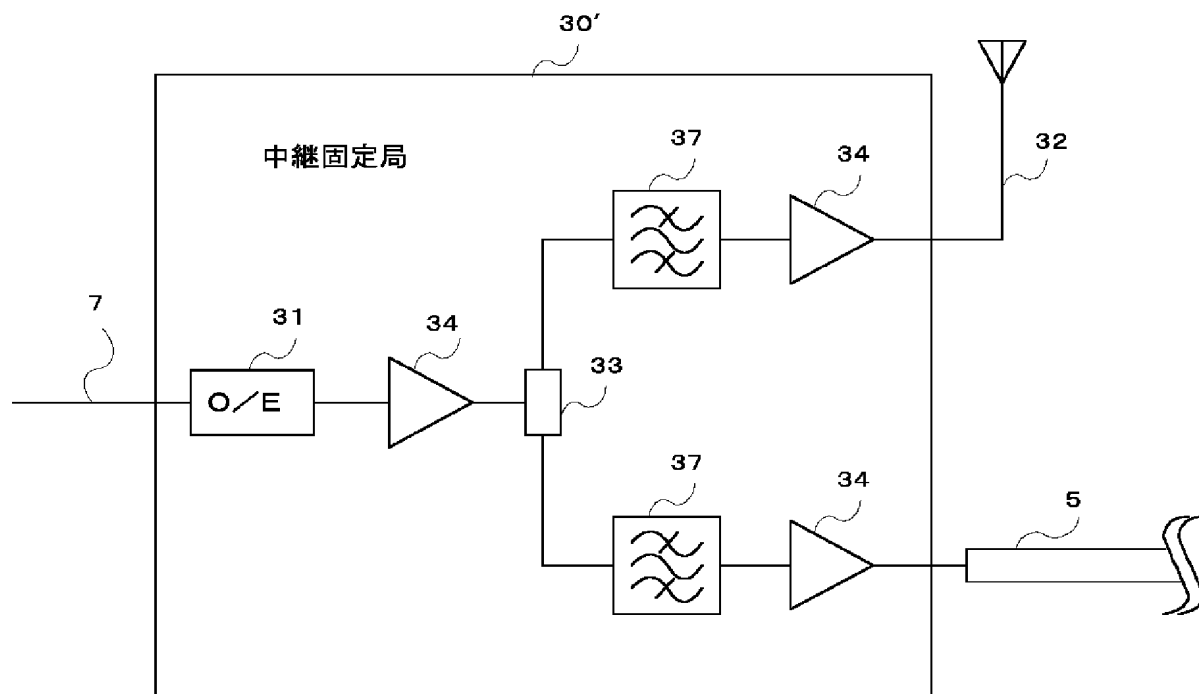
【図6】



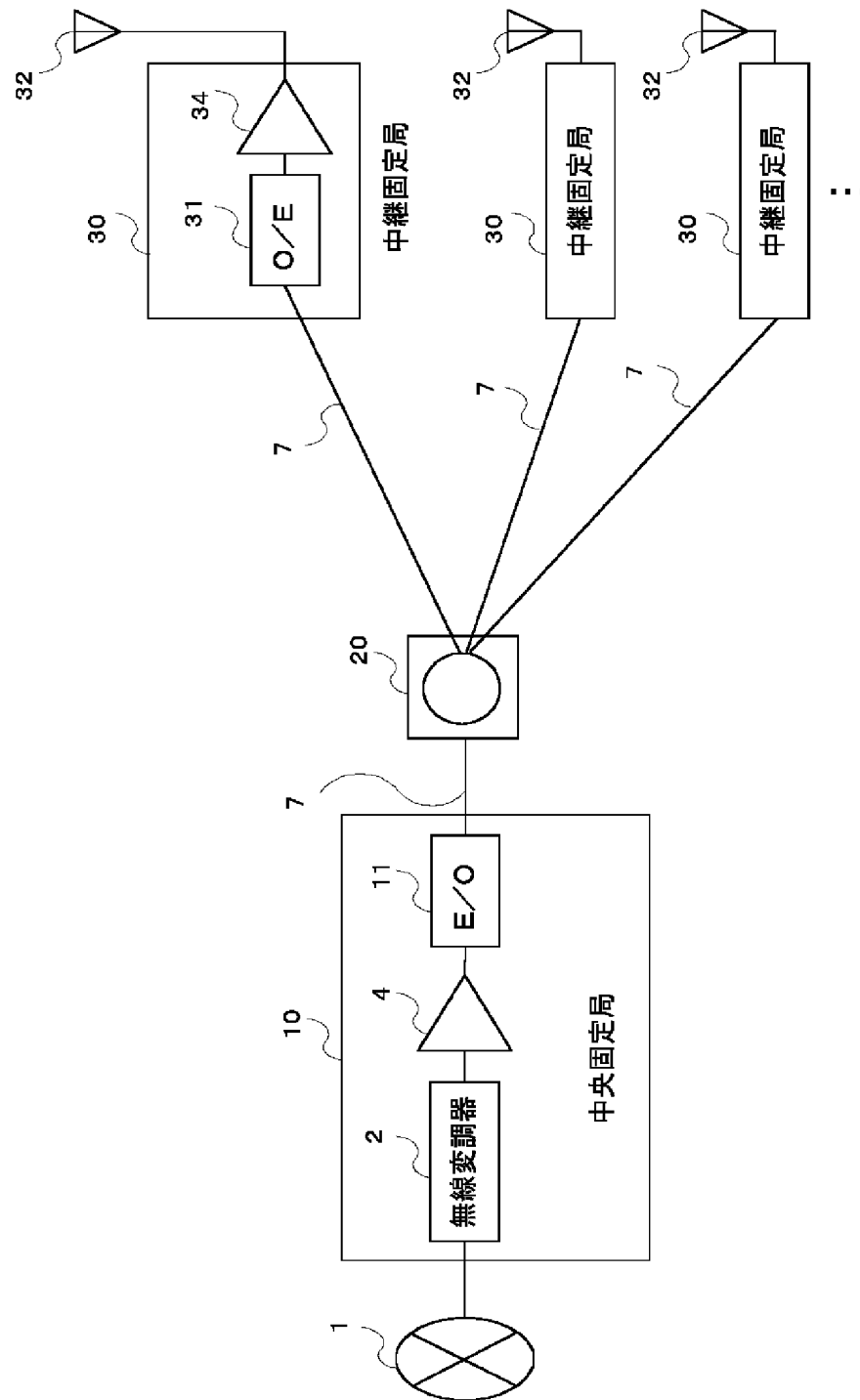
【図 7】



【図8】



【図10】



フロントページの続き

(51)Int.Cl.⁶

識別記号

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H 0 4 B 9/00

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10/00

Electronic Patent Application Fee Transmittal

Application Number:	14054223			
Filing Date:	15-Oct-2013			
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT			
First Named Inventor/Applicant Name:	Philip M. Wala			
Filer:	Wade A. Whisenant/Danielle Suess			
Attorney Docket Number:	100.019US05			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
Total in USD (\$)				1200

Electronic Acknowledgement Receipt

EFS ID:	24078157
Application Number:	14054223
International Application Number:	
Confirmation Number:	6118
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT
First Named Inventor/Applicant Name:	Philip M. Wala
Customer Number:	34206
Filer:	Wade A. Whisenant/Danielle Suess
Filer Authorized By:	Wade A. Whisenant
Attorney Docket Number:	100.019US05
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Payment Type	Credit Card
Payment was successfully received in RAM	\$ 1200
RAM confirmation Number	1997
Deposit Account	502432
Authorized User	WHISENANT, WADE A.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

1018

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		00518271.PDF	1037753	yes	14
			2d197c8ec5c286ada6412c512682f3c35cf28fb2		
	Multipart Description/PDF files in .zip description				
	Document Description	Start	End		
	Amendment Submitted/Entered with Filing of CPA/RCE	1	1		
	Claims	2	13		
	Applicant Arguments/Remarks Made in an Amendment	14	14		
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	00509474.PDF	697544	no	3
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Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	00508477.PDF	612057	no	4
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Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
4	Foreign Reference	00508480.PDF	1250575	no	25
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5	Non Patent Literature	00508481.PDF	156670	no	14
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Warnings:					

Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30708	no	2
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Warnings:					
Information:					
Total Files Size (in bytes):				3785307	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

Applicant(s)	Wala	<u>AMENDMENT AND RESPONSE UNDER 37 C.F.R. § 1.114</u>
Serial No.	14/054,223	
Filing Date	10/15/2013	
Confirmation No.	6118	
Examiner Name	Duc M. Nguyen	
Group Art Unit	2647	
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

The Notice of Allowance mailed on August 14, 2015 has been reviewed. This amendment and response is submitted with a Request for Continued Examination and the required fee in accordance with 37 C.F.R. § 1.114. Please amend the above-identified application as follows.

Amendments to the Claims are reflected in the listing of claims that begins on page 2 of this paper.

Remarks begin on page 14 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of claims:

1. (Currently Amended) A system for digital transport of a wireless ~~radio-frequency~~ spectrum, the system comprising:

a first unit; and

a plurality of second units communicatively coupled to the first unit using at least one wired communication link and remotely located from the first unit, ~~wherein each of the plurality of second units is associated with a portion of the coverage area;~~

wherein each of the plurality of second units receives a respective analog wireless signal comprising the wireless ~~radio-frequency~~ spectrum and any transmissions from any ~~of the~~ wireless units ~~that are~~ within a respective coverage area associated with that second unit;

wherein each of the plurality of second units is configured to generate respective digital ~~RF~~ samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit;

wherein each of the plurality of second units is configured to communicate the respective digital ~~RF~~ samples generated by that second unit to the first unit using the at least one wired communication link;

wherein the first unit is configured to digitally sum corresponding digital ~~RF~~ samples derived from the digital samples received from the plurality of second units to produce summed digital ~~RF~~ samples; and

wherein the system is configured so that an input used for base station processing is derived from the resulting summed digital ~~RF~~ samples.

2. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.
3. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.
4. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.
5. (Original) The system of claim 1, wherein the system includes base station signal processing functionality configured to perform base station processing.
6. (Original) The system of claim 5, wherein the base station processing functionality is at least one of: co-located with the first unit and remote from the first unit.
7. (Original) The system of claim 1, wherein the system comprises at least a portion of a base station for performing the base station processing.
8. (Currently Amended) The system of claim 1, wherein the system further comprises software configured to perform the base station processing using the input derived from the resulting summed digital ~~RF~~ samples.
9. (Currently Amended) The system of claim 8, wherein the first unit comprises the software configured to perform the base station processing using the input derived from the resulting summed digital ~~RF~~ samples.

10. (Currently Amended) The system of claim 1, wherein the system is configured to convert the summed digital ~~RF~~ samples to a replicated analog wireless ~~radio frequency~~ signal.

11. (Currently Amended) The system of claim 10, wherein the system comprises a digital-to-analog converter to convert the summed digital ~~RF~~ samples to the replicated analog wireless ~~radio frequency~~ signal.

12. (Currently Amended) The system of claim 1, wherein each of the plurality of second units comprises:

a respective analog-to-digital converter to digitize the respective analog wireless ~~radio frequency~~ signal received at that second unit in order to produce the respective digital ~~RF~~ samples.

13. (Currently Amended) The system of claim 1, wherein each of the plurality of second units generates the respective digital ~~RF~~ samples indicative of the respective analog wireless signal received at that second unit by frequency shifting the respective analog wireless ~~radio frequency~~ signal received at that second unit and digitizing the frequency-shifted analog wireless ~~radio frequency~~ signal.

14. (Currently Amended) The system of claim 1, wherein each of the plurality of second units is configured to generate the respective digital ~~RF~~ samples indicative of the respective analog wireless signal received at that second unit by down converting the respective analog wireless ~~radio frequency~~ signal received at that second unit and digitizing the down-converted analog wireless ~~radio frequency~~ signal.

15. (Currently Amended) The system of claim 1, wherein the first unit ~~digitally~~ is configured to digitally sum the corresponding digital RF samples derived from the digital samples received from the plurality of second units as a part of generating ~~in order to produce~~ the summed digital RF samples at a resolution greater than a resolution of the digital RF samples being summed.

16. (Currently Amended) The system of claim 1, wherein the wireless ~~radio-frequency~~ spectrum comprises a cellular radio frequency spectrum.

17. (Previously Presented) The system of claim 1, wherein the at least one wired communication link comprises at least one of: a single mode optical fiber, a multi-mode optical fiber, a coaxial cable, and a category cable.

18. (Currently Amended) A first unit used in digital transport of a wireless ~~radio frequency~~ spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units receives a respective analog wireless signal comprising the wireless ~~radio-frequency~~ spectrum and any transmissions from any ~~of the~~ wireless units that are within a coverage area associated with that second unit and wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit, wherein the interface is used to receive the digital RF samples from the plurality of second units;

a digital summer to digitally sum corresponding digital RF samples derived from the digital samples received from the plurality of second units to produce summed digital RF samples; and

wherein the first unit is configured so that an input used for base station processing is derived from the resulting summed digital ~~RF~~ samples.

19. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

20. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

21. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

22. (Currently Amended) The first unit of claim 18, wherein the base station processing is at least one of: co-located with the first unit and remote from the first unit.

23. (Original) The first unit of claim 18, wherein the base station processing is performed by at least a portion of a base station.

24. (Currently Amended) The first unit of claim 18, wherein the first unit further comprises software configured to perform the base station processing using the input derived from the resulting summed digital ~~RF~~ samples.

25. (Currently Amended) The first unit of claim 18, wherein the first unit is configured to convert the summed digital ~~RF~~ samples to a replicated analog wireless ~~radio frequency~~ signal.

26. (Currently Amended) The first unit of claim 25, wherein the first unit comprises a digital-to-analog converter to convert the summed digital ~~RF~~ samples to the replicated analog wireless ~~radio frequency~~ signal.

27. (Currently Amended) The first unit of claim 18, wherein the first unit is configured to digitally sum the corresponding digital ~~RF~~ samples derived from the digital samples received from the plurality of second units in order to produce the summed digital ~~RF~~ samples at a resolution greater than a resolution of the digital ~~RF~~ samples being summed.

28. (Currently Amended) The first unit of claim 18, wherein the wireless ~~radio frequency~~ spectrum comprises a cellular radio frequency spectrum.

29. (Currently Amended) A method for digital transport of a wireless ~~radio frequency~~ spectrum used with a first unit and a plurality of second units, each of the plurality of second units being remotely located from the first unit, the method comprising:

at each of the plurality of second units:

receiving a respective analog wireless signal comprising the wireless ~~radio frequency~~ spectrum and any transmissions from any of the wireless units that are within ~~the portion of the~~ a coverage area associated with that second unit;

generating respective digital ~~RF~~ samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit;

and

communicating the respective digital ~~RF~~ samples generated by that second unit to the first unit using at least one communication medium; and

at the first unit, digitally summing corresponding digital ~~RF~~ samples derived from the digital samples received from the plurality of second units to produce summed digital ~~RF~~ samples.

30. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

31. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

32. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

33. (Currently Amended) The method of claim 29, further comprising performing base station processing using an input derived from the resulting summed digital ~~RF~~ samples.

34. (Original) The method of claim 33, wherein the base station processing is at least one of: co-located with the first unit and remote from the first unit.

35. (Original) The method of claim 33, wherein the base station processing is performed by at least a portion of a base station.

36. (Currently Amended) The method of claim 29, further comprising converting the summed digital ~~RF~~ samples to a replicated analog wireless ~~radio-frequency~~ signal.

37. (Currently Amended) The method of claim 29, wherein the corresponding digital ~~RF~~ samples derived from the digital samples received from the plurality of second units are digitally summed at a resolution greater than a resolution of the digital ~~RF~~ samples being summed.

38. (Currently Amended) The method of claim 29, wherein the wireless ~~radio-frequency~~ spectrum comprises a cellular radio frequency spectrum.

39. (Currently Amended) The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital ~~RF~~ samples indicative of the at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit comprises:

frequency shifting the respective analog wireless ~~radio-frequency~~ signal received at that second unit; and

digitizing the frequency-shifted analog wireless ~~radio-frequency~~ signal.

40. (Currently Amended) The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital ~~RF~~ samples indicative of the at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit comprises:

down converting the respective analog wireless ~~radio-frequency~~ signal received at that second unit; and

digitizing the down-converted analog wireless ~~radio-frequency~~ signal.

41. (Currently Amended) A system for digital transport of a wireless ~~radio-frequency~~ spectrum, the system comprising:

a first unit; and

a plurality of second units communicatively coupled to the first unit using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit;

wherein each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless ~~radio-frequency~~ spectrum;

wherein each of the plurality of second units is configured to generate respective digital ~~RF~~ samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit;

wherein each of the plurality of second units is configured to communicate the respective digital ~~RF~~ samples generated by that second unit to the first unit using the at least one wired communication link;

wherein the first unit is configured to digitally sum corresponding digital ~~RF~~ samples derived from the digital samples received from the plurality of second units to produce summed digital ~~RF~~ samples; and

wherein the system is configured so that an input used for wireless protocol processing is derived from the resulting summed digital ~~RF~~ samples.

42. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

43. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

44. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

45. (Original) The system of claim 41, wherein the wireless protocol processing is at least one of: co-located with the first unit and remote from the first unit.

46. (Original) The system of claim 41, wherein the system comprises at least a portion of a base station for performing the wireless protocol processing.

47. (Currently Amended) The system of claim 41, wherein the system further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital ~~RF~~ samples.

48. (Currently Amended) The system of claim 47, wherein the first unit comprises the software configured to perform the wireless protocol processing using the input derived from the resulting summed digital ~~RF~~ samples.

49. (Currently Amended) A first unit for digital transport of a wireless ~~radio~~ frequency spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless ~~radio frequency~~ spectrum and wherein each of the plurality of second units is configured to generate respective digital ~~RF~~ samples indicative of at least a portion of the wireless spectrum of the respective analog wireless signal received at that second unit, wherein the

at least one interface is configured to receive the digital ~~RF~~ samples from the plurality of second units at the first unit;

a digital summer to digitally sum corresponding digital ~~RF~~ samples derived from the digital samples received from the plurality of second units to produce summed digital ~~RF~~ samples; and

wherein the first unit is configured so that an input used for wireless protocol processing is derived from the resulting summed digital ~~RF~~ samples.

50. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

51. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

52. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

53. (Currently Amended) The first unit of claim 49, wherein the wireless protocol processing is at least one of: co-located with the first unit and remote from the first unit.

54. (Original) The first unit of claim 49, wherein the wireless protocol processing is performed by at least a portion of a base station.

Serial No.: 14/054,223

Filing Date: 10/15/2013

Attorney Docket No. 100.019US05

Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

55. (Currently Amended) The first unit of claim 49, wherein the first unit further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital ~~RF~~ samples.

Serial No.: 14/054,223

Filing Date: 10/15/2013

Attorney Docket No. 100.019US05

Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

REMARKS

The Notice of Allowance mailed on August 14, 2015 has been reviewed. This amendment and response is submitted with a Request for Continued Examination and the required fee in accordance with 37 C.F.R. § 1.114 in order to submit the claim amendments set forth above after the Notice of Allowance.

Claims 1, 8-16, 18, 22, 24-29, 33, 36-41, 47-49, 53, and 55 are currently amended. Claims 1-55 are pending in this application.

Applicant respectfully requests entry of the amendments to the above-identified application set forth above.

CONCLUSION

Applicant respectfully submits that claims **1-55** are in condition for allowance and notification to that effect is earnestly requested. If necessary, please charge any additional fees or credit overpayments to Deposit Account No. 502432.

If the Examiner has any questions or concerns regarding this application, please contact the undersigned at the telephone number listed below.

Respectfully submitted,

Date: November 13, 2015

/Wade A. Whisenant/

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NOTICE OF ALLOWANCE AND FEE(S) DUE

34206 7590 08/14/2015
FOGG & POWERS LLC
4600 W 77th Street
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MINNEAPOLIS, MN 55435

EXAMINER

NGUYEN, DUC M

ART UNIT

PAPER NUMBER

2647

DATE MAILED: 08/14/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.

14/054,223

10/15/2013

Philip M. Wala

100.019US05

6118

TITLE OF INVENTION: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	11/16/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
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Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

34206 7590 08/14/2015
FOGG & POWERS LLC
4600 W 77th Street
Suite 305
MINNEAPOLIS, MN 55435

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

TITLE OF INVENTION: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	11/16/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, DUC M	2647	455-517000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118

34206 7590 08/14/2015
FOGG & POWERS LLC
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EXAMINER

NGUYEN, DUC M

ART UNIT PAPER NUMBER

2647

DATE MAILED: 08/14/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/054,223	Applicant(s) WALA, PHILIP M.	
	Examiner DUC M. NGUYEN	Art Unit 2647	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 7/29/15.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-55. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____ 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____

/DUC M NGUYEN/ Primary Examiner, Art Unit 2647	8/6/15

Search Notes 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

CPC- SEARCHED		
Symbol	Date	Examiner
H04B 3/36; 7/2606, 2609	4/22/15	DN
H04W 16/26	4/22/15	DN
Updated	8/6/15	DN

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	7, 14, 16, 20, 22, 560, 561	4/22/15	DN
Updated	same as aboves	8/6/15	DN

SEARCH NOTES		
Search Notes	Date	Examiner
see EAST search history	4/22/15	DN
	8/6/15	DN

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H04B	3/36; 7/2606, 2609	8/6/15	DN
H04W	16/26	8/6/15	DN
455	7, 14, 16, 20, 22, 560, 561	8/6/15	DN

	/DUC M NGUYEN/ Primary Examiner.Art Unit 2647

Issue Classification 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.	
	Examiner DUC M NGUYEN	Art Unit 2647	

CPC						
Symbol					Type	Version
H04W		4		06	F	2013-01-01
H04B		10		25754	I	2013-01-01
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H04W		88		08	I	2013-01-01
Y10S		370		906	A	2013-01-01
Y10S		370		907	A	2013-01-01
H04B		7		2606	I	2013-01-01
H04L		65		1016	A	2013-01-01
H04L		51		28	I	2013-01-01
H04L		51		38	I	2013-01-01
H03M		7		4006	I	2013-01-01
H04L		51		04	A	2013-01-01
H04L		65		1006	I	2013-01-01
H04W		4		12	A	2013-01-01
H04W		4		14	I	2013-01-01
H04N		19		139	I	2014-11-01
H04N		19		109	I	2014-11-01
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H04N		19		625	I	2014-11-01

CPC Combination Sets							
Symbol				Type	Set	Ranking	Version

NONE		Total Claims Allowed:	
		55	
(Assistant Examiner)	(Date)	O.G. Print Claim(s)	O.G. Print Figure
/DUC M NGUYEN/ Primary Examiner.Art Unit 2647	8/6/15	1	6
(Primary Examiner)	(Date)		

Issue Classification 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
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	15		31		47										
	16		32		48										

NONE		Total Claims Allowed: 55	
(Assistant Examiner)	(Date)		
/DUC M NGUYEN/ Primary Examiner.Art Unit 2647	8/6/15	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	"14054223"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:11
L2	28	09/619431	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:22
L3	3251	H04B7/2606.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:31
L4	1624	H04W16/26.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:32
L5	4083	3 4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:32
L6	14	5 and (digital\$\$ near2 sum\$4)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:33
L7	14	5 and (digital\$4 near2 sum\$4)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:35
L8	11724	455/16 455/18 455/20 455/20 455/561	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:36
L9	59	8 and (digital\$4 near2 sum\$4)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/08/06 13:37

EAST Search History (Interference)

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L10	2373	H04B7/2606.cpc.	US-PGPUB; USPAT; UPAD	OR	ON	2015/08/06 13:56
L11	1182	H04W16/26.cpc.	US-PGPUB; USPAT; UPAD	OR	ON	2015/08/06 13:56
L12	11725	455/16 455/18 455/20 455/20 455/561	US-PGPUB; USPAT; UPAD	OR	ON	2015/08/06 13:56
L13	14244	10 11 12	US-PGPUB; USPAT; UPAD	OR	ON	2015/08/06 13:57
L14	28	13 and (digital\$4 near2 sum\$4).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2015/08/06 13:57
L15	59	("20030143947" "4183054" "4611323" "4628501" "4654843" "4667319" "4691292" "4760573" "4999831" "5193109" "5243598" "5321736"	US-PGPUB; USPAT	OR	ON	2015/08/06 14:02

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"7035671"	"8326218")	PN.				

8/ 6/ 2015 2:09:43 PM
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<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant				☐ CPA				☒ T.D.				☐ R.1.47			
CLAIM		DATE													
Final	Original	04/22/2015	08/06/2015												
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	2	✓	=												
	3	✓	=												
	4	✓	=												
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	36	✓	=												

<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant				☐ CPA				☒ T.D.				☐ R.1.47			
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Doc Code: DIST.E.FILE Document Description: Electronic Terminal Disclaimer - Filed		PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce	
Electronic Petition Request	TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT		
Application Number	14054223		
Filing Date	15-Oct-2013		
First Named Inventor	Philip Wala		
Attorney Docket Number	100.019US05		
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		
☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action ☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.			
Owner	Percent Interest		
ADC Telecommunications, Inc.	100%		
The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s) 8958789 6704545 7639982 8326218 8577286			

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:

- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

☒ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

☐ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

- ☐ Small Entity
- ☐ Micro Entity
- ☒ Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

☒ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 59593

☐ A sole inventor

☐ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

☐ A joint inventor; all of whom are signing this request

Signature	/Wade A. Whisenant/
Name	Wade A. Whisenant

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	14054223			
Filing Date:	15-Oct-2013			
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT			
First Named Inventor/Applicant Name:	Philip M. Wala			
Filer:	Wade A. Whisenant/Danielle Suess			
Attorney Docket Number:	100.019US05			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Statutory or Terminal Disclaimer	1814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				160

Doc Code: DISQ.E.FILE

Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 14054223

Filing Date: 15-Oct-2013

Applicant/Patent under Reexamination: Wala et al.

Electronic Terminal Disclaimer filed on July 29, 2015

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	23055005
Application Number:	14054223
International Application Number:	
Confirmation Number:	6118
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT
First Named Inventor/Applicant Name:	Philip M. Wala
Customer Number:	34206
Filer:	Wade A. Whisenant/Danielle Suess
Filer Authorized By:	Wade A. Whisenant
Attorney Docket Number:	100.019US05
Receipt Date:	29-JUL-2015
Filing Date:	15-OCT-2013
Time Stamp:	15:02:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$ 160
RAM confirmation Number	1304
Deposit Account	502432
Authorized User	WHISENANT, WADE A.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

1018

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Electronic Terminal Disclaimer-Filed	eTerminal-Disclaimer.pdf	35345	no	3
			0ad075cbb49d43d7d8e1f51af6369954ec456765		

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30630	no	2
			d1da0519466e975edfb183b8a35ed6e388a565890		

Warnings:

Information:

Total Files Size (in bytes):			65975

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Applicant(s)	Wala	<u>AMENDMENT AND RESPONSE UNDER 37 C.F.R. § 1.111</u>
Serial No.	14/054,223	
Filing Date	10/15/2013	
Confirmation No.	6118	
Examiner Name	Nguyen, Duc M	
Group Art Unit	2647	
Attorney Docket No.	100.019US05	
POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

The Office Action mailed on April 29, 2015 has been reviewed. Please amend the above-identified application as follows.

Amendments to the Claims are reflected in the listing of claims that begins on page 2 of this paper.

Remarks begin on page 13 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of claims:

1. (Currently Amended) A system for digital transport of a wireless radio frequency spectrum, the system comprising:
 - a first unit; and
 - a plurality of second units communicatively coupled to the first unit using at least one wired communication link and remotely located from the first unit, wherein each of the plurality of second units is associated with a portion of the coverage area;
 - wherein each of the plurality of second units receives a respective analog wireless signal comprising the wireless radio frequency spectrum and any transmissions from any of the wireless units that are within a respective coverage area associated with that second unit;
 - wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit;
 - wherein each of the plurality of second units is configured to communicate the respective digital RF samples generated by that second unit to the first unit using the at least one wired communication link;
 - wherein the first unit is configured to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and
 - wherein the system is configured so that an input used for base station processing is derived from the resulting summed digital RF samples.

2. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.
3. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.
4. (Original) The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.
5. (Original) The system of claim 1, wherein the system includes base station signal processing functionality configured to perform base station processing.
6. (Original) The system of claim 5, wherein the base station processing functionality is at least one of: co-located with the first unit and remote from the first unit.
7. (Original) The system of claim 1, wherein the system comprises at least a portion of a base station for performing the base station processing.
8. (Original) The system of claim 1, wherein the system further comprises software configured to perform the base station processing using the input derived from the resulting summed digital RF samples.
9. (Original) The system of claim 8, wherein the first unit comprises the software configured to perform the base station processing using the input derived from the resulting summed digital RF samples.

10. (Original) The system of claim 1, wherein the system is configured to convert the summed digital RF samples to a replicated analog wireless radio frequency signal.

11. (Original) The system of claim 10, wherein the system comprises a digital-to-analog converter to convert the summed digital RF samples to the replicated analog wireless radio frequency signal.

12. (Original) The system of claim 1, wherein each of the plurality of second units comprises:

a respective analog-to-digital converter to digitize the respective analog wireless radio frequency signal received at that second unit in order to produce the respective digital RF samples.

13. (Original) The system of claim 1, wherein each of the plurality of second units generates the respective digital RF samples indicative of the respective analog wireless signal received at that second unit by frequency shifting the respective analog wireless radio frequency signal received at that second unit and digitizing the frequency-shifted analog wireless radio frequency signal.

14. (Original) The system of claim 1, wherein each of the plurality of second units is configured to generate the respective digital RF samples indicative of the respective analog wireless signal received at that second unit by down converting the respective analog wireless radio frequency signal received at that second unit and digitizing the down-converted analog wireless radio frequency signal.

15. (Original) The system of claim 1, wherein the first unit digitally is configured to sum the corresponding digital RF samples received from the plurality of second units in

order to produce the summed digital RF samples at a resolution greater than a resolution of the digital RF samples being summed.

16. (Original) The system of claim 1, wherein the wireless radio frequency spectrum comprises a cellular radio frequency spectrum.

17. (Currently Amended) The system of claim 1, wherein the at least one wired communication link comprises at least one of: a single mode optical fiber, a multi-mode optical fiber, ~~[[and]]~~ a coaxial cable, and a category cable.

18. (Original) A first unit used in digital transport of a wireless radio frequency spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units receives a respective analog wireless signal comprising the wireless radio frequency spectrum and any transmissions from any of the wireless units that are within a coverage area associated with that second unit and wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit, wherein the interface is used to receive the digital RF samples from the plurality of second units;

a digital summer to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the first unit is configured so that an input used for base station processing is derived from the resulting summed digital RF samples.

19. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface

configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

20. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

21. (Original) The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

22. (Original) The first unit of claim 18, wherein the base station processing is at least of: co-located with the first unit and remote from the first unit.

23. (Original) The first unit of claim 18, wherein the base station processing is performed by at least a portion of a base station.

24. (Original) The first unit of claim 18, wherein the first unit further comprises software configured to perform the base station processing using the input derived from the resulting summed digital RF samples.

25. (Original) The first unit of claim 18, wherein the first unit is configured to convert the summed digital RF samples to a replicated analog wireless radio frequency signal.

26. (Original) The first unit of claim 25, wherein the first unit comprises a digital-to-analog converter to convert the summed digital RF samples to the replicated analog wireless radio frequency signal.

27. (Original) The first unit of claim 18, wherein the first unit is configured to digitally sum the corresponding digital RF samples received from the plurality of second units in order to produce the summed digital RF samples at a resolution greater than a resolution of the digital RF samples being summed.

28. (Original) The first unit of claim 18, wherein the wireless radio frequency spectrum comprises a cellular radio frequency spectrum.

29. (Original) A method for digital transport of a wireless radio frequency spectrum used with a first unit and a plurality of second units, each of the plurality of second units being remotely located from the first unit, the method comprising:

at each of the plurality of second units:

receiving a respective analog wireless signal comprising the wireless radio frequency spectrum and any transmissions from any of the wireless units that are within the portion of the coverage area associated with that second unit;

generating respective digital RF samples indicative of the respective analog wireless signal received at that second unit; and

communicating the respective digital RF samples generated by that second unit to the first unit using at least one communication medium; and

at the first unit, digitally summing corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples.

30. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

31. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

32. (Original) The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

33. (Original) The method of claim 29, further comprising performing base station processing using an input derived from the resulting summed digital RF samples.

34. (Original) The method of claim 33, wherein the base station processing is at least one of: co-located with the first unit and remote from the first unit.

35. (Original) The method of claim 33, wherein the base station processing is performed by at least a portion of a base station.

36. (Original) The method of claim 29, further comprising converting the summed digital RF samples to a replicated analog wireless radio frequency signal.

37. (Original) The method of claim 29, wherein the corresponding digital RF samples are digitally summed at a resolution greater than a resolution of the digital RF samples being summed.

38. (Original) The method of claim 29, wherein the wireless radio frequency spectrum comprises a cellular radio frequency spectrum.

39. (Original) The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital RF samples indicative of the respective analog wireless signal received at that second unit comprises:

frequency shifting the respective analog wireless radio frequency signal received at that second unit; and

digitizing the frequency-shifted analog wireless radio frequency signal.

40. (Original) The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital RF samples indicative of the respective analog wireless signal received at that second unit comprises:

down converting the respective analog wireless radio frequency signal received at that second unit; and

digitizing the down-converted analog wireless radio frequency signal.

41. (Original) A system for digital transport of a wireless radio frequency spectrum, the system comprising:

a first unit; and

a plurality of second units communicatively coupled to the first unit using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit;

wherein each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless radio frequency spectrum;

wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit;

wherein each of the plurality of second units is configured to communicate the respective digital RF samples generated by that second unit to the first unit using the at least one wired communication link;

wherein the first unit is configured to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the system is configured so that an input used for wireless protocol processing is derived from the resulting summed digital RF samples.

42. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

43. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

44. (Original) The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

45. (Original) The system of claim 41, wherein the wireless protocol processing is at least one of: co-located with the first unit and remote from the first unit.

46. (Original) The system of claim 41, wherein the system comprises at least a portion of a base station for performing the wireless protocol processing.

47. (Original) The system of claim 41, wherein the system further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital RF samples.

48. (Original) The system of claim 47, wherein the first unit comprises the software configured to perform the wireless protocol processing using the input derived from the resulting summed digital RF samples.

49. (Original) A first unit for digital transport of a wireless radio frequency spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless radio frequency spectrum and wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit, wherein the at least one interface is configured to receive the digital RF samples from the plurality of second units at the first unit;

a digital summer to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the first unit is configured so that an input used for wireless protocol processing is derived from the resulting summed digital RF samples.

50. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

51. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

52. (Original) The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

53. (Original) The first unit of claim 49, wherein the wireless protocol processing is at least of: co-located with the first unit and remote from the first unit.

54. (Original) The first unit of claim 49, wherein the wireless protocol processing is performed by at least a portion of a base station.

55. (Original) The first unit of claim 49, wherein the first unit further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital RF samples.

REMARKS

The Office Action mailed on April 29, 2015 has been reviewed. Claims 1 and 17 are currently amended. The amendments are at least supported by paragraphs [0005] and [0026] of the application as filed. Claims 1-55 are pending in this application.

Double Patenting Rejections

Claims 1-55 were rejected under the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-79 of U.S. Patent No. 6,704,545. Claims 1-55 were rejected under the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-81 of U.S. Patent No. 7,639,982. Claims 1-55 were rejected under the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-28 of U.S. Patent No. 8,326,218. Claims 1-55 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-40 of U.S. Patent No. 8,577,286. Claims 1-55 were rejected under the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-24 of U.S. Patent No. 8,958,789.

A Terminal Disclaimer in compliance with 37 C.F.R. 1.321(b)(iv) has been submitted via e-Terminal Disclaimer on EFS Web to overcome these rejections. Applicant believes the e-Terminal Disclaimer overcomes the double patenting rejections and respectfully requests allowance of claims 1-55.

Allowable Subject Matter

Applicant thanks the Examiner for the indication that claims 1-55 would be allowable if a Terminal Disclaimer is submitted that would overcome the Double Patenting rejections set forth in the Office action.

Serial No.: 14/054,223

Filing Date: 10/15/2013

Attorney Docket No. 100.019US05

Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

CONCLUSION

Applicant respectfully submits that claims **1-55** are in condition for allowance and notification to that effect is earnestly requested. If necessary, please charge any additional fees or credit overpayments to Deposit Account No. 502432.

If the Examiner has any questions or concerns regarding this application, please contact the undersigned at the telephone number listed below.

Respectfully submitted,

Date: July 29, 2015

/Wade A. Whisenant/

Wade A. Whisenant

Reg. No. 59,593

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Electronic Acknowledgement Receipt

EFS ID:	23059123
Application Number:	14054223
International Application Number:	
Confirmation Number:	6118
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT
First Named Inventor/Applicant Name:	Philip M. Wala
Customer Number:	34206
Filer:	Wade A. Whisenant/Danielle Suess
Filer Authorized By:	Wade A. Whisenant
Attorney Docket Number:	100.019US05
Receipt Date:	29-JUL-2015
Filing Date:	15-OCT-2013
Time Stamp:	16:01:39
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		00500371.PDF	154714 c361d74055c29e1a2100dd90260fdc81496e6a62	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	12
	Applicant Arguments/Remarks Made in an Amendment	13	14

Warnings:

Information:

Total Files Size (in bytes):	154714

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/054,223	Filing Date 10/15/2013	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

(Column 1)

(Column 2)

FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	07/29/2015	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	* 55	Minus	** 55	= 0	X \$80 =	0
	Independent (37 CFR 1.16(h))	* 5	Minus	*** 5	= 0	X \$420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
TOTAL ADD'L FEE						0	

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =
	☐ Application Size Fee (37 CFR 1.16(s))					
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
TOTAL ADD'L FEE						

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DEBORAH POLLARD/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/054,223	10/15/2013	Philip M. Wala	100.019US05	6118
34206	7590	04/29/2015	EXAMINER	
FOGG & POWERS LLC			NGUYEN, DUC M	
4600 W 77th Street			ART UNIT	
Suite 305			PAPER NUMBER	
MINNEAPOLIS, MN 55435			2647	
			NOTIFICATION DATE	
			DELIVERY MODE	
			04/29/2015	
			ELECTRONIC	

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

DAVID@FOGGLAW.COM
docketing@fogglaw.com

Office Action Summary	Application No. 14/054,223	Applicant(s) WALA, PHILIP M.	
	Examiner DUC M. NGUYEN	Art Unit 2647	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on _____.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-55 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) _____ is/are allowed.
- 7) ☒ Claim(s) 1-55 is/are rejected.
- 8) ☐ Claim(s) _____ is/are objected to.
- 9) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date 10/15/13, 2/27/15
- 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 4) ☐ Other: _____

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Information Disclosure Statement

1. The references listed in the information disclosure statements submitted on 10/15/13 and 2/27/15 have been considered by the examiner (see attached PTO-1449).

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

3. Claims **1-55** are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-79 of U.S. Patent No. **6,704,545**.

Although the conflicting claims are not identical, they are not patentably distinct from each other because they both claim a host unit with an interface that digitally sums corresponding upstream digital RF samples received from a plurality of remote units to produce summed upstream digital RF samples and then converting the summed upstream digital RF samples to an upstream analog wireless RF signal.

4. Claims **1-55** are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-81 of U.S. Patent No. **7,639,982**.

Although the conflicting claims are not identical, they are not patentably distinct from each other because they both claim a host unit with an interface that digitally sums corresponding upstream digital RF samples received from a plurality of remote units to produce summed upstream digital RF samples and then converting the summed upstream digital RF samples to an upstream analog wireless RF signal.

5. Claims **1-55** are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-28 of U.S. Patent No. **8,326,218**.

Although the conflicting claims are not identical, they are not patentably distinct from each other because they both claim a host unit with an interface that digitally sums corresponding upstream digital RF samples received from a plurality of remote units to produce summed upstream digital RF samples and then converting the summed upstream digital RF samples to an upstream analog wireless RF signal.

6. Claims **1-55** are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-40 of U.S. Patent No. **8,577,286**.

Although the conflicting claims are not identical, they are not patentably distinct from each other because they both claim a host unit with an interface that digitally sums corresponding upstream digital RF samples received from a plurality of remote units to produce summed upstream digital RF samples and then converting the summed upstream digital RF samples to an upstream analog wireless RF signal.

7. Claims **1-55** are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-24 of U.S. Patent No. **8,958,789**.

Although the conflicting claims are not identical, they are not patentably distinct from each other because they both claim a host unit with an interface that digitally sums corresponding upstream digital RF samples received from a plurality of remote units to produce summed upstream digital RF samples and then converting the summed upstream digital RF samples to an upstream analog wireless RF signal.

Allowable Subject Matter

8. Claims 1-55 would be allowable if a Terminal Disclaimer is submitted that would overcome the Double Patenting rejection(s) set forth in this Office action.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

See the attached PTO-892.

10. **Any response to this action should be mailed to:**

Commissioner of Patents

P.O. Box 1450

Alexandria, VA 22313-1450

or faxed to:

(571) 273-8300 (for **formal** communications intended for entry)

(571)-273-7893 (for informal or **draft** communications).

Hand-delivered responses should be brought to Customer Service Window,

Randolph Building, 401 Dulany Street, Alexandria, VA 22314.

Any inquiry concerning this communication or communications from the examiner should be directed to Duc M. Nguyen whose telephone number is (571) 272-7893,

Art Unit: 2647

Monday-Thursday (9:00 AM - 5:00 PM), or faxed to (571)-273-7893 (for informal or **draft** communications).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nay Maung can be reached on 571-272-7882. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

/Duc M. Nguyen/

Primary Examiner, Art Unit 2647

Apr 22, 2015

Notice of References Cited	Application/Control No. 14/054,223		Applicant(s)/Patent Under Reexamination WALA, PHILIP M.	
	Examiner DUC M. NGUYEN		Art Unit 2647	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-8,958,789	02-2015	Bauman et al.	455/422.1
*	B	US-8,577,286	11-2013	Wala, Philip M.	455/16
*	C	US-8,326,218	12-2012	Wala, Philip M.	455/16
*	D	US-7,639,982	12-2009	Wala, Philip M.	455/16
*	E	US-6,704,545	03-2004	Wala, Philip M.	455/16
*	F	US-5,809,422	09-1998	Raleigh et al.	455/449
*	G	US-6,697,603	02-2004	Lovinggood et al.	455/13.1
*	H	US-6,262,981	07-2001	Schmutz, Thomas R.	370/347
*	I	US-5,644,622	07-1997	Russell et al.	455/422.1
*	J	US-5,878,325	03-1999	Dail, James E.	725/125
*	K	US-4,667,319	05-1987	Chum, Stanley P. K.	370/260
*	L	US-6,198,558	03-2001	Graves et al.	398/135
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S128	15	"6704545" and wala.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 18:15
S129	182	H04B7/2609.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 18:56
S130	3117	H04B7/2606.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 18:56
S131	1538	H04W16/26.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 19:37
S132	471	H04B3/36.cpc.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 19:39
S133	4533	S129 S130 S131 S132	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 19:42
S134	40	S133 and ((sum\$3 add\$4) near3 (digital\$3 digitiz\$4))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 19:43
S135	26	S133 and ((sum\$3 add added) near3 (digital\$3 digitiz\$4))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 19:43
S136	53	("20030143947" "4183054" "4611323" "4628501" "4654843" "4667319"	US-PGPUB;	OR	ON	2015/04/22 19:49

		"4691292" "4760573" "4999831" "5193109" "5243598" "5321736" "5321849" "5339184" "5499047" "5603080" "5621786" "5627879" "5642405" "5644622" "5657374" "5708961" "5724385" "5765097" "5765099" "5774789" "5802173" "5809431" "5852651" "5878325" "5946622" "5969837" "5978650" "6005884" "6112086" "6147786" "6181687" "6192216" "6198558" "6262981" "6275990" "6317884" "6337754" "6362908" "6374124" "6466572" "6480551" "6486907" "6697603" "6771933" "6785558" "6801767" "7035671").PN.	USPAT; USOCR			
S137	6	08/650683	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 19:57
S138	9	S136 and ((sum\$3 add added) near3 (digital\$3 digitiz\$4))	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 20:14
S139	0	S137 and ((sum\$3 add added) near3 (digital\$3 digitiz\$4))	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 20:14
S140	135	("20030143947" "4183054" "4611323" "4628501" "4654843" "4667319" "4691292" "4760573" "4999831" "5193109" "5243598" "5321736" "5321849" "5339184" "5499047" "5603080" "5621786" "5627879" "5642405" "5644622" "5657374" "5708961" "5715235" "5724385" "5765097" "5765099" "5774789" "5802173" "5809431" "5812605" "5852651" "5878325" "5946622" "5969837" "5978650" "6005884" "6112086" "6147786" "6181687" "6192216" "6198558" "6262981" "6275990" "6317884" "6337754" "6356374" "6362908" "6373611" "6374124" "6449071" "6466572" "6480551" "6486907" "6697603" "6771933" "6785558" "6801767" "7035671" "8326218").PN.	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 20:45
S141	20	S140 and ((sum\$3 add added) near3 (digital\$3 digitiz\$4))	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 20:45
S142	1	"14054223"	US- PGPUB;	OR	ON	2015/04/22 20:57

			USPAT; USOCR; EPO; JPO; DERWENT			
S143	1	S142 and ((sum\$3 add added) near3 (digital\$3 digitiz\$4)).clm.	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 20:57
S144	3	"4667319".pn.	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 21:08
S145	30	("4667319").URPN.	USPAT	OR	ON	2015/04/22 21:08
S146	6	S145 and wala.in.	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 21:08
S147	23	("4667319" "5644622" "5809422" "5878325" "6198558" "6262981" "6697603" "6704545" "7639982" "8326218" "8577286" "8958789").PN.	US- PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2015/04/22 21:20

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CONFIRMATION NO. 6118

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.	
14/054,223	10/15/2013	455	2647	100.019US05	
RULE					
APPLICANTS ADC Telecommunications, Inc., Shakopee, MN, Assignee (with 37 CFR 1.172 Interest); INVENTORS Philip M. Wala, Savage, MN; ** CONTINUING DATA ***** This application is a CON of 13/662,948 10/29/2012 PAT 8577286 which is a CON of 12/617,215 11/12/2009 PAT 8326218 which is a CON of 10/740,944 12/19/2003 PAT 7639982 which is a CON of 09/619,431 07/19/2000 PAT 6704545 Yes DN No DN ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 10/22/2013					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /DUC M NGUYEN/ Acknowledged Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY MN	SHEETS DRAWINGS 8	TOTAL CLAIMS 55	INDEPENDENT CLAIMS 5
ADDRESS FOGG & POWERS LLC 4600 W 77th Street Suite 305 MINNEAPOLIS, MN 55435 UNITED STATES					
TITLE POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT					
FILING FEE RECEIVED 5240	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14054223
	Filing Date		2013-10-15
	First Named Inventor	Wala	
	Art Unit	2647	
	Examiner Name	Nguyen	
	Attorney Docket Number	100.019US05	

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Application Number	14054223
Filing Date	2013-10-15
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Examiner Name	Nguyen
Attorney Docket Number	100.019US05

1	EUROPEAN PATENT OFFICE, "European Office Action for Application Serial No. 10011450.3", "from Foreign Counterpart of U.S. Application Serial No. 09/619,431", 01/16/2015, Page(s) 1-4, Published in: EP	☐

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Examiner Signature	/Duc Nguyen/	Date Considered	04/22/2015

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Application Number	14054223
Filing Date	2013-10-15
First Named Inventor	Wala
Art Unit	
Examiner Name	
Attorney Docket Number	100.019US05

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

- ☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

- ☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

- ☒ See attached certification statement.
- ☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.
- ☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2015-02-27
Name/Print	Wade A. Whisenant	Registration Number	59593

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant		☐ CPA		☐ T.D.		☐ R.1.47			
CLAIM		DATE							
Final	Original	04/22/2015							
	1	✓							
	2	✓							
	3	✓							
	4	✓							
	5	✓							
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	31	✓							
	32	✓							
	33	✓							
	34	✓							
	35	✓							
	36	✓							

<i>Index of Claims</i> 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
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CLAIM		DATE							
Final	Original	04/22/2015							
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	38	✓							
	39	✓							
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	49	✓							
	50	✓							
	51	✓							
	52	✓							
	53	✓							
	54	✓							
	55	✓							

Search Notes 	Application/Control No. 14054223	Applicant(s)/Patent Under Reexamination WALA, PHILIP M.
	Examiner DUC M NGUYEN	Art Unit 2647

CPC- SEARCHED		
Symbol	Date	Examiner
H04B 3/36; 7/2606, 2609	4/22/15	DN
H04W 16/26	4/22/15	DN

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	7, 14, 16, 20, 22, 560, 561	4/22/15	DN

SEARCH NOTES		
Search Notes	Date	Examiner
see EAST search history	4/22/15	DN

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/DUC M NGUYEN/ Primary Examiner.Art Unit 2647

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14054223
	Filing Date		10/15/13
	First Named Inventor	Wala -	
	Art Unit		2647
	Examiner Name	Nguyen	
	Attorney Docket Number		100.019US05

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Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4183054		1980-01-08	Patisaul et al.	
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Application Number		14/054223
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First Named Inventor	Wala	-
Art Unit		2647
Examiner Name	Nguyen	
Attorney Docket Number		100.019US05

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10	5243598		1993-09-07	Lee	
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Attorney Docket Number		100.019US05

20	5657374		1997-08-12	Russell et al.	
21	5708961		1998-01-13	Hylton et al.	
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Art Unit		2647
Examiner Name	Nguyen	
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	31	5878325		1999-03-02	Dail	
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	42	6275990		2001-08-14	Dapper et al.	
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	44	6337754		2002-01-08	Imajo	
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Attorney Docket Number		100.019US05

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6	9115927	WO		1991-10-17	Cook et al.		☐

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		10/15/13
First Named Inventor	Wala	-
Art Unit		2647
Examiner Name	Nguyen	
Attorney Docket Number		100.019US05

4	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 3/7/2007, Page(s) 1-8, Published in: CN	☐
5	CHINESE PATENT OFFICE, "Notification to Grant Patent Right for Invention", "from Foreign Counterpart of U.S. Application No. 09/619,431", 5/28/2013, Page(s) 1-3, Published in: CN	☐
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7	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 3/19/2010, Page(s) 1-7, Published in: CN	☐
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Examiner Name	Nguyen	
Attorney Docket Number		100.019US05

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25	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "Application Serial No. 10/740,944", 8/24/2006, Page(s) 1-19	☐

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Examiner Name	Nguyen	
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26	U.S. PATENT AND TRADEMARK OFFICE, "Final Office Action", "Application Serial No. 10/740,944", 2/5/2007, Page(s) 1-16	☐
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33	INTERNATIONAL SEARCHING AUTHORITY, "International Search Report", "from Foreign Counterpart of U.S. Application No. 09/619,431", 11/15/2001, Page(s) 1-7, Published in: WO	☐
34	AKOS ET AL., "DIRECT BANDPASS SAMPLING OF MULTIPLE DISTINCT RF SIGNALS", 7/1/1999, Page(s) 983-988, Volume 47, Publisher: IEEE Transactions on Communications	☐
35	FOXCOW WIRELESS PROPRIETARY INFORMATION, "LITENNA IN-BUILDING RF DISTRIBUTION SYSTEM", 1998, Page(s) 1-8	☐
36	1998 FOXCOW WIRELESS PROPRIETARY INFORMATION, "Application Note "RFiber- RF Fiberoptic Links for Wireless Applications"", 1998, Page(s) 3-11, Published in: US	☐

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	Filing Date		10/15/13
	First Named Inventor	Wala	–
	Art Unit		2647
	Examiner Name	Nguyen	
	Attorney Docket Number		100.019US05

37	GRACE, MARTIN K., "Synchronous Quantized Subcarrier Multiplexing for Transport of Video, Voice and Data", "IEEE Journal on Selected Areas in Communications", Sept. 1990, Page(s) 1351-1358, Volume 8, Number 7, Publisher: IEEE	☐
38	HARVEY ET AL., "Cordless Communications Utilising Radio Over Fibre Techniques for the Local Loop", "IEEE International Conference on Communications", June 1991, Page(s) 1171-1175, Publisher: IEEE	☐
39	NAKATSUGAWA ET AL., "SOFTWARE RADIO BASE AND PERSONAL STATIONS FOR CELLULAR/PCS SYSTEMS", 2000, Page(s) 617-621, Publisher: IEEE	☐
40	WALA, "A New Microcell Architecture Using Digital Optical Transport ", "Freedom Through Wireless Technology", 5/18/93, Page(s) 585-588, Publisher: Proceedings of the Vehicular Technology Conference, New York, IEEE, Published in: US	☐

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Wala
Art Unit	
Examiner Name	
Attorney Docket Number	100.019US05

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2013-10-10
Name/Print	Wade A. Whisenant	Registration Number	59593

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		14054223	
	Filing Date		2013-10-15	
	First Named Inventor	Wala		
	Art Unit			
	Examiner Name			
	Attorney Docket Number	100.019US05		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14054223
	Filing Date	2013-10-15
	First Named Inventor	Wala
	Art Unit	
	Examiner Name	
	Attorney Docket Number	100.019US05

1	EUROPEAN PATENT OFFICE, "European Office Action for Application Serial No. 10011450.3", "from Foreign Counterpart of U.S. Application Serial No. 09/619,431", 01/16/2015, Page(s) 1-4, Published in: EP	☐

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(Not for submission under 37 CFR 1.99)

Application Number	14054223
Filing Date	2013-10-15
First Named Inventor	Wala
Art Unit	
Examiner Name	
Attorney Docket Number	100.019US05

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Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2015-02-27
Name/Print	Wade A. Whisenant	Registration Number	59593

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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Applicant(s)	Wala	CERTIFICATION STATEMENT
Serial No.	14/054,223	
Filing Date	10/15/2013	
Group Art Unit		
Examiner Name		
Confirmation No.	6118	
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Applicant respectfully states that:

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- ☐ Pursuant to 37 CFR 1.97(e)(1), each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

If the Examiner has any questions or concerns regarding this application, please contact the undersigned at 952-465-0770.

Respectfully submitted,

Date: February 27, 2015

/Wade A. Whisenant/

WadeWhisenant
Reg. No. 59593

Attorneys for Applicant
Fogg & Powers LLC
4600 W 77th Street, Ste 305
Minneapolis, MN 55435
T – (952) 465-0770 | F – (952) 465-0771

Electronic Acknowledgement Receipt

EFS ID:	21628651
Application Number:	14054223
International Application Number:	
Confirmation Number:	6118
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT
First Named Inventor/Applicant Name:	Philip M. Wala
Customer Number:	34206
Filer:	Wade A. Whisenant/Danielle Suess
Filer Authorized By:	Wade A. Whisenant
Attorney Docket Number:	100.019US05
Receipt Date:	27-FEB-2015
Filing Date:	15-OCT-2013
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Application Type:	Utility under 35 USC 111(a)

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/054,223	10/15/2013	Philip M. Wala	100.019US05

CONFIRMATION NO. 6118

PUBLICATION NOTICE



OC00000066482482

34206
FOGG & POWERS LLC
5810 W 78TH STREET
SUITE 100
MINNEAPOLIS, MN 55439

Title:POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Publication No.US-2014-0036758-A1

Publication Date:02/06/2014

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <http://pair.uspto.gov/>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number
14/054,223

APPLICATION AS FILED - PART I

(Column 1)		(Column 2)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(j))	55 minus 20 =	* 35			OR	x 80 =	2800
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 2				x 420 =	840
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	5240

APPLICATION AS AMENDED - PART II

(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
Total (37 CFR 1.16(i))	* Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	* Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))						OR		
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						OR		
				TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
Total (37 CFR 1.16(i))	* Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	* Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))						OR		
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						OR		
				TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
14/054,223	10/15/2013	2631	5240	100.019US05	55	5

CONFIRMATION NO. 6118

34206
FOGG & POWERS LLC
5810 W 78TH STREET
SUITE 100
MINNEAPOLIS, MN 55439

FILING RECEIPT



Date Mailed: 10/29/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Philip M. Wala, Savage, MN;

Applicant(s)

ADC Telecommunications, Inc., Shakopee, MN

Assignment For Published Patent Application

ADC Telecommunications, Inc., Shakopee, MN

Power of Attorney: The patent practitioners associated with Customer Number 34206

Domestic Priority data as claimed by applicant

This application is a CON of 13/662,948 10/29/2012 PAT 8577286
which is a CON of 12/617,215 11/12/2009 PAT 8326218
which is a CON of 10/740,944 12/19/2003 PAT 7639982
which is a CON of 09/619,431 07/19/2000 PAT 6704545

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

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If Required, Foreign Filing License Granted: 10/22/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/054,223**

Projected Publication Date: 02/06/2014

Non-Publication Request: No

Early Publication Request: No

Title

POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Preliminary Class

375

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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14/054,223	10/15/2013	Philip M. Wala	100.019US05

34206
FOGG & POWERS LLC
5810 W 78TH STREET
SUITE 100
MINNEAPOLIS, MN 55439

CONFIRMATION NO. 6118
POA ACCEPTANCE LETTER



Date Mailed: 10/29/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/15/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/atesfai/

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14/054,223	10/15/2013	Philip M. Wala	100.019US05

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I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with the Customer Number:

34206

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name Registration	Number	Name Registration	Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number:

34206

OR

☐ Firm or Individual Name			
Address			
City	State	Zip	
Country			
Telephone	Email		

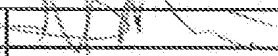
Assignee Name and Address:

ADC Telecommunications, Inc.
1187 Park Place
Shakopee, MN 55379

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on the behalf of the assignee

Signature		Date	23 MAY 2010
Name	Driscoll A. Nina	Telephone	41 7144 70980
Title	Vice President of Intellectual Property		

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of
Invention

POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

As the below named inventor, I hereby declare that:

This declaration
is directed to:

☒

The attached application, or

United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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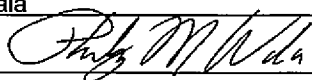
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LEGAL NAME OF INVENTOR

Inventor: Philip M. Wala

Date (Optional): 10/3/13

Signature: _____



Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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	Filing Date		
	First Named Inventor	Wala	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	100.019US05	

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4183054		1980-01-08	Patisaul et al.	
	2	4611323		1986-09-09	Hessenmuller	
	3	4628501		1986-12-09	Loscoe	
	4	4654843		1987-03-31	Roza et al.	
	5	4667319		1987-05-19	CHUM	
	6	4691292		1987-09-01	Rothweiler	
	7	4760573		1988-07-26	Calvignac et al.	
	8	4999831		1991-03-12	Grace	

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		
First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

9	5193109		1993-03-09	Chien-Yeh Lee	
10	5243598		1993-09-07	Lee	
11	5321736		1994-06-14	Beasley	
12	5321849		1994-06-14	Lemson	
13	5339184		1994-08-16	Tang	
14	5499047		1996-03-12	Terry et al.	
15	5603080		1997-02-11	Kallander et al.	
16	5621786		1997-04-15	Fischer et al.	
17	5627879		1997-05-06	Russell et al.	
18	5642405		1997-06-24	Fischer et al.	
19	5644622		1997-07-01	Russell et al.	

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STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		
First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

	20	5657374		1997-08-12	Russell et al.	
	21	5708961		1998-01-13	Hylton et al.	
	22	5715235		1998-02-03	Sawahashi et al.	
	23	5724385		1998-03-03	Levin et al.	
	24	5765097		1998-06-09	Dail	
	25	5765099		1998-06-09	Georges et al.	
	26	5774789		1998-06-30	van der Kaay et al.	
	27	5802173		1998-09-01	Hamilton-Piercy et al.	
	28	5809431		1998-09-15	Bustamante et al.	
	29	5812605		1998-09-22	Smith et al.	
	30	5852651		1998-12-22	Fischer et al.	

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
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Application Number		
Filing Date		
First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

	31	5878325		1999-03-02	Dail	
	32	5946622		1999-08-31	Bojeryd	
	33	5969837		1999-10-19	Farber et al.	
	34	5978650		1999-11-02	Fischer et al.	
	35	6005884		1999-12-21	Cook et al.	
	36	6112086		2000-08-29	Wala	
	37	6147786		2000-11-14	Pan	
	38	6181687		2001-01-30	Bisdikian	
	39	6192216		2001-02-20	Sabat, Jr. et al.	
	40	6198558		2001-03-06	Graves et al.	
	41	6262981		2001-07-17	Schmutz	

**INFORMATION DISCLOSURE
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Application Number		
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First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

	42	6275990		2001-08-14	Dapper et al.	
	43	6317884		2001-11-13	Eames et al.	
	44	6337754		2002-01-08	Imajo	
	45	6356374		2002-03-12	Farhan	
	46	6362908		2002-03-26	Kimbrough et al.	
	47	6373611		2002-04-16	Farhan et al.	
	48	6374124		2002-04-16	Slabinski	
	49	6449071		2002-09-10	Farhan et al.	
	50	6466572		2002-10-15	Ethridge et al.	
	51	6480551		2002-11-12	Ohishi et al.	
	52	6486907		2002-11-26	Farber et al.	

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Examiner Name		
Attorney Docket Number	100.019US05	

	53	6697603		2004-02-24	Lovinggood et al.	
	54	6771933		2004-08-03	Eng et al.	
	55	6785558		2004-08-31	Stratford et al.	
	56	6801767		2004-10-05	Schwartz et al.	
	57	7035671		2006-04-25	Solum	
	58	8326218		2012-12-04	Wala	

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		
First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

1	1127056	CN		1996-07-17	Russell et al.		☐
2	3707244	DE		1988-09-15	Schalamon		☐
3	0391597	EP		1990-10-10	Chu et al.		☐
4	0664621	EP		1995-07-26	Zarem et al.		☐
5	0209319	WO		2002-01-31	Wala		☐
6	9115927	WO		1991-10-17	Cook et al.		☐

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	1	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 7/8/2005, Page(s) 1-8, Published in: CN	☐
	2	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 5/11/2007, Page(s) 1-5, Published in: CN	☐
	3	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 10/26/2007, Page(s) 1-3, Published in: CN	☐

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Filing Date		
First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

4	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 3/7/2007, Page(s) 1-8, Published in: CN	☐
5	CHINESE PATENT OFFICE, "Notification to Grant Patent Right for Invention", "from Foreign Counterpart of U.S. Application No. 09/619,431", 5/28/2013, Page(s) 1-3, Published in: CN	☐
6	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 2/4/2013, Page(s) 1-7, Published in: CN	☐
7	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 3/19/2010, Page(s) 1-7, Published in: CN	☐
8	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 11/2/2010, Page(s) 1-9, Published in: CN	☐
9	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 6/21/2012, Page(s) 1-18, Published in: CN	☐
10	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 1/23/2013, Page(s) 1-11, Published in: CN	☐
11	CHINESE PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 4/6/2012, Page(s) 1-12, Published in: CN	☐
12	EUROPEAN PATENT OFFICE, "Communication under Rule 71(3) EPC", "from Foreign Counterpart of U.S. Application No. 09/619,431", 5/3/2011, Page(s) 1-5, Published in: EP	☐
13	EUROPEAN PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 2/24/2006, Page(s) 1-5, Published in: EP	☐
14	EUROPEAN PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 3/6/2007, Page(s) 1-4, Published in: EP	☐

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Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

15	EUROPEAN PATENT OFFICE, "Office Action", "from Foreign Counterpart of U.S. Application No. 09/619,431", 11/16/2010, Page(s) 1-4, Published in: EP	☐
16	EUROPEAN PATENT OFFICE, "Summons to Attend Oral Proceedings", "from Foreign Counterpart of U.S. Application No. 09/619,431", 5/21/2010, Page(s) 1-6, Published in: EP	☐
17	EUROPEAN PATENT OFFICE, "Extended European Search Report", "from Foreign Counterpart of U.S. Application No. 09/619,431", 1/14/2011, Page(s) 1-9, Published in: EP	☐
18	U.S. PATENT OFFICE, "Notice of Allowance", "Application Serial No. 09/619,431", 8/12/2003, Page(s) 1-9	☐
19	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "Application Serial No. 09/619,431", 3/13/2003, Page(s) 1-15	☐
20	U.S. PATENT AND TRADEMARK OFFICE, "Final Office Action", "Application Serial No. 10/740,944", 4/25/2007, Page(s) 1-16	☐
21	U.S. PATENT AND TRADEMARK OFFICE, "Final Office Action", "Application Serial No. 10/740,944", 7/18/2007, Page(s) 1-21	☐
22	U.S. PATENT AND TRADEMARK OFFICE, "Final Office Action", "Application Serial No. 10/740,944", 10/3/2007, Page(s) 1-22	☐
23	U.S. PATENT AND TRADEMARK OFFICE, "Final Office Action", "Application Serial No. 10/740,944", 10/14/2008, Page(s) 1-25	☐
24	U.S. PATENT AND TRADEMARK OFFICE, "Notice of Allowance", "Application Serial No. 10/740,944", 8/13/2009, Page(s) 1-12	☐
25	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "Application Serial No. 10/740,944", 8/24/2006, Page(s) 1-19	☐

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Attorney Docket Number	100.019US05	

26	U.S. PATENT AND TRADEMARK OFFICE, "Final Office Action", "Application Serial No. 10/740,944", 2/5/2007, Page(s) 1-16	☐
27	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "Application Serial No. 10/740,944", 4/3/2008	☐
28	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "Application Serial No. 10/740,944", 2/27/2009, Page(s) 1-25	☐
29	U.S. PATENT AND TRADEMARK OFFICE, "Notice of Allowance", "Application Serial No. 12/617,215", 8/2/2012, Page(s) 1-11	☐
30	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "Application Serial No. 12/617,215", 4/11/2012, Page(s) 1-12	☐
31	U.S. PATENT AND TRADEMARK OFFICE, "Notice of Allowance and Fees Due", "from U.S. Application Serial No. 13/662,948", 07/03/2013, Page(s) 1-10, Published in: US	☐
32	U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "from U.S. Application Serial No. 13/662,948", 04/24/2013, Page(s) 1-23, Published in: US	☐
33	INTERNATIONAL SEARCHING AUTHORITY, "International Search Report", "from Foreign Counterpart of U.S. Application No. 09/619,431", 11/15/2001, Page(s) 1-7, Published in: WO	☐
34	AKOS ET AL., "DIRECT BANDPASS SAMPLING OF MULTIPLE DISTINCT RF SIGNALS", 7/1/1999, Page(s) 983-988, Volume 47, Publisher: IEEE Transactions on Communications	☐
35	FOXCOW WIRELESS PROPRIETARY INFORMATION, "LITENNA IN-BUILDING RF DISTRIBUTION SYSTEM", 1998, Page(s) 1-8	☐
36	1998 FOXCOW WIRELESS PROPRIETARY INFORMATION, "Application Note "RFiber- RF Fiberoptic Links for Wireless Applications"", 1998, Page(s) 3-11, Published in: US	☐

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Filing Date		
First Named Inventor	Wala	
Art Unit		
Examiner Name		
Attorney Docket Number	100.019US05	

37	GRACE, MARTIN K., "Synchronous Quantized Subcarrier Multiplexing for Transport of Video, Voice and Data", "IEEE Journal on Selected Areas in Communications", Sept. 1990, Page(s) 1351-1358, Volume 8, Number 7, Publisher: IEEE	☐
38	HARVEY ET AL., "Cordless Communications Utilising Radio Over Fibre Techniques for the Local Loop", "IEEE International Conference on Communications", June 1991, Page(s) 1171-1175, Publisher: IEEE	☐
39	NAKATSUGAWA ET AL., "SOFTWARE RADIO BASE AND PERSONAL STATIONS FOR CELLULAR/PCS SYSTEMS", 2000, Page(s) 617-621, Publisher: IEEE	☐
40	WALA, "A New Microcell Architecture Using Digital Optical Transport ", "Freedom Through Wireless Technology", 5/18/93, Page(s) 585-588, Publisher: Proceedings of the Vehicular Technology Conference, New York, IEEE, Published in: US	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Wala
Art Unit	
Examiner Name	
Attorney Docket Number	100.019US05

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Wade A. Whisenant/	Date (YYYY-MM-DD)	2013-10-10
Name/Print	Wade A. Whisenant	Registration Number	59593

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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Applicant(s)	Wala	IDS COMMUNICATION
Serial No.		
Filing Date		
Group Art Unit		
Examiner Name		
Confirmation No.		
Attorney Docket No.	100.019US05	
Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In compliance with 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. § 1.97, *et seq.*, the enclosed materials are brought to the attention of the Examiner for consideration in connection with the above-identified patent application. All of the references listed were previously disclosed by the Applicant or cited by the Examiner in one of the parent applications 13/662,948, filed October 19, 2012; 12/617,215, filed November 12, 2009; 10/740,944, filed December 19, 2003; and 09/619,431, filed July 19, 2000; copies are therefore not enclosed.

Copies of the below listed documents are being included herewith:

- CN 1127056
- EP 0664621
- U.S. PATENT AND TRADEMARK OFFICE, "Notice of Allowance and Fees Due", "from U.S. Application Serial No. 13/662,948", 07/03/2013, Page(s) 1-10, Published in: US
- U.S. PATENT AND TRADEMARK OFFICE, "Office Action", "from U.S. Application Serial No. 13/662,948", 04/24/2013, Page(s) 1-23, Published in: US
- INTERNATIONAL SEARCHING AUTHORITY, "International Search Report", "from Foreign Counterpart of U.S. Application No. 09/619,431", 11/15/2001, Page(s) 1-7, Published in: WO
- AKOS ET AL., "DIRECT BANDPASS SAMPLING OF MULTIPLE DISTINCT RF SIGNALS", 7/1/1999, Page(s) 983-988, Volume 47, Publisher: IEEE Transactions on Communications
- FOXCOM WIRELESS PROPRIETARY INFORMATION, "LITENNA IN-BUILDING RF DISTRIBUTION SYSTEM", 1998, Page(s) 1-8

Serial No.:

Filing Date:

Attorney Docket No. 100.019US05

Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

- 1998 FOXCOT WIRELESS PROPRIETARY INFORMATION, "Application Note "RFiber- RF Fiberoptic Links for Wireless Applications"", 1998, Page(s) 3-11, Published in: US
- NAKATSUGAWA ET AL., "SOFTWARE RADIO BASE AND PERSONAL STATIONS FOR CELLULAR/PCS SYSTEMS", 2000, Page(s) 617-621, Publisher: IEEE

Applicant respectfully requests that this Information Disclosure Statement (IDS) be entered and the documents listed on the attached Form 1449 be considered by the Examiner and made of record. Pursuant to the provisions of MPEP §609, Applicant requests that a copy of the 1449 form, initialed as being considered by the Examiner, be returned to the Applicant with the next official communication.

Respectfully submitted,

Date: October 11, 2013

/Wade A. Whisenant/

Wade A. Whisenant

Reg. No. 59593

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著录项目摘要

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说明书

权利要求书

摘要附图

法律状态

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Application Number	94192782	Application Date	1994/5/25
Publication Number	1127056	Publication Date	1996/7/17
Announcement Number	1065402	Announcement Date	2001/5/2
Priority Country	美国(US)	FIELD	
AGENCY	中国专利代理(香港)有限公司(72001)	AGENT	DONG WEI ZOU GUANGXIN
Applicant(s)	ADC Telecommunications, Inc.		
ADDRESS			
ZIP			
INVENTOR(s)	David S. Russell Larry G. Fischer Philip M. Wala		
IPC	H04B 10/12 H04Q 7/22		
Title	Cellular radio system with centralzed located base stations and distributed antenna units		
Abstract			
A microcellular communications network includes a plurality of base station units(106) and corresponding antenna units(102). The base station units are housed in a common location(114). Each includes either conventional transmitters and receivers or all digital transmitter and receiver equipment, and interface circuitry(112) to a mobile telecommunications switching office. The microcell traffic output is applied to a frame generator/multiplexer. The output of the frame generator/multiplexer is applied to a digitally modulated laser. The laser output is conveyed by fiber to a remote antenna unit, which demultiplexes the microcell traffic signal and applies it to a digital-to-analog converter. The output of the digital-to-analog converter is applied to a power amplifier, which in turn is connected to a main antenna. RF signals from the mobile units are received at both a main and a diversity antenna. The received signals are filtered, digitized, multiplexed together and transmitted over the optical fiber back to the base station. The strongest signal is selected for use. Deployment of an all digital microcellular communications system occurs in two stages. The method thus allows for the benefit of a digital system to be accomplished in the early stages of the upgrade while without the expense of modifying the digital microcell antenna units in the second stage of the upgrade. Digital filtering of the digitized RF signal is also provided, so that only those channels associated with a cell are extracted for transmission to and from the antenna unit, and a digital passive handoff system provides for an FFT analysis of all traffic in the cell and passive switching in response thereto.			
Claim			
KeyWord			
Priority	US 1993/5/28 [08/068389]		
Priority	US 1994/1/14 [08/183221]		
Priority	US 1994/3/2 [08/204660]		

说明书附图数: [56]

说明书页数: [57]

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[12] 发明专利申请公开说明书

[21]申请号 94192782.2

[51]Int.Cl⁶

H04Q 7/22

[43]公开日 1996 年 7 月 17 日

[22]申请日 94.5.25

[30]优先权

[32]93.5.28 [33]US[31]08 / 068389

[32]94.1.14 [33]US[31]08 / 183221

[32]94.3.2 [33]US[31]08 / 204660

[32]PCT / US94[33]05[31]97 94.5.25

[32]WO94 / 286[33]0 [31]英 94.12.8

[32]96.1.15[33][31]

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J·布伦南

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代理人 董巍 邹光新

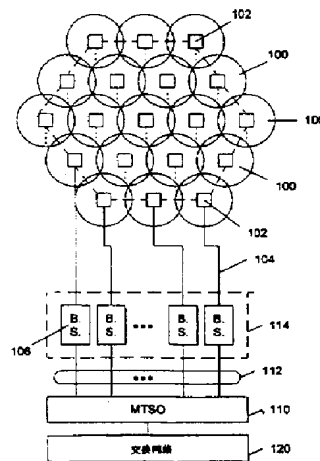
H04B 10 / 12

权利要求书 28 页 说明书 57 页 附图页数 56 页

[54]发明名称 基站集中放置,天线单元分布式放置的蜂窝无线系统

[57]摘要

一种包括多个基站单元(106)和相应天线单元(102)的微蜂窝通信系统,所有基站单元放置于同一区域内(114),每个基站单元包含传统的发射机和接收机或者全数字发射机和接收机设备,和与移动通信交换局的接口电路(112)。微小区通讯输出供给一个帧发生器/复接器,帧发生器/复接器的输出供给一个数字调制激光器,激光器的输出通过光纤传送给远端天线单元。远端天线单元分接微小区通讯信号,然后提供给数模转换器,数模转换器的输出供给一个功率放大器,功率放大器连接到主天线。来自移动单元的 RF 信号被主天线和分集天线接收。接收信号经滤波,数字化,复用后通过光纤回传给基站,最强的信号被基站选用。安装一个全数字微蜂窝通信系统分两个步骤。第一步实现的数字系统有利于升级,在升级的第二步中无须花费来改变微小区天线单元。同时也提供了数字化 RF 信号的数字滤波,因而只有那些与小区相关的信道才被提取出来以与天线单元间相互进行传输,并且一种数字式被动越区切换系统对小区中所有通讯进行 FFT 分析,据此实现被动切换。



(BJ)第 1456 号

权利要求书

1. 一种微蜂窝通信系统，包括：

多个公共设置的微小区基站单元，每个基站单元经光纤通道连接到多个相应的天线单元。每个基站单元包括：

RF 发射机和接收机，分配给微小区的每条信道各有一个；

用于组合发射机的 RF 信号输出的组合装置；

模数转换装置，将组合信号转换为数字化的采样信号流。

成帧装置，将数字化流组装成帧。

接收已成帧的流的装置，和为光纤通道提供相应激光信号的装置，以传输给相应天线单元。和

光接收装置，检测光纤中光调制的串行比特流；其中每个天线单元进一步包括：

解复用器装置，接收成帧的流，提取数字化的 RF 信号。

数模转换装置，接收数字化 RF 信号并恢复模拟 RF 信号。

放大器装置，放大恢复出的信号。

天线装置，接收放大后的信号并发射到微小区区域。

在天线上用于接收 RF 微小区业务信号的装置。

模数转换器，把收到的 RF 微小区信号转换为数字化数据流。

帧发生器，将数字流组成帧；和

激光装置，用于装收成帧的流和给相应光纤通道提供激光信号，传送给相应的基站单元。

其中每个基站单元进一步包括：

解复用装置，从天线单元接收成帧的微小区信号，并提取数字化 RF 信号；和

数模转换器，接收数字化 RF 信号，及恢复出模拟 RF 信号，RF 信号被送到接收机。

2.根据权利要求 1 的系统进一步包括将至少一个附加信道复用在上述光纤中传送的微小区信号上的装置。

3.根据权利要求 2 的系统，其中一些附加信道用于提供可选业务。

4.根据权利要求 3 的系统，其中一个附加信道是个人通信网（PCN）信道。

5.根据权利要求 3 的系统，其中一个附加信道是寻呼业务信道。

6.根据权利要求 2 的系统，其中一个附加信道是告警信道。

7.根据权利要求 2 的系统，其中一个附加信道是在基站和天线单元间传送双向点到点话音级通信的话音信道。

8.一种微蜂窝通信系统，通过电缆系统为微小区地域提供移动电话业务。包括：

微小区基站单元，由光纤通道连接到有线电视分配系统前端站的前端单元，该系统有多个通过各光纤通道连接到前端单元的光节点。基站单元包括：

多个 RF 发射机和接收机，分配给微小区的每条信道各一个，多个信道构成蜂窝频段。

组合器装置，组合发射机的 RF 信号输出。

模数转换器装置，把组合信号的蜂窝频段的内容转换为样值的数字化流。

第一成帧装置，将数字化流组装成帧。和

数字调制激光器装置，接收成帧的流，并为向前端单元传输的光纤通道提供相应激光信号。

前端单元包括：

解复用器装置，用于接收成帧的流并提取数字化 RF 信号。

数模转换器装置，接收数字化 RF 信号并恢复包含蜂窝频段的模拟 RF 信号。

单个或多个滤波器装置，把蜂窝频段分为多个子频段，每个子频段包含前述多个信道的子集。

调制器装置，用于调制上述子频段中的一个，并将调制后的输出送光发射机，产生相应激光信号，供给连接到光节点的上述多个光纤通道之一。

光接收机装置，接收载有子频段的调制光信号，并产生相应电信号。用于解调子频段，以生成相应的包含子频段的模拟 RF 信号。

模数转换器装置，从解调器接收 RF 信号，并将其转换为数字化数据流。

第二成帧装置，将数字化流分为帧。和

数字调制激光器装置，接收成帧的流，因为向相应基站单元传输的光纤通道提供相应激光信号。

其中每个基站单元进一步包括：

解复用器装置，从天线单元接收成帧的微小区信号流，并提取数字化 RF 信号。

数模转换装置，接收数字化 RF 信号，并恢复模拟 RF

信号，该 RF 信号提供给接收机。和

处于有线电视系统光节点的光节点单元，光节点单元包括：

光接收机装置，从上述某一光纤通道接收调制的子频段。

解调器装置，解调经调制的子频段，产生包含子频段的 RF 信号。

放大器装置，放大 RF 信号，用于从主天线传输。

滤波器装置，从主天线接收的 RF 信号中滤出子频段。

调制器装置，调制接收的子频段。和

光发射机装置，给一条光纤通道提供相应光信号。

9. 根据权利要求 8 的系统，其中在前述前端单元和光节点单元的调制器装置和解调器装置为幅度调制 (AM)，所以在一条光纤通道上以模拟方式传送子频带。

10. 一种微蜂窝通信系统，通过电缆系统给一个微小区地域提供移动电话业务，并使用数字调制。包括：

微小区基站单元，经光纤通道与有线电视分配系统前端站中的前端单元相连，系统包括多个光节点经各自光纤通道与前端单元相连。基站单元包括：

多个 RF 发射机和接收机，每个分配的微小区信道各配置一个，多个信道组成蜂窝频段。

组合器装置，组合来自发射机子集的 RF 信号输出，上述子集包含一个子频段。

模数转换装置，把组合信号的蜂窝频段内容转换为样值的数字化流。

成帧装置，把数字化流组装成帧；和

激光器装置，接收成帧的流，为向前端单元传输的光

纤通道提供激光信号。

前端单元进一步包括：

解复用器装置，用于接收成帧的流，并提取与上述发射机子集相应的数字化 RF 信号。

数字调制器装置，接收数字化 RF 子频道信号，并给光发射机提供调制后的输出，以产生用于上述连接到光节点的光纤通道的相应光信号。

光接收机装置，接收调制光信号，调制光信号载有相应于上述子频段的数字化 RF 信号，并产生相应的电信号，用于数字解调器，数字解调器产生相应于子频段的数字数据流。

成帧装置，把数字化流组成帧。和

激光器装置，接收成帧的流，并为向基站单元传输的光纤通道提供激光信号。

其中每个基站单元进一步包括：

解复用器装置，从天线单元接收成帧的微小区信号流，并提取数字化 RF 信号。

数模转换装置，接收数字化 RF 信号并恢复模拟 RF 信号，RF 信号被送给接收机。和

光节点单元，位于有线电视系统的光节点，光节点单元包括：

光接收机装置，在上述某一条光纤通道上接收调制的子频道。

数字解调器装置，解调经调制的子频段，产生包含数字化子频段的数字信号。

数模转换器装置，把数字信号转换为相应 RF 信号。

放大器装置，放大从主天线传输来的 RF 信号。

滤波器装置，从由主天线接收的 RF 信号中滤出子频段。

模数转换装置，把模拟 RF 信号转换为相应数字信号。

数字调制器装置，调制数字信号。和

光发射机装置，为某一条光纤通道提供相应激光信号。

11.一种微蜂窝通信系统，利用电话交换网传输 RF 信号，包括：

多个公共设置的微小区基站单元和多个相关的天线单元，每个基站单元包括：

RF 发射机和接收机，分配给微小区的信道各一个。

组合器装置，组合发射机子集的 RF 信号输出。

模数转换器装置，把组合信号转换成样值的数字化流。

帧发生器装置，将数字化流组成帧，使信号格式与电话交换网兼容。和

接口装置，完成组成帧的信号与电话交换网的接口功能，并寻址到远端天线单元。其中每个天线单元包括：

接口装置，与电话交换网接口，以接收数字化流。

解复用器装置，用于接收成帧的流，并提取数字化 RF 信号。

数模转换器装置，用于接收数字化 RF 信号，恢复模拟 RF 信号。

功率放大器装置，放大恢复后的信号。

天线装置，接收放大的信号并发射到微小区地域。

模数转换装置，接收由天线接收到的 RF 微小区业务信号。

模数转换器装置，将收到的 RF 微小区信号转换为数字化数据流。和

帧发生器装置，把数字化流组成帧，使信号格式与电话交换网兼容。

接口装置，用于进一步用于接收数字化流，并通过交换网传送给相应基站单元。

其中每个基站单元进一步包括：

解复用器装置，从天线单元接收成帧的微小区信号流，并提取数字化 RF 信号。和

数模转换器装置，接收数字化 RF 信号。

恢复模拟 RF 信号。该 RF 信号已送到接收机。

12.一种微蜂窝通信系统。包括：

多个公共设置的微小区基站单元，每个基站单元由光纤通道连接到相应天线单元。每个基站单元包括：

合成器装置，用于接收来自移动通信交换局的电话信号，并将其转换为样值的数字化流，然后送给天线单元中的数模转换器，提供相应的 RF 信号。

帧生成器装置，将数字化流组成帧。

数字调制激光器装置，用于接收成帧的流，并为向相应天线单元传输的光纤通道提供相应激光信号。

解复用器装置，用于接收成帧的流，并提取样值的数字化流。

数模转换器装置，用于接收数字化 RF 信号，并恢复模拟 RF 信号。

功率放大器装置，用于放大恢复的信号。

天线装置，用于接受放大后的信号，并将其广播发射到微小区地域。

模数转换装置,用于接受由天线收到的 RF 微小区通讯信号。

模数转换装置,将收到的 RF 微小区业务信号转换为数字化数据流。

帧发生器装置,将数字化流组成帧。

数字调制激光器装置,接受成帧的流,并为向相应基站单元传输的光纤通道提供相应激光信号。

其中每个基站单元进一步包括:

解复用器装置,从天线单元接收成帧的微小区信号流,并提取数字化 RF 信号。

合成器装置,进一步包括能将提取出的数字化 RF 信号转换为可传送到 MTSO 的形式。

13.分步设置数字化微蜂窝通信系统的方法,包括以下步骤:

(a) 设置多个公共设置的模拟微小区基站单元,每个单元由光纤通道连接到相应的远端天线单元,每个模拟基站单元包括 RF 发射机和接收机,分配给微小区的每个信道各一个;组合发射机 RF 信号输出的组合器;宽带模数转换器,把组合的信号转换为样值的数字化流;将数字化流组成帧的成帧电路;数字调制激光器,接收成帧的流,并为向相应天线单元传输的光纤通道提供相应的激光信号。

(b) 设置多个远端天线单元,每个天线单元包括:解复用器装置,接收成帧的流并提取数字化 RF 信号;数模转换器,接收数字化 RF 信号并恢复模拟 RF 信号;功率放大器,放大恢复的信号;天线,接受放大后的信号,并发射到微小区地域;模数转换器,接收天线收到的微小区

业务信号；模数转换器，将收到的 RF 微小区信号转换为数字化数据流；成帧电路，将数字化流组成为帧；数字化调制激光器，接收成帧的流，并为向相应基站单元传输的光纤通道提供相应的激光信号。

基站单元进一步包括：解复用器，从天线单元接收成帧的微小区信号流，并提取数字化 RF 信号；数模转换器，接收数字化 RF 信号，并恢复模拟 RF 信号，该 RF 信号已送给接收机；以及

(c) 以多个全数字基站代替多个模拟微小区基站，每个上述全数字基站包括：合成器装置，从移动通信交换局接收语音信号，并将其转换为取样值的数字化流，然后数字化流送到天线单元中的数模转换器，提供相应 RF 信号；成帧电路，将数字化流组成帧；数字调制激光器，接收成帧的流，并为向相应天线单元传输的光纤通道提供光信号。

14. 一种微蜂窝通信系统，包括：

多个公共设置的微小区基站单元，每个基站单元由光纤通道连接到相应天线单元上，每个基站单元包括：

RF 发射机和接收机，分配给微小区的每条信道一个。

组合器装置，组合发射机的 RF 信号输出。

模数转换器装置，将组合的信号转换为样值的数字化流。

帧发生器装置，用于把数字化流组成帧。

数字调制激光器装置，用于接收成帧的流，为向相应天线单元传输的光纤通道提供相应的激光信号。

每个天线单元包括：

解复用器装置，用于接收成帧的流并提取数字化 RF

信号。

数模转换器装置，用于接收数字化 RF 信号并恢复模拟 RF 信号。

功率放大器装置，用于放大恢复的信号。

主天线装置，接受放大的信号并将其发射到微小区地域。

模数转换器装置，用于接收在主天线收到的主 RF 微小区业务信号。

模数转换器装置，将收到的 RF 微小区信号转换为第一数字化数据流。

分集天线装置，用于接收分集的 RF 业务信号。

模数转换装置，用于将收到的分集 RF 业务信号转换为第二数字化数据流。

帧发生器装置，将主的和分集的数字化数据流分为帧。

数字调制激光器装置，接收成帧的流，为向相应基站单元传输的光纤通道提供激光信号。

其中基站单元进一步包括：

解复用器装置，从天线单元接收成帧的微小区信号流，并提取数字化 RF 信号。

数模转换器装置，用于接收主数字化 RF 信号，恢复主模拟 RF 信号，且最强的分集或主的 RF 信号被提供给接收机。

数模转换器装置，接收分集数字化 RF 信号，并恢复分集模拟 RF 信号。

15. 一种蜂窝通信系统，每个小区有多个分配的信道。包括：

小区基站单元，通过传输装置连接到相应天线单元，其中安装一天线，用于小区地域中信号的发射和接收。基站单元包括：

多个 RF 发射机和接收机，分配给小区的每个信道一个。

组合器装置，组合发射机的 RF 信号输出。

模数转换装置，将组合的信号转换为样值的数字化流。

成帧装置，将数字化流组成帧。

接收成帧的流，并为向相应天线单元传输的传输装置提供相应数字信号的装置。

接收机装置，从相应天线单元的传输装置接收数字比特流，其中，每个天线单元进一步包括：

解复用器装置，接收成帧的流并提取数字化 RF 信号。

数模转换装置，用于接收数字化 RF 信号，并恢复模拟 RF 信号。

放大器装置，放大恢复的信号。

给天线提供放大的信号的装置，并将信号发射到小区的相关地域。

接收由天线收到的 RF 信号的装置。

模数转换器装置，将收到的 RF 信号转换为数字化数据流。

帧发生器装置，将数字化流组成帧。

接收成帧的流，并将其提供给向基站传输的传输装置的装置。

其中每个基站单元进一步包括：

解复用器装置，从天线单元接收成帧的信号，并提取

数字化 RF 信号。以及

数模转换器，用于接收数字化 RF 信号并恢复模拟 RF 信号，和提供 RF 信号给接收机的装置。

16. 蜂窝通信系统包括一个小区，其中多个电话信号在基站和相应的多个使用 RF 传输的移动单元之间发射和接收，包括：

小区基站单元，通过传输装置连接到相应天线单元，天线单元中安装一个用于在小区地域发射和接收信号的天线，基站单元包括：

模拟 RF 信号产生装置，用于在不同的信道产生多个 RF 信号，各信道将承载的电话信号送到小区地域，并用于组合 RF 信号，产生合成模拟信号。

模数转换装置，将组合信号转换为样值的数字化流，并把样值送传输装置，以传输到相应天线单元。

其中每个天线单元进一步包括：

数模转换装置，从基站单元接收样值的数字化流，恢复相应的模拟合成信号，并将放大的信号送给天线，以发射到小区地域。

模数转换装置，接收由天线收到的 RF 信号，将收到的 RF 信号转换为样值的数字化流，并将样值送到传输装置，以传输给基站单元。

其中每个基站单元进一步包括：

数模转换器装置，用于从天线单元接受样值的数字化流，并恢复模拟 RF 信号。

17. 蜂窝通信系统包含一个小区，其中在基站和相应多个使用 RF 传输的移动单元之间发射和接收多个电话信号。包括：

小区基站单元，通过传输装置连接到相应天线单元，其中安装一天线用于与小区有关地域信号的发射和接收，基站单元包括：

用于从无线控制器接收模拟电话信号的装置，并用于数字化合成不同信道的多个 RF 信号，以将电话信号传送到微小区地域的移动单元，相应于多个合成 RF 信号的数字形式产生样值的数字化流，并把数字化流提供给传输装置，以传输到相应天线单元，其中每个天线单元进一步包括：

数模转换装置，用于从基站单元接收样值的数字化流，恢复相应的合成模拟 RF 信号，并提供放大的信号给天线，然后广播发射到小区的相关地域。

模数转换装置，接收由天线收到的 RF 信号，把收到的 RF 信号转换为样值的数字化流，并把样值送传输装置，传输到基站单元。以及

其中每个基站单元进一步包括：

转换器装置，用于从天线单元接收样值的数字化流，数字合成样值代表的模拟电话信号的数字形式，并产生相应电话信号，并将其提供给电话无线控制器。

18. 蜂窝通信系统包含一个小区，其中在基站和相应多个使用 RF 传输的移动单元之间发射和接收多个电话信号。包括：

小区基站单元，通过传输装置连接到相应的天线单元，天线单元配置一个在小区相关地域内发射和接收信号的天线。基站单元包括：

特定的装置，用于从与移动电话交换局的接口接收数字形式的多个电话信号；对小区地域内传送电话信号到移

动单元的各不同信道中的多个 RF 信号进行数字化合成；产生采样的数字化流，采样对应于多个综合的 RF 信号的数字化形式；并把采样供给传输装置，传输到相应天线单元。

其中每个天线单元包括：

数模转换装置，用于从基站单元接收采样的数字化流，恢复相应的复合模拟 RF 信号，并将放大后的信号供给天线发射到小区的相关地域。

模数转换装置，接收天线收到的 RF 信号，将其转换为取样的数字化流，然后将样值提供给传输装置，传输到基站单元。

其中每个基站单元进一步包括：

数模转换器装置，从天线单元接收采样的数字化流，数字化合成采样所代表的模拟电话信号，将数字电话信号供给与移动电话交换局的接口。

19.一种蜂窝通信系统包括小区，其中在基站和相应的多个小区中使用 RF 传输的移动单元间发送和接收多个电话信号，包括：

小区基站单元，通过传输装置连接到多个天线单元，每个天线单元配置一个在与此天线单元相关的区域中发射和接收信号的天线，各区域分布于小区中，基站单元包括：

数字化装置，从移动电话交换局接收多个电话信号，对小区中传送电话信号到移动单元的各信道产生的多个 RF 信号进行数字化合成。产生多个采样的数字化流，采样对应于合成的 RF 信号。产生一个上述数字化流供给一个天线单元，上述数字化装置包括响应第一控制信号的装置，用于控制每个采样流中的每个信道，因此每个采样流

所代表的信道可以被控制。并将每个流中的采样供给传输装置，以传输到相应的天线单元。

其中每个天线单元进一步包括：

数模转换装置，用于从基站单元接收样值的数字化流，重建相应的模拟 RF 信号，和到天线的信号，这样它就被发射到小区的相关地域。

模数转换装置，用于接收在天线收到的 RF 信号，将收到的 RF 信号转换为采样的数字化流，并将采样供给传输装置传输给基站单元，以及

其中每个基站单元进一步包括：

转换器装置，从天线单元接收采样的相应数字化流，数字化合成样值所代表的模拟话音信号，产生相应的话音信号，送给移动电话交换局，上述转换器装置包含响应第二控制信号的装置，用以从来自天线的上述采样流之一中选择至少一个上述信道，并使用至少一个信道，以合成该信道中传送的模拟话音信号的数字形式。因此可选择获得一个信道的区域。

控制器装置，监视每个天线单元收到的数字化采样，以数字方式分析每个流中每个信道的能量等级，产生上述第一和第二控制信号，供给上述数字化装置和上述转换器装置，因此，根据天线单元接收的信号的电平，可对在每个区域中发射的信道和每个区域中用来接收话音信号的信道进行控制。

20. 根据权利要求 19 的系统，其中上述控制装置包含衰落控制装置，以监测一区域中收到的 RF 信号的衰落，并产生第二控制信号，切换获得 RF 信号的区域，从而获得分集功能。

21.根据权利要求 20 的系统,其中上述衰落控制装置可在 1 秒内完成上述的监测与切换。

22.一种蜂窝通信系统,包含一个被分为多个区域的小区,其中多个话音信号在基站和相应的多个使用 RF 传输的区域中移动单元间进行发送和接收,包括:

小区基站单元,经传输装置连接到多个天线单元,每个区域中至少有一个天线单元,每个天线单元配置一个在相关区域中发射和接收信号的天线,基站单元包括:

模拟 RF 信号发生装置,产生多个 RF 信号,用于传送话音信号到小区中移动单元的各不同信道。

第一交换装置,响应第一控制信号,以交换和组合 RF 信号,以为每个区域形成复合 RF 信号,每个小区的复合信号包含选择的信道。

模数转换装置,将供给各小区的复合信号转换为相应采样的数字化流,并将采样供给传输装置,传输到各相应天线单元。

其中每个天线单元进一步包括:

数模转换装置,从基站单元接收采样的数字化流,恢复相应的复合模拟 RF 信号,并将放大的信号供给天线,以发射到小区的相关地域。

模数转换装置,接收在天线收到的 RF 信号,将收到的 RF 信号转换为采样的数字化流,并将采样供给传输装置传输到基站单元。

其中每个基站单元进一步包括:

数模转换器装置,从各天线单元接收采样的数字化流,为各天线单元重建模拟 RF 信号。

第二交换和组合装置,响应第二控制信号,选择性地

组合来自天线单元的 RF 信号，以形成多个复合信号用于接收机，每个复合信号包含来自天线单元的一个或多个 RF 信号。

控制装置，用于监测来自所有天线单元的采样的数字化流，并数字地分析每个区域中每个信道的电平，据此产生第一和第二控制信号，以选择性地控制发射各信道的区域和接收各信道的区域。

23. 根据权利要求 22 的系统，其中上述控制装置包含衰落控制装置，用以监测区域中收到的 RF 信号的衰落，并产生第二控制信号，以切换获得 RF 信号的区域，从而获得了分集功能。

24. 根据权利要求 23 的系统，其中上述衰落控制装置可在 1 秒内完成上述监测和切换。

25. 一种蜂窝通信系统，包含一个小区，其中多个电话信号在基站和相应多个使用 RF 传输的移动单元间发射和接收，包括：

小区基站单元，经传输装置连接到相应天线单元，天线单元配置一个用于在小区地域内发射和接收信号的天线，基站单元包括：

模拟 RF 信号发生装置，用于不同信道上产生多个 RF 信号，各不同信道用于传送电话信号给小区地域中的移动单元，用于组合 RF 信号，以形成复合模拟信号。模数转换装置，将复合信号转换为采样的数字化流。

数字滤波器装置，对复合信号滤波并产生多个单独的数字化信号流，每个数字化流对应至少一个信道，并将采样的单独数据流供给传输到相应天线单元的传输装置。

其中每个天线单元进一步包括：

数模转换装置，用于从基站单元接收采样的数字化流，恢复相应的模拟 RF 信号，并将放大的信号提供给天线发射到与小区相关的地域。

模数转换装置，接收由天线收到的一个 RF 信号，将其转换为采样的数字化流。

数字滤波器装置，对源于收到的 RF 的采样流进行滤波，产生多个采样的单独数字化流，每个数字化流对应至少一个信道。且将单独数据流供给传输到基站单元的传输装置。

其中每个基站单元进一步包括：

数模转换器装置，用于从天线单元接收采样的数字化流，恢复相应于每个流的模拟 RF 信号，并将 RF 信号供给接收机。

26. 根据权利要求 25 的系统，其中传输装置包含电话交换网。

27. 一种蜂窝通信系统，包含一个小区，其中在基站和相应多个使用 RF 传输的移动单元间发送和接收多个电话信号，包括：

小区基站单元，经传输装置连接到相应天线单元，天线单元配置一个在小区地域发射和接收信号的天线，基站单元包括：

特定的装置，用于从无线控制器接收模拟话音信号，并数字地合成生成的多个 RF 信号，用以在各不同信道传送话音信号给小区地域中的移动单元，并产生多个采样的数字化流，每个流对应至少一个数字化形式的一个合成 RF 信号，并将采样的流供给传输装置，以传输到相应天线单元。

其中每个天线单元进一步包括：

数模转换装置，从基站单元接收采样的数字化流，恢复相应的模拟 RF 信号，并将放大的信号供给天线，以发射到小区的相关地域。

模数转换装置，接收由天线收到的 RF 信号，将其转换为多个采样的单独数字化流，每个流对应至少一个信道，并将采样的流供给传输装置，以传输到基站单元。

其中每个基站单元进一步包括：

数模转换器装置，从天线单元接收采样的数字化流，数字合成采样所代表的话音信号，重逢模拟话音信号，并将其提供给无线控制器。

28. 根据权利要求 27 的系统，其中传输装置包含电话交换网。

29. 一种蜂窝通信系统，包括一个小区，其中多个话音信号在基站和相应多个在小区中使用 RF 传输的移动单元间发送和接收。包括：

基站单元，经传输装置连接到多个天线单元，每个天线单元配备一个在与该天线单元相关的区域中发射和接收信号的天线，各区域分布于小区内，基站单元包括：

数字化装置，用于从移动电话交换局接收多个话音信号，并数字地合成用于传送话音信号给小区中移动单元的各不同信道所产生的多个 RF 信号，并产生多个采样的单独数字化流，每个流对应多个合成的 RF 信号，一个上述的数字化流对应传送给天线单元的一个信道，因此基本上只有那些传送到一个区域的信道才由采样的数字化流所代表。上述数字化装置包含响应第一控制信号的装置，使传送到每个天线单元的每个信道的内容可被控制。每个单独

流的采样供给传输装置，以传输到相应天线单元。

其中，每个天线单元中进一步包括：

数模转换装置，从基站单元接收采样的数字化流，恢复相应的模拟 RF 信号，并将其供给天线以发射到小区地域。

模数转换装置，接收由天线收到的 RF 信号，产生多个采样的单独数字化流，每个流对应至少一个收到的 RF 信号中的信道的数字化形式，因此基本上只有那些在某特定区域中收到的信道由采样的数字化流所代表，采样供给传输装置，以传输给基站单元。

其中每个基站单元中进一步包括：

转换器装置，从天线单元接收各自的采样的数字化流，数字地合成采样所代表的模拟话音信号的数字形式，并产生相应话音信号传送给移动电话交换局。上述转换器装置包含响应第二控制信号的装置，以从来自天线单元的上述采样的流中选择至少一个上述的信道，并使用至少一个信道来合成在该信道中传送的模拟话音信号的数字形式，因此使用信道的区域可选。

控制器装置，用于监测从每个天线单元收到的数字化采样，数字地分析每个流中每个信道的电平值，产生上述的第一和第二控制信号提供给上述的数字化装置和上述的转换器装置，从而播发到每个区域中的信道和每个区域中用来接收话音信号的信道可以根据单元收到的信号电平加以控制。

30.根据权利要求 29 的系统，其中上述的传输装置是电话交换网。

31.根据权利要求 30 的系统，其中所述控制装置包括衰

落控制装置，用以监测一个区域中接收的 RF 信号的衰落，并产生第二控制信号用于切换获得 RF 信号的区域，从而实现分集功能。

32. 根据权利要求 31 的系统，其中上述衰落控制装置能在 1 秒内完成上述的监测和切换功能。

33. 一种蜂窝通信系统，包含一个被分为多个区域的小区，其中在基站和相应多个在区域中使用 RF 传输的移动单元间发送和接收多个话音信号，包括：

小区基站单元，经传输装置连接到多个天线单元，每个区域中至少有一个天线单元，每个天线单元配置一个在相关区域内发射和接收信号的天线，基站单元包括：

模拟 RF 信号发生装置，产生多个 RF 信号，用于各不同信道传送话音信号给小区中移动单元。

第一切换装置，响应第一控制信号，切换和组合 RF 信号，形成复合 RF 信号供给各区域，每个区域的复合信号包含选择信道。

模数转换装置，将供给每个小区的复合信号转换为相应的采样的数字化流。

数字滤波器装置，对复合信号进行滤波，并产生多个单独数字化流，每个流对应至少一个信道，采样的单独数据流供给传输装置，以传输到相应天线单元。

其中每个天线单元进一步包括：

数模转换装置，以从基站单元接收采样的数字化流，重建相应的复合模拟 RF 信号，并将放大后的信号供给天线，以便将其发射到微小区地域。

模数转换装置，接收由天线收到的 RF 信号，并将其转换为采样的数字化流，

数字滤波器装置，对源于收到的 RF 的采样流进行滤波，并且产生多个独立的样值数字化流，每个流对应至少一个信道，并将单独的数据流供给传输装置，以传送到基站单元。

其中每个基站单元进一步包括：

数模转换器装置，从每个天线单元接收采样的数字化流，为每个天线单元重建模拟 RF 信号。

第二切换与组合装置，响应第二控制信号，选择性地组合来自天线单元的 RF 信号，形成多个复合信号供给接收机。每个复合信号包括一个或多个来自天线单元的 RF 信号。

控制装置，监测来自所有天线单元的采样的数字化流，并数字地分析每个区域中每条信道的电平，据此产生第一和第二控制信号，选择性地控制每条信道发射的区域和各信道所接收的区域。

34. 根据权利要求 33 的系统，其中上述控制装置包括衰落控制装置，用于监测一个区域中接收的 RF 信号的衰落，并用于产生第二控制信号切换获得 RF 信号的小区，从而完成分集功能。

35. 根据权利要求 34 的系统，其中上述衰落控制装置可在 1 秒内完成监测和切换。

36. 蜂窝电话系统中被动式切换的一种方法，系统中的小区被分为多个区域，每个区域共享一组信道，包括以下步骤：

(a) 在基站，为每个区域产生用于信道组的 RF 信号的数字化表示，从而可以单独地控制从每个区域发射的信道发送到每个区域的数字化表示。

(b) 在每个区域中接收数字化表示, 通过数模转换产生相应的 RF 信号, 以及在区域中发射 RF 信号;

(c) 在小区中为信道组接收 RF 信号, 并将其转换为相应的数字化表示, 用于传回给基站。

(d) 在基站从区域中接收数字化表示, 并且为每个区域获得相应的 RF 信号。

(e) 监测来自于每个区域的 RF 信号的数字化表示, 并且根据每个区域中的每条信道的电平 (i), 通过控制数字化表示的产生, 如步骤 (a) 所完成, 有选择地控制发射到区域中的信道 (ii) 选择性地选定获得接收信号的区域, 从而实现被动式切换。

37. 蜂窝电话系统中被动式切换的一种方法, 系统中一个小区被分为多个区域, 每个区域共享一组信道, 包括以下步骤:

(a) 在基站, 为每个区域生成信道组的 RF 信号的数字化表示, 从而从每个区域发射的信道能被单独控制, 并只发送每个区域的组中那些信道的数字表示;

(b) 接收每一区域内的数字化表示, 并用数模转换生成相应的 RF 信号, 并在区域中发射 RF 信号;

(c) 在区域中为信道组接收 RF 信号, 并将 RF 信号转换成相应的数字化表示, 以传输回基站, 只有信道组中的那些信道被传输回到基站;

(d) 在基站中从区域接收数字化表示, 并为每一区域获得相应 RF 信号;

(e) 监视来自每一区域的 RF 信号的数字化表示, 并且基于每一区域中每一信道的能量 (i) 如同步骤 (Q), 通过控制生成数字化表示, 来选择性地控制信道发射到区

域中及 (ii) 选择地选择在哪个区域获得接收信道，以便能实现被动切换。

39.使用信道组传送蜂窝电话通信给小区的方法，包括以下步骤：

(a)在基站，为每个信道产生 RF 信号的数字化表示，数字化表示从基站传送到远端小区。

(b) 在小区接收数字化表示，并通过数模转换产生相应 RF 信号， RF 信号发射到小区。

(c) 在小区内接收用于信道组的 RF 信号，将 RF 信号转换为相应的数字化表示，然后回传给基站；并且

(d) 在基站从小区接收数字化表示，并获得每个信道的相应 RF 信号。

40.使用信道组传输蜂窝电话传输给小区的方法，包括以下步骤：

(a) 在基站，产生用于每个信道的 RF 信号的数字化表示，基本上只传送信道组中每一条信道的数字化表示给远离基站的小区，因此这些信道传输所需带宽小于传输蜂窝频段中所有信道所需的带宽窄。

(b) 在小区接收数字化表示，并通过数模转换产生相应 RF 信号， RF 信号发射到小区。

(c) 在小区中接收用于信道组的 RF 信号， RF 信号转换为相应数字化表示，基本上只传输信道组中的每一条信道的数字化表示给基站单元，故传输这些信道所需带宽小于传输蜂窝频段中所有信道的带宽。

(d) 在基站接收来自小区的数字化表示，并为每一信道获得相应的 RF 信号。

41.根据权利要求 40 的方法，进一步包括在小区和基站

间通过电话交换网传送数字化表示的步骤。

42.使用信道组传送蜂窝电话传输给小区的方法，包括以下步骤：

(a) 在基站，将来自移动电话交换局的话音信号数字地合成为用于每条信道的 RF 信号的数字化表示，并将数字化表示传送给远离基站的小区，因此不需要模拟发射机。

(b) 在小区中接收数字化表示，并且通过数模转换产生相应的 RF 信号，并在小区发射 RF 信号；

(c) 在小区中为信道接收 RF 信号，并将 RF 信号转换成相应的数字化表示，用以传输返回基站，及

(d) 在基站从小区接收数字化表示，以数字方式获得用于每条信道的相应话音信号，因此不需要模拟接收机。

43.使用信道组传送蜂窝电话传输给小区的方法，包括以下步骤：

(a) 在基站，将来自移动电话交换局的话音信号数字合成为用于每条信道的 RF 信号的数字化表示，基本上只传输信道中每一条信道的数字化表示给远离基站的小区，因此不需要模拟发射机，并且传输这些信道所需带宽小于传输蜂窝频段中所有频段所需带宽。

(b) 在小区接收数字化表示，并通过数模转换产生相应的 RF 信号，并在小区发射 RF 信号；

(c) 在小区中，为信道组接收 RF 信号，并将 RF 信号转换成相应的数字化表示，并且基本上只将组中每条信道的表示传输给基站，从而传输信道所需带宽小于在蜂窝频带传输所有信道所需的带宽。以及

(d) 在基站接收来自小区的数字化表示, 并为每一信道获得相应数字化语音信号, 因此无需模拟接收机。

44. 根据权利要求 43 的方法进一步包括在小区和基站间经电话交换网传送数字化表示的步骤。

45. 蜂窝电话系统中被动式切换的方法, 系统包含多个宏小区。其中包括第一宏小区, 每个宏小区共享公用信道组, 步骤如下:

(a) 提供多个基本和辅助微小区天线单元;

(b) 将第一宏小区分为数个基本微小区单元, 其中划分步骤包括, 安置基本微小区天线单元, 以覆盖整个第一宏小区;

(c) 提供多个辅助微小区天线单元;

(d) 安置辅助微小区天线单元, 以提供宏小区覆盖, 覆盖范围与基本微小区重叠。

(e) 在基站, 产生从移动电话交换局来的话音信号的数字化表示, 从上述多个基本和辅助微小区中选择一个微小区, 并传送数字化表示给选择的微小区的微小区天线单元。

(f) 在选择的微小区, 接收数字化表示, 通过数模转换产生相应的 RF 信号, 且在所选微小区中发射 RF 信号;

(g) 在多个用于信道组的基本和辅助微小区中的每个中接收 RF 信号, 将 RF 信号转换为相应的数字化 RF 信号表示, 然后回传给基站。

(h) 在基站接收来自基本和辅助微小区的数字化 RF 信号表示。

(i) 监测来自每个基本和辅助微小区的数字化 RF 信

号表示。监测基于每个区域中每条信道的电平。

选择性地控制在每个基本和辅助微小区发射的信道。控制是通过控制数字化表示的产生实现的，如步骤 (e)；及

选择性地从多个基本和辅助微小区中选择一个收到接收信道的微小区，从而实现被动切换。

46.根据权利要求 45 的方法，其中从移动电话交换局接收的电话信号中产生一个数字化表示的步骤包括，数字地合成上述电话信号供给每个信道传送。

47.根据权利要求 45 的方法中，其中从移动电话交换局接收的电话信号中产生一个数字化表示的步骤包括：产生用于每个信道的 RF 信号的数字化表示。

48.在特定蜂窝通信地域的扇区覆盖方法，其中包括以下步骤：

提供含多个微小区天线单元的一个远端单元，该单元包括第一和第二微小区天线单元，其中每个微小区天线单元中的天线覆盖一个特定扇区，以及一个信道滤波器单元为分配给特定扇区的信道滤波。

连接远端单元到扇区基站单元，其中连接步骤包括，提供与每一天线单元扇区相关的唯一扇区频率；

连接扇区化基站单元到移动通信交换局；

在扇区化基站单元，生成从移动电话局接收的电话信号的数字化表示；

为特定扇区发送微小区天线单元的数字化表示；

在第一微小区天线单元，接收第一 RF 信号，数字化第一 RF 信号，并将数字化第一 RF 信号转换成第一扇区频率；

在第二微小区天线单元，接收第二 RF 信号，数字化第二 RF 信号，并将数字化第二 RF 信号转化成第二扇区频率；以及

将第一扇区频率的数字化第一 RF 信号和在第二扇区频率的数字化第二 RF 信号复用，并将复用的信号传输给扇区基站。

说明书

基站集中放置，天线单元分 布式放置的蜂窝无线系统

发明领域

本发明一般涉及高容量移动通信系统，具体涉及数字微型蜂窝通信系统。

背景

图 1A 示出了一个传统的蜂窝电话系统。这种系统在美国得到了广泛的应用。正如图 1A 所表明的一样，系统 5 有固定数目的信道组，分布在基站 12，13 之间，而基站 12，13 又服务多个以预定的，可重复使用的模式布置的小区 11，16。典型的小区地域范围是 1 至 300 平方英里。一般情况下，较大的小区覆盖乡村区域，较小的小区覆盖城市区域。使用相同信道组的小区天线以足够远的距离间隔放置，从而确保同信道干扰被抑制在一个可以接受的水平。

小区 11 中的移动单元 10 备有无线电话收发信机，当它从一个小区移动到另一个小区时，这种设备可用来与具有同样设备的基站进行通信。每个基站 12，13 通过通信线路 18 在移动单元 10 和移动通信交换局（MTSO）17 之间传送电话信号。小区和 MTSO17 之间的线路 18，典型为 T1 线路，含有为小区每一个无线信道所单独提供的语音级线路，以及为交换和其它控制功率所提供的数据线路。MTSO17 还经由通道 19 连接到一个包含固定用户电

话站及各种电话交换局的电话交换网络 15 上。

图 1A 中的 MTSO17 包含一个交换网络，它用于在公共交换电话网络 15 和小区 11，16 中的移动单元 10 之间建立通话连接，并将通话连接从一个小区到另一个小区进行切换。另外，MTSO 使用两条接入线，将一个小区的通话连接换到另一个小区。现有技术中已有多种越区切换标准。如有的运用相位变化得出移动单元距接收小区的距离，有的用三角测量法和接收信号的强度等方法得出可能的越区切换。在 MTSO17 中同时还包含一个中央处理单元，处理从小区收到的数据，并处理从网络 15 获得监控信号，以控制通话连接的建立和拆除。

图 1B 表明了一个传统的基站 12。MTSO 出来的 T1 线路和基站无线设备之间的接口由无线控制单元 22 提供。发射机 23 一基站的每一信道配备一台一由电路 22 驱动，它提供给每个发射机一个模拟的语音信号。接下来，信号分别被送到为每一信道所配备的非线性功率放大器上，或者如图 1B 所示的一样，信号被组合然后送到一个线性功率放大器 24。功率放大器 24 的输出通过双工器 25 送到天线 26，然后再广播到由基站服务的蜂窝区域中。

天线 26 接收到的信号通过双工器送给滤波器 27。滤波器 27 将整个蜂窝频段的信号从相邻频段中分离出来并送给接收机 28，每一信道都配备一台这样的接收机。再将接收机 28 输出的模拟语音信号送给电路 22。基站 20 可能包含一个分集天线 26' 以及相应的分集滤波器 27' 和多个分集接收机 28'，这些分集接收机每一个都对应于一个主接收机 28。在实际应用中，分集接收机 28' 的输出送给电路 22，因此电路 22 应包含一个使用已知技术用于从

相应的接收机 28 和 28' 之间选出最强信号的电路。

在人口密集的城区，由于小区 11，16 中的信道数量相对较少，传统系统 5 的容量受到了极大的限制。此外，城市蜂窝电话系统还受到阻塞、损耗以及 RF 信号被高层建筑和其它物体遮蔽的限制。对于郊区的办公建筑及其它综合建筑物也存在这一问题。

为了增大容量和覆盖范围，可对一个小区地域进行细分，以更密集的频率安排并以较低的功率在较小区域内进行分配频率的再用。细分可以通过按地理区域划分一个小区来实现，例如把小区按建筑物或按建筑物内的楼层来划分。虽然对于容量和覆盖区域来讲，这样的“微小区”系统是一个可行的解决方案，但是要以一个合理的费用找到地方在每个微小区内安装传统的基站设备，尤其是在人口密集的城区，却可能是十分困难的。更重要的是，在一个人口密集的城区，维护遍及各处的大量基站可能是费时而且是不经济的。

AT&T 提出了一种系统，它不必使用大量的传统基站就可解决城区的覆盖范围问题。图 1 中示出了这种系统，AT&T 的欧洲专利申请号为 NO.0391597，于 1990 年 10 月 10 日颁布。在这一系统中，整个微小区系统布置了一个天线位置 40 的网格。一个光纤网络 42 将天线与基站 44 连接起来。为了将信号经由光纤网络 26 传送到天线 22，使用 RF 移动无线信道对光载波进行模拟调制。每个天线 22 配备一个检测电路 27，以接收调制的载波并重建 RF 信号，然后再把 RF 信号送到天线 22 以传送到微小区地域 21。天线 22 接收到的从移动单元来的 RF 信号同样被调制到光纤上，并经由光纤网络 26 传回到基站 25。从基站 25

发送的所有信道被分配给各个天线 22。同时，从基站 25 发送的所有信道也可以被任一微小区 21 中的移动单元接收到，并可经由光纤传送到基站 25。

上面描述的 AT&T 系统具有某种局限性。模拟调制和解调光的能力，线路反射所带来的局限性，以及光纤线路损耗都给模拟调制信号引入了显著的畸变和误差，从而限制了可以经由模拟系统，尤其是在上行方向上有效传输的信号的动态范围。这些因素限制了从基站到天线的距离。

此外，在 AM 系统中，需要天线发送一个或从天线接收一个频带之外的信号，来传送控制和告警信息，这又增加了调制解调设备的费用。此外，诸如寻呼系统，个人通信网络及移动数据业务等其它的业务需求很难加入到象 AT&T 的欧洲应用中所描述的类似的模拟 AM 系统中。

AT&T 系统要求我们为每个远端天线使用安装的专用光纤线路。而我们想要的是利用现有的传输线路或光纤通路，以避免安装新的光纤线路。

Lee 的 U.S. 专利 NO.4,932,049 号公开了另外一种增加覆盖范围的方案。Lee 的专利描述了一种“被动越区切换”系统，其中一个小区被细分为几个区域，使用定向天线来覆盖每个区域。小区中的所有天线共用同一组发射机和接收机。使用一个区域开关来有选择性地接收机和发射机与天线单元相连接。在实际操作中，MTSO 将最好地服务于某给定信道上移动单元的天线连接到分配给该移动单元的发射机接收机对上，其它天线与发射机/接收机对脱离。为了控制发射机和接收机与天线间的切换，一个扫描接收机不断轮询小区中所有占线信道上天线单元所接收到的信号的强度。具有最佳接收信号强度的区域被选作相关

信道的激活区域。因此，Lee 专利中所揭示的这一系统改善了与移动单元之间的通信性能，同时通过定向技术及限制一个小区中总的信号强度减小了它与其它小区之间的相互干扰。

发明概述

本发明不需要在每个微小区地域内使用独立的传统基站，而通过在整个微小区系统内分配可重复使用的信道组来扩大覆盖范围和提高容量。与上面描述的如 AT&T 系统那样的模拟系统相比，它还具有很好的动态范围，可以覆盖更远的距离。

根据本发明的一个示例性实施例，提出了一种微小区系统：其中多个公共设置的基站与多个相应的微小区内的微小区天线单元之间进行通信。每个基站单元包含传统的 FR 基站发射机和接收机对，给微小区的每一信道都配备一对这样的发射机和接收机对。此外还配备另外的接收机以接收分集信道。从发射机输出的 RF 信号被组合，然后送给一个宽带的模-数转换器。数字信号通过光纤传送到微小区单元。每个微小区单元接收数字化的 RF 信号，并使用一个数-模转换器来重建模拟的 RF 信号。重建的 RF 信号被送给功率放大器，它的输出送到天线，以广播到微小区地域。

天线单元包括一个主天线和一个分集天线。这两个天线分别独立地接收来自移动单元的 RF 信号。来自主天线的 RF 信号经过第一组滤波器进行滤波，给微小区的每一个信道都配备一套这样的滤波器，然后把经过滤波组合之后的主信号送给一个模数转换器。第二组滤波器接收来自分集天线分集信号。分集信号也被送给一个模数转换器。

数字化的主信号和分集信号被复接并通过光纤传回给微小区基站。基站本身又包括一套数一模转换器，它重建提供给接收机的主模拟 RF 信号和分集模拟 RF 信号。与传统的分集技术一样，我们选用最强的信号。使用传统电路将发射机与接收机接口于 MTSO 上。

因此，以上描述的示例性实施例设想通过设置微小区基站/天线单元对，来在微小区内提供一种可重复使用型的信道（如同传统蜂窝技术中的一样）。微小区基站单元通常不包含天线，并且可以放置在方便的，低费用的地方，如果需要，甚至可以放置在微小区系统区域之外。

根据另一个示例性实施例，本发明可用来扩展传统小区的覆盖范围。在这一实施例中，基站可能包括一个用于发射和接收直接从发射机和接收机过来的模拟 RF 信号的天线，如第一个示例性实施例中所描述的一样，这一天线同时还使用经由光纤的数字载波发射和接收从微小区天线单元过来的信号。

根据本发明的另一示例性实施例，数字化的微小区业务以帧的形式发送到天线或从天线进行接收。每一帧包含许多用于运载数字化微小区信号的比特，其它比特用于控制和设备监控，错误检测和纠错以及在基站和天线单元之间传送端到端，点到点的语音信号。一些其它的可选业务，例如个人通信网络业务，寻呼业务以及移动数据业务也可使用帧的形式进行传送。

根据本发明的另一不同的示例性实施例，光纤载体可以用电缆或其它传输媒质来代替。

根据又一示例性实施例，本发明可以用来将一组信道分配给多个微小区地域。在这一实施例中，一个基站单元

给多个微小区天线单元发送同一组数字化的信道，这些天线单元也将同一组信道信号返回给微小区基站。

因此，本发明通过使用数字传输，获得了更好的信号质量，并且增大了基站和微小区天线之间的距离，从而解决了一些如前面 AT&T 应用中所提到的与模拟 AM（或 FM）系统相关的问题。正如在一个示例性实施例中所应用的那样，本发明无需在每一个微小区地域内使用传统基站，与现有移动电话系统相比，它极大地提高了系统的容量，并且可以满足一些可选业务，例如寻呼系统，移动数据业务或个人通信网络等的需求。本发明还改善了信号的动态范围，并且增加了信号从基站到天线单元之间有效传输的距离。在另一示例性实施例中，本发明很容易地实现了将控制和监测信息传送到微小区天线单元及从微小区天线单元接收控制和监视信息。

为了提供更多的益处，我们还提出了一种微蜂窝系统的全数字式示例性实施例，其中，用多个公共设置的基站与多个相应的微小区天线单元进行通信，这些微小区天线单元应用于各自的微小区地域。根据这种全数字的实施例，基站为全数字式的，并且它合成直接从 MTSO 接收的 T1 载波来的数字信号。数字信号经由光纤送到微小区单元。微小区单元接收数字信号，并使用一数模转换器重建模拟的 RF 信号。然后将 RF 信号送给功率放大器，它的输出送到天线，以发射到微小区地域。天线单元接收从移动单元来的 RF 信号。RF 信号通过一组滤波器进行滤波，给微小区的每一信道都装有一套这样的滤波器，然后将滤波后的信号传送给模一数转换器。数字信号再经由光纤传回给数字微小区基站。基站接着直接将数字信号合成到回到

MTSO 的 T1 载波上。使用传统电路将发射机和接收机接口于 MTSO 上。因此，这一实施例设想微小区基站单元为全数字式的，并且不再需要基站中的 RF 设备，也不再需要模一数和数一模转换器，从而为降低费用，减少基站设备所占体积以及减少对于低可靠性模拟系统的维护需要创造了条件。数字微小区基站可以设置在方便的，费用低的地方，如果需要，甚至可以在微小区系统区域之外。

一种方法可快速安装使用模拟基站的系统，而且模拟基站也可容易地升级为全数字基站。这一方法的第一步要求使用多个我们上面描述的那种微小区基站单元，每一基站包括传统的 RF 基站发射机和接收机，给微小区的每一信道都配有一套这样的发射机和接收机。

在应用的第二个阶段中，用全数字基站来替换模拟基站，这种基站是全数字式的，并且合成直接从 MTSO 接收到的从 T1 载波上来的数字信号。数字信号经由光纤传送到在应用的第一阶段中所安装的微小区天线单元。微小区天线单元接收数字信号，并使用数一模转换器重建模拟 RF 信号。然后将 RF 信号送给功率放大器，它的输出送到天线，以广播到微小区地域。天线单元也接收从移动单元来的 RF 信号。将 RF 信号通过一组滤波器进行滤波，给微小区的每个信道都配备一套这样的滤波器，然后将滤波后的信号传送给模-数转换器。数字信号经由光纤再传回给数字微小区基站。基站又直接将数字信号合成到返回 MTSO 的 T1 载波上。

因此，以上描述的示例性实施例设想当用全数字微小区基站取代模拟微小区基站单元时，第一阶段中安装的天线单元无需变动或替换。因此，这一方法不用支出用于改

变现有已安装的微小区天线单元的费用，就可以获得全数字基站的所有优点。

根据另一种可行的示例性实施例，运载微小区或 PCN 业务的数字化 RF 信号被组成帧，以在电话交换网络上传送。在这一实施例中，有限数量的数字微小区或 PCN 信道被组合在一起，使用标准 DS - 3，OC - 1 或其它协议以标准的帧形式进行传输。

在另一个可行的示例性实施例中，数字微小区或 PCN RF 信号经由已安装的电缆系统的光纤基础设施以幅度调制方式（AM）从前端到光结点进行传输。

另一个更进一步的示例性实施例设想，将微小区或 PCN 业务使用 QAM 调制或其它数字调制方式以数字的形式在电缆系统的馈线上进行传输。

因此，根据这些实施例，微小区或 PCN 信道可以在已建立的交换网络上或使用已建立的电缆系统基础设施来进行传输。

根据本发明的另一实施例，它提出了一种被动越区切换系统，这种系统使用数字信号分析，来实现在小区的不同微小区内不同的天线单元之间快速切换发射机和接收机。

根据本发明的又一实施例，提供了一种带阻滤波器，这种滤波器可以由从模数转换器来的数字流中滤出选定的一组信道，并把选定的信道复用到一个或更多个低速载波上，例如 T1 线路或 SONET 载波。

根据本发明的又一实施例，它描述了一种被动切换方法，这一方法用于具有多个宏小区（其中包括一级宏小区）的蜂窝电路系统中，每一宏小区分享同一组信道，这一方

法包含几个步骤：提供多个基本和辅助微小区天线单元；把一级宏小区划分为多个基本微小区，其中划分步骤包括，放置基本微小区天线单元，以覆盖一级宏小区；提供多个辅助微小区天线单元；放置辅助微小区天线单元，提供和基本微小区重叠的宏小区覆盖范围，于基站处将从移动电话交换局接收到的电话信号生成相应的数字化表示，从以上提到的许多基本和辅助微小区中选择一个微小区，并且将电话信号的数字形式传送给选定微小区的微小区天线单元；在选定的微小区接收数字信号，并通过数一模转换器产生相应的 RF 信号，然后在选定的微小区发射这一 RF 信号；在每一个基本和辅助微小区接收这组信道的 RF 信号，并把接收到的 RF 信号转换为相应的 RF 信号的数字化表示，返回传输给基站；在基站接收来基本和辅助微小区的 RF 信号的数字化表示；监视来自基本和辅助微小区的 RF 信号的数字化表示，并以每一区域中的各信道的能量级别为基础，有选择地控制广播到每个基本和辅助微小区的信道，并从多个收到接收信道的基本和辅助微小区中选择一个微小区，从而实现被动式切换。

根据本发明的另一实施例，它描述了一种扇形覆盖某一特定蜂窝通信区域的方法，这一方法包括以下几个步骤：提供一个具有许多微小区天线单元的远端单元，这些微小区天线包括一个基本和一个辅助微小区天线单元，其中每个微小区天线单元包含一个用于覆盖某一特定扇区的天线，并且使用一信道滤波器单元来滤出分配给特定扇区的信道；将远端单元与按扇区划分的基站单元相连，其中连接步骤包括，为每一个天线单元扇区提供一个单元的扇区频率；把按扇区划分的基站单元连接到移动通信交换

局；在按扇区划分的基站单元那里，将从移动电话交换局接收到的电话信号转换为相应的数字化表示；将数字信号传送给某一特定扇区的微小区天线单元；在一级微小区天线单元处，接收一级 RF 信号，将一级 RF 信号数字化，并且数字化的一级 RF 信号转变为扇区频率；在二级微小区天线单元接收二级 RF 信号，将二级 RF 信号数字化，并把数字化的二级 RF 信号转换为二级扇区频率；然后复用一级扇区频率上的一级数字 RF 信号和二级扇区频率上的二级数字 RF 信号，并将复用后的信号传送到按扇区划分的基站。

附图的简述

通过参考以下的详尽描述，补充说明和附图，可以获得有关本发明各类特点，目的和优点的更加完全的理解。

图 1A 是先有技术中移动通信系统的功能框图。

图 1B 是先有技术中基站的功能框图。

图 1C 是先有技术中微小区移动通信系统的功能框图。

图 2 是本发明微小区通信系统示例性实施例的简要功能框图。

图 3 是图 2 实施例中基站的详细框图。

图 4 是图 3 基站的更详尽的说明。

图 5 是图 4 帧发生/复用器 134 的详细框图。

图 6 是一典型数据帧结构的简图。

图 7 是另一典型数据帧结构的示意图。

图 8 为据图 2 中典型实施例中微小区天线单元的功能框图。

图 9 是图 4 中解复用器 142 和相关接口的功能框图。

图 10 是本发明全数字典型实施例的功能框图。

图 11A 是图 10 中系统的详细框图。

图 11B 是图 11A 中系统的可选实施例。

图 11C 是图 11A 中系统的另一可选实施例。

图 11D 是图 11A 中系统的又一可选实施例。

图 12 是根据本发明的微小区通信系统的可选实施例的简要说明。

图 13 是图 12 系统的可选实施例 106' 的功能块设计图。

图 14 是本发明微小区通信系统另一个可选示例性实施例。

图 15 是表明本发明的另一可选示例性实施例中的可选业务，如个人通信网（PCN）通信业务和寻呼通信业务，可复用到蜂窝系统的通信系统中。

图 16 是有线电视系统基础设施这一先有技术的简要说明。

图 17 是本发明的可选示例性实施例的简要框图，其中有有线电视系统基础设施用于与微小区间双向传送数字化 RF 信号。

图 18 是图 17 典型实施例的基站单元的框图。

图 19 描述了图 17 典型实施例中处于有线电视系统前端的前端单元。

图 20 是图 17 典型实施例中处于有线电视系统前端的 AM 调制器/解调器的较详细框图。

图 21A 是模数转换器 132 的更详细的框图，模数转换器 132 用于本发明的多个实施例中。

图 21B 是用于本发明的不同实施例中的数模转换器

144 的更详细的框图。

图 22 是用于图 2 中本发明实施例的一种可选的优选帧结构。

图 23 是用于图 2 中本发明实施例的另一种可选的优选帧结构。

图 24 是图 17 实施例中，处于电缆系统光节点处的微小区远端单元的更详尽的框图。

图 25 是用于图 17 实施例中的幅度调制器的说明。

图 26 是用于图 17 实施例中的幅度解调器的更详尽的说明。

图 27A 是图 17 所示系统的可选示例性实施例的基站的说明，其中 RF 微小区信号或 PCN 信号是数字调制的。

图 27B 是图 17 所示系统的可选实施例的说明，其中 RF 微小区信号或 PCN 信号是数字调制的。

图 28 是使用数字调制的可选实施例的进一步说明。

图 29 进一步描述了使用数字调制的实施例中的光节点的结构。

图 30 另一个典型实施例的全景图，该实施例中数字化微小区通信或 PCN RF 通信被组成帧，并通过电话交换网传送。

图 31A 是图 30 实施例中基站单元的更详尽的框图。

图 31B 是图 30 实施例中基站单元的一个可选典型实施例。

图 32A 是图 31A 所示基站单元中模数转换器和成帧电路的更详细的框图。

图 32B 是图 31B 所示基站单元的一个可选典型实施例中模数转换器和成帧电路的更详细的框图。

图 33A 是图 30 所示系统的远端天线单元的更详细的框图。

图 33B 是图 30 所示系统中远端天线单元的一个可选典型实施例的更详细的框图。

图 34 是本发明的另一典型实施例，其中数字化 RF 信号通过电话交换网和电缆系统传送。

图 35A 是一种微小区通信系统典型实施例的全景式的功能框图，根据本发明该系统具有被动越区切换能力。

图 35B 是根据本发明的系统 35A 的典型基站单元 114' 的更详细的框图。

图 35C 是一个移动单元从一个区域运动到另一个区域的图示化说明。

图 36 是图 35A 中系统的数字发射/接收单元 130'' 的一个示例性实施例。

图 37 描述了图 35A 系统中控制器 810 的一个示例性实施例。

图 38 是图 35A 系统中控制器 810 的工作过程的简要框图。

图 39A、39B、39C、39D 是带全数字基站单元的被动越区切换系统的另一个可选示例性实施例。

图 40 是图 35B 系统的一个可选实施例。

图 41A、41B、41C 是冗余微小区覆盖的示例性实施例。

图 42 是根据本发明的扇区化微小区通信系统示例性实施例的简要框图。

图 43 是图 42 中所示基站的实施例的更详细的框图。

图 44 是图 42 中所示远端单元实施例的更详细的框

图。

图 45 是图 44 中所示远端单元中的信道滤波器单元的一实施例的更详细的框图。

图 46 是图 42 中所示基站单元实施例的一个可选实施例。

图 47 是图 42 中所示远端单元实施例的一个可选实施例。

优选实施例的详细说明

在以下本发明典型实施例的详细说明中，可以参考前一部分的附图，在所有附图中相同的数字代表相同的部件。附图仅作为一种说明方式，可以用于本发明的具体实施例。可以理解，不偏离本发明范围，可实现其它一些实施例，并进行一些结构上的变动。

本发明一典型实施例的一般结构示于图 2 中。微小区系统包括许多微小区地域 100。在每个微小区地域 100 中使用的是微小区远端天线单元 102。这样的单元可以架设在楼房顶部或楼房内，或者其它建筑物之上或之内。例如，微小区天线单元可以架设在邻近或座落于天线塔上楼房内的每一层中，或者架设在高速公路边上。

远端天线单元 102 通过光纤 104（或其它宽频带载波）与相应的基站单元 106 相连接。基站单元 106 经由 T1 线路 112 接口于 MTSO 110。如同传统蜂窝电话系统中的一样，MTSO 与一个电话交换网络 120 相连。微小区基站单元 106 最好放置在单个地点 114，这一地点可以在微小区系统服务区域之内或之外，但是，在任何情况下都应该设置得有利于维护。

现在参看图 3，它示出了本发明一典型实施例中微小

区基站 106 的简单框图。基站 106 分别包括传统的发射机 23 和接收机 28，以及传统的无线控制器或与 MTSO 110 的接口电路 22。一个数字发射机/接收机单元 130 接收由发射机 23 来的组合后的 RF 信号，然后将组合的信号数字化，并以数字形式经由连接到远端天线单元 102 的光纤进行传输。单元 130 也接收经由光纤 104B 从远端天线单元 102 来的数字化 RF 信号，并重建相应的模拟 RF 信号，然后将其送到接收机 28。因此，在数字发射/接收单元 130 的下行方向一侧可以使用传统设备。

现在参看图 4，它详尽地描述了发射/接收单元 130。单元 130 包括一个宽带的数字转换器 132，用它来接收从发射机 23 来的组合的 RF 信号。数字转换器 132 提供数字化的微小区信号流，这一数据流由一系列送到的模拟 RF 信号的采样组成。帧发生器/复用器 134 将数字化的微小区信号数据与控制，语音和检错数据一起组装成帧，并送给数字调制激光器 136。语音数据信道，也被称作公务信道，产生于公务接口 135，它为手机 137 或二线的电话线提供一个输入。公务接口 135 用于双向点到点的语音级通信。典型情况是一个在远端使用的手机与一个在基站的手机相连。控制信号产生于控制/告警电路 131，电路 131 为远端天线单元 102 产生控制信息，以监测错误和告警信息。

从数字调制激光器 136 出来的光信号被送到光纤 104A，然后传送到相应的远端天线单元 102。根据一个可行的实施例，数字转换器 132 可以提供 30.72 兆采样/秒 (MSamples/s) 速率传输的 24 比特宽的字 (并行结构采样)。帧发生器/复用器 134 把 30.72M 采样/S 的字转换为以 819.2 兆比特 (Mb/s) 速率传输的单一串行比特流。

数字转换器 132 通过使用带通滤波器抑制带外信号来实现对宽带 RF 信号的调整，同时它还调整增益以防止模数转换器过载。模数转换器通过直接对 RF 信号进行采样或者先将 RF 信号下变换到基带或中频，然后再采样的方法来将调整后的宽带 RF 信号转换为一并行比特流。在优选实施例中，数字转换器从 Massachusetts 的 steibrecher corporation of woburn 公司获得，它以 30.72M 采样/S 的速率对下变换到第一或第二奈奎斯特区的 12.5MHZ 带宽的信号进行 12 比特抽样。

单元 130 还包括一个数字光接收机 140。接收机 140 输出一个送给解复用器 142 的电数字信号，正如我们以下将进一步讨论的一样，解复用器 142 提取由远端天线单元 102 产生的数字化微小区信号数据。解复用器 142 还提取与微小区信号数据同帧传输的告警（监视）和语音信息。数字化的微小区信号数据被送到数模转换器 144，它重建模拟 RF 信号，并将它传送给接收机 28。

数模转换器对解复用器 142 提取的并行比特流进行操作，并重建由数字转换器 132 数字化的宽带 RF 信号的一个基带拷贝。这一基带拷贝然后通过与一本地振荡器混频，并滤除镜像频率的方法向上变频到其最初的无线频率。在优选实施例中，数模转换器也从 Massachusetts 的 steibrecher corporation of woburn 公司获得，并以 30.72M 采样/S 的抽样速率运行。

现在参看图 21A，它更加详尽地描述了图 4 中的宽带数字转换器或模数转换器电路 132 和图 8 中的 170。模数转换器电路包含一本地振荡器 132A，它将其输出送给混频器 132B，132B 接收从发射机 23 来的组合后的输出信

号。在送给模数转换器 132C 之前，132B 将高频微小区信号（在传统蜂窝电话业务中为 850MHz，在 PCN 通信中约为 1.8GHz）降到约 1 ~ 15Hz 的（例如这两频率之间的 12.5MHz）中频（或基带）。

图 21B 描述的分别是图 4 和图 8 中的数模转换器 144 和 164，它执行与模数转换器 132 和 170 相反的操作。数模转换器 144 包含一数模转换器 144A，它输出一中频信号，然后将这一中频信号与本地振荡器 144C 进行混频实现向上变频。向上变频将 RF 的操作频率恢复为蜂窝或 PCN 系统的广播频率。

现在参看 5，它详细描述了图 4 所示本发明典型实施例中的帧发生器/复用器电路 134。电路 134 包括一个循环冗余校验码（CRC）发生器 155，它接收从数字变换器来的微小区信号数据并输出 CRC 码。

根据本发明的一个典型实施例，成帧器/复用器 154 将 CRC 信道，微小区信号数据，公务（语音）信道和控制（告警）信道复用进如图 6 所示的帧结构。每一帧包含 12 比特的微小区信号数据码，一比特 CRC 信道，一比特控制/告警公务信道和 6 比特成帧码。控制—告警和公务数据一起被复用进一个信道。

图 7 示出了一种可行的帧结构，其中 12 比特用于主天线信道，12 比特用于 12.5MHz 范围的其它可选业务或分集信道，1 到 2 比特 CRC 信道，1 比特控制信道和 6 比特的帧字。其它可能的帧结构可以包含 48 个信息比特，将它们用于全频道范围和分集容量，或用于运载其它附加业务。可以理解，本发明不限于这些提到的或其它特定的帧结构，可用的任何其它形式都没有脱离本发明的范围。

为了实现与并行传输字的同步，图 6 和图 7 中示出的帧信号以 819.2Mb/S（例如 $32 \times 25.6 \times 106\text{bit/s} = 819.2 \times 10^6$ 比特/S）的速率传输。（对于 40MHz/48bit 或其它的帧结构，比特率和抽样速率应作相应改变）。通过在接收解复用器 142（下面描述的图 8 中的 162）处搜寻帧面来实现同步。32 个独立帧组成一个超级帧。因此 32 帧中的一帧有一比特与其余 31 帧不同。每个帧比特为具有相同个数的“0”，“1”的对称码。解复用始发帧搜寻以找到连续的帧面，接下来搜索 32 帧中某一帧内的特定比特序列。当解复用器 142（或 162）找到超级帧和帧之后，就可以据此获得正确的信号数据样本和数据样本。这种类型的成帧方法在通信技术中已为人们所熟悉，并且那些熟练的技术人员也将认识到还有其它各种各样的成帧方法可以应用。帧发生器/复用器 134 包括用于对输出数据进行扰码的电路，以提供适于光纤传输的对称线性码。

现在参看图 22 和 23，它们示出了图 2 典型实施例中另一种优选帧结构。正如图 22 所示出的，这种帧结构包括用于 PCN/微小区业务的 12 比特，一个成帧比特，用于 CRC 与告警—控制公务信道的 1 比特，4 个保留比特。图 23 中的帧结构除了把 13 比特分配给 PCN/微小区信号数据外，其余与图 22 帧结构一样。这些帧结构都没有为容纳分集信号数据而分配比特，但是，它们都可以加以扩充。图 22 和 23 中的帧结构假定都是以 30.72Mb/S 的速率进行 12 比特抽样。而基本的帧结构为 18 比特，它在以 30.72Mb/S 运行时，将产生 522.96Mb/S 的串行速率。正如图 22 所示出的，一比特被用于成帧。另一比特在 CRC，告警—控制

和公务功能之间进行复用。这两个比特通过如下序列形式来实现成帧和复用。

成帧码	CRC.EtC
00	帧 1
01	帧 2
10	帧 3
10	帧 4
1C	帧 5
1D	帧 6

如上所述，这一典型实施例的成帧结构设想以六个帧组成一“超级帧”。每一超级帧的头四帧包含 00， 01， 10， 10 序列。在第五帧中，成帧比特为 1，另外的比特代表一比特 CRC 码。在第六帧中，成帧比特为 1，其余比特为告警—控制/公务信道比特。

CRC 码最好为 32 比特宽，所以为了获取整个 CRC 码，必须接收 32 帧。因此，每 32 数据码查一错。在以前描述的成帧结构中提供了对称的线性码。

现在参看图 8，根据本发明的第一个典型实施例，它示出了远端天线单元 102 的功能框图。数字光接收机 160 接收从微小区基站传送过来的光纤 104A 上的光数字业务数据。接收机 160 将光通讯数据转换为相应的电脉冲序列，并将它送给解复用器 162，解复用器 162 提取出微小区信号数据并将 12 比特（或 13 比特）抽样送给数模转换器 164。转换器 164 重建 RF 信号，并将其送给线性功率放大器 24。转换器 164 最好与上面描述的图 4 中的数模转换器相同。放大器 24 通过双功器 25 与主天线 26 相连接。相应地，微小区基站内发射机 23 所产生的无线频率信号从

主天线 26 上发射出去。解复用器 162 也提取供给控制/告警电路 161 的控制信号。同时它也提取公务数据并将其送到公务接口 163 以提供双向点到点的语音级通信。

主天线 26 接收到的 RF 信号通过双工器 25 送到滤波器 27。正如参考图 1B 所描述的一样，功率放大器 24，双工器 25，主天线 26 和滤波器 27 都是传统基站的组件。滤波器 27 的输出被组合，然后送到一宽带模数转换器 170（与上面图 4 中描述的 144 是同一类型），它将模拟 RF 信号数字化并送到帧发生器/复用器电路 172。电路 172 的输出被送到数字调制激光器 174，激光器 174 提供相应的光数字流给光纤 104B。帧发生器/复用器 172 与帧发生器/复用器 34 实质上是相同的设计。它从电路 161 接收一个告警（或监视）信号数据流和从公务接口 163 上接收公务数据流。

远端天线单元 102 可以有选择地包含一个分集天线系统 180。系统 180 包含一个分集天线 26'，该天线将输出馈给滤波器 27'，然后送给宽带的模数转换器 170'，这与主天线 26 到滤波器 27，再到宽带的模数转换器 170 的工作方式相同。模数转换器 170' 的输出供给电路 172，在那里将从分集天线收到的数字化射频信号复用成数据流，送给光纤 104B。在这样一种情况下，成帧结构包含了分集业务的容量。

现在参看图 9，图 4 和图 8 详细说明了解复用器 142（和相应的 162）。电路 142（162）包括一个解复用器 190，该解复用器从数字光接收机 140 接收数字数据流。解复用器 190 从数字数据流中提取控制/告警信道、公务信道、CRC 信道和微小区业务信道。另一方面，在提供分集功能之处，相应地，分集的 CRC 信道和分集的微小区信道

也被提取出来。主 CRC 信道和主微小区业务信道供给 CRC 校验电路 192，它提供一个差错信号给控制/告警电路 131。电路 131 监测发生在远端天线单元 102 的数据和告警的差错率。公务信道供给公务接口 163，提供双向的点对点通信。

当选择有分集功能时，一个第二 CRC 校验电路 192，接收分集的 CRC 信道和分集的微小区信道，并提供一个差错信号给控制/告警电路 131。

全数字式实施例

现在参照图 10，图示的是本发明的一个可选的典型实施例 200。可选的实施例 200 包含了一个图 8 所示的远端天线单元 102。远端天线单元 102 通过光纤 104A 和 104B 与全数字式微小区基站 210 相连。微小区基站 210 与 MTSO 相连。

全数字式微小区基站 210 的详细情况见图 11A。电路 210 包含一个 T1 接口 202，该接口提取由一根 T1 线传送或从 MTSO 而来的数字化话音信道，并把这些信道以数字式的形式提供给数字合成器 212。数字合成器 212 代替了图 4 中的发射机 23 和模数转换器 132。通过数字逻辑或软件，数字合成器 212 功能上等同于宽带数字转换器 132，均提供数字化输出给帧发生器/复用器 214。合成可以由如硬件的或软件的仿真完成，仿真模拟的话音信号的产生和以此相关的传输信号。被仿真的信号发射机的输出信号可以直接表示为数字形式，以便于处理，这样就仿真了 A/D 转换器的输出。

图 11B 说明了另一种图 11A 所示的可选的实施例。图 11B 的系统中，合成器 212' 从控制器 22 接收模拟信号输

入，并将其（即相应的模拟语音信号）转换为相应的数字式业务流。在这个过程中，合成器 212' 可以先数字化输入的各单路模拟信号，然后进行数字处理，产生数字化的信号传给单元 106。在反向通路，数字解调器 224' 解调出一系列的模拟语音信号输入到无线控制器 22。复用器 241 与前面图 4、图 5 所示的帧发生器/复用器 134 功能一样。复用器 214 的输出提供给数字调制激光器 216，该激光器输出光数据流到光纤 104A。数字光接收机 220 从光纤 104B 接收光数据流，并提供给解复用器 222，该解复用器与图 4 所示的解复用器 142 功能一样。解复用器 222 的输出提供给数字解调器或接收机电路 224，从那儿提取微小小区信道并输出到 T1 接口电路 202，然后送到 MTSO。

图 11C 说明了另一种可选择的全数字化基站的实施例。图 11C 中，帧发生器/复用器 211' 被调整以直接输出给电话交换网，以一种与电话交换网协议兼容的格式诸如 DS1、DS3 或 SONET 方式。因此，交换网被用于通过各个天线单元 106 连接各基站。根据这个实施例，调整后的合成器 212' 为每个正在使用的信道（不同于所有信道都在同一个蜂窝频段内）产生一个单独的数字化输出（比如下图 32B 所示），因此，只有用于天线单元 106 的数字化信道才实际被发送，这样就极大地减少了为此目的所需的带宽。类似地，解复用器 222' 被配置为从交换网接收独立地打包的数字化信道，解调器 224' 被调整以便接收和提取这些独立信道。图 11B 的实施例也可以被修改成为这种工作方式，如图 11D 所示。

这样，全数字化基站 210 综合了以下的功能，数字化发射数字流、和提供从电路 202 到传给光纤 104A 的数据流

的全数字化转换。综合后的信号被远端天线单元 102 接收，该单元通过使用字模拟转换器建立射频信号 164，因此不须使用发射机 23。类似地，数字解调器或接收机电路 224 的应用，直接将分接的数字化 RF 数据流转换成数字语音信道给电路 202，再传给 MTSO，从而省去了接收机 28。

图 12 说明了本发明的另一个典型可选的实施例。图 12 所示的可选实施例包括一个基站 106'，其中有一个天线 250 用于一个蜂窝地域的发射和接收射频信号。另外，106' 还包括了一个或多个远端天线单元 102 以能达到阴影地域。这个实施例不是为了扩大容量的目的，而是为了提高覆盖率。

参照图 13，这里说明了基站 106' 的详细情况。图 13 的构置与图 3 的基本一样，唯一不同的是射频收发信号是通过一个双工器和功率放大器一起接到主区位置的天线上。

参考图 14 说明了一个参考的基站单元 106 和天线单元 102 的实施例。据此实施例，基站 106 和远端天线单元 102 有波分复接器 270。波分复接器 270 提供一根单根光纤 271 来替代一对光纤 104A 和 104B，这与图 4 示的典型实施例一样。波分复接器 270 的相应的各作波长为 1310nm ($\pm 20\text{nm}$) 和 1550nm ($\pm 20\text{nm}$)。

图 15 说明了本发明的另一个典型可选实施例。图 15 中，可选的通信业务（如个人通信网业务（PCN）和/或寻呼业务）复接到数字载波上，并传给远端天线单元 102，作为由数模转换器重建的宽带信号中的一部分。为此种可选服务，远端天线单元被修改为包括独立的模数转换器、数模转换器、滤波器、双工器、线性功率放大器和可选业

务的天线。至于光接收机、发射机则共享微小区域的业务。PCN 发射信号被远端天线单元 102 接收，并被在数字载波上返回给基站 106。增值服务可以通过简单地在每一个帧后增加比特数而达到。因此，图 15 所示的实施例可以在蜂窝通信基础上以最小代价，加入一些不同的可选业务。可以预料，本实施例还可以完成其它的业务，本发明的应用决不仅限于微蜂窝、寻呼、PCN 或移动数据业务。

安装和升级微小区系统的方法

为便于全数字化实施例的实现，两个阶段的部署是必要的。第一阶段，使用微小区基站单元 106（图 3 所示设计中）。在基站单元里，这些单元可能已经有传统的发射机和接收机技术及传统的到 MTSO 的接口电路在使用。第二阶段，单元 106 被替换或升级为全数字微小区基站单元 210，淘汰模拟发射机和接收机。这种升级可以不改变远端天线单元 102 而实现，因此可以迅速而且方便地升级。这种安装方法，允许建有原来的造价相对较低的单元 106，并且提供快速的使用，同时还允许不用改变远端天线单元 102 而升级到更可靠的全数字式基站设备。

由上所述，本发明不仅提高了覆盖率，且通过对整个微小区系统分配复用信道组，从而不必在每个微小区地域使用独立的、传统的基站，而扩大了容量。同时，由于数字传输的优点，它与模拟系统相比有好的动态范围，可覆盖更广的区域。

所述的典型配置，基站 106 和远端天线单元 102 提供控制/告警/监示和双向点对点话音信道，这些信道可以直接复接到数字载波上，这比诸如 AT&T 提供的模拟系统更具优越性。再者，一个分集信道也可以被复接到数据流中，

提供分集功能而不需附加光纤通路。

本发明也提供有与微小区蜂窝业务同时进行的可选业务，诸如 PCN、移动数据和寻呼业务的现成的适应性。

本发明的另一项优越性是它的对所有全数字化基站技术现成的适应性。以数字形式从一个 MTSO 接收到的微小区信号数据可以被数字化为一个综合的数据采样流，提供给远端天线单元 102 的数模转换器。

可以理解，基站与天线单元之间其它种类的控制或监视信道也是可行的，并且本发明并不限于典型实施例中的特指的某个信道。

在电缆系统光纤馈线上的微小区和 PCN 业务的传输。

图 16 表示了一个传统的电缆系统。系统 300 包括一个或多个卫星蝶形天线 304，从卫星 302 接收卫星电视信号。另外前端可以从本地或其它媒介如光纤、同轴电缆或视距微波链路线接收视频信号。视频单元 308 进行视频信号分离，然后供给 AM 发射机 310 一个视频信号，在 310 中，典型地是向下变频后传输给光纤馈线一个幅度调制信号。光纤馈送器传输视频信号给光节点 312，在那儿处理收到的信号，典型地是通过铜芯同轴电缆或光纤链路分送到一系列住宅区 314。一个典型的效区的这样安装方式最适合使用本实施例，一个光节点 312 一般可供约 250 个住宅，覆盖约 1 ~ 2 平方英里的范围。

图 17 将阐述本发明的一个典型实施例。其中电缆系统 300 被用于传送微小区或 PCN 业务给微小区地域。图 17 的系统提供了使用已安装的电缆电视系统传输微小区和 PCN 业务的优越性。如图 17 所示，电缆系统的前端包括一个前端微小区/PCN 单元 332。视频复接器 308 和一个普

通老式电话业务 (POTS) 及数据源 336 。虽然在本实施例中提供了 POTS 和数据服务, 但它们对于传输蜂窝/PCN 业务并不是必须的, 因此可以在系统中忽略。一般地, POTS/data 被放在一个特定带宽中的一系列副载波中, 一个单独的副载波分配给一个系统用户。类似地, 视频信道同样被包含在一个特定带宽的许多副载波上。另外, 微小区/DCN 信道也被放在一个规定带宽的许多副载波中。前端单元 332, 通过一对光纤 331A 和 331B, 与基站单元 330 接口。基站单元 330 通过一个移动电话交换局 (MTSO) 332 与电话交换网接口。

此外, 前端还包括一系列 AM 调制器/解调器 338, 通过光纤 340A 和 340B 与微小区光节点 342 相连。每个光节点 342 包括一个接收和发送给微小区或 PCN 业务的天线单元, 并与许多用户住宅 342 接口。POTS/数据源 336、复用器 308 和前端 332 都与 AM 调制器/解调器 338 相连, 详见下述的图 20。

基站单元 330 的详细情况见图 180。单元 330 与前述图 3 所示的单元 106 功能一样。如图 2 实施例所示, 基站单元 330 可以放置在一个方便的位置, 远离前端。另一方面, 基站 330 可以放在前端, 从而省去了光纤连线及其它不必要的部件。这样发射机的输出 RF 信号可以被滤波并直接供给 AM 调制器/解调器 338, 反过来由 AM 调制器/解调器 338 传来的信号被滤波并直接给接收机 28。基站 330 的数字发送机/接收机 130 的结构见图 4。

如图 19 示, 前端单元 332, 实际上与图 2 的实施例中的单元 102 结构一样。前端单元 332 与基站 330 通信的 RF 信号, 其数字化和成帧与前述单元 102 与 106 之间通信一

样。然而，数模转换器 164 的输出供给滤波器 335，它将 RF 信号滤成许多带宽信号，每个带宽与一个光节点 342 所连的特定的微小区相连。这里所述的典型实施例中，微小区或 PCN 系统的信道被分成一系列 1MHz 的带宽，每个带宽包含了许多微小区或 PCN 业务的信道（如 10 个 100kHz 的信道或可能 30 个 30kHz 的标准信道）。每个 AM 调制器/解调器 338（详见图 20）接收一个 1MHz 带宽的信道，并通过光纤 340A 和 340B 以 AM 调制供给微小区光节点 342。在反向通路上， 1MHz 带宽从微小区光节点 342（通过光纤 340B）被接收，然后由 AM 调制器/解调器 338 解调，经滤波器 337 滤波与组合，传给宽带模数转换器 170，最后经回送通路供给基站单元 330。

参考图 20，这里详述了调制器/解调器 338。每个单元 338 包括一个 AM 调制器 338A，它接收一个 POTS/data 输入信号、一个视频输入信号和一个 PCN/微小区业务输入信号。AM 调制器 338A 组合这些信号，并产生一个 AM 调制信号给 AM 光发射机 338B，在那里转换成光波长输出给光纤 348。在反向通路中，AM 解调器 338C，从 AM 光接收机 338D 接收输入信号，产生 PCN/微小区和分集业务，同时还有 POTS/data 输出信号。

参考图 24 详示了光节点单元 342。单元 342 包括一个 AM 接收机 400，它从 AM 调制器/解调器 338 接收 AM 调制信号。光接收机 400 的输出供给 AM 解调器 402，输出一个 POTS/data 信号和一个视频信号。POTS/data 信号通过光节点送到用户的数据传输媒介传给各家庭用户。视频信号也传给家庭用户（通过同轴电缆或光纤）。

PCN/微小区业务从 AM 解调器 402 分离输出，供给上变频器变频到它的操作频率，该上变频器中有混频器 404 和本地振荡器 406。信号经放大器 408 放大，通过双工器 410 和一个主天线 412 发射到微小区地域。根据这里公开的典型实施例，在光节点的天线单元发射的 1MHz 的带宽里包含许多信道。天线 412 接收到的 RF 信号通过双工器 410 馈给滤波器 420。可以选择分集天线 424 提供输出，通过滤波器 426 送给混频器 428。本地振荡器提供混频器 422 和 428 的一个输入，对收到的 PCN 或微小区业务和回送的 POTS/data 业务进行下变频，然后传给 AM 调制器 432。AM 调制器 432 合并主信道、分集信道和 POTS/数据信号，并将它们进行 AM 调制，通过 AM 光发射机送到光纤 340B。

图 25 和 26 更详细说明了 AM 调制器 (338A, 432) 和解调器 (338C, 402)。参考图 25，这里详述了 AM 调制器 338A。POTS/data、视频信道和微小区/PCN 信道信号源供给相应的混频器 350、352 和 354，经频率变换到适合组合电路 356 组合的频率。组合后的信号供给传统的 AM 调制器 358。

图 26，在反向通路中，AM 信号供给传统的 AM 解调器 360，其输出给滤波器 362 和 364 滤波，然后供给相应的混频器 366 和 368，在那里复原为它们相应的载波频率。

这样，如上述，图 17 描述了一个可选的实施例，可以通过已安装的现有的有线电视系统的光纤分布系统，提供微小区或 PCN 业务。另外，还描述了用同样的系统提供 POTS/data 业务。然而，对本发明而言，POTS/data

业务是完全不必须的。

可选的数字调制/解调

前述系统中，数字化 RF 信号在传输给远端光节点单元 342 之前被变换为模拟形式。根据下述的可选的典型实施例，运用如 QAM 调制的数字调制，数字形式的 RF 信号可以保持直到远端光节点单元 342。图 27A 的可选的典型实施例中，发射机组 453 输出组合信号给相应的模数转换器 456（包含下变频到中频或基带频率），帧发生器/复用器 458 将这些信号组成帧结构，这样，在链路的另一端就可以从这个帧结构中提取信号组。类似地，解复用器 459，将收到的信号解复用，并提供相应的数字输出信号给各模数转换器 457（包含上变频），再到相应的接收机组 455。也可以有选择地加以提供分集输出。发射机组可以有如多达 10 个的发射机，这样组合的数字化的带宽是 1MHz 左右，加上成帧和控制比特，组成约 300KHz 的频谱，以 $(2 + X)$ 倍的速率被数字化。图 27B 阐述了可选数字调制实施例的前端单元 332'。尽管本实施例所述的是 QAM 调制，可以理解，其它形式的数字调制技术也是可以纳入本发明中的。根据本实施例，前端单元 332' 收到的数字化 RF 信号，在解复用器 450 中解复用，成组地输出信号，以数字形式提供给一系列图 28 所示的 QAM 调制器/解调器 338'。从 QAM 解调器 464 得到的反向信号供给帧发生器/复用器单元 452，由它通过数字式的调制激光器 174 把数字信号返送到光纤 331B。

如图 28 所示，QAM 调制器 460 接收一个数字的 POTS/数据输入信号、一个数字视频信号和一个数字 PCN/微小区业务信号。QAM 调制器 460 将输入信号复用并产

生一个 QAM 调制的输出信号给 AM 光发射机 462，然后送到光纤 340A。在反向通路中，AM 光接收机 466 从光纤 340B 接收一个 QAM 调制信号，然后供后 QAM 解调器 464。解调器 464 将收到的信号解复用，然后产生一个数字微小区/PCN 信号和一个数字 POTS/数据信号。

参考图 29 说明了微小区光节点 342' 的另一 QAM 实施例。可选的光节点 342' 包括一个 AM 光接收机 500，从光纤 340A 接收输入信号。QAM 解调器 502 接收 AM 光接收机的输出信号，将信号解复用，解调给数模转换器 504。经混频器 506 和本地振荡器 508 的上变频作用，转换器 504 输出中频或基带信号。这信号给放大器 510，经滤波器 512 滤波，再经双工器 514，由主天线单元 516 发射出去。在反向通路中，RF 信号由主天线单元 516 接收，经双工器 514，再经滤波器 518 滤波提供给由混频器 528 和本地振荡器 530 组成的下变频器。分集天线 520 选择性地与滤波器 522 和由一个本地振荡器 526 和混频器 524 组成的下变频器一起被提供。主天线信号和分集天线信号经组合电路 532 组合，供给模数转换器 534。模数转换器 534 的输出供给 QAM 调制器 536，再输出给 AM 光发射机 538，发送到光纤 340B 传输给前端。

由此，如上述，可选典型实施例提供了到光节点单元 342 始终保持 RF 或 PCN 信号为数字形式的一个系统。它比 AM 调制机制具有更高的信号质量。

在电话交换网上传输数字化 RF 信号

本发明的另一个可选的典型实施例示于图 30。图 30 中，基站单元 600 通过一个电话交换网 120 与远端天线单元 602 相连，详见图 31A、32A、33A 和 34。如图 31A，

每个基站单元 600 包括无线控制器和 T1 接口电路 22，从 MTSO 接收一系列 PCN 或微小区信道。多个 610 中的各发射机 23 的输出信号在组合电路 612 先被组合，然后再传给模数和数模转换器/成帧/解复用电路 614。组 620 中的接收机 28 从电路 614 的输出接收一个模拟信号。每个 614 也产生一个模拟分集信号，供给组 622 中的分集接收机 28'。

每个电路 614 的功能是将模拟 RF 信号(经合适的下变频后)转换为一个成帧的数字信号供给电话交换网从电话交换网接收信号，解复用并还原为相应模拟 RF 信号。另外，电路 614 供给相应的接收机组 620 或分集接收机组 622。

在所示的典型实施例，下述情况是可以实现的。大约 10 个 30KHz 、PCN 或 AMPS 蜂窝信道(给定当前 7 信道间隔的要求)可以被数字化成相应的 1.05 或 1.25MHz 带宽，该带宽被格式化成一个 44.736Mb/s DS-3 或 OC-1 的带控制和差错检测比特的信号，通过 T1 线或光纤链路给电话交换网。AMPS 或先进的移动电话业务，是蜂窝业务的最早的和标准的制式，使用 30KHz 宽的调频(FM)信道。然而，该系统可以接入 15 到 18 个时分复用(TDMA)信号，或也可使用 AMPS 和 TDMA 的组合信号。正如一般技术人员所周知的，在蜂窝中，TDMA 是用 3 个时分复用数字信号来代替一个 AMPS 信道的一种可选的调制技术。因此，5 到 6 个 AMPS 信道对应 15 到 18 个 TDMA 信道。

参考图 32A，详细说明了电路 614。电路 614 与图 4 所示的电路 130 基本上一样，但它包括了一个网络接口电路 630 和 632，替代了相应的数字调制激光器 136 和

数字光接收机 140。接口电路 630 和 632 提供一个必要的 T1 接口或到一个光通路的接口。

远端天线单元 602 详见于图 33A。天线单元 602 与图 8 示的远端天线单元 102 结构基本一样。然而，它用与交换网络 120 接口的网络接口 640 和 642，代替光接收机 160 和数字调制激光器 174。

前述图 6、7、22、23 所用的帧结构同样能用于本发明的这个实施例中，不过速率必须低一些。当提供分集功能时，反向通路中将包括附加的 DS - 3 或 DC - 1 信号，这要求在反向通路中有附加的 T1 或 SONE T 线容量。

参考图 31B，32B，33B 说明了图 30 所述的基站 600 的一个可选的典型实施例 600'。可选的典型实施例 600'，规定基站的所有发射机 23 输出给图 32B 示的单元 614'。类似地，单元 614' 服务于基站中的所有接收机 28 和 28'。因此，图 31B 的实施例与图 31A 的实施例不同在于，只给基站提供一个单元 614'，并且发射机和接收机未组成组。

参考图 32B 说明了模数和数模转换器/成帧/解复用单元 614'。单元 614' 接收基站 600' 的所有发射机 23 的输出的组合信号。一个宽带数字转换装置 132 将组合信号数字化。宽带数字转换装置 132 的输出供给一系列数字滤波器 802。每个滤波器 802 一般包括一个带通滤波器和一个有限脉冲响应 (FIR) 滤波器。带通滤波器 802A 接收 30.72M 采样/秒 (12bit 宽) 的数据流，并产生一个与发射机 23 输出相应的一个数字化数据流 (即一个信道)，该数据流由约 80K 采样/秒，12bit 宽的数据流组成。80K 采样

/秒速率对应的是以 2.4 倍速率采样 30KHz 信号（信道带宽）。但是，任何大于 2 倍符合奈奎斯特标准的采样速率都是可以的。

带通滤波器 802 一般是一个带通数字滤波器，例如：Melbourne Florida 的 Harris Semiconductor 公司的集成电路 Hsp 43200。这种滤波器的另外一个销售商是 Esl，一个 TRW 公司的子公司。再来参考图 32B，每个数字滤波器 802 被编程为从数字转换装置 132 的宽带输出中滤出与发射 23 相对应的一个信道。因此，一个有 20 个发射机的基站要有 20 个数字滤波器 802，来提取数字数据流给每一个发射机。宽带数字转换装置 132 将整个微小区业务的频谱数字化，例如 AMPS 系统，即为 12.5MHz 的带宽。在有 20 个信道的情况下，传输带宽就可以由 12.5MHz 大大地减少成为 600KHz 。因此，数字滤波器 802 极大地减少了要发送到交换网络的数据量。

一个帧发生器/复用器一般与帧发生器/复用器 134' 设计相同，被规定为用来将数字滤波器 802 的输出复接到一个或多个 T1，SONET 或其它载体上。举例来说，一个 72K 采样/秒，12bit 采样的单信道，组成一个 864Kb/s 的串行数据流。加入成帧和控制比特数，如图 22 或 23 所示（如有一个 1 bit CRC 信道，一个 1 bit 告警/控制/底层公务信道，和一个 6 bit 的帧字符），生成一个约 1.54Mb/s（ $20 \text{ bits} \times 72\text{KHz}$ ）的串行数据流。

帧发生器/复用器 134' 可以将一个数字滤波器 802 的输出成帧为一个 DS1 格式，以 1.55Mb/s 送到 T1 载体，或者可以将数字滤波器 802 的多个输出复用成 44.736Mb/s 的 DS - 3 或 DC - 1 信号给电话交换网。

单元 614' 也提供了一个滤波器控制电路 803, 输出给每个数字滤波器 802. 滤波器控制器 803 允许数字滤波器 802 被编程, 这样它们的滤波器参数 (和信道选择) 就可以被选择地任意地改变. 滤波控制器 803 还包括一个从无线控制器 22 来的输入, 它给出控制输入来规定从数据流中提取的信道. 一个网络接口电路 630' 与帧发生器/复用器 134' 接口, 接到电话交换网上.

参考图 33B 说明了可选的实施例 602', 该实施例与可选的实施例 614' 相结合工作. 一个网络接口电路 640' 从电话交换网接收一个或多个 T1、SONET 或其它的载波, 它们携带着帧发生器/复用器 134' 产生的数字化微小区业务. 这个数字化数据流供给解复用器 162', 162' 与解复用器 162 设计相同, 它逐信道地从每个载波中提取数字流, 每个单独提取的信道供给一个独立的数模转换器 164'. 数模转换器 164' 的输出被组合提供给放大器 24, 通过天线 26 广播出去. 每个数模转换器 164' 与图 21B 示的数模转换器 164 设计相同. 然而它不同于数模转换器 164 之处, 164' 仅需处理一个单信道, 这样就可能简化信道提取的设计.

远端单元 602' 的另一个实施例还包括一系列数字滤波器 802, 该滤波器与基站单元 614' 中的数字滤波器 802 工作方式一样, 都是从宽带模数转换器 170 输出的数字化信号中提取被选的微小区数字化信道. 帧发生器/复用器 172' 与 172 设计相同, 它与帧发生器/复用器 134' 工作方式类似, 都是将提取的信道复接到一个或多个 T1、SONET 或其它载波上, 通过网络接口 642' 供给电话交换网.

再来参考图 32B，解复用器 142' 与 142 设计一样，它通过网络接口 632' 从远端单元 602' 接收复接后的信号。单元 142' 将信号解复用成各单个的信道，并提供给各数模转换器 144' 一个相应的信道，144' 与 164' 的设计相类似。数模转换器 144' 的输出可以供给接收机 28。

如图 33B 所示，远端单元 602' 也可包括一个带数字滤波器 805 的分集通路，来提供从数字化分集信号中提取分集信道。分集信道可以通过帧复用器 172' 复用到电话交换网上。在基站单元 614' 中，分接器 142' 提供一个分集通路，在那儿提取的分集信道可以供给分集接收机 28'。这样，如前所述，图 31B、32B 和 33B 所示的另一实施例提供数字滤波器，来从宽带数字化信号中提取所选的微小区信道，其中宽带数字化信号被传到远端单元 602' 并从 602' 传回。从发射机 23 到远端单元传送信号和从远端单元返回被接收信道到基站的过程中，提取得到的所选信道被规定了严格限制的信道容量。

在另一个可选实施例中，图 11 的系统被修改为在电话交换网上传输数字化信号，就如以上所述一样。

与电缆系统的网络接口

图 34 阐述了本发明的另一个替换典型实施例，在这里，在电话交换网上发送数字化 RF 与在电缆系统上发送 RF 结合在一起。更特别地，如图 34 所示，一个网络接口 702 在前端单元接收电话交换网的数字 PCN/微小区信号。这个信号被送到 QAM 调制器 460 和 AM 光发送机 462（见图 28）。类似地，网络接口电路 704 从 QAM 解调器 464 接收数字 PCN 或微小区信号，并提供给交换网络。这样，

从基站 600 产生的信号可以通过交换网送到电缆系统，并且再回来。

如上所述，本发明的这个替换典型实施例提供了方便地在电话交换网上传输 PCN 或微小区信号的方法。这种方法有明显的优越性，允许附加容量的快速安装，而不需要安装附加的传输线。

这样，这些实施例提供了一种能力，能通过一个交换网和已安装的电缆系统提供传输射频的微小区或 PCN 信号。

图 17 到图 34 的实施例中的各种修改和另外的配置是可以的。图 17 或图 27A 的实施例的一个全数字式的配置（与图 10 的实施例类似）去掉了基站 330 中的发射机、接收机和模数与数模转换设备。图 30 的实施例的一个全数字式配置省去了基站 600 中的这些模拟部件。按如上所述图 2 - 15 的实施例，从模拟实施例到全数字化实施例的安装和升级的方法是切实可行的。另外，对图 17 到 35 的实施例的修改包括波分复用，这样光纤对就可以被一根光纤所替代。

被动越区切换系统

现参见图 35A 中的一个被动越区切换微蜂窝通信系统 800 的典型实施例，此系统除了基站单元 114' 有所差别外，其余部分类似于图 2 所示的系统的结构，因为要提供有关被动越区切换的交换，其结构如图 35B 所示。

为了描述系统 800，我们称微小区覆盖范围 100 为“微小区区域”。各区域按一典型实施例被具体标为 A1 - A6，B1 - B6 和 C1 - C6。每一个区域均包括一个独立的天线，用于从移动站接收或向其发射。区域 A1 - A6 一起构成“小

区 A”，区域 B1 — B6 构成“小区 B”，而区域 C1 — C6 则构成“小区 C”。按照传统的蜂窝系统设计，A、B、C 每一个小区都拥有一组可在小区内重复使用的频率。

被动越区切换系统 800 假设分配给在一个给定单元中的移动单元的传输频率或信道，在单元 114' 的控制下，无需 MTSO 110 的干与或控制，能从任何一个微小区 100 内的远端单元 182 发射。因此这个信道可以追随移动电话单元，在给定小区内从一个微小区域移动到另一个区域。多个微小区区域可使用同组信道（即发射频率），于是使每个区域中的信号发射功率电平最小化，从而避免了邻近微小区区域或小区的不想要的干扰。该系统也减小了 MTSO 110 的交换负载。然而，当移动单元从一个小区移动到另一个时，MTSO 110 还是以传统的方式将此单元切换到新进入的小区的一个新信道（相应的一对发射/接收频率）上。

现在参照图 35B，根据本发明给出了基站单元 114' 更为详细的框图。单元 114' 包括一个无线控制器 22，用以提供来自 MTSO 110 的 T1 线与基站无线设备之间的接口。发射机 23 - 1 至 23 - N（N 为正整数）与开关矩阵 802 相连接，开关矩阵的输出端接着连接到组合电路 804 - 1 至 804 - X（X 为正整数），组合电路 804 - 1 到 804 - X 又分别连接到多个数字发射/接收单元 130'' - 1 到 130'' - X 之一。如图 35A 所示，在对应传输通道上单元 130'' - 1 至 130'' - X 与微小区域 102 相连接。

载有模拟微小区信号的发射/接收机数字化单元 130'' 的相应输出送入开关矩阵 808。开关矩阵 808 通过相应输出端 806 - 1 至 806 - X，及组合电路 807 - 1 到 870 - X，

将任何输入连接到接收器 28 - 1 至 28 - N 之一。控制器 810 通过相应的控制线 812 和 814 去控制开关矩阵 802 和 808。控制器 810 通过采样线 816，从每一个数字化单元 130' 接收数字化微小区信号的样值。

下面将更详细地描述，控制器 18 连续地处理收自单元 130'' 的数字化采样，根据处理结果控制开关矩阵 802 和 808，从而实现将每一个发射机单元 23 切换到 一个（或多或无）单元 130'' 去，且同时连接接收机 28 与单元 130'' 之一（或多或无）。例如，在一种典型交换结构中，开关矩阵 802 可通过输出 803 - 1 将三个发射机 23 - 1，23 - 2 和 23 - N 与组合器电路 804 - 1 连接起来，由此，这三个发射机频率 F_1 ， F_2 ，和 F_n 被组合送入单元 130'' - 1，用于数字化和向微小区区域的传送。在另一种结构中，发射机 23 - 1 可能通过输出端 803 - 1 之一同组合器 804 - X 相连，而发射机 23 - 2 则通过输出端 803 - 2 之一同组合器 804 - 2 相连，发射机 23 - X 通过输出端 803 - 1 之一同组合器 804 - 1 相连。开关矩阵允许任意的组合，即任意一个发射机 23 可同任意一个组合器 804 相连接。

于是交换 802 允许发射频率“追随”移动单元从一个微小区域移到另一个。例如图 35C 所示的一个在 T_1 时刻发起呼叫 A1 区域的移动单元 820。在此例中，移动单元 820 被安置在车上。然而，它也能被携带，从一个区域进入另一个区域。为了建立呼叫和实施控制，小区 A、B 或 C 的控制信道几乎同时被所有对应小区域发射和接收，这一工作完全由开关 802 和 808 完成。当以传统的方式来完成呼叫的建立时，例如“Mobile Cellular Telecommunications Systems, by William C.Y.Lee”一

书中所述的，由 MTSO 110 分配给移动单元 820 一个当前可用信道，而频率由发射机 23 - 1 和接收机 28 - 1 来决定（假定有一对发射/接收机当前可供分配的话）。于是，通过对 MTSO 110 编程来获得确认，即发射机 23 - 1 至 23 - N 和接收机 28 - 1 至 28 - N 相关联的信道已被集中分配给了小区 A。在此例中，小区 A 包括了 A1 至 A6 区域。初始建立时，分配的收发信道就应能在小区内各区域发射或接收，直到区域能完全处理通话。

因此，初始化建立时，移动单元 820 独立地工作在发射/接收频率 F_1 和 F_1' 上。控制器 810 不间断地监测发自小区 A 中移动单元 820 的各个信号强度，而这些信号是从定位于各区域的远端天线单元 102 接收到的。各区域的信号强度是通过对从远端单元 102 返回到单元 130'' 的数字化 RF 微小区信号进行取样而被检测出来。当移动单元处于微小区 A1 内时，由于 A1 区域的远端天线单元 102 - 1 最接近移动单元 820，因此接收到的信号 F_1' 的强度很可能是最大的。然而同样频率 F_1' 也能被区域 A2 内的远端天线单元 102 接收到，甚至更远的区域 A3 也一样。控制单元 810 监测从小区 A 中所有远端单元 102 接收到的数字化微小区信号中得到的接收信号 F_1' 的强度，并根据至少一种典型的方法，识别出在频率 F_1' 收到最强信号的远端单元 102。假设这么一个例子，在区域 A1 中的远端单元 102 上接收到的信号是各区域中最强的，控制器 810 便发一个指令去控制矩阵开关 802，以连接发射机 23 - 1 到组合器 804 - 1；组合器 804 - 1 随后将输出送入数字化单元 130'' - 1。单元 130'' - 1 再将包含频率 F_1 的数字化微小区信号传送给区域 A1 的远端单元，其接着便在区

域 A1 内发射频率 F_1 (同切换进入组合器 804 - 1 的任何其它频率一起)。在反向通路上, 控制器 810 控制开关矩阵 808 使数字化单元 130' - 1 的输出端, 当在线 806 - 1 上接收时, 与接收机 28 - 1 相连。发射机 23 - 1 最好不同任何另外的数字化单元 130' 相连, 这样除了单元 102 - 1 外, 没有别的远端单元 102 以频率 F_1 发射。类似地, 最好没有别的数字化单元 130' 通过开关矩阵 808 与接收机 28 - 1 相连。由此可以避免由同频发射引起的邻近微小区域的干扰和由于接收机 28 接收超过一个区域的多个同频 (不同相位和变化的失真) 信号导致的干扰。

现在, 将此例进一步延伸, 考虑在 t_2 时刻移动单元 820 从区域 A1 移动到微小区区域 A2, 控制器 810 对从小区 A 中接收到的发射频率 F_1' 的信号强度连续地进行采样和检测。在从微小区区域 A1 向 A2 的运动过程中, 控制器 810 应当在微小区区域 A2 内检测到一个不断增强的频率为 F_1' 信号, 而且在小区域 A1 内应检测到该频率信号强度在减弱。当满足确定的交换准则时, 控制器 810 就会实施一个“被动越区切换”, 即通过交换将发射机 23 - 1 从与组合器 804 - 1 的连接改为与组合器 804 - 2 相连, 相应地通过交换使接收机 28 - 1 改变为接收来自 130' - 2 的输出。从而区域 A1 内的远端单元 102 停止以频率 F_1 发射, 从远端单元 102 接收到的信号也将不再通过交换 808 送入接收机 28 中。于是系统 800 便能够在小区内追随移动单元, 被动地从一个微小区域的信道切换到另一个区域的信道上。

下例示范了当移动单元从一个小区移动到另一个时, 系统 800 的运行过程。例如, 如果移动单元 820 在

t_3 时刻从微小区域 A3 移动到区域 B1，控制器 810 会再一次检测到从区域 A3 接收的远端单元 102 的信号强度有相应的减弱。然而，并非是通过检测出小区 A 中其它区域相应信号的增强来触发一个被动越区切换。正相反，当 MTSO 110 察觉到移动单元 820 在小区 A 和 B 之间运动时，MTSO 110 将实施从小区 A 向 B 的越区切换。在离开小区前，由于信号强度减弱，收发可能要通过小区内的所有区域来完成。当单元 820 移动到 B 小区内时，MTSO 110 从分配给小区 B 的频率当中分配一个新的信道给移动单元。服务于小区 B 的基站单元 114'，同样按上面所述的方式识别出初始的收发区域，并执行小区 B 内的被动越区切换。所以，小区 A、B 或 C 之间交换的实现是独立于小区内不同区域之间分配频率的被动越区切换的。当然小区 B 可采纳传统的，只设一个单独的天线服务于整个小区的设计方案。

如上所述，本发明提出了一个被动越区切换系统，其中一发射频率被分配给移动单元，而且该频率在控制器 810 的控制下可跟踪或追随移动单元从一个微小区域到另一个，而无需 MTSO 110 进行发射频率的切换或干预。这种运行模式在某些微小区应用中有着显著的优点，比如那些需要多个远端单元 102 以覆盖一个区域，但又没有足够的通讯密度来支持设立一个传统小区的地方。例如地面上的一个狭窄衰落带，具体可能为一条峡谷或一条邻近河床的公路，那里可能都需要安装多个天线来获得充足的信号覆盖。另一种例子可能是地下停车场或大型办公楼内，那里信号衰减常常超过正常的范围，导致信号电平无法令人接受。更糟糕的是，在一些蜂窝系统中，小区的位置往往不

够接近，因此使得在小区之间会存在一个不良的覆盖区。另外还有一例是沿都市中心的交通走廊。对于这种情况和其它情况，采用被动越区切换系统将会带来一定好处，因为它能扩展覆盖的地域范围而又不需分配独立的频率集和相应各区域的发射机与接收机。

每一个交换机 802 和 808 最好至少支持 20 个发射机和 20 个接收机。另外，每一个交换 802 机和 808 最好允许发射机和接收机与多达 6 个数字转换单元 130'' 相连接。相应地，开关矩阵 802 可能用于，比如去连接多达 20 个发射机 ($N = 20$) 以通向任一个数字化单元 130''。类似地，数字转换装置 130'' 的输出端可能会选择地连接到任一接收机 28，这样一单独的数字化单元 130'' 可能会连接所有的接收机 28，或所有的数字化单元连接一单独的接收机 28。然而，应当清楚，开关矩阵 802 和 808 或许适宜处理或多于或少于 20 个接收机和发射机，或者或多于或少于 6 个单元 114'。

交换机 802 和 808 最好是矩阵开关，其在矩阵节点上以 Wilkinson 组合器的形式集成了组合功能，而该 Wilkinson 组合器中使用了无反射 PIN 二极管衰减器。这类器件可从 Salisbury Engineering, Inc., of Salisbury, Maryland 获得。交换机尽管采用衰减器类型的，可允许线性地控制上升和下降时间。交换最好在中断前就能完成。

现参见图 36，这里给出了单元 130'' 的第一个典型示范例。单元 130'' 在设计和运行上与单元 130 几乎相同，除了多包括一个数据总线 830，此数据总线 830 与将从解复用器 142 来的解复用的数字化微小区信号传送到数模转换器 144 的总线相连。总线 830 通向并入并出 FIFO 缓冲

器 832，其输出允许受控于来自控制器 810 的使能线 834。在允许情况下，缓冲器 832 将数据总线 836 上的数字化微小区信号复制一份输出。

现参见图 37，按照本发明给出了控制器 810 的典型实施例。图 38A 中的控制器适合与图 36 所示的单元 130' 一起使用。控制器 810 包括一个多路复用器 884，其通过一个 12bit 数据总线、一个时钟线同单元 130' - 1 至 130' - X 中的每一个缓冲器 832 相连接。多路复用器 884（最好为三态）选择来自总线 836 的一个输入，并将其提供给快速傅里叶变换（FFT）处理器 856。选择是通过控制线 862 在微处理器系统 860 的控制下实现的。FFT 处理器记录下由 12bit 字构成的数字化微小区信号的取样值。数字 FFT 处理器 856 最好采用一个 Raytheon 部件 NO.3310，其可从 Raytheon, Inc 得到。

FFT 处理器 856 的输出是位于存储器里的多个 16bit 字，每一存储器都代表了一个 30KHZ 信道（或者 PCS 及其它业务的信道）的强度或幅度。使用控制线 861 通过数据总线 859 将 FFT 处理器 856 的输出送入系统 860。选择电路 886 从系统 860 接收控制信号 863，从而在使能线 834 上选择性地产生信号。使能线 834 用于有选择选通缓冲器 832 输出，这样 FFT 处理器 856 便能够从待选源有选择地处理数字化微小区样信号采样。微处理器系统 860 连接着开关矩阵驱动器 875，驱动器 875 驱动开关矩阵 802 和 808。图 37 所示的控制器 810 的工作过程将在下面详细地加以描述。

图 38 为一个简化的程序微处理器系统 860 的工作过程和对系统 800 工作过程实施相应控制的流程图。图 39

示出了微处理器系统 860 执行的程序 900 和系统 800。程序 900 包括一个初始化/配置例行程序 910。系统配置提供了对服务于基站 114' 的信道的识别。微处理器系统 860 应该包括磁介质存储媒体，例如硬盘驱动器或等效的能存贮配置信息、其它数据及计算机程序的存储媒体。一旦配置好了，就可以激活轮询和交换操作了。在这种运行方式中，微处理器系统 860 首先选择（例行程序 912）小区内的“第一”区域的数字化信号。在图 37 的实施例例中，选择是通过使能线 834 实现的。选中的使能线被启动，以允许采集和输出来自相应缓冲器 832 的微小区信号数据。使能缓冲器 832 将来自单元 130' 中解复用器 142 的数字化微小区信号的复制本送给复用器 884，复用器又将此数字化信号流送到 FFT 处理器 856 中。

例行程序 914 通过控制线 861 在微处理器系统 860 控制下启动 FFT 处理器 856 来写入数字化微小区信号流。缓冲器 832 可能会写入，比方说 1024 个数字化微小区信号采样。当 FFT 处理器 856 从缓冲器 832 接收到微小区信号数据时，便记录下数字化的 12bit 微小区信号采样或字。FFT 处理器 856 的输出由一系列的 16bit 字组成，而这些字表示了数字化微小区信号流中传送的相应信道的信号强度。

微处理器系统 860 推荐采用“Intel 486”型微处理器或至少工作在 33MHZ 主频。以这样的速率，选择数字化微小区信号流和接收 FFT 处理器 856 的频谱分析数据之间所花的时间将能够少于 5 毫秒。一旦微处理器系统 860 收到（916）来自于 FFT 电路 856，包括了区域中各频率的信号幅度的频谱数据，就记录下这些数据，以便供

即时或以后的分析之用（例程序 918）。另外，也可以选择将信号测量的日期、时间和其它任何感兴趣的参数一起记录下来。如果在本轮询周期当中还有某个区域没有被测量过，轮询处理将持续进行。如果继续轮询，那将按如上所述的数据采集、分析的处理过程挑选（1 例程序 924）小区中下一区域的数字化微小区信号流，存储过程也会重复进行。

一旦当前周期内所有区域都被测量过了，微处理器系统 860 就将根据本周期内记录的信号电平来决定区域的信道（即发射机/接收机）分配。虽然决定过程的特殊的方式不是本发明的重点，但是仍尽量抽出一部分来在下面加以描述。

可以估计到用于单元 114' 收发通路上的交换算法将会有所不同。在发信通路上，交换方法将使用给定区域内，在 1/2 秒到 3 秒的时间内接收的信号强度，信号强度最大的小区被选为激活小区，另一算法中，当前一个不处于衰落状态的区域，即使其信号强度较弱也可能被选中。如果哪一个区域被使用无关紧要的话，比如若信号强度差不多时，则在小区内信道分配的分布范围之外的区域也可能被选中。当无法决定最佳区域时，比如当移动单元处于小区边缘时，几个或者所有区域都能被选中或激活。

对于交换接收机，通过跟踪瞬时和平均电平及其衰落情况，能够预测出大致的趋势并估计到接收端从一个区域向另一个的切换。如果接收到的信号强度低于一门限电平，比如移动单元处于小区边缘时，那么为了更好地接收，接收机可能连接所有区域，接收端的切换是以比发射端快得多的转换速率完成的，这是由于更大的难题在于接收和

移动单元发射机功率相对较低带来的衰落。

当然，也可能有其它适于收发信道的切换算法，无疑对于那些应用于传统蜂窝切换的算法仍然不失为一种好的选择。

一旦确定了要分配新的信道（发射/接收），系统 860 就会通过矩阵交换驱动器 875，用交换机 802 和 808 完成发射机和接收机的切换。

作为上面业已描述的程序 900 所规定的另一种运行方式，当获得了每一个新频谱的测量结果后，将连续地决定信道（发射/接收机）的区域分配。例如图 38 中的程序 900 通过在步骤 920 和 924 之间插入步骤 930 和 932 及删除判决步骤 922 可以得到改进。如上所述，系统 810 可能在不到 2ms 的时间内完成给定区域内对所有信道的分析。在具有 6 个区域的越区切换系统中，所有的分析工作能够在 12ms 内完成。这类快速的信道分析带来的一个好处便是使基站的分集接收成为可能，这会改善小区边缘地区或者信号暂时阻塞区域的信号质量。既然在偏远区域衰落成为了主要难题，在接收源之间快速切换的能力会允许一种分集接收形式，即用其它区域的天线作为每一区域天线的“分集”天线。

快速分析的一个可能的优越方面是可以积累衰落状态下的统计数据，以便帮助业务提供者寻找最佳的天线/小区位置。

上面曾提到过，微处理器系统 860 可能会记录了每一次对数字化微小区信号流进行频谱测量的日期和时间。相应地，很容易得到一份包括了任意给定信道的信道使用和信号测量的历史记录，并将其用于重新配置系统这一目

的，例如移动一下天线单元，相应地，本发明进一步示范了一个记录区域内信道使用状况和信号强度，并随后利用这一信息重新配置系统的方法。

作为另一种典型实施例，修改图 35A（和图 39 下边）中的系统，使数字化 RF 信号通过电话交换网被传送到各区域，如图 30 所示的例子，或者如此所示的例子，通过调整以便在电缆系统上传送数字化 RF。

在图 39A 的另一个实施例中，基站 144' 改为合数字基站 114''。全数字基站象图 11A 中系统那样采用数字合成器（212'）和数字解调器 224 来代替基站的模拟 RF 无线设备。T1 接口 202 与 MTSO 110 接口，并负责将数字形式的每一个电话信号和所有控制信号从 MTSO 送到每一个数字合成器 212'。每一个合成器在线 812' 上接收来自控制器 810' 的控制信号，并响应这一信号从而产生合成的数字数据流，以用于帧的形成和传输给区域内相关联的单元 106，于是分配给小区的信道不管如何组合都能在小区内广播。

在反向通路上，数字转换采样来自于从单元 106 返回的经多路分解的数字数据流，随后此采样被送给控制器 810'。从解复用器 221' 获得数字采样采用了如上所述的同样方式，可详见图 36。控制器 810' 随后使用这些采样数据，按照上面所述的控制器 810 的方式，控制切换的进行。选择器被用于从任一个解调器 224 选择需要信道的接收信号，并送入 T1 接口 202。另外，选择器/处理器 880 被设置成能处理每一个信道的两个或多个输入流，以便产生一个降噪复合流。

图 39B 示出了图 39A 系统的另一实施例。图 39B 系统

在某些地方类似于图 11B 系统，例如数字合成器 212' 接收来自无线控制器 22 的模拟电话信号输入，并象图 11B 中的合成器 212' 那样工作。类似的，数字解调器 224' 象图 11B 中的解调器 224' 那样将模拟信号传送给无线控制器 22。

另外，还有两个可替换图 35 系统的实施例，如图 39C 和图 39D 所示，经以类似于图 11C 和 11D 系统的方法修改后，于是不但可在交换网络上传输，而且合成器能产生将传送给网络的单个数字化信道。

图 40 示出了另一个可替换图 35A 系统的典型实施例，在此例中依靠以图 32B 中电路 614' 的改进型 614''（被改进可得到数字化通信流的取样值）替代单元 130''，以改进通过电话交换网络的通信状况。在这个实施例中，只有那些确定要在天线单元 106 中使用的信道才被传送给单元，如同系统 614' 一样节省带宽。

图 41A - C 示出了可替换本发明的被动越区切换系统的其它几个典型实施例。图 41A - C 中的系统是依靠安置多个微小区单元 102，由此使每一小区或“宏小区”的覆盖区域至少由两个微小区单元来覆盖以获得冗余度。相应地，在某一个单元发生故障时，冗余的微小区 103 将能提供对故障区域的覆盖。

图 41A 中，三个基本微小区 102 和三个辅助微小区 105 覆盖了一个宏小区 103。在此例中，辅助微小区 105 分布在类似于基本微小区 102，但又围绕宏小区中心旋转了 45 度角的地点。显然，其它的分布形式也能优越地提供类似的冗余覆盖。

正常工作时，基本微小区对宏小区提供完全的覆盖。

万一其中一个微小区 102 出现故障，两个邻近微小区 105 能够覆盖由出现故障的基本微小区 102 所服务的区域。在另一个实施例中，基本微小区 102 对宏小区 103 的一类区域提供基本覆盖，对宏小区 103 的二类区域提供辅助覆盖，同时，辅助微小区 105 对宏小区 103 的二类区域提供基本覆盖，对一类区域提供辅助覆盖。

第二种提供冗余覆盖的方法如图 41B 和 41C 所示的两个实施例，图中的每一个微小区 102 提供两种功率电平。正常工作时，各微小区 102 以维持覆盖微小区 102 所必需的功率电平运行。当某一种微小区 102 发生故障，邻近的微小区 102 将被提高到更高的功率电平上（如图中所示的 102'）。由图 41B 和 41C 可看出功率电平的提高维持了对故障微小区 102 的覆盖。虽然示于图 41A 和 41B 中的微小区 102 被分裂为三个扇区，但是显然其它划分扇区的方式或干脆不分扇区，两者都能够在上面描述的冗余度方案中使用。

扇区划分

下面讨论划分扇区的问题。

根据本发明的另一方面，本发明中的微小区系统能被用于替代如图 1A 所示传统小区中的传统基站发射/接收机 12。而且，由图 41A 和 41B 可见，每一微小区能够被分割成几个扇区，每一扇区由一个定向的微小区天线单元负责。按照图 42 所示的实施例，一个拥有多对收发天线 902 的扇形天线单元 900 将一个微小区或宏小区分割成几个扇形区。每一对天线 902 将采用不同的信道集以实现发和收。例如根据一优选实施例，微小区 16 被划分成三个 120

度的扇区，一个扇区对应一对天线 902。每对天线 902 利用 10 个收发信道服务于所属扇区，且保证扇区内的信道间隔应有 21 个信道宽度。此外据一优选实施例，在扇区、信道间提供了 7 个信道的信道间隔。

每个宏小区的天线对 902 由远端单元 904 提供支持，其接收用于所有三扇区内信道的数字化 RF 信号，再将之转换成模拟 RF 信号后，通过天线对 902 发射到扇区覆盖的区域中去。远端单元 904 还包括了用于对各扇区接收到的 RF 信号进行数字化变换和将数字化 RF 信号传送到扇区基站单元 906 的模数转换器。每一个扇区基站单元 906 与 MTSO 17 相连，而 MTSO 又接着连接电话交换网 15。

每一个扇区基站单元 906 包括供宏小区中各扇区信道集使用的射频发射/接收机和用于向远端单元传送数字化 RF 信号的数模转换单元，以及接收数字化 RF 信号并送入接收机单元的模数转换单元。扇区基站单元 906 与远端单元 904 的连接最好使用上面所述的采用波分复用的单个光纤链路 905，虽然如果需要使用分离的收发链路也未尝不可。

对扇区基站单元 906 更详细的描述可参见图 43。每一个扇区基站单元 906 都包括一个用于其服务的各扇区的无线控制器 22，每个控制器 22 均同 MTSO 17 相连接。另外还提供了相当数量的发射/接收机组 912，其中每一组均具有多个发射/接收机。根据此处所示的典型实施例，最好每一组 912 包括 10 个发射/接收机。每一组 912 中发射机的输出端都被组合在一起，并通向模数转换单元 914，这与前面所描述的模数转换单元在设计上有相似之处，例如图 4 所示的。模数转换单元 914 完成数字转换和将数字化 RF

信号组成帧信号并随后将光输出送入波分复用器 916，而由波分复用器再连接光纤 905。同时从远端单元 904 收到的光信息通过波分复用器 916 送入光滤波器 918，再根据光波长的差别滤出从远端单元 904 收到的信号。例如在三扇区系统中能够使用 1520、1550 和 1580nm 三个波长。经滤波分离的各波长信号被加在一个或多个数模转换单元 920 的输入端上，在此从远端单元 904 收到的数字形式的 RF 信号被多路分解出来，并被转换成模拟形式的 RF 信号。数模转换单元 920 的模拟输出，随后被送给每一组 912 的相应接收机。

对远端单元 904 更详细的介绍可参见图 44。这里每一个远端单元 904 均包括一个连接到光纤 905 上的波分复用器 930。波分复用器 930 从扇区基站单元 906 接收载有由远端单元 904 服务的所有扇区信道的数字化光信号，并通过数模转换单元 932 将数字光信号转换成能够反映出由远端单元 904 服务的扇区各信道特征的模拟 RF 信号。转换单元 932 的模拟输出再被分路器 934 分成 N (N 二扇区数) 路模拟 RF 信号，以送给信道滤波器单元 936，而这每一路都相当分配给一对天线 902 的总信道。每一对天线 902 都有自己的信道滤波器单元 936，以滤除来自分路器 934 的那些将在其它对应扇区传播的信道。信道滤波器单元 936 的输出被送给放大器 938，其输出又连接带通滤波器 940，从而只有那些带内信道才能被允许通过。最好带通滤波器 940 的输出被送往天线对 902 的发射机天线 902a。同时天线对 902 的接收天线 902b 主要从相同扇区接收 RF 信号，并将收到的信号送给带通滤波器 942。带通滤波器 942 只允许那些带内信道通过，并将此滤波后的

RF 信号送给模数转换单元 944，以便使模拟 RF 信号转换成对应于一个独有波长的数字光信号，比如可以是上文所提供的某一个光波长。每一个模数转换单元 944 可能与图 8 所示的单元 102 采用同样的设计。每个单元 944 的光输出被送入光混合器 946，而其输出又被送给波分复用器 930。数模转换单元 932 一般来说最好采用与图 4 所示的单元 130 相同的设计。

对信道滤波器单元 936 更详细的介绍参见图 45。每一个单元 936 最好包括一个线性可编程预放大器 950，用于提供分路器和组合器损耗的增益补偿。放大器 950 的输出经分路器 952，将模拟信号分解出 M 路（ M = 分配给扇区的传播信道数）模拟信号。每一路随后通过一个已经调谐到各自信道上的窄带滤波器 954。每一个窄带滤波器均可编程并被设计为能在温度变化时保持 30KHZ 的带宽。这是依靠首先将所需信道下变频为 70MHZ IF 信号，而得以完成的。70MHZ 信号再通过一个晶体滤波器，以获得所要求的窄带滤波特性。IF 频率再被上变频到所需 RF 频率。最好使用微处理器来控制频率，通过使用计算机，比如一个便携机可以使 RF 频率以 1HZ 的增量逐渐增到所需频率，频率稳定是通过对光纤链路 905 上的编码信号进行时钟恢复而获得的。理想的话，窄带滤波器 954 要足够窄，使扇区中的相邻信道比基站单元 906 产生的主时钟低 50dB 以上。每一个窄带滤波器 954 的输出被送入组合器 956，而组合器 956 的输出接着送往放大器 938 放大。在本发明的典型实施例中，放大器 938 最好选用一个 25W 功放。

在优选实施例中，通过对远端单元 904 与扇区基站

单元 906 进行同步，可以使频率偏移最小。在一个这样的实施例中，扇区基站单元 906 依靠将 RF 下变频至 IF，来实现 RF 频谱的搬移和数字化过程（例如，在 0 - 30MHz 范围内）。在被传输到另一端后，IF 信号将被重新恢复并上变频回 RF。

下变频和上变频均是通过将信号与一个本地振荡器（LO）进行混频来实现的。为了恢复原来频率的信号，信号必须使用一个 LO 进行上变频，而且要求此 LO 与下变频时使用的 LO 具有完全相同的频率。LO 频率的任何差别都将会带来一个等量的端到端频率偏移。在上面的实施例中，上下变频的 LO 相距遥远。因此，在一优选实施例中，本振和远端本振之间的频率相干性将建立在下面所介绍的方法上。在主端有一个 552.96MHz 的主时钟以建立光纤上的比特率。这一时钟同时也产生一个 30.72MHz 的时钟（ $30.72 = 552.96 \div 18$ ），作为主数字化转换器 LO 锁定的基准。

在远端，有另外一上 552.96MHz 的时钟，它是在锁相环的帮助下从光比特流中恢复出来的。因为这个时钟是从主时钟产生的比特流中恢复出来的，所以它与主时钟的频率之间具有相干性。然后再产生一个 30.72MHz 的时钟，以作为远端本地振荡器的基准。因为 552.96MHz 的时钟频率相干，所以 30.72MHz 基准也一样，且任何与它们锁定的 LO 之间也相干，于是便确保了主端与远端 LO 的频率锁定。

图 45 和图 46 示出了有关本发明的扇区微小区系统的另一个可选用的典型实施例。在该实施例中，扇区基站单元 906 提供了模数复用器和数模解复用器单元

906，以实现接收来自各个信道组 912 的分立的输入和独立地将每一个来自信道组的 RF 复合信号转换为相应的数字化 RF 流。数字化 RF 流随后被复用成单个的光形式数字化流，以便用于波分复用器 916。在反方向上，单个数字化 RF 流被从波分复用器 916 接收，随后又被多路分解为 N 个分离的数字流，每一个都对应 N 个扇区中的某一个（在图 42 的示例中， $N = 3$ ）。每一个数字流都代表着一个从相应扇区天线对 902 上接收到的去同步的模拟 RF 信号。多路分解出的数字流随后被从数字形式转换为模拟形式，并送往信道组中的每一个相应接收机。

图 47 示出了可替换图 42 中远端单元 904 的实施例。图 47 中的远端单元 900 包括一个多路复用器/解复用器单元 970，以接收来自波分复用器 930 的数字流，并对来自图 46 中所示的扇区基站单元 906 中的各个相应组的复用数字流进行转换。每一组多路分解出的数据流被送往对应的数模和模数转换单元 972，以实现将数字化信号转换为相应的模拟 RF 信号。模拟 RF 信号以同图 44 相似的方式经放大器 938 放大，再通过一带通滤波器 940 最后到达发射机天线 902a。类似地，RF 接收天线 902b 与带通滤波器 942 相连，其输出又作用于单元 972，在那里模拟信号又被转换为数字形式，以便用于多路复用器/解复用器 970。来自每个单元 972 的数字化数据流在单元 970 中被复用且转换成光输出以送入波分复用器 932，随后再通过光纤将光信号传送到图 46 中的扇区基站单元 906。数字化数据流被图 46 扇区基站单元 906 中的波分复用器 916 接收，然后再送入单元 960。单元 960

将数字化流多路分解成同各扇区相关的数字流，并将每一扇区的数字流转换为扇区 RF 信号。最后这些扇区 RF 信号被送入扇区相应信道组的接收机。

另外本发明还考虑了用扇形微小区系统替代传统小区基站的问题。在上述实施例中，每个扇区使用的天线均为位于相同地点的定向天线。每一个定向天线都负责向所服务扇区定向地收发信号。例如，扇区可能是圆形的，而定向天线恰好位于圆形的中心。另外也可能在小区的不同位置使用无方向性天线。在这样的情况下通过同轴电缆将天线与小区站址连接起来。而且虽然上面描述了使用天线对划分扇区的例子，但是很明显若在此系统中使用一个扇区具有一个或者三个甚至更多个天线的技术可能会带来很大的好处。进一步来说，虽然例子仅提到了对从 MTSO 来的电话信号所产生的 RF 信号进行数字化转换，但是很明显这项图 10 所描述的数字合成技术同样适合于扇形微小区系统。如上所述也可以建立分集信道。

最后，虽然上面所述的每一个例子都是有关通过远端单元收发的“模拟” RF 信号的使用，但是显然从众所周知的技术角度看，上述系统和所使用的方法完全可以很好地适用于数字 RF 蜂窝系统。

如上所述，扇形小区替代系统通过将传统小区甚至微小区划分为多个扇区而得以能提供更多的复用信道。进一步讲，系统提供了微小区系统的所有益处和优点，而且小区内所有信道的发射/接收机均可集中位于方便经济的地点。

由此可见，本发明提供了一个多样的数字系统和在

基站与天线单元之间传送蜂窝信号以及被动切换的方法。虽然发明是以推荐的形式被描述的，但是已经考虑到了对那些技术可能会做许多改进和变更，只要不背离所附带权利要求的精神和范畴。

说明书附图

图1A

现有技术

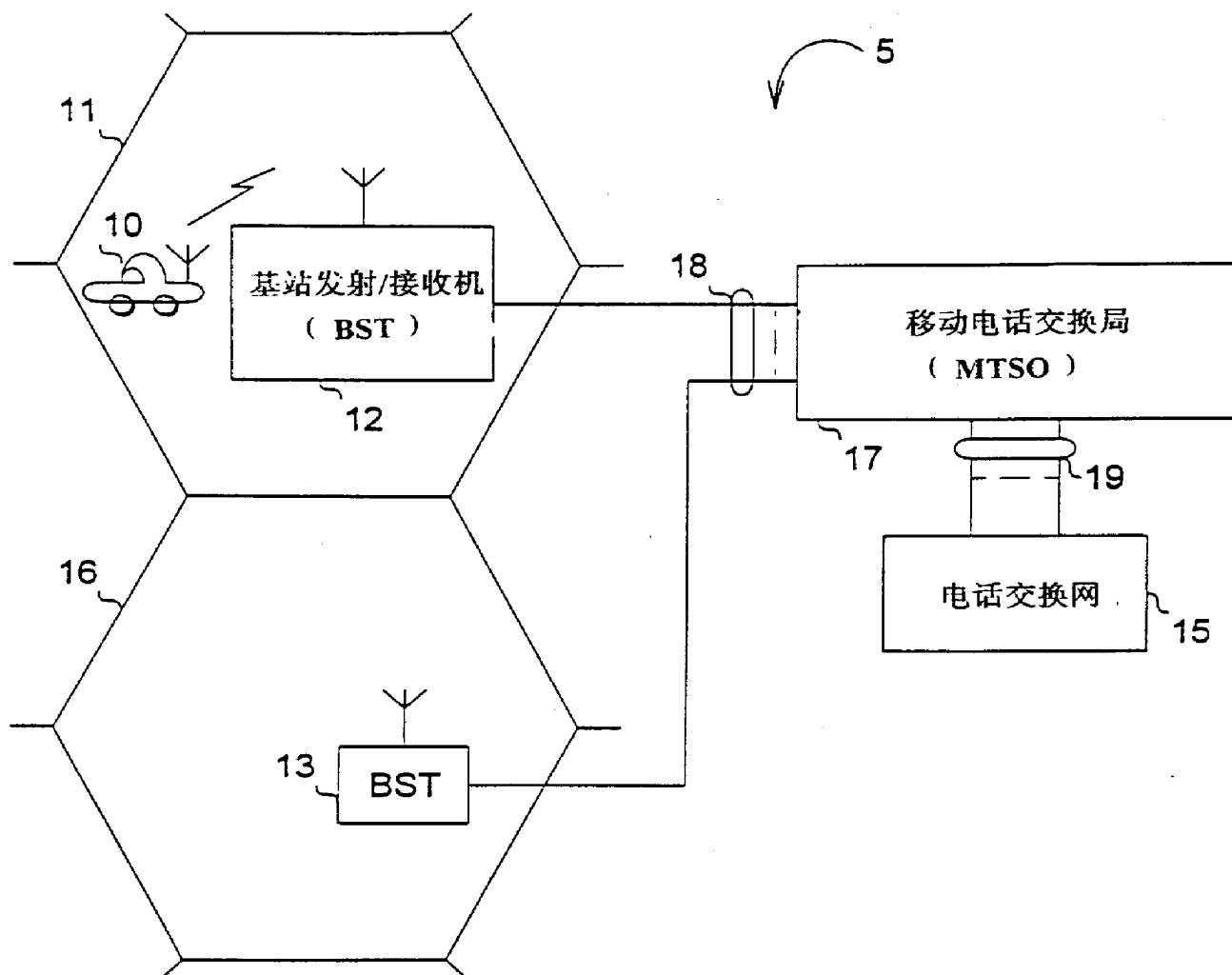


图 1B

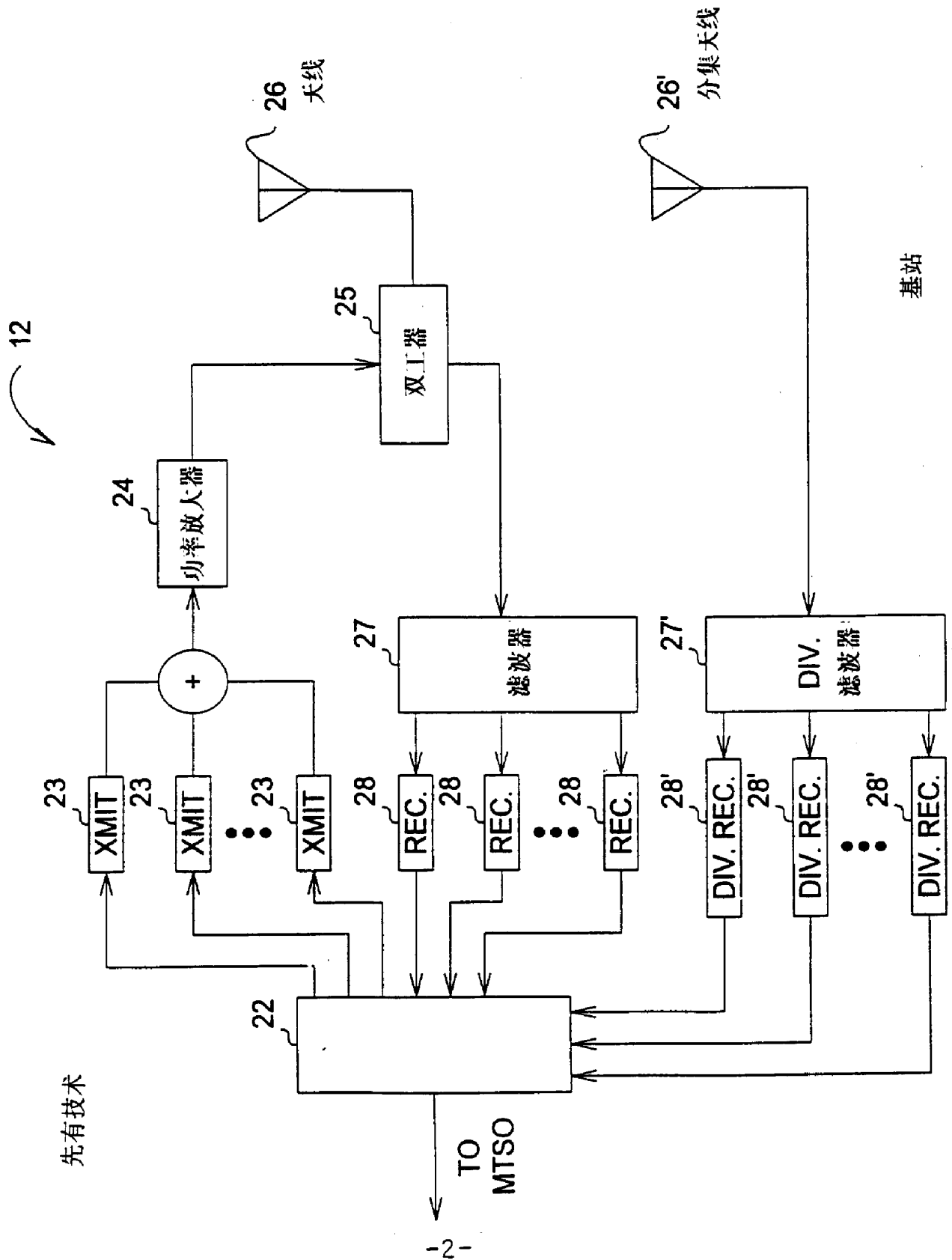


图 1C
先有技术

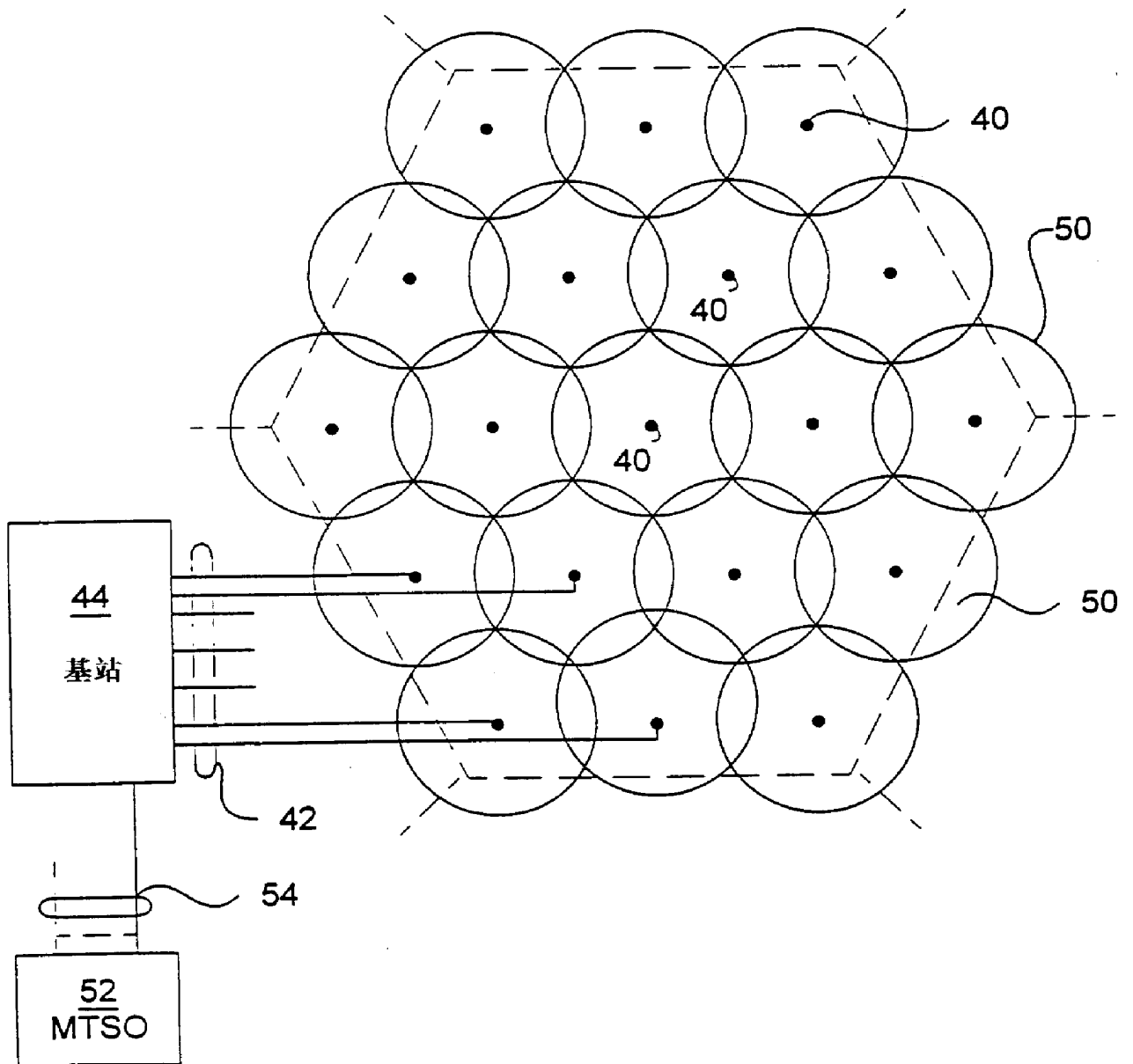


图 2

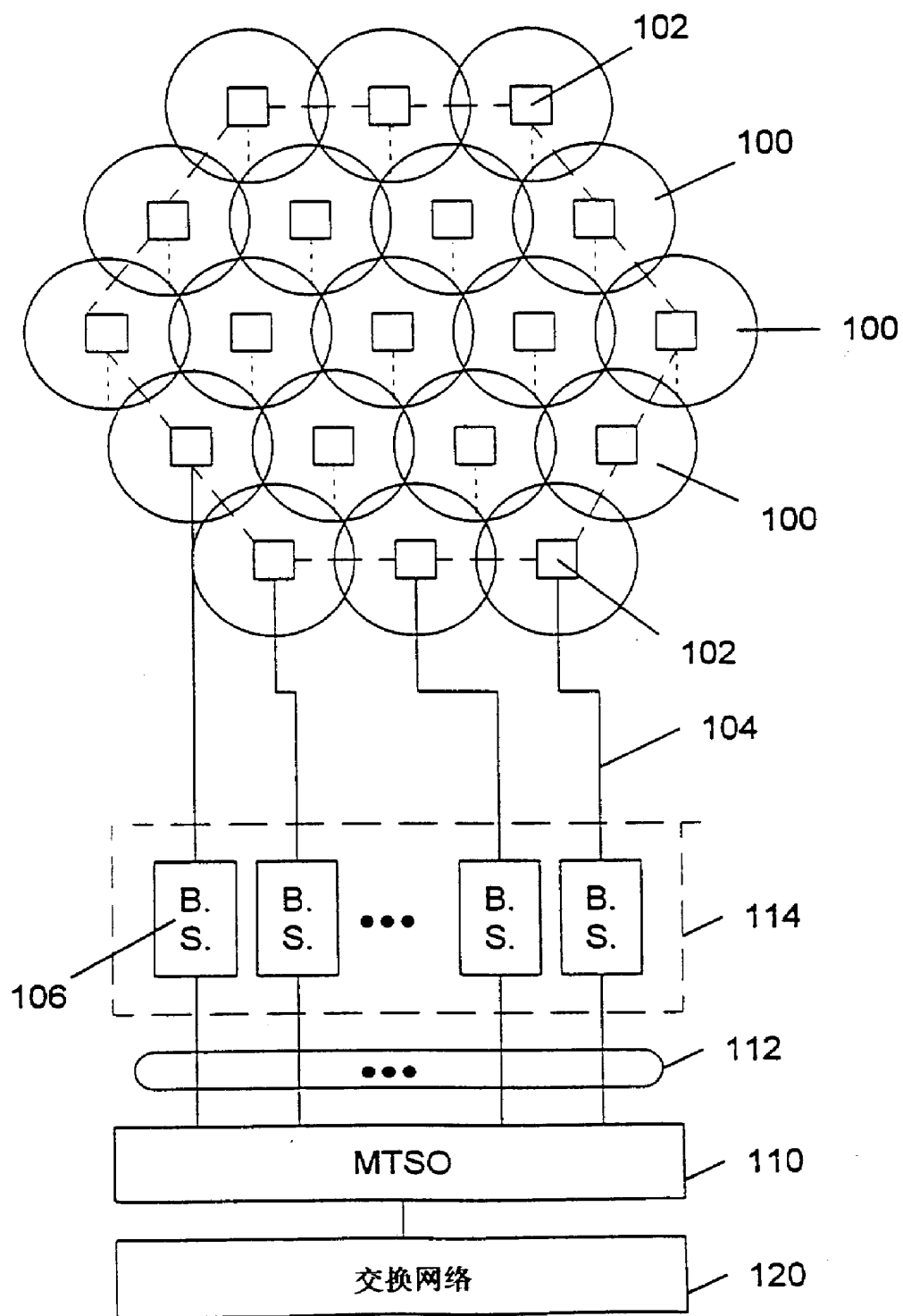


图 3

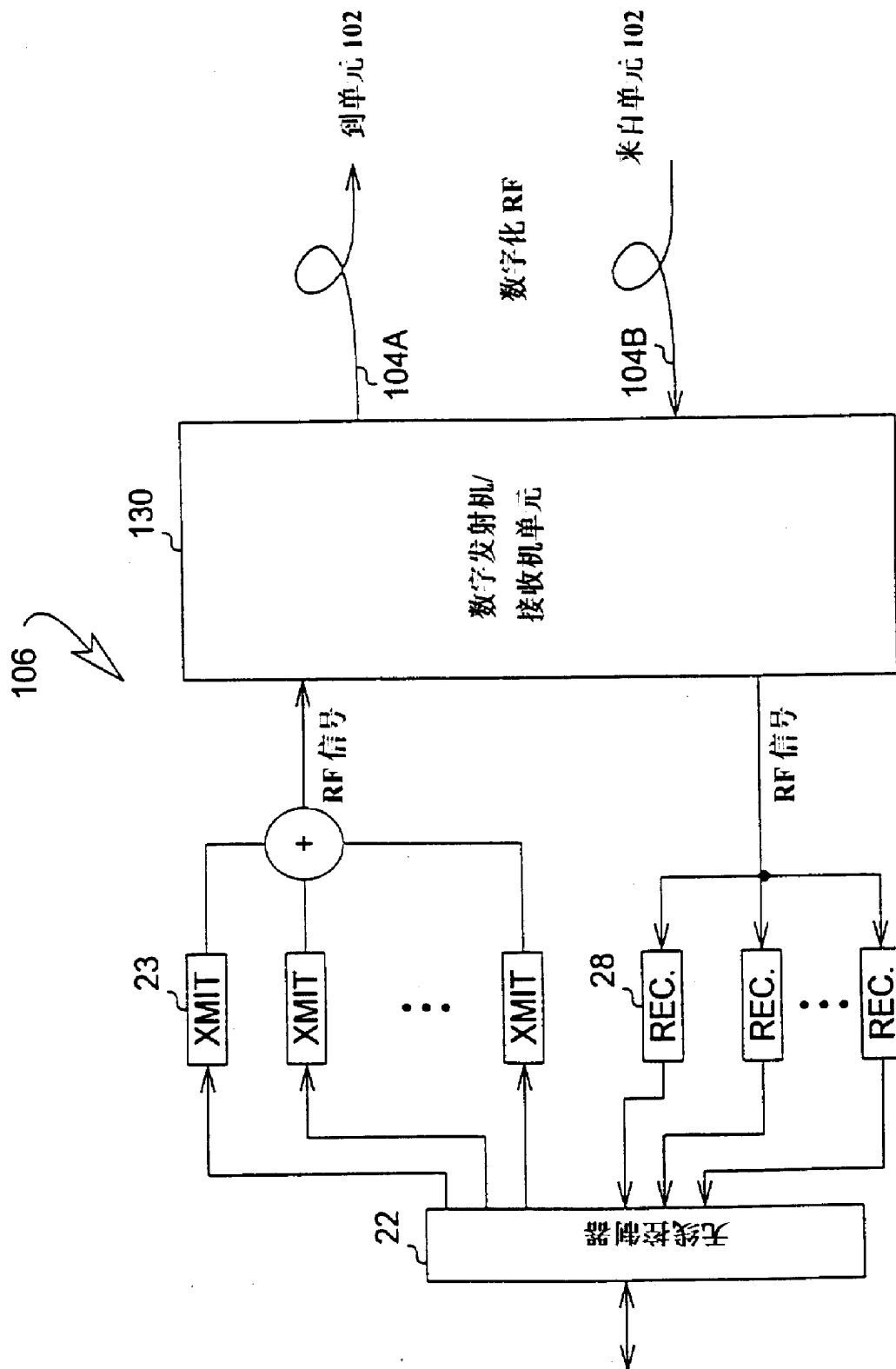


图4

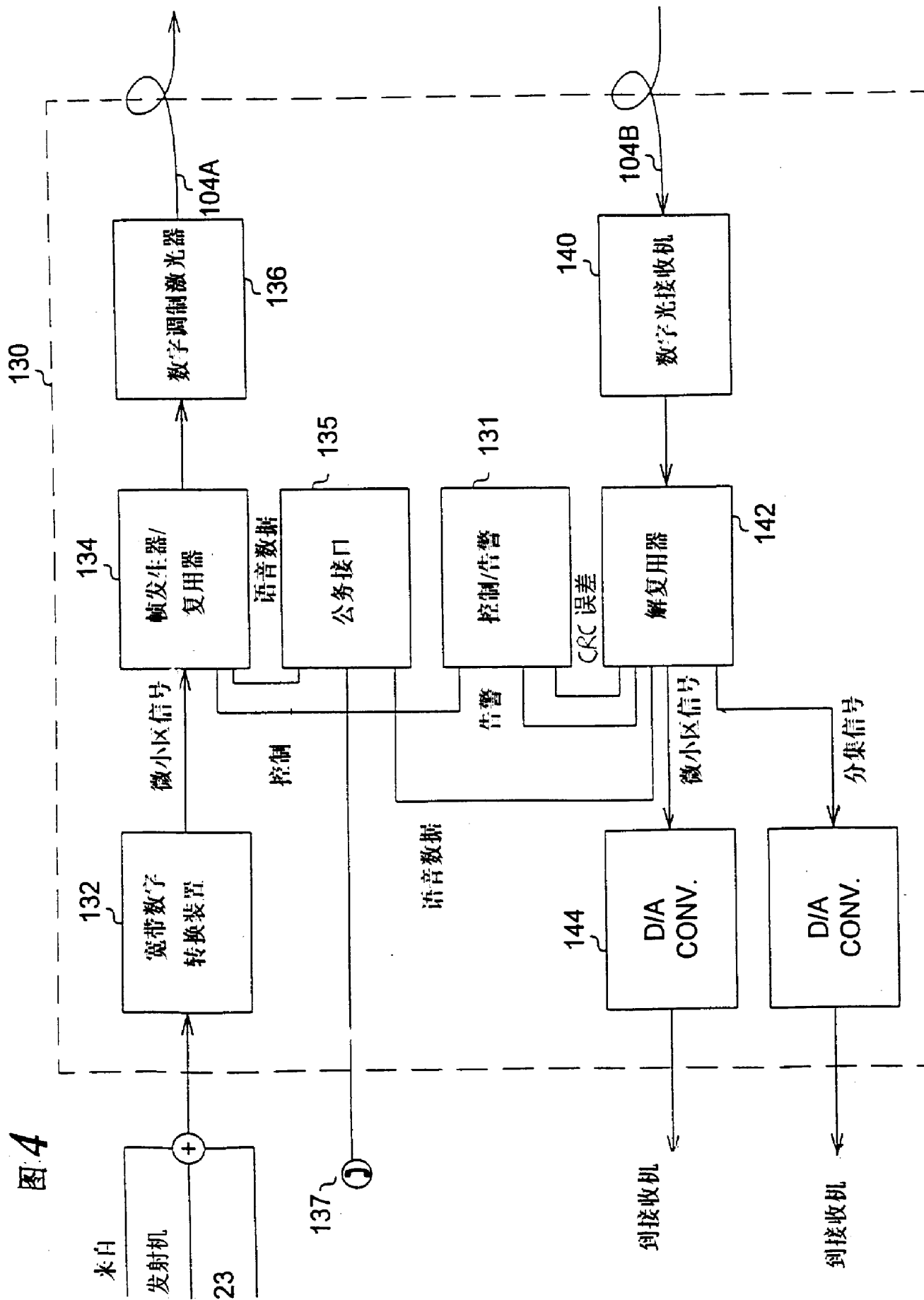


图 5

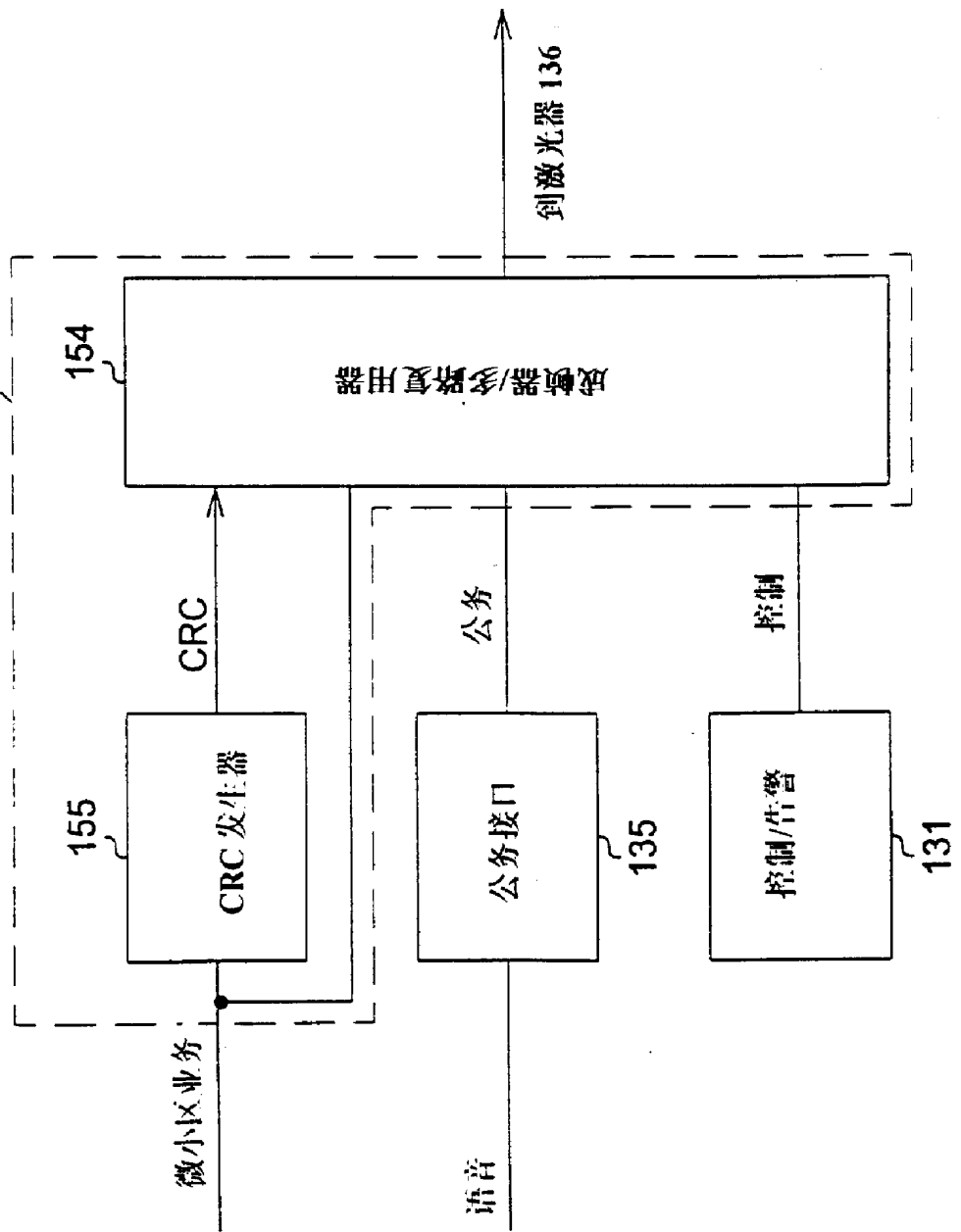


图 6

微小区信号 12BITS
CRC 信道 1BIT
告警 - 控制/公务信道 1BIT
帧字 6BITS

图 7

微小区信号 12BITS
可选业务/分集信号 12BITS (12.5 MHZ)
CRC 信道1 0R2BITS
告警 - 控制/公务信道 1BIT
帧字 6BITS

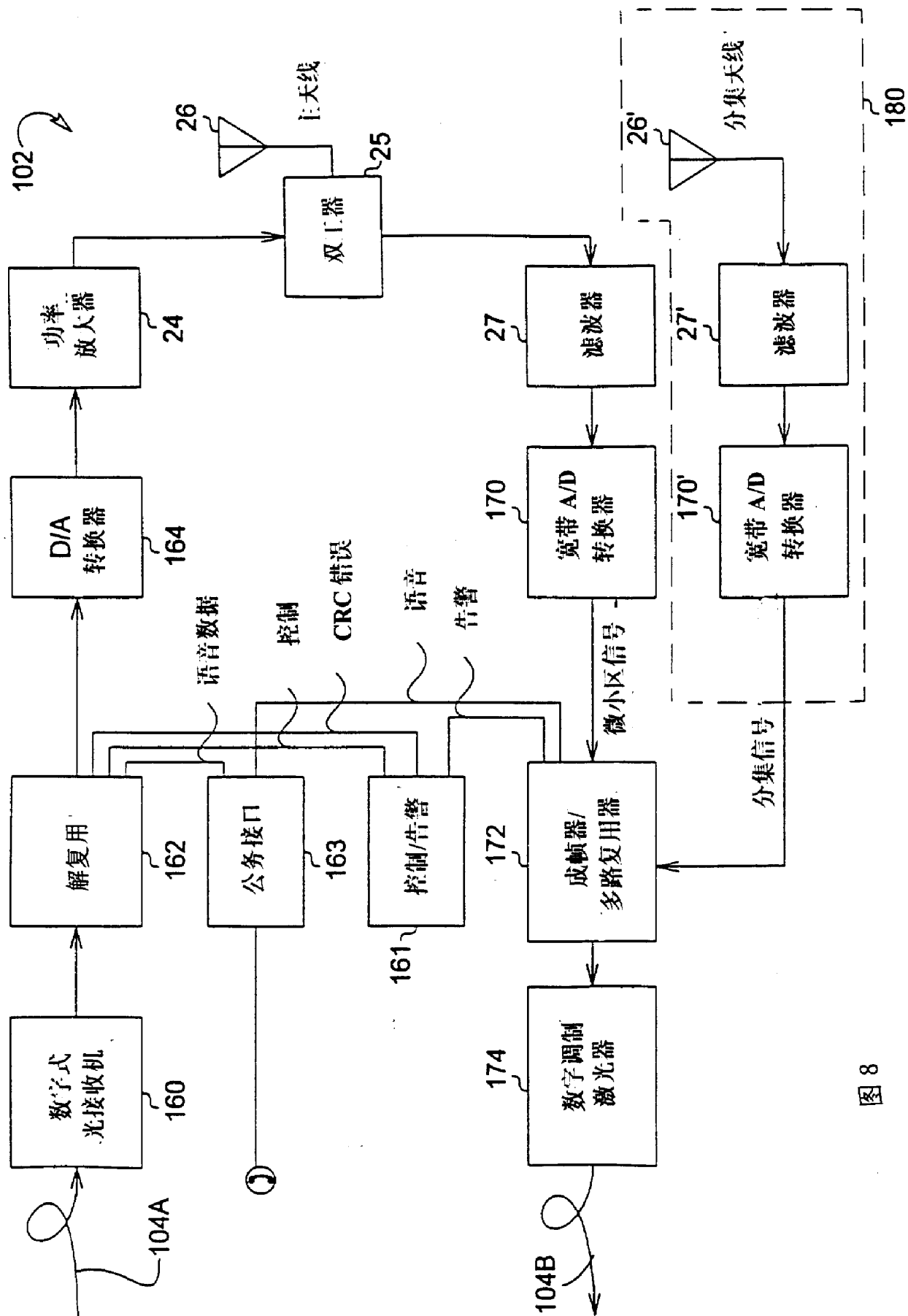


图 8

图 9

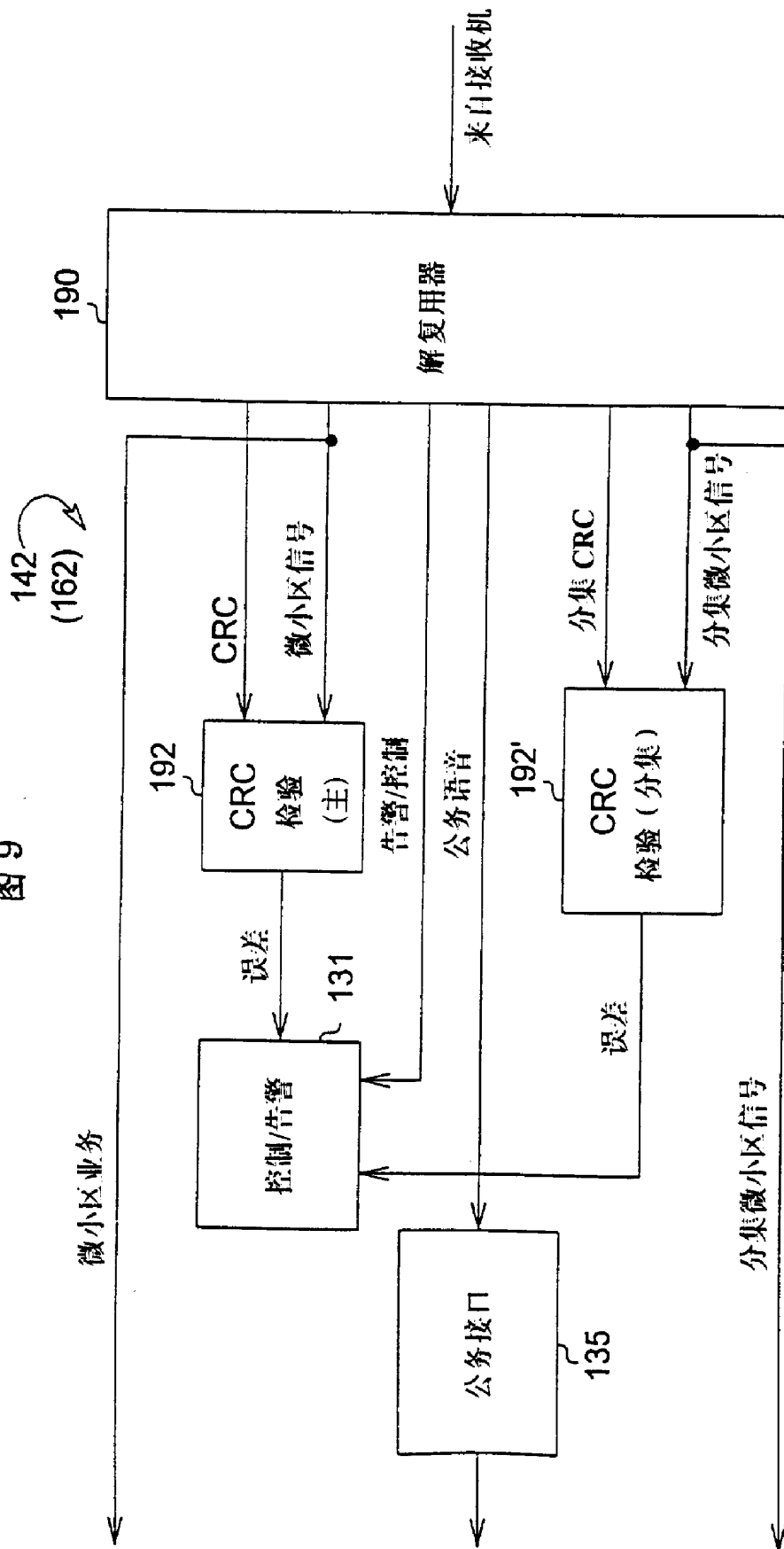


图 10

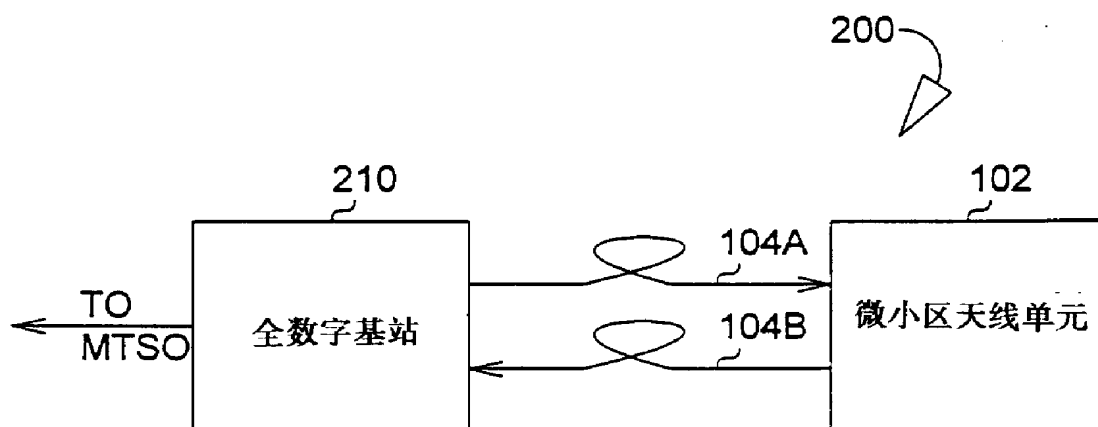


图 11A

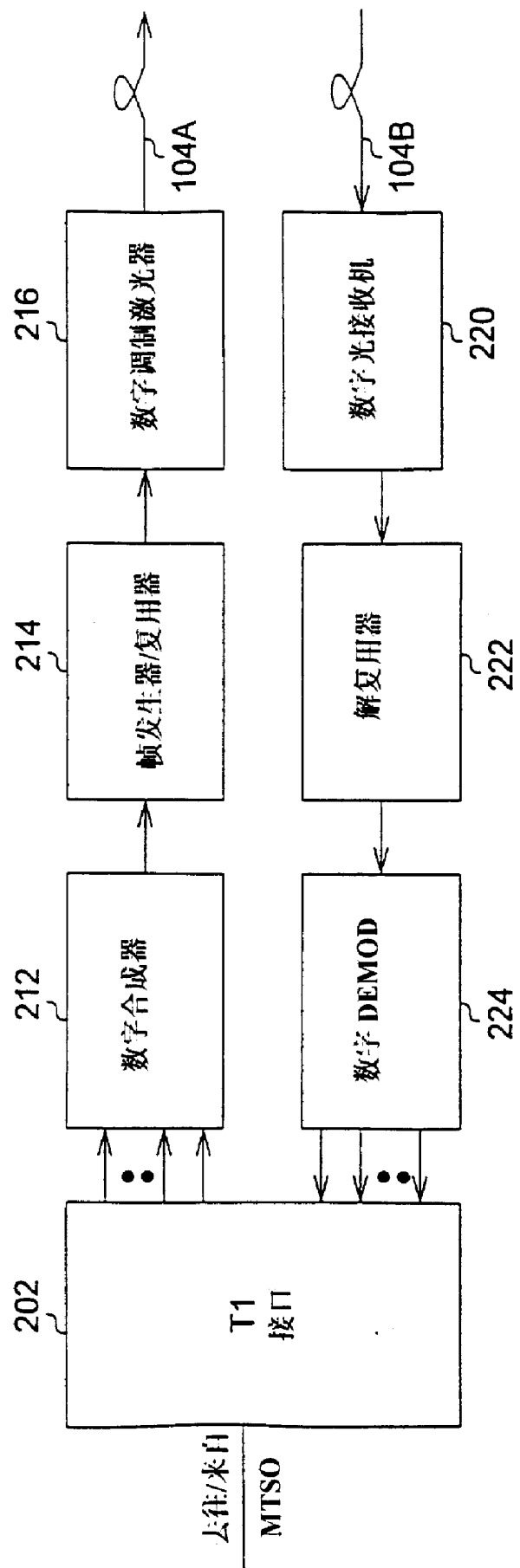


图 11B

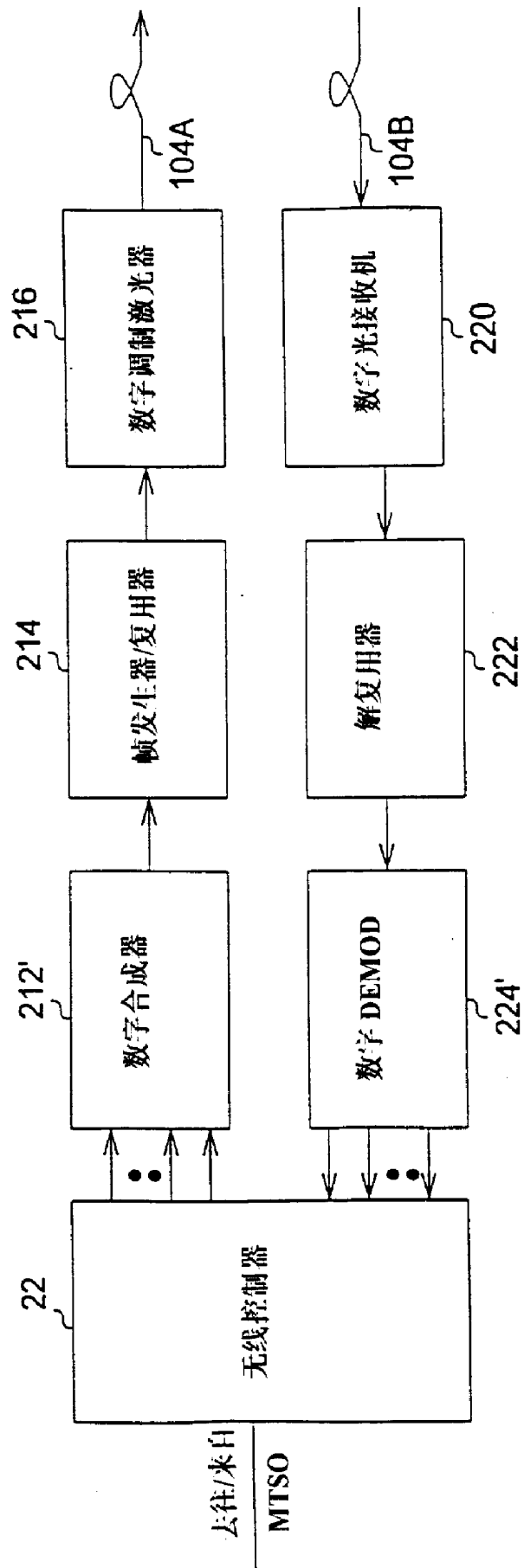


图 11C

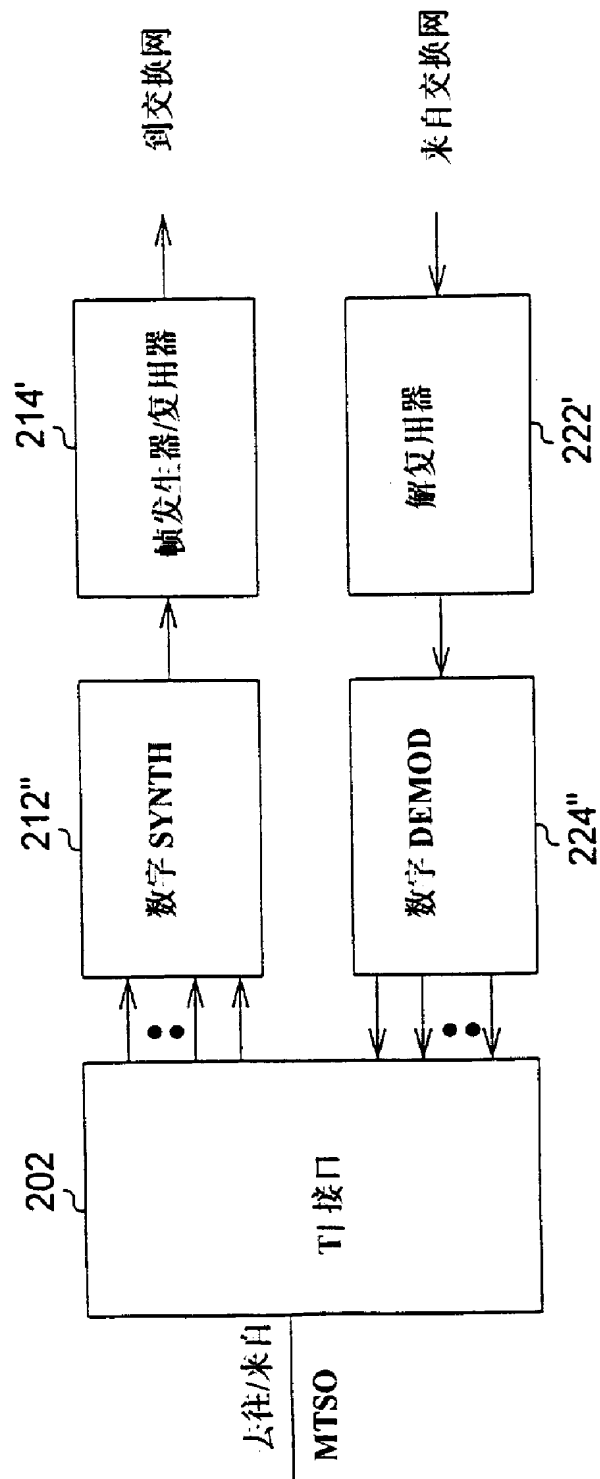


图 11D

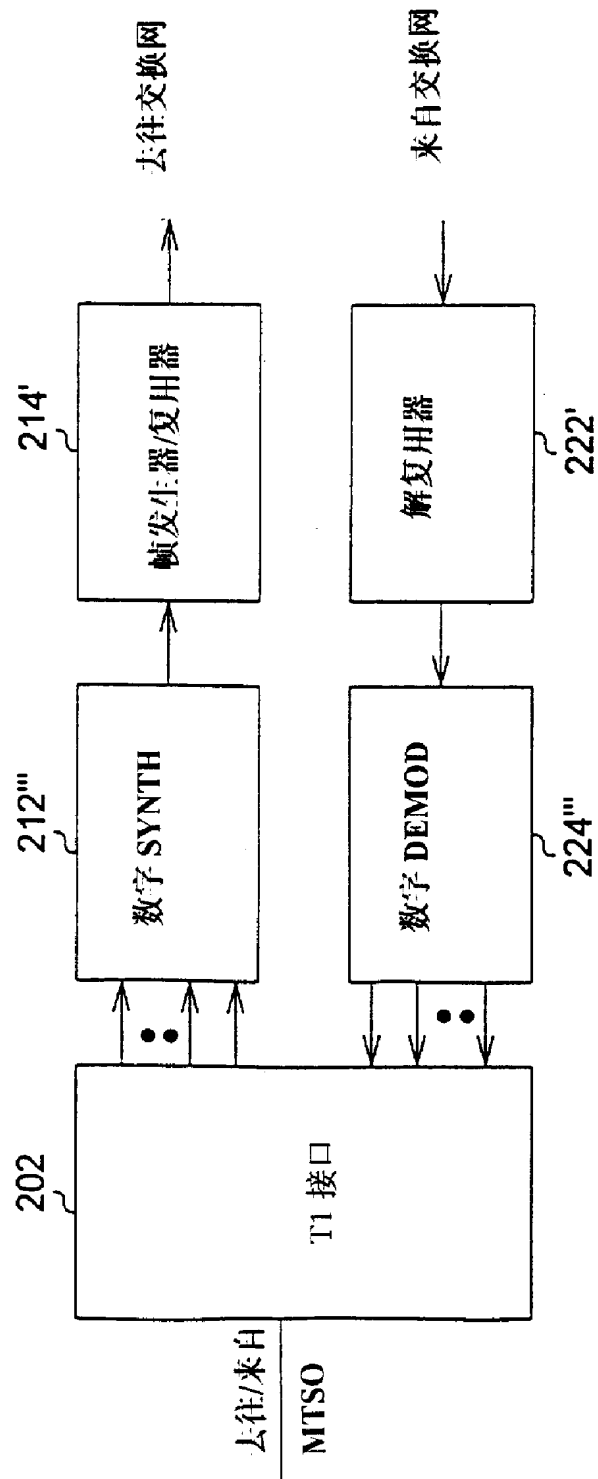


图12

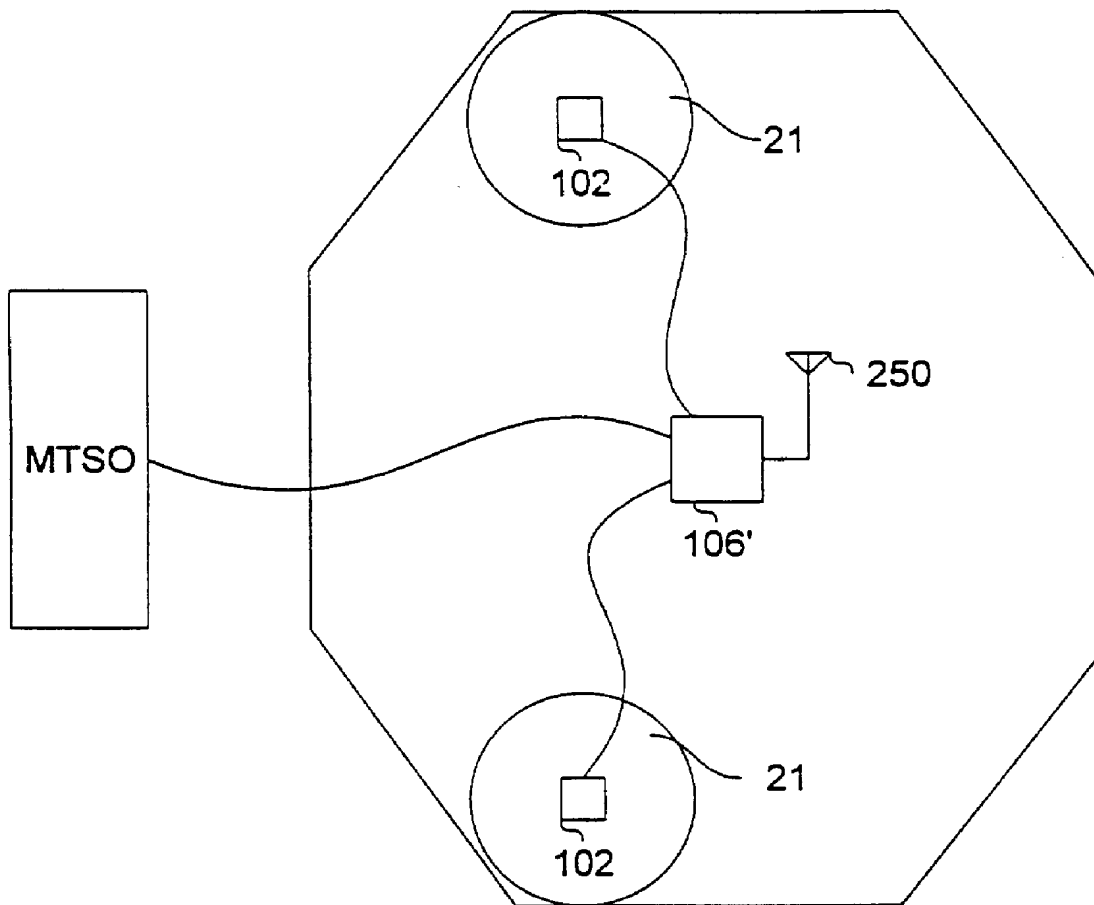


图 13

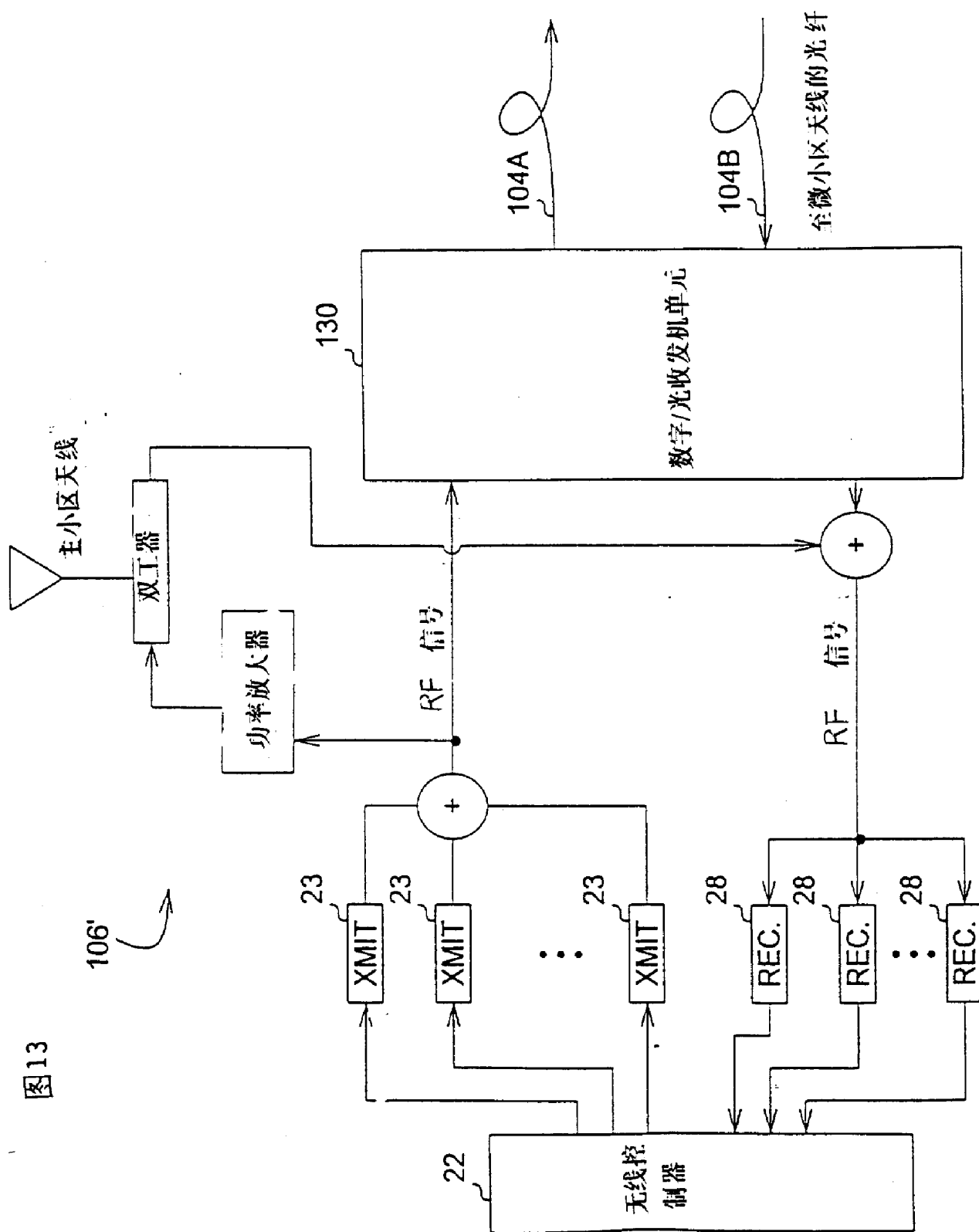


图 14

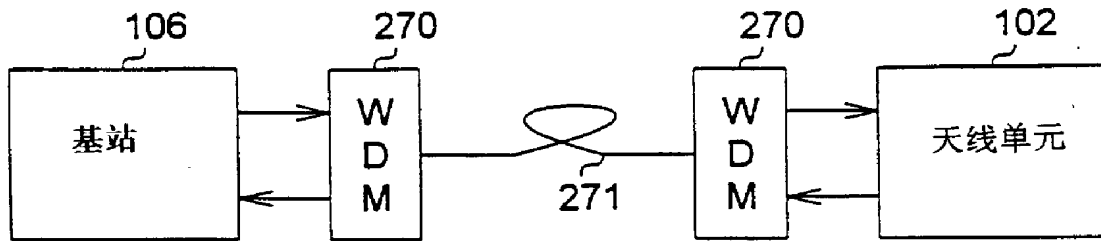


图 15

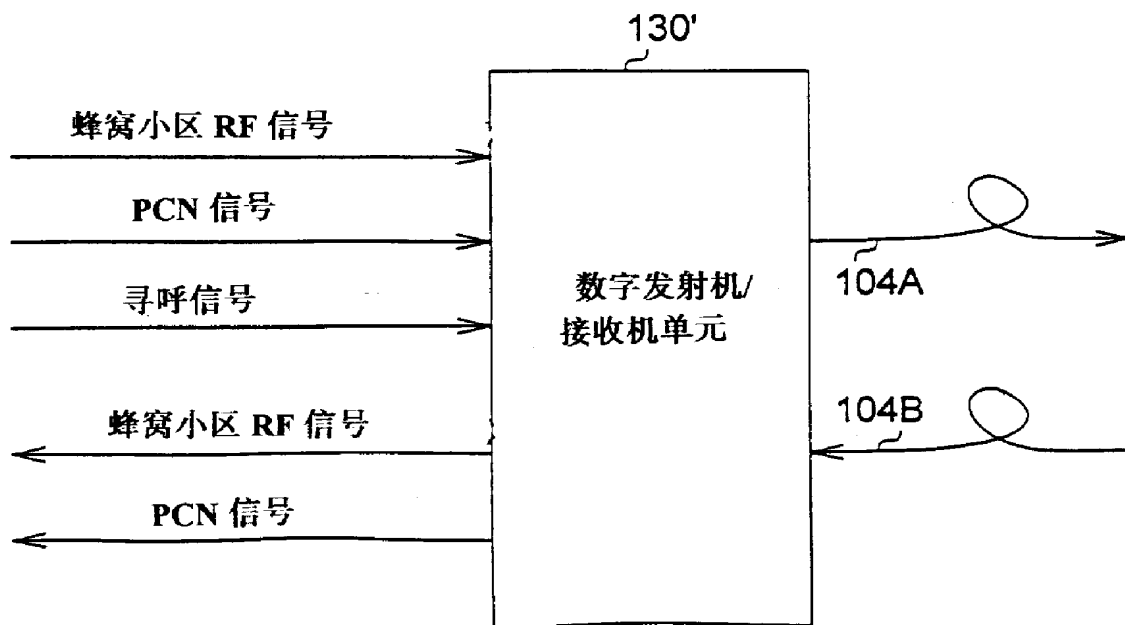
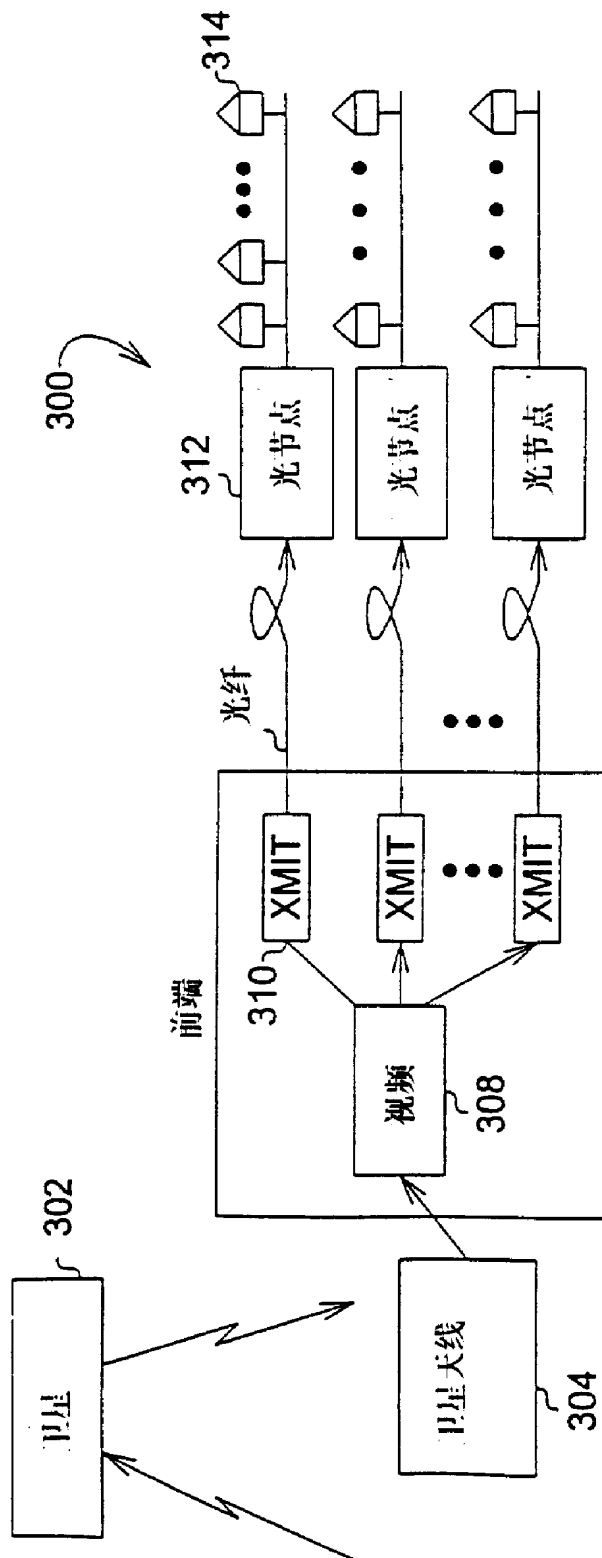
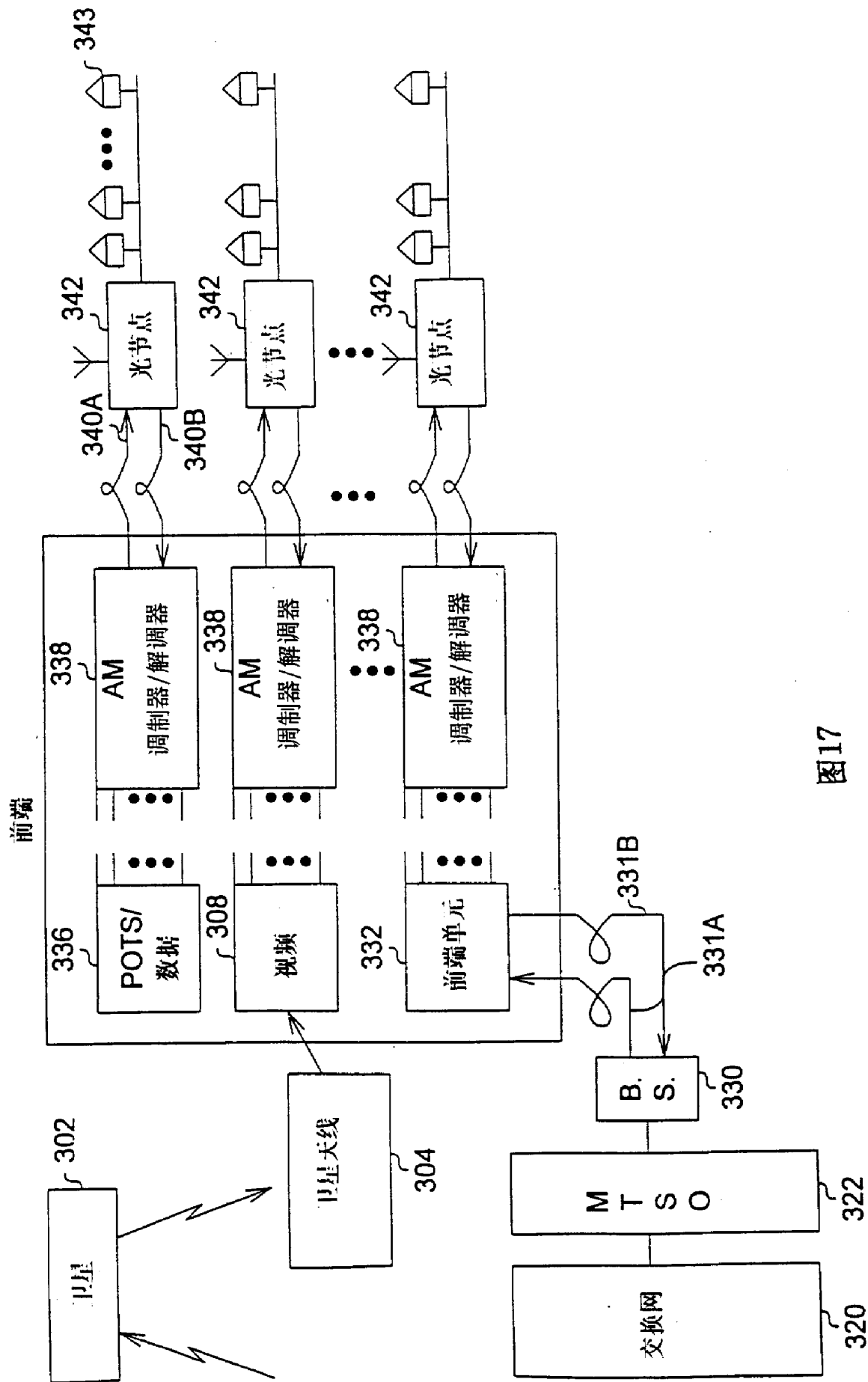


图 16

先有技术
电缆系统





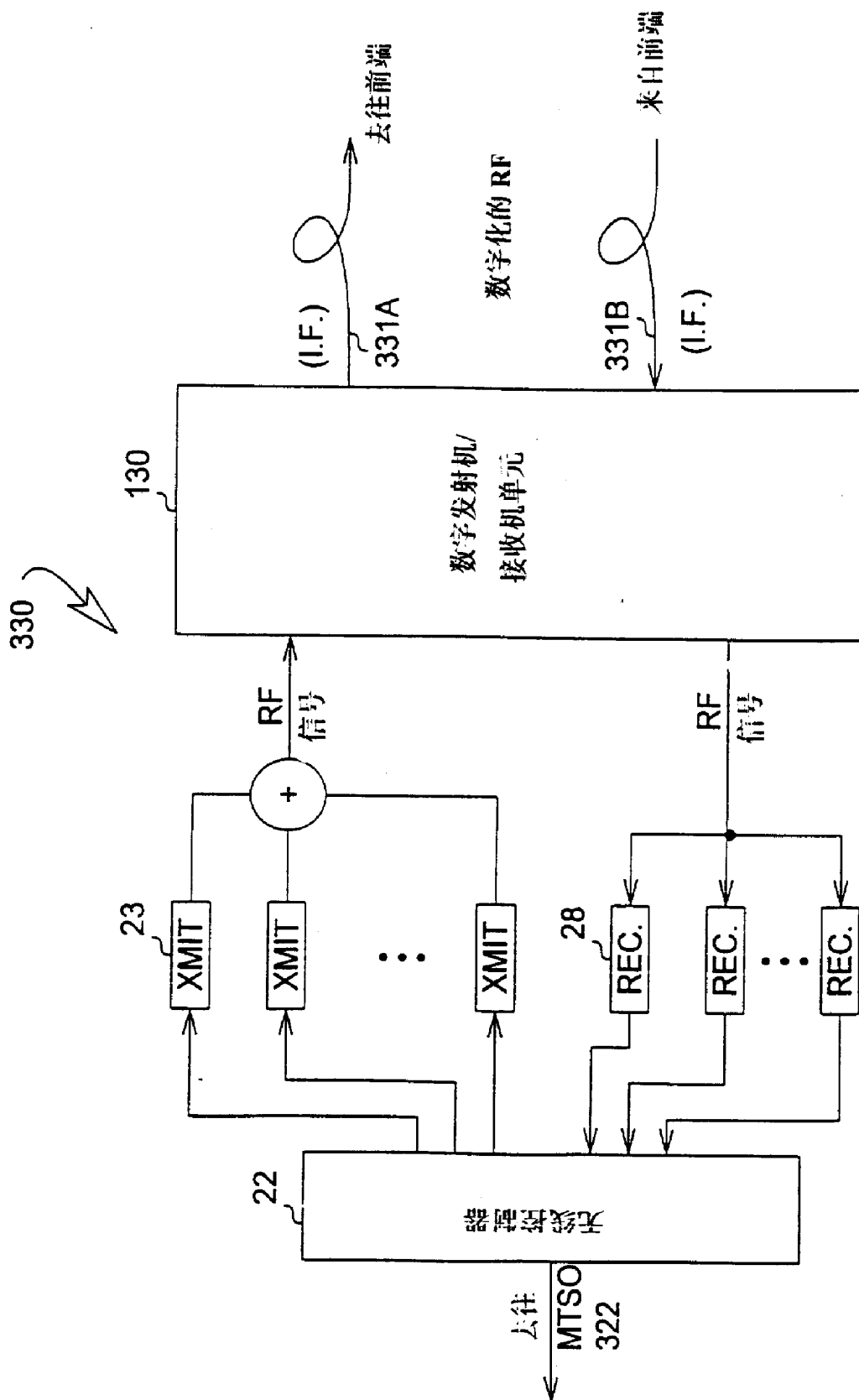


图 18

图19

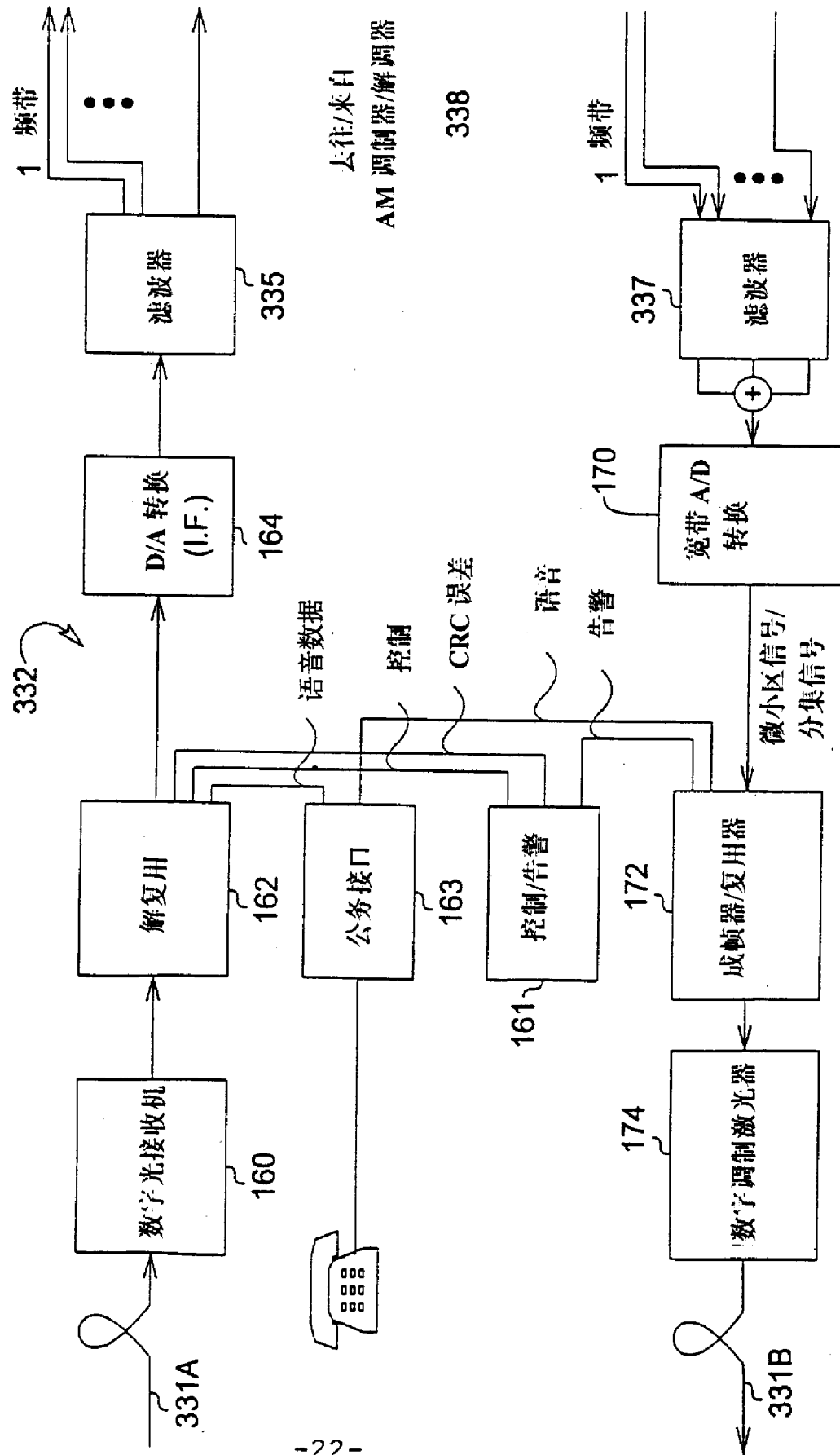


图 20

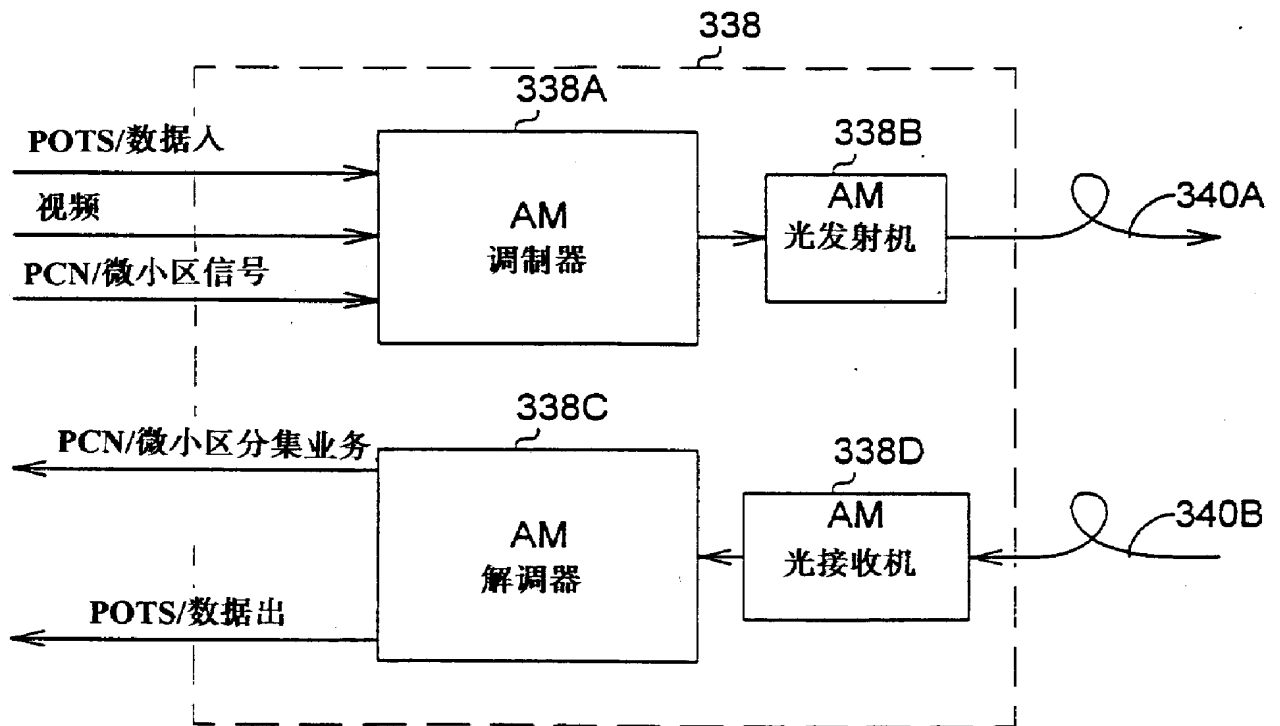


图 21A · 132

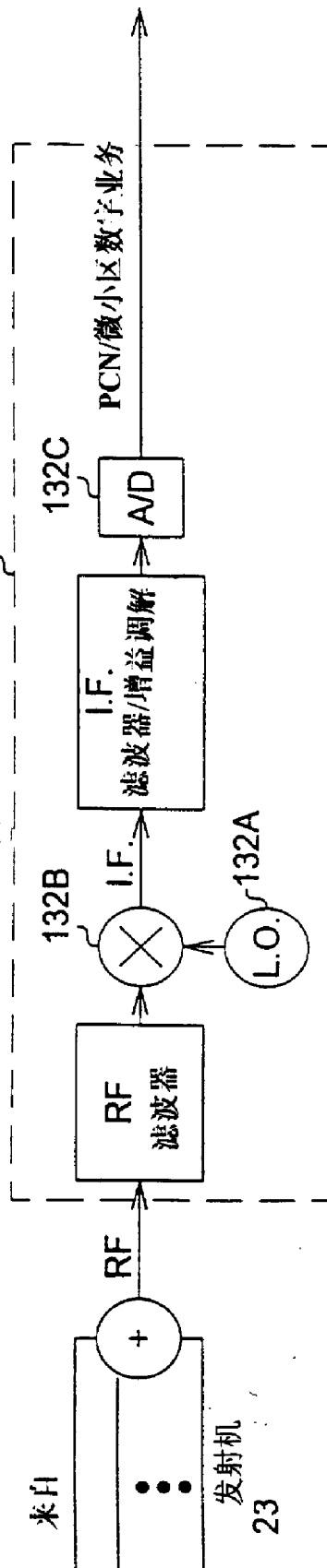


图 21B

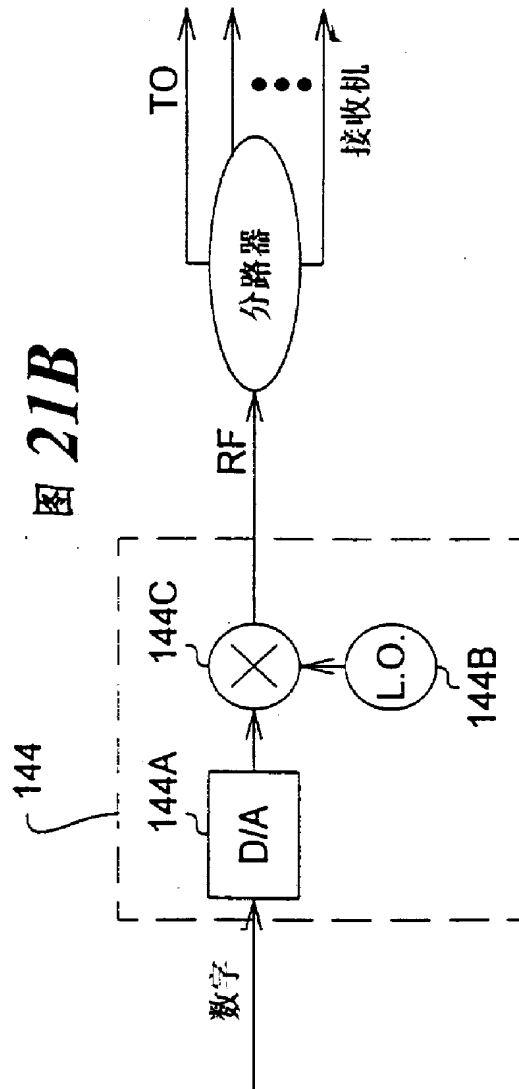


图 22

PCN/微小区信号 12 BITS
成帧 1 BIT
CRC 和告警 - 控制/公务信道 1 BIT
4 BITS 保留

图 23

PCN/微小区 信号 13 BITS
成帧 1 BIT 1 BIT
CRC 和告警 - 控制/公务信道 1 BIT
3 BITS 保留

图24

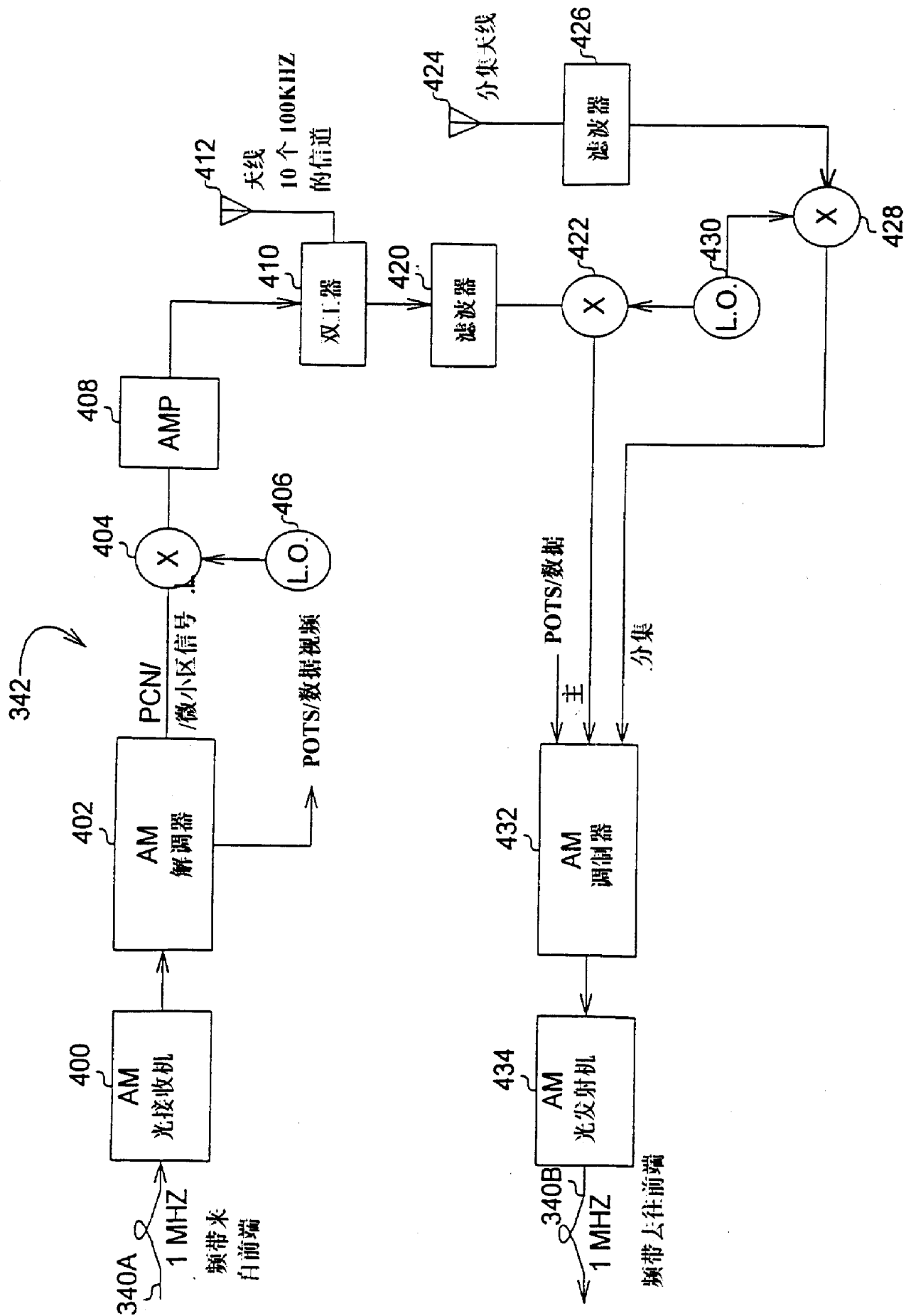


图25

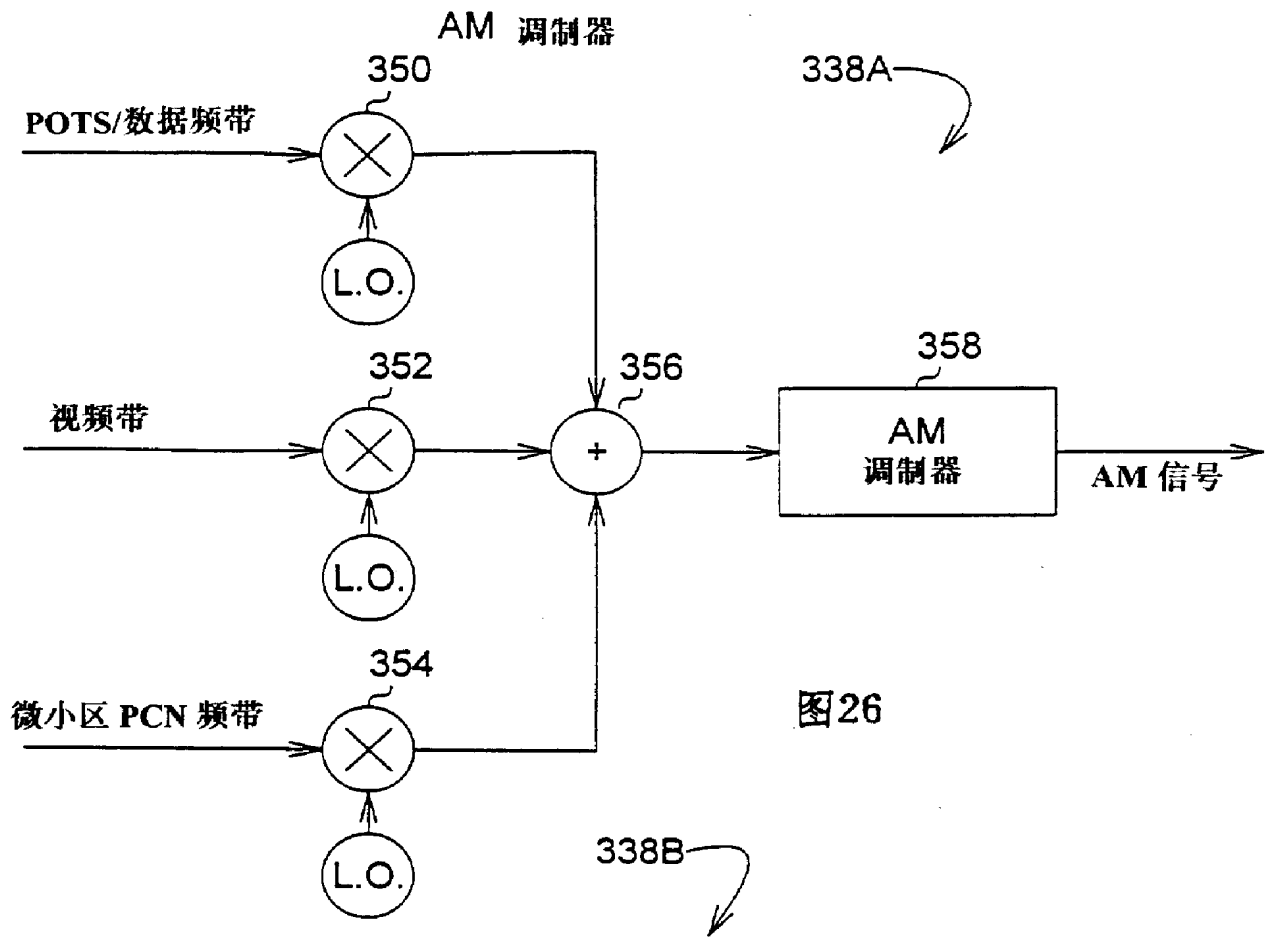


图26

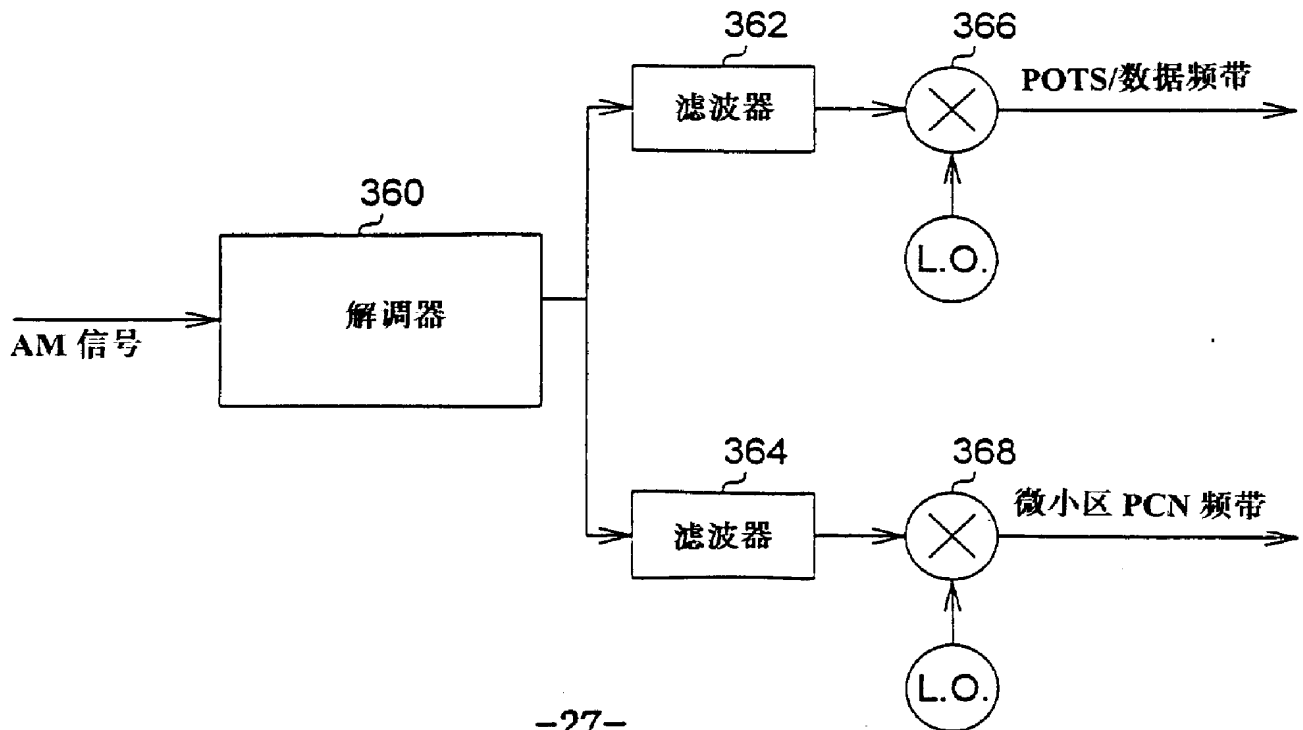


图 27A

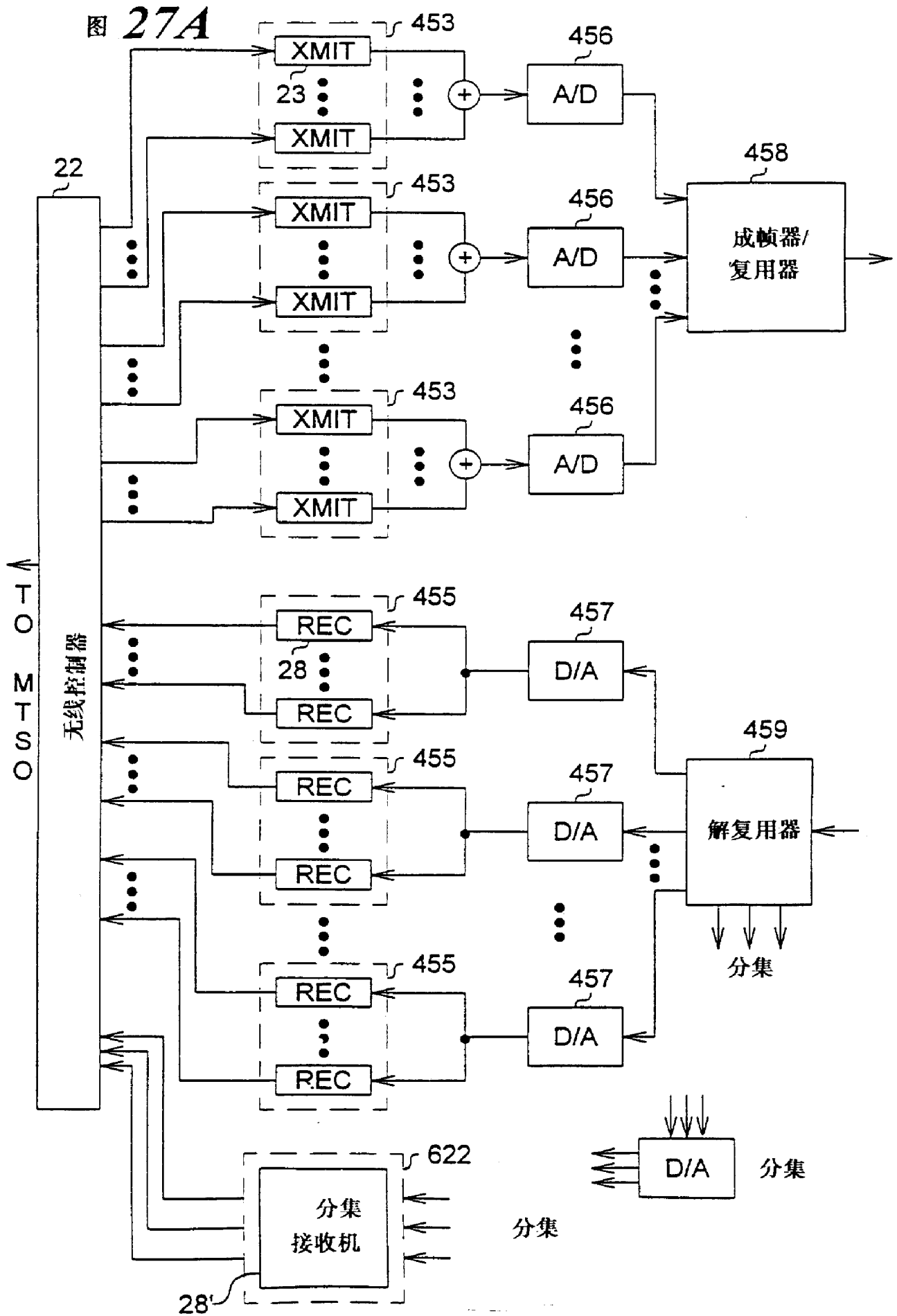


图 27B

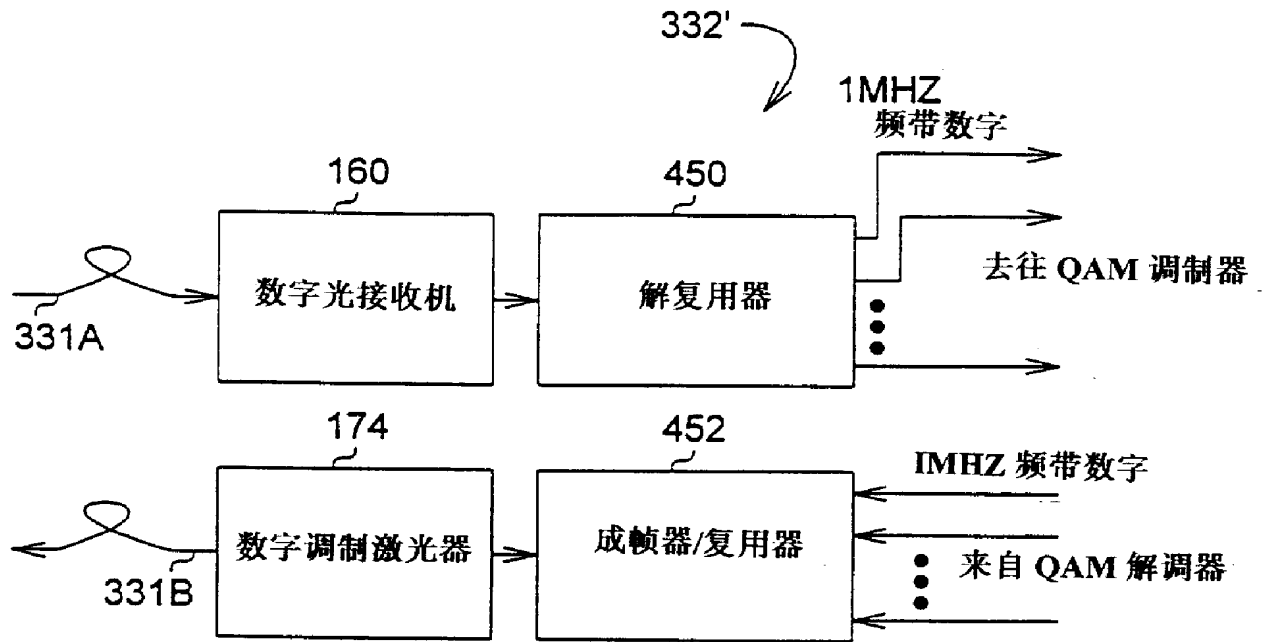
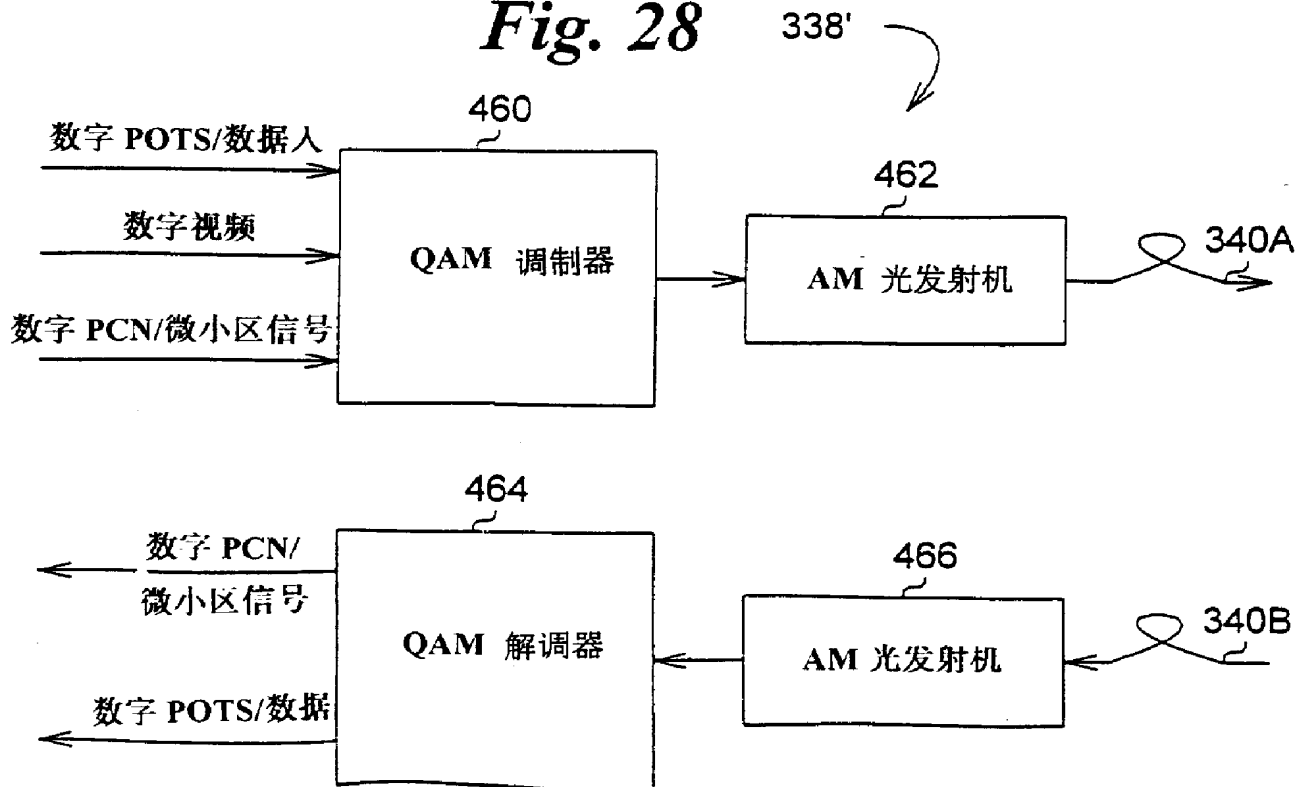


Fig. 28



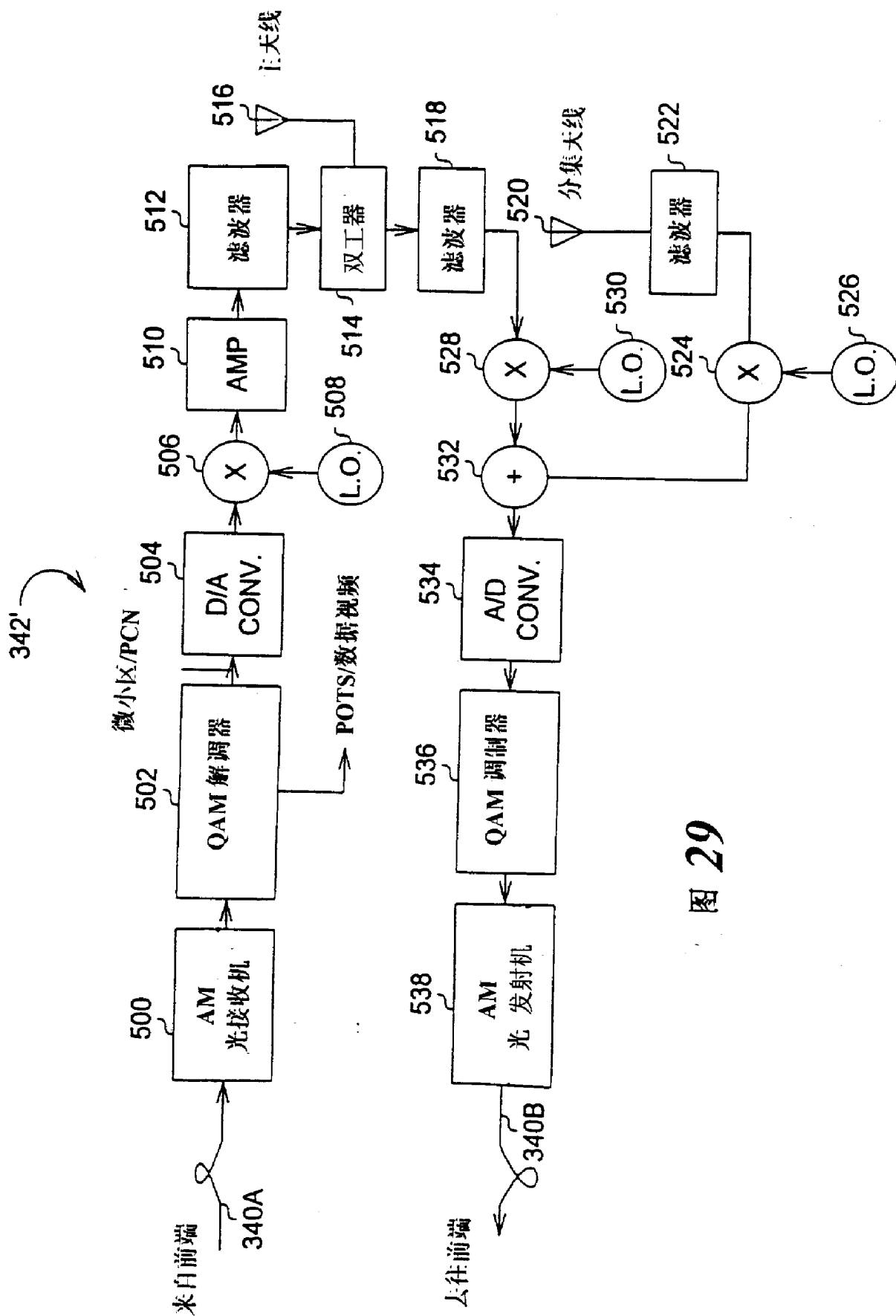
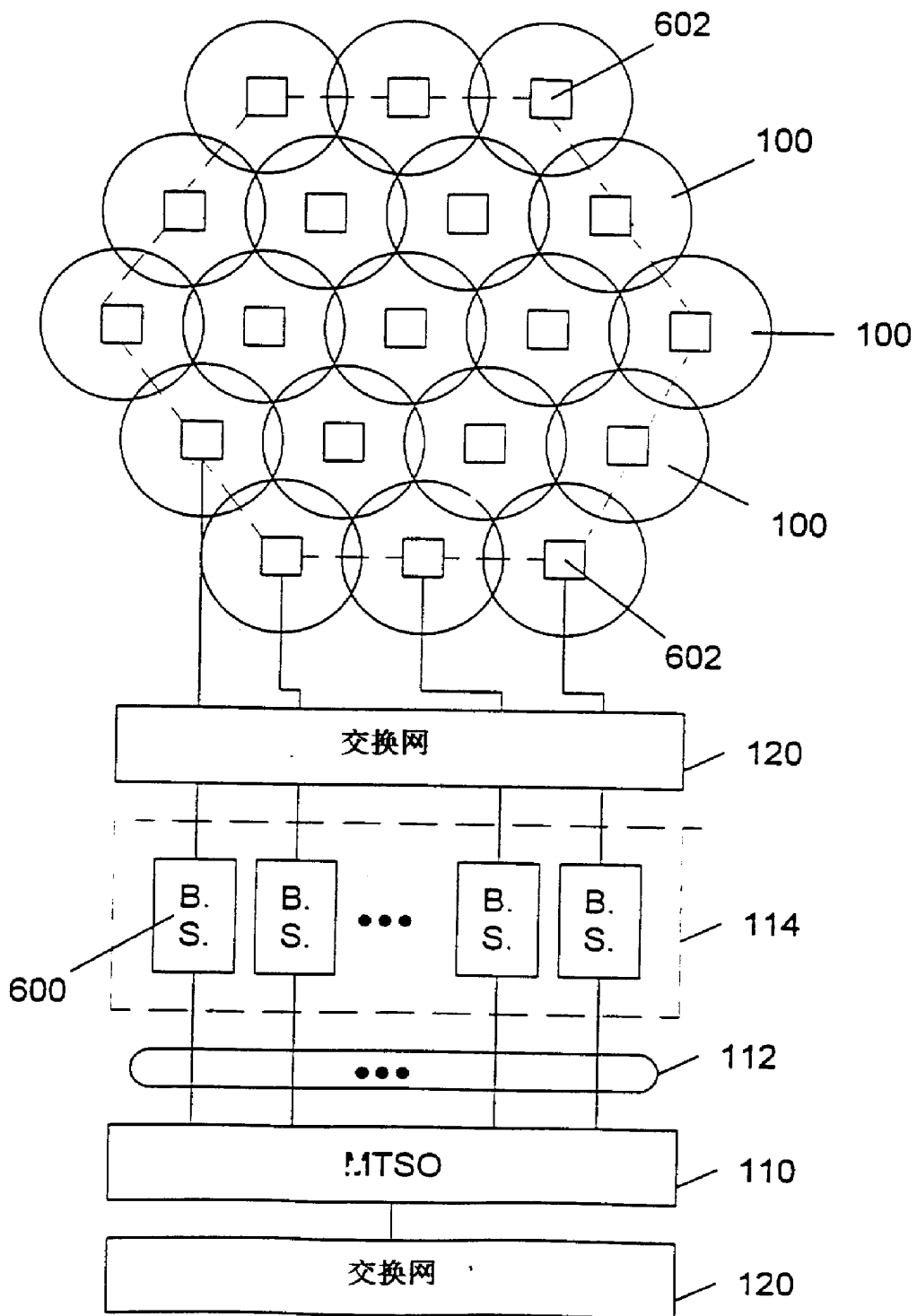


图 29

图30



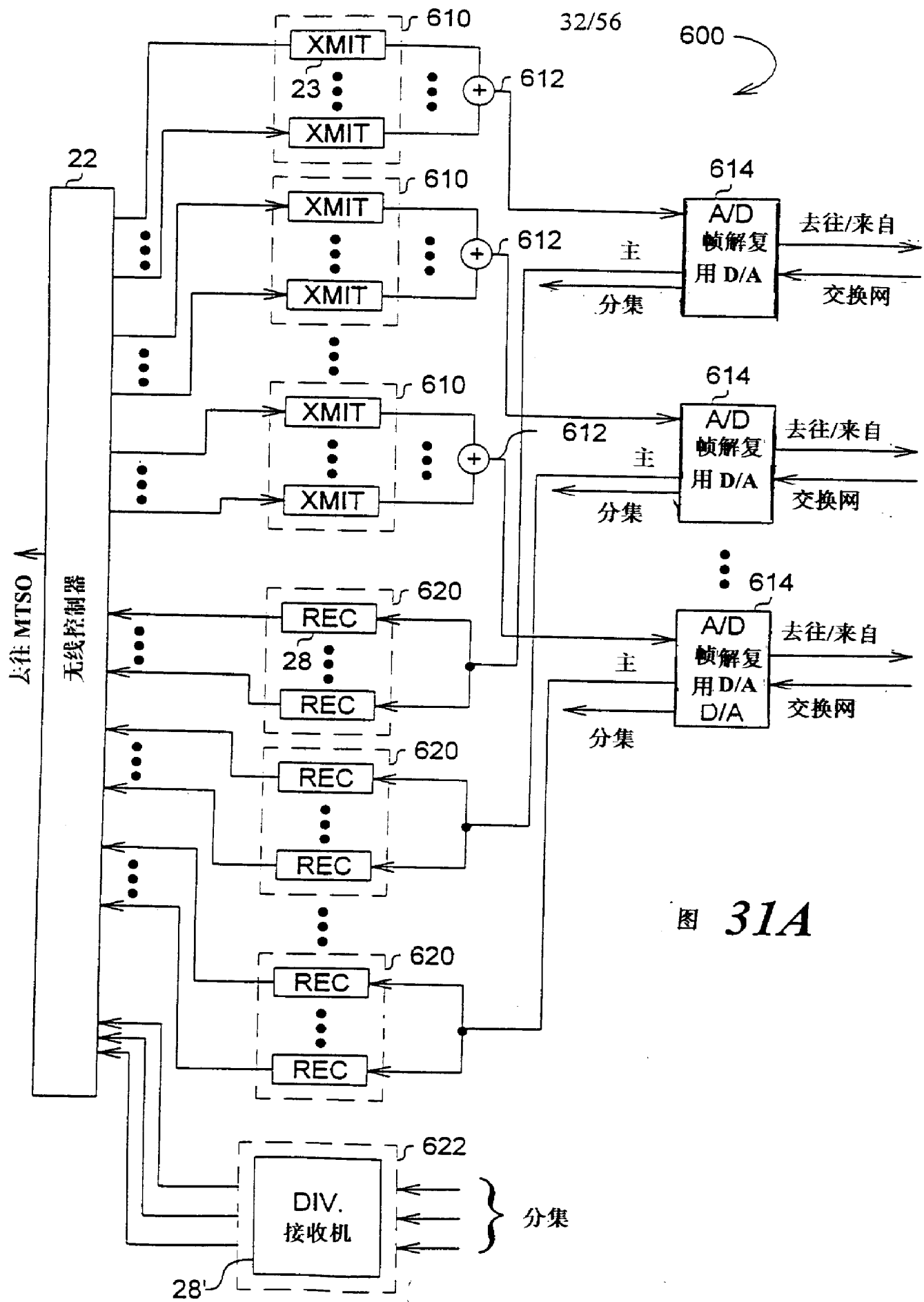
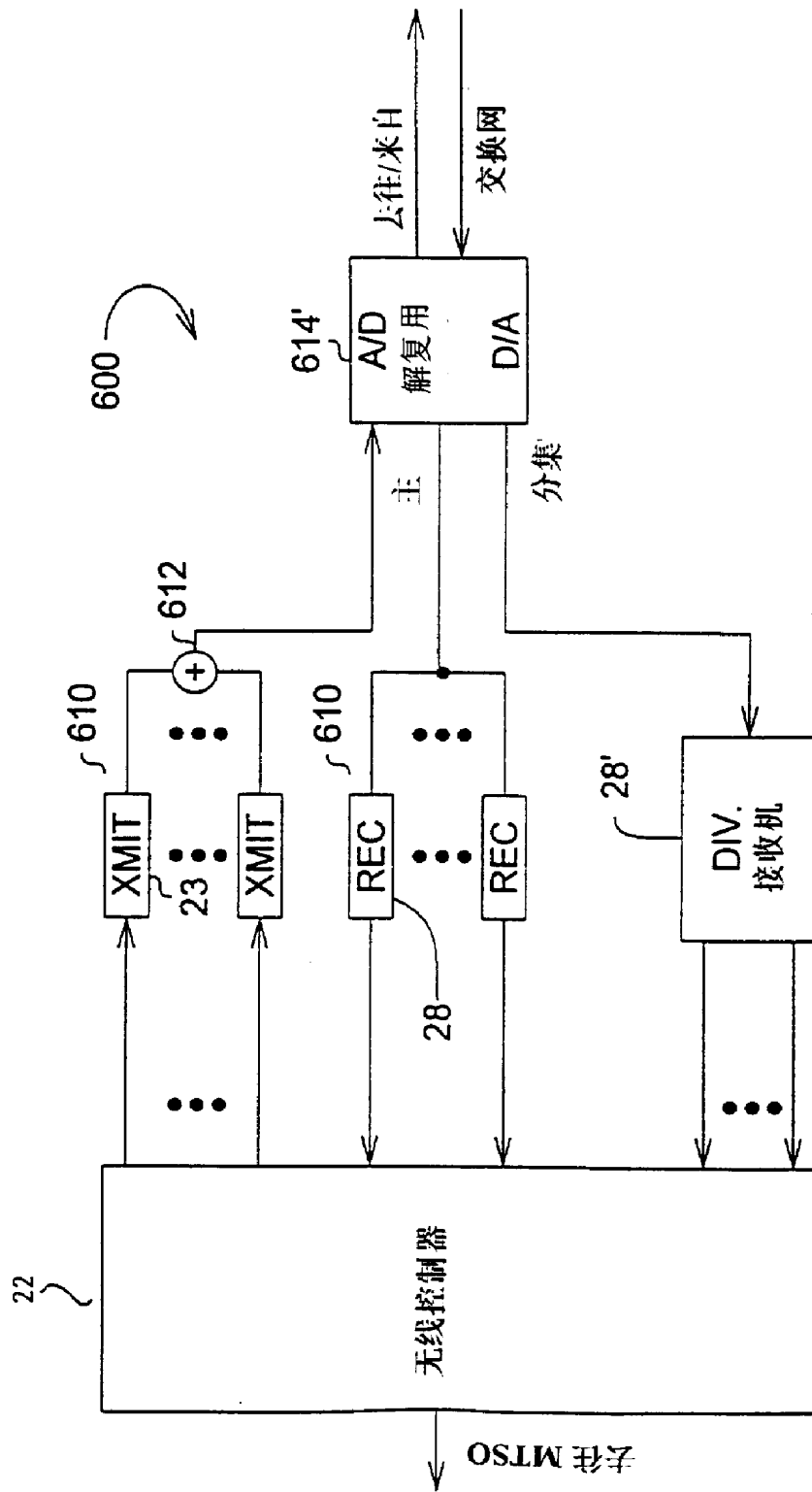


图 31A

图 31B



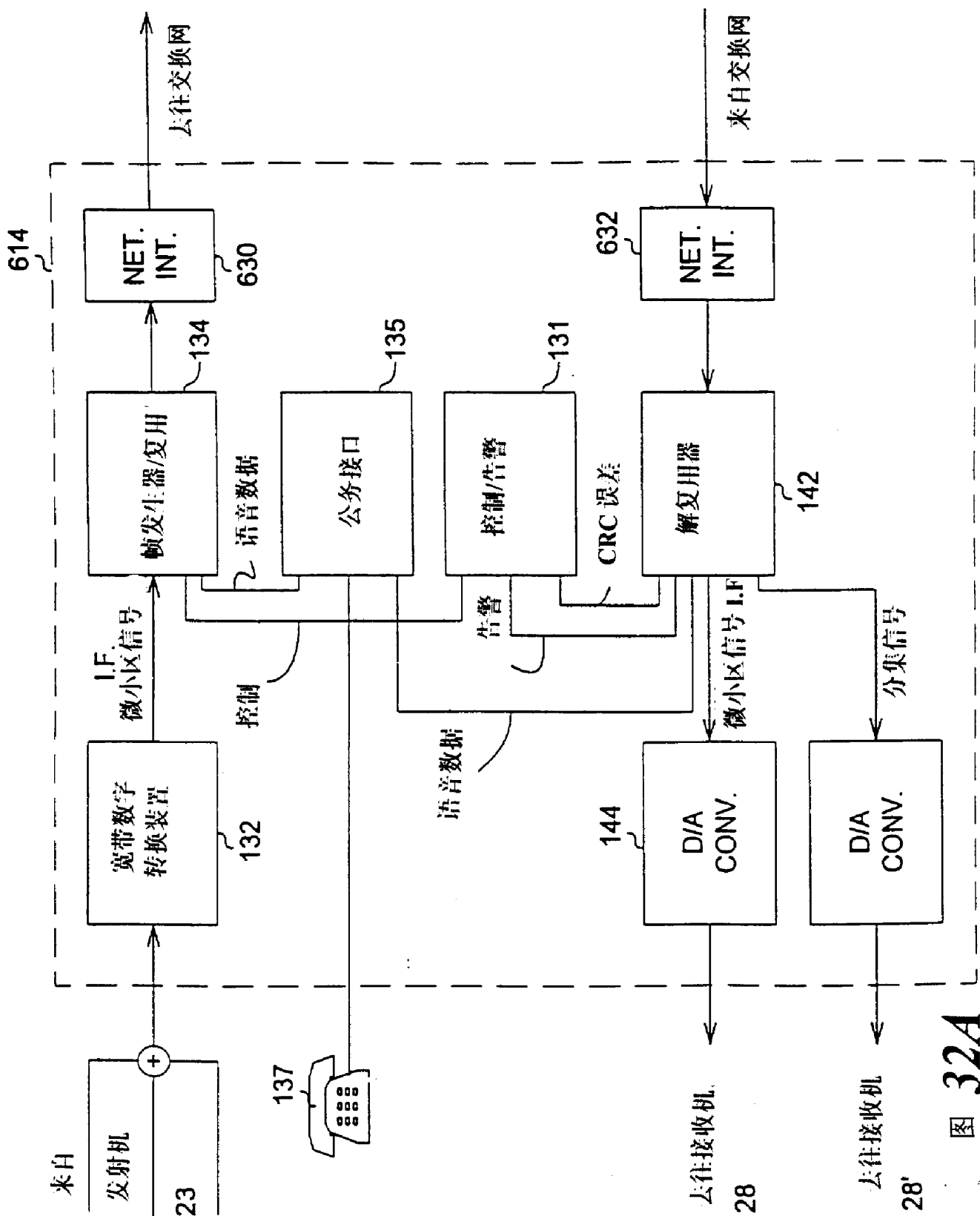
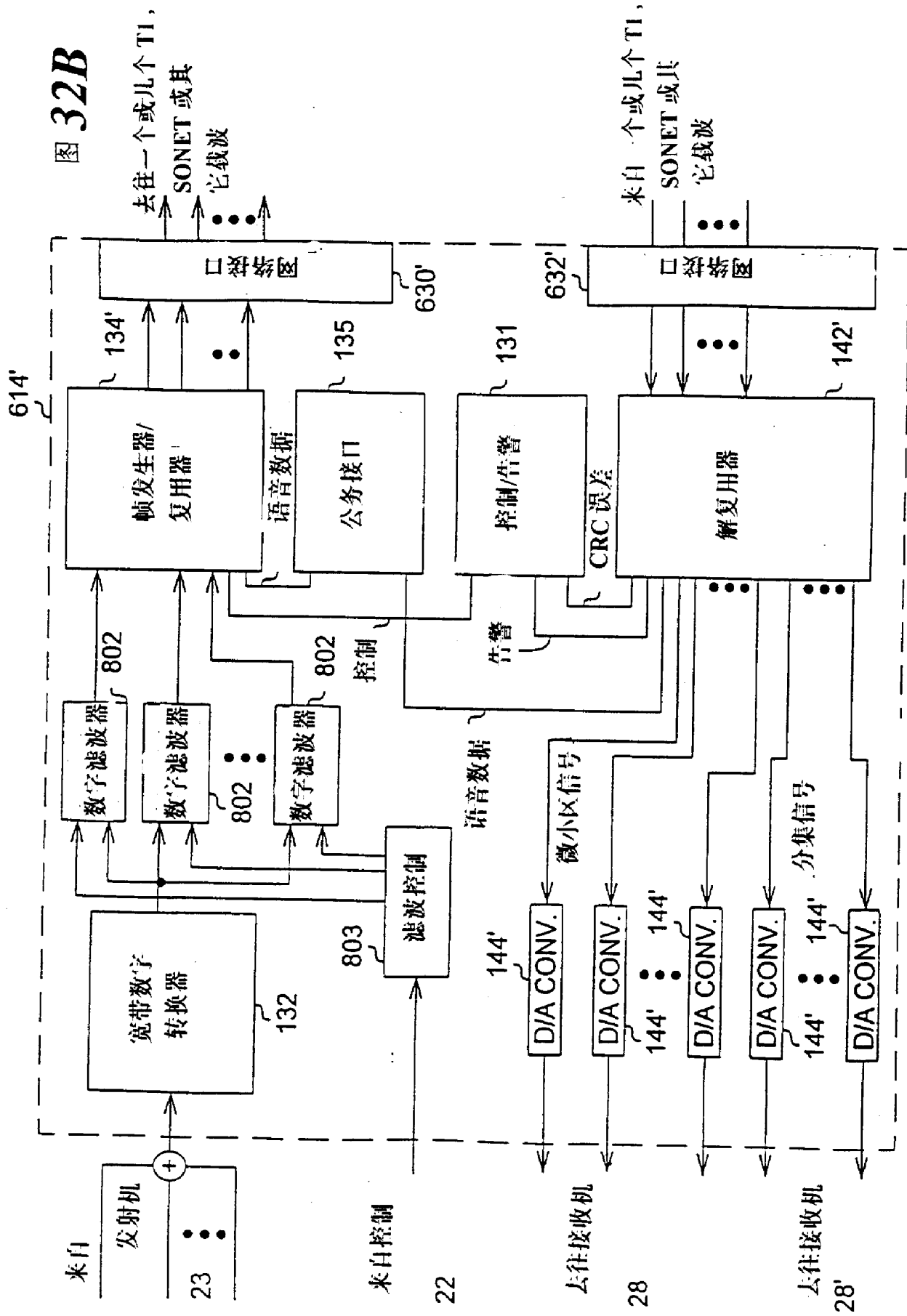
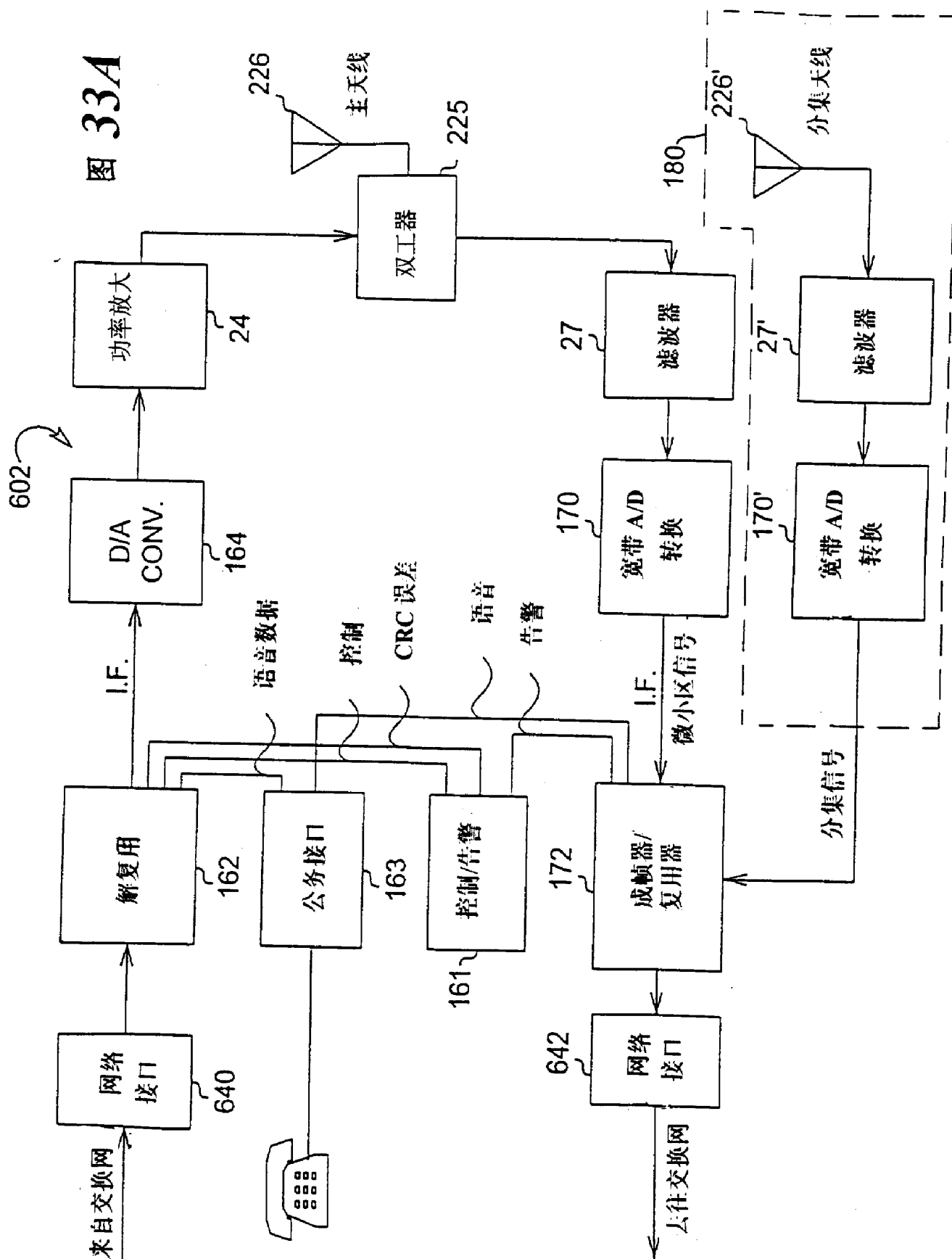


图 32A

图 32B





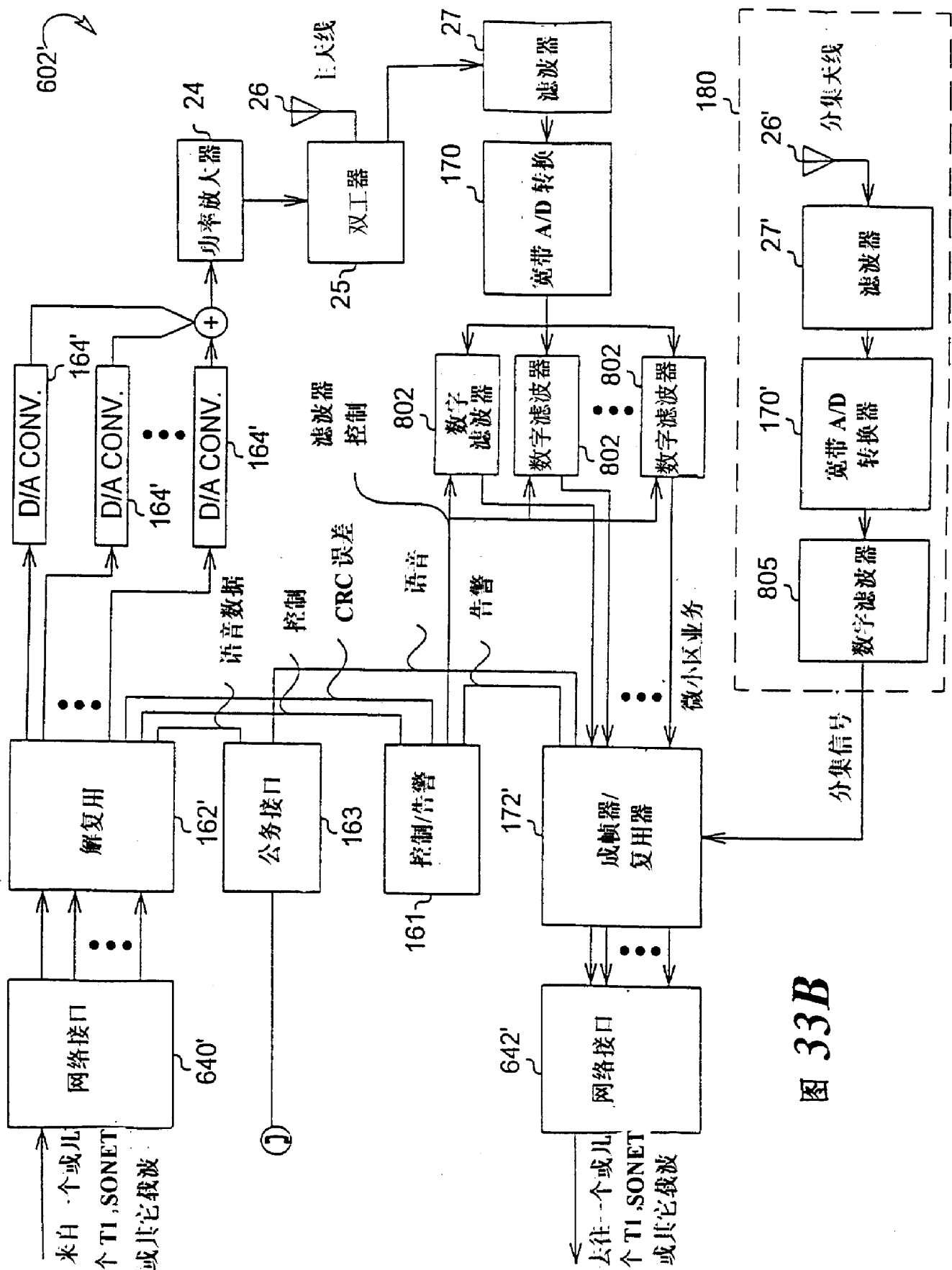


图 33B

图34

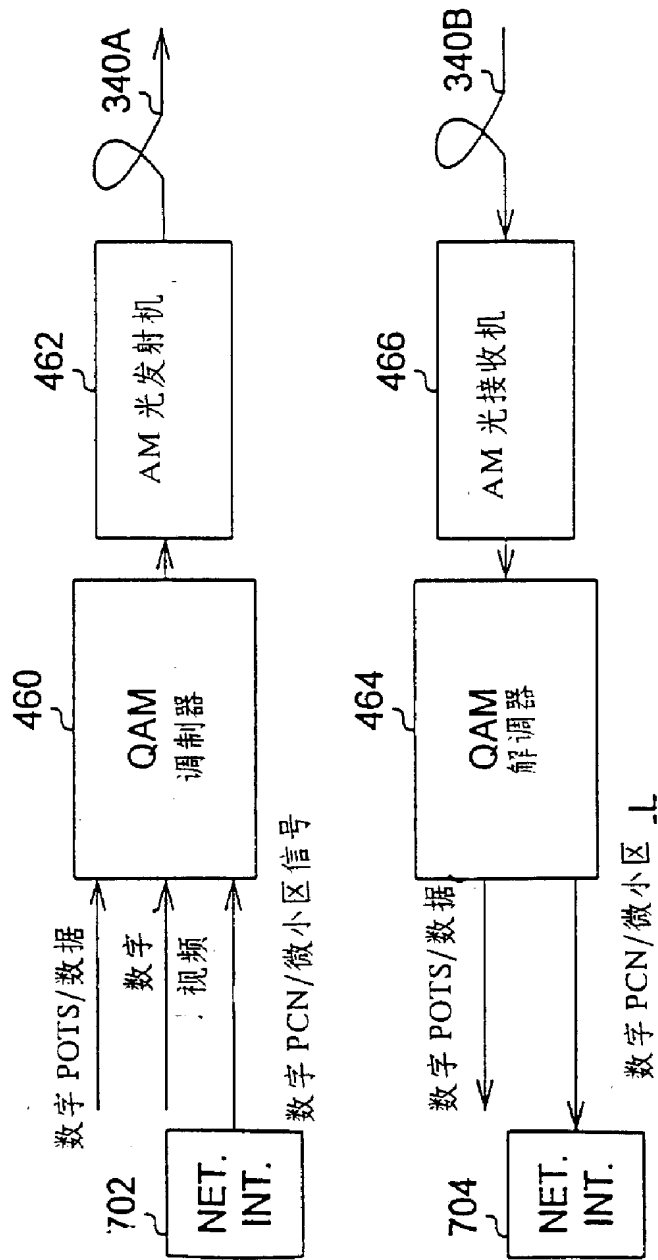


图 35A

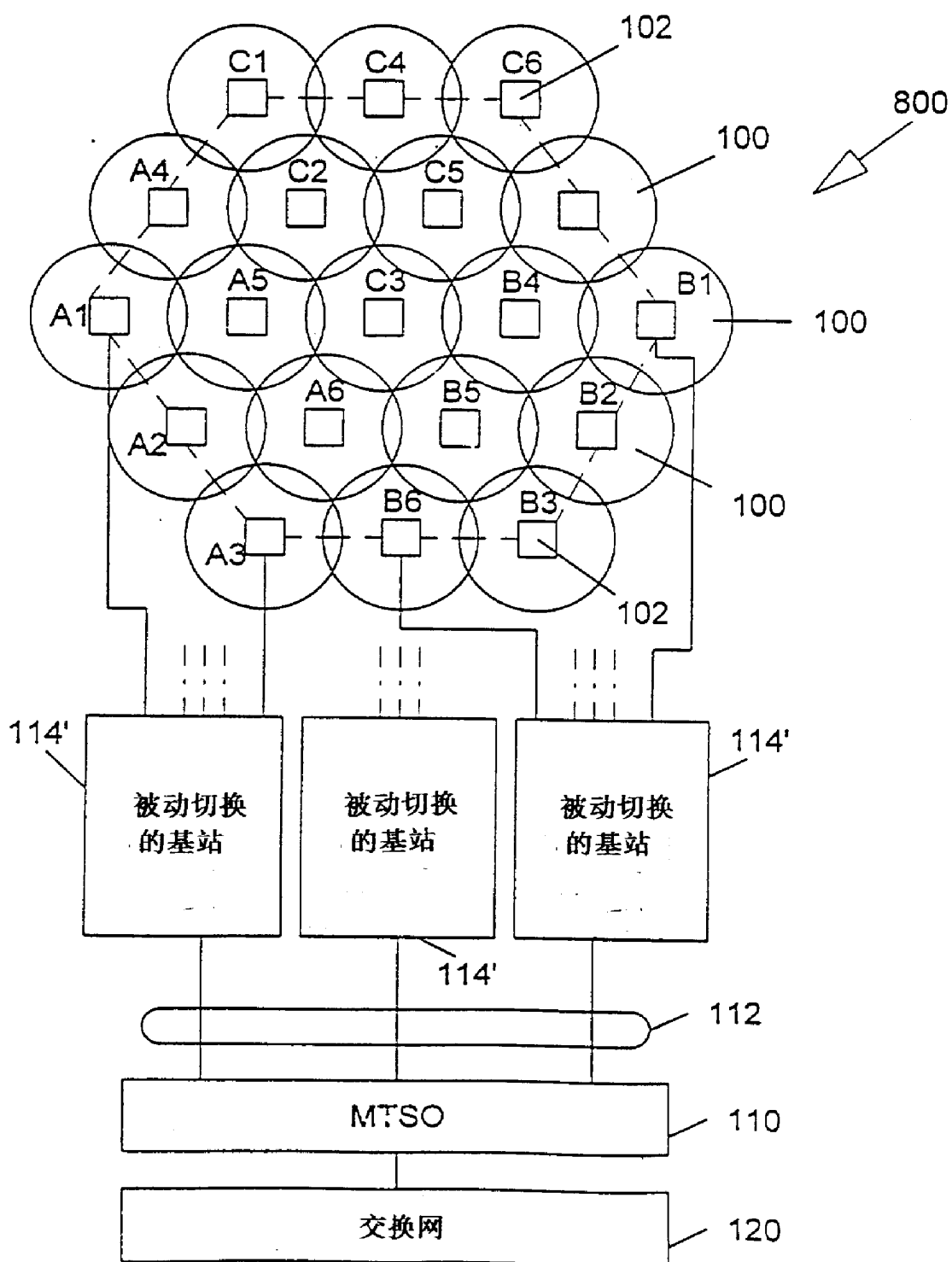


图 35B

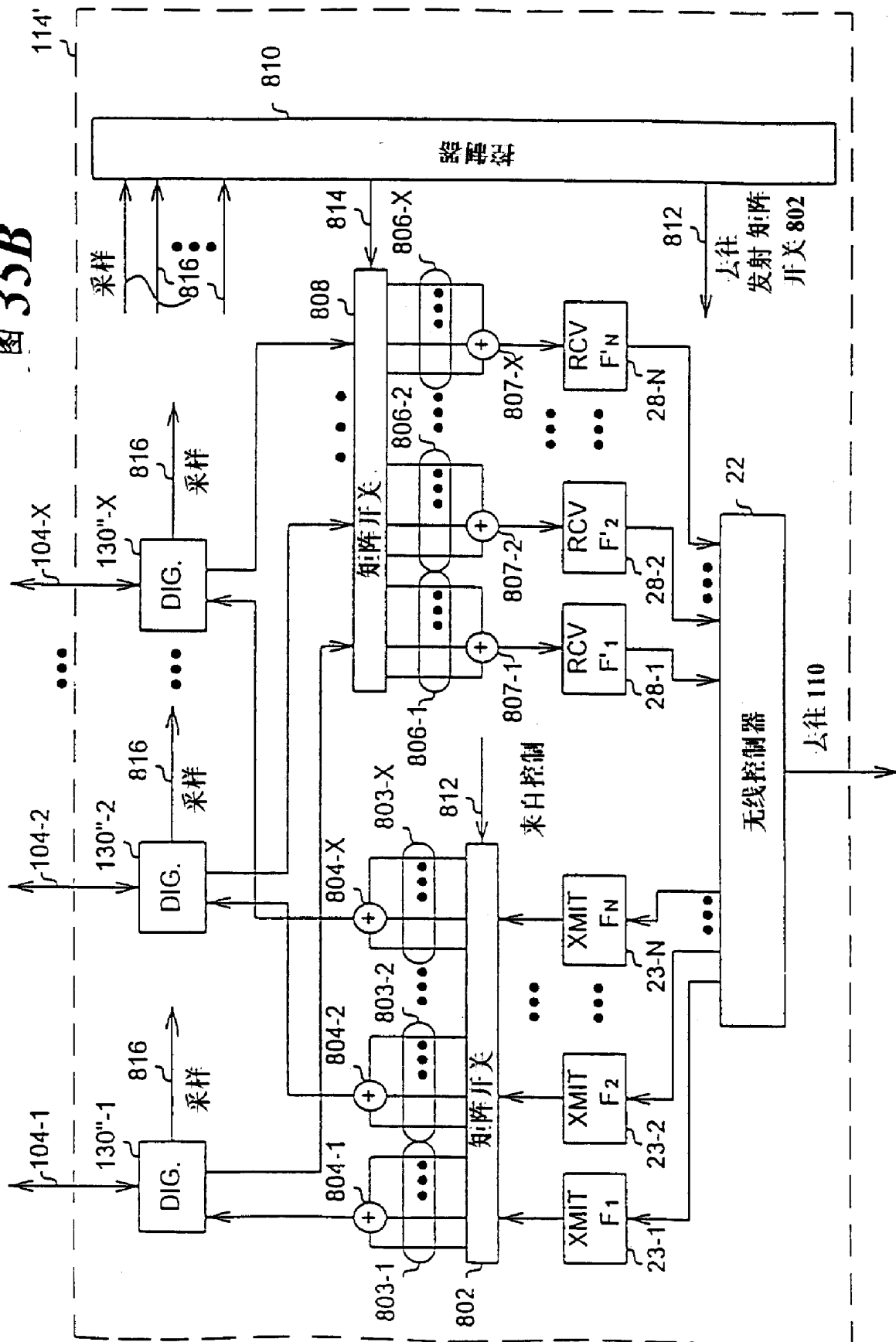


图 35C

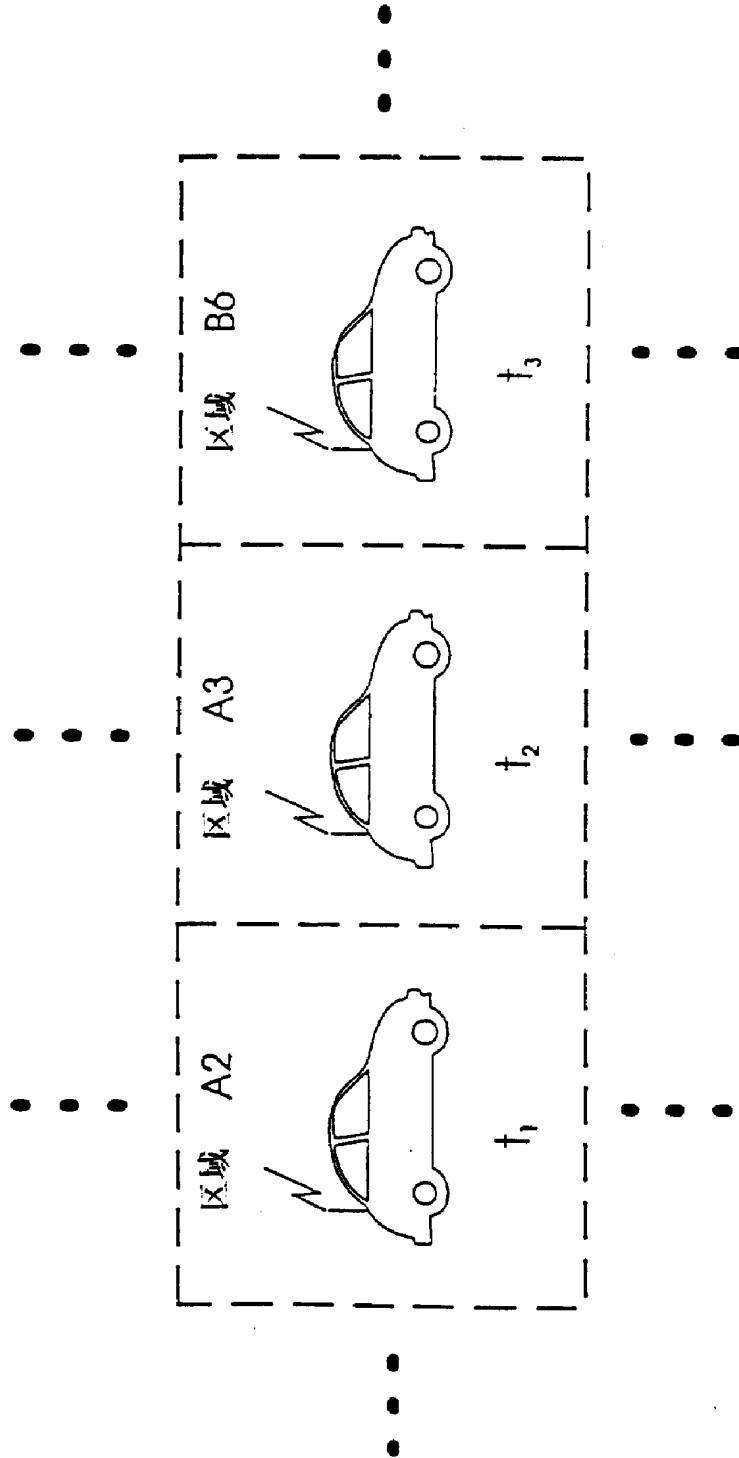


图36

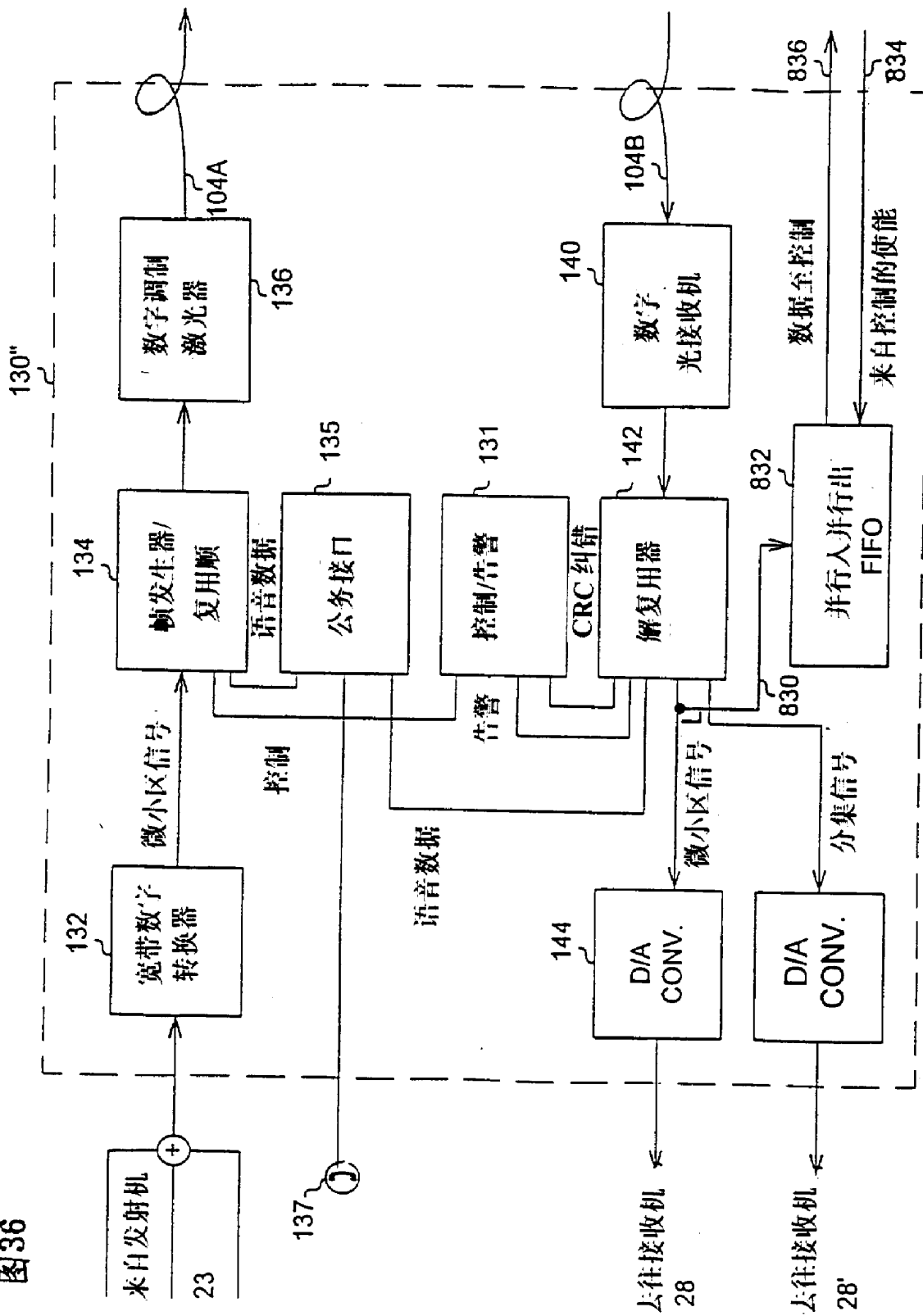


图37

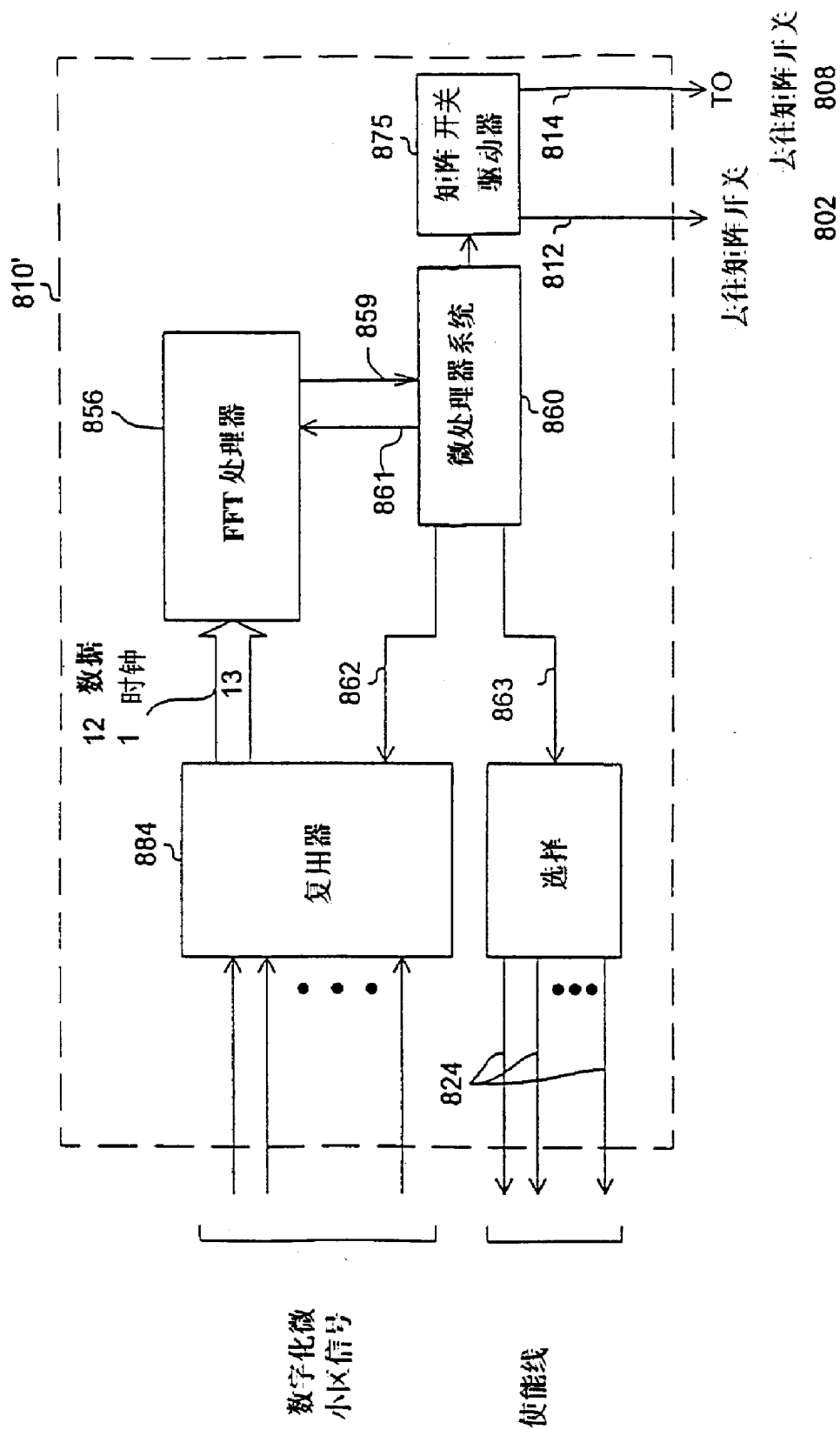
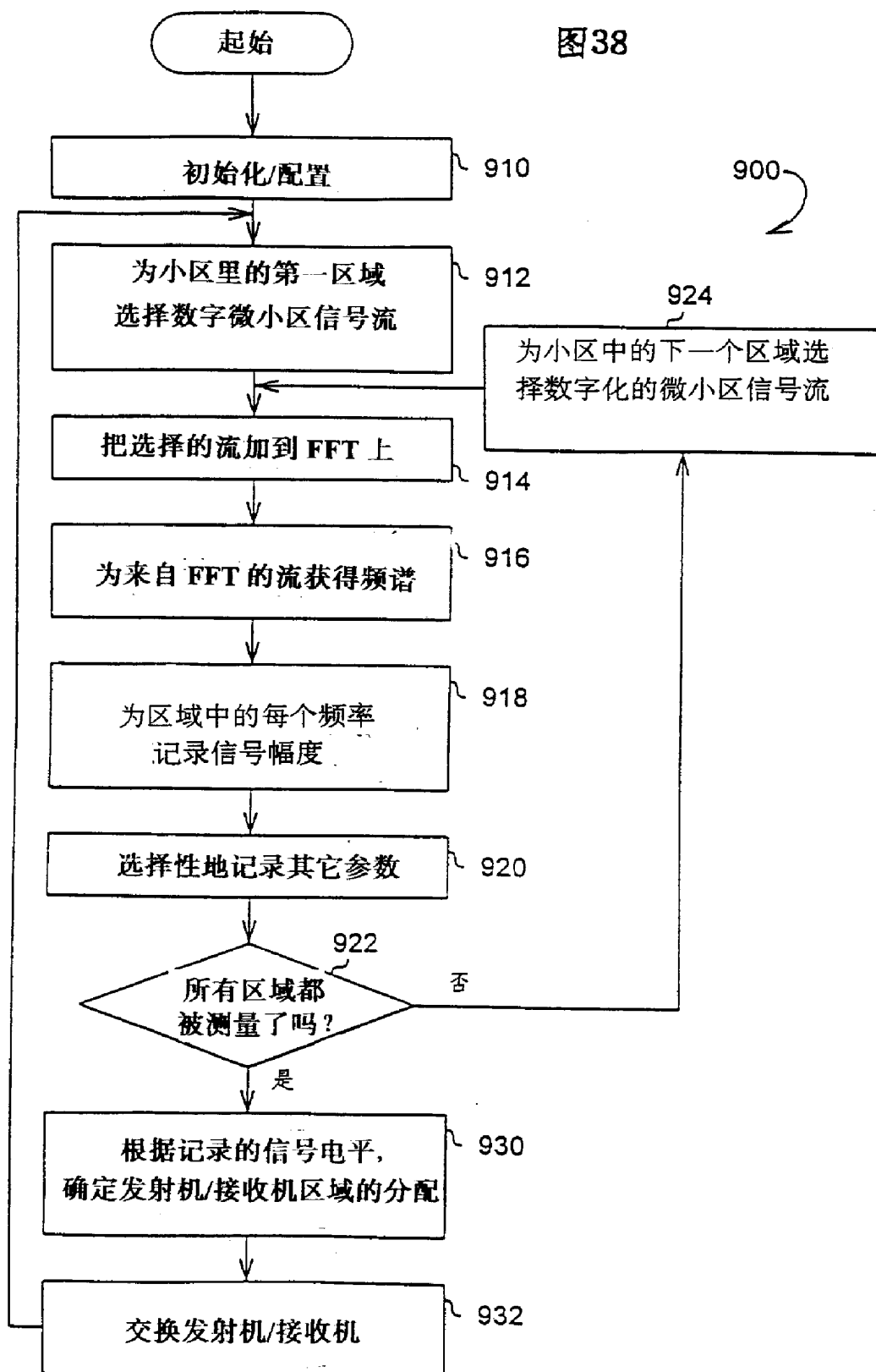


图38



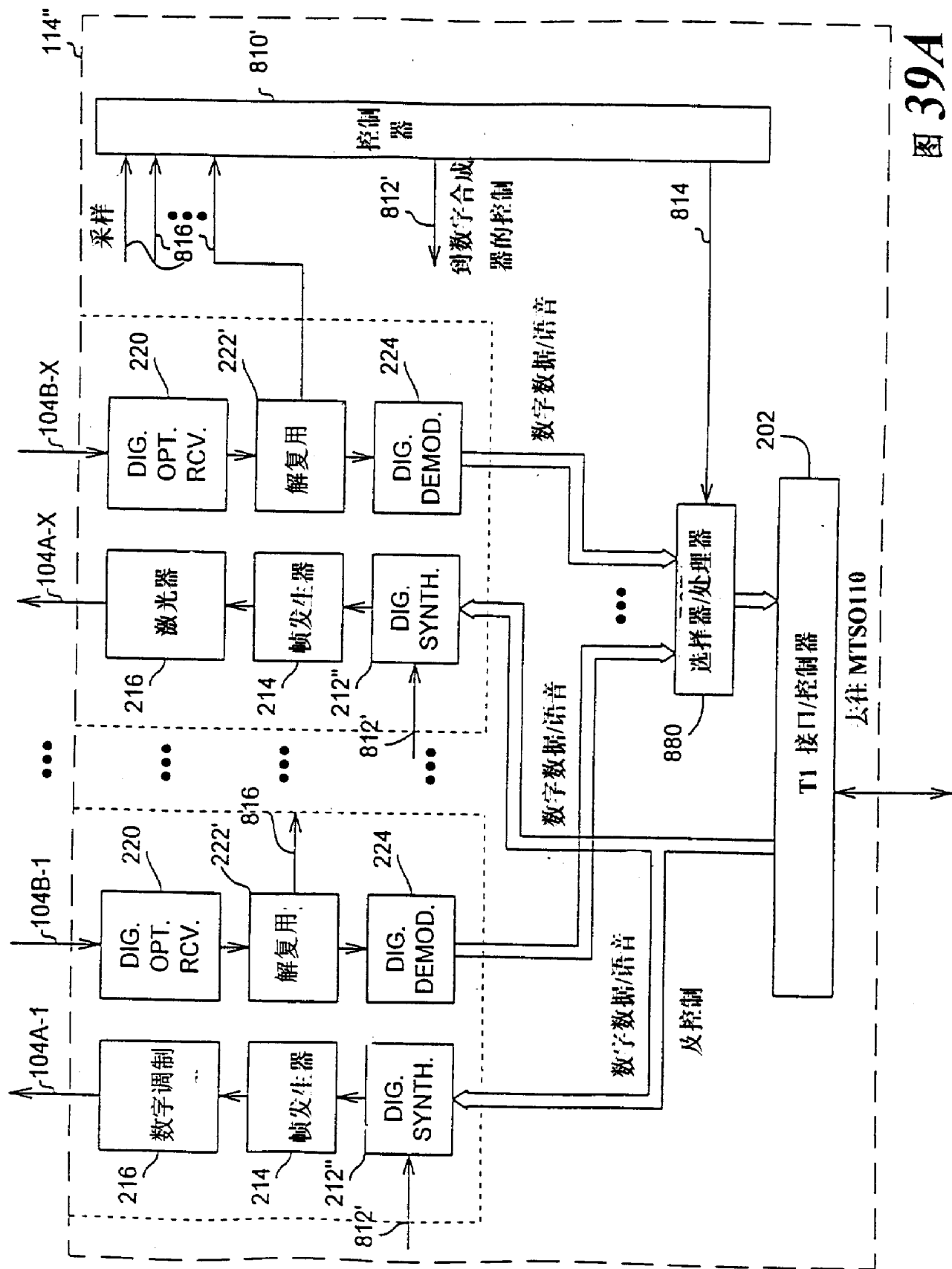


图 39A

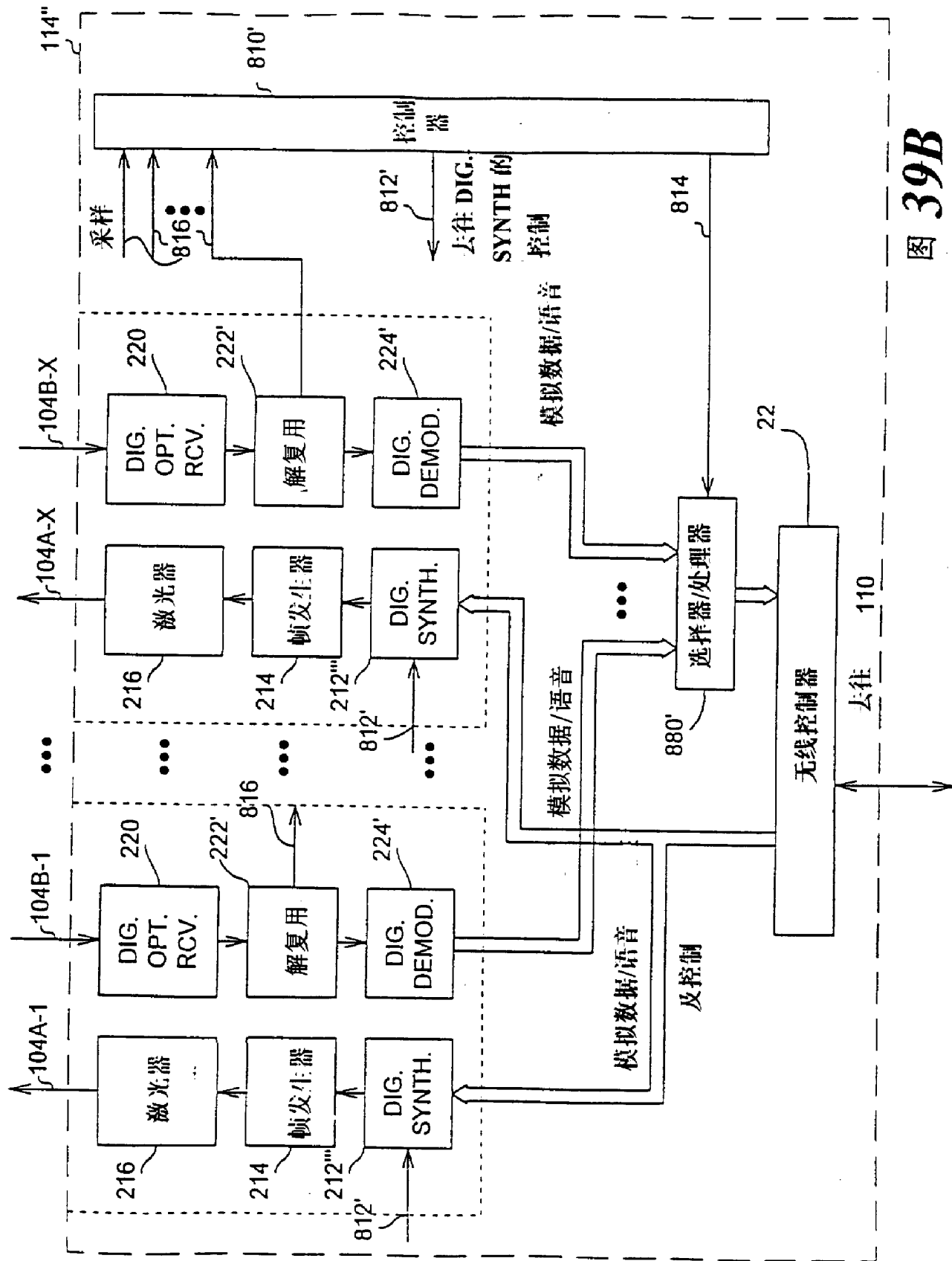
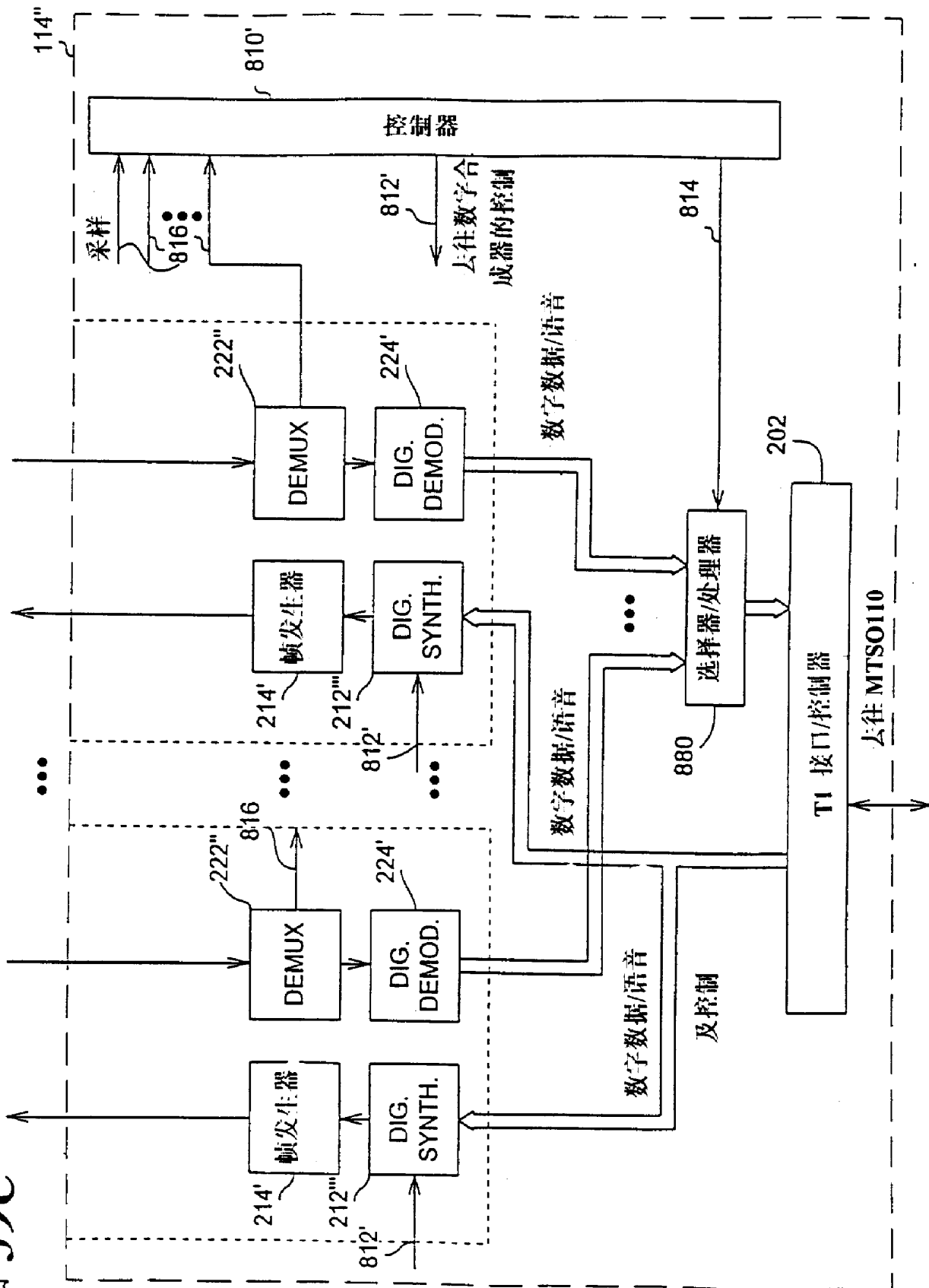


图 39B

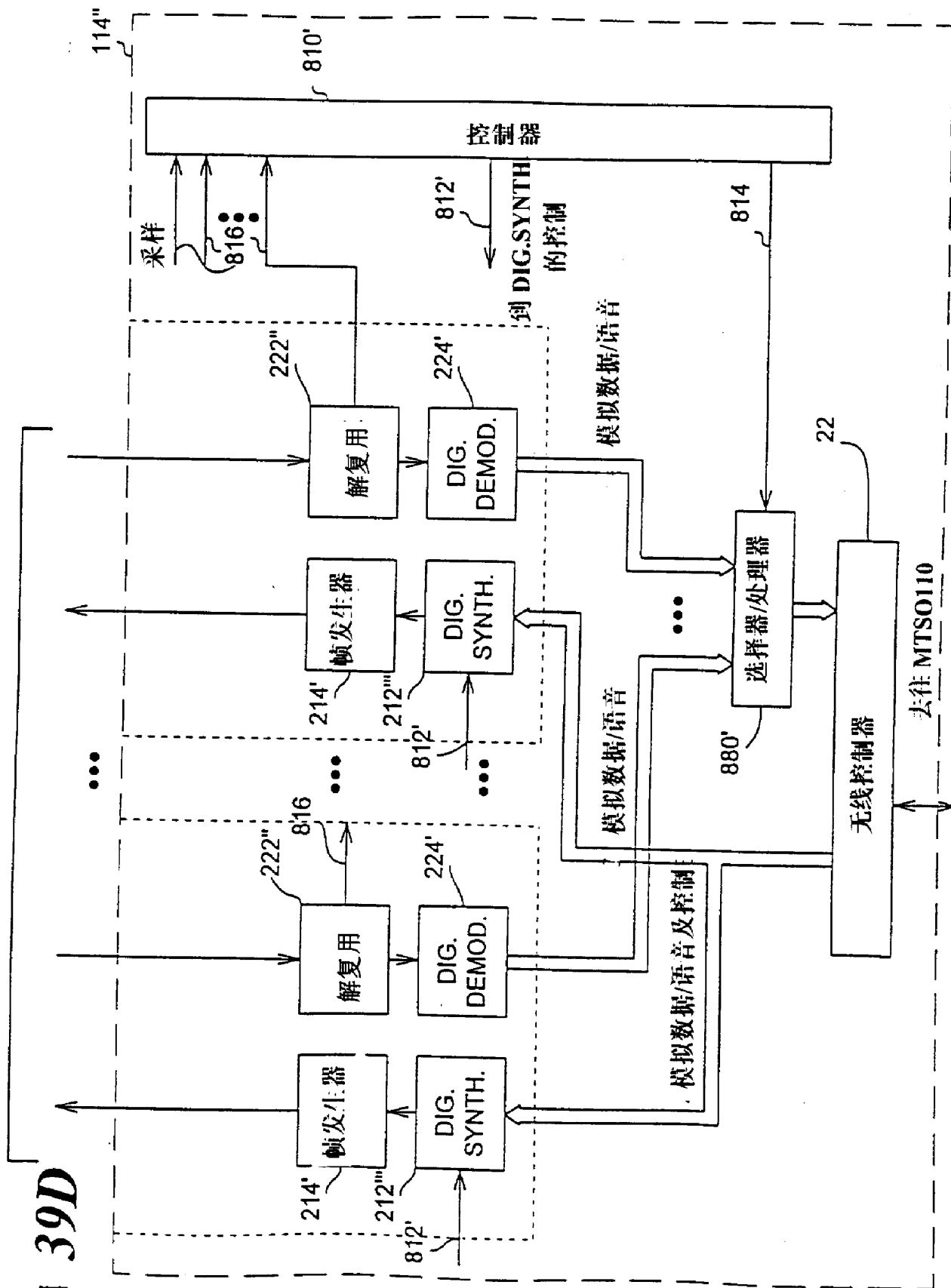
去往/来自交换网

图 39C



去往/来自交换网

图 39D



去往/来自交换网

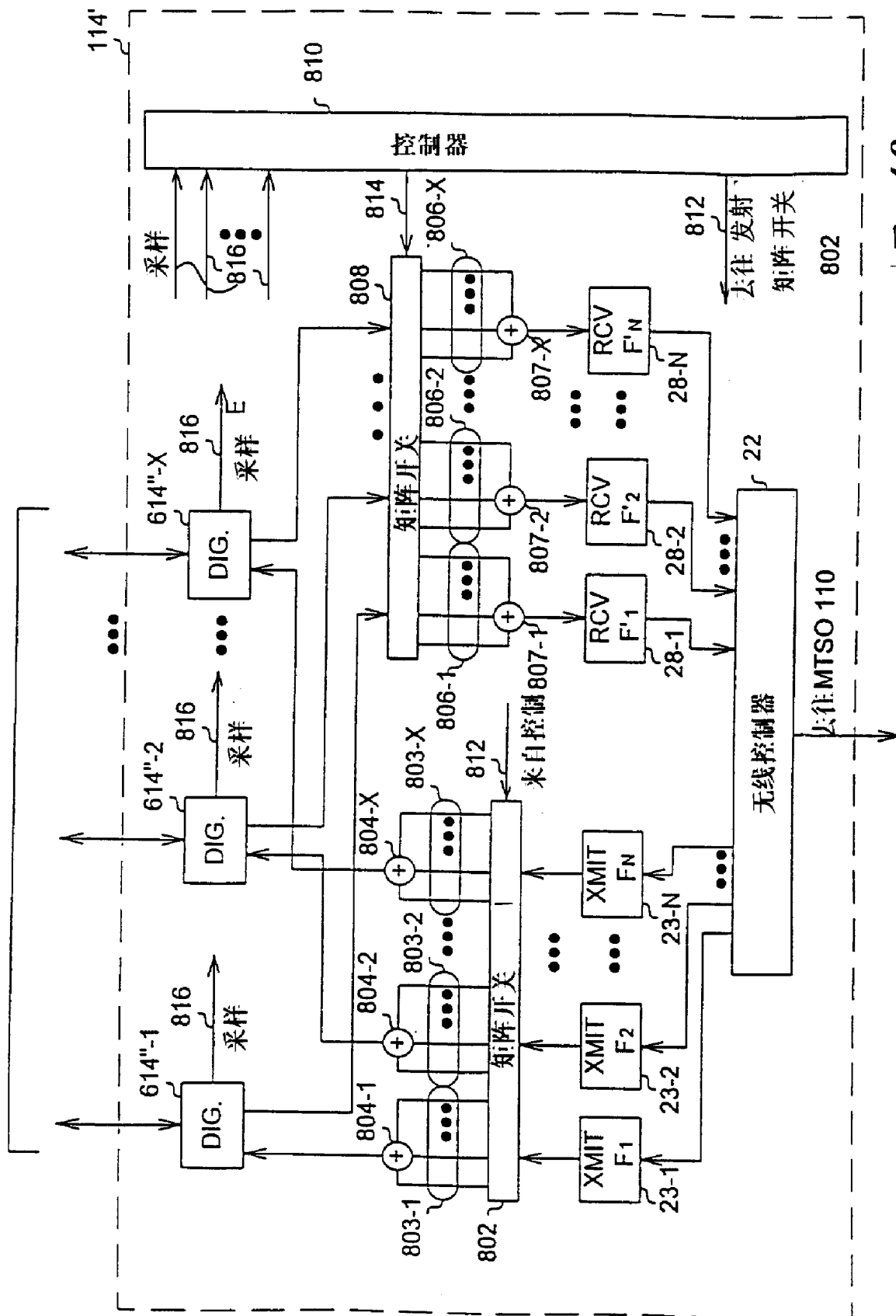
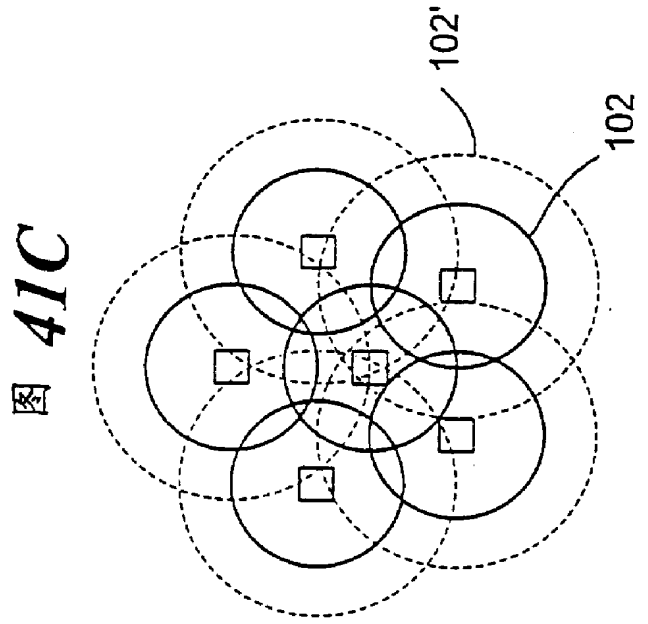
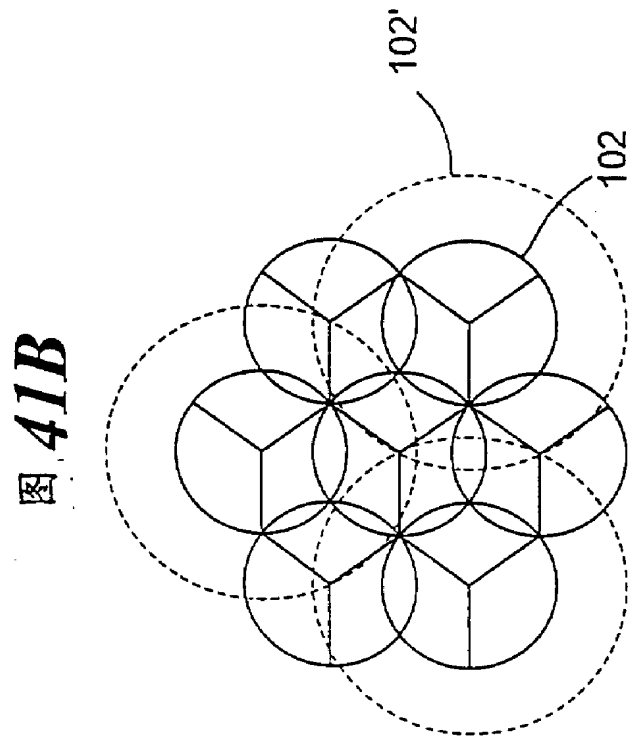
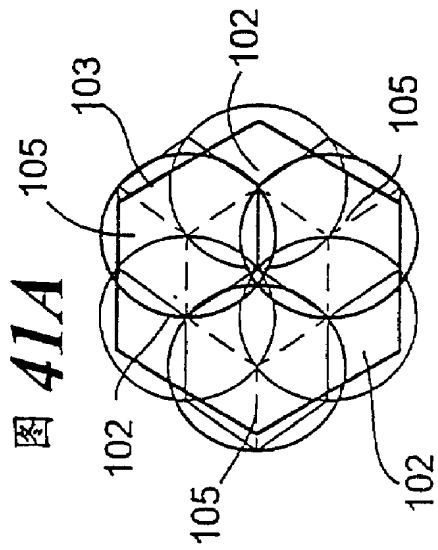


图 40



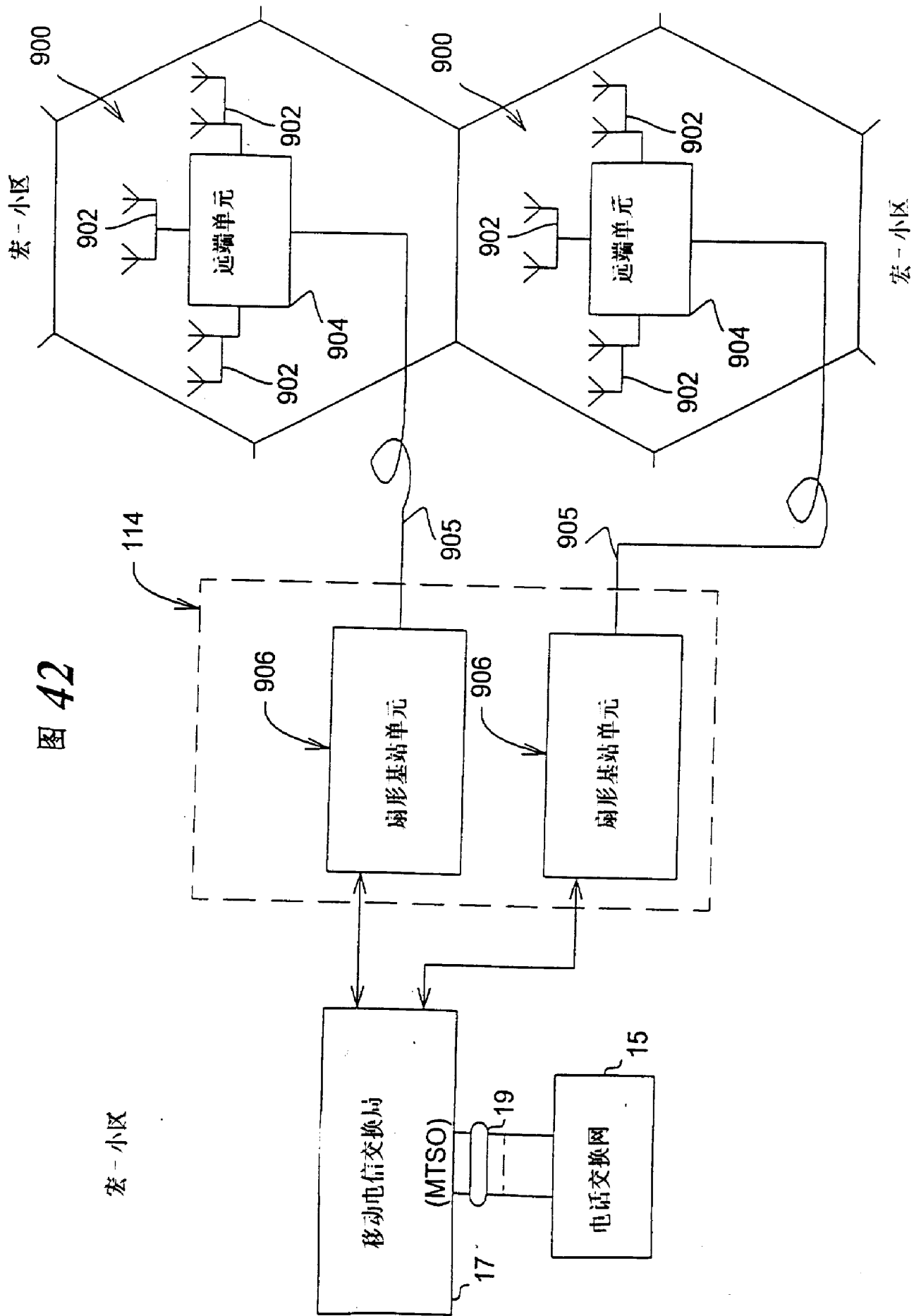


图 42

图 43

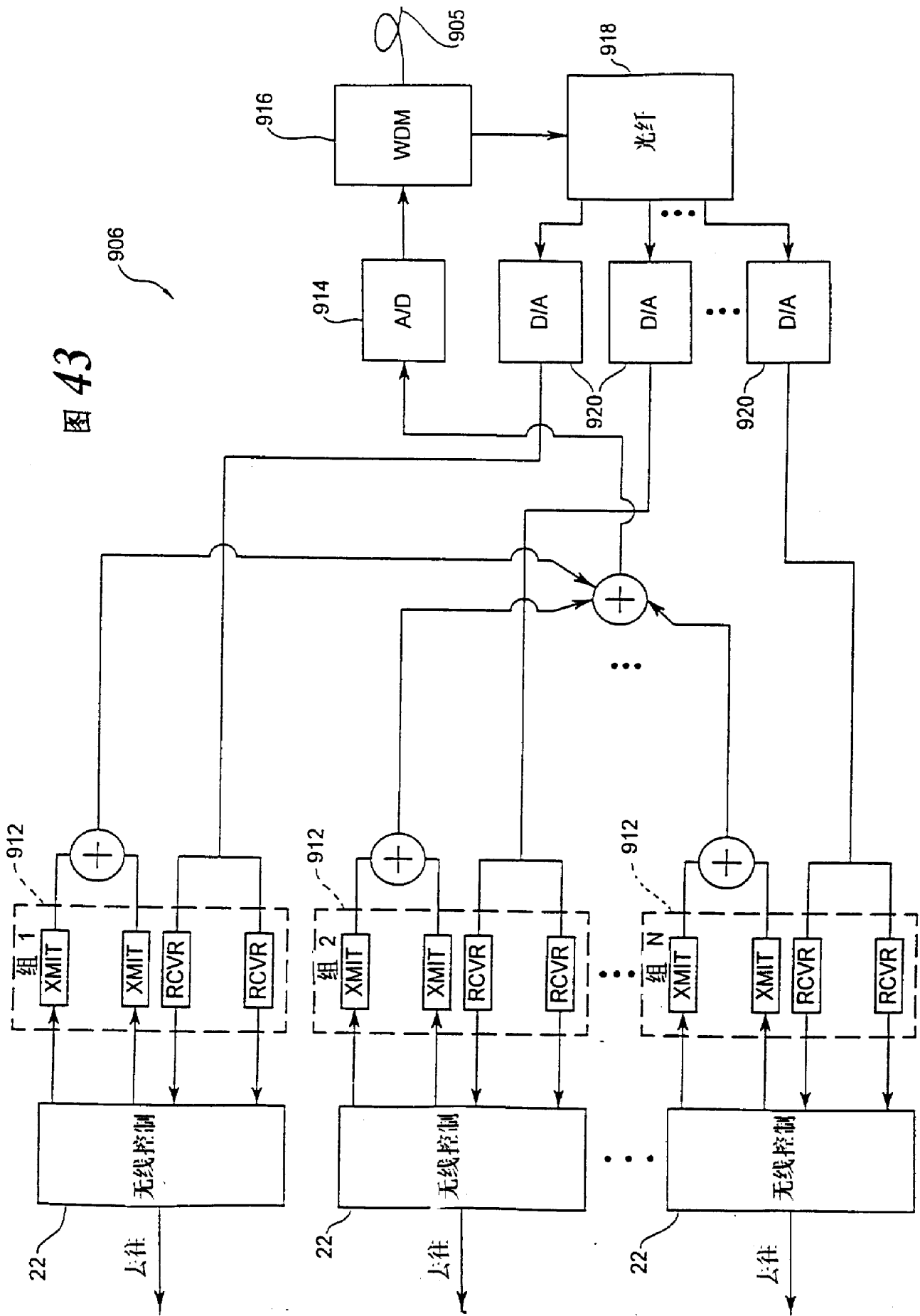


图 44

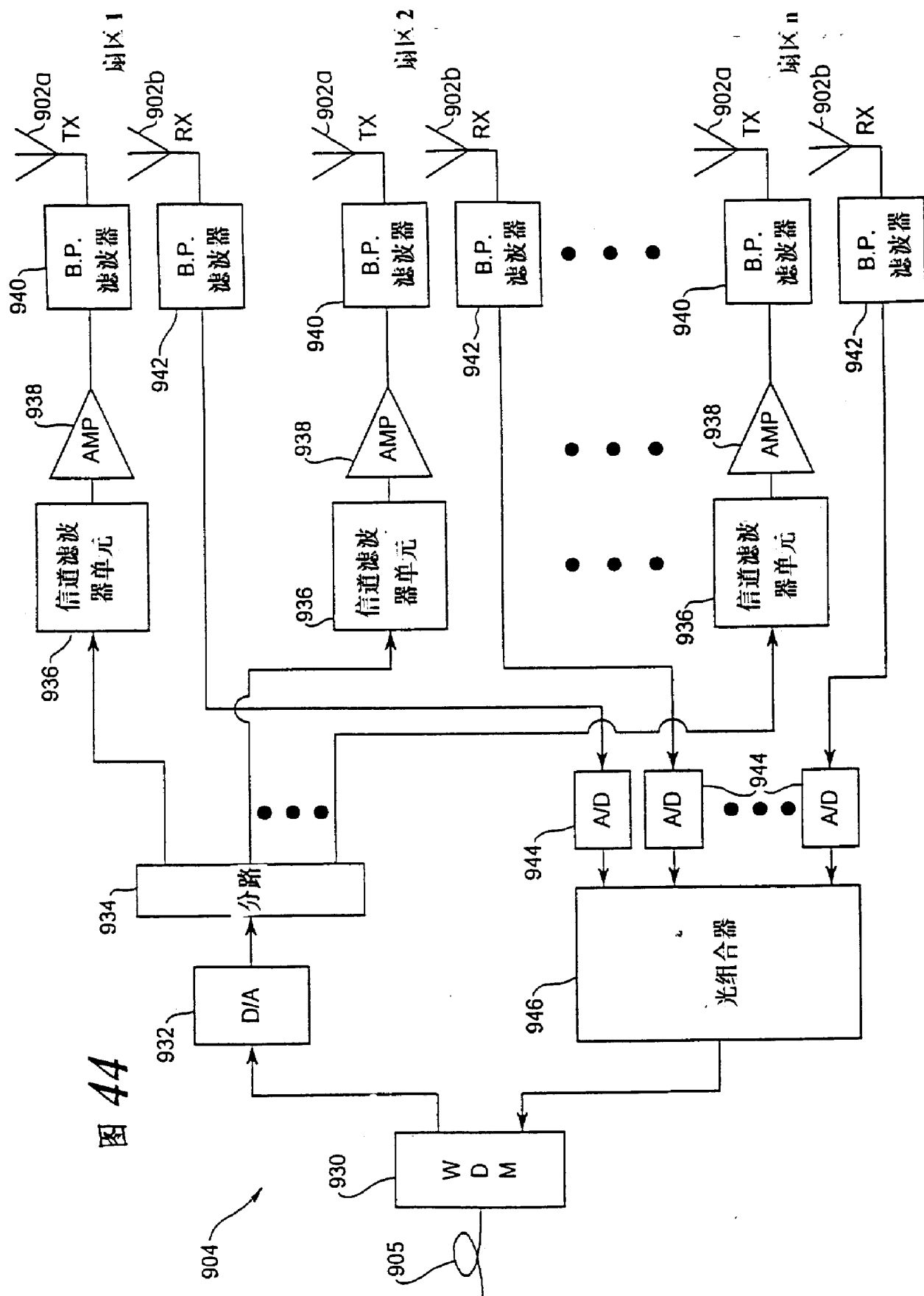
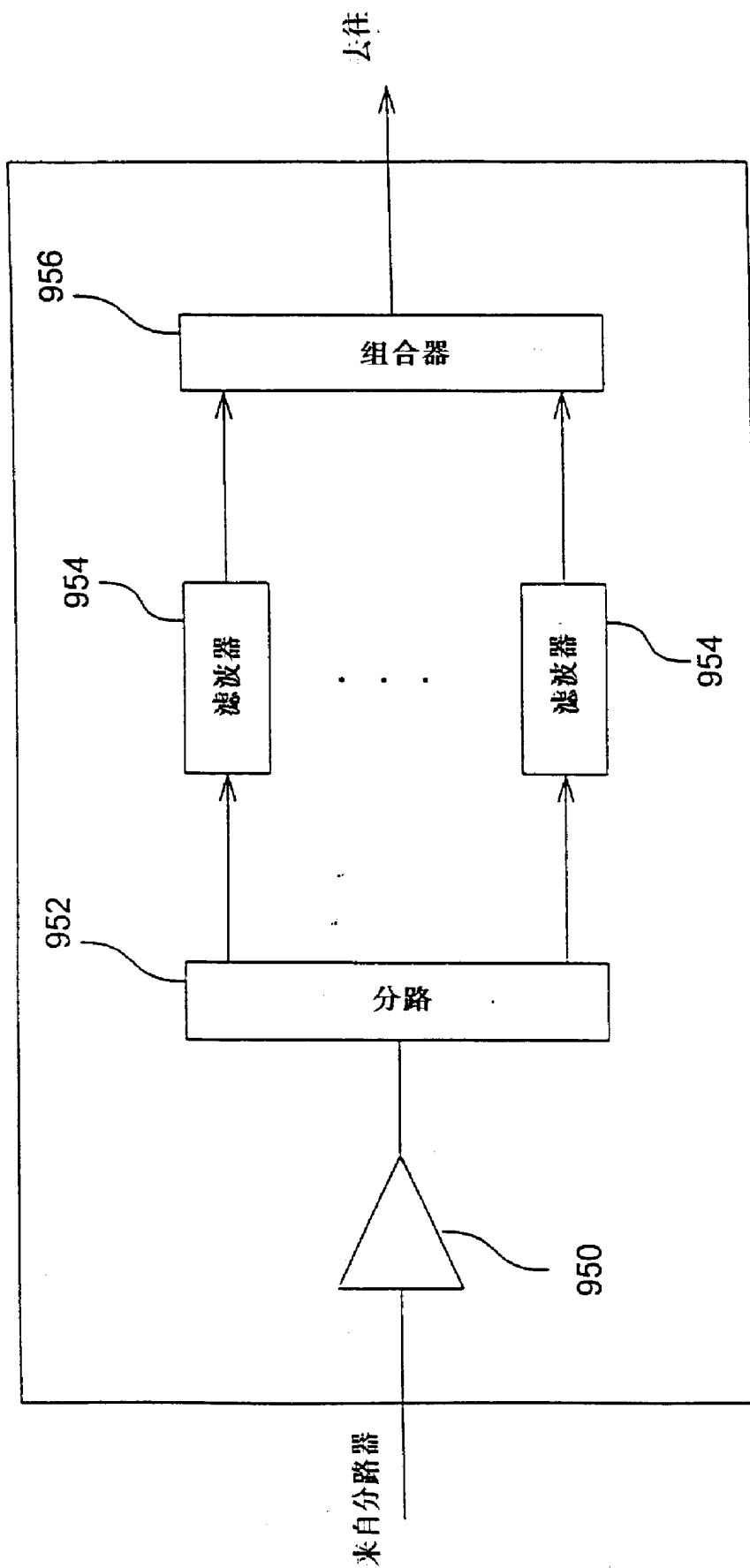


图 45



46

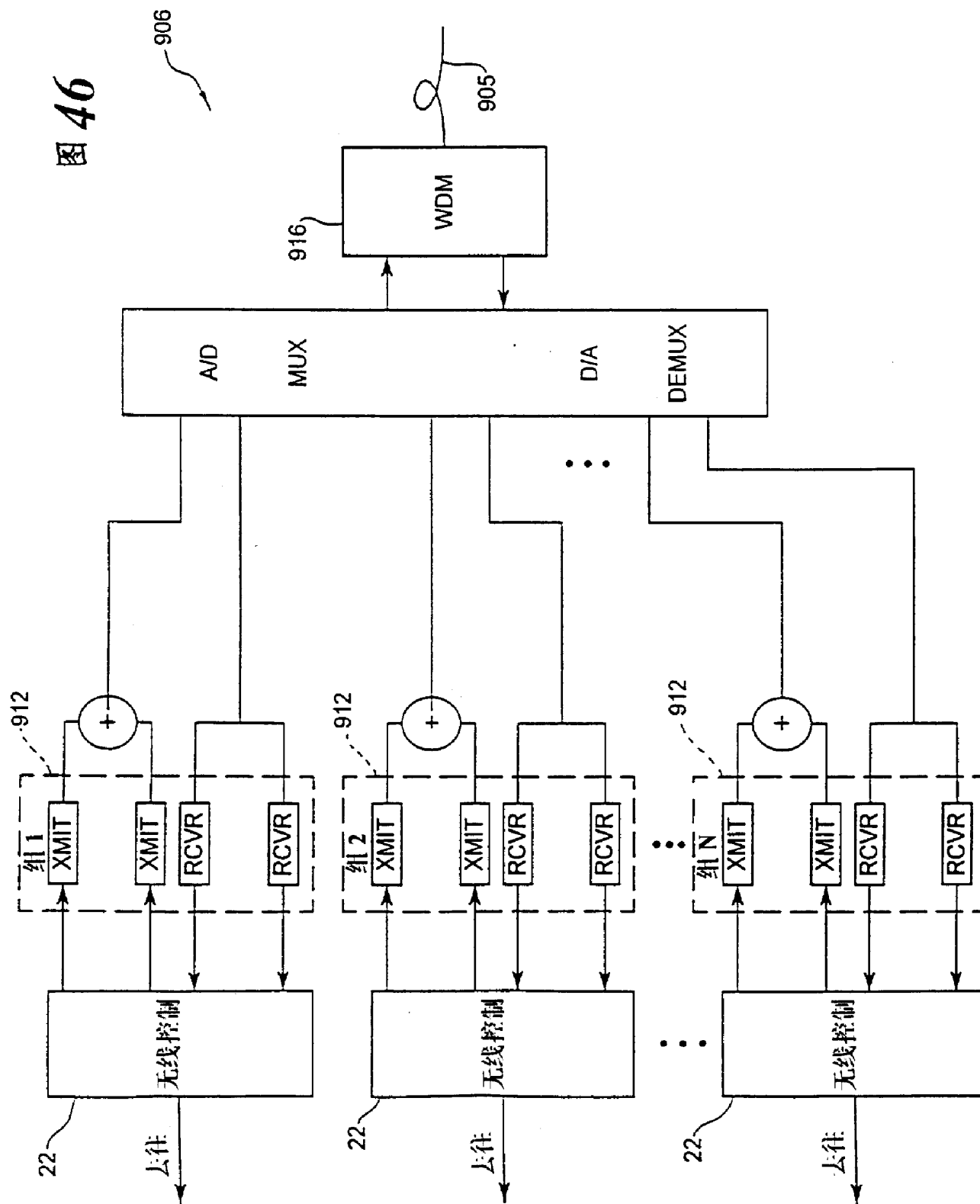
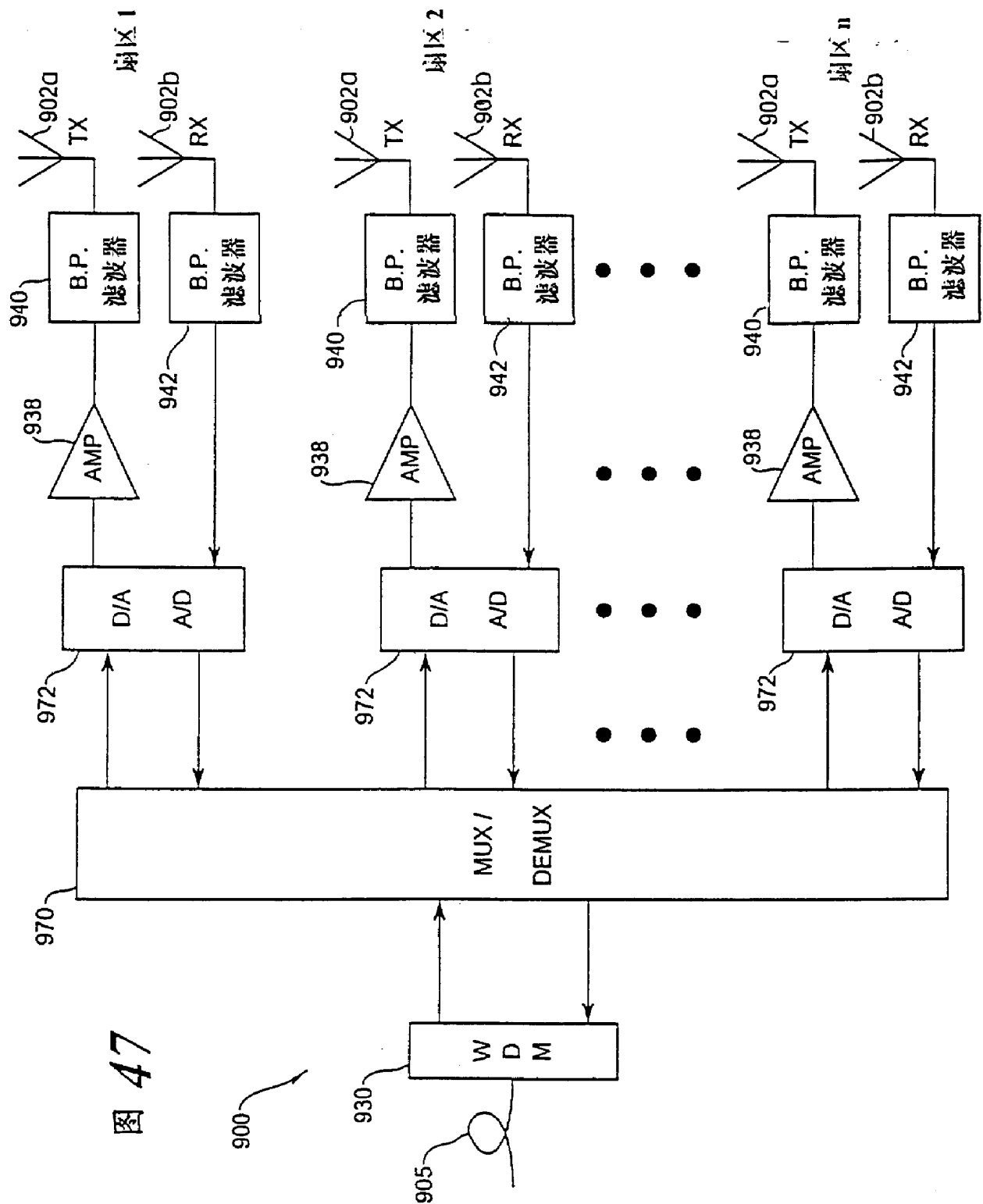


图 47





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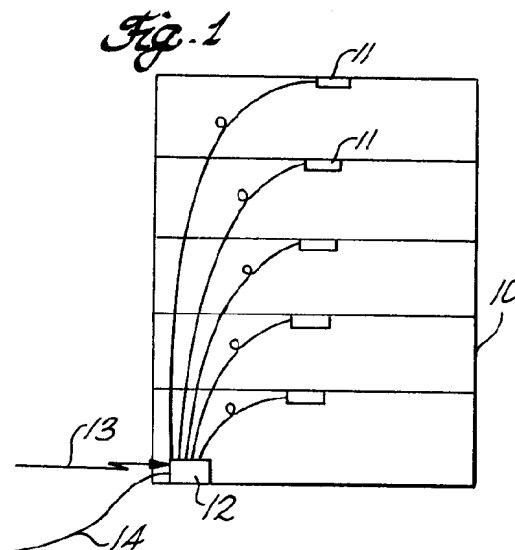
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(54) **Optical fiber RF signal distribution system.**

(57) A fiber optic RF signal distribution system has a plurality of antenna stations (11), each station including an RF antenna. A central RF signal distribution hub (12) receives and transmits signals within and external to the system. A pair of optical fibers (28,31) connects each antenna station (11) directly to the distribution hub (12) with the connections being in a star configuration. A connectorized laser module permits direct coupling of a distributed feedback semiconductor laser to the end of each optical fiber (28,31) without an intervening connector. The module accepts an APC connector (29) with the angled end of its optical fiber in an aperture plane in a connector housing (41). A distributed feedback laser (39) is mounted in the connector housing with a lens for illuminating the aperture plane and hence, the end of the fiber at an acute angle to the axis of the fiber. Furthermore, the illumination is defocused at the aperture plane for loose optical coupling to the fiber and minimized reflection to the DFB laser (39).



This invention concerns a local area wireless network using optical fibers for distributing signals to and from short range antenna stations. A semiconductor laser is mounted in a connector housing for illuminating the angled end of an optical fiber in a connector for minimized reflection interference. A connectorized photodiode is also used for receiving signals from an optical fiber.

Wireless cellular telephone and similar communication systems have proliferated rapidly and are expected to expand dramatically in numbers of users. Furthermore, whereas present cellular telephone systems have a limited capacity sufficient for voice communications and limited handling of data, much broader band systems are expected for handling vast amounts of information for personal and business communications. New systems are needed for this expanding utilization.

It is common practice to increase the overall system capacity by dividing the system into ever smaller cellular units known as microcells. Optical fibers have heretofore been used to interconnect cellular base stations with large microcells, but it has not been considered cost effective to use fiber optics for smaller microcells. Thus, a low cost optical fiber signal distribution system is desirable for use in such microcells or for local area distribution of other RF signals.

In an RF signal distribution system, an individual building or a campus of buildings might, for example, have numerous short range RF antennas scattered within the building or buildings. Communications from outside this microcell or group of microcells are to and from a base station which is connected to an RF signal distribution hub for the building or buildings. Signals are transmitted and received between the hub and the scattered RF antennas for communicating with telephones or data transceivers within the microcell. Such a local network may also serve as a wireless PBX or LAN for communications within the microcell.

There are a number of advantages to such a system. For example, by handling some of the communication paths in a microcell instead of an entire cell of a cellular system, the capacity of the cell can be increased. The bandwidth that can be used for data transmission can be larger when such local area networks are used. Since a telephone or other portable device needs to communicate only over a short range, its power requirements can be decreased, thereby increasing its battery lifetime.

It is important, however, since a large number of antenna stations are needed in such a microcell, that each of the stations have a low cost. This low cost includes not only the components used, but also the ease of assembling a system with a few standardized devices to keep assembly and installation costs low.

It would be desirable to have a low cost reliable optical fiber system for such an RF signal distribution

system for a number of reasons. Optical fibers and the lasers and photodetectors used with them are capable of handling very high data rates at low cost. The attenuation by fibers is very low; negligibly low for in-building distances. The RF levels at the antenna stations are therefore nearly independent of their distance from a distribution hub. Fiber is light, flexible and requires relatively little labor to install. Special electrical shielding is not required for preventing radio interference. Such systems can operate with very high reliability and low power consumption. However, no suitable low cost fiber optic systems or components are known.

There is, therefore, provided in practice of this invention a fiber optic RF signal distribution system for a building, for example, having a plurality of antenna stations distributed through the building, with each antenna station including an RF antenna. A single RF signal distribution hub receives and transmits signals within the system. A pair of optical fibers connects each antenna station directly to the RF signal distribution hub.

A typical RF signal distribution system has an RF signal distribution hub for receiving and transmitting signals external to the system or communicating signals within the system. A plurality of electrical to optical converters at the hub convert received electrical signals to outgoing optical signals. Preferably, such an electrical to optical converter comprises an RF modulated distributed feedback semiconductor laser. Similarly, a number of optical to electrical converters at the hub convert incoming optical signals from an optical fiber to electrical signals for transmission outside or back into the system. Conventional photodiodes are suitable optical to electrical converters.

The RF signal distribution hub communicates with a plurality of antenna stations by optical fibers. Each of the antenna stations has an RF antenna, a photodetector for sensing outgoing optical signals and means for connecting the photodetector to the antenna for broadcasting an outgoing RF signal. For incoming optical signals, each antenna station comprises a laser and means for connecting the antenna to the laser for converting an incoming RF signal to an incoming optical signal.

The electrical signals may be reconverted to an optical signal for transmission external to the RF signal distribution system. Similarly, the external signals may be originally received as optical signals and converted to electrical signals for processing before being reconverted to an optical signal for distribution in the system.

This invention provides a low cost RF signal distribution system having an electrical to optical connector housing for receiving a connector with an angled end of an optical fiber, such as a standard angled physical contact (APC) connector. An RF modulated distributed feedback semiconductor laser is mounted

in the housing with a lens adjacent to the laser for directing light to an aperture plane in the housing. The laser and the lens are offset from the axis of the housing so that light from the laser passes through the aperture plane at an acute angle relative to the axis of the housing. Furthermore, the laser and lens are spaced so that the area of the aperture plane illuminated by the laser is larger than the end of an optical fiber. An APC connector can be mounted in the housing with the angled end of its optical fiber in the aperture plane for illumination by the laser.

These and other features and advantages of the invention will be appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 illustrates schematically a building having an RF signal distribution hub and fiber optics connected to a number of RF antennas;

FIG. 2 illustrates schematically such a hub connected to antenna stations;

FIG. 3 illustrates schematically an exemplary fiber optic transceiver for use in such a system;

FIG. 4 illustrates schematically a fiber optic antenna station;

FIG. 5 illustrates in perspective an electrical to optical connector housing;

FIG. 6 is a schematic diagram of such an electrical to optical connector housing;

FIG. 7 is a longitudinal cross section through such a connector housing;

FIG. 8 is a transverse cross section through an optical isolator for use in the housing of FIG. 7; and

FIG. 9 is a schematic diagram of a photodiode in a connector housing.

An RF signal distribution system for a multi-floor building 10 has one or more antenna stations 11 distributed through the building. Each of the antenna stations includes an RF antenna for broadcasting signals to and receiving signals from devices within range of the antenna. Such an antenna station is small and unobtrusive, appearing not much different from the smoke detectors which are ubiquitous in homes, offices and hotels. Antenna stations may be located above drop ceilings in business buildings and not be seen at all. Several such antenna stations may be placed on ceilings or walls on each floor of such a building. Alternatively, such short range antenna stations may be located in several adjacent buildings. The building has one or more RF signal distribution hubs 12 for communicating inside or outside the building.

For purposes of this description a convention has been adopted. A "received signal" means a signal received from outside the system. A "transmitted signal" is a signal transmitted to outside the system. An "outgoing signal" refers to a signal transmitted from

the RF signal distribution hub to an antenna station or user. An "incoming signal" is a signal transmitted from an antenna to the RF signal distribution hub. The same convention is used, for example, for designating the optical fibers used in the system as "outgoing" or "incoming".

Signals external to the system may be transmitted and received as radio signals 13 as in a cellular network or may be transmitted and received via a fiber optic cable 14 or copper wires 15. The hub also includes an RF interface unit 16 which converts a received signal into an outgoing RF electrical signal at 17 and converts an incoming RF signal at 18 into a transmitted signal for transmission outside the system. The outgoing RF signal is applied to one or more fiber optic transceivers 21 which convert the RF electrical signal to an optical signal. The outgoing RF signal passes through an RF splitter 19 for application to several fiber optic transceivers. Similarly, multiple incoming RF signals from several transceivers are summed in an RF combiner 20.

In the case of signals entirely within the system, i.e. from one antenna station to another antenna station or between two devices within a sector, incoming optical signals are converted to electrical signals via fiber optic transceivers, processed by the RF interface unit, routed by an local area network server or the like (not shown) and returned as outgoing signals to appropriate fiber optic transceivers.

Each fiber optic transceiver serves a sector of the building. Such a sector may be a floor of the building, a suite of offices, a department or the like. Each sector is served by an antenna station 22. A fiber optic cable 23 connects each of the antenna stations with one of the fiber optic transceivers. Each of the fiber optic cables comprises an outgoing optical fiber for conveying an optical signal from the transceiver to the antenna station and an incoming optical fiber for conveying an incoming signal from the antenna station to the receiver. Typically, the cable also includes a DC power supply circuit for operating the antenna station, or the antenna stations may be locally powered.

In some cases it may be more economical to use a combination of fiber optic and coaxial cables for serving a sector. In such a situation one may add antennas 38 to a sector's antenna station 22 by connecting the antennas to a coaxial cable 24 by RF couplers 25.

The antenna stations are connected to the RF signal distribution hub by fiber optic cables arranged in a star configuration. A conventional network may have the stations connected in a loop or "daisy chain" where each station is connected in turn to the next station around the loop. Another common network configuration is tree and branch as is used for cable television signals, for example, where a signal from a central station goes to a remote location where it is

split into branches for a number of users.

The fiber optic system provided in practice of this invention has a star configuration or hub and spoke. By having each antenna station 22 connected directly to the RF signal distribution hub, it becomes quite easy to install additional antenna stations. For example, a connection need be made only at the antenna station and at the hub. There is a reliability benefit in that if a connector cable or laser is defective, only one antenna station is degraded and the balance of the network is still operable. In the event individual antenna stations become defective, they can be easily identified and replaced.

A star configuration for a fiber optic local area system has several advantages in addition to robustness and reliability. Such a star configuration system is easily installed since identical cabling and connectors can be used between the hub and the distributed RF antenna stations. Furthermore, the optical fiber connections in a star configuration can be simple and all connections can be identical. The attenuation of optical fibers is negligible throughout a building or campus of buildings so that no specific site engineering is required to assure that a system operates properly for a given installation. Such a system is easily expanded or modified. Such a system has low power consumption.

FIG. 3 illustrates schematically an exemplary fiber optic transceiver 21. An outgoing RF signal is applied to an amplifier 26 and semiconductor laser diode 27. The laser is adjacent to the end of an outgoing optical fiber 28 in a conventional angled physical contact (APC) connector 29. An "outgoing" optical fiber carries a signal from the RF signal distribution hub to an antenna station.

An incoming signal arrives at the fiber optic transceiver from an antenna station by way of an incoming optical fiber 31 with a separate connector 32 to the transceiver. A photodiode 33 is adjacent to the end of the incoming optical fiber and is connected to an amplifier 34 which provides an incoming electrical signal to the RF transceivers.

The other end of the outgoing optical fiber 28 has a connector 36 which plugs into an antenna station 22 as illustrated in FIG. 4. An outgoing photodiode 37 is adjacent to the end of the outgoing optical fiber. The photodiode signal is amplified and applied by way of a coupler 40 to an RF antenna 38 from which the signal radiates to cellular devices within range of the antenna.

An incoming RF signal from a cellular device is picked up by the RF antenna, amplified and applied for modulating a semiconductor laser diode 39. The laser diode is adjacent to an angled physical contact (APC) connector 41 for an incoming optical fiber 31 which transmits the incoming optical signal to the fiber optic transceiver.

An important feature for making a low cost reli-

able fiber optic RF signal distribution system comprises the laser and optical fiber connection. At least one end, and preferably both ends, of each optical fiber in the star configuration includes a conventional APC connector. A typical APC connector has a metal body surrounding a cylindrical ceramic plug through which the end of the optical fiber passes. A threaded nut on the APC connector removably fastens it to a connector housing. The details of the APC connector are not illustrated herein since they are conventional and well known in the art. The ceramic plug of such a connector is illustrated schematically in FIG. 6.

In an APC connector, the end of the optical fiber is flush with the outermost end of the ceramic plug. In conventional use of an APC connector, good optical coupling is provided between the end of the optical fiber and an adjacent similar fiber by physical contact between the ends of the ceramic plugs and hence the ends of the optical fibers. By avoiding an air gap between the fibers, there is good optical coupling. To assure that there is good physical contact between the ends of the optical fibers, the ends of the ceramic plugs are made with a very slight curvature instead of being plane. The curvature has a very large radius so that the end of the fiber is nearly flat. Furthermore, the center of curvature is offset from the axis of the fiber so that there is an acute angle (about 8°) between the axis of the fiber and a radius to the center of curvature. All such connectors have a similar angle so that the contact between the ends of the optical fibers is angled relative to the fibers. This type of construction is the origin of the designation APC, "angled physical contact" connector.

An APC connector is one example of a connector useful in this invention. As will become apparent, other connectors with an angled end on the fiber may also be used. "Angled end" means an end plane which is not normal to the axis of the fiber.

Low cost in the fiber optic RF signal distribution system is achieved by employing a connector housing containing a laser and optical system for direct optical coupling between the laser and a connector with an angled end on the optical fiber that is plugged into the connector housing. Such a housing is illustrated in perspective in FIG. 5.

A typical connector housing for an APC connector has a metal body 41 with laterally extending flanges 42 for bolting the housing to the chassis of the RF signal distribution hub or an antenna station. The outer end of the body is threaded for receiving the nut on a standard APC connector. A slot 43 in the threaded end forms a key way for receiving a raised key on the body of an APC connector for correctly aligning the angled ceramic plug in the connector. A tight fitting split sleeve 44 in the body assures concentricity of the ceramic plug of the connector with the optical system in the connector housing. Such an arrangement for receiving a standard APC connector is conventional.

The connector housing may have a significantly different exterior. For example, instead of flanges for bolting to a housing, the connector half may have male threads for receiving a nut for fastening to a housing in the same manner as conventional panel mounting connector halves.

As illustrated in FIG. 7, in the connector housing provided in practice of this invention, there is a hollow insert 46 inserted into the body and laser welded to the body. The insert has a passage from its hollow interior to an end referred to herein as an aperture plane 48. A stop surface 49 is immediately adjacent to the perimeter of the passage at the aperture plane. The stop surface engages the end of the ceramic plug (not shown in FIG. 7) of a standard APC connector when it is inserted into the housing. The stop surface assures that the end of the optical fiber in the plug is located very close to the aperture plane. The split sleeve 44 engages an external surface on the insert 46 as well as the ceramic plug to keep the plug concentric with the insert.

A base 51 includes an upstanding sleeve 52 which fits over the outside of the body insert and is secured thereto by a plurality of spot welds or circumferential laser weld 53. As explained hereinafter, this fit between the sleeve and insert are used for adjustment during assembly of the connector housing.

A header 54 is secured in the base 51, typically by press fitting. Four metal pins 56 extend through glass seals in the header for making electrical connections to components inside the connector housing.

A lid 57 is hermetically sealed on the header to form a laser subassembly. A rigid post 58 within the laser subassembly supports a semiconductor laser 59. In the embodiment illustrated in FIG. 7, a photodiode 61 is cantilevered from another post and is directly behind the laser. Other electrical components are formed on a substrate 62 on the rigid post.

Typical electrical connections are illustrated schematically in FIG. 6. The laser is connected to a DC bias by an inductor 63 and is also connected to ground. An RF modulating signal is also connected to the laser by a resistor 64 and capacitor 66. The inductor, capacitor and resistor tend to isolate the RF signal and the DC bias from each other. The DC bias, RF modulating signal and electrical ground use three of the four pins through the header.

The fourth pin may be used for either a photodiode 61 as illustrated in FIG. 7 or a thermistor 67 (FIG. 6). Either of these additional components may be used as desired for a particular application. When a photodiode is used, a portion of light through the back face of the laser illuminates the photodiode. The photodiode output may be used in an external feedback circuit for adjusting the DC bias current for controlling laser performance. Alternatively, a thermistor which is mounted on the bottom of the laser subas-

sembly monitors the temperature of the connector housing. The thermistor signal may be used in an external feedback for controlling temperature or adjusting the DC bias for compensating changes in laser performance as a function of temperature.

The front of the electrical to optical converter module has at least a center portion that is transparent and includes a lens 68. The lens and laser are aligned for appropriately illuminating the aperture plane with light from the laser. The correct positions of the laser and lens are determined during assembly of the laser subassembly. The sequence of assembly of the laser module into the connector housing fixes the least critical positions first and the more critical positions last.

The laser module is assembled first. A laser 59 is mounted on the post 58 in its correct position off of the axis of the header 54. The cover 57 is then hermetically sealed onto the header with the lens coaxial with the header. The header is then pressed into the base 51. A subassembly of insert 46, sleeve 52 and base with laser module is then loosely assembled. The insert and sleeve are welded together at the appropriate telescoped spacing for placing the focus of the light from the laser near, but not in, the aperture plane for the desired illumination of the aperture plane. Finally, the base is positioned so that the lens is in an appropriate position off the axis of the insert and the base is welded to the sleeve.

This insert assembly is then inserted into the body of the connector housing and spot welded in place. This position is not critical since the optical fiber is positioned relative to the insert 46 by the stop surface 49 and split sleeve 44. The angular orientation of the insert subassembly and the body 41 also has a loose tolerance and the position of the pins 56 relative to the slot 43 is adequate for alignment.

Although this sequence of aligning and welding the parts together is preferred, a different sequence could be used. Parts of the connector can be assembled with epoxy bonding or the like instead of welding.

As can be seen by the schematic illustration of FIG. 6, the laser 59 and lens 68 are not aligned with the axis of an optical fiber 69 extending through the ceramic plug 71 of a standard APC connector (indicated schematically). Instead, the laser and lens are offset at an angle that assures that light enters the end of the fiber in an axial direction after refraction at the angled end. It is for this reason that the laser, lens and interconnecting structures are carefully oriented relative to the key way of the connector housing which positions the connector and hence ceramic plug in its correct orientation.

The semiconductor laser used for the low cost RF signal distribution system is preferably a distributed feedback (DFB) laser. DFB lasers are conventional semiconductor devices. Many semiconductor lasers use cleaved output and back facets to obtain the feed-

back necessary for lasing. Feedback can also be obtained by periodic variations within the lasing cavity. Typically, this is produced by corrugating the interface between two adjacent cladding layers. The periodic ridges and grooves of the corrugated portion form a diffraction grating so that constructive interference due to the grating provides feedback distributed along at least a portion of the cavity length. As a result, the DFB laser has a single longitudinal mode output. The single output frequency (actually a narrow band of frequencies) is determined by the periodicity of the grating.

A DFB laser is preferred in the low cost transceiver system since it has the lowest noise of semiconductor lasers. A DFB laser, however, is more sensitive to external reflections than a Fabry-Perot laser. The optical system in the connector housing is therefore designed to minimize reflections. This design includes non-axial alignment of the laser and lens and "loose coupling" of the light from the laser to the optical fiber.

An angled end on the optical fiber such as provided in an APC connector is employed with the DFB laser so that illumination from the laser is not normal to the end of the ceramic plug and fiber. Thus, specular reflections from the end of the plug and fiber cannot reenter the laser.

The spacings of the laser, lens and aperture plane are fixed during assembly of the connector housing so that light from the laser is deliberately not focused on the aperture plane. The alignment is set so that about three to five percent of the light from the laser actually enters the core of the fiber. This is a result of two effects. One is that with the defocusing of the illumination at the aperture plane, the wave fronts encountering the end of the fiber are somewhat spherical instead of flat. Only the "flat" component of the spherical wavefront successfully traverses the fiber. Secondly, the area of the ceramic plug illuminated is larger than the area of the end of the fiber core and only light that illuminates the end of the fiber core can enter it.

Another way of loosely coupling light from the laser into the fiber would be to have the light from the laser illuminate the angled end of the optical fiber at an angle that is not optimum for refraction into the fiber in the axial direction. Flooding the end of the fiber with light that is not focused at the aperture plane, but which is at the correct angle for refraction into the fiber, is preferable since the proportion of light coupled into the fiber remains substantially unchanged if the fiber is displaced laterally within the illuminated area. Thus, manufacturing and positioning tolerances are significantly relaxed as compared with a device where the laser light is focused on the core of the fiber.

Since only about three to five percent of the light from the DFB laser enters the optical fiber, any reflec-

tions or backscattering from the fiber which could reenter the laser have extremely low power levels relative to the power level of the laser. Such loose coupling of the illumination thereby avoids reflections from the fiber that would destabilize the DFB laser.

As an alternative to loose coupling of the laser output and the optical fiber input, one may employ an optical isolator and couple a higher proportion of the laser light into the fiber. Very small dimension and low cost optical isolators are becoming available. Such an optical isolator can be placed in a passage 47 in the insert 46 between the lens and aperture plane of the connector.

Such an optical isolator is illustrated in FIG. 8 and comprises a sandwich of a plane polarizer 72, polarization rotator 73 and another polarizer 74, positioned within a rare earth magnet 76. Each polarizer comprises a thin sheet of glass including a surface layer containing silver dipoles tuned to the wavelength of the light from the laser and stretch oriented for high quality polarization of the light beam. Such a polarizing material is available from Corning as Polacor. The rotator is a garnet type crystal sandwiched between the polarizers. The polarizers are set at 45° with respect to each other in the optical isolator. Other polarizers may also be used.

A light beam from the laser is plane polarized by the first polarizer. The rotator then rotates the plane of polarization 45° so that it is aligned with the second polarizer and readily passes therethrough. Any light reflected back toward the optical isolator passes through the first polarizer and is again rotated 45° by the rotator. This places the plane of polarization of the reflected light 90° from the polarization of the original light beam. When this rotated reflected light beam encounters the second polarizer, its passage is prevented.

It is important to use an angled end on the optical fiber, such as in an APC connector, for the connectorized laser module. When two APC connector halves are connected together, there is essentially no air gap between the ends of the fibers and there is good optical coupling. In addition, there is very low reflection from the fiber connection. When there is an "open" connector where a fiber end has a glass-air interface, reflected light will be coupled back into the fiber if the fiber has an end that is normal to the axis of the fiber. In this case, light that is backscattered from within the fiber or reflected from the far end will be reflected from the near end and interfere with forward traveling light. That is avoided with an angled end on the fiber. The end of a fiber in the connector described herein has a glass-air interface and reflections within the fiber are inhibited by using an angled end face.

It is also desirable to employ an angled end face such as provided by an APC connector half at the output end of an optical fiber. In a low cost system it is also desirable to avoid having both halves of a con-

connector in use at the output end of the fiber. Instead, one may use a fiber-air interface of an APC connector in combination with a connectorized photodiode. Such an arrangement is illustrated schematically in FIG. 9. Structurally the connector arrangement is similar to what has already been illustrated in FIGS. 5 and 7 and the details are omitted from FIG. 9.

At this output end of the fiber optic cable an optical fiber 169 extends through the ceramic plug 171 of a standard APC connector 81 indicated only as a dashed outline in the drawing. The APC connector is mated with a connectorized photodiode, the housing 82 of which is also indicated schematically in FIG. 9. This connector housing includes a lens 168 positioned close enough to an aperture plane 83 of the housing that light from the optical fiber encounters the lens despite being refracted at an angle from the axis of the fiber because of the angled end on the fiber. Preferably the lens is large enough or positioned close enough to the end of the fiber that the light is incident on a central portion of the lens where optical aberrations are minimized. The lens refocuses the light from the fiber toward the optical axis of the connector.

A photodiode 84 is located on the optical axis in or near the focal plane of the lens. Light from the fiber refracted by the lens is therefore directed onto the photodiode. Precise focusing on the photodiode or exact positioning on the optical axis are not critical. All that is required is that a maximum amount of the light from the fiber actually illuminates the photodiode.

This lack of criticality can be appreciated by recognizing that a connectorized photodiode may be employed without a focusing lens between the end of the fiber and the photodiode. All that would be needed is that the photodiode have a large enough area to receive most or all of the light from the fiber even though the light is off axis. It is preferred, however, to employ a lens instead of a large area photodiode since the capacitance of the photodiode increases with increasing area and such capacitance can limit the high frequency response of the photodiode.

It will be noticed that in a connector arrangement as illustrated in FIG. 9 it is not necessary to angularly orient the APC connector relative to the housing of the connectorized photodiode. A large enough lens can readily be provided on axis for illumination by the light from the fiber regardless of its angular orientation.

As an alternative arrangement, one may provide for angular orientation between the APC connector and the housing of the connectorized photodiode. In such an embodiment a small area photodiode may be placed off axis at a location where it will be illuminated by light from the fiber. Such an off axis photodiode can be a relatively small size for adequate high frequency response.

Thus, a suitable low cost fiber optic signal transmission system may comprise a connectorized laser

module as illustrated in FIGS. 5 to 7, an optical fiber having an angled end at each end such as by having an APC connector at each end, and a connectorized photodiode as illustrated in FIG. 9. Thus, each end of the optical fiber has a fiber-air interface, but since both ends are angled relative to the axis of the fiber, reflections do not pose any problems. Such an arrangement is desirable for a number of reasons. Such a fiber optic cable is not "handed". In other words, either end of the cable can be the input or the output. Surplus connector halves can be avoided by reason of the connectorized laser module and connectorized photodiode. The system is low cost since low cost components are used. Installation is easy and does not require highly skilled labor.

Although described for particular utility in an RF signal distribution system, it will be apparent that a connector housing with built-in DFB laser is useful in a number of other applications where a modulated semiconductor laser illuminates an optical fiber. Previously, low reflection laser modules have been constructed which have an optical fiber output. This optical fiber is connected to another optical fiber for long transmission distances by means of an APC connector or the like. Regardless of the excellent transmission characteristics of APC connectors, there is the cost of a pair of such connectors. In effect, applicants have provided a laser module with an output for direct coupling to an optical fiber connector instead of an optical fiber output. This permits connecting the optical fiber directly to the module instead of requiring an additional connector half.

Although described as an RF signal distribution system for communications outside of a system, it will be apparent that a cellular telephone system is merely exemplary of the applications. Such an optical fiber wireless signal distribution system may be used in mobile radio systems for vehicles moving around a warehouse, for example. Because of the broad bandwidth available in a short range system of this sort, it is ideally suited for mobile personal communications. Such a system may also be used as a broadband wireless local area network with or without communication outside of the local area network. Such a system may simply be used as a wireless PBX which permits communication with anyone within range, regardless of their location. Other wireless digital terminal equipment systems will be apparent.

Although the connectors for a fiber optic data transmission system have been described as standard APC connectors, it will be apparent that these are merely exemplary of connectors that may have an angled end on the optical fiber. Thus, in a standard APC connector the end of the fiber is not only angled relative to the axis of the fiber, the ceramic plug and fiber end have a slight curvature so that the ends of adjacent fibers are sure to be in physical contact. Such curvature is not important in practice of this in-

vention since the ends of the fiber have a fiber-air interface instead of a fiber-fiber interface. A connector with a simple flat diagonal end is equivalent for practice of this invention. A standard APC connector with curvature may, however, be useful so that cables may be standardized and used with conventional connectors as well.

Claims

1. The fibre optic RF signal distribution system comprising:
 - a plurality of distributed antenna stations, each antenna station including an RF antenna and means for converting between optical and electrical signals;
 - an RF signal distribution hub for receiving and transmitting optical signals within the system; and
 - a pair of optical fibres connecting each antenna station directly to the distribution hub for transmitting signals therebetween.
2. The fibre optic RF signal distribution system according to claim 1 further comprising means for coupling a semiconductor laser directly to a connector on the end of each optical fibre without an intervening connector.
3. The fibre optic RF signal distribution system according to claim 2 wherein the means for coupling a laser comprises:
 - a fibre connector having an angled end on the optical fibre;
 - a connector housing for receiving the fibre connector;
 - means for positioning the angled end of the optical fibre in the fibre connector in an aperture plane in the housing;
 - a laser mounted in the connector housing; and
 - means for directing illumination from the laser onto the aperture plane at an acute angle to the axis of the optical fibre.
4. The fibre optic RF signal distribution system according to claim 1 further comprising:
 - a fibre optic connector housing at the distribution hub for connection to one of the optical fibres for an antenna station, the connector housing comprising:
 - a plurality of electrical input pins,
 - a semiconductor laser mounted in the housing and connected to the input pins, and
 - a socket for receiving an optical fibre connector with the end of an optical fibre in the connector being angled relative to the axis of the fi-

bre and optically aligned with the laser.

5. The fibre optic RF signal distribution system according to claim 1 comprising a connector housing including a laser and a lens between the laser and an aperture plane positioned for receiving the end of the optical fibre of an APC connector, the optical axis of the lens and laser being at an acute angle to the axis of the housing and aligned for illuminating an area of the aperture plane larger than the area of the end of an optical fibre.
6. The fibre optic RF signal distribution system comprising:
 - a plurality of antenna stations, each antenna station including an RF antenna;
 - an RF signal distribution hub for receiving and transmitting signals within the system;
 - a pair of optical fibres connecting each antenna station directly to the distribution hub;
 - means at an end of each optical fibre for removably placing the end of the optical fibre in an aperture plane; and
 - a semiconductor laser illuminating the aperture plane.
7. The fibre optic RF signal distribution system according to claim 11 wherein the means for placing the end of an optical fibre in an aperture plane comprises an APC connector, and further comprising a lens between the laser and aperture plane for illuminating the aperture plane at an acute angle to the axis of the optical fibre.
8. The fibre optic RF signal distribution system according to claim 11 further comprising:
 - means at the opposite end of each optical fibre for removably placing the end of the optical fibre in an aperture plane; and
 - a photodetector optically placed for illumination by light from the end of the optical fibre in the aperture plane.
9. The fibre optic RF signal distribution system according to claim 4 comprising an optical system aligned so that the laser is not focused on the aperture plane.
10. The fibre optic RF signal distribution system comprising:
 - an RF signal distribution hub for receiving and transmitting signals within the system;
 - a plurality of distributed feedback lasers connected to the distribution hub for converting each received electrical signal to an outgoing optical signal;
 - a plurality of optical to electrical converters connected to the distribution hub for convert-

ing an incoming optical signal to a transmitted electrical signal;

a plurality of antenna stations, each antenna station comprising:

an RF antenna,

a photodetector for sensing an outgoing optical signal,

means for connecting the photodetector to the antenna for broadcasting an outgoing RF signal,

a laser, and

means for connecting the antenna to the laser for converting an incoming RF signal to an incoming optical signal;

an outgoing optical fibre connecting each electrical to optical converter to the photodetector of one of the antenna stations; and

an incoming optical fibre connecting the laser of one of the antenna stations to each optical to electrical converter.

11. The fibre optic RF signal distribution system according to claim 15 further comprising means for minimizing reflections from the optical fibre back into the laser.

12. The fibre optic RF signal distribution system according to claim 16 wherein the means for minimizing reflections comprises means for defocusing the laser at the end of an optical fibre or means for aligning the laser at an acute angle to the axis of the optical fibre.

13. The fibre optic RF signal distribution system comprising:

a plurality of distributed antenna stations, each antenna station including an RF antenna and means for converting between optical and electrical signals;

an RF signal distribution hub for receiving and transmitting optical signals within the system; and

a pair of optical fibres connecting each antenna station directly to the distribution hub for transmitting signals therebetween, each optical fibre comprising a connector having an angled end on the optical fibre at each end;

a semiconductor laser adjacent to such a connector at one end of each optical fibre and optically coupled to the end of the fibre via an air-fibre interface; and

a photodiode adjacent a connector having an angled end on the optical fibre at the opposite end of each optical fibre and optically coupled to the end of the fibre via a fibre-air interface.

14. The fibre optic connector housing comprising:
a semiconductor laser in the housing;

a lens for directing light from the laser to an aperture plane in the housing, the laser and lens being offset from the axis of the housing so that light from the laser passes through the aperture plane at an acute angle relative to the axis of the housing, the laser and lens being spaced so that the area of the aperture plane illuminated by the laser is larger than the end of an optical fibre;

means for positioning a removable fibre connector in the housing with an end of an optical fibre in the aperture plane;

means in the housing for orientating an angled end of the optical fibre in the removable fibre connector so that illumination from the laser enters the fibre axially; and

means for applying an RF modulating signal to the laser in the housing.

15. The fibre optic connector housing according to claim 14 wherein the means for positioning the end of an optical fibre in the aperture plane comprises an axial passage in the housing and a stop surface adjacent the passage for engaging an end of an APC connector around the end of the optical fibre of the connector.

16. The fibre optic connector housing according to claim 14 comprising a hermetically sealed module containing the laser, the lens forming a window in the module; and a telescoping mounting between the module and the balance of the housing for adjusting the spacing between the lens and the aperture plane.

17. The fibre optic connector housing comprising:
a threaded body;

a key way for aligning a standard APC connector on the body;

a split sleeve centred in the body for receiving the plug of an APC connector;

a stop surface for aligning the end of the plug of a standard APC connector with an aperture plane in the body;

a semiconductor laser mounted in the housing; and

a lens for directing illumination from the laser onto the aperture plane at an acute angle to the axis of the split sleeve.

18. The fibre optic connector housing according to claim 17 wherein the laser and lens are spaced so that the area of the aperture plane illuminated by the laser is larger than the end of an optical fibre in an APC connector.

19. The fibre optic connector housing according to claim 18 comprising:

a telescoping mounting for the lens for defocusing illumination from the laser at the aperture plane.

- 20.** The fibre optic connector housing comprising: 5
 a semiconductor laser in the housing;
 a lens for directing light from the laser to an aperture plane in the housing;
 an optical isolator in the optical path between the laser and the aperture plane; 10
 means for positioning a fibre connector in the housing with an end of an optical fibre in the aperture plane; and
 means for applying an RF modulating signal to the laser in the housing. 15
- 21.** The fibre optic connector housing according to claim 20 wherein the laser and lens are offset from the axis of the housing so that light from the laser passes through the aperture plane at an acute angle relative to the axis of the housing, and further comprising means in the housing for orientating an angled end of an optical fibre in the fibre connector so that illumination from the laser enters the fibre axially, and stop means adjacent the aperture plane for engaging the fibre connector and locating the end of the optical fibre in the aperture plane. 20 25
- 22.** The fibre optic invention according to any one of the preceding claims wherein each laser is a distributed feedback laser. 30
- 23.** The fibre optic connector housing comprising:
 means for positioning a removable connector with an angled end of an optical fibre in an aperture plane in the housing; 35
 a photodiode axially mounted in the housing;
 a lens between the aperture plane and the photodiode and sufficiently close to the aperture plane for directing substantially all of the light from the end of an optical fibre in the aperture plane to the photodiode. 40 45
- 24.** The fibre optic connector housing comprising:
 means for positioning an APC connector with an angled end of an optical fibre in a selected angular orientation in an aperture plane in the housing; and 50
 a photodiode mounted off axis in the connector housing for illumination by light from the angled end of a fibre in the aperture plane.

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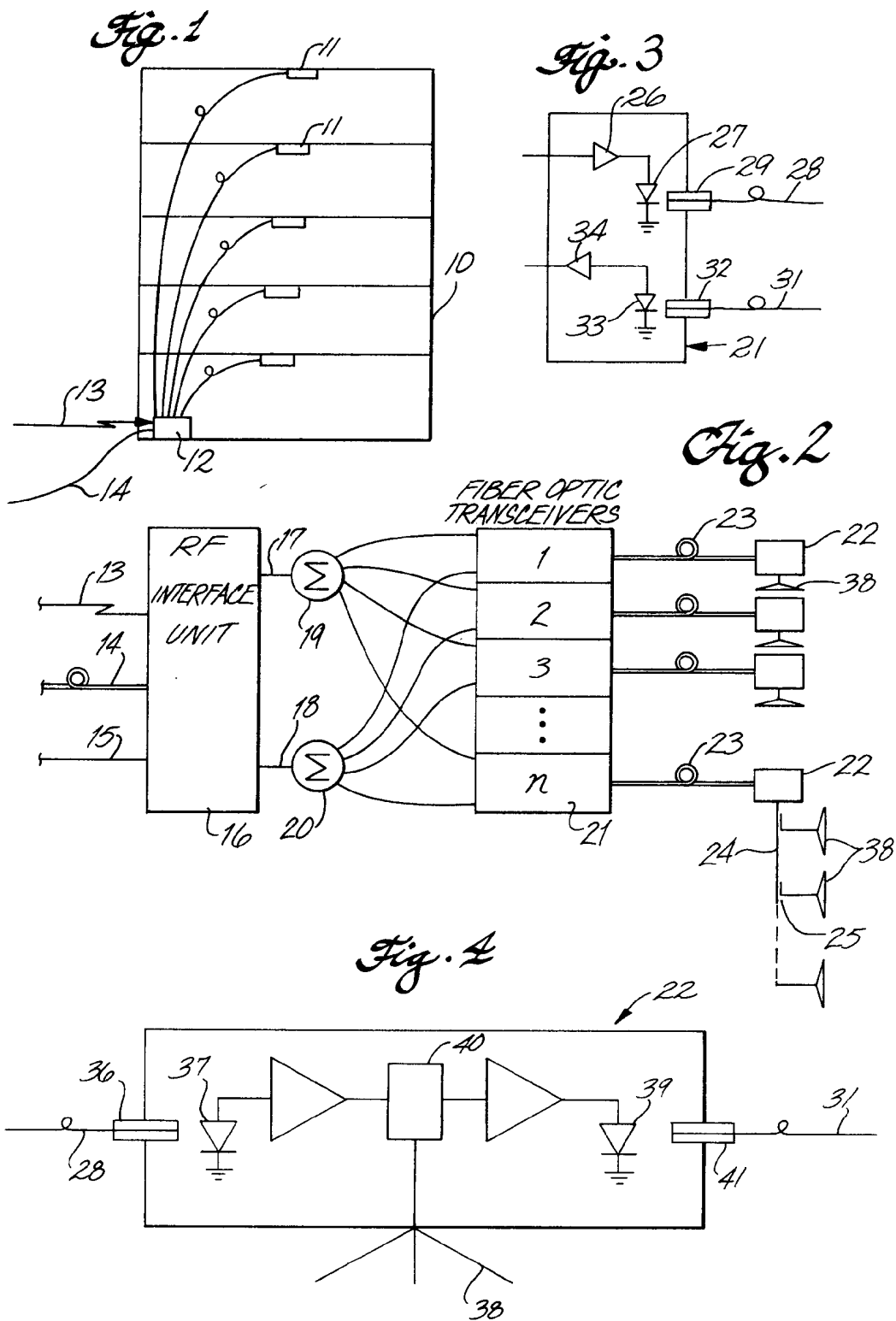
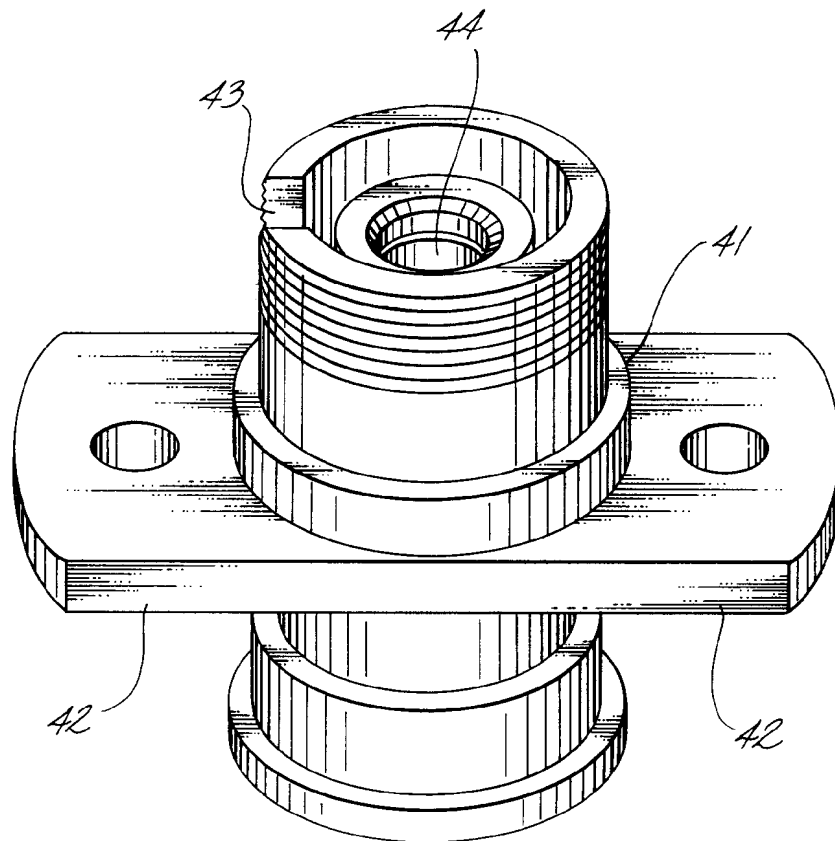


Fig. 5



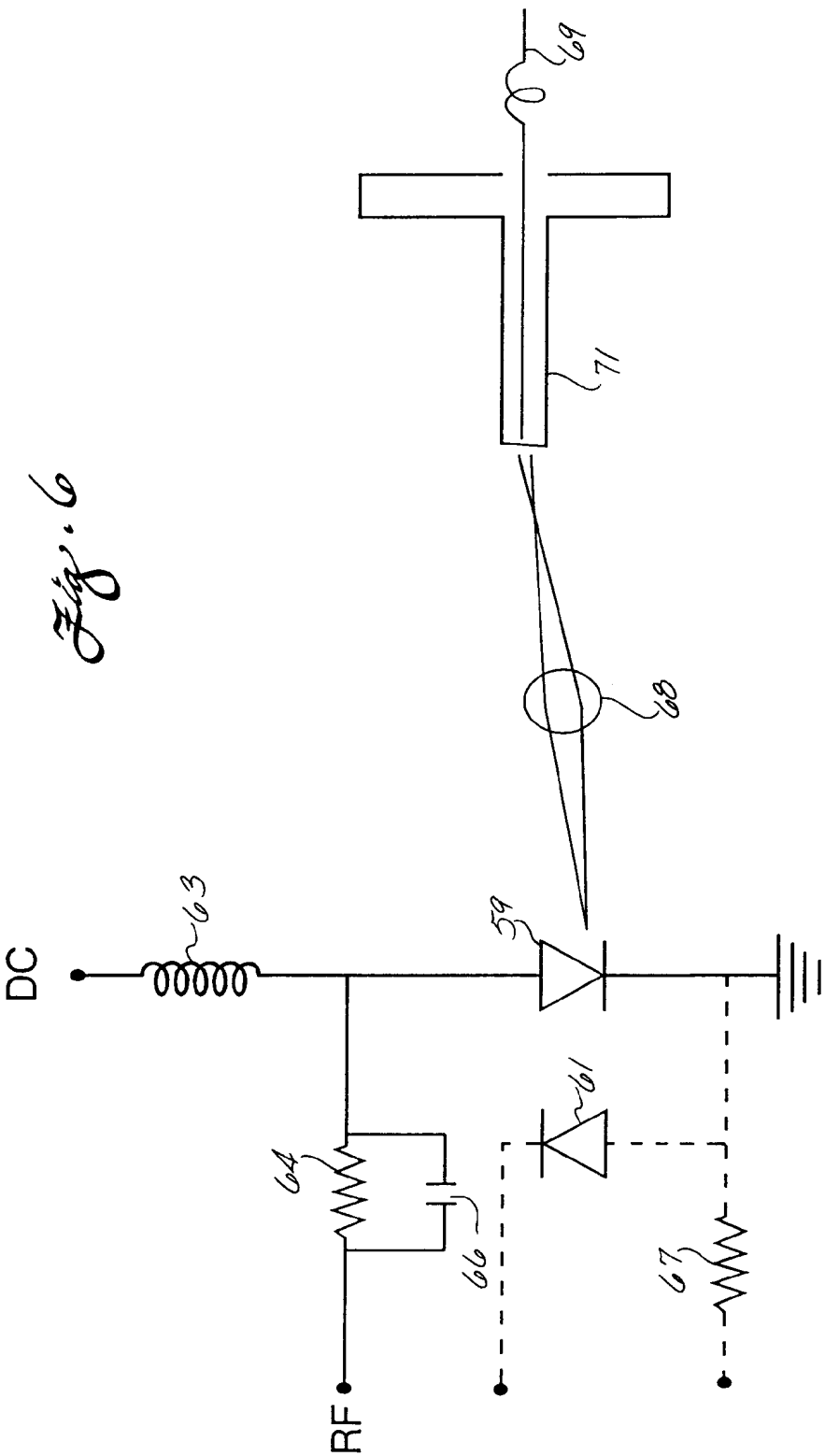


Fig. 7

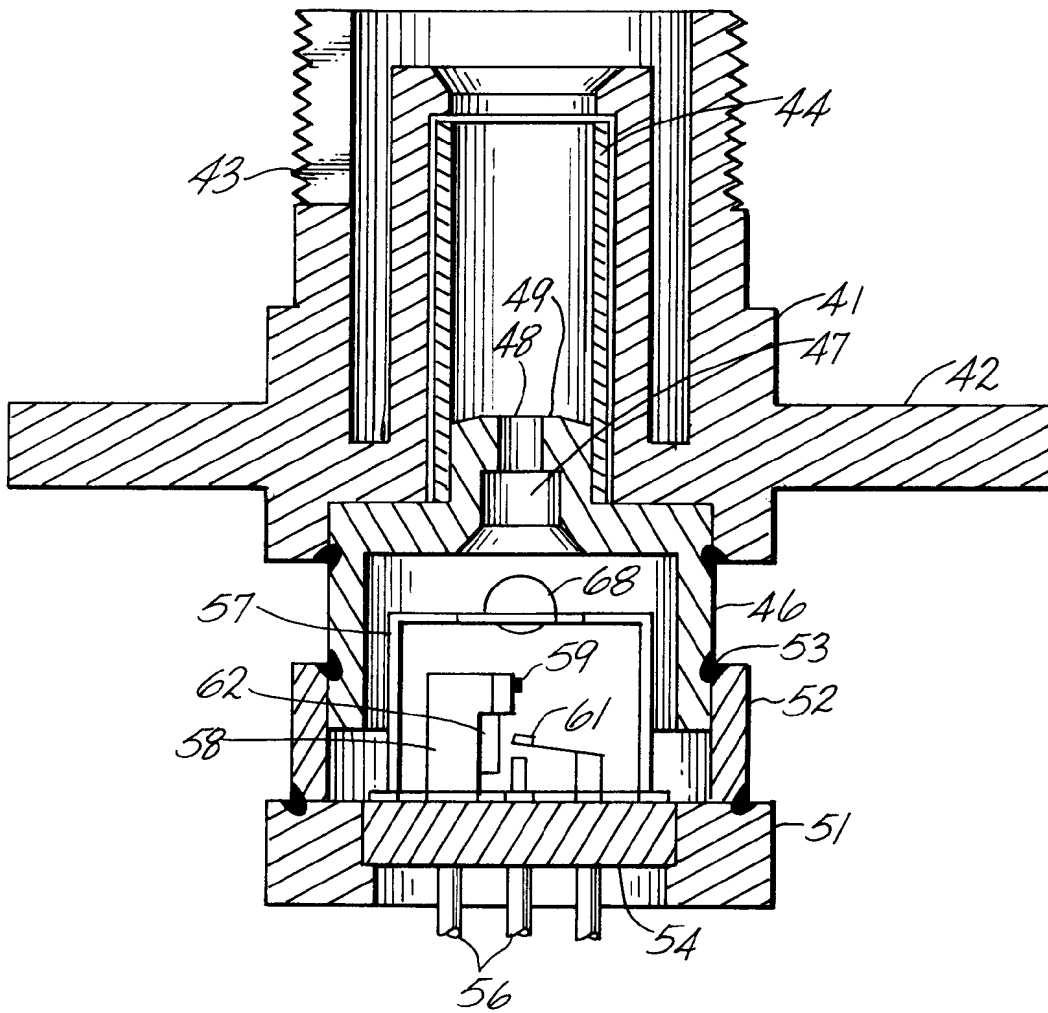


Fig. 8

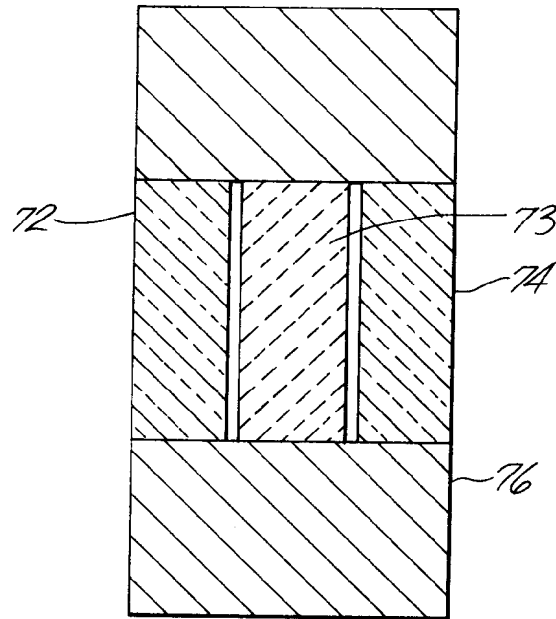
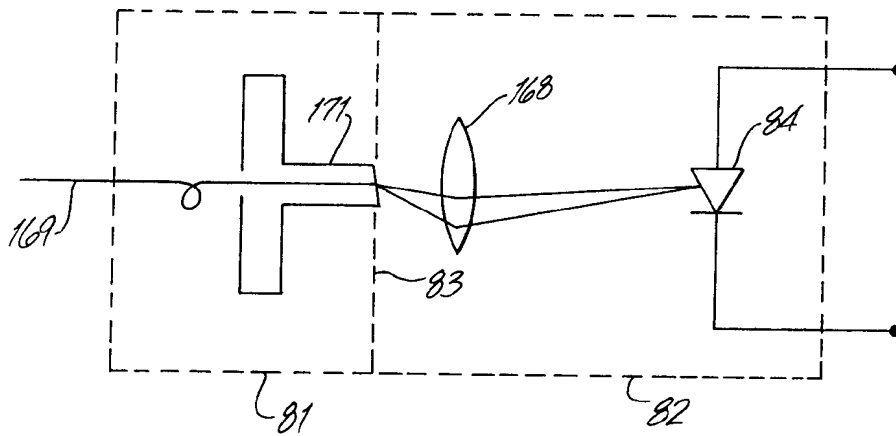


Fig. 9





**European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 0366

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	IEICE TRANSACTIONS ON ELECTRONICS, vol.E76-C, no.2, February 1993, TOKYO JP pages 287 - 292 SHIBUTANI ET AL 'Reflection induced degradations in optical fibre feeder for microcellular mobile radio systems' * page 288, right column, line 13 - line 14; figures 1,2,5 *	1,10,11	H04B10/12 G02B6/42
Y	---	2-9, 12-15	
X	FR-A-2 586 305 (LTT) * page 4, line 17 - line 27 * * page 4, line 32 - line 33 * * page 5, line 7 - line 13 * * page 5, line 21 - line 25 * * page 5, line 32 - page 6, line 18 * * page 6, line 33 - page 7, line 2 * * figures 1-7 *	20-24	
Y	---	2-9, 12-15, 17,18	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X	GB-A-2 184 289 (NEC) * page 2, line 34 - line 43 * * page 3, line 18 - line 34 *	20	H04B G02B
A	---	2-19, 21-24	
Y	OPTICS COMMUNICATIONS, vol.68, no.3, 1 October 1988, NL pages 183 - 186 HILLERICH 'Trade-off between beam truncation and defocussing with taper lenses on single mode fibres' * figure 1 *	9	
A	---	12,14	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 April 1995	Examiner Williams, M.I.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 0366

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 327 (P-513) 1986 & JP-A-61 134 712 (FUJITSU) * abstract * -----	17, 18	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 April 1995	Examiner Williams, M.I.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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From the INTERNATIONAL SEARCHING AUTHORITY

PCT

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THE INTERNATIONAL SEARCH REPORT
OR THE DECLARATION

(PCT Rule 44.1)

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15/11/2001

Applicant's or agent's file reference

100.019W001

FOR FURTHER ACTION

See paragraphs 1 and 4 below

International application No.

PCT/US 01/21021

International filing date
(day/month/year)

03/07/2001

Applicant

ADC TELECOMMUNICATIONS, INC.

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46).

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Lisa O'Sullivan

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 100.019W001	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/US 01/21021	International filing date (day/month/year) 03/07/2001	(Earliest) Priority Date (day/month/year) 19/07/2000
Applicant ADC TELECOMMUNICATIONS, INC.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

4. With regard to the **title**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows:

A METHOD FOR POINT-TO-MULTIPOINT COMMUNICATION USING DIGITAL RADIO FREQUENCY TRANSPORT

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1

☐ None of the figures.

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04B H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 774 789 A (DUBOVSKY GEORGE S ET AL) 30 June 1998 (1998-06-30) column 1, line 51 - line 61 column 6, line 6 -column 7, line 32; figures 1,2	1-32
Y	US 5 765 099 A (LAU KAM Y ET AL) 9 June 1998 (1998-06-09) column 1, line 19 - line 23 column 11, line 66 -column 12, line 7; claims 1-8; figure 11 -/-	33-83

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

5 November 2001

Date of mailing of the international search report

15/11/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Sorrentino, A

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	NAKATSUGAWA M ET AL: "SOFTWARE RADIO BASE AND PERSONAL STATIONS FOR CELLULAR/PCS SYSTEMS" VTC 2000-SPRING. 2000 IEEE 51ST. VEHICULAR TECHNOLOGY CONFERENCE PROCEEDINGS. TOKYO, JAPAN, MAY 15-18, 2000, IEEE VEHICULAR TECHNOLOGY CONFERENCE, NEW YORK, NY: IEEE, US, vol. 1 OF 3. CONF. 51, 15 May 2000 (2000-05-15), pages 617-621, XP000970694 ISBN: 0-7803-5719-1 the whole document	1-83
A	US 5 946 622 A (BOJERYD NILS JOHAN) 31 August 1999 (1999-08-31) column 1, line 53 - line 61 column 2, line 29 -column 3, line 14; figures 1-5	1,33,57, 60,65, 66,75,83
A	AKOS D M ET AL: "DIRECT BANDPASS SAMPLING OF MULTIPLE DISTINCT RF SIGNALS" IEEE TRANSACTIONS ON COMMUNICATIONS, IEEE INC. NEW YORK, US, vol. 47, no. 7, July 1999 (1999-07), pages 983-988, XP000849074 ISSN: 0090-6778 abstract paragraphs '0002!, '0003!	1,33,57, 60,65, 66,75,83
A	EP 0 664 621 A (ORTEL CORP) 26 July 1995 (1995-07-26) column 1, line 51 -column 2, line 52	1,33,57, 60,65, 66,75,83

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5774789	A	30-06-1998	EP 0954910 A1	10-11-1999
			JP 11510355 T	07-09-1999
			WO 9722186 A1	19-06-1997
US 5765099	A	09-06-1998	AU 715343 B2	20-01-2000
			AU 2811297 A	12-11-1997
			CA 2251959 A1	30-10-1997
			EP 0894369 A1	03-02-1999
			JP 2000509224 T	18-07-2000
			US 6157810 A	05-12-2000
			WO 9740590 A1	30-10-1997
			US 6014546 A	11-01-2000
			US 5983070 A	09-11-1999
			US 5930682 A	27-07-1999
US 5946622	A	31-08-1999	AU 733200 B2	10-05-2001
			AU 5508298 A	10-06-1998
			BR 9713086 A	28-03-2000
			CN 1276135 A	06-12-2000
			DE 19782122 T0	28-10-1999
			FI 991131 A	19-07-1999
			GB 2334857 A , B	01-09-1999
			JP 2001503951 T	21-03-2001
			WO 9823116 A2	28-05-1998
EP 0664621	A	26-07-1995	US 5457557 A	10-10-1995
			AU 695818 B2	20-08-1998
			AU 1134795 A	03-08-1995
			CA 2140699 A1	22-07-1995
			CN 1121281 A	24-04-1996
			EP 0664621 A1	26-07-1995
			JP 7261061 A	13-10-1995
			US 5515469 A	07-05-1996

Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT			
First Named Inventor/Applicant Name:	Philip M. Wala			
Filer:	Wade A. Whisenant/Emily Reller			
Attorney Docket Number:	100.019US05			
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	280	280
Utility Search Fee	1111	1	600	600
Utility Examination Fee	1311	1	720	720
Pages:				
Claims:				
Claims in Excess of 20	1202	35	80	2800
Independent claims in excess of 3	1201	2	420	840
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				5240

Electronic Acknowledgement Receipt

EFS ID:	17110004
Application Number:	14054223
International Application Number:	
Confirmation Number:	6118
Title of Invention:	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT
First Named Inventor/Applicant Name:	Philip M. Wala
Customer Number:	34206
Filer:	Wade A. Whisenant/Emily Reller
Filer Authorized By:	Wade A. Whisenant
Attorney Docket Number:	100.019US05
Receipt Date:	15-OCT-2013
Filing Date:	
Time Stamp:	16:22:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$5240
RAM confirmation Number	3830
Deposit Account	502432
Authorized User	WHISENANT, WADE A.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

1018

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		00390616.PDF	134229 abc3af2e6a7549feb411d07e941bea89563a958c	yes	29
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	18	
	Claims		19	28	
	Abstract		29	29	
Warnings:					
Information:					
2	Drawings-only black and white line drawings	00391860.PDF	3852819 ddc9d5b998b7370a03e7931125903eef2a80e055	no	8
Warnings:					
Information:					
3	Application Data Sheet	00390643.PDF	1503316 361dad4492cf1aaa84d6e83a7cd1b7923fcd165	no	6
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73.	00390645.PDF	411457 098480b44c34be01a820d5c43ea9bdd37f3c41c1	no	4
Warnings:					
Information:					
5	Power of Attorney	00390644.PDF	295429 b732015363a4fcb7c770471786fec174004cefa	no	1
Warnings:					
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Information:					
6	Oath or Declaration filed	00390629.PDF	48491 427f5a37e7c588543f6139174565657789c85567	no	1

Warnings:					
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Information:					
7	PTO/SB/69-Authorize EPO Access to Search Results	00390647.PDF	114449	no	2
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Warnings:					
Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	00390654.PDF	615074	no	13
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Warnings:					
Information:					
9	Transmittal Letter	00392043.PDF	97305	no	2
			ac07a19692bb7421378dc9596f34d401fc08f86		
Warnings:					
Information:					
10	Non Patent Literature	00390652.PDF	546407	no	10
			af453d23b186d211632982a6dcc95fd67392cf58		
Warnings:					
Information:					
11	Non Patent Literature	00390653.PDF	859182	no	23
			79018649d51e1823dd445f05985cb11a5ffa5fa4		
Warnings:					
Information:					
12	Non Patent Literature	00170753.PDF	575750	no	6
			f581b6f8c3761f164780396edb06fcbb487cd0f		
Warnings:					
Information:					
13	Non Patent Literature	00170755.PDF	1098775	no	8
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Information:					
14	Non Patent Literature	00050527.pdf	390940	no	9
			a29222f0b23b8b123f519d8012eab119fb71551f		
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Information:					

15	Non Patent Literature	00061107.pdf	433897 22ace8f442050e13eea6603d4d47899651bedc5	no	5
Warnings:					
Information:					
16	Foreign Reference	00310482.PDF	4794458 184cdb5c229e5aa6967b89c3e53c00ba9d68316e	no	143
Warnings:					
Information:					
17	Foreign Reference	00076002.PDF	954016 3c801d4f0e7b2b1f133b9e4cd34d5ab904c9bdcf	no	17
Warnings:					
Information:					
18	Non Patent Literature	00170752.PDF	462917 0bc86107e9d2038690708de6d63458452248bf97	no	7
Warnings:					
Information:					
19	Fee Worksheet (SB06)	fee-info.pdf	38046 3d407e7de6e26b82e5759739153a2d6a724b0fc5	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			17226957		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Cross Reference to Related Applications

[0001] This application is a continuation of U.S. Application Serial No. 13/662,948, filed on October 29, 2012 entitled “POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT”, which, in turn, is a continuation of 12/617,215, filed on November 12, 2009 entitled “POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT” (which issued as U.S. Patent No. 8,326,218), which, in turn, is a continuation of U.S. Application Serial No. 10/740,944, filed on December 19, 2003 entitled “POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT” (which issued as U.S. Patent No. 7,639,982), which, in turn, is a continuation of U.S. Application Serial No. 09/619,431, filed on July 19, 2000, entitled “POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT” (which issued as U.S. Patent No. 6,704,545). All of the preceding applications and patents are incorporated herein by reference.

Technical Field

[0002] The present invention is related to high capacity mobile communications systems, and more particularly to a point-to-multipoint digital micro-cellular communication system.

Background Information

[0003] With the widespread use of wireless technologies additional signal coverage is needed in urban as well as suburban areas. One obstacle to providing full coverage in these areas is steel frame buildings. Inside these tall shiny buildings (TSBs), signals transmitted from wireless base stations attenuate dramatically and thus significantly impact the ability to communicate with wireless telephones located in the buildings. In some buildings, very low power ceiling mounted transmitters are mounted in hallways and conference rooms within the building to distribute signals throughout the building.

Signals are typically fed from a single point and then split in order to feed the signals to different points in the building.

[0004] In order to provide coverage a single radio frequency (RF) source needs to simultaneously feeds multiple antenna units, each providing coverage to a different part of a building for example. Simultaneous bi-directional RF distribution often involves splitting signals in the forward path (toward the antennas) and combining signals in the reverse path (from the antennas). Currently this can be performed directly at RF frequencies using passive splitters and combiners to feed a coaxial cable distribution network. In passive RF distribution systems, signal splitting in the forward path is significantly limited due to inherent insertion loss associated with the passive devices. Each split reduces the level of the signal distributed in the building thereby making reception, e.g. by cell phones, more difficult. In addition, the high insertion loss of coaxial cable at RF frequencies severely limits the maximum distance over which RF signals can be distributed. Further, the system lacks any means to compensate for variations of insertion loss in each path.

[0005] Another solution to distributing RF signals in TSBs is taking the RF signal from a booster or base station, down converting it to a lower frequency, and distributing it via Cat 5 (LAN) or coaxial cable wiring to remote antenna units. At the remote antenna units, the signal is up converted and transmitted. While down-conversion reduces insertion loss, the signals are still susceptible to noise and limited dynamic range. Also, each path in the distribution network requires individual gain adjustment to compensate for the insertion loss in that path.

[0006] In another approach, fiber optic cables are used to distribute signals to antennas inside of a building. In this approach, RF signals are received from a bi-directional amplifier or base station. The RF signals directly modulate an optical signal, which is transported throughout the building as analog modulated light signals over fiber optic cable. Unfortunately, conventional systems using analog optical modulation transmission over optical fibers require highly sophisticated linear lasers to achieve adequate performance. Also, analog optical systems are limited in the distance signals can be transmitted in the building. Typically, this limitation is made worse due to the use of multimode fiber that is conventionally available in buildings. Multimode fiber is

wider than single mode fiber and supports a number of different reflection modes so that signals tend to exhibit dispersion at the terminating end of the fiber. In addition, analog installation typically includes significant balancing when setting up the system. Further, RF levels in the system need to be balanced with the optical levels. If there is optical attenuation, the RF levels need to be readjusted. In addition, if the connectors are not well cleaned or properly secured, the RF levels can change.

[0007] Digitization of the RF spectrum prior to transport solves many of these problems. The level and dynamic range of digitally transported RF remains unaffected over a wide range of path loss. This allows for much greater distances to be covered, and eliminates the path loss compensation problem. However, this has been strictly a point-to-point architecture. One drawback with digitally transported RF in a point-to-point architecture is the equipment and cost requirement. A host RF to digital interface device is needed for each remote antenna unit. In particular, for use within a building or building complex the number of RF to digital interface devices and the fiber to connect these devices is burdensome. For example, in a building having 20 floors, the requirement may include 20 host RF to digital interface devices for 20 remote antenna units, 1 per floor. In some applications more than one remote antenna unit per floor may be required. As a result, there is a need in the art for improved techniques for distributing RF signals in TSBs, which would incorporate the benefits of digital RF transport into a point-to-multipoint architecture.

Summary

[0008] The above-mentioned problems with distributing RF signals within a building and other problems are addressed by the present invention and will be understood by reading and studying the following specification.

[0009] In one embodiment, a digital radio frequency transport system is provided. The transport system includes a digital host unit and at least two digital remote units coupled to the digital host unit. The digital host unit includes shared circuitry that performs bi-directional simultaneous digital radio frequency distribution between the digital host unit and the at least two digital remote units.

[0010] In another embodiment, a digital radio frequency transport system is provided. The transport system includes a digital host unit and at least one digital expansion unit coupled to the digital host unit. The transport system further includes at least two digital remote units, each coupled to one of the digital host unit and the digital expansion unit. The digital host unit includes shared circuitry that performs bi-directional simultaneous digital radio frequency distribution between the digital host unit and the at least two digital remote units.

[0011] In an alternate embodiment, a method of performing point-to-multipoint radio frequency transport is provided. The method includes receiving radio frequency signals at a digital host unit and converting the radio frequency signals to a digitized radio frequency spectrum. The method also includes optically transmitting the digitized radio frequency spectrum to a plurality of digital remote units. The method further includes receiving the digitized radio frequency spectrum at the plurality of digital remote units, converting the digitized radio frequency spectrum to analog radio frequency signals and transmitting the analog radio frequency signals via a main radio frequency antenna at each of the plurality of digital remote units.

Brief Description of the Drawings

[0012] Figure 1 is an illustration of one embodiment of a point-to-multipoint communication system according to the teachings of the present invention.

[0013] Figure 2 is a block diagram of one embodiment of a communication system according to the teachings of the present invention.

[0014] Figure 3 is a block diagram of another embodiment of a communication system according to the teachings of the present invention.

[0015] Figure 4 is a block diagram of one embodiment of a digital host unit according to the teachings of the present invention.

[0016] Figure 5 is a block diagram of one embodiment of a digital remote unit according to the teachings of the present invention.

[0017] Figure 6 is a block diagram of one embodiment of a digital expansion unit according to the teachings of the present invention.

[0018] Figure 7 is a block diagram of one embodiment of a microcell base station according to the teachings of the present invention.

[0019] Figure 8 is an illustration of one embodiment of an overflow algorithm for a channel summer according to the teachings of the present invention.

Detailed Description

[0020] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

[0021] Figure 1 is an illustration of one exemplary embodiment of a point-to-multipoint digital transport system shown generally at 100 and constructed according to the teachings of the present invention. The point-to-multipoint digital transport system 100 is shown distributed within a complex of tall shiny buildings (TSBs) 2. Although system 100 is shown in a complex of TSBs 2, it is understood that system 100 is not limited to this embodiment. Rather, system 100 in other embodiments is used to distribute signals in a single building, or other appropriate structure or indoor or outdoor location that exhibits high attenuation to RF signals. Advantageously, system 100 uses digital summing of digitized RF signals from multiple antennas to improve signal coverage in structures, such as TSBs.

[0022] Point-to-multipoint digital transport of RF signals is accomplished through a network of remote antenna units or digital remote units 40 and 40' and a digital host unit 20, which interfaces with a wireless network 5 which is coupled to the public switched telephone network (PSTN), or a mobile telecommunications switching office (MTSO) or other switching office/network. System 100 operates by transporting RF signals digitally over fiber optic cables. Signals received at DHU 20 are distributed to multiple DRUs 40 and 40' to provide coverage throughout a building complex. In addition, signals received at each of the DRUs 40 and 40' are summed together at the DHU 20 for interface to a wireless network.

[0023] In one embodiment, digital expansion unit DEU 30 is situated between the DHU 20 and one or more DRUs. In the forward path, DEU 30 expands the coverage area by splitting signals received from DHU 20 to a plurality of DRUs 40'. In the reverse path, DEU 30 receives signals from a plurality of DRUs 40', digitally sums the signals together and transports them to a DHU 20 or another DEU such as 30. This system allows for successive branching of signals using DEUs 30 and expanded coverage to multiple DRUs 40 and 40'. This system provides an efficient way of providing signal coverage for wireless communication without added attenuation loss and distance constraint found with analog systems. By using DEUs 30, antennas can be placed further from DHU 20 without adversely affecting signal strength since shorter fiber optic cables can be used.

[0024] Digital transport system 100 includes a wireless interface device (WID) 10 that provides an interface to a wireless network. In one embodiment, the WID 10 includes either conventional transmitters and receivers or all digital transmitter and receiver equipment, and interface circuitry to a mobile telecommunications switching office (MTSO). In one embodiment, the wireless interface device 10 is coupled to an MTSO via a T1 line and receives and transmits signals between the MTSO and the DHU 20. In another embodiment, the wireless interface device 10 is coupled to the public switched telephone network (PSTN). In one embodiment, WID 10 comprises a base station and connects directly to DHU 20 via coaxial cables. In another embodiment, WID 10 comprises a base station and wirelessly connects to DHU 20 via a bi-directional amplifier that is connected to an antenna. In one embodiment, the antenna is an outdoor antenna.

[0025] WID 10 communicates signals between wireless units and the wireless network via digital remote units DRUs 40 and 40'. WID 10 is coupled to DHU 20. The DHU 20 is coupled to at least one digital expansion unit DEU 30 and a plurality of DRUs 40. In addition, DEU 30 is coupled to a plurality of DRUs 40'. The DHU 20 receives RF signals from WID 10 and converts the RF signals to digital RF signals. DHU 20 further optically transmits the digital RF signals to multiple DRUs 40 either directly or via one or more DEUs 30.

[0026] Each DRU 40 and 40' is connected through a fiber optic cable (or optionally another high bandwidth carrier) to transport digital RF signals to one of DHU 20 or DEU 30. In one embodiment, the fiber optic cable comprises multimode fiber pairs coupled between the DRUs 40 and the DHU 20, between the DRUs 40 and 40' and the DEUs 30 and between the DEUs 30 and the DHU 20. In one embodiment, the DEU 30 is coupled to the DHU 20 via single mode fiber and the DEU 30 is coupled to the DRUs 40' via multimode fiber pairs. Although, transport system 100 has been described with fiber optic cable other carriers may be used, e.g., coaxial cable.

[0027] In another embodiment, the DHU 20 is coupled to the DRUs 40 by a direct current power cable in order to provide power to each DRU 40. In one embodiment, the direct current power cable delivers 48 VDC to each DRU 40 connected to the DHU 20. In another embodiment, the DEU 30 is coupled to DRUs 40' by a direct current power cable to provide power to each DRU 40'. In one embodiment, the direct current power cable delivers 48 VDC to each DRU 40' connected to the DEU 30. In an alternate embodiment, DRUs 40 and 40' are connected directly to a power supply. In one embodiment, the power supply provides DC power to the DRUs 40 and 40'. In an alternate embodiment, the power supply provides AC power to the DRUs 40 and 40'. In one embodiment, DRUs 40 and 40' each include an AC/DC power converter.

[0028] Both DHU 20 and DEU 30 split signals in the forward path and sum signals in the reverse path. In order to accurately sum the digital signals together at DHU 20 or DEU 30 the data needs to come in to the DHU 20 or DEU 30 at exactly the same rate. As a result all of the DRUs 40 and 40' need to be synchronized so that their digital sample rates are all locked together. Synchronizing the signals in time is accomplished by locking everything to the bit rate over the fiber. In one embodiment, the DHU 20 sends out a digital bit stream and the optical receiver at the DEU 30 or DRU 40 detects that bit stream and locks its clock to that bit stream. In one embodiment, this is being accomplished with a multiplexer chip set and local oscillators, as will be described below. Splitting and combining the signals in a digital state avoids the combining and splitting losses experienced with an analog system. In addition, transporting the digital signals over multimode fiber results in a low cost transport system that is not subject to much degradation.

[0029] The down-conversion and up-conversion of RF signals are implemented by mixing the signal with a local oscillator (LO) at both the DRUs and the DHU. In order for the original frequency of the RF signal to be restored, the signal must be up-converted with an LO that has exactly the same frequency as the LO that was used for down conversion. Any difference in LO frequencies will translate to an equivalent end-to-end frequency offset. In the embodiments described, the down conversion and up conversion LOs are at locations remote from one another. Therefore, in one preferred embodiment, frequency coherence between the local and remote LO's is established as follows: at the DHU end, there is a 142 MHz reference oscillator which establishes the bit rate of 1.42 GHz over the fiber. This reference oscillator also generates a 17.75 MHz reference clock which serves as a reference to which LO's at the DHU are locked.

[0030] At each of the DRUs, there is another 17.75 MHz clock, which is recovered from the optical bit stream with the help of the clock and bit recovery circuits. Because this clock is recovered from the bit stream generated at the host, it is frequency coherent with the reference oscillator at the host. A reference 17.75 MHz clock is then generated to serve as a reference for the remote local oscillators. Because the remote recovered bit clock is frequency coherent with the host master clock, the host and remote reference clocks, and any LO's locked to them, are also frequency coherent, thus ensuring that DHU and DRU LO's are locked in frequency. It is understood that in other embodiments the bit rate over the fiber may vary and the frequency of the clocks will also vary.

[0031] Figure 2 is a block diagram of one embodiment of a communication system, shown generally at 200 and constructed according to the teachings of the present invention. In this embodiment, a digital host unit (DHU) 220 is coupled to a bi-directional amplifier (BDA) 211. The BDA 211 receives communication signals from a wireless interface device (WID) and transports the communication signals as RF signals to the DHU 220 and receives RF signals from DHU 220 and transmits the RF signals to the WID. The DHU 220 receives RF signals from the BDA 211 and digitizes the RF signals and optically transmits the digital RF signals to multiple DRUs via transmission lines 214-1 to 214-N. DHU 220 also receives digitized RF signals over transmission lines 216-1 to 216-N from a plurality of DRUs either directly or indirectly via DEUs,

reconstructs the corresponding analog RF signals, and applies them to BDA 211. In one embodiment, DHU 220 receives signals directly from a plurality N of DRUs. The signals are digitally summed and then converted to analog signals and transmitted to BDA 211. In another embodiment, DHU 220 receives signals from one or more DEUs and one or more DRUs directly. Again, the signals are all digitally summed and then converted to analog signals and transmitted to BDA 211. The signals received via transmission lines 216-1 to 216-N may be received directly from a DRU or signals that are received by a DEU and summed together and then transported via 216-1 to 216-N to DHU 220 for additional summing and conversion for transport to BDA 211. DEUs provide a way to expand the coverage area and digitally sum signals received from DRUs or other DEUs for transmission in the reverse path to other DEUs or DHU 220. In one embodiment, transmission lines 214-1 to 214-N and 216-1 to 216-N comprise multimode fiber pairs. In an alternate embodiment, each fiber pair is replaced by a single fiber, carrying bi-directional optical signals through the use of wavelength division multiplexing (WDM). In an alternate embodiment, transmission lines 214-1 to 214-N and 216-1 to 216-N comprise single mode fibers. In one embodiment, N is equal to six. In an alternate embodiment, the number of transmission lines in the forward path direction 214-1 to 214-N is not equal to the number of transmission lines in the reverse path direction 216-1 to 216-N.

[0032] Figure 3 is a block diagram of an alternate embodiment of a communication system shown generally at 300 and constructed according to the teachings of the present invention. Communication system 300 includes a base station 310 coupled to a DHU 320. Base station 310 includes conventional transmitters and receivers 323 and 328, respectively, and conventional radio controller or interface circuitry 322 to an MTSO or telephone switched network. DHU 320 is coupled to base station 310. DHU 320 is also coupled to transmission lines 314-1 to 314-M, which transmit in the forward path direction and transmission lines 316-1 to 316-M, which transmit in the reverse path direction.

[0033] DHU 320 essentially converts the RF spectrum to digital in the forward path and from digital to analog in the reverse path. In the forward path, DHU 320 receives the combined RF signal from transmitters 323, digitizes the combined signal and transmits

it in digital format over fibers 314-1 to 314-M, which are connected directly to a plurality of DRUs or indirectly to one or more DRUs via one or more DEUs.

[0034] In one embodiment, DHU 320 receives signals directly from a plurality M of DRUs. The signals are digitally summed and then converted to analog signals and transmitted to base station 310. In another embodiment, DHU 320 receives signals from one or more DEUs and one or more DRUs directly. Again, the signals are all digitally summed and then converted to analog signals and transmitted to base station 310. The signals received via transmission lines 316-1 to 316-M may be received directly from a DRU or signals that are received by a DEU and summed together and then transported via 316-1 to 316-M to DHU 320 for additional summing and conversion for transport to base station 210. DEUs provide a way to expand the coverage area by splitting signals in the forward path and digitally summing signals received from DRUs or other DEUs in the reverse path for transmission upstream to other DEUs or a DHU. In the reverse path, DHU 320 also receives digitized RF signals over fibers 316-1 to 316-M from a plurality of DRUs, either directly or indirectly via DEUs, reconstructs the corresponding analog RF signal, and applies it to receivers 328.

[0035] In one embodiment, transmission lines 314-1 to 314-M and 316-1 to 316-M comprise multimode fiber pairs. In an alternate embodiment, each fiber pair is replaced by a single fiber, carrying bi-directional optical signals through the use of wavelength division multiplexing (WDM). In an alternate embodiment, transmission lines 314-1 to 314-M and 316-1 to 316-M comprise single mode fibers. In one embodiment, M is equal to six. In an alternate embodiment, the number of transmission lines in the forward path direction 314-1 to 314-M is not equal to the number of transmission lines in the reverse path direction 316-1 to 316-M.

[0036] Referring now to FIG. 4, there is shown one embodiment of a DHU 420 constructed according to the teachings of the present invention. DHU 420 includes an RF to digital converter 491 receiving the combined RF signals from a wireless interface device such as a base station, BDA or the like. RF to digital converter 491 provides a digitized traffic stream that is transmitted to multiplexer 466. Multiplexer 466 converts the parallel output of the A/D converter into a framed serial bit stream. At the output of

the multiplexer is a 1 to P fan out buffer 407, which splits the digital signal P ways. There are P optical transmitters 431-1 to 431-P one feeding each of the P optical transmission lines 414-1 to 414-P. The digitized signals are applied to fibers 414-1 to 414-P for transmission to corresponding DRUs either directly or via DEUs. In one embodiment, P is equal to 6.

[0037] In one embodiment, DHU 420 includes an amplifier 450 that receives the combined RF signal from a wireless interface device such as a base station or BDA. The combined RF signal is amplified and then mixed by mixer 452 with a signal received from local oscillator 468. Local oscillator 468 is coupled to reference oscillator 415. In one embodiment the local oscillator is coupled to a frequency divider circuit 470, which is in turn coupled to reference oscillator 415. The local oscillator is locked to the reference oscillator 415 as a master clock so that the down conversion of the RF signals is the same as the up conversion. The result is end to end, from DHU to DRU, or DHU to one or more DEUs to DRU, no frequency shift in the signals received and transmitted. The local oscillator 463 is also coupled to a synthesizer circuit 476.

[0038] The output signal of mixer 452 is provided to amplifier 454 amplified and then filtered via intermediate frequency (IF) filter 456. The resultant signal is the combined RF signal converted down to an IF signal. The IF signal is mixed with another signal originating from the reference oscillator 415 via mixer 460. The output of mixer 460 is summed together at 462 with a signal produced by field programmable gate array (FPGA) 467. The output is then converted from an analog signal to a digital signal via analog/digital (A/D) converter 464 once converted the digital RF signal is applied to multiplexer 466. In one embodiment, the A/D converter 464 is a 14-bit converter handling a 14-bit signal. In other embodiments, the A/D converter 464 may be of any size to accommodate an appropriate signal. In one embodiment, the input signal from FPGA 467 is a dither signal from dither circuit 462 that adds limited out of band noise to improve the dynamic range of the RF signal.

[0039] In one embodiment, DHU 420 includes an alternating current to digital current power distribution circuit 6 that provides direct current power to each of the DRUs coupled to DHU 420.

[0040] DHU 420 further includes a plurality of digital optical receivers 418-1 to 418-P in the reverse path. Receivers 418-1 to 418-P each output an electronic digital signal, which is applied to clock and bit recovery circuits 445-1 to 445-P, respectively, for clock and bit recovery of the electronic signals. The signals are then applied to demultiplexers 441-1 to 441-P, respectively, which extract the digitized signals generated at the DRUs, as will be explained in detail below. Demultiplexers 441-1 to 441-P further extract alarm (monitoring) and voice information framed with the digitized signals. The digitized signals output at each demultiplexer 441-1 to 441-P are then applied to FPGA 467 where the signals are summed together and then applied to digital to RF converter 495. Converter 495 operates on the sum of the digitized signals extracted by demultiplexers 441-1 to 441-P, reconstructing baseband replicas of the RF signals received at all the digital remote units. The baseband replicas are then up-converted to their original radio frequency by mixing with a local oscillator 482 and filtering to remove image frequencies. Local oscillator 482 is coupled to synthesizer 476 and reference oscillator as discussed with respect to local oscillator 468 above.

[0041] In one embodiment, digital to RF converter 495 includes digital to analog (D/A) converter 484 coupled to an output of FPGA 467 the digitized RF signals are converted to analog RF signals and then mixed with a signal from reference oscillator 415 by mixer 492. The signal is then filtered by IF filter 490 and amplified by amplifier 488. The resultant signal is then mixed with a signal from local oscillator 482 and then applied to RF filter 484, amplifier 480 and RF filter 478 for transmission by a wireless interface device such as a BDA or base station.

[0042] In one embodiment, FPGA 467 includes an alarm/control circuit 474, which extracts overhead bits from DRUs to monitor error and alarm information. In one embodiment, the FPGA 467 includes a summer 498, which mathematically sums together the digital RF signals received from fibers 416-1 to 416-P. In another embodiment FPGA includes an overflow algorithm circuit 486 coupled to the output of summer 486. The algorithm circuit 496 allows the summed digital RF signals to saturate and keep the summed signal within a defined number of bits. In one embodiment, the algorithm circuit includes a limiter. In one embodiment, the RF

signals are 14-bit signals and when summed and limited by summer 498 and overflow algorithm 496 result in a 14-bit output signal.

[0043] For example, in one embodiment each of the digital RF signals received from fibers 416-1 to 416-P, where P is equal to 6, comprise 14 bit inputs. All of those 6 different 14 bit inputs then go into summer 498. In order to allow for overflow, at least 17 bits of resolution is needed in the summer 498 to handle a worst-case scenario when all 6 of the 14 bit inputs are at full scale at the same time. In this embodiment, a 17-bit wide summer 498 is employed to handle that dynamic range. Coming out of summer 498 is needed a 14-bit signal going in the reverse path. In one embodiment, an algorithm circuit 496 for managing the overflow is implemented. In one embodiment, the summer and 498 and overflow algorithm 496 are included in FPGA 467. In one embodiment, overflow algorithm 496 acts like a limiter and allows the sum to saturate and keeps the summed signal within 14 bits. In an alternate embodiment, overflow algorithm circuit 496 controls the gain and scales the signal dynamically to handle overflow conditions.

[0044] Figure 8 illustrates one embodiment of an algorithm 863 for a channel summer 865 in order to limit the sum of input signals 0 to 5 to 14 bits. In this embodiment, input signals 0 to 5 comprise 6 signals that are summed together by summer 865. The sum of input signals 0 to 5 is reduced to a signal having 14 bits or less by the algorithm 863. It is understood that the algorithm 865 is by example and is not meant to restrict the type of algorithm used to limit the sum of signals 0 to 5 to 14 bits or less.

[0045] For example, when the sum of the 6 input signals 0 to 5 is greater than or equal to 13FFBh then the sum is divided by 6 for a signal that is 14 bits or less. When the sum of the 6 input signals 0 to 5 is greater than 13FFBh but less than or equal to FFFCh then the sum is divided by 5 for a signal that is 14 bits or less. When the sum of the 6 input signals 0 to 5 is greater than FFFCh but less than BFFDh then the sum is divided by 4 for a signal that is 14 bits or less. When the sum of the 6 input signals 0 to 5 is greater BFFDh but less than 7FFEh then the sum is divided by 3 for a signal that is 14 bits or less. Finally, when the sum of the 6 input signals 0 to 5 is greater than 7FFEh but less than or equal to 3FFFh then the sum is divided by 2 for a signal that is 14 bits or less.

[0046] Figure 5 is a block diagram of one embodiment of a digital remote unit (DRU) 540 constructed according to the teachings of the present invention. A digital optical receiver 501 receives the optical digital data stream transmitted from a DHU directly or via a DEU. Receiver 501 converts the optical data stream to a corresponding series of electrical pulses. The electrical pulses are applied to clock and bit recovery circuit 503. The series of electrical pulses are then applied to demultiplexer 505. Demultiplexer 505 extracts the digitized traffic signals and converts the signals from serial to parallel.. The output parallel signal is then applied to digital to RF converter 595 for conversion to RF and transmission to duplexer 547. RF converter 595 is connected to the main antenna 599 through a duplexer 547. Accordingly, radio frequency signals originating from a wireless interface device are transmitted from main antenna 547.

[0047] In one embodiment, digital to RF converter 595 includes a digital-to-analog (D/A) converter 509, which reconstructs the analog RF signal and applies it to IF 504 and amplifier 506. The analog signal is mixed with an output signal of reference oscillator 515 by mixer 502. The output of amplifier 506 is mixed with a signal from local oscillator 519 that locks the RF signal with the return digital signal via reference oscillator 515 that is coupled to local oscillator 519. In one embodiment, the reference oscillator is coupled to frequency divider 517 that in turn is coupled to local oscillators 519 and 529. The local oscillators 519 and 529 are also coupled to synthesizer 521 that is coupled to programmable logic device 525.

[0048] RF signals received at main antenna 599 are passed through duplexer 547 to RF to digital converter 593. The RF signals are converted to digital signals and then applied to multiplexer 536 converted from parallel-to-serial and optically transmitted via optical transmitter 532 to a DEU or DHU.

[0049] In one embodiment, RF to digital converter 593 includes a first amplifier 543 that receives RF signals from duplexer 547, amplifies the signals and transmits them to digital attenuator 539. In one embodiment, amplifier 543 is a low noise amplifier. Digital attenuator 539 receives the amplified signals and digitally attenuates the signal to control the levels in case of an overload situation. RF to digital converter 593 further includes a second amplifier 537, which receives the attenuated signals, amplifies the signals and applies the amplified signals to mixer 535. Mixer 535 mixes the amplified

signals with a signal received from local oscillator 529. The resultant signals are applied to a third amplifier 533 an IF filter 548 and a fourth amplifier 546 in series to down convert to an IF signal. The IF signal is then mixed with a signal from reference oscillator 515 and the mixed signal is summed with a signal from dither circuit 527. The resultant signal is applied to analog-to-digital converter 538 and converted to a digital signal. The output digital signal is then applied to a multiplexer 536. In one embodiment, the multiplexer 536 multiplexes the signal together with a couple of extra bits to do framing and control information. In one embodiment, multiplexer 536, clock and bit recovery circuit and demultiplexer 505 comprise a multiplexer chip set.

[0050] Programmable logic circuit 525 programs synthesizer 521 for the reference oscillator and for the up and down conversion of local oscillators 519 and 529. The programmable logic circuit 525 looks for error conditions, for out of lock conditions on the oscillators and reports error modes and looks for overflow condition in the A/D converter 538. If an overflow condition occurs the programmable logic circuit 525 indicates that you are saturating and adds some extra attenuation at digital attenuator 539 in order to reduce the RF signal levels coming in from RF antenna 599 and protect the system from overload.

[0051] In one embodiment, DRU 540 includes an internal direct current power distribution system 5. In one embodiment, the distribution system receives 48 VDC and internally distributes 3 outputs of +3.8V, +5.5V and +8V.

[0052] Figure 6 is a block diagram of one embodiment of a digital expansion unit (DEU) 630 constructed according to the teachings of the present invention. DEU 630 is designed to receive optical signals and transmit optical signals. An optical receiver 651 receives digitized RF signals and transmits them to clock and bit recovery circuit 653 that performs clock and bit recovery to lock the local clock and clean up the signal. The signals are then split into X RF digital signals by 1 to X fan out buffer 607. The signals are then transmitted via optical transmitters 655-1 to 655-X to X receiving units such as DEUs or DRUs. The X receiving units may be any combination of DEUs or DRUs. In one embodiment, X is equal to six.

[0053] DEU 630 also includes optical receivers 669-1 to 669-X, which receive digitized RF signals directly from DRUs or indirectly via DEUs. In operation the signals are

received, applied to clock and bit recovery circuits 673-1 to 673-X respectively to lock the local clock and clean up the signals and then applied to demultiplexers 671-1 to 671-X. Demultiplexers 671-1 to 671-X each extract the digitized traffic and apply the samples to field programmable gate array 661. The signals are summed together digitally and transmitted to multiplexer 657, which multiplexes the signal together with a couple of extra bits to do framing and control information. In addition, the multiplexer 657 converts the signals parallel to serial. The signals are then applied to optical transmitter 659 for further transmission. In one embodiment, the signals are directly transmitted to a DHU or indirectly via one or more additional DEUs.

[0054] In one embodiment, the FPGA 661 includes summer 665, which mathematically sums together the digital RF signals received from demultiplexers 671-1 to 671-X. In another embodiment, FPGA 661 includes an overflow algorithm circuit 663 coupled to the output of summer 665. The algorithm circuit 663 allows the summed digital RF signals to saturate and keep the summed signal within a defined number of bits. In one embodiment, the algorithm circuit includes a limiter. In one embodiment, the RF signals are 14-bit signals and when summed and limited by summer 665 and overflow algorithm 663 result in a 14-bit output signal.

[0055] In one embodiment, DEU 630 includes an alternating current to digital current power distribution circuit 7 that provides direct current power to each of the DRUs coupled to DEU 630.

[0056] In an alternate embodiment, the digital host unit (DHU) and wireless interface device (WID) are located some distance from the building being served. The DHU in the building is replaced by a DEU, and the link between that DEU and the remotely located DHU is via single mode fiber. Figure 7 is a block diagram of this embodiment.

A microcell base station shown generally at 700 includes conventional transmitters and receivers 723 and 728, respectively, and conventional radio controller or interface circuitry 722. In the forward path, a DHU 767 receives the combined RF signal from transmitters 723, digitizes the combined signal and transmits it in digital format over single mode fiber to a DEU. In the reverse path, DHU 767 receives digitized RF signal from a DEU, reconstructs the corresponding analog RF signal, and applies it to receivers 728.

[0057] In another alternate embodiment, the wireless interface device (WID) is a software defined base station, and the interface between the DHU and WID takes place digitally, eliminating the need for the RF to digital conversion circuitry in the DHU.

Conclusion

[0058] A digital radio frequency transport system has been described. The transport system includes a digital host unit and at least two digital remote units coupled to the digital host unit. The digital host unit includes shared circuitry that performs bi-directional simultaneous digital radio frequency distribution between the digital host unit and the at least two digital remote units.

[0059] In addition, a digital radio frequency transport system has been described. The transport system includes a digital host unit and at least one digital expansion unit coupled to the digital host unit. The transport system further includes at least two digital remote units, each coupled to one of the digital host unit and the digital expansion unit. The digital host unit includes shared circuitry that performs bi-directional simultaneous digital radio frequency distribution between the digital host unit and that at least two digital remote units.

[0060] Further, a method of performing point-to-multipoint radio frequency transport has been described. The method includes receiving analog radio frequency signals at a digital host unit and converting the analog radio frequency signals to digitized radio frequency signals. The method also includes splitting the digitized radio frequency signals into a plurality of a digital radio frequency signals and optically transmitting the digital radio frequency signals to a plurality of digital remote units. The method further includes receiving the digital radio frequency signals at a plurality of digital remote units, converting the digital radio frequency signals to analog radio frequency signals and transmitting the signals via a main radio frequency antenna at each of the plurality of digital remote units.

[0061] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement which is calculated to achieve the same purpose may be substituted for the specific embodiments shown. For example, a digital remote unit is not limited to the receipt and summing and

splitting and transmitting of digitized radio frequency signals. In other embodiments, the digital host unit is capable of receiving and summing analog radio frequency signals in addition to or instead of digitized radio frequency signals. As well, the digital host unit is capable of splitting and transmitting analog radio frequency signals in addition to or instead of digitized radio frequency signals. This application is intended to cover any adaptations or variations of the present invention. Therefore, it is intended that this invention be limited only by the claims and the equivalents thereof.

What is claimed is:

1. A system for digital transport of a wireless radio frequency spectrum, the system comprising:

a first unit; and

a plurality of second units communicatively coupled to the first unit using at least one wired communication link and remotely located from the first unit, wherein each of the plurality of second units is associated with a portion of the coverage area;

wherein each of the plurality of second units receives a respective analog wireless signal comprising the wireless radio frequency spectrum and any transmissions from any of the wireless units that are within a respective coverage area associated with that second unit;

wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit;

wherein each of the plurality of second units is configured to communicate the respective digital RF samples generated by that second unit to the first unit using the wired communication link;

wherein the first unit is configured to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the system is configured so that an input used for base station processing is derived from the resulting summed digital RF samples.

2. The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

3. The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.
4. The system of claim 1, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.
5. The system of claim 1, wherein the system includes base station signal processing functionality configured to perform base station processing.
6. The system of claim 5, wherein the base station processing functionality is at least one of: co-located with the first unit and remote from the first unit.
7. The system of claim 1, wherein the system comprises at least a portion of a base station for performing the base station processing.
8. The system of claim 1, wherein the system further comprises software configured to perform the base station processing using the input derived from the resulting summed digital RF samples.
9. The system of claim 8, wherein the first unit comprises the software configured to perform the base station processing using the input derived from the resulting summed digital RF samples.
10. The system of claim 1, wherein the system is configured to convert the summed digital RF samples to a replicated analog wireless radio frequency signal.
11. The system of claim 10, wherein the system comprises a digital-to-analog converter to convert the summed digital RF samples to the replicated analog wireless radio frequency signal.

12. The system of claim 1, wherein each of the plurality of second units comprises:
a respective analog-to-digital converter to digitize the respective analog wireless radio frequency signal received at that second unit in order to produce the respective digital RF samples.
13. The system of claim 1, wherein each of the plurality of second units generates the respective digital RF samples indicative of the respective analog wireless signal received at that second unit by frequency shifting the respective analog wireless radio frequency signal received at that second unit and digitizing the frequency-shifted analog wireless radio frequency signal.
14. The system of claim 1, wherein each of the plurality of second units is configured to generate the respective digital RF samples indicative of the respective analog wireless signal received at that second unit by down converting the respective analog wireless radio frequency signal received at that second unit and digitizing the down-converted analog wireless radio frequency signal.
15. The system of claim 1, wherein the first unit digitally is configured to sum the corresponding digital RF samples received from the plurality of second units in order to produce the summed digital RF samples at a resolution greater than a resolution of the digital RF samples being summed.
16. The system of claim 1, wherein the wireless radio frequency spectrum comprises a cellular radio frequency spectrum.
17. The system of claim 1, wherein the wired communication link comprises at least one of: a single mode optical fiber, a multi-mode optical fiber, and a coaxial cable.
18. A first unit used in digital transport of a wireless radio frequency spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units receives a respective analog wireless signal comprising the wireless radio frequency spectrum and any transmissions from any of the wireless units that are within a coverage area associated with that second unit and wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit, wherein the interface is used to receive the digital RF samples from the plurality of second units;

a digital summer to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the first unit is configured so that an input used for base station processing is derived from the resulting summed digital RF samples.

19. The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

20. The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

21. The first unit of claim 18, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

22. The first unit of claim 18, wherein the base station processing is at least of: co-located with the first unit and remote from the first unit.

23. The first unit of claim 18, wherein the base station processing is performed by at least a portion of a base station.

24. The first unit of claim 18, wherein the first unit further comprises software configured to perform the base station processing using the input derived from the resulting summed digital RF samples.

25. The first unit of claim 18, wherein the first unit is configured to convert the summed digital RF samples to a replicated analog wireless radio frequency signal.

26. The first unit of claim 25, wherein the first unit comprises a digital-to-analog converter to convert the summed digital RF samples to the replicated analog wireless radio frequency signal.

27. The first unit of claim 18, wherein the first unit is configured to digitally sum the corresponding digital RF samples received from the plurality of second units in order to produce the summed digital RF samples at a resolution greater than a resolution of the digital RF samples being summed.

28. The first unit of claim 18, wherein the wireless radio frequency spectrum comprises a cellular radio frequency spectrum.

29. A method for digital transport of a wireless radio frequency spectrum used with a first unit and a plurality of second units, each of the plurality of second units being remotely located from the first unit, the method comprising:

at each of the plurality of second units:

receiving a respective analog wireless signal comprising the wireless radio frequency spectrum and any transmissions from any of the wireless units that are within the portion of the coverage area associated with that second unit;

generating respective digital RF samples indicative of the respective analog wireless signal received at that second unit; and

communicating the respective digital RF samples generated by that second unit to the first unit using at least one communication medium; and

at the first unit, digitally summing corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples.

30. The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

31. The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

32. The method of claim 29, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

33. The method of claim 29, further comprising performing base station processing using an input derived from the resulting summed digital RF samples.

34. The method of claim 33, wherein the base station processing is at least one of: co-located with the first unit and remote from the first unit.

35. The method of claim 33, wherein the base station processing is performed by at least a portion of a base station.

36. The method of claim 29, further comprising converting the summed digital RF samples to a replicated analog wireless radio frequency signal.

37. The method of claim 29, wherein the corresponding digital RF samples are digitally summed at a resolution greater than a resolution of the digital RF samples being summed.

38. The method of claim 29, wherein the wireless radio frequency spectrum comprises a cellular radio frequency spectrum.

39. The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital RF samples indicative of the respective analog wireless signal received at that second unit comprises:

frequency shifting the respective analog wireless radio frequency signal received at that second unit; and
digitizing the frequency-shifted analog wireless radio frequency signal.

40. The method of claim 29, wherein, at each of the plurality of second units, generating the respective digital RF samples indicative of the respective analog wireless signal received at that second unit comprises:

down converting the respective analog wireless radio frequency signal received at that second unit; and
digitizing the down-converted analog wireless radio frequency signal.

41. A system for digital transport of a wireless radio frequency spectrum, the system comprising:

a first unit; and
a plurality of second units communicatively coupled to the first unit using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit;
wherein each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless radio frequency spectrum;

wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit;

wherein each of the plurality of second units is configured to communicate the respective digital RF samples generated by that second unit to the first unit using the at least one wired communication link;

wherein the first unit is configured to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the system is configured so that an input used for wireless protocol processing is derived from the resulting summed digital RF samples.

42. The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link.

43. The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

44. The system of claim 41, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

45. The system of claim 41, wherein the wireless protocol processing is at least one of: co-located with the first unit and remote from the first unit.

46. The system of claim 41, wherein the system comprises at least a portion of a base station for performing the wireless protocol processing.

47. The system of claim 41, wherein the system further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital RF samples.

48. The system of claim 47, wherein the first unit comprises the software configured to perform the wireless protocol processing using the input derived from the resulting summed digital RF samples.

49. A first unit for digital transport of a wireless radio frequency spectrum, the first unit comprising:

at least one interface to communicatively couple the first unit to a plurality of second units using at least one wired communication link, wherein each of the plurality of second units is remotely located from the first unit and each of the plurality of second units is configured to receive a respective analog wireless signal comprising the wireless radio frequency spectrum and wherein each of the plurality of second units is configured to generate respective digital RF samples indicative of the respective analog wireless signal received at that second unit, wherein the at least one interface is configured to receive the digital RF samples from the plurality of second units at the first unit;

a digital summer to digitally sum corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples; and

wherein the first unit is configured so that an input used for wireless protocol processing is derived from the resulting summed digital RF samples.

50. The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a separate wired communication link, wherein the first unit comprises a separate interface configured to communicatively couple the first unit to each of said at least some of the plurality of second units using the respective separate wired communication link.

51. The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit at least in part using a shared wired communication link.

52. The first unit of claim 49, wherein at least some of the plurality of second units are communicatively coupled to the first unit using an intermediary digital expansion unit.

53. The first unit of claim 49, wherein the wireless protocol processing is at least of: co-located with the first unit and remote from the first unit.

54. The first unit of claim 49, wherein the wireless protocol processing is performed by at least a portion of a base station.

55. The first unit of claim 49, wherein the first unit further comprises software configured to perform the wireless protocol processing using the input derived from the resulting summed digital RF samples.

Abstract of the Disclosure

One embodiment is directed to a system for use with a coverage area in which one or more wireless units wirelessly transmit using a wireless radio frequency spectrum. The system comprises a first unit, and a plurality of second units communicatively coupled to the first unit using at least one communication medium. Each of the plurality of second units generates respective digital RF samples indicative of a respective analog wireless signal received at that second unit. Each of the plurality of second units communicates the respective digital RF samples generated by that second unit to the first unit using the at least one communication medium. The first unit digitally sums corresponding digital RF samples received from the plurality of second units to produce summed digital RF samples. The system is configured so that an input used for base station processing is derived from the resulting summed digital RF samples.

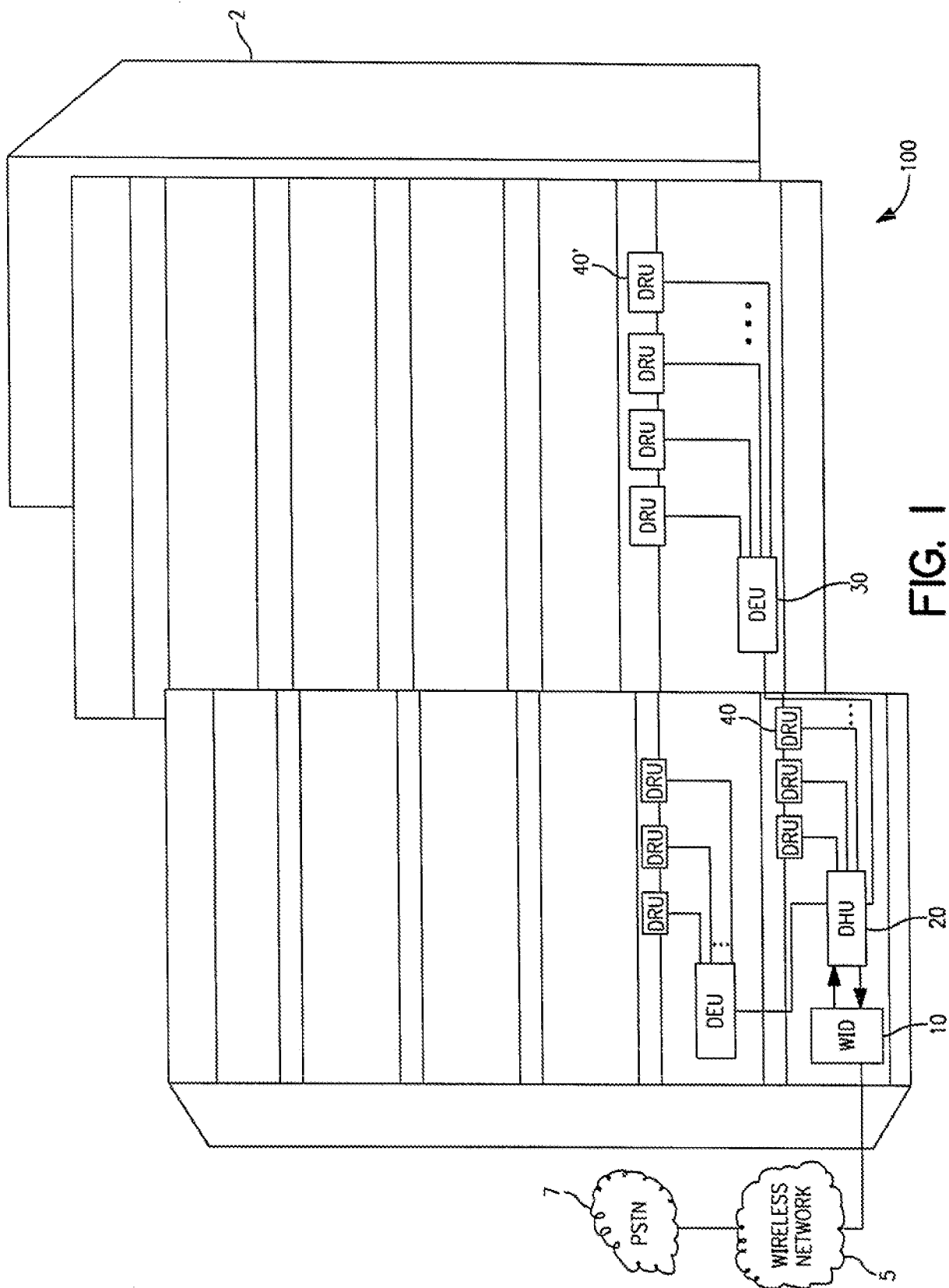


FIG. 1

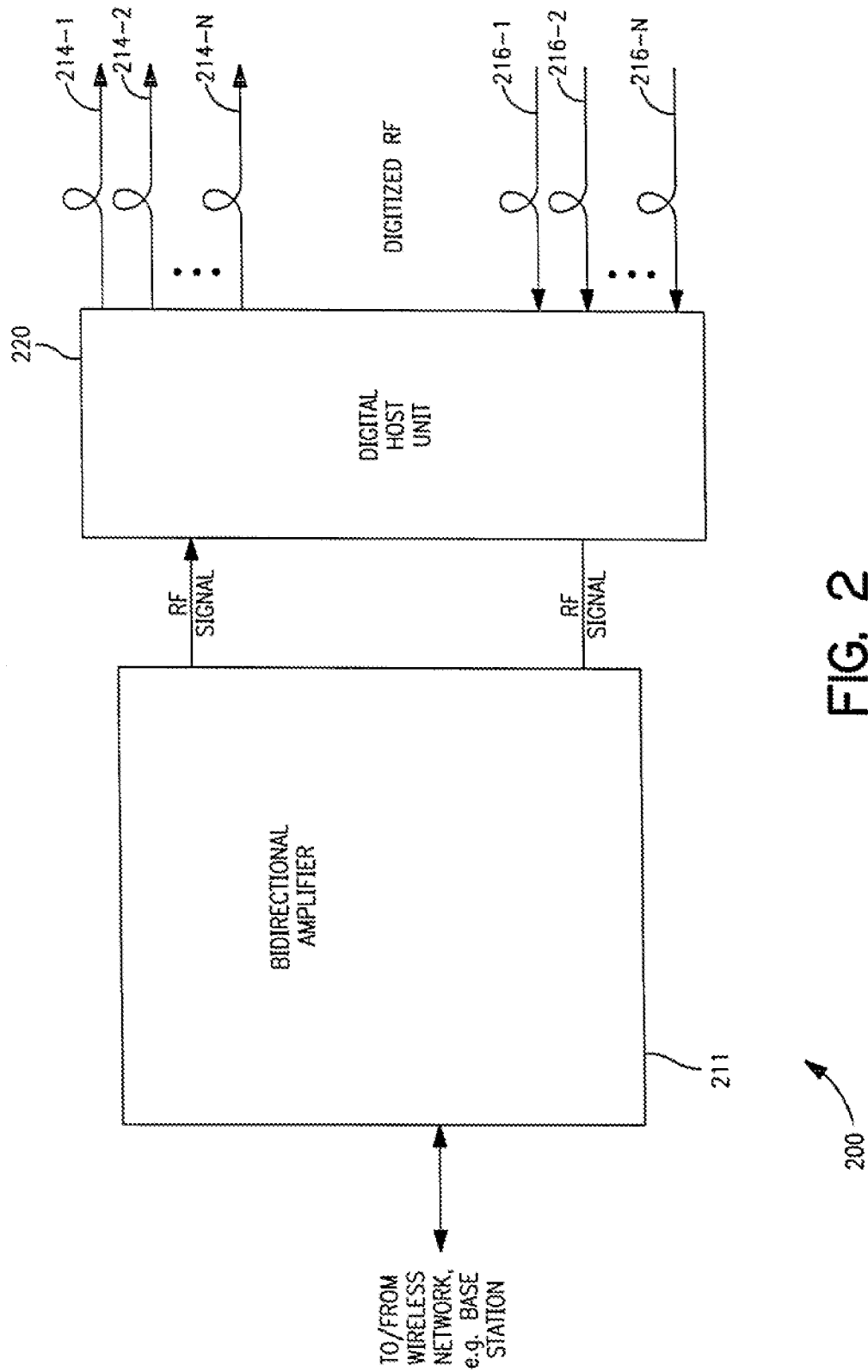


FIG. 2

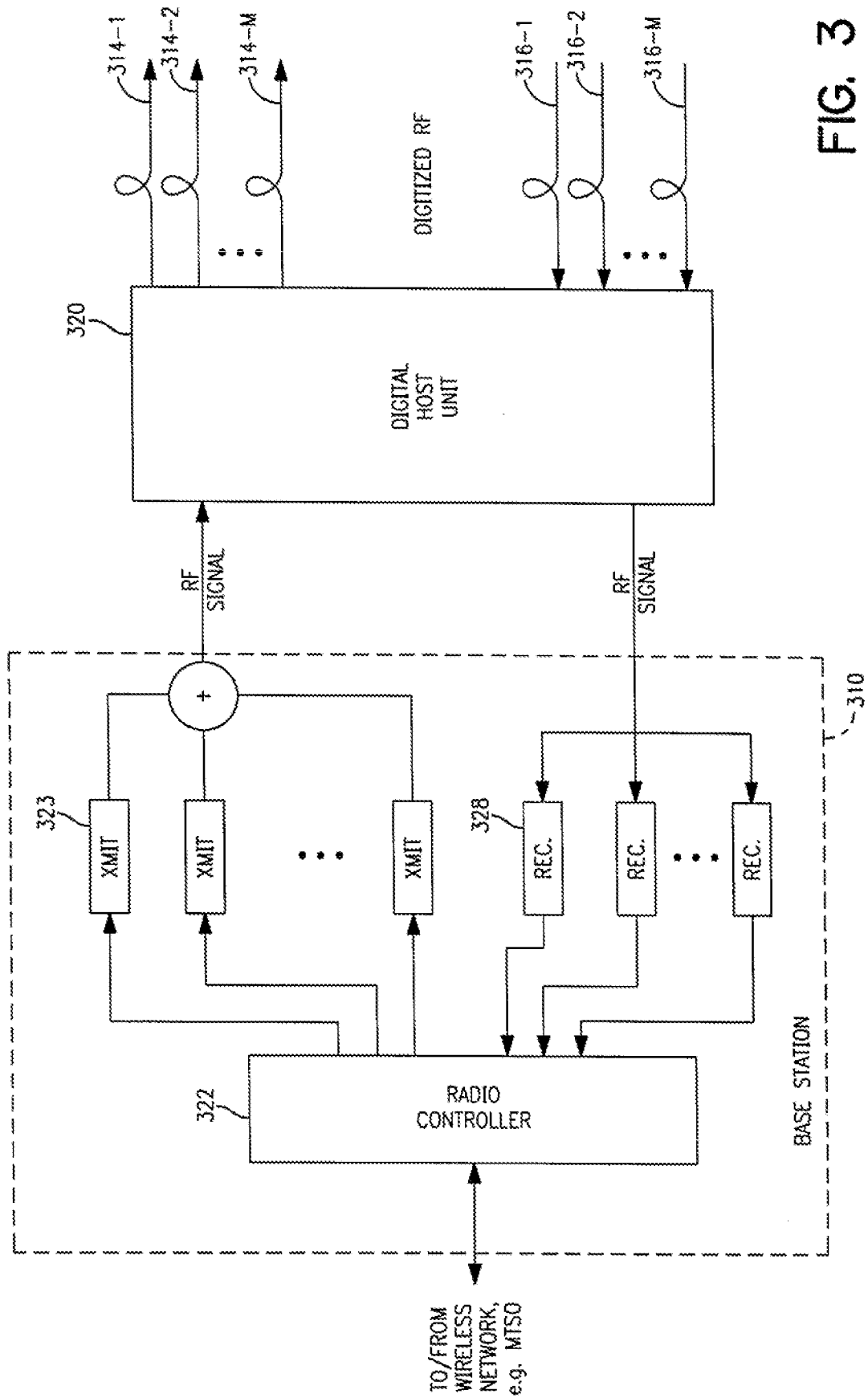


FIG. 3

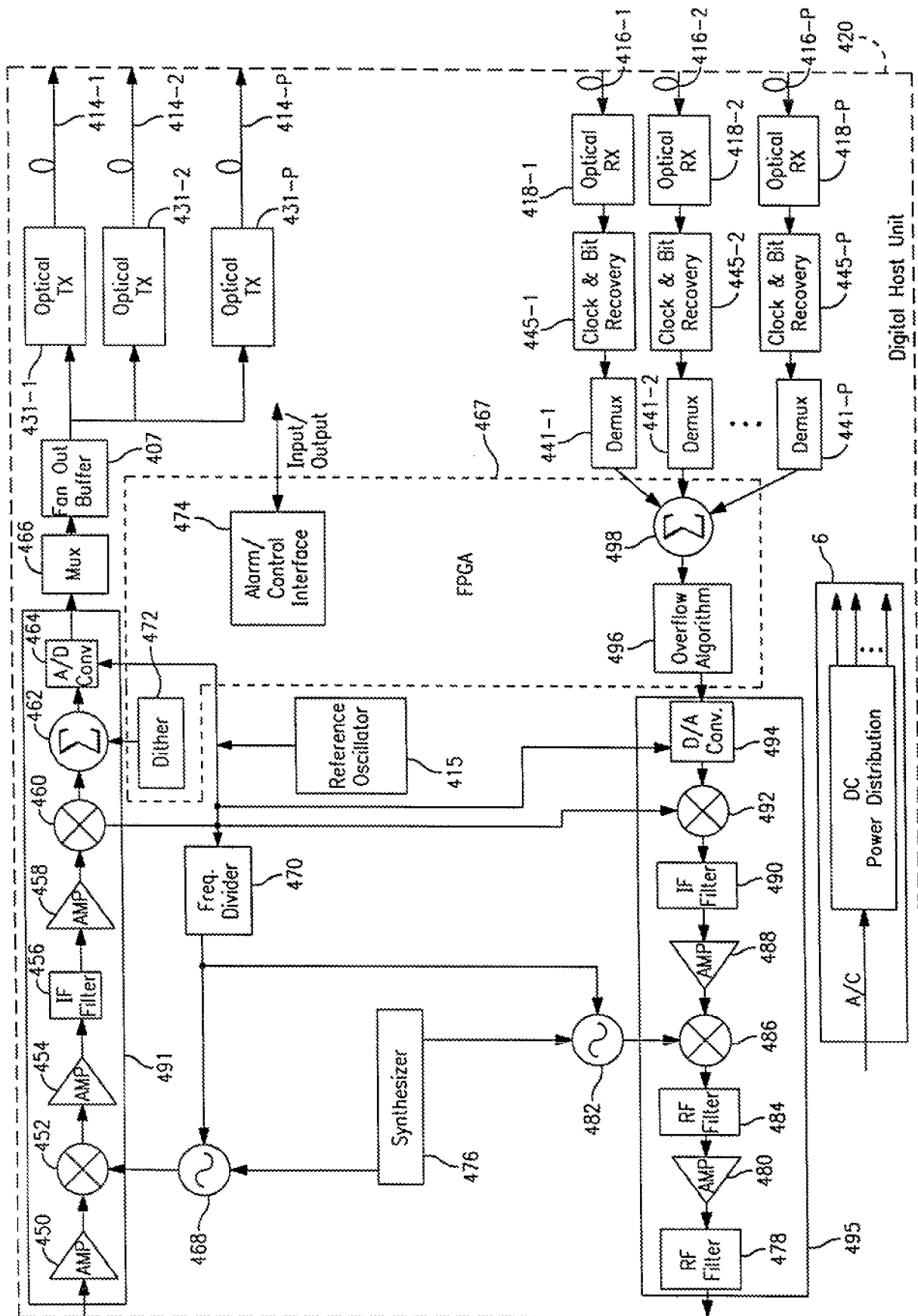


FIG. 4

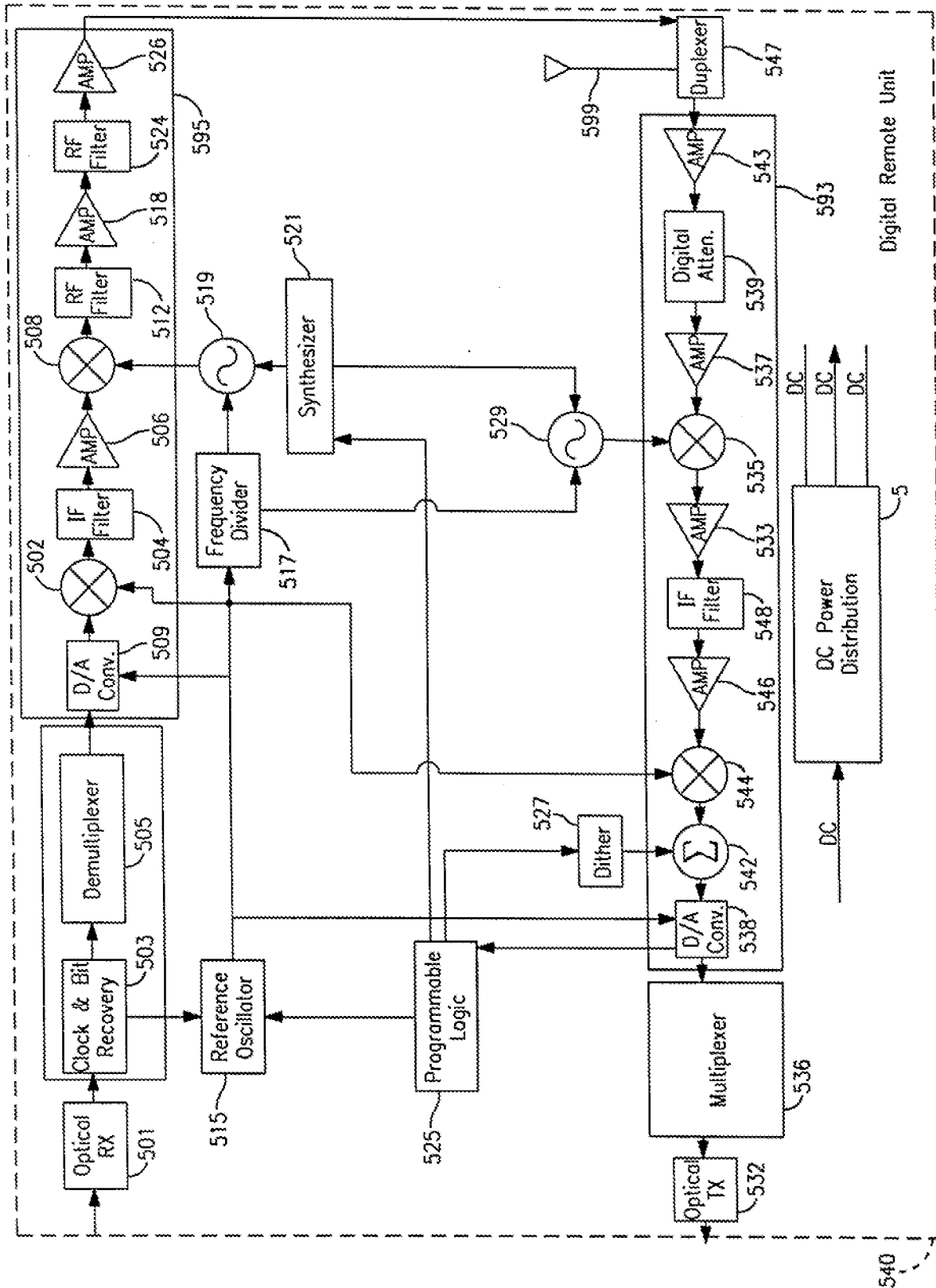


FIG. 5

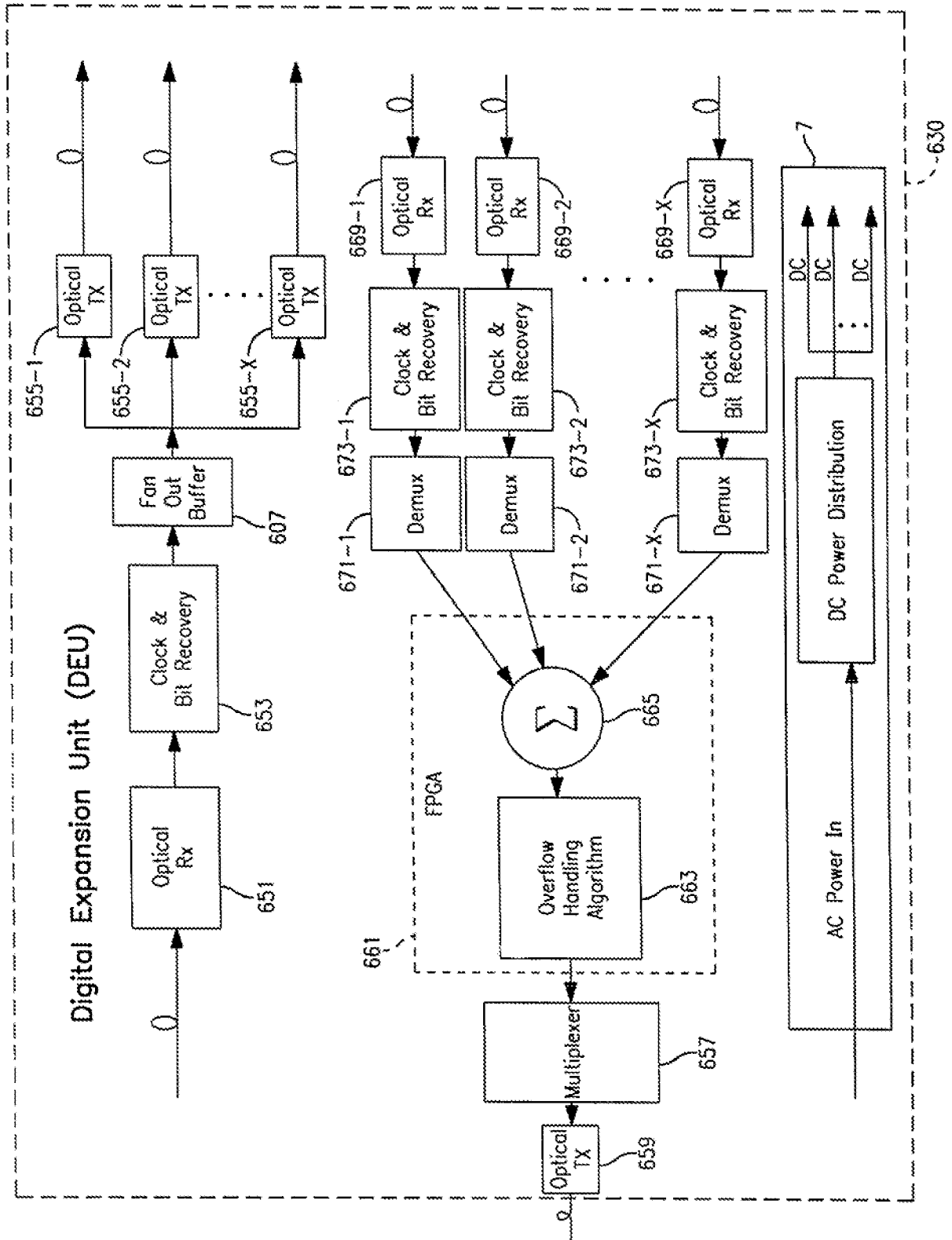


FIG. 6

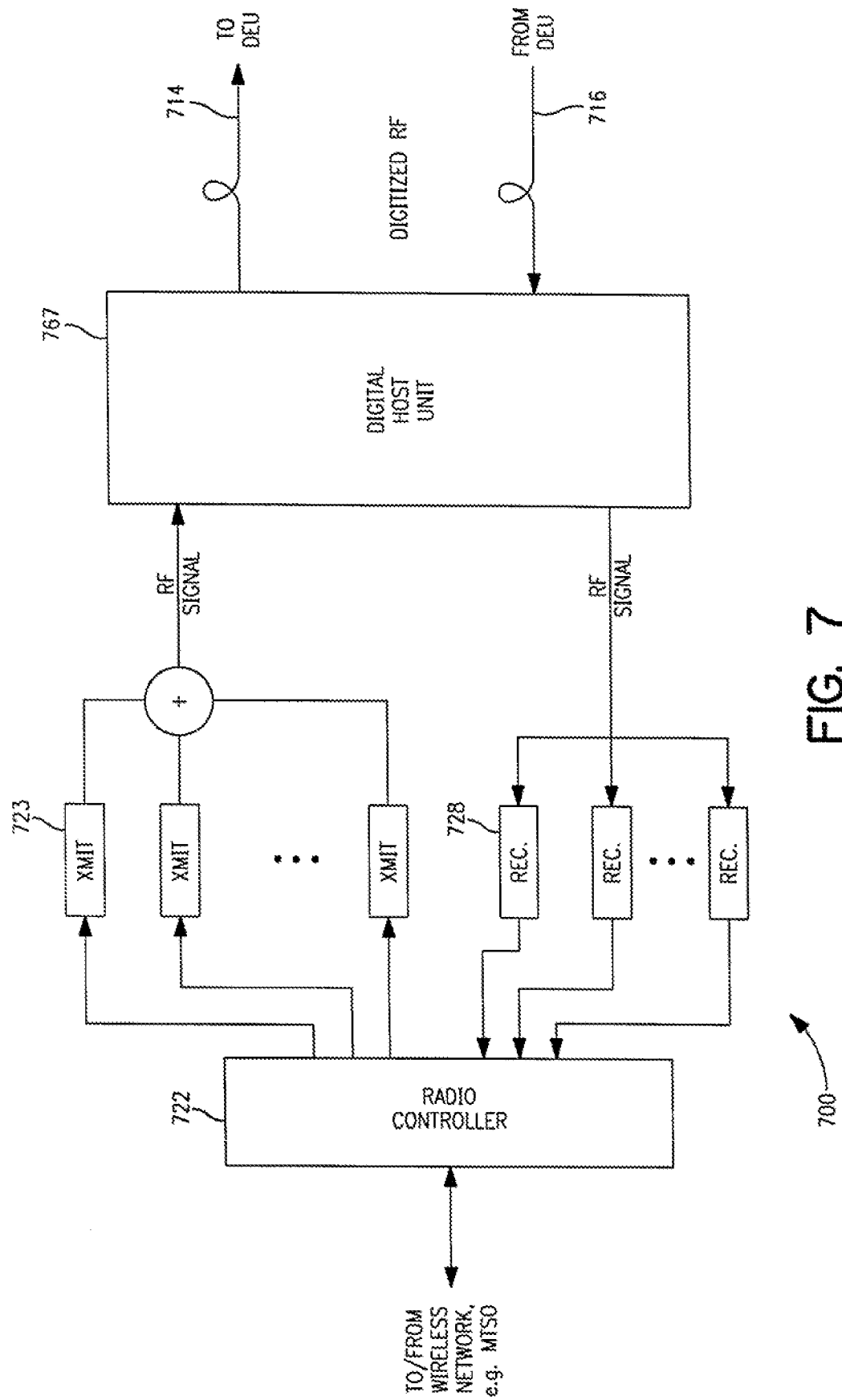


FIG. 7

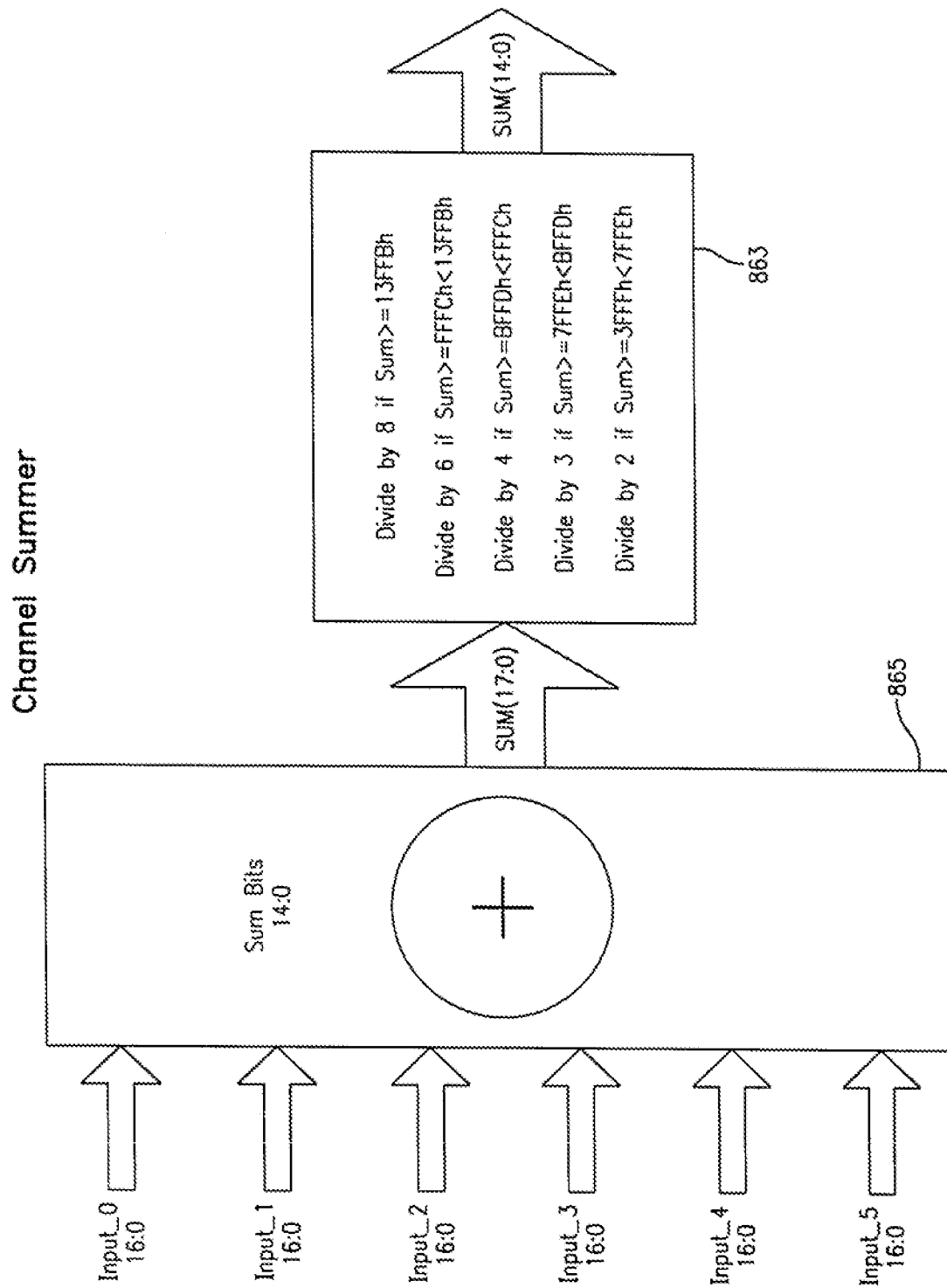


FIG. 8

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name		Suffix	
Mr.	Philip	M.	Wala			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	Savage	State/Province	MN	Country of Residence i	US	
Mailing Address of Inventor:						
Address 1		14082 Toledo Court				
Address 2						
City	Savage	State/Province	MN			
Postal Code	55378	Country i	US			
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.						
Add						

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence Information of this application.			
Customer Number	34206		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		
Attorney Docket Number	100.019US05	Small Entity Status Claimed ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	8	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.			
Please Select One:			
☒	Customer Number	☐	US Patent Practitioner
☐	Limited Recognition (37 CFR 11.9)		
Customer Number	34206		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.					
Prior Application Status	Pending	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)		
	Continuation of	13662948	2012-10-29		
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13662948	Continuation of	12617215	2009-11-12	8326218	2012-12-04
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12617215	Continuation of	10740944	2003-12-19	7639982	2009-12-29
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
10740944	Continuation of	09619431	2000-07-19	6704545	2004-03-09
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove			
Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices
If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application. In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application. In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant 1			Remove
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
Clear			
☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor	
☐ Person to whom the inventor is obligated to assign.		☐ Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor :			
If the Applicant is an Organization check here. ☒			
Organization Name	ADC Telecommunications, Inc.		
Mailing Address Information:			
Address 1	1187 Park Place		
Address 2			
City	Shakopee	State/Province	MN
Country ⁱ	US	Postal Code	55379
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button. Add			

Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	100.019US05
		Application Number	
Title of Invention	POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT		

Assignee 1				
Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).				
Remove				
If the Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information:				
Address 1				
Address 2				
City		State/Province		
Country i		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Assignee Data may be generated within this form by selecting the Add button. Add				

Signature: Remove				
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications				
Signature	/Wade A. Whisenant/		Date (YYYY-MM-DD)	2013-10-10
First Name	Wade A.	Last Name	Whisenant	Registration Number
				59593
Additional Signature may be generated within this form by selecting the Add button. Add				

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: ADC Telecommunications, Inc.

Application No./Patent No.: _____ Filed/Issue Date: _____

Titled: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Attorney 100.019US05
Docket No.

ADC Telecommunications, Inc., a Corporation _____,
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is _____ %. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

- A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in United States Patent and Trademark Office at Reel/Frame _____, or for which a copy thereof is attached.

- B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.
2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO:**
Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____
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☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Wade A. Whisenant/
 Signature

October 10, 2013
 Date

Wade Whisenant
 Printed or Typed Name

59593
 Title or Registration Number

[Page 2 of 2]

ASSIGNMENT

WHEREAS, I, Philip M. Wala, residing at 504 14th Avenue NW, Waseca, MN 56093, made certain new and useful inventions and improvements for which I executed an application for Letters Patent of the United States on Even Date Herewith, which is entitled POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT (the "Application").

AND WHEREAS, ADC Telecommunications, Inc., a corporation organized and existing under and by virtue of the laws of the State of Minnesota, and having an office and place of business at 12501 Whitewater Drive, Minnetonka, MN 55343, (hereinafter "Assignee") is desirous of acquiring the entire right, title and interest in and to the inventions, improvements and the Application and in and to the Letters Patent to be obtained therefor;

NOW, THEREFORE, to all whom it may concern, be it known that for good and valuable consideration, the receipt and sufficiency whereof is hereby acknowledged, I have sold, assigned, and transferred, and by these presents do sell, assign and transfer unto the Assignee, its successors or assigns, the entire right, title and interest for all countries in and to all inventions and improvements disclosed in the Application, and in and to the Application, all divisions, continuations, or renewals thereof, all Letters Patent which may be granted therefrom, and all reissues or extensions of such patents, and in and to any and all applications which have been or shall be filed in any foreign countries for Letters Patent on the inventions and improvements, including an assignment of all rights under the provisions of the International Convention, and all Letters Patent of foreign countries which may be granted therefrom; and I do hereby authorize and request the Commissioner of Patents and Trademarks to issue any and all United States Letters Patent for the inventions and improvements to the Assignee as the assignee of the entire right, title and interest in and to the same, for the use of the Assignee, its successors and assigns.

AND, for the consideration identified above, I do agree that I and my executors and legal representatives will make, execute and deliver any and all other instruments in writing including any and all further application papers, affidavits, assignments and other documents, and will communicate to the Assignee, its successors and representatives all facts known to me relating to the improvements and the history thereof and will testify in all legal proceedings and generally do all things which may be necessary or desirable more effectually to secure to and vest in the Assignee, its successors or assigns the entire right, title and interest in and to the improvements, inventions, applications, Letters Patent, rights, titles, benefits, privileges and advantages hereby sold, assigned and conveyed, or intended so to be.

Assignment

Page 2 of 2

Title: POINT-TO-MULTIPOINT DIGITAL RADIO FREQUENCY TRANSPORT

Attorney Docket: 100.019US01

AND, furthermore I covenant and agree with the Assignee, its successors and assigns, that no assignment, grant, mortgage, license or other agreement affecting the rights and property herein conveyed has been made to others by me and that full right to convey the same as herein expressed is possessed by me.

IN TESTIMONY WHEREOF, I have hereunto set my hand this 19th day of JULY, 2000.



Philip M. Wala

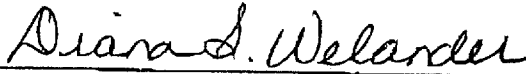
STATE of Minnesota

)ss.

COUNTY of Wasega

On this 19th day of July, 2000, before me personally appeared Philip M. Wala to me known and known to me to be the person described in and who executed the foregoing instrument, and he duly acknowledged to me that he executed the same for the uses and purposes therein set forth.

[SEAL]



Notary Public

