The method of shadowed areas elimination and a service zone expansion by the co-channels repeaters using

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ПАТЕНТ

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СПОСІБ ЛІКВІДАЦІЇ ЗАТІНЕНИХ ДІЛЯНОК ТА РОЗШИРЕННЯ ЗОНИ ОБСЛУГОВУВАННЯ МЕРЕЖІ МОВЛЕННЯ ЗА РАХУНОК ЗАСТОСУВАННЯ РЕТРАНСЛЯТОРІВ СУМІЖНИХ КАНАЛІВ

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Голова Державного департаменту інтелектуальної власності М.В. Паладій

At the expense of the method assuming introduction in a multichannel broadcasting network (mainly multichannel single frequency synchronous network – multichannel SFN) equipment structure co-channels repeaters shadowed areas in network cells are liquidated, and also network as a whole borders extend.

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P. Ksenzenko, M. Boichenko, P. Himich,

“ROKS”-company

The invention concerns multichannel broadcasting networks (including to multichannel single frequency synchronous broadcasting networks – multichannel SFN) in which signaling from the central station to base stations is carried out on multichannel radio relay lines (RRL).

The method according to which earth television broadcasting signals are relayed intra the channel, more particularly, by means of an intrachannel repeater which according to an earth television

broadcasting method receives, gains and transmits a signal in the same frequencies band is known, and radio-frequency (RF) broadcasting signal which is transmitted by the main transmitter, at first will be converted in a repeater to a baseband signal, then back in RF signal, and then will once again be converted upwards on frequency and transmitted in the same frequencies band.

The high-quality equalizer deletes noise and the detained in time signal copies which get in a protective interval and which arise as result of a multibeam mode propagation in a radio channel between the transmitter and an intrachannel repeater from a baseband signal. By means of feedback signal processing which gets into the receiver because of rather weak isolation between transmit and receive antennas, in a repeater the received baseband signal moves in time. The shifted in time baseband signal again will be converted in RF broadcasting signal so that the same input and output signal was relayed in the channel [1].

In the specified broadcasting system the main transmitter and an intrachannel repeater relative positioning depends on district landscape and system service zone geometry. Usually a repeater place so that a weak broadcasting signal which is received by a repeater from the main transmitter, it was processed for the gaining purpose, and at the main transmitter service zone expense would extend. In the intrachannel repeaters extended at present, which often name Gap-Filler, the received signal will be converted to an intermediate frequency signal on which it is filtered and amplifies in amplifiers with automatic gain control, and then will be converted again upwards on frequency and radiated as a target signal.

The specified method lack is that in the given system relaying is carried out on intermediate frequency, therefore those noise and the signal detained copies which result from multibeam propagation and which in an explicit form are present only at a baseband signal cannot be removed from a signal. Thus, a useful signal copies shifted in time will be broadcasted back on-air together with the deformed signal main copy which distortions are caused by frequency fading action. Some user's receivers sensitivity which perceive these distortions as additional noise (as these signals are not synchronized with the main transmitter signal) thereby decreases.

Relayed signals have an uncertain time lag which is a hardware delay in a repeater that is some synchronization infringement with the main transmitter is shown. At the repeater work expense a signal level in service zones shadowed sites increases, but synchronization with the basic transmitter signal can appear broken. On the shaded site border user's receivers can receive as a signal transmitted by the basic transmitter, and a signal transmitted by an intrachannel repeater. There is a danger of that for these receivers the delay dispersion size will exceed protective interval duration, and signal receiving becomes impossible. In multichannel SFN this problem becomes even more essential as delays on different channels frequencies will have different size.

The lack which is shown at this method use in multichannel single frequency synchronous networks consists that the repeater with signal processing in the baseband is unequivocally single-channel. In a multichannel network to service only one shadowed site it will be necessary to apply repeaters in quantity which is equal to channels quantity. Thus the repeaters block becomes bulky and very expensive. Besides, at a considerable transmitting and receiving antennas quantity which take places in one place, it is very difficult to provide necessary isolation between them.

In this case in system there is necessary one more frequencies band use and user's receivers of two types, but thus system there are more flexible in construction, and multichannel repeaters which in it are used, will be much cheaper, than repeaters blocks consisting of separate single-channel repeaters. Besides, thanks to other working frequencies band, repeaters in no way will not disturb to multichannel SFN work.

As the closest method which is used on the same appointment, as declared, the method at which sound (audio), video, and also other digital information transfer within certain geographical district with communication channels set creation at very low expenses possibility is provided. The given system application technical result is satellite signaling techniques application possibility for earth signaling. The earth communication system includes, at least, one local land repeater (LTS) which is established on a mast or other basic design. Everyone LTS is completed with high-frequency communication equipment which basically corresponds to the usual geostationary satellite equipment, for digital transmission of the visual and sound information transferred in L - a range (1-2 GHz), S - a range (2-4 GHz) or in higher frequencies ranges at rather low level of a radiated signal. For transfer realization mainly in a horizontal plane it is desirable to use the omnidirectional antenna [2]. The specified method is chosen as a prototype.

The resulted method lack is that fact that the practical specified scheme embodiment is represented problematic. The main obstacle is that omnidirectional transferring antennas are difficult for making with beamwidth in a vertical plane which would be less than 5 deg. Thus, a those user's stations (USs) antennas which are approximately as equals distances from adjacent LTS, will receive signals at once several transmitters that does reception impossible. And at presence even the weak reflected signals the interference with adjacent channels picture will

appear very difficult. Therefore in actual practice which are characteristic for the earth communication, the given network organization scheme cannot be put into practice. The network can be executed as multichannel SFN, but in this case transferring aerials diversity on height is deprived sense. In this case transmitters MNR work in one frequencies band but that they did not create mutual disturbances each other, the space diversity principle is used. It is clear that in this case at use of the equipment for a satellite broadcasting it is impossible to carry out a continuous covering of the service zone occupying the big space. Such scheme is suitable only for service of the small settlements chain which service zone are not supposed, i.e. It can be applied only in specific conditions.

Thus, to the reasons which prevent with expected technical result achievement at use of a known method, that at creation of a multichannel single frequency synchronous broadcasting network (multichannel SFN) in which are used one CS and several BSs, having rather small radiated power (it is considerable smaller, than the television centers transmitters power), it is necessary to build a network in the form of several mutually overlapping cells concerns. Thus the frequencies of all channels used for synchronous transfer in all network cells, coincide. At occurrence in cells of the shaded sites their liquidation at the expense of blocks from single-channel Gap-Filler is inefficient, as quantity Gap-Filler will be equal to broadcasting channels quantity, and the repeaters block will appear very bulky and expensive. The CS and BSs transmitting antennas diversity on height use does not give expected result as it is difficult to make antennas with beamwidth in a vertical plane smaller 5 deg. CS and BSs diversity in space across so that they did not disturb each other (on distance more than cell radius) does not give possibility to form a continuous cover zone.

The task in view dares because in a broadcasting network use the multichannel repeaters which signals divide by their transmitting aerials diversity on height or in space, and also into a multichannel broadcasting network enter the multichannel co-channels repeaters working in a radio relay communication lines frequency band which connect among themselves the network central station (CS) with base stations (BS) set, and co-channels repeaters receiving antennas place in a beam space which is formed the radio relay communication line transmitting antenna, and co-channels repeaters transmitting antennas place in space so that their beams completely would cover the shaded sites and provided signal distribution to bigger zone to the transmitting antenna radiation direction, and in a band of the radio relay communication line user's stations receivers work, and receiving and signaling by co-channels repeaters is conducted on the same frequencies coinciding with frequencies of radio relay communication lines, co-channels repeaters receive the signals extending in one wireless transfer environment, namely, - in radio relay lines (RRL) radio channels, and transfer them in other environment – in a wireless network of a multichannel television broadcasting, and in a network of a multichannel broadcasting user's stations of two types are used: stations which receive signals from both central and base stations, and the stations receiving signals from multichannel co-channels repeaters.

Repeaters receive antennas settle down within the volume limited from the outside to a cone surface, which has the transmitting RRS antenna beam form (established in transmitter CS location), and from within – an ellipsoid of rotation surface, which diameter (in the RRL middle) it is equal in the widest place of 80 % from diameter a Fresnel zone diameter, and on beam continuation for RRL limits (further to reception RRS which had on BS tower) – only a cone surface. The transmitting antenna installation site gets out so that it was possible to provide the cell shaded site covering and signal distribution to the greatest zone in the repeater transmitting antenna radiation direction.

Proceeding from listed, the resulted known signs association and a declared method essential signs set provides at the introduction expense in multichannel broadcasting network equipment (mainly multichannel single frequency synchronous network – multichannel SFN) co-channels repeaters structure shadowed sites in network cells liquidation , and also a network cover zone as a whole limits expansion.

Taking into account all resulted before reasons, in the system constructed on the declared method basis it is recommended to carry out communication between CS and BS set on the radio relay lines working in other, higher frequencies range. Higher frequencies range use yields the best result as here the relative frequencies bandwidth occupied with a multichannel signal, becomes smaller, therefore and a multichannel repeater realization will be easier.

The declared network construction method allows essentially increase possibilities of a multichannel single frequency synchronous broadcasting network (multichannel SFN) at the expense of additional co-channel in relation to RRL channels repeaters introduction. Application of the given repeaters supplements application usual Gap-Filler which because of inherent in them band narrowity can appear limited in multichannel SFN. Co-channels repeaters will help to provide with a service zone signal "the shaded" sites and it is essential to expand the service zone sizes in some directions.

The offered invention essence is explained by the drawing represented on Fig.: - The system block

diagram in which according to a declared shadowed area liquidation method at the expense of introduction in network a co-channel repeater is carried out. On Fig. the broadcasting network consisting from one CS and several BSs (on the scheme one of them is conditionally shown only) which, radiating a signal in all directions is represented, form mutually overlapping cells.

In structure CS and several BSs omnidirectional antennas or sector antennas systems are used. CS can communicate several BSs by means of any communication lines: radio (radio relay), cable or fiber-optic. In this case it is a question of networks in which communication between CS and any of working in network BSs is carried out by means of radio relay lines (RRL). The each of RRL structure includes transmitting radio relay stations (transmitting RRSs) which antennas usually place on the same tower on which it is established antenna CS and receiving radio relay stations (receiving RRSs) which antennas place on BS towers. On fig. pos. 1 is a one of BS cells.

The repeater 5 receiving antenna place in the volume limited to the transmitting antenna RRS 3 beamform. The transmitting RRS antenna directed action factor (DAF) is calculated under the formula:

DAF = 32000 / (2θ3x * 2θ3y),

where 2θ3x and 2θ3y is the real orientation diagram main petal width on half power level (- 3 дБ) in two mutually perpendicular planes x and y (on Fig. the beamwidth in a horizontal plane 2θ3x is shown). The transmitting RRS antenna beamwidth can be any (2θ3x = 30... 360 deg.).

The declared method essence consists that the repeater 5 receiving antenna (Fig.) place in the middle of the volume occupied with a beam which is radiated by the transmitting RRS antenna. At antennas with the narrow diagram of an orientation use this area usually has the form of a cone with a corner in top which is equal 2θ3x = 2θ3y. Generally equality 2θ3x = 2θ3y is not observed, and the beam gets more difficult form, and the repeater antenna can take places as along RRL (between transmitting and receiving RRS), and on its continuation (Fig.). At the aerial 5 along RRL placing the geometrical place of its possible arrangement points is in the volume limited to two surfaces: a cone surface outside and an extended ellipsoid of rotation surface 6 from within. The ellipsoid of rotation width in the widest part (in the RRL middle) pays off as 80 % from a Fresnel zone width. If not to suppose the repeater reception antenna placing in the specified zone (on Fig. It is shaded) losses at the expense of a gleam for beam reduction passage can be neglected. The Fresnel zone radius (or diameter) size depends on distance between antennas and frequency.

The declared method in practice can be realized thus. In any of the points located in formed by CS and BSs cells, shadowed sites 7 can arise. It shadow is caused by that on a site behind an obstacle 8 having considerable in comparison with the wave length, and also height, comparable with CS or BS tower height, radio-waves propagation is complicated or at all it is impossible. In such cases in usual SFN for maintenance with a signal being in a shadowed zone subscribers use Gap-Filler. However in itself Gap-Filler has the limited working frequencies band, therefore for the task in view decision, i.e. for "flare" only one shadowed site, in multichannel SFN it should to use considerable quantity Gap-Filler. In this case the repeaters block will appear excessively bulky and expensive. Besides, to isolate among themselves a considerable quantity of the receiving and transmitting antennas belonging several Gap-Filler, it is not obviously possible. To realize a broadband repeater it is possible only on higher frequencies because on higher frequencies at the same absolute bandwidth occupied with a multichannel signal, the relative bandwidth will be less. According to a declared method, for each shadowed site only one co-channel group repeater 9 which should work in higher frequencies range (in a range used RRL), than CS and BSs transmitters is used. Thus the repeater 5 receive antenna place in space of the beam formed by the transmitting RRS antenna, and transmitting antenna 10 place in space so that its beam has completely covered a shade site 7 and thus as much as possible would expand all network cover zone in the antenna 10 radiation direction (a zone 13). Antennas 10 can have the diversified diagrams of an orientation: circular, in the form of sector or the narrow diagram of an orientation. The repeater 9 transmit and receive bands completely coincide, therefore, as well as in case of Gap-Filler traditional application, a relative positioning and diagrams of an orientation receive 5 and transmit 10 antennas should be chosen so that between them sufficient isolation degree would be provided. Receiving and transmitting are conducted in a frequencies band which coincides with RRL working band. In the same band the US 11 receivers work also. Thus, in a network two types of the US are used: stations 12 which receive the multichannel broadcasting signals transmitted by CS or BSs, and stations 11 which receive signals from co-channels repeaters 10 transmitters. These signals are radiated in sector 13 by repeaters 10 antennas which work in a radio relay lines frequencies band. Co-channels repeaters also receive and transmit in the same frequencies band. Their difference from usual Gap-Filler consists that they receive the signals extended in one wireless transfer environment, namely, - in radio relay lines (RRL) radio channels, and transmit them in other environment – on-air broadcasting environment. Therefore even at full received and transmitted by them signals parameters coincidence they should be considered as co-channels repeaters. For shadowed sites liquidation and increases in all network service zone sizes, in the beams formed by transmitting RRS antennas which take places on CS, except for 80 % of a Fresnel zone, establish co-channels

multichannel repeaters receive antennas. Thus repeater transmitting antennas place in space so that to transmit a signal in a cells shadowed site and as much as possible to expand a service zone. Receiving and transmitting by co-channels repeaters is conducted on the same frequencies. In a network two types of user's receivers are used: for reception of the signals transmitted by CS and several BSs; for reception of the signals transmitted by co-channels multichannel repeaters.

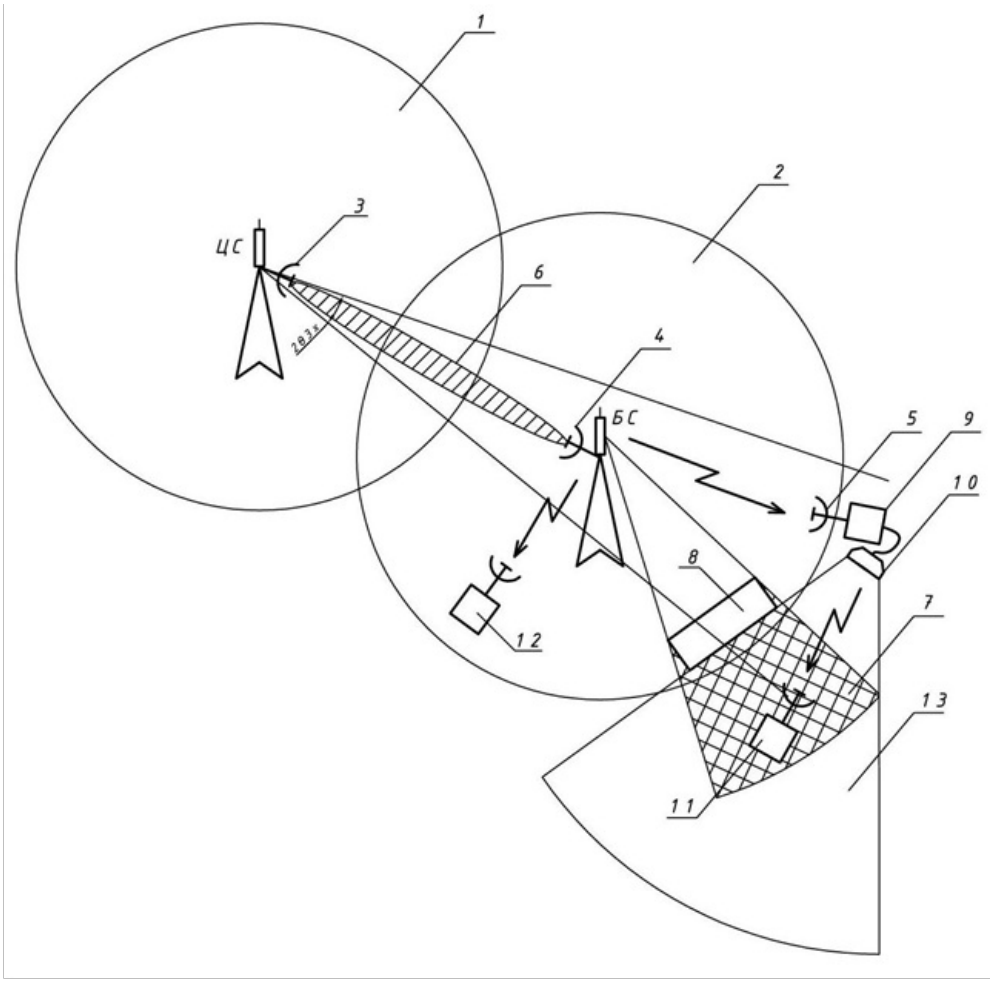

Fig.1 The method of shadowed areas elimination and the service zone expansion by the co-channels repeaters using

The multichannel data transmission network with co-channels repeaters use can be constructed according to such initial data:

1	Quantity of transmit TV programs	more than 100
2	The Frequencies Band of Broadcasting	5.705– 5.825MHz
3	The Frequencies Band Intended for RRL	11.7– 12.2GHz
4	Radius of CS and BS Cells of a Broadcasting Network	10 – 15 Km
5	The Standard Used for Transfer of Broadcasting Signal	DVB-T
6	The Frequencies Band of one radio channel DVB-T	8 MHz
7	The Step of a Frequencies Grid for Broadcasting	10 MHz
8	The Signaling Standard on RRL	DVB-S
9	The Frequencies Band of RRL radio channel	35MHz
10	The Step of a grid of frequencies for the signals transferred on RRL	40 MHz
11	Quantity of broadcast channels with the frequency multiplexing	12
12	Quantity of the channels transferred on RRL	12

Proceeding from specified, the broadcasting in a network is carried out in a frequencies band 5705

– 5825 MHz with use of a 12-channels broadcasting signal (mainly with transfer of separate channels to a synchronous mode) at 8 MHz channel width and 10MHz multiplexing frequencies grid step. BSs quantity in a broadcasting network is defined in the cover zone sizes and configuration. The broadcasting network answering to the listed initial data construction is quite real.

Referencies:

1. The USA Patent №2004/0237117A1, pub. 2004.11.25
2. The Patent of the Russian Federation № 2189702, pub. 9.20.2006, bul. №26.

The applicant, general director of Company "ROKS" Ksenzenko P. J.

The invention formula

1. The method of shadowed areas elimination and a service zone expansion by using of the co-channels repeaters which assumes the multichannel repeaters application which signals are divided by their transmitting antennas diversity on height or in the space, different by that the co-channels multichannel repeater working in a radio relay communication lines frequencies band which connect among themselves the network central station (CS) with include in a broadcasting network base stations (BSs), and co-channels repeaters receive antennas place in the beam space formed by the radio relay communication line transmitting station antenna, and co-channels repeaters transmitting antennas have in space so that their beams completely covered the shadowed areas and provided signal distribution to whenever possible big zone to the repeater transmitting antenna radiation direction, and in the radio relay communication line frequencies band the user's stations receivers work.
2. The method of the shadowed areas liquidation and service zone expantion by using of the co-channels repeaters at the expense of co-channels repeaters application, under item 1, different that receiving and transmitting by co-channels repeaters are conducted on the same frequencies which coincide with frequencies of radio relay communication lines.
3. The method of the shadowed areas liquidation and service zone expansion by the co-channels repeaters using at the expense of co-channels repeaters application, under item 1, different that co-channels repeaters accept the signals extended in one wireless transfer environment, namely, - in radio relay line (RRL) radio channels, and transfer them in other environment – on a multichannel television broadcasting wireless network environment.
4. The method of the shadowed areas liquidation and service zone expansion by using of the co-channels repeaters at the expense of co-channels repeaters application, under item 1, different that in a multichannel broadcasting network the user's stations which accept signals or from the central station and base stations, or from co-channels multichannel repeaters use.

The applicant, general director of Company "ROKS" Ksenzenko P. J.

ABSTRACT

Object of the invention: The method of the shadowed areas liquidation and service zone expansion by the co-channels repeaters using at the expense of co-channels repeaters application.

Application branch: the Invention concerns multichannel broadcasting networks (including to multichannel single frequency synchronous broadcasting networks – multichannel SFN) in which signaling from the central station to base stations is carried out on multichannel radio relay lines (RRL).

An invention essence: The multichannel repeaters application in broadcasting networks, which signals divide by their transmitting antennas diversity on height or in space, and also co-channels multichannel repeaters in a broadcasting network working in a radio relay communication lines frequencies band which connect among themselves the network central station (CS) with base stations (BSs), and co-channels repeaters receive antennas place inclusion in space of the beam formed by the radio relay communication line transmitting station antenna, and co-channels repeaters transmitting antennas place in space so that their beams completely covered the shadowed areas and provided signal distribution to whenever possible big zone to the repeater transmitting antenna radiation direction, and in the radio relay communication line frequencies band the user's stations receivers work, receiving and transmitting by co-channels repeaters is conducted on the same frequencies which coincide with frequencies of radio relay communication lines, co-channels repeaters accept signals which extend in one wireless transfer environment, namely, - in radio relay lines (RRL) radio channels, and transfer them in other environment – on wireless multichannel television broadcasting network environment, and in a multichannel broadcasting network the user's stations accepting signals or from the central station and base stations, or from co-channels multichannel repeaters are used.

Technical result: At the expense of the method assuming introduction in a multichannel broadcasting network (mainly multichannel single frequency synchronous network – multichannel SFN) equipment structure co-channels repeaters shadowed areas in network cells are liquidated, and also network as a whole borders extend.