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THE VUS-12 AUXILIARY REMOTELY SUPPLIED REPEATER STATION

Vestnik Svyazi
[Communications Herald],
No 8, 1952, Moscow,
Pages 3-5

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The article describes the purpose and the means of switching and supplying the VUS-12 station (auxiliary remotely-supplied repeater station of the 12-channel system of high-frequency telephony over aerial communication lines). The block diagram and the principal electric parameters of this station are given and its distinguishing features discussed.

The VUS-12 auxiliary remotely-supplied repeater stations are intended to maintain normal operation of the channels of the V-12 system under unfavorable meteorological conditions. (A description of the V-12 system can be found in the periodical Vestnik Svyazi [Communications Herald] Nos 6, 7, and 11, 1951.) These stations are placed in trunk lines that are carrier-channelized up to 143 kc, between the PV-12 or OV-12 stations. In the summertime the VUS-12 stations are disconnected from the trunk line. In the fall and winter period one connects the filter equipment of the VUS-12 station into the circuit that is carrier-channelized by the V-12 system and this makes it possible to connect the repeater equipment into the transmission channel by remote control. The repeater equipment of the VUS-12 station is switched on and supplied separately for each direction of transmission, as required, by applying the plate voltage from any of the neighboring PV-12 or OV-12 stations to the corresponding wire of the carrier-channelized circuit.

To prevent sharp changes in the transmission-level diagram, the gain of the repeater equipment of the VUS-12 station is 0 nep for all the transmitted frequencies at the instant that this equipment is switched into the transmission channel. The gain of the station is gradually increased to the required value, with the aid of ARU [avtomaticheskaya regulirovka urovnya -- automatic level-regulation] installations, which are regulated by the control currents of the V-12 apparatus. If the meteorological conditions improve so that there is no further need for operating the VUS-12 station, the gain of the repeater equipment is automatically reduced to a 0 value. The voltage at the supply stations is then automatically disconnected and the VUS-12 repeater equipment is disconnected from the transmission channel.

If the PV-12 stations are far apart (more than 125 km) it is possible to install two VUS-12 stations between these stations. With such an arrangement of the stations the repeater equipment of the VUS-12 may be connected to the transmission channel for a long time.

The measurement power levels of the sideband frequencies of each of the channels of the system at the output of the VUS-12 station are 0.5 nep. The minimum permissible reception level is taken to be 7 nep. The amplifying capacity of the station for the highest transmitted frequency is 7.5 nep and permits compensating for the attenuation of a section of copper circuit up to 71 km long under "frost 25 mm" conditions. The frequency characteristic of the maximum gain of the VUS-12 station therefore corresponds to the frequency attenuation characteristic of a section of copper circuit 71 km long under "frost 25 mm" conditions.

Block Diagram of VUS-12 Station

The block diagram of the VUS-12 station is shown in Figure 1. When the remote supply is disconnected, the transmission channel contains line filters D-33 and K-33, directional filters D-88 and K-88, and the Vyr [vyravnivateli filtrov -- filter equalizers] which compensate for the distortion produced by the filters at the edges of the transmitted bands. The D-33 filters permit passage of the d-c telegraph current, the tonal-frequency channel currents and the currents of the V-3 system, while filters K-33 pass the channel currents of the V-12 system.

The supply to the tubes that are contained in the equipment assembly for a certain direction of transmission is connected to the energized wire with the aid of the RPDP [rele priyema distantsionnogo pitaniya -- remote-supply reception relay]. Two RChT [rele chastotnogo tranzita -- frequency transit relays] are connected in series with the cathode of one of the tubes in each of the transmission directions. After the tubes become heated and the cathode current reaches a certain value, the PChT relay operates and connects to the transmission channel the repeater equipment for a given direction of transmission. Thus, if wire one is energized (by any of the neighboring PV-12 stations), the tubes in the transmission direction A-B heat up and relays $RChT_3$ and $RChT_4$ operate. But if the voltage is applied to wire 2 the tubes in the direction B-A heat up and relays $RChT_1$ and $RChT_2$ pull in their armatures.

After relays $RChT_1$ and $RChT_2$ operate, the currents of the lower frequency groups (36--84 kc) pass through the repeater equipment, with the transmission channels consisting of the following: VU_1 [vvodnyye ustroystvo -- lead-in equipment] and filters K-33 and D-88 of the B side, Vyr_1 [vyravnivatel' filtrov -- filter equalizer] of the B--A direction, Udl [udlinitel' -- lengthener], the contacts of the $RChT_1$ relay, the networks and KNR_1 [kondensator naklonnoy regulirovki -- capacitor of the sloping regulations], KPR_1 [kondensator ploskoy regulirovki -- flat regulation capacitator] C_1, Us_1 [usilitel' -- amplifier], contacts of relay $RChT_1$, filters D-88 and K-33, and the lead-in equipment VU_2 of the A side.

When relays $RChT_1$ and $RChT_4$ operate, the transmission channel of the upper frequency group (92--143 kc) will consist of lead-in equipment VU_2 and filters K-33 and K-88 of the A side, one of the 2 ("flat" or "sloping") filter equalizers Vyr_2 of the A--B directions, the contacts of relay $RChT_3$, the flat regulation capacitor KPR_2, DU [dopolnitel'nyy usilitel' -- supplementary amplifier], low-pass filter D-153, networks and capacitor of sloping regulation KNR_2, amplifier Us_2, contacts of relay $RChT_4$, filters K-88 and K-33, and lead-in equipment VU_1 of the B side.

The functions of almost all the elements contained in the transmission channels of the VUS-12 stations are the same as of the corresponding elements of the PV-12 stations; we shall therefore examine only the distinguishing features of the VUS-12 apparatus.

In order to match the input impedances of the lead-in cable to the station equipment, the lead-in equipment of the VUS-12 station employs newly-developed matching auto transformers which permit remote supply of the apparatus over each of the wires of the network separately. It must be noted that these auto transformers will be employed also in the OV-12 and PV-12 stations. The circuits of the D-33 filters have been modified so that they can pass direct current over each wire of the transmission channel. The

line and the directional filters employ terminations that consist of half-links of the mm' type; this limits the reflection coefficient, caused by failure of the input impedance of the apparatus to match 600 ohms, to not more than 10% for all frequencies transmitted over the carrier-channelized circuit.

The filter equalizer in the B-A direction is so designed that the total attenuation of the two K-33 filters, the two D-88 filters, and the equalizer itself is within 0.5 ± 0.05 nep in the frequency band of 36--84 kc. The "flat" filter equalizer of the A--B direction maintains the total attenuation of both K-88 filters and the equalizer within 0.5 ± 0.05 nep for the 92--143 kc frequencies, while the "sloping" equalizer of the same direction is so designed that the frequency characteristic is a straight line passing through the following points: 0.5 nep at 92 kc and 0.25 nep at 143 kc.

The lengthener connected at the output of the filter equalizer of the B--A direction protects the amplifier of this direction against overloads by currents at frequencies near 36 kc; this overload can occur if the sections adjacent to the VUS-12 are short. The sloping regulation networks of the B--A direction are so designed that the difference in amplification of the VUS-12 at 84 and 36 kc is 2.7 nep. The sloping regulation networks of the A--B direction produce a 2.3 nep difference in the gain at 143 and 92 kc frequencies in the VUS-12 equipment.

The amplifiers of both directions of transmission have identical circuit diagrams and differ only in the output transformers and in the arrangement of the parts. Each have 3 stages of amplification. The first 2 stages -- voltages amplifiers -- contain one type-12Zh1L tube each. The last (output) stage contains 2 tubes of this same type, connected in parallel. The stages are resistance coupled. The amplifiers have high-impedance inputs and the output impedance is 135 ohms. The value of the negative feedback, which includes the entire amplifier, is 2.6 nep. The gain for all frequencies of the transmitted band (with the feedback chain connected) is within 6.3 ± 0.05 nep. To obtain the required gain at 92--143 kc, a supplementary single-tube amplifier employing a 12Zh1L type tube is connected in the transmission channel of the upper frequency group. Its gain is 2.5 ± 0.05 nep for the frequencies from 92 to 143 kc.

In addition to the elements indicated above, which form the transmission channels, the VUS-12 equipment also contains ARU installations as well as installations for the reception of remote supply. The ARU installations of each direction of transmission contain the following: (1) two PKK [priyemniki kontrol'nogo kanala -- control channel receivers] CCR (flat and sloping regulation); (2) 50-cycle generator G to supply the MPR [motor ploskoy regulirovki -- flat regulation motor] and the MNR [motor naklonnoy regulirovki -- sloping regulation motor]; (3) motor-capacitor block, identical with that used in the PV-12 station; (4) control panel for the ARU, with relays RPR and RNR which control the flat and sloping regulations. Unlike the control-channel receiver of the PV-12 station, each receiver of the VUS-12 station employs two 12Zh1L tubes and has a somewhat higher gain. The 50-cycle generator consists of a generator stage with one tube and an amplifying stage with 2 tubes, all of the 12Zh1L type.

The control panels for the ARU, which differ somewhat from the corresponding units of the PV-12 stations, as well as the devices for transmitting and receiving the remote supply, will be described below.

ARU Control Diagram

The movement of the regulating motors is controlled by means of relay

circuits (Figure 2). The rectified control currents of the flat and sloping regulations, which flow through the working windings of sensitive polarized relays RPR-P and RPR-N (type RP-5), attempt to press the armatures of these relays against the contacts marked on the diagram by the letter L. However, if the control currents at the output of the VUS-12 have normal levels, the fact that the auxiliary currents passing through the compensation windings act in opposition keeps armatures of these relays in the central position. If the control-current level rises or falls, the armature of the corresponding polarized relay will be thrown over to the right or to the left contact. As a result, relay RNU or RVU operates and starts motor MPR for the flat regulation or motor MNR of the sloping regulation to turn in one direction or the other.

Low-sensitivity ("coarse") RAB [rele avariynoy blokirovki -- relays for emergency blocking] are connected in series with the sensitive polarized relays in the circuit of the rectified control currents. When the control current stops flowing or if its level drops sharply, the corresponding emergency blocking relay interrupts the circuit to the armature of the RPR relay and consequently stops the particular regulation motor.

At the instant that the repeater equipment is switched in, when the gain is 0, the ARU regulators are at their 0 positions. The movement of the flat regulators from the 0 position to the 100 position corresponds to an increase in gain for all the transmitted frequencies.

In order automatically to switch on the repeater equipment, eccentrics are placed on the shafts of the flat-regulation capacitors of both directions of transmission. These eccentrics act on the springs of the DKG [dopolnitel'naya kontaktnaya gruppa -- supplementary contact group] and are so mounted that the contacts of the DKG are closed whenever the flat regulator is in a position that does not exceed a previously chosen limiting position, and are open at all higher values. The limiting position of the regulator, at which the above-mentioned contacts close, corresponds to a value of gain that permits connecting the amplifier from the transmission channel without damage to the action of the system channels.

If the gain of the VUS-12 station does not exceed the limiting value and if at the same time the control current level of the flat regulation is too high, the RPD [rele prinuditel'nogo dvizheniya -- forced-motion relay] will operate through the closed contacts of the DKG. The contacts of this relay short out one winding in each of the polarized relays RPR-P and RPR-N. This causes the armatures of the latter to press against the contacts (regardless of the level of the control current at the output of the VUS-12) in such a way that the flat and sloping regulation motors start rotating towards the 0 positions. When both regulators reach the 0 positions, a circuit is formed for operating the remote-supply relay. As a result the remote-supply relay will open the supply circuit to the tubes, the RChT relays will release their armatures and the repeater equipment of the particular transmission direction will be disconnected from the transmission channel.

Equipment for Transmission and Reception of Remote Supply

As was already indicated, the VUS-12 station is fed from the power supplies of the neighboring PV-12 or OV-12 stations. The supply is fed from the plate batteries located at these stations and having a voltage that is maintained at 206 v ± 3% with the aid of ARN [avtomaticheskiye regulyatory napryazheniya -- automatic voltage regulators]. The supply current passing through each of the wires has a nominal value of 160 ma. The nominal value of the voltage at the VUS-12 is 160 v. In order to obtain this nominal value at sections of different lengths, the remote-supply equipment contains

regulating rheostats, which bring the supply resistance up to a definite value.

The equipment used for the transmission of the remote supply consists of a choke panel and a remote-supply transmission panel. The choke panel is designed to feed the supply to four VUS-12 stations and can be placed on the PSVK rack of the PV-12 station or on the OSVK rack of the OV-12 station. The remote-supply transmission panel is designed to feed a single VUS-12 station. This panel can be placed on any of the racks of the OV-12 or PV-12 stations at a place that is easily accessible to service personnel.

The former panel contains 4 independent sets for connecting the plate voltage to the circuit wires. Each set consists of a supply choke with 2 windings, 2 isolating capacitors, and an RTT [rele telegrafnogo tranzita -- telegraph-transit relay]. When the remote supply is switched off, the choke windings are disconnected from the circuit wires, and the isolating capacitors, connected into the wires, are short-circuited by the contacts of the RTT relay. When the supply is switched on, however, the RTT relay operates, joins the choke windings to the line wires and removes the shunt from the isolating capacitors which block the passage of the remote-supply current into the station apparatus.

The following are mounted on the remote-supply transmission panel:

(1) switches for connecting the plate battery to each of the wires of the circuit, (2) meters for the remote-supply voltage and current in the wires, (3) a rheostat for regulating the supply current, (4) a set of relays, which disconnect the supply voltage from the wire (if the current in the latter changes by more than ± 40% from the nominal value), and connect visual and audible signals.

The equipment for the reception of the remote supply (Figure 1) comprises a choke panel and 2 remote-supply reception panels (one panel each for each transmission direction). The reception choke panel contains two Dr [drosseli -- chokes] which are connected to the wires of both sections of the lines adjacent to the VUS-12 station, 2 isolating capacitors, and a telegraph-transit relay RTT. Mounted on the reception panel of the remote supply are sets of RPDP relays with which the filament and plate supply circuits for the tubes in any given transmission direction are connected to a specified wire in the circuit.

Structural Design of the VUS-12 Station

The basic equipment of the VUS-12 station is mounted in 2 moisture proof metal cabinets measuring 1,573 x 670 x 450 mm. Each cabinet has 2 doors and is filled with equipment on the front and on the back side. The protective devices, the lead-in and switching equipment, and the cut-off filters, intended to be connected to parallel circuits, should be placed separately.

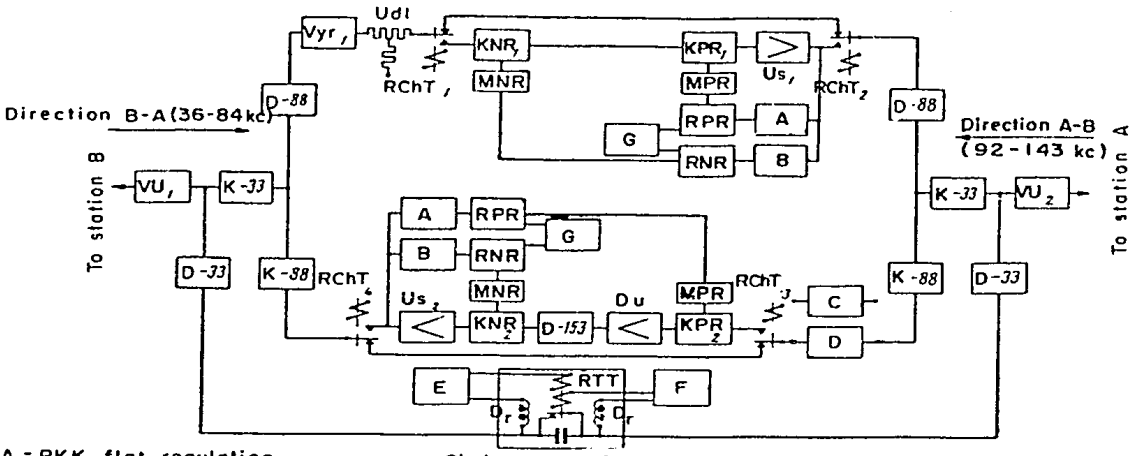

Figure 1

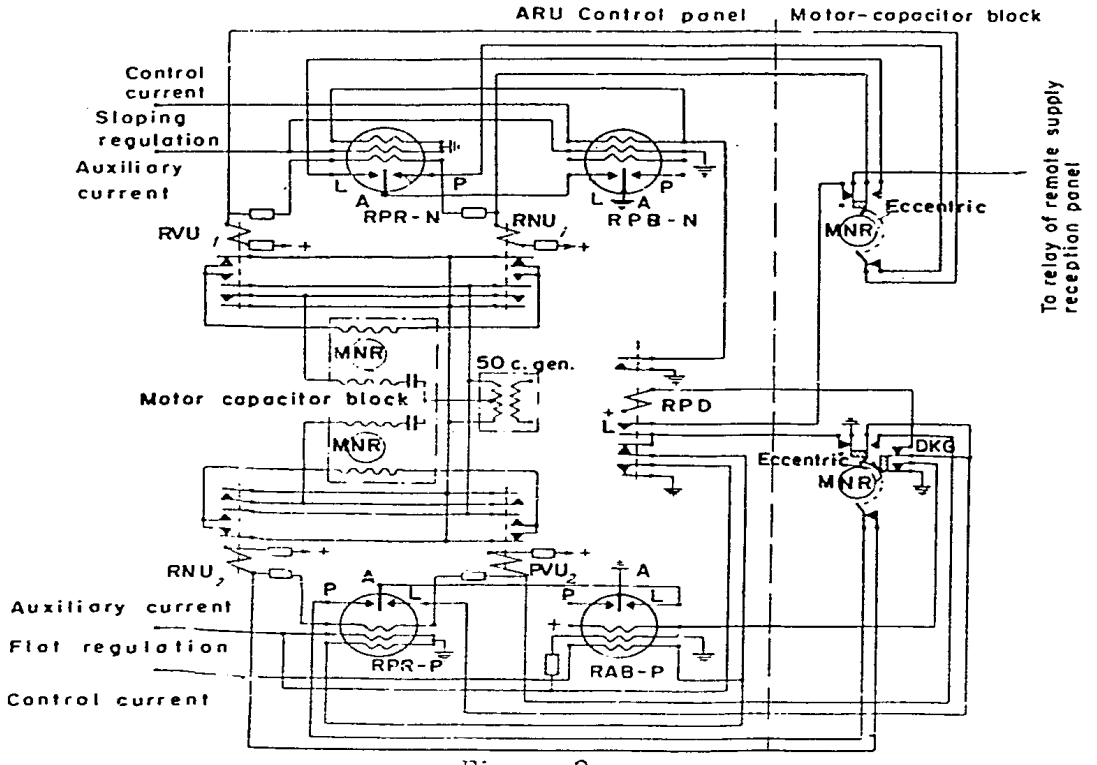

Figure 2

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