Television Antenna Curtain

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Abstract: **In the article are observed technology of construction, production and measurement of full-length television antenna curtain with one basic aim – to achieve the necessary exploitation parameters. The production is ensured by Bulgarian joint-free steel pipes. Construction method is precise and is achieving high technological sustainability and reproduction in log life cycle of exploitation. By these television curtains are equipped television retranslators (relays) and transmitters. Foreseen is exploitation of antenna systems in conditions of dissemination of ground digital television (DVB-T).**

Key words: **antenna, gain, curtain, broadcasting, wavelength, VHF-band, voltage standing – wave radio – VSWR, methodology.**

The calculation methods are optimized step by step [1, 2] in conformity with the requirements of the ISO 9000 standard and restrictive conditions are formulated [3, 4, 5, 6] from the shot diagram of direction (Fig 1) during the building of complex antenna systems (Fig 2) aiming at their exploitation and in regard to the inculcation of the ground digital television dissemination.

The developed construction and technologies of production are realized experimentally accompanied by detailed measurements and comparison with similar transmitting antennas [7].

The sequence of the calculating operations is related to the average length of the wave λ_{AV} for III VHF – Very High Frequency (170 to 230 MHz) and is related to asymmetric supply of antenna curtains through concerted transformer Tp1 (Fig 3).

The letters given for geometric dimensions are responding to the construction of Fig 4.

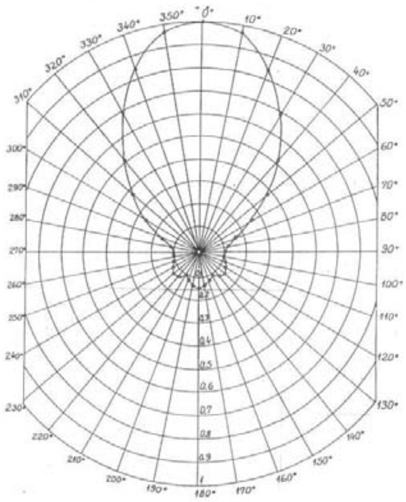

Fig. 1

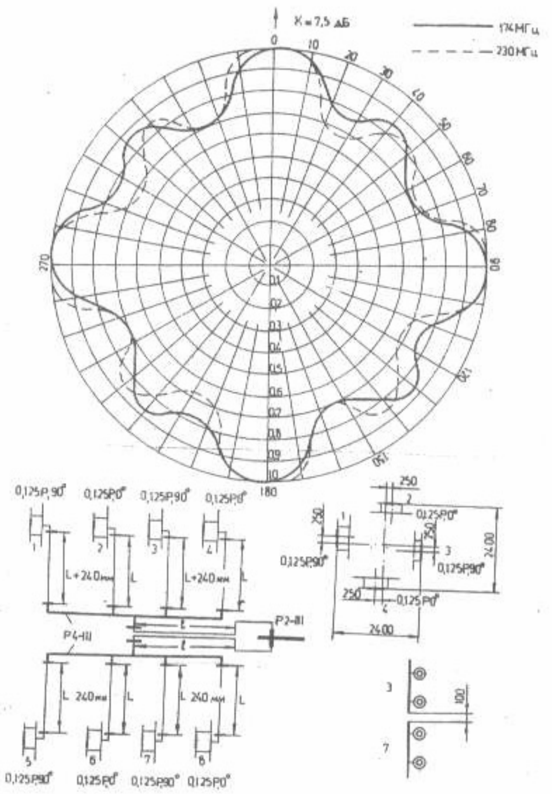

Fig. 2

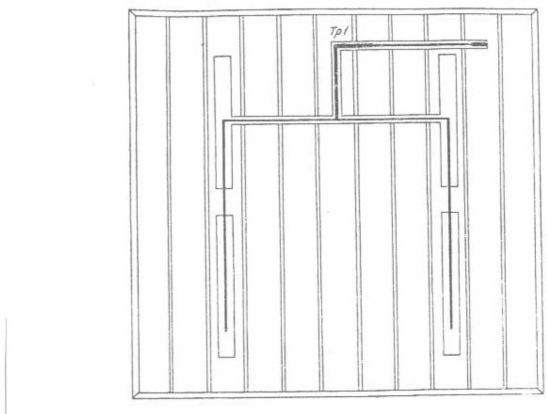

Fig. 3

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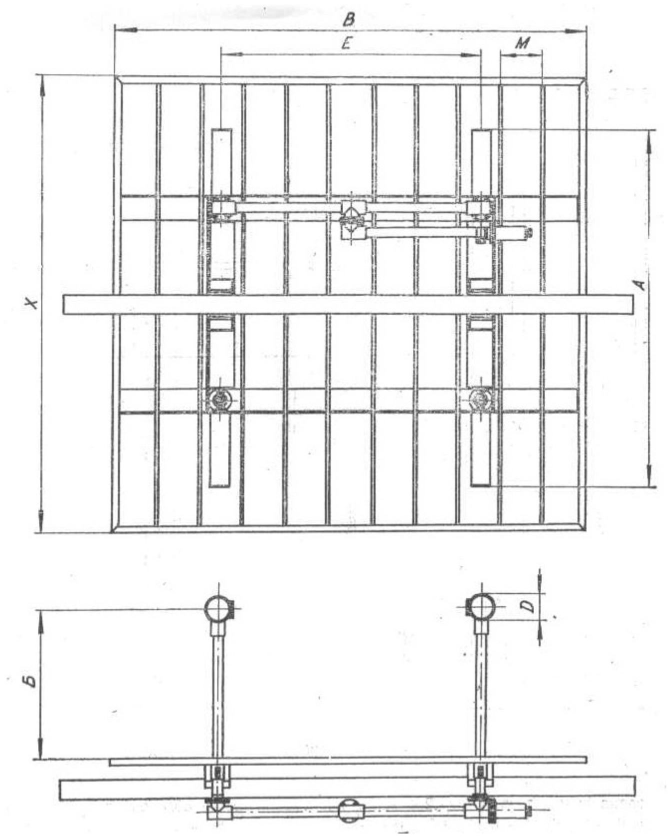

Fig 4

Rest (fulcrum) wave length for III VHF is determined:

$$\lambda_{AV} = 1480 \text{ mm} \quad (1)$$

the length of the two mutually dependant dipoles in antenna curtain is determined by:

$$A = K_C \,.\, \lambda_{AV} \quad (2)$$

Where K_C is general coefficient of curtail (shortening), that reports the influence of the diameter D of the joint-free steel pipe, i. e.

$$D = 0{,}04\ \lambda_{AV} \quad (3)$$

A standard size is calculated D = 60/3 mm.
One-direction emission with great coefficient face/back (Fig 1) is ensured by the distance B dipol-reflector grid (Fig 4) depending on the optimal coefficient of the standing wave (VSWR), i. e.:

$$B_{opt} = \varphi\ (VSWR) \quad (4)$$

The coefficient of the standing wave VSWR is defined by the expression:

$$VSWR = \frac{U_i + U_r}{U_i - U_r} = \frac{U_{max}}{U_{min}} = \frac{1+r}{1-r} = \frac{1+r}{t} \quad (5)$$

Where U_i is the straight wave voltage, U_r is the reflected wave voltage, $r = U_r/U_i$ is coefficient of reflection when the coefficient of the transmission of the efficient signal t = 1 – r.
Experimental subjection of the distance B:

$$B = (0{,}26 \div 0{,}3)\ \lambda_{AV} \quad (6)$$

The results of the experiments are given in Table 1

TABLE 1

B[mm]	400		430		460		700		730	
f[MHz]	r	VSWR	r	VSWR	r	VSWR	r	VSWR	r	VSWR
175	0,09	1,21	0,06	1,14	0,06	1,14	0,04	1,08	0,03	1,06
180	0,06	1,14	0,05	1,12	0,05	1,12	0,04	1,08	0,04	1,07
190	0,04	1,09	0,03	1,06	0,02	1,04	0,03	1,06	0,02	1,04
200	0,05	1,11	0,03	1,06	0,02	1,04	0,03	1,06	0,03	1,06
220	0,03	1,06	0,02	1,04	0,01	1,02	0,02	1,04	0,01	1,03
230	0,01	1,03	0,02	1,04	0,02	1,04	0,02	1,04	0,01	1,03

The distance E between the two full length dipoles, forming the system of dipole antenna curtain, influences the coefficient of gain $D_{H,V}$ expressed visually on the horizontal vertical diagram of direction, i. e.:

$$D_{H,V} = \varphi\ (E) \quad (7)$$

From the experimental research we have received the following expression:

$$E = (0{,}5 \div 0{,}65)\ \lambda_{AV} \quad (8)$$

In this case the B size is:

$$B = (1{,}8 \div 2)\ E \quad (9)$$

And for the X the following expression is valid:

$$X(1{,}2 \div 1{,}45)\ A \quad (10)$$

To ensure effectiveness of the reflector grid, i. e. minimal back of the diagram of direction (Fig 1) joint-free steel pipes with standard diameter 10/3 mm are fixed (put) on the distance M (Fig 4) and following the experimental research is received this expression:

$$M = (0{,}1 \div 0{,}08)\ \lambda_{AV} \quad (11)$$

In this case on the face of the diagram of direction gain G > 10 dB is received.
Maximum admissible power reaches 1 kW.
The input resistance of the sequence transformer Tp1 (Fig 3), that ensures asymmetric power supply of the two full-length dipoles, is between 50/75 Ω.
The maximum wind loading reaches 255 kg/m^2 when the mass (weight) of the antenna is 65 kg and dimensions are 1450 x 1395 x 730 mm.
The quality control in production and diagnosis are realized in following conditions:
- noise coefficient N = 4 of the receiver;
- the coefficient of power gain in numbers is G = 4;
- the fulcrum tension of the electrical field is E_{AV} = 82 [μV/m];
- the minimum ratio signal/noise (S/N) for quality receiving of TV image in analog television is compared to the ratio carrying coefficient of the image/noise (C/N) for the quality image and in digital ground television [3, 4, 5], i. e.:

$$N/S = C/S = 20 \text{ dB} \quad (12)$$

These relations are controlled by the extract of 50 full-length antenna curtains taken from production on casual method. This ensures a possibility of big enough number of independent measurements of the chosen parameter for control – field tension E [μV/m];

The received variation order has the following scope (range):

$$R = E_{max} = E_{min} = 85 – 79 = 6 [\mu V/m] \quad (13)$$

When grouping 50 measured field tensions in interval order this gives information for correlation subjection between technological sustainability and reproduction of the antenna.

In Table 2 in interval order are given measured values of field tension.

TABLE 2

E [μV/m]	$E_1 = E_{min}$ 79	E_2 80	E_3 81	$E_{AV} = E_4$ 82	E_5 83	E_6 84	$E_7 = E_{max}$ 85
Number of hits n_i	4	5	5	10	15	4	5
$\sum n_i = 50$							
Probability of hits in the interval $P_i = n_i/\sum n_i$	0,08	0,1	0,2	0,14	0,08	0,1	0,1
$\sum P_i = 1$							

The diversion of the nominal fulcrum value $E_{AV} = 82 [\mu V/m]$ is under 5 %, where the nominal value is:

$$Emax = EAV + 3 \% \quad (14)$$

And the minimal is:

$$Emin = EAV – 4 \% \quad (15)$$

CONCLUSIONS

1. Developed is relevantly precise methodology for calculation, construction and production technology of full-length antenna curtain with control and quality diagnostic.
2. The analysis and quality control are developed using statistical method in group extract of 50 numbers for proving the technological sustainability and reproduction.
3. Measured are television antenna system from full-length antenna curtains for proving compatibility of dissemination of ground and digital television.
4. The researches show the possibilities for creation of methods and means for measuring quality of joint-free steel pipes.
5. The produced full-length antenna curtains have proved life over 30 years in non-stop regime of work.

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