ACADEMICIAN JOVAN SURUTKA

Prof. Milić Stojić, President of **ETRAN**[1]

(Introduction lecture of Prof. Milić Stojić given at the special session of the **LXV Conference of ETRAN**, dedicated to Prof. Jovan Surutka)

Jovan Surutka was born in 1921 in Banja Luka, where he finished grammar school in 1939. He graduated from the Department of Electrical Engineering of the Technical Faculty, University in Belgrade in 1947. After the graduation, he was an instructor with the Institute for Telecommunications of the Serbian Academy of Science and Arts. In 1950 he was appointed a lecturer at the Faculty of Electrical Engineering in Belgrade for the course of Theoretical Fundamentals of Telecommunications Techniques. He was promoted to the post of assistant professor in 1954 and to the post of associate professor for the course of Theoretical Electromagnetics in 1959. He became a full professor in 1968. Besides the courses for which he was elected, he also taught the course Antennas and Propagation. From 1976 up to his retirement in 1986, he taught Fundamentals of Electrical Engineering.

Professor Surutka supported considerably the establishment of curriculum at a number of newly founded faculties of electrical engineering including the Faculty of Electronics in Niš, Faculty of Electrical Engineering in Banja Luka, Faculty of Technical Science in Novi Sad, and Faculty of Electrical Engineering in Skopje.

In two electoral periods (1962-64 and 1969-70), Professor Surutka was elected a dean of Faculty of Electrical Engineering in Belgrade. Twice he was the deputy dean. For a number of years, he was a member of the Council for University Studies of the Government of the Republic of Serbia, member of the University Council of the University in Niš, member of the Education Council of the Republic of Serbia.

The scientific, professional, and pedagogical activities of Professor Surutka cover the following fields: theoretical and applied electromagnetics, theory and design of antenna systems, propagation of radio waves in natural media and systems and networks for radio and television broadcasting.

He was an author or co-author of over 160 scientific papers, many of which are published in renowned journals, conference proceedings and documents of the International Telecommunication Union - Radio-Communication (ITU-R, former CCIR). Besides, he was an author of some 50 major projects and proposals.

The most important papers of Professor Surutka, by which he greatly influenced development of theory and profession, refer to the field of linear antennas and antenna systems. Theoretical and practical contributions in these papers distinguish Professor Surutka as the pioneer and expert in this field. Thanks to papers written by Professor Surutka and his associates, the Faculty of Electrical Engineering in Belgrade won the reputation of an important research centre in the field of linear antennas.

As an university professor and a pedagogue, Professor Surutka predetermine the basis of modern electromagnetics in Yugoslavia. He was the first to introduce the teaching of antennas and radio waves propagation. He also radically reformed course of Fundamentals of Electrical Engineering. He was the pioneer in antenna research, managed a number of scientific projects and took part in a major project of the European Union (COST 25/2).

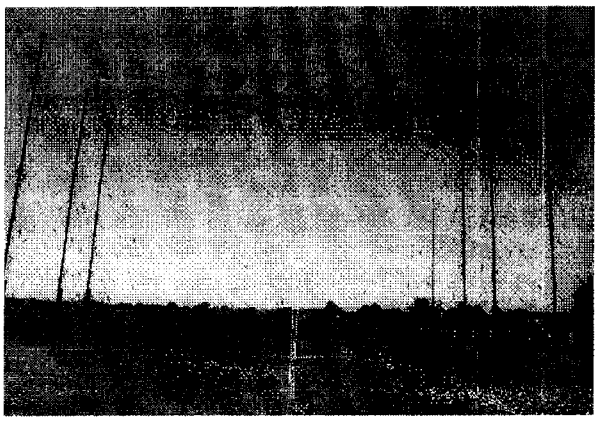


Fig.1 - A three-element Yagi antenna for broadcasting RTS programme on SW (7200 kHz) in the European area

[1] **ETRAN** - Society of Electronics, Telecommunication, Computer Science, Automation, and Nuclear Engineering

He designed a great number of antenna systems for medium, short, and ultra-short waves for various organisations and institutions in this country and abroad (Fig.1).

In a considerable number of papers from the earlier period of Professor Surutka's career, a method of variation calculus is used. Professor Surutka and his associates broadened the application of variation calculus on a wide class of linear antennas, derived appropriate formulas and developed computer programmes for calculation of input impedance, current distribution, and other characteristics. As trial functions, two-member trigonometric series and polynomials are used. By application of variation method, the problem of input impedance and current distribution was solved for the following linear antennas: V-dipole, asymmetric dipole with different lengths and widths of dipole wings, two coupled and axially moved dipoles, circular frame antenna, etc.

In his PhD Thesis titled "**The Influence of the Antenna Feeding on the Vertical Radiation Pattern of MF Anti-Fading Transmitting Antennas**" (Faculty of Electrical Engineering, Belgrade, 1957), he gave a valuable contribution to the theory and techniques of anti-fading antennas. If the antenna mast is fed with the RF energy at a height *h* above the ground (instead at its base), professor Surutka notices, alike some other investigators, an approving effect of the elevated feeding on the anti-fading vertical radiation pattern of antenna. To realise physically an elevated point of antenna feeding, the antenna must be cut off at the height *h* into two parts. The parts of the antenna mast should be firmly coupled to each other by means of strong ceramic insulators. Evidently, the coupling place represents an unreliable point of the mast mechanical construction. In his PhD Thesis, professor Surutka cleverly replaces the cutting of the antenna mast by the shunt feeding the upper part of the mast. Some twenty years later a similar idea was applied in France.

In co-operation with Professor Branko Popović, he proposed a new method of adjustment of antenna systems, in their paper "**Improved Method of Adjustment of Medium-Wave Directional Antenna Systems**" (*Proc. IEEE*, Vol. 114, No. 3, 1967). In the later stage of research of linear antennas, the methods based on integral equations of the Hallen type and integral-differential equations of the Pocklington type were used. For numerical solutions of these equations, a simple and efficient method of adjustment in points (Roger Harrington) with a polynomial current approximation in antenna conductors (Branko Popović) was utilised.

In a remarkable paper (Zbornik SANU[2], 1974, No. 51) as well as in a number of papers that followed later, a theoretical consideration of the

[2] Zbornik SANU - Proceedings of the Serbian Academy of Science and Arts

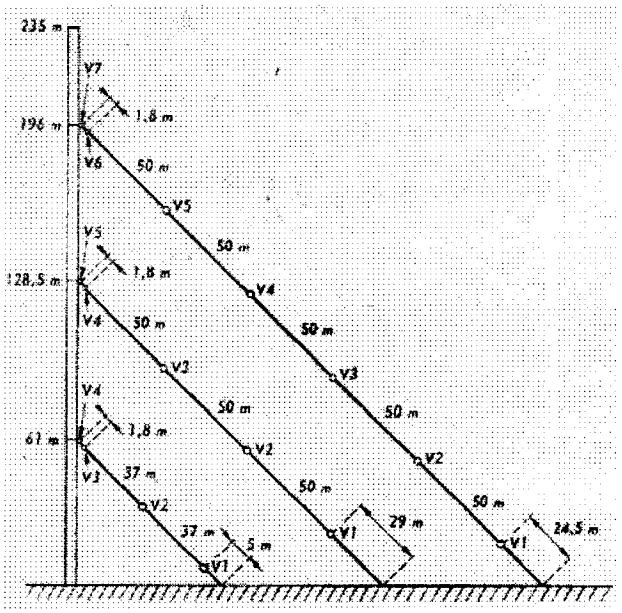


Fig.2 - The configuration of stays and insulators at the MF antenna for broadcasting of the First Programme of Radio Belgrade (f = 684 kHz, P = 2000 kW, Antenna height 235 m)

problem of symmetrical dipoles fed by symmetric two-conductor transmission line was presented and elaborated for the first time. The basic idea of these papers was that the antenna and transmission line are considered as an entirety, i.e. as the unique problem of boundary conditions. Thus, the coupling via field between antenna and the line was taken into consideration. Moreover, a new more appropriate definition of antenna impedance was introduced. This procedure has solved the problem of straight symmetric dipole, V-antenna and dipoles coupled in parallel and fed by two-conductor transmission lines.

Apart from his contribution to the theory and calculation methods, this research also produced original solutions in the field of design and construction of antennas covering all radio-frequency bands, excluding microwave ones. Among many good and successful solutions, the well-known Professor Surutka's method for elimination of static discharges on the stays of high-power MF antenna fully merits to be explained in more details.

The most common type of transmitting antenna for use in the long and medium wave bands comprises a vertical metallic (steel) mast insulated and driven at its base and kept in the upright position by means of steel stay ropers. The height of mast is between 0.1 and 0.65 of the transmitting wavelength, depending on the desired vertical radiation pattern and radiated power. Towards the lower end of MF band, antennas may therefore be up to 300 meters high, if they are to have vertical radiation patterns having so-called 'anti-fading' properties. All base insulated masts require stays and those more than a few tens of meters high must be stayed at several levels.

In order to suppress induced radio-frequency (RF) currents in the steel stays, and thus to prevent undesired radiation from these stays, they are normally divided into short sections by a number of insulators. Figure 2 shows the configuration of stays and insulators in the MF antenna of Radio Belgrade (f = 684 kHz). Sectionalised stays are also used with other types of LF and MF transmitting antennas such as T or inverted L wire antennas or shunt fed mast antennas.

The stay insulators are subjected to two kinds of voltages: induced RF voltages due to the RF current flowing in the antenna mast and electrostatic voltages caused by atmospheric electrostatic fields in the vicinity of the antenna.

Whereas induced RF voltages are practically constant in time and depend on the radiated power, electrostatic voltages are variable and can reach very high values. Immediately before and during a thunderstorm electrostatic voltages as high as 200 to 300 kV may occur across an insulator and values even high as 400 kV are possible. These voltages are the result of very strong atmospheric electrostatic fields between the clouds and the earth: maximum field strengths of 5 to 10 kV/m have been quoted. Despite the use of very expensive and bulky stay insulators, such high voltages can produce flashover between the metal fittings at either end of an insulator and these can lead to a severe damage.

This problem of static discharges across stay insulators plagues many high-power LF and MF transmitting stations with tall stayed mast antennas. Although the problem was observed and described as early as 1939, it is gaining increasing importance at the present time with the steady increase of the power of the transmitters which are often in excess of several hundreds even one thousand kilowatts. Therefore, greater attention has been paid to the problem in recent years and a number of articles on the influence of electrostatic and RF fields on stay insulators have been published in the specialist literature.

An accurate method of computing the electrostatic field in the surroundings of a stayed mast, and electrostatic voltages across the stay insulators, has been presented by Surutka and Veličković (*The Radio and Electronic Engineer*, No.3, December 1973). Calculated static and RF voltages in kV across stay insulators for static electric field strength of 10 KV/m, and RF power of 2000 kW were calculated using this method.

The static voltages and flashover they cause are not in themselves particularly dangerous when the transmitter power is low. Problems do arise, however, in the case of high power transmitters. Once the static voltage has caused a break-down in the insulator spark-gap, the induced RF voltage can

Fig.3 - An old ceramic stay insulator damaged by RF arcing

maintain the arc even if the voltage is much less than that needed to trigger a flashover.

If the arc occurs at the insulator which connects the stay to the mast structure, there will be an appreciable change in the antenna feed point impedance and transmitter's reflectometer protection system will momentarily interrupt the transmission thus extinguishing the arc. The only fault in this case will be a very short break in transmission.

In contrast, a flashover across an insulator which is not in contact with the mast will not activate the reflectometer and RF energy from the transmitter but will maintain the arc; in high-power transmitters, the power in the RF arc can be considerable and the resulting thermal stresses may damage the insulator. (Fig. 3).

In the absence of the system serving to extinguish such arcs, the safety of the mast can be jeopardised. In particular, prolonged arcing can cause catastrophic damage to strain insulators in which the fittings are not interlinked. In any event, the replacement of a broken insulator is time consuming and costly. Contrary to what might be, a lighting strike which touches the mast directly or which falls in the immediate vicinity represents an incomparably smaller risk as regards antenna safety than a flashover triggered by the general level of the electrostatic field. A direct strike will cause flashover on all insulators on a stay and this in turn will trigger the reflectometer interrupting the transmission.

Professor Surutka, together with Professor Veličković, gave this problem a very thorough consideration and developed a reliable method for calculation of not only electrostatic but also high frequency voltages in insulators induced by the current in the antenna. These papers frequently quoted in the scientific literature greatly contributed to better understanding of mentioned phenomena that used to be a big warry of many broadcasting organisations. Finally, as a result of above mentioned research activities, Professor Surutka proposed a very simple and efficient solution

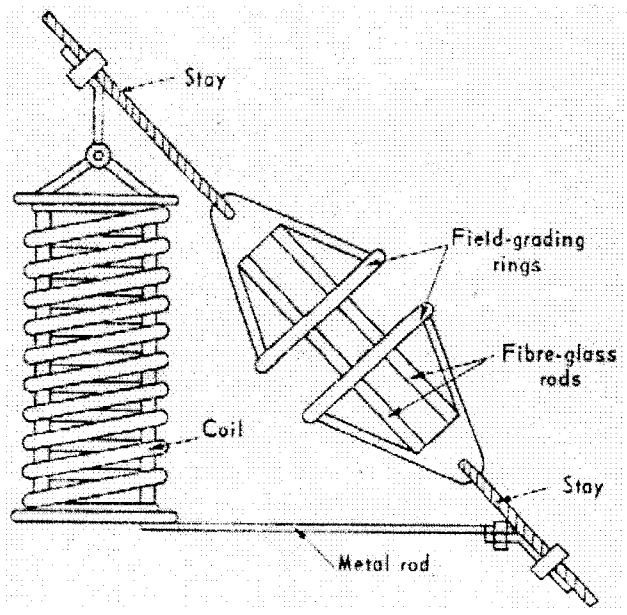


Fig.4 - Professor Surutka's method of the eliminating of static discharges on the stays of high-power MF antennas. Sketch of static drain coil connected in parallel with the stay insulator

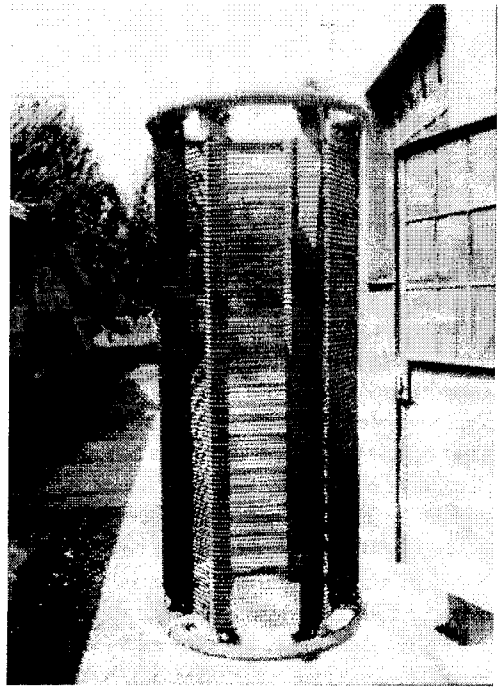


Fig.5 - A static drain coil on the ground

for elimination of static electricity from stays of the MF and LF mast antennas This solution was first applied in 1976 upon the reconstruction of Radio Belgrade antenna operating at 684 kHz with the power of 2000 kW (antenna height is 235 meters). Faced with a serious situation requiring a rapid solution, Professor Surutka set about solving the problem himself. An experience to date suggests that the solution was indeed a good one. Not only it is very effective but it has an additional merit of being extremely simple: it involves the connection of static drain coils in parallel with all stay insulators (see Figs. 4, 5, and 6) except those immedi-

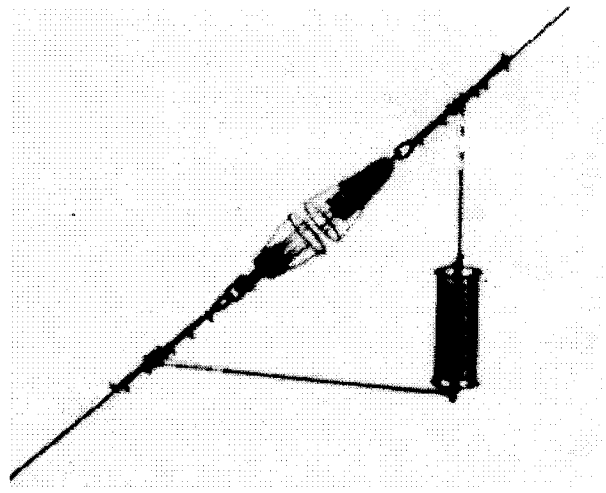


Fig.6 - A stay insulator and its static drain coil installed on the stay

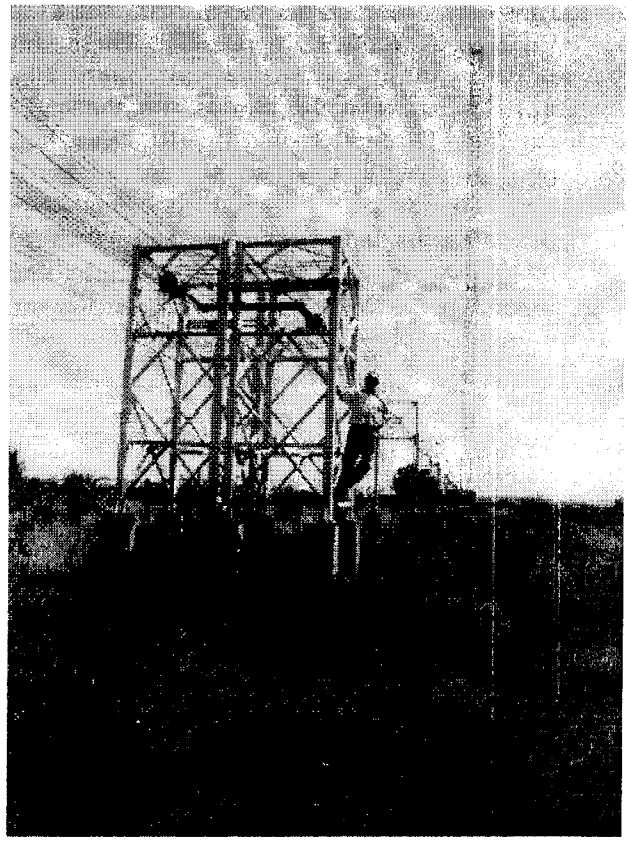


Fig.7 - The feeder line for 2000 kW and the stand-by antenna for the main transmitter of Radio Belgrade (in the background). The antenna has no stay insulators (original construction)

ately attached to the mast. These coils act in a similar manner to the static leak resistors, draining static charges to the earth. The coil inductance was calculated so that a parallel resonant circuit would form with insulator capacitance at the carrier frequency. Not only does this eliminate the accumulation of static charges, it also results in an appreciable increase in RF impedance between the

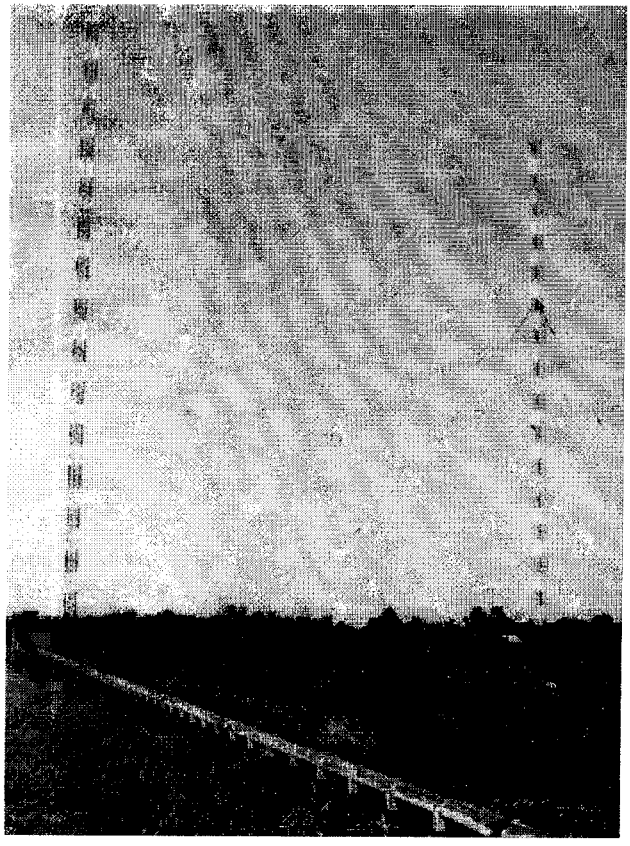


Fig.8 - Directional MF antenna for broadcasting of the second and third programs of Radio Belgrade. A similar MF antenna with cardioidal radiation pattern in the horizontal plane constructed by Professor Surutka for Radio Koepenick (Ministarstvo PTT, DDR)

stay sections. The system was put in operation in April 1977 and since that time there has been no recur of the problems experienced earlier as a result of atmospheric electrostatic fields. The proposed solution has been cited in the CCIP Report 943, 16th Plen. Ass., October 1986 and accepted by the American Corporation 'Continental Electronics', which delivered the new MF transmitter for Radio Belgrade. It was a simple twist of fate that the reconstructed antenna survived intact the NATO attack on the Zvecka broadcasting centre. Based on this method for elimination of static electricity, he presented "**A New Design of Insulation in Mast Antennas Stays**" (*Journal IERE*, Vol. 58, 1988). The design allows the use of lightweight and cheap insulation in the supports and was first applied on a new MW antenna of Radio Podgorica 172 m high. He also developed a mast antenna with no insulators in the stays as a cheap solution for high powers. It was constructed as stand-by antenna for the main 2.000 kW transmitter of Radio Belgrade (Fig.7).

A new and simple antenna with variable cardioidal and undirected radiation is especially interesting. The antenna is also very economical as it only consists of one metallic mast and an inclined bunched wire radiator stretched between the mast

[3] RTS - Radio Television Serbia

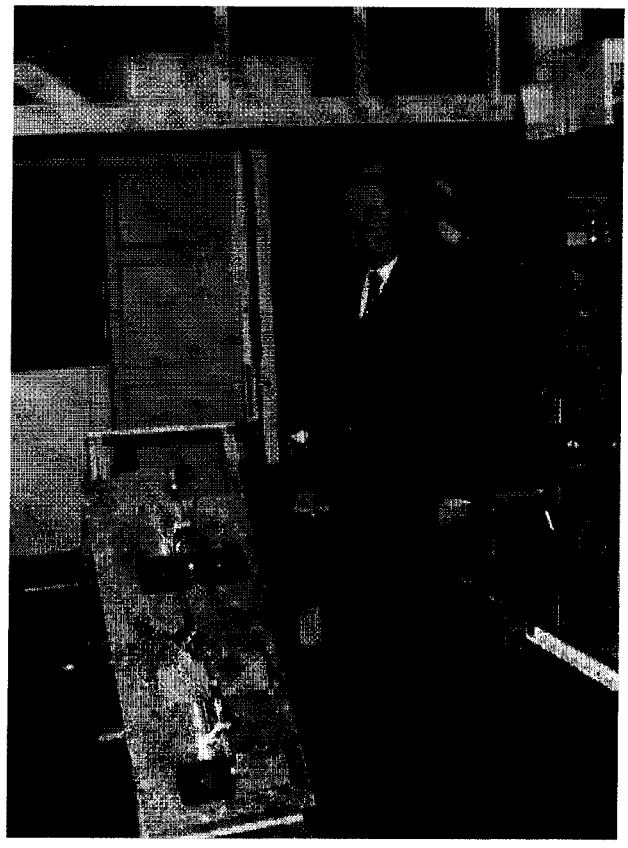


Fig.9 - UHF panel Antenna SMK1/8 (470-790 MHz) produced by the ELMAR - Trebinje. The photograph has been taken at the Electrical Engineering Faculty in Belgrade during the antenna development

top and its own grounding. Besides, the antenna is easily manipulated and adjusted. The antenna was constructed in Kosovo, in a village of Baksija near Priština and was used to broadcast the programme in Serbian language. The antenna was fairly good accepted by the ITU-R's 10 A working group, on which an appropriate document was issued in March 1998. The paper won the RTS[3] Annual Reward in the field of telecommunications.

Professor Surutka's original method for adjustment of directional antennas should also be pointed out (Fig.8) It was presented in his paper titled "**Low-Power Method of Adjustment of Medium-Wave Directional Antennas**" (*Electronic Letters*, Vol. 4, No. 8, pp.150-152).

I would also like to mention his contribution in design, development and serial production of UHF television and VHF UKT radio antennas as well as the antenna accessories (connectors, diplexers, directional couplings, etc.). Such activities were most valuable for the post war reconstruction of radio and television broadcasting centres in Serbia and Montenegro. Professor Surutka also co-operated in industrial production of TV UHF antennas and VHF logarithmically periodic receiving antennas for household purposes (Fig.9).

Professor Surutka has been co-operating with RTS for 45 years (former Radio Belgrade and

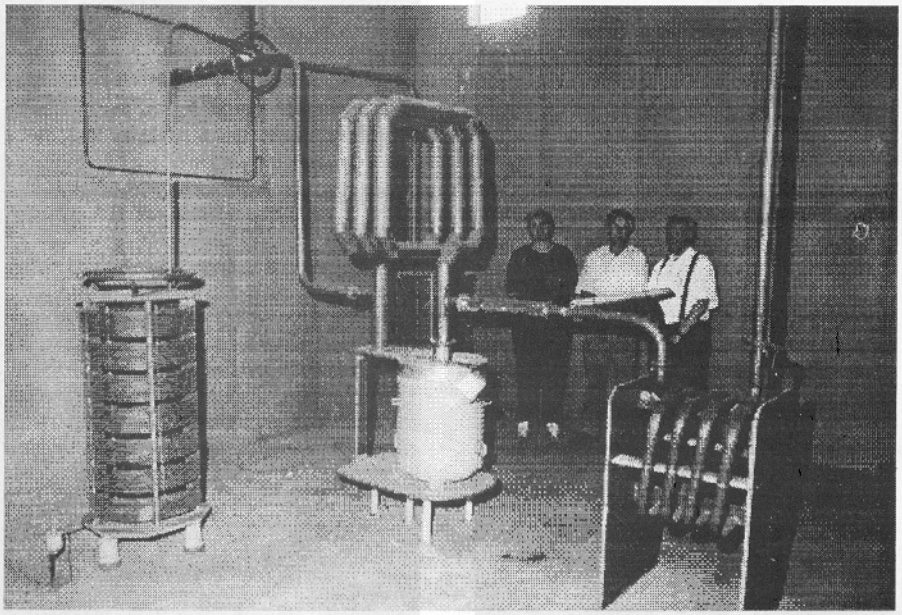


Fig.10 - Interior view of the antenna housing (Antenna power P = 2000 kW)

Radio-Television Belgrade). He had a very important role in all plans and projects regarding construction of the radio and TV network in Serbia and Yugoslavia.(Fig.10)

He was delegated by the government of former Yugoslavia to take part in making of the frequency plan at the European Region Conference held in Stockholm in 1961. He also took part in many missions and international commissions for co-ordination of frequency plans.

His most important book is Electromagnetics - a university textbook rewarded by the University Award, which had seven editions in a very short period of time. The book was the first of that kind in Yugoslavia and was used at majority of electrical engineering faculties. He also wrote a valuable book to support his lecturing in Fundamentals of Electrical Engineering. It consists of four parts: *Fundamentals of Electrical Engineering - Electrostatics and Continuous Direct Currents* (12 editions), *Fundamentals of Electrical Engineering - Electromagnetism* (9 editions), *Alternative Electrical Currents* (co-author Milić Djekić). He also published a monograph titled "**Ionosphere and its Influence on Radio Waves Propagation**", which was the result of Professor Surutka's research of radio waves propagation of many years.

Many generations of students remember Professor Surutka as one of the best pedagogue whose lectures were eagerly expected. His books are distinguished for their deep and clear observations and good style. They were not written to promote the author but to offer an insight into deep and complex problems of electrical engineering. He was a strict but just teacher to his students and younger colleagues. Students respected and loved him and awarded him with the Award of Presidency of the Conference of Socialist Youth Union of the Faculty of Electrical Engineering in Belgrade for a prominent co-operation with students. Professor Surutka respects his colleagues and associates and he takes care of their advancement. The facts speak for themselves, three of his associates have also became members of the Serbian Academy of Sciences and Arts.

Besides linear antennas, Professor Surutka also tackled different problems of electrostatics and stationary magnetic field. He had a successful and long co-operation with the Cable Factory in Jagodina, which included a research project regarding the problem of electrical field in cable endings and in extensions of single conductor high voltage energy cables.

In recent years, Professor Surutka and his associates have been engaged in research of protection of personnel and citizens exposed to strong non-ionising electromagnetic fields forming near powerful radio transmitters. In relation to this, simple and reliable methods for calculation of near electromagnetic field and security zones of MW and LW antennas (ITU-R Report No. 1117) and especially short wave (SW) antennas, so called dipole curtains, have been developed. The last developed method in this field have been published under the title "**Near Electromagnetic Field of HF Transmitting Curtain Antennas**" as a document of the ITU-R 10/A working group.

Professor Surutka is one the main creators of the project of the new SW centre of Radio Yugoslavia near Bijeljina. In the domain of radio communications and SW broadcasting, He was the first to introduce modern methods of designing and SW broadcasting via ionosphere. After he had spent some time at the French Ionosphere Bureau, Professor Surutka wrote a distinguished monograph for the necessity of the Yugoslav Army titled "**Ionosphere and its Influence on Propagation of Short Waves**".

Professor Surutka, together with Mr. Ljubiša Dulović, former director of the Federal Bureau for

Radio Communications, was the scientific supervisor of realisation of the digital model of the topographic map of former Yugoslavia. The digital map was intended to help efficient and reliable management of the radio frequency spectrum. The project was finished in 1985 and was rendered to the Federal Bureau for Radio Communications. The immediate constructor of the project was Dr. Dušan Starčević.

For his merits earned over the long period of work in the field of sciences, electrical engineering, education and his results in education of scientists and professionals, Professor Surutka was awarded with many prizes. I would like to mention only the most important ones.

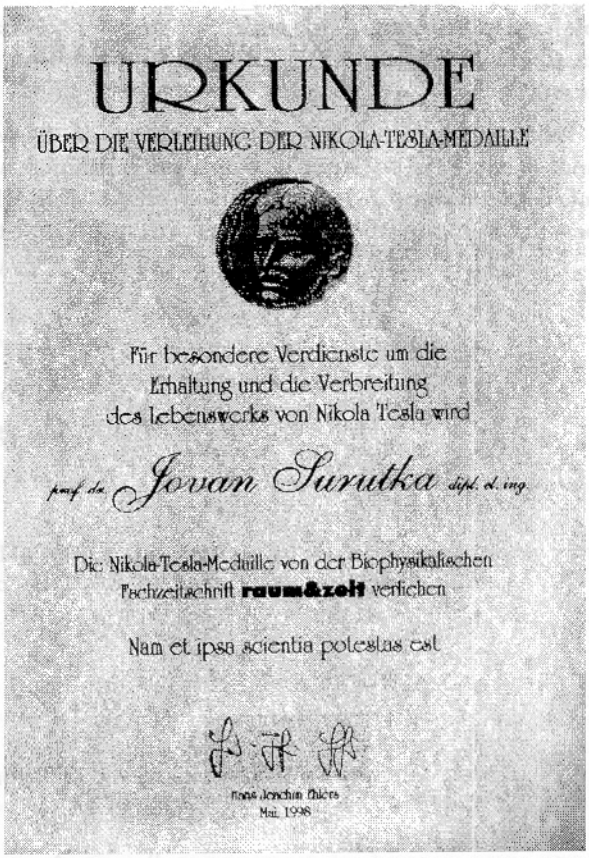
He was admitted to the Serbian Academy of Scences and Arts - first as an associate member and in 1983 as a regular member. He has been a member of the Serbian Scientific Society since its foundation in 1969. He is a honorary member of the Engineering Academy of Yugoslavia and the Society of Mechanical and Electrical Engineers and Technicians of Yugoslavia and a honorary doctor of science of the University in Banja Luka.

For his outstanding merits on the field of sciences, culture and education and results achieved in education of professionals and scientists, he was awarded with the Gold Wreath People's Medal, the Gold Wreath Labour Medal and the Silver Wreath Republic Medal.

Professor Surutka was very active in founding universities and he was engaged in creation and improvement of university curriculum's and research work. For these activities he also received a number of prizes: Charter and Medallion of the University in Niš, Charter of the Electronics Faculty in Niš and Medallion of the Faculty of Electrical Engineering in Skopje. For his contribution to development of the Yugoslav broadcasting organisations, he received prizes of highest rank: Charter and Gold Medallion of Radio Television Belgrade and Special Medallion of Radio Television Titograd.

There are also many awards that Professor Surutka received for his outstanding scientific and professional contributions in his papers that he published or presented at conferences: October Reward of the city of Belgrade for mathematics and technical sciences, RTS Annual Reward (1971, 1978, 1998), Diploma of the "Tehnika" journal. Tesla's Reward and Gold Medallion of 1988 INOST for the best exhibit at the Fair of Innovation in Banja Luka.

Professor Surutka joined many other Yugoslav scientists and scientific enthusiasts in organisation and maintenance of the Nikola Tesla Museum and promotion of life and work of our most famous


URKUNDE

ÜBER DIE VERLEIHUNG DER NIKOLA-TESLA-MEDAILLE

Für besondere Verdienste um die Erhaltung und die Verbreitung des Lebenswerks von Nikola Tesla wird

Jovan Surutka

Die Nikola-Tesla-Medaille von der Biophysikalischen Fachzeitschrift raum&zeit verliehen

Nam et ipsa scientia potestas est

Hans Joachim Thiers
Mai 1998

Fig.11 - In 1998 Professor Surutka was awarded with Tesla's Gold Medal, a prestigious award of the German scientific journal Raum und Zeit

scientist. For his achievements in this field, in 1998 he was awarded with Tesla's Medal, a prestigious award of the renowned German scientific journal Raum und Zeit (Fig. 11)

I would like to take this opportunity to point out the praises and awards that Professor Surutka received from the **ETRAN** Society for his outstanding contribution in development of the Society and advancement of the professional areas for Telecommunications, Antennas and Propagation and Microwave and Sub-millimetre Techniques. He was awarded twice for the best papers in Telecommunications and once in Antennas and Propagation. He also received a Charter for his continuous work of many years in the Yugoslav Society for **ETAN**[4]. Professor Surutka is looking forward to each conference of **ETRAN** and enjoys them as he is taking the opportunity to present his most valuable results and see how his younger colleagues, especially his own associates, are getting along. Just like a number of other aged professors, he never missed the opportunity to take part in the Conference of **ETRAN**, always with a paper. It was only once or twice that he was absent due to illness. He is presiding over working sessions, reading invited papers and taking part in plenary sessions. The last such example was the plenary session that Professor Surutka organised during the **XLIII ETRAN** Conference held in Zlatibor with his

[4] **ETAN** - Yugoslav Society of Electronics, Telecommunication, Automation, and Nuclear Engineering

plenary presentation of wide spectrum of broadcasting TV UHF and VHF antennas and antenna accessories.

Professor Surutka loves the Society of **ETRAN** and is anxious to save it from daily politics and marginal, non-professional issues. He is doing his best to hold up the Society, according to its Statute, as a non-political and non-governmental organisation of professionals of all ages and varied inclinations with one interest in common: science and research in the professional areas of **ETRAN**. On behalf of the **ETRAN** Society, I would like to express deep and warm thanks to Professor Surutka wishing him good health, long life and participation at many more **ETRAN** conferences.