From the Desk of
MARVIN HOBBS

August 20, 1993

Mr. Ned Carlson
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Dear Ned,

Enclosed is a copy of the study that I made at the tube factory in Nis, Yugoslavia, in 1952. That was 41 years ago. I suppose a lot of things have happened since then.

Also, you said that you had not seen the article in GLASS AUDIO, where you were quoted. I am also enclosing a copy of that article too.

I hope that I will have an opportunity to drop by your place again in the near future.

Sincerely yours,
Marvin Hobbs.

The following file is a report submitted by Mr. Marvin Hobbs of Chicago (he is rather well known in the antique radio collector's community as an ex-engineer for the legendary E.H.Scott radio company),in 1952 in his capacity as a consultant to the Mutual Security Agency, regarding the R R Savodi (now Electronska Industrija) factory in Nis, Yugoslavia.

This file contains a list of the equipment & materials used and the productionm methods in the Nis tube factory, and a list of the equipment needed for a tube factory that could produce 1,500,000 tubes per year. Note that the costs are given in 1952 dollars..

Lastly, Mr. Hobbs gives his recommendations to MSA regarding the Nis facility.

Ned Carlson www.tubezone.net 19 December 2005

R. R. Savodi Facilities and Problems \

OUTLINE

The factory, R. R. Savodi, located at Nis, Serbia, has been established to manufacture receiving tubes, X-Hay tubes and Y-Ray apparatus. At present the receiving tube production facilities are located in a single story building having an area of 1,200 square meters.

A considerably larger factory area, providing a manufacturing space of approximately 19,800 square meters has been constructed and is being equipped for future production. In this space, approximately 11,000 square meters is planned for receiving tube production; 1,600 square meters for X-Ray tube production and 7,200 square meters for X-Ray apparatus production. This building has three floors, The space occupied by the present tube plant of 1,200 square meters will be used as a stock roam after the product equipment has been moverd into the larger area, Separate small buildings will house gas production facilities and other auxiliary services. The factory has good access to a railroad and a highway, Approximately 600 workers of all categories are employed at present at the R. R. Savodi factory, but the ma)ority of them are engaged in building and installing equipment for the above areas.

I. RECIEVING TUBE PRODUCTION

A. Present Production and Plans

At present 300 to 400 rectifier tubes of the AZ1I type (a European full-wave rectifier with a side contact base) are being produced daily. Pilot production is also under way for the 6K7G (an American pre-war pentode), the EZ12 and FZ21 (European rectifiers) and the EBL21 (an European double diode -- -- output pentode). Present plans are that the following types will be introduced into greater production later this year: 6K7G (Sept.), EZ12 (Sept.), KZ21 (Sept.), EBL21 (Oct,) and ECH21 (Nov.).

It is estimated that the following quantities of receiving tubes will be produced for civilian consumption on an annual basis by 1954:
EBL21 -- 100,000; ECH21 -- 200,000; rectifiers (AZ1, AZ11, EZ12 and EZ21) -- l50,000; and all other types -- 50,000.

On August 19, 1952, at a meeting in the Yugoslavian Foreign Office in Belgrade, the requirements for receiving tube production to meet, military needs for one year were stated as follows:

Battery Operated Filament Types

	Quantity
lA3	20,000
lL4	140,000
1T4	120,000
lR5	80,000
1S5	80,000
3A4	100,000
3Q4	20,000

Indirectly Heated Cathode Types

	Quantity
9002	70,000
9003	10O,OOO
6BA6	20,000
6BE6	6,000
6AL5	10,000
6AK5	10,000
12AU7	5,000
6C4	16,000

It was estimated by the staff of R. R. Savodi that a total of 20,000 to 30,000 tubes of the first five types would be required on an annual. basis for civilian use. It is also estimated that the above annual requirement for military support will increase after the first year to approximately twice this quantity within two or three years, bringing the total annual requirement for miniature tubes to about 1,500,000 per year.

At a meeting on August 26, 1952, it was decided to consider the initial requirements for miniature tubes to be in the order of 1,000,000 units and to plan accordingly. Further detail on the plans for this phase of production are given in the section, "The Future Production Program"

B. Present Production Methods and Personnel

At this time approximately 86 Yugoslavian workers and 21 German specialists are engaged in the manufacture of receiving tubes. The production equipment is either of German origin or has been built at the R. R. Savodi factory. It is understood that considerably more automatic machinery has been ordered and will be installed in the new factory space. The chief German specialists appear to be experienced and knowledgeable in the production techniques which have been used in Germany and Europe as well as in the USA for standard tube production. The chief German electronics specia1ist is also acquainted with German machinery for miniature tube production.

In the present plant glass flares are produced on a hand-operated machine obtained from Gustav Bruckner of Germany. The flares are processed further on an automatic flare spreading machine of 12 positions fram the same organization. Two tubulating machines of the hand-operated type from Gladitz, G.m.b.h., Germany, are used for this operation. The glass stems are produced on a Bruckner 12-head automatic stem machine.

Grids are wound primarily on hand-operated machines, which are capable of producing 30 grids per hour. Twenty of these machines are available. Two automatic grid machines of Telefunken origin are also available and are now operating. However, they are being used primarily to wind grids with copper side rods, which do not lend themselves to the welding technique employed with the hand-operated machines. It is desired to use copper whenever possible, because it is available in Yugoslavia. As will be shown later in this report, nickel must be imported and a substitute is used wherever possible. Filaments are wound on an automatic Bruckner machine. Welding equipment from Bruckner is also available for connecting the elements and their leads.

The cathodes and filaments are sprayed chiefly with triple carbonates (50% barium, 45% strontium, 5% calcium) obtained from Gigneux, a French firm. For indirectly heated filaments, the insulating materlal is deposited by a cataphoresis method. Some work has been done with cataphoresis coatings of emission material, and although the unifomity is better than with the spraying method, the emission is not as great.

The assembled tubes are sealed on a Bruckner type H-400 12-position machine and are exhausted on a 36-position automatic machine made by Schmid and Kleinberg. Two sealing and exhaust combinations are available. One exhaust machine has been installed for about two years and another has been received recently from Germary. The tubes are then based, aged and tested in a conventional manner on equipment which has been constructed at the R.R. Savodi factory.

While several of the machines mentioned above are hand-operated and consequently very slow in comparison with automatic machines, the basic techniques of production as introduced by the German specialists should be quite satisfactory for the production of standard European and American types of tubes of good quality. materials are a definite problem and variations in tolerances and the content of many of the elements can continually introduce problems in production.

C. Present Production Problems

One of the chief deterrents to rapid production at this time is the use of hand-operated machines for many production stages, such as those for grid winding which produce only 30 grids per hour (less than 10% of that produced by modern automatic machinery), However, with only a small production in each type, automatic machines could not be used to their full advantage and much time would be lost in setting them up for the many types of grids to be made. Until the quantities of tubes can be increased and until more automatic machinery is installed and brought into use, the production rates will continue low and the operation will be comparatively inefficient. It is understood that the installation of a full complement of automatic machinery in the large factory space is contemplated and that, some has been ordered.

Another deterrent to production and a source of rejects at present is the tolerance variations of the glass parts, which are obtained from Paracin in Yugoslavia. These variations lead to excessive breakage in the sealing operation. It is understood that the installation of an automatic glass machine in Yugoslavia in the future to permit uniform production of these glass parts is contemplated. The glass which is now imported is apparently satisfactory in regard to tolerance and quality and when used the percentage of rejects is normal.

Another source of defective material arises from the lack of controlled temperature and humidity conditions in the chemical department, where the heaters and cathodes are prepared with emissive coatings.
The presence of dirt in the air or other foreign matter which can enter due to lack of air cleaning can also introduce defects.

It is preferable to maintain the temperature at about 18 degrees centigrade and to change the air several times per hour in the chemical department to insure a high quality of the emission coatings. It is understood that control of this type will be installed in the new factory space.

There are additional problems in adapting some of the metals available in Yugoslavia to replace imported items. An example of this problem is the quality of the copper wire required for grid side mentioned above. A list of the materials now used in tube production at R. R. Savodi is included at, the end of this report.

D. The Future Production Program

The principal problems relating to future productiop lie in the field of miniature tubes. All of the types listed in the military requirements as mentioned above are either filamentary or indirectly-heated miniatures. To carry on this manufacturing program it will be necessary to obtain and install additional precision grid winding machines, button stem machines, sealing and exhaust machines, colloid milling equipment and heater coating equipment.

While it is possible to obtain equipment for miniature tube production from Germany, the staff at R. R, Savodi would prefer to obtain the machines and techniques from the USA, It is felt that recent production experience in this field has been much more extensive in America than in Germany, and the American techniques assure that the tubes will meet military requirements in regard to performance and life.

When the machines for miniature tube production are installed, technical assistance will be required in the following subjects:
1. Formulas and methods for heater emission coating for 1.4 volt, miniature types.
2. The aging process for 1.4 volt types.
3. Design criteria and construction data for 1.4 volt series.
4. Data on the quality of glass and procedures for miniature stem production.
5. Fabrication data for other elements, such as grids, plates and insulators.

Referring to the military requirements shown previously it will be noted that for the fifteen types shown only seven types are in annual quantities exceeding 50,000 tubes, and ten types are in excess of 20,000 tubes per year per type. In order to achieve greater efficiency in production it is desirable that consideration be given to manufacturing only the seven or ten types which are required in sufficient quantity to make it economical to set up the machines. While quantities of 5,000 to 10,000 tubes per year might be handled on hand-operated machines, the cost even then would undoubtedly be greater than the cost, of importing these types.

Such small quantities could be produced in two or three days on automatic machinery, but the tooling and set-up time would add so much to the cost that the types produced in these quantities would be certain to have an excessive cost. Therefore, those types required in such small quantities at 5,000 to 15,000 per annum could better be procured from foreign sources, unless other considerations dictate that they be made in Yugoslavia.

The Director and staff at R. B. Savodi desired to consider the possibility of obtaining funds from their Ministry in Belgrade for the procurement of U.S. machinery for the production of 1,500,000 miniature tubes per year. To explore this possibility it was requested that a list be prepared to show approximate estimated costs for such equipment and the following estimate was prepared:

Item	Estimated Approximate Cost
1 Colloid mill for emission material @$4,000 ea.	$4,000
1 Heater coating machine @ $2,000 ea.	$2,000
5 Precision lathe type grid machines @ $8,000 ea.	$16,000
2 Tubula,ting machi.nes Q $8,000 em.	$16,000
3 Sealing machines @ $5,000 ea.	$15,000
3 Automatic exhaust machines (36 or 48 position) @ $15,000 ea.	$45,000
2 Automatic stem machines (24-Head) for button stems 4 $15,000 ea.	$30,000
1 Shock machine (Taft-Pierce type)	$15,000
1 Vibration machine (Waugh-Johnson type)	$3,500
Subtotal=	$170,000
+ Additional test, equipment and auxiliary equipment	$75,000
Total $245,500	

Most of the test equipment and auxiliary equipment could be obtained or constructed in Europe.

The above estimate was submitted strictly for the temporary convenience of determining whether dollar purchases of equipment of this order could be considered by the Yugoslavian authorities and with the complete understanding that exact prices and complete machine data would be obtained from USA equipment or tube manufacturers.

SUMMARY

In summary, the following points wore stated by a member of the R.R. Savodi staff before the departure of this consultant from Yugoslavia.

A. The planned production per year in the R, R. Savodi factory at Nis will be 1,000,000 miniature receiving tubes, 3,000,000 fixed resistors and 3,000,000 fixed capacitors.

B. It is their desire to obtain an offer from one or more US concerns for the entire equipment required for the above production.

C. It is their desire to obtain an offer for one or more US organizations for the technical aid for the above production of receiving tubes, resistors and capacitors; that is, technical documentation, production techniques, licenses, etc.

D. They desire an offer for complete technical aid for the production of an x-ray apparatus with 4 rectifiers operating at about 120 KV. and 250 HA. for diagnostic and picture work.

E. They desire to send five men to the U. S. A. for type A technical assistance in x-ray tube and equipment production.

F. It is their desire to obtain 2 specialists (one x-ray apparatus production engineer) from the U. S. A. for type B assistance.

G. They desire to send four men from their present receiving tube factory to the U. S. A. for type A assistance, and to have three men sent to Yugoslavia for type B assistance on receiving tube production.

APPENDIX

Data on Recieving Tube Materials:

Material	Use	Supplier
1. Nickel "C" 99.8 nickel 0.065-0.15% magnesium 0.03% manganese 0.1% iron 0.14 copper	Cathode tubing	a) Fabrik Breweg, Badensee, Germany b} Sud-Deutsche Prasizion-werke, Frankfurt-au-Main, Germany
2. Nickel "E" 99 nickel .3% manganese .019% sulphur	rectifier filaments, grid support rods, plate and cathode leads b) Hereos Vakuumschrneltze	a)Vereinigte Deutsche Nickelworke (VDN), Schwerte(Ruhr),Germany Frankfurt-au-Main, Germany
3. Iron, P-2 type plate material aluminum-coated iron 10-15 microns of aluminum on both sides		a) Triere Walzwerk, Ruhr, Germany b) Stahlwerke,Wickede- Ruhr, Germany
4. Iron, N-2 Type Nickel-coated iron .15 microns of nickel on both sides	Material for output tube plates (higher dissipation)	a) Vereingte Deutsche Nickelwerke, Schwerte, Ruhr
5. Iron, P-N type Aluminum coating on one side and nickel coating on other. 10-15 micron coating.	plate material	a) Trier Walzwerk, Ruhr Germany b) Stahlwerke, Wickede, Ruhr, Germany
6. Iron, E Type not coated 0.05% carbon) 0.05% aluminum)	shields for elements	a) Armke, Dusseldorf, Germany
7. Copper Coated Nickel Iron Wire 45% Nickel 55% Iron Electrolytic Copper (DIN 1708) Coef, of expansion between 25C and 100C -73 x 10-7 to 78 x lO-7 Specific Gravity -8.3	stem leads	a) Rau, Pfozzheim, Germany b) Gustav Bruckner, Eisenergasse L. Vienna, Austria c) Leonische Drahtwerke, Nurnberg, Germany d) British American Company London, England
8. Copper, Z Type Electrolytic DIN 1703	1st grid support	a) Herecs Vakuumsmeltze, Frankfurt-au-Main, Germany b) Also starting to prcduce in Novi Sad,Yugo.

9.	Molybdenum Specific Gravity -- 12,2 Thermal Expansion @ 20 C -88 X 10-7 Melting Point -- 260C	Grid Wires	a) Plansee, West Germany
10.	Lead Glass No. 352 Specific gravity -- 2.84 Coefficient of ex- pansion @ 50C 90 x 10-7	Stem tubes	a) Osram,Wieswasser, Germany
11.	Wolfram (Tungsten)	Filaments and heaters	a) Metalwerke, Flansee Germany b) Bayerische Metallwerke Dachau, Germany
12.	Barium Nitrate Calcium Nitrate Strontium Nitrate	Emission coatings	a) I.D. Riedel, Berlin Tempelhof, Germany b) Gignoux, Lyon, France

For the 1953 production program it is planned to import the following materials:

1. Bakelite material Type 315 (DIN 7705),
   from: Venditor,Troisdorf, Bezirk, Koln, Germany

2. Lead Glass Tubes
   from: Osram, Gmbh, K.G., Berlin, Helmholtz etr., 4-8

3. Iron Wires and strips
   from: Hille and Miller, Dusseldorf,Germany

4. Iron Strips from: Walz and Stahlweke, Vogelsang,Germany

5. P-2 and P-N Iron from: Stahlwerke, Wickede, Ruhr, Germany

6. Getters (Nickel and iron with getter material)
   from: Velbe, Vienna, Austria

7. Copper-Coated Wire
   from: Gustav Bruckner, Eisengasse 6, Vienna, Austria and
   Leonische Drahtwerke, Nurnberg, Germany

8. Nickel C for Cathode Tubes
   from: Sud-Duetsche Prasizionwerke, Frankfurt-au-Main, Germany

g. Wolfram (N-S wires)
   from: Bayerische Metallwerke, Dachau, Cermany

10. Molybdenum from: Metallwerke, Plansee, Germany

11. Constantin Wire from: Vacuumsmeltze, Hanau Germany

12. Paint for Type Designations
    from: Grauel and Company, Berlin, Germany

13. Cement for Bases (Palentinol "M")
    from: Badische Anilin and Sodafabrik, Ludwigshaven, Germany

It is planned to obtain the following matetial in Yugoslavia

1. Brass
2. Glass Bulbs
3. Mica
4. Copper Wire
5. Probes for Constantin
6. Cement
7. Calcite
8. Bakelite in Powder Form
9. Alcohol
10. Butyl Acetate
11. Collodium
12. Electrolytic Copper
13. Paper Cartons

B. SPECIFICATIONS OF GERMAN MACHINES NOW IN THE FACTORY

1. Flare Machine -- 3-position, hand-operated
from: Gustav Bruckner, Coburg, Germany

2. Automatic Flare Spreading Machine -- 12 positions, Type D300
from: Gustav Bruckner, Coburg, Germany

3. Tubulating Machines -- l-position, hand-operated
from: Gladitz, G.m.b.h., Schab, Germany

4.Automatic Heater Winding Machine -- Type- 2400 or Type E200; capacity 360/420/48O heaters per hour; 0.5 hp motor; air pressure 0.3- 0.5 atmospheres; gas pressure 80 - 120 and 2.5 - 3.5 cubic meters per hour
from: Gustav Bruckner, Coburg, Germany

5.Welding Equipment for leads -- Type C300; capacity 35 -- 45 contacts per minute; 0.6 kw motor

6.Automatic Grid Winding Machines -- Telefunken type, rebuilt; capacity 150 grids per hour

7. Hand-Operated Grid Machines -- capacity 30 grids per hour

8. Automatic Stem Machine -- type F400, 12 positions; capacity 360/420/480 per hour; gas flow 2.5 -- 3.5 cubic meters; gas pressure on burners 80 -- 120 mm of water; air pressure -- 0.3 -- 0.5 atmospheres; 0.5 horsepower motor
from: Gustav Bruckner, Coburg, Germany

9- Automatic Sealing Machine -- Type H 400, 12 positions, 0.5 hp motor 1400 cpm; air pressure 0.3 -- 0,5 atmospheres; gas pressure, to 120 mm water; capacity 360 to 4.80 per hour.
from: Gustav Bruckner, Coburg, Germany

10. Automatic Exhaust Machine -- Type PA36D; capacity with speed of 6 minutes/tube is 360 tubes/hour when all positions are full; energy -- 18 kw for diffusion pumps, .5 kw for the motor; water 2 cubic meters per hour; tunnel heating 4.8 kw; 36 positions with diffusion pumps; equipped with 5 kw RF Bombarders
from: Schmid and Kleinberg, Neu Ulm, Germany

11. Diffusion Pumps --type 280; Vacuum 10-6 mm mercury; speed of exhausting 3.6 cubic meters/hour. These pumps require a fore-pump prov1ding 20Cmm of mercury
from:Elektra, Germany

SPECIAL MACHINES FROM GERMAN SOURCES FOR THE PRODUCTION OF 1,500,000 MINIATURE TUBES PER YEAR From Gustav Bruckner, Coburg, Germany

		DM	USD
1.	3 Stem Machines with all accessories (capacity 500/hr) @ 30,000 DM ($7,1OO)	90,000	21,300
2.	3 12-position sealing machine for press base types; type H4BO (capacity -- 400/hr) 15,500 DM ($3,700)	46,000	11,100
3.	2 Glass-cutting Machines for Bulbs Type D550(capacity 800/hr) @ 8,500 DM ($2,000)	17,000	4,000
	8 Automatic Grid Winding Machines with all accessories, Type E800 (capacity 300/600 hr) 2 18,000 DM ($4,280)	144,000	34,240
5.	3 Filament, Spiraling Machines, Type 210 @ 4,000 DM ($952)	12,000	2,856
6.	2 Single Position Sealing Machine, Type Hl00 (for laboratory work) (capacity 100/hr) @ 1,075 DM. ($256)	2,150	512
7.	2 Strip-cutting Machines, Type 4070 @ 2,500 DM, ($600)	5,000	1,200
8.	3 Wire-Cutting and Bending Machines Type 4345 @ 3,050 DM ($720)	9,150	2,160
9.	2 Bulb-marking Machines, 3 2,400 DM ($571) from: Schmid and Kleinberg, Neu Ulm,Germany	4,800	1,142
10.	3 Automatic Exhaust Machines (36 positions) 360/hr @ 34,500 DM ($8,300)	104,400	24,000
11.	2 Tubulating Machines (l2 positions) @ 16,500 DM ($4,OOO)	33,000	8,000

YUGOSLAV ELECTRONIC FACILITIES AND PROBLEMS
At R. R. Savodi Factory, Nis, Serbia

To finalize the report on R. R. Savodi facilities and problems, the following conclusions are drawn:

1. Type A technical assistance in the x-ray field, particularly in the design and application of apparatus, would be helpful to the staff at R. R. Savodi. It is understood that such technical assistance would not include in-plant training, but rather visits to a number of factories and x-ray apparatus installations.

2. Type B technical assistance in the x-ray tube and apparatus field would be helpful after production of tubes and apparatus is established. Production in this field will not, be achieved before the early part of 1953.

3. Further Type A or Type B technical assistance in the production of receiving tubes as might be furnished through the Mutual Security Agency would not be particularly effective until a decision is made in Yugoslavia regarding the procurement of U. S. miniature tube production equipment and the availability of a U. S. manufacturing license is fully explored.

4. Production and technical assistance in the form of equipment, its installation, and the training of personnel in the production of receiving tubes, x-ray tubes or apparatus is customarily supplied by direct arrangements between American firms and foreign organizations under licensing agreements. Such a transaction is outside the scope of technical assistance dollar financing and can not, be arranged by the Mutual Security Agency. While it is possible to obtain catalogues, price lists, etc. from U. S. sources of production equipment through correspondence, it is suggested that an engineer from the R. R. Savodi staff be sent to the U. S. A. to examine the available U, S. production equipment and to contact U. S. companies relative to licensing arrangements. The engineer could also be present during the initiation of any program for the procurement of U. S. equipment. This recommendation applies to resistor and capacitor production equipment as well as receiving tube equipment.

5.Since U. S. electronic manufacturers are operating to capacity in connection with the defense effort,, it should be recognized that a program for immediate technical assistance may be difficult to conclude and also that some difficulty may be experienced with the approval of export licenses. Therefore, the management of R. R. Savodi should give careful consideration to the technical services and equipment to which it, now has access in Kurope. It is recommended that the present technical staff be maintained until the possibilities for American technical and production assistance have b en more completely developed and considered.

6. It is not within the scope of Mutual Security Agency operations to finance the services of either a Yugoslavian or American engineer for the purposes of concluding arrangements of the type mentioned in paragraph J above, Therefore, the class B technical assistance rendered on this project up to this time should be considered completed, the Type A assistance mentioned in paragraph 1 and the type B assistance mentioned in paragraph 2 are separate projects and must, be established through the normal MSA channels and by consideration of the criteria upon which such prospects are normally based. The commercial transactions of the type mentioned in paragraph 4 must be arranged directly between the U. S. companies and the Yugoslav organization preferentially with the assistance of a Yugoslavian staff engineer who could spend some time in the U. S. A. The other alternative would be an arrangement, between a U. S. consulting engineer and the proper group in Yugoslavia.

MARVIN HOBBS
Consultant,
Mutual Security Agency