General Electric
Cathode Ray Tube Dept.
Syracuse, N.Y.

12/8/54

TRIP REPORT

Object of Visit: To establish a gun development program with certain Eureopean companies.

Duration of Trip: November 20 - December 4, 1954 (2 weeks)

Companies Visited:

Telefunken.....	Germany
C.F.T.H.....	France
Cie des Lampes.....	France
E.M.I.....	England
Edison Swan.....	England

General Approach:

Before leaving, the writer had discussed with Mr. R.M. Estes and C. M. Hutchins, the possibility of obtaining U.S. patent rights for any idea or structure which might result from our development.

We had two forms of agreement which resulted from further talks between G.E. and I.G.E. (Copies attached).

In view of the above, the general approach was to discuss our problem first on a purely technical level and when enough interest had been obtained, to discuss the contents of the proposed agreement form with the local patent and/or International Agreement Specialist. Finally, management was approached for the financial angle.

This plan worked out well, especially with Telefunken.

TELEFUNKEN

I arrived in Ulm a/d Donau on the evening of November 22 Two days were spent in technical discussions. The subjects covered were:

(a) P.A. tri-color gun.
(b) Monochrome guns and processing.
(c) Lighthouse tubes 2C39A and similar, and as a consequence:
(d) long-life cathodes

On subjects a) and b) the following were present:

Prof. H. Rukop	Dr. Schaffernicht
Dr. Gundert	Eng. Lange

On c) and d) the problem was discussed with:

Von. W. Dahlke
Dr. Brueck
Eng. Bingel

P.A. Tri-Color Gun

Dr. Gundert is of course well known in the field of electron-optics and needs no further introduction.

Dr. Schaffernicht is Manager of the CRT factory and Eng. Lange is an engineer specialist on guns.

After explaining in detail the P.A. gun problem, the technical staff felt that they could contribute materially towards the solution.

Dr. Gundert proposed the following approach:

(a) Find out the required beam diameter at the exit of the gun for sufficient focusing. This can be calculated and moreover a magnetically focused sample will be made.

(b) Find the required potential distribution along the Z-axis to give minimum spherical observation.

Note: At first thought he believes that the length of the structure is sufficient to achieve this objective.

(c) He will make the equivalent of a large diameter cylinder by adjusting potentials on smaller cylinders.

(d) Concerning apertures, he proposes:
(1) first aperture not too far from the cathode to prevent electrons striking the cylinders.
(2) a final exit aperture at the last anode so as to be sure about the exit beam position.

(e) Use electrostatic positioning measure and do away with the central magnetic shield. One external purity coil can do the rest.

(f) Some theoretical study has been done to use two crossed slits for focusing. This gives less spherical observation. He will investigate this and try to incorporate the principle in his design.

Monochrome Guns and Processing

The writer saw a quick filming method which according to Dr. Schaffernicht gave excellent results. I have the complete formulation and the main difference between our methods is the addition of a special wetting agent to promote even spreading. I also brought back samples of the wetting agent (manufactured by Badische Anilin und Soda Fabrik, connected with the big German Chemical Trust.) It is recommended that we try this filming method.

In monochrome guns, Telefunken still prefers the penthode gun. They are going to electrostatic focusing. Their guns perform extremely well and due to the penthode characteristic individual cut-off adjustment is easily achieved. Depth of focus is excellent (as it should be).

Note: It is interesting to see that EMI is working along the same line, namely, a penthode gun.

Lighthouse Tubes

The writer was asked by Bldg. 5 to look into the Telefunken version of the 2C39A. Apparently Telefunken obtained better life with higher input.

In the discussion, Dr. Dahlke was joined by Mr. Nickel.

Dr. Dahlke explained that the cathode base materials which were used in the Telefunken tube had been completely studied by them, so as to obtain long life with higher loading. The results of this work are given in a paper entitled "Tubes With Long Life" published in the July 1954 issue of

the Telefunken ZEITUNG. The best base material is one using Ni + 4% W + 0,04% Mg. I have a sample big enough to make several cathodes.

The following results were obtained:
On life, static anode current goes generally up from 120 to 140 in A during the first 100 hrs. This stays constant up to 2,500 hrs. and then goes slowly down to 60 M. A. at 5,800 hrs.

Output is constant at 135 watts up to 5,800 hrs. The slope varies during these hours only between 21 and 22 in A./V. This tube was still good at 5,800 hrs.

The above performance is considered as a good average. There have been quite some tubes reaching 7,000-8,000 hrs for the German P.T.T. in F.M. microwave links.

The cooler has been changed, According to Telefunken the cooling is more efficient. The number of fins or rings has been reduced to 6, made of aluminum 1 m.m. thick, the last fin being 1,5 m.m. thick.

The 2C40 has also been modified, and as a result a life of over 7,000 hrs is obtained at 10 c.m. wavelength. During life g_m is maintained at 6 m.A/V at an anode current of 10 m.A.
The improvements were:

(a) reduce cathode temperature (3,2 watts heater as against 4,7 watt.
(b) use the same Ni, W, Mg base material as in the 2C39 series.
(c) by reducing the grid opening evaporation of cathode material on the glass was eliminated;

Long Life Cathodes

Dr. Dahlke explained the paper mentioned under "lighthouse tubes". The reading of the paper by all those working in this field is recommended. The materials which were studied are found in table 2 (pgg 77). Best results were obtained with Ni W.

The behavior of the interface impedance during life is studied.

I discussed with Telefunken the problem of better life cathodes with higher loading for color tubes. In European monochrome tubes, the life problem is not as important because they are somewhat limited in brightness due to flicker (50 cycles as against 60).

Telefunken recognized that the color problem is different as long as we want smaller spot size for a given current.

I would suggest that we make some cathodes using the sample material given to me for the base and using the mixture as recommended by Dahlke. For Completeness sake the resume of the paper is as follows:

> "After a statement of the processes and changes taking place in the oxide-coated cathode, the author critically considers the methods for the measurement of properties of the cathodes during their life and then states the results concerning the life of oxide coated cathodes having sleeves of Ni (with different additions of Mg, Al, Co, Ti, W) and Pt as core material. Exhaustion of emission due to evaporation of Ba, formation of intermediate layers, and cathode poising are stated to be the most important causes of the limitations of tube life. The relationships existing between these effects and the temperature of the cathode during operation is used for judging the probable life of the cathodes."

Technical Result

Dr. Rukop was in favor of doing the P.A. gun work and before I left Ulm we made arrangements for me to see Mr. Von Honk (their international agreement negotiator) and Dr. Heyne (Chairman of the Board) in Frankfurt. Dr. Rukop and Dr. Schaffernicht made also, a technical recommendation on necessary engineering and assistant engineering manpower, which I could submit to Dr. Heyne.

Meeting with Dr. Heyne

The whole day of Nov. 25 was spent discussing the development program. It was agreed that Dr. Heyne would hold a meeting of the Board of Directors to explain the program and get official approval. The finantial angle was discussed and it was agreed that the writer would phone Dr. Heyne on Friday, December 3rd in Berlin from London to settle final details. (See under Final Results).

FRANCE

The writer arrived in Paris early Friday morning, November 26. Meetings had been arranged with C.F.T.H. for November 26 and with the Cie. des Lampes on Saturday, November 27. The November 26 meeting was in the SUFFREN factory (tube factory). Present were:

Mr. Courtillot, Mr. Matricon, Dr. Musson-Genon and Dr. Rostas.

The gun problem was explained in detail and although we all agree that we would prefer to work with Telefunken and E.M.I., the writer felt that it was too early to close any doors definitely.

It is interesting to note that a gun structure was mentioned, which although difficult to make had given very good results.

Briefly, a low potential grid is mounted coaxially with a surrounding cylinder at higher potential. The penetrating anode field will now keep a transversing beam along the main axis, giving a minimum of observation.

The C.F.T.H. approach was going to be an electrolytic tank study combined with ray tracing methods for which they are completely equipped.

I asked the technical staff to give us their preliminary thoughts in a report and pointed out that we then reserved the right to accept their proposals and eventually work out further financial details.

In the evening, I met Mr. Jean, in charge of the Electronics Division, and discussed together with him and Mr. Courtillot, the general aspects (financial and patent-wise) of our eventual cooperation. Mr. Jean agreed to G.E.'s general approach.

In view of the close relationship which exists between the Cie des Lampes and C.F.T.H. (C.F.T.H. laboratories do most of the CRT work for the Cie des Lampes), I asked Mr. Courtillot to attend the Saturday, November 27 meeting.

Present at that meeting were:

Mr. Cerceau, General Manager - Cie des Lampes
Mr. Menot, Manager " " "
Mr. Kahn, Technical Advisor " " "

It was agreed that if France would help us, C.F.T.H. would do the basic work, although the services of Mr. Kahn would be available.

At my suggestion, Mr. Kurcz of I.G.E. Paris office attended the C.F.T.H. meeting

ENGLAND

I arrived in London on Monday, November 29. Meetings were arranged with E.M.I. and Edison Swan as follows:

November 30 and December 2nd, E.M.I.
December 1st, Edison Swan

E.M.I.

The meetings were held in the Research Lab in Hayes. Those present were:

Dr. Condliffe
Dr. Broadway

In the afternoon we were joined by Dr. Pearce, Mr. Puleston, Mr. Bull and Mr. Webley.

Mr. Preston, Patent Specialist, joined us for lunch.

So as to enable I.G.E. to do some follow-up, if necessary, I asked Mr. R. B. Sankey, Manager of I.G.E.'s London office to attend the E.M.I. meeting.

E.M.I. was, of course, familiar with our P.A. tube and was aware of the low voltage gun problem.

Dr. Condliffe explained that they felt that color work had to be done in E.M.I. in the near future, (The BBC will run tests on a modified NTSC system next spring) and that the Lab would therefore be glad to work together with us on this gun problem.

Several ideas were discussed, which might improve the gun.

On the second visit (December 2) the E.M.I. staff had given some further thought to the problem and we arrived at the following program:

1) E.M.I. will assemble G.E. guns and measure carefully the spot characteristics in the undeflected case (pulsing, etc.)
2) They will scale down their present monochrome gun, which is essentially a penthode gun.
3) Necessary modifications will then be introduced to meet our specifications.

The above program is what Dr. Boradway calls the short-range crash program. They would put, apart from Broadway and Pearce, 2 engineers on (one 3/4 and one 1/2 time) and 100% on time, 3 lab assistants, plus the necessary auxiliary mechanical and electrical personnel. They expect to get a fairly good result in 3 to 4 months.

This approach is based on the assumption that scanning and convergence will be solved by us. (This has been done already in the Electronics Lab circuit group.)

Dr. Broadway would immediately, on completion of the short range program, start a long range program if we so desire. In this program, such points as one common magnetic focusing element for three spaced beams would be considered.

Pearce and Broadway asked whether there would be any objection against introducing an element with a higher voltage in the gun, as long as the final anode voltage would be the required 6,5 - 6,7 KV. In the penthode approach this might prove useful. I pointed out that the voltage should not be much higher than 9KV because such a voltage should be brought out via the base. The element should also not take any current.

Phosphors

I discussed red phosphors with Mr. Puleston, who told me that they make their own phosphors. I was shown measuring results of a red cadmium-sulphide silver activated, which is more efficient than the phosphates.

The sample which I was given was not the best available, but they will send us better samples if we are interested. So as to get our phosphor cooperation program going, I proposed that we give them our way of measuring (raster size, various current densities, voltages, etc.), so that our measurements and curves would be immediately comparable. This idea was enthusiastically received by E.M.I.

So far they had not given too much attention to the problem of color-shift at higher excitation levels.

Deflection Yoke

I was shown a square yoke deflection coil but on checking with D. W. Pugsley of RTVD, I find that he has a sample.

Monochrome

Their best gun is a penthode gun which behaved beautifully in a 17" tube, also whenw.took the voltage down to 6,7 KV, depth of focus was excellent.

EDISON SWAN (Wednesday, December 1)

Mr. E. Y. Robinson, Mr. Hirschman

Both had been in the Electronics Park just before summer vacation. Mr. Robinson was somewhat familiar with our P.A. tube.

I gave them a set of our drawings and our specifications, as had been done with all other companies.

Mr. Robinson asked for one or two weeks to study the problem and to study the possibility of freeing the necessary manpower. He explained that a new laboratory is being built for CRT work (9,000 sq. ft.) in March and that therefore, probably he could not get facilities and manpower available before then. We finally agreed that Edison Swan would let us know by letter whether they were interested.

FINAL RESULTS

On Friday, December 3, I phoned Dr. Heyne in Berlin from London. He told me they could go ahead with the approval of the Board and agreed to accept the details as discussed in Frankfurt.

I negotiated our monthly payment down to $1,500 for which we get the full man-power requirements for a maximum of six months as counted from December 1, 1954, subject to our right to cancel as per our agreement draft. If we feel that progress is satisfactory, we can continue the work for the above amount. When an acceptable result is achieved, there will be a further payment of $20,000. To further safeguard our interests (Telefunken might come up with an idea which might be better in the long run than E.M.I, although we would get short time results from E.M.I.), we agreed that the above mentioned $20,000 would be decreased by $1,500 per month after May 1955 if we wish to continue the program.

E.M.I. will start to work immediately and there won't be any payments involved unless we feel that we would prefer to make a payment if we get a final result.

We will send them immediately, gun parts and 20 pin stems so as to avoid losing time, because the 20 pin item is not available in Europe.

Monthly engineering reports on the progress will be submitted.

I obtained the following materials:

From Telefunken:
2 samples of Emulphor wetting agent for filming.
Complete filming formulation.

From E.M.I.
Sample red phosphor.

The following papers and reports:

From Telefunken:
Tubes with long life by Dahlke
Abberations in Electron Optical Lenses
Electron Current Distribution in Multiple Element Tubes
Experimental Verification of the Power Law in CRT Tubes
The Pin Cushion Distortion in Oscillograph Tubes
Calculation of the Main Dimensions in CRT Tubes
(All above papers by Dr. Gundert)

From E.M.I.
Report RW/3 on the Square Yoke Deflection Coil

J.C. NONNEKENS

JCN/mcy
Dec. 8, 1954