About the French TM-valve

the forerunner of the R-valve

by Fons Vanden Bergen

This article is based on an extensive study (48 pages) conducted by Robert Champeix and published in the Bulletin de Liaison of the transmission section of the French army in November/December 1980.

It's a fascinating document that describes in detail both the technology and the people behind it, with their strong qualities as well as their intrigues. The author has consulted an enormous number of sources, among them a great deal of correspondence between the protagonists from that initial period as well as a considerable number of interviews with their descendants. He himself spent a good part of his career in the manufacture of radio tubes and so is excellently placed to evaluate and present the pioneering work.

R Valve

The situation before 1914

We know that it was Thomas A. Edison who in 1883 made an observation (the 'Edison-effect') that would only much later prove to be of great importance for the development of the radio tube.

John A. Fleming was the first, in 1904, to see its utility, which he succeeded in using to detect HF signals in wireless telegraphy. Three years later, and more 'by accident', Lee de Forest observed that the addition of a 'grid' between the filament and the plate (the anode) could improve the sensitivity enormously and so arrived at the 'audion' (1). However, the degree of vacuum of the de Forest's audion was not adequate, so the US Navy stopped its tests. One had to wait until 1912 when H.D. Arnold and primarily Irving Langmuir were able to show that one could obtain much better results with a much higher vacuum. But - unfortunately - a world war, with its enormous need for telecommunications, was needed to stimulate the development and to achieve industrial production. We will now see that France played an extremely important role in this.

Gustave Ferrié

A name that immediately comes to the fore here is that of the then technical director of the Télégraphie Militaire - and hence TM as the name of the tube - Colonel Gustave Ferrié. Ferrié, who later was promoted to general, succeeded in surrounding himself with some very strong personalities. In this 'bande Ferrié' occurred names like Henri Abraham, Gabriel Pelletier, and François Péri (more on this later). Together, they succeeded in perfecting the TM tube and to have some 1 million manufactured in World War I for use primarily in military transmitters and receivers. In 1912, the French Navy (in Toulon) asked the Compagnie des Lampes to build a grid and a plate in a tube. This resulted in the 'French Audion', as shown in Figure 1. In the same year, Edouard Branly (known to us for the 'coherer', which he himself preferred to call the 'radioconducteur', also experimented in the Institut Catholique (2) with one of de Forest's ideas, a tube with 2 plates, each along both sides of the filament: see Figure 2.

These two devices had no further practical use. And so we come back to Gustave Ferrié. He was born in 1868 and, after his secondary-school studies in the lycée of Marseilles, he went on to higher education in the Ecole Polytechnique. He then stayed with the army and specialised further in transmission. Thus, he was involved in 1898 in Marconi's tests in the Pas-de-Calais. His report on them to his minister was so enthusiastic that the minister charged him with the development of French wireless telegraphy (T.S.F. = Télégraphie Sans Fil or Wireless Telegraphy) equipment. He was responsible for such things as the T.S.F. station on the Eiffel Tower, which demonstrated its worth for many years (Moroccan campaign in 1908, the sending of time signals to ships, and so on) as well as a large T.S.F. network between France and its colonies.
In March 1913, he had the good fortune of being able to go to America together with Henri Abraham in the

Left: Some tubes in the TM style with, among others, the British R, the Philips E and ZI, an SBR bi-grilleÖ (collection of F. Vanden Berghen; photograph: my book Classics of Communication p.33)

Left: A few coloured tubes with, among others, Métal CL124, TM Métal Mazda, Valve CO, Microtriode Fotos, Radiofotos, Métal Kenetron, and the de Forest Audion Marconi (collection of F. Vanden Berghen ; photograph: my book Classics of Communication p.33).

context of transatlantic tests with the time signals. There he had contacts with Reginald Fessenden and Lee de Forest, whom he had already met in 1908 in Paris, and he was able to study the possibilities of the audion as a detector, amplifier, and oscillator.

Deus ex machina: Paul Pichon

Shortly after the war with France broke out (2 August 1914), Ferrié was contacted by a certain Paul Pichon. This Frenchman had worked up to then for the German Telefunken and had just come back from the U.S.A. with a few audions (see Figure 3) that he, because of the war conditions, gave to Ferrié instead of to Telefunken. The tests were rather disappointing as the vacuum was too weak and the noise too high.

Henri Abraham, Francois Peri, and 'La-Doua'

Ferrié then sent Abraham to Lyon in October 1914 to try to make better audions. In Lyon, there was the GRAMMONT light-bulb factory and the audion was actually a sophisticated light bulb. All this was done together with François Péri, who had already earned his spurs in the radio-telegraph centre of Lyon-la-Doua.

The first tests

Before we come to the TM tube we know, a number of stages were gone through. First, one began with the copying of the de Forest audion, as shown in Figure 3 (vertical structure, M-form filament). It turned out to be too delicate and too unstable. Then one made a model based on the 'pliotron' of Langmuir. This was of excellent quality but turned out to be too expensive because it was very complex.

The third model is shown in Figure 4, but it was also too complex.

In December 1914, Abraham proposed a fourth structure. It was still vertical but now with concentric electrodes: a cylindrical anode, a central wire as the filament, and between them a spiral grid, as shown in Figure 5. This tube was produced from February 1915 through October 1915.

Abraham was thus more the brain and Péri the producer. Both were strong personalities, and so they clashed more than once. One of Abraham's brilliant ideas was how to determine the degree of vacuum of a tube by measuring the inverse grid current, which occurs because positive ions, generated by ionisation of the residual gases in the tube, collide with the grid.

Péri then succeeded in 1915 in making a tube with movable electrodes! This permitted the behaviour of a tube to be studied experimentally, which was very useful for the theory was then by far from complete.

The patent of Peri & Biguet

These 'vertical' tubes were essentially used by the T'élégraphie Militaire. But, unfortunately, they were often damaged on arrival because of the poor shock resistance during transport. When Ferrié complained about this to Péri, he, together with Jacques Biguet (Abraham had left Lyon in the meantime in May 1915), developed a new model within 48 hours in which the electrodes were arranged horizontally. Péri and Biguet

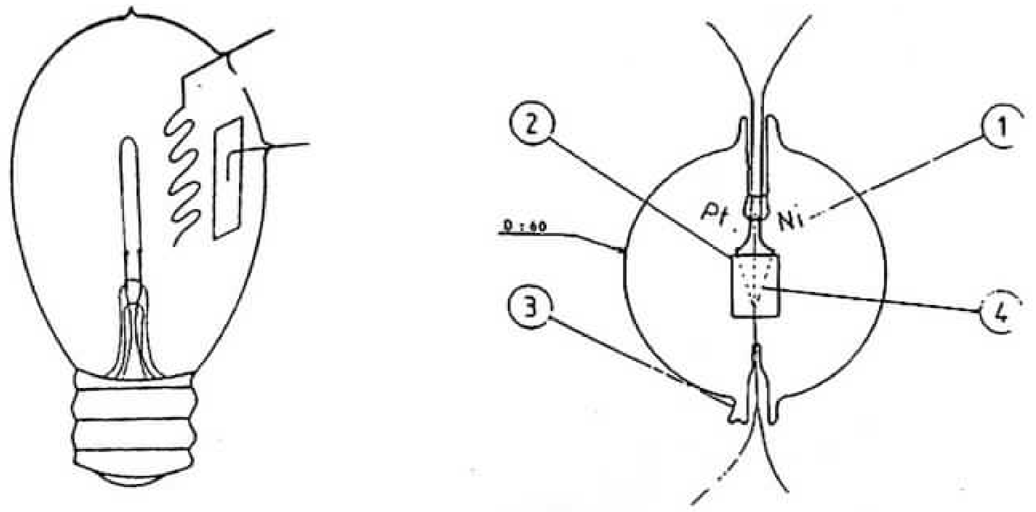

Fig. 1: Audion, made by the Compagnie des Lampes in 1912.

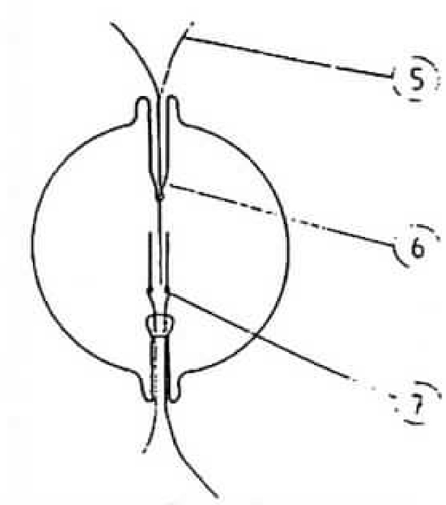

Fig. 2: Audion made by Edouard Branly in 1912.

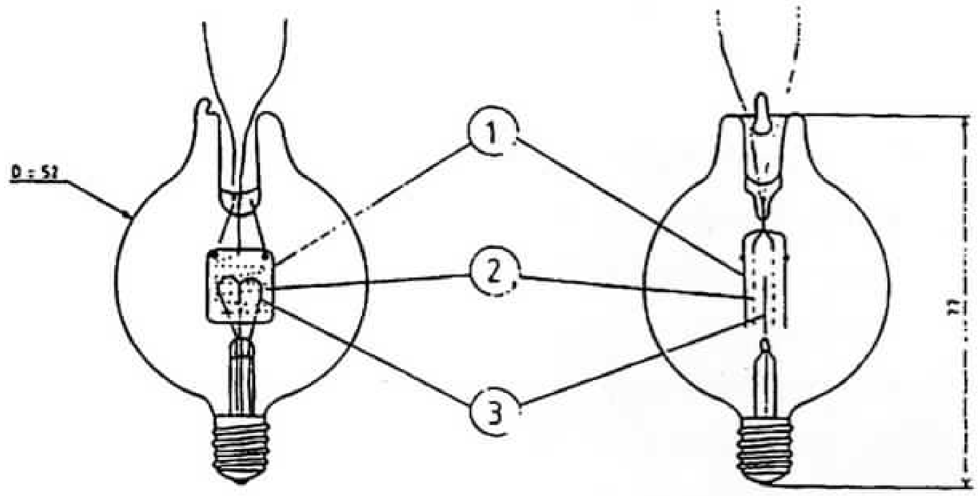

Fig. 3: American Audion by Pichon, given to Ferrié in 1914.

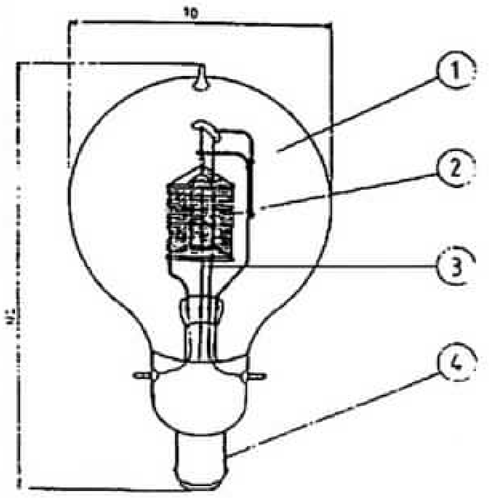

Fig. 4: Prototype of the tube of Abraham and Petit in 1915.

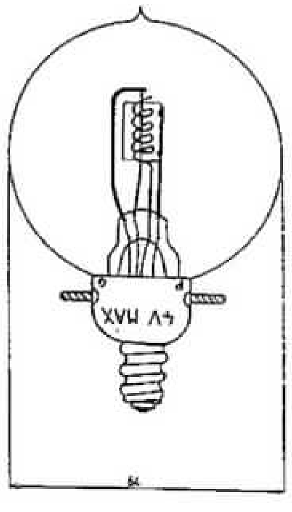

Fig. 5: Model by Abraham (Dec. 1914) manufactured by Grammont from February 1915 to October 1915.

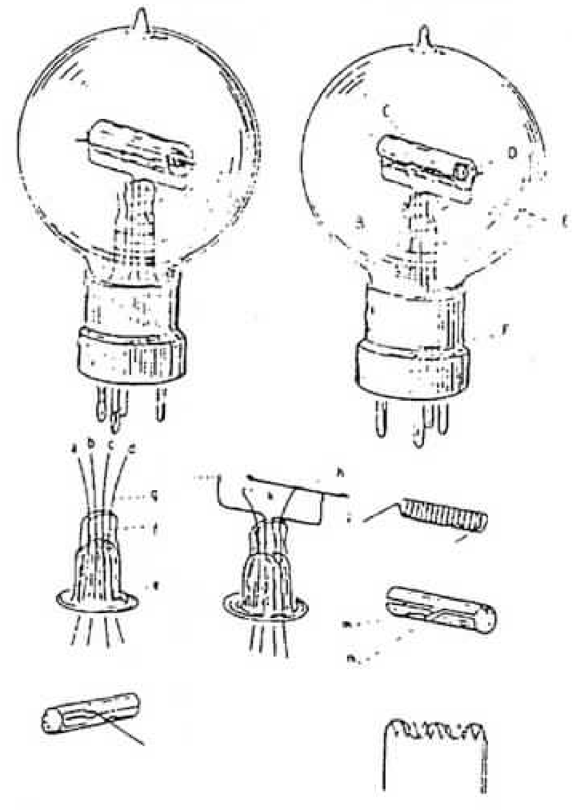

Fig. 6: (right) The TM drawings from the patent application of Péri and Biguet.

applied for the first patent for the TM tube on 23 October 1915 (granted on 21 March 1919). Figure 6 comes from this patent application.

Figure 7 gives the definitive form and the dimensions. For the first time, one also has the base with 4 pins instead of a screw thread. The reason for this was to make it easier to change the tube.

The sturdiness of this construction turned out to be excellent.

As often is the case, here, too, the patent gave rise to a considerable amount of trouble and dispute. Here, it was primarily between the insiders Ferrié, Abraham, Péri, and Biguet. Indeed, after a patent was granted, a lot of money was involved as well as status.

The production

We have seen that the manufacture of the 'Abraham' TM tubes began in the Grammont plant in Lyon in February 1915, followed by the 'Péri-Biguet' model in November of the same year. But in the beginning of 1916, Ferrié started looking for another manufacturer in order to increase production and also to have an alternative, for a war was on. So he came to the Compagnie Générale d'Electricité, which produced light bulbs in its subsidiary in Ivry under the tradename 'METAL'. The production started there in April 1916 under the direction of Auguste Petit.

The indications of the number produced diverge considerably. Robert Champeix calculated on the basis of the many documents he assembled that by the end of the war more than a million had been produced: about 800,000 by Grammont (FOTOS) and about 300,000 by the Compagnie des Lampes (METAL). Tyne (3) speaks of 'more than 100,000' tubes. It should be noted that all the allied armies were supplied with TM tubes from France. It is also certain that in 1918 up to 1000 were produced per day. In 1918, the sale price to the army was 5 French francs (in 1923, it was 25 French francs in retail).

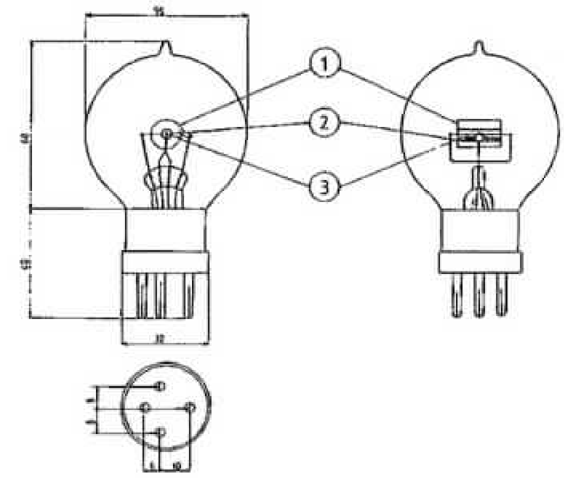

Fig. 7: Definitive form of the TM tube of Péri & Biguet as manufactured by Grammont from November 1915 on.

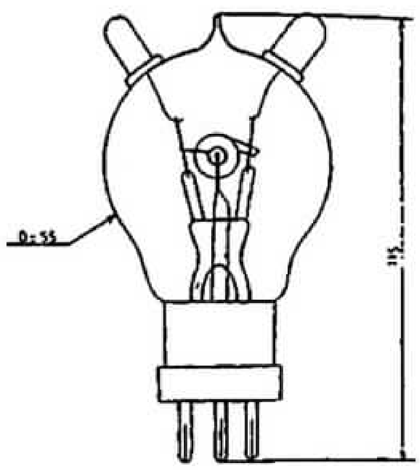

Fig. 8: The double horn tube of Beauvais. Manufactured by S.I.F. from 1922 on.

Description

Filament: Tungsten wire: diameter = 0.06 mm, length= 31 mm
Plate: Cylinder of nickel with a diameter of 10 mm, a length of 15 mm, and a thickness of 0.15 mm.

Grid: 1. FOTOS In molybdenum with a length of 16 mm and a wire thickness of 0.2 mm. The diameter of the spiral = 4.5 mm with 12 turns.

METAL
In nickel with a length of 19 mm and a wire thickness of 0.3 mm. The diameter of the spiral= 4 mm with 11 turns.
Characteristics: A filament voltage of 4 V yields a heater current of 0.7 A. With an anode voltage of 160 V and -2 V at the grid (with respect to the negative pole of the filament), the anode current is from 3 to 6 mA and the grid current less than 1 micro-A.

Use: When used as a detector or amplifier, a VA of 40 V is sufficient and with a Vg of 0 V, the average IA = 2mA. In addition, the conductance = 0.4 mA/V, the internal resistance 25,000 ohm and thus the amplification factor = 10.
R. Champeix reported in his article a curiosity that can be important for serious collectors. Some tubes produced during the war by Grammont were marked with a cross on the glass. This was an indication that the tubes were of poorer quality because of a temporary lack of raw materials.

Some late arrivals

The W tube. In December 1917, limited production was started of what was called the W tube. The great difference was that the filament could work at 3V - 0.15 A so 2 dry batteries in series could be used for the power supply. This was possible by reduction of the diameter of the wire to 20 micrometers (patent of Beauvais). Their lifetime was thereby also considerably less, and their use remained restricted to the 'Amplifier'.

The blue tubes. These were manufactured by Grammont from 1923 to 1928 (FOTOS bleu). Several reasons for colouring the tubes have been suggested: To keep the radio operator from using these bright lights for ordinary illumination (and since they had a limited life time).

An opposite reason: operators are said to have complained that the light was too fatiguing for the eyes. Easy to spot by the enemy. Probably the real reason is this. When a vacuum is drawn in the tubes, some metal always evaporates from the electrodes. This metal deposits on the inner wall of the glass envelope. This grey deposit sometimes caused the buyer to wonder if it wasn't a used tube. This effect was avoided by colouring the tubes.

The 'double horn' tube. Beauvais filed his patent in August 1917 for a special construction that was intended to limit the inter-electrode capacitance so the tubes could be used for higher frequencies. However, Biguet had already tried this previously by means of a special construction, but without success. Beauvais did get a result by having the connection wires of the grid and the anode come out on the upper side of the lamp. Thus, one had the 'lampe - cornes' or 'horned tube': see Figure 8.

The end - and a new beginning

When one looks more closely at the British R tube and the E tube from Philips, one can see immediately that they had the TM as the model. We note, too, that the radio tubes were made in the TM style by Radiotechnique up till about 1935! Today, too, perfect replicas are still made by a few specialised amateurs in the former way. They have a guaranteed lifetime of at least a thousand hours. My A.J. Stevens model F from about 1925 has been playing merrily for several years now with 4 such external tubes. Thus, I can save my authentic tubes

Notes

The names 'diode' and 'triode' were proposed for the first time only in 1921 by W.H. Eccles in his book 'Continuous Wave Telegraphy'.

The Institut Catholique in Paris houses a cosy museum that evokes the work of Edouard Branly. It can only be visited by appointment, which didn't turn out to be simple to arrange. I had the good fortune, thanks to the right introduction, to be able to spend a couple ofhours there last January 3rd with Branly's granddaughter as my dedicated guide. Her many stories and anecdotes (she still remembered sitting on Marconi's lap) as well as the exhibited historical items (many specially made just for experiments) made it a unique experience.

All the items are also shown in colour in the book 'MUSEE BRANLY - Appareils et matériaux d'expériences' - 1997 - 210 FFR - ISBN 2-9511246-0-0., Saga of the Vacuum Tube - by G. Tyne. Chapter 10 goes into the TM in detail.