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Electron Tube Research, Development and Production

25 YEAR RE-REVIEW

CLASSIFICATION SECRET

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[redacted] 25X1

A. Vacuum Tubes* (Background)

1. Foreign Influences on Vacuum Tube Technology.

a. "In the immediate post-World War II period Soviet activities in vacuum tube technology were influenced very strongly by the German developments, methods, techniques and personnel. [redacted] the original Soviet idea might have been to pattern their vacuum tube build-up in accord with the German experience and know-how. If such were the case, the idea did not progress very far. [redacted] the USSR was guided in its plans and programs much more strongly by the USA developments than by the German recommendations. They continued to exploit fully the German technological know-how, their shop and production techniques and their testing and production tools. They had the German specialists in the USSR survey and analyze their war-time and post-war research and development, and were willing to adopt those that fitted their plans and requirements. They used Germans to design and build new devices, testing tools and equipment and to establish several well-organized modern vacuum tube institutes and plants. It was, however, the American methodology that the Soviets were impressed by, and tried to master. One of the important continuing jobs that the German specialists were expected to perform for the Soviets was to elucidate the USA vacuum tube technology and its developments. It got to the point that the best way for a German to convince the Soviets of the merits of his proposal was to claim that it was based upon an American development.

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[redacted] Note: The term 'vacuum tubes' is commonly used to include a wide variety of electronic devices, as well as transistors which replace vacuum tubes. 'Electron tubes,' a generic term used in the title of this report, is coming into more widespread use to cover this wide range of circuit components.7

 [redacted] 25X1

b. [redacted] the Soviets 25X1
believe that American methods as a whole are better suited to their purposes than the German, and that the American products lend themselves to much easier production processes in the USSR than the German. The second reason is that the American high-frequency technique is greatly superior to the German. Thirdly, American electronics progress in World War II was exceedingly well reviewed, analyzed and described in readily available publications of MIT, Bell Telephone Laboratories, RCA, etc, and that these developments were kept up to date by the US open technical literature also readily available to the Soviets. These books and publications which were translated by the Soviets, as well as the US Joint Army-Navy specifications and RCA Blue Books, were available to the Soviet engineers in all institutes [redacted] It is much easier and more 25X1
satisfying to the Soviet engineer to be able to read books at home and keep informed than to ask questions in the office and show his ignorance, particularly to the Germans. That this view was shared by the higher authorities in the USSR can be seen [redacted] from the fact that all senior 25X1
Soviet electronics specialists have dollar funds assigned for purchases of foreign literature and can use these funds at their discretion.

2. Vacuum Tube Activities in the USSR.

a. "All vacuum tube institutes of MCEI (the Ministry of Communications Equipment Industry) are directed by the Second Main-Administration Group (for vacuum tubes), the Chief Engineer of which is /Fnu/ Sorokin. [redacted] 25X1
Each of these institutes is headed by a Technical Director, all of whom [redacted] are very 25X1
capable administrators and high-[redacted]cal men. Each institute has also a political commissar, who, however, do not interfere in technical matters.

b. "In addition to MCEI vacuum tube institutes there are some vacuum tube capabilities in other institutes of MCEI (ie, Radar Institute in Moscow) and in the institutes of other ministries. Of these [redacted] the best are those 25X1
of the Soviet Navy, Air Force and MGB.
[redacted]
25X1

c. "All Soviet institutes are organized to be fully self-sufficient, and in theory at least capable of all activities required to support their operations. All main vacuum tube institutes have their independent research and development facilities, they design and produce their own testing equipment, they have their own workshops, they produce their own raw material and also do their own metallurgical and chemical work as required. Three reasons for this Soviet procedure which is quite foreign to the normal German procedure are: (1) reliance upon a host of suppliers located frequently at great distances from the vacuum tube plants in laboratories, the tremendous distances in the USSR coupled with poor transportation make the flow of material slow and hazardous; (2) the specialized needs of the vacuum tube institutes for relatively small quantities of high quality material not generally produced elsewhere, and (3) the desire of the Soviets to have as many operating units as possible in any eventuality similar to the invasion of the USSR by the Germans in World War II.

 [redacted] 25X1

d. "In order to eliminate unnecessary duplication of effort and to keep each institute informed on the progress and problems of all others biannual meetings are held of representatives of all institutes on specialized problems in their field. [redacted] 25X1
[redacted] a good deal of thought and preparatory work is required for 25X1
such meetings and [redacted] they are considered very effective. At 25X1
these meetings communal problems are discussed and recommendations are made for assignment of problems to one or more qualified organizations. When the project is assigned to one institute, a special committee is selected from members of other institutes to pass on the progress and outcome. At times the same project is given to several institutes and the best solution is accepted for all. [redacted] this method works very satisfactorily in the USSR. 25X1

3. Svetlana Group (Leningrad)

a. [redacted] Svetlana Institute occupies a position in the USSR in the field of vacuum tubes not unlike that in the USA of MIT in the field of radar, or the Bell Telephone Laboratories in the field of telecommunications. 25X1

b. "The Svetlana Institute grew out of the old Marconi plant in Svetlana which manufactured transmitter tubes. It is one of the oldest and best electronics groups in the USSR; it is here that some of the best Soviet electronics specialists at present were trained. (Zuzmanovskiy is one of them.) Svetlana men are not only considered good engineers, they are regarded as an outstanding lot of people and are welcomed in any other plant or institute. All new vacuum tube institutes in the USSR have several Svetlana men assigned to them to serve as a core in technical administration and activities. There were four or five Svetlana men in Fryazino, and the same number in Novosibirsk and Tashkent where some Svetlana people were stationed even during the war.

c. [redacted] Svetlana engineers are not influenced by the Communist Party ideology, are quite independent and yet are left unmolested because of their technical superiority. For example, there was the instance of the former leader of Svetlana being imprisoned for political unreliability in 1947 without any detrimental effect upon Svetlana personnel. 25X1

d. "There is also another facet of the special position of the Svetlana group: it is a closed fraternity and its influence can be just as strong in support of progress as against it. An interesting case to support this opinion occurred in 1939/40. A Soviet article was published on magnetrons* in which the author, N F Alekseyev, appears to have made the basic discovery of the use of resonant cavities in connection with magnetrons. It is known that this article had some influence on German magnetron developments during 1941/42 [redacted] this 25X1
influence was not greater because the Germans at that time were primarily interested in tunable magnetrons and missed fully the potentialities of the fixed magnetron technique so well recognized by the British [redacted]. In the USSR Alekseyev's work was 25X1
wholly disregarded by the Svetlana people, responsible for this field of activity, because Alekseyev was not one of the Svetlana group and worked with Kapitza in another institute.

[redacted] Note: This might refer to an article appearing in the Journal of Technical Physics, Vol 10, 1940, pp 1297-1300, by N F Alekseyev and D D Malairov, which was translated and published in March 1944 issue of IRE Proceedings./ 25X1

/Note: The fact that the Soviets ignored this development is one of the most significant factors in the history of Soviet microwave tube development. The Soviets missed a major discovery and exploited only one part of magnetron technique--- continuous wave generation./

[redacted] 25X1

4. Institute 160- Fryazino (Moscow)

a. [redacted] Institute 160 is the biggest and most important general vacuum tube organization in the USSR because of the presence there of the largest group of German specialists. Two-thirds of the German specialists were well-trained in radar and high-frequency work and [redacted] all were very keenly aware of the importance of measuring and testing techniques and instruments. The Soviets apparently recognized their potential in testing techniques and most of the German specialists there were assigned to this field, not only to meet the needs of the Fryazino Institute but for the general benefit of all vacuum tube institutes. The Institute built practically all its measuring devices and these [redacted] were better than those produced in Germany. 25X1 25X1 25X1 25X1

b. "Once the Soviets recognized the importance of laboratory equipment, the German engineers received considerable assistance in their work on such equipment. They were in a position to obtain the necessary materials, even those otherwise not obtainable because of scarcity and were encouraged to initiate, through their Soviet superiors, requests for foreign-made equipment of specialized design or performance characteristics. Other Germans and myself in Fryazino asked on many occasions for the purchase abroad of American-made laboratory equipment advertised in USA technical periodicals and got them.

5. Political Ideology and Tube Research.

a. "No hindering effects were evidenced in the whole field of electronics and in the specialized field of vacuum tubes by the Soviet Communist ideology or the demands for Party line purity. There are many Party members among Soviet vacuum tube specialists. There are many more who are not. [redacted] 25X1 Among those in responsible positions there are men who not only are not members of the Party, but are quite outspoken in their non-Party views without any apparent penalties.

b. "Although there are such cases as a past scientific leader of Svetlana who was imprisoned for his political views and /fnu/ Katzmann who, as a Jew, was not considered reliable and removed from Moscow to Novosibirsk, however, there are other cases such as that of Maj Cheletnin [redacted] who was caught in an attempt to desert to the West and who was not punished (in the USSR the penalty for his act is death) but, in addition, was placed in charge of subminiature tube development and production in Kalinin and was permitted to travel frequently to Leningrad which is in the zone of severe security restrictions, and of /fnu/ Zuzmanovskiy who was quite candid in his views of the highest Soviet officials without any detrimental effect upon his professional position. 25X1

c. "In Institute 160, as in all others, there was a political commissar. He was totally ignorant in technical matters and had nothing to do [redacted] with scientific activities of personnel of the Institute, but handled such matters as procurement of materiel. This, I believe, is indicative of the general situation in the USSR in regard to the vacuum tube and electronics fields. The Soviets are too anxious to use all their capabilities in building up their potential to permit their political views to interfere with this goal, at least at present. 25X1

[redacted] 25X1

B. Vacuum Tube Techniques, Production and Materials

1. General Assessment.

a. [redacted] the basic weaknesses in Soviet electronics and, more specifically in vacuum tubes, were recognized by the Soviet leaders towards the end of World War II in that they were pinpointed and analyzed during the immediate post- 25X1 war period and that most of these weaknesses were alleviated by 1951/52. By that time the Soviets had built a number of well-operated and effective institutes for the development and production of all modern vacuum tubes; absorbed the war-time and post-war progress of German and American technology; recognized the importance of effective laboratory and production measuring and testing techniques and set up special facilities for developing and producing testing equipment. They fostered a new generation of vacuum tube specialists, theoretically well-trained in Soviet educational institutions and provided plentiful facilities for their practical on-the-job training in electronics and vacuum tube institutes. Therefore, although the Soviets are still behind the USA in the field of vacuum tubes, a firm basis has been established in the USSR for future growth and expansion, and the growing Soviet vacuum tube potential should be watched closely.

b. "Soviet vacuum tube specialists have been guided to a large extent by American methodology, technology and progress /see para 1b above/.

c. "Although originally the Soviets concentrated on outright copying of American methods and end-products, the period of imitation by the Soviets of American tube technology has passed, and original native developments by the Soviets or basic native redevlopments of foreign ideas should be on the increase. Specific examples of post-war original Soviet efforts are the multi-cavity high-output, high-efficiency magnetron in the 40-150 cm region, the 'Samovar' klystron and the high-quality theoretical work of Zeitlin on space charge in the reflex klystron.

2. Tube Production.

[redacted] 25X1

b. "At Fryazino one department was established in 1948 to design tube machinery and develop methods and means for tube production. (There were 200 to 300 engineers in this department.) [redacted] 25X1 At the beginning of the operation of this department the performance and output of this department was poor due to severe lack of specialists, inadequate tools, meager experience in this field and poor coordination with other departments. [redacted] do not know what steps were taken later to change this situation. [redacted] good work was done at Fryazino on copying of American machinery. [redacted] in line with the general betterment in all the quality and quantity of Soviet specialists and with the determination of the Soviets to improve their vacuum tube production, the work of this department must 25X1 25X1

largely administrative. The Ministry of Metallurgy was not interested in adjusting its production processes to provide a small quantity of high quality nickel and ultimately the Ministry of Communications ... build its own special plant for production of cathode nickel. Up to my departure /April 195?/ from the USSR the ... had hardly any special nickel.

Phosphors were initially imported from Germany, one of the main sources being Dr Kamm who had a factory in Thuringia. Later Dr Kamm moved to Heidelberg where he is now /September 1953/ in production of phosphor. Later a special laboratory was established by the Soviets for production of phosphor. [redacted] the quality of this phosphor is fully comparable with that of German phosphor. Also an experimental phosphor laboratory was established by a German chemist in Fryazino, with good results. 25X1

SECRET

 [redacted] 25X1

d. [redacted] the Soviets have solved fully or satisfactorily the problem of the use of thorium oxide in cathodes. [redacted] At that time some thorium oxide material was available in Fryazino which was removed by the Soviets from the Heyden Plant in Dresden. When this supply was exhausted work was initiated at Fryazino on developing substitute materials and on the production of thorium oxide. Serious difficulties were encountered [redacted] the only good thorium oxide in the USSR is that supplied by the Heyden Plant; others were not good enough. [redacted] the problem is still unsolved in the USSR. [redacted] the quality of thorium oxide is a matter of luck and the success of Heyden is due to such luck and the characteristics of the raw material used. 25X1 25X1 25X1 25X1 25X1

e. "The Soviet mica was of poor quality. This is based upon the fact that it does not last, particularly under conditions of over and under heating. Operating conditions in the USSR are very hard on tubes as line voltage fluctuates widely -25% to +15%. Mica was carefully handled by the Soviets and was graded into three classes: (a) for high-frequency technique; (b) for use in power tubes and (c) for general purpose tubes. The only source of mica in the USSR is in Zhitomir in the Ukraine. [redacted] there are some deposits of mica in Northern Siberia [redacted] Although considerable work was done by the Germans on synthetic mica, [redacted] no knowledge of similar work by the Soviets. In the summer of 1951 an important request came from MCEI to a German specialist to study the replacement of mica by ceramic products. [redacted] do not know the present status of this project. [redacted] Note: Analysis of Soviet general purpose tubes by ATIC indicates that the quality of mica used in these tubes is very good and in fact somewhat superior in quality to ours. It is therefore possible that [redacted] was not familiar with the mica situation in the USSR or that mica supplied to the development institutes in the USSR was of poorer quality than that available to the production plants.7 25X1 25X1 25X1 25X1

f. [redacted] The basic Soviet requirements for copper for tubes (including magnetrons) were (a) suitable electrical characteristics (b) easy machining. The Soviets have had no trouble with copper and they have had enough experience with copper in other industrial uses so that normal quality copper was considered by the Soviets to be good enough for magnetrons. 25X1

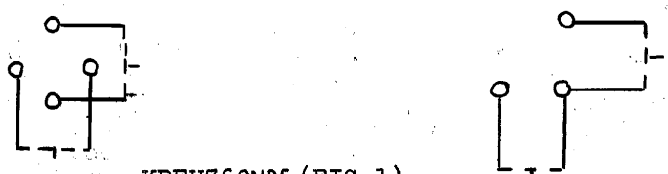
[redacted] 25X1

g. "In general, the Soviets are quite familiar with all modern problems and progress in vacuum tube techniques and methods and have proven capable of adapting the foreign developments and ideas to their purposes. The Soviets are presently doing very capable research in the vacuum tube field. They are capable of originality although not adverse to borrowing ideas from abroad. Older specialists such as

 [redacted] 25X1

Svetlana engineers are being augmented in this regard by very capable young engineers fully comparable if not better than young German engineers; for example, Zuzmanovskiy and Alekseyev's work on magnetrons, Zeitlin's work on klystrons, Vogelsohn's work on gas tube technique. The Soviets are very imaginative and stubborn people and permit experimental work, at times very costly, on problems which would not be tolerated in Germany or the USA; ie, 'Samovar' which [redacted] would have been abandoned elsewhere, intense work on 10 megawatt and higher magnetrons. 25X1

h. "The following sketch /Fig 1/ is of the kreuzsonde device reported [redacted] previously [redacted] The device consists of two sets of electrodes at right angles to each other. These were used in the electrolytic trough to obtain two right-angle components of the magnetic field. The device was of considerable laboratory use at Fryazino. 25X1 25X1



KREUZSONDE (FIG 1)

4. Research.

a. "All research in the USSR, including the work on vacuum tubes was centered in and coordinated by the Academy of Sciences in Moscow and by biannual meetings of the research leaders of the important tube institutes /see par 2d above/. Some of the tube research was centered in an institute in Kharkov, presumably for the Ukraine although [redacted] the good work done there was felt in all institutes. 25X1

b. "Special problems relating to cathode problems were centered in Kiev [redacted] 25X1

C. General Tubes.

1. Glass Bulb.

[redacted] 25X1

2. Metal-Ceramic

a. "The metal-ceramic tubes made at OSW were of the World War II type and construction; ie, LD-9, LD-11 and LD-12. Considerable development work was done on the LD-15 [redacted] 25X1 25X1

b. "Metal-ceramic tubes were produced at Novosibirsk. The LD-12 grid was in the form of a woven mesh /see Appendix Fig 2a and 2 b/. [redacted] this grid is inferior to the German grid due to wider variations in grid-to-cathode spacing. 25X1

c. "In the summer of 1946 the German group at OSW experimented with a new form of grid to reduce the grid-to-cathode spacing and improve high-frequency cut-off characteristics.

 [redacted] 25X1

A glass form was stamped in the form of a cathode and a grid mesh was machine-engraved on it. The grooves of the mesh were filled with carbon and a copper grid was produced by electrolysis. The work was stopped when the Germans were moved to the USSR. [redacted] 25X1

D. Special Tubes

1. Cathode Ray Tubes

a. [redacted] 25X1 the tube might have been used in a special computer then under development, most probably for a ballistic computer, is based on the type of special accuracy requirements supplied to the Cathode Ray Department at Fryazino and on special work on testing devices which the Germans were asked to undertake for the project. [redacted] 25X1

b. "Dr Roethe worked on dark trace tubes at OSW. Development work on these tubes was continued in the USSR. In 1950 the work was considered so secret that the Germans were not permitted to work on it.
[redacted] Note: In line with [redacted] repeated 25X1 statements that the normal Soviet procedure was to eliminate Germans from the classified projects whenever [redacted] development was completed or proceeded to the 25X1 point that it could be completed by the Soviets, it is possible that [redacted] reference to the elimination of the 25X1 German specialists from further work on dark trace tubes might have meant that the Soviets considered the project sufficiently advanced for production or pre-production engineering [redacted] 25X1

c. "There was a special development in 1946 at OSW on a high-speed writing cathode ray tube. The principle used in these tubes was the same as in the USA and a microscope was used for observing the cathode ray trace. [redacted] 25X1 [redacted] not [redacted] any connection between this work and Geiger counter tubes or high rise-time counters. At Fryazino a special oscilloscope was built to study the build-up time of magnetrons.

2. Modulator Tubes.

a. "At first the Soviets tried spark gap modulators for high efficiency jobs but the methods were given up when they later developed high efficiency hydrogen thyratrons and hard tube modulators. Their experience with hydrogen thyratrons was good. [redacted] 25X1 Of special interest was the Soviet use of the technique to maintain the hydrogen pressure at constant level by using silver cathode in an iron sponge. This was tried in 1951/52 and [redacted] not know whether the 25X1 development was completed. The Soviet work on iron sponge was very good and the pore-volume was about 50%. The 5 AC-21 tube was an interesting one developed and produced at Fryazino. This is a half-megawatt tube using plate-anode voltage of 35,000 volts. [redacted] no trouble 25X1 was experienced with this tube.

[redacted] 25X1

b. "Samovar.- The Soviets spent five or six years in the development of a five-megawatt hard tube known as 'Samovar' /see Appendix Fig 3/. It was based on an RCA idea for a tube (and according [redacted] seen in RCA by 25X1 the Soviet engineers) for other purposes and transferred by the Soviets to a modulator tube. The tube consists of 13 cathodes arranged outside with the anode in the center, with the grids as shown. [redacted] the tube extremely 25X1 complicated and very bad. [redacted] in such a tube the electron scattering angle must be small to be effective, and such is the case only when the anode and cathode occupy conventional positions. With the reversed position of Samovar the scattering angle is much greater than the optimum. Nevertheless, the Soviets produced these tubes at the rate of 30 to 40 per month, in spite of its poor performance and complexities and in spite of [redacted] arguments 25X1 with which the Soviet engineers were inclined to agree. [redacted] these tubes were to be used 25X1 in some high-priority equipment available in sufficient quantities to require 30 to 40-tube production per month. [redacted] believe [redacted] the tubes were for use in early warning 25X1 equipment.

c. "5D-21.- This tube was copied originally at OSW and later re-developed by the Soviets in Fryazino and perhaps elsewhere. The tube developed at Fryazino has two to four times the capacity of the American 5D-21. This was accomplished by increasing the cathodes, raising the anode voltage (35,000) and inserting an electrostatic shield at the end of the screens. The development work took about six months and the tubes were uniform and good /a schematic drawing of the tube developed at Fryazino is shown in the Appendix, Figures 4a and 4b/. This type uses two pairs of cathodes instead of four cathodes as in the American 5D-21. [redacted] the Soviets 25X1 find this design easier to manufacture, although [redacted] 25X1 [redacted] the Soviets continue to manufacture the four-cathode 25X1 American type also.

/[redacted] Note: Reports from OSW indicate that 25X1 there were considerable difficulties with this tube. The difficulty was most probably due to the fact that the war-time 5D-21 was too small for the power and voltage requirements. It is, therefore, very interesting that [redacted] did not point out any special difficulties 25X1 with this tube in the USSR beyond [redacted] estimate of the six-months development time and the quality of the products./

3. T-R Tubes.

[redacted] 25X1

b. "Much discussion took place in the USSR in regard to wide-band T-R tubes and that the problem was considered very important. The problem was not handled in Fryazino but elsewhere.

c. "Later in Fryazino the problem of a very fast recovery T-R tube was handled by Miss Vogelson's group [redacted] 25X1 Question 82 et seq/. She worked at 3 cm and [redacted] primarily on measuring techniques for such tubes. Thus [redacted] somewhere in the USSR the basic development 25X1 work on such tubes was carried on under high priority.

[redacted] 25X1

[redacted] the basic development was done at Svetlana (Miss Vogelson is a Svetlana engineer) and the reason for high importance was to equip their night-fighters with 3-cm equipment. The short recovery there might be important in some sort of short-range (intercept) radar. /Note: In spite of additional efforts no more specific information was obtained from source. If the above opinion is to be taken seriously this is the first reference to Soviet research and development work, which goes back to 1950/51, on night interceptor radars./ 25X1

4. Subminiature Tubes.

[redacted] 25X1 the Kalinin plant was completed for production in 1949/50. This plant, under the general guidance of Major Cheletnin, is the production center for subminiature tubes and proximity fuses and the output of this plant is very sizeable (no estimates of output).

5. Image Converters

[redacted] 25X1 the Soviets removed, among other plants, an OSW plant for image converters to the USSR and the plant was dismantled with special care and shipped to the USSR without any German specialists. The Soviets claimed that they knew a great deal on this subject and did not need German specialists, but wanted the German production facilities only to increase their total output capacity of these tubes.

E. Magnetrons.

1. "The information on Soviet work on basic types of magnetrons, available to source, is summarized in Tab 1 (general description and comments), in Tab 2 (technical data) and in the Appendix, Fig 5, 6, and 7. In discussion, additional projects on magnetrons were mentioned. These were either in the nature of general laboratory work, or were abandoned as unprofitable or else the amount of information available was insufficient to clearly formulate the extent of Soviet activities or interest.

[redacted] 25X1

2. "German magnetron developments have influenced the Soviets in Magnetron #10, which is essentially the same as the German RM 4032, developed at Oberpfaffenhofen in World War II. Magnetrons #4 and 7 are similar to the German LMS 16 and LMS-32 which were developed by the Germans for jamming. 25X1

[redacted]

 [redacted] 25X1

3. "The Soviet magnetron developments were also strongly influenced by the US developments. The MIT series was the source of a number of designs, and particularly of Magnetron #8 /see Appendix, Fig 7/, which was assigned great importance by the Soviets/perhaps for use with token radars?/."

4. "Rising Sun" Magnetron.

a. [redacted] 25X1 The technical data on this magnetron (#5) is given in Tab 1 and 2. A schematic sketch of the cross section of the magnetron is shown in the Appendix, Fig 5.

b. [redacted] information on the Rising Sun magnetron came from Zuzmanovskiy who was responsible for the magnetron development in general and for work on the Rising Sun in particular. The basic data on this magnetron was known to Zuzmanovskiy in 1946, and [redacted] was not obtained directly from Japan* but probably from RCA in the USA. The active development on the Rising Sun magnetron was initiated in 1947 by an all-Soviet group under Zuzmanovskiy's supervision. 25X1

c. [redacted] 25X1 the project was considered very important and was protected by high security restrictions.

d. [redacted] 25X1 On the basis of remarks of the Soviet engineers and rumors of other German specialists [redacted] some channels might have existed. [redacted] In general the Soviets were very active and successful in getting basic and detailed technical information and equipment from the USA. They attached high importance to US developments, techniques and methods and used all methods (covert and overt) to procure them. While in the USSR [redacted] became more familiar with the US electronics post-World War II activities than with the German. 25X1

5. Magnetrons in the 40 - 150 MC Region.

a. "The Soviet work on magnetrons in this frequency region was top secret, was done by the Soviets only and thus no Germans knew exactly what the Soviet program or progress was. It was known that a group of Fryazino

[redacted] 25X1

[redacted] 25X1

Soviet engineers worked on the project under the direct supervision of Zuzmanovskiy. Additional work might have been done elsewhere (Leningrad or Moscow). Some German specialists worked on specialized problems believed to be related to this project (such as pulse technique) and in the course of conversation with Zuzmanovskiy (in 1950?) [redacted] told about a top-secret project on high-power, high-efficiency magnetrons which Zuzmanovskiy believed would require a new and different principle of magnetron construction. The idea /see Appendix, Fig 8/ was to use not one central cathode, but several individual cathodes located in individual cavities. The Soviet goal apparently was to produce a very high-power magnetron, perhaps 10 megawatts or more, operating at high efficiency (80% or more). [redacted] [redacted] several experimental magnetrons were developed for this frequency range with output of over one megawatt, by Zuzmanovskiy and his people. [redacted] do not know whether these were normal type single cathode magnetrons scaled up for their frequency range, or prototype models incorporating Zuzmanovskiy's ideas. [redacted]. 25X1 25X1 25X1 25X1 25X1

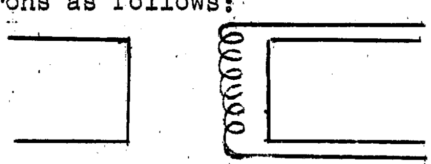
b. "Magnetron #9 could be used for only two purposes: as a linear accelerator in atomic physics, or in radar. Since it is not likely that the narrow frequency band of such magnetrons would be of use in the linear accelerator application, [redacted] present opinion is that the magnetron was developed either for high-power early warning radar against missiles at distances of 300 to 400 miles or for missile control. Both problems were of intense interest to Capt Shokin* (phonetic) [redacted], who was in the position to initiate the project of the development of such magnetrons, to guide it, and with the help of Zuzmanovskiy, to solve the problem. 25X1 25X1

6. Magnetron Techniques

a. "The problem of magnetron strapping was studied by the Soviets very intensely and all outside work was thoroughly investigated. The Soviets reached a point of a reasonably good understanding of the problem and of applications.

b. "Much work was done on this at Fryazino under Zuzmanovskiy's direction, who also contributed some capable and original research work on the problem. Both single and double strapping were used. The Soviets also used the method of accurately controlling the frequency of magnetrons by carefully adjusting the distance between the strapping rings.

c. "The Soviets used spiral cathodes for wide-frequency modulations in magnetrons as follows:



The nature of modulation by such a cathode is such that a very wide frequency band can be produced by the use of the very high frequencies used for heating of the cathode. [redacted] this was used by the Soviets as a simple method to produce wide-frequency band magnetrons for use in jamming. The work was tested at Institute 108 on jamming magnetrons and proved successful. Also noise frequency modulation was tested on jamming magnetrons with this cathode and believed to be successful." 25X1

[redacted] 25X1

25X1

TABLE I

MAGNETRONS

Magnetron No 1 /Magnetrons were numbered for ease of discussion during interview./

According to the source, the 0.8 cm tube is only in the experimental stage, and possibly in development in Inst 108, Moscow. This is in contrast to information obtained from other German returnees who stated that there was a large production of this tube already in effect.

Magnetron No 2

This tube is in the planning stage only, and is designed for 1 cm operation (30,000 Mc/S). The proposed construction would follow the wartime Telefunken LMS-14 tube.

Magnetron No 3

This tube is a copy of US 725 magnetron which was designed for the H2X X-band blind bombing radar. This is called "Meddo" by both Germans and Soviets.

Magnetron No 4

This tube, like magnetron No 7, is designed for jamming. It is a CW, mechanically tunable type similar in design to the German LMS-32. A copper tuning ring is mechanically moved toward and away from the cavities.

Magnetron No 5

The tube is a "Rising Sun," fixed tuning, pulse type X-band magnetron. Development is not yet complete /see Appendix, Fig 5/.

Magnetron No 6

This is a copy of a Canadian tube of the CV series, S-band.

Magnetron No 7

This tube is CW, mechanically tuned magnetron designed for jamming. /See Appendix, Fig 6./ An inductive ring is used for tuning in a manner similar to Tube No 4, and German type LMS-32.

Magnetron No 8

This tube is an S-band, pulse-type, fixed-tuning, 2-megawatt peak power such as would be used for early warning. Its efficiency is about 60 - 70%, and frequency stability 1:5,000. The internal structure, coupling device and test equipment were designed by Soviet engineers. The test equipment is reported to have filled a room of about 300 sq ft floor area. The tube development took three years, requiring seven or eight Soviet engineers.

Magnetron No 9

This tube was designed by the Soviets, without German assistance. It was rumored to have 10 MW or larger power output by having the equivalent of a number of two cavity magnetrons in parallel. The tuning was accomplished by wave guide techniques and had a range from 40 to 150 cm. It is probably intended for early warning.

Magnetron No 10

This tube is a copy of the German RM 4032, called the "zero slot" magnetron. It consisted of a cylindrical anode with axially centered wire cathodes. As in the Rice tube, there is a strong axial magnetic field. Two tubes are made--one of a range from 0.8 to 3 cm, another from 3.0 cm to 12 cm. The main use of this tube is experimental.

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TABLE II-MAGNETRONS (Date of Info-April 1952)

Nomenclature	Magnetron No. 1	Magnetron No 2	Magnetron No 3	Magnetron No 4	Magnetron No 5	Magnetron No 6	Magnetron No 7	Magnetron No 8**	Magnetron No 9	Magnetron No 10***
Wavelength, cm	0.8	1.0	3.2	3.0	3.2 - 3.5	9 - 10	9 - 10	10.0	40-150	Two Models 0.8-3 cm 3 cm-12 cm
Fixed or Tunable	Fixed			Tunable	Fixed	Fixed	Tunable	Fixed	Fixed - wave guide techniques	Tunable
Pulse or CW	CW			CW	Pulse	Pulse	CW	Pulse	Pulse	CW
Anode Voltage					20,000		2000-3000v	230,000v	750,000v	4,000 max
Anode Current					Duty cycle 1-1,000 or 1-2,000		300-400 ma			21 ma
Heater Supply					Thor oxide heater		Directly heated cathode-Tungsten	Ba oxide heater		
Output Power					500-600 KW	80-100 KW	600 W(CW)	2 MW Eff. 60-70%	High. Eff 80%	A few milliwatts
Application			Meddo Radar	Jamming	Radar	Radar	Jamming	Radar,EW?		Laboratory Tests
Development Data Start Completion Special remarks	Now in experimental stage	Similar to Telefunken LMS-14 only in planning stage	Copy	1949 Intermittent In preprod. stage	1947 Not complete	Copy	1946 1948-49	1946 * 1949		
Production Data						Mass produced in 1948	In 1949 several hundred per month			100
Where Developed	Moscow 108?			Fryazino			Fryazino		Fryazino	Regulator equipment developed in Fryazino
Where Produced			Saratov				Fryazino Special unit	In production		

* Comparable development during the war by the Germans took about one-half the time.

** Inside of magnetron was developed by Soviets coupling and external "plumbing" by Germans.

*** Equals German RM-4032

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25X1

 [redacted] 25X1

F. Klystrons

1. "Soviet klystron work was influenced by both German and US designs /see Table III, page 18, made [redacted] assistance, which summarizes [redacted] knowledge of Soviet klystrons/. [redacted] following additional comments: 25X1 25X1

   a. "Klystron #1 - the tube is a copy of a General Electric .42 cm tube, scaled up. The Germans in Fryazino were asked to produce such a klystron for use in testing gear for 8 mm crystal detectors, but found it a hard job. In order to speed their work, the Soviets supplied Fryazino with this klystron, and some additional testing gear, which was produced elsewhere.

   b. "Klystron #2 is a copy from a US prototype as copied by the Soviets from a 1949 or 1950 IRE publication. The tuning range was claimed to be 2.5 to 12 cm, and the tuning was accomplished by mechanical control of the cavity /see Appendix, Fig #9/.

   c. "Klystron #3 and #4 were copied from the US Western Electric 725 klystron and German LD-20, which was a copy of the same prototype. Klystron #3 was tuned around 3.2 cm and used for 'Meddo' radar; #4 was tunable from 28 - 29 cm and represents a variation of #4.

   d. "Klystron #5 is the same as the British tube, which was copied by the Germans during the war, known as LD-25, or klystron 1 (Siemens-Halske).

   e. "Klystron #6 is a shortened version of #5. Both these tubes have a glass envelope and use an external tuning cavity.

G. Transistors and Crystal Detectors.

1. "The USSR work on crystal detectors was based upon the German developments in OSW. In 1950 a plant was established in Fryazino to manufacture silicon detectors following OSW procedures. Attempts were made in Moscow to manufacture these detectors following the American procedure. Results were rumored not to be very good and best work was done with the German method. The second step was the introduction of germanium detectors. These were first made in Institute 28 in Moscow but with relatively little success and in 1950 Fryazino started to produce germanium detectors in small quantities on an experimental basis. Some production was done at Fryazino, primarily for Institute 160's requirements. The main work of production of crystal detectors must have been done elsewhere.

2. "It was only in 1952 [redacted] that basic development and research work was initiated by the Soviets on transistors. The background of knowledge was available to the Soviets in American publications. There was a book by William Shockley which became available in the USSR in January 1952. A special committee was established in MCEI, consisting of the best specialists in the Soviet Union, to work out the fundamentals of transistors. Everyone was very optimistic [redacted] 25X1 25X1

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TABLE III
KLYSTRONS (Date of Information-April 1952)

25X1

Nomenclature	Klystron No 1	Klystron No 2	Klystron No 3 US Type No 725	Klystron No 4	Klystron No 5 K 10-1	Klystron No 6 K 10-2
Wavelength, cm	0.8	2.5 - 12	3 cm	2.8 - 2.9	10 cm	
Fixed or Tunable	Fixed	Tunable			Tunable	
Pulse or CW	CW	(see sketch)			CW	
Anode Voltage	2,000					
Anode Current	220 ma					
Heater Supply						
Output Power	5 milliwatt				Same as English and German Pro-totypes	Same as K 10-1 but modified in shape
Application	Measuring device	Experimental				
Development Data Start Completion Special remarks		 1949 1952	 1 year At OSW (LD-20 Copy of US type	 1951 Variation of 725		
Production Data Schedule, etc.						
Where Developed	Moscow (Inst 108?)			Fryazino and Svetlana		
Where Produced	Moscow		Svetlana (presently believed to be in pro-duction in Saratov)	Svetlana in production		

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25X1

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25X1

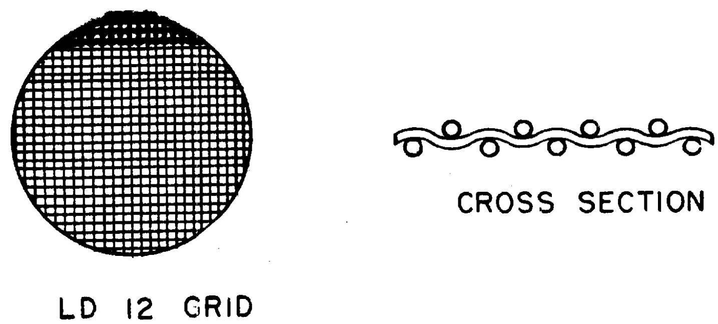
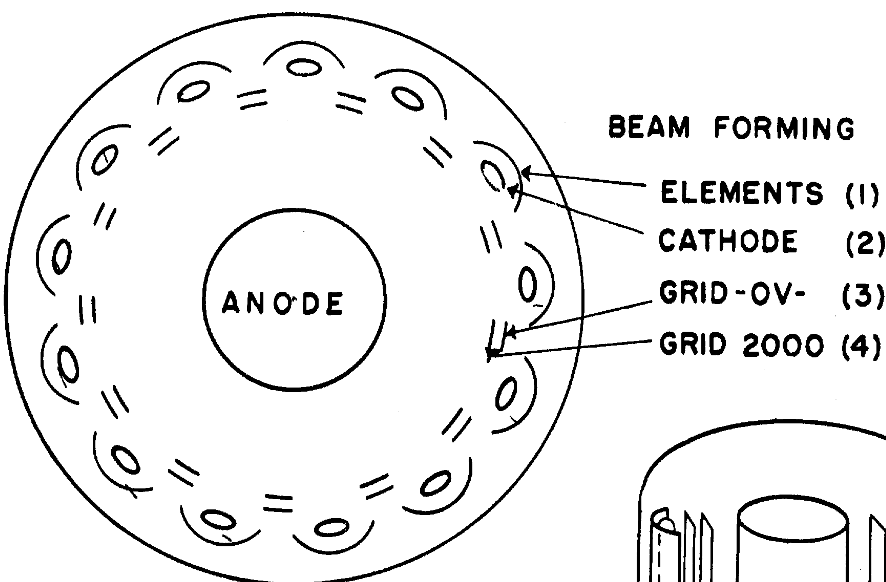


Fig. 2a and 2b - Details of Metal-Ceramic Tube LD-12



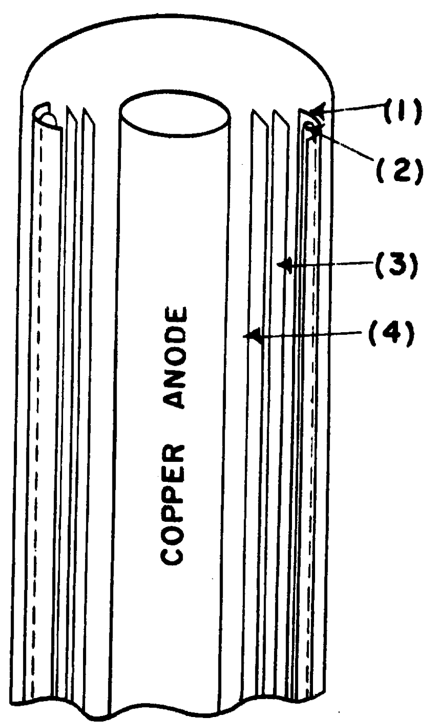


Fig. 3 - Modulator Tube 'Samovar'

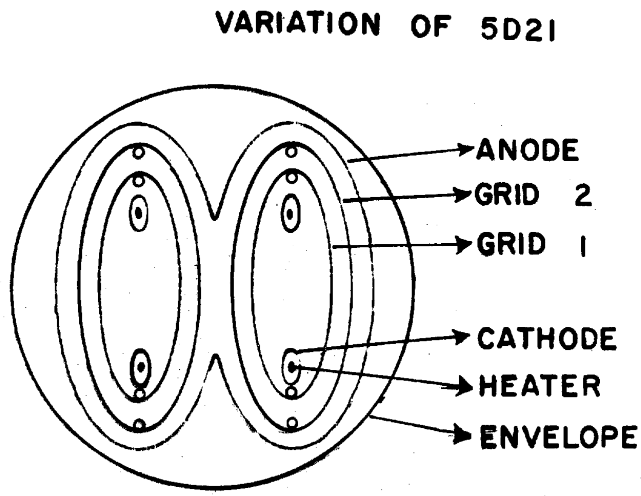


Fig. 4a

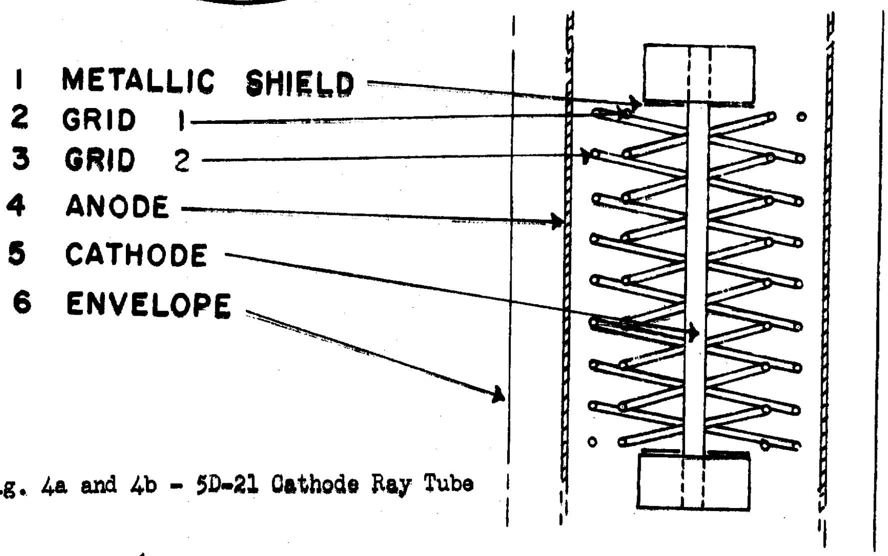


Fig. 4b

Fig. 4a and 4b - 5D-21 Cathode Ray Tube

LATER MODEL OF ABOVE TUBE
CATHODES IN-LINE AS IN 5D21

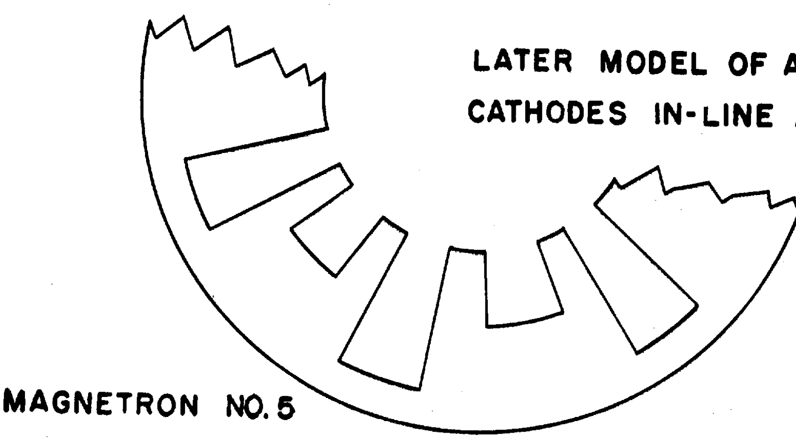


Fig. 5 - 'Rising Sun' Type X-Band Magnetron

25X1

MAGNETRON NO. 7

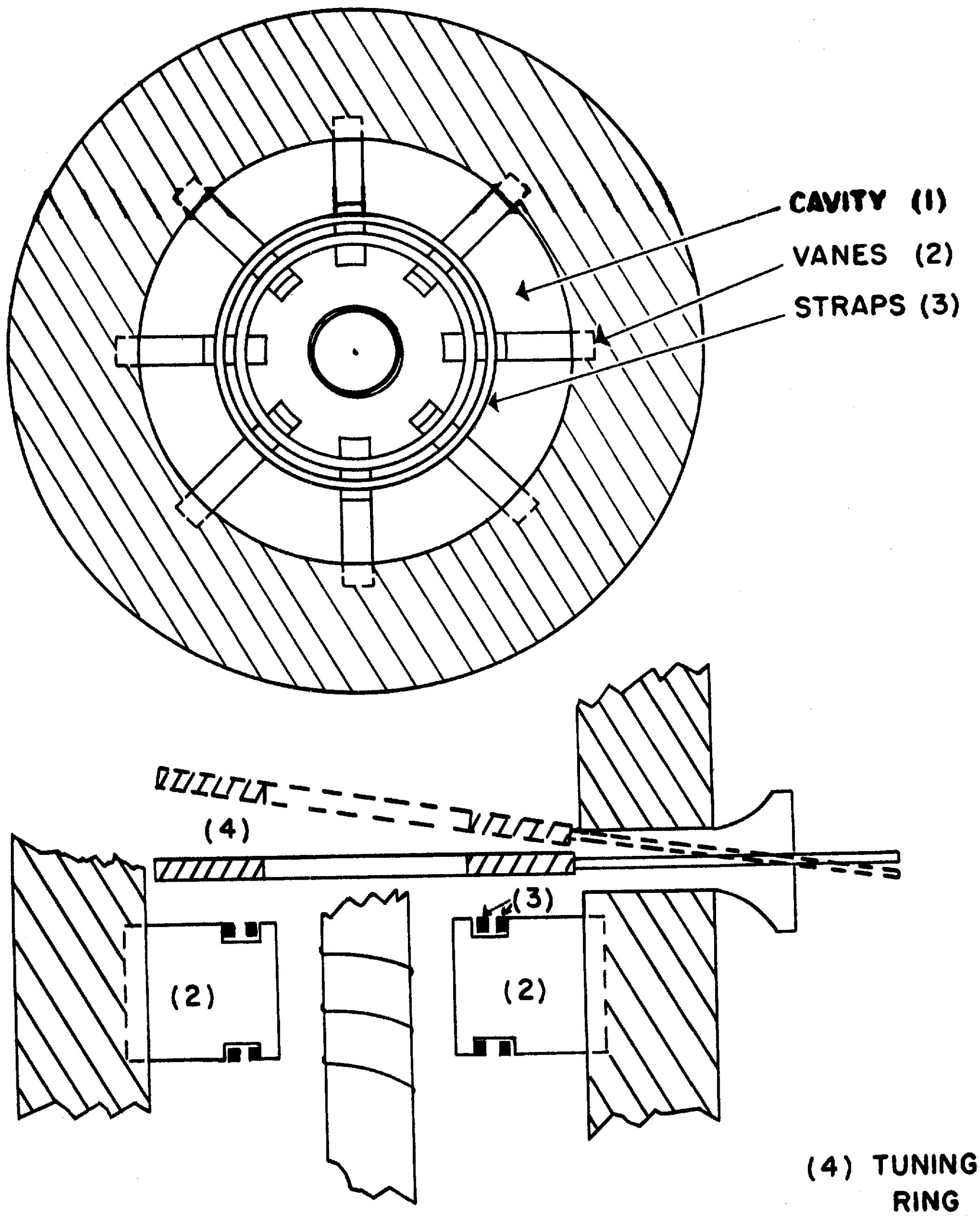


Fig. 6 - Magnetron No. 7 - Jamming

25X1

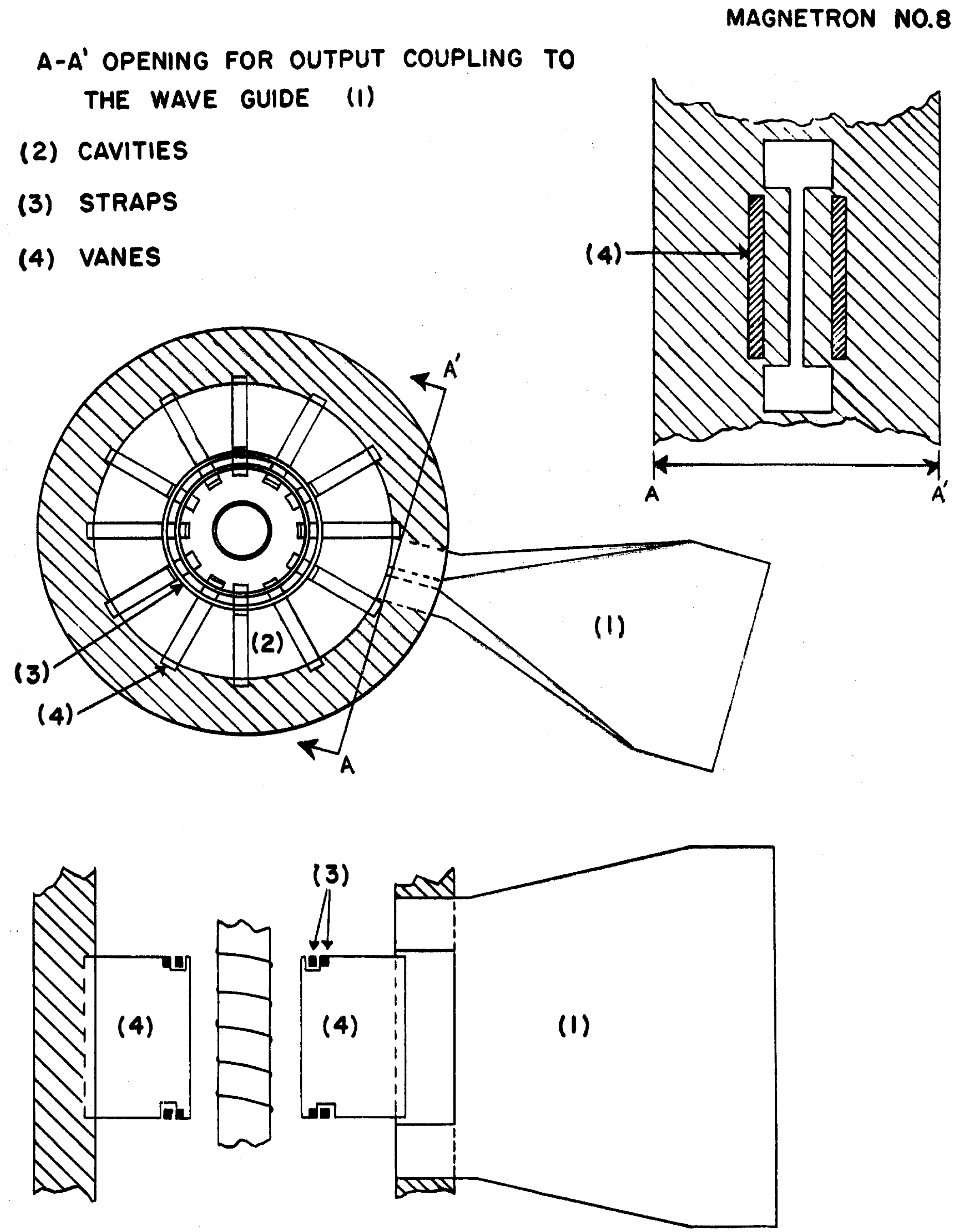


Fig. 7 - Magnetron No. 8 - Radar, Early Warning?

25X1

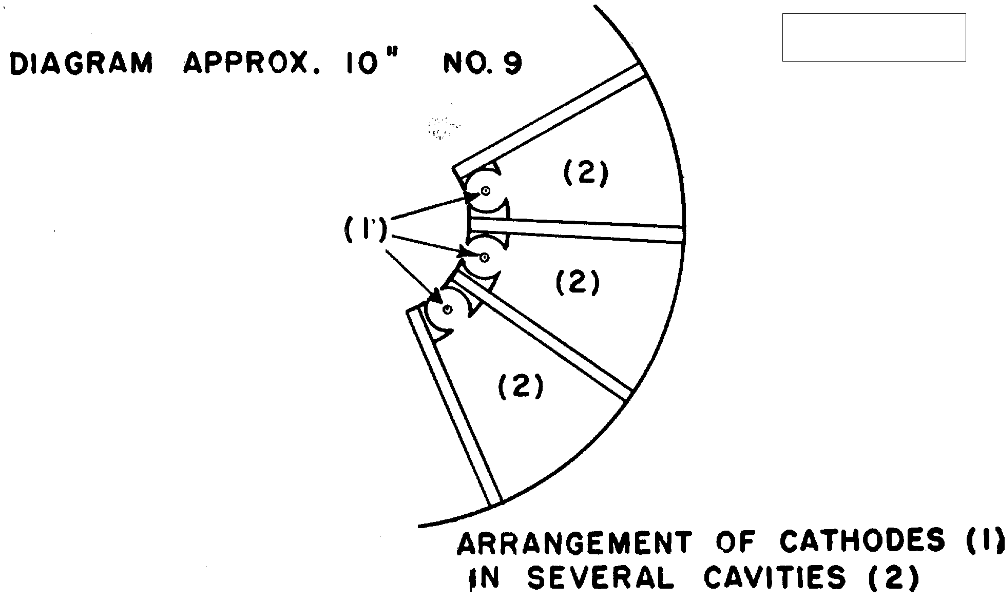
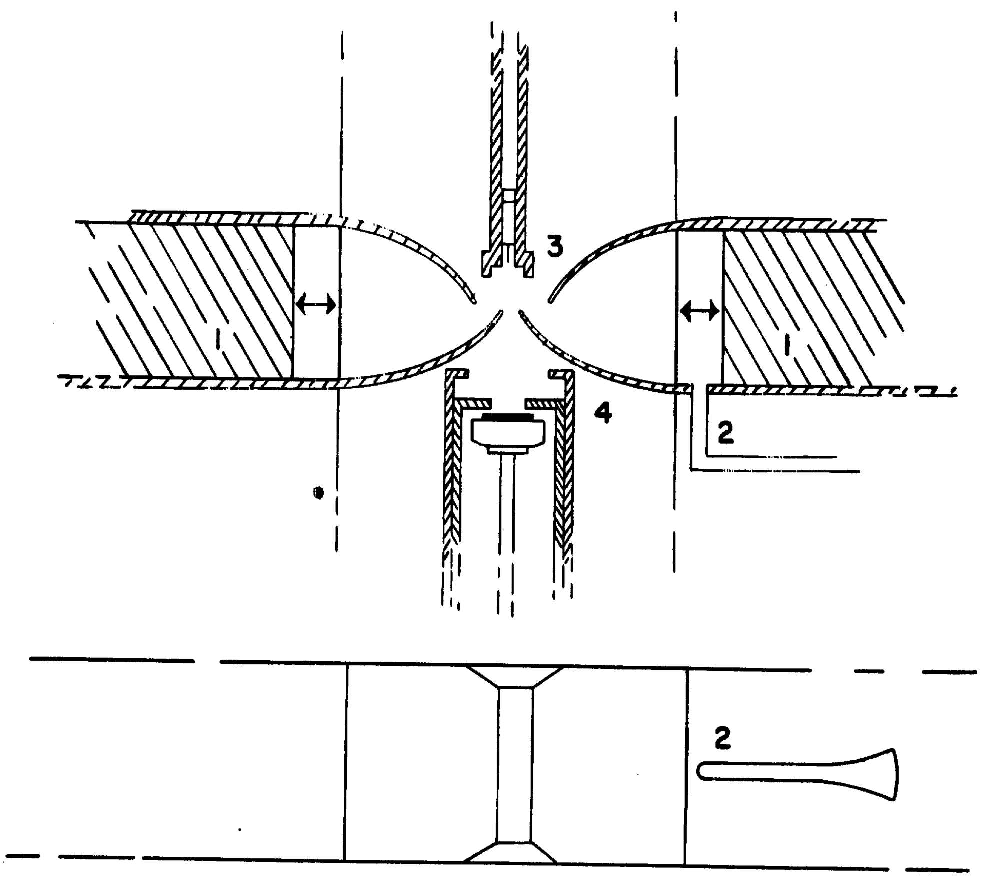


Fig. 8 - Magnetron No. 9



1 TUNING SLUGS
2 OUTPUT COUPLING TO WAVE GUIDE
3 REPELLER
4 ELECTRON GUN

Fig. 9 - Klystron No. 2 - Tuneable