SECRET **A. D. I. (K) Report No. 380/1945**

THE FOLLOWING INFORMATION HAS BEEN OBTAINED FROM P/W AS THE STATEMENTS HAVE NOT AS YET BEEN VERIFIED, NO MENTION OF THEM SHOULD BE MADE IN INTELLIGENCE SUMMARIES OF COMMANDS OR LOWER FORMATIONS, NOR SHOULD THEY BE ACCEPTED UNTIL COMMENTED ON AIR MINISTRY INTELLIGENCE SUMMARIES OR SPECIAL COMMUNICATIONS.

RADIO AND RADAR EQUIPMENT IN THE LUFTWAFFE – IX.

German Radio Countermeasures.

1. This report is the ninth of the series dealing with radio and radar equipment in the Luftwaffe. The present information was mainly obtained from Dr. Ingenieur SCHOLZ, a civilian employee of the Reichspost Zentrale who was in charge of a sub-section of Abteilung 6 of the Generalnachrichtenführer dealing with the problem of RCM (radio countermeasures).

2. Interrogation of this man has been supported by information gained from other members of General MARTINI's staff and by a number of relevant documents of recent date in possession of the General's Chief of Staff. Some useful additional help was given by two engineers who had recently been engaged in testing ground and airborne jamming equipment at the G.A.F. research establishment at Werneuchen.

3. The radio countermeasures used by the Germans have been treated in this report under four headings, the first being a brief historical account of their employment, and the other three dealing in turn with RCM against communications, metric radar and centimetre radar. The types of jamming transmitters referred to by name, or of which a mention has been found in documents, are listed in alphabetical order and their functions briefly described in Appendix I to this report.

THE GERMAN MONITORING SERVICE AND EVOLUTION OF COUNTERMEASURES.

BASIS FOR COUNTERMEASURES.

4. At the beginning of the war the G.A.F. High Command was not radio minded; GOERING in particular has been frequently accused by his underlings of paying no attention to technical matters. In the opinion of General MARTINI's staff, the vital

importance of radio warfare and radio countermeasures was only truly appreciated by the General Staff towards the end of 1944. Those responsible for German jamming, therefore, had great difficulty in obtaining permission to use the countermeasures to the extent that they could have wished.

5. The countermeasure organisation relied in the first place on the German "Y" service, which formed Abteilung 3 of General MARTINI's staff, to give advance information of new radio activities, and for this purpose it employed a staff of expert radio engineers whose task was to identify and explain any new frequencies or types of transmissions received. If, however, novel features in a monitored transmission were observed and could not be explained, a commission for the investigation of the particular subject was set up. This commission was composed of representatives of the "Y" service and of the Development (E) departments of the R.L.M., representatives of the research (F) department of the R.L.M., and such experts from the leading firms as had special experience in the field of radio which was thought to be in question.

6. Evidence collected by listening, though it could be very valuable as intelligence, did not necessarily tell the whole story or indicate the most suitable form of countermeasures. As far as airborne equipment was concerned, statements made by prisoners of war often helped to fill out the details and the capture of equipment and its identification with the new transmission was of great value, even if the equipment was severely damaged.

7. Intelligence information from the above three sources could usually be pieced together to tell the whole story, so that decisions could be taken as to whether radio countermeasures were required.

8. The Germans relied very largely on the laboratories and experience of the Reichspost Zentrale (RPZ) to solve the technical problem of how and with what equipment to jam, and they obtained for the duration of the war the loan of an engineer of that organisation (the present P/W) who was put in charge of RCM and carried out liaison with RPZ to this end.

EVOLUTION OF COUNTERMEASURES.

9. The decision to jam a particular type of transmission rested very largely with General MARTINI and was often taken despite the protests of the "Y" service section of his staff, who were interested professionally in monitoring all transmissions. Particularly in the case of R/T, the "Y"

service insisted that more strategic and tactical information could be obtained by D/F'ing enemy transmissions than any tactical advantage which might be gained by jamming them.

10. As an instance of the extent to which the decision lay with General MARTINI the following case was quoted: In 1942 Allied night fighters were becoming a nuisance in the Mediterranean area but General KESSELRING had to ask General MARTINI's permission to jam their ground-to-air R/T control in his theatre of operations and only then could the countermeasures be undertaken.

11. The first German radio countermeasures were instituted in September 1940 during the day bombing raids of the Battle of Britain and were directed against British radar operations in the Channel. The first and most important site used was that at Mont Couple behind Calais were, by the end of the war, a battery of some 35 jammers had been set up.

12. Radio countermeasures against Gee were put in hand in the summer of 1942 and at about this same time the first attempts were made to jam A.S.V. in the Channel. From this time on, the countermeasure warfare increased and consideration was given to jamming all types of new radar devices.

13. In about 1943 it was realised that countermeasures might well be called for on every wavelength, and Dr. SCHOLZ put up a requirement to the Reichspost Zentrale (RPZ) laboratories for a series of jammers to be designed for covering all wavelengths from 50 cm. upwards. These jamming transmitters were designed in the Potsdam RPZ laboratories, and improvements were constantly being incorporated in them so that if there was a sudden call for countermeasures on an as yet unused frequency, a practical design was available and apparatus could be built at short notice.

14. As a result of this policy new countermeasures could be put in hands quickly, but in practice they usually took considerably longer to organise than might theoretically be expected because the ground crews had to be trained in their use. Dr. SCHOLZ stated that with a few exceptions these ground crews were of second-rate material and it was frequently a matter of weeks before they were sufficiently well-trained for the countermeasures to become effective.

COUNTERMEASURES AGAINST COMMUNICATIONS.

GROUND-TO-GROUND COMMUNICATIONS.

15. With the possible exception of communications between land and convoys, P/W believed that no attempt was made to jam

Allied W/T communications on the ground. Listening to them was considered to be of the greatest strategic intelligence value and little or no tactical object was served by jamming.

16. Radio countermeasures against the B.B.C. news service were in the hands of civilian authorities, and the G.A.F. had nothing whatsoever to do with them. Dr. MEINEL of the Reichspost was believed to have been responsible for the production of the type of jamming modulation which was generally used.

GROUND-TO-AIR R/T.

17. The question of jamming Allied ground-to-air and air-to-air R/T was one of the points most strongly disputed between the "Y"-service and the operational side of the G.A.F. The "Y"-service maintained that by listening to and D/F'ing traffic, both strategic and tactical intelligence was obtained and that it was frequently their best source of early warning of attack by aircraft; as a result relatively few attempts were made to jam Allied R/T.

18. In the case of German raids on England the signals staff agreed that there was an advantage in jamming British R/T communications; this point arose when the possibilities of Mark IV A.I. were first realised early in 1941. The question of how to undertake countermeasures against British A.I. was discussed and the weak point of the system was held to be the R/T link from ground to air, because it appeared to be essential for the night fighter to be brought within 2 km. of the bomber before contact could be made.

19. The Reichspost Zentrale built an airborne R/T jammer set which was given the name of Karuso and was intended to prevent R/T being heard by the night fighter when the latter was within 3 km of its target. Within eight weeks the first Karuso equipment was ready and a total of 100 were built. With the cessation of the bombing of England in about May 1941, the majority arrived too late and Karuso was only used once in a limited number of aircraft in a bombing operation when, P/W believed, Plymouth was the target.

20. When in 1943 trouble with British night fighters was again being experienced in the Mediterranean, the Karuso sets were sent down to that theatre. There, however, the range of British A.I. was found to be about 4 km. instead of 2 km., so that the power output of Karuso had to be boosted to give it a range of 5 km.

21. The method employed was barrage jamming using two bands (100 - 110 mc/s and 110 - 120 mc/s) with mechanical condenser-

tuned sweep through the band. There was not room for two transmitters in one aircraft so only half the band could be covered in any one German bomber. Karuso III, a later improvement, was to be capable of being tuned through 100 - 150 mc/s band but so far as is known, it was not put into use.

22. Subsequent tests of Karuso indicated that it had insufficient range, and by December 1944 the Starnberg, which was developed in 1940 by D.V.L. as a jammer against radar, had also been tried out but was likewise considered inefficient. A new set named Nervtöter was under development but never came into operational use.

23. It was decided that the jamming of R/T would be of value against air activity when the invasion took place and prior to D-Day some 50 or 60 modified Karl II jammers had been formed into a Störderf (= jamming village) and assembled at a site on the Channel coast near Dieppe. With this assembly of jammers, all possible frequencies in the 100 - 150 mc/s R/T band could be covered.

24. A few days before the invasion the site was carpet bombed by the Americans and although the jammers had been somewhat dispersed, 90 of them had their aerials damaged or were put out of action. There was some delay in bringing up reserve motorised units and the invasion took place before they reached the Channel coast. As a result, no countermeasures against fighter R/T took place during the invasion.

25. In November 1944 a limited amount of jamming of fighter R/T in the 70 - 100 mc/s band was carried out on the western front by motorised units and from a few fixed sites. These countermeasures were on a restricted scale, owing to lack of apparatus, but it was hoped to interfere with Allied ground control of fighters and fighter R/T.

AIR-TO-AIR R/T.

26. During defensive operations over the Reich against Allied aircraft, countermeasures were very rarely used owing to the insistence of the "Y"-service on the value of D/F'ing transmissions, particularly as the German early warning radar was heavily jammed. Early in 1945, however, it was planned to create four jamming villages (Störderf) each with ten Karl transmitters in order to jam R/T during raids over German territory. The use of airborne jammers to carry out the same task had been considered but it was felt that airborne jamming was less rational than jamming from ground stations because the frequencies had to be constantly monitored.

27. By the end of the war a new jamming transmitter called the Feuerland had been developed by Blaupunkt. This allowed noise modulation to be used in addition to the more generally used Reichspost modulation. A few sets were sent up to the Holstein area just before the capitulation, but it was believed that they had never been used in operations.

28. The standard type of modulation which had been developed by Reichspost consisted of a number of "Kipp" frequencies - sharp triangular pulses produced by blocking oscillators - superimposed on the carrier wave. Tests of its effectiveness at audio frequencies were carried out early in the war and a statistical analysis of them seemed to show that it was the most effective modulation against R/T.

RUSSIAN R/T

29. The airborne FuGe.10 was being developed for use as a jamming transmitter against the 3 - 6 mc/s band R/T used by the Russian Air Force. This apparatus never came into operational use.

R.C.M. AGAINST METRIC RADAR

EARLY WARNING RADAR

30. It was in August or September 1940 during the Battle of Britain that the first German countermeasures were directed against British ground radar. The site at Mont Couple behind Calais was used at first, but was gradually extended to a chain of ground jammers along the whole Channel coast, and ultimately there were sufficient to have every identified British ground radar station covered by at least one suitable jammer.

31. In 1940 the stations jammed were those in the 20 - 30 mc/s and 50 – 90 mc/s bands. Both ground stations and airborne apparatus carried in Ju.52's were used. By 1941 a chain of Karl jammers which also covered the 200 mc/s band had been set up along the whole coast.

32. During the initial period, various efforts were made to spoof our early warning radar. The first of these was the brain-child of Dr. SCHOLZ and was tried out in 1940.

33. Pulses radiated by one of our C.H. stations were picked up on the ground and re-transmitted on a different frequency to an aircraft flying some way behind the Channel coast. The aircraft re-transmitted the original radar pulse on the C.H. frequency, but a slightly different phasing, so that a phoney blip located over the Channel was received. Owing to the ease

with which this phoney blip could be D/F'd and the spoof immediately revealed by a second station, this method was soon discarded.

34. About the beginning of 1941 a special experimental equipment called the Garmisch Partenkirchen, which produced no less than five different phasings and five phony blips, was tried out. For the same reason this was not much used in practice.

How the "S & G" Got Through.

35. The first big operation on which the jamming chain against British radar ground stations was used was on the occasion of the passage through the Channel of the Scharnhorst and Gneisenau in February 1942. A few days prior to the operation Dr. SCHOLZ was specially brought from Berlin to supervise it.

36. The radar cover of our C.H. and C.H.L. had been carefully plotted and it was ascertained that the ships would come within its range as they passed off Fecamp, where they were due at 10 a.m. At that hour every available jammer was switched on. The fact that the ships passed through unscathed was, in P/W's opinion, the best proof of the effectiveness of the German countermeasures. P/W was not aware that we had either decimetre or centimetre radar in operation at this time.

Siege of Malta.

37. In July 1942 P/W was sent to Sicily to take charge of an intensive jamming programme which he suspected was to be the precursor of the invasion of Malta, although he was never told so officially. The first four Karl jammers on 193 mc/s were brought into service in the neighbourhood of Noto en 3rd July 1942 and the number was later increased to eight, to cover both A.I. and ground stations. They were beamed on to the sites at Malta. These transmitters were half kilowatt, C.W. amplitude-modulated at 100 c.p.s. using an unsmoothed HT supply, plus a modulation of 150 - 200 kc/s. The reason for the amplitude modulation being unsmoothed was that there was a shortage of high-voltage smoothing condensers.

38. After a time it was observed that we had adopted frequency changes. The German jammers were however, controlled by monitoring receivers on sites so arranged that the jamming signals and the original radar signals could be seen side by side on a C.R. tube; this enabled the frequency change to be followed within a few seconds. A great aid to them in following and preparing for these changes was that new frequencies were invariably tried out during the day from

Malta and the monitoring service could warn the jamming operators of frequencies likely to be employed.

39. It was noticed that signals on the 50 - 80 mc/s frequency were switched on during a raid and it was suspected that they were due to the height-finding equipment of the radar station controlling our night fighter which seemed to operate in a similar fashion to the German Würzburg. This opinion was confirmed when "Y" service heard a ground station say that they could give the range of the bandits but that height measurements were not yet available.

40. To jam the "height-finding" frequencies a Ju.52 fitted with eight jammers covering the 50 - 80 mc/s band was brought down to Catania. An hour before a raiding force became airborne this aircraft left Catania to patrol half way between Sicily and Malta and jam this band.

41. After P/W left, jamming was also carried out on the 42 mc/s band with the same type of Karl ground transmitter as was used for other frequencies.

Modulation of Jammers.

42. When jamming out ground radar, H.F. modulation was always preferred to noise modulation since the equipment necessary to produce a given effect with noise modulation was much more extensive than for H.F. modulation, and in particular a large number of high-power valves was needed. The greater efficiency of noise modulation was not considered sufficient to warrant the extra power and extra equipment needed. It was also thought unlikely that H.F. modulation could be filtered out of the radar receiver without severe deterioration of the picture.

Düppel (Window).

43. The idea of using window to spoof ground radar had occurred to the Germans in 1941 and a series of experiments was carried out in great secrecy over the Baltic in February 1943 (See A.D.I.(K) 334/1945 Part, IV). Very careful arrangements were made to ensure that the wind was in the right direction so that the window strips would fall into the sea and not in Sweden, or even on German occupied territory.

44. The effect of window was observed on all types of German ground radar deployed along the Baltic coast, and its efficacy as a countermeasure was realised. The German codename for Window was "Düppel" - a word with a very similar pronunciation to the German word "Dipol" (= dipole), indicating the function of the metal strips.

45. The Signals Staff realised that Düppel was a two edge weapon and although its development was completed sometime in 1942, and a certain quantity was manufactured, no use was made of it for fear of Allied retaliation.

46. The whole project was, in fact, kept so secret, that only a very few high officers and technical experts in the G.A.F. were aware of the scheme. So closely was the secret of Düppel guarded that the scientists were not even allowed to carry out research work to discover what anti-window measures could be applied to the various types of German radar.

47. Although the Germans were free to employ window as a countermeasure over this country after its first use by the R.A.F.in July 1943, it was realised by the Signals Staff that they had never used it to such good effect as the Allies.

48. The reason was that the small German bomber aircraft like the Ju.88 could only carry a very limited quantity and therefore could not produce a real window cloud. They therefore decided to drop small quantities scattered over a wide area in the hope of deceiving the night fighters and of producing the impression that a larger number of aircraft was engaged on a certain raid as well as in the hope that ground controllers might vector night fighters on to a window cloud instead of on to an aircraft.

Final Policy against Early Warning Radar.

49. The general policy followed by the G.A.F. at the end of the war with regard to the countermeasures against early warning metric radar appear to be summarised in a document dated December 1944, which states that the use of ground jammers against all ground radar is, in principle, particularly desirable during German bomber raids on enemy territory, but that there is no advantage in using airborne jammers because the frequency of the ground radar has to be constantly monitored and followed.

50. This principle was not strictly adhered to because an airborne jammer for the 170 - 220 mc/s band named Kettenhund was used to a small extent in raids on the South-West of England in May 1944 (sec A.D.I.(K) 321/1944) but it was not considered to be very effective.

51. Some attempt was being made to develop a noise-modulated airborne transmitter named Wolke but it was never used operationally.

METRIC A.S.V.

52. The first attempts to jam A.S.V. were made in the Channel in the summer of 1942. During the preparations for the proposed invasion of Malta it was found that reception of British A.S.V. transmissions was obtained at extraordinary ranges in the Mediterranean area. This was ascribed largely to the fact that the receivers were placed as high as possible - in some cases 3,000 foot above sea level - and attempts were made to jam A.S.V. by using Karl transmitters placed near them on high points of the coast of Sicily, Greece and Crete.

53. At about this time a Sonderkommando KOCH was formed and based at Athens-Kalamaki. Its duties were to monitor and jam A.S.V. and it was thought they used the Kobold airborne transmitter with a frequency range of 160 - 200 mc/s. It had the disadvantage that it could only be built into large aircraft and some doubts arose as to whether it was very effective.

54. Up to the of the war, the Bari ground jammers continued to be employed against A.S.V., particularly along the length of the Adriatic and along the Norwegian coast at points where German coastal convoys obtained no cover from islands lying off the coast.

55. In mid-1943 U-boats leaving Brest were suffering a serious increase in losses owing, it was thought, to the use of our A.S.V. a Sonderkommando Rastädter was formed with a few He.111 and Ju.88 aircraft for the purpose of listening to British A.S.V. on metric and centimetric wavelengths and determining what type of radar was being used with such effect (see A.D.I.(K) 38/1944). These aircraft carried, amongst other receivers, both Naxos and Korfu. The net conclusion reached as a result of these investigations was that Coastal Command was using a centimetric frequency (presumably H2S) for which the Germans had no jamming transmitter.

56. The Allied attacks on U-boats took place so far from the coast that ground jamming of A.S.V. on metric wavelength was impossible and too many aircraft were needed to carry out efficient airborne jamming. It was feared, too, that if airborne jamming were carried cut, it would only attract A.S.V.-equipped aircraft or surface vessels to the vicinity, and be a proof that U-boats were about.

57. Warning receivers were therefore installed in U-boats. The first of these - Metox - was used against metric A.S.V. It suffered from the disadvantage that its local oscillator radiated strongly, and it was suspected that we could home on to this radiation from 100 km.; the Samos receiver later replaced Metox. A form of Naxos was introduced to provide

warning against 9 cm. A.S.V. and was used up to the end of the war.

METRIC A.I.

58. The weak link in the British night fighter organisation was, as already mentioned, considered to be the R/T communication; the airborne jamming of British A.I. itself by German bombers or special R.C.M. aircraft was not considered a practical measure because it was believed that British night fighters would be able to home on to the jamming aircraft and severe losses were therefore to be expected.

59. No intentional jamming of Mark IV A.I. was ever carried out from the air or from the ground, although it was considered possible that Karl jammers against G.C.I. and harmonics of the Heinrich transmitter against Gee, and possibly of all transmitters jamming Oboe and C.H., may have had some effect.

60. In this connection P/W stated that it was extremely convenient for the Germans that we had so many equipment working on such a restricted frequency band in the 200 mc/s region. This fact has eased their jamming problem very considerably.

GEE.

61. The value of Gee system of navigation referred to by the Germans as Hyperbel, is that it allows an aircraft to navigate by a radar method without transmitting any signals which could be used to D/F the raider from the ground. This threat was realised by the Germans in March 1942 when the existence and method of operation of the system was first discovered, but the decision to jam Gee was not taken until August 1942.

62. A jamming transmitter was hurriedly improvised out of the standard A.S. ground transmitter used for R/T traffic with the FuGe.16. This was modulated with the standard "Mont Couple" modulation at 150 - 200 kc/s. Prior to this makeshift coming into use, a certain Dr. MÖGEL had experimented locally with jamming transmitters but these only operated for a short time and no details are known of them.

63. An order for a large number of suitable jamming transmitters for countering Gee was placed in August 1942 and the first of these - $^{1}/_{2}$kw. Heinrich - went into service in November 1942. As the Heinrich transmitters became available in quantity they were deployed all over Germany and by the end of the war some 270 were in operation against Gee.

64. Estimates of the effectiveness of jamming by the deployed Heinrich transmitters were obtained by flying captured Gee equipment and by questioning British P/W. The conclusion reached was that before the invasion the Gee chains were of no use further East than 4°.

65. After the invasion the situation changed, and in August 1944 a so-called Störderf (= jamming village) was set up on the Feldberg in the Taunus area and controlled and run by the Reichspost Zentrale. Installation began in August and in September the first equipment came into use.

66. The Gee countermeasures from the Feldberg site were of a different type. In addition to a number of normal Heinrich transmitters, three new types of much greater power were used. These were Feuerzange, a very powerful pulse transmitter with a peak power of 1 megawatt, Feuerstein with a peak power of 120 kw. at 5,000 pulses and a smaller transmitter, Feuerhilfe with a power of 30 kw. which had been improvised by Köthen. These three powerful transmitters were used to pick up the Gee transmissions and retransmit them but with a very slightly different p.r.f. A keying arrangement was incorporated so that the pulses of the master and slave stations could be imitated.

67. In the immediate neighbourhood of the site it was expected that the pulse powers used would be so high that the Gee presentation screen would be completely jammed. At greater distances aircraft would receive on each frequency used three or four false pictures broadcast by the Feuerzange and Feuerstein. As they transmittal their spoof pictures on p.r.f's which differed only slightly from that used by the British stations, the effect produced was that the false pictures wandered very slowly over the true pictures so that it was difficult for an operator to tell which was the correct set of blips.

68. At the beginning an insufficient number of sets was available to carry out this spoofing on all the chains, but by January 1945 the site was fully equipped. The Germans were convinced that this system was successful because on 2nd March 1945 at 1230 p.m. a number of fighter bombers paid them a very unwelcome, visit and completely destroyed the site.

69. Consideration given to the idea of jamming the link between the Gee ground stations, was never carried out as it was thought that we would certainly anticipated such measures by providing a number of reserve links, possibly on centimetre wavelengths, or oven co-axial cable links.

70. When Gee jamming was first properly undertaken towards the end of 1942, a large number of monitoring stations placed

about 100 km. apart were erected around the occupied coast form Brest to Norway. Each site had two Heinrich transmitting units, one operational and one spare, and monitored all possible wavelengths. Changes of phase were also reported so that German aircraft flying with Gee equipment could be notified by W/T.

71. The whole problem of Gee jamming was considerably simplified on the few occasions that we made unexpected frequency changes, because our transmitters lined up on the new frequency before they were used operationally. Had this not been done the effectiveness of the German jamming program, might have been considerably reduced.

LORAN.

72. As has been mentioned in a previous report of this series, the discovery of Loran came as a great shock to the Germans because Professor von HANDEL had convinced himself that a long-range, comparatively long-wave pulse system would be too inaccurate for employment as a means of navigation. The Germans' first knowledge of the system was obtained about the middle of 1944 when maps were captured, and ultimately a complete apparatus was obtained from an American aircraft.

73. Attempts were made to jam it, and by March 1945, 10 to 20 one kW noise jammers, which jammed the ground wave satisfactorily within a radius of 50 to 100 km., were in operation. At this time transmitters to meacon the pulses were being built and consideration had been given to jamming the synchronisation of the transmitters from the ground, using a 100 kW. C.W. transmitter which was to be erected as near the front line as possible in order to be near the ground link.

74. The transmitter was ready and hat been taken to Thüringen but the disruption of transport and communications prevented it ever being used operationally.

G.II.

75. The same equipment was used for jamming G.H., known to the Germans as Diskus, as was used for jamming Gee.

76. A number of jamming villages (Störd örfer) with from two to eight Heinrich transmitters were deployed throughout Germany. It was calculated in December 1944 that at 20,000 feet G.H. could only be received and used up to a line joining Emden and Kassel and from there swinging South in an arc to Stuttgart, while at 33,000 feet reception was thought to be possible up to an arc joining the mouth of the Elbe, Weimar and Augsburg.

77. In addition, it was planned to use the powerful Feuerzange and Feuerstein transmitters in an attempt to trigger-off the ground stations from the Feldberg/Taunus Stördorf used to jam the Gee chains.

OBOE - METRIC WAVELENG.

78. In the autumn of 1942 a new type of radar signal in the 200 mc/s band was picked up by the German monitoring service at Calais. Statistics were kept and it was observed that these transmissions occurred mainly at night, and seemed to be associated with British M.T.B. activity in the Channel.

79. In about June 1943 the same type of radar signals was heard in Essen during a very heavy bomber raid on Cologne and Dr. SCHOLZ was able to correlate them with the dropping of T.I's visually observed. It was realised at once that these signals were the same as those heard at Calais and an immediate investigation was carried out. For this purpose a "noise investigation commission" was formed and a special experimental Freya with a number of D/F receivers was set up. The Freya was used to plot the course of the T.I.-carrying aircraft while the receivers D/F'd and monitored the signals.

80. Some 6 to 8 weeks after the signals had first been attributed to path-finders, a satisfactory story had been worked out by the Germans as to how Oboe, called by them Bumerang, worked. When this had been accomplished, subsequent Oboe raids were systematically monitored by the normal monitoring service.

81. At this time (August 1943) plenty of jammers were available because of the reserve apparatus available for use against 200 mc/s radar stations on the Channel coast. Ten sites were chosen to give jamming coverage over the Ruhr and eight ½ KW MCW Karl jammers employed at each site. The standard Mont Couple modulation also used against C.H.L. stations was applied giving 150 mc/s sine wave modulation at 100 c.p.s from an unsmoothed H.T. line.

82. The radio frequency was determined by picking up the aircraft return signal and tuning the jamming transmitter until the normal signal failed. Four frequencies in the 200 mc/s band were ultimately detected, but though the ground station frequencies were found to be steady, those of the airborne transmitter were not very stable.

83. Aerials recovered from crashes appeared to be mounted sometimes en the starboard wing and sometimes on the port wing of the aircraft. This fact, combined with some information obtained from a British P/W, caused the Germans to believe

that the aerials were directional, and in order to jam more successfully, all transmitters were moved to the West of the Ruhr.

84. Jamming was almost entirely confined to the Ruhr area because this territory was far away, the most important target within the limited range of Oboe. The Germans were greatly relieved when Oboe was used against the rocket sites in Northern France, as the pressure on the industrial Ruhr was thereby reduced. From about December 1943, intermittent attempts were made to jam Oboe ground stations from the site at Mont Couple behind Calais. These were not very successful - a fact which was attributed to the beam width of British aerials.

85. In June 1944 a new form of jamming which was known as the Ballverfahren was suggested. This was essentially meaconing, using an A.B.G. responding transmitter in the hope of confusing the aircraft's return signals to the ground station. It was believed to work well, and P/W quoted as an example a raid on Nürnberg when aircraft deviated from their course as soon as the jamming was switched on and returned to their course when it lifted.

86. An instance of the success of Oboe jamming on the Ball system was quoted. In June 1944 an oil installation - possibly Wanne-Eickel - was the target, and all Oboe aircraft were successfully jammed. The T.I's were dropped late and some 8 km away from the target. As a result of this the main bomber force spread out and many aircraft were shot down.

87. Only one metric Oboe receiver fell into German hands and that was 90% destroyed; although the Germans knew the principle, therefore, the details of the airborne set were lacking, and the effectiveness of jamming could only be judged by the accuracy of bombing.

88. By observing on a Freya the point at which bombs left the aircraft, the Germans estimated the accuracy of Oboe as 300 x 300 metres for bombing from 9,000 metres, but a further 200 metres of ballistic inaccuracy occurred, giving an effective error of 500 x 500 metres in the Ruhr area.

89. The success of jamming Oboe was considered to depend partly on the training of personnel, so it was less effective on a new target than on an old target which had been jammed before. It was finally believed that the jamming was 90% effective.

90. The Germans claim to have been so familiar with Oboe that they were able to plot aircraft and withhold their jamming

until the aircraft turned onto the bombing run. They were then able to identify the real target and localise the air-raid warnings so as to disturb industrial production in the neighbourhood as little as possible.

91. It is of some interest that on several occasions there was a consistently good concentration of bombs in an open field near Leverkusen, which P/W presumed to be due to an error in computing the exact location of the target.

COUNTERMEASURES AGAINST RADAR.

OBOE - CENTIMETRE WAVELENGTHS.

92. Signals which were recognised as Oboe by the type of coding were detected on a wavelength of 9 cm on the Channel coast about the spring of 1944. The normal monitoring service had previously intercepted unexplained 9 cm. signals in October 1943 but had not finally connected them with Oboe.

93. When 9 cm. Oboe was recognised, it presented the Germans with a great problem, as no jamming valves were available for that frequency and German intelligence had not given any hint that a centimetre version of Oboe might be produced.

94. By July 1944 a valve called LD.7o (= 7 ohne = without) had been produced, which was an LD.7 valve without cooling fins. A transmitter unit called Feuermolch, tuneable from 8.6 - 9.6 cm., pulse modulated and giving 3 kW peak pulse power, was than built. The whole apparatus, a Feuermolch transmitter together with a mirror reflector to achieve 200 km. range by beaming, was called Feuerball or A.B.G. (Anti Bumerang Gerät).

95. Jamming on 9 cm. Oboe was first used in operations in October 1944 at Weser and Leuna. The Feuerball jammer was used as a pulse repeater, after the frequency had been established by interrogating the aircraft. The jammer then set up ringing between the aircraft and jammer on the Ball system used against metric Oboe.

96. The latest type of centimetric meacon responder called Feuerburg had receiver and transmitter aerial mechanically linked to follow individual aircraft, the jammer aerial system giving a beam of 13° width. The aircraft was followed by hand by means of a spinning dipole in a receiving dish.

97. According to Dr. SCHOLZ the wavelength originally used by British centimetric Oboe was 9.26 cm. Sites were set up with both 200 mc/s and 9 cm. jammers so that either could be selected by a change-over switch on the receivers.

98. The jamming of Oboe by spoof massages was never tried although the meaconing jammers were fitted with a keying arrangement which would have allowed them to attempt this.

99. Oberleutnant Dr. BÄHRE of Ln. Versuchs Regt. Köthen had doubts as to the effectiveness of the Ball system and had proposed building a jammer with a very high p.r.f. to saturate the aircraft receiver with pulses so that the strength of each individual pulse re-radiated by the aircraft transmitter would be greatly reduced and the range of the system would therefore be considerably decreased. The Roland J transmitter which had been designed for H2S countermeasures was to be adapted by Lorenz for this purpose, but the idea was never put into operation as the end of hostilities occurred shortly after it was made.

100. An example of the success of jamming centimetric Oboe was quoted and concerned a series of five raids on Gotha. Three attacks, each with between three and five aircraft, were unjammed and all scored hits on the railway station. The fourth attack was jammed and no hits were scored on the same target. The fifth attack was again let pass without jamming and the station was once more successfully hit.

101. A further proof of the efficiency of the Ball system was that in plotting aircraft a diversion from track could be induced when the jammer was switched on and the aircraft would return to track if the jammer were switched off again.

102. On the only occasion on which a 9 cm. Oboe aircraft was known to have been shot down, it crashed in the Zuider Zee in shallow water where it could neither be reached from shore nor by sizable ship, and it was not possible to salvage the equipment. As a result, the Germans never obtained any Mark II Oboe equipment and detailed information as to how the system worked was always lacking. There was no explanation, for instance, of why certain aircraft transmitted pulses which did not appear to have normal Oboe coding, although the aircraft flow at heights and along tracks which obviously identified them with Oboe procedure.

103. No advance information of the target could be obtained from these aircraft but this was easily obtained from the W/T transmissions between ground stations. The W/T channel used was also monitored in order to see if jamming had been successful. It was also noticed that some aircraft would not respond to the interrogator but the reasons for this were not fully understood. These aircraft seemed to be operating on a wavelength above 9.6 cm.

104. A new valve to cover the 9.6 - 10.6 cm. band was being produced by Dr. GROOS. It was a 100-watt Klystron and it was proposed to jam with its aid as soon as it was finally produced.

105. Towards the end of the war there was a great increase in the daylight use of Oboe but P/W did not believe that the Americans had ever used it. With so many aircraft over Germany towards the end of the war correlated evidence was not available.

H2S.

106. Shortly after the discovery of H2S in January 1943 panic orders were given for the production of a jammer. Later in the year Roderich, which was manufactured by Siemens and which used a Magnetron of theoretically 5-watt power, was made available. The transmitters were unbeamed and the power was so low that they were useless. By 1944 the use of Roderich had been discontinued.

107. The difficulties of jamming highly-beamed centimetric radar were so great that it was decided that all that could be done was to attempt to defend a few vital targets. The first target to be chosen was the Leuna works which was considered a good target.

108. The Reichspost Zentrale was called on for assistance and Dr. GROOS of that institution successfully developed a Klystron valve, which was a water cooled 100-watt valve tuneable by hand from 8.5 - 9.5 cm. This was built into the jamming transmitter which was known as the Postklystron.

109. In order to concentrate as much of the energy as possible to the aircraft, horns or paraboloid aerial reflectors were employed with the transmitters. About eight sites around Leuna were chosen, bearing in mind that the attacks always seemed to use a route coming in from the North, presumably because the best H2S pinpoints lay in this direction.

110. Four Postklystron transmitters were placed on suitable sites and spaced in frequency across the observed 30 mc/s band of H2S by putting them about 5 mc/s apart and making use of the side bands from 2 - 10 mc/s single frequency amplitude modulation. This barrage was used with low directivity.

111. A second type of jammer employed made use of the Roland transmitter built by Siemens, which had a 30° beam, but its development was abandoned about March 1945, as it was not considered very successful.

112. In yet a third system Postklystrons were used with a beamed aerial system giving a lobe 6° wide. The transmitter was coupled mechanically to the D/F, receiving aerial of a Korfu receiver, its aerial being provided with rotational eccentric split. The receiving aerial was trained on a single H2S bomber, which was followed manually.

113. The detection range for setting up was about 300 km. With the less beamed type, Roland, effective jamming ranges up to about 30 km had been obtained but with the narrow 6° beaming the H2S tube was completely obliterated at 40 km if the beam was focussed on the H2S aircraft.

114. One P/W had flown with H2S equipment installed in German aircraft in order to carry out experiments in ground camouflage against H2S with the aid of corner reflectors. The conclusion was that corner reflectors were ineffective. It had originally been planned to cover arms of the sea and lakes with corner reflectors, but in the first place too many were needed, and in the second place arrangements had to be made for these to remain fixed in a certain orientation in order to produce an effect.

115. Another suggestion had been made that metallic powder could be used to increase the reflectivity of an area. This was obviously no use as camouflage for a target, which was the end originally in view. Consideration was given to producing a dummy target with its aid but it was concluded that the quantity of powder necessary was so enormous that it was not a practical proposition.

H2X.

116. The Germans had such leeway to make up with the production of 3 cm valves that no active countermeasures against H2X had been put in operation up to the end of the war. Development of a transmitter called Roland 2 was started in December 1944 with Telefunken Ceramic 3 cm valves believed to be known by the designation LD.72 and LD.77.

117. The set was to be modulated by 100 kc/s pulses and to sweep through a small radio frequency band. The power achieved was 50 watts average. With horn aerials a 20° beam was to be achieved. The range against an H2X set which had been captured undamaged at Wiesbaden was 20 km. in the initial experiments.

A.I.

118. Owing to the strong beaming and method of sweep of centimetre A.I. the G.A.F. was doubtful if any jamming would

be possible. No airborne transmitters against centimetric radar were developed.

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29th August, 1945.

S.D.Felkin,
Group Captain.

A.B.G. (DALL)

The A.B.G.(Anti Bumerang Gerät) meaconing jammer was first used in June 1944 and was an idea fathered by P/W. It was a responder beacon which was employed against Oboe to set up "ringing" between the aircraft return signal and the A.B.G. so that the aircraft return to the ground station was confused. The jamming transmitter had a 20 - 30 kW power in the case of the model used against 200 mc/s Oboe. In the A.B.G. used against 9 cm. Oboe (Feuerball) the power was 3 kW.

BRESLAU.

This was the pulse modulated transmitter with a range from 20 - 250 mc/s developed and built in the G.A.F. laboratories in PARIS. It was believed to have consisted of six or eight ½ kW transmitters. Some 50 sets only were put in hand and about half of them were completed. It was thought that they had been used against ground radar stations along the Channel but with what success it was not known.

FEUERBALL.

This was the name for the A.B.G. centimetric responder used to jam centimetre Oboe. The jammer was used as a pulse repeater and set up ringing between the aircraft and the jammer. It consisted of a transmitter using a klystron valve developed by the R.P.Z. which covered the frequencies 9.0 - 9.6 cm., backed by a beaming reflector. The peak power was about 3 kW.

FEUERBURG.

In order that the Feuerball transmitter should be beamed on to the transmitting aircraft, a beamed receiver was mechanically linked to the Feuerball set. The receiver was operated so that the receiving mirror was aligned on the aircraft and the Feuerball paraboloid mirror followed any changes of elevation or direction made by the receiving operator. This complete set-up of beamed Korfu receiver with a Feuerball beamed transmitter was known as Feuerburg.

FEUERHILFE.

This was a smaller form of Feuerstein improvised by Köthen with a peak pulse power of 30 kW.

FEUERLAND.

This was a two-stage inductive transmitter (final stage LS.1000) manufactured by Blaupunkt and served the same purpose as the Karl II. The first production sets were ready in March 1945 and were believed to have been sent to the Holstein area, but they were never used operationally.

The frequency of the Feuerland could be adjusted from 30 mc/s to 300 mc/s by means of interchangeable H.F. coils. Different types of modulation could be introduced according to whether it was to be used against R/T or radar. Against R/T it was known to have had the four-tone chime modulation described under Nervtöter below. It could also be used with noise modulation with an adjustable bandwidth up to 2 mc/s. The power output was about 350 - 500 watts.

FEUERMOLCH.

This was the name given to the centimetric transmitting equipment of the Feuerball.

FEUERSTEIN.

The Feuerstein designed by Telefunken was used for producing a false picture on Gee sets, the keying of the pulses being carried out by equipment supplied by Telefunken and Siemens. A number of these sets were installed on the Feldberg. It was a high-power pulse transmitter at frequency range of either 20 - 52 mc/s (known as the Feuerstein 1) or 48 - 90 mc/s (known as the Feuerstein la). At a p.r.f. of 5,000 cycles it had a peak power of 120 kW.

FEUERZANGE.

This was the highest-powered pulse transmitter possessed by the Germans and was used in 1945 on the Feldberg to provide spoof Gee transmissions. The transmitter, developed by Dr. FREUDENHAMMER and built by Siemens, was water-cooled and could be modulated in exactly the same way as Feuerstein. The frequency range of the transmitter was 20 - 87.5 mc/s and at a p.r.f. of 5,000 cycles a power of 1 megawatt was claimed. It was considered a very effective set but only came into operation towards the end of 1944.

GARMISCH PARTENKIRCHEN.

Garmisch Partenkirchen was believed to be an improvised airborne apparatus, probably manufactured by Neufeld and Kuhnke of Kiel. It was used to a very limited extent in 1941. It consisted of a receiver which picked up a ground radar transmission and re-transmitted on the same wavelength but returned no less than five different pulses with slightly

different phases with the object of creating false echoes. As these false echoes could be immediately identified if a second ground radar D/F'd the jamming aircraft, the idea was carried no further.

GEWITTERZIEGE.

An experimental spark, ground jamming transmitter for employment against flight radar and using a $^{1}/_{2}$ wavelength dipole aerial in front of a reflector, was given the code name Gewitterziege. The band width was very large but it was claimed that it was an effective jammer at close range.

HEINRICH.

This transmitter was developed by the Reichspost Zentrale in 1942 with the specific intention of providing the G.A.F. with a jammer against the Gee navigation system. A large number of these sets was built and deployed all over Germany to jam Gee. A set of the same type, from which Heinrich had been developed, was used in Sicily in July 1942 for jamming the radar stations in the 50 - 80 mc/s band in Malta.

In its ultimate form, Heinrich II, the transmitter had a power of 500 watts and covered the band from 20 - 90 mc/s in four separate sections. For this output it used four LS.180 valves arranged in parallel push-pull.

It was 100% modulated by 150 kc/s sine wave with the addition of 100 cycle ripple obtained from an unsmoothed H.T. power supply. The set needed only two controls, one for the main tuning and one for the aerial coupling.

The aerial consisted of a wide band dipole of squirrel cage circular section, with normal tapping at the feeding point. This one aerial was used in the entire frequency band from 20 – 90 mc/s. It was stated to have a standing wave ratio of 20% in voltage.

KARL I.

This was the standard jamming transmitter for use against British radar and was designed to cover the frequencies 90 - 250 mc/s in two bands. Development work on it was started at the end of 1940. The transmitter employed four LS.180 valves and had a power output of between 300 and 500 Watts. It was modulated by the standard Mont Couple 150 kc modulation on which a 100-cycle tone coming from an unsmoothed 50-cyle source of supply was imposed. The type of modulation employed could not be changed in the field.

KARL II.

This was on improvement of Karl I with few changes in the electrical specifications but it was really composed of two more powerful Karl I units with a common feed. It was also modified so that any desired standard type of modulation could be substituted at the site where it was employed, thus obviating the necessity for returning the transmitter to the factory, as was the case with Karl I.

The Karl II employed an LS.1500 valve with an output of 2 kW, and besides being used against ground radar, it had been modified for use against R/T with the Post type of modulation. It was not known what degree of success had been achieved with this set.

KARUSO.

The original Karuso I was improvised by the R.P.Z. with the specific object of providing aircraft with an airborne transmitter to jam the R/T link between the British ground control stations and British night fighters. It was origina11y intended to sweep through the whole 100 - 120 mc/s band. 0wing to the relatively large frequency sweep, however, jamming was not vary effective, so it was manufactured in two forms, to sweep from 100 - 110 or from 110 - 120 mc/s.

It had ultimately an effective range of about 5 km. and a power of about 30 Watts. Altogether, only 100 sets were manufactured.

The designation Karuso II was given to a development which never got farther than the laboratory stage, but Karuso III was produced and covered the 100 - 150 mc band. The width of the jamming band was only 3 mc/s and the frequencies used was set up on the ground according to intelligence information given by the German "Y"-service. It was not known whether this set was used operationally.

KETTENHUND.

Kettenhund was a 30 watt air-born jammer developed in 1943 by a certain KETTEL of Telefunken covering the 170 - 200 mc band. It was used against British ground radar stations in raids over South-West England in 1944. Tests with the set led the Germans to the conclusion that it was not very effective. Modulation employed was a triangular wave with a frequency of several hundred kc/s.

KLYSTR0N.

This was the name commonly applied to a centimetre jamming transmitter witch was also referred to as the "Postklystron". It acquired this name because it made use of a centimetre klystron valve developed by Dr. GROOS of the Reichspost. A power of 100 watts was claimed for it. It was a CW jammer which could be tuned by hand between 8.5 cm. and 9.5 cm. It was fitted with a horn aerial to be aligned on the approaching H2S force. It was claimed that at a range of about 40 km. the H2S tube was completely obliterated when the Postklystron was focussed on an individual aircraft. This set came into operation about March 1945.

KOBOLD.

The Kobold was an airborne set designed by the Post specifically to jam A.S.V. and was originally used in the Mediterranean in conjunction with a Karl transmitter working from the ground. It was, in effect, half a Karl transmitter and used two LS.180 valves. A modulation of about 400 cycles originating from the aircraft transformer was superimposed on it. It had the handicap that it could only be built into very large aircraft.

NERVTÖTER.

Nervtöter I was designed as an airborne transmitter to jam Allied R/T but considerable difficulties were encountered in tuning it in the air to the frequency observed and it was never used in operations.

As a result of the criticism made by T.L.R., the Nervtöter II, which was also believed to be known as FuGe. 40, was to be developed. This set employed an LS.50 valve in the final stage and the frequency of the R/T was to appear as a blip along is time base on a cathode ray tube, while the frequency, to which the transmitting jammer was adjusted, appeared on a similar blip on a second time base on the tube. By setting these two opposite each other the operator could easily see that he was jamming the required frequency.

A so-called chime modulation of four changing tones was used. The power output was 25-30 watts and the frequencies ranged from 90-160 mc/s. Wide band aerials were to be used. This set had not got beyond the experimental stage by the end of the war.

OLGA.

Olga was a self-excited, grid-keyed, one valve transmitter (LS.180) developed by the Navy and had a frequency range of 150 - 200 mc/s and an output of about 300 watts. It was

believed that a p.r.f. of 500, 700 or 900 cycles was used. This jammer was an early type used against British coastal watch radar without much success.

RODERICH.

This was the name applied to the first set developed by Siemens for jamming H2S when panic counter-measures were called for early in 1943. It used a magnetron valve with a maximum power output of 5 watts and was virtually of no use whatsoever. It took some months to develop; in the meantime, German knowledge of how to Jam H2S had increased to such an extent that it was never used.

ROLAND.

The Roland jammer was developed for use against H2S by Dr. WEHRMANN of Siemens and was said to employ a triode transmitter valve designated L.D.72 or possibly L.D.75. The wavelength was 8.5 - 9.5 cm. and with the aid of a horn aerial it produced a 30° beamed transmission, modulated, it was believed, by 100 kc sine wave and pulses of an unknown p.r.f. It had less than 50 watts average power. The range at which obliteration of the H2S tube was claimed, was about 30 km.

The Roland II was the name applied to an attempt to produce a similar set on 3 cm using, it was thought, a LD.77 triode valve and a horn aerial a 20° beam. It is doubtful if it was used operationally as the valves had a very short life.

STARNBERG.

This was believed to be the precursor of Kettenhund and was designed by D.V.L. Adlershof in about 1940 but never used. In a document there is an indication that attempts were later made to use it as an R/T airborne jammer; A.D.I.(K) 231/1944 also gives an account of preparations to use the Starnberg operationally.

WOLKE

Wolke was believed to be the code name applied to the first German attempt to imitate a noise jammer like that used by the Allies. It was believed to use two L.D.5 valves in the final stage and to have a carrier frequency of 90 mc/s. The average power output was 15 - 20 watts, the width of the noise band being about 2 mc/s.

As a result of the examination of Wolke the conclusion was reached that noise modulation required too many valves and too much power and that with the some number of valves a better effect could be obtained with other types of modulation. The

set was therefore used for training night fighter crews to see through electronic jamming of SN.2.