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Summary.—Reasons for Enquiry.—Measurements of cabin noise level, by means of an objective noisemeter and octave filter, have been made on a number of multi-seater aeroplanes. It was desired to examine these results to determine whether they could be predicted from the geometry and other features of the aeroplanes, and whether they could be correlated with noise assessments by the crew.

Range of Investigation.—Curves of noise level in decibels against frequency have been obtained for eight aeroplanes, in various flight conditions, at different crew stations, and on one aeroplane with and without soundproofing. These curves have been examined in conjunction with details of the geometry of the aeroplanes, the frequencies of airscrew and engine rotation and of the engine explosions, and assessments of the aeroplane noise made by pilots and observers.

Conclusions.—The principal sources of noise are airscrew rotation and engine exhaust at low frequencies and aerodynamic noise at high frequencies; in certain cases, other factors such as airscrew torsional vibration and engine vibrations appear to contribute.

The noise level to be expected can be predicted roughly from a consideration of the distance of the crew stations from exhausts and airscrews, the area of perspex present, the aerodynamic cleanness of the windscreen and the degree of soundproofing.

The curve of noise level against frequency does not in all cases agree with an assessment by the crew, and it appears that some other measurement is necessary to complete the picture. It is suggested that a more complete determination of the noise characteristics would be given by a combination of three tests—frequency analysis, a measurement of peak values, and an aural investigation of rattles, etc.

The introduction of some degree of soundproofing is considered to be desirable in the majority of British bombers. The material used must not interfere with maintenance by making pipelines, etc., inaccessible, and it is for consideration whether some local thickening of the fuselage skin and windows in the plane of the airscrews would not be of advantage in reducing the amount of internal material required.

Care should be taken to eliminate noises such as rattles, buzzes, whistles and drumming panels which can be very irritating to the crew even when they are not very loud.

1. *Introduction.*—Measurements of cabin noise level, by means of an objective noisemeter and a band-pass filter, have been completed on eight multi-engined bombers, measurements having been made in various flight conditions, at different crew stations, and on one aeroplane with and without soundproofing. This report gives the results of the tests, together with sketches of the aeroplanes and details of any soundproofing, and comments on features of interest on the individual aeroplanes.

2. *Details of Tests.*—The instruments used were an Objective Noisemeter to Specification 791/R.A.E./W.T.610 and an Octave Analyser type 74101B. They have been calibrated at the National Physical Laboratory and the appropriate corrections have been made to all measurements.

The majority of the tests were made in the pilot's or wireless operator's position, and in cruising engine conditions, but other positions or conditions were sometimes included. The

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microphone was held about six inches from the pilot's head and in the positions which would be occupied by the heads of other members of the crew. No measurements were made close to the fuselage walls. All windows and communicating doors were closed.

3. *Presentation of Results.*—The results of the measurements are presented as tables and curves. The tables show the engine conditions, the airscrew tip speed in terms of the velocity of sound, and the noise level in decibels (db) for each of the sixteen octave bands of the analyser. There is usually a periodic fluctuation in the readings of the noisemeter at low frequencies, due to beats between the engines, and the limits of this fluctuation have been given in the tables. In the curves, the noise level in decibels is plotted against the mean frequency of the band; to simplify the curves, only the mean noise level has been plotted in most cases.

In an attempt to relate peaks in the noise curves to their sources, the frequency of the crankshaft rotation, the explosion, and the passage of the airscrew blades past the fuselage, has been indicated on the curves. The analyser is not very suitable for such an investigation, because the width of the band (one octave for 10 db. reduction) smooths out narrow peaks; nevertheless, some useful information can be obtained from this comparison.

Sketches are given of the eight aeroplanes. They show the distance between the crew stations and the airscrew tips or exhaust exits, and give a rough indication of the areas of transparent material.

The Halifax was tested with and without soundproofing, and photographs are included to show the type of soundproofing in the wireless compartment and in the pilot's cockpit.

The following table gives general particulars of the tests made, and shows the table and figure numbers relevant to each aeroplane.

Aeroplane	Positions tested	Engine conditions tested	Sound-proofed or not	Sketch Fig. No.	Results Table No.	Results (curve) Fig. No.
Halifax L.7245	Pilot W/T	Maximum level cruise, weak and rich.	N.S. and S.	1	1	10, 11
Fortress A.N.531	Pilot W/T Navigator	Maximum level cruise, weak and rich.	S.	2	2	12
Wellington IA, R-3155 ..	W/T	Maximum level cruise ..	N.S.	3	3	13
Wellington IV, R-1515 ..	W/T	Maximum level climb cruise.	N.S.	4	3	13
Hudson N.7205	W/T	Maximum level cruise, glide.	S.	5	4	14
Lancaster B.T. 308 ..	Pilot W/T	Cruise, weak and rich ..	N.S.	6	5	15
Albemarle P.1360	Pilot Navigator	Cruise, weak and rich ..	N.S.	7	6	16
Manchester L.7277 ..	Pilot	Maximum level cruise ..	N.S.	8	7	17

Figs. 18–21 are photographs of the pilot's and wireless operator's positions on Halifax, with and without sound-proofing. Fig. 9 shows the variation in noise level on different aeroplanes, at maximum cruising conditions, at the pilot's position.

4. *Results.*—It will be seen from Fig. 9 that there is a large variation of noise level between the various aeroplanes, amounting to 15–20 db. at low frequencies and 30 db. at high frequencies. In this section, the results on each aeroplane will be considered in turn, and an attempt will be made to account for the observed curve, qualitatively, by considering the geometry of the aeroplane, the surroundings of the crew stations, and the degree of soundproofing.

In examining the curves, the following points should be remembered :—

(*a*) The noise due to the passage of the airscrew blades past the fuselage will usually be most pronounced at a frequency equal to six times the airscrew rotation frequency, i.e., two three-blade airscrews out of phase. In certain cases, when the effect of one airscrew predominates, the noise will be most pronounced at half this frequency.

(*b*) Similarly, the exhaust noise will usually be most pronounced at the explosion frequency or at twice this frequency, depending on the number and positions of the exhaust manifolds.

(*c*) Aerodynamic noise, of high frequency, will arise whenever air at high speed passes projecting edges, such as occur on windscreens, bomb aimer's windows etc.

(*d*) There will sometimes be noise from such sources as airscrew blade vibration, engine vibration transmitted through the structure, rattling of loose installations, etc.

(*e*) Soundproofing will reduce high frequency noise considerably, but will have little effect at low frequencies.

4.1. *Halifax.*—Without soundproofing, the Halifax was, to the ear, a borderline case, *i.e.* the noise was not excessive, but it was considered that a reduction would be welcome. The aeroplane was therefore tested both with and without soundproofing.

Tests were made in the pilot's and W/T operator's positions. The pilot's position (1 of Fig. 1 and Figs. 18 and 19) has transparent material down to chest level, and metal walls and floor below. In the soundproofed condition, soundproofing material was introduced wherever possible on the walls, and the floor was carpeted. The W/T. operator's position is shown at 2 in Fig. 1, and in Figs. 20 and 21. In the unsoundproofed state, the operator is surrounded by metal surfaces except on his right hand, where the compartment is open to a gangway leading to the nose. There is a small perspex window on the operator's left. For the second tests, all the metal surfaces were covered with soundproofing material and a curtain down to table level divided the compartment from the gangway. The soundproofing material was applied by Rumbolds in layers from ½ in. to 1 in. thick, and the weight was about 100 lb.

Referring to Figs. 10 and 11, it will be seen that at low frequencies the noise level is about the same at the pilot's and W/T operator's positions, but at high frequencies the pilot's position is the noisier. Soundproofing produces a decrease of about 10 db. in the high frequency noise at both positions, but gives a slight increase at low frequencies, probably due to resonance of one of the panels of material.

The high frequency noise at the pilot's position does not appear at the W/T operator's position which is at a similar distance from the engine and airscrew ; this noise may therefore be attributed to aerodynamic noise from the cockpit cover.

In the unsoundproofed condition, the principal sources of noise seem (from the frequency curves) to be the airscrew rotation (*i.e.* six times the rotation frequency) and the exhaust (fundamental frequency) at the pilot's position, and the airscrew alone at the W/T position. The noise level at these frequencies is not high, because the distance of the airscrews and engines from the fuselage is greater than the average. It may be noted that the frequency of six times airscrew rotation rate disappears from the W/T position when soundproofed, because the position is then screened from the starboard airscrew.

In the soundproofed condition, the noise level judged by ear is satisfactory.

4.2. *Fortress.*—The noise level in the Fortress in cruising conditions is unusually low, and this must be attributed to the excellence of the soundproofing, which is very thorough. The weight of material used for soundproofing is not known.

At a given engine condition, the noise level is highest at the navigator's position (2 of Fig. 2), due to this position being in the plane of the inboard airscrews. The curve shows a marked peak at the blade frequency of a single airscrew, with other peaks apparently due to the two airscrews and to the explosion frequency.

The pilot's position is unusually quiet when cruising at 1900 and 2100 r.p.m. but in maximum level speed conditions (2500 r.p.m.) the airscrew tip speed rises to about 0·95 of the speed of sound, and there is an increase of about 15db. between 200 and 2000 cycles. Under these conditions, peaks are apparent at the explosion frequency and at twice this frequency.

4.3. *Wellington IA and IV.*—Measurements were made only at the W/T operator's position shown in Figs. 3 and 4. It will be seen that this position is well away from the engine exhaust, and from the windscreen and would therefore be expected to be reasonably quiet at high and medium frequencies. It is, however, within 3–4 ft. of the airscrew tips and would be expected to show rather more airscrew noise than say the Halifax.

The curves show a behaviour approximating to the above, except the Wellington IV at maximum level speed conditions. In this case, a series of high frequency peaks appear, which, to the ear, suggest airscrew noise. Remembering that the position of the peaks is not very well defined because of the small number of points, the peaks occur at two, four and eight times the explosion frequency, and may perhaps be torsional blade vibrations, excited by the explosion frequency.

4.4. *Hudson.*—The Hudson, like the fortress, is well soundproofed and shows almost as low a noise level, in the W/T operators position. There are two small windows, and the remainder of the wall space is soundproofed by means of two layers of a wool-like substance, $\frac{1}{8}$–$\frac{1}{4}$ in. thick, with a $1\frac{1}{2}$ in. airspace, the whole being covered by fabric.

As on Wellington, and for similar reasons, there is little high and medium frequency noise. There is a moderate amount of noise at a frequency which might be either three times the airscrew rotation rate, or twice the crankshaft rate. In view of the distance from the airscrews, the fact that it is felt as a vibration rather than a noise, and the fact that the beats suggest an effect due to both engines (and therefore at twice some frequency of the system), it seems probable that this noise is an engine vibration effect transmitted through the structure.

A point of interest in the Hudson curves is the effect of the undercarriage hooter on the glide. This noise, of about 97 db. at 2000 cycles, is piercing and very annoying when heard alone, yet reference to Fig. 9 shows that it would contribute little to the noise of a Halifax, Lancaster or Manchester at cruising speeds, and we may obtain from this some impression of the intensity of the noise in these three aeroplanes.

4.5. *Lancaster.*—There is no soundproofing in the Lancaster. The pilots' position (1 of Fig. 6) is within 4–5 ft. of the airscrew tips, has metal walls and floor, and windows $\frac{1}{8}$–$\frac{3}{16}$ in. thick above chest level. The noise would be expected to be similar to that of the unsoundproofed Halifax, or perhaps rather more because of the greater area of transparent material, and this is confirmed by the curves, which show that the principal sources of low frequency noise are the explosion frequency and six times the airscrew rotation rate. There is a fairly high noise level at high frequencies in the pilot's cockpit, but, as would be expected, there is a decrease of about 7 db. at the W/T position (2 of Fig. 6).

The Lancaster was tested with airscrews of 12 and 13 ft. diameter. There was no systematic difference in the noise level, the reason being, presumably, that the decreased pitch compensated for the decreased clearance and increased tip speed.

4.6. *Albemarle*.—Tests were made at the navigator's and pilot's positions. The two positions are similar in that they both have large areas of transparent material, wooden skin and metal floor. There is no sound proofing.

The pilot (1 of Fig. 7) is within 3 ft. of the airscrew tips, and there is a high noise level at low frequencies; the high frequency noise is, however, low compared with the same position on other unsoundproofed aeroplanes, suggesting fewer excrescences on the windscreen, which is confirmed by inspection. There is little sign in the curves of exhaust noise.

The navigator's position (2 of Fig. 7) gives, as expected, less airscrew noise, but gives peaks at the explosion frequency and at two and four times this frequency; the reason is not clear.

4.7. *Manchester*.—Tests were made in the pilot's position, which is similar in all respects (including airscrew clearance and distance from exhaust) to the pilot's position on Lancaster. It will be seen from Fig. 17 that the resulting curves are also very similar. There is a suggestion in the curves of a peak at half the explosion frequency, probably due to the starboard exhaust of the port engine being nearer to the pilot than the other three exhausts.

5. *General Discussion of Results*.—5.1. *Comparison of Measurements with Aural Assessment*.—It seems from Section 4 that the noise level to be expected in an aeroplane at any crew station can be predicted very roughly from a consideration of the distances of the crew stations from sources of noise such as exhausts and airscrews, the presence or absence of large areas of transparent material, the aerodynamic cleanness of windscreens and the degree of soundproofing.

The pilot's reaction to a noise does not, however, depend only on its loudness, and at least three other effects must be considered.

(*a*) *Masking of speech*.—Low frequencies mask higher frequencies more easily than the reverse, and thus aeroplane noise in which low frequencies predominate (and are less easily removed by soundproofing) can easily mask those speech frequencies which are necessary for intelligibility. The importance of the effect has declined with the improvement of intercommunication.

(*b*) *Annoyance*.—The degree of annoyance caused by a noise does not depend only on its loudness. Rattles, squeaks, whistles, drumming etc., annoy out of proportion to their loudness. For continuous sounds, the middle frequencies are stated by London[1] (1940) to be the least annoying, and this shows the need for eliminating projections into the airstream which give rise to high frequency whistles.

(*c*) *Vibrations*.—These may contribute to the general effect of noise. The greater the frequency, the smaller the amplitude of vibration which can be detected, and a high frequency noise may not only be undesirable as a noise, but may be the key to an irritating vibration.

These considerations, together with the fact that the noisemeter does not record peak values of the pressure wave, make it impossible to obtain any exact correlation between the frequency curves and the assessment made by the crew.

Opinions have been collected from pilots and observers of the relative merits of the six aeroplanes for which noise levels have been measured in the pilot's position. These opinions were based mainly on annoyance and after effects following flights of moderate duration, and the same group of pilots had flown all the aeroplanes. In cruising conditions, Albemarle is considered to be noisy, Manchester and Halifax (unsoundproofed) average, Lancaster and Halifax (soundproofed) quiet or pleasant, and Fortress very pleasant. In all-out level conditions, Albemarle is considered excessively noisy, Manchester noisy, Halifax (soundproofed or not) and Lancaster average, and Fortress pleasant. Measurements on all six aeroplanes are available only in cruising conditions. A comparison with the curves of Fig. 9 will show agreement with the above order for Manchester, Halifax (soundproofed or not), and Fortress. Albemarle, however, is noisier than the curves would suggest and Lancaster less noisy.

The noise on the Albemarle, particularly in all-out level conditions, is described by different pilots and observers as either a piercing, high frequency note or as a throbbing note, in both cases affecting the eardrums during and after flight. The general noise level measured in cruising conditions is not high, but there is a hint of a possible explanation in Table 6 where beats at low frequencies show maximum of 123 db. and there may be peaks of short duration (which would not be observed on the noisemeter) rising higher still.

There is no obvious explanation of the pilot's opinion that the Lancaster, in cruising conditions, is similar to the soundproofed Halifax and quieter than the unsoundproofed Halifax. At high frequencies, the Lancaster curves agree closely with the unsoundproofed Halifax, and at low frequencies the Lancaster noise level exceeds that of the unsoundproofed Halifax. Table 1 shows that no record was made of the beats during the tests of the unsoundproofed Halifax, and it is possible that, as on Albemarle, high peak values were present compared with Lancaster. But, unless the improvement due to soundproofing on Halifax was due to a reduction in low frequency peaks and not to the reduction of noise level at high frequencies, this would not explain why the Lancaster is not considered to be noisier than the unsoundproofed Halifax.

It seems therefore that although the general shape of the mean noise curve can be predicted, yet this curve does not in all cases agree with the crew's assessment of comfort or discomfort, and that some supplementary test is required to complete the picture.

5.2. *Suggested Tests to Assess Noise.*—It is, therefore, suggested that a more complete determination of the noise characteristics of an aeroplane would be given by the following tests:—

(*a*) Measurement of the curve of noise level against frequency, by means of the present equipment. This would show whether the general noise level, at any part of the frequency range, is too high.

(*b*) An exploration of the aeroplane, by ear, to detect any noise of an "annoying" type such as rattling fittings, drumming panels, aerodynamic whistles etc., and to identify their source.

(*c*) A measurement of the peak sound pressure. This is not determined by the frequency analysis, because the phase relationship is not known. If a high peak value is present, the ears would be affected unpleasantly both during and after flight.

5.3. *Soundproofing.*—It is clear from the curves and the pilot's comments that the majority of British bombers are near the borderline between tolerable and excessive noise. Even when the aeroplane is not so noisy that some improvement must be made to reduce after-effects on the ears of the crew, the comfort and therefore the efficiency of the crew after long flights would benefit from a reduction of noise towards the value observed in the Fortress.

The Halifax is the only example available of the result of applying soundproofing materials after the construction of the aeroplane; about 100 lb. of material produced an appreciable decrease in noise, both to the ear and by measurement. It is, however, difficult to apply the soundproofing material at this stage without interfering with maintenance by covering pipes, cables, etc., and the area which can be covered is limited by various fittings. It is, therefore, for consideration whether it would not be desirable to devote some of the weight to local thickening of the fuselage panels and windows, particularly in the plane of the airscrews; this would reduce the amount of soundproofing material required, and if the distribution of the material were considered, in the design stage it should be possible to produce a more acceptable noise level, without interfering with maintenance. It should also be noted that, unless non-inflammable material is used, a reduction in the amount of material is desirable to reduce the risk from incendiary bullets.

5.4. *Miscellaneous Noises.*—In addition to noises from the normal sources, a number of noises of the "annoying type" have been observed on various aeroplanes. Although the noise level is usually not high, such noises can be very irritating to the crew, and care should be taken to eliminate them. Examples are aerodynamic whistles from a gun turret, rattling fittings, pipes which vibrate and make contact with a panel to produce a buzzing sound, and drumming panels. They are easily detected by aural investigation.

6. *Conclusions.*—A comparison of the curves of noise level against frequency with rotational frequencies present shows that the principal sources of noise are airscrew rotation and exhaust noise at low frequencies, and aerodynamic noise at high frequencies; in certain cases other factors such as airscrew torsional vibration and engine vibration appear to contribute.

The noise level to be expected can be predicted roughly from a consideration of the distances of the crew stations from sources of noise such as exhausts and airscrews, the presence or absence of large areas of perspex, the aerodynamic cleanness of windscreens and the degree of soundproofing.

The curve of noise level against frequency does not in all cases agree with an assessment by the crew, and it appears that some other measurement, probably of peak pressures, is necessary to complete the picture. It is, therefore, suggested that a more complete determination of the noise characteristics would be given by a combination of three tests—frequency analysis, peak value, and an aural investigation of rattles, etc.

The introduction of some degree of soundproofing is considered to be desirable in the majority of British bombers. The soundproofing material must not be so placed as to interfere with maintenance, and it is for consideration whether some local thickening of the fuselage skin and windows in the plane of the airscrews would not be of advantage in reducing the amount of internal material required.

Care should be taken to eliminate noises of " annoying " type such as rattles, buzzes, whistles and drumming panels, which can be extremely irritating to the crew.

REFERENCE

No.	*Author*	*Title, etc.*
1	London	Principles, Practice and Progress of Noise Reduction in Airplanes. N.A.C.A. Technical Note No. 748. January, 1940.

TABLE 1

Noise Measurements on Halifax L.7245 in Level Flight at about 10,000 ft. with and without Soundproofing.

Condition of Test					Noise Level in Decibels in Frequency Range															
Position	Whether sound-proofed	r.p.m.	Boost lb./sq. in.	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9,600	6,400 12,800
Pilot ..	No.	3,000	$+5\frac{3}{4}$	0·80	115	111	112	112	113	111	106	104	101	99	97	98	101	99	97	99
Pilot ..	No.	2,600	$+4\frac{1}{2}$	0·70	107	105	106	106	110	108	104	102	101	101	99	98	99	101	96	103
Pilot ..	No.	2,600	$+1\frac{3}{4}$	0·69	110	108	110	109	107	105	101	97	94	94	96	96	95	94	92	96
W/T Operator	No.	3,000	$+5\frac{3}{4}$	0·80	105	105	117	116	113	110	100	104	100	97	95	92	94	91	85	86
W/T Operator	No.	2,600	$+4\frac{1}{2}$	0·70	102	103	114	113	108	104	102	100	98	97	95	94	92	89	86	88
W/T Operator	No.	2,600	$+1\frac{3}{4}$	0·69	102	101	111	108	105	103	100	98	92	93	90	88	87	84	82	83
Pilot ..	Yes	2,600	+4	0·70	111 116	113	109 112	108 112	107	101 104	95 96	92	89	88	90 91	93 94	91 92	92	93	95
Pilot ..	Yes	2,600	$+1\frac{3}{4}$	0·69	106 116	103 113	109 114	105 109	105 107	101 103	93 95	90	86	86 87	87 88	86	87	87 88	86	89
Pilot ..	Yes	2,400	−2		111 112	105 109	109 112	105 110	103 104	96 99	92 94	88 90	86 87	87	89 90	88	91 92	89	90	95
W/T Operator	Yes	2,600	+4	0·70	108 114	104 111	103 106	100 104	100 101	95 97	92 94	89 90	84 85	84	80 81	78	78	76	72	74
W/T Operator	Yes	2,600	$+1\frac{3}{4}$	0·69	107 111	105 109	104 109	102 109	98 100	94 96	91 92	88 90	83 84	82 83	79	77 78	77	73 74	70 71	72
W/T Operator	Yes	2,400	−2		99 109	100 106	103 109	101 105	94 96	90 92	83 86	81 83	78 80	77 79	77	76	74	69 70	66	67

Note.—In tests without soundproofing, only the mean noise level was recorded. In the tests with soundproofing, the limits of noise fluctuation due to beats were recorded but, to simplify the diagram, only the mean values have been plotted in Figs. 10 and 11.

TABLE 2

Noise Measurements on Fortress A.N.531 in Level Flight.

Conditions of Tests					Noise Level in Decibels in Frequency Range															
Position	M/c	r.p.m.	Boost in. Hg	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9,600	6,400 12,800
Pilot ..	A/R	2,500	39·5	0·95	106 110	103 116	105 112	110 113	111 115	108 111	109 113	103 105	100 102	95 95·5	90 91	85·5 86·5	84 85	77 78	75·5 76·5	79 80
Pilot ..	A/R	2,100	31	0·81	106 111		99 105		97 103		91 92		82 83		77 78		78 79		77 78	
W/T Operator	A/R	2,100	31	0·81	100 102	98 100	97 99	95 96	96 97	94 96	93 94	90 91	87	84 85	81 82	78 79	75 76	72	70 72	73 74
Navigator ..	A/R	2,100	31	0·81	100 109	113	95 100	102 107	111 113	101 106	102 104	95 96	91 92	86	81 82	76 77	74 75	72	69 70	72 74
Pilot ..	A/W	1,900	27	0·72	102 109	101 104	94·5 95·5	93 99	94 95·5	83·5 91·5	83·5 84·5	82·5 83·5	75·5 76·5	77	75 76	75 76	69·5 71	66·5 68	66·5 68	70 72
W/T Operator	A/W	1,900	27	0·72	98 104	95 101	95 97	93 96	93·5 94·5	90·5 92·5	85·5 86·5	85 86	82·5 83·5	78·5 79·5	76 77	71·5 72·5	70 71	67 68	66·5 67·5	70 72
Navigator ..	A/W	1,900	27	0·72	96 107	105 106	96 101	103 104	103 104	100·5 101·5	93 94	93 93·5	83 84	78 79	75 76	70 72	69 71	67·5 68·5	67·5 68·5	71 73

TABLE 3

Noise Measurements on Wellington IA. R.3155 (Pegasus) and Wellington IV. R.1515 (Twin Wasp)
W/T Operator's Position

Conditions of Tests				Noise Level in Decibels in Frequency Range															
Aircraft	Engine/s	r.p.m.	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9,600	6,400 12,800
Wellington 1A	Pegasus XVIII	2,600	0·82	118 120	109 111	117 119	115 118	114	113	109	107	103 106	105	96	91	91	89	88	89
Wellington 1A	Pegasus XVIII	2,250	0·72	107 115	103 113	109 111	110 115	110 113	103 107	98 99	95	93	93	91	88	88	87	85	87
Wellington IV	Twin Wasp S3C4G	2,700	0·91	126 129	124 128	118 122	117 121	115 117	112 115	110 112	112 115	106	113 115	99	107	92	92	85	89
Wellington IV	Twin Wasp S3C4G	2,250	0·77	117 118	113 118	113 115	113 115	103 106	102 103	100 102	95 96	94 96	94 95	91	87	81	79	75	78
Wellington IV	Twin Wasp S3C4G	2,550*	0·84	118 121	113 118	115 119	113 117	113 115	108 111	109 110	104 105	102	95 96	94	89 90	86 87	84 86	83 86	85 88

* On climb.

TABLE 4

Noise Measurements on Hudson N.7205, at Wireless-operator's Position

Conditions of Test				Noise Level in Decibels in Frequency Range															
	r.p.m.	Boost in. Hg	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9,600	6,400 12,800
Maximum level speed..	2,300	35·4	0·85	106 113	101 115	104 107	105 107	102 105	101 103	101 103	101 103	102	98 100	98 100	97 98	95 96	92 93	89 90	89 90
Cruising rich mixture..	1,900	30	0·71	103 109	103 117	103 108	99 103	99 103	96 99	93 94	93 94	91 92	91 92	89 90	87 88	82 83	81 82	83	85 86
Glide, hooter on ..				101 106	100 103	89 91	87 89	88 91	85 87	82 84	81 82	83	86	83 95	95 96	90 94	86 88	82	83 84
Glide, hooter off ..														90 92	89 90	81			

TABLE 5

Noise Measurements on Lancaster B.T.308 with 12 ft. Airscrews and with 13 ft. Airscrews on Inboard Engines

Conditions of Test					Noise Level in Decibels in Frequency Range															
Position	Inboard A/S dia.	r.p.m.	Boost lb/ sq. in.	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9,600	6,400 12,800
Pilot ..	12 ft.	2,650	+7	0·73	113	106 112	119	111	112	107	102	101	99	100	99	98	101	101	100	104
Pilot ..	12 ft.	2,650	$+3\frac{3}{4}$	0·72	107 111	106 112	114	114	106	103	101	98	96	96	92	96	97	96	97	99
W/T Operator	12 ft.	2,650	$+3\frac{1}{4}$	0·72	107 111	108 112	114	115	112	107	103	99	96	95	97	92	91	89	89	91
Pilot ..	13 ft.	2,650	+7	0·77	113	112	117	114	109	104	98	97	96	97	98	97	99	98	99	102
Pilot ..	13 ft.	2,650	$+3\frac{3}{4}$	0·76	112	109	114	114	107	103	100	96	95	95	96	95	97	96	97	100
W/T Operator	13 ft.	2,650	$+3\frac{3}{4}$	0·76	111	108	111	111	108	105	105	102	98	95	97	92	92	90	89	91

TABLE 6

Noise Measurements on Albemarle P.1360 in Level Flight

Conditions of Test				Noise Level in Decibels in Frequency Range															
Position	r.p.m.	Boost lb./sq. in.	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9,600	6,400 12,800
Pilot	2,400	+2½	0·79	115 123	114 122	111 117	109 113	105 107	101	101	97	96	94	93	89	90	88	87 89	91 94
Navigator ..	2,400	+2½	0·79	105 115	102 112	103 107	105 109	107 109	109	105 107	104 106	102	104	101	99	95	92	89	92
Pilot	2,400	−1	0·78	115 121	112 118	113	105 110	103	99	95 96	94 95	92	90 91	88	87	85	84 85	85 87	86 88
Navigator ..	2,400	−1	0·78	107 113	102 110	101 105	101 105	105 109	103 107	103 105	101 103	100 101	101	100 101	97	94	90	88	89

TABLE 7

Noise Measurements on Manchester L.7277 in Level Flight

Conditions of Test				Noise Level in Decibels in Frequency Range															
Position	r.p.m.	Boost lb./sq. in.	$\frac{V_t}{a}$	37·5 75	50 100	75 150	100 200	150 300	200 400	300 600	400 800	600 1,200	800 1,600	1,200 2,400	1,600 3,200	2,400 4,800	3,200 6,400	4,800 9.600	6,400 12,800
Pilot	2,600	+4	0·77	106 116	106 110	112	106 108	105	102 104	101	98	96	96 97	97	97	98	97	98	100
Pilot	3,000	+6	0·88	118	116	112 118	114	114	112	107	104	100	99	98	98	99	99	99	103

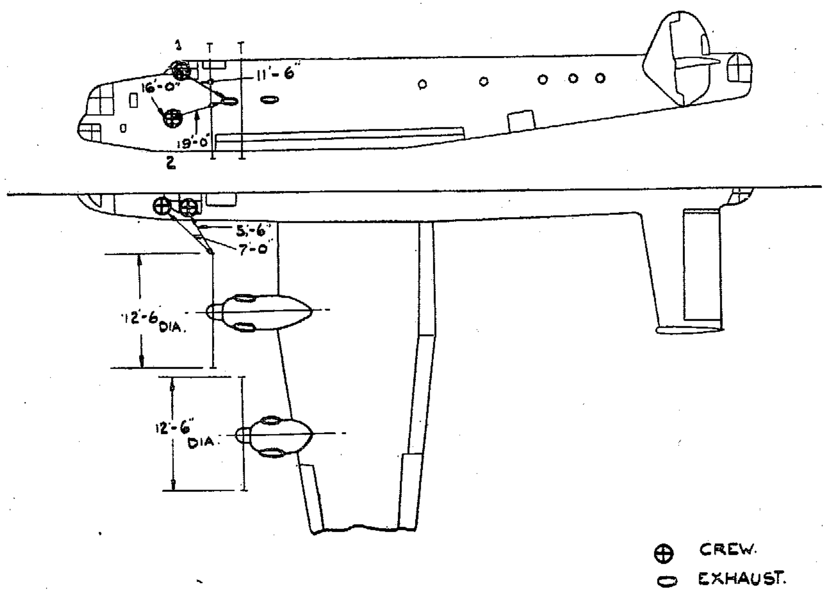

FIG. 1. Halifax.

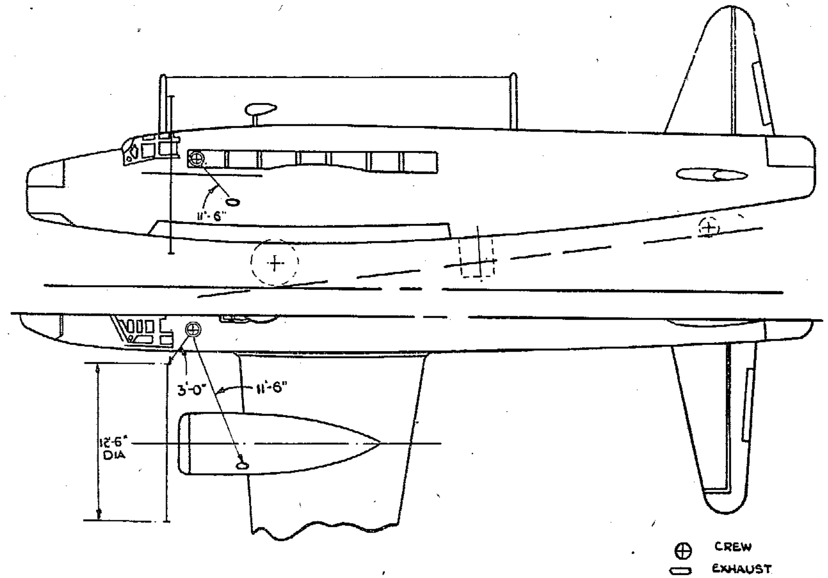

FIG. 3. Wellington Mk. IA.

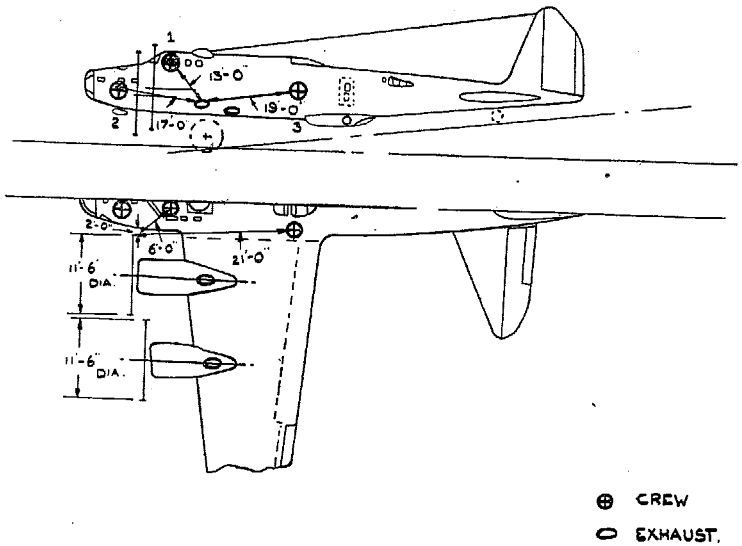

FIG. 2. Fortress.

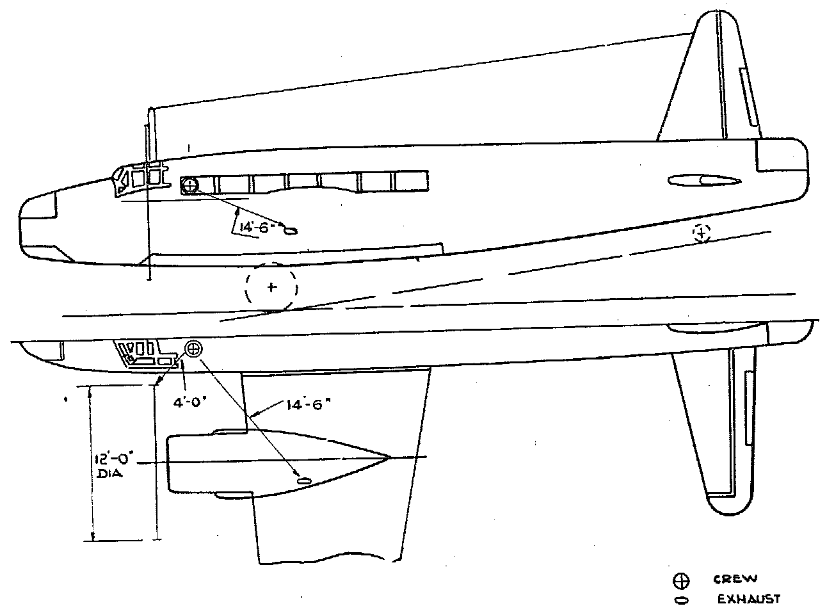

FIG. 4. Wellington Mk. IV.

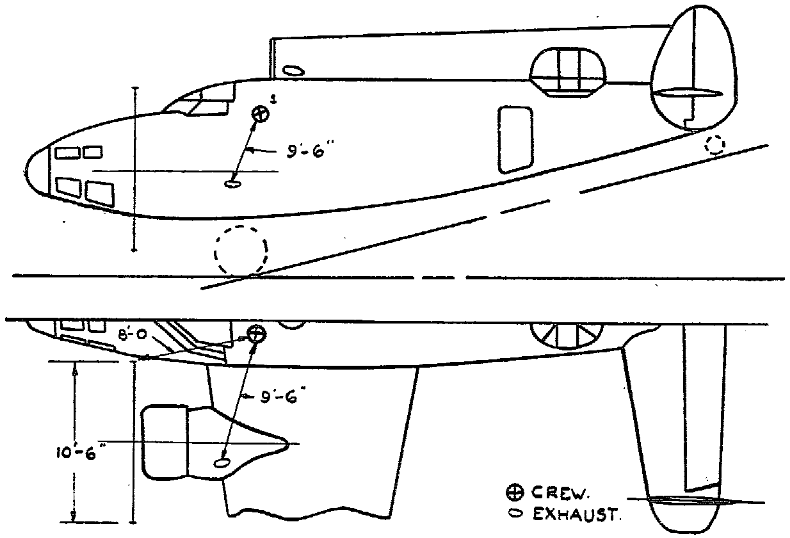

Fig. 5. Hudson.

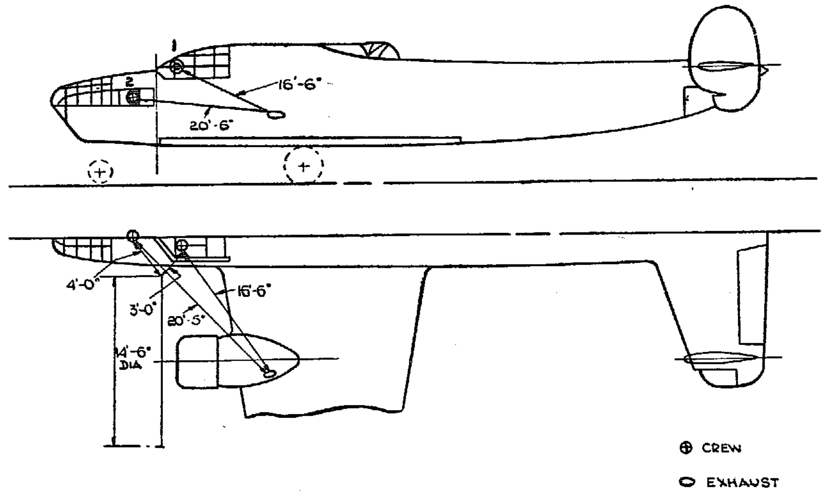

Fig. 7. Albemarle.

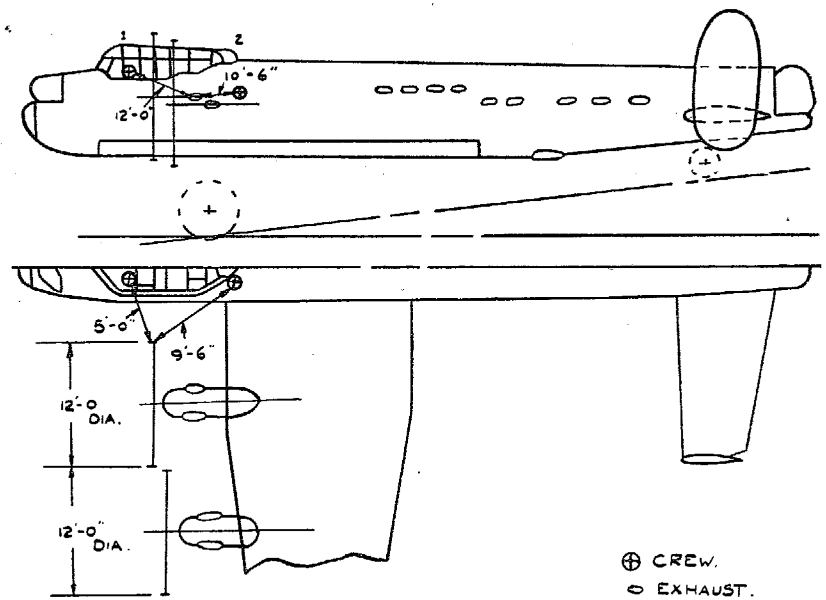

Fig. 6. Lancaster.

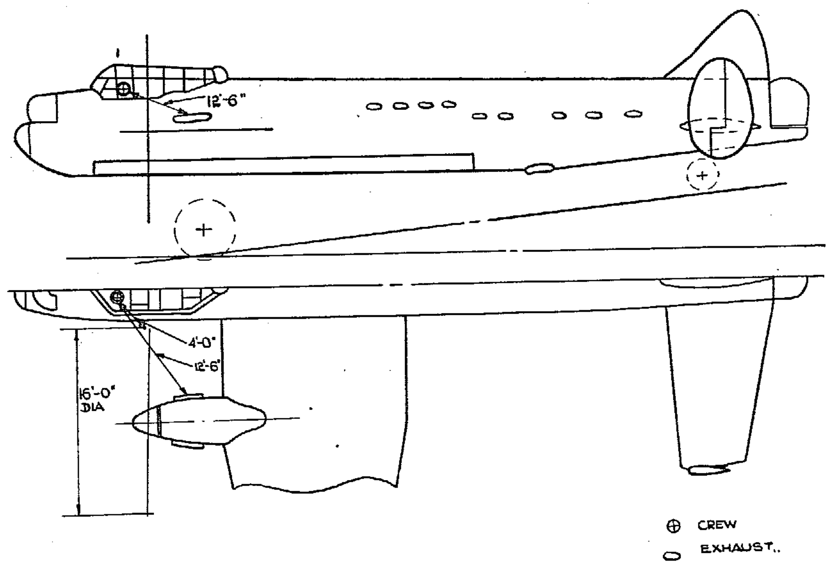

Fig. 8. Manchester

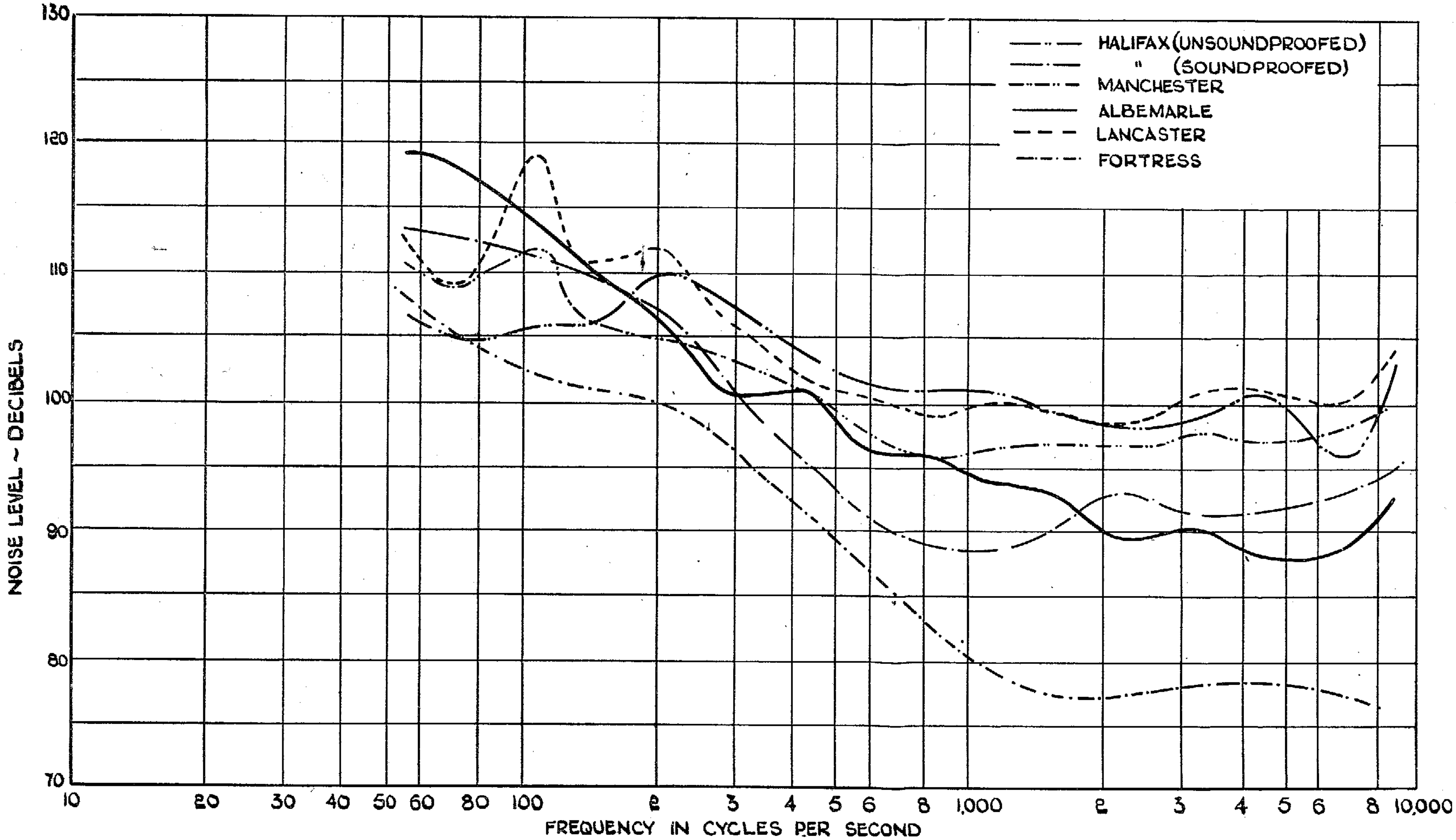

FIG. 9. Frequency Analysis. Comparison of Noise Level on Various Aeroplanes-Pilots' Position. Engine in Maximum Cruising Conditions.

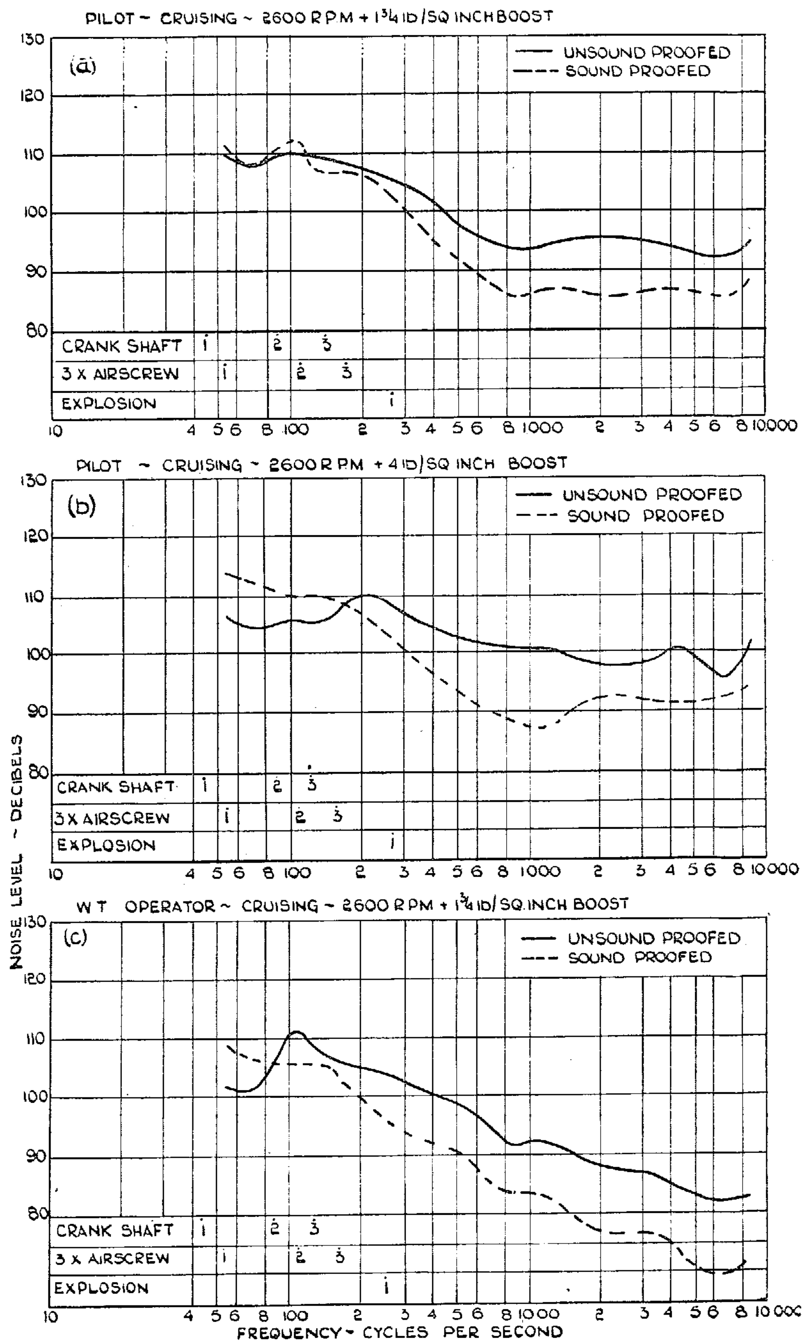

Fig. 10. Halifax L-7245. Frequency Analysis.

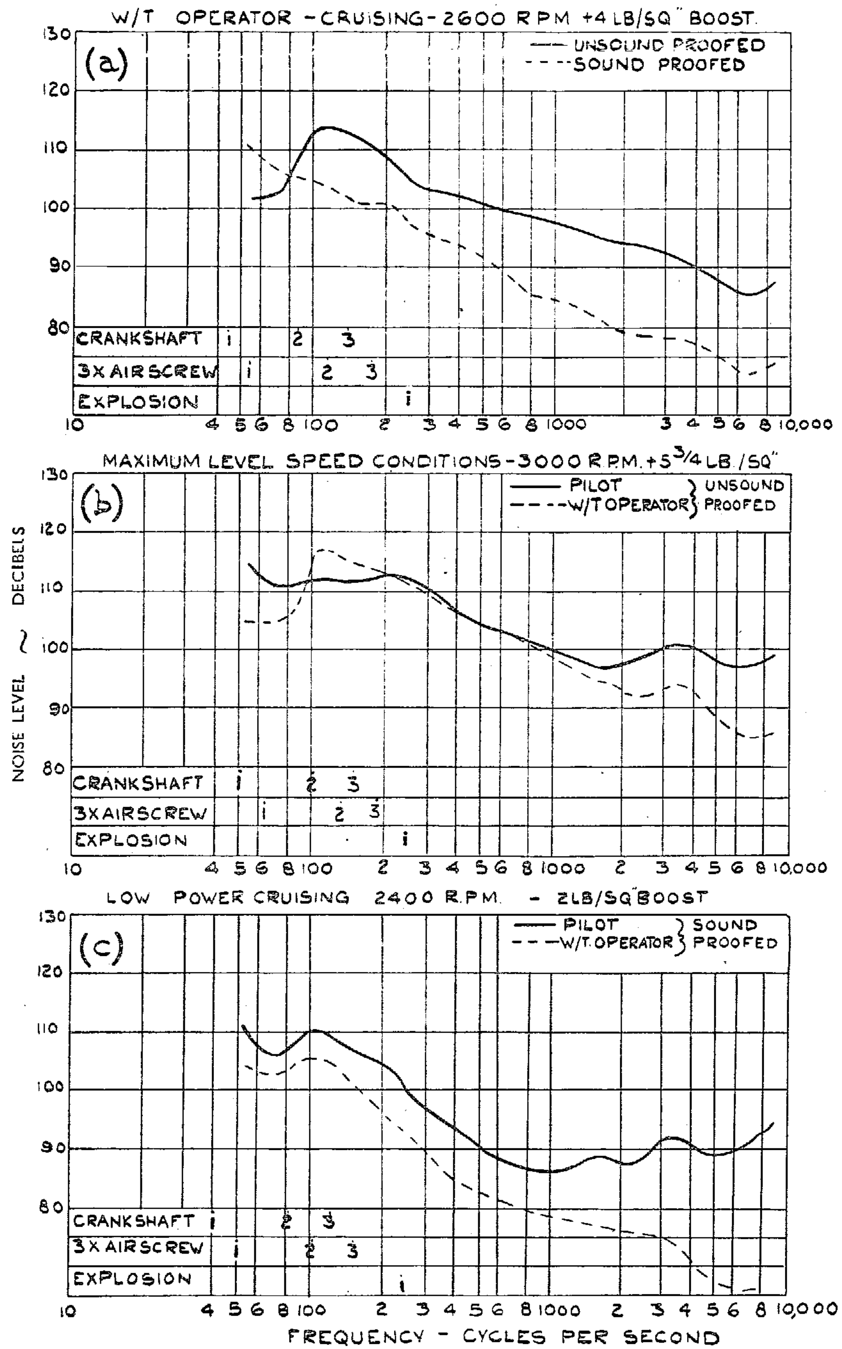

Fig. 11. Halifax L-7245. Frequency Analysis.

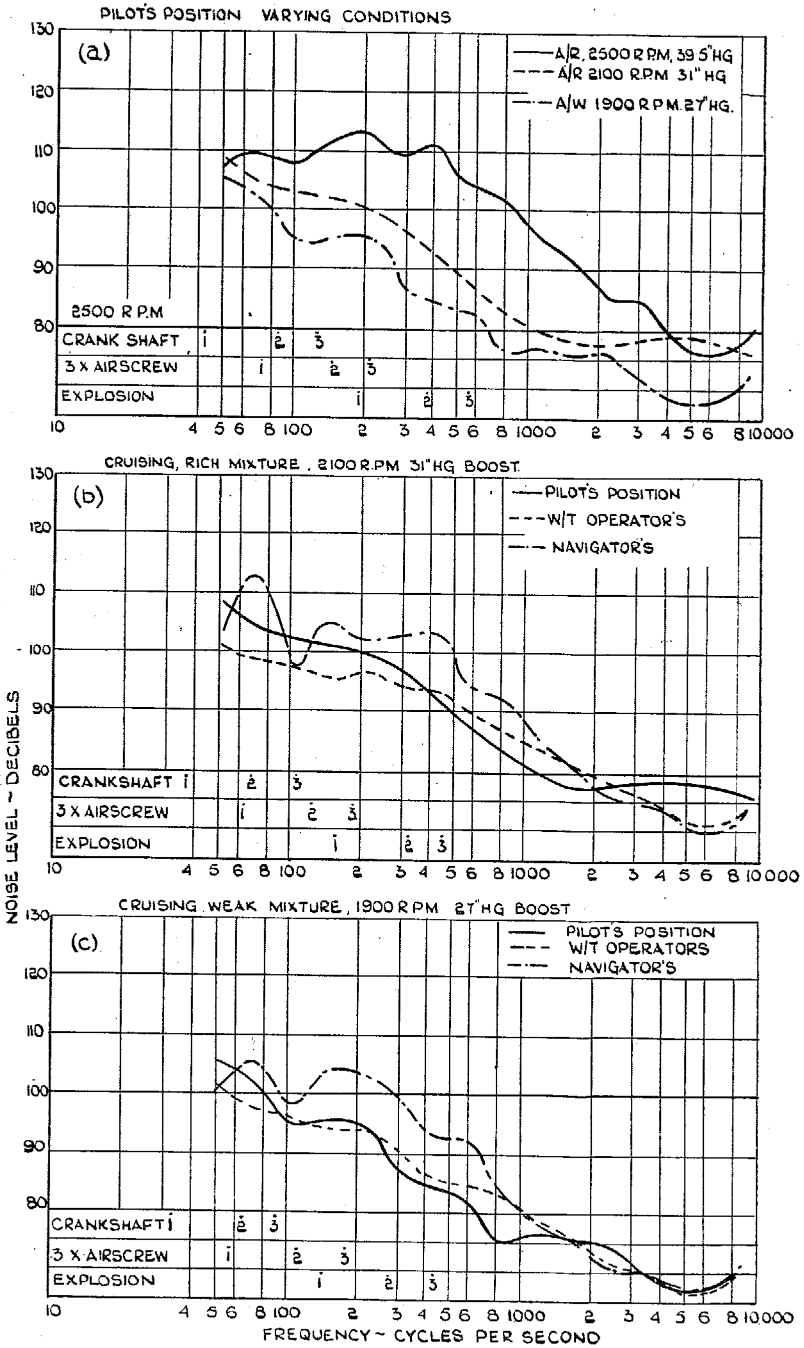

FIG. 12. Fortress AN-531. Frequency Analysis.

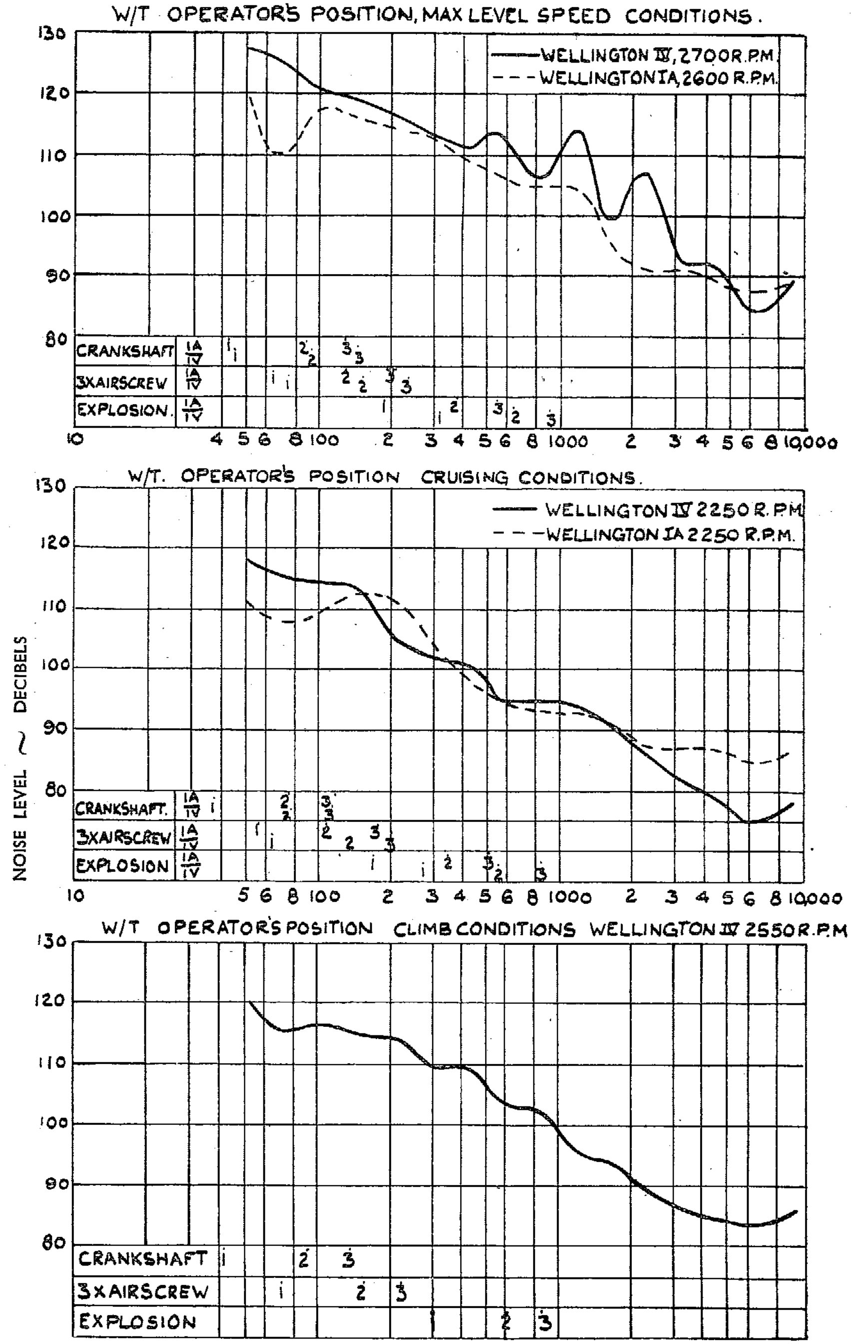

FIG. 13. Wellington IA R3155 and Wellington IV R1515. Frequency Analysis.

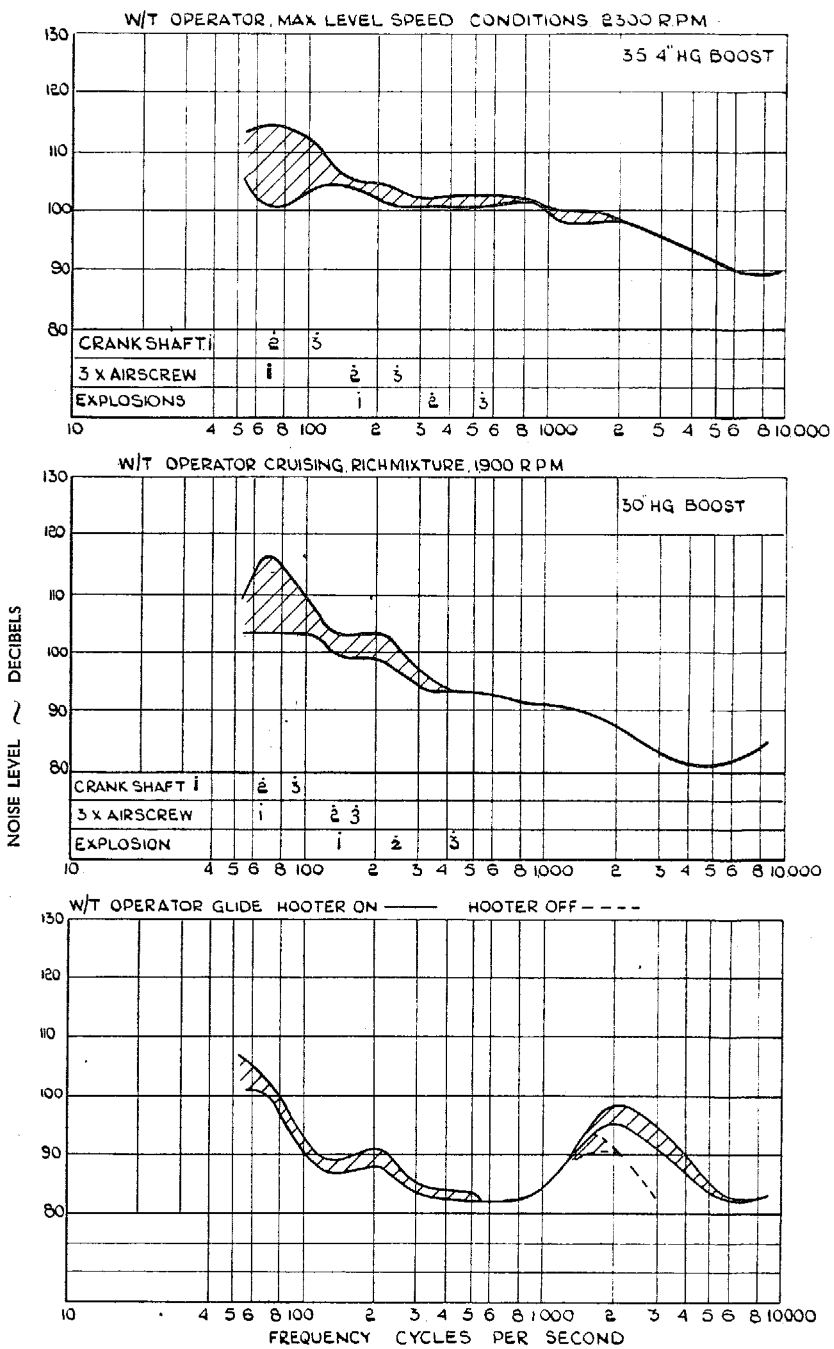

FIG. 14. Hudson N-7205. Frequency Analysis.

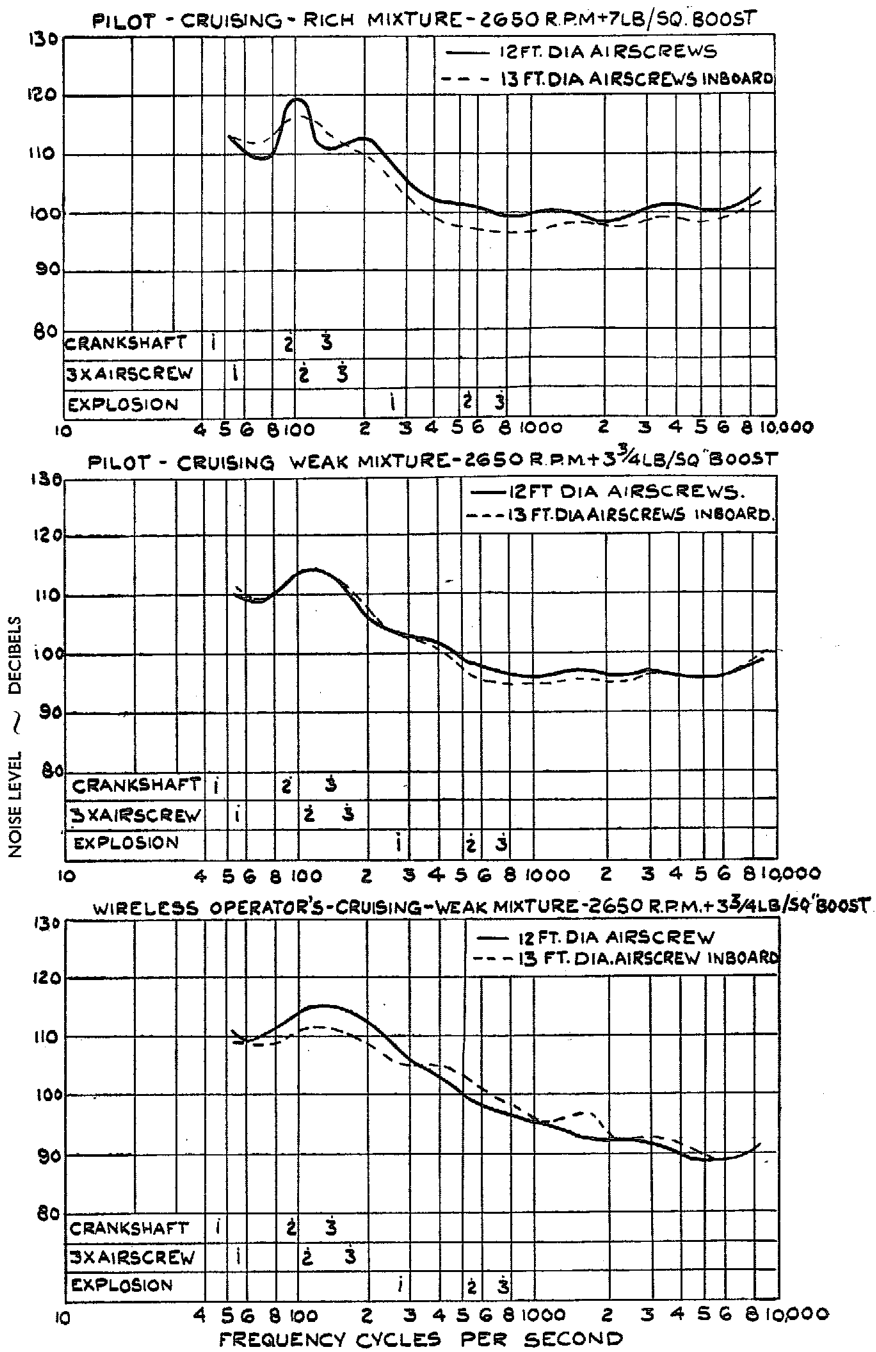

FIG. 15. Lancaster BT308. Frequency Analysis.

(84833)

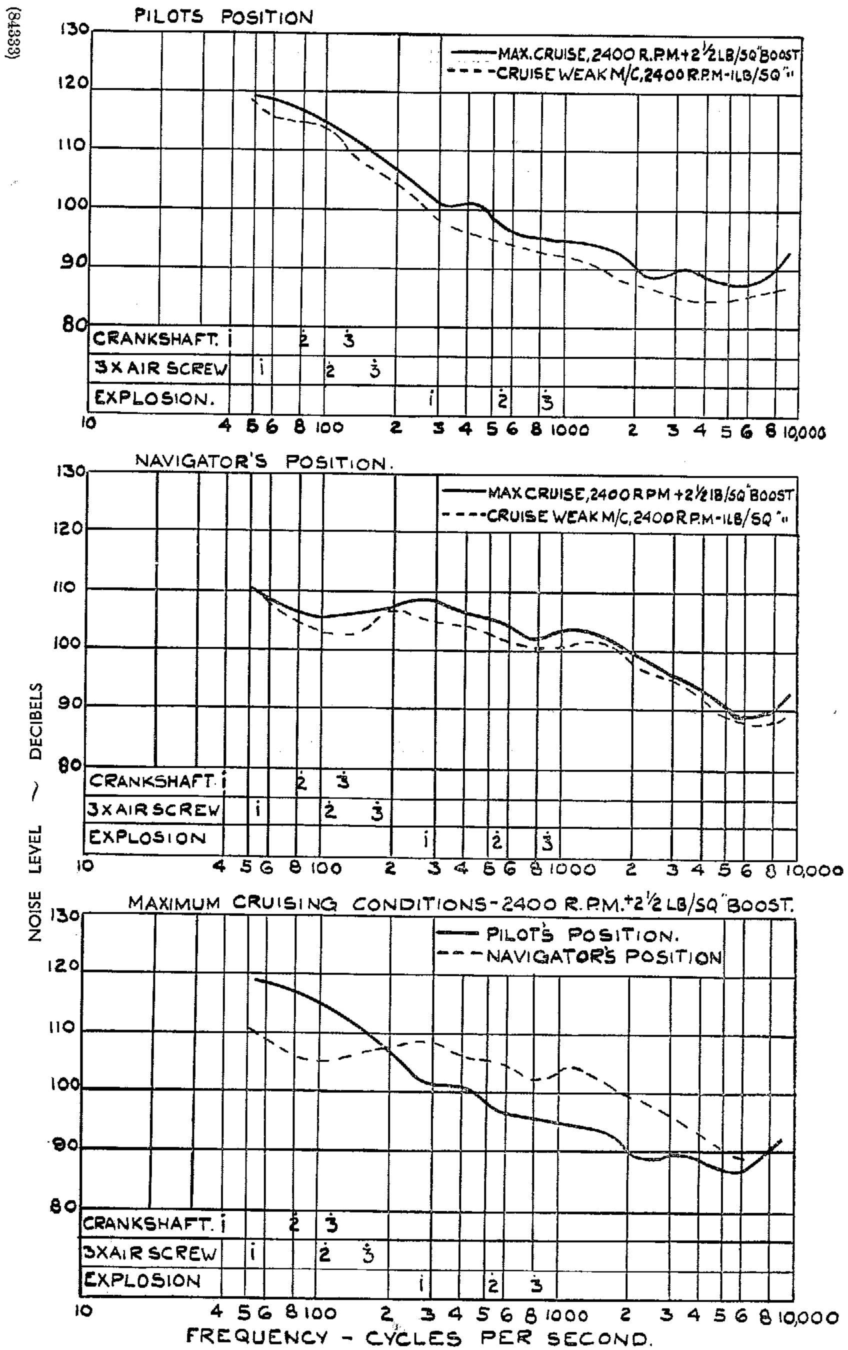

FIG. 16. Albemarle P-1360. Frequency Analysis.

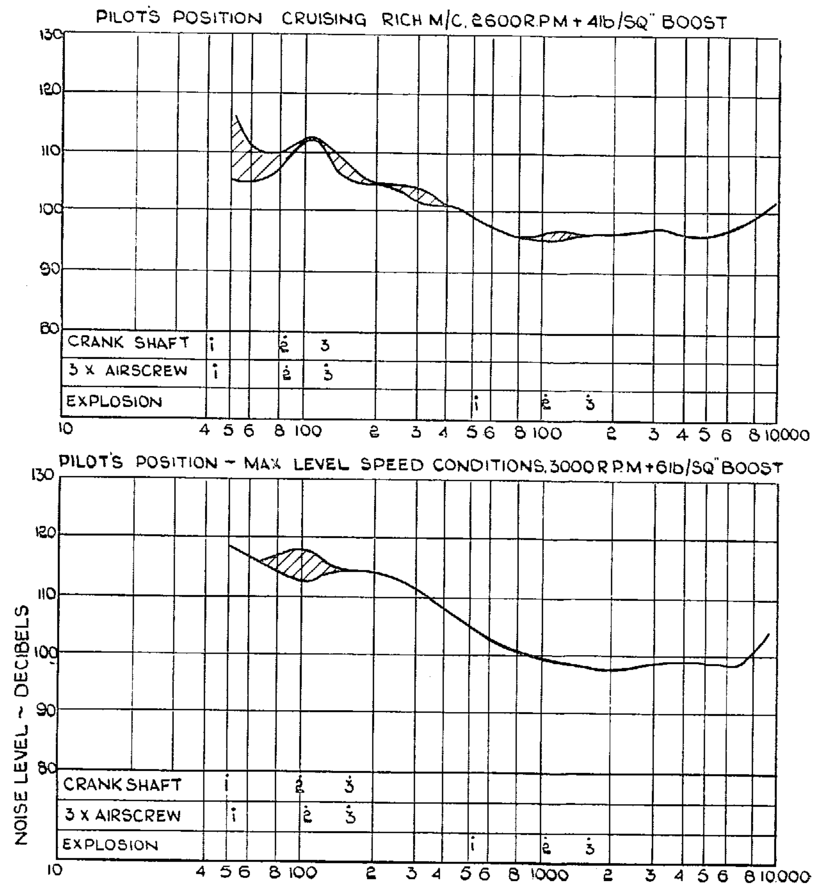

FIG. 17. Manchester L-7277.
Frequency Analysis.

(84333) Wt. 12/818 8/48 Hw.

Halifax—Pilot's Cabin Looking Aft.

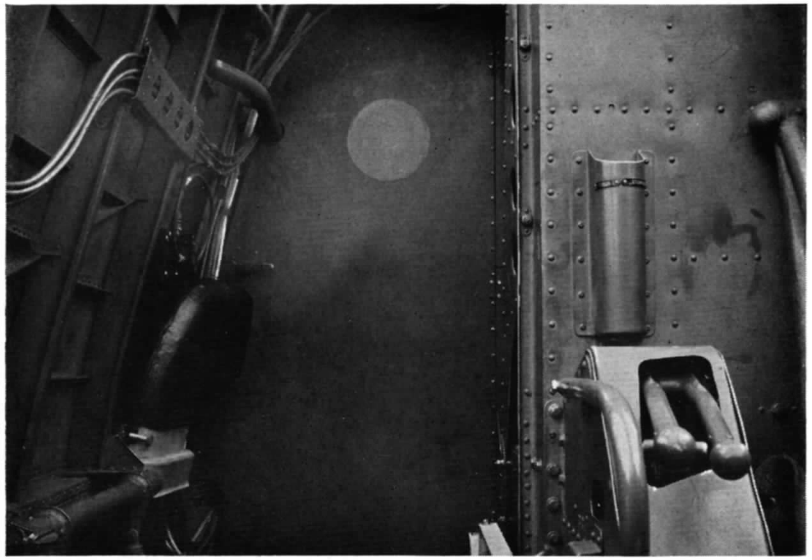

FIG. 18. Unsoundproofed.

FIG. 19. Soundproofed.

Halifax—Radio Compartment.

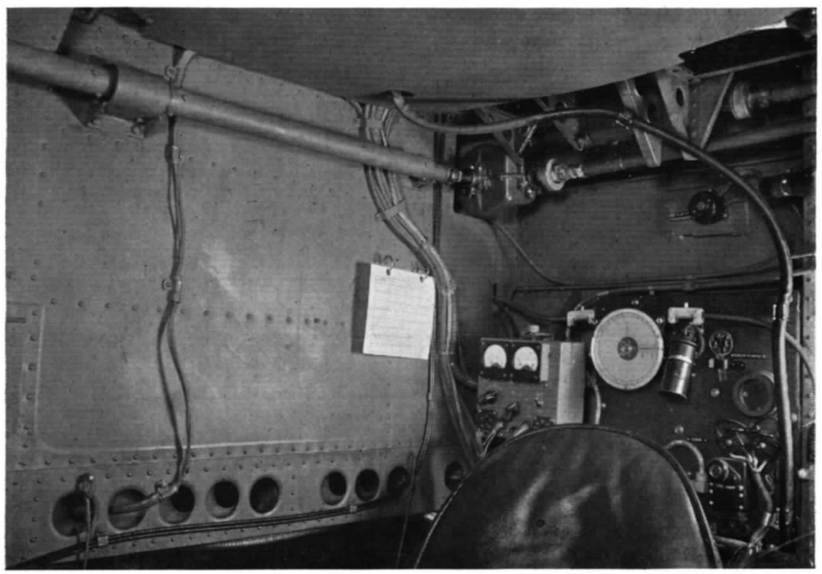

FIG. 20. Unsoundproofed.

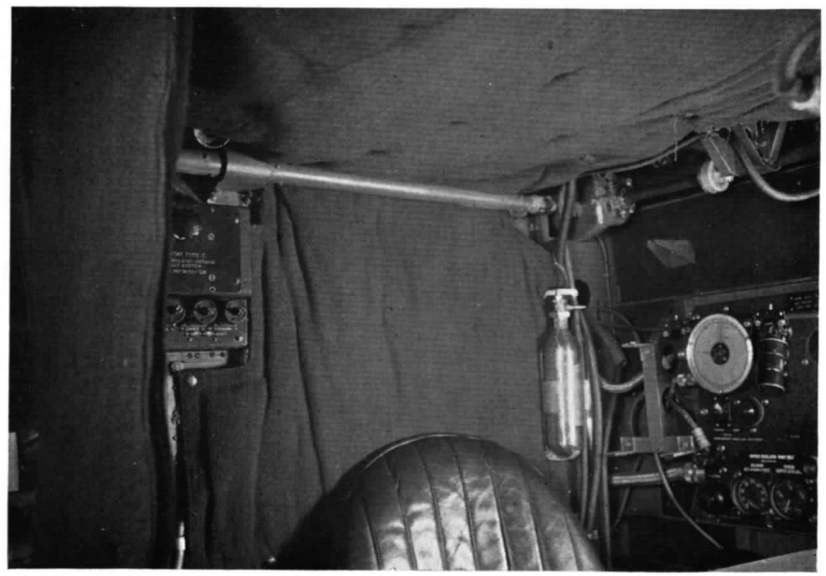

FIG. 21. Soundproofed.

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