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Test Data

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LYCOMING
DIVISION - THE AVIATION CORPORATION
WILLIAMSPORT, 38, PENNA.

INVESTIGATION OF THE PERFORMANCE OF
THE 70727 REED VALVE COMBUSTION CHAMBER USING
THE 70862 FUEL SCREEN
Section I - Item 3 - Contract NOa(s)-4718

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LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1100

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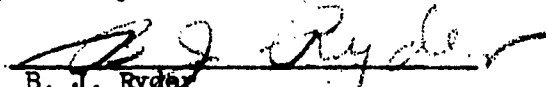
Dates of Test:
February 25, 1947 and
March 5, 1947
Date of Report:
March 31, 1947

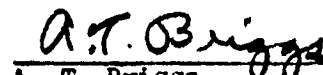
INVESTIGATION OF THE PERFORMANCE OF
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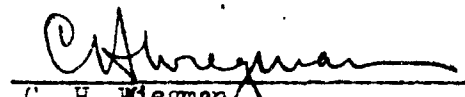
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LYCOMING
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REPORT NO. 1100

INVESTIGATION OF THE PERFORMANCE OF THE 70727
REED VALVE COMBUSTION CHAMBER USING THE 70862
FUEL SCREEN.

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A P P E N D I X

Copies of log sheets, pages 135, 137, 145, 146 are attached
to this report.

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REPORT NO. 1100

~~R E S T R I C T E D~~INVESTIGATION OF THE PERFORMANCE OF THE
70727 REED VALVE COMBUSTION CHAMBER USING
THE 70862 FUEL SCREEN.OBJECT:

1. The object of this investigation was to determine the relative performance of the 70727 reed valve combustion chamber using the 70862 fuel screen.

SUMMARY:

2. The 70862 fuel screen is a steel cone with the surface perforated with holes. It was located in the front end of the chamber with the big end toward the rear.

3. The 70862 fuel screen was tested in an effort to improve the performance of the 70727 reed valve combustion chamber by promoting better atomization of fuel and mixing with the air.

4. The investigation was carried out with both the 1.060" diameter and the 1.375" diameter jet nozzle sizes.

5. While use of the 70862 fuel screen promoted steadier operation, no improvement in performance was found.

CONCLUSIONS:

6. It is concluded that:

- (a) Operation with the 70862 fuel screen promotes consecutive cycles more nearly alike, than without the screen.
- (b) No improvement in performance was found by use of the fuel screen.

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- (c) The performance with the fuel screen was slightly inferior to the "no screen" performance when using the 1.375" jet nozzle. The difference in performance with and without screen when using the 1.06" jet nozzle was negligible.
- (d) Varying the injection nozzle tip distance from the front of the combustion chamber over a range of .75" to 1.75" did not affect performance.

RECOMMENDATIONS:

7. It is recommended that:

- (a) Additional fuel screen and fuel injection nozzle design combinations be submitted for testing.
- (b) Other methods of introduction of the air-fuel mixture into the combustion chamber be devised for testing.

DESCRIPTION:

8. Reference is made to Report No. 1097 entitled "Initial Test of the Multi Reed Valve Combustion Chamber", for a detailed description of the 70727 reed valve combustion chamber.

9. Print No. 70862 on page 12 shows the construction of the fuel screen. The sketch on page 5 shows the location of this screen in the combustion chamber.

10. A 60° spray angle Bosch injection nozzle was used.

METHOD OF TEST:

11. Using the 1.060" diameter jet nozzle, runs were made 900 cpm, 20 psi ram and about 95 lb/hr fuel flow. Both with and without the fuel screen, three injection nozzle tip distances from the front of

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the chamber were tested over a range of .75" to 1.75". This distance (A) is shown on the sketch on page 5.

12. Using the 1.375" diameter jet nozzles, runs were made with and without the fuel screen at 900 cpm, 20 psi ram and three fuel flows from about 125 to 190 lb/hr. An injection nozzle tip location of 1.25" from the front of the chamber was used.

13. The report referred to in paragraph 8 and also Report No. 1056, entitled "Report on the Initial Test of the Rotary Sleeve Valve Combustion Chamber" describe the test stand and the equipment used in the subject tests.

RESULTS:

14. Results of the subject investigation are shown on the curves on pages 6 through 11. Data used is presented on prints of the original data sheets which will be found in the Appendix of this report. In addition, for the runs used, M.I.T. pressure-time indicator cards and photographs of the oscilloscope diagrams taken with the Trimount electronic pressure pick-ups are shown on pages 13 through 26.

15. The curve No. 7463, page 6 of thrust versus distance of the injection nozzle tip from the chamber end shows that with or without the use of the fuel screen, thrust remains practically constant over distances of .75" to 1.75" from the chamber end at a given set of operating conditions. This data was taken while using the 1.060" diameter jet nozzle.

16. Curves No. 7464 through 7468, pages 7 through 11 show comparative data taken on the 1.375" jet nozzles with and without the fuel screen. Over a range of fuel flows, operation without the fuel screen produced both higher thrust and higher specific thrust.

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17. Referring to the M.I.T. pressure time indicator cards for run 751 on page 22 and run 754 on page 25, which were taken respectively with and without the fuel screen at the same conditions, it can be seen that the card taken for run 751 has somewhat more scattered points than run 754 because of the unsteadier operation. This condition is more evident when observing the oscilloscope diagrams for runs Nos. 752 and 755 (Page 13) which were taken with and without the fuel screen.

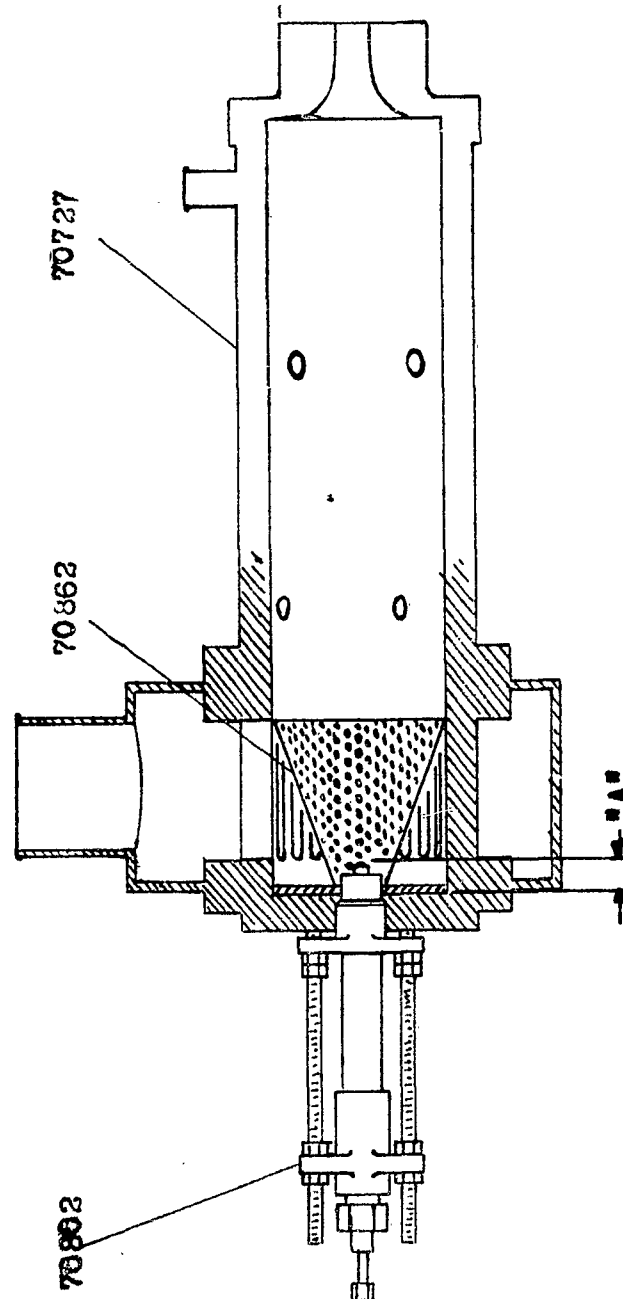
DISCUSSION:

18. Tests of the 70862 fuel screens were restricted in scope since 60° was the widest spray angle obtainable with the fuel injection nozzles on hand. It is believed that this angle was too small to cause the fuel to impinge on the fuel screen when in use. To properly evaluate the performance with fuel impinging on the fuel screen in an attempt at better fuel atomization and mixture with the air, the fuel screen and the fuel injection nozzle designs should be selected in combination to ensure that fuel impingement on the screen occurs.

19. Judging by tests so far conducted investigation of other means of introduction of the air fuel mixture into the combustion chamber are imperative if any appreciable operational improvement is to be gained.

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REPORT NO. 1100

Sketch of 70862 Fuel Screen Installed in the
70727 Reed Valve Combustion Chamber

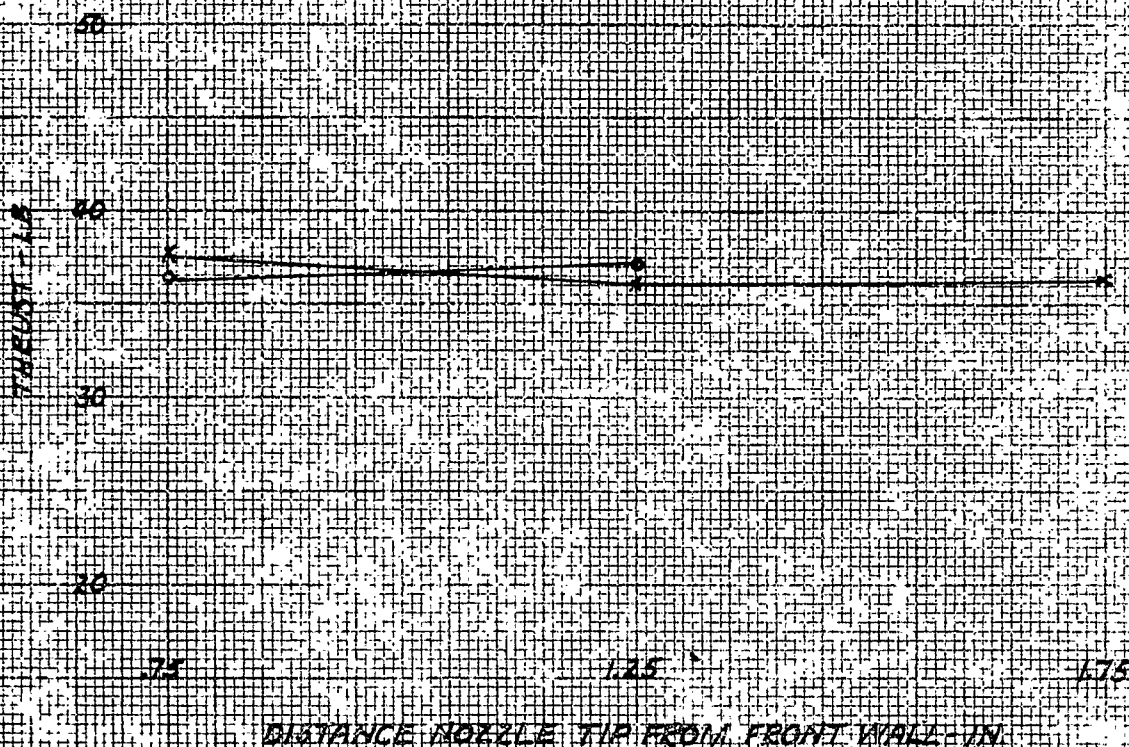
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REPORT NO. 1100
CURVE NO. 7463

REF. VALVE COMBUSTION CHAMBER THRUST vs NOZZLE LOCATION

1000 IN. DIA JET NOZZLE
900 CPM
20 PSI RAM
9% LMPR FUEL FLOW APPROX
DATE: FEBRUARY 15, 1947

○ FUEL SCREEN IN, RUNS 729, 730
X NO FUEL SCREEN, RUNS 733, 734, 735



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REPORT NO. 1100
CURVE NO. 7464

REED VALVE COMBUSTION CHAMBER THRUST VS AIR FLOW

1.375 IN. DIA JET NOZZLE

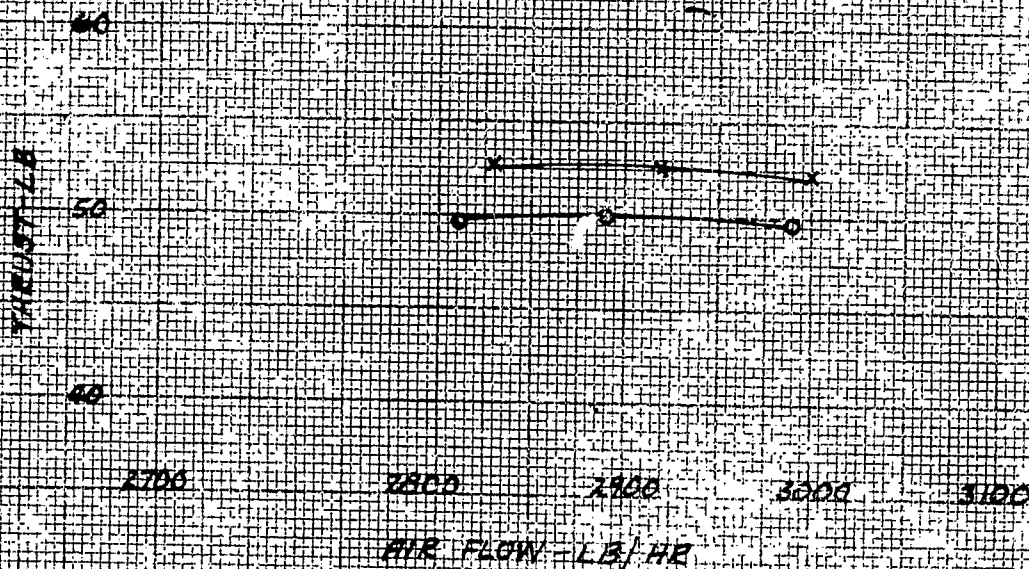
900 RPM

20 PSI RAM

DATE MARCH 5, 1947

O FUEL SCREEN IN - RUNS 750, 751, 752

X NO FUEL SCREEN - RUNS 753, 754, 755



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REPORT NO. 1100
CURVE NO. 7465

REED VALVE COMBUSTION CHAMBER THRUST VS FUEL FLOW

1.375 IN DIA JET NOZZLE

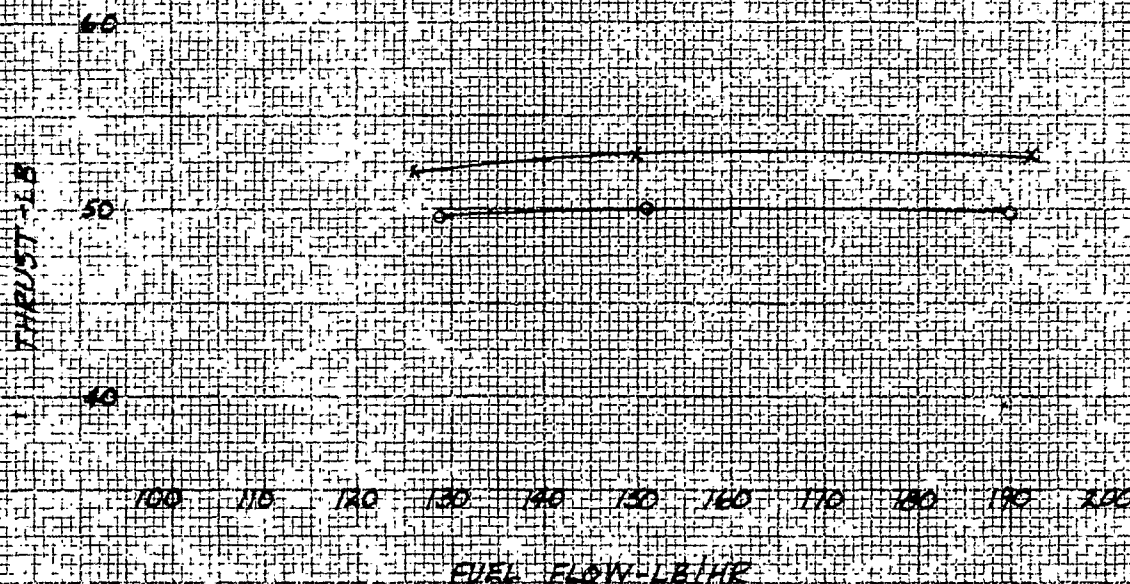
900 RPM

20 PSI RAM

DATE MARCH 5, 1947

○ FUEL SCREEN IN RUNS 750, 751, 752

x NO FUEL SCREEN RUNS 753, 754, 755



LYCOMING
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REPORT NO. 1100
CURVE NO. 7466

REED VALVE COMBUSTION CHAMBER THRUST vs AIR-FUEL RATIO

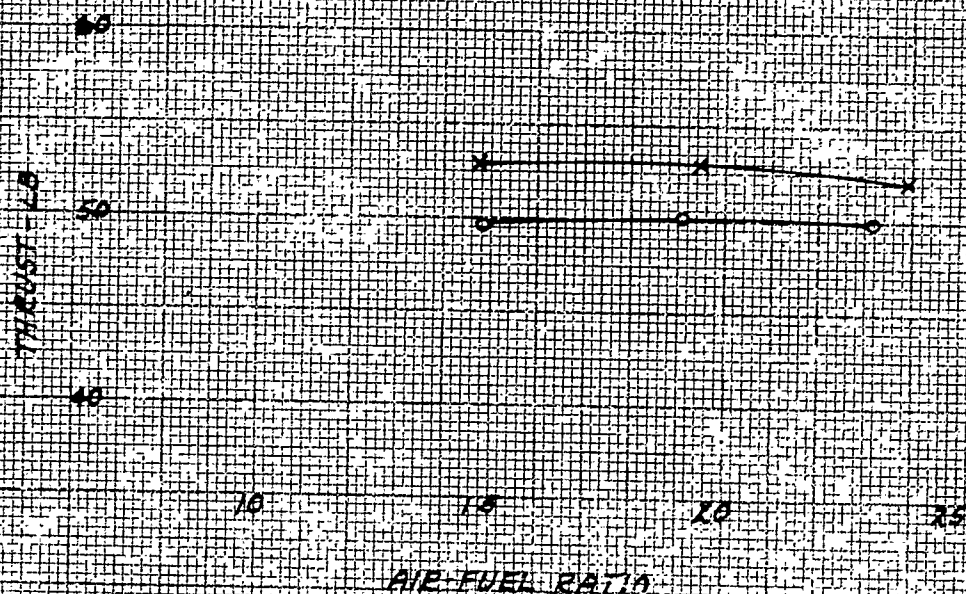
1.375 IN. DIA. JET NOZZLE

900 RPM

20 PSI RAM

DATE MARCH 3, 1947

- FUEL SCREEN IN RUNS 750, 751, 752
- * NO FUEL SCREEN RUNS 753, 754, 755



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Division - The Aviation Corporation

REPORT NO. 1100
CURVE NO. 7467

REED VALVE COMBUSTION CHAMBER SPECIFIC THRUST VS AIR-FUEL RATIO

1.375 IN DIA JET NOZZLE

900 CPM

20 PSI RAM

DATE MARCH 5, 1947

○ FUEL SCREEN IN RUNS 750, 751, 752

x NO FUEL SCREEN RUNS 753, 754, 755

0.20

LB THRUST PER LB AIR

0.15

0.10

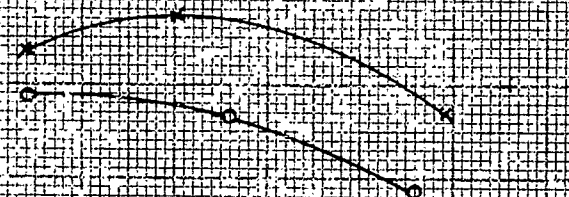
10

15

20

25

AIR-FUEL RATIO



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REPORT NO. 1100
CURVE NO. 7468

REED VALVE COMBUSTION CHAMBER SPECIFIC THRUST vs AIR-FUEL RATIO

1.375 IN DIA JET NOZZLE

900 RPM

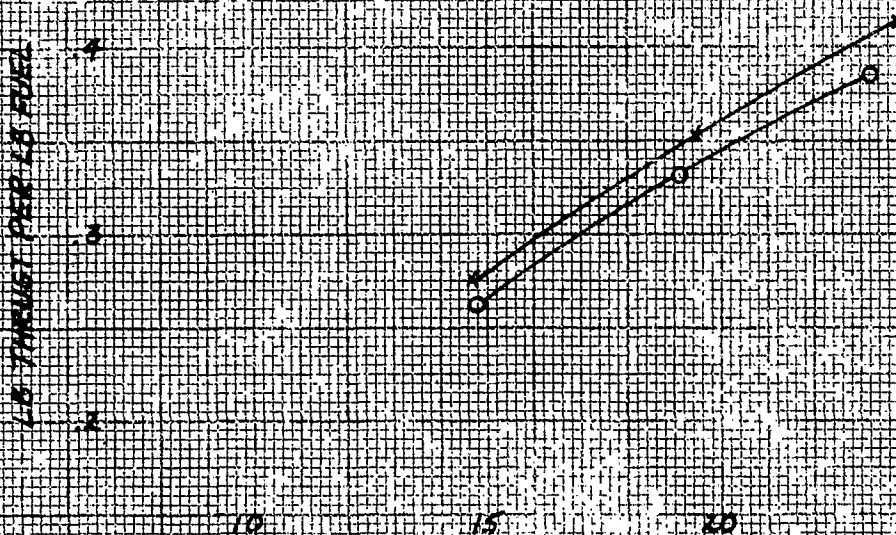
20 PSI RAN

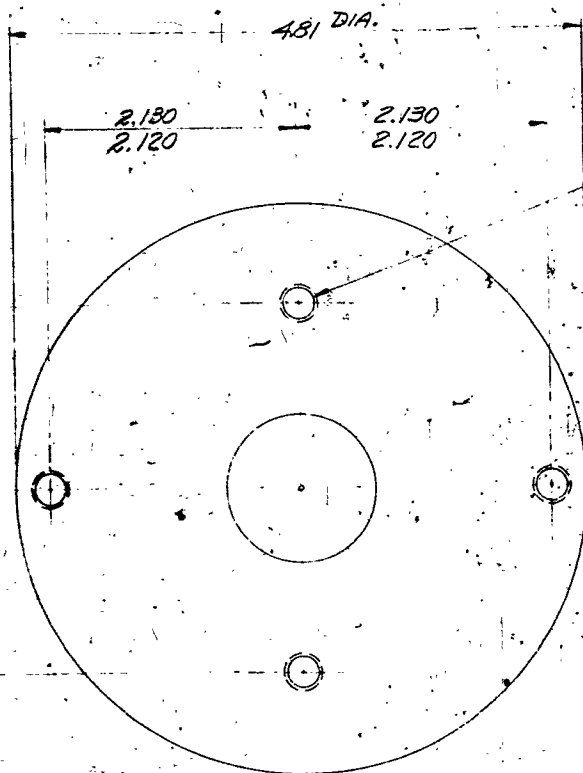
DATE - MARCH 8, 1947

O FUEL SCREEN IN RUNS 750, 751, 752
X NO FUEL SCREEN RUNS 753, 754, 755

LB THRUST PER LB FUEL

AIR-FUEL RATIO





DRILL .2656
TAP 3/25-24 NF3
P.D. - .2878 - .2954
4 HOLES

.25 STEEL

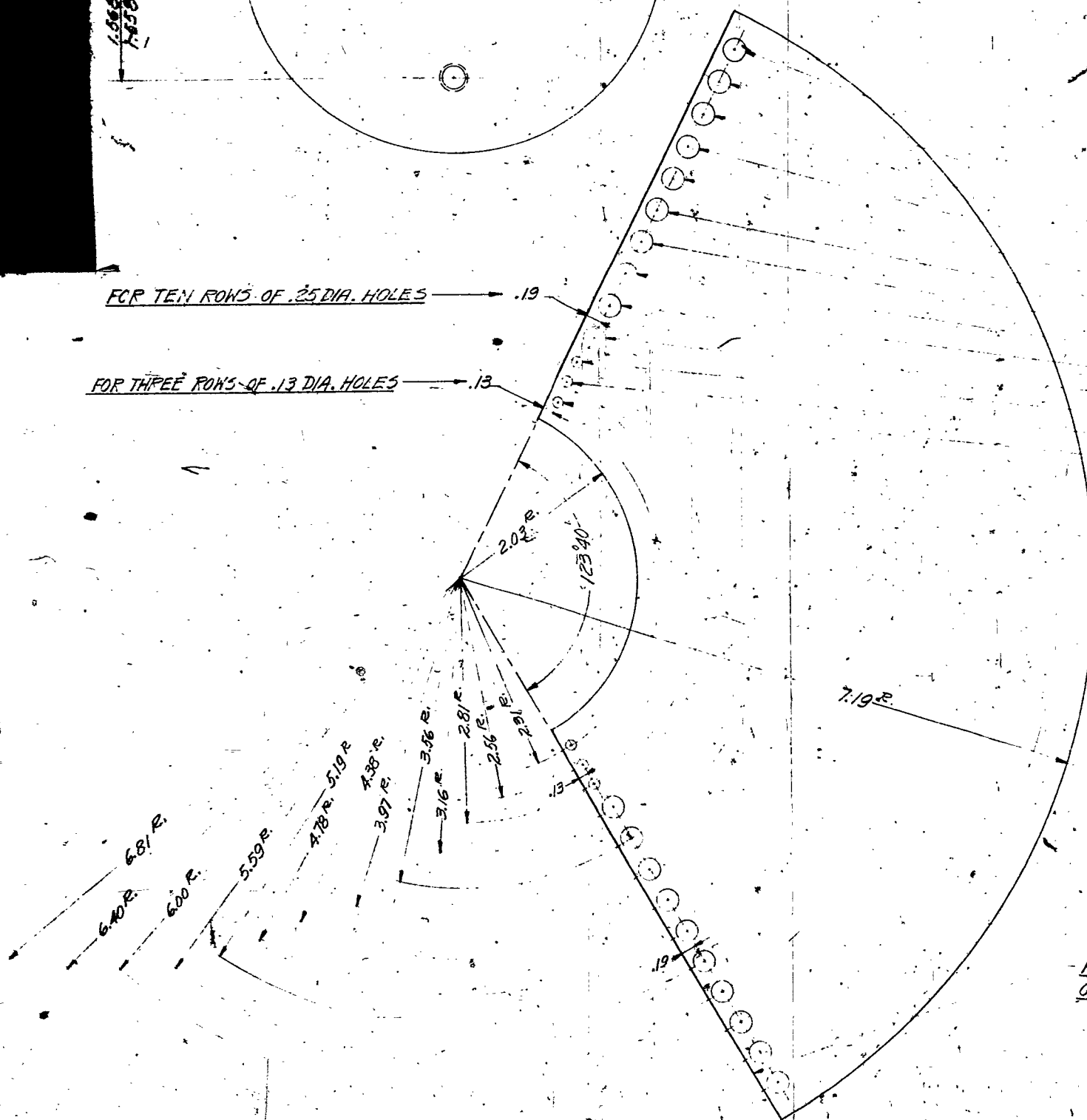
WEAR
CONES MUST BE
IN & OF PLATE

33 HOLES EQUALLY SPACED

31	"	"	"
29	"	"	"
27	"	"	"
25	"	"	"
23	"	"	"
21	"	"	"
19	"	"	"
17	"	"	"
15	"	"	"
20	"	"	"
20	"	"	"
20	"	"	"

FOR TEN ROWS OF .25 DIA. HOLES

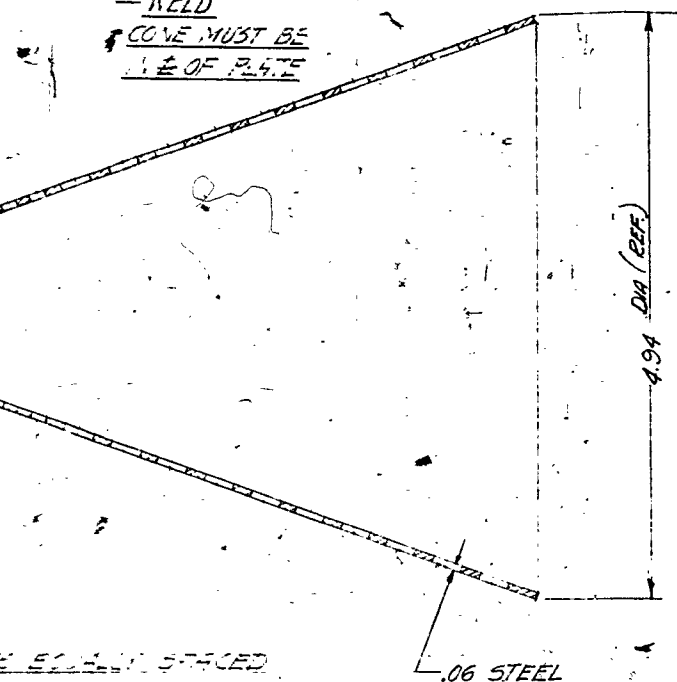
FOR THREE ROWS OF .13 DIA. HOLES



FORM INTO CONE AND WELD TO
OTHER SIDE WITHOUT OVERLAP

5 STEEL

WELD
CONE MUST BE
1/2 OF PLATE

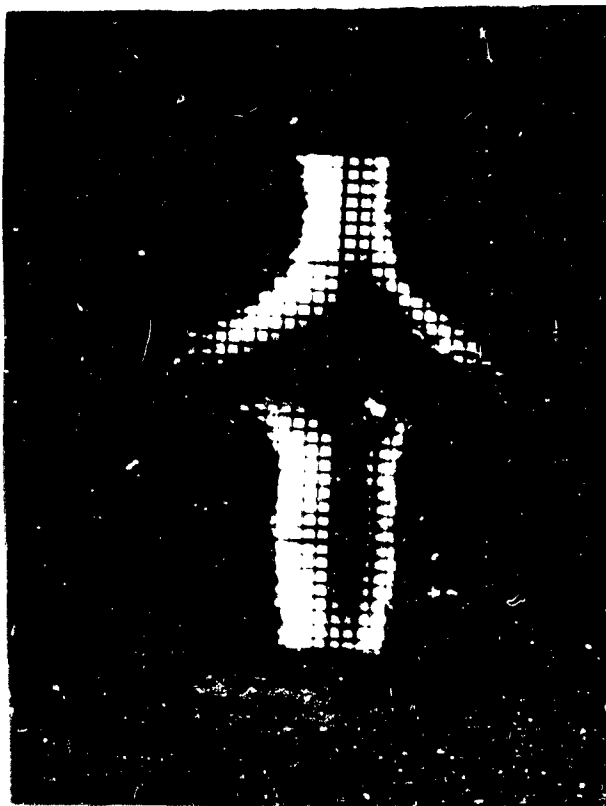
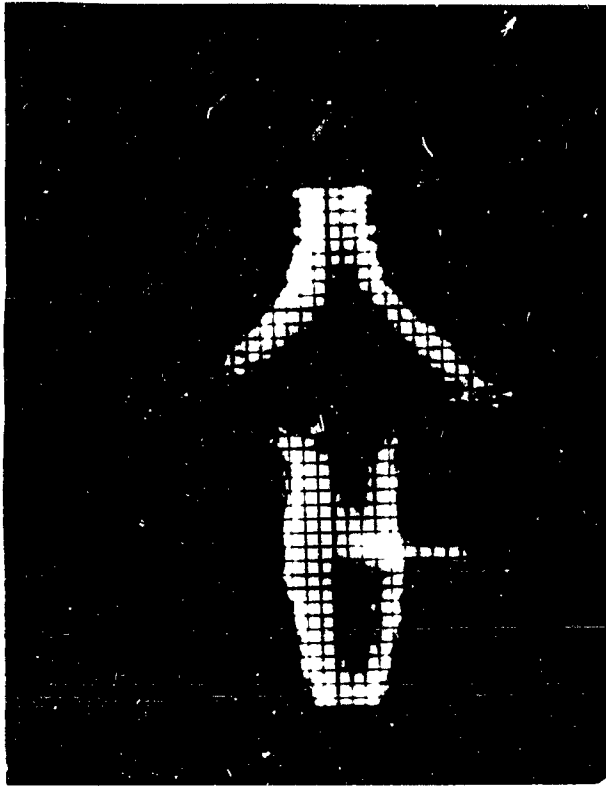


EQUAL STAGED

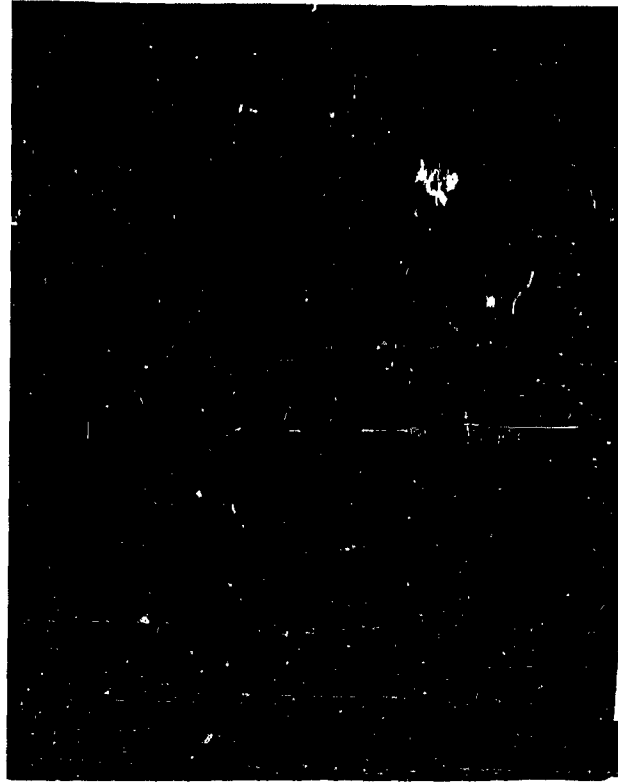
1	11
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100	11

E-HIS WELD TO
17-017 OVERLAP

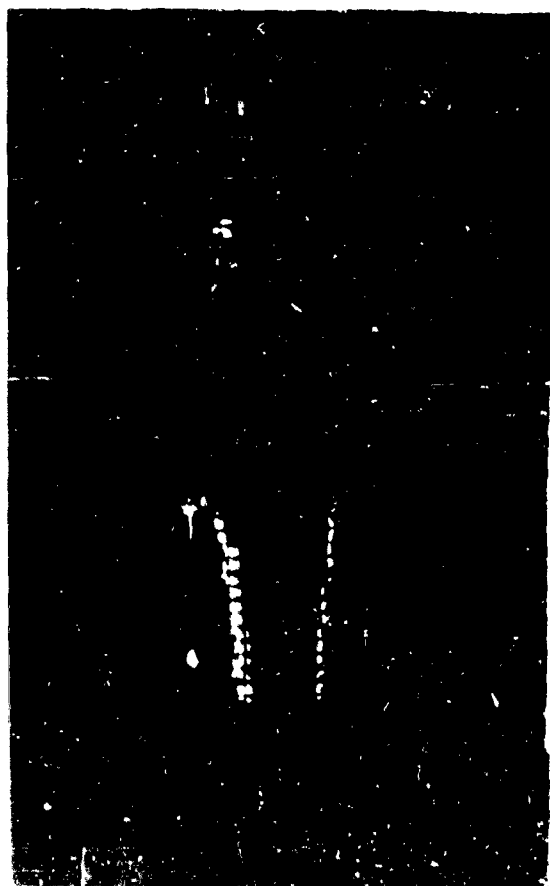
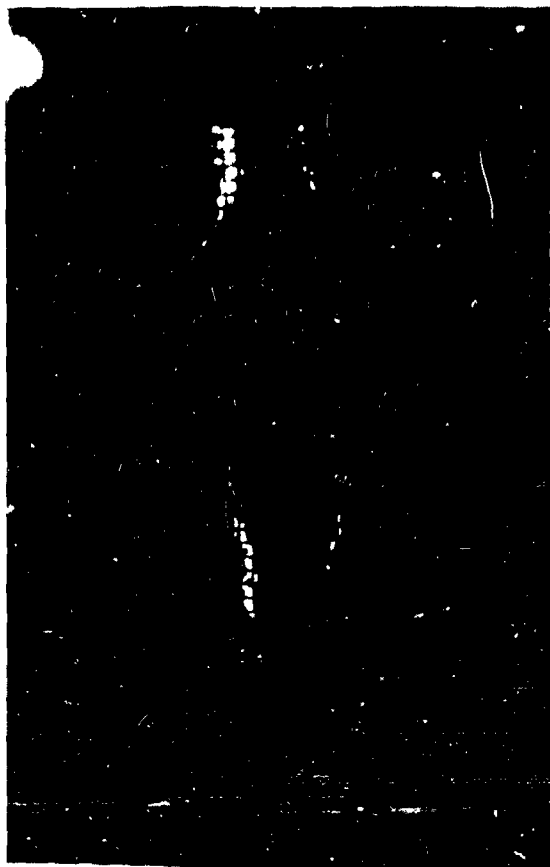
DRAWN		ETG	8-16-46	UNLESS OTHERWISE SPECIFIED		MAG INSP		TREATMENT	FINISH	RETURN TO	
TRACED				BREAK SHARP EDGES .005-.015							
CHECKED				APPROXIMATE RADIUS							
STRESS				ALLOWABLE TOLERANCE ON							
CF MET.				ANGULAR DIMENSIONS $\pm 2^\circ$							
CF DF				ALLOWABLE TOLERANCE ON							
PROJ ENG		ATP	8-21-46	FORGINGS IS $\pm .06-.00$							
PROD ENG				ALLOWABLE TOLERANCE ON							
CF ENG				CASTINGS IS $\pm .03$							
				ALLOWABLE TOLERANCE ON							
				FINISHED DIMENSIONS IS $\pm .01$							
NEXT		NO.		LYCOMING		DIVISION—THE AVIATION CORP.		PART NAME		70862	
ASSEM		REQ		WILLIAMSPORT, PA.				DATE OF ISSUE			



From Left to Right, kun Nos. 752 with Fuel Screen
and 755 without Fuel Screen. 1.375" Dia. Jet Nozzle.
900 CPM., 20 PSI Ram. March 5, 1947

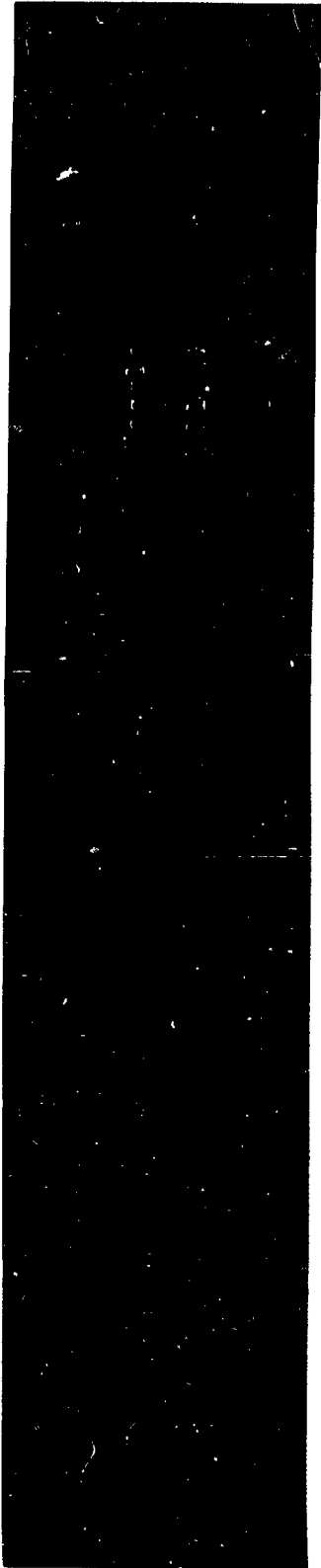


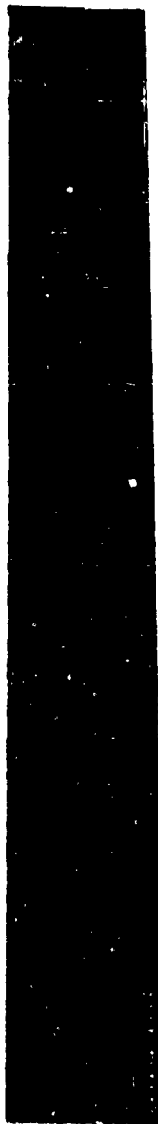
From Left to Right, Run Nos. 729 and 730
Fuel Screen In. 1.060" Dia. Jet Nozzle.
Fuel Injection Nozzle Tip .75 and 1.25 Inches
from Front Wall of Chamber.
900 CPM., 20 PSI Ram. February 25, 1947



Above, from Left to Right, Run Nos. 733 and 734. To the Right, Run No. 735.
No Fuel Screen. 1.060" Dia. Jet Nozzle.
Fuel Injection Nozzle Tip .75, 1.25 and 1.75 Inches Respectively from Front Wall of Chamber.

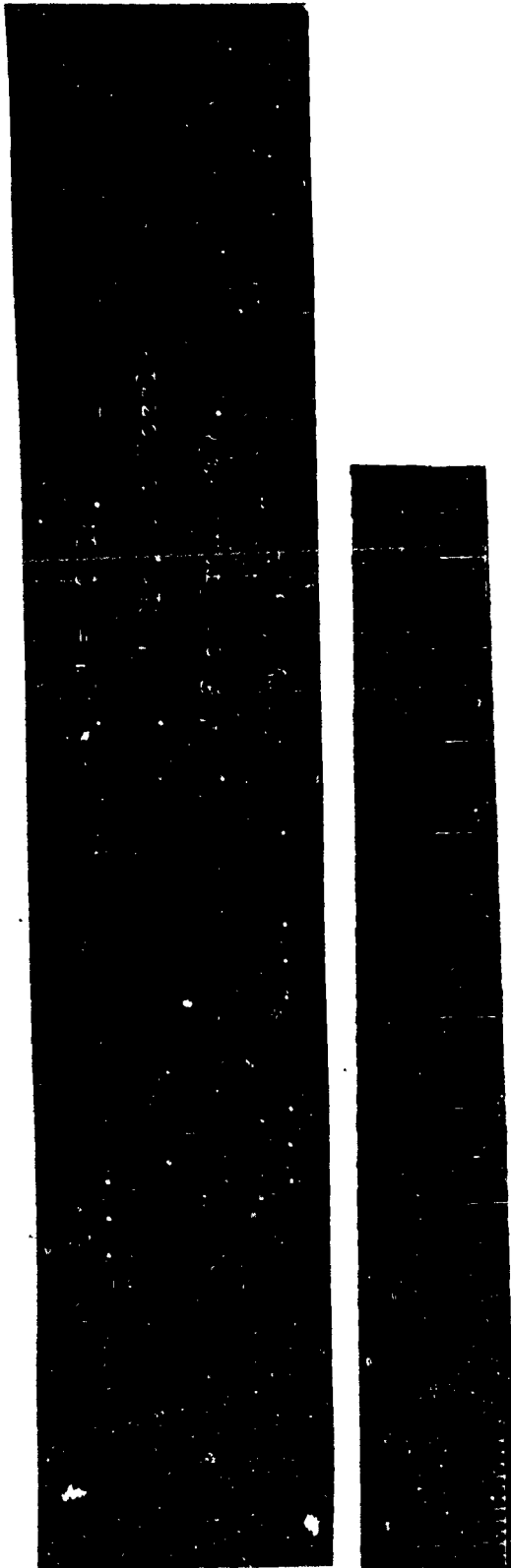
900 CPM, 20 PSI Ram
February 25, 1947

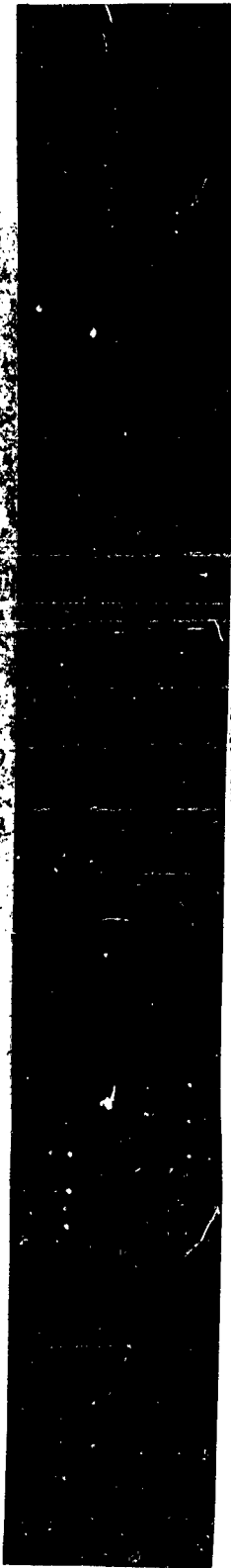




Report 1100



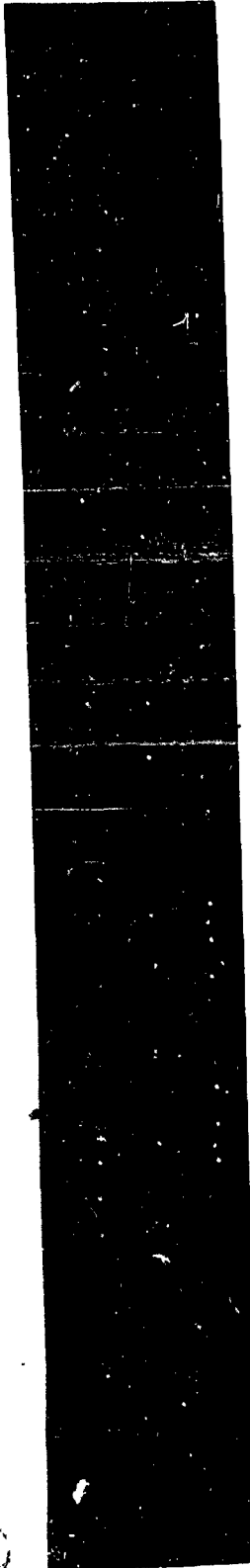




Report 1100









TEST BASKET IN FRONT
TWO FLUES IN FRONT
AND REAR BASKETS, RIM
DIFFUSERS, 60° NOZZLES

LOCOMOTIVE
 AERIAL TESTS
 OBSERVED DATA
 CONFIDENTIAL

Sheet No 1385
 Date 2-28-47

		FRONT				REAR				FRONT	
RUN NO.		725	START	726	727	728	729	STOP	START	720	
1	Time of Day	10:13	10:15	10:31	10:38	10:46	10:50	10:55	11:00	11:09	
2	Cycle Speed			910	906	906	904			906	
3	Reg. Air Pressure	20		20	20	20	20			20	
4	Fuel Flow Meter			150	150	100	100			100	
5	Fuel Temp			72.96	74.21	71.13	71.88			70.25	
6	Fuel Temp			112.96	114.71	115.13	115.58			114.55	
7	Fuel Sp. Wt.			5.930	5.934	5.936	5.934			5.924	
8	Fuel Sample			15	15	15	15			15	
9	Thrust Gauge Reading	40.9		52.9	52.8	50.0	50.6			50.1	
10	Thrust Meter Reading										
11	Ind. Thrust Hyd	23.0		40.5	40.4	36.8	37.1			36.4	
12	Ind. Thrust Electromot										
13	Cyl. Press - Gauge Read g	18.7		30.4	30.8	27.0	28.0			27.8	
14	Cyl. Press - Meter Read g	100		32.4	33.0	29.0	30.6			29.5	
15	Ind. Cyl. Press - Electromot			35	35.3	31.1	33			32	
16	Comb. Air Flow - T ₁	76		76.1	76.0	76.1	76.0			76.0	
17	Comb. Air Flow - I ₁	183.7		183.9	183.7	183.9	183.7			183.7	
18	Comb. Air Flow - O ₂	12.9		5.9	5.1	6.5	6.9			7.0	
19	Comb. Air Flow - T ₂	62		108	117	123	128			148	
20	Comb. Air Flow - T ₃	522		568	577	583	588			608	
21	Air Flow	2467		1613	1487	1537	1714			1692	
22	Cooling Water Press	19.9		29.0	27.5	26.6	26.1			17.5	
23	Cooling Water T ₁ In	57		47	48	48.5	49			49.5	
24	Cooling Water T ₂ Out	46		101	120	107	115			122	
25	Oil Press Temp FUEL			276.5	281					374	
26	Oil Temp Temp AIR			102.51	102.72					102.15	
	COMP. CHARGES TEMP			1410	1130	940	1180			1050	
	RAM AIR TEMP	45		78	84	91	96			121	
	" " " "	50		53.8	54.4	55.1	55.6			55.1	
	FUEL FLOW (Discharge) #/hr			146.5	144.0	95.8	95.7			97.4	
	AIR FUEL RATIO			11.0	10.31	16.02	17.91			17.38	

FULLY RETRACTED
 (NO NOZZLES)
 BACK ON DIFF. NOZZLES

Run No BASKET

TWO PLUGS IN FRONT
+ REAR PLUGS, DIA.
OPPOSITE 60° NOZZLE

TESTING
FROM 11:58
CONTINUED DATE
CONFIDENTIAL

Sheet No 157
Date 2-25-47

			732	START	733	STOP	START	734	STOP	START	735
1	Time of Day		11:50	11:55	2:04	2:30	2:34	2:41	2:46	2:50	2:59
2	Cyl Press	PSI			901			885			906
3	Ind Air Pressure	PSI	20		20			20			20
4	Fuel Flow Meter	gph			100			100			100
5	Fuel Temp	°F			110.00 115.00			116.10 115.10			111.30 115.30
6	Fuel Sp. Hr	gph			48			41.5			41.5
7	Fuel Sp. Hr	gph			50.4			51.28			51.28
8	Fuel Sp. Hr	gph			5			5			5
9	Thrust Gauge Reading	PSI	40.3		50.9			50.0			50.1
10	Thrust Meter Reading										
11	Ind Thrust Hyd	Lb	22.0		37.6			36.2			36.3
12	Ind Thrust Electronic	Lb									
13	Cyl Press - Gauge Read g	PSI	1875		28.4			27.7			27.7
14	Cyl Press Meter Read g	100*			31.8			30.7			30.4
15	Ind Cyl Press Electronic	PSI			34			33			32.9
16	Comb Air Flow P1	PSI	75.6		76.1			76.0			76.0
17	Comb Air Flow P2	PSI	152.7		153.9			152.7			152.2
18	Comb Air Flow P3	PSI	13.2		6.6			7.0			7.0
19	Comb Air Flow P4	PSI	67		103			135			142
20	Comb Air Flow P5	PSI	527		563			595			602
21	Air Flow	Lb	2528		1714			1713			1710
22	Cooling Water Press	PSI	24		21.1			25.2			21.3
23	Cooling Water T In	°F	51.5		48.5			49			50
24	Cooling Water T Out	°F	49.0		119.5			111.5			114.5
25	Cyl Press	PSI									
26	Cyl Scale	Lb									
	Comb Chamber Temp	°F			400			1320			1340
	Rear Air Temp	°F	50		74			108			114
	" " "	°R	510		534			568			574
	Fuel Flow (Direct)				96.5			91.8			95.8
	Air Fuel Ratio				17.75			18.65			17.85

Corr Bar. 28.92

* REAR PLUG OPERATIONS UNSATISFACTORY - ONLY 115.30
AND 115.30 THRUST, REAR FUEL 15.30.

Sheet No 145
Date 3-5-47

* REAR ALPS GAVE ABOUT 2 * LESS THURSDAY, SOME LESS
MORN. PRESS.

Test FUEL CASSET IN,
1 7/8" DIA JET NOZZLE
60" INJ NOZZLE 1/2 IN
FROM FULLY RETRACTED

LYCOMING
AERO PULSE
OBSERVED DATE
CONFIDENTIAL

Sheet No 146
Date 3-5-47

FROM FULLY RETRACTED			FRONT FRONT			FRONT FRONT FRONT					
	RUN NO.		757	752		STOP	START	753	754	755	STOP
1	Time of Day	HR	3:07	3:16		3:31	3:40	3:52	4:04	4:10	4:20
2	Cyclas. Speed	IPM	896	902				910	895	903	
3	Ram Air Pressure	PSIG	20	20	1/4"		20	20	20	20	1/4"
4	Fuel Flow Meter	#/hr	155	195	1/4"			130	156	195	1/4"
5	Fuel Time	Sec	70.66 112.86	112.86 152.56	1/4"			64.66 112.56	69.0 119.00	85.92 151.56	1/4"
6	Fuel Temp	°F	41	40	30			43	41	39.5	20
7	Fuel Sp Wt	#/Gal	5.930	5.934	N			5.924	5.930	5.936	N
8	Fuel Sample	Gal	.5	1.0				.5	.5	.5	
9	Thrust Gauge Reading	PSI	59.4	59.0	20 PSI Range			60.5	61.0	61.0	20 PSI Range
10	Thrust Meter Reading										
11	Ind. Thrust Hyd	Lb	50	49.6				52	52.7	52.7	
12	Ind Thrust Electronic	Lb									
13	Cyl Press -Gauge Read'g	PSIG	21.8	22.0				21.8	21.8	22.2	
14	Cyl. Press Meter Read'g	100	25	24.8				24.5	24.3	24.0	
15	Ind. Cyl. Press -Electronic	PSIG	29	28.7				28	28	24.2	
16	Comb Airflow P ₁	PS	184.99	184.99				184.19	184.19	184.99	
17	Comb Airflow P ₂	"H ₂ O	76.5	76.5				76.0	76.1	76.5	
18	Comb Airflow ΔP	"H ₂ O	20.3	19.4				21.2	20.5	19.4	
19	Comb Airflow T ₁	°F	153	158				130	147	152	
20	Comb Airflow T ₂	°R	613	618				590	607	612	
21	Airflow	Lb/Hr	2890	2810				3000	2920	2830	
22	Cooling Water Press	"H ₂ O	14.5	14.0				16.6	17.0	17.0	
23	Cooling Water T In	°F	48	48.5				50	50	50	
24	Cooling Water T Out	°F	113	110.5				108	109	107.5	
25	Exhaust Thrust	PS	332	261				413	351	274	
26	Exhaust Thrust	Lb	0173	0176.5				01732	018	0186	
COMB CHAMBER TEMP			°F	1030	940?			1060	1040	1060	
RAM AIR TEMP			°F	130	135			108	122	130	
" " "			°R	590	595			568	582	590	
FUEL FLOW (DISP METER)			1/hr	150.7	190			126	150	192.2	
AIR FUEL RATIO				11.6	14.8			23.8	19.45	14.72	
MAN PRESS (MEAN)			50"	35.8	36.8			35.9	35.7	35.5	
" " "			PSIG	18.8	19.2			19.0	18.8	18.7	

* REAR PLUGS COVERED - 60" PRESS, BUT OPERATED UNDER
OVERSTRESS