KAPL-1246

General Electric Company
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York

A RECENT MODEL OF THE MINIATURE MIXER-SETTLER

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DISCLAIMER

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ABSTRACT

A new modification of the miniature mixer-settler is described. The new bank is fabricated from stainless steel and fluorothene, and it can be used for elevated temperature operation. Changes in stage design increase phase separation and minimize back-mixing. Described also is a new feed system, composed of Zenith Gear Pumps. Pictures and production drawings are included.

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INTRODUCTION

Early miniature mixer-settler models have been described in several KAPL reports,[1,2,3] and the development, installation, and operation of these units have been discussed in various Quarterly Progress Reports of the Chemistry and Chemical Engineering Section.[4,5,6,7,8] This report describes the most recent miniature model, designed for use in high temperature process work. Five such units have been built and are currently in operation; two of them in the high-activity-level Mini Cascade.

When process studies at room temperature only had been contemplated, the material Homalite (a glasslike thermosetting plastic chemically stable to nitric acid at 25°C) was used for stage-block construction, rather than fluorothene, since it allowed for precision machining of the stages. This made possible the use of mass production techniques for the impeller heads, with complete interchangeability of parts as well as assembled units. As higher temperature processing showed promise, especially with respect to throughput rates and to decontamination in Purex systems, the resulting chemical and thermal instability of Homalite required the return to fluorothene as a material of construction. Accordingly, the Mini bank was redesigned so that the compression of fluorothene would not require the fabrication of a "tailor-made" impeller head for each bank, as in some of the earliest models.

DESCRIPTION

The new unit has a 1/2-inch-thick plate of Type 347 stainless steel running the length of the bank and "sandwiched" between two 1/2-inch-thick sheets of fluorothene, the whole held together by a stainless steel framework. (See Figures KS-1492, KS-1488, and KS-1494.) All milling operations for stages and aqueous and organic ports are done on the inner surfaces of each fluorothene sheet. Only two types of machining operations, other than shaping and finishing, are required on the stainless plate: (1) a 1/2-inch x 1/8-inch slot as the port from each mixing section to its settling section, and (2) drilling, for frame-work support and liquid entrance and exit lines.

Runs performed to measure the efficiency of a 12-stage Homalite bank were described in KAPL-961.[3] The results indicated that loss of efficiency with increasing total flow rate was caused primarily by poor hydraulic operation rather than by low mixing efficiency. In order to increase phase separation and minimize back-mixing, several changes in stage design were incorporated in the new units. Each settling section was increased from 3/8 inch x 1/4 inch to 3/8 inch x 3/8 inch and in addition, the end settling sections were made 5/8 inch x 3/8 inch. The total holdup per stage is about 10 cc. The ports

connecting adjacent stages have been increased in size and made in the form of slots rather than holes. The effective length of the aqueous port was increased twofold by constricting the bottom of the mixing section to within about 1/8 inch of the bottom of the impeller.* The result of this change is to decrease the effect of impeller revolutions per minute on interface level; back-mixing is therefore less likely to occur for a given impeller speed.

In order to eliminate the water bath in which the Homalite banks were immersed for controlled temperature operation, a 3/8-inch stainless steel tube was brazed to the bottom of the center stainless plate. Water from an external bath was pumped through this tube; the metal plate provided sufficient heat capacity for constant temperature operation up to about 80°C.

The bank was designed to fit the existing impeller heads. (See Figure KS-1489.) End plates bolted to each end of the center plate provide support for the head as well as for the entire unit. Figure KS-925 shows two 16-stage units in cascade.

The bank shown in Figure KS-1488 required 130 hours of machining time, and the impeller head (Figure KS-1489) required about 140 hours. Approximately 70 dollars worth of fluorothene was used with the cost of the remaining materials, fittings and gears amounting to not over 150 dollars. Five such banks have been built for us by the Westlake Manufacturing Corporation of Canastota, New York.

The syringe feed system has been replaced by an arrangement of Zenith Gear Pumps, shown in Figure KS-926. All gear pumps (one for each feed stream) are driven from one shaft through standard Boston Change Gears, thus assuring constant flow ratios. Total flow rates to the Mini banks can be conveniently adjusted by the Graham Variable Reducer which drives the shaft. Flow rates from 0.1 to 5.0 cc per minute with an accuracy of $\pm$ 1% can be easily obtained with this system. The Zenith pump arrangement eliminates two problems inherent in the other method of feeding; namely, the necessity of shutting down the run from time to time in order to refill syringes, and the occasional surging of feed streams due to intermittent binding of the syringes.

*Modification proposed by A. S. Jennings, duPont Savannah River Laboratory.

CONCLUSION

The banks described here have been operated almost continuously over a period of six months under a wide variety of temperatures and flow sheet conditions. No sign of degradation or loss of efficiency has been observed, and operation has been the most trouble-free in our four years of Mini operating experience.

Although further slight changes in bank design may be desirable, as different process conditions arise, we feel that the current model will give long use at high efficiency. Relatively little additional Mini development work is contemplated in this laboratory. (See pp. 25 to 31 for bank production drawings.)

[redacted]

6

LIST OF REFERENCES

1. KAPL-449, "A Miniature Mixer-Settler," by H. W. Alter, B. V. Coplan, E. L. Zebroski, December 21, 1950.

2. KAPL-609, "An Improved Miniature Mixer-Settler," by E. L. Zebroski, J. W. Codding, B. V. Coplan, and H. W. Alter, September 10, 1951.

3. KAPL-961, "A Miniature Mixer-Settler for Continuous Countercurrent Solvent Extraction," by H. Ward Alter, James W. Codding and A. S. Jennings, November 25.

4. KAPL-914, "Report of the Chemistry and Chemical Engineering Section for February, March and April 1953."

5. KAPL-1002, "Report of the Chemistry and Chemical Engineering Section for August, September, October 1953."

6. KAPL-1069, "Report of the Chemistry and Chemical Engineering Section for November, December 1953, and January 1954."

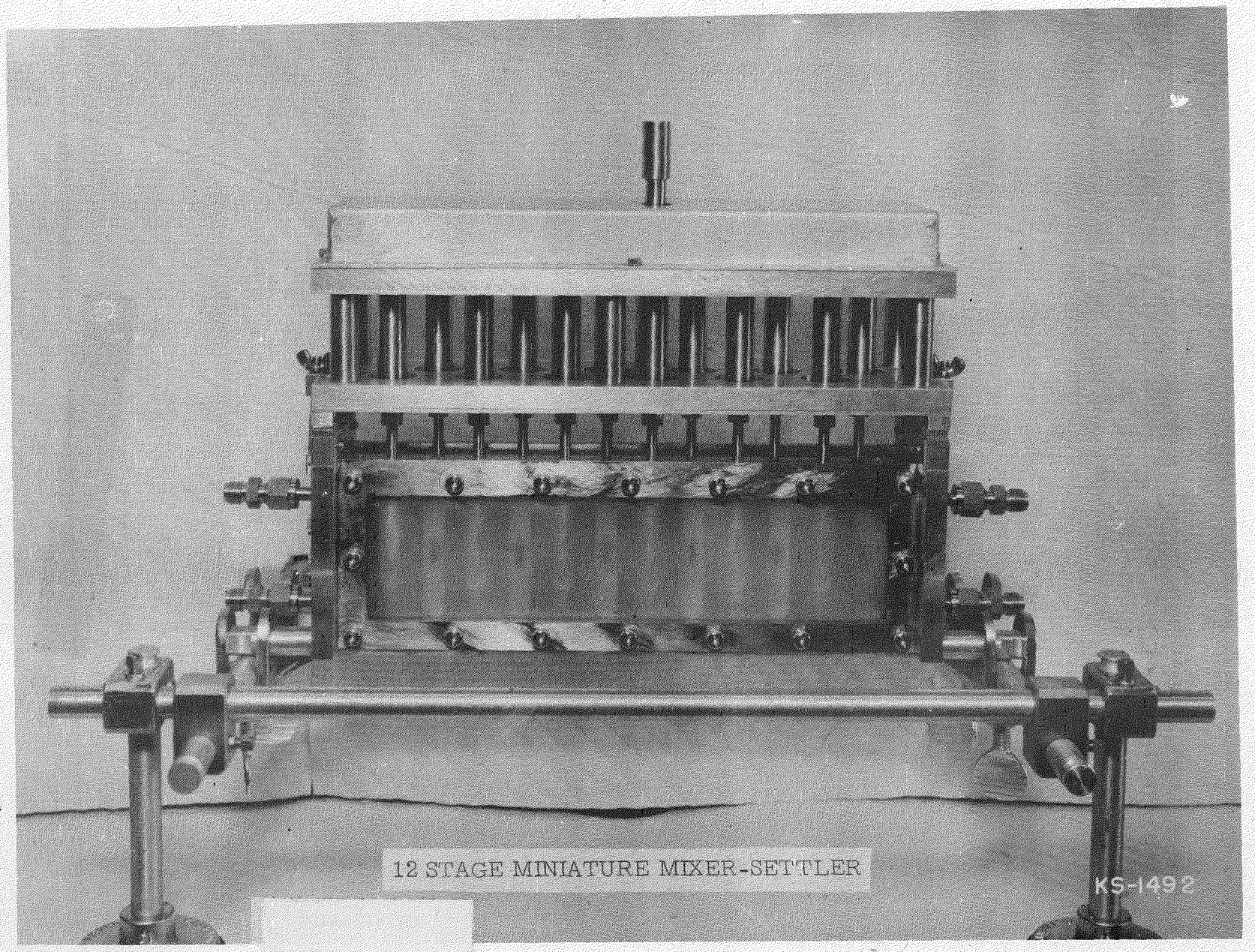
7. KAPL-1140, "Report of the Chemistry and Chemical Engineering Section for February, March, and April 1954."

8. KAPL-1159, "Report of the Chemistry and Chemical Engineering Section for May, June, July, 1954."

[redacted]

164 007

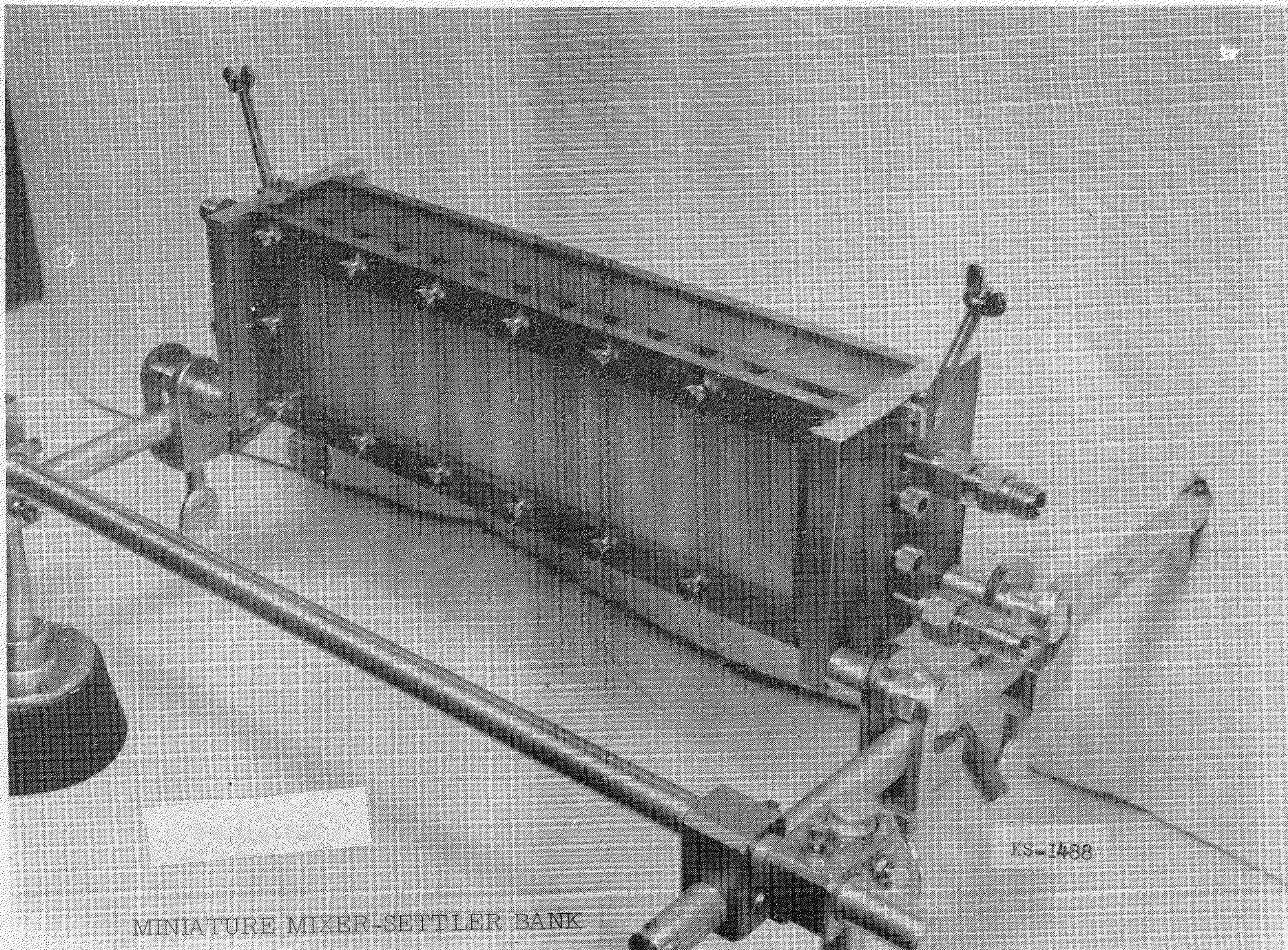
[redacted]



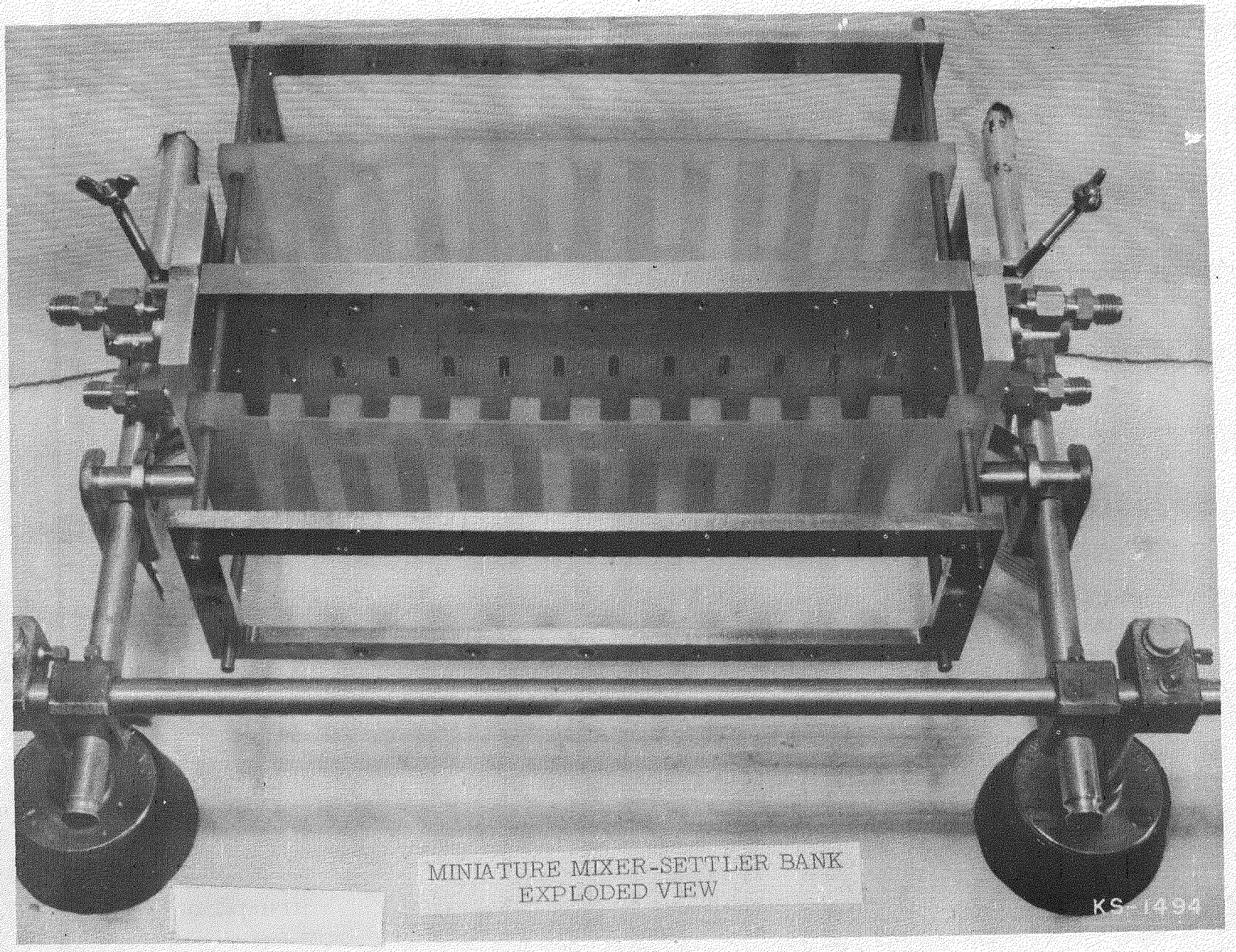
12 STAGE MINIATURE MIXER-SETTLER

KS-1492

8

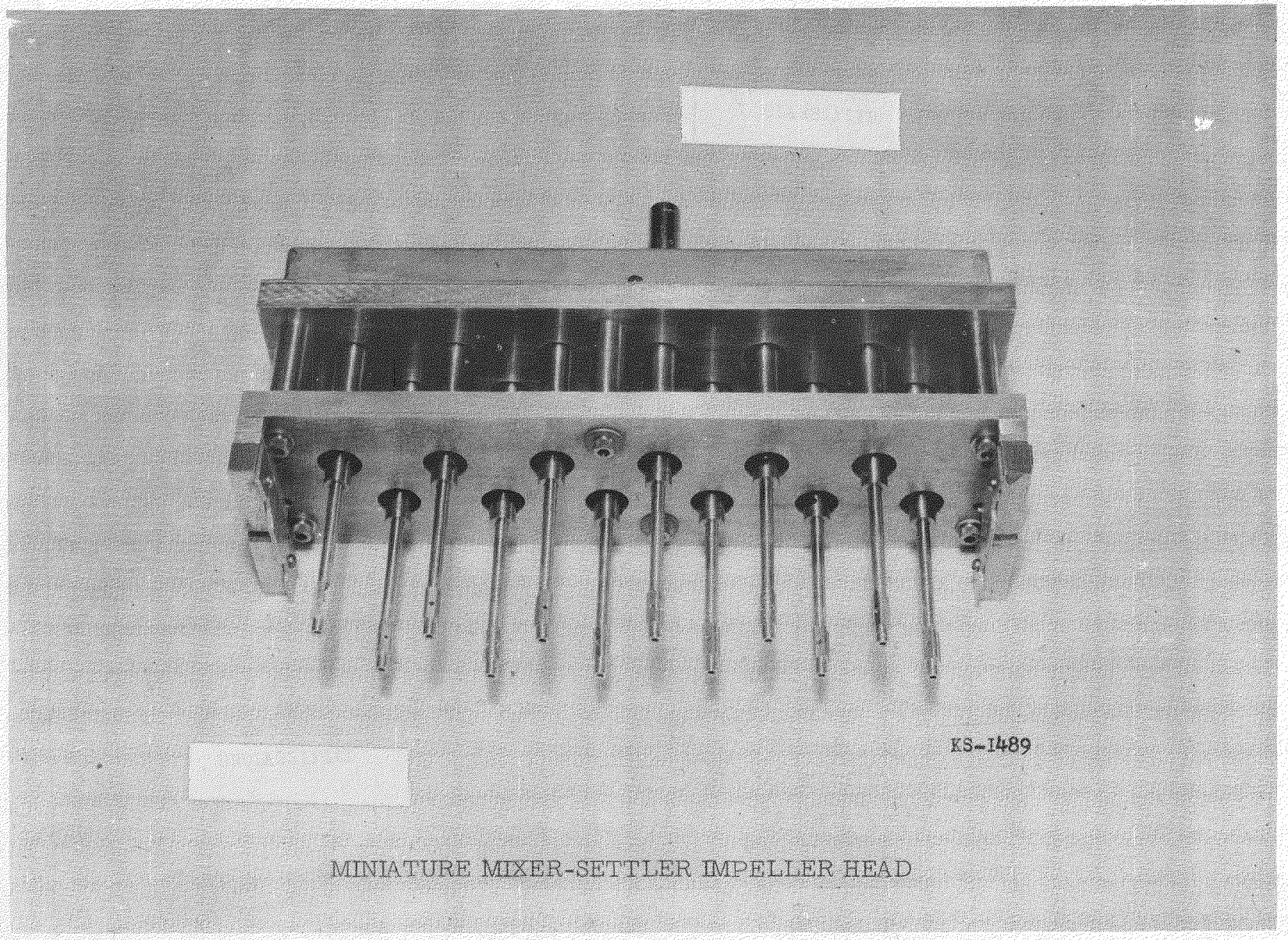


MINIATURE MIXER-SETTLER BANK



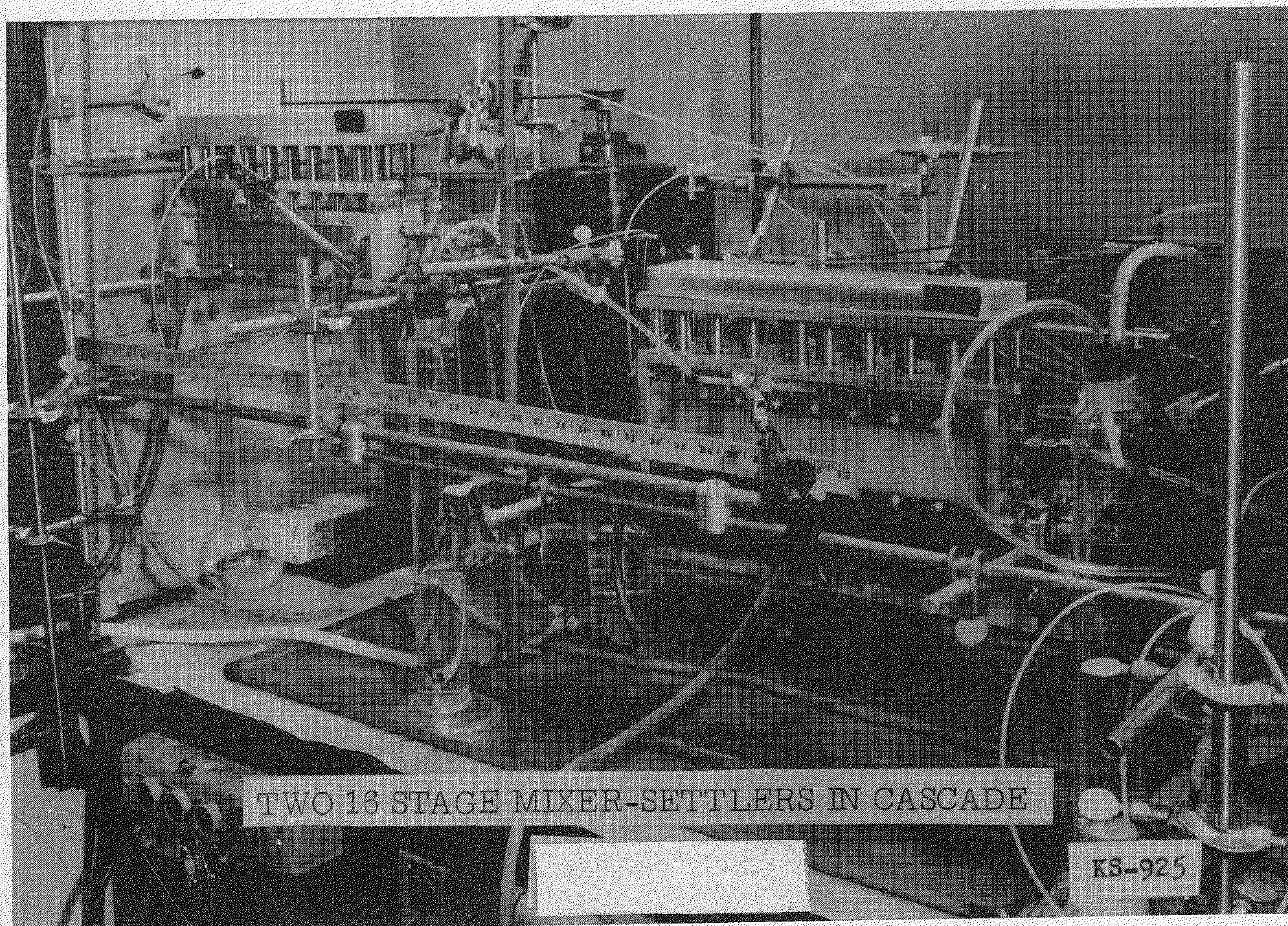
MINIATURE MIXER-SETTLER BANK
EXPLODED VIEW

KS-1494



MINIATURE MIXER-SETTLER IMPELLER HEAD

11



TWO 16 STAGE MIXER-SETTLERS IN CASCADE

19

GENERAL ELECTRIC

K-8A1085 CONT ON SHEET SH NO.

REV NO.

TITLE PARTS LIST FOR JWC-5, 6 AND 7 SKETCH

CONT ON SHEET SH NO.

FIRST MADE FOR MINI CONTACTOR

GROUP NO. AND QUANTITY	PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
1	1	BLOCK	JWC-5
1	2	STAGE BLOCK	JWC-6
1	3	STAGE BLOCK	JWC-6
2	4	FRAME	JWC-5
2	5	END PLATE	JWC-7
2	6	TIE BOLT	JWC-7
2	7	WING NUT	5-40 18-8 STN. STL.
4	8	LUG	JWC-7
4	9	SCREW	HEX. SOC. HD. $\frac{1}{4}$-20 NC x $\frac{3}{4}$ LG. 18-8 STN. STL.
20	10	BOLT	HEX. HD. 10-32 X $2\frac{1}{4}$ LG. 18-8 STN. STL.
20	11	NUT	HEX. 10-32 18-8 STN. STL.

NOTE: PART NO. 10 TO BE THREADED FOR 1 INCH OF LENGTH.

DESCRIPTION OF GROUPS	REVISIONS	PRINTS TO
	164 C14	

MADE BY J.W. Cockburn 11/18/54

ISSUED November 18, 1954

APPROVALS JWC

DIV WORKS

K-8A1085 CONT ON SHEET SH NO.

13

DECLASSIFIED

DRAWING NO. CONT ON SHEET SH NO.

14

15

GENERAL ELECTRIC

M-8A4003
CONT ON SHEET SH NO.
SKETCH 20

REV NO.

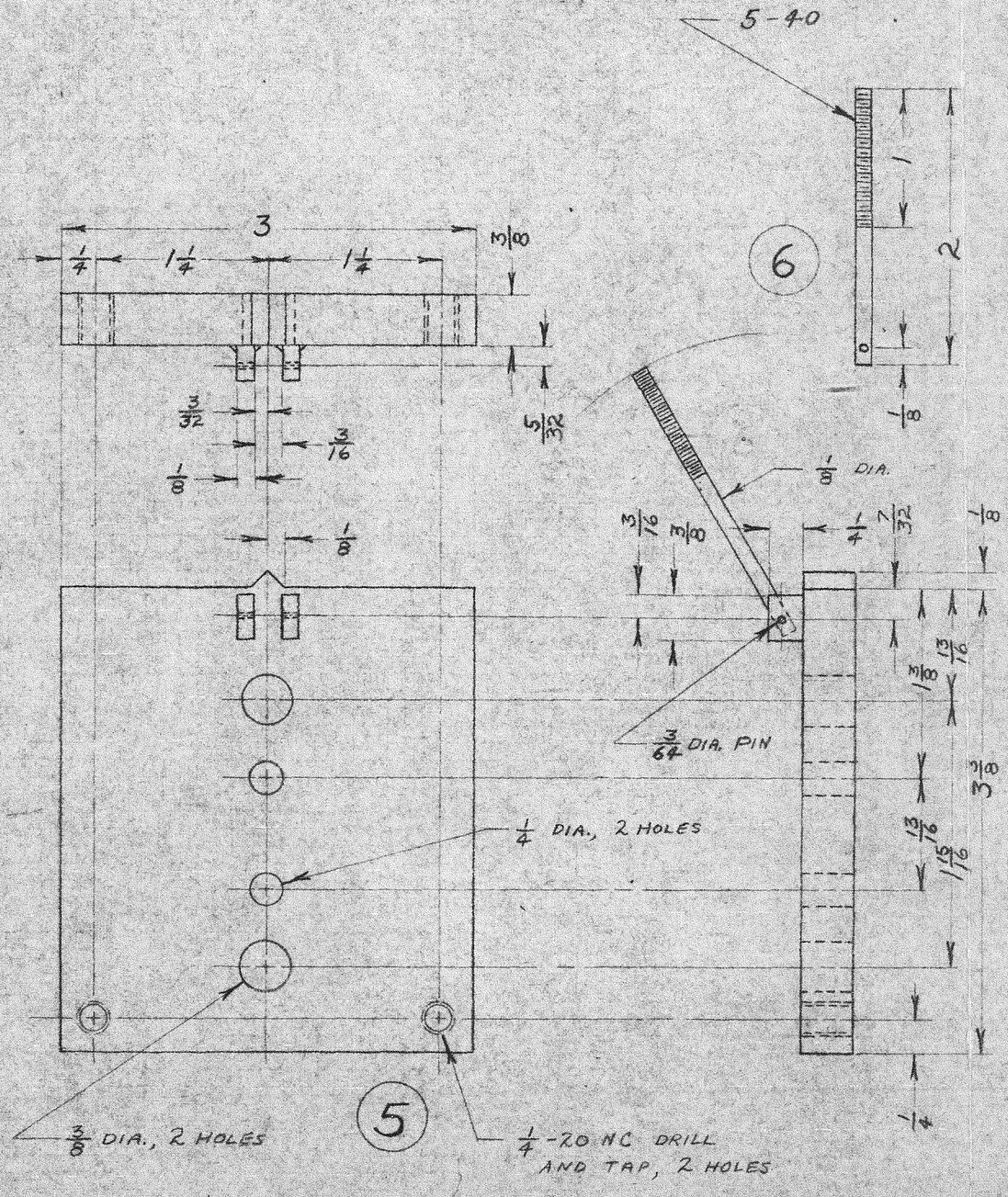
CONT ON SHEET SH NO.

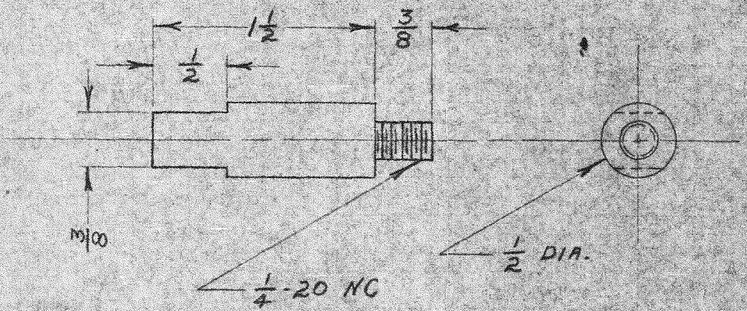
TITLE END PLATE, TIE BOLT AND LUG.

FIRST MADE FOR MINI CONTACTOR

GROUP NO. AND QUANTITY	PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
2	5	END PLATE	DURAL
2	6	TIE BOLT	18-8 STN. STL.
4	8	LUG	DURAL

FORMER DESIGNATION JWC-7





DESCRIPTION OF GROUPS	REVISIONS	PRINTS TO

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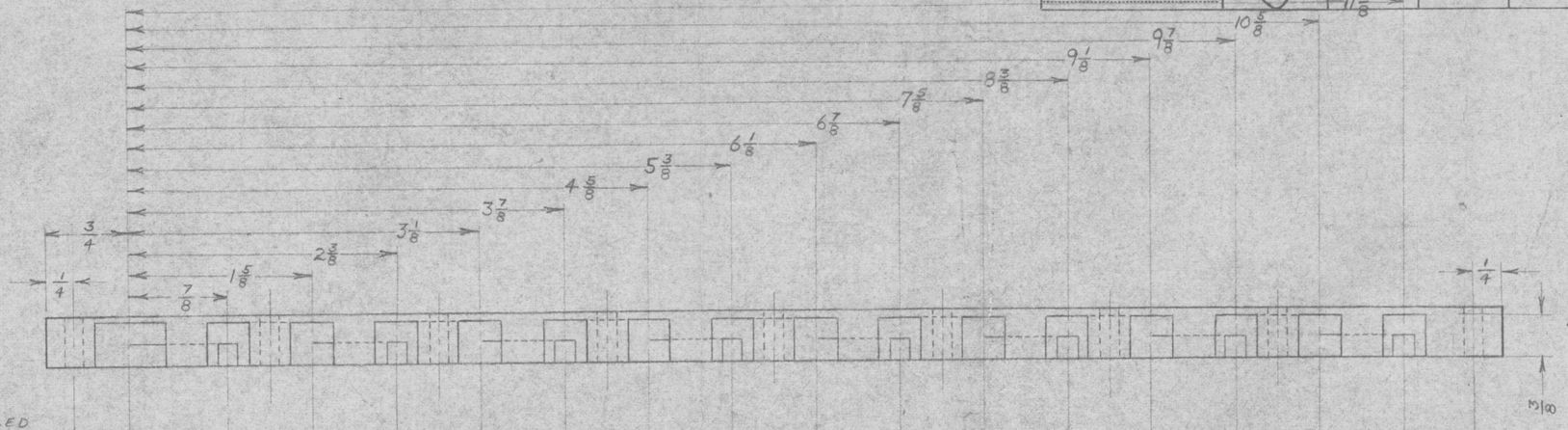
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
		± 1 1/8	±	±

TITLE STAGE BLOCK SKETCH 21

FIRST MADE FOR MINI CONTACTOR

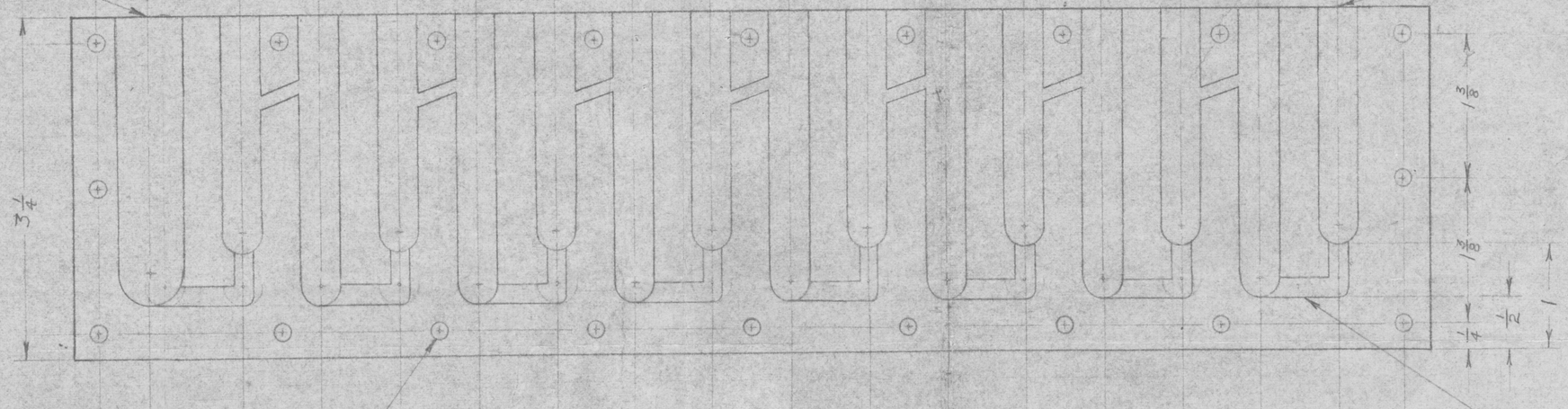
FORME DESIGNATION JWC-6

MATERIAL: 1/2" THICK FLUOROTHENE



5/8" SLOT MILLED TO 3/8" DEEP

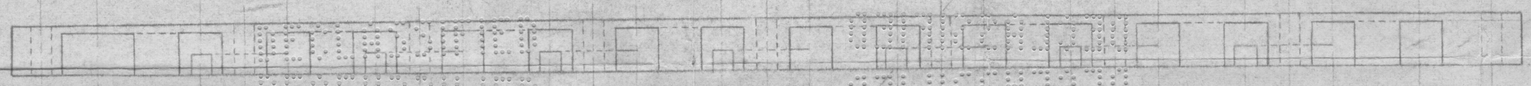
ALL SLOTS 3/8" WIDE MILLED TO 3/8" DEEP EXCEPT AS NOTED



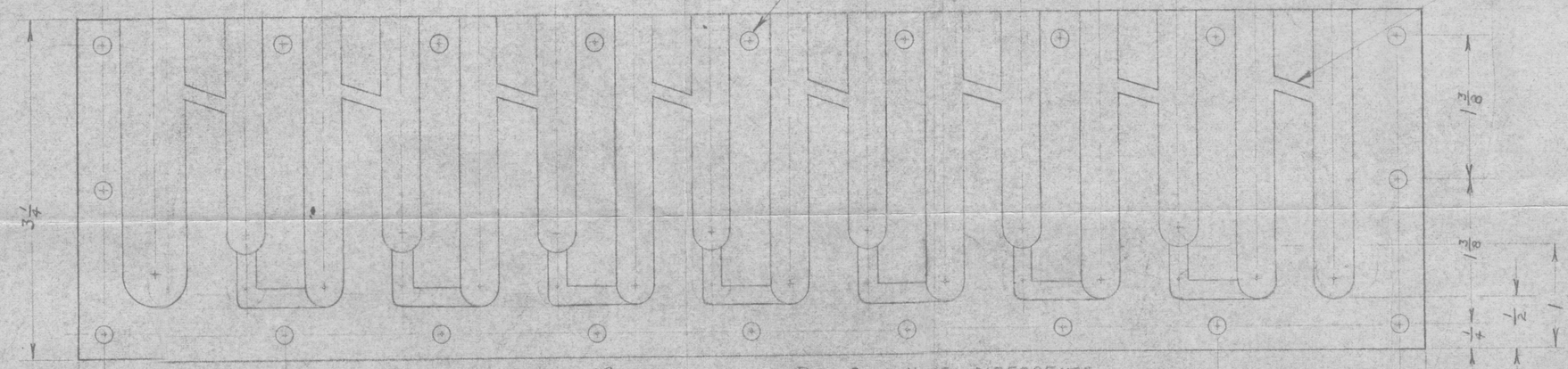
2

3/16 DIA. 20 HOLES, SAME CENTERS AS PT 1.

3/16" SLOT AND RISER, MILLED TO 3/16" DEEP



1/8" SLOT MILLED TO 3/8" DEEP AT ~ 20° ∠ UPPER EDGE 5/8" BELOW TOP



CENTERS SAME AS PT. 2, NOTE DIFFERENCE IN CONFIGURATION

3

REV. NO. 1

REVISIONS | PRINTS TO

164 016

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FF-809-P (4-52) rev.
PRINTED IN U.S.A.

19 20 21

DRAWING NO. 22 CONT ON SHEET SH NO.

GENERAL ELECTRIC

P-8A7102

CONT ON SHEET SH NO. 22

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APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	±	±	±

TITLE BLOCK AND FRAME SKETCH

FIRST MADE FOR MINI CONTACTOR

FORMER DESIGNATION JWC-5

SECTION AA

SECTION BB

SECTION CC

SECTION DD

$\frac{1}{4}$ DIA., 4 HOLES $\frac{3}{8}$ DP. WITH END MILL, TO MEET $\frac{1}{4}$ DIA. HOLES DRILLED FROM END OF PLATE

$\frac{1}{2} \times \frac{1}{8}$, .16 SLOTS, CLEAR THRU, $\frac{3}{4}$ ℄ TO ℄

$\frac{3}{16}$ DIA., 20 HOLES CLEAR THRU $1\frac{1}{2}$ ℄ TO ℄ EXCEPT AS NOTED

125

$\frac{1}{4}$ STN. STL. TUBING, STND. WALL, WELDED ALL AROUND

DRILL AND TAP $\frac{1}{4}$-20 NC $\frac{1}{2}$ DEEP 4 HOLES

45°

13

$\frac{3}{16}$ DIA., 20 HOLES, SAME CENTERS AS PC. 1.

(4) $\frac{1}{4}$" THICK

(1) $\frac{3}{8}$ STN. STL. TUBING STND. WALL, SILVER BRAZED INTO SLOT

DECLASSIFIED

BLOCK AND FRAME

MATERIAL: 347 STN. STL.

REV NO. 1

REVISIONS | PRINTS TO

164 017

MADE BY J.W. Ading 11/4/54

ISSUED December 15, 1954

APPROVALS

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P-8A7102 CONT ON SHEET SH NO.

FF-809-P (4-52) rev. PRINTED IN U.S.A.

95

27

DECLASSIFIED