TOM Reel 188, Item 38U, Frames 20951-20960

W. M. Sternberg
8/19/47

1101

Essen June 4, 1945

OPERATION BALANCE OF THE KOPPERS POWDERED COAL PRODUCERS

a) Gasification Test of Powdered Bituminous Coal of the Rheinpreussen Mine.

Analysis of Raw Powdered Coal:

Moisture	1.25%	
Ash	8.75%	
H_2	4.27%	
C	80.50%	Upper heating value 7947 Kcal/Kg. Raw powdered coal
S, Comb.	1.88%	
N_2	1.19%	Lower heating value 7744 " " " " "
O_2	1.40%	
	100.00%	

Analysis of Synthesis Gas produced. (Experimental values)

CO_2	15%	
CO	42%	Upper heating value 2550 Kcal/m³
H_2	42%	Lower heating value 2347 " "
N_2	1%	Difference 203 " "
	100%	

[illegible] of gas produced ([illegible] gasification)

[illegible] = 2.47 m³/kg. Coal

[illegible]

H_2 in gas produced: 2.47 x 0.42 [illegible]	=	1.028 " " "
H_2 in the Powdered Coal 0.427 / 0.09	=	0.475 " " "
[illegible]	=	0.553 " " "
[illegible] K = [illegible] 0.12 [illegible] / 0.42	=	0.853 " " "
[illegible]	=	1.431 " " "
[illegible] 0.0188 / 0.81	=	0.024 " " "
[illegible]	=	1.407 " " "
[illegible]	=	39.3[illegible]

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Steam decomposed referred to ___

H_2 contents of gas produced $\frac{0.42}{0.420 + 0.351}$ = 54.5%

<u>Oxygen balance</u>

O_2 in gas produced 0.16 x $\frac{0.42}{2}$ x 2.47 = 0.590 m^3/kg

O_2 from decomposed steam $\frac{0.536}{2}$ = 0.268 " "

O_2 from outside $\frac{0.322}{2.47}$ = 0.232 m^3/m^3 synthesis gas

<u>Heat balance</u>

Brought in: 1 kg [illegible] coal [illegible] heat val. = 7377 heat un.

Steam 1.207 x 0.51 x 600 = 685 " "

1.407 x 0.452 x 1200 = 712 " "

Total 9374 h.u.

Carried out:

2.47 m^3 synthesis gas [illegible] = 5200 h.u.

Difference [illegible] = 510 h.u.

Undecomposed steam [illegible] = 422 h.u.

[illegible] = 482 h.u.

Loss of [illegible] = [illegible]

Sensible heat [illegible]

2.47 x 0.32 [illegible] = 1026 h.u.

Loss by radiation [illegible] = 711 h.u.

[illegible] 2374 h.u.

= $\frac{711}{[illegible]}$ x 100 [illegible]

<u>Steam [illegible]</u>

Available for steam [illegible] = 1581 h.u.

Waste heat [illegible]

[illegible]

[illegible] 340 h.u.

[illegible] 1194 h.u.

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Received from waste heat boiler:

Steam production: 1194 x 0.9 = 1075 h.u.

Steam consumption = 685 h.u. = 1.05kg/8atm.

Excess steam = 390 h.u. = 0.52kg/16atm. 350°C

Firing:

Preheating: 1.407 m^3 steam to 1200 C = 712 h.u.

Heat exchanger loss (η = 80%) = 178 h.u.

Total for firing = 890 h.u./kg. Coal

Total efficiency: $\frac{5820 + 390}{7744 + 890}$ = 72.5%

Gasification efficiency: $\frac{5820}{7744}$ = 75.0%

Summary of consumption and production values:

Amount of raw powdered coal = 1.0 kg.

Synthesis gas produced 2.47 m^3

Lower heat value per 1 m^3 synthesis gas 2347 h.u.

Concentration of CO + H_2 in gas produced 84%

Firing per kg. raw powdered coal 1890 h.u.

O_2 consumption = 0.358 m^3/m^3 synthetic gas = 0.822 m^3/kg. coal

Steam production (excess steam): 0.52 kg. 16 atm. 350°C

Steam consumption (covered by steam produced): 1.05 kg. 8 atm.

Inlet temperature (preheating): 1200°C

Outlet temperature of gas produced taking the heat 1200°C

(See flow diagram Fig. 1201)

b) Gasification consumption of brown coal, powdered 1104

Analysis of powdered coal:

Moisture	13.00%		
Ash	5.18%		
C	56.20%	Upper heat value of 5313 h.u.	
H_2	4.71%	Lower heat unit	5120 "
		Difference	193 "
S (comb.)	0.33%		
O + N	20.58%		
	100.00%		

Analysis of gas produced (80% concentration)

CO_2	19.0%		
CO	35.0%	Upper heat value 2480 h.u.	
H_2	45.0%	Lower heat value 2284 "	
N_2	1.0%	Difference 216 "	

Amount of gas 1.84 m^3/kg coal.

Carbon Gasification $\frac{1.84 \times 0.536 \times 0.80}{0.562} = 95\%$

H_2 balance:

H_2 in gas produced = 0.450 m^3/m^3

H_2 in crude coal $\frac{0.0471}{0.09 \times 1.84}$ = 0.284 " "

H_2 from steam = 0.166 " "

Decomposed steam = 0.166 " "

O_2 balance:

O_2 in gas = 0.355 m^3/m^3

O_2 from powdered coal $\frac{0.20}{1.43 \times 1.84}$ = 0.076

O_2 from steam $\frac{0.166}{2}$ = 0.083

= 0.159 m^3

O_2 from outside source 0.205 m^3/m^3 syn. gas

0.205×1.84 = 0.378 m^3/kg powdered coal

1105

Amount of steam:

Decomposed steam 0.166 x 1.84 = 0.304 nm^3/kg coal

Undecomposed steam with k = 1.6 (1000°C)

$$1.6 \times \frac{0.19 \times 0.45}{0.55} \times 1.84 = 0.716 \text{ " "}$$

Steam required 1.020 " "

Steam from moisture in fuel $\frac{0.13}{0.81}$ = 0.160 " "

Steam from outside source 0.860 " "

Degree of decomposition of steam $\frac{0.304}{1.020}$ = 30.0%

Heat balance:

Supplied:

1 kg. powdered coal, upper h. v. = 5813 h.u.

Steam 0.85 x 0.81 x 800 = 7617 h.u.

0.86 x 0.428 x 1200 = 424 h.u.

6164 h.u.

Generated:

1.81 nm^3 synthesis gas x 3814 = 4076 h.u.

Difference upper - lower h.v.:
1.84 x 216 = 397

Undecomposed steam:

0.716 x 0.81 x 800 = 348 h.u.

0.716 x 0.45 x 1000 = 323 h.u.

Sensible heat in gas produced:

1.84 x 0.388 x 1000 = 674 h.u.

Of loam: 0.36 x 0.566 x 1000 = 225 h.u.

Loss in radiation and conductence = 151 h.u.

6164 h.u.

$\frac{151}{5120} \times 100 = 2.95\%$, referred to 1 kg powdered coal.

Steam produced and consumed:

Available for production of steam:

674 + 293 = 967 kg

Waste heat losses:

0.716 x 0.361 x 300 = 79 h.u.
1.840 x 0.380 x 300 = 182 h.u.

261 h.u.

Used in waste heat boiler: 706 h.u.

Steam production 5 atm. $\frac{706 \times 0.9}{651.2} = 0.97$ 636 h.u.

heat loss 70 h.u.

Steam consumption: 5 atm. $= \frac{417}{651.2} = 0.64$ kg.

= 437 h.u.

Steam excess : 5 atm. 0.33 = 199 h.u.

Firing:

For preheating: 0.330 m³ steam 1300°C 224 h.u.

Heat exchange loss: (70%) = 157 h.u.

to be supplied in firing = 380 h.u. per kg powdered coal

Total efficiency: $\frac{4076 + 219}{5120 + 575} =$ 76.5%

Gasification efficiency $= \frac{4076}{5120} =$ 79.6%

Summary of consumption and production figures:

Amount of raw powdered coal 5.12 kg.

Synthesis Gas produced:		1.84 nm^3
Lower heating value per nm^3 gas produced		2214 h.u.
Concentration CO + H_2:		80 %
Coal fed for heating per kg. coal		579 h.u.
O_2 Consumption: 0.206 nm^3/nm^3	=	0.379 nm^3/kg powdered coal
Steam produced 3 atm.		0.97 kg.
Steam consumed 3 atm.		0.64 kg.
Excess steam 3 atm.		0.33 kg.
Inlet temperature (preheating)		1200°C
Outlet temperature of the gas produced from gasifier		1000°C

(See heat flow diagram 170, 40m)

Siemag Rolandwerk Koppers, GmbH
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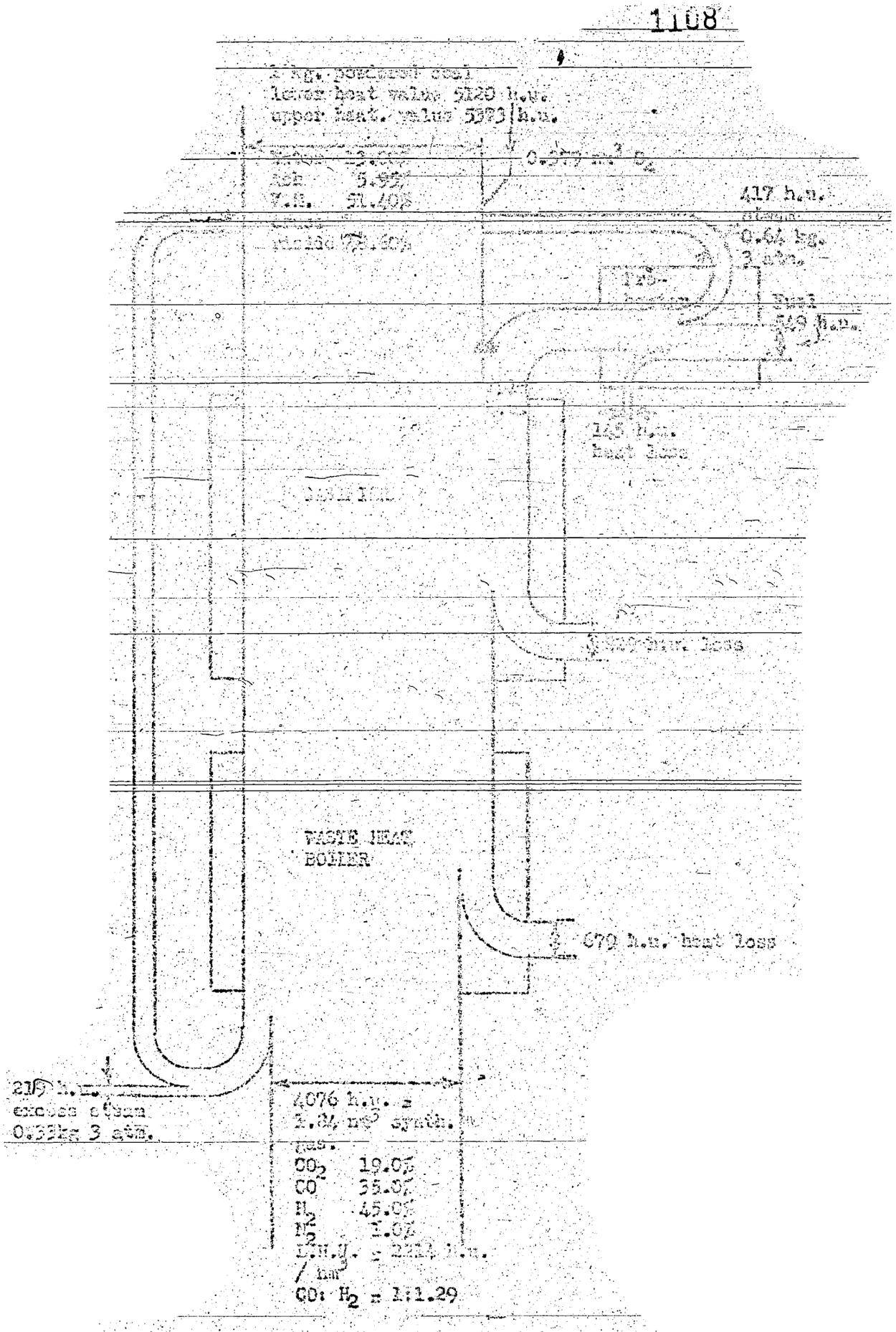
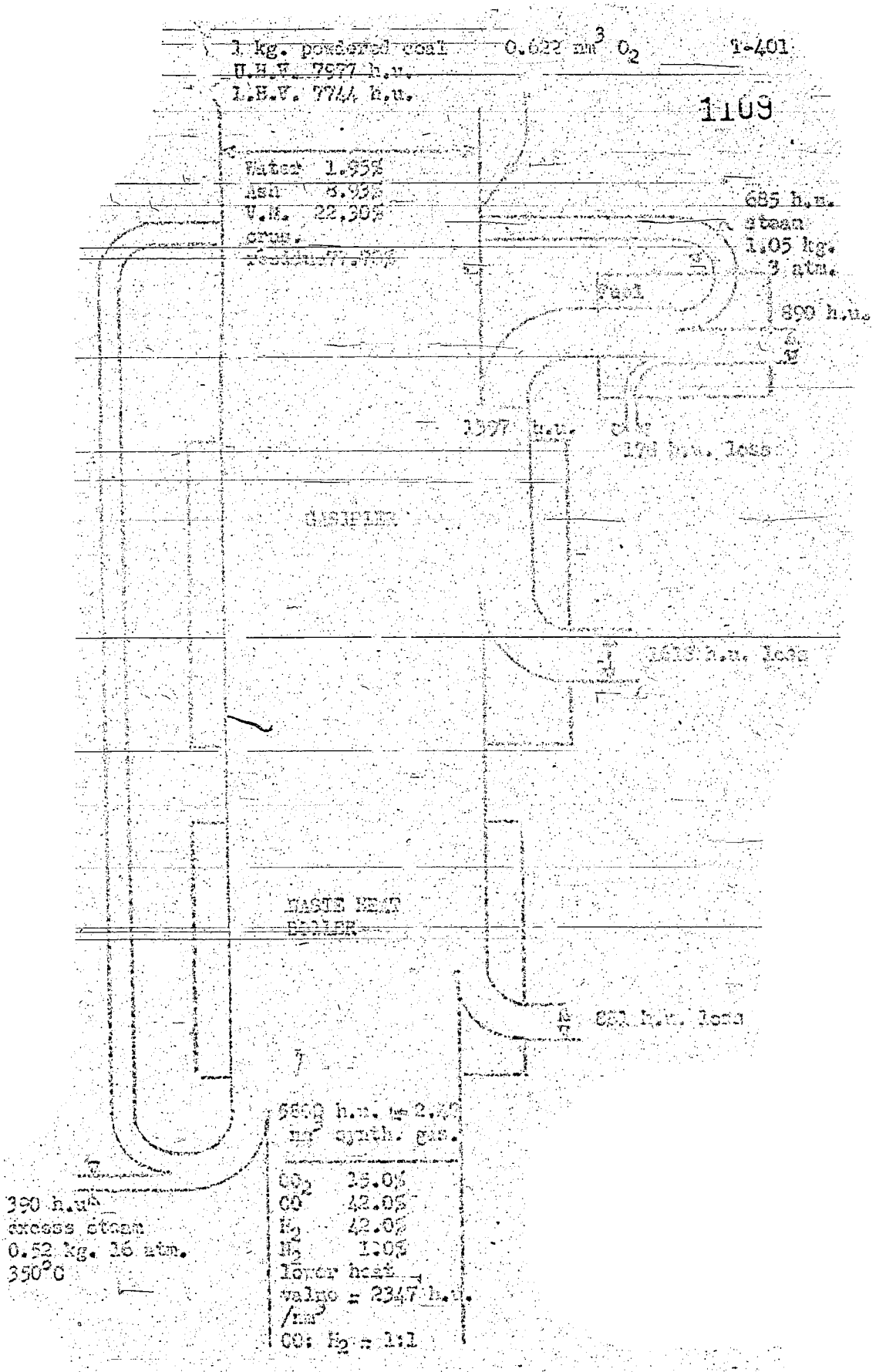


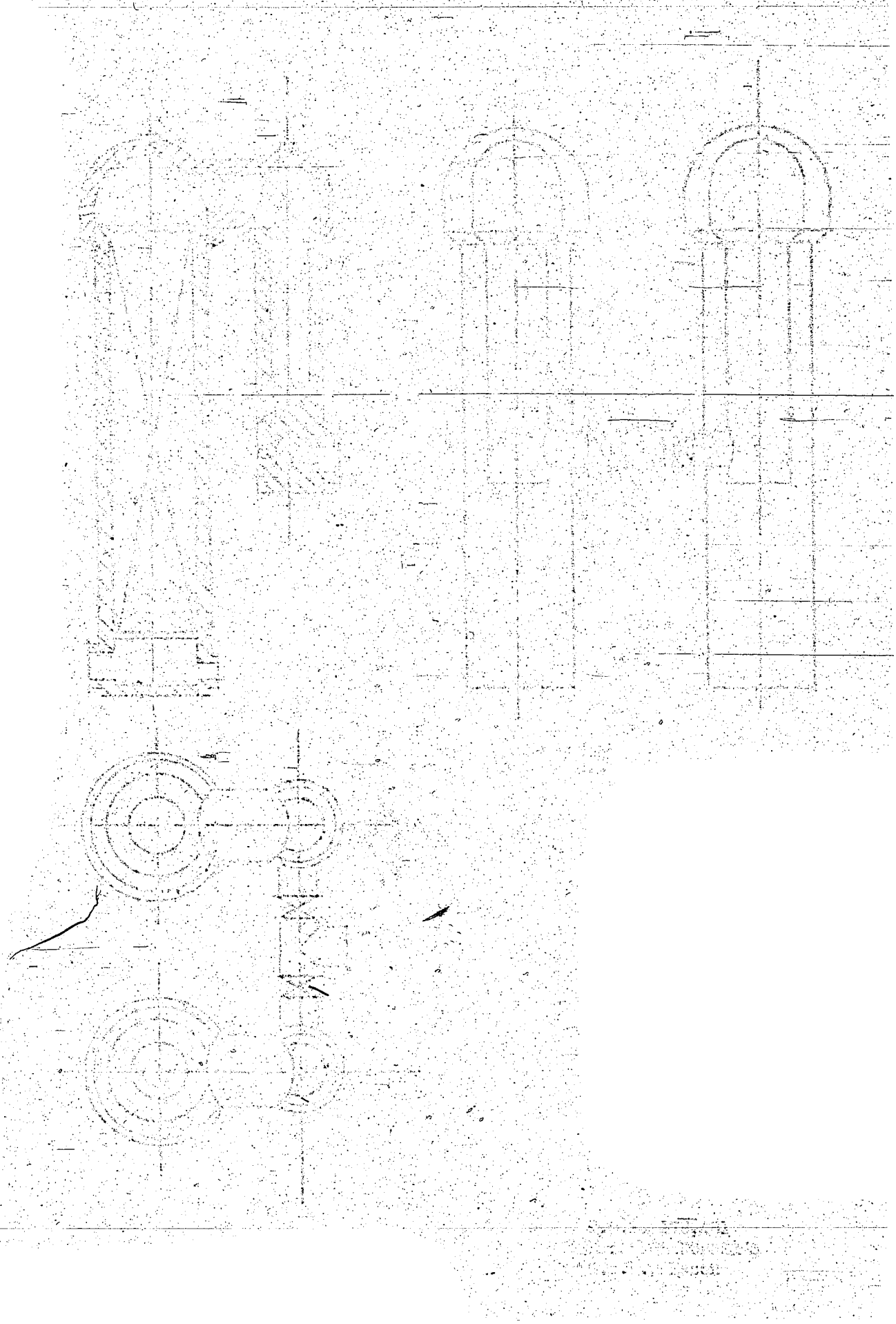
HEAT FLOW DIAGRAM IN THE PRODUCTION OF SYNTHESIS GAS FROM POWDERED BROWN COAL.



HEAT FLOW DIAGRAM IN THE PRODUCTION OF SYNTHESIS GAS FROM POWDERED BITUMINOUS COAL

HEINRICH KOPPERS
G.m.b.h Essen

I.O.S. 176,466a
9/17/43



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SCHEMATIC PRESENTATION OF THE KOPPERS POWDERED COAL PRODUCER INSTALLATION

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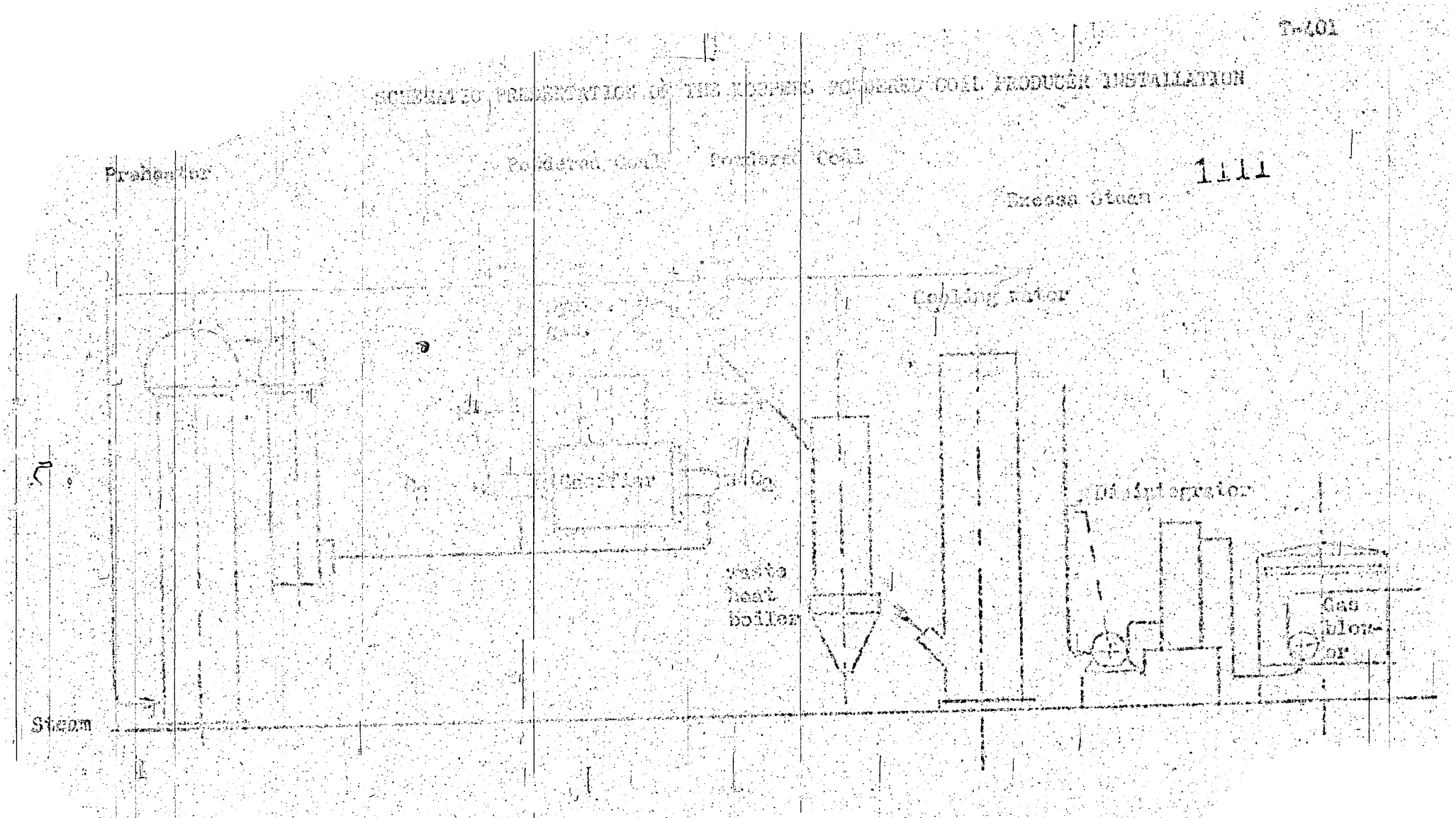

HEINRICH KOPPERS
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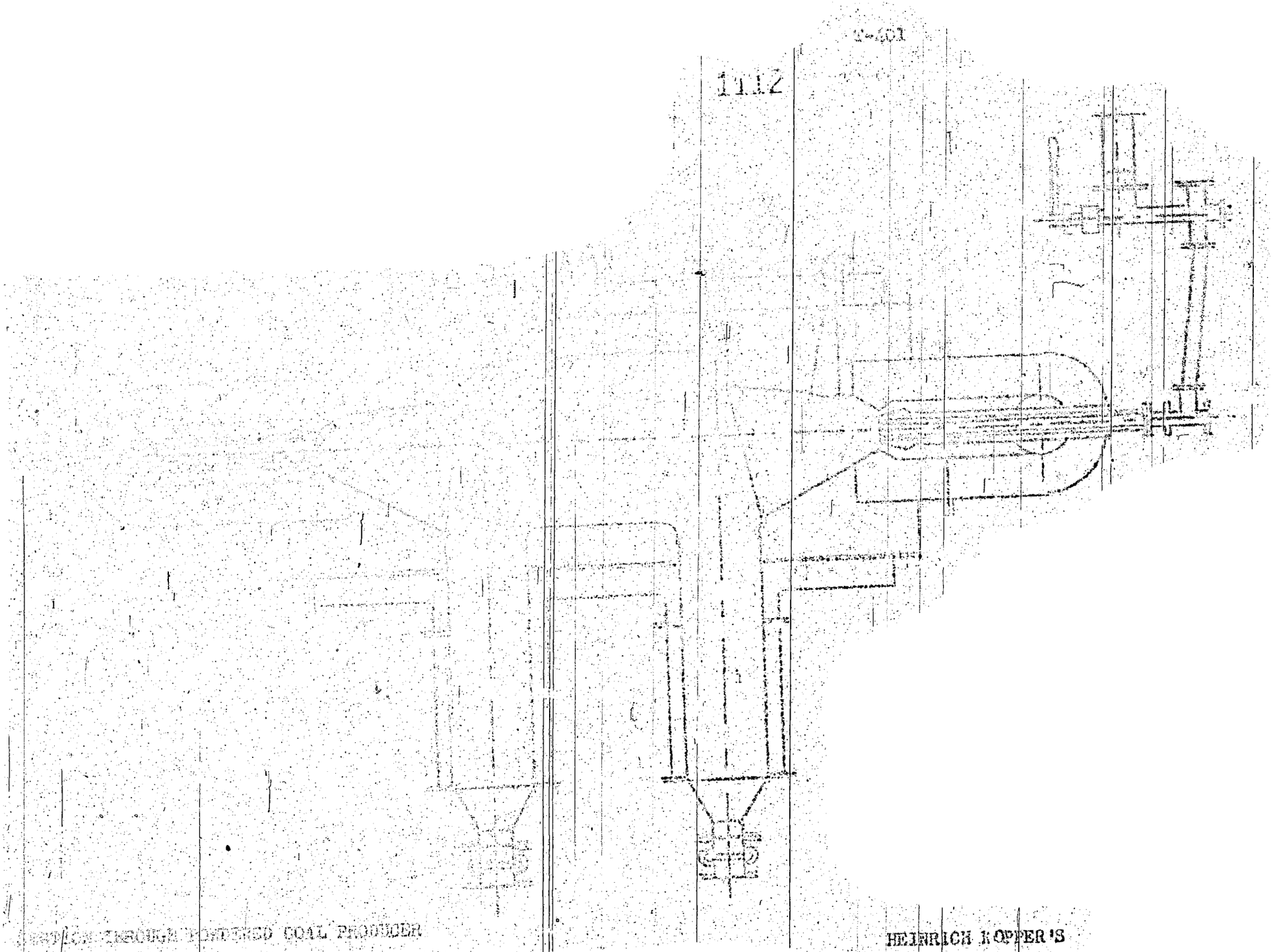
I.C.S. 173,479



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