SPELTER PAN - DESIGN, HEATING SYSTEMS AND OPERATIONS

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The design of spelter pan depends on:

a. cubic content and shape
b. heating area
c. thickness of wall
d. material of pan
e. welding electrodes and method of welding

Cubic content and shape of pan

This is decided by the shape of article to be galvanized. It should be possible to immerse and withdraw articles without much agitation of the bath. The pans for wire, tube, strip, fasteners, have suitable designs to take care of this factor.

The galvanizing bath works like a heat container. The articles being immersed will draw heat to raise itself to galvanizing temperature and the bath should be able to supply this heat without much fall in temperature. As a thumb rule, the pan should contain 20 times zinc than the quantity of iron goods galvanized per hour, minimum, but in many high temperature galvanizing it may be as high as 40 times. The shape of tank should be such that no pockets should be formed, as such, round cornered tanks are preferred over right angled cornered tanks which accumulate dross and are causes of local heating and resulting higher dissolutions and reduction in wall thickness. Fig. 1 shows such design with round corners & welding away from the corners.

Heating area

The galvanizing bath should not be heated from bottom and generally heated from sides. In order to have small difference in temperature on outside and inside temperature and to supply enough heat input, large surface area of the pan is required which means deep tanks. Also the exposed zinc surface of the tank should be as small as possible to avoid formation of ash and heat loss.

Wall Thickness

The real calculations of the wall thickness is very complex. It involves temperature of outside wall, the hydrostatic pressure of molten zinc which is practically unsupported from sides and is just lying on the refractory base. At temperature around 500^{0}C the permanent resistance is 4.5

Kg/mm^2 for most of the silicon free iron plates. The tanks mechanical strength can be calculated by standard structural formulae considering it as freely supported beam. In order to compensate for dissolution of iron in zinc, additional allowances are made. The wall thickness less than 20 m/m and more than 50 lm/m are not recommended.

Material

Material of the tank is selected by consideration of dissolution of iron in zinc at the galvanizing temperature. The phenomenon of dissolution of iron is complex and depends on various factors:

* Temperature of zinc
* chemical composition of iron to be galvanized
* iron pot and the accessories like sinker, rolls, etc. immersed in zinc
* various alloying elements in the bath

Complex zinc iron alloy is formed by dissolution of iron in zinc known as dross, which is 94% of zinc and 6% of iron. The iron comes from:

* Dissolution of iron from kettle walls
* iron salts from pickling
* reaction of molten zinc with iron
* dissolution of fixtures like sinker rolls

Slides 2 to 5 show the various factors affecting the dissolution of iron in zinc. Figures 2,3 and 4 show the effect of bath temperature. Please note that the maximum rate of dissolution is at 500°C. Figure 5 shows effect of presence of various metals in the bath. Nearly pure iron is used for manufacture of galvanizing pan; silicon, carbon and phosphorus accelerate the rate of dissolution of iron in molten zinc. Highly refined iron with fine grains is used. Grain size less than 5 microns is recommended. Figure 6 shows the typical steel chemistry and IS 8917 recommendation of steel chemistry.

Method of welding

The tank should be designed to avoid any blind corners and the welding should be confined to straight portions away from the corners. Figure 1 shows one such design. The preparation of weld joints is very important and should be made in consultation with electrode manufacturing companies. Figure 7 and 8 show typical electrodes used for welding of galvanizing pans.

INITIAL HEATINGS AND GOOD OPERATING PRACTICES

The pan when installed should be charged with lead plates touching the walls of the pan as far as possible to avoid initial local heating. Also, before firing, the pot is filled with water along with lead and zinc slabs to at least do uniform heating upto 100°C. The drossing and cleaning is very important to avoid hard deposits and also to avoid further formation of dross. The iron content of flux tank should be controlled at low level, beneficial metals like Al can be added. Intermittent heating and cooling will shorten the pot life. The tanks should be utilized to its maximum capacity. It is not only necessary to keep it hot for 24 hrs, but material should pass through it continuously.

HEATING SYSTEMS

Since the inception of galvanizing, various heating media have been used, some with success, and constant development is being done to achieve the optimum results. Various energy sources used are :

* pulverized coal
* producer gas, coke oven gas, natural gas
* liquid fuels
* electricity, coil heating and induction
* immersion burners

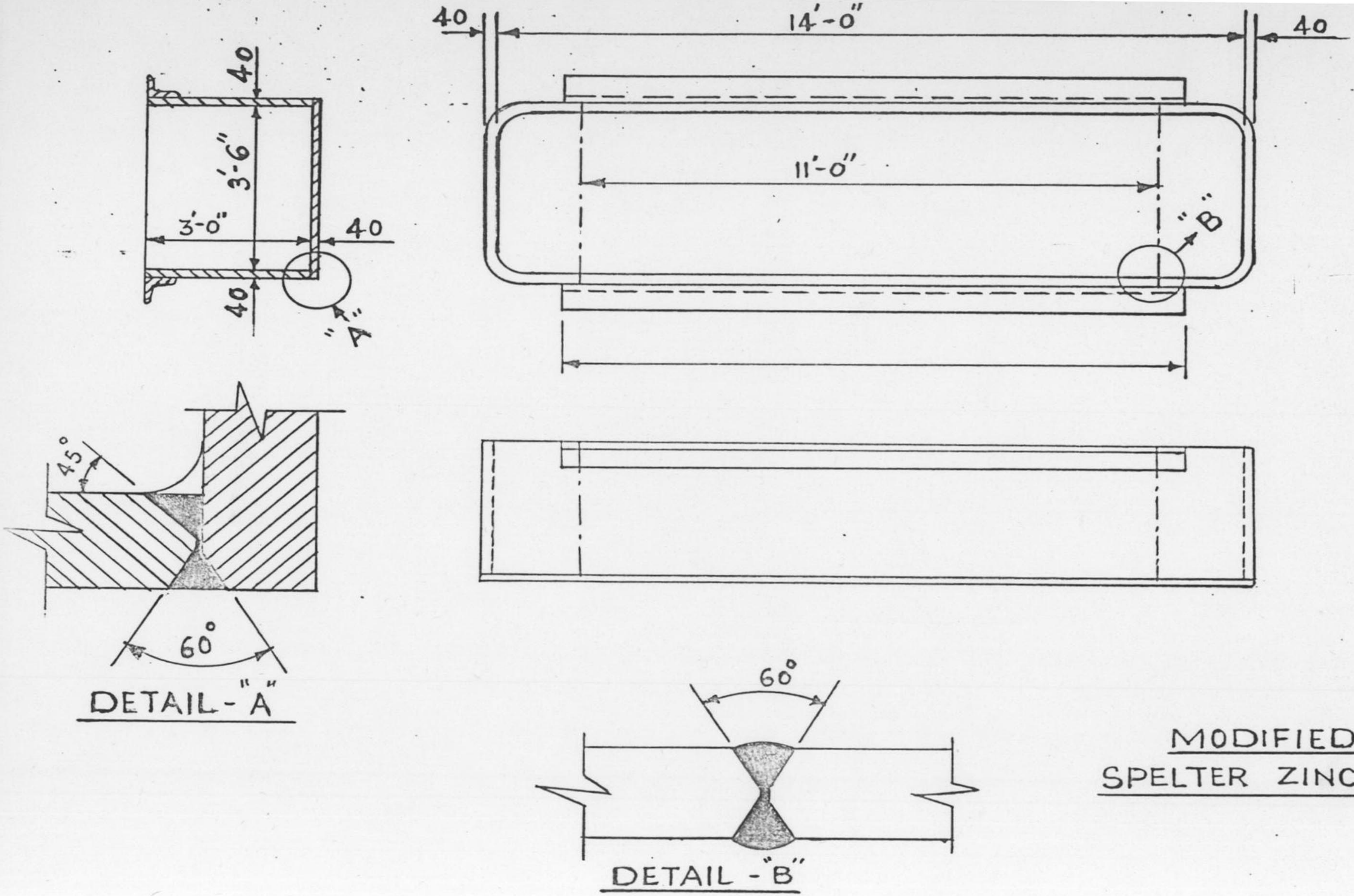
Figure 10 to 19 show the different heating arrangements.

HIGH TEMPERATURE GALVANIZING

Galvanizing of structural work cast iron fittings and fasteners can only be carried satisfactorily at temperatures of 550-560°C. As such kettles for this type of galvanizing cannot be made from steel plates since it will result in excessive dross formation and very short kettle life. Therefore kettles for high temperature galvanizing have to ceramic lined and cannot be externally fired because of poor conductivity of ceramics. Till recently, only method of heating such ceramic baths was by top heating. Figure 20 shows one such design. The heat transfer is only by surface of zinc, as such you need a large exposed area of zinc bath resulting in poor energy efficiency and formation of large quantities of ash which is not only wasted but also spoil the surface of the galvanizing articles during withdrawing. To overcome this drawback, immersion type recuperative heaters have been developed as shown in figures 13 and 14. Recently work is being done on floating burners as shown in figure 21.

CONCLUSIONS

Properly designed spelter pans, proper firing system and correct operating practice will not only prolong the life of the pan but will also reduce the formation of dross and ash.



MODIFIED
SPELTER ZINC PAN

FIG. 1

Iron Solubility in Zinc

IRON SOLUBILITY IN ZINC

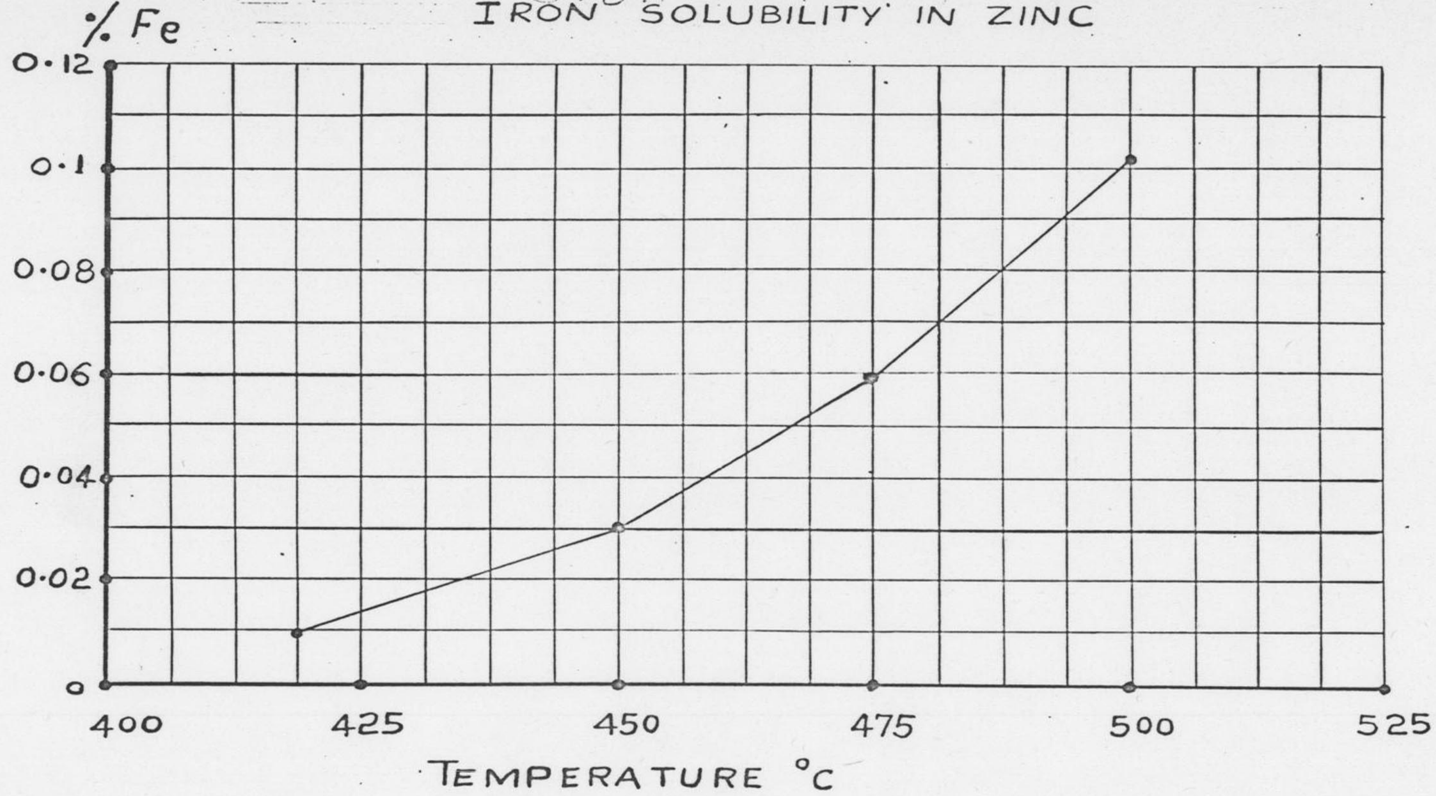


FIG. 2

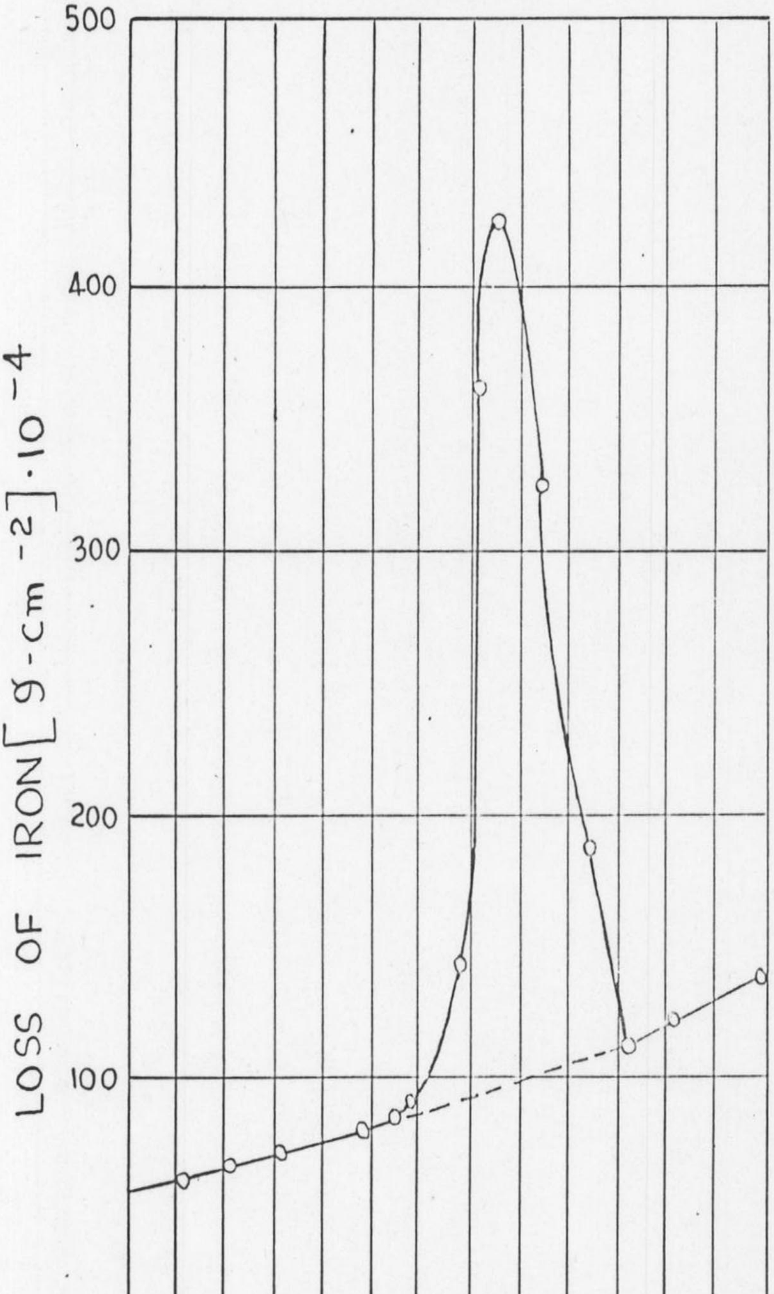

LOSS OF IRON [g-cm -2]·10 -4
500
400
300
200
100
0
415
448
482
515
548
TEMPERATURE °C

FIG. 3

INFLUENCE OF TEMPERATURE ON ZINC ATTACK MAXIMUM ATTACK ROUND ABOUT 500°C

1. TOTAL IRON DISSOLVED
2. IRON-CONTENT OF ALLOY LAYER
3. IRON-CONTENT IN LIQUID ZINC

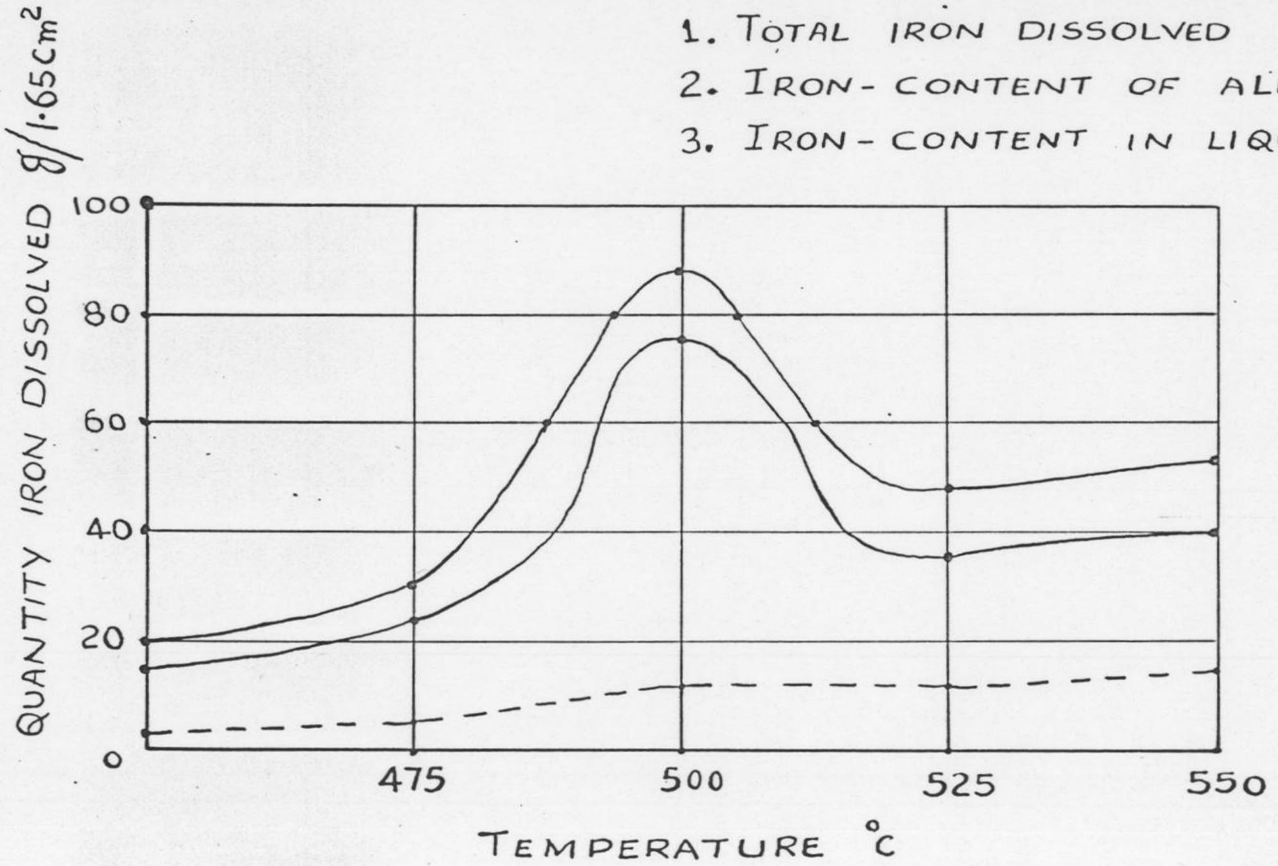
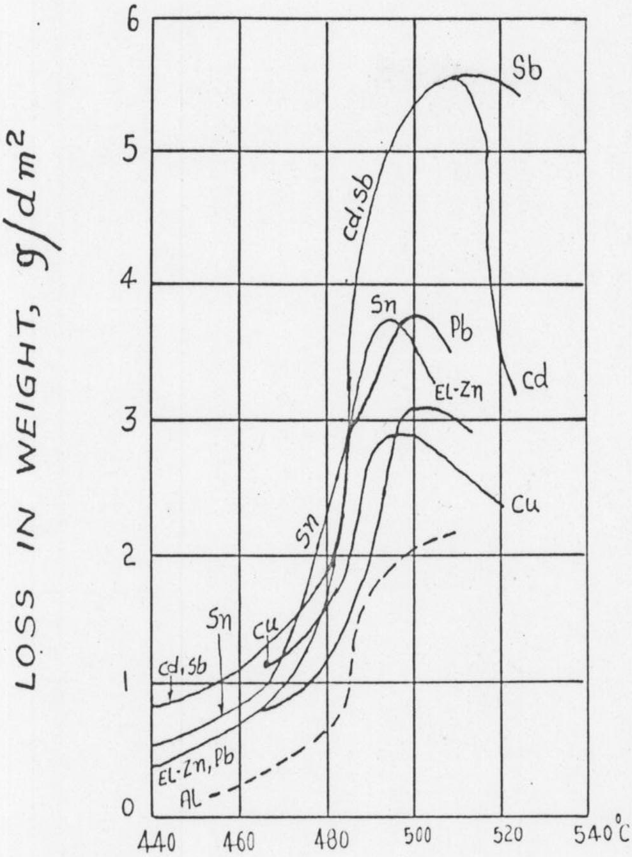


FIG. 4



LOSS ON DISSOLUTION OF ARMCO IRON AFTER 1 HOUR'S IMMERSION AT DIFFERENT TEMPERATURE.S IN BATHS CONSISTING OF

EL. Zn	=	ELECTROLYTIC ZINC		
Cu	=	"	"	+ ·2% Cu
Sn	=	"	"	+ 1·0% Sn
Pb	=	"	"	SATURED WITH LEAD
Cd	=	"	"	+ 1% Cd
Sb	=	"	"	+ 1% Sb
AL	=	"	"	+ ·2% AL

FIG. 5

TYPICAL STEEL CHEMISTRY OF GALV. KETTLE.

C = 0.024 %
P = 0.009 % MAX.
Mn = 0.06 % MAX.
S = 0.019 % MAX.
Si = 0.005 % MAX.

CHEMICAL COMPOSITION IS: 8917-1978.

THE LADLE ANALYSIS OF STEEL, WHEN MADE IN ACCORDANCE WITH APPROPRIATE PARTS OF IS: 228* SHALL BE AS FOLLOWS:

STEEL	CONSTITUENT, PERCENT.				
	C MAX	Mn MAX	S MAX	P MAX.	Si MAX.
GRADE A.	0.05	0.25	0.025	0.025	0.05
GRADE B.	0.10	0.35	0.030	0.030	0.05

FIG. 6

FIGURE-8

CHARACTERISTICS & APPLICATIONS :

D&H-45S is a special purpose electrode depositing almost pure iron weldmetal which is ideally suited for welding galvanizing baths. The very low silicon content ensures excellent resistance to corrosion by molten zinc. Typical applications include welding of galvanizing baths and filling up of worn out bodies of galvanizing bath to resist corrosion by molten zinc. The low hydrogen version D&H-45S(LH) is also available.

TYPICAL CHEMICAL COMPOSITION OF ALL WELD METAL :

Element:	C	Mn	Si
Percent:	0.06	0.20	0.051

TYPICAL MECHANICAL PROPERTIES OF ALL WELD METAL :

UTS Kg/mm^2	Elongation (L = 4d) %
41.2	30.0

CURRENT & PACKING DATA : AC/DC (+)

Size DxL (mm)	:	5x450	4x450	3.15x450
Current(Amps)	:	200-240	160-180	110-135
Qty./Carton(Kg)	:	4	4	4

PRECAUTIONS :

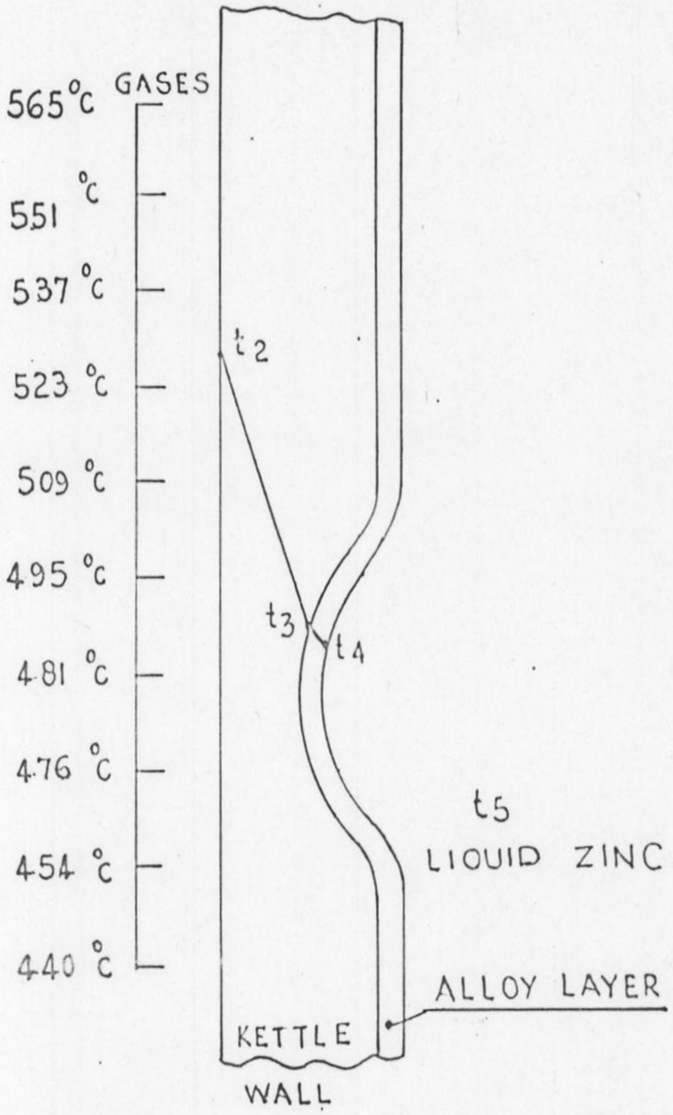
1. Ensure the electrodes are dry. in case of moisture pick-up, redry the electrodes at 150°C for one hour.

RECOMMENDED WELD MATERIAL FOR KETTLE REPAIR.

SMAW	FLEET WELD	5P
	FLEET WELD	7
	FLEET WELD	35 LS.
FCAW	NR	203 NI D
	NR	311
	NR	431

FIGURE-7

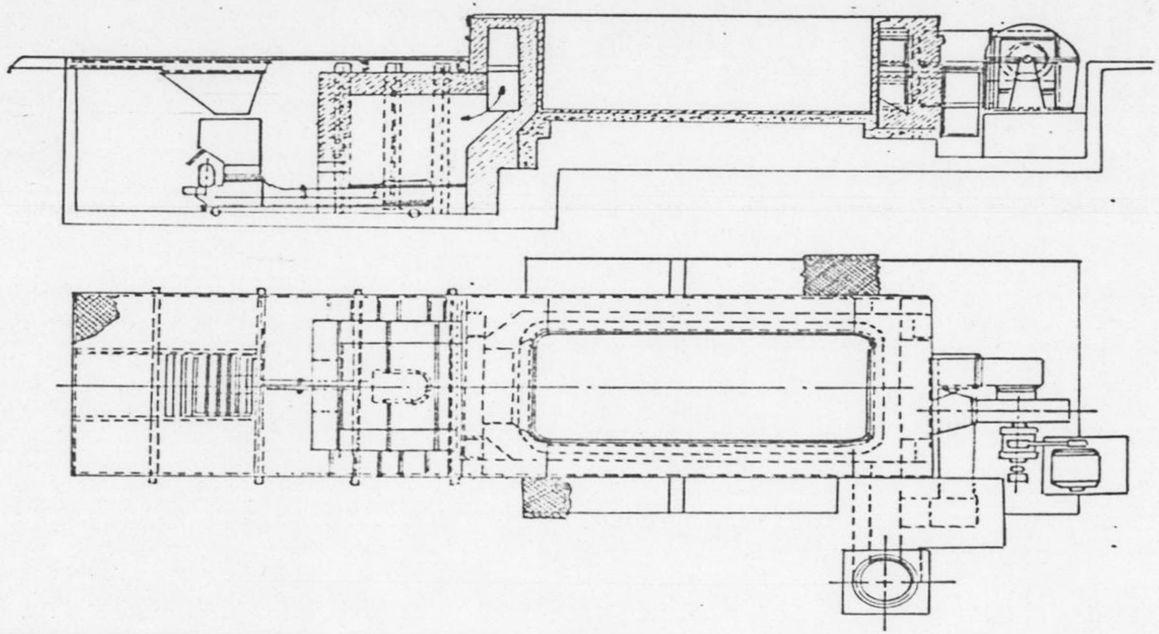
TEMPERATURE DISTRIBUTION ACROSS A KETTLE WALL SHOWING THE INFLUENCE OF THE LOSS OF SECTION ON ZINC ATTACK.



SERIOUS ATTACK CAN OCCUR TO THE GALVANIZING KETTLE WALLS DUE TO LOCALIZED OVER HEATING. ONCE THE KETTLE WALL IS REDUCED IN THICKNESS IN A LOCAL AREA THE RATE OF ATTACK ACCELERATES RAPIDLY.

NOTE:- AS THOSE POINTS OF THE KETTLE THAT HAVE FULL THICKNESS. TEMPERATURE T3 WOULD BE APPROXIMATELY 476°C AT THE REDUCED CROSS SECTION, TEMPERATURE T3 IS APPROXIMATELY 490°C

FIG. 5A



COAL - SLACK HEATING.

FIG. 10

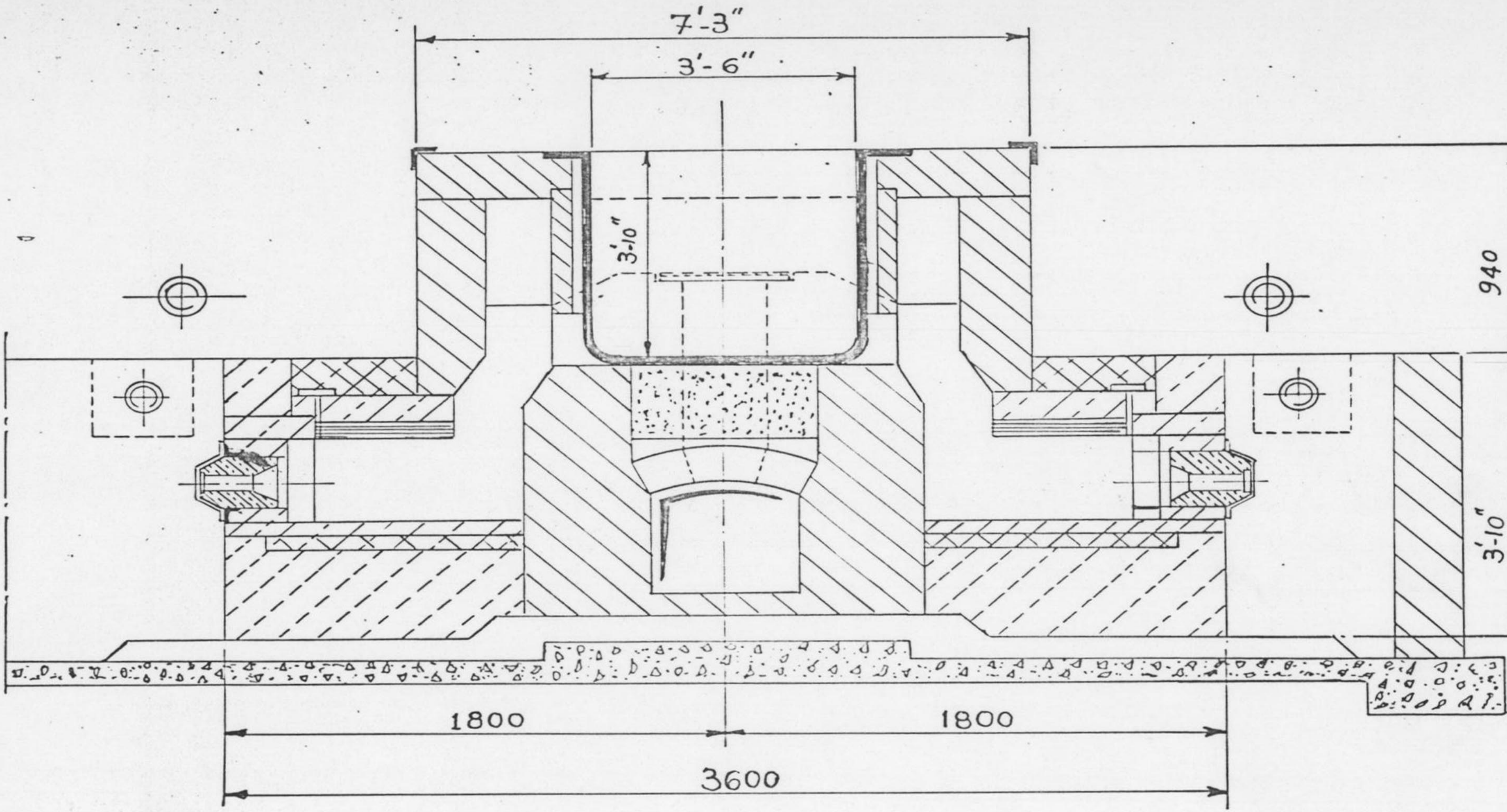


FIG. 11

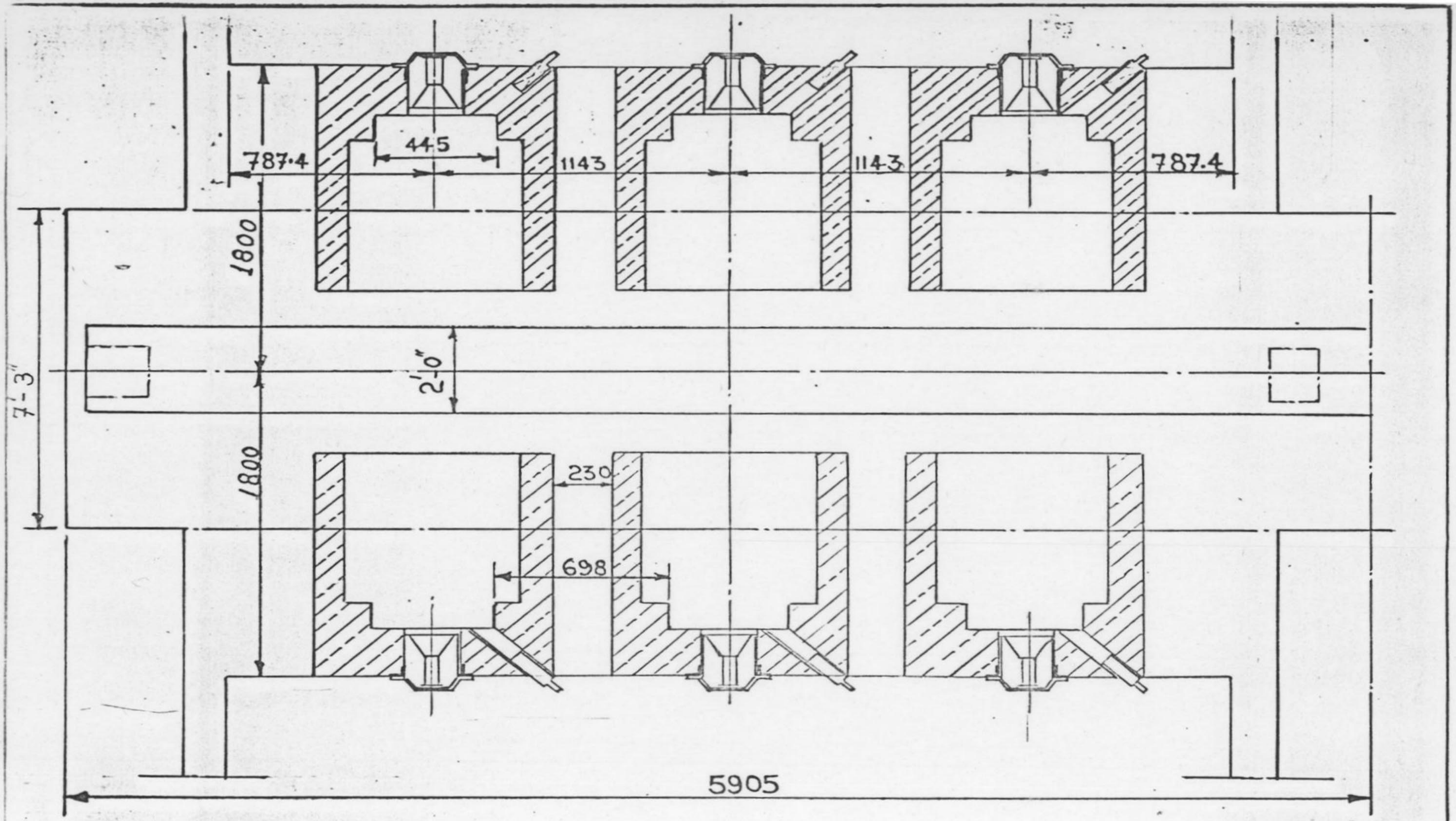
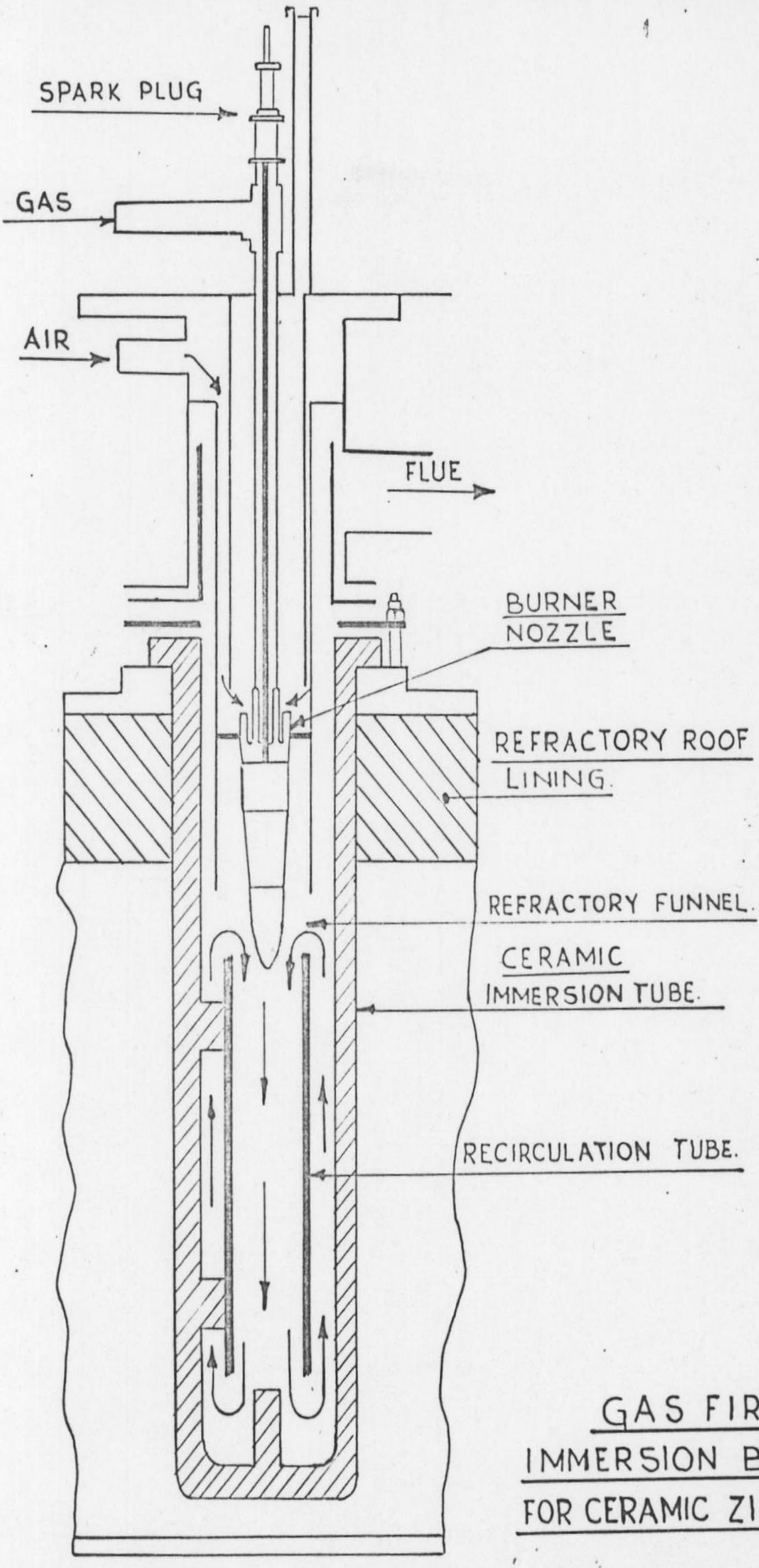
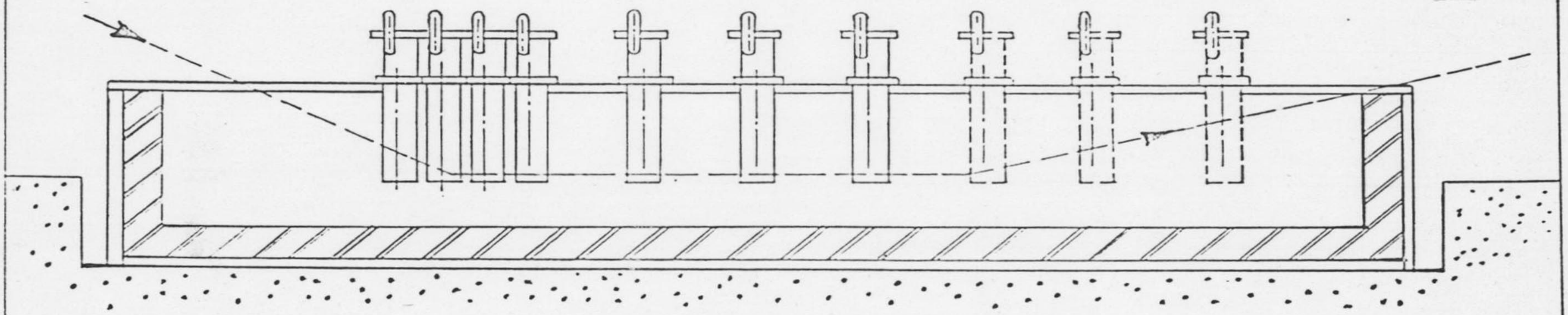


FIG. 12



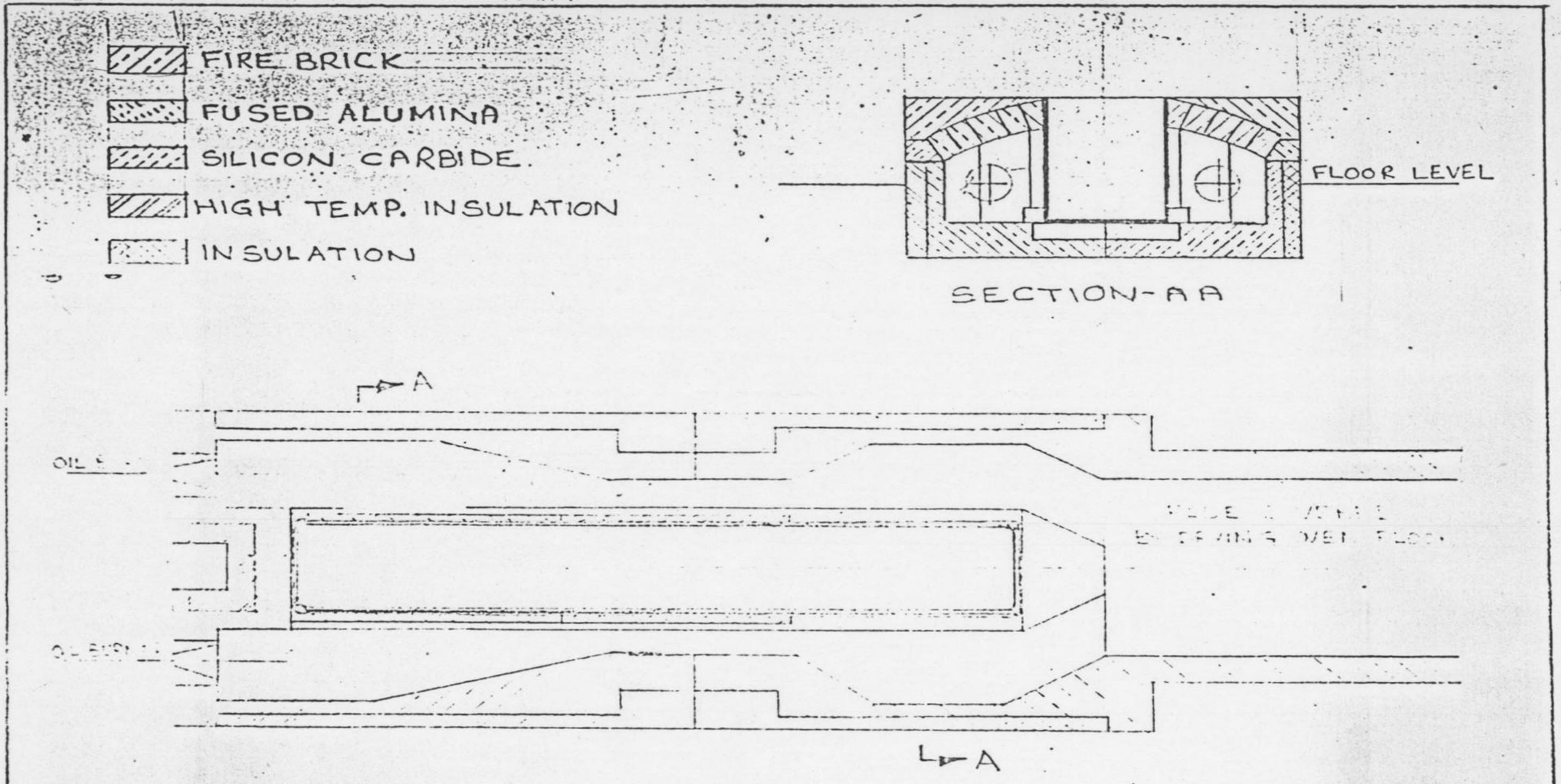
GAS FIRED IMMERSION BURNER FOR CERAMIC ZINC BATH.

FIG. 13



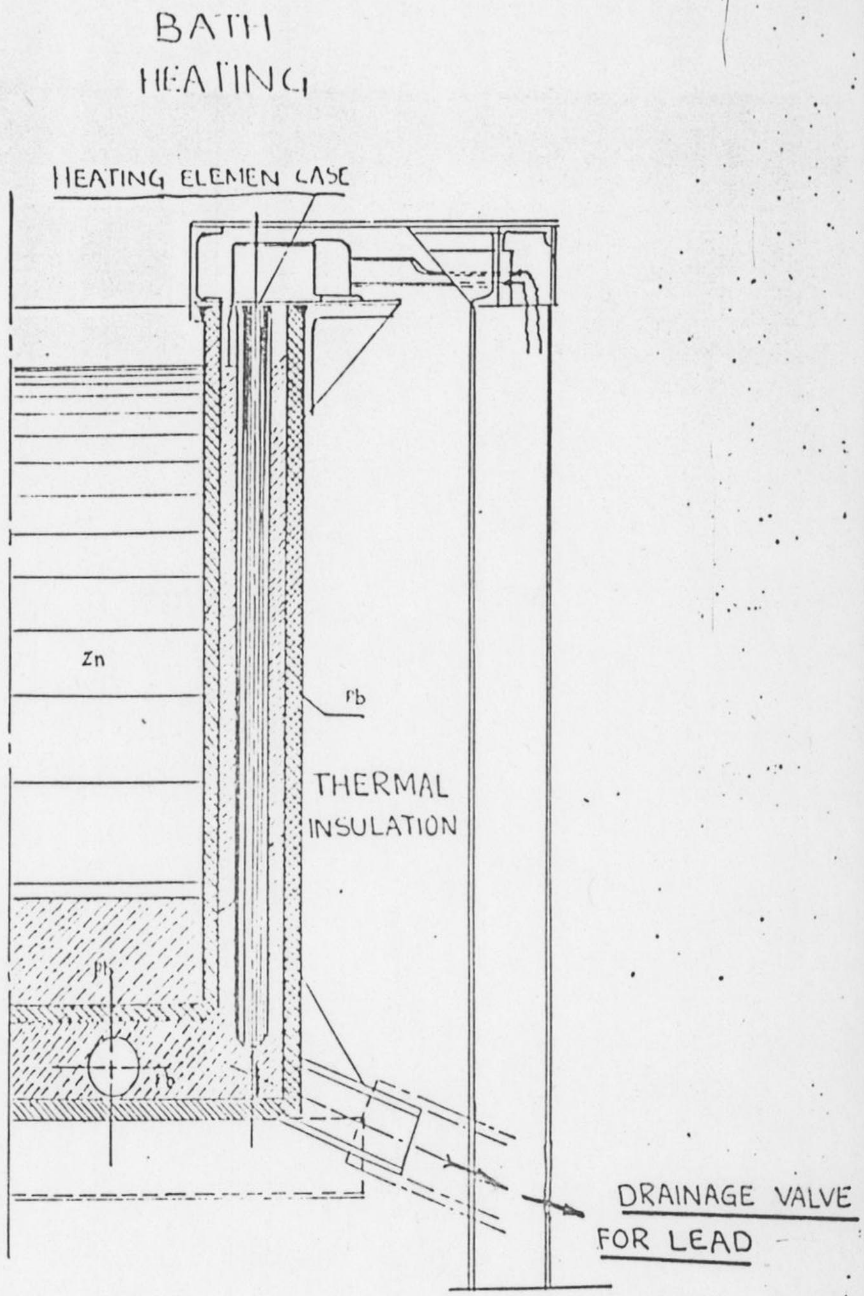
TYPICAL PROFILE OF PAN FOR IMMERSION BURNERS

FIG. 14



OIL FIRED GALVANIZING BATH WITH BRICK PROTECTION

FIG. 15



SECTION THROUGH BATH WALL SHOWING
HEATING ELEMENT

16

FIG.16

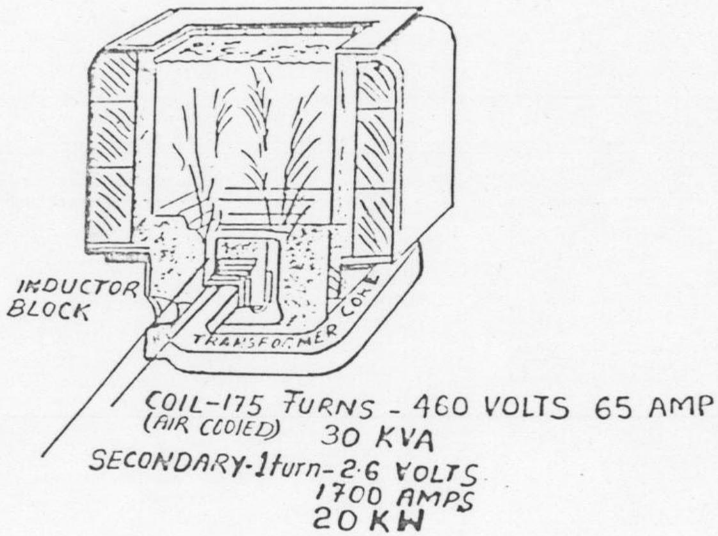
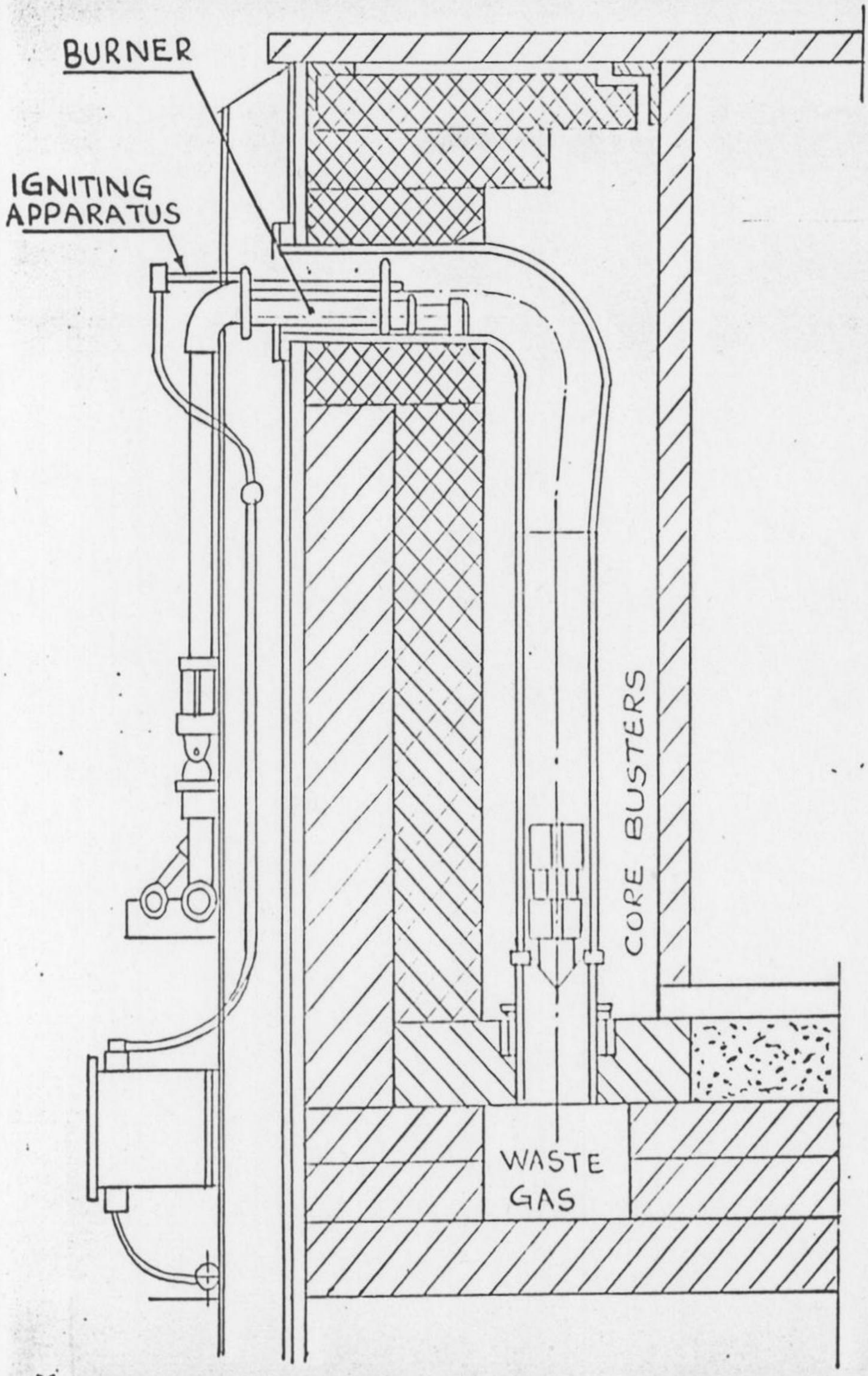
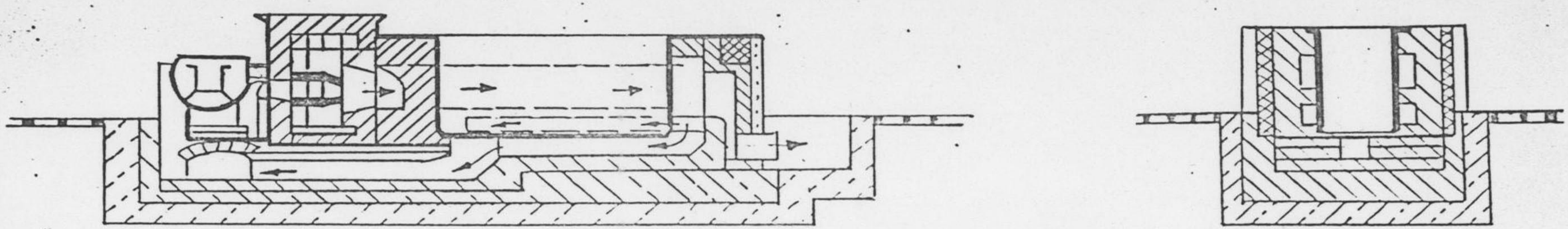

INDUCTOR BLOCK
TRANSFORMER CORE
COIL-175 TURNS - 460 VOLTS 65 AMP
(AIR COOLED) 30 KVA
SECONDARY-1turn-2.6 VOLTS
1700 AMPS
20 KW

FIG. 17

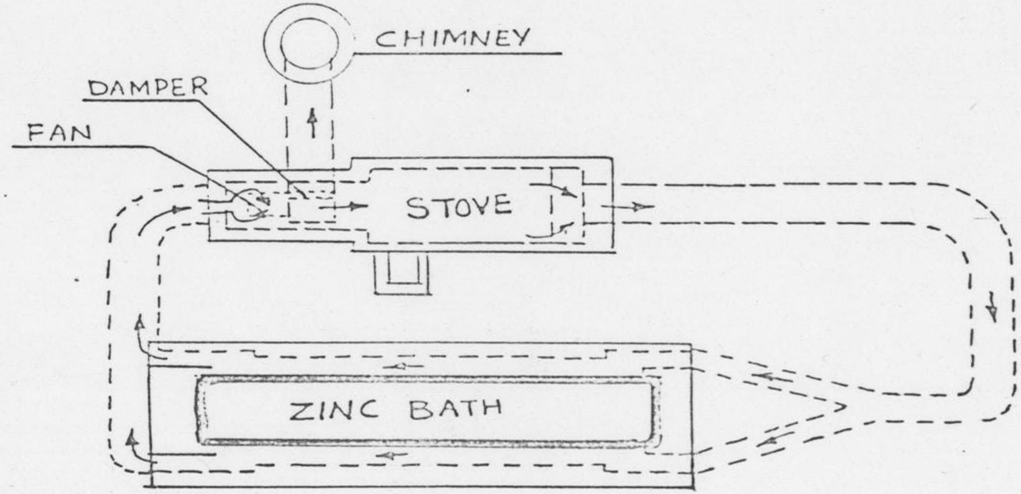


CONSTRUCTION OF RADIATING TUBE HEATING

FIG. 18



LAOUT OF A RECUPERATIVE HEATING INSTALLATION



RECUPERATIVE HEATING INSTALLATION WITH SEPARATE COMBUSTION CHAMBER

FIG. 19

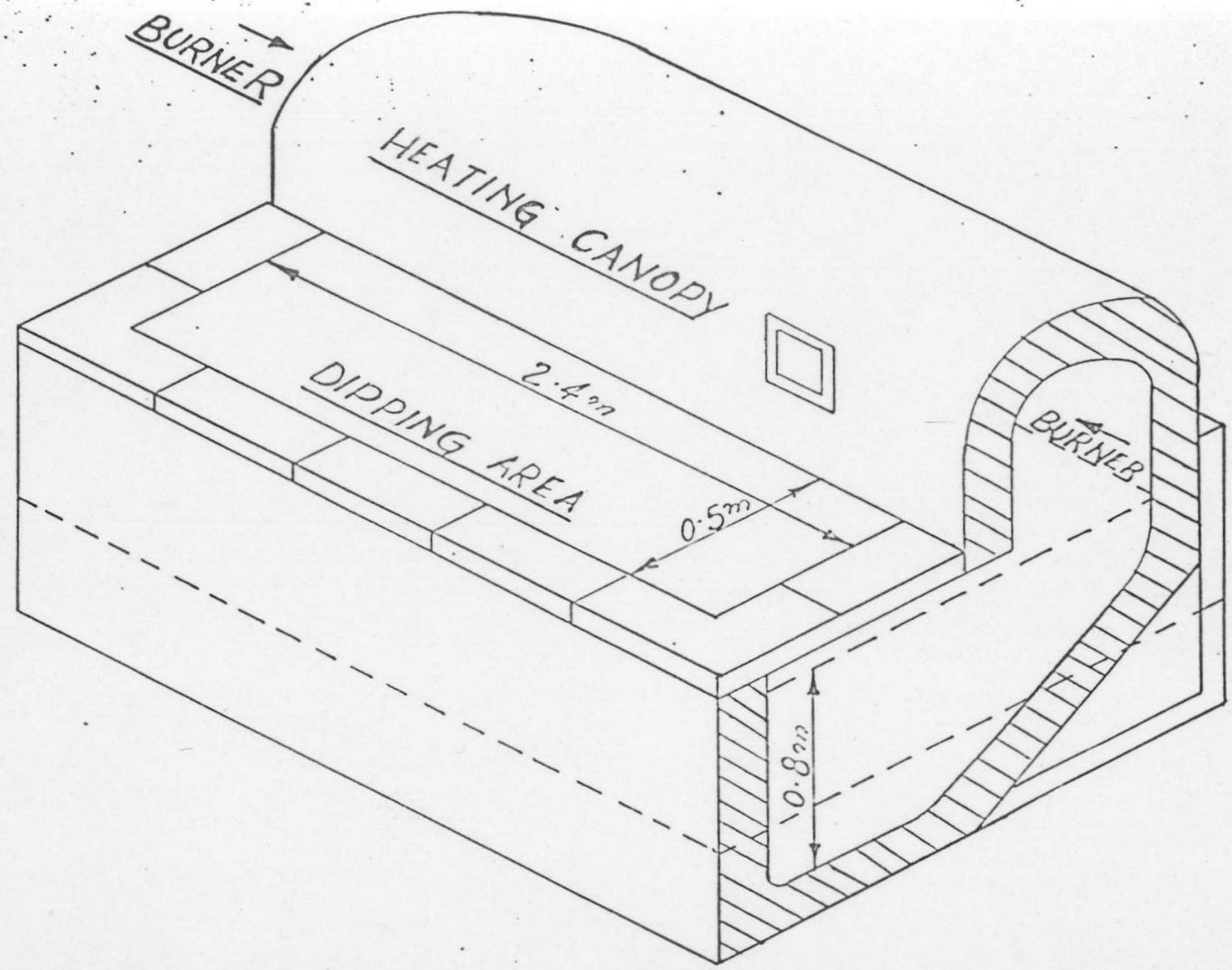
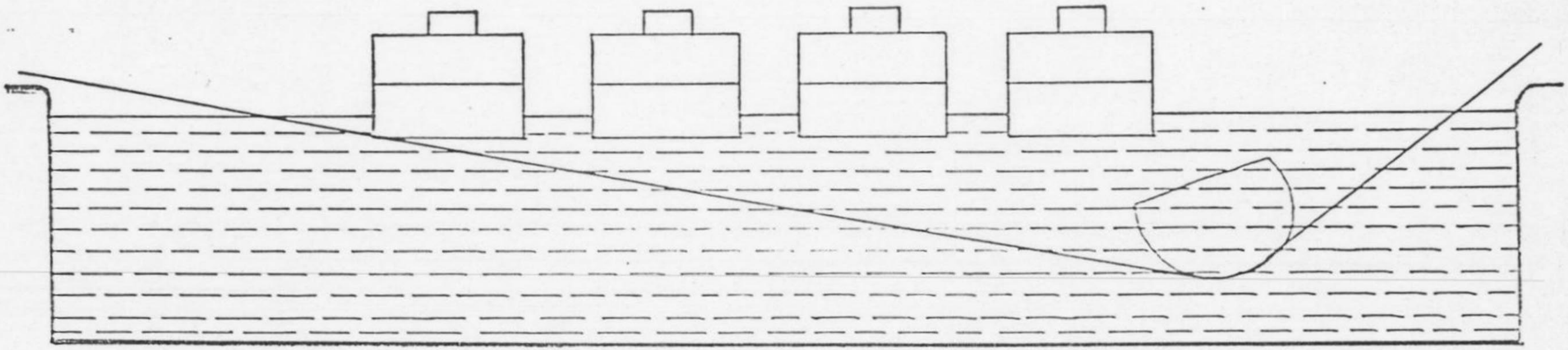


FIG. 20



THE PRINCIPLE OF "FLOATING BURNER", AN EFFICIENT AND COMPACT HEATING EQUIPMENT

FIG. 21